

**Towards an architecture that facilitates research  
and education in a World Heritage Site:**

*An Environmental Research Facility for the iSimangaliso Wetland Park*

Mark Lloyd Bellingan

**Towards an architecture that facilitates research  
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A Dissertation submitted to the School of Architecture, Planning and Housing,  
University of KwaZulu-Natal, Durban, South Africa, In partial fulfilment of a  
Masters in Architecture.

January 2008

## **Declaration**

Submitted in partial fulfilment of the requirements for the degree of Masters of Architecture, in the Graduate Programme in Architecture, University of KwaZulu-Natal, Durban, South Africa.

I declare that this dissertation is my own unaided work. All citations, references and borrowed ideas have been duly acknowledged. It is being submitted for the degree of Masters of Architecture in the Faculty of Humanities, Development and Social Science, University of KwaZulu-Natal, Durban, South Africa. None of the present work has been submitted previously for any degree or examination in any other university.

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**Mark Lloyd Bellingan**  
**January 2008**

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## Abstract

The purpose of this research document was to determine a relevant, responsible and appropriate architecture for the design of an Environmental Research Facility for the iSimangaliso Wetland Park World Heritage Site in Northern KwaZulu-Natal, South Africa.

The nature of this architecture was generated through the investigation of current literature, case and precedent studies and personally conducted interviews with a number of informed professionals. The reason for these recommendations was ultimately the design of the facility for research and education, the goal was always the eventual application of the findings into a design.

Ultimately, an appropriate architecture for an Environmental Research Facility for iSimangaliso Wetland Park, a UNESCO World Heritage Site, is one which is accountable and responsible regarding the social, economic and environmental aspects of its design. These three rubrics of sustainability were then unpacked and investigated in order to clarify how this would be most effectively be achieved in the eventual design.

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**Mark Lloyd Bellingan**

## Introduction

There are currently nearly 200 research projects being conducted in South Africa's first World Heritage Site: the iSimangaliso Wetland Park. The Park covers an area of 280 000 ha and extends from Mozambique in the North to Mapelane in the south. Research is conducted in a number of fields by a range of organisations. This document seeks to determine an appropriate architecture for the design of a facility to house those scientists conducting environmental research.

The architecture required for such a sensitive area as the border of a UNESCO World Heritage Site, is one which is accountable and responsible regarding the social, economic and environmental aspects of its design. The building will be designed on an abandoned brownfield site which contains a redundant boathouse which straddles the edge of the St. Lucia Estuary itself.

In order to fully accommodate the needs of the research scientists a full range of facilities will be provided. These will include regular laboratories, more specialised spaces, as well as the necessary ancillary support functions such as a library, storage, GIS facility, research offices and a variety of meeting spaces.

In addition to housing the environmental researchers, the building will also provide an interface where interested tourists and locals can gain a behind-the-scene look at the research process. The Educational Centre will be provide opportunities for groups of school children to

learn through a variety of teaching methods, from visual presentations to the tactile world of an Experiential Laboratory; where the students can conduct their own hands-on experiments. In addition to these spaces, a larger gathering auditorium will be provided in order to introduce interested parties to the research currently being conducted by scientists based at the Environmental Research Facility.

Throughout the process the three over arching design considerations will be Social, Economic and Environmental sustainability, and these areas will be analysed critically in order to determine the appropriate architectural response for this specific site, in this region. Guidelines for an appropriate architecture have been garnered through the analysis of local and international precedent and local case studies as well as through a rigorous investigation of available literature pertaining to this field.

The Environmental Research Facility will be a scientific and tourism centre for the town of St. Lucia, and the World Heritage Site as a whole. It will conceptually begin to break down the barriers between the research community and the people who visit this sensitive, beautiful region. The architecture of the facility will be one which provides an effective space for both researchers and visitors, while concomitantly highlighting the surrounding natural beauty at every possible turn.

## INTRODUCTION

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## **Chapter I: Research Background and Research Methodology**

### **1.1 Research Introduction**

#### **Towards an architecture that facilitates research and education in a World Heritage Site:**

##### ***An Environmental Research Facility for the iSimangaliso Wetland Park***

This research document will seek to uncover the opportunities and issues related to the design of a medium scale research facility in an environmentally sensitive area. More specifically the research will focus on information that will ultimately inform the design of an Environmental Research and Education Facility for the iSimangaliso Wetland Park in Northern KwaZulu-Natal, South Africa.

#### **1.2 Hypothesis:**

An appropriate architecture for an Environmental Research Facility for iSimangaliso Wetland Park, a UNESCO World Heritage Site, is one which is accountable and responsible regarding the social, economic and environmental aspects of its design.

In order to prove this hypothesis, the research will break down the problem into three interrelated portions and deal with each accordingly, ultimately determining the appropriate response. The three rubrics, under which this statement will be examined, will be: Social, Economic and Environmental.

### **1.3 Research Questions**

Under each of the aforementioned headings, it is helpful to outline a list of research questions which need to be answered in order to verify the hypothesis.

#### **1.3.1 Social**

What facilities should be included? (Determine the brief and appropriate size of the building).

How will the building be used and by whom? (Determine number estimates).

What functions do these various users need the building to perform?

What are the requirements of each space regarding:

- Lighting
- Services
- Furniture/Fixtures
- Flexibility

How can the construction and day-to-day running of the facility positively impact the local community?

How can the building serve as an education device for all who visit?

What are the implications of these social issues, on the architectural design?

#### **1.3.2 Economic**

Who is the client or organisational body behind the facility?

How can the design fit into the economic developmental plans for the area?

In what ways can this design responsibly manage the resources of this area?

What are the economic implications for the architectural design?



### 1.3.3 Environmental

Which site is the best choice for this design, and why?

What are the characteristics of the site in terms of the following?

- Ecological biome
- Climate
- Geology
- Flora
- Fauna
- Infrastructure
- Hydrology

What are the most appropriate materials for this design in this context?

What is the best manner, in this site and context, to achieve a building that is sustainable with regards to:

- Energy management
- Waste management
- Water management

What implications do these environmental findings have on the architectural design?

### 1.4 Research scope delineation

Now that these research questions have been delineated, it is appropriate to determine the restrictions and limits of this research. By way of delimitation, the scope of the study must be established. This thesis will be focused on a very specific site and a clearly delineated design brief. It will not in any way attempt to cover all the available technology or methods of construction within environmentally sensitive sites, but rather, it will focus on the architectural response which is specifically relevant and applicable to this definite problem. The research

is clearly restricted to being architectural in nature and it will therefore not comment on the appropriateness of travel in these sensitive regions, nor will it pass judgement on the validity or suitability of the existing research projects. In addition, the research will be restrained in the amount of time dedicated to the economic questions that have been raised. The research is limited in its focus; the goal is to determine the appropriate design of an environmental research facility for iSimangaliso Wetland Park, on a purposely selected site.

### 1.5 Research Methodology: Introduction

All research conducted for the completion of this Masters thesis has been done with the design of the building as the ultimate driving force. The research findings documented will provide the foundation for the creation of a conceptually strong, effective and efficient design. Interest has therefore been on the scientific research community in KwaZulu-Natal predominantly, with specific concern for the town of St. Lucia, at the southern tip of the iSimangaliso Wetland Park. However, in order to build up a sufficient understanding of the design problem and solution, it was also necessary to slightly widen the scope of research in order to include international examples of similar building types. All of the research, whether it be primary or secondary, was conducted in order to provide answers for the aforementioned research questions, all of which are asked in an attempt to provide a clear framework within which the building will be designed.

### 1.5.1 Primary Research

Primary research is effectively any information gained first hand, through direct interaction with the source. The primary research conducted for this thesis can be divided into two headings: Case Studies and interviews. While they are both considered primary, due to the direct nature of information acquisition, they are not equally weighted in their informing of the design. Rather, in the field of architecture, case studies form a major portion of the information gathered, case studies will therefore far outweigh the interviews in terms of their importance and length in this document.

#### 1.5.1.1 Case Studies

The study of recently completed buildings within the same typology or in a similar socio-political, climatic or geographic setting is crucial in order to achieve a full understanding of the requirements and necessary approach essential to provide solutions to the variety of design problems. In order to select the appropriate buildings it is vital to outline a specific rubric of strictures. It is from these parameters that the selected studies were critically analysed and compared and it is out of these findings that conclusions have been drawn. Conclusions which will inform the design of the research facility when that process is initiated.

The parameters which the case studies needed to fall into, and under which they have been analysed, are as follows:

Firstly, the case-studies of buildings had to be within South Africa. It would make very little



sense to conduct an in-depth critical analysis of an international building, with the intention of learning valuable, regionally specific and locally appropriate lessons. Furthermore, it was seen to be important that the building was within the province of KwaZulu-Natal, within similar climatic conditions as the selected site in St. Lucia.

Secondly, it was important that the selected case-studies perform a similar function to the proposed design. Namely research from the buildings, (not necessarily environmental in nature), was imperative. It was also seen as an additional benefit if the building contained laboratories for the research scientists, while also providing a component catering for the needs of visitors.

There were two local case studies which fell into these appropriate, outlined parameters, and were selected can be found in Chapter IV. They are:

- The SAAMBR offices at uShaka Marine World designed by Boogertman Kriege Architects (with Architects Collaborative)
- The Medical Research Facilities for The Africa Centre at Somkhele in Northern KwaZulu-Natal, designed by East Coast Architects.

#### 1.5.1.2 Interviews

In addition to this critical analysis of the case study designs a number of interviews were conducted. These interviews served as data gathering exercises which complement the case studies, while providing a more complete set of

findings. The interviews indicate the manner in which the users relate to the building provided for their daily duties and jobs, while concomitantly providing an explication of any critical analyses perceived by the author during an observation of the functions and spaces provided. In order to acquire the necessary information, interviewees were selected from a variety of relevant fields:

Firstly, scientists currently in the field of environmental research were able provide information about the specific functions that such a facility would be expected to perform. From specific requirements to more subjective desires, these interviews were the source of much information and inspiration. Of specific interest were the interactions had during a visit to the region with researchers staying at the Hluhluwe-Mfolozi Research Station. Through these interviews the nature of a research team was further understood, as were their requirements and desires. These interviews informed decisions made regarding site selection and the arrangement of spaces in relation to one another. These were also crucial in the clarification of questions regarding social concerns as well as the environmental approach necessary in this sensitive context.

Those interviewed were: Dr. Louis Celliers, Senior scientist at the Oceanographic Research Institute

- Dr. Caroline Fox, local ecologist at Ezemvelo KZN Wildlife's St. Lucia Headquarters
- Dr. Sue van Rensburg, Research Manager at the Hluhluwe-Mfolozi Game Reserve

- Steven Weerts, Research Manager at CSIR, Durban
- Claire Geoghen, Researcher at the Hluhluwe-Mfolozi Game Reserve

It was of paramount importance that contact was made with those currently in authority at the World Heritage Site itself: The iSimangaliso Wetland Park Authority. From these encounters the objectives for the facility became much clearer, as did the broad context into which it would fit. The interviews also led to the decision to create a strong link between the Park Authority and the proposed research facility.

- Bronwyn James, the head of Research at iSimangaliso Wetland Park Authority
- Roland Vorwerk, Media and Communications Coordinator
- Nerosha Govender, researcher with the iSimangaliso Wetland Park Authority

During the research into applicable case studies, it was imperative to interview the architects involved in each of the projects. They were able to reveal the thinking behind the finished building and provided opportunity for clearer conclusions to be drawn about each of the studies. Of particular interest were the interactions had with architect Derek van Heerden, of East Coast Architects, who has much exposure to the both the socio-political and environmental climates of Northern KwaZulu-Natal. Architects interviewed were:

- East Coast Architects cc (Africa Centre)
- Boogertman Kriege Architects  
[with Architects Collaborative]  
(uShaka Marine World)

### 1.5.2 Secondary Research

Secondary Research is any information garnered from secondary sources.

#### 1.5.2.1 Precedent Studies

A major portion of the secondary research conducted was the investigation of existing international and local precedent. The appropriate aspects of the following designs were examined through an analysis of published journals, books, photos and written descriptions. These can be found in Chapter III and include:

- Queenscliff Centre, Australia  
(Lyons Architects)
- Institute of Forestry and Nature Research, Wageningen, The Netherlands  
(Stefan Behnisch)
- JN Centre for Advanced Scientific Research, Bangalore, India  
(Charles Correa)
- Singita Lebombo Lodge, Kruger National Park, South Africa  
(OMM Design Workshop)
- Global Ecology Research Centre, California, USA  
(EHDD Architecture)

Similar to the aforementioned case studies, these precedent buildings have been critically analysed in order to inform the design of the

facility. Where the selection of precedent cases differed from the case studies, was that the chosen buildings did not have to be in a similar South African context, nor did it have to be the same typology, climate or even provide a similar schedule of accommodation. (There are examples that meet some of these requirements, but it was not a necessity in the selection of the buildings for study). More importantly, the selected precedent studies needed to offer some insight, however small, into the appropriate design of this facility. Specific aspects of interest were:

- Efficient Resource Management
- Connection to the Environment
- Life-cycle considerations
- User-controlled flexibility
- Critically regional architecture
- Passive solar design

#### 1.5.2.2 Literature Review

A review of literature in order to answer questions of environmental responsibility, research facility functionality and to establish a theoretical framework.

##### Social

Firstly, there is a need to determine how best to design an efficient and effective Facility for Environmental Research. Much of the information required to answer questions of laboratory efficacy, was gleaned from the *Laboratory Design Guide* (2000) by Brian Griffin.

##### Economic

The building will be operating within both a macro and micro economic context and it has

been very important to determine how best to achieve an economically sustainable result. Although most of the questions related to this heading have been determined through primary research, there has been some investigation conducted into the implementation of local materials (constructed and maintained by local contractors), as well as the appropriate manner of design of these portions of the building. Another major point of consideration has been the responsible management of the available resources of the region.

The economic concerns ultimately provide a framework that will guide the design decisions regarding the building's relationship with its local economic setting and its macro and micro-context with regard to the regional resources and community.

##### Environmental

Ever since Ian McHarg wrote his seminal work, *Design with Nature* (1969) there has been an exponentially increasing plethora of published papers, journal articles and other such secondary sources which document strong design solutions for an architecture that is environmentally responsive and responsible.

Of relevance regarding a right climatic response is Richard Hyde's very useful tool: *Climate Responsive Design: A study of buildings in moderate and hot humid climates* (2002), as well as the slightly more geographically relevant offering from Alaric Napier, entitled: *Enviro-Friendly Methods in Small Buildings for South Africa* (2000).

Using these information resources a number of design guidelines have been drawn regarding:

- Passive Solar Design
- Fenestration arrangement
- Ventilation
- Sun Control
- Architecture in Hot-Humid regions
- Methods to effectively connect the facility, and its users, with the Environment

### **1.6 Conclusion**

Throughout the Literature Review the goal of the research is the design of an Environmental Research Facility for iSimangaliso Wetland Park in a specific climatic condition on a specific site. The research and Literature Review is therefore guided by this overall aim, and the manner in which this can best be achieved. Information is therefore practical and relevant in nature. The research will culminate in a range of conclusions to be addressed in the research facilities design.

## Chapter II: Theoretical Framework and Literature Review

### 2.1 Introduction

The previous chapter outlines the three rubrics under which the research will be structured, namely: Social, Economic and Environmental. To continue the investigatory sequence, this chapter will assess the aforementioned concrete parameters and suggest the manner in which the building will be carefully and appropriately designed. As mentioned, these issues are complex and for simplicity sake they have been kept separate. There are, however, points at which there is much overlapping, where the three become almost indistinguishable, which highlight the complex nature of architectural research and design.

### 2.2 Social Concerns

There are two people groups that need to be separately examined: facility staff and visitors to the building. Both groups have differing requirements and expectations of the space, these needs will thus be independently investigated, and conclusions on each people group will be drawn.

#### 2.2.1 Research Staff

First and foremost, the facility is a working research centre with definitive functions conducted by the research staff in the laboratories and office space. Fulfilling the requirements that staff have over the spaces is therefore of paramount importance and the needs of all other users are subservient to those of the environmental research scientists.

By way of introduction to this group, it is important to first understand the nature of the environmental research that they are involved in, with specific attention paid to this local context.

#### 2.2.1.1 Environmental Research

Ultimately, research is conducted in order to generate knowledge of our environment. It is imperative that we conduct research into our living resources and what we use, and how we can do so in a sustainable manner (Celliers 2007). There are basically two types of research that one can be involved in: Applied Research and Fundamental Research.

Effectively, Applied Research is where a problem or hypothesis is stated and a solution is found in order to solve the problem or prove the hypothesis (Celliers 2007). On the other hand, fundamental research is the generation of knowledge with no real problem which needs a solution. This is the cornerstone of science as it gets right down to the biological details of natural design (Celliers 2007).

These two types of research are dependent on one another and currently occur in approximately a 70/30 ratio nationwide-with fundamental being less dominant-there is however a move towards conducting more fundamental research (Celliers 2007).

#### 2.2.1.2 Research Funding

In South Africa almost all research funding is directed through the National Research Foundation (NRF). The NRF was established as



a result of the South African Government's NRF Act, and now acts as the government's agent in the awarding of research funding for all advanced research in all fields of the humanities, social and natural sciences, engineering, and technology; including indigenous knowledge ([www.nrf.ac.za/profile/](http://www.nrf.ac.za/profile/)).

Funds are most frequently provided from the Department of Environment and Tourism (DEAT), although certain projects could get their source of capital from the Department of Science or local government (Celliers 2007).

In the case of large, multi-national and multi-institutional research projects it is quite conceivable that an international body such as the European Union may provide the funding. (Celliers 2007)

#### 2.2.1.3 Research in South Africa

A research project may be conducted over the course of anything between one and ten years depending on the research problem and the availability of funding. Environmental research obviously requires a lot of time in the field; collecting samples and recording observations. A research team consists of anything from one to twenty people, although not all of these members would travel to the field on each occasion. A trip into the field usually lasts between one and three weeks, with accommodation being in chalets, guest houses or Research Stations. For example, The Oceanographic Research Institute has a station at Sodwana with all the necessary functions being served from there. (Celliers 2007)

#### 2.2.1.4 Current Research in iSimangaliso Wetland Park

There are currently nearly two hundred research projects being conducted in the iSimangaliso Wetland Park (Govender, 2007). An unpublished report on these projects shows that they can be divided up as follows (Ill. 2.1):

- 43% science
- 25% science (ecosystems)
- 8% social science
- 21% science/social science
- 3% unknown

From this breakdown we can see that a large majority of the research projects currently being undertaken are scientific in nature. Within this portion of the projects there is a great diversity in focus which is representative of the biodiversity of the park itself. These include studies of the:

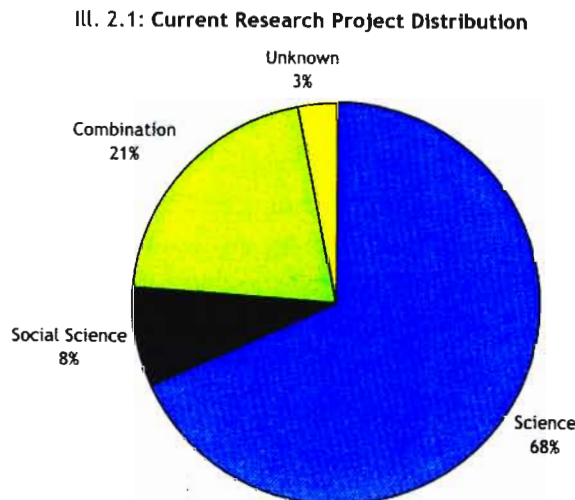
- Ecosystems
  - Overall interaction between the systems across the whole park
  - Focused studies of each of the individual ecosystems
- Flora
- Fauna
- Marine Systems

Research is conducted by a number of independent bodies, under the oversight of an autonomous arm of Ezemvelo KZN Wildlife: The iSimangaliso Wetland Park Authority. These research teams often represent organisations as diverse as:

- University of KwaZulu-Natal
- Agricultural Research Council
- University of Cape Town
- Oceanographic research institute
- Human Science Research Council
- Marine and Coastal Management
- International Mire Conservation Group (Govender 2007)

#### 2.2.1.5 Staff Requirements

There are two areas that need to be carefully investigated when we consider the design of a research facility; these are the ideas of flexibility and those of ownership of space. While these are two seemingly separate concepts, there is an element of overlap that occurs in the field of research. An examination of Herman Hertzberger's *Lessons for Students of Architecture* (1991) has been particularly interesting in the process of formulating an architectural response to these two aspects of design.



## Flexibility

As outlined earlier, scientific research is by nature, transient. It is this transience that dictates that spaces should be designed with the significance of flexibility in mind. Research projects, and therefore teams, could be assembled for a specific timeframe, meaning that a defined area within a laboratory or office may be occupied by one research team for anything from a year, right up to five or ten years. While these spaces change hands on such an extended time-scale, other spaces may change hands on a weekly or even daily occurrence: it is therefore important to design these spaces so that they can be modified to the user's needs as the requirement arises.

As Herman Hertzberger states, flexibility has become something of an architectural catchphrase denoting some miracle panacea to a number of design problems (Hertzberger 1991:146). The ultimate solution being a building with maximum neutrality - one that could, in theory, accommodate the functions and changes selected by future users of the spaces - the problem with this theory, is that it negates the creation of an architectural identity (Hertzberger 1991:146). Flexibility, as Hertzberger continues, signifies the denial of a fixed or clear-cut standpoint due to the understanding that no single solution would be preferable in all eventualities. As Hertzberger states: *"The flexible plan starts out from the certainty that the correct solution does not exist, because the problem requiring a solution is in a permanent state of flux: it is always temporary"* (Hertzberger 1991:146). The result, however, is as equally unknowable as the potential future

uses of the structure - falling back onto outright flexibility shows a lack of architectural rigour that is required to solve these complex problems. As architect's refuse to accept their responsibility to design these spaces the solution will resultantly never be the optimal or most suitable solution to any one single problem. While a wholly neutral building can adapt to provide any solution, the resolution will never be the most appropriate or competent layout or design for that precise requirement. Flexibility ultimately represents a complete set of unsuitable solutions to any one problem (Hertzberger 1991:146).

Rather than advocate pure flexibility Hertzberger goes on to suggest a far more responsible and constructive approach to the need for a building to change over time. He suggests that a form that starts with change as an invariable, inert factor, will more readily adapt to shifting functions. Hertzberger calls this ability of form: Polyvalence. He goes on to define a polyvalent form as one *"that can be put to different uses without having to undergo changes itself, so that a minimal flexibility can still produce an optimal solution"* (Hertzberger 1991:147). According to Hertzberger, the only way in which this can be achieved will be through a re-evaluation of the programmed living patterns which architect's enforce through the re-creation of said patterns. If these predetermined forms were abandoned, the focus could be on the creation of a diversity of space in which different functions could be refined into prototypical forms (Ill. 2.2) (Hertzberger 1991:147). These polyvalent forms could then, in turn, be reinterpreted by the individuals or

Ill. 2.2: Centraal Beheer Office in Apeldoorn: Herman Hertzberger. Polyvalent office spaces which look onto the atrium are used for a variety of functions; from personal workspaces to meeting areas.





community responsible for their usage (Ill. 2.2). What sets these polyvalent forms apart from the neutral, lithe forms of flexible architecture is their ability to maintain a constant identity, despite adaptations for a plethora of uses (Hertzberger 1991:148). The goal is therefore to create a less fixed, less static architecture which is able to meet the innumerable requirements of the scientific research community, while maintaining a constant architectural identity.

In conclusion, Hertzberger says that *“in order to be able to have different meanings each form must be interpretable in the sense that it must be capable of taking on different roles. And it can only take on those different roles if the different meanings are contained in the essence of the form, so that they are an implicit provocation rather than an explicit suggestion”* (Hertzberger 1991:149).

### Ownership of Space

Within this problem of flexibility, there is also the adjoining idea that users should feel a sense of ownership of space. The only reason that ownership is seen as an issue needing to be addressed is that there is a tendency among the more transient researchers to not care for the spaces that they work at-be they laboratories or general office spaces (Ill. 2.3) (Geoghen 2007). It is crucial that the users feel obligated to look after the space; they must feel compelled to care for it, whether they call the facility home for just two weeks or even two years.

Hertzberger determines that the character of

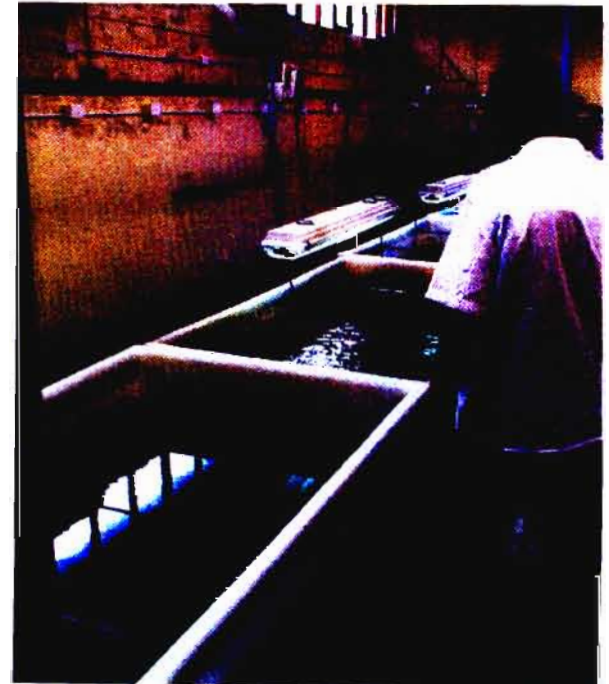
each area within a building will largely depend on who determines spatial layout and the arrangement of space as well as who is in charge, who takes care of it and who feels responsible for it (Hertzberger 1991:22). The more influence the researchers can personally exercise on their work environment, the more they will feel emotionally involved these spaces and therefore the more attention you will pay to them by caring for them as well as the surrounding areas (Hertzberger 1991:170).

An interview with researcher Clair Geoghen at the Hluhluwe-iMfolozi Research Station confirmed this, she says that the trend amongst researchers is that if they are able to customise their surroundings over a longer stay, then they will care for their surroundings, while the same cannot be said for more transient visitors (Geoghen 2007), or those unable to take charge of their personal environment. Hertzberger terms this personalisation of space: territorial claim (Hertzberger 1991:25), and in his vast experience he is able to highlight examples of territorial claims within his own work. He points to the Centraal Beheer Office building in Apeldoorn in The Netherlands (Ill. 2.2) as an instance where users have applied the finishing touches by arranged and personalised their office spaces with colours of their own choice, potted plants and objects that meet their own personal taste (Hertzberger 1991:24). He goes on to warn that, although the grey interior was deliberately left as a clear indication that the users are expected or invited to complete the interior, this is not a guarantee that they will do just that.



Ill. 2.3: A communal work area in the Hluhluwe-iMfolozi research station showing the disregard for spaces when users do not have a sense of ownership.

Ill. 2.4: An example of a space which is not adequately polyvalent. The users of SAAMBR's research aquarium have to create a makeshift servicing system in order to meet their shifting functional requirements.



He continues by explaining that the liberty for personal initiative is first and foremost from the top down. In the case of a client prepared to give the users on lower echelons the responsibility to personalise their work environment (Hertzberger 1991:164). While this is beyond the architect's realm - the form of the building is not - Hertzberger argues that the architect can deliberately leave something unfinished with the expectation that the users are more capable of doing a better job at finishing the job than he or she is. He adds though, that the form that is employed must, on the technical and practical level, lend itself to such purposes (Hertzberger 1991:164). The architect is effectually extending an invitation to the final users to complete and 'colour' the spaces as they see fit (Hertzberger 1991:170). More than a mere invitation the semi-finished product acts as an inducement to complete the design - the incomplete parts are therefore not only intended to be receptive to adaptation and addition, they are furthermore designed to accommodate a variety of solutions (Hertzberger 1991:164) which the transient users would potentially suggest (Ill. 2.5).

#### Conclusion: Inviting Form

The interesting thing to note is the relationship between flexibility, or polyvalence and the territorial claims discussed under the rubric of space ownership. Ultimately, the users have the freedom to decide for themselves how they want to use each space and it is their personal interpretation is infinitely more important than the architect's desires.

It is therefore the architect's role to create designs that are sufficiently accommodate a wide variety of potential usage requirements (Ill. 2.5), what is more, not only adequate in terms of the accommodation provided, but in the provision of a stimulus to complete the design (Hertzberger 1991:174). It is this fundamental and active adequacy that Herman Hertzberger calls inviting form: form which displays empathy for the users (Hertzberger 1991:174). It is impossible to tailor for everyone's circumstances exactly, which is why the onus is on the designer to create the potential for personal interpretation by designing things in such a way that they can indeed be interpreted (Hertzberger 1991:170).

Architecture is a social art and whatever the architect does will undoubtedly play a role in the lives of every user, Hertzberger therefore argues that the architect's main role is therefore to create a building that is adequate for life (Hertzberger 1991:174). The question of this efficacy is that it is not merely related to whether it is practical or not, but also whether the design is "*attuned to normal relations between people and whether or not it affirms the equality of all people*" (Hertzberger 1991:174). Architecture has consequences for the users and it is therefore not merely an art related to the creation of beautiful works, nor the design of purely useful buildings, but rather the challenge of the architect is to concurrently and equally create both (Hertzberger 1991:174).

#### 2.2.2 Visitors

This group of people can be split into two sub-

divisions: the local community and tourists.

##### • 2.2.2.1 Community

Through discussion with architect: Derek van Heerden, it is clear that working in this rural and politically charged area it is essential to include the local communities in the design. There are various areas where this occurs. Community participation is vital. This leads to an important result: a transfer of skills and sustainable relationships with local communities. The community must feel like they have some stake in the building. Additionally, it is appropriate to ask how architecture can aid the development

Ill. 2.5: An example of an inviting, polyvalent space in one of Hertzberger's Apollo Schools. This central hall invites the teachers and children to use the space for anything from homework to small plays and lessons or even school meetings.





of a community in a region, through education, job provision or other opportunities. Here the question is: “what can the building give back to the community, through their participation in the process?” This is discussed more indepthly in the following orition of this chapter where local contractors, maintenance companies and materials are to be selected over others.

- 2.2.2.2 *Tourists*

Being a World Heritage site is important that tourists to the region are informed of what current research is occurring in the park. It is important that the building facilitates this education process by providing an interface where tourists can engage with the ecology through presentations and tours. Architects James Cutler and Bruce Anderson believe that to know nature is to love it and to love it is to fight for its preservation (Olson 2004:10). It is this nexus that the building will seek to facilitate through the provision of such platform where this can occur.

While these two people groups have been separated, it must be added that the local community must also be encouraged to fight for the preservation of the ecology on their doorstep. This will only be achieved through understanding, and so the Research Facility must actively encourage the expansion of local knowledge.

#### 2.2.2.3 *Research and the Public*

Ultimately, the *raison d’être* of research is the generation of knowledge about our environment. Research findings are meant to filter down to the general public in order that they may be more

informed as to how environmental research findings affects them and how they too can help to care for and protect our natural resources. Numerous interviewed environmental researchers and scientists agreed with this premise, arguing that it was imperative that the general public be exposed to this knowledge, so that they too can understand the plight that our world is in and suggest how they can join the fight to protect what we have (Weerts, Celliers, van Rensburg and Govender 2007).

#### 2.2.2.4 *Access Restrictions*

This desire to expose the general public to these findings need to be balanced with the requirements of the research facility (Chapter VI). Firstly, there is the necessary security, which is crucial in research facilities. It is of supreme importance that research findings are 100 percent certain, with no risk of contamination from an outside influence (Weerts 2007), and for this reason it is impossible to allow unrestricted access to the entire facility.

Another reason why unhindered access is not advisable is that environmental research is not always very glamorous. Clair Geoghen warned that dissections are done and that wounded or recently deceased animals are brought into the facility in order to ascertain a cause of death or injury (Geoghen 2007). These are obviously not the kind of experiences that the general public would desire to be privy to.

Despite these potentially stifling restrictions, the Environmental Research Facility provides a great opportunity for the public to find out what projects

are currently underway and even possibly to see how the research was conducted, so that the whole process would be one of empowerment and education. The facility would therefore become an interface between the public and the working researchers. The line between the two, though existent, could be blurred to give the visitors as full an experience of the behind the scenes as the aforementioned constraints would allow.

#### 2.2.2.5 *Dual Access*

There is an opportunity to achieve just this through the creation of a pedagogical architecture which seeks to expose the behind-the-scenes elements and activities through the concept of dual access. To expand: there are spaces within the facility, such as the experimental aquarium and laboratories, which the researchers require uninhibited access to, but which also provide an opportunity for the visitors to gain a greater understanding of what occurs in these spaces. While the visitors cannot share the same access status-they can freely have visual access. It is through this didactic visual access to these spaces that the barrier between researcher and public, can be broken down.

#### 2.2.2.6 Connection to the Environment

In addition to this dual-servicing, there is an opportunity to reinforce the connection between the visitor and the environment around them. Architect James Cutler believes that at the core of the problem of man's indifference about deteriorating environmental conditions is man's *"fundamental disconnection from the living world"* (Olson 2004:9) that sustains all mankind. He points out that *"we, as a culture, no longer have a primitive emotional knowledge that we and the rest of the living world are one. We may not be able to do anything about this loss and its concomitant problems, but if there is a path that avoids the looming future, it will start with an ethic of respect, appreciation and love for all the variety of this planet. That love can only be fostered by first promoting an emotional connection with the world. Where our hearts go, our minds and actions will follow"* (Ibid., 9).

Mexican architect, Luis Barragán deftly described this disengagement in Clive Bamford-Smith's 1967 publication *Builders in the Sun*: *"Before the machine age, even in the middle of cities, Nature was everybody's trusted companion... Nowadays, the situation is reversed. Man does not meet with Nature, even when he leaves the city to commune with her. Enclosed in his shiny automobile, his spirit is stamped with the mark of the world whence the automobile emerged; he is, within Nature, a foreign body. A billboard is sufficient to stifle the voice of Nature. Nature becomes a scrap of Nature and man a scrap of man"* (Barragán, 1967:77).

Architect Glenn Murcutt is of the school that architecture should neither oppose nature, nor prevent its occupants from enjoying the landscape (Fromonot 2003:47). Rather, as Françoise Fromonot puts it, *"[architecture] should reveal the environment to them and enable them to live in it"* (Fromonot 2003:47). He goes on to say that the basics of organic life: water, air and light are not merely seen as *"necessities for survival, but rather the challenge is to make them visible, legible almost palpable, to make their presence felt in the very stuff of the building"* (Ill. 2.6) (Fromonot 2003:47). In the case of Murcutt, he brings this strong connection with the environment down to the very details of his buildings (Ill. 2.6, 2.8 and 2.9). He expresses the nexus between the inside and out as a blurred, 'feathered' edge (Ill. 2.7) wherein there is a progressive stripping down of materials as the eye moves towards the interface between the built, and natural environments (Ill. 2.8 and 2.9)

Ill. 2.6: In the Donaldson House Glenn Murcutt displays an integration of nature into the very fabric of the built environment.



The architect has an opportunity to aid in the repair of this all too frequent disconnection between man and the environment by highlighting the latter wherever possible. Through the creation of spaces where man and 'nature' can be reacquainted and that ultimately neither is reduced to a scrap of its former self.



Ill. 2.7: A photograph taken by Murcutt showing the presence of 'feathering' in the natural world.

Ill. 2.8 & Ill. 2.9: Murcutt employs feathering as an architectural concept in the Marika-Alderton House. The edges of the building are blurred as the structure is revealed, and even protrudes beyond the 'enclosure'.



## 2.3 Economic Concerns

### 2.3.1 Responsible Resource Management

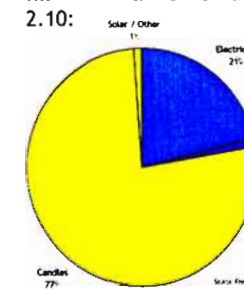
*"To begin our position-fixing aboard our Spaceship Earth we must first acknowledge that the abundance of immediately consumable, obviously desirable or utterly essential resources have been sufficient until now to allow us to carry on despite our ignorance. Being eventually exhaustible and spoilable, they have been adequate only up to this critical moment. This cushion-for-error of humanity's survival and growth up to now was apparently provided just as a bird inside an egg is provided with liquid nutrient to develop it to a certain point."*

Buckminster Fuller, Operation Manual for Planet Earth (Rogers and Gumuchdjian, 1997:2)

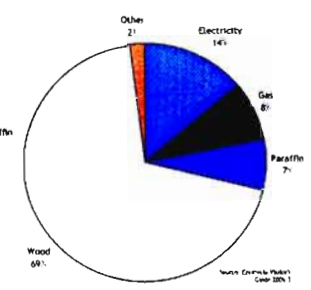
Our modern society has a seemingly built in propensity to exploit resources (Ill. 2.11). One need only look at current levels of deforestation (Ill. 2.12 and 2.13) and the escalation in oil consumption over the past half a century (Ill. 2.11). Ours is a resource eating culture and architecture and building construction is often a prime candidate for the most inefficient and insensitive abuser. With this in mind it is obvious that the reduction of this environmental resource abuse is crucial and that there is much improvement to be made in the field of construction. While there are practical and environmental reasons to reduce the consumption of energy generally, there is much to be said for avoiding complete reliance on non-renewable electricity provision specifically-especially in the case of a research facility such as this one, where loss of power

Ill. District Energy Usage (Lighting)

2.10:

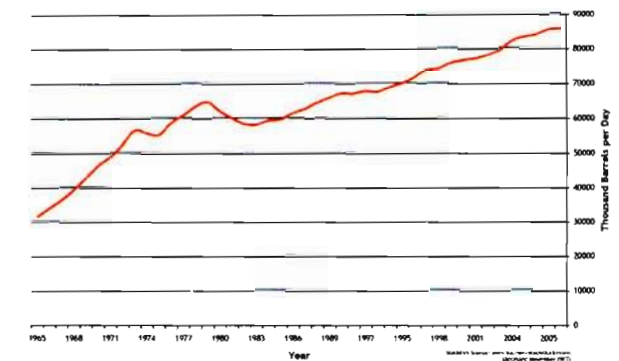


District Energy Usage (Cooking)



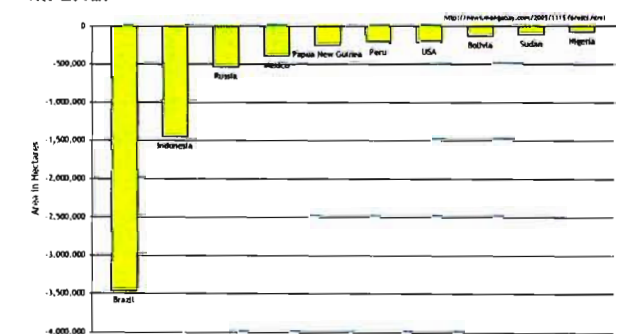
Ill. 2.11:

Global Oil Consumption (1965-2006)



Ill. 2.12:

Highest average annual deforestation of primary forests (2000-2005)



Ill. 2.13: Deforestation of a Peruvian forest





could result in loss of thousands of Rands worth of research investment! Reliance on an inconsistent electricity supply is simply not an option in the Environmental Research Facility. Access to uninterrupted electricity is non-negotiable when dealing with sensitive systems and samples that require steady temperature or humidity levels. For this reason, there is a necessity to have an on-site energy production system (see Environmental Concerns below). As we move into a time when our natural resources will become more and more stretched, it is crucial that we look for alternatives and that those resources that are used are renewable.

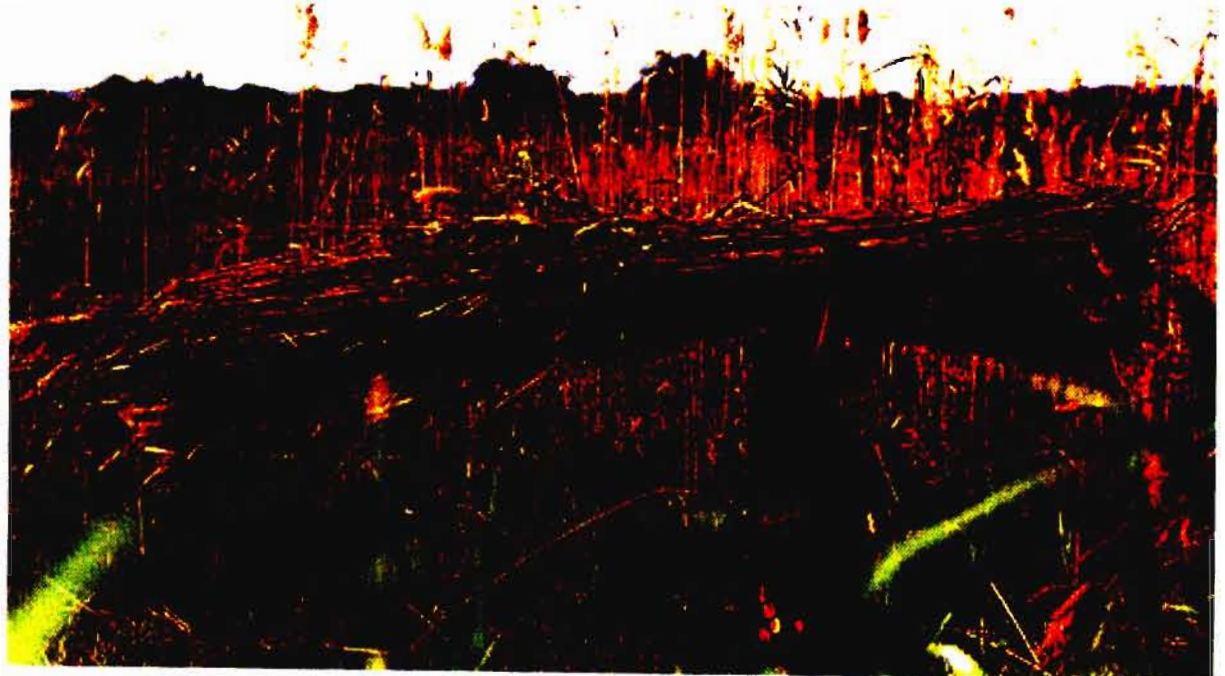
There is no reason that a symbiotic relationship with the land could not be unachievable. There have been numerous local communities that have lived in this region for many years and their impact on the land has been minimal because there was an equilibrium struck. Their relationship with the land to this point has been sustainable. One example of this sustainability in action is the annual spring-time harvesting of *Ncema* grass (Ill. 2.15). The grass is used by these communities to make sleeping and sitting mats and the symbiotic relationship is demonstrated in the fact that the grass is only ever cut to the point where it will grow sufficiently in time for the following spring season. The symbiotic usage patterns are historically determined, and are not exploitive, with the result being two healthy, co-existing systems.

Another example of a long standing relationship between the land and the people, are the

elaborate, 700 year old Kosi Lake fishing traps (Ill. 2.14) (Khuzwayo & Vorwerk 2006:7), used by the local Tonga people for the sustainable harvesting of their marine resources ([www.kosibay.net/Fishtrap.htm](http://www.kosibay.net/Fishtrap.htm)).

The area is today called the uMkhanyakude District and the statistics of energy usage reflect a current lack of dependence on non-renewable energy resources (Ill. 2.10), which could well be a positive for the future. As the infrastructure is setup, there is an opportunity to encourage the usage of renewable energy resources: this area could therefore highlight a viable alternative to our own urban tendencies to exploit resources. Here, rather, the future could reflect the balance that has precedent in the past.

Ill. 2.15: The annual collection of *Ncema* grass for basketry and mat weaving.



Ill. 2.14: An aerial view of the 700 year old Kosi Bay fish traps: an example of a long standing relationship between the land and the people of this area.

As the pressure of development and growth expands in this district it will become more and more imperative to respond in a responsibly regional way. In the case of the Environmental Research Facility it will be with much interest that the local vernacular will be explored. In order to achieve a harmony with nature - much like the local residents have developed over time - it will become increasingly necessary to investigate and incorporate local knowledge into the design of this facility.

### **2.3.2 Contribution to the Local Economy**

An opportunity that a project like the Environmental Research Facility provides is the long term injection of capital into the local economy through a variety of means:

### **2.3.3 Local Contractors and maintenance**

Firstly, and most obviously, is the selection of a local contractor with a small company to construct the building. This has design ramifications: the building needs to be designed in a manner that does not exclude labourers that are not as trained as perhaps urban contractors may provide. A regional example of this in attitude is the Medical Research Facilities (See Case Study) at Somkhele just 20 minutes drive from St. Lucia. Architect Derek van Heerden points out that the local community had to have a sense of ownership for the 'product', (Van Heerden 2007) and that of the ways this could be achieved was through the transfer of skills. The result was that 100 percent of the unskilled labour and 62 percent of the skilled labour came directly from the surrounding community, (Lipman, 2002b:36)

additionally, where there were no available workers local men and women were taught, thus ensuring that a skills transfer occurred (Ill. 2.16). This skills development has been a great success, with many of these trained labourers finding jobs as a result of their interaction with the process at Somkhele. This transfer of knowledge, and economic benefits, to the local community, is an apparent and viable option, which should be taken at every possible turn.

Similarly, ongoing maintenance and repairs can be outsourced to local companies with similar effect. The additional benefit in this instance is that this is a more durable, more sustainable opportunity for long term development of the local economy.

### **2.3.4 Local Materials**

The specification of materials sourced within a 100km radius makes economic sense in a number of ways. Firstly, the transportation cost could be radically reduced as the material would not have to travel vast distances to get to the construction site. This also means that the embodied energy of these materials will be reduced, as the transport cost drops. Secondly, selecting local materials, results in local companies gaining a profit. Materials have to be selected and bought in order to build a building, and this opportunity is thus clearly viable, and the benefits are clearly evident for both parties.

Ill. 2.16: A local chief of Somkhele who became one of the many local labourers on the construction of the Africa Centre.





## 2.4 Environmental Concerns

*"Man in space is enabled to look upon the distant earth, a celestial orb, a revolving sphere. He sees it to be green, from the verdure on the land, algae greening the oceans, a green celestial fruit. Looking closely at the earth, he perceived blotches, black, brown, grey and from these extend dynamic tentacles upon the green epidermis. These blemishes he recognises as the cities and works of man and asks, "Is man but a planetary disease?"*

(Loren Eiseley quoted in McHarg 1969:43)

#### 2.4.1 Selecting a brownfield site

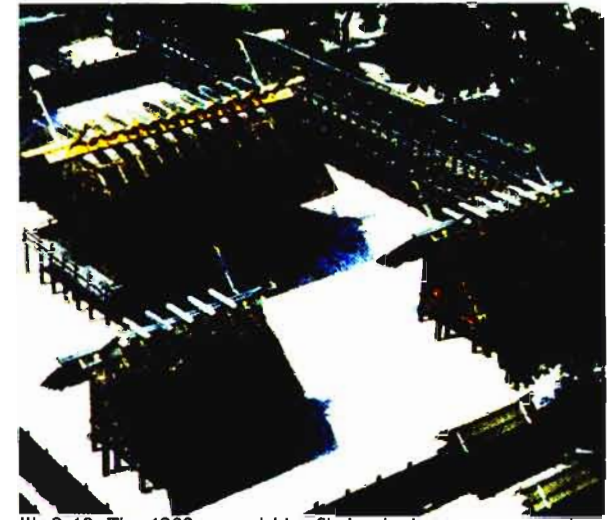
*"In relation to the potential for the adaptive re-use of pre-existing structures we should surely restrict our current habit of exploiting ex-agricultural greenfield sites in favour of re-using ex-industrial brownfield sites. Rather than continuing to proliferate urban sprawl we should either re-use obsolete buildings or demolish them and re-use their sites once they have been cleared. Only provisions of this order will save us from the continual consumption of fertile land and along with this, ultimate depletion of the planet's non-renewable resources"* (Frampton 2002:15).

Kenneth Powell argues that using brownfield sites or reusing buildings makes both functional and financial common-sense (Powell 1999:9), but as Virginia Kent Dorris adds: confining new development to land that has already been altered by human intervention is also good land stewardship (Kent Dorris 1999:99). It is an opportunity to invert the "future eating tendencies of our culture" and empower us to "begin building a sustainable future" (van Schalk 2005:56).

For ages the Italian's have better understood the idea of reusing structures. In the "Beyond History and Memory" Seminar Alexander Stille refers to the example of the Renaissance and early 17<sup>th</sup> century wherein the architects of Rome were using the Coliseum as a quarry (Stille, Frampton and Cole 2004). Such practice would be poorly looked on in our current westernised world. Another example Stille points out, is the *Ise Shrine*

(Ill. 2.18) in Japan. The shelter is ceremonially destroyed and rebuilt on a twenty year cycle as part of celebration of renewal (Stille, Frampton and Cole 2004). UNESCO did not consider this site as a historical piece of heritage due to their western analysis methods. According to UNESCO's classification method, the *Ise Shrine* is, at its oldest, twenty years. The Japanese on the other hand, consider the shrine to be 1,200 years old. While there is no such site in the iSimangaliso Wetland Park, there is certainly a lesson to be learned from this example which challenges the ubiquitous western opinion of re-use. To these Japanese and Italian builders, the past belongs to them; it is something to be connected with. The attitude of the Romans makes sense when we consider that the Latin word *Renavatio*, from where we derive our English word *Renovation*, is accurately translated as 'rebirth' or 're-new'.

This idea of rebirth was further extended in the 1950's and early 60's by another Italian architect, Carlo Scarpa (Ill. 2.19), who as Frampton says: *"wove his own new work, very sensitively into the old fabric, so that one could clearly see what was old and what was new"* (Stille, Frampton and Cole 2004). In the West there exists a proclivity to preserve. Frampton goes on to comment that Scarpa's intricately woven preservation *"would probably not be possible because of a bureaucratically rigid attitude towards preserving the object in an immaculate but unspecified temporal state"* (Stille, Frampton and Cole 2004).



Ill. 2.18: The 1200 year old Ise Shrine in Japan, an example of re-use and renewal in architecture

Ill. 2.19: Carlos Scarpa's Castelvécchio Museum in Venice, Italy, where new structures are weaved into the historic architecture.





As one examines the world around it we are left with little doubt that the environment is in a state of flux. As the primary habitants of the planet, and chief pollutants, it is our responsibility to be stewards of the environment. As the environmental problems we face become more and more apparent, it will become harder to deny the looming consequences of our selfish behaviour. We must take responsibility now and determine a path forward.

#### 2.4.2 Embodied Energy

While everyone understands that building consume energy in their long term operation, it is less understood that it takes energy to make them: this is called embodied energy (Ill. 2.20) and is basically all the energy required to extract, manufacture and transport these materials to site, as well as the energy requirements of assembly and finishing (Buchanan 2005:33). This energy is effectively 'locked in' to the complete product; each building therefore represents an energy amount that cannot be lowered once construction is complete. The reduction of long-term energy costs of electricity and servicing is one thing; the reduction of embodied energy is another. This is therefore another reason to select local materials, the transport of which will aid in the reduction of the energy bound in the building. It is also another reason why the sensitive re-use of old buildings or structures is advisable (Buchanan 2005:33).

According to Peter Buchanan, the material with

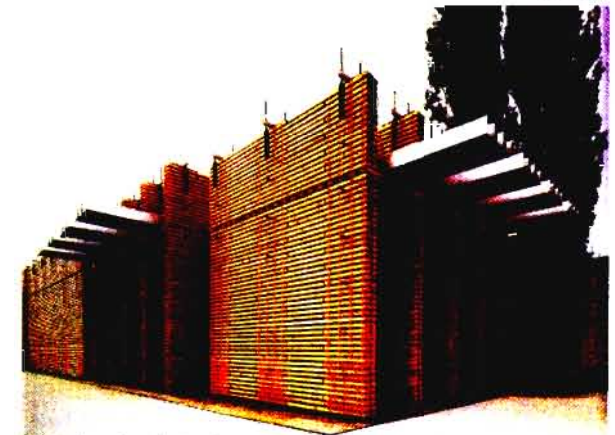
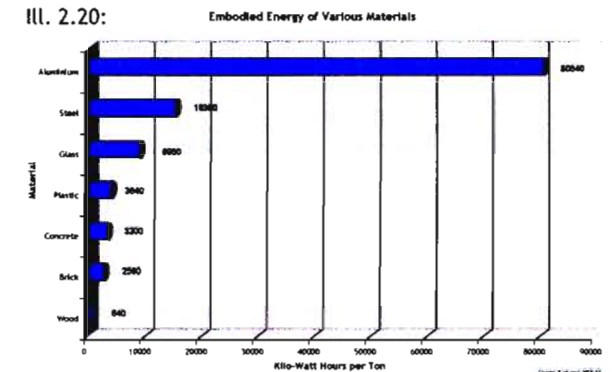
the lowest embodied energy is wood: with about 640 kilowatt-hours per ton (Buchanan 2005:33). Timber is therefore, by definition, the 'greenest' building material available (Ill 2.21) (Buchanan 2005:33). This graph (Ill. 2.20) shows how other materials rate against timber, with Aluminium being the highest with a figure 126 times that of timber (Buchanan 2005:33). If the design of the Environmental Research Facility is to be serious about having minimal environmental impact, it is important that the embodied energy is considered and constrained at every possible turn.

#### 2.4.3 On-site energy production system

As stated earlier (Economic concerns) access to an uninterrupted electricity source is a non-negotiable when dealing with sensitive systems and samples that require steady temperature or humidity levels. While this has pragmatic and economic backing, there is also much to be said for a responsible production of electricity in a world that is becoming increasingly thirsty for energy.

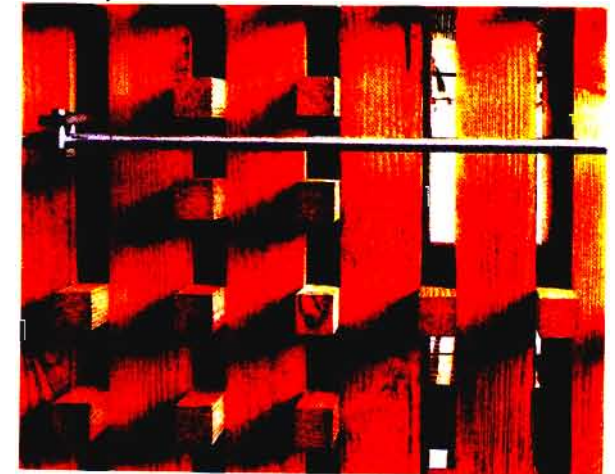
South Africa is very fortunate in that it has a very high insolation average of 5.28kWh per m<sup>2</sup> per day. Which means that over its entire area, this country receives over 10000 times the amount of energy necessary. ([http://library.thinkquest.org/C006373/electricity\\_from\\_the\\_sun.html](http://library.thinkquest.org/C006373/electricity_from_the_sun.html)) It must be noted that the commonly available photovoltaic modules convert between 4% and 13% of the sunlight received into electrical energy, with the rest being reflected off of the cells or absorbed in the form of heat (Ill. 2.23) (<http://library.thinkquest.org/C006373/>

Ill. 2.20:



Ill. 2.21: The Swiss Pavilion at the Hanover Expo in 2000 in Germany was designed by Peter Zumthor, and constructed from timber connected by steel tension rods. None of the timber was drilled for fixing, and could therefore be reused once the Expo was complete.

Ill. 2.22: A detail of the Swiss Pavilion showing the steel tension system.





electrcity\_from\_the\_sun.html). Using these figures it can be deduced that 100m<sup>2</sup> of maximum efficacy Photovoltaic-Cells in St. Lucia will provide almost 25 000 kW Hours per year, or 70kWh a day. This power could then supplement the electricity supply (Ill. 2.24). A supply which will also need to include a generator for times that power is lost when there is no sun produced power or local electricity supply to rely on.

#### 2.4.4 Waste management and pollution reduction

In nature there is no waste (Buchanan 2005:32), rather, in nature waste equals food (McDonough & Braungart 2002:92). The 'waste' from one animal, plant or process is the nutrient for the next animal, plant or process. Nature, it could be argued, is extremely inefficient and in their book *Cradle to Cradle* (2002), William McDonough and Michael Braungart use the cherry tree as example of this: Thousands of blossoms from the tree produce fruit for hundreds of birds, humans and other creatures, all so that one pit may fall to the ground, take root and grow. But no-one would look at the entire cherry blossom covered floor and complain or pronounce that this system was in some way inefficient (McDonough & Braungart 2002:73). Rather, nature is seen to be *eco-effective*. The fecundity of the cherry tree provides nourishment for the environment that surrounds it (Ibid. 73). Conversely, our society not only consumes or utterly destroys nature's resources faster than they can be regenerated, but the only thing we 'contribute' to our planet is the burden of toxic waste and pollution (Buchanan 2005:32). We need to rethink our opinion of

waste, and the production thereof.

For the purpose of this research, it will be most helpful to break down the waste into sub-headings, and suggest methods in which this 'produce' can be dealt with in a responsible manner.

##### 2.4.4.1 Water and Sewerage

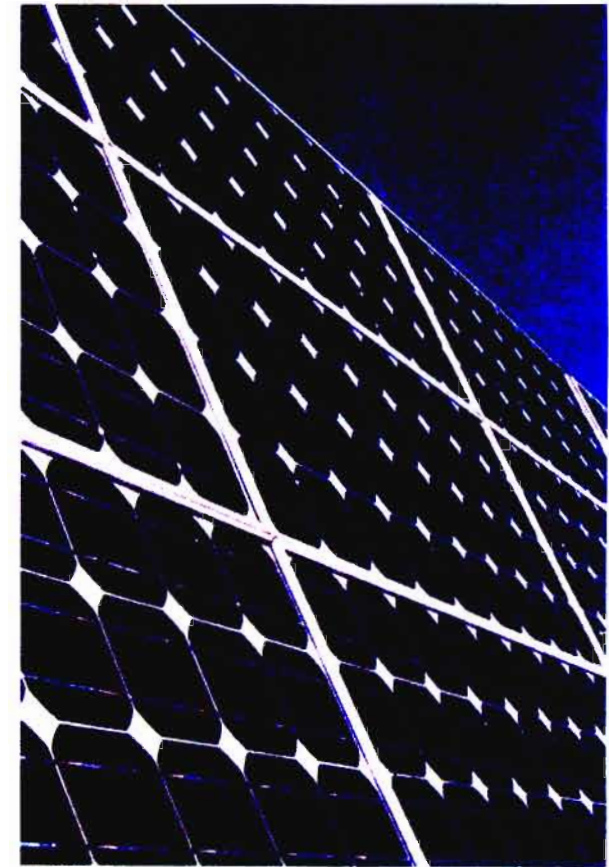
Operating within a sensitive ecological setting such as the Lake St. Lucia estuary system calls for care to be taken when dealing with waste water. A subdivision is useful at this point, and the waste water from the facility will be dealt with through two different systems: black-water and greywater.

##### Black-Water

Black-water is effectively all water which has been flushed from toilets, as well as any water from kitchen sinks, dishwashers or washing machines (Wilhide 2004:40). This water is contaminated with a variety of organic matter, and must be carefully dealt with. There is, however, the potential for the use of a waterless composting toilet, which would isolate the human waste from the definition of black-water in the Environmental Research Facility (see below Composting Toilets). The remaining black-water would then be treated with the greywater output from the building.

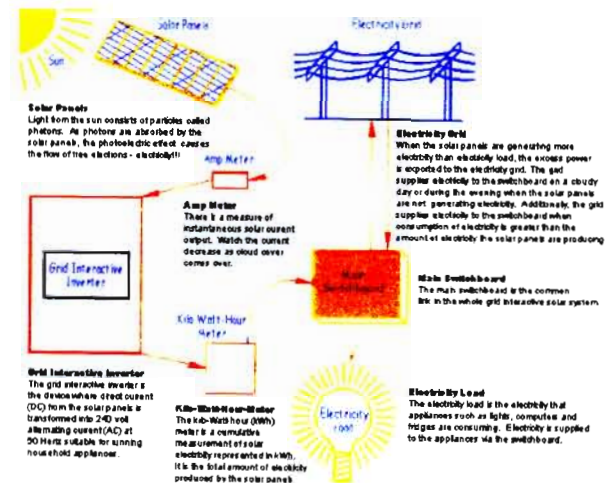
##### Greywater

By definition, greywater is water mildly soiled from washing, showering or bathing (Wilhide 2004:40), and it is possible to treat greywater in order to reuse it for similar purposes. The most robust example of a treatment option available on the South African market is the Lilliput™



Ill. 2.23: Photovoltaic panels used to collect sun energy, which is converted into usable electrical energy.

Ill. 2.24: A simplified diagram of the process of solar energy collection and conversion.



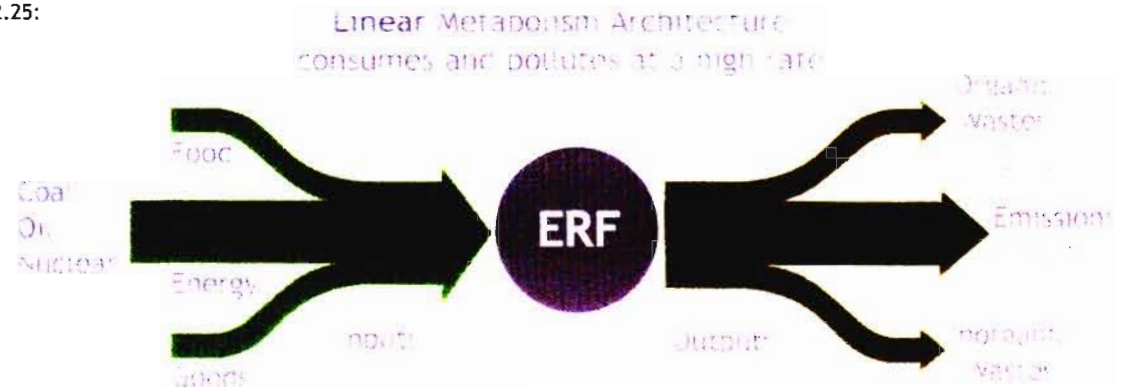
system. A Lilliput™ can be used to purify grey and black-water through a variety of systems (Chapter IV.2), with the end product being clean enough to use again wherever non-potable water is required. This water could also enter into a network of wetlands (as in the Africa Centre case study in Somkhele) which would provide a home to various local flora and fauna.

### Composting Toilets

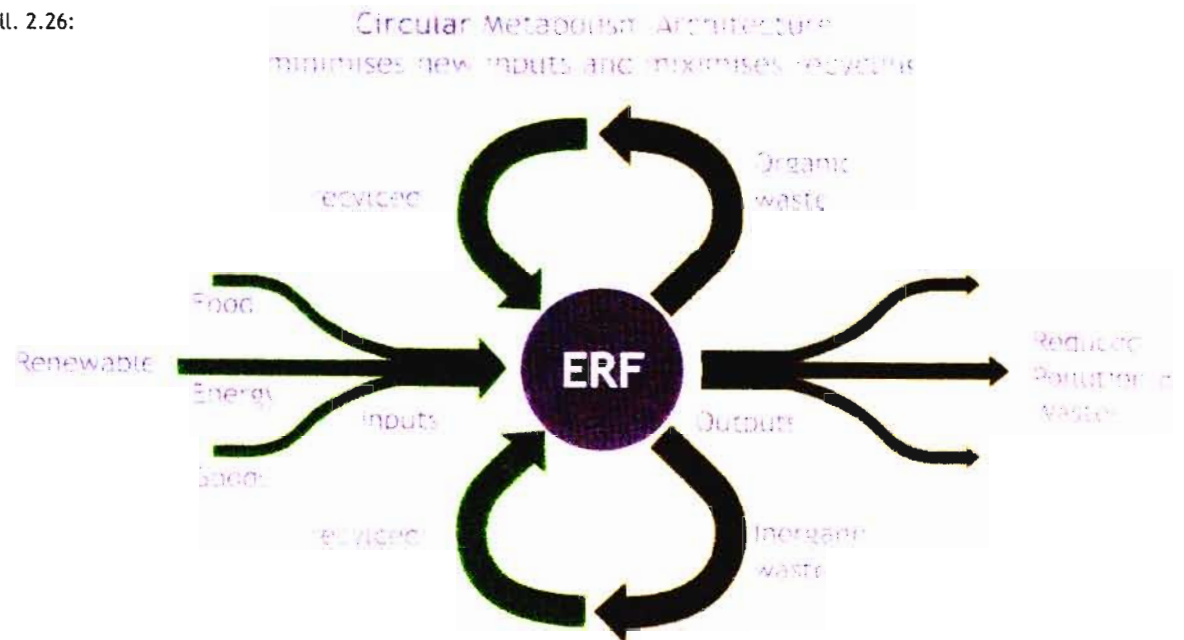
A most interesting publication on the ideas of composting toilet systems is Joseph Jenkins *Humanure Handbook* (2005) which assumes the premise that human manure or *humanure* is a resource and not a waste (Jenkins 2005:230). In the same way that nature recycles all natural forms of refuse into compost, products such as the Enviro Loo™ Dry Sanitation System provide the right environment for human waste, toilet paper and organic material to break down through a natural process ([www.eloo.co.za/products.html](http://www.eloo.co.za/products.html)). The result is an inoffensive compost-like material, which, once having been further composted, can be used like any regular soil fertiliser. The system only needs to be cleared out annually, depending on the number of users, and the odourless dry product is roughly 10% of its original mass ([www.eloo.co.za/products.html](http://www.eloo.co.za/products.html)).

The system basically allows radiant heat and adequate ventilation to pass through the waste within the sealed container, which stimulates bacterial and biological activity. It is this aerobic process which deodorises the solid waste, and converts it into the compost-like material ([www.eloo.co.za](http://www.eloo.co.za)). The ventilation and subsequent

Ill. 2.25:



Ill. 2.26:



The two flow diagrams above highlight the difference between an Architecture which has a Linear Metabolism, and one which is Metabolically Circular. All buildings require inputs, which are used in the daily functions of each space. The Linear model shows the ubiquitous manner in which non-renewable inputs are used, with environmentally damaging pollutants and waste being the outputs. The alternative is suggested in the circular diagram which highlights the potential for inputs being renewable and the large portion of output being recycled into the building. The result is a reduction in the production of pollution and waste, and the goal is complete eradication of any output which does not go back into the building as a recycled input.



temperature difference causes a negative pressure within the container, thus ensuring that there is no back-draft into the toilet itself (www.eloo.co.za).

The biggest deterrent with systems such as the Enviro Loo™ is not the effectiveness of the product itself, but rather the human reaction to the idea of composted human waste. The Environmental Research Facility provides an opportunity to debunk the myths that exist, by implementing this technology into a public building, and therefore provide a didactic influence on the visitors to the facility: showing them that it is possible to achieve this sustainable and eco-friendly system with no adverse affects on any of the users.

#### 2.4.4.2 Laboratory and Solid Waste

Eco-friendly laboratory and solid waste management is discussed in detail in Chapter VII.

#### 2.4.5 Materials and maintenance

As previously investigated, and discussed, the best way to reduce waste in the construction of a building is to re-use an existing building or structure. Unfortunately, obsolete buildings tend to be treated as waste (Buchanan 2005:32), while they actually provide an opportunity to cut cost and heavily reduce the impact a building has on the surrounding environment.

When it comes to selecting materials, there are a number of wise considerations in addition to the aforementioned embodied energy of each. Firstly, the life-cycle of the building should be

considered from start to finish. Most buildings are not designed with the end in mind, with the more frequent result being demolition with hardly any recycling or re-use of any components or materials. This would be termed a cradle-to-grave construction method. There is however another option: designing with the end in mind, and producing a building that can go from cradle-to-cradle. This means that building with reusable materials is wise (Buchanan 2005:39), as is considering the ability of future generations to easily reuse entire components or recycle materials off of the building (Ill. 2.22) (Ibid., 39). In addition, it makes little sense to choose construction materials that are themselves toxic, or require toxic cleansing or treatment (Ibid., 39).

From this standpoint it is therefore suggested that timber, especially locally grown in sustainable forests, should provide the bulk of the materials used in the design of the research facility. The materials pallet should be restricted wherever possible to timber, glass and steel, as these three materials represent the lower scale of the embodied energy chart (except for Steel, which is still relatively low when compared with Aluminium, but should nevertheless be used sparingly). These materials should then be carefully connected to the existing concrete structure. Where possible, it would be ideal if the new structure remain separate from the old in order that there is the potential to reuse most of the materials when one the day such a need arises.

## 2.5 Theoretical Conclusion:

### A Critically Regional Response

No architecture operates within a vacuum; rather, every building should be created through discourse with a large context, from historical examples and traditional construction to current issues and debates. To attempt to produce a response devoid of this interaction would result in a design that is not reflective of its position in the global or local context. We see this less desirable response on a daily basis, in what French philosopher, Paul Ricoeur has termed 'elementary culture', he expands on this theory by declaring that: *"Everywhere throughout the world, one finds the same bad movie, the same slot machines, the same plastic or aluminium atrocities, the same twisting of language by propaganda, etc. It seems as if mankind, by approaching en masse a basic consumer culture, were also stopped en masse at a subculture level."* (Ricoeur in Frampton 1983a:16)

This elementary culture is a by-product of our globalising world. Globalisation is increasing, and the result is a homogeneous world culture. Since the early 1960's there has been much debate on an alternative to the sprawling cities and neighbourhoods that characterise so many developed countries, and continue to be the trend in the countries currently going through this supposed 'developmental' process.

The result is a concomitant uniformity of analogous features, similar in form and function, which in reality have origins that are perceptibly different. A 'placelessness' which has lead Fred

Matter to conclude that *“when in Rome...we should go to the Kentucky Fried Chicken stand”* (Matter 1989). The prevalent architecture in this ‘placeless’ world is one that is a product of a ‘placeless’ universal expression (Matter 1989) achieved through the standardisation in material, form, function and even spatial arrangement.

The result is an indistinguishable domain (Paterson 1995), which Kenneth Frampton calls the Megalopolis: the universal, centreless sprawl which is patently antipathetic to a dense differentiation of culture (Frampton 1983b:162). Rather than showing any respect for local culture, geography or climate, *“[the Megalopolis] intends, in fact, the reduction of the environment to nothing but commodity. As an abacus of development, it consists of little more than a hallucinatory landscape in which nature fuses into instrument and vice versa”* (Frampton 1983b:162). Matter describes this landscape as the product of a consumer society that has lost its sense of continuity, (Matter 1989) resulting in *“...the fragmentation of time into a series of perpetual presents.”* (Jameson in Foster 1983:125)

Kenneth Frampton proposes a rational response to this dulled down, homogenised world culture, a response which respects local culture, geography and climate: Critical Regionalism. Although the term was coined in 1961 by architectural critics: Alexander Tzonis and Liliane Lefaivre, the movement’s most prodigious protagonist has been fellow architectural critic Kenneth Frampton, who laid out the *Six points for an Architecture of Resistance*. (Frampton 1983a:16-30)

Roughly defined, critical regionalism endeavours to amalgamate the ingrained features of a region, including physical and cultural characteristics, with appropriate current technology. Ultimately, it is the search for an architecture that is meaningful within its micro-context, while concurrently participating in the more universal aspects of a contemporary, mobile society (Matter 1989).

This would be achieved where value is placed on the context, resulting in an emphasis on topography, climate, light and tectonic form rather than scenography, the production of a universally progressive, tactile architecture rather than the design of the visual. Were one to sift out the single most influential principle of critical regionalism, it would have to be a commitment to the creation of place rather than the mere provision of space (Frampton 1983b:162).

In his 1986 paper entitled *“Towards an Architecture of Place,”* Douglas Kelbaugh initiates a set of five criteria which he feels results in said place-creation. Criterion which would distinguish a critically regional response, from any other architectural creation: Love of Place, Love of Nature, Love of History, Love of Craft, and Love of Limits (Matter, 1986).

In the paper, he goes on to expand on each of the five essential elements which should be considered in the design of the facility:

1. **Love of Place:** *“What makes a place unique is worth celebrating and protecting with architecture: finding and keeping the difference that makes a difference”* (Kelbaugh quoted in Matter, 1986).
2. **Love of Nature:** *“By working together, architects, landscape architects and urban planners can fulfil an ecological role, namely to protect and preserve ecosystems, natural cycles, loops and chains and the symbiosis between organisms and their environment”* (Ibid.).
3. **Love of History:** *“A building type that has stood the test of time for many generations must be doing something right in terms of responding to building materials and practices, to climate, to social and cultural needs, to tradition, and to economy”* (Ibid.).
4. **Love of Craft:** *“The dry-walling of America has brought a slow and subtle loss of precision and substantiality in construction--the interior design equivalent of soil erosion.” “In the meantime, critical regionalists keep ripping off the fake plastic wood from their dashboards and refrigerator handles and insisting on real slate floors in their foyers”* (Ibid.).
5. **Love of Limits:** *“...critical regionalists keep designing modest, bounded, resource-conserving buildings”* (Ibid.).

## Chapter III: Precedent Studies

### Introduction

The inclusion of a wide range of local and international precedent studies offers a diversity which cannot be achieved through focussing on one particular building typology. For this reason, the buildings studied in this chapter are from across the globe, with each one offering something unique to the design research process.

During the selection of these buildings it was not seen as imperative that they share a similar biome, socio-political or topographical climate, or even that they house similar functions. Rather, the purpose of these studies is to identify designs which typify certain aspects of the architecture of the Environmental Research Facility, and to draw from these examples in order to ensure a better result.

The first project involved the rehabilitation of a brownfield site on the edge of a World Heritage site in Australia. The Queenscliff Centre by Lyons Architects, provides a number of intelligent responses to the architectural problems on hand. Of particular interest, as mentioned, is the site itself, as well as the connections with the environment and the intuitive passive solar design of the building.

In a completely different climate all together is the Behnisch, Behnisch and partners designed Institute of Forestry and Nature Research in a small town in The Netherlands. This building performs a very similar function to that of the Environmental Research Facility, while avoiding

the potentially clinical outcome so often achieved in laboratory-type buildings. The building achieves great user-controlled flexibility in a comfortable work environment with strong connections to the exterior. There is certainly much to be learned from this Dutch example.

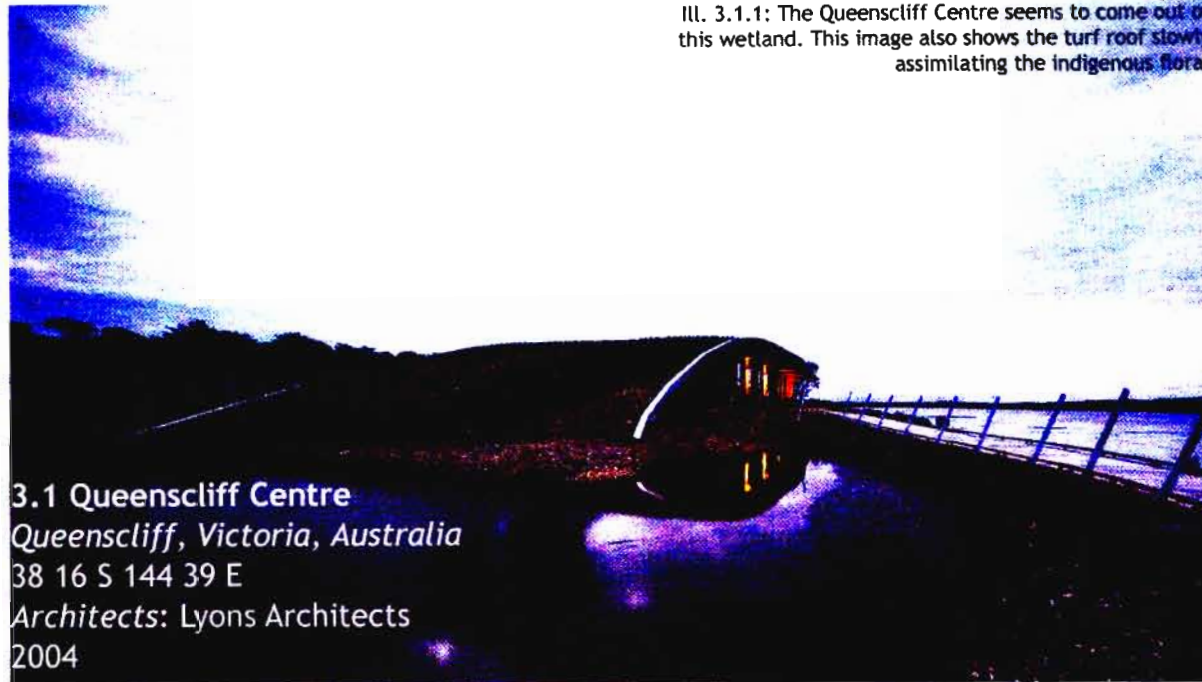
Across the globe in Bangalore, India is the JN Centre for Advanced Scientific Research designed by Charles Correa. Although this building has a similar schedule of accommodation, the focus was rather on the conceptual approach taken by the architect. The manner in which this building highlights the nature around it, is astounding.

A local precedent which offered much to the development of guidelines for an architecture which considers the life-cycle of the structures, is the OMM Design Workshop, Singita Lebombo Lodge in South Africa's Kruger National Park.

The last precedent study conducted, was of the Global Ecology Research Centre in California, USA designed by EHDD Architecture. The building is part of a university campus, and therefore share few climatic or topographical similarities with the research facility. The schedule of accommodation is however very similar. Of greatest interest though, is the arrangement of spaces and the passive solar design, as well as an inventive system for cooling and heating the building.

Each new studies provides something different to the last, and this diverse process has resulted in a number of applicable and helpful guidelines.





Ill. 3.1.1: The Queenscliff Centre seems to come out of this wetland. This image also shows the turf roof slowly assimilating the indigenous flora.

### Introduction

In the Australian state of Victoria on a corridor of dunes between the World Heritage Site of Swan Bay Tidal Wetland and Port Phillip Bay there was once a highly contaminated council garbage depot (van Schaik 2005:56). The spit of land joins the resort town of Queenscliff with the Australian mainland and local environmental campaigners wanted the site to be cleaned up and rehabilitated to its pristine state, while the Local Government wanted a project that was high-profile and demonstrated the benefits of research and the responsible management of environmental resources. The result was the Queenscliff Centre, a building that has brought these two conflicting aims to an amicable compromise (van Schaik 2005:56).

The Centre is the foremost marine research facility for Victoria, and above and beyond the government's wishes; it acquired a 6-Star environmental design rating. On the Australian scale 5-stars represent international best-practice while 6-star breaks new ground (van Schaik 2005:54). Rough estimates suggest that upfront capital required to achieve such a rating was a 10 percent increase to the overall cost (van Schaik 2005:56). However one must say that the long term savings should far exceed the costs had none of the systems been implemented (van Schaik 2005:56).

*"[One way of seeing it, is] that this building and its systems have inverted the future-eating tendencies of our culture and have enabled us to begin building a sustainable future."* (van Schaik 2005:56)



Ill. 3.1.2: Queenscliff, Australia



Ill. 3.1.3: The exterior façades have been treated to eradicate excessive heat gain, while maintaining views to the World Heritage Site.

Ill. 3.1.4: Exterior view at night





### Brief and Arrangement

The brief called for four main accommodation types: Laboratories, conference facilities, Marine Discovery Centre and administrative offices (van Schaik 2005:56).

The state of the art laboratories are the only part of the accommodation that had to be air-conditioned: due to the strict control requirements for experiments (van Schaik 2005:60). The air-conditioning system that was installed is a 5-star environmentally rated one which involves pumping sea water from in the Port Phillip Bay via underground ducts (van Schaik 2005:60).

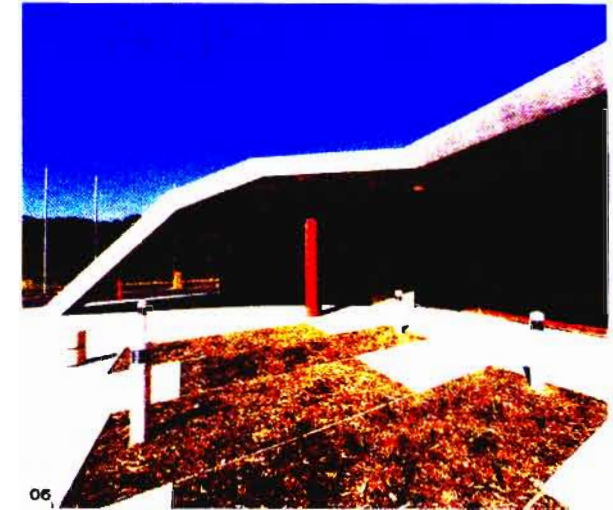
The Marine Discovery Centre is the educational portion of the brief. Here students and school

children can come and see marine life up close, in tanks, and engage in some simple experiments of their own. It is accessed by going around the front of the building along a timber path-this movement passage introduces visitors to the earth roof, the on-site wetland and the World Heritage site itself (van Schaik 2005:60). There are educational displays along a looped tour that visitors take, and the idea is that people will be more likely to conserve and protect, once they fully understand. Adjacent to the Marine Discovery Centre is a conference facility.

### Connection with the Environment

There is a continual effort made to connect the experience of the interior with views out to the

Ill. 3.1.5: An aerial image which shows the unique locality of the Centre. Swan Bay Tidal Wetland is on the right in the image, with Port Phillip Bay on the left.



Ill. 3.1.6: At various points along the buildings structure the Centre seems to 'come out of' the local soil.



Ill. 3.1.7: Interior showing the office workspaces

Ill. 3.1.8: Interior of the Reception area





Wetland, the reason the whole Centre is there in the first place (van Schaik 2005:60). This exposure to views starts from the entrance. As visitors make their way into the reception area they are faced with extensive views across the wetland (van Schaik 2005:60).

### Energy saving systems

The offices are 80 percent open plan-which allows for maximum cross ventilation through shutters on the north and south sides (van Schaik 2005:60). Aiding the natural ventilation of the building is a courtyard which runs the between laboratories and the offices. This means that the office space can be naturally ventilated without adversely affecting the air-conditioned spaces of the laboratories. The architects allowed for a larger than usual temperature range, from 19 to 25 degrees Celsius, this after the scientists who were going to inhabit the space had bought into working in this natural variation (van Schaik 2005:60).

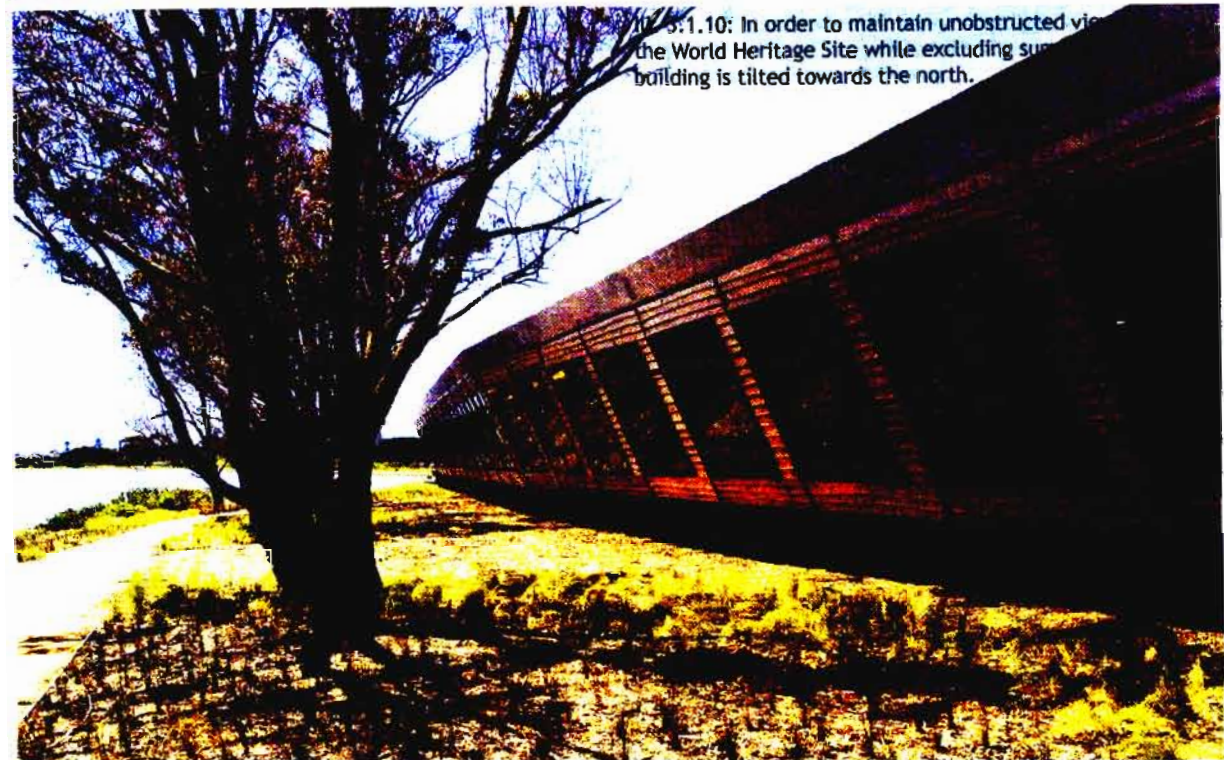
There is a higher than usual floor to ceiling height and the open plan also allows the building to take full advantage of the vertical temperature striations (van Schaik 2005:60). An additional benefit gained by the lack of full height walls is the views from the interior out to the Wetland. This again reinforces the connection between the two.

### Form derivation

The form is basically a flowing extrusion of the shoreline-from where the plan is derived. The building rises out of an on-site wetland, to the



Ill. 3.1.9: Drop-off area



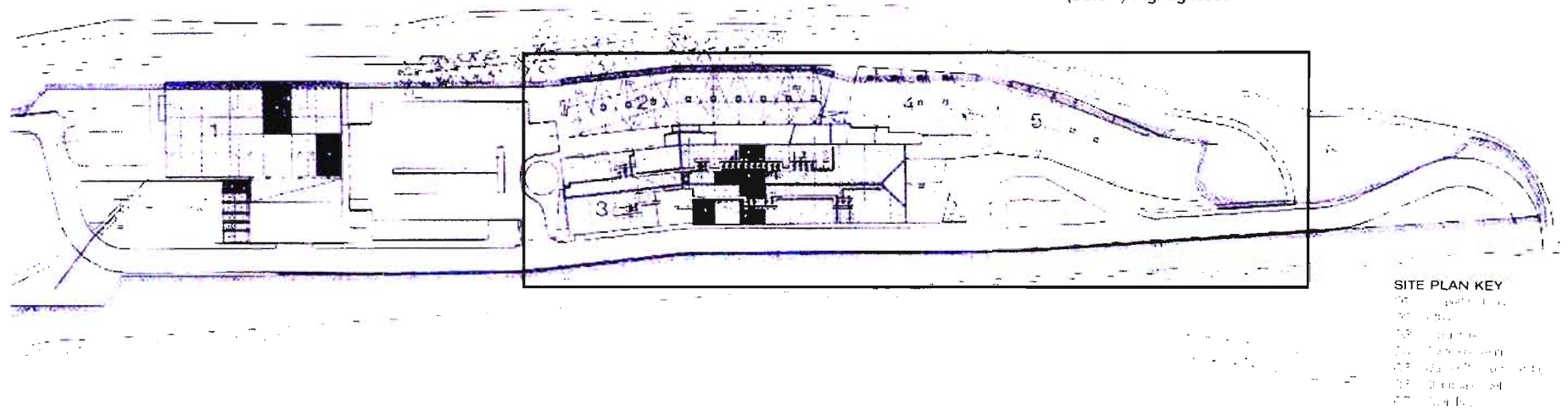
Ill. 3.1.10: In order to maintain unobstructed views of the World Heritage Site while excluding sunlight, the building is tilted towards the north.

east, and worms its way up the coastline (van Schaik 2005:56). The building is terminated by the large water collection tank, into which all leachate and storm water is collected, redirected and treated (van Schaik 2005:56). Collection occurs in this water harvesting tank, from where

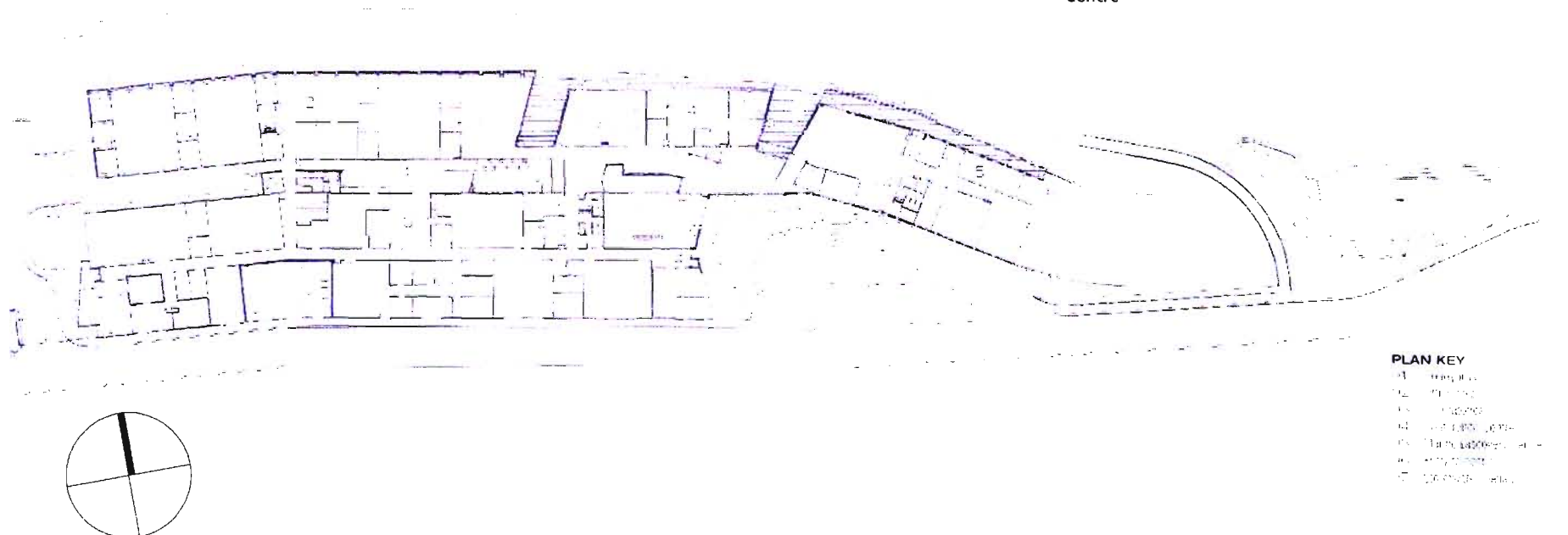
it is reused in the building's grey water system. Alternatively, collected water is treated in the man-made wetland system to the east. Once the water has met stringent requirements it is fed back into Swan Bay (van Schaik 2005:56). Fresh water is effectively like poison to a wetland



Ill. 3.1.11: Overall Site plan of Queenscliff Centre with plan (below) highlighted.



Ill. 3.1.12: Plan of Research area and Marine Discovery Centre



system, and as such this treatment process protects the natural heritage of the area (van Schaik 2005:56).

The roof is covered in 300mm of turf which is expected to slowly assimilate the local dune flora (van Schaik 2005:56), and also serves to reduce heat gain through the roof. Another intelligent solution to the problem of heat gain through direct sunlight is the canted north façade (van Schaik 2005:60). The length of the building is angled towards the summer insolation angle, the result being that all glazing along this edge is in shade all summer (van Schaik 2005:60).

#### **Regionally specific solution**

The architectural solution for the Queenscliff Centre is not a directly replicable or extendable system. It is entirely site specific. It captures, celebrates and gives physical form to the genius loci of the site. As Leon van Schaik puts it: *“Every site needs its own interpretation, its own design.”* (van Schaik 2005:60) The design offered by Lyons Architects of Australia is certainly site specific; one could not merely transplant it to another place, time or climate and expect the same response (van Schaik 2005:60). One could say that it is an environmentally regional response.

That is not to say that no lessons can be learned through the investigation of the Queenscliff Centre. There is much to be gleaned from the seriousness of purpose, and commitment to testing the alternatives before settling on the most suited solution. The Centre is a picture of what can be achieved, even on a garbage dump,

and if ecologically sensitive architecture can occur here, it can transpire anywhere.

#### **Conclusion**

As with all of the precedent studies, there are numerous lessons which can be learned from Queenscliff Centre despite the fact that its context is not identical to that of the research facility.

- **Regionally specific design**

The manner in which the architects have created a building which is inextricably linked to the specific site on which it is built, is admirable, and noteworthy. One thing about regionally specific design, is that it cannot merely be replicated, rather, it makes the challenge to determine the most relevant solutions for each and every site. Queenscliff Centre creates such a challenge for the design of the research facility.

- **Renewal of a brownfield site**

Following on from this, there is, in addition, the challenge to reuse sites which have already been damaged by human hands. In the case of Queenscliff, a garbage dump has been rejuvenated into a centre for the environment. With the design of the research facility, there is the opportunity to do a similar renewal of some previously affected, brownfield site.

- **Connection with the environment**

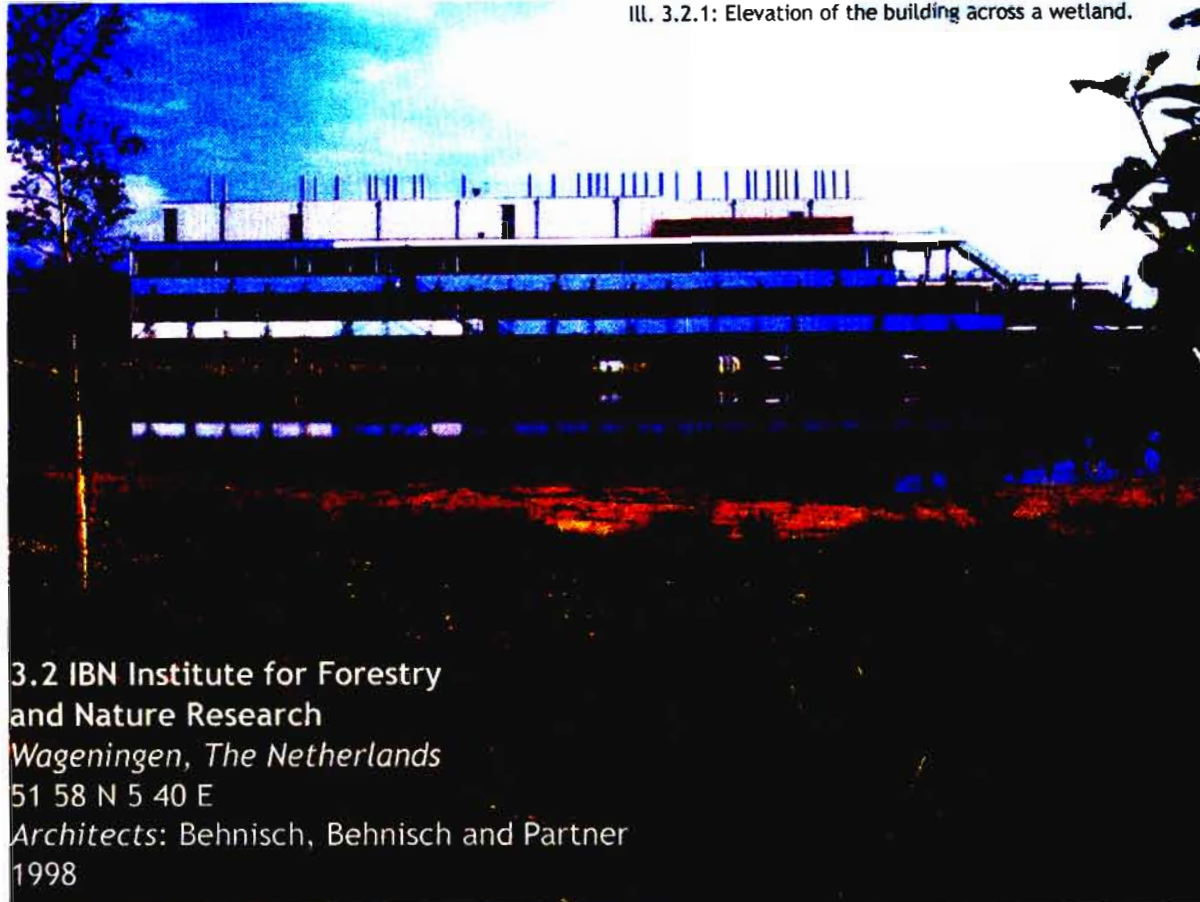
It was an express concern of the architect to highlight the surrounding environment. The local ecology and World Heritage Sites are the reason for the existence of both the Queenscliff Centre

and Environmental Research Facility, and for this reason it is important that the natural beauty is high lit at every turn. Furthermore, a connection to the local environment will spur visitors on to caring for these delicate biomes.

- **Passive Solar response**

In order to reduce the load on the local electricity supply, the Queenscliff Centre incorporates a variety of climatically responsive design techniques. These relate to the lighting, ventilation, cooling and heating of the building, and while the responses on that building are not to be directly replicated, there are numerous lessons to be learned. This need is given further weight in the South African context where basic infrastructure such as electricity is often stretched to the limit. The design of the Environmental Research Facility must consider this.

Ill. 3.2.1: Elevation of the building across a wetland.



### 3.2 IBN Institute for Forestry and Nature Research

Wageningen, The Netherlands

51 58 N 5 40 E

Architects: Behnisch, Behnisch and Partner  
1998

#### Introduction

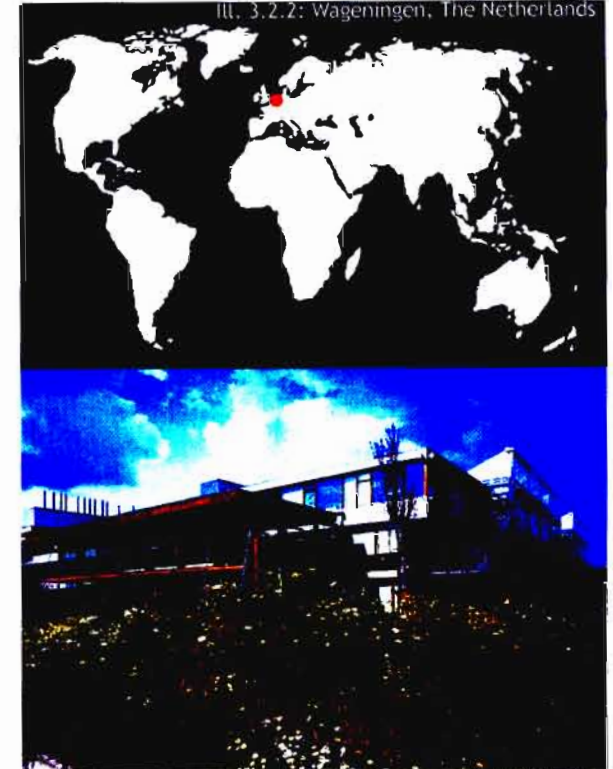
In 1993, the Dutch Ministry of Housing and the Environment organised an architectural competition for the design of a building for a newly formed government department: the Institute for Forestry and Nature Research.

The resultant building was to be a pilot project in sustainable and user friendly architecture. Through this came the main philosophies behind the brief requirements: an environmentally friendly building and a user-friendly building.

#### Brief Requirements

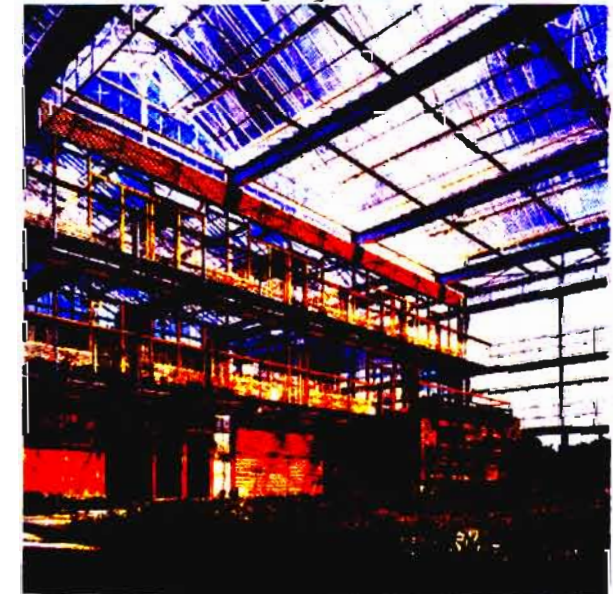
Environmentally it was to highlight the effectiveness, and availability of ecologically sensitive responses to regular architectural problems. No extra funds or incentives were made available; rather this project was to be achieved within normal cost limits and therefore act as an example for future developments. The competition called for a design that aimed to follow the ecological ideals laid out at the Rio Earth Summit of 1992 and although this was to be a primary concern, “empty eco-rhetoric was to be avoided” (Blundell Jones 2001:28).

Ill. 3.2.2: Wageningen, The Netherlands



Ill. 3.2.3: View of the exterior, with the now rehabilitated agricultural land in the forefront.

Ill. 3.2.4: The covered courtyards perform two functions: as climatic buffer and as regular gardens.





Meanwhile as a user-friendly design it needed to provide a working space that directly combated sick building syndrome. It would need to address issues of indoor air quality, spatial requirements, and visual and physical comfort. It was to avoid the current trend of aiming for a completely multi-functional and flexible space, which oftentimes occurs at the cost of the users comfort (www.hku.hk).

### Site Selection

After a careful selection process the site was chosen: a pasture that had become unusable due to over farming. Effectively this was not a pristine, untouched place, but rather land that had already been adversely affected by human hands. The rehabilitation of such fields is part of the Institute's work, and an opportunity was identified whereby the site and surrounding area could be treated like a 'rehabilitation case study' for the Institute. Due to these reasons, this was seen to be the best possible location for the design.

### Winning Scheme

The entry from Stuttgart based architectural firm: Behnisch, Behnisch and Partner was selected as the winning scheme. They explain their solution as being a low-tech building with a high tech result (Metz 2000:97). Stefan

Behnisch, the partner in charge of the project, underlined the two prevailing schools in the world of 'green' architecture when he said: *"There is the Norman Foster view, which says you can solve ecological problems with more technology, or the Soleri view that says: no technology. We're in the middle, but my sympathy is with Soleri. I don't want to change our lives or go back to the Stone Age, but if we are prepared to accept its warmer in summer and cooler in winter, I am convinced that we can attain an acceptable degree of comfort by following the rules of nature"* (Metz 2000:103).

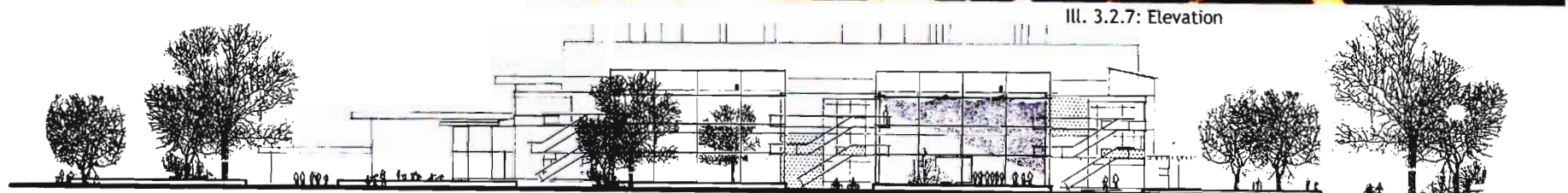


Ill. 3.2.5: Photograph showing the covered courtyard with two office wings either side of this climate regulating zone. The pond of collected rainwater acts as a source of evaporative cooling.



Ill. 3.2.6: A model of the building clearly showing the main circulation spine and the two covered courtyards.

Ill. 3.2.7: Elevation





### Life Cycle Consideration

Behnisch, Behnisch and Partner's design considers three phases in the life-cycle of a building: the building phase, the use phase and reutilisation phase (www.hku.hk).

- **Building Phase:** a responsible approach to material selection was imperative. Renewable materials such as wood were preferred over finite, non-renewable materials. Another concern was the reduction of embodied energy (Blundell Jones 2001:28). Waste was avoided wherever possible: as Behnisch says it is "...an ecological issue. Every nail you don't use goes to the benefit of the environment" (www.hku.hk). When the generation of off cuts and other outputs was unavoidable, the aim was to use or recycle the raw materials which would normally have gone to waste (www.hku.hk).
- **Use Phase:** this focuses on the effective management of energy, water and waste while the building is in use.
- **Reutilisation phase:** the third and final phase of a building's life-cycle was to be considered prior to the commencement of construction. Everything from future recycling of structural components and building materials to the ability to easily demount the entire building was to be well planned. There is also the possibility of the building being completely reused in the future (Blundell Jones 2001:28).

Everything from the choice of finishes to the position and footprint of the building were determined by these ecological and economic considerations. It is this restrained focus that leads Peter Blundell Jones (2001:28) to refer to the building as being principal- and not image-driven. The entire building flows as a result of this; form and function, inside and out, blur together to provide an 'image' that is entirely process derived.

### Planning

The plan is effectively an 'E' shape-with two gardens between three 'fingers' of offices. Within the spine along the northern edge of the building, are the laboratories: the only mechanically ventilated spaces in the whole structure and the primary circulation route. This arrangement articulates the two basic accommodation types and allows for a straightforward economical grid which means that the building is extendable if necessary, this could easily be achieved by lengthening



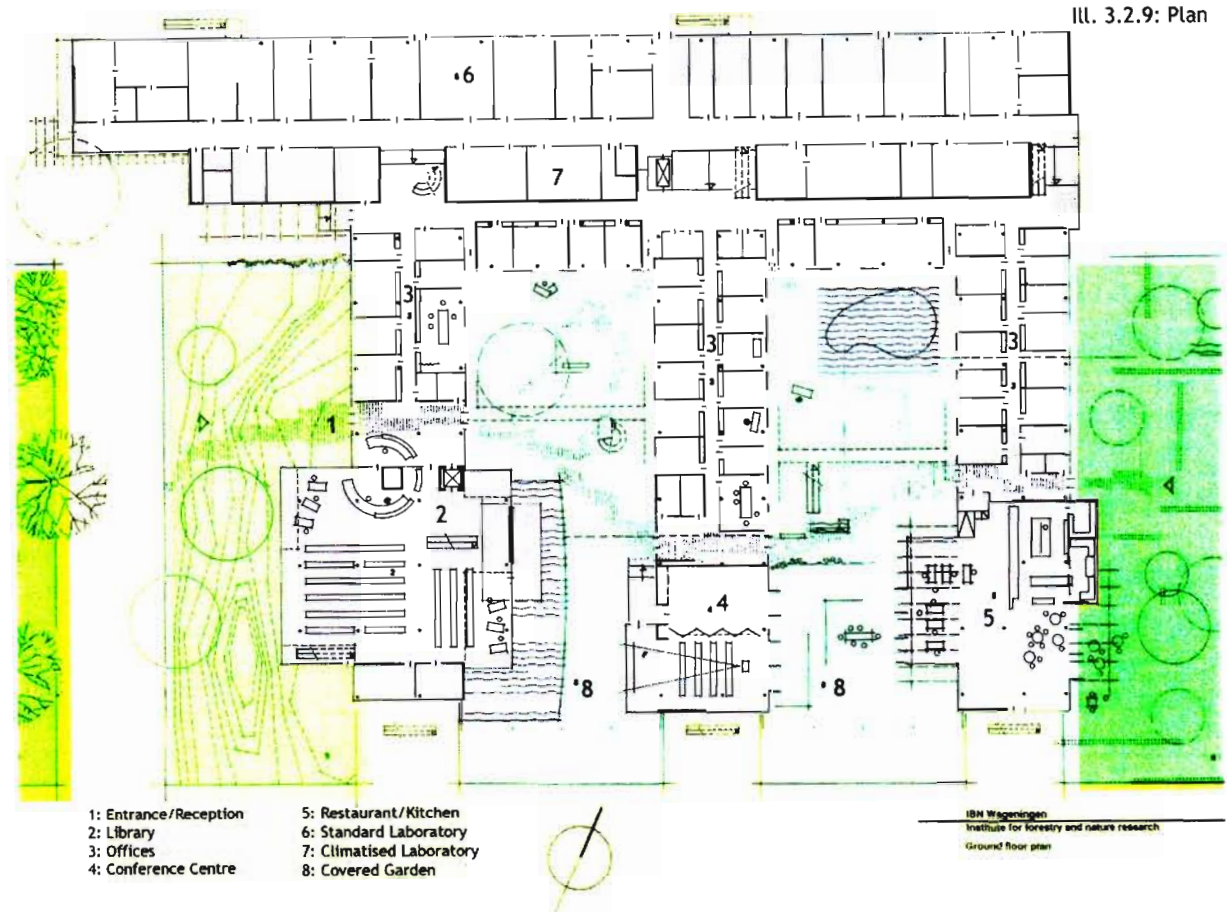
ILL. 3.2.8: View from the South-West showing the sun control on the west facade and the glass covered courtyards to the south.

the spine and adding more fingers (Blundell Jones 2001:28). At the termination of each of the three existing 'fingers' is a public amenity: library, cafeteria and conference suite. Although these facilities are planned using the column grid, they bulge out at the edges, expanding beyond the narrow wings to create terraces for the offices above (Blundell Jones 2001:31).

### Human Working Environment

Behnisch, Behnisch and Partner have always been commended for their commitment to providing humane office environments. They were not prepared to compromise on this just because they were not using air-conditioning throughout. Rather, they saw this as an opportunity to create offices for the Institute for Forestry and Nature Research that are as humane as any before. Daylighting was seen as integral in providing such an environment. Where central corridors occur, they are partly lit by high level glazing. Plan depth is kept to a minimum with functions rather occurring within a narrow section. The provision of these shallow spaces means that winter sun can penetrate deep within the offices providing daylighting for the majority of interior spaces.

Users are given more control than just having operable windows, rather, every office has: a glass fanlight looking to the hallway, and glass sliding doors revealing the garden courtyards: the major architectural innovation of the design and the secret to the entire heating/cooling system of the building.



### The Courtyards

The courtyards are roofed by off-the-shelf modern horticultural systems prevalent in the design of greenhouses in Europe. These negative spaces fulfill two major functions: as gardens, and as climatic buffers.

As gardens they are in a sense neither indoors nor out. Rather, they are treated as an extension of the interior spaces and are used for many functions: from experiments or meetings to lunch or reading (Metz 2000:97). This 'unity of space' was achieved through the intervention of American landscape artist Michael Singer, who

says that his "goal was to unify the outdoor and indoor architecture by means of pathways and gardens" (Metz 2000:97). This has been so successful that although the spine to the north of the courts is officially the main circulation route, the meandering path linking the three ground level public spaces has become more popular (Metz 2000:97). As the users make their way between the fingers by moving through these courtyards, there are spaces for chance meetings with visitors or colleagues; one can stop and share information or a conversation at any point along the way (Metz 2000:97).



The concept of covering the courtyards is not merely to provide an extension of interior into the exterior. There is a far more pragmatic rationale for their incorporation: they are an integral part of a seemingly effortless seasonal solution to the problem of heating and cooling of the building. The solution makes use of the seasonal changes themselves in order to efficiently deal with variations in temperature.

In summer adjustable sun blinds are closed over the courtyard space to reduce solar gain (Ill. 3.1.13). In addition large roof vents are opened to provide a thermal chimney. This makes use of the Venturi effect and as the hot air is drawn out at high level, the change in pressure means that cool air is sucked in through the crawl space in the north façade. This cool air from the north undergoes further temperature reduction through evaporative cooling (www.hku.hk): Approximately 7000 Litres of water evaporate daily. This water comes from the ponds and plants and escapes into the atria- this effectively humidifies the air, thus cooling it down. (Blundell Jones 2001:28)

During the summer nights the blinds are opened to allow the buildings and internal gardens to cool off as much as possible via nocturnal ventilation and radiation. Users are encouraged to leave doors and windows open at night, with the result being a cooler morning temperature than with regular air-conditioning; the interior temperature obviously rises as more and more computers are switched on, at this point

Ill. 3.2.10: The earth covered roof captures rainwater, while also providing mass to combat solar gain.



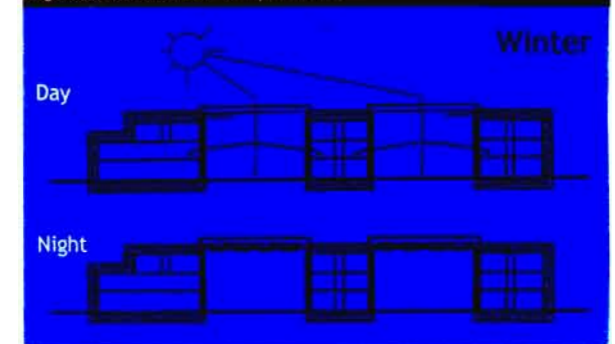
sensors which monitor light intensity cause the aluminium laminated roof sunscreens to close to prevent overheating (Metz 2000:97) .

During the winter months the cooling/heating system operates in reverse (Ill. 3.1.12). During these colder days the courtyards function much like regular greenhouses. The blinds are opened to allow the space to be heated up. This hotter air then flows into the building via the windows and sliding doors of the garden-facing walls. During the night the adjustable blinds are closed: the heat reflecting foil on the sun blinds means that the heat is kept in the building as it is prohibited from escaping by radiation during the night (www.hku.hk).

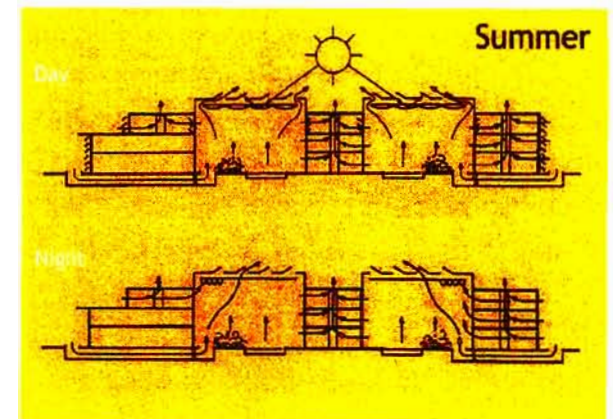
As climatic buffers the gardens provide so much thermal insulation it was possible to make 65% of the office outer walls from regular glass- this is as opposed to tinted glass. The result being that the offices can be largely lit by daylight, which reduces energy costs drastically (Metz 2000:97).



Ill. 3.2.11: The reflective aluminium blinds which help to regulate the diurnal temperature.



Ill. 3.2.12 and Ill. 3.2.13: Diagrammatic sections showing how the buildings climate regulating systems operate during the winter and summer months.





The roof is predominantly covered in earth and all rainwater runoff is reused in some way in the building to save water usage. It is either put into the grey water circuit for toilets, or used to top up the pools in the gardens. Whenever this runoff is not required it is stored in a tank on the north, therefore keeping it fairly cool since it is not exposed to much direct sunlight.

Where practicality and economics drove the selection of the off-the-shelf greenhouse roofing system, research prescribed the selection of all other materials in the design. Behnisch, Behnisch and Partner conducted research into various materials; focusing on areas such as embodied energies, environmental performance, possible toxic off-gassing, as well as ways in which they could be reutilized after their use in the institute.

Out of this principle, research driven investigation came some inventive solutions:

- All interior wooden surfaces were made from short planks to reduce waste.
- Wherever possible local woods were used to reduce transport cost
- Mass, earth-covered roofs helped

III. 3.2.14: Landscape plan of the two covered gardens



III. 3.2.15: Diagram showing the movement of heat out of the three wings, and into the covered courtyards which regulate the temperature and provide fresh air ventilating the building.





reduce solar gain

- No standard PVC was used, chlorine free plastic pipes were preferred
- Railings consist of a metal mesh connected between posts by standard mountain climbing clips
- Exposed concrete slab ceilings act as heat stores which stabilize the temperature.

The firm's intense scrutiny of all alternate materials led Peter Blundell Jones to highlight how difficult it is to completely avoid environmental damage. As an example he points to an example given by the ecologists housed in the building. They felt that the use of galvanised steel frames for glazing was unfortunate because of gradual run-off of toxic zinc salts (Blundell Jones 2001:28). We have made great strides in the last decade but the current trend of research and investigation must continue if we are to design buildings that are even more climatically responsive, while being even more ecologically sensitive.

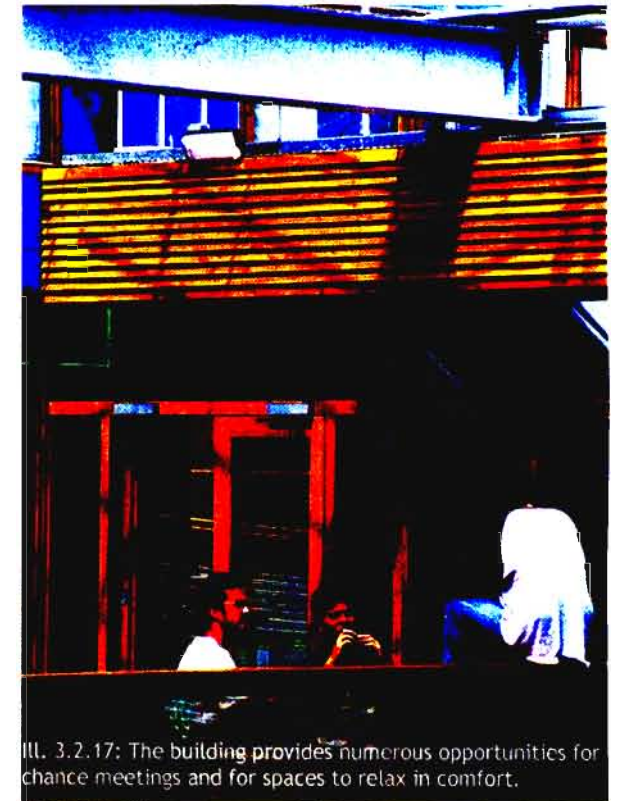
Once the winning scheme had been selected, the Dutch Government commissioned a team of experts to carry out an environmental audit on the building from phase one through three, effectively from 'cradle to grave'. It has been judged on all the prerequisites set out in the brief and it was reported that all targets have been fully met (Architettura Cronache e Storia 2003:654).

## Conclusions and Relevance

- Cradle to Cradle Response

Although this is a European example, there is still much that can be gleaned from the approach taken by Stefan Behnisch. There is an overriding attitude that has resulted in a building that is serious about sustainability and ecology. Of particular interest is the concept of designing from 'cradle to grave'. A subject greatly expanded in the book *Cradle to Cradle* (McDonough and Braungart 2002); in this interesting thesis the two authors suggest that being 'less bad' is no good. Their proposition is for a universal design ethos that thinks in a cradle to cradle mentality, where materials to not have to be 'down-cycled', but rather can be put to the same use, or better.

Ill. 3.2.16: The building is designed so that workers feel like they are almost in the courtyard while they work.



Ill. 3.2.17: The building provides numerous opportunities for chance meetings and for spaces to relax in comfort.

Ill. 3.2.18: The connection with the courtyards is always prevalent.





*"As far as we architects are concerned, it was an exciting challenge to demonstrate that architecture and ecology are by no means two separate and antagonistic entities. Ecology is taken very seriously here, and not, as often happens, just as a matter of paying 'lip-service'. I also found it is fascinating to design a place that turns out to be something more than the usual, a building capable of adapting flexibility to the set requirements and uses while being exposed at the same time to the non-Cartesian impact of nature."*

Stefan Behnisch (quoted in Architettura Cronache e Storia 2003:654)

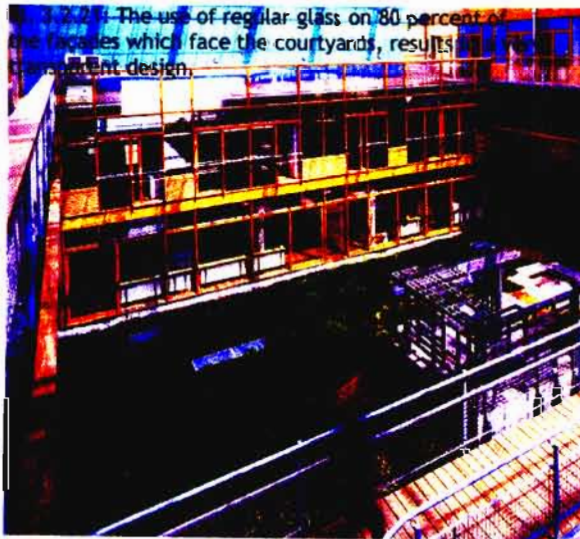


III. 3.2.20: Exterior view of the south façade.

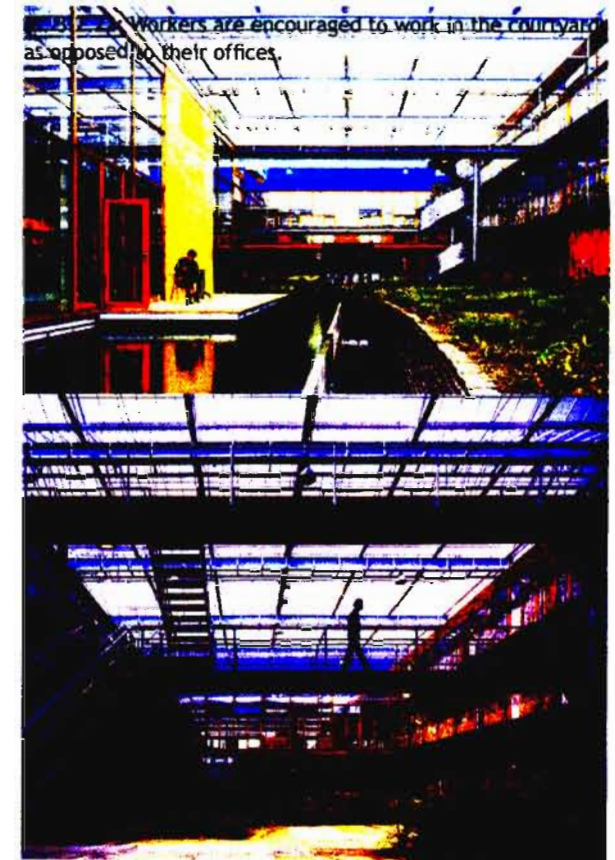


- User controlled flexibility

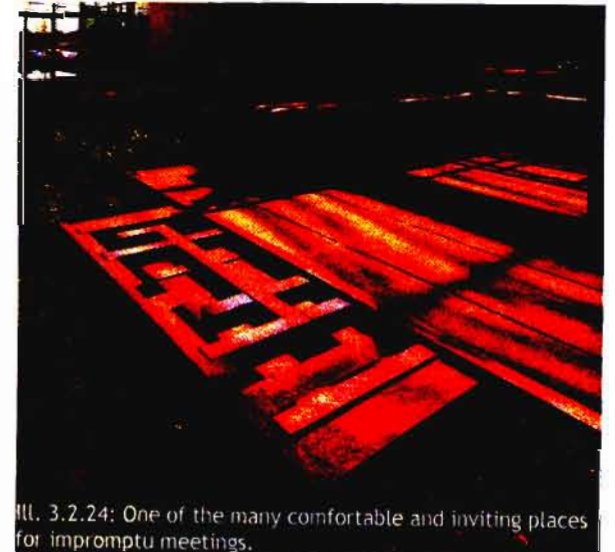
The flexibility of the building is enhanced by the flexibility of the users, who, by putting up with a slight temperature variation have facilitated a considerable savings of energy cost. In addition it is healthy and psychologically beneficial to experience the difference between day and night, summer and winter (Blundell Jones 2001:32). Stefan Behnisch has provided an example that runs contrary to the regular attitude of planning buildings indiscriminately and then using mechanical systems like air conditioning to ensure the comfort of all users. Behnisch shows us that we can be more intelligent in our initial choices, by building to welcome sunlight and daylight and providing adjustments against excess (Blundell Jones 2001:32). This building is one that is tied into the *genius loci* of its site: as the seasons ebb and flow, so too does the building. It is connected to a much larger context and its detail and sustainable choice making echoes this fact.



III. 3.2.21: The use of regular glass on 80 percent of the facades which face the courtyards, results in a transparent design.

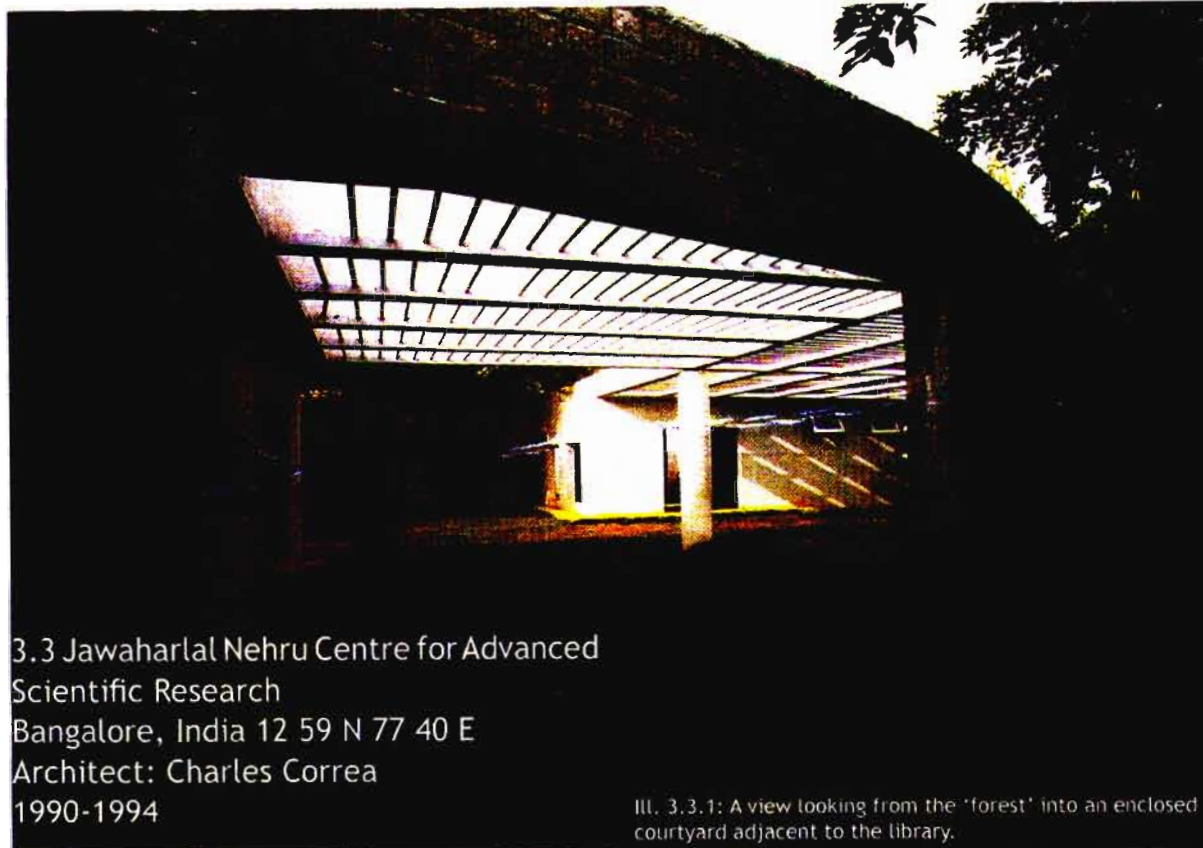


III. 3.2.23: The lush garden courtyards with overhead bridges connecting the office wings to one another.



III. 3.2.24: One of the many comfortable and inviting places for impromptu meetings.





3.3 Jawaharlal Nehru Centre for Advanced Scientific Research  
Bangalore, India 12 59 N 77 40 E  
Architect: Charles Correa  
1990-1994

*"Since time immemorial, holy men and scholars in India have renounced the world and gone to live a life of contemplation in forests and high mountains."* (Correa and Frampton 1996: 46)

#### Client and Brief

In 1990 when Charles Correa began work on the design for the Jawaharlal Nehru (JN) Centre for Advanced Scientific Research this idea, of the holy men retreating into nature for clarity of thought was taken as the starting metaphor for generating the concept and layout of this research campus. The client for the project was the Indian Institute of Science, a very well respected Institute and the brief was for the provision of research facilities

III. 3.3.1: A view looking from the 'forest' into an enclosed courtyard adjacent to the library.

and accommodation for distinguished visiting scientists and scholars. In addition to these facilities there was a library, lecture halls and an administrative component, while a service road provides access to all facilities by skirting the back of the site.

#### Symbolism and Concept

The aforementioned, traditional renunciation of the world by Indian *rishi* (holy men) is given physical symbolism through the design of a granite block wall which encircles a forest in the centre of the site. The meandering wall effectively divides the site into two regions- 'the world' and 'the forest'.



III. 3.3.2: Bangalore, India

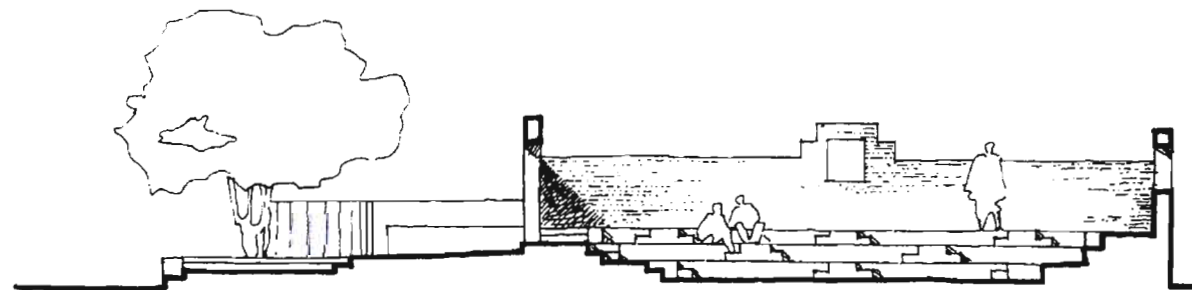
III. 3.3.3: View from a walkway into the sanctity of the 'forest'.



Perforations of the partition occur at various points along its length, with the result being that during the course of their studies and research; the scientists- who Correa sees as 'the new *rishis*'- step across this figurative division, into the forest for enlightenment and wisdom. Extending this concept into the arrangement of built forms, we see the library-the ancient symbol of knowledge-'break through' the containment of the wall. The result is the establishment of a closer relationship with the forest. So the border; between the 'worldly' source of researched information and facts, and the contemplative knowledge and wisdom to be found in the forest, is blurred, but not wholly broken.

### The Kund

A further function that 'breaks through' the division of the granite wall is the *kund*, which is placed within the forest itself. Traditionally, *kunds* play a very specific, very important role in India. They are effectively rectangular water ponds where the faithful come for ritual purification before worship and are thus generally located next to temples. The orientation of the *kund* in the environment is precisely determined by the cardinal points of the compass. The sides consist of geometric patterns of steps which surround the body of water. During the seasonal monsoon, the water in the *kund* is full; whilst during the hotter months the water level recedes, to reveal more and more steps. This does not, however, adversely affect the relationship of the devotees with the water; rather, it allows them to perform their sacred rituals along a new layer of steps. To stop the explanatory sketch at this point would do a great disservice to the metaphysical nature of the *kund*; their form is derived from the *vastu-purush-mandalas*, ancient Vedic diagrams which envisage architecture as a Model of the Cosmos. Like many aspects of India, these diagrams are both contemporary and ancient, both pragmatic and metaphysical. The *mandalas* physical form



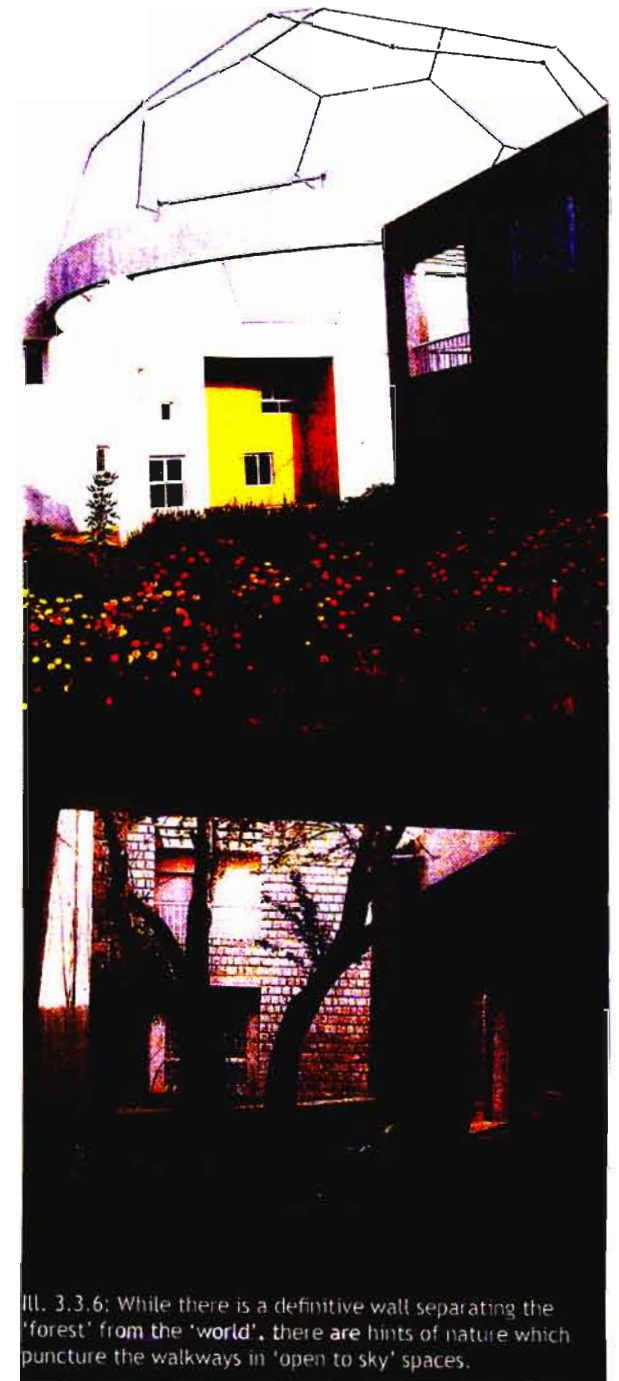
Section

and that of the *kund*-seems timeless. (Correa and Frampton 1996: 186)

In 1986 Charles Correa designed a *Surya Kund* in Delhi for a futurologist who hosts think-tanks on various social and political issues concerning India. There is no water incorporated in that design, rather it is "a place where one comes to think-and hopefully purify!-oneself." (Correa and Frampton 1996: 186) There are certainly similarities between this *Surya Kund* and the *kund* in the forest of the JN Centre for Advanced Scientific Research. There is a clear parallel being drawn between ancient religious temples for worship and the modern 'temple of science' represented by the Research Centre. That the *kund* is located in the forest, the symbol of contemplative knowledge and wisdom, is also a clear clue: this is about the power of the mind. It is without doubt a very singular viewpoint. To draw a comparison, in the African context the focus is on community as opposed to the power of one. Rather than one person in the forest, contemplating life and nature, we see a collection of elders under a tree. This is the African source of guidance and decision-making; this is the local paradigm of an Indian *kund*. This idea is most

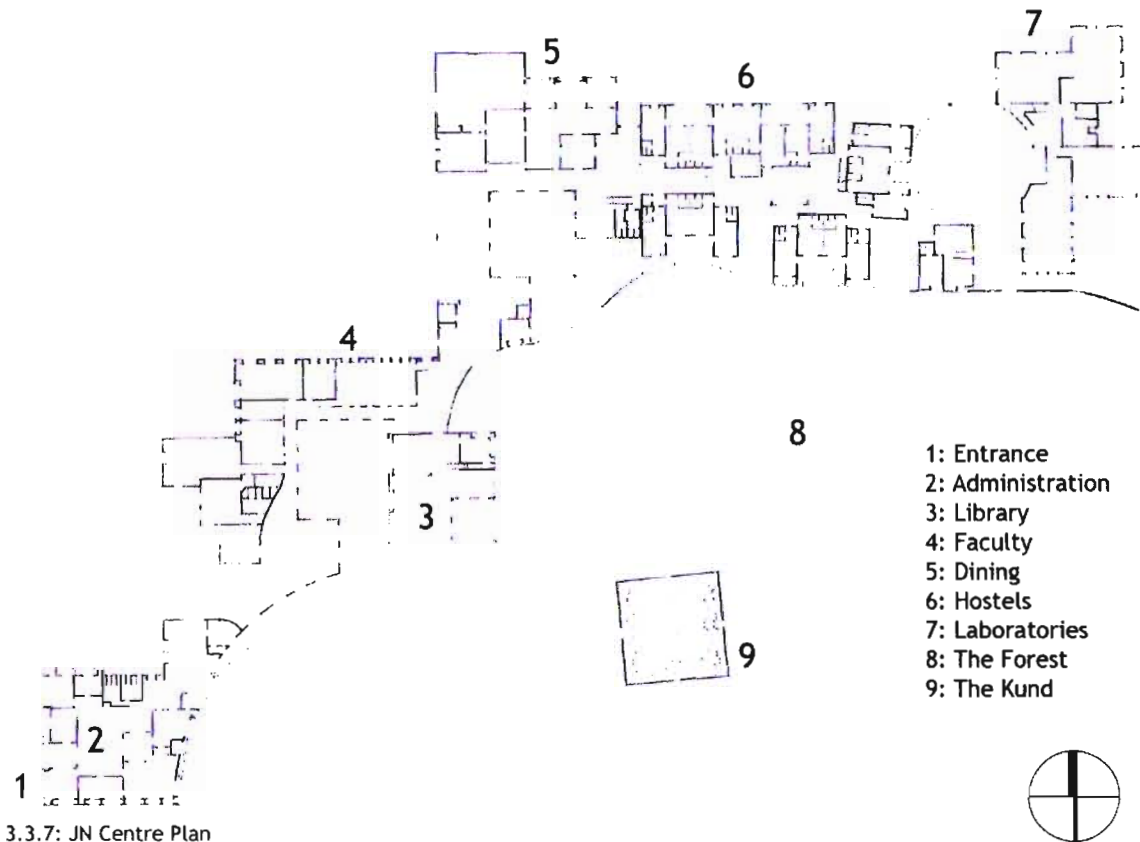
Ill. 3.3.4: Section through a typical Kund.

Ill. 3.3.5: Buckminster-Fuller's geodesic dome appears as Correa pays homage to a scientific 'giant'.



Ill. 3.3.6: While there is a definitive wall separating the 'forest' from the 'world', there are hints of nature which puncture the walkways in 'open to sky' spaces.





III. 3.3.7: JN Centre Plan

notably expounded in the recent design of the Constitutional Court for South Africa by OMM Design Workshop. The mantra of that design was “African justice under a tree”; a concept carried through to the selection of artwork and floor finishes.

### Juxtapositions and Contradictions

The JN Centre is a design full of juxtapositions and contradictions. The wall continually acts as the barrier that sharply divides two sides of a very different coin; we see the juxtaposition between the landscaped, controlled environment of the built area, as opposed to the wild, uncontrollable ‘forest’. There is a sense herein that this is about

the sacred and profane—where the forest is seen as pure and inhibited, while there the world is seen as somehow tarnished: the worldly and the natural. There is an attitude of exclusion, not inclusion. The natural world is not seen as part and parcel of the daily lives of researchers, but rather as a source of quiet, serenity and peace, and yet despite this division there is still a very strong connection. This is best summed up through the theory which Correa calls “open-to sky space”. There is the frequent juxtaposition of a closed space with a space that is connected with the sky.



III. 3.3.8: African justice under a tree.

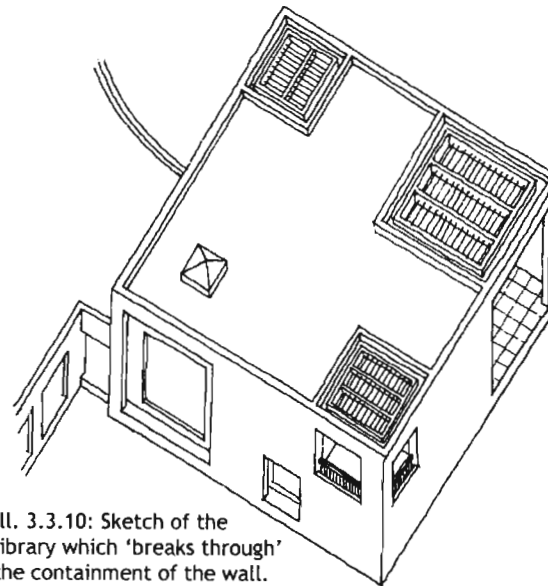
III. 3.3.9: A view of the wall dividing the ‘forest’ on the left, and the ‘world’ to the right.



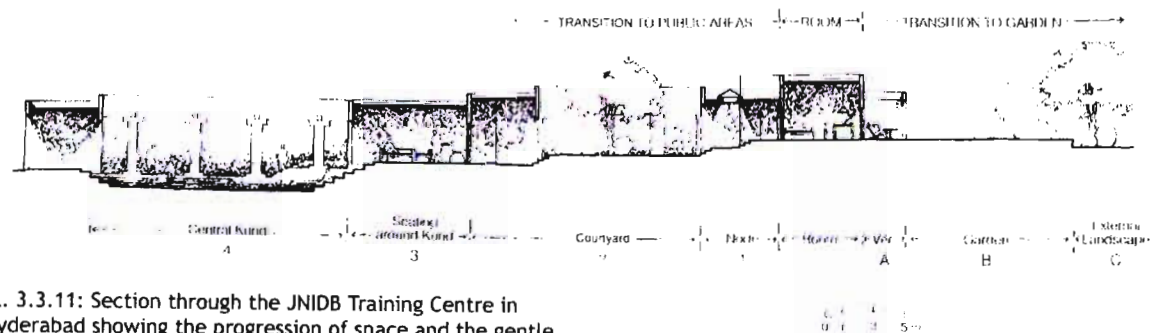
At this point it would be most helpful to juxtapose the harsh division between man and nature in the JN Centre, with another design by the Indian master: Correa. In the conceptual planning for the JNIDB training centre in Hyderabad we see a much gentler connection with the natural world; we see a calm transition rather than the movement through a perforated screen. The edge is blurred. There is no longer the distinctive line across the site. The concept here is that one experiences 'the forest', to varying degrees, within the confines of the Training Centre. The forest is embraced. Correa uses a succession of courtyards connected by a pathway which meanders through the Training Centre. The courtyards represent the forest within the confines of the Centre; they are used for as public spaces, for social gatherings. It could be argued that this is a more African tradition where Nature and Man live in harmony, living without harsh borders. That as opposed to a granite wall forming a wall through which all must pass. There is a transition from this public space to the more private spaces such as the single hostel room, and finally to the forest, where the solo *rishi* may escape to ponder all things.

## Conclusion

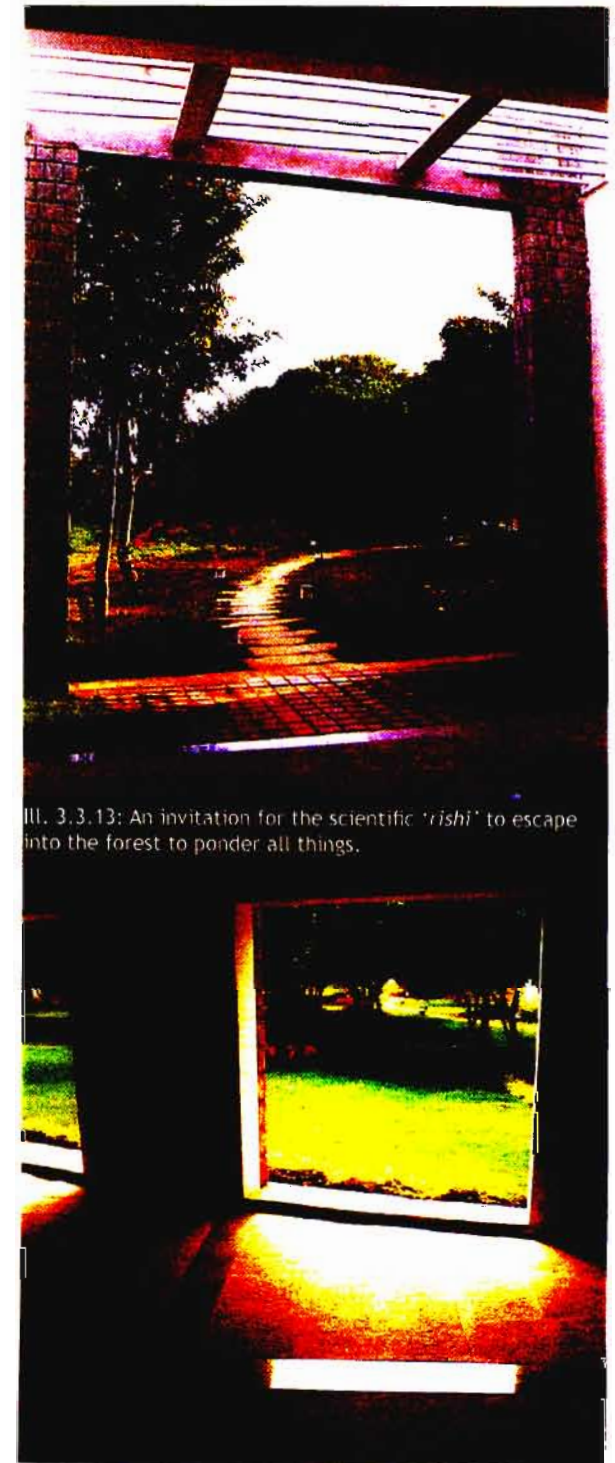
In a very different manner, Correa suggests a way in which such a building and its users can be 'connected' to the surrounding environment. By separating the two realms, the architect has managed to highlight the beauty in each. Symbolically this is achieved by the figurative forest and dividing wall, and while this may not be the exact method adopted in the Environmental Research Facility, it still aids in the formulation of a conceptually strong solution.



Ill. 3.3.10: Sketch of the library which 'breaks through' the containment of the wall.



Ill. 3.3.11: Section through the JNIDB Training Centre in Hyderabad showing the progression of space and the gentle transition between the forest and the courtyards.



Ill. 3.3.13: An invitation for the scientific '*rishi*' to escape into the forest to ponder all things.



**3.4 Singita Lebombo Lodge**  
 Kruger National Park, South Africa  
 24 50 S 26 10 E  
 Architects: omm Design Workshop  
 2005

**Site and Brief**

Singita Lebombo Lodge is a 5-star resort in the world famous Kruger National Park in South Africa. The site is set against the backdrop of the Lebombo Mountains, which run along the border between South Africa and Mozambique and is bordered by the N'wanetsi and Sweni Rivers. The land is not owned-but rather the Kruger National Park allowed a concession of 20 years, a major design determinant, of great interest to the problem of development in an ecological sensitive region. If a building is designed with the end in mind, it completely affects the construction methods selected, and the design approach taken. The question is not: 'how long

ILL. 3.4.1: Interior of living space showing the incorporation of dappled light which echoes of the shade of the local trees.

is the concession, how can we best exploit our opportunity?', but rather: 'how can this building reduce environmental impact in construction, and how can it be easily removed once it is no longer viable, necessary or effective?' This question is not reliant on length of time, it may just as well be 10 or 50 years, rather, it is dependent on an attitude of preservation.

**Overview**

The solution offered by Design Workshop is an insightful one; type of structure and positioning of the structures were key site usage determinants. All indigenous plant material and sensitive site features we vigorously protected. Wherever

ILL. 3.4.2: Singita, South Africa



ILL. 3.4.3: The individual units perched in the local landscape.

ILL. 3.4.4: Interior photograph



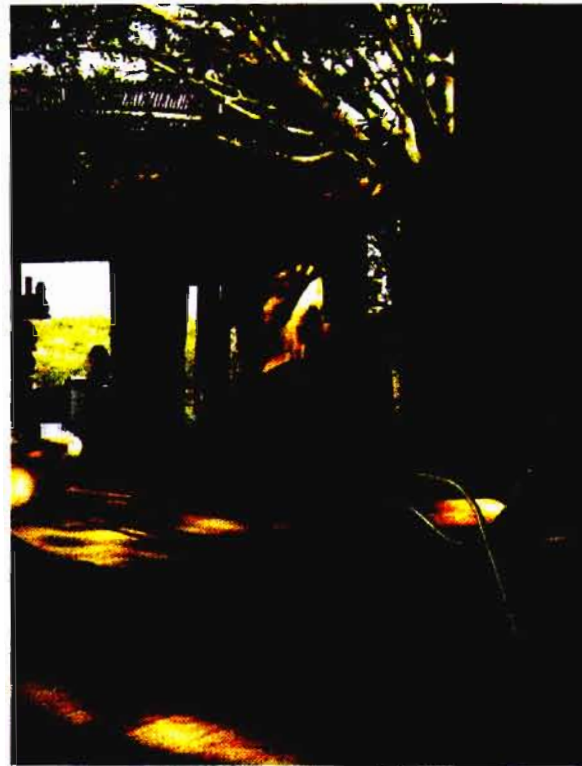


necessary the buildings were constructed on stilts. The 20 year lease was taken seriously by all involved, and the outcome is a design driven by a desire to protect our natural heritage. In a resort where patrons get almost anything at a whim, water usage is restricted, again highlighting the commitment to touching or affecting this earth lightly.

### Architecture and Environment

The design is of further interest because it is local, and in a similar climatic region. Passive solar design was incorporated throughout-the solution was to reduce most spaces to just one room thick, which allows for maximum natural cross-ventilation. Roofs over sail to protect the interior from direct sunlight, rather allowing for dappled light to dance across the interior spaces.

Secondly, this arrangement of functions dictates that there was a strong connection with nature and views in particular, from all spaces. There is a sense of place, it is not an ordinary lodge, but rather one that makes a definite attempt to



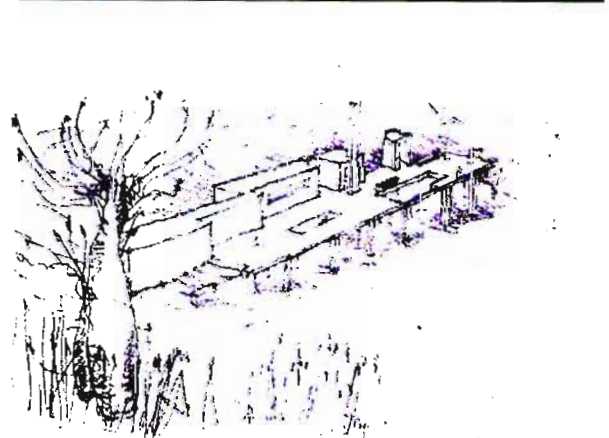
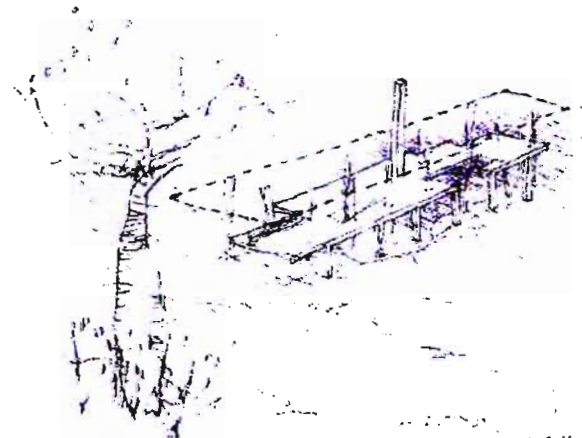
Ill. 3.4.5: The spaces between the main buildings are treated as connections between cover and as extensions of the interior.

Ill. 3.4.8: This series of sketches shows the conceptual progression of the construction from start to finish. They also highlight the respect shown for the local land, as the structure seems to float over and above the ground.



Ill. 3.4.6: Interconnected forms.

Ill. 3.4.7: Connection to the environment through views is encouraged wherever possible.



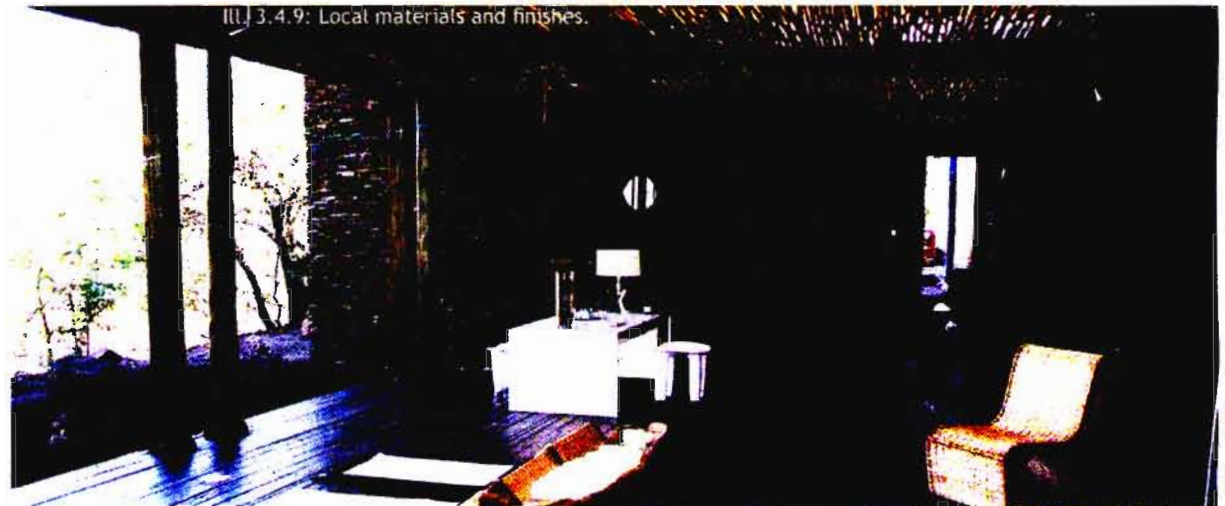
capture the *genius loci* specific to the Lebombo ridge. This can again be demonstrated through the example of the dappled light as it echoes of the 'shade of the trees and the traditions of place-making in the area' (Cooke 2006a:12).

### Local Labourers

Commitment to this 'sense of place' is further demonstrated by the fact that many local labourers were used in the construction of the lodge. The concomitant result is a transfer of skills and Julian Cooke reports that the local community has been positively affected due to the economically sustainable approach taken in the construction process (Cooke 2006b:25).

### Local Technology

The technology employed is a natural product of the sustainable method employed. There is a contrast that exists-at points the Lodge is built *into* the landscape with heavy walls, while at others it appears to effortlessly float *over* it, touching it lightly.

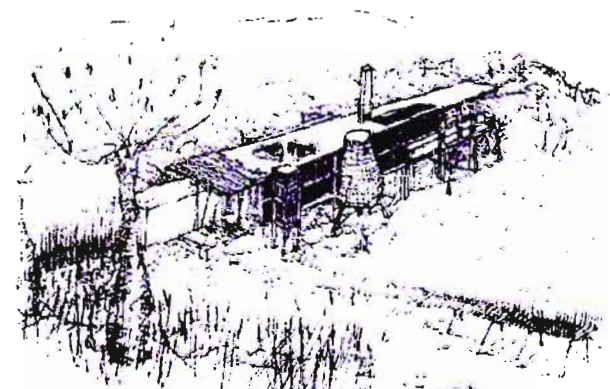
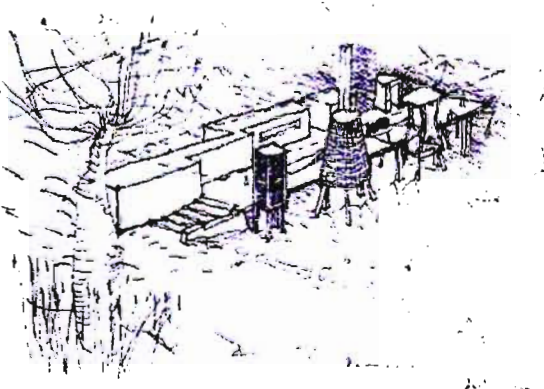
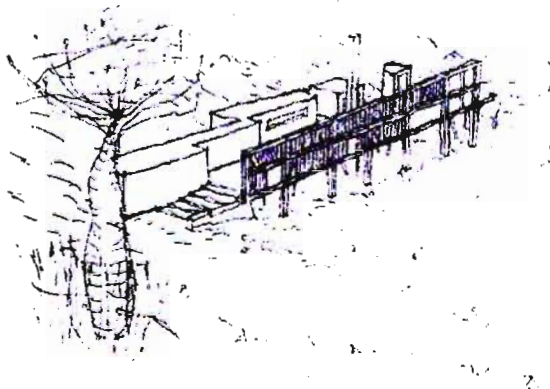
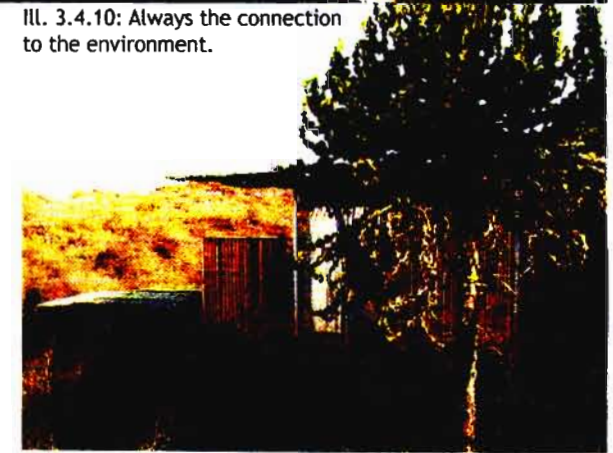


III. 3.4.9: Local materials and finishes.

### Conclusion

This building highlights numerous opportunities for a relevant and responsible architectural response to complex and sensitive ecological problems. There is an active commitment to the creation of place through the use of local labour and materials, with the result being a responsible architecture strongly connected to the land. In addition, the sensitive technological approach is noteworthy. South Africa needs more buildings of the same ilk.

III. 3.4.10: Always the connection to the environment.



III. 3.4.11: Continuation of the progression sketches.



**3.5 Carnegie Institution of Washington:  
Global Ecology Research Center**  
Stanford University, Palo Alto, California,  
USA 37°27'N 122°10'W  
Architects: EHDD Architecture  
2004

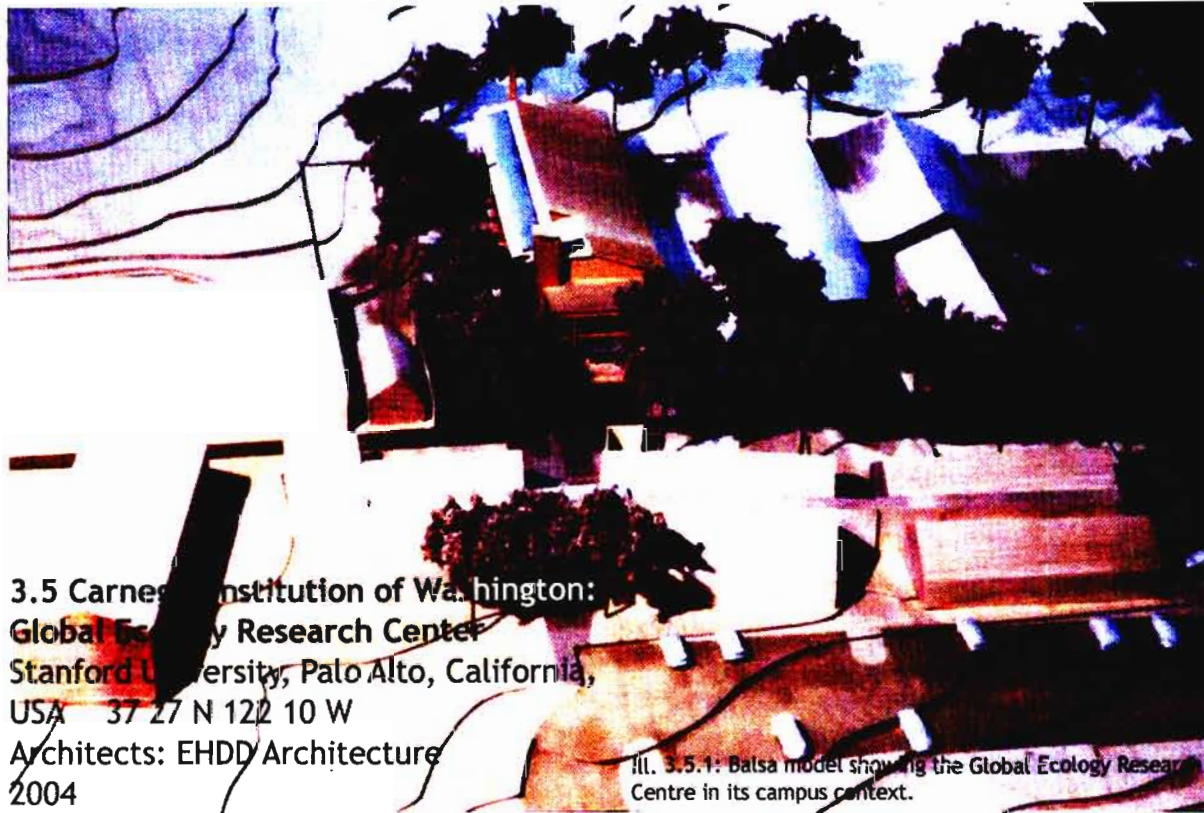
**Project Background and Client**

The Global Ecology Research Center at Stanford University in California is a low-energy laboratory and office building for the Carnegie Institution of Washington. The Centre falls under a new arm of the Carnegie Institution: the Department of Global Ecology. Their mission is to conduct basic research on the interactions between the earth's ecosystems, land, atmosphere and oceans ([www.aiatopten.org/](http://www.aiatopten.org/)). Research conducted by the Department shows that the most pressing environmental issues are global climate change, biodiversity and water issues. It was as a result of this understanding, that this building was to act local while thinking globally, thus becoming a case

study as a laboratory that reduced carbon impact and addressed biodiversity and water issues. All this whilst still providing laboratory and research spaces that meet the highest standards of comfort and performance. There was no option to forfeit such values due to environmental concerns; rather, both should be achieved to a ground-breaking level. The building is typically occupied by 50 people at one time with an average of 15 visitors per week ([www.aiatopten.org/](http://www.aiatopten.org/)).

**Brief and Site**

There were two potential sites within an existing collection of structures housing the Carnegie Institute's Department of Plant Biology. The



Ill. 3.5.1: Balsa model showing the Global Ecology Research Centre in its campus context.



Ill. 3.5.2: Palo Alto, USA

Ill. 3.5.3: Exterior view showing dual functioning sun control and light shelves as well as the operable windows in the first floor office space.





Ill. 3.5.4: View of the building from the plaza in front. One can see how the doors into the foyer open up to create one continuous, connected space between interior and exterior.



choice was between a mature oak woodland and a paved utility zone. The selection of the more difficult, paved site was driven by a commitment to rehabilitate brownfield sites and to avoid construction in an area where damage to fragile ecosystems could not be avoided ([www.aiatopen.org/](http://www.aiatopen.org/)). This site also provided the architects with the opportunity to improve contact and circulation between these two departments, while concurrently activating the exterior by creating an outdoor collaboration space ([www.aiatopen.org/](http://www.aiatopen.org/)).

The brief was to house the Laboratory and Office requirements of the Department in a small design (1000sq.m), which would be built to last 100 years ([www.aiatopen.org/](http://www.aiatopen.org/)). The response is a carefully considered response to the conditions of the site, both climatic and urban, and shows a commitment to a responsive architecture by including various intelligent solutions.

#### Flexibility and Adaptability

Due to the nature of the Department's research programs, flexibility over the short and long term was of utmost importance. The researcher's time



Ill. 3.5.5: High level view of the foyer with the doors closed.

Ill. 3.5.6: The open work spaces have an exposed structure, which creates a higher floor-to-ceiling height and allows for maximum servicing flexibility.





is divided equally between the field, office, and carrying out of laboratory work, and the spaces therefore needed to allow for the expansion and contraction of research teams. It also meant that there was a need for an informal sharing of space, that as opposed to a more rigid separation of resources. This adaptability was achieved through various simple, yet highly effective means. Firstly, a clear-span structure allowed for flexibility of the open plan office space below. The original request was for a cellular office arrangement, but it was decided that this was too prescriptive and did not allow for the shrinking and expansion of spaces as required ([www.aiatopten.org/](http://www.aiatopten.org/)). Additionally, a standardised lab layout was selected. This meant that with movable benches and shelving, the lab spaces could be transformed to serve a variety of functions. Overhead in these lab spaces there is an exposed steel structure allowing for easy reconfiguration of services and spaces as the researchers requires change ([www.aiatopten.org/](http://www.aiatopten.org/)).

This commitment to adaptability was taken right down to the details. Connections between materials in the windows, roofing, and flashing were designed so that their disassembly would not affect adjacent finishes. While the timber siding is fixed with exposed screw-heads to allow for this material to be re-used elsewhere in the future. ([www.aiatopten.org/](http://www.aiatopten.org/))

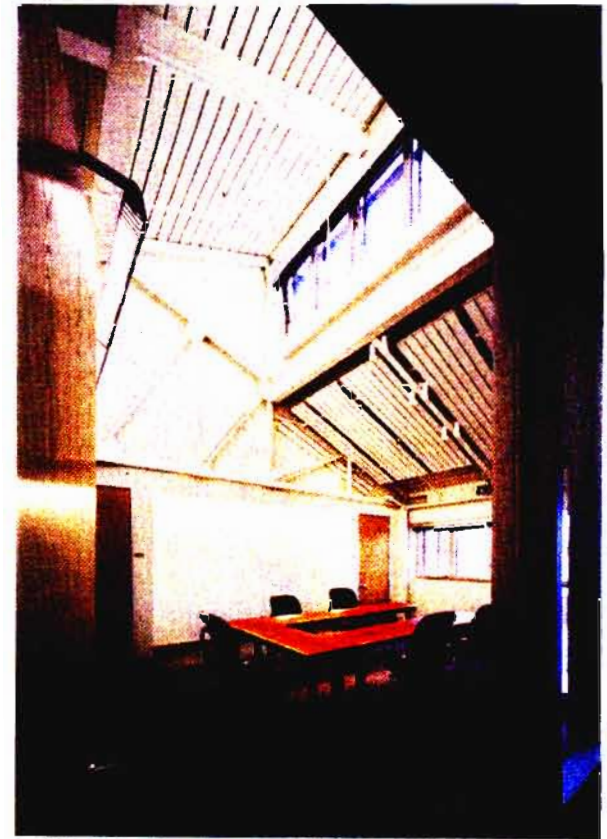
### Ventilation

The accommodation provided is not too complex, basically consisting of the laboratories (and associated spaces), the offices, meeting rooms and a small conference facility. The design team

chose to arrange the facilities into two stories, which reduced the amount of site area required while also allowing for the dramatically different cooling and ventilation requirements to be addressed separately ([www.aiatopten.org/](http://www.aiatopten.org/)).

The upstairs office spaces are naturally ventilated through a south-facing clerestory equipped with operable windows for maximum occupant-control. In addition to the operable windows on the north and south facades there are casement windows that open to the west to enhance ventilation from prevailing northwest breezes. There are thermostats in the office spaces which show both indoor and outdoor temperatures, which means that occupants can make informed decisions about the most suitable ventilation method in any climatic condition ([www.aiatopten.org/](http://www.aiatopten.org/)).

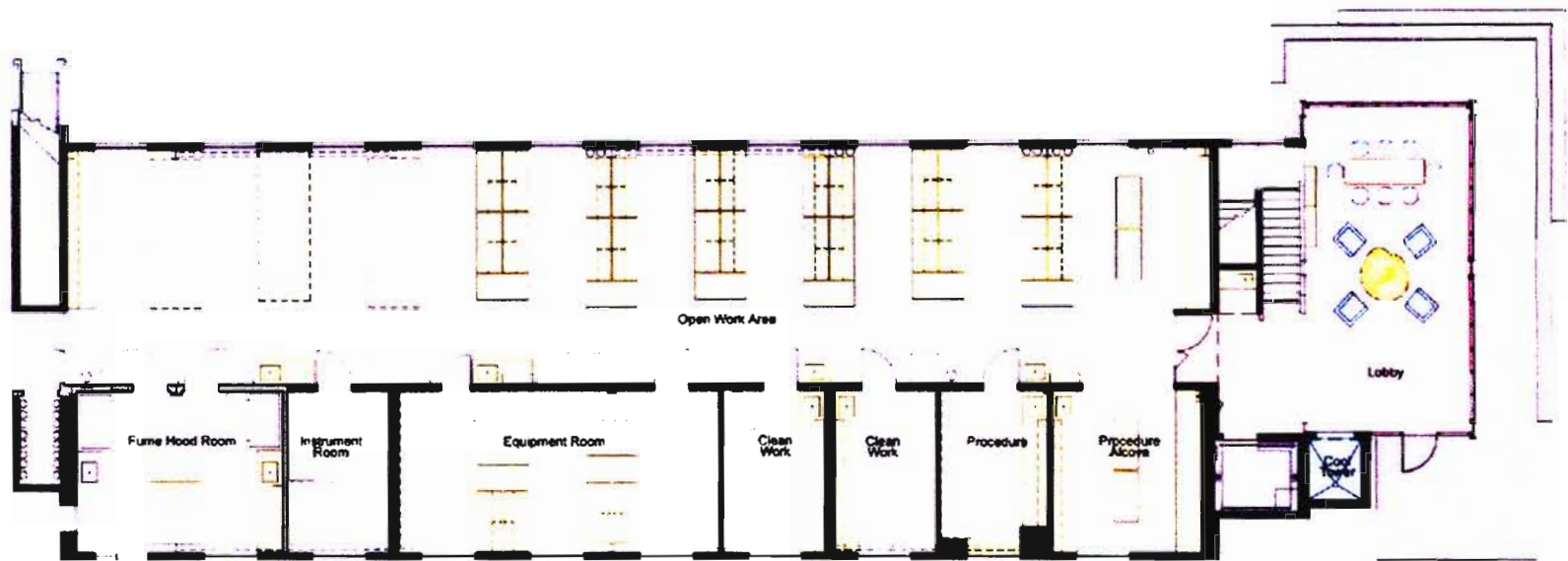
Downstairs, the ventilation and cooling requirements for the laboratory areas dictate that there is more control than merely operable windows. All of the air that enters the laboratory passes through either 85 percent efficient filters, or 99 percent efficient HEPA filtration systems, and then enters a cascading air flow through the lab spaces. This means that this mechanically moved, natural air is first supplied to non-critical laboratory areas (those with no chemical use), and then cascaded through critical areas (fume-hood rooms) before being exhausted ([www.aiatopten.org/](http://www.aiatopten.org/)). The result is that approximately 20% less air is moved, thus reducing the energy required for ventilation. Energy is further saved through an intelligent design whereby the ventilation rate is lowered when the lights are turned off at night.



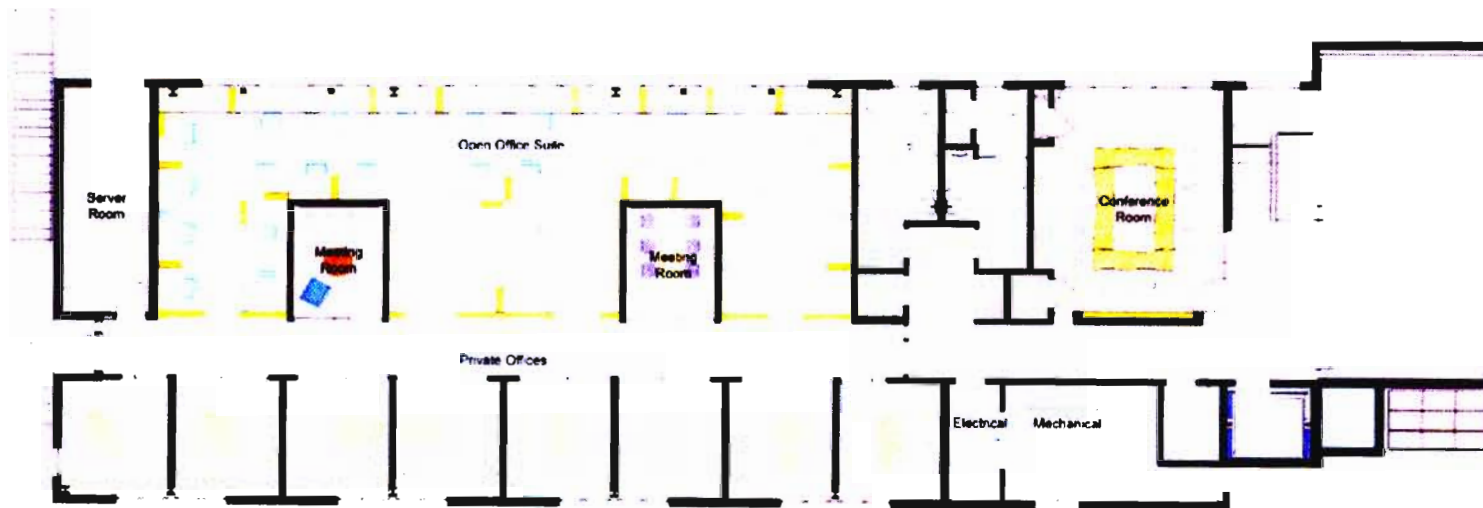
Ill. 3.5.7: Double volume meeting space. The meeting table is made from timber salvaged from a nearby municipal yard.

Ill. 3.5.8: The open plan office space with exposed structure and operable windows for maximum natural ventilation.





III. 3.5.9: Ground Floor Plan



III. 3.5.10: First Floor Plan





The separation of functions onto two floors also had another benefit in that it encouraged interaction among building inhabitants. The often-used lab design model includes offices inside the individual labs, which, as one can imagine, leads to the scientists spending hours secluded from their peers. The separation requires that the researchers circulate through the public spaces, where they are more likely to encounter and interact with their colleagues ([www.aiatopten.org/](http://www.aiatopten.org/)). Although this idea is extremely good in principle, in practice, it has been drastically watered down and now occurs in the form of a wider than usual corridor space running along the long-axis of the building. There is certainly much opportunity to improve in this area.

### Heating and Cooling

Essentially the heating and cooling system for both the laboratory and office spaces is a simple, elegant, and innovative hydronic system ([www.aiatopten.org/](http://www.aiatopten.org/)). The process provides all spaces with either hot or cold water depending on the heating or cooling requirements. Collected rainwater is either heated up or cooled down and pumped through the internal structure and radiant panels.

While the heating is a simple matter of using a condensing gas boiler, the cooling of the water is far more innovative. The solution is provided by a system which incorporates the same process at play when heat is lost, radiantly, from the earth to outer space. An area of research the Institute's scientists are involved in investigating. The

designers have named it the “night sky” radiant cooling system ([www.ehdd.com/images/ehdd\\_pdf\\_224.pdf](http://www.ehdd.com/images/ehdd_pdf_224.pdf)), which basically works like this: During the night, a thin film of water is sprinkled onto the roof of the building. Through the process of radiation the water loses any heat to the night air. This chilled water is then stored in an insulated 12,000-gallon tank. A hydronic radiation cooling system uses pumps and pipes to move this water into a radiant slab and some ceiling radiant panels ([www.ehdd.com/images/ehdd\\_pdf\\_224.pdf](http://www.ehdd.com/images/ehdd_pdf_224.pdf)). The hot or cold water is thus the highly efficient medium for heat transfer throughout the building using the same network of radiant surfaces.

In addition to this water based system-there is a cooling tower at the entrance which functions both as iconic urban way-finder and temperature control device. At the termination of the tower, a small, but effectively designed “wind-catcher” captures breezes and directs them down into the lobby area. As this warm air moves down it passes through a series of spray nozzles which cool the air through evaporation by increasing the air humidity. This cooling induces a thermally driven flow of cool air down into the building ([www.ehdd.com/images/ehdd\\_pdf\\_224.pdf](http://www.ehdd.com/images/ehdd_pdf_224.pdf)).

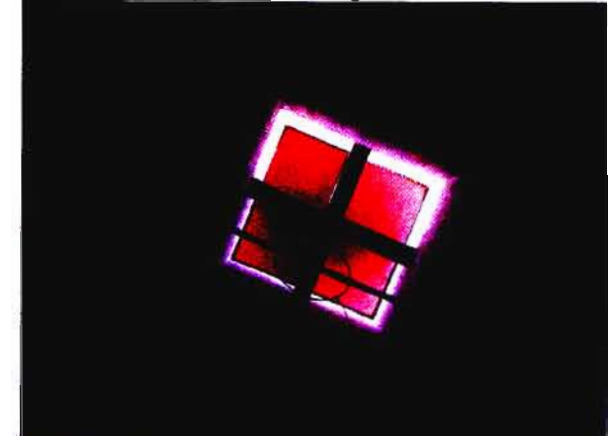
### Lighting

The building was kept narrow, and the orientation (on an east-west axis) was carefully determined using real-life model sun prediction studies, which also informed the design of the exterior sun control. The result of this process is that natural daylight provides the center's primary

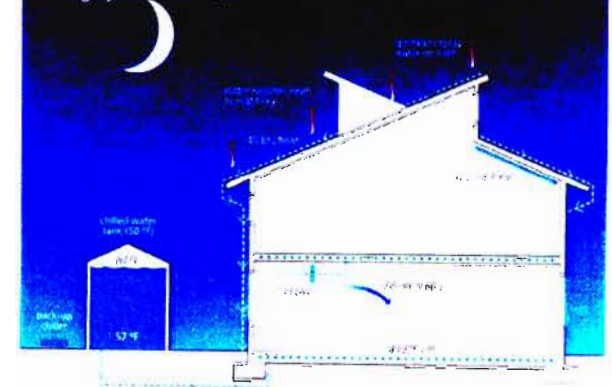


Ill. 3.5.11: A demonstration of the thin film of water sprayed onto the roof for the “night sky” radiant system to be effective.

Ill. 3.5.12: View up into the cooling tower.



Ill. 3.5.13: Diagram showing how the night sky radiant cooling system works.



night sky radiant cooling

task lighting and enters indirectly through light-shelves, or north facing windows. At every step it ensured that there was a reduction in direct sunlight so as to avoid excessive heat gain (which then requires costly cooling). The carefully designed exterior solar shading devices provide control, meaning that daylight always enters the spaces from two sides, which provides balanced, diffused light in all spaces. This, coupled with direct exterior views from all workspaces, results in an interior environment that provides visual comfort for all users.

The natural light is supplemented where necessary by direct-indirect pendants. In the labs, each module is served by a fixture that uses a high-output T5 lamp; this is again supplemented with movable under-shelf task lights. Throughout the building the majority of lights are fixed with occupancy sensors, and are automatically dimmed when the daylight provision is sufficient ([www.aiatopten.org/](http://www.aiatopten.org/)).

### Energy security

One thing that cannot be allowed to affect laboratory spaces is a loss of power. It was necessary to include a back-up generator so that essential functions could be maintained during power outages. Add this to the natural ventilation and daylighting already discussed, and the building can operate quiet functionally during a blackout ([www.aiatopten.org/](http://www.aiatopten.org/)).

Another way of reducing strain on the buildings energy requirements in terms of cooling was to locate refrigerators and freezers away from heat

sources and in particular direct sunlight ([www.aiatopten.org/](http://www.aiatopten.org/)).

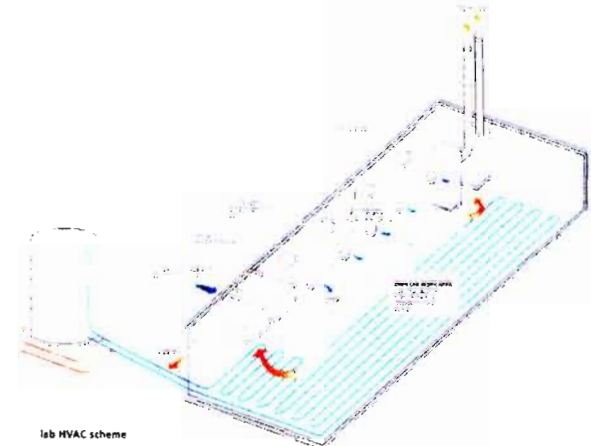
### Finishes

Rather than use environmentally exploitative finishes, the team looked for the alternative methods of letting the materials themselves provide the architectural character through an integral finish. As a result, the acoustic deck ceiling is left exposed, so too are the trusses and columns, while the concrete contains an integral colour-and is ground down in certain spaces, so that the aggregate is exposed ([www.aiatopten.org/](http://www.aiatopten.org/)).

There is a frugality applied to the selection of materials, in that wherever possible, recovered materials are preferred to virgin materials ([www.ehdd.com/images/ehdd\\_pdf\\_224.pdf](http://www.ehdd.com/images/ehdd_pdf_224.pdf)). The siding is redwood recovered from old wine vats, the tables in the conference room and lobby were made from trees found in a local municipal dumping yard and the tabletops were created by using recycled doors. A quarter of the casework is recovered, so too are all of the laboratory taps ([www.aiatopten.org/](http://www.aiatopten.org/)).

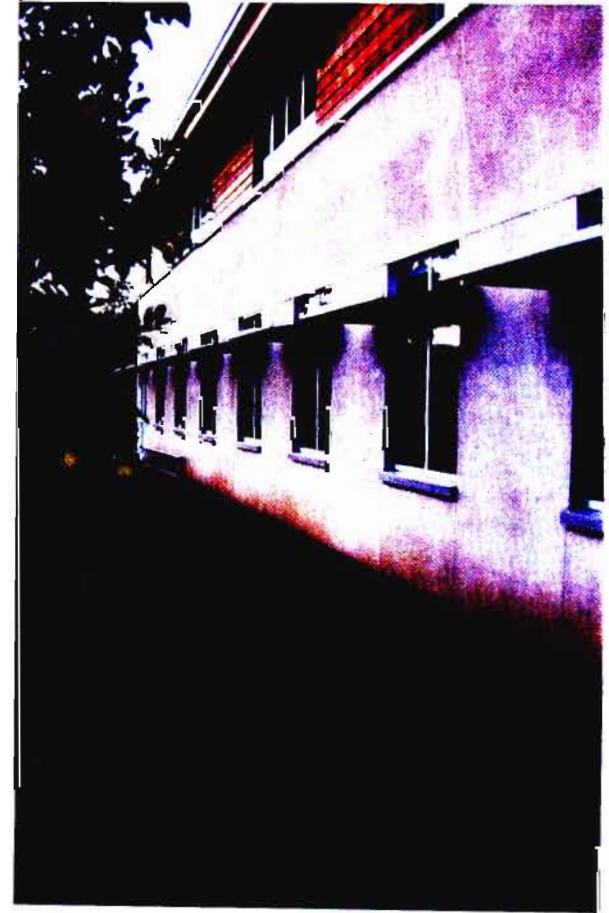
Wherever the timber used is not salvaged, it was domestic ash certified according to Forest Stewardship Council (FSC) standards.

Twenty percent of the aggregate for the concrete is recycled, while over half of the cement is replaced with fly-ash, a by-product of coal-fired electric generating plants ([www.greenbuilder.com/sourcebook/Flyash.html](http://www.greenbuilder.com/sourcebook/Flyash.html)). This decision



III. 3.5.14: Diagram showing the Laboratory HVAC system

III. 3.5.15: Sun Controlling light shelves which reflect light deeper into the laboratory spaces while reducing direct solar penetration from the South.





alone resulted in a reduction in the projects embodied carbon emissions by 43 percent ([www.aiatopten.org/](http://www.aiatopten.org/)).

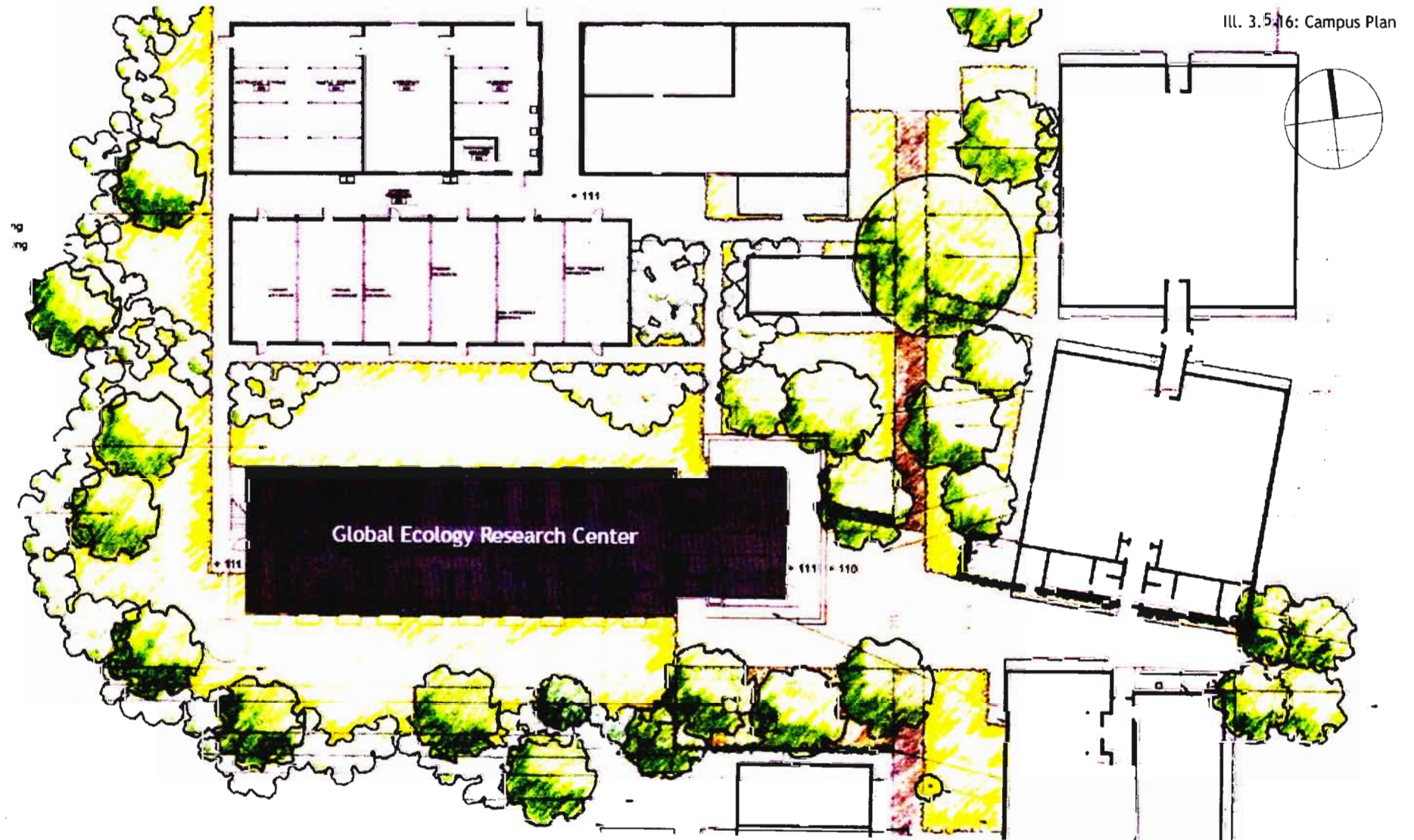
### Water and Landscaping

Water is a precious resource at the best of times; in the semi-arid region of California, the responsible use of it is of paramount importance. The design incorporates no-irrigation landscaping, dual-flush

toilets, a waterless urinal, and low-flow sinks with automatic sensors ([www.ehdd.com/images/ehdd\\_pdf\\_224.pdf](http://www.ehdd.com/images/ehdd_pdf_224.pdf)). The indigenous, no-irrigation landscape saves an estimated 20,000 gallons of water each year, compared to conventional landscaping. This no-irrigation solution was achieved by replacing the existing grassed areas with native grasses which are perfectly suited to the region's long summer dry season.

All other storm-water runoff is controlled by directing the water into bio-swales which act to filtrate the water before it enters into the ground water system.

Paved and impermeable areas are kept to a minimum and wherever they do occur; they are shaded so as to avoid the creation of a heat island ([www.aiatopten.org/](http://www.aiatopten.org/)).



## Conclusion and Applicability

While the climatic and environmental conditions of the GEC are completely foreign, there are nevertheless lessons which can be learned and applied in the design of the Environmental Research Facility. This is the case because the goal of the GEC's brief was nothing less than the protection of the very Global Ecosystems the centre researches. To use a cliché, the building was to provide a local response to an international problem, thinking globally, acting locally.

- Energy usage and Passive solar response

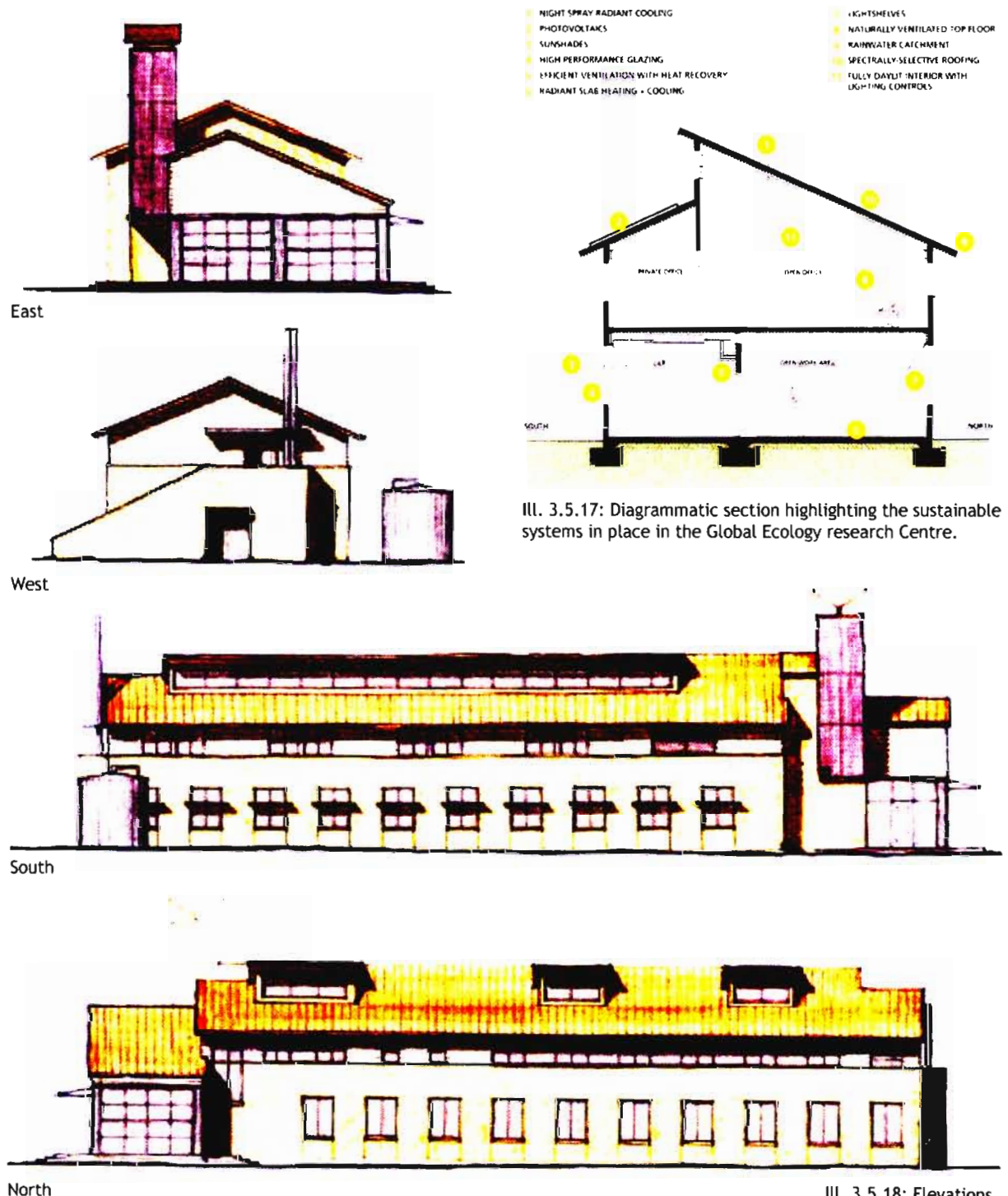
The architects have been consciously aware of the eventual energy requirements of this building, and have made every attempt to reduce this load through intelligent spatial arrangement and careful design with regard to lighting, heating, cooling and ventilation. Natural daylighting was carefully controlled in order to create a light filled building which does not rely on electrically powered illumination.

- Flexibility and user control

There is an active effort to create flexible yet functional spaces for the conducting of research. While many lessons have been learnt from Hertzberger in this regard, there are still some fairly good points which can be adopted. In particular-the inclusion of thermostats allows users to make educated decisions.

- Finishes

The building shows a commitment to the local ecology through the careful selection of finishes which do not create an unhealthy work environment. The research facility should certainly follow suit in this regard.



III. 3.5.18: Elevations



## Chapter IV: Case Studies

### Introduction

Conducting a study into recently completed research buildings within the same or similar socio-political, climatic or geographic setting is necessary in order to garner the conclusions and guidelines needed for the design of the research facility.

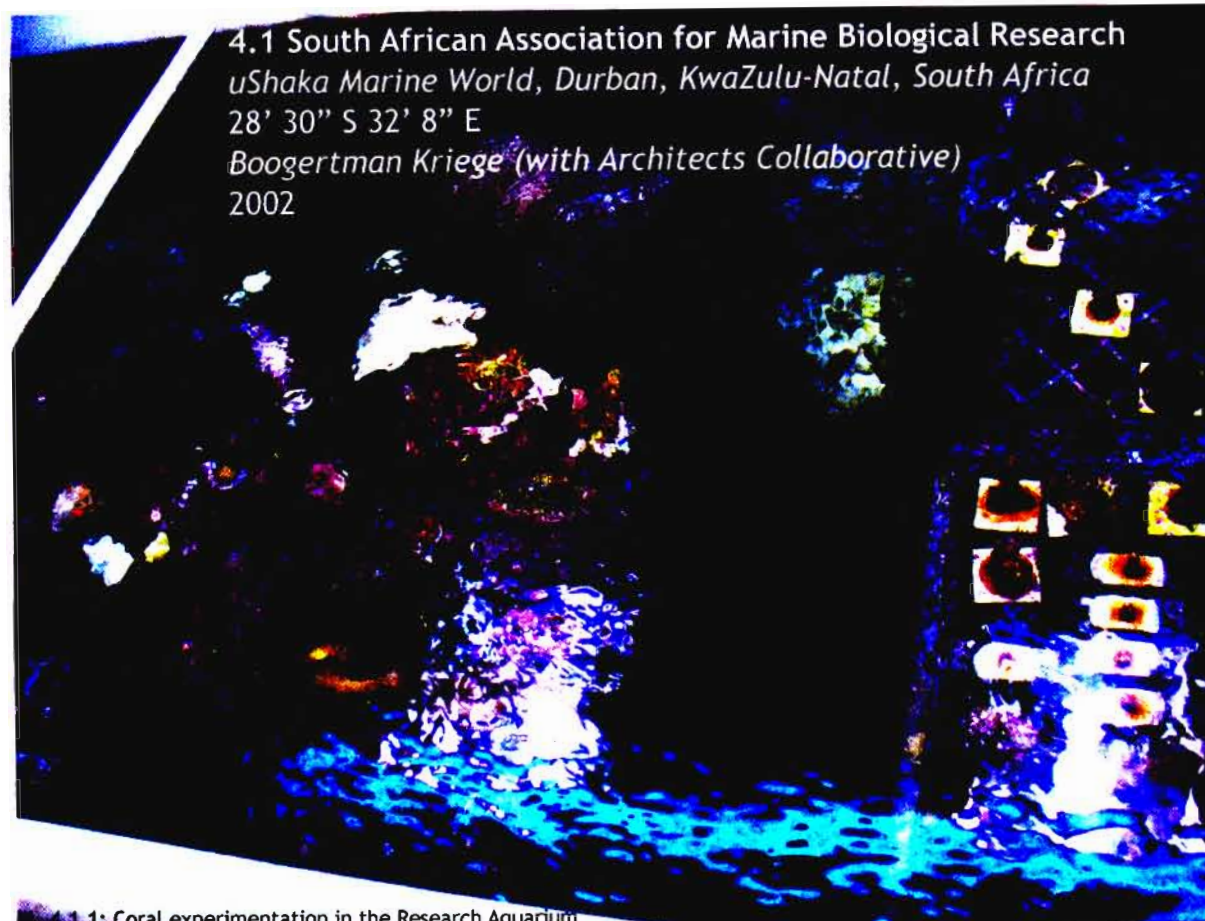
The two most relevant and applicable South African buildings were chosen for this study. The two projects differ vastly, and provide a wide range of lessons in a variety of architectural areas.

The first building, is the South African Association for Marine Biological Research at uShaka Marine World in Durban designed in 2002 by Boogertman Kriege (with Architects Collaborative). This centre was important in that it addressed issues of research and education; including facilities such as research offices, laboratories and a library as well as an full scale education centre which sees 400 children a day. In this instance many lessons were learned through mistakes made in the design of this facility, these errors will be avoided in the design at St. Lucia. There were positives to be drawn from the successful separation of these two compartments. Another difference is the urban nature of the site for SAAMBR, and for this reason much of the focus is internal, on the way the building is arranged, as opposed to the manner in which it addresses its context.

The second case study was the Medical Research Facilities designed in 2001 by East Coast Architects to house the Africa Centre for Health & Population Studies at Somkhele in Northern KwaZulu-Natal.

This building was of particular interest for a variety of reasons, not least of all the fact that it was within 20 kilometres of the research facility site. It therefore responded to very similar climatic conditions in the same socio-political climate as St. Lucia. Although this building does not house laboratories of any sort, it is still home to a wide range of researchers. Africa Centre has much to offer by way of guidelines with regard to the connections between the users and the environment, as well as with other users of the spaces. In addition to this, it is a critically regional response to a complex design problem, in a politically charged and poverty stricken part of KwaZulu-Natal. The interaction with the local community throughout the design and construction process is to be admired, and the commitment to local labour and materials has resulted in a building which is connected to its site, and to the people whom it serves.

As diverse as these two buildings are, so too are the conclusions drawn from each. By studying two varied offerings, the findings have achieved a depth which could well have been lost were the focus merely on one or the other.



Ill. 4.1.1: Coral experimentation in the Research Aquarium

#### Client and Introduction

The South African Association for Marine Biological Research (SAAMBR) consists of three independent bodies, namely, the Oceanographic Research Institute (ORI), Sea World and the Education Centre. The association's headquarters are located in the uShaka Marine World precinct and the facilities housed herein are very similar in nature to the Environmental Research Facility for St. Lucia's Wetland Park. Understanding the operation and layout of SAAMBR will therefore greatly inform the design of that facility.

SAAMBR's research arm, ORI, conducts biological, ecological and marine resource research throughout the province of KwaZulu-Natal. In order to most effectively conduct their research, the non-governmental organisation has created this central base from where research projects are managed. Basically, a team of scientists go out into the field to collect samples and record data, before returning to their Durban facilities where samples are analysed and data recorded. The functions performed by the building therefore relate directly to this process.



Ill. 4.1.2: Durban, South Africa



Ill. 4.1.3: The thatch facade entrance into the facility.

Ill. 4.1.4: Aerial view of the buildings location with reference to the uShaka complex.





## **Spatial Arrangement**

### **Offices and Support Facilities**

The main building is a very simply arranged design solution; a U-shaped double loaded corridor surrounds a courtyard, with the library completing the fourth facade. The offices off of the corridor provide a range of sizes according to the user requirements; with each research scientist having their own offices, while part-time Doctorate and Masters Science Students have an open plan office to share. Also accessed from this central spine are a computer room connected via the internet to a national data service, a Geographic Information Systems (GIS) room, meeting rooms, administrative functions and a staff kitchen.

Conceptually the anchors for the U-shaped corridor are the library and the laboratory spaces; the heart of operations in any research facility.

### **Library**

The content of ORI's academic library is said to be the best in southern Africa, and includes an extensive range of books, journals, slides and maps (Celliers 2007). As with many library spaces, there is a shortage of storage arising from the fact that the content is not weeded like in a regular public library, rather it is continually accumulating material for shelving. A major downfall of the library space is that it does not provide for a variety of functions, from quiet, focussed personal work areas, to bigger, more social areas where teamwork could occur (Celliers 2007).

### **Laboratories**

The laboratory spaces provided are: a preparation room, microscope laboratory, genetics/microbiology laboratory and wet laboratory, all of which are overlooked by a laboratory manager.

### **Preparation Room**

The chemical preparation room is the starting point of research. It is here that chemical volumes are stored and prepared prior to experimentation, and where samples and materials collected in the field are cleaned in preparation for investigation. Due to the nature of these functions it is important that this space is well ventilated, naturally if possible (Celliers 2007).

Unfortunately at the SAAMBR facilities, the chemical preparation room is sub-standard. Firstly, it does not provide a sufficiently ventilated space considering the noxious gases that could be worked with, and although it is the start of the research process, researchers have to make their way through two other, clinically maintained laboratory spaces in order to get to preparing material for investigation. As a result of this ineffectiveness, the preparation room is no longer used for its intended purpose, rather it is now used for a combination of storage and regular laboratory functions.

### **Microscope Laboratory**

In most regular research facilities microscopes are provided in each research office (Celliers 2007), which is obviously a very expensive manner of supplying this necessary equipment. At SAAMBR, the solution is to centralise fewer microscopes into a common facility adjacent to the other

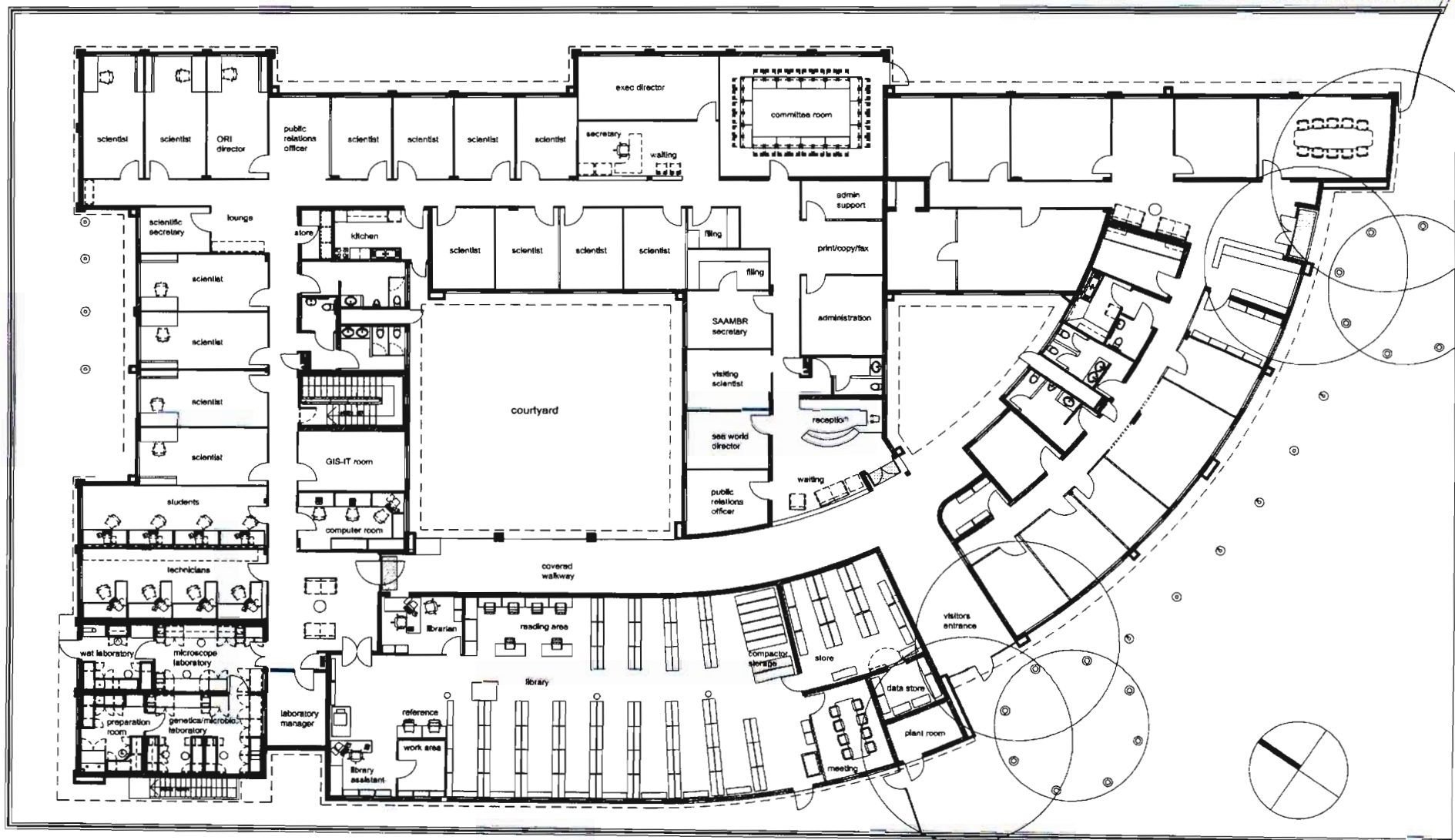
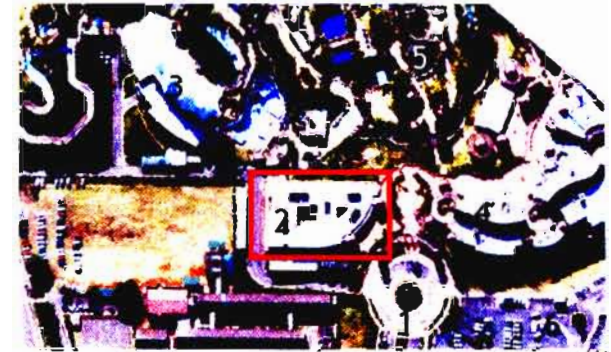


Ill. 4.1.5: The depressing U-shaped corridor which links the facilities together.

Ill. 4.1.6: The library.

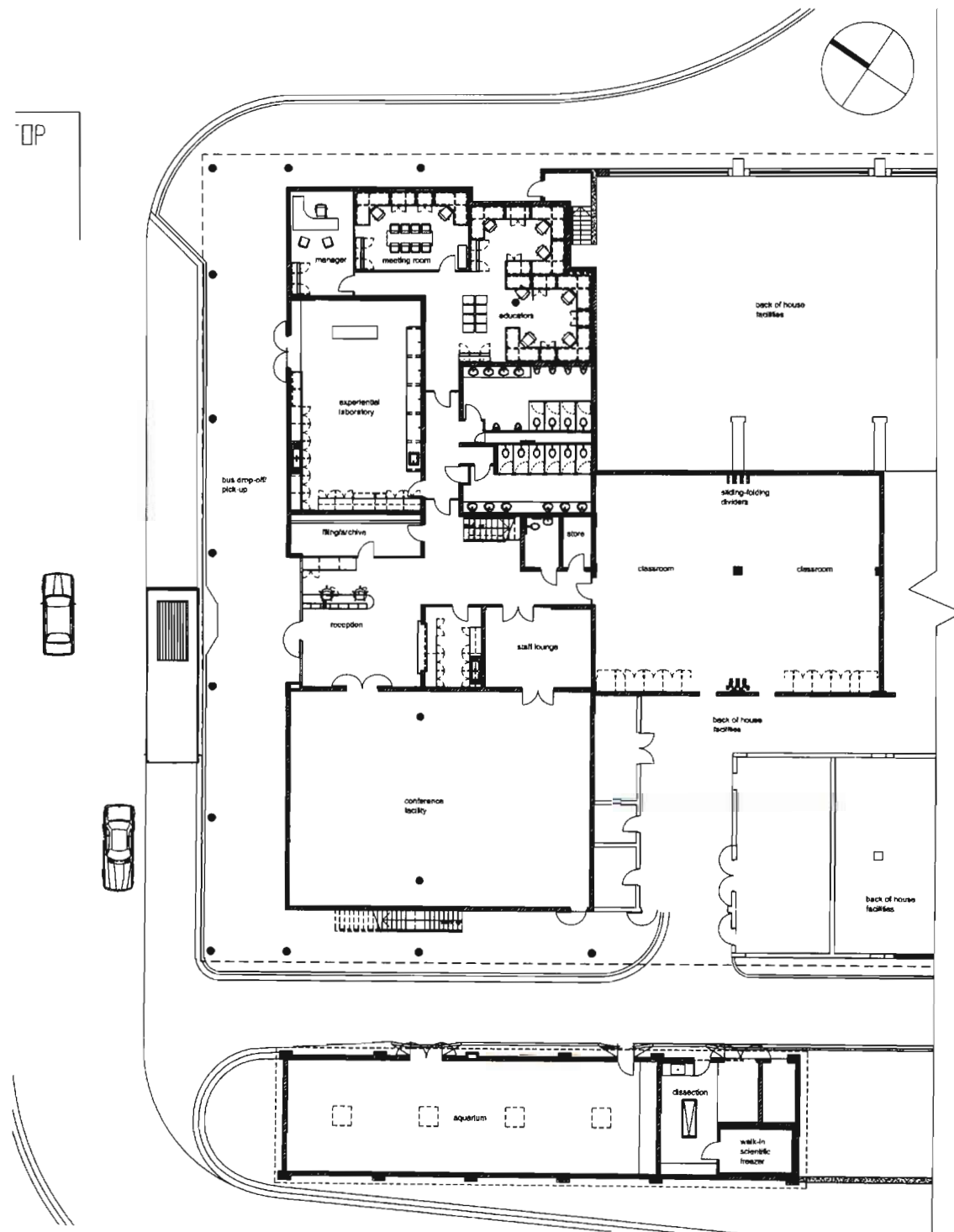


- Location Plan Legend**
- 1: Entrance
  - 2: SAAMBR
  - 3: Dolphin Show Theatre
  - 4: uShaka Mall
  - 5: Waterpark
  - 6: Parking Lot



III. 4.1.7: Upper floor plan





III. 4.1.8: Lower floor plan.

laboratory spaces. As with the preparation space, there are however some unfortunate problems; there are fewer plug points than microscopes, the desks are at the wrong height to stand or sit at, there is insufficient space around the microscopes themselves for regular desktop usage and finally, the space is not wide enough, with the result being that anyone working at a scope is disturbed anytime another researcher has to get to the wet lab, which is accessed through this space (Celliers 2007).

### Genetic/Microbiological Laboratory

Contrary to common practice the histogenetic and microbiological laboratories are combined into one space (Celliers 2007). While the two labs are compatible in that they are both dry laboratory spaces, the space provided for both, is certainly insufficient. In addition to this space and storage shortage, the servicing is sub standard and the work tops are not adjustable in anyway, with their current height being uncomfortable for either sitting or standing.

### Wet Laboratory

As the name suggest, activities conducted in the wet lab are those which involve the frequent use of chemicals and other liquids. These labs should therefore be designed to effectively deal with spills through the inclusion of a change in level to contain any spills as well as the installation of finishes which allow for the space to be hosed down (Celliers 2007). Another crucial consideration is the provision of natural ventilation which helps to eradicate unpleasant smells such as Formalin, unfortunately in this



Ill. 4.1. 9: The genetic/microbiological laboratory.

Ill. 4.1.10: Liquid storage.



Ill. 4.1.11: A view from the genetic/microbiological laboratory into the poorly functioning preparation room.

Ill. 4.1.12: Looking from the genetic/microbiological laboratory into the microscope laboratory.





facility, ventilation is supplied by a small, ineffective extractor fan. The wet lab is the only lab with access to the exterior, a connection which aids in the ventilation requirements, while also allowing in much needed daylighting.

The remainder of the laboratory accommodation is situated on the lower level and the connection between the two, related, levels. This architectural disconnection does not serve the research process well. The laboratories on the lower level are:

### Research Aquarium

The research aquarium is one of the most important facilities at SAAMBR. The space is used for long and short term experiments that involve salt water; coral and particularly sensitive sea life are kept in tanks. Experimentation and investigation is conducted in order on wet benches whenever necessary. The space has a high level of service and flexibility requirements. Another important consideration, is the provision of natural daylighting, crucial for the tank contents survival and growth.

### Dissection Room

Adjacent to the Research Aquarium is the space where dissections are conducted. In order to effectively deal with the solid waste and noxious smells which are produced during any dissection, this space is connected to the exterior; the two benefits of this are that it can be subjected to a comprehensive cleaning after use, and that it allows for maximum natural ventilation. The space also contains an industrial freezer and makeshift equipment storage area.



Ill. 4.1.13: The Research Aquarium showing the experimentation tanks and the skylights.



Ill. 4.1.14: A wet bench.



Ill. 4.1.15: The dissection room.

Ill. 4.1.16: Walk in freezer is an essential inclusion in the dissection space.



## Public Amenities

### Education and Conference Centre

The raison d'être for environmental research is for the generation of knowledge about the planet in order that there is a greater understanding of available resources, so that they are used in a more sustainable manner (Celliers 2007). This accumulation of knowledge is futile if the findings are not propagated to as wide an audience as possible. The SAAMBR scientific community is in agreement that the purpose of research is not just information creation, but also dissemination thereof (Celliers 2007). It is for this reason that the Education Centre is viewed as a 'living museum' focused on a hands on experience for school children and teachers alike (Celliers 2007). It accommodates 130 000 children a year (almost 400 a day), and can deal with up to six school buses at one time (Celliers 2007).

Once these large volumes of children have arrived at the centre, they make their way to one of the three facilities; the classrooms, the experiential laboratory or the conference room.

### Classroom spaces

There are two classrooms provided, each accommodating 50 children. One of the major design generators for this space was the need for maximum flexibility (Celliers 2007). For this reason the two classrooms are divided by a sliding folding screen which can be removed to create one extended classroom. There is one major oversight; the classrooms, accessed down a small corridor, have only one entry point. The second room does not have its own door, but is rather

accessed through the first classroom, a far from ideal arrangement.

### Experiential laboratory

While the classrooms house regular teaching activities, the Experiential Laboratory is a space which provide the visiting school children with the opportunity to have a first hand encounter the marine creatures on display in the aquarium. This the real 'living museum' with display cases and "Touch-and-feel tanks" surrounding the children as they sit at their own laboratory work benches conducting small experiments (Celliers 2007).

### Conference Facility

Over 150 people can be accommodated in the conference facility. While it can be used to house all of the children for a group presentation, it is regularly home to internal meetings and public presentations on current research being conducted by ORI (Celliers 2007). The room is simple in its arrangement, and therefore allows for a large amount of furniture layout flexibility. Unfortunately, the space is completely dependent on mechanical ventilation, and has no connection to the exterior. As with many spaces in this facility, the result is a substandard provision.

### Staff Facilities

A number of full time staff employed in order to support the education centre by performing the twofold function of education and management (Celliers 2007). One major requirement that these staff member have is for the provision of a large amount of notice board space and flat work tops where they can prepare their educational



Ill. 4.1.17: Display cabinet in the Experiential Laboratory.

Ill. 4.1.18: The multi-functional conference room.





posters. The second, managerial aspect, is housed in the only closed off office. In addition to these officer spaces, there is a team meeting room provided.

From this understanding of the operational structures in place, it would be most useful to now investigate the facility from a conceptual standpoint, with particular focus on the three sustainability sub-headings: Social, Economic and Environmental.

### Social Sustainability

There has been a seemingly minimal amount of focus placed on the social sustainability of the SAAMBR facilities. The work environment is far from humane, with no provision for staff gathering spaces or areas of relaxation. An example of where this has been attempted, is a small staff lounge provided for the mostly elderly volunteers who conduct the children's tours through the aquarium spaces. The lounge was, in fact, originally designed as a storage space, and as a result it is an under utilised, windowless space.

Another facility which would have contributed greatly to the comfort of the users, is a central locker room, where researchers could leave their personal belongings during the work day. To conclude, social sustainability is certainly not a strong point of the SAAMBR facilities at uShaka Marine World.

### Environmental Sustainability

#### 'Green Brief'

During the derivation of the design brief, the scientists of SAAMBR asked for a 'green' building; a facility which reflected their own commitment to environmental conservation and education (Celliers 2007). The architectural solution that exists today, is a good distance from that aspiration. Rather than respond to the local climate in a sustainable and responsible manner, the building seems to ignore its context, the users or any concern for a responsive architecture. It seems that the driving force behind many of the design decisions was in fact the bottom-line. This has lead to an air-conditioned facility with no operable windows, and one skylight.

#### Critical Regionalism?

SAAMBR is, as previously stated, attached to the uShaka Marine World: a recent addition to Durban's growing inventory of buildings committed to the city's *Disneyfication*, a list which includes Suncoast Casino and Sibaya. The word *Disneyfication* was coined in 1996 by Sharon Zukin in her book *The Cultures of Cities*, and has come to refer to the transformation of unique communities across the globe into one big, privatised theme park. These buildings follow in the footsteps of Disney's Parks in Florida, California, Tokyo and Paris as they attempt to meld entertainment with escapism and consumerism.

So rather than the creation of a regional, South African architecture, the designers have provided a pastiche of typically 'African' forms and materials. The design shows no sympathy

for a truly African vernacular, an architectural language that is a product of the local climate, geography, materials, culture and topography, and as such, is in sync with these factors. In uShaka Marine World, we find a building that has all the exterior trappings of a local architecture, with none of the conceptual strengths; so in truth, the thatched facade covers a flat roofed, concrete enclosed, air-conditioned and fake interior.

Ill. 4.1.19: uShaka Marine World's architectural 'style'.



Ill. 4.1.20: SunCoast Casino, Durban, an example of the ever increasing Disneyfication of the city.



### **The Courtyard**

There is one function that is frequently associated with environmentally responsive buildings: a courtyard. There are a number of adjacent spaces - none of which has a door or operable window onto the courtyard. It is an uninviting space due to the fact that it is tarred, and in Durban's hot-humid climate it merely becomes a heat island. It does provide any ventilation and there is little doubt about why it is never used by any of the staff (Celliers 2007).

### **Economic Sustainability**

#### **Air-Conditioning**

Due to the fact that there are no operable windows, the entire facility requires continual air conditioning and humidity control. While the laboratories may require this level of servicing in order to replicate experiments in a variety of climatic conditions, the office spaces in particular could have been designed utilising natural ventilation. This would have saved a lot of electricity, and created a far more humane working environment.

#### **Construction Technique**

The building is constructed with a concrete frame structure with brick in fill plastered to match the rough African-style of the rest of the uShaka campus. The roof is a flat concrete slab - with timber screens which cover the air-conditioning units and a thatch façade which matches the uShaka shopping complex. The cost saving in selecting such a simple construction technique may have been significant, but the result is a work environment which is not welcoming or

comfortable. The manner in which the building has been constructed and designed means that it is continually dependent on expensive air-conditioning rendering it very economically unsustainable.

### **Conclusion and recommendations**

Despite the desire, expressed by the client, for a building that responds to the environment in a conscientious manner - the final result is anything but that. It is possible in a case like this, to glean some recommendations from the weaknesses of the examined design:

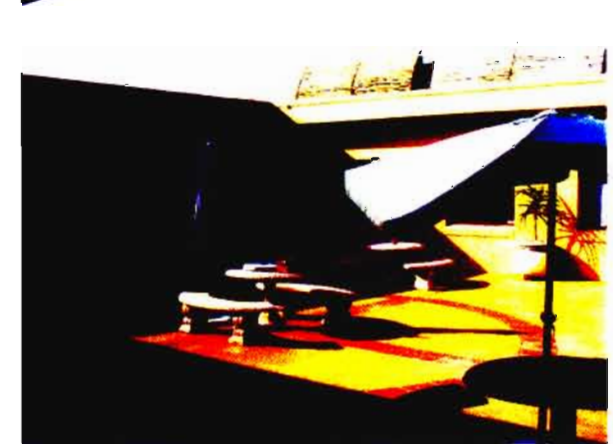
#### **Offices**

- The creation of strong social links between the staff by allowing for informal meetings and group gathering areas.
- Open plan offices reduce the temptation for a researcher to completely close off from the other scientists at the centre, thus encouraging a cross-pollination of ideas.
- Allow building users the option of opening the windows of their office and turning off the air-conditioning.

#### **Library**

- Embrace the digitalisation of the library information, and combine the computer facility and GIS room with the library.
- Allow light to enter the library space from two sides to create a more comfortable reading and working environment.
- Allow for expansion of the facilities as the content of the library grows.

Ill. 4.1.21: The tarred, under-utilised courtyard.



#### **Laboratories**

- The Preparation room cannot be accessed via another space. It must be near to the place where samples are off-loaded from vehicles, and it must be naturally ventilated.
- The Laboratories must all have adjustable workbenches to allow for changes as staff see fit, as well as provide the opportunity for a researcher with a disability to use the space.
- There needs to be a central locker room for staff to store personal effects as well as diving equipment and wetsuits.
- Wet laboratories should have a roller door accessing the exterior to maximise ease of cleaning, daylight and ventilation.
- The research aquarium cannot have any painted surfaces. This is due to the corrosive environment in this space arising from the salt water.

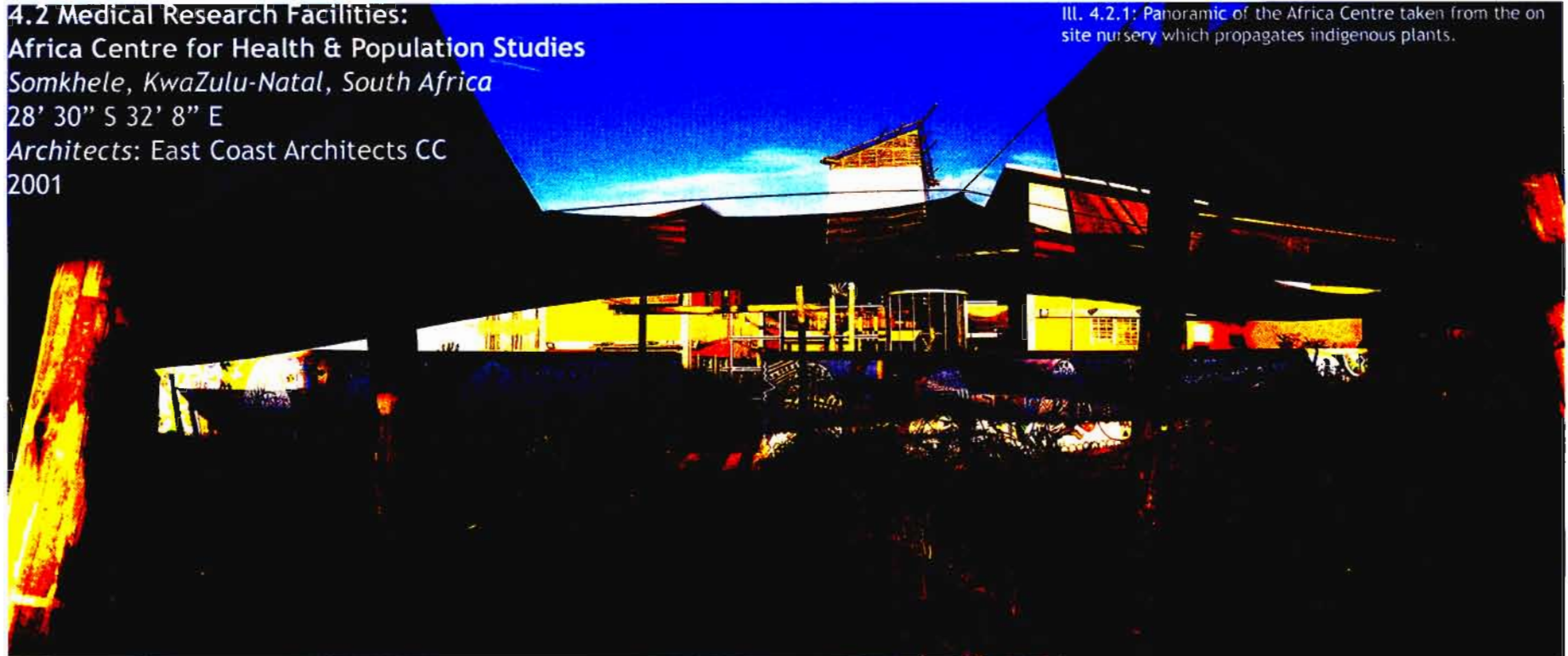
#### **Classrooms and conference facilities**

- Flexibility is key in any teaching space, be it for 500 children or 150 adults.



**4.2 Medical Research Facilities:**  
**Africa Centre for Health & Population Studies**  
 Somkhele, KwaZulu-Natal, South Africa  
 28° 30' S 32° 8' E  
 Architects: East Coast Architects CC  
 2001

Ill. 4.2.1: Panoramic of the Africa Centre taken from the on site nursery which propagates indigenous plants.



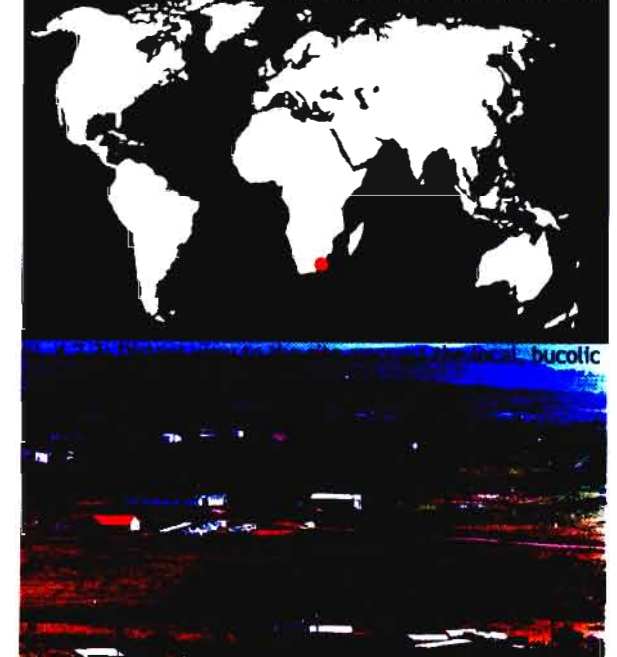
### Introduction

The Africa Centre for Health and Population Studies is a 10 year old initiative begun by three Research Institutions: The University of Natal, the University of Durban-Westville (now combined as the University of KwaZulu-Natal) and The Medical Research Council. The Africa Centre is funded by local and international bodies and their work is both field and office based research into the health and population issues in the rural KwaZulu-Natal District Council of uMkhanyakude, meaning that research into problems such as HIV/AIDS is focused on a group of 85,000 people living in this specific area (van Heerden and Kinsler 2002:8).

### Site

The 13 hectare site is on the crest of a south-facing slope at the epicentre of the distinctly rural research area. Views to the north are of the Hluhluwe-iMfolozi Game Reserve while to the south is the meandering valley of the White Mfolozi River. The Centre also has views to nondescript clusters of rural homes amidst the valleys of the area: a connective reference to the community that this building serves. The climate is hot, with humidity coming in off the Indian Ocean, which is approximately 20 kilometres east of the site. Africa Centre overlooks adjacent sites which house local chief Mkhwananzi's tribal courthouse, a community hall and the regional water supply offices. The positioning of the Centre alongside these smaller existing structures has effectively

Ill. 4.2.2: Somkhele, South Africa



created a small node in the heart the northern KwaZulu-Natal town of Somkhele.

### History

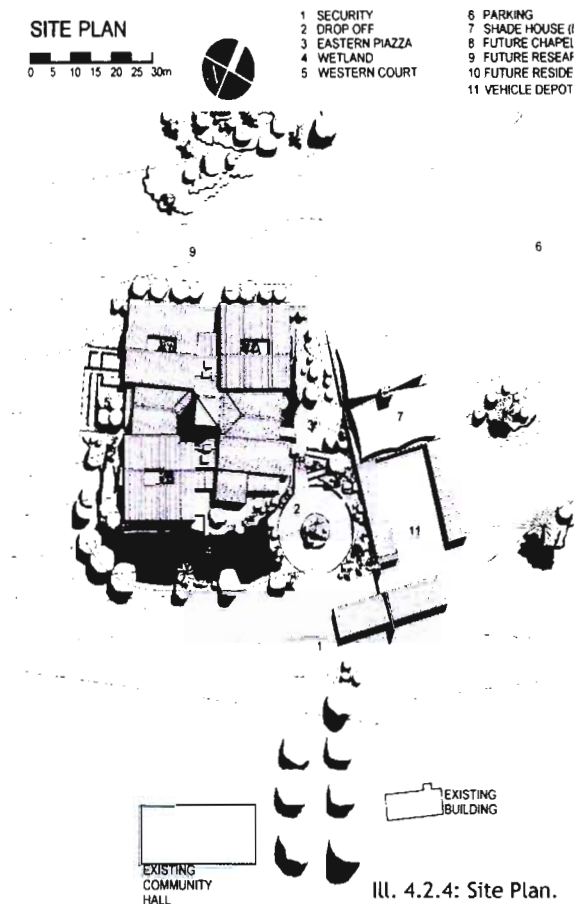
In its early days the Africa Centre was seemingly stuck in a tumultuous and cyclical history of design-growth-redesign. The centre originally began as a cluster of trailer contained offices around an acacia tree. It contained some residential units and housed 12 permanent and six visiting medical and social scientists. The field of scientists and researchers grew from steadily to 18, then to 40 and its current number stands at over 80 scientists with an equal number of field researchers.

As this exponential increase occurred, the preconceptions of an impermanent and temporary structure were discarded as being naïve and short-sighted. East Coast Architects were involved in the development of the Centre from the beginning and it was during this time of continual growth that two requirements were clarified: firstly, rather than being impermanent, this Centre would be expected to grow and any design that went forward would have to allow for expansion. Secondly, as the building continued to grow and become more visible in the area, there was a need to determine an identity. This would no longer be an innocuous cluster of buildings in Somkhele. East Coast suggested that the Centre become a symbolic and iconic structure that directed “the centre further away from ‘invisibility’ in the area” (van Heerden and Kinsler 2002:7).

During this time of expansion, the administrative structure of the Centre went through its own changes, and a new director, Dr. Mike Bennish, was appointed. With Dr. Bennish’s egalitarian leadership came additional requirements for the building: The discourse between rural and urban and the introduction of an open office arrangement. These will be discussed through the course of the chapter.

With East Coast Architects and Dr. Bennish at the helm, the way forward was ascertained, the Africa Centre would be a centralised facility with a loose fit, dynamic approach to open plan research office space (van Heerden and Kinsler 2002:7). In the words of Dr. Bennish the architectural response was to “*help define an intellectually vibrant research centre that contributes to the community that it is part of. The buildings should make good use of indigenous strengths and be aesthetically pleasing to both their occupants and the surrounding community*” (van Heerden and Kinsler 2002:8).

The building has been selected as a case study for a number of reasons. For one thing, it is located just 20 kilometres from the centre to the town of St. Lucia, where the Environmental Research Facility will be sited. Of greater importance than this, is that Africa Centre has within this specific context, achieved a critically regional response to the design problem. There are certainly many lessons to be gleaned from the experience of building the Africa Centre and it is hoped that many of these guidelines can be implemented into the design of the Environmental Research



Ill. 4.2.4: Site Plan.





Facility at St. Lucia. For this reason, it too will be investigated under the three rubrics of sustainability which run through this thesis: Social, Environmental and Economic.

## Social Sustainability

### Planning and accommodation

The Africa Centre consists of four enclosed office pods with the space left behind being a cruciform space which provides access to all public facilities: entrance, reception, cafeteria, auditorium and the toilet block. Each of the four office pods is named after a different indigenous medicinal plant and contains open plan offices, archive storage, resource centre, computer training facility and meeting spaces.

### Office arrangement

As previously stated, the Africa Centre director, Dr. Mike Bennish, felt that cellular offices did not allow for or encourage dynamic research collaborations. Rather, it was suspected that these spaces encouraged academic fiefdom and made management of the centre difficult (van Heerden and Kinsler 2002:7). For these reasons, the offices are all open plan: the entire Africa Centre management bought into the belief that the building should be designed in a manner which disregarded class. Rather, everyone, from the drivers to the medical doctors would be completely welcome and encouraged to gather together at the café. It was for this reason also, that there were no tea kitchens provided; everyone from the director to the dishwasher would sit together (van Heerden 2007).



Ill. 4.2.6: The cafeteria- home to everyone from the drivers to the director.



Ill. 4.2.7: Panoramic of an open plan office pod. No desk is more than three metres from a source of natural daylight.

Ill. 4.2.8: The cruciform central atrium, which provides access to all the public amenities.





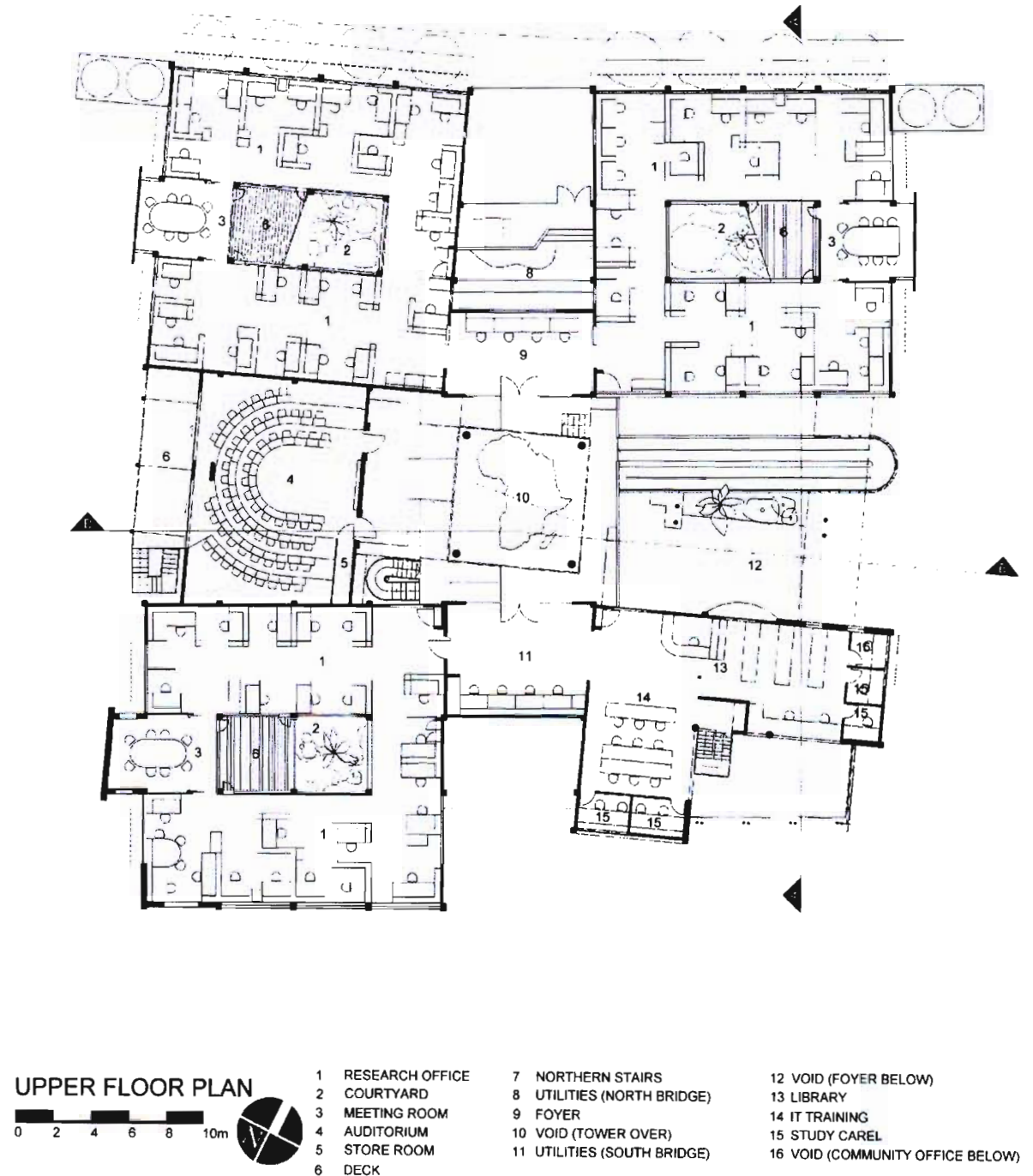


Ultimately, the *raison d'être* for the open plan arrangement in the office area was that it would encourage and facilitate communication regardless of race, position, project, funding, qualifications, country or gender. The spaces were designed to promote interaction across all these boundaries. An interaction which is not merely to create a humanistic office environment; but additionally to encourage a cross-pollination of ideas and a pooling of resources. The subject of the Africa Centre's macro focus is the same across all disciplines, and so the researchers are a team, no matter where their micro focus is placed.

### Environmental Sustainability

Africa Centre is a building which seeks to create connections with the context in which it is placed; it is a regional response to a regional problem. Public Relations Officer Mdu Mahlinza sees the buildings interaction with the environment as one of its most successful achievements (Mahlinza 2007). There is, however, a sense in which this interaction is not merely for interactions sake, but that it also serves to educate the staff and locals about how it responds environmentally: Alan Lipman suggests that during staff interviews conducted in November 2002 there seemed to be a fairly good understanding that this was a 'good' building (Lipman, 2003a:20), an idea that was corroborated during interviews by the author during a follow-up visit in March 2007. So not only does the building respond to the environment in which it is placed, but it takes on an educatory role by informing the local community that there is a way to do things right; to create a humane working environment without disregarding the environmental context.

Ill. 4.2.10: First Floor plan.



Having said this, a requisite of the brief was that all the offices were be fitted with air-conditioning. In order to combat the potentially banal work environment that could have been created as a result, the architects introduced small courtyards which pierce each office pod in an attempt to bring some humane nature to the office environment by complimenting and reflecting the exterior landscaping and providing internal views (Lipman, 2003a:19).

A corollary of this is that due to the positioning of these planted courtyards no work desk is more than three metres from a source of natural daylight. Furthermore they create a strong connection between interior and exterior by acting as an extension of the interior and these courtyards often play host to a range of meetings, from formal to informal. In an unforeseen and serendipitous turn of events these courtyards also provide natural ventilation for the third of a year when the air conditioning system is in need of repair (Mahlinza 2007).

The conditioned air from the office pods is exhausted into the crucifix public area. As this air begins to heat up, a pressure difference is achieved because the hotter air has natural buoyancy; it displaces the cooler air as it rises up and out of the building (Hyde 2000:74). This pressure shift brings fresh air in from the reception area and cafeteria, a movement of air called the 'stack effect'.

#### Sun Control and Lighting

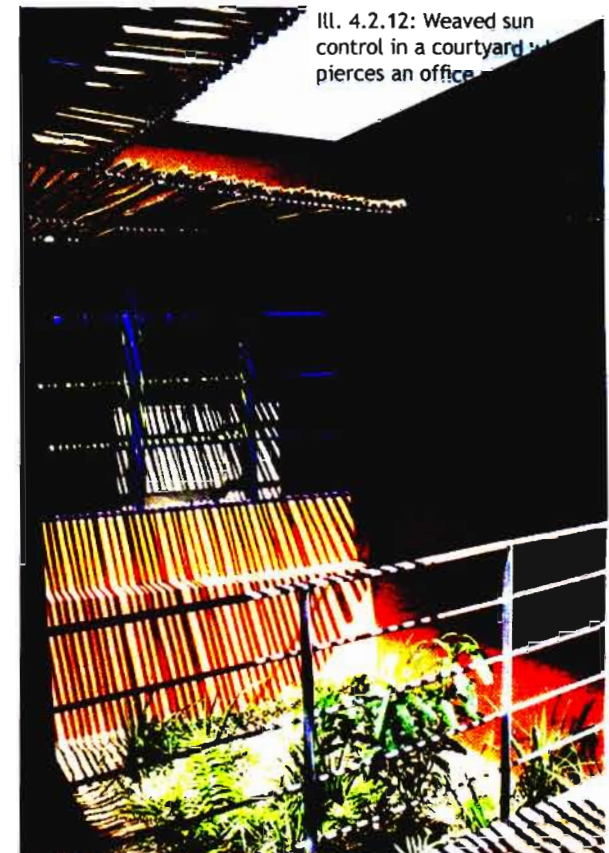
Despite the fact that the offices are air conditioned and therefore have a controlled interior climate,

the architects still dealt with the sunlight entering the spaces with great care. Their stance was that no direct sunlight should enter into the pods as this would only serve to heat the open plan office area and thus placing the conditioning units under unnecessary pressure. Grass mats were weaved by local woman and are held in place by robust, purpose made steel connections-a prime exemplar of the dichotomy of rural and urban. Despite the exclusion of direct sunlight there is certainly a large amount of filtered or indirect sunlight which negates the usual reliance on artificial daylighting. A statement backed up by Mdu Mahlinza, who says there is little or no need for compensatory lighting during most of the year (Mahlinza 2007).

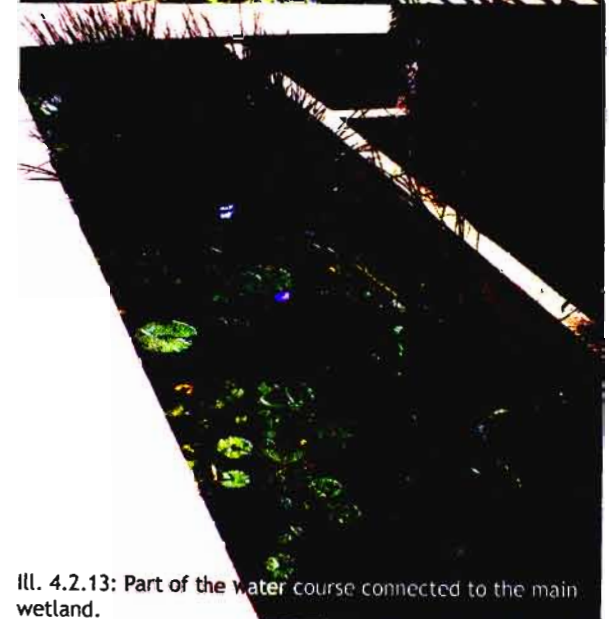
#### Water and wetland

The wetland and streams are a solution to an unforeseen water runoff problem caused by the soil: clay with a with high water percentage.

A further intention was that the wetland would become home to frogs and birds-which would control the mosquito problem, and in these terms it has been an entirely successful intervention. The wetland was planted with numerous indigenous water plants which have flourished (Lipman, Ill. 4.2.11: The stack effect demonstrated in this sketch by the designers at East Coast Architects.



Ill. 4.2.12: Weaved sun control in a courtyard that pierces an office



Ill. 4.2.13: Part of the water course connected to the main wetland.



2003a:20), with some old locals claiming that the wetland has brought back birds that have not been seen for many years (van Heerden 2007).

In effect, the wetland serves three purposes, not only does it provide a home for the local flora and fauna and deal with the excess run-off, but it is part of a water treatment system designed to reduce waste. All water that is used in the building is dispelled into the wetland. This includes all grey and black water, this waste is treated in a *Lilliput* system before entering the wetland. Waste water from the centre is collected through gravity through a stilling well within a pre-digester which neutralises all the potentially harmful substances such as Pathogen organisms, heavy metals, nutrients and synthetic organics ([www.lilliput.co.za](http://www.lilliput.co.za)). From here it moves through an equilisation tank into an air blower, where a complex system involving the input of dissolved oxygen is conducted before it moves through a clarifier before being discharged into the wetland ([www.lilliput.co.za](http://www.lilliput.co.za)).

### Critical Regionalism

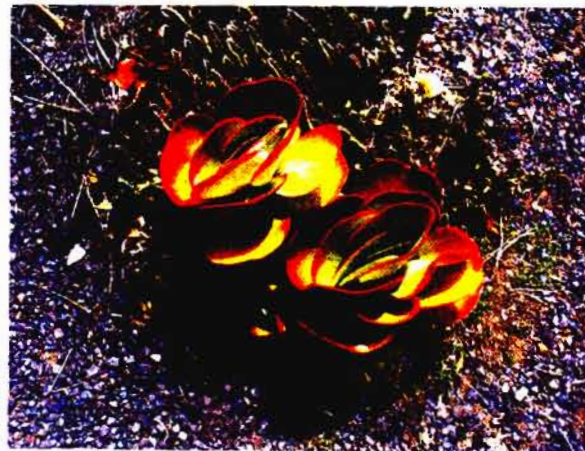
In an article about the Africa Centre, architectural critic Alan Lipman concludes that the building is an exemplar of critical regionalism at work. (Lipman 2002b:36) It is clear to any visitor, that the architects have actively made every effort to contrast the rural with the urban, unfinished with the machined, the modern with the traditional. The building is undoubtedly a departure from the pre-industrial structures which dot the surrounding bucolic landscape and modern construction techniques, materials and processes

have been actively melded and tempered with overtly rural elements (Lipman 2002b:35-36). An example of this is the contrast between the clean, machined lines of the concrete and steel construction and the ubiquitous stripped blue-gum tree trunks, branches and saplings: used throughout the building, from the iconic tower, to the balustrades, sun control and roof trusses.

It is, however, under further investigation that the true extent of this rigorous process is evident:

- o Firstly, in the matter of joints: Wherever the gum poles are fixed or held in position it is achieved through an adeptly designed metal cups, shoes or brackets (Lipman 2002b:36). Resultantly, this roughly finished timber creates dancing shadows which predominantly fall onto typically 'urban' materials.
- o Secondly: one is struck by the seamless inclusion of local craft in the form of murals, plaster insets and tile mosaic work-these beautifully created pieces are at home in the Africa Centre.

Ill. 4.2.14: Local plant: source of the Africa Centre colour?



Ill. 4.2.15: Part of a mural wall with the tones of the background.



Ill. 4.2.16: Local artwork adorning the walls of this 'modern' building.

Ill. 4.2.17: Urban and rural materials effortlessly join on the ramp handrail.





- o And lastly, a commitment to a regionally critical response is highlighted through the use of indigenous landscaping in the exterior spaces as well as in the interior itself. All of the landscaping was created using planting material indigenous to this region of Zululand and in particular from propagated plants cleared off of the site when construction began (Peters 2003:1). There is still a nursery on the site which is actively involved in the promulgation of local plants in the region.

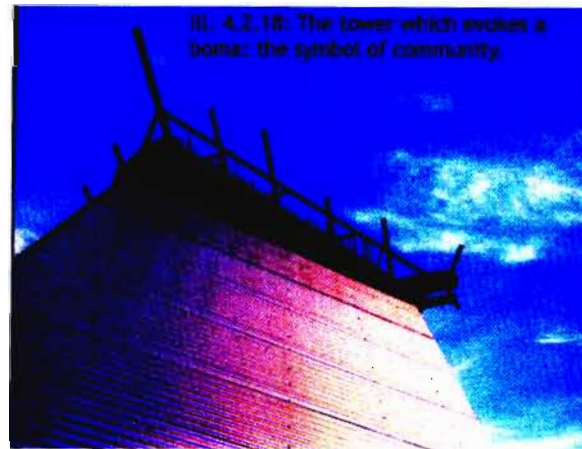
East Coast Architects have successfully achieved a project that is authentically regional, a specifically southern African response. This result has been achieved by remaining committed to technological modernisation, displayed in an employment of contemporary building procedures, techniques and materials, while concomitantly making an obvious effort to acknowledge the region, the local culture. It is a sensitive response that has managed to weld these two together into a building that is of his place and time; regionally and nationally. As Lipman concludes: “[East Coast Architects] *have underscored rather than by-passed the split inherent in the [Africa] Centre’s chosen site, a choice that springs, of course, from the necessary propinquity of the research personnel and the rural population they are studying*” (Lipman 2002a:11).

### The Tower

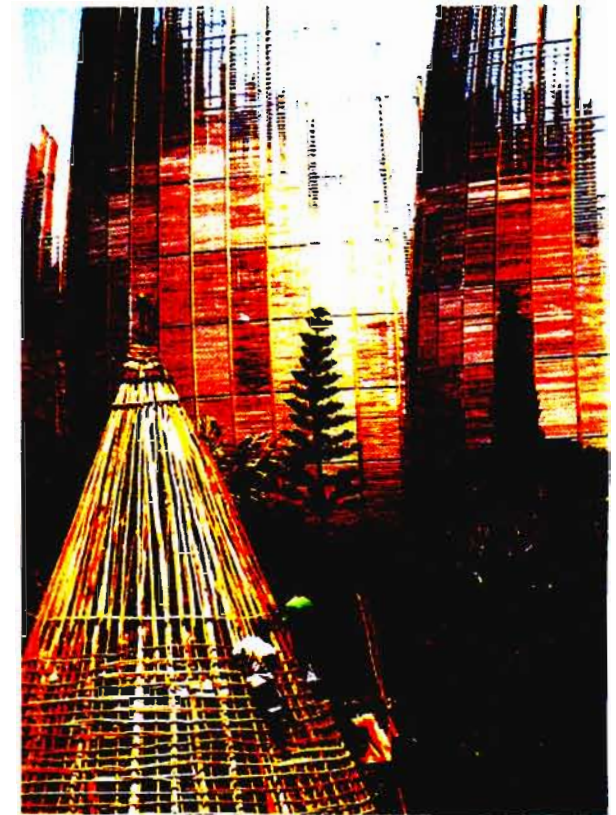
Designed as a transmuted reminder of the *bomas* traditionally used for community gatherings (Lipman 2003a:20), the tower contributes

to the overall aesthetic of the design, while concurrently mediating bioclimatic elements. The vertical element therefore symbolises the idea of ‘community’ through the suggestion of a traditional *boma*, while concomitantly facilitating the pragmatics of the stack effect.

One could suggest that the Africa Centre has achieved, in its own specific context, a result comparable with Renzo Piano’s Tjibaou Cultural Centre, realised in Nouméa, New Caledonia in 1999. In this structure, the timber clad public volumes were designed not only to evoke the form of woven fabric of the traditional Kanak dwelling, but also to induce and redirect natural ventilation by responding to a variety of wind speeds and directions (Frampton 2002:15). Rather than recreate the exact forms of the local Kanak dwelling, these volumes recall the spirit of the vernacular tradition. The result in both the Africa Centre and the Tjibaou Cultural Centre is the same. They are thoroughly embedded in place through their physical setting and engagement with the culture, a response expressed through what is in actuality, a contemporary design language. (Buchanan 2005:26)



III. 4.2.18: The tower which evokes a *boma*: the symbol of community.



III. 4.2.19: Kanak hut under construction, with the Tjibaou Cultural Centre in the background.

III. 4.2.20: Interior view of the tower.





## Economic Sustainability

### Community

Architect Derek van Heerden mentioned two factors that were crucial for the success of the Africa Centre. Firstly, the local community had to have a sense of ownership of the 'product' (van Heerden 2007). It could not become an *us* and *them* building, where there is no connection between the local community and the events which occur in the Africa Centre. On way in which this could be achieved from the outset, was the selection of labour from the area. This decision was made and followed through on and in the end 100 percent of the unskilled labour and 62 percent of the skilled labour came directly from the surrounding community (Lipman 2002b:36). Where there were no available workers local men and women were taught, thus ensuring that a skills transfer occurred. These people performed a range of tasks such as building workers, mural artists, tilers, basketry weavers and sculptors (Lipman, 2002a:11). The majority now find themselves being in a position to gain employment while many of these people have so honed their skills that they have been employed as full-time staff at the Centre-mostly as field workers (Lipman 2002b:34).

The second crucial aspect of community acceptance was seen to be transparency. Derek van Heerden claims that were it not for the insurance company there would be no fence surrounding the centre (van Heerden 2007). There was a vote taken amongst all involved in the design process and the conclusion was that there should be no front door (van Heerden 2007). The

Centre needed to belong to the people and they needed to trust the scientists and researchers that it housed, transparency was seen as a crucial consideration in order to achieve this.

Another manner in which the nature of community commitment has continued is through the computer training centre. Through the donation of computers from a major corporation the Africa Centre has been in a position to teach basic

Ill. 4.2.21: The computer training facility.



Ill. 4.2.22: Local community support was imperative for the success of the project.



computer skills to the locals. To this date nearly 2000 people have been trained, included amongst this number are all of the local headmasters (Mahlinza 2007). The long term impact of such a scheme cannot be quantified, but it is sure to have a hugely positive influence on this district.

Ill. 4.2.23: Local labourers made up 100% of the unskilled labour and 62% of the skilled labour.





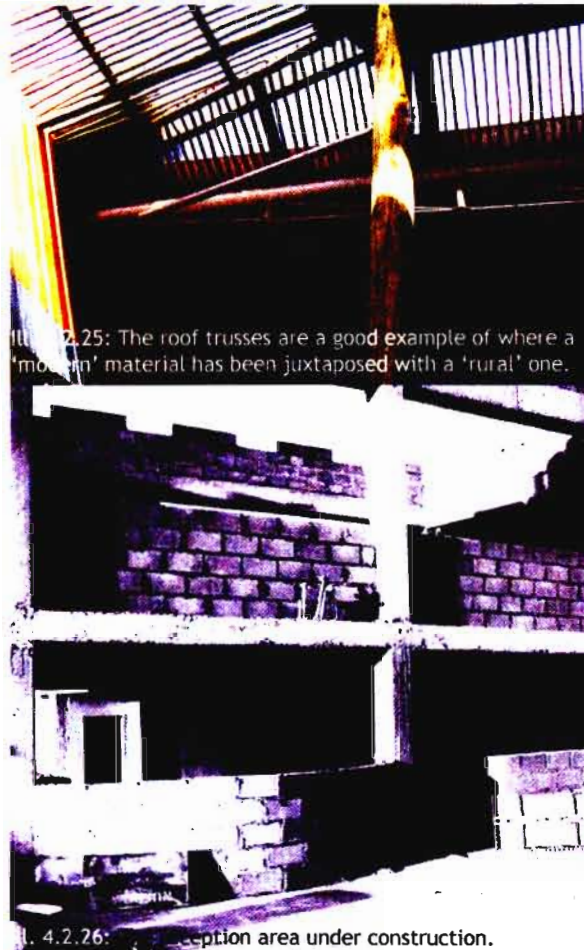
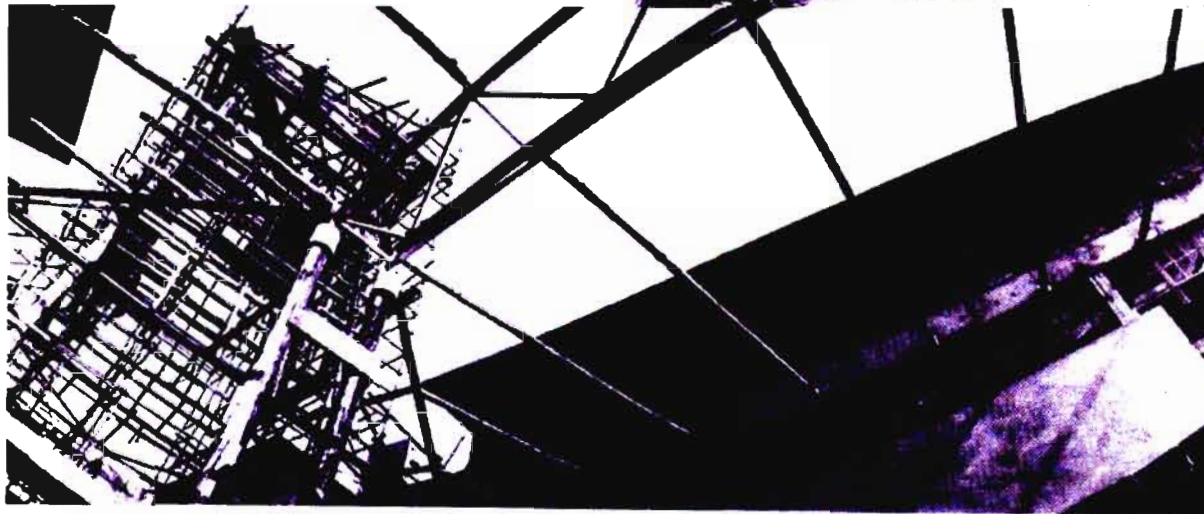
### Materials and Construction

The building is constructed from the careful arrangement and amalgamation of various materials. Everywhere you look there is a contrast of machined with rough—an example would be the trusses above the walkway on the first floor: they are composite trusses consisting of both steel and gum pole elements.

The building basically consists of a reinforced concrete frame structure with infill. Attached to this more solid of arrangements, are the steel stair-cases and balcony structures with the gum pole tower rising out from between the four solid pods.

At every turn the selected materials were scrutinised in terms of embodied energy—and wherever possible, a local alternative was selected over national products that would need to be transported to the site.

Ill. 4.2.24: Black and white construction photograph revealing the concrete frame structure and brick infill.



Ill. 4.2.25: The roof trusses are a good example of where a 'modern' material has been juxtaposed with a 'rural' one.

Ill. 4.2.26: Reception area under construction.



Ill. 4.2.27: Gum poles provide shade while allowing dappled light to penetrate the atrium area.

Ill. 4.2.28: Steel structures such as stairs 'clip-on' to the concrete and brick structure.





### Conclusion: Relevance to the 'Environmental Research Facility'

While the Environmental Research Centre is officially situated Maputaland and not in Zululand, there are still numerous lessons that can be learned considering that the two sites are only 20 minutes apart, and fall within the same, uMkhanyakude, district.

There are various obvious lessons-such as the fact that the two are very close geographically and therefore subject to many of the same climatic conditions. The landscape, though different, needs to be confidently engaged with in St. Lucia-there is inherent vitality in this place and much to be gained through a critically regional discourse with the local context.

The Africa Centre shows that there is much potential in training up local labourers to conduct all the unskilled and much of the skilled labour. The results of this transfer of skills in this district-wrought with poverty-are both long-lasting and far-reaching.

Both facilities house a collection of disparate researchers working on a vast number of seemingly unrelated projects, and yet Africa Centre shows the potential for promoting a sense of community despite this incongruence. This problem has been addressed through the provision of open plan offices and through the design of the public spaces between the more private pods-and the fact that all staff are encouraged to make use of the communal cafeteria; from the director to the lowest of employees.

The Africa Centre also highlights the potential for the contrasting of the functions housed within the Facility and the surrounding environment. The Environmental Research Facility will obviously be accommodating sophisticated technological resources, highly trained personnel and advanced systems; all of which are executed according to a strict timetable. All of this, however, occurs within the seemingly timeless world of the iSimangaliso Wetland Park-where time is determined by the seasons and nature is the technology. There is certainly much opportunity for contrasts and dichotomies.

Where the Africa Centre espouses a very rural vernacular, there remains the prospect for the research facility design to be less about local technology. While the Africa Centre speaks the language of its study group-the people of uMkhanyakude-there remains the potential for the Environmental Research Facility to adopt the argot of its study focus: the iSimangaliso Wetland Park. The result may therefore be completely different, even though geographically the two structures would be so proximal.

As architect Douglas Kelbaugh argues: *"What makes a place unique is worth celebrating and protecting with architecture: finding and keeping the difference that makes a difference"* (Kelbaugh in Matter, 1986). The Africa Centre has achieved just this for its particular setting. It has identified, celebrated and protected that which is special and unique about that specific site. There would be no point in merely replicating that response, however, to follow in those footsteps, to identify, protect and celebrate the unique qualities of the Environmental Research Facilities site. In a similar vein, it must also be understood that 'site', can have far reaching influences, from micro- to macro- context.

The Africa Centre in Somkhele is certainly a work worthy of praise-it has managed to achieve what few South African architects have: a high-tech facility in a rural setting, that responds directly to its context without producing a mere pastiche of the local vernacular. It is truly a great building of our time-and the conceptual path it begins to tread is certainly one worth following.

III. 4.2.29: The Africa Centre.



## Chapter V: Client Body and Organisational Objectives

### Introduction

A large majority of scientific research conducted by South African organisations or institutions is in some way funded by the government agent; the National Research Foundation (NRF), which was established in 1999 ([www.nrf.ac.za](http://www.nrf.ac.za)). According to the NRF website their objective is “to support and promote research through funding, human resource development and the provision of the necessary research facilities, in order to facilitate the creation of knowledge, innovation and development in all fields of the natural and social sciences, humanities and technology” ([www.nrf.ac.za](http://www.nrf.ac.za)). The goal of the NRF is ultimately to contribute to the improvement of life for all South Africans ([www.nrf.ac.za](http://www.nrf.ac.za)). A goal to be achieved through the “creation of an innovative, knowledge-driven society where all citizens are empowered to contribute to a globally competitive and prosperous country” ([www.nrf.ac.za](http://www.nrf.ac.za)).

### NRF's Mission from [www.nrf.ac.za](http://www.nrf.ac.za)

*A dynamic, quality-driven organisation that provides leadership in the promotion and support of research and research capacity development in the natural, social and human sciences, engineering and technology to meet national and global challenges through:*

- Investing in knowledge, people and infrastructure
- Promoting basic and applied research and innovation

Ill. 5.1: The NRF Logo



- Developing research capacity and advancing equity and redress to unlock the full creative potential of the research community;
- Facilitating strategic partnerships and knowledge networks
- Upholding research excellence

### Funding

In order to maintain these high standards, the NRF has developed local and international relationships ([www.nrf.ac.za](http://www.nrf.ac.za)), which aid in the expansion of resources available in South Africa and thus expand the research capabilities in this country. This funding from the NRF is then redirected towards academic research, developing high-level human resources, and supporting the nation's national research facilities ([www.nrf.ac.za](http://www.nrf.ac.za)).

The NRF is currently involved in supporting six National Research Facilities and it is foreseen that the Environmental Research Facility at iSimangaliso Wetland Park would be funded in a similar fashion to these.

Additional funding for the facility could also be garnered from other interested international bodies such as UNESCO, the European Union or other bodies associated with Ramsar. Ultimately, funding will not be a prohibitive factor.



## Chapter VI: Context and Site Analysis

*“The St. Lucia Wetlands Park must be the only place on the globe where the world’s oldest land mammal (the rhinoceros) and the world’s biggest terrestrial mammal (the elephant) share an ecosystem with the world’s oldest fish (the coelacanth) and the world’s biggest marine mammal (the whale).”*

Former President Nelson Mandela, August 2001  
(Khuzwayo and Vorwerk 2006:6).

### 6.1 Context

#### 6.1.1 A Brief History of the iSimangaliso Wetland Park

The history of this area begins centuries ago, when Nguni tribes from the North-Eastern coast of southern Africa migrated southwards to the Eastern Shores of Lake St. Lucia (Khuzwayo and Vorwerk 2006:20). Although these regions were originally home to primitive iron-age men, it was these people, the Tembe-Thonga who developed the richest connection with this place. Their kingdom grew strong ties with King Shaka’s Zulu people and the two people groups now share much of their heritage. The land of the park, although used by these people for thousands of years, has never been occupied by significantly large human settlements, nor has the area been subjected to significant man-induced land-use disturbances ([www.environment.gov.za/Branches/BioConservation/17Ramsar/st\\_lucia/st\\_lucia\\_ris.htm](http://www.environment.gov.za/Branches/BioConservation/17Ramsar/st_lucia/st_lucia_ris.htm)).

Having said this, the park certainly has a checkered history, including hunting, the eviction of people from their land and even the creation of a missile testing site on the Park borders. Following a century of increased hunting for ivory, rhino horn and hippo, the Park was established April 27<sup>th</sup> in 1897 by the British, making the original reserve of 36 826 hectares the oldest National Park in Africa ([www.stluciasa.co.za/sl\\_history.htm](http://www.stluciasa.co.za/sl_history.htm)).

In 1971 the International Convention on Wetlands, was signed in the Iranian city of Ramsar. The Lake St. Lucia and surrounding coastline were listed for protection under the guidelines of the Ramsar Convention: which is basically an intergovernmental treaty, now consisting of 155 members (including South Africa: an original signatory), which provides *“the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources”* ([www.ramsar.org/](http://www.ramsar.org/)).

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III. 6.1.1: The Ramsar Logo.



This conservation was threatened when, in 1989, South African company Richard's Bay Mining made a claim on the mining rights which they held in the park. They put forward a proposal to retrieve Titanium and a variety of other metals from along the coastline: a process that would have involved the destruction of a large portion of the Eastern Shores dune system ([www.phinda.com/Attractions/st\\_lucia.aspx](http://www.phinda.com/Attractions/st_lucia.aspx)). This proposal obviously caused a major uproar among conservationists, as well as the Ramsar organisation. These bodies used strong mining laws and convinced the government to have an environmental impact assessment prepared and although the South African Government carefully weighed the potential economic benefits of allowing the mining; the panel conducting the environmental assessment advised against any mining activity. And in 1996, the government rejected the Richard Bay Mining's proposal ([www.environment.gov.za/Branches/BioConservation/17Ramsar/st\\_lucia/st\\_lucia\\_ris.htm](http://www.environment.gov.za/Branches/BioConservation/17Ramsar/st_lucia/st_lucia_ris.htm)) and announced its aim to create jobs in the area through ecotourism, with The St. Lucia Park as the focus of this effort ([www.phinda.com/Attractions/st\\_lucia.aspx](http://www.phinda.com/Attractions/st_lucia.aspx)). The 150 jobs that would have been created through the mining project were now to be created in a more sustainable manner.

From that day the Park began to make strides to ensure that this occurred and just three years on the Lake and associated ecosystems were registered for UNESCO World Heritage Status. In December 1999 The Greater St. Lucia Wetland Park became South Africa's first World Heritage Site. It was recognized because of its

unique ecological processes, superlative natural phenomena and exceptionally rich biodiversity ([www.phinda.com/Attractions/st\\_lucia.aspx](http://www.phinda.com/Attractions/st_lucia.aspx)).

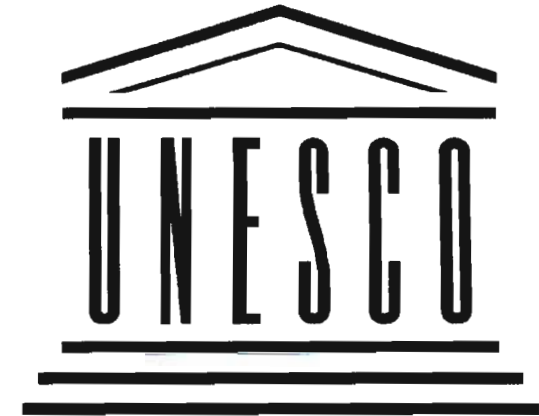
#### Dredging

In the 1930's a number of factors, including the channeling of the Mfolozi Floodplain led to sedimentation of the combined St Lucia/Mfolozi estuary mouth, which caused this mouth to close. In order to combat this in 1952, a separate mouth for the Mfolozi River was constructed to the south of St Lucia estuary and in the same year a program was implemented, which involved the dredging of the St. Lucia Estuary in order to forcefully maintain open mouth conditions. ([www.environment.gov.za/Branches/BioConservation/17Ramsar/st\\_lucia/st\\_lucia\\_ris.htm](http://www.environment.gov.za/Branches/BioConservation/17Ramsar/st_lucia/st_lucia_ris.htm)) Although this program followed nature-based operating rules, it was abandoned in the early Nineties in favour of a more natural ecosystem. As a result of these decisions the entire dredger system - including boats and maintenance facilities - became completely obsolete at this time.

In May 2007 the Greater St. Lucia Wetland Park was renamed, and the new name: iSimangaliso Wetland Park, derived from the words *Miracle* or *Secret* in isiZulu ([www.stluciasa.co.za/sl\\_history.htm](http://www.stluciasa.co.za/sl_history.htm)) has officially been in affect from the 1<sup>st</sup> of November, 2007.



III. 6.1.2: The newly adopted iSimangaliso Logo.



III. 6.1.3: The UNESCO Logo.



III. 6.1.4: World Heritage Site Logo.

III. 6.1.5: View of the St. Lucia Estuary mouth looking from the north.





## 6.1.2 Description of iSimangaliso Wetland Park

### 6.1.2.1 Introduction

The park covers an area of 328 000 hectares and spans 280 kilometres of the KwaZulu-Natal coastline from Mapelane in the south to the Mozambican border in the north. Similar in size to the European country of Luxembourg, the iSimangaliso Wetland Park can be described by the ecosystems it is made up of. There are five distinct systems:

- **The Marine System:** The 280 kilometre coastline and adjacent Indian Ocean marine ecosystem is made up of beaches and coral reef ([www.stluciasa.co.za/sl\\_history.htm](http://www.stluciasa.co.za/sl_history.htm)).
- **The Eastern Shores:** A network of sand dune and coastal forests which extend the full length of the reserve. These dunes form a natural barrier between the lake in the West and the Indian Ocean to the East ([www.stluciasa.co.za/sl\\_history.htm](http://www.stluciasa.co.za/sl_history.htm)).
- **The Estuarine System:** The 85 kilometre Lake St. Lucia is the largest such system in the world, with some of the most complex water networks ever studied. At an average depth of just 1 metre the system is home to thousands of crocodiles, hippopotamus, birds, fish and a plethora of other life ([www.stluciasa.co.za/sl\\_history.htm](http://www.stluciasa.co.za/sl_history.htm)).
- **The Mkuze Swamps:** These vast papyrus swamps connect to the northern edge of the Lake itself ([www.stluciasa.co.za/sl\\_history.htm](http://www.stluciasa.co.za/sl_history.htm)).

- **The Western Shores:** The driest of the five ecosystems, this area is made up of savannah and thornveld ([www.stluciasa.co.za/sl\\_history.htm](http://www.stluciasa.co.za/sl_history.htm)).

### 6.1.2.2 Climate

The iSimangaliso Wetland Park has a typically subtropical climate with warm, humid summers, and mild, dry winters. The annual rainfall average for the area is 1200mm, with 60 percent of this precipitation occurring in the summer months. In addition to this yearly regular rainfall, there are sporadic large scale floods caused by tropical cyclones which move down the east coast along with the Mozambique Channel. As with the majority of the KwaZulu-Natal coastline, the prevailing winds tend to be parallel to the coast, blowing from the north-east or from the south-west ([www.environment.gov.za/Branches/BioConservation/17Ramsar/st\\_lucia/st\\_lucia\\_ris.htm](http://www.environment.gov.za/Branches/BioConservation/17Ramsar/st_lucia/st_lucia_ris.htm)).

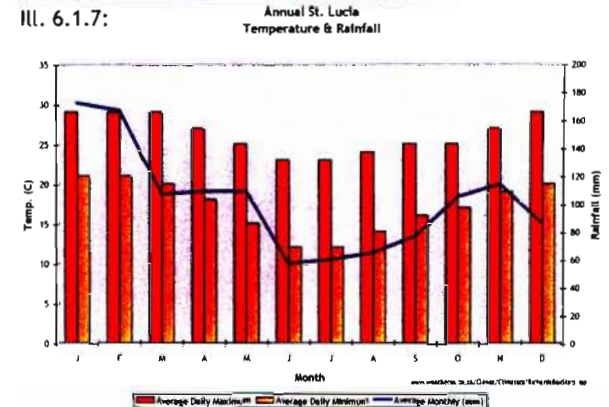
### 6.1.2.3 Flora and Fauna

The park has a highly diverse assortment of flora and fauna. By way of flora there are a total of 2 173 recorded species made up of 152 families and 734 genera, while the fauna diversity is no less startling, with estimated population sizes show the importance of conserving this natural heritage with vigour. The park is home to the largest South African populations of Nile Crocodile (1500), Hippopotamus (800), Red duiker (1000) and Southern reedbuck (6000). In addition, it is home to the largest KwaZulu-Natal populations of Steenbok (300), Warthog (4



Ill. 6.1.6: Lake St. Lucia

Ill. 6.1.7:



Ill. 6.1.9: Loggerhead Turtles use the park coastline as a breeding ground.

Ill. 6.1.10: A Malachite Kingfisher.



000), Impala (9000), Bushpig (500), Nyala (8000) and Bushbuck (700) ([www.environment.gov.za/Branches/BioConservation/17Ramsar/st\\_lucia/st\\_lucia\\_ris.htm](http://www.environment.gov.za/Branches/BioConservation/17Ramsar/st_lucia/st_lucia_ris.htm)).

#### 6.1.2.4 Visitors to the Park

There are approximately two million tourists who enter the iSimangaliso Wetland Park annually through any one of the ten gates. These members of the public enter either as day visitors or as overnight visitors who make use of accommodation or camping facilities. The park itself provides 6000 beds in the form of chalets and camping facilities, while the town of St. Lucia and surrounding game-ranches provide an additional 2000 privately owned beds ([www.environment.gov.za/Branches/BioConservation/17Ramsar/st\\_lucia/st\\_lucia\\_ris.htm](http://www.environment.gov.za/Branches/BioConservation/17Ramsar/st_lucia/st_lucia_ris.htm)). These tourists are then encouraged to take part in one of the many non-consumptive uses, which includes:

- Game-viewing
- Bird-watching
- Turtle viewing
- Beach leisure activities such as swimming, snorkeling or scuba-diving
- Day-walks and overnight hiking
- Camping and caravanning (in demarcated bush-camps)
- Religious activities (such as mass baptism)

([www.environment.gov.za/Branches/BioConservation/17Ramsar/st\\_lucia/st\\_lucia\\_ris.htm](http://www.environment.gov.za/Branches/BioConservation/17Ramsar/st_lucia/st_lucia_ris.htm))

In order to preserve the pristine character of the park, there are however restrictions in place on what activities can occur in which areas of the park. These usage restrictions are dictated by the three part zoning system which has been incorporated:

- *Low intensity zone*-which allows entrance by foot only (except for staff and authorised researchers) (Celliers 2007);
- the *Moderate use zone*-where visitors may enter by vehicles, and includes such facilities as small campsites and hides (Celliers 2007);
- And finally the *High intensity zone*-wherein there are roads, interpretative and educational centres, guided walks, accommodation and more (Celliers 2007).

In addition to these tourist activities, there are also people who have, for centuries, entered the St. Lucia Estuary for the food and materials that it and the surrounding wetlands offer. Two examples of this relationship between park and man have been previously discussed, namely: the Kosi fish traps and the harvesting of *Ncema* grass each spring for making sleeping and sitting mats. It is agreements like these which represent the strides taken by the iSimangaliso Wetland Park to create jobs and a vibrant local economy, while still maintaining the rich ecology richness which is so finely balanced between man and the five ecosystems.

## 6.2 Site Selection

In order to select the ideal site for this development, it was first crucial to create a list of criterion by which potential land could be graded. The ideal site needs to fulfill two seemingly opposed and yet equally necessary determinants:

- Ease of access to the research subject (Geoghen 2007).
- Ease of access to the outside world (Geoghen 2007).

For these two conflicting reasons, selection of the ideal site position is therefore somewhat complex and will be investigated below:

### 6.2.1 Access to Research Subject

Firstly, it goes without saying that the facility needs to be located within an intelligent radius from the subject of investigation, in this case the iSimangaliso Wetland Park. Now, it must be remembered that the park covers a distance of 280 kilometres from north to south along the KwaZulu-Natal coast, and that at its narrowest distance from east to west it is just a few kilometres. This means that it will be almost impossible to find a truly central site to cover such a vertically expansive reserve.

### 6.2.2 Access to Outside World

While the above reasoning suggests that a site within the boundaries of the world heritage site would be most beneficial, research interviews suggests that the selection of a site just outside of the park borders provides some prodigious

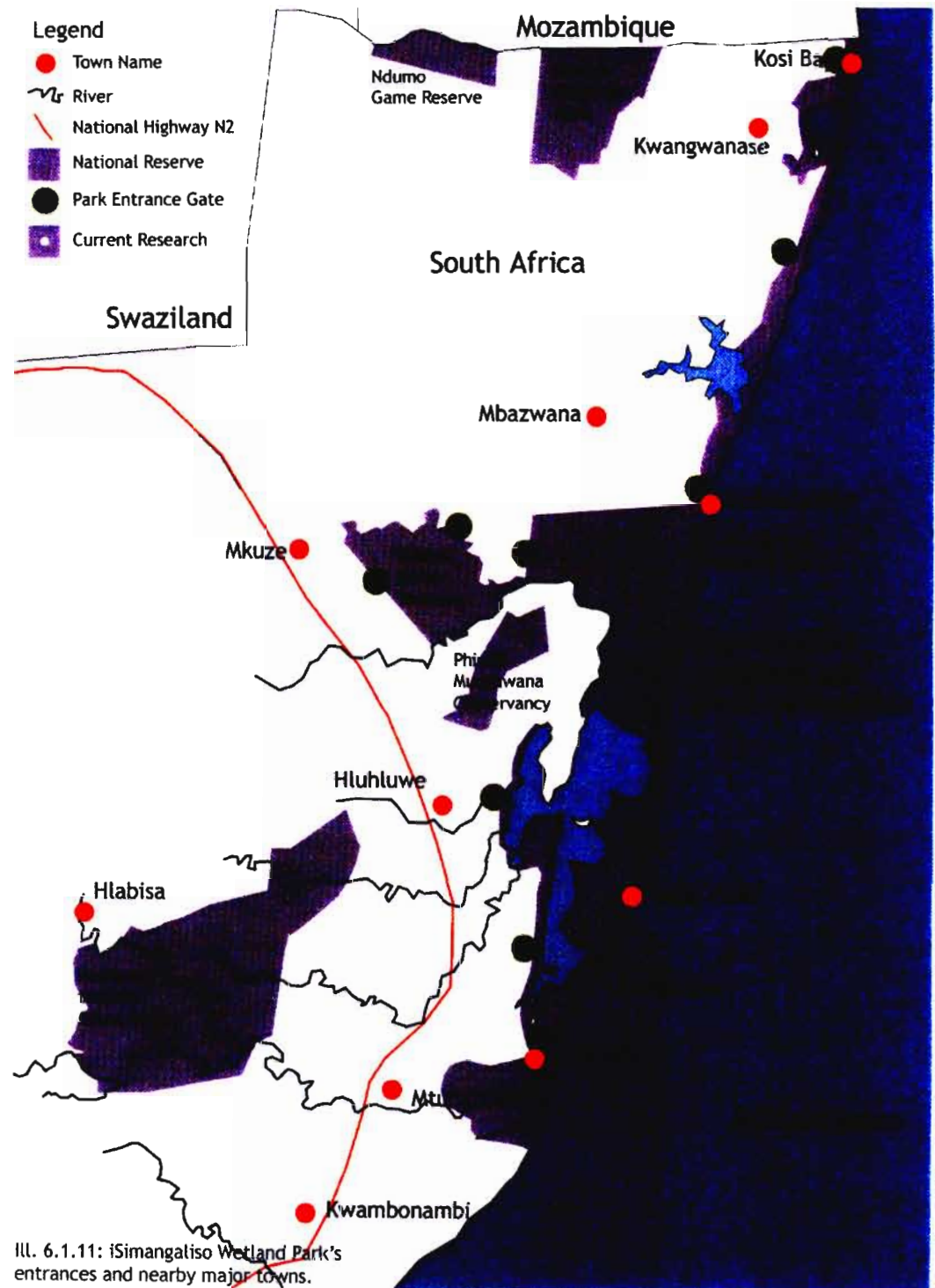


benefits (Geoghen 2007). From a purely pragmatic standpoint it makes it possible for the researchers to get to a local vet after hours as well as allowing other local scientist access to the facilities long after they would were the building within the park boundaries.

Another equally important *raison d'être* for placing a research centre just outside of a park gate would be that it meets the second site selection requirement in that provides the researchers with access to the 'outside world'; a surprisingly significant feature. A researcher at the Hluhluwe-iMfolozi Game Reserve, Clair Geoghen, told us that this connection to 'normal activities' is one of the most underestimated prerequisites of any site selection. She clearly conveyed that researchers tend to suffer from a kind of cabin fever when they do not have access to a newspaper or the ability to dine at a local restaurant (Geoghen, 2007).

Having determined that the site should ideally be located close to a town just outside of a park entrance, thus allowing equal access to both park and the outside world, it becomes crucial to identify these points of entry, and identify the gate that best suits these requirements, while concomitantly analysing the gate's relationship with a macro-context.

This map shows the location of the nine main entrance points into the iSimangaliso Wetland Park. In terms of proximity of infrastructure and the location of entrance gates-it is clear from this map there are only three potential towns

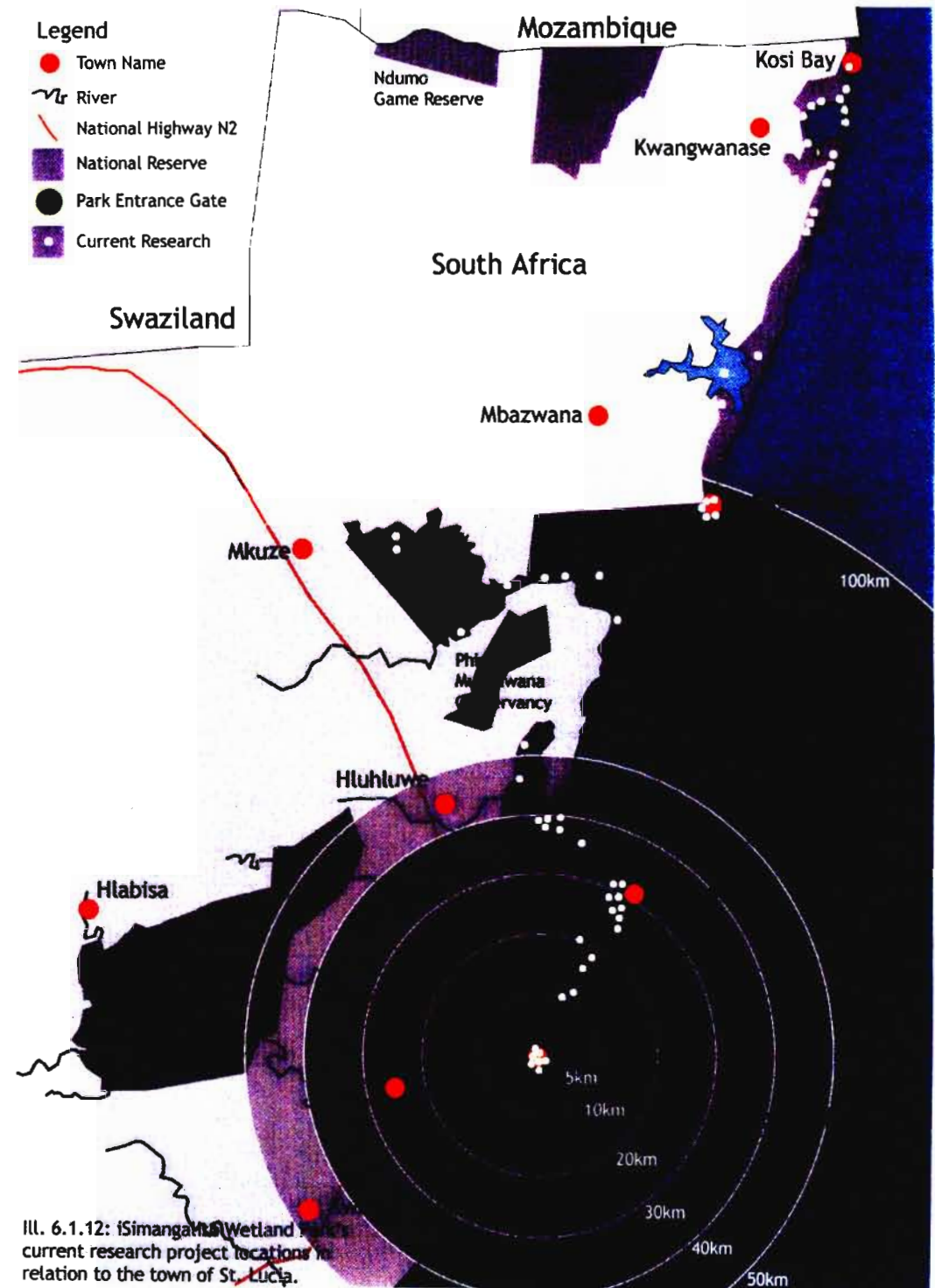


within which to place the research facility: St. Lucia, Sodwana Bay or Kosi Bay. To resolve the site selection between these three potentials, there are a few other factors that first need to be evaluated:

Firstly-it should be noted that a large percentage of the current research institutes involved at Isimangaliso are themselves based in Durban (Celliers 2007), 250 kilometres south of the southernmost town: St. Lucia, and therefore over 500 kilometres to the northermost option: Kosi Bay. It would therefore be an inhibitive decision to choose Kosi Bay. Another reason why that town would not be a sufficient choice, is that it is not well endowed with efficient infrastructure, and would therefore struggle to support a facility of this kind.

In addition, an analysis of the current research projects occurring in the World Heritage Site reveals that due to the available infrastructure and the proximity of potential study areas, the town of St. Lucia is either home to, or within a 100 kilometre radius, of a large percentage of these research projects. St. Lucia is therefore relatively close to Durban, as well as being within a reasonable distance of the majority of the current research.

These factors lead to the conclusion that the best macro-site is the town of St. Lucia. From here , it is a matter of analysing the town itself to reveal which site fulfils the access requirements laid out above.





### 6.3 Site Analysis

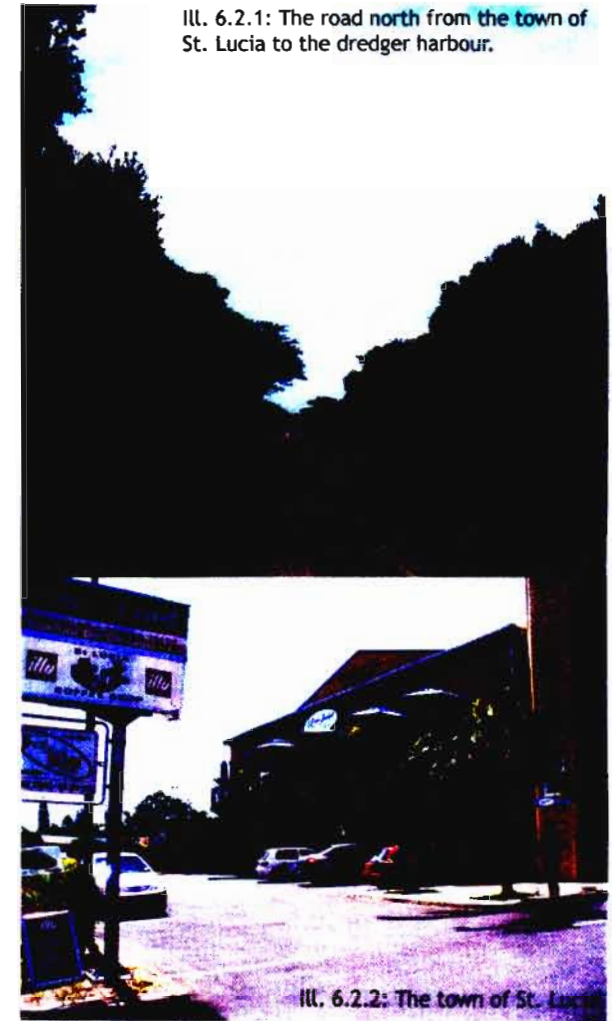
#### Dredger Harbour, St. Lucia

28° 21' 44" S 32° 24' 41" E

Recently, the administrative arm of Ezemvelo: The iSimangaliso Wetland Park Authority decided to relocate their offices from within the town of St. Lucia itself. Their new home will be in a dilapidated warehouse (Ill. 6.2.6) which local Durban architectural firm, East Coast Architects will responsibly convert into an administrative centre for the Authority. The warehouse is part of a campus of obsolete buildings once used as the headquarters for the dredging of the St. Lucia Estuary (Ill. 6.2.8). On the Eastern edge of the estuary an artificial harbour was dredged out of the surrounding forest and various ancillary structures were constructed in order to support the dredging process. These include a boathouse, a dry dock, warehouse facility, administrative block and boat jetty (pg 82). These buildings were used up until the early Nineties, when it was decided that on environmental grounds, the estuary dredging would cease in favour of a more naturally regulated system. Since this date, these buildings have fallen into disrepair due to their redundancy.

The move of the Park Authority into one of these buildings has renewed interest in the land and structures surrounding these newly designed offices. For this reason, there is certainly the potential for the creation of a campus of Wetland Park related buildings.

Ill. 6.2.1: The road north from the town of St. Lucia to the dredger harbour.



Ill. 6.2.2: The town of St. Lucia

Ill. 6.2.3: An aerial view of the town. The bridge into town is lower right, while the estuary mouth is top left. The harbour is just off the image to the lower left.

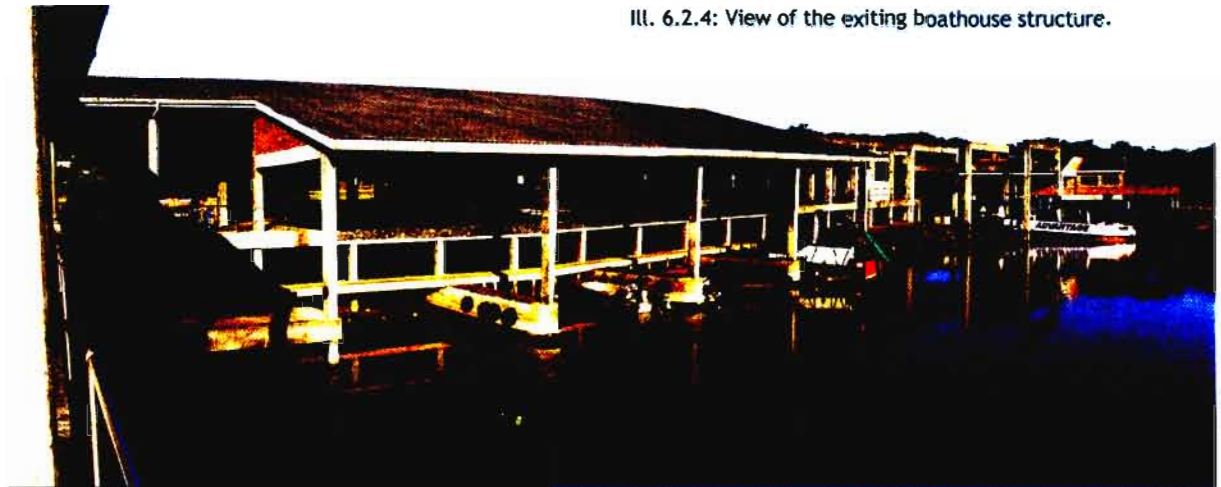


The harbour is just five minutes drive north of the town of St. Lucia and another two minutes in the same direction is the St. Lucia gate into the World Heritage Site. As such, the Dredger Harbour fulfils all site access requirements because it is outside of the park borders and close to an entry gate. Due to the fact that the land was once used as the maintenance and operational centre for the dredging of the Estuary, the road network has been well maintained, while all other infrastructural requirements are already on site and available for usage.

One of the abandoned structures; the concrete framed boathouse, which straddles the waters edge has been all but engulfed by the local flora. It is this building which best matches the requirements regarding size and location, for the design of an environmental facility. As previously discussed, the selection of a brownfield site displays good stewardship and to reinterpret the Aboriginal mantra made famous by Glenn Murcutt, the best way to “touch a place lightly” is to use a previously ‘touched’ place.

The concrete frame of the boathouse is in very good condition. There is no sign of spalling, and the structure has been designed to support five ton gantries which run the length of the structure. This extra strength means that this structure could support the addition of another floor. In addition, the manner in which this structure has been designed lends itself to the creation of connections with the environment, a key theoretical component of this design on both

III. 6.2.4: View of the exiting boathouse structure.



III. 6.2.5: Photograph showing the context of the boathouse.



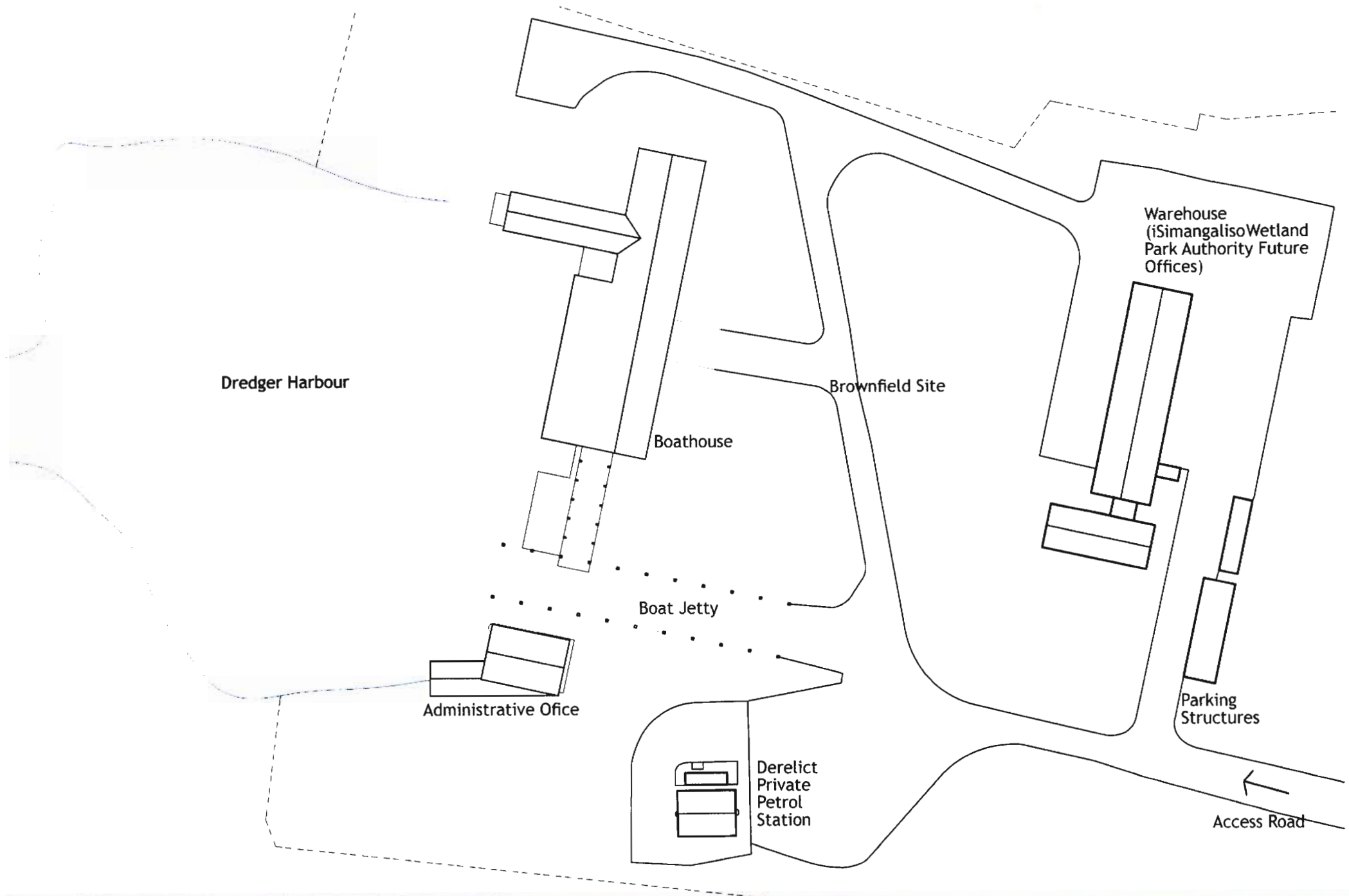
III. 6.2.6: Looking east from the boathouse; a view to the warehouse and entrance gate.



III. 6.2.7: A view to the boathouse taken from in front of the soon to be converted iSimangaliso Wetland Park Authority offices.







## 6.4 Environmental Features

Although the dredger harbour does not fall within the boundaries of the World Heritage Site itself, it is still home to a unique environment which is worth protecting:

### 6.4.1 Hydrological Features

The site fronts onto the lower regions of Lake St Lucia, a stretch of water considered to be the St. Lucia Estuary. This entire water system is hydrologically dynamic ([www.environment.gov.za](http://www.environment.gov.za)), responding to a variety of climatic conditions. The principle sources of water are rainfall and rivers ([www.environment.gov.za](http://www.environment.gov.za)), while in periods of drought sea water may flow into the estuary mouth as the Lake falls below sea level ([www.environment.gov.za](http://www.environment.gov.za)). Meanwhile water loss occurs through either evaporation or discharge into the Indian Ocean ([www.environment.gov.za](http://www.environment.gov.za)). Due to the high surface area to volume ratio the system is particularly susceptible to evaporation, which exceeds rainfall, even in years of above-average precipitation ([www.environment.gov.za](http://www.environment.gov.za)).

Another important feature of the hydrological system, is the salinity; which is determined by the amount of fresh or sea water recieved. During periods of above average precipitation the salinity gradient ranges from fresh water at the river mouths, to sea water in the estuary mouth. During the opposite, drought periods, the gradient is reversed as a result of sea water inflow ([www.environment.gov.za](http://www.environment.gov.za)). The Lake itself becomes hyper-saline, with recordings in the northern reaches of salinity levels exceeding three times regular sea water. This hyper-salinity occurs on average for two years each decade ([www.environment.gov.za](http://www.environment.gov.za)).

All this serves to show that the system is by no means simple, and these continual changes in salinity levels exert major influence on the sensitive biomes along the edge of the Estuary and Lake ([www.environment.gov.za](http://www.environment.gov.za)). Much of the adjacent flora and every aquatic species have specific, individual salinity-tolerance levels, meaning that the ecological response to these fluctuating salinity levels leads to a continual flux of species population arrangements and levels ([www.environment.gov.za](http://www.environment.gov.za)). The Lake, Estuary and indeed Dredger Harbour of St. Lucia therefore provide a dynamic ecosystem for ever changing flora and fauna populations ([www.environment.gov.za](http://www.environment.gov.za)).

### 6.4.2 Ecological Features

As previously discussed, the Park vegetation is diverse, and contained in a mosaic of forest, thickets, woodlands, grassland and wetland types, the distribution of which is largely determined by topography, micro-climate, soil conditions, drainage and salinity levels ([www.environment.gov.za](http://www.environment.gov.za)). In order to gain a fuller understanding of the specific site, it is crucial to be aware of which biomes occur.

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Ill. 6.2.9: An image of the predominant wetland vegetation species: *Phragmites mauritianus*





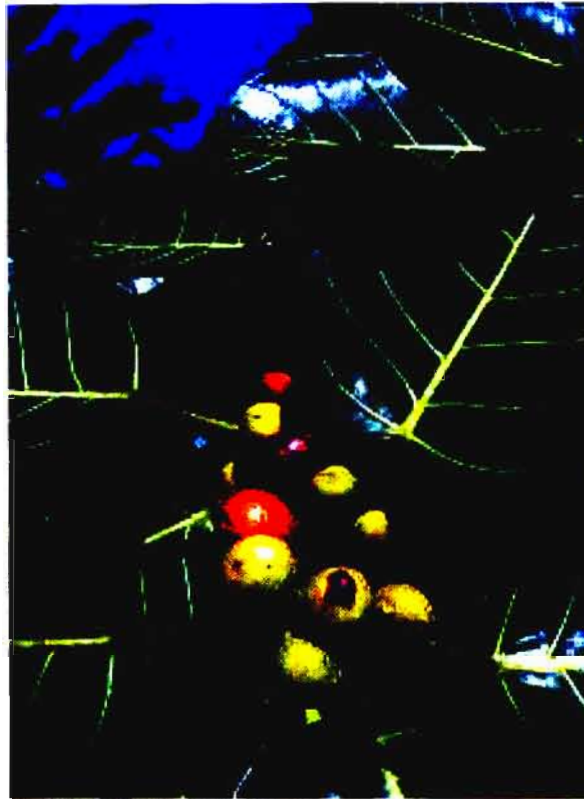
#### 6.4.3 Dredger Harbour Wetland type

The wetland surrounding the Dredger Harbour is a Saline reed swamp (Ill. 6.2.9), which grows well in the saline alluvial soil, and provides detritus and shelter for estuarine organisms. The predominant species is *Phragmites mauritianus* ([www.environment.gov.za/Branches/BioConservation/17Ramsar/st\\_lucia/st\\_lucia\\_ris.htm](http://www.environment.gov.za/Branches/BioConservation/17Ramsar/st_lucia/st_lucia_ris.htm)).

#### 6.4.4 Dredger Harbour Grassland type

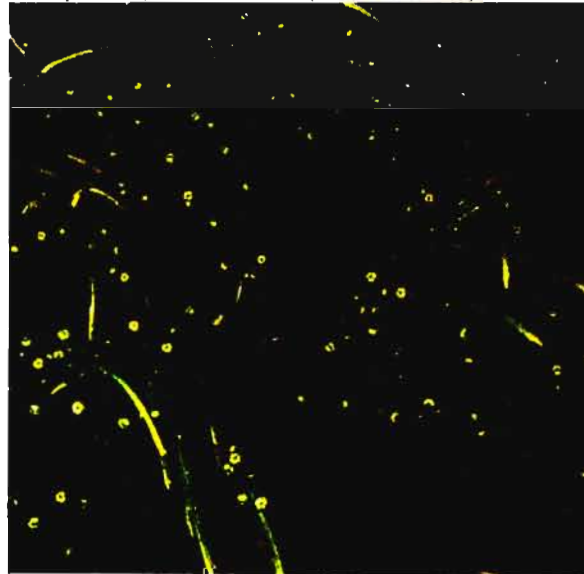
There are a variety of grassland types which proliferate the park, surrounding the site, more specifically, is the *Echinochloa* floodplain grassland, which is regularly found in the seasonally flooded plains of the larger rivers (Mkuzi and Mfolozi) ([www.environment.gov.za/Branches/BioConservation/17Ramsar/st\\_lucia/st\\_lucia\\_ris.htm](http://www.environment.gov.za/Branches/BioConservation/17Ramsar/st_lucia/st_lucia_ris.htm)). Characteristic species are: *Echinochloa pyramidalis* (Antelope Grass), *Eriochloa* species, *Sorghum* species and a variety of *Cyprus* species ([www.environment.gov.za/Branches/BioConservation/17Ramsar/st\\_lucia/st\\_lucia\\_ris.htm](http://www.environment.gov.za/Branches/BioConservation/17Ramsar/st_lucia/st_lucia_ris.htm)).

Ill. 6.2.10: The flower of the Powder-Puff tree (*Barringtonia racemosa*), a common species in the swamp forest.



Ill. 6.2.11: Berries of the Swamp Fig (*Ficus Trichopoda*).

Ill. 6.2.12: Another plant species common to the sites Swamp Forest, the Whisk Fern (*Psilotum nudum*).



Ill. 6.2.13: Two species of grass very common in the small area of grassland on the site are the *Eriochloa* species, and Ill. 6.2.14: a variety of *Sorghum* species.





#### 6.4.5 Dredger Harbour Forest type

While the aforementioned grassland does occur, the dominant ecosystem on this site is swamp forest. This forest typology is extremely rare in South Africa with a total extent of approximately 4 843 ha. In addition, an estimated 64% (3 095 ha) of this total occurring in the Park itself ([www.environment.gov.za/Branches/BioConservation/17Ramsar/st\\_lucia/st\\_lucia\\_ris.htm](http://www.environment.gov.za/Branches/BioConservation/17Ramsar/st_lucia/st_lucia_ris.htm)), which highlights the importance of sites where it does occur. The forest is integral in the protection of the wetland in that it provides filtration.



Ill. 6.2.15: The berry of the aforementioned Powder-Puff tree, also called the Hippo Apple (*Barringtonia racemosa*).

Ill. 6.2.16: Coast Goldleaf (*Bridelia micrantha*).



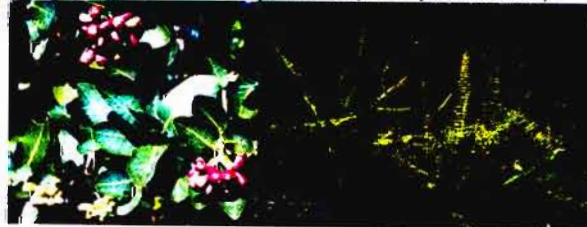
Ill. 6.2.17: Wild Date Palm (*Phoenix Reclinata*).

The forest is home to many rare species, in particular birds. Characteristic species are *Ficus trichopoda*, *Voacanga thouarsii*, *Syzygium cordatum*, *Barringtonia racemosa*, *Phoenix reclinata*, *Macaranga capensis*, *Bridelia micrantha*, *Psychotria capensis*, *Tarenna pavettoides*, *Psilotum nudum*, *Stenoclaena tenuifolia* and *Nephrolepis biserrata* ([www.environment.gov.za/Branches/BioConservation/17Ramsar/st\\_lucia/st\\_lucia\\_ris.htm](http://www.environment.gov.za/Branches/BioConservation/17Ramsar/st_lucia/st_lucia_ris.htm)).



Ill. 6.2.18: The Swamp Fig (*Ficus Trichopoda*) on the edge of the St. Lucia Estuary.

Ill. 6.2.19: Swamp Forest Waterbessie (*Syzygium cordatum*).



Ill. 6.2.20: below the Swamp Forest canopy grow Giant Sword Ferns (*Nephrolepis biserrata*).

Ill. 6.2.22: Black Bird-Berry (*Psychotria capensis*).



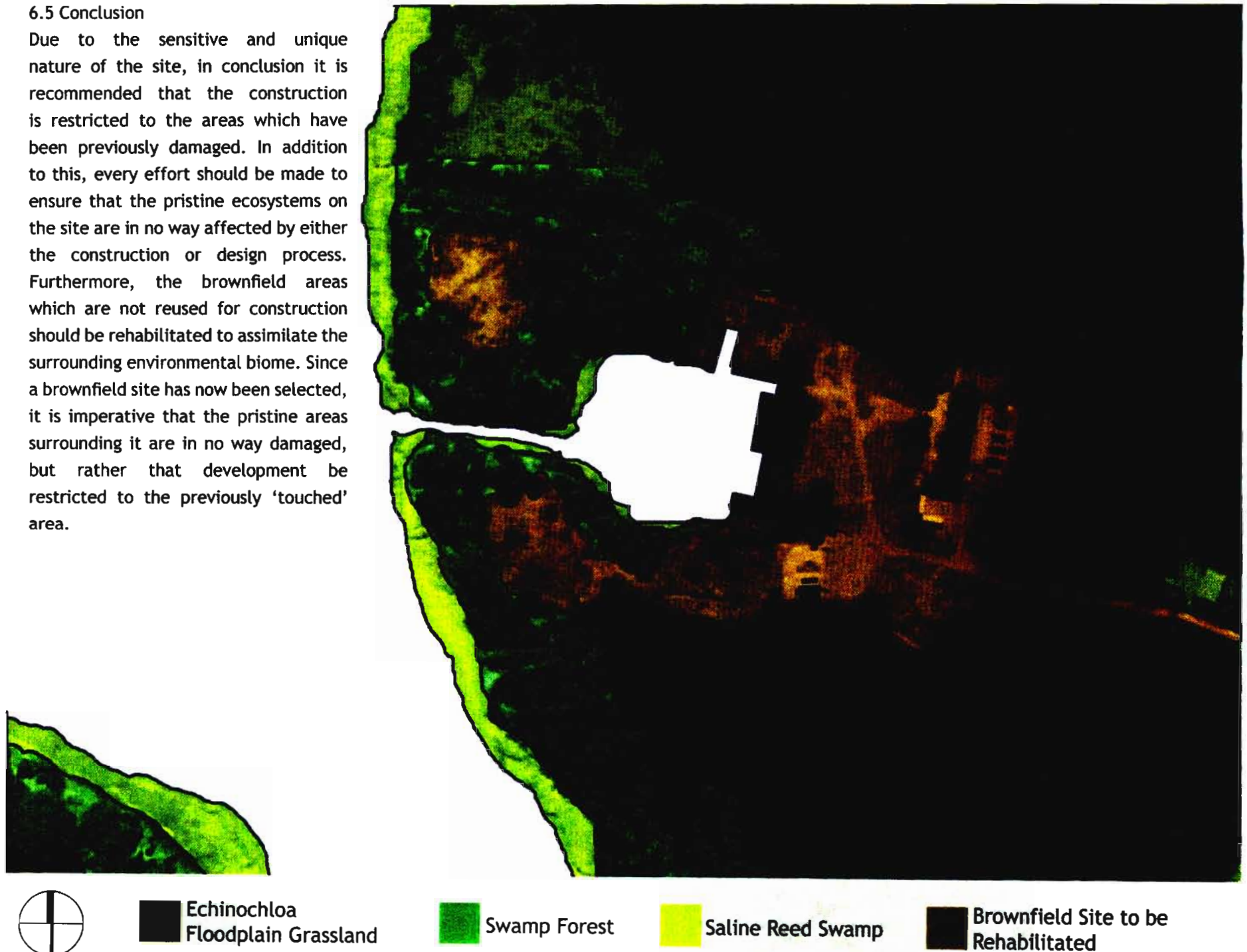
Ill. 6.2.23: The berry of the Swamp Fig (*Ficus Trichopoda*).

Ill. 6.2.21: These Swamp Figs (*Ficus Trichopoda*) show the density of the surrounding Swamp Forest.



### 6.5 Conclusion

Due to the sensitive and unique nature of the site, in conclusion it is recommended that the construction is restricted to the areas which have been previously damaged. In addition to this, every effort should be made to ensure that the pristine ecosystems on the site are in no way affected by either the construction or design process. Furthermore, the brownfield areas which are not reused for construction should be rehabilitated to assimilate the surrounding environmental biome. Since a brownfield site has now been selected, it is imperative that the pristine areas surrounding it are in no way damaged, but rather that development be restricted to the previously 'touched' area.



## Chapter VII: Technical Report and Building Requirements

In order to most effectively determine the requirements for the Environmental Research Facility, it will first be most helpful to outline the distinct portions of the brief, namely:

- Research Support Spaces
- Laboratories
- Public Facilities

Each of these three areas have certain specific functions which they need to perform. There is little overlap, they are distinct, and will be dealt as such. Once these specifics have been covered, the discussion will continue on to determine the manner in which the research facility will sustainably respond to the specific social, environmental and economic issues of the harbour site.

### 7.1 Research Support Spaces

#### 7.1.1 Introduction

While the actual experimentation and research findings occur in the laboratories (see below), there are a number of necessary spaces which contribute to these findings. The requirements for each of these ancillary spaces will be investigated below.

#### 7.1.2 Office space

As previously discussed (*Research in South Africa*) a research project may be conducted over a course of anything between one and ten years depending on the research problem and the availability of funding. And while there is significant amount

of time spent in the field collecting samples and recording observations, there are the additional jobs of writing up findings and ensuring that the research team (of up to twenty people) is on the same page regarding the activities that need to be conducted: It is for this reason that Watch and Tolat (2002) suggest that office space should be designed to allow for teamwork and that these spaces should be easily readjusted to meet future usage requirements. This suggest that the office areas should be open plan, a concept which is contrary to the territorial tendency that research and scientific staff have (Griffin 2000:6, Weerts, Celliers 2007). Despite this, research suggest that is the most productive form of office planning in a research environment (Watch and Tolat 2002, Weerts 2007).

Having said this, there is frequently a justified need for visual and aural privacy, and these needs should not be ignored (Putnam Gould 1986:62). Spaces that provide such privacy would range in size to meet different size requirements, and would include interview and meeting spaces.

#### 7.1.3 Meeting Spaces

As just stated, there is the frequent need for a more private setting for meetings to occur. These rendezvous' could be between anything from two to fifteen people, and so a range of spaces should be provided to meet these requirements.

#### 7.1.4 Library

There are currently numerous volumes which pertain to research findings in the iSimangaliso Wetland Park alone (van Heerden 2007), and



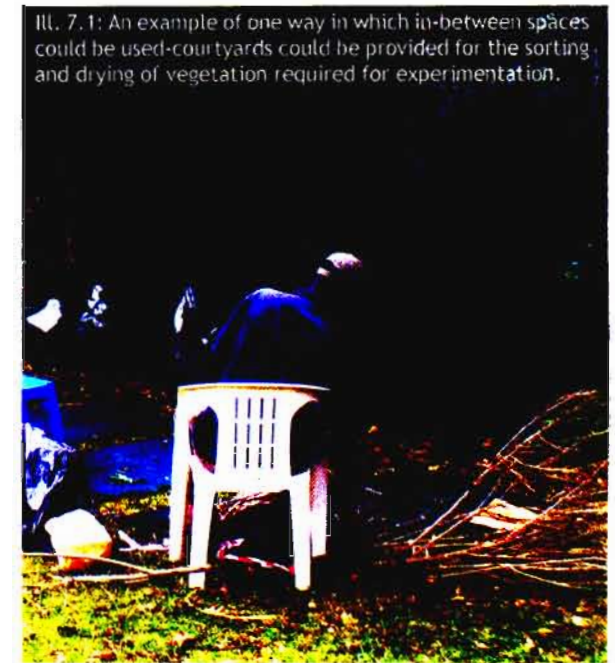
these books need a central home. There would be no better location for such a library than at the Environmental Research Facility, where these publications could be shelved alongside numerous pertinent texts on other environmental research findings. This library would not be public in nature, but rather it would provide a resource for scientists conducting research at the facility, while concurrently providing space for social interaction to encourage the cross-pollination of research findings and ideas (Celliers 2007). While such spaces are encouraged, there is also the need to provide for more private, quiet and focused study areas. Celliers (2007) also points out the importance of being able to separate the library off from the office and laboratory accommodation so that it does not have to be manned 24 hours a day, a sensible consideration.

#### 7.1.5 'In-between' spaces

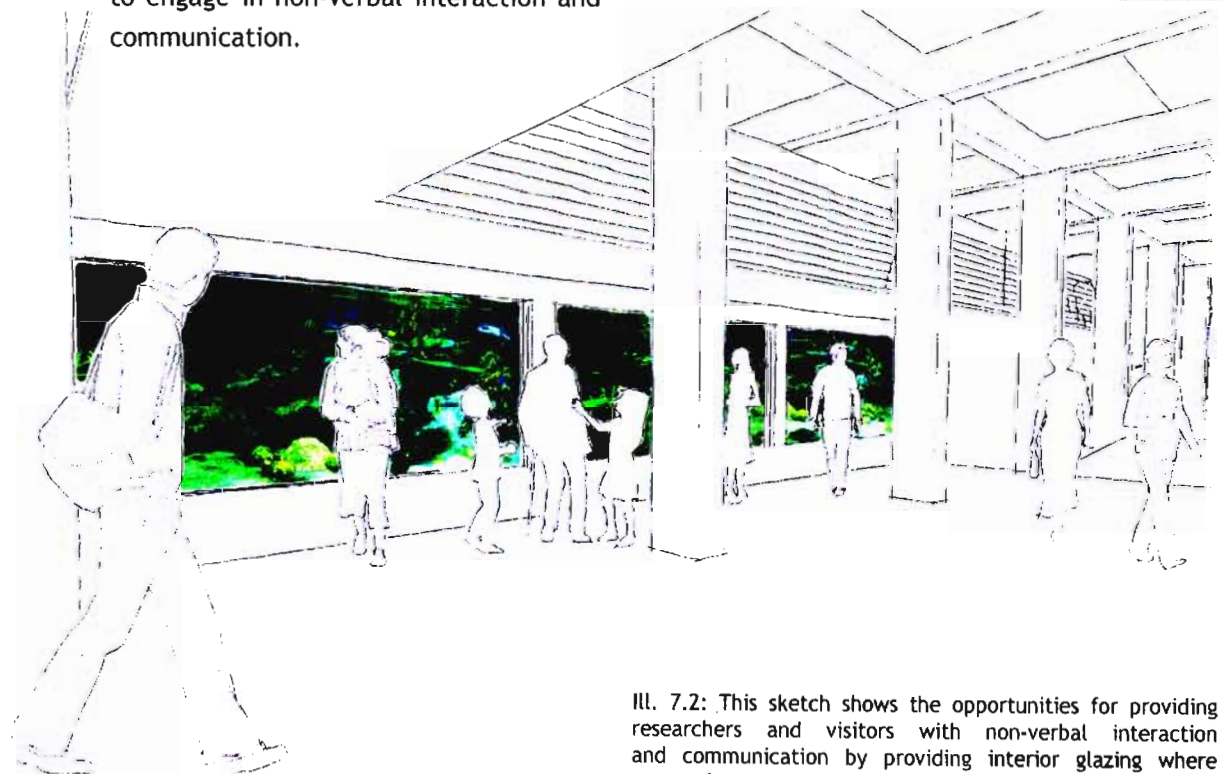
Through interviews (Weerts, Celliers, Geoghen, Van Heerden 2007), it became apparent that scientific discovery occurs on two levels, namely the formal and informal. While there is certainly a necessity to allow for planned, rigid meeting places and times, there is also the opportunity to allow for and encourage the occurrence of serendipitous interactions throughout the facility. It has been said that *"science functions best when it is supported by architecture that facilitates both structured and informal interaction, flexible use of space, and sharing of resources"* (Watch & Tolat 2002). In their extremely helpful guidelines: *Sustainable Laboratory Design*, authors Daniel Watch and Deepa Tolat suggest a few architectural approaches, functions and spaces that should be

allowed for if this mix of formal and informal social interaction is to occur:

- o Formal meetings spaces such as break rooms, discussion rooms and central social areas.
- o Informal spaces which allow for interaction such as atria, aptly placed benches and even widened stair landings.
- o A minimisation of areas that are 'owned' by one or another research group or project.
- o The provision of central, wide and specifically established circulation routes.
- o The provision of interior glazing where appropriate, thus allowing researchers to engage in non-verbal interaction and communication.



Ill. 7.1: An example of one way in which in-between spaces could be used—courtyards could be provided for the sorting and drying of vegetation required for experimentation.



Ill. 7.2: This sketch shows the opportunities for providing researchers and visitors with non-verbal interaction and communication by providing interior glazing where appropriate.

## 7.2 Laboratories

### 7.2.1 Introduction

By way of definition, there are basically two types of laboratories: Wet Labs, and Dry Labs, each with their own specific and differing requirements. It is important to note these requirements at the offset of design, since they are specific to the point that they are not interchangeable. That is to say that a Wet Lab cannot be used as a Dry Lab, and *visa versa*. Definitions of each were acquired through interviews (Weerts, Celliers, Geoghen 2007), and are as follows:

### 7.2.2 Wet Lab

- Services
  - Water
  - Piped Gas
  - Electricity
- Sinks
- Fume hoods
- Chemically resistant counter top finishes
- Natural ventilation. No need for Air Conditioning but often the smells are overpowering when working with Formalin etc., so air flow is crucial
- Roller Doors to provide connection to exterior; both for the ventilation, and ease of cleaning
- Tiled surfaces so that the entire lab can be hosed down
- Ambient, Natural daylighting
- Contains some fixed casework
- Walk-in freezer
- Changes in level to divide and contain any spills

### 7.2.3 Dry Lab

- Services
  - Water (only at individual sinks)
  - Electricity
  - Data wiring
- Flat worktops essential
- Can have either reticulated air or natural ventilation
- Contain expensive, fragile electronic equipment
- Can be outfitted entirely of mobile casework
- Examples:
  - Microbiological Lab
  - Genetics Lab

In addition to these two broadly defined laboratories, there are some other spaces which have very specific requirements which need to be discussed.



III. 7.4: An example of the expensive, electronic equipment in a dry laboratory at CSIR's Durban campus.



III. 7.5: An example of a fume cupboard; essential for safety in laboratories.



#### 7.2.4 Research Aquarium

In a rather self-explanatory manner, a research aquarium operates in a similar way to that of a regular aquarium, but with the added controls of a laboratory, so that experiments can be conducted on a variety of aquatic species. The requirements for such a laboratory space are:

- Services
  - Water
  - Electricity
  - Climate (humidity and temperature) control
- Flexibility is key-the more moveable the plugs, tanks, power, water etc., the better
- Natural daylighting is crucial-the contents of the tanks require sunlight to effectively replicate their natural biome
- Paint is easily corroded due to the presence of salt water

#### Constant Temperature Rooms (CTR)

As the name suggests, a CTR is a space, or number of spaces, where researchers have control over the climatic conditions in the space. Practically, researchers will repeat the same experiment into three or four CTR's set to different climatic conditions, and examine the responses in each to determine the effects that the temperature and humidity have on various naturally occurring events. In order to achieve this, the following services are required:

- Water
- Electricity
- Climate (humidity and temperature) control

#### 7.2.5 Chemical Storage and Preparation room

Rather than have chemical storage in every lab space, it is more intelligent to centralise this storage with a space for preparation of these chemicals for use in the lab spaces (Weerts, Celliers 2007). Such a space requires:

- Services
  - Water
  - Electricity
- Storage (Combustible and regular)
- Changes in level to divide and contain any spills

III. 7.6: The Research Aquarium at SAAMBR used by the Oceanographic Research Institute; natural daylight is essential in these laboratories.



III. 7.7: The Research aquarium at CSIR's Durban campus.

III. 7.8: A storage cupboard in the preparation space at CSIR's Durban campus.



### 7.2.6 Services

The expectations of laboratory users can change from project to project, and as such a servicing system which responds to these fluctuations is a most sensible option in such as facility. The provided services need to suitably meet the needs of current users while being easily adaptable in order to satisfy the needs of future users (Griffin 2000:3). In order to best achieve this, there are two requirements that should be met; firstly, the selection of a flexible supply system and secondly the provision for a 25 percent increase in current maximum service supply to meet any future demand (Loring 1986:70, Watch 2002).

Additionally, the recent increased mechanisation of laboratory equipment (Griffin 2000:45) dictates that there has been a concomitant increase in the need for power, data and communication supply to meet the requirements of more electronic and automated laboratory instrumentation. The net result, is an augmentation in the need to design the servicing of laboratories in order to acquire the most effective and efficient servicing setup. A number of design considerations need to be introduced in order to achieve just this:

- Easy connects/disconnects (Watch 2002)
- Clearly marked and easily accessible service shut off valves (Watch 2002)
- Maximum control regarding the isolation of individual service branches without shutting down supply to an entire laboratory (Loring 1986:73)
- There must be clear identification (using the DIN standard colour coding system) of

all piped services and their outlets (Griffin 2000:81)

- There should be no unnecessary joints or elbows within the service lines (Loring 1986:73)

### 7.2.7 Service Distribution Alternatives

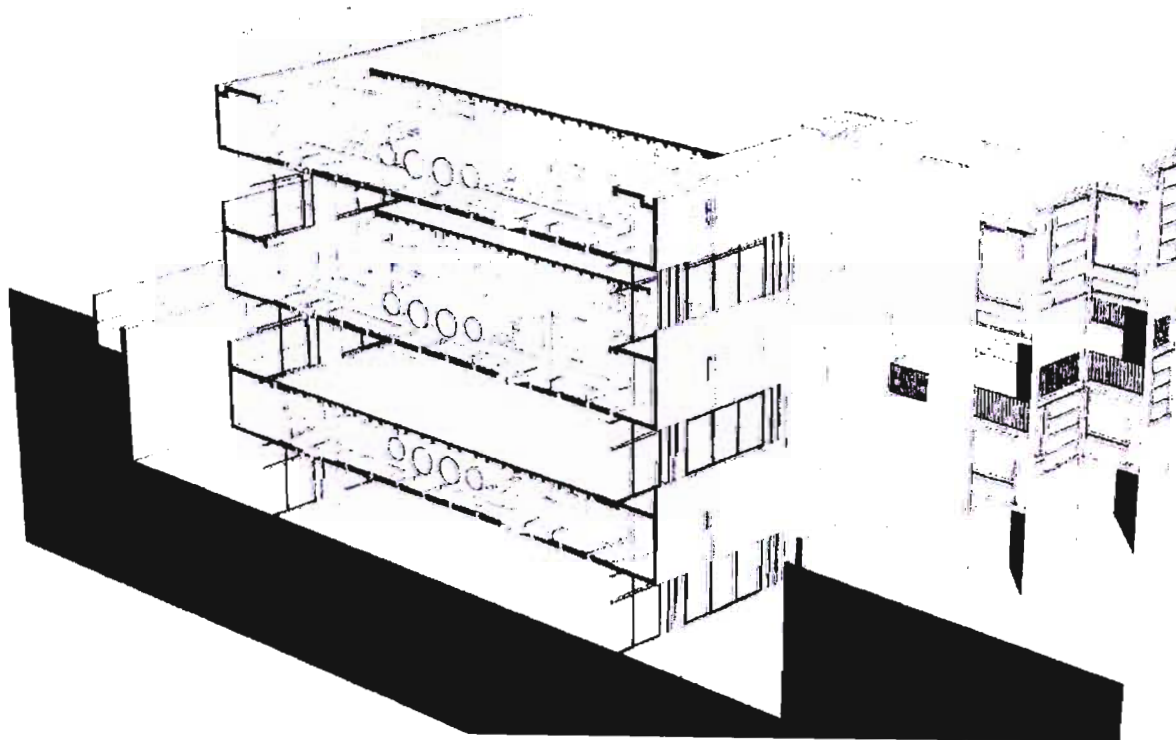
Loring (1986:69-70), sets out the four most frequently employed methods of distributing services to laboratories, these are:

- Interstitial floors
- Continuous end-wall service corridors
- Vertical distribution
- Horizontal distribution

#### 7.2.7.1 Interstitial floors

The design of an interstitial floor is most commonly associated with the Louis Kahn designed Salk Institute in La Jolla, California, which was designed over 40 years ago. In essence, this model incorporates an entire new service floor sandwiched between two laboratory floors. An interstitial floor provides an unprecedented ability to change the layouts of the laboratories, while allowing for a high level of maintenance. However, while this system allows for this flexibility and ease of maintenance, Loring (1986:9, 69) points out that it adds more than 20% to the volume of the building. In addition, an interstitial floor is in many instances, prohibitively expensive, and it is essentially this factor that has lead to a reduction in popularity.

III. 7.9: The interstitial floor servicing scheme employed at the Louis Kahn designed Salk Institute in California.





#### 7.2.7.2 Continuous end-wall service corridors

The second method of providing servicing for laboratory spaces is the creation of a continuous end-wall service corridor. Each lab therefore has a dedicated, adjacent service space which means that flexibility is maximised, as is the ease of maintenance.

The major downfall of this servicing method is that the corridor is at some point going to prove to be a barrier. Either internally, or in the more frequent problem whereby the corridor completely eradicates the daylight from an entire wall. This often leads to a complete lack of natural light in the space-certainly not ideal in this facility.

#### 7.2.7.3 Vertical distribution

As the name suggests, services are distributed vertically through what amount to cores which run the vertical length of the building. These services then enter a space either just below or above the slab. As Loring points out, it is comparatively inflexible and costly to maintain and modify (1986:69), and while this system was once popular, it is now not a wise option, not least of all for the fire hazard that these vertical ducts provide (van Heerden 2007).

#### 7.2.7.4 Horizontal distribution

Lastly, there is the method of service distribution which works horizontally. In this system, major services are grouped into an overhead carrier hung from the structure above. When access to these services is required, there are options for a system which provides quick connect/disconnect

fittings. While initial installation costs are high, they are not inhibitive; and ultimately this system offers the lowest life cycle costs (Loring 1986:70). Another prerequisite is the existence of a higher than usual floor to ceiling height, however, in the case of the existing concrete boathouse structure, there is pre-determined ceiling height of 5000mm which is more than sufficient for such a system. Considering the existing structure, the long term benefits, short term flexibility and the ease of maintenance, this option seems to be the most suitable for implementation in the research facility.

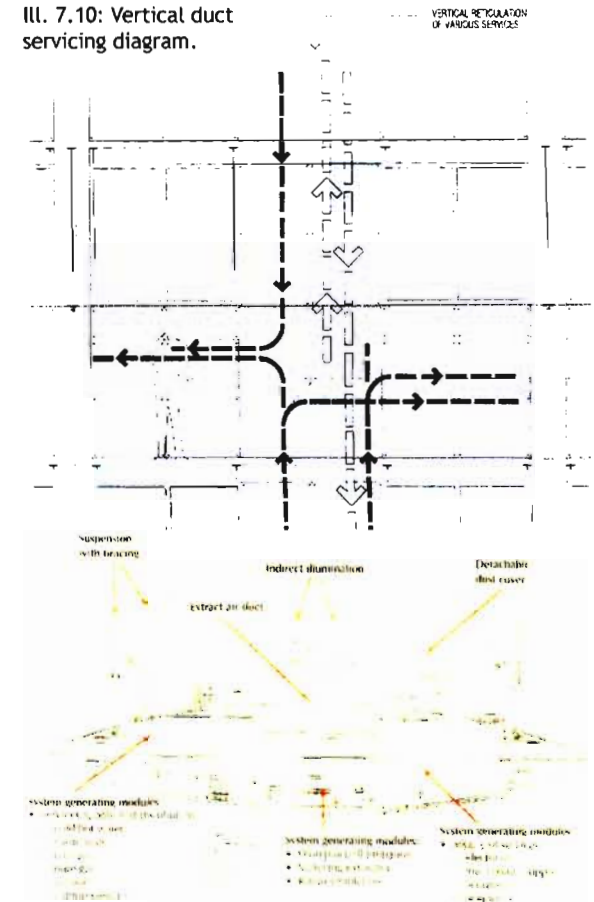
### 7.2.8 Electricity Supply

Laboratory equipment can be serviced by a standard 220V system which should be kept separate from supply to the rest of the building and for every 55m<sup>2</sup> of laboratory space there should be a dedicated distribution board placed beyond the laboratory confines (Loring 1986: 73 - 74). As previously discussed (in *Responsible Resource Management*) reliance on inconsistent municipal electricity supply is simply not an option in the Environmental Research Facility. There must be some sort of back-up energy supply to ensure that the sensitive systems within the lab environment are maintained, and that the findings are therefore viable and valuable.

### 7.2.9 Gas supply

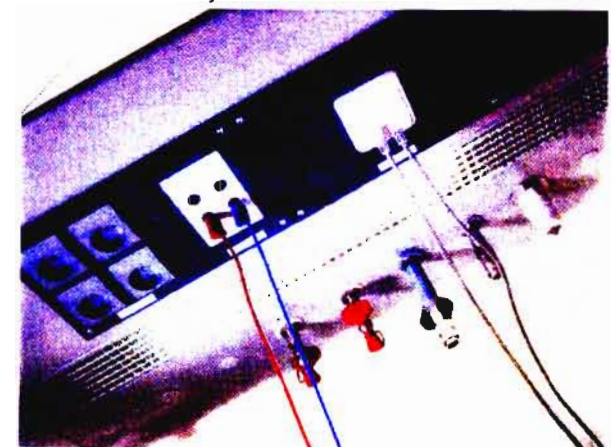
Loring highlights that the most frequently required gases are: butylene, carbon dioxide, hydrogen, helium, oxygen, nitrogen, propylene, propane and natural gas (1986:91), while the specific requirements will be dictated by each

Ill. 7.10: Vertical duct servicing diagram.



Ill. 7.11: Diagrammatic section through a horizontal servicing product.

III. 7.12: Easy connect/disconnect system on an overhead horizontal service system.



individual research project. Having said this, the use of gas in environmental facilities does not match the frequent usage in medical laboratories and for this reason, it would be more beneficial to adopt a system whereby gases are delivered to workbenches on a trolley, a system which provides the most flexible and secure option. These gases need to be kept in a central gas storage area. This area needs to meet certain requirements in order to be effective and safe (Loring 1986:73):

- A separate, outdoor and above ground structure
- Protected from the sun to ensure that there is no overheating
- Must be located away from any potentially combustible sources such as power lines.

### 7.2.10 Water supply

In Laboratory Design Guides, Griffin lays out that there are essentially three types of water that are required for regular lab usage (Griffin 2000:77, 80), namely:

- Regular potable water.
- Non-Potable water [with clearly marked outlets (Griffin 2000:81)].
- Analytical grade water.

However, it has been highlighted that in a facility of this nature, there is also the need to supply salt water for use in the experimental aquarium (Weerts, Celliers 2007). Since the salt water is required in only the one laboratory, it would make the most sense to separate the supply of this service by providing a sea water recirculation

system in the aquarium: a cost saving and efficient solution (Weerts, Celliers 2007). Water supply outlets should be of a high quality, and fitted with flow control devices which will assist in the conservation of water, the elimination of water hammer and provision of a predictable and reliable water flow. In order to further reduce water and electricity consumption hot water supply runs should be well insulated (Griffin 2000:79).

### 7.2.11 Ventilation

Loring (1986:75) suggests that due to a number of contributing factors, the laboratory environment requires 15 to 25 air changes per hour. One of the contributing factors for such a requirement, is the excessive heat loads created by the lab equipment, as well as the necessity to remove odours and gasses that may be by-products of research and experimentation (Ibid.: 75). In order to satisfy these needs where required; Griffin (2000:71) suggests that this flexibility is best achieved through a decentralised plant system. The only place where climate control is required in the facility, would be the CTR's, and so a decentralised air-conditioning plant should be employed there.

### 7.2.12 Illumination requirements

In a laboratory setting, a lighting level between 300 and 500 lux across workbenches is sufficient for most tasks (Baiche 2000:149), while more intensive tasks requiring more light can be supplemented with specific task lighting (Griffin 2000:34; Watson 1986:93). In the case that task lighting is not provided, the overhead light fittings

Ill. 7.13: Horizontal service system providing water to a researcher.



Ill. 7.14: Central horizontal lighting system with task lighting off the workbench.



should run perpendicular to the workbenches to avoid shadows being cast by the researcher, similarly, work benches should be perpendicular to the windows (Koenig 1985:158). There is also the potential to install a light controlling system which monitors the lux levels across the worktops, and concomitantly reduces the artificial lighting whenever the natural daylight is supplying sufficient light, or dims the artificial light to merely supplement the daylight - thus saving electricity.

As with most spaces, natural daylighting is to be viewed as the primary source of light, with artificial supplementation occurring only where necessary. Designing for natural illumination not only creates the most comfortable and work-friendly environment, but reduces the consumption of energy (Watch 2002). While daylighting is essential, there is a need to avoid direct sunlight from falling onto the workspaces. The way that the natural daylight enters spaces should therefore be considered in order to avoid this occurrence. It may be practical to include light shelves which bounce indirect daylight further into the space to reflect off of the interior surfaces.

Another helpful consideration when designing the windows would be to provide an opportunity for researchers to rest their eyes by having access to a long distance view. This also encourages connections between the interior and exterior, the researcher and their source of research.

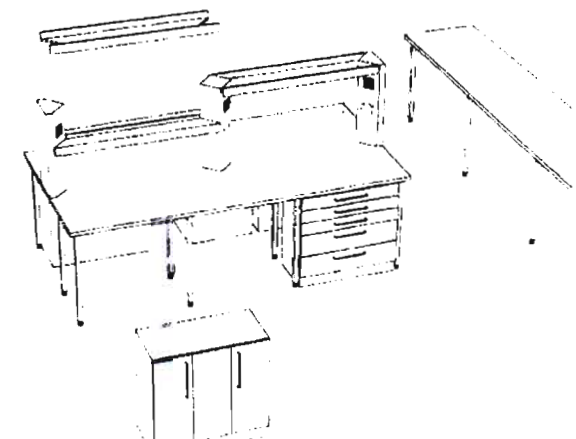
### 7.2.13 Laboratory Workbenches

Watch (2002) points out that the current trend in the laying out of laboratory spaces is to provide mobile casework wherever possible; fixing only the furniture that cannot avoid being predetermined such as fume hoods, sinks and safety showers. The work tops are then placed on moveable steel frames with interchangeable storage cabinets which connect under the top. The result is a laboratory that can easily be reconfigured to meet the needs of any individual or group. To go even further, these moveable workbenches can also be modified to a variety of heights to suit the needs of all users; especially those in wheelchairs (Griffin 2000:56). From an additional, purely pragmatic standpoint moveable workbenches also allow for easy access to the floor for cleaning purposes (Griffin 2000:67; Koenig 1985:157). There are basically two workbench arrangements within the laboratory work area, either an island setup or a peninsula configuration can be adopted. Each has their own strengths and weaknesses. With an island workbench plan, servicing is difficult, especially when it comes to providing an effective drainage run (Putnam Gould 1986:62). While this may be an obvious weakness, a strength is that there are potentially two circulation routes - one each side of the island itself. This advantage is, however, also unfavourable in that it does not provide for the creation of 'work enclaves' where teams can set up a specific experiment over a period of time without being continually disturbed by other researcher. This is where peninsula planning comes into its own. With a peninsula planning arrangement, each area creates an 'inlet', which



Ill. 7.16: In order to avoid casting shadows onto the study matter, it is advisable that lighting runs perpendicular to the workbenches in a laboratory space.

Ill. 7.17: Workbench types.



can be used for an extended period by one or two research teams; a very attractive strength when it comes to planning an independent research station such as the one in St. Lucia. In addition, servicing is easier in that each bench is connected to a wall for easy service runs, and as Griffin (2000:33) adds, a peninsula arrangement provides the maximum floor area to bench length ratio.

#### 7.2.14 Glassware washing

In many of the older laboratories, the regular approach to glass washing was to have basins in workbenches throughout the laboratory environment. This is obviously very inefficient: it takes up valuable worktop space and also creates the potential for potential water splashing or spilling in dry labs (Celliers 2007). Rather, the more recent trend has been towards a centralised glass washing facility. The used glassware is collected from each of the laboratories, taken to the central glass washing facility before it is returned to the labs where it is required (Weerts 2007).

#### 7.2.15 Storage

Storage in laboratories or lack thereof, seems to be a perennial design problem (Weerts, Geoghen and Celliers 2007). While sufficient storage is a necessity from a purely pragmatic standpoint, Griffin (2000:13) adds that it is required to ensure proper house keeping, thus facilitating a safer lab environment. The traditional model is one where materials are stored below the workbenches and in full height glass fronted cabinets. Recent shifts in safety awareness have meant that this is no

longer the most frequently selected option.

Rather, by limiting chemical storage within the labs themselves the result is a safer work environment. Chemicals are therefore preferably kept in a central storage area. Where chemicals or equipment needs to be kept within the lab spaces, it is crucial that precautions are taken to ensure that this storage also contributes to a healthier workplace. For one thing, if under counter deep shelving is eradicated; researchers no longer have to reach below or over work surfaces, which is hazardous. As an alternative, full height wall storage cabinets are preferred since they are ergonomically better than bending down and reaching into deep under bench cupboards (Griffin 2000:13, 43). In addition, these cabinets should have narrow shelves to avoid stacking bottles behind each other, a health risk (Weerts 2007), and they should be adjustable to allow for modification (Watch 2002).

#### 7.2.16 Laboratory Waste

In order to safely, effectively and efficiently deal with laboratory waste it is helpful to separate the problem into solids, liquids and gaseous waste.

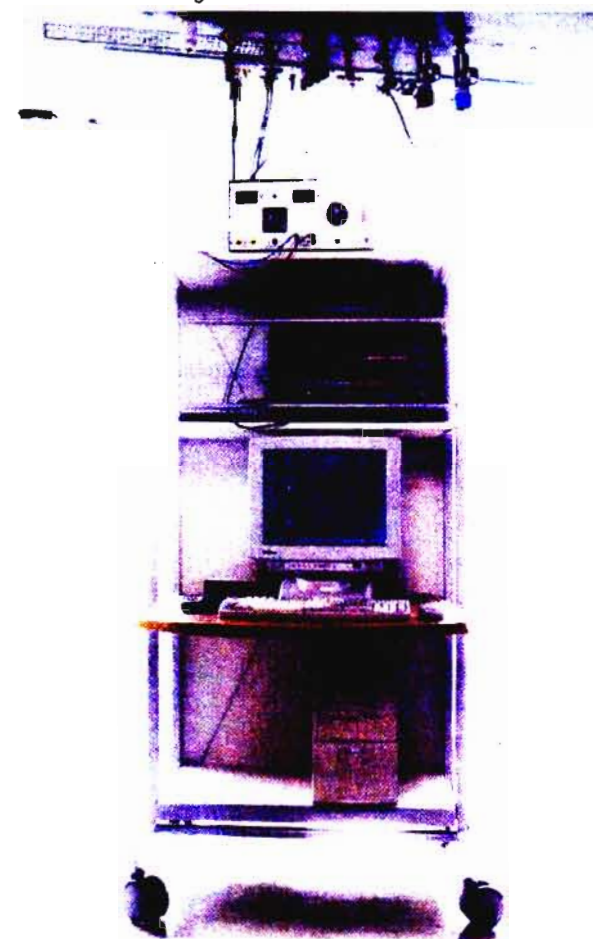
##### 7.2.16.1 Liquid waste

There are a number of potential ways of dealing with any liquid waste that comes from the research facility. One option is that the waste could be directed into a dilution pit or sump containing limestone chips so that the pH is raised before being drained into the municipal water supply (Loring 1986:85). Griffin, however, suggests a more environmentally responsible manner of removal from site; the water drains into a holding



Ill. 7.18: Moveable workbench with removable storage underneath.

Ill. 7.19: A moveable instrument rack plugged into overhead horizontal servicing.





tank which is then collected from site by a local waste management contractor (Griffin 2000:47, 67) who then deals with the waste appropriately so as to ensure that the local water supply is not adversely affected.

#### 7.2.16.2 Solid Waste

In environmental research there is often a substantial amount of solid waste (Geoghen 2007) and this waste needs to be dealt with appropriately. The best way to deal with this waste is to dispose of it into containers in the laboratory spaces, which are then collected (along with the waste water) by a local waste management contractor (Griffin 2000:67). When it comes to dealing with plant waste, it would be most appropriate to create a disposal system which results in the creation of compost to be used in any areas of landscaping (such as the public gathering space).

#### 7.2.16.3 Gas Waste

Noxious gas waste is dealt with by limiting gas producing procedures to fume cupboards.

#### 7.2.17 Laboratory Safety

Safety of all laboratory workers is of paramount importance to the designer. The laboratory working environment includes the use of numerous dangerous materials and as such all manner of precautions must be taken to ensure that the researchers are well protected from all foreseeable eventualities. In order to do just this there are two safety systems which need to be well designed, namely: accident safety and fire safety.

##### 7.2.17.1 Accident Safety

###### Personal accident safety

In the event of an accident it is important that the researchers involved are not adversely affected by any dangerous materials that they have made contact with. In the case of an accident occurring, all involved facility staff must be able to walk safely and quickly to a safety shower and eye and face wash station within the laboratory space itself. For this reason it is best that these safety installations are not in the main circulation route in the laboratory itself.

###### Personal Protective Equipment

Another prevention method was highlighted when Stephen Weerts pointed out the importance of Personal Safety Equipment (PPE) in the laboratory environment, and suggested that ideally there should be a central locker space wherein researchers prepare for the day, as well as storage in each lab for PPE, a view shared by others (Weerts, Celliers 2007).

###### Planning for safety

Since there are sometimes uninformed visitors that may walk through the laboratories (such as sponsors or potential clients), there is also the necessity to provide for their safety through clear signage to inform these people of the potential dangers, as well as the procedure in the event of an accident. Griffin also suggests that the access points are kept to a minimum, and that these are controlled by security tag (Griffin 2000:16). Another way in which workers and visitors can be kept safe, is through the inclusion of emergency lighting throughout. The best option here being

Ill. 7.20: A variety of safety signage necessary in laboratory facilities.



lights with integrated power packs (Watson 1986:102).

#### 7.2.17.2 Fire Safety

In order to ensure that the laboratory area is sufficiently protected, it is best to employ a combination of a fully automated wet pipe sprinkler system as well as fire hose reels and portable fire extinguishers (Loring 1986:91). The reels and extinguishers should be located within the laboratory spaces along the main internal circulation route, as Griffin points out this means that there will not be tendency for access to the space to be hindered (2000:34-5). In fact to more effectively reduce the possibility of entrance obstruction, it makes sense to consolidate these fire-fighting objects with the aforementioned safety shower and wash basin.

#### Fume extraction cupboards

The adage goes: prevention is better than cure, and this truism certainly applies when it comes to the field of laboratory safety. A method of doing just this in the laboratory environ is to limit work involving potentially dangerous or hazardous fumes to contained spaces called fume cupboards. Griffin suggests that these fixed cupboards should be located on a perimeter wall well away from the fire escape (Griffin 2000:50). He goes on to suggest that these fume cupboards need to allow for a researcher to sit comfortably, with space for their knees below the worktop (Ibid., 45). Where there is the additional risk of intense heat or fumes, the provision of an extraction hood ensures the safety of all laboratory inhabitants.



Ill. 7.21: A fireproof storage cabinet.

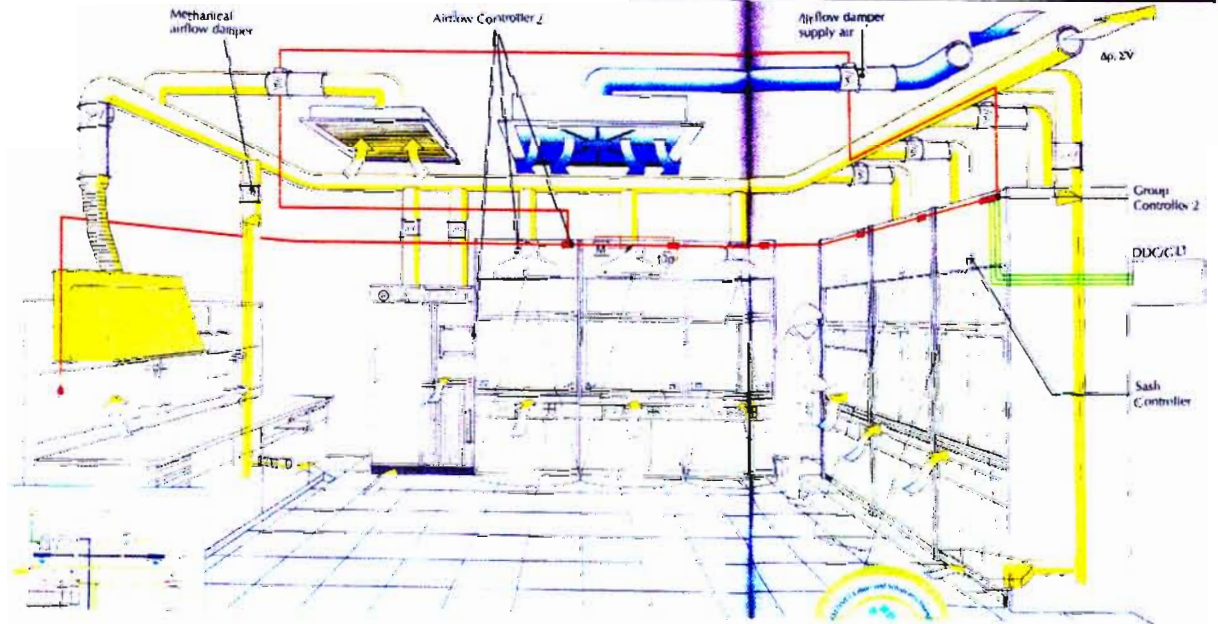


Ill. 7.23: An eye wash station.

Ill. 7.24: Colour coded piping is essential for a safe operating environment.



Ill. 7.22: A diagram showing fume cupboards and fume extraction methods.





## 7.2.18 Laboratory Finishes

### 7.2.18.1 Floor finishes

Due to the specific usage requirements of laboratories there are concomitant requirements when it comes to the selection of finishes for these spaces. In terms of the floor, it is essential that this surface is level and covered with a pre-finished material that can be joint-welded to ensure that it is a consistent finish, with no weak points. The finish should also extend up the walls to a level of 150mm so that any spilled substances are contained and do not come into contact with any other surfaces (Griffin 2000:34). An option for flooring that meets these requirements is natural linoleum. It is a more stable, more resilient, more renewable (Wilhide 2004:138) option than regularly selected sheet vinyl, and it can be installed in the same laboratory settings, which defines it as the floor finish choice.

### 7.2.18.2 Wall finishes

Furr points out that for an effective laboratory the finish of the walls must be impermeable, non-porous and smooth to allow for easy cleaning (Furr 2000:103). If a porous material is used for the wall finish, then these will need to be treated or painted (Furr 2000:104) with acrylic or urethane epoxy wall paint (Bridgen 1996). It maybe helpful at this point to address the issue of 'off-gassing': Certain solids and liquids emit, or off-gas, volatile organic compounds (VOCs), some of which have adverse short and long term health effects ([www.epa.gov/iaq/voc.html](http://www.epa.gov/iaq/voc.html)). Paints are one of the many thousands of materials responsible for a lot of off-gassing, and can emit VOCs for extended periods of time after application and drying

(Green Seal 2006:17). In fact, concentrations of many VOCs are consistently up to ten times higher indoors than outdoors ([www.epa.gov/iaq/voc.html](http://www.epa.gov/iaq/voc.html)). As a result, when it comes to selecting an appropriate paint, it is best to settle on one that does not off-gas such as a modified acrylic vinyl ([www.bestpaintco.com/faq.html](http://www.bestpaintco.com/faq.html)). In terms of colour selection, is recommended that a light wall colour is chosen in order to the interior, reflected light (Griffin 2000:34).

### 7.2.18.3 Worktop finishes

The worktops on the laboratory spaces need to be able to withstand chemical spills, and so they need to be impervious. They also need to be easily cleaned, potentially with an abrasive pad which does not damage the solid surface (Griffin 2000:39). There are a number of new materials which match these requirements; it is merely a case of choosing the one most suited to the laboratory design. In the case of this facility, it is also, however, important to choose a material that is not responsible for the off gassing of toxic VOCs or the depletion of a non-renewable resource.

## 7.2.19 Efficient environmental resource management

Due to the energy intensive nature of any laboratory facility, it is the norm that they would consume five times more energy and water than a typical office building of comparable square metreage (Watch 2002). A fact which further highlights the need to reduce environmental impact. There are specific energy requirements for the laboratory spaces which need to be met,



Ill. 7.25: An example from CSIR of a worktop finish which is not suitable for the chemical spills which may occur.

Ill. 7.26: This microbiological worktop finish has withstood the daily wear and tear.



and the scope for improvement is therefore in the efficacy, productivity and design of these necessary systems (Watch 2002) and the selection of a renewable source of electricity (Griffin 2000:70). There are a number of processes and factors which are particularly energy intensive in any research facility. Below are a few, which are coupled with methods of addressing these problems:

- *Intensive ventilation requirements (Watch 2002)*

Wherever possible, in the Environmental Research Facility, natural ventilation is to be incorporated. This will encourage the required high number of air changes per hour and greatly reduce the burden that ventilation systems place on the electricity supply. In a laboratory with natural ventilation, the equipment that is selected is therefore important. Many of the newly developed laboratory apparatuses are self regulating regarding humidity and temperature, and can therefore be placed in a room that is not strictly managed regarding the climate. Natural ventilation therefore becomes a very viable option in many of the laboratory spaces.

- *Extensive containment and exhaust requirements (Watch 2002)*

As stated above, most of the new laboratory equipment incorporates controls, which include the containment and exhausting of air (when plugged into an efficient servicing system). The result is that the entire laboratory does not have to be entirely contained for the sake of the equipment. The result is that the volume of air which needs to be moved is therefore greatly

reduced, thus saving energy.

- *Heat generating equipment (Watch 2002)*

This would mostly be a problem where the laboratory is not naturally ventilated and the burden of the regulation of temperature is placed entirely on a mechanical system of ventilation, thus drawing much more electricity. This could well be avoided by intelligent natural ventilation.

- *24 hour access to Laboratories (Watch 2002)*

While the Environmental Research Facility does require 24 hour access for its researchers there are ways to avoid this being an energy intensive requirement. Firstly, where natural ventilation is incorporated, there is no need for mechanical systems to run throughout the night. Secondly, it is very possible to install motion sensitive lighting systems which control the lighting of each space. The fixtures are dimmed when the last researcher leaves a space and come back on when another researcher enters: regardless of the hour. This lighting system would be coupled with a light sensitive control which would dim or completely turn off all the lights in a laboratory whenever there is sufficient sunlight to meet all lighting requirements of that space.

- *Inefficient servicing (Griffin 2000:70)*

Improving the efficacy of services offers the largest scope for improvement regarding energy usage. A number of the previously mentioned high energy processes involve the matter of servicing; water, ventilation and lighting. It is the role of

the architect to encourage any consultants in these matters to design a system which is as energy efficient as possible (Griffin 2000:28).

### 7.3 Public Facilities

#### 7.3.1 Introduction

As previously discussed in *Research and the Public*, the ultimate underlying principle for the conducting of any scientific research is the generation of knowledge about our environment. There is however the danger of it resulting in the creation of information for information creation's sake (Celliers 2007). In order to avoid just this, it is important that the public is exposed to the findings, and therefore informed as to how it affects their life. While this was discussed in rather conceptual terms in that earlier chapter, it will now be discussed using a more concrete vocabulary.

By way of introduction it must be noted that there is an opportunity to reinforce the connection between the visitor and the environment around them. In order to repair man's indifference about deteriorating environmental conditions it is crucial to create visual, didactic and educational connections with the world which man is so disconnected from. This can practically be achieved through the framing of the surrounding nature wherever possible, as well as to highlight the natural beauty by bringing the local flora within the structural envelope wherever possible. As Murcutt says, "[architecture] should reveal the environment to [the users] and enable them to live in it" (Fromont 2003:47).



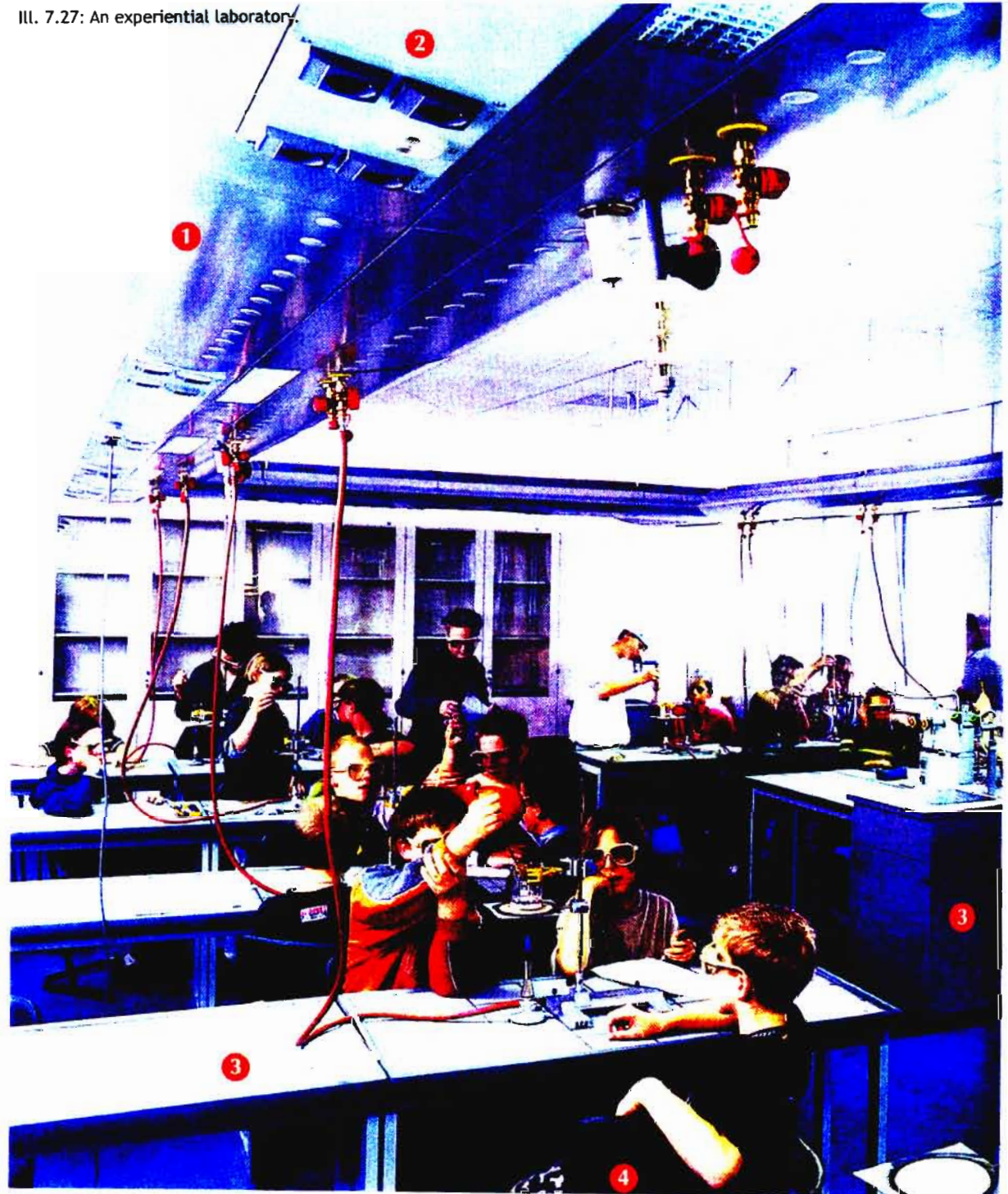
### 7.3.2 Auditorium

The auditorium space is where visiting groups would be educated through a variety of medium and sources, from visual and auditory shows to explanatory presentations by local researchers. It is additionally the space wherein local, interested public could come to hear regular presentations by researchers about their research findings (Fox, Celliers 2007). It is opportunities such as these, which will begin to break down the barriers of understanding that exist between these scientists and the public at large. The auditorium will therefore, on a pragmatic level, need to be designed as a fully functional auditorium in terms of lighting, acoustics, electronic and sound controls and visual connections with the stage. There are, however, limited requirements in terms of back-of-house functions such as green rooms or the like, in this regard it is a rather simple space, designed to fulfill the basic requirements for which it will be used.

### 7.3.3 Experiential Laboratory

Similar in design to the larger scale working laboratories elsewhere, the experiential laboratory is aimed at teaching school children through a very hands-on environment (Celliers 2007). The lab would be laid out in a similar fashion to a school classroom with regular desks substituted by worktops. The children would be involved in conducting simple, fun experiments which would pique their interest in the research field, while teaching them at the same time. The experiential laboratory will need to be accessed by the staff, and by the students themselves, and there is also the need for servicing. These

III. 7.27: An experiential laboratory.





two points lead to the conclusion that the most intelligent place for this lab would be to straddle the border between the public domain and the research laboratories (for ease of servicing and staff access).

#### 7.3.4 Seminar rooms

Like the aforementioned experiential laboratory, the seminar rooms are designed to provide a form of education. While the lab is more hands on, the seminar or class rooms would fulfill a very similar function to a regular school teaching venue. This would include space to pin up presentation boards and present interesting shows in a variety of media. Also, like the experiential laboratory, it is important that these spaces are able to be accessed by both staff and the public.

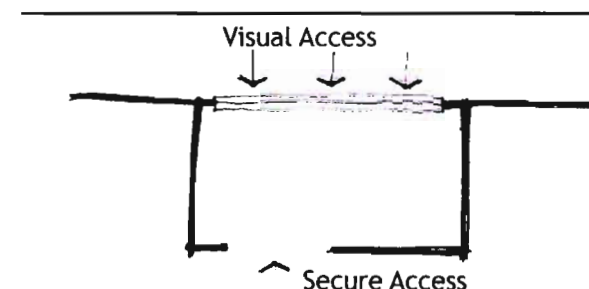
#### 7.3.5 Mangrove Exhibition

The Environmental Research Facility and the recently completed Siyabonga Visitors Centre are to be connected by a network of boardwalks which traverse the local mangrove. While there will be information boards along the path itself there is still scope for an exhibition located at the facility which will prepare potential walkers for what to expect. It could also function to inform them of the greater context; showing them how these mangroves contribute to the larger St. Lucia biome. Since the people who come into this space will already be on their way to walk along the uncovered boardwalk, there is also an opportunity for this mangrove exhibition space to be partially outdoors, with a strong connection to the environment.

#### 7.3.6 'In-between' spaces

While there are a number of defined, educational spaces that have already been discussed, there is still the prospect of using the often times ignored 'in-between' spaces for an equally didactic function. The concept of dual access was discussed in an earlier chapter and the challenge is to create a pedagogical architecture which seeks to expose the behind-the-scenes elements and activities. For example, it is possible to design the circulation route in such a way that it is a space where visitors are exposed to any number of research functions that would normally go unnoticed or even unseen. This opportunity, and others, should not be overlooked when

creating and designing the 'in-between' spaces. By allowing a didactic visual access to strictly research spaces helps even further to destroy the barrier between researcher and public.



III. 7.29: Sketch showing the concept of dual access, visitors gain visual access into oftentimes closed off areas.

III. 7.28: House in Stradbroke Island, Queensland designed by Brit Andersen and Peter O'Gorman. Highlights the possibility of the mangrove exhibition space being partially outdoors, and thus encouraging a strong connection between visitor and environment.





## 7.4 Sustainable Response

Before construction commenced on the recently designed Siyabonga Visitor and Craft Centre in St. Lucia, an Environmental Impact Assessment was conducted. Seeing as that centre is just 800m south of the dredger harbour site, there are very many pointers to be gleaned from that document. Using this, and other resources, the following pages will discuss foreseeable problems that may arise and the suggested manner in which the Environmental Research Facility can respond to these issues. As has been the case throughout the document, these issues will be investigated under the three rubrics of sustainability: Social, Economic and Environmental:

### 7.4.1 Social Sustainability

#### 7.4.1.1 *Threat to human safety from wild animals*

As previously discussed (Chapter VI), the park and estuary is home to large populations of crocodiles and hippos, and their presence needs to be carefully considered during the design of this facility (ACER 2001:9). In particular, the hippos need to be considered because they are prone to graze on lawns throughout the town of St. Lucia itself. The following precautionary measures are recommended in order to nullify the risk to construction workers and consequent visitors and researchers during operation (ACER 2001:9):

- The creation of awareness as to the presence of these potentially dangerous animals.
- The placement of signs to warn people of the associated risks which arise due to the presence of these wild animals.
- Visitors should be discouraged from getting

to the waters edge. Where necessary, this could be achieved through a physical barrier, but the steepness of the bank performs this function to a large degree.

#### 7.4.1.2 *Security*

Crime is a reality in South Africa, and needs to be considered during the design of a building such as this. Money will be handled in the restaurant, and the office and laboratories will contain valuable equipment on site. Every effort should be made to ensure the safety of the researchers and other facility employees, this includes the provision of either a security guard or armed response alarm system (ACER 2001:9) and the careful design of the building to avoid points of easy access..

### 7.4.2 Economic Sustainability

#### 7.4.2.1 *Local and regional economy*

In light of the poverty in the region and high levels of unemployment, the contribution that this project makes towards job creation and training, together with other contracts, will certainly have a significant positive impact on the local and regional economy (ACER 2001:10).

In addition to the previously discussed selection of local contractors for the construction of the facility, the building will provide further employment opportunities into the future, jobs such as the restaurant, administration of the boat jetty, cleaning, catering, security, garden services and maintenance (ACER 2001:10). For these reasons, the facility would very likely be well supported by residents of the local towns, in particular those in the poverty stricken Khula Village.

Ill. 7.30: The newly designed Siyabonga Craft Centre on the bank of the estuary, at the entrance into the town of St. Lucia.



Ill. 7.31: A Nile Crocodile on the banks of the estuary.



Ill. 7.32: A herd of Hippo in the St. Lucia Estuary.



In order to maximise the positive economic impact of the facility, the following measures are recommended for implementation (ACER 2001:10-11):

- The facility should be sufficiently staffed and professionally run by predominantly locally sourced employees.
- As previously discussed, building materials, supplies and services should be sourced locally wherever possible.
- The facility should be sufficiently staffed and constructed by predominantly locally sourced skilled, semi-skilled and unskilled staff.

#### *7.4.2.2 Sustainable operation of the facility*

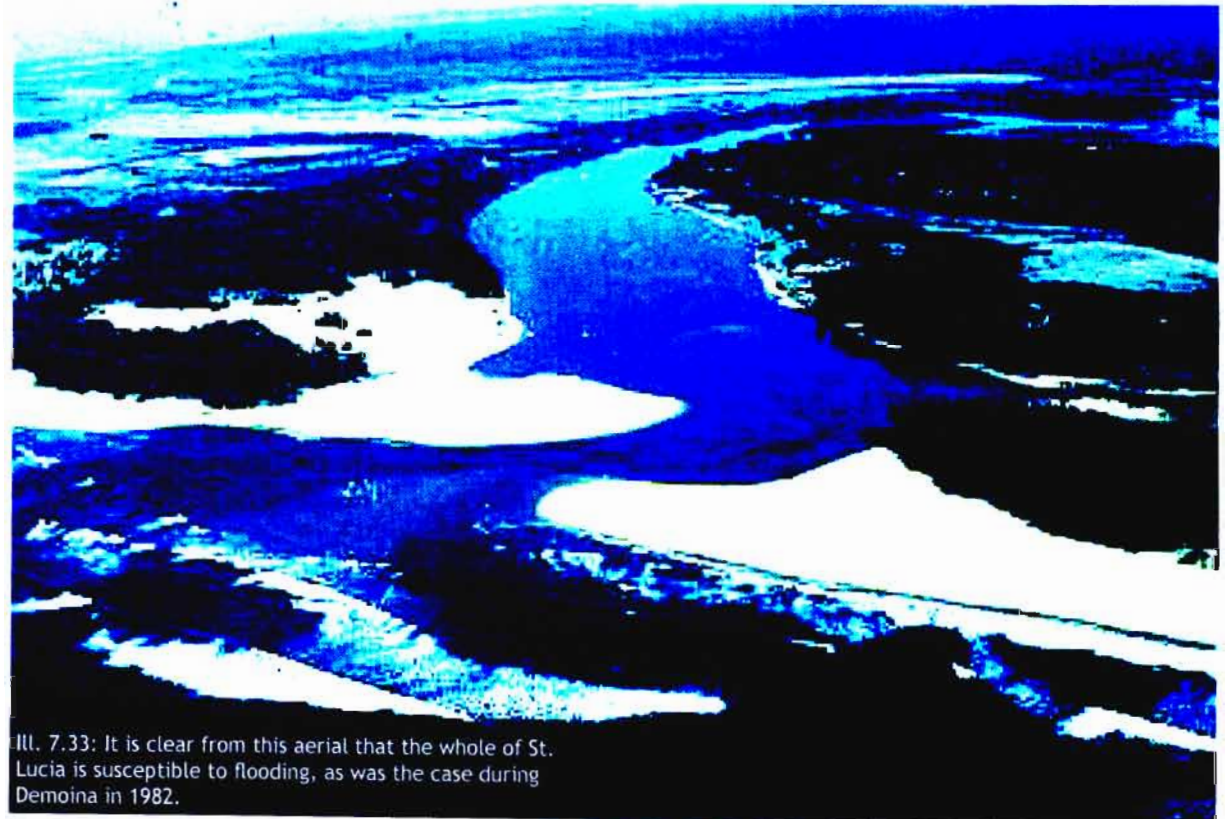
The operation of the research side of the facility would be funded by the client, the NRF, while ideally the tourist and educational portions, as well as general maintenance, would be funded by the popular educational and recreational boat cruises. A well outlined business plan and budget should be prepared in order to ensure that the facility operates in a sustainable, long-term manner (ACER 2001:11).

### **7.4.3 Environmental Sustainability**

#### *7.4.3.1 Threat of flooding*

Whenever a building is constructed as close to the waters edge as the Environmental Research Facility will be, there is often the potential threat of flooding. Such is the case in St. Lucia, a site located on a floodplain, and is approximately 4.0 metres above mean sea level (+4.0 msl) (ACER 2001:7). The lake itself has a mean level of +0.17 msl, with fluctuations from +0.85 msl to -0.6 msl (ACER 2001:7). The Estuary in the region of the

site is affected by the tide, and a range of up to 1.5 m may be experienced on a spring tide (ACER 2001). More importantly though, the area is prone to floods, as was shown in the 1982 Demoina floods. Eventual water levels experienced at such times are virtually impossible to predict as they depend on the lake level, mouth condition and tide at the time of flooding (ACER 2001:7). During the aforementioned Demoina flood, the water level rose to above +4 msl (ACER 2001:7). In order to combat the possibility of site flooding it is suggested that the building floor levels are kept at a minimum of +5.0 msl (thus designed for a 1:50 year flood) (ACER 2001:7). Any spaces located below such a level will be susceptible to flooding.



Ill. 7.33: It is clear from this aerial that the whole of St. Lucia is susceptible to flooding, as was the case during Demoina in 1982.

#### *7.4.3.2 Alien vegetation*

The site around the dredger buildings could potentially contain various species of alien invasive plants, the proliferation of which is not to be encouraged. Any existing plants are to be removed and the rehabilitation of these and other previously affected areas are to be initiated as soon after earthworks as is feasible (ACER 2001:8).

#### *7.4.3.3 Erosion of estuary banks*

Since the site and harbour are artificially made, the bank has been stabilised in part by a combination of armour flex mat and geotextile fabric. The other banks are naturally stabilised by the swamp forest and wetland edge. Any banks



that are in any way affected by construction or earthworks are to be stabilised with suitable vegetation to match the existing wetland and forest ecosystems (ACER 2001:9).

#### 7.4.3.4 Effect of night lights

The study conducted for Siyabonga highlights one potential adverse ecological effect being one on the migration patterns of a variety of migrating fish and crustaceans (ACER 2001:8). The fear is that night lights could confuse these migratory aquatic creatures such as adult mullet and the larvae of the Varuna crab (Siyabonga EIA:8). The simple recommendation is that lights are shaded and positioned away from the waters edge in order to reduce and potential impact (ACER 2001:8).

#### 7.4.3.5 Waste management and pollution control

The construction and operation of a medium scale building in an environmentally sensitive site such as this, brings with it the potential for rampant waste and pollution production. While the management of water and laboratory waste has been discussed already (Chapter VII), there are a number of other areas which need to be addressed in order to ensure the sustainability of this facility (ACER 2001:8-9):

- The selection and usage of environmentally friendly soaps and cleaning detergents wherever necessary.
- The placement of signs discouraging the disposal of foreign material into the toilets.
- The provision of suitable, animal-proof, refuse bins to contain litter, as well as the

provision of signs discouraging litter.

In addition to these operational measures, there is also the matter of construction which needs to be sustainably conducted. The construction process provides potential pollutants such as machinery fluids, sewage, litter and construction materials (cement, off-cuts or rubble) (ACER 2001:9).

In order to combat the disastrous consequences of contaminating the estuary, strict specifications with respect to handling, storage and use of hazardous materials and other pollutants should be stipulated and enforced throughout the construction process (ACER 2001:9). The entire construction team needs to understand the reasons behind these regulations, and an education course may be suitable and beneficial for all (ACER 2001:9).



III. 7.34: A photograph of the geotechnical erosion bank under the boathouse on the edge of the Dredger Harbour.



III. 7.35: Varuna Crabs; the migrating larvae of which could potentially be distracted by lights shining onto the estuary at night.

[illegible]



Visitors					
Visitors	Restaurant	250	1	250	Conference Centre/restaurant kitchen,
	Kitchen	60	1	60	Sized according to
	Bin Area	6	1	6	Connected to kitchen, delivery yard
	Delivery Yard	15	1	15	Connected to kitchen/bin area
	Auditorium	1.2	200	240	Raked Seating, acoustic, +/-200 seats, lighting control
		12	1	12	Back of auditorium
	Lecture Halls/Classrooms	35	2	70	Flexible divider screens
	Mangrove Exhibition	N/A	1	0	Strong Connection with Exterior
Services					
Serv.	Equipment Washing	30	1	30	Close to storage area
	Equipment Storage	45	1	45	Close to wash up area
	Circulation	10%	75	7.5	
Toilets					
Toilets	Public	40	2	80	10 wc/7 whb
	Staff Toilets and Lockers	50	2	100	PPE storage, personals locker storage, close to workshops if possible
	Circulation	10%	180	18	
Outdoor					
Outdoor Facilities	Parking	N/A	30	0	
		N/A	40	0	
			6	0	
			3		
			3	0	
	Tour Boat Jetty		1	0	Relate to reception/public space/restaurant
	Bus drop off point	N/A		0	
	Entrance Foyer reception		1		
TOT. 2487					

Lighting  
Control

## 7.5 Brief

From this chapter it is now possible to finalise a brief for the this building. The principle aim of the brief is the creation of a research facility for environmental research pertaining to the iSimangaliso Wetland Park World Heritage Site, with an Education Centre for the dispersion of research findings to as wide an audience as possible.

The brief has been arrived at through the investigation of case and precedent studies with similar schedules of accommodation, and through interviews conducted with a variety of scientists in the field (Weerts, Celliers, van Rensburg and Geoghen 2007), as well as through the use of Neuferts Architects Data (2000).

## Chapter VIII: Conclusion and Recommendations

This research document has repeatedly shown that the key to a successful design in this context is one which responds to the three areas of sustainability. For this final chapter the conclusions drawn throughout will be composed as social recommendations, economic recommendations and environmental recommendations.

### Social Recommendations

At every possible turn the research facility is to contribute towards the creation of an socially sustainable work environment; the following are recommendations as to how this can be achieved:

#### Polyvalence

The research facility must contain a variety of polyvalent spaces which can adapt to the ever changing functional requirements of the researchers. The architectural form therefore has to start with change as an invariable, inert factor, with the result being that the spaces will more readily adapt to shifting functions. These forms are therefore not always definitive or utterly resolved. For example, a meeting space could potentially host an around the table gathering of 15 people, or 3 groups of five. Well sized rectangular spaces are therefore the most obvious example of a form *“that can be put to different uses without having to undergo changes itself, so that a minimal flexibility can still produce an optimal solution”* (Hertzberger 1991:147). This

however must occur without losing any sense of identity which may have been achieved. The over arching idea is that these adaptations do not obliterate the constant character, view or identity of a space.

#### Ownership of Space

The need for users to have a sense of ownership over the spaces they inhabit has been repeatedly highlighted. As discussed, inhabitation could occur for a short (one week) or prolonged (two years) period of time. Users must feel that they have some control over their space, so that they will better treat their surrounding area.

It has been discussed that Herman Hertzberger determines that the character of each area within a building will have a strong influence over who feels responsible for it (Hertzberger 1991:22). Researchers must be able to exert personal influence over the spaces so as to feel more emotionally involved in these spaces and therefore pay more to them (Hertzberger 1991:170). This would include everything from the ability to place pictures on the wall, or even determine the colour of certain wall to the adjustment of their personal work spaces as each employee sees fit. The form must invite researcher to adapt their spaces to their own standards, thus displaying empathy for the users (Hertzberger 1991:174), by allowing them to tailor their surroundings. The research facility must therefore create the potential for personal interpretation by including spaces which can indeed be adjusted (Hertzberger 1991:170).



### Access Restrictions

While there are stringent security requirements for visitors into the research area, there is still the opportunity to allow a visual connection to the researchers themselves.

Wherever possible the visitors must be allowed to see into the laboratories, gaining exposure to the behind-the-scenes elements and activities through the concept of dual access. Some of the laboratories which provide opportunities for this pedagogical architecture to occur are:

- Research aquarium
- Wet Laboratory
- Genetic Laboratory

The building must seek, through these potential didactic visual connections, to break down barriers between *us* and *them*, researcher and public.

### Connection to the Environment

In order to combat man's "*fundamental disconnection from the living world*" (Olson 2004:9) the building is to reinforce the connection between the visitor and the environment around them. This can be achieved by highlighting the surrounding beauty and encouraging visitors and users alike to connect. Such events could occur in spaces such as courtyards or through the framing of views to the ubiquitous natural beauty.

Wherever possible the basics of organic life: water, air and light are not to be seen merely as "*necessities for survival, but rather the challenge is to make them visible, legible almost palpable, to make their presence felt in the very stuff of*

*the building*" (Fromonot 2003:47).

Precedent studies which achieve a semblance of this connection with the environment are:

- Queenscliff Centre
  - Singita Lebombo Lodge
  - IBN Institute for Forestry and Nature Research
  - JN Centre for Advanced Scientific Research
- 

### Economic Recommendations

At every possible turn the research facility is to contribute towards the creation of an economically sustainable environment; the following are recommendations as to how this can be achieved:

#### Responsible Resource Management

The research facility must deal responsibly with all of the resources which it uses. These particularly include water and electricity. Financially the less that the building relies on non-renewable and inconsistent electricity supply, the better.

The goal is a symbiotic relationship with the land which mimics the sustainable connection shown by the local people through the Kosi Bay fish traps and Ncema grass collection.

#### Contribution to the Local Economy

An opportunity that a project like the Environmental Research Facility provides is the long term injection of capital into the local economy through a variety of means:

#### Local Contractors and maintenance

Firstly, and most obviously, is the selection of a

local contractor with a small company to construct the building. This has been demonstrated at Somkhele's Medical Research Facilities (See Case Study) just 20 minutes drive from St. Lucia. In that project 100 percent of the unskilled labour and 62 percent of the skilled labour came directly from the surrounding community (Lipman, 2002b:36), where there were no available workers local men and women were taught, thus ensuring that a skills transfer occurred. The long term ramifications of such a decision cannot be numerated.

#### Local Materials

Wherever possible, materials for the construction of the facility should be sourced within a 100km radius. This makes economic sense in that it reduces transportation costs, while concomitantly contributing to the local economy.

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### Environmental Recommendations

At every possible turn the research facility is to contribute towards the creation of an economically sustainable environment; the following are recommendations as to how this can be achieved:

#### Selection of a brownfield site

If the research facility is to be environmentally responsible, it is recommended that rather than continuing to proliferate urban sprawl it should make use of an obsolete building. Since the existing concrete boathouse in St. Lucia has been selected and analysed as the site, this recommendation has been met. In addition to this though, it is recommended that the land surrounding the boathouse itself be rehabilitated

and potentially re-assimilated into the surrounding swamp forest.

Precedent studies which make use of a brownfield site are:

- Queenscliff Centre
- IBN Institute for Forestry and Nature Research
- Global Ecology Research Center

#### **Embodied Energy, Materials and maintenance**

It was earlier deduced that when embodied energy is considered, timber is the 'greenest' material available for construction. The embodied energy of materials must be considered, and when designing the building it is recommended that the material pallet is reduced to contain timber, glass and steel connectors where necessary. These members will then be carefully connected to the reused existing concrete structure. These three materials have been selected for their low position on the embodied energy chart. In addition to selecting these lower energy materials, it is important to consider the way in which they are connected to each other. The building must be designed with the end in mind. This means that building with reusable materials is wise (Buchanan 2005:39), as is considering the ability of future generations to easily reuse entire components or recycle materials off of the building (Ibid., 39).

#### **Waste management and pollution reduction**

Considering the sensitive nature of the surrounding ecology, the research facility must be concerned with effective waste management and the reduction of pollution. Due to the functions performed at the facility, there will waste

produced in a variety of forms. The facility must deal with these effectively and efficiently.

This waste includes:

- Black-Water
- Greywater
- Laboratory Waste

#### **Critically Regional Response**

Since no architecture operates within a vacuum; the iSimangaliso facility must be created through discourse with a large context, from historical examples and traditional construction to current issues and debates. The key component drawn from various writings on critical regionalism has been the creation of place over the mere provision of space (Frampton 1983b:162). Wherever possible the facility is to be concerned with the context, resulting in an emphasis on topography, climate, light and tectonic form

This is to be achieved through an architectural amalgamation of the ingrained features of this specific region, including physical and cultural characteristics, with appropriate current technology. Ultimately, the goal is for the creation of a meaningful architecture in this context, which is connected to the more universal aspects of human life.

As architect Douglas Kelbaugh argues: "*What makes a place unique is worth celebrating and protecting with architecture: finding and keeping the difference that makes a difference*" (Kelbaugh in Matter, 1986). There is much about the iSimangaliso Park which is worth celebrating

and protecting, and as such it is the duty of this new architectural endeavour find and keep that difference.

Precedent and Case studies which could be said to be particularly critically regional are:

- Queenscliff Centre
- Africa Centre at Somkhele



## Chapter IX: Design Report

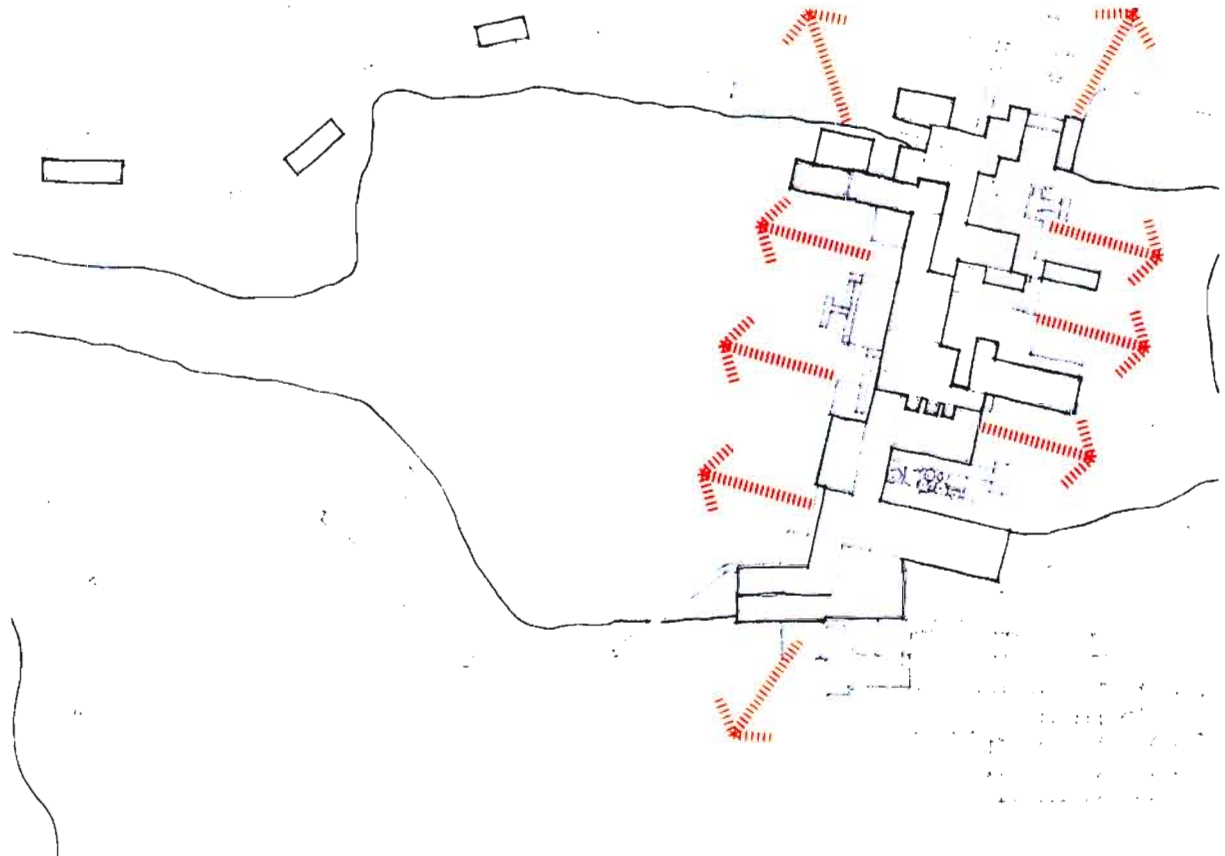
From the recommendations derived through research, the design of the Environmental Research Facility (ERF) has followed an informed path to arrive at a relevant, site-specific and functional facility for the iSimangaliso World Heritage Site. This chapter will serve to show, from the design, the ways in which the various conclusions have been implemented into this design. The key principles have been derived, and followed, and this is the report on how this was achieved.

### Connection to the environment

#### Views

The need to connect to the surrounding environmental context was repeatedly ratified through the research process. In the case of the ERF the site is cradled in a protective, beautiful man-made harbour, with ubiquitous opportunities for views. The design so carefully considered this visual connection that the result is that every user in any inhabitable space has at least one view to the surrounding flora through a variety of windows or fold-away doors.

Ill. 9.1: Diagrammatic site plan showing the views in all directions from the Environmental Research Facility.



### Integration

The second manner in which the environment has been connected to, is through the integration of local vegetation within the building outline. This has predominantly been achieved through the inclusion of courtyards, as well as through the feathering of the building edge. The newly formed wetland to the east of the ERF has ensured that this integration is continued through to the iSimangaliso campus of buildings, which includes the newly designed administrative centre for the Wetland Park.

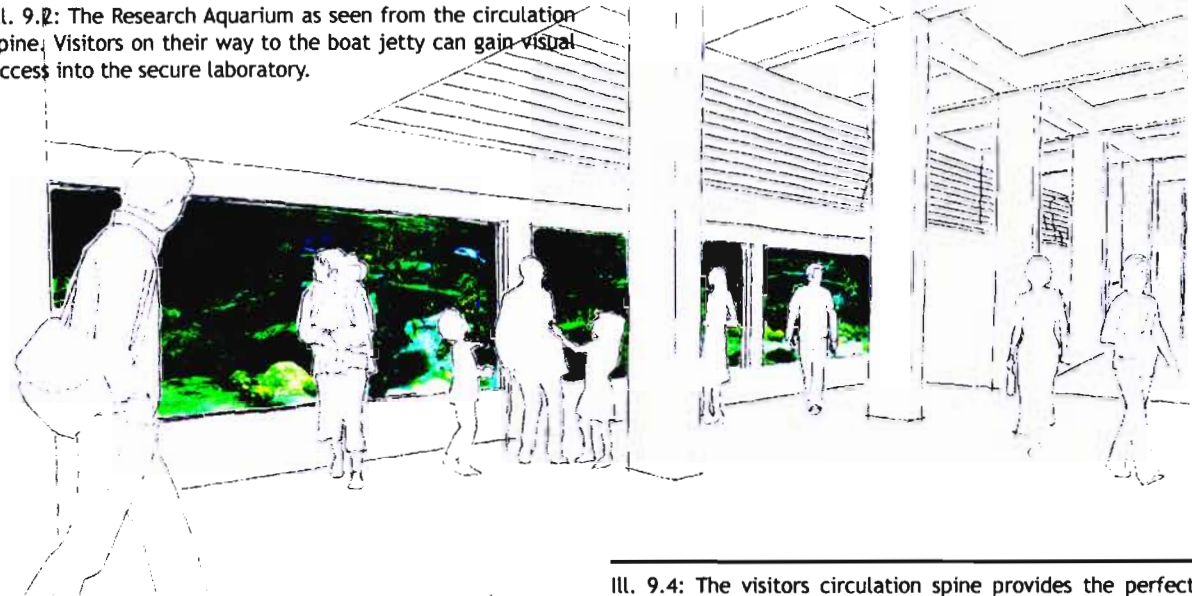
### Interaction

The last way in which the environment and ERF are connected, is the way in which interaction is encouraged. An example of this is the network of boardwalks which connect the ERF to the iSimangaliso Authority Offices and to the Siyabonga Craft Centre at the entrance to the town of St. Lucia. The boardwalks make their way through the rehabilitated swamp forest allowing up close interaction with this biome. In particular the school children visiting the education centre will be encouraged to engage in their own experiments, and could even collect their own samples from the surrounding site. This interaction encourages the creation of a connection between the users and the local ecology.

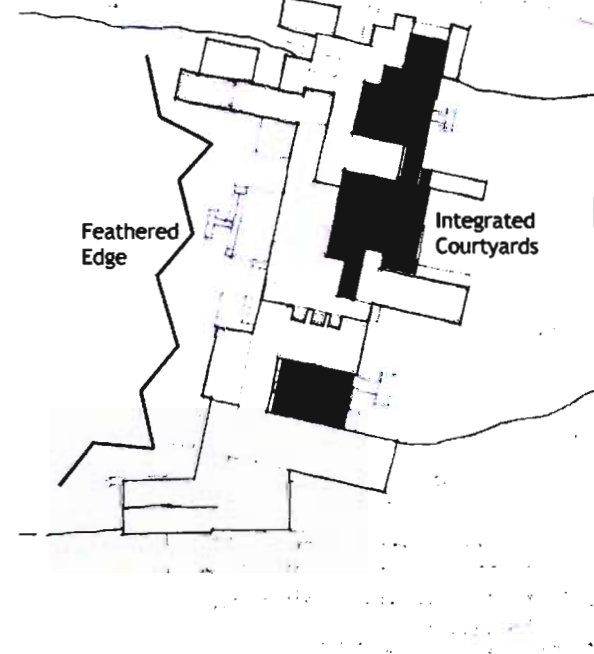
### Access Restrictions and Dual Access

Due to the varied functions which occur across the extent of the building it was very important to address the issues of access and security, while still encouraging the removal of traditional barriers between researcher and public. A large

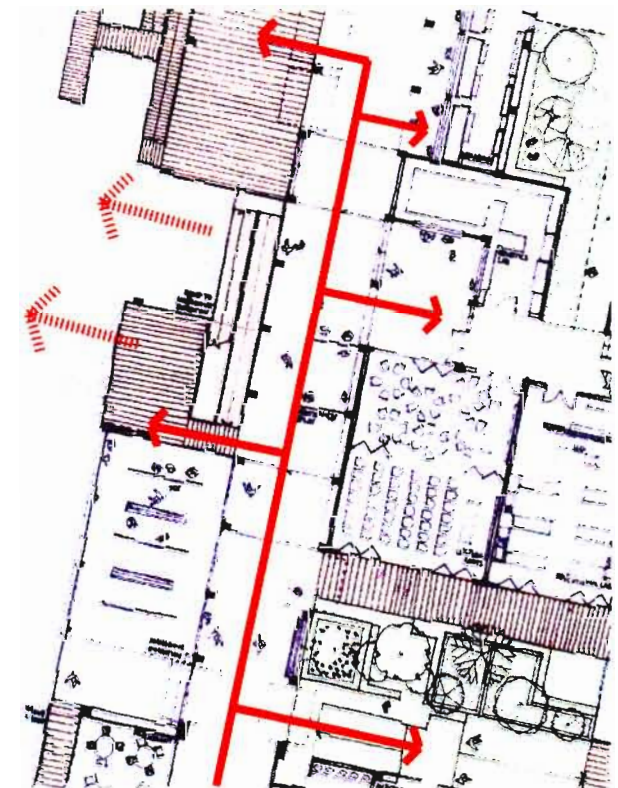
Ill. 9.2: The Research Aquarium as seen from the circulation spine. Visitors on their way to the boat jetty can gain visual access into the secure laboratory.



Ill. 9.4: The visitors circulation spine provides the perfect opportunity to exploit the concept of dual access, while concomitantly providing views to the surrounding environment.



Ill. 9.3: Digram showing the integration of te environment through the inclusion of courtyards, and the feathering of the building dge.





driving concept for the ERF was the blurring of the lines between these two frequently separated people groups by providing an interface for interaction. The solution has been labelled 'Dual Access', and has been implemented wherever possible or applicable.

One area which provided great opportunities for this visual access to secure areas, was the visitors circulation spine. It is off of this spine that the visitor specific facilities are located, and it was also along this spine that dual access is displayed architecturally. For example, while a tourist moves from the entrance to the boat jetty they encounter a visual connection to the research aquarium as they are afforded complete views into this scientific space. Another instance is at the entrance to one of the classrooms, from where children can look into the Genetics laboratory to gain a better understanding of what occurs in this sterile location. In addition to these opportunities, visitors can gain visual access to spaces such as the wet laboratory from the boardwalk which extends out into the newly formed wetland to the east of the ERF.

Overlaid over this circulation and interaction spine is the idea of a privacy gradient across the site. From the more public entrance area, to the scientifically private spaces such as the locker rooms, library and meeting spaces.

### **Polyvalence**

Examples of polyvalent architectural forms can be found throughout. These spaces start with change as an invariable, inert factor and will

therefore more readily adapt to shifting functional requirements. As pointed out previously, this was to be achieved while maintaining the architectural identity of each space. As a response, the ERF incorporates polyvalent spaces such as the classrooms and staff office areas which can be completely readjusted by the users in order to better meet their requirements. In addition, staff are encouraged to personalise their individual spaces in order to encourage a sense of ownership. As well as these polyvalent spaces, the laboratories have been designed with a very flexible servicing systems and a percentage of the furniture is moveable. As above, this means that these spaces can be laid out according to each scientific teams requirements, and then readjusted as projects and researcher's needs change.

### **Responsible Resource Management**

The ERF must be responsible in the impact that it has to the local environment. Resources have been managed through active and passive means:

#### *Daylighting, ventilation and passive solar design*

A way in which the electricity requirements can be passively reduced is through effective use of daylighting, ventilation and passive solar design. Complete reliance on artificial illumination has been avoided by incorporating the light provided by the sun. Harsh direct sunlight has been avoided in sensitive areas such as the laboratory spaces, rather, tempered, controlled light is allowed reflect through the fenestration to provide a pleasant interior work environment where no work spaces is more than 5 metres from a natural light source.

### *Power production*

It was necessary to include on-site electricity production in order to assist the local supply to as large an extent as possible. This has been achieved through the inclusion of photo-voltaic electricity cells on the roofs and a series of small wind-powered generators all of which contribute to the electricity requirements of the ERF.

### *Embodied Energy*

As a means of responsible energy management, materials with a low embodied energy were preferred to those higher up on the energy graph. This led to the selection of timber as the predominant construction material, with steel and glass as connection elements wherever necessary.

### **Contribution to the Local Economy**

Throughout the design process any contribution made to the local economy will be very beneficial. This includes the selection of local contractors, maintenance companies and materials wherever possible. It has also had an impact on the design approach in that the building cannot be extremely complex by way of construction techniques, but rather incorporate simpler solutions which can be managed by local labour.

### **Rehabilitation of the selected brownfield site**

Throughout the research process it was clear that the best site for any development in an area such as this, would be one that has already been changed or affected by human hands. Such a site was selected for the construction of the ERF. The reuse of such a site does however extend

to the rehabilitation of the areas that have been affected. All areas that surround the new building will be rehabilitated once construction is completed. This rehabilitation of the local swamp forest to the proverbial door of the ERF will also continue to develop the desired connection with the environment.

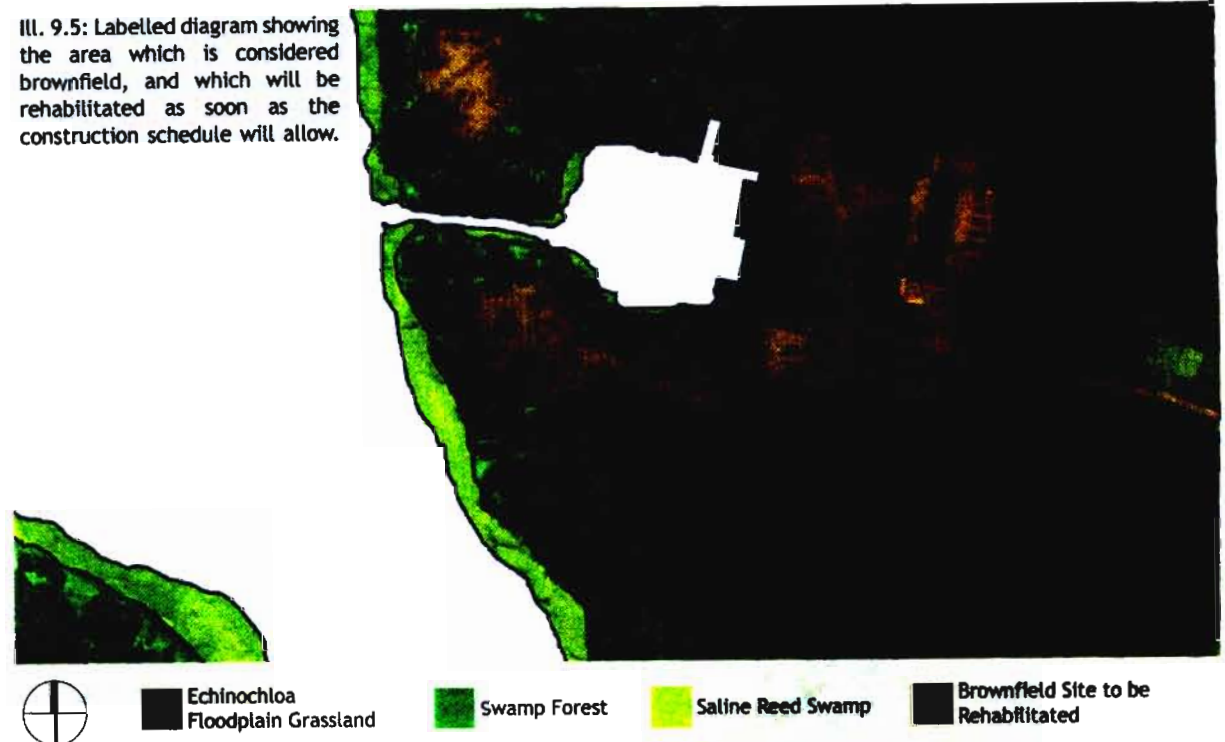
### Critically Regional Response

The over arching theory of a critical regionalism in many ways incorporates all of the aforementioned principles of design. The design has been concerned from the offset with the local topography, climate, light and how the form can be a tectonic response to these contextual forces.

Ultimately, the ERF design seeks to be derived through a principle driven process, that as opposed to an outcome where the eventual architectural image has been the driving force. The ERF has not been designed to be a 'green' building with specifically green architectural forms or add-ons. It does not attempt to say: "I am green", but rather the intention is that through interaction with the building, visitors will understand that the celebration and protection of the context was paramount.

Such conclusions will be drawn through users interactions with the spaces that have been created. The building focusses on the beauty of the site, rather than trying to be iconic itself. Visitors or users do not simply move through provided spaces, but acquire a sense of the uniqueness of this specific *place*.

III. 9.5: Labelled diagram showing the area which is considered brownfield, and which will be rehabilitated as soon as the construction schedule will allow.



The existing boathouse in St. Lucia provides a similar opportunity to those provided for Carlo Scarpa. It is possible to weave the new work into the old fabric, so that it is still clear to the occupant what is old and what is new. This response thus grounds the building in the past, drawing attention to what has gone before, while concomitantly suggesting an alternative path into the future. This intervention is given more gravity when one considers that the boathouse represents the past of the area, it is about the human intervention into the natural ecosystems in the wetland. As we begin to understand the Wetland better, we learn that our actions have great consequences for the natural balance. Additionally, the potential for these results to be irrevocably destructive is increased exponentially as we enter the fuel-run engine into the scenario.

With the boathouse there exists the potential to shift the path of this place away from the destructive, exploitative methods of the past, and advocate a new, responsible *modus operandi* for the future.

### Sustainable Building Assessment Tool Report

On the following page is the graph output from the Sustainable Building Assessment Tool (SBAT) which gives an indication of the effectiveness of the sustainable responses put in place (See Appendix 2). This graph represents the Environmental Research Facility and it clearly shows that the design decisions made throughout this research process and implemented in the design, have resulted in an efficient, effective and responsible facility.

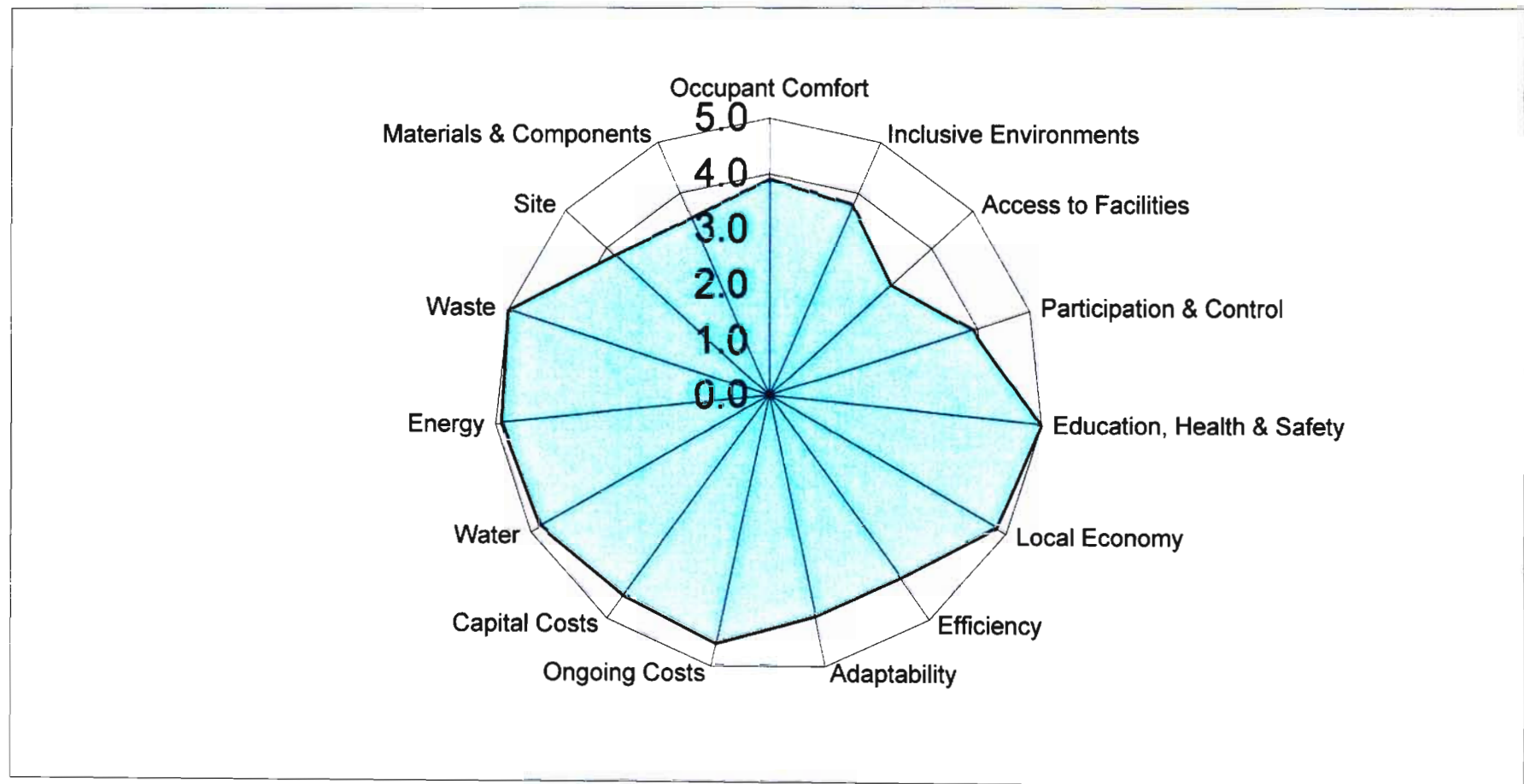


# SUSTAINABLE BUILDING ASSESSMENT TOOL (SBAT- P) V1

## PROJECT

Project title: Environmental Research Facility  
 Location: St. Lucia  
 Building type: Research and Education  
 Internal area (m2): 2800  
 Number of users: 200

Ill. 9.6: SBAT graph indicating, out of 5, the sustainability of the research facility.



**Social** 3.9

**Economic** 4.4

**Environmental** 4.4

**Overall** 4.2

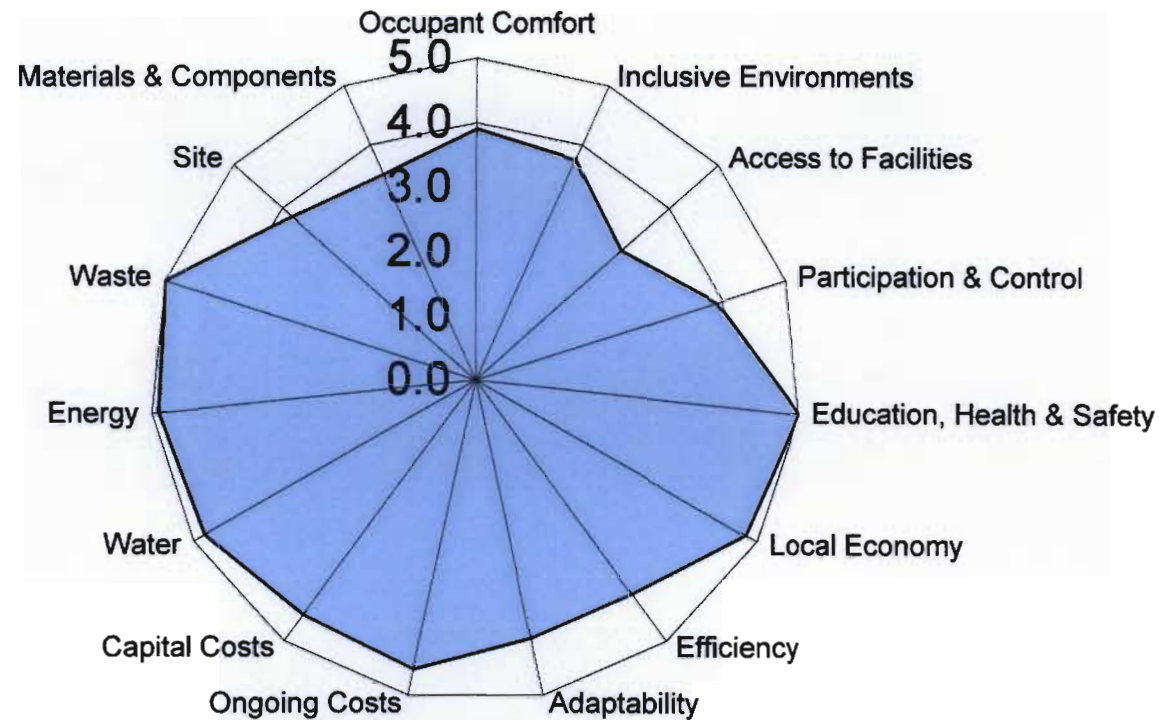
**Classification**

# SUSTAINABLE BUILDING ASSESSMENT TOOL (SBAT- P) V1

## PROJECT

Project title: Environmental Research Facility  
Location: St. Lucia  
Building type: Research and Education  
Internal area (m2): 2800  
Number of users: 200

Ill. 9.6: SBAT graph indicating, out of 5, the sustainability of the research facility.



Social 3.9

Economic 4.4

Environmental 4.4

Overall 4.2

Classification



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All illustrations in Chapter IX by Author



## Abbreviations and Acronyms

<b>CTR:</b>	Constant Temperature Room
<b>EU:</b>	European Union
<b>FSC:</b>	Forest Stewardship Council
<b>GEC:</b>	Global Ecology Centre
<b>HIV/AIDS:</b>	Human Immune Virus / Acquired Immune Deficiency Syndrome
<b>NRF:</b>	National Research Foundation
<b>ORI:</b>	Oceanographic Research Institute
<b>SAAMBR:</b>	South African Association for Marine Biological Research
<b>UNESCO:</b>	United Nations Educational, Scientific and Cultural Organisation
<b>VOCs:</b>	Volatile Organic Compounds

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All illustrations in Chapter IX by Author

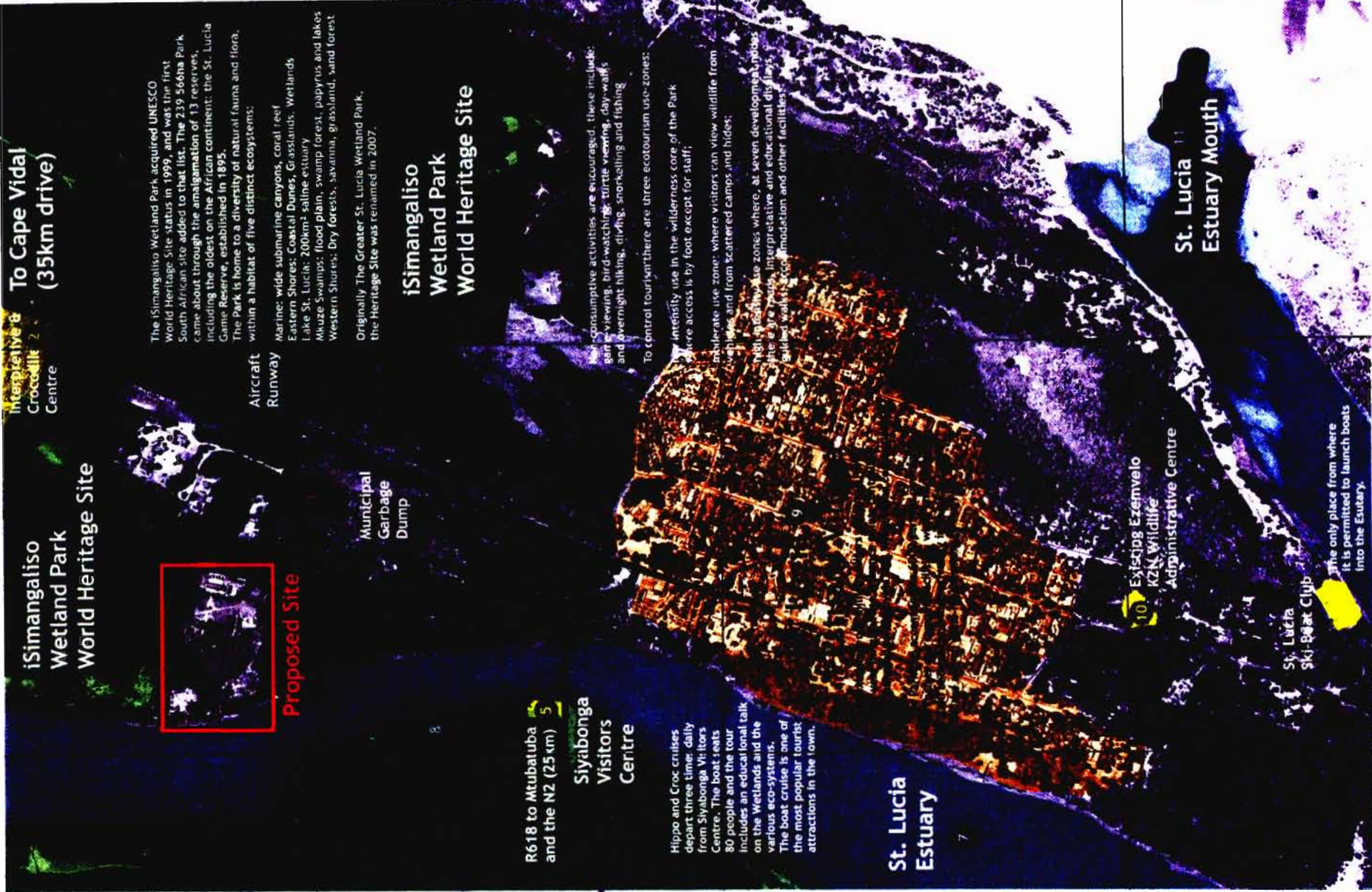


## **ABBREVIATIONS AND ACRONYMS**

<b>CTR:</b>	Constant Temperature Room
<b>EU:</b>	European Union
<b>FSC:</b>	Forest Stewardship Council
<b>GEC:</b>	Global Ecology Centre
<b>HIV/AIDS:</b>	Human Immune Virus / Acquired Immune Deficiency Syndrome
<b>NRF:</b>	National Research Foundation
<b>ORI:</b>	Oceanographic Research Institute
<b>SAAMBR:</b>	South African Association for Marine Biological Research
<b>UNESCO:</b>	United Nations Educational, Scientific and Cultural Organisation
<b>VOCs:</b>	Volatile Organic Compounds

## Appendices





The iSimangaliso Wetland Park acquired UNESCO World Heritage Site status in 1999, and was the first South African site added to that list. The 239 566ha Park came about through the amalgamation of 13 reserves, including the oldest on the African continent: the St. Lucia Game Reserve, established in 1895. The Park is home to a diversity of natural fauna and flora, within a habitat of five distinct ecosystems:

- Marine: wide submarine canyons, coral reef
- Eastern Shores: Coastal Dunes, Grasslands, Wetlands
- Lake St. Lucia: 200km<sup>2</sup> saline estuary
- Mkuze Swamps: flood plain, swamp forest, papyrus and lakes
- Western Shores: Dry forests, savanna, grassland, sand forest

Originally The Greater St. Lucia Wetland Park, the Heritage Site was renamed in 2007.

### iSimangaliso Wetland Park World Heritage Site

Non-consumptive activities are encouraged. These include: game viewing, bird-watching, turtle viewing, day-walks and overnight hiking, diving, snorkelling and fishing.

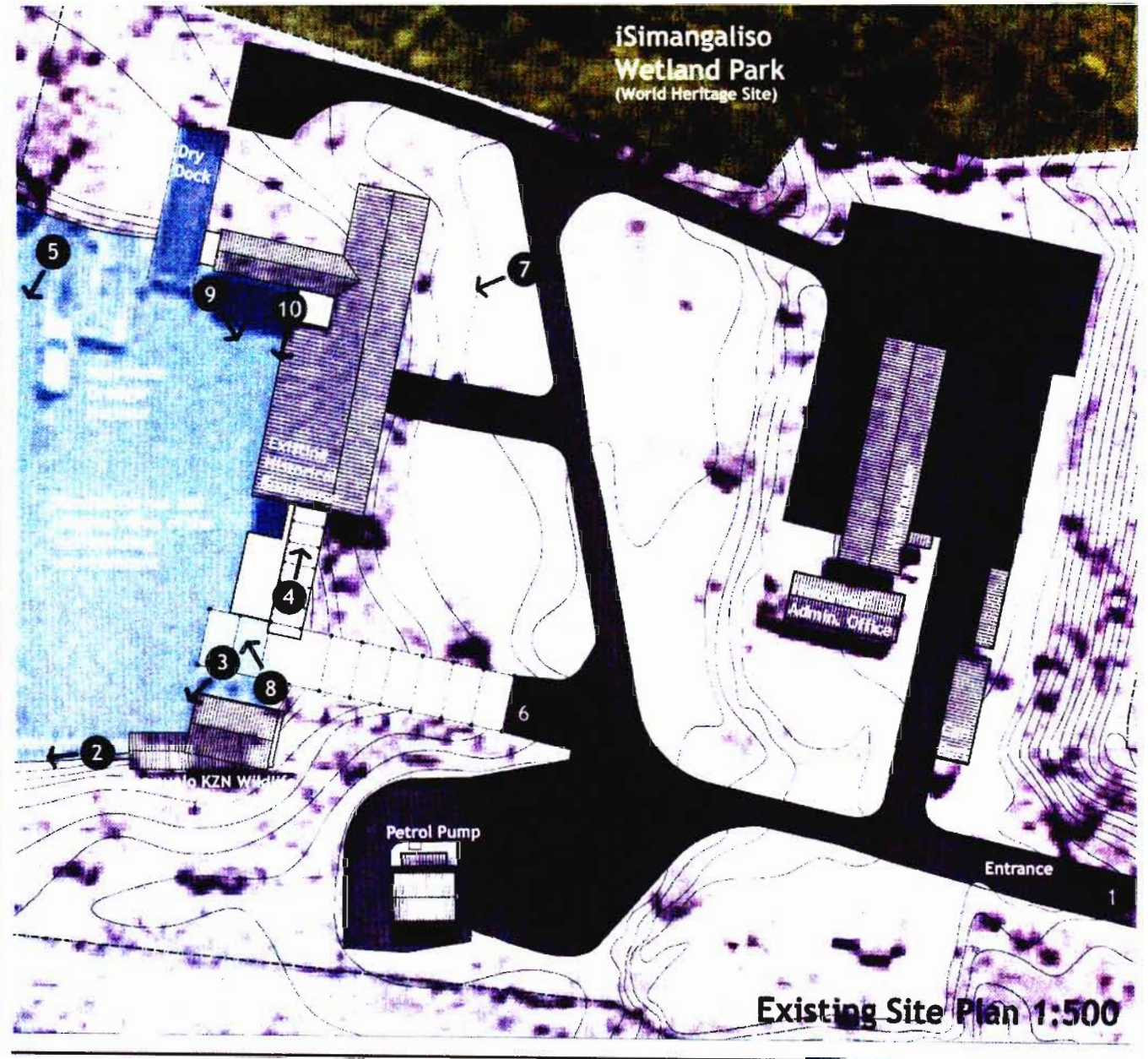
To control tourism there are three ecotourism use-zones: Intensely use in the wilderness core of the Park where access is by foot except for staff;

moderate use zone: where visitors can view wildlife from vehicles and from scattered camps and hides;

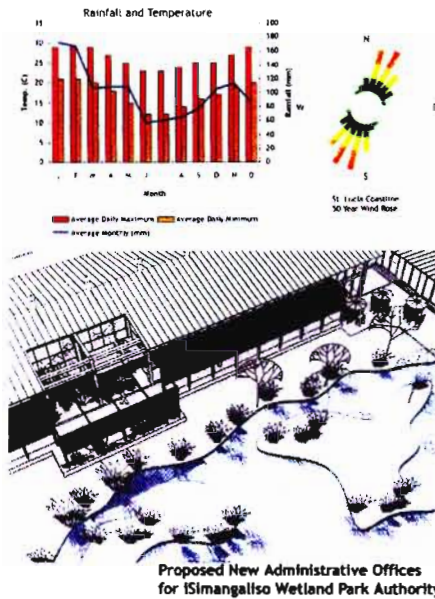
Multi-use zone: where, at seven development nodes, there are trails, interpretative and educational displays, guided walks, accommodation and other facilities.

The only place from where it is permitted to launch boats into the Estuary.









### Proposed Site:

A brownfield site surrounding a man-made harbour. Originally designed as a maintenance dock for the dredger boats used (until recently) to dredge out the St. Lucia Estuary.

The Site contains 3 structures:

#### 1-Existing Boathouse:

Current used as a workshop.

Existing Infrastructure:

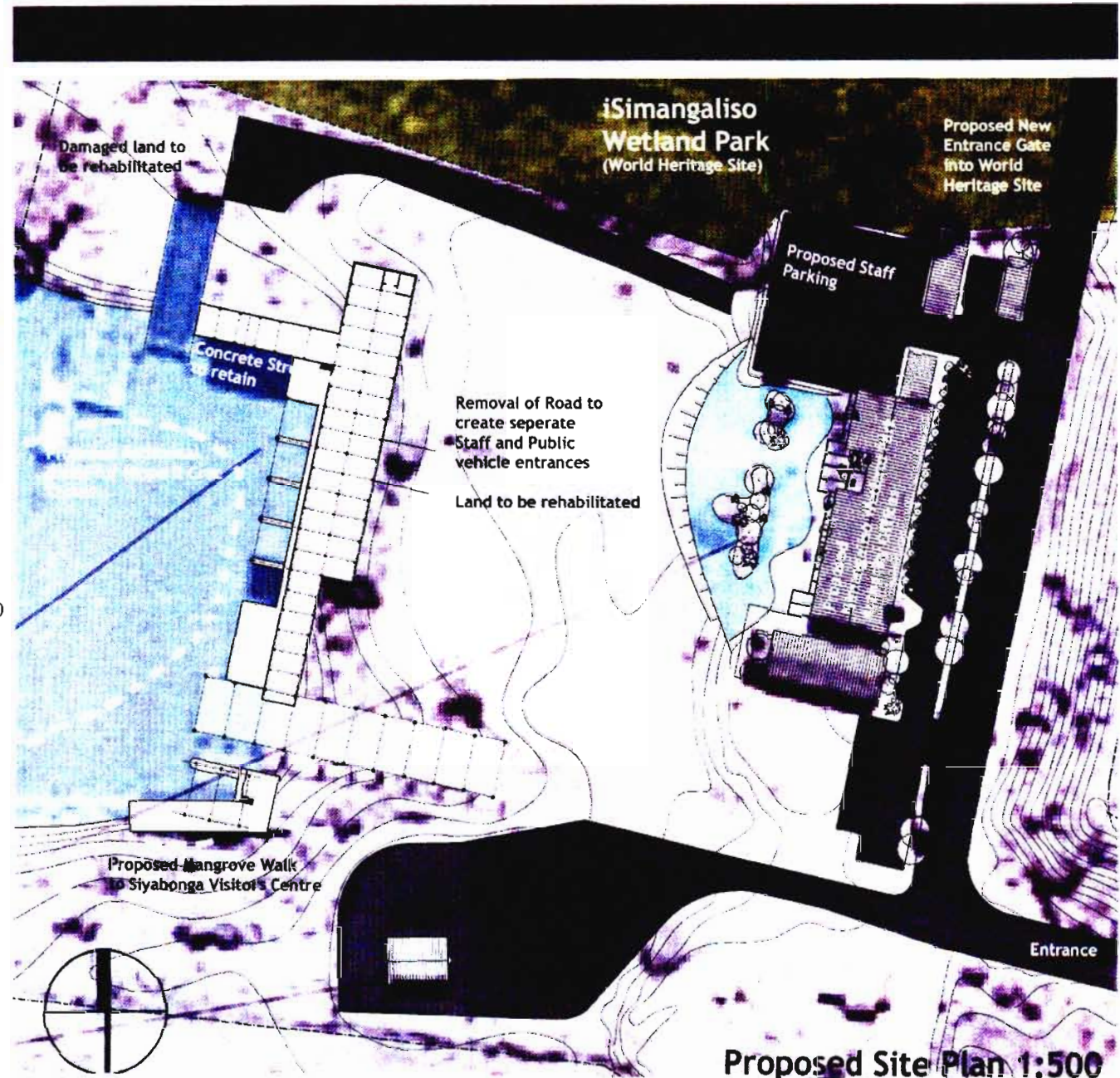
- Concrete Stilt Structure
- Brick Infill
- Asbestos Roof
- Electricity Supply
- No Sewage pipes
- No Water Supply

#### 3-Warehouse & Admin. Office

Currently dilapidated

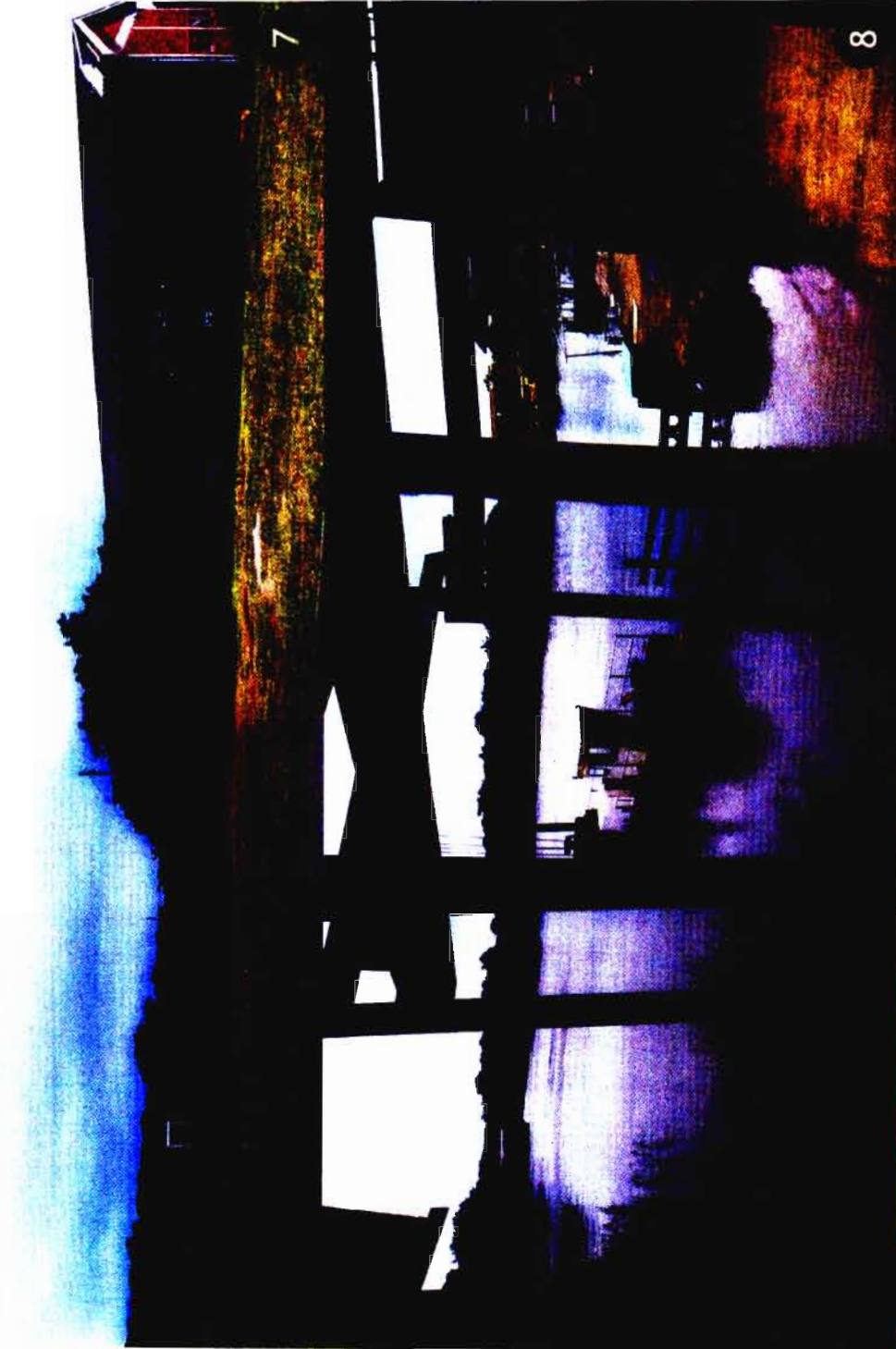
This structure will house the iSimangaliso Wetland Park Authorities offices, a small exhibition space and Park Museum.

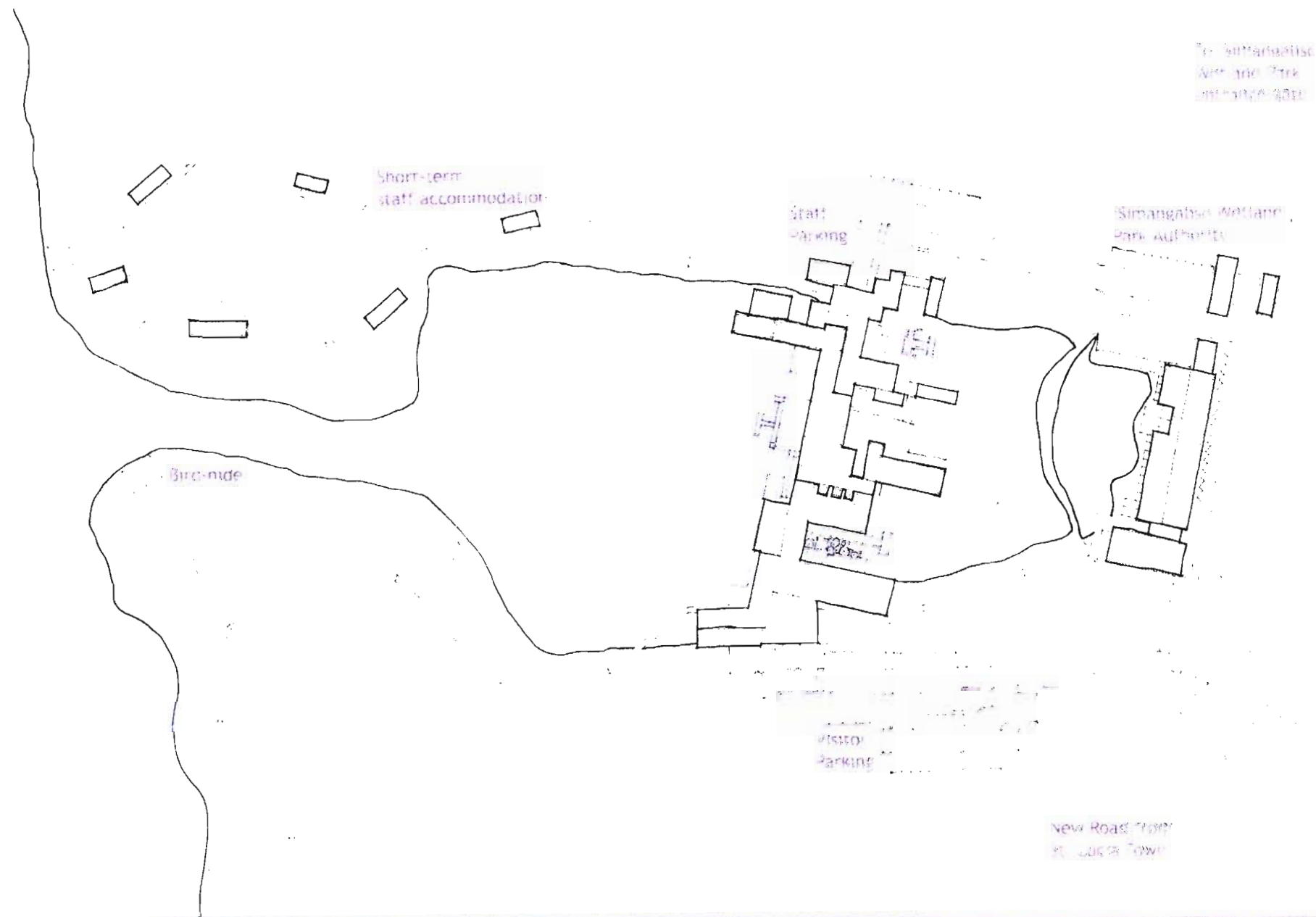
#### 3-Dilapidated Petrol Station





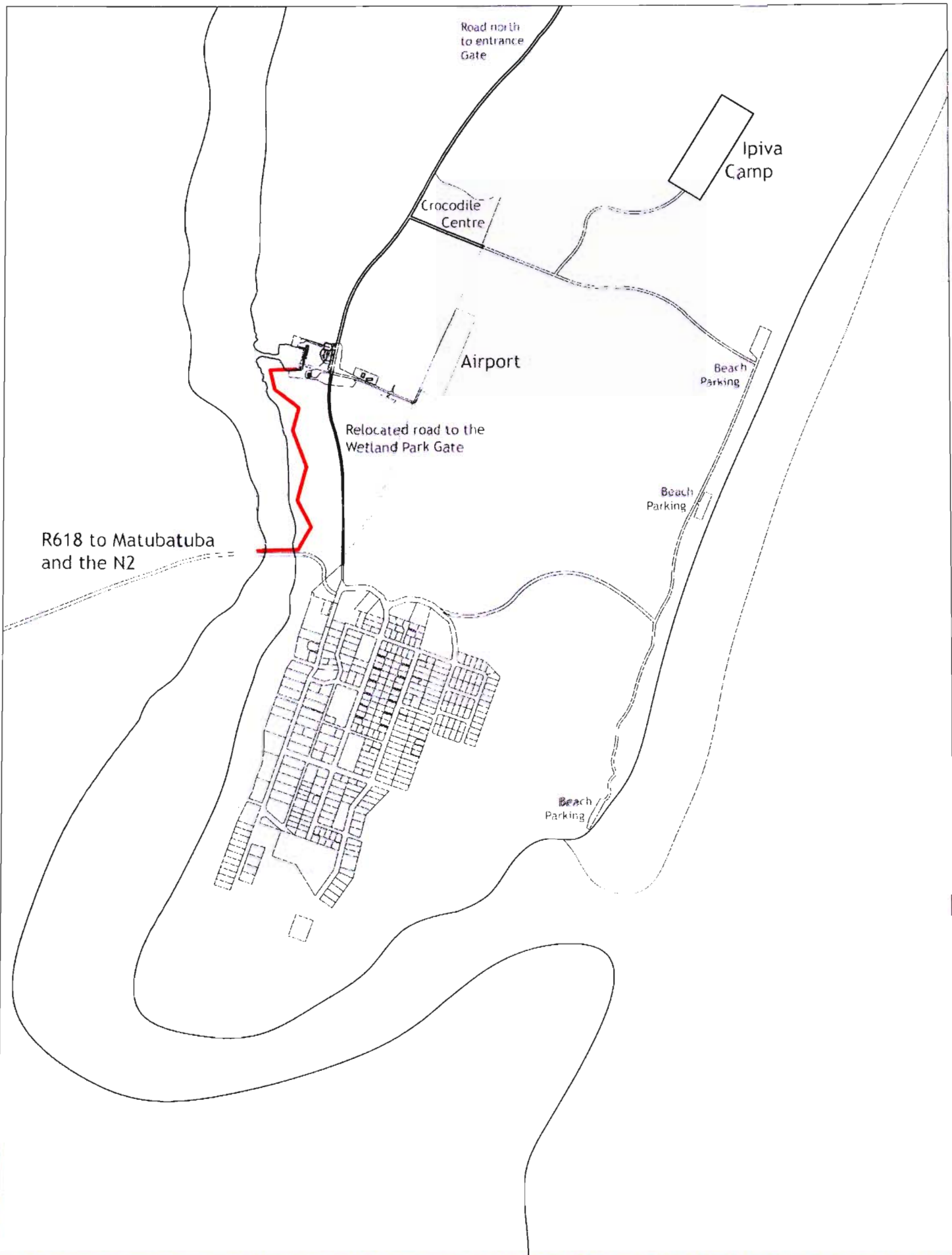




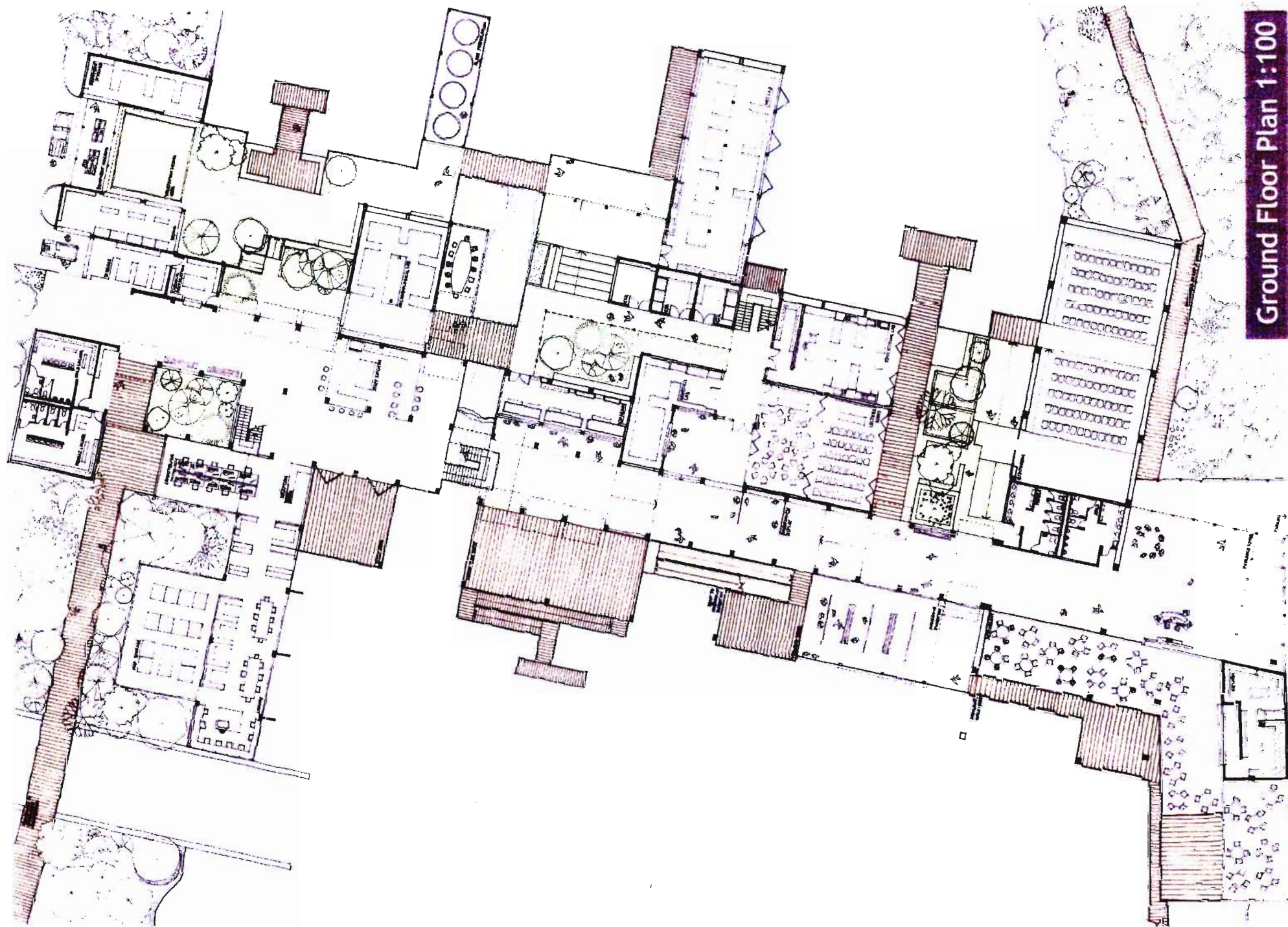


Site Plan 1:500

Environmental Research Facility  
Mark Bellingan Masters Thesis 2007



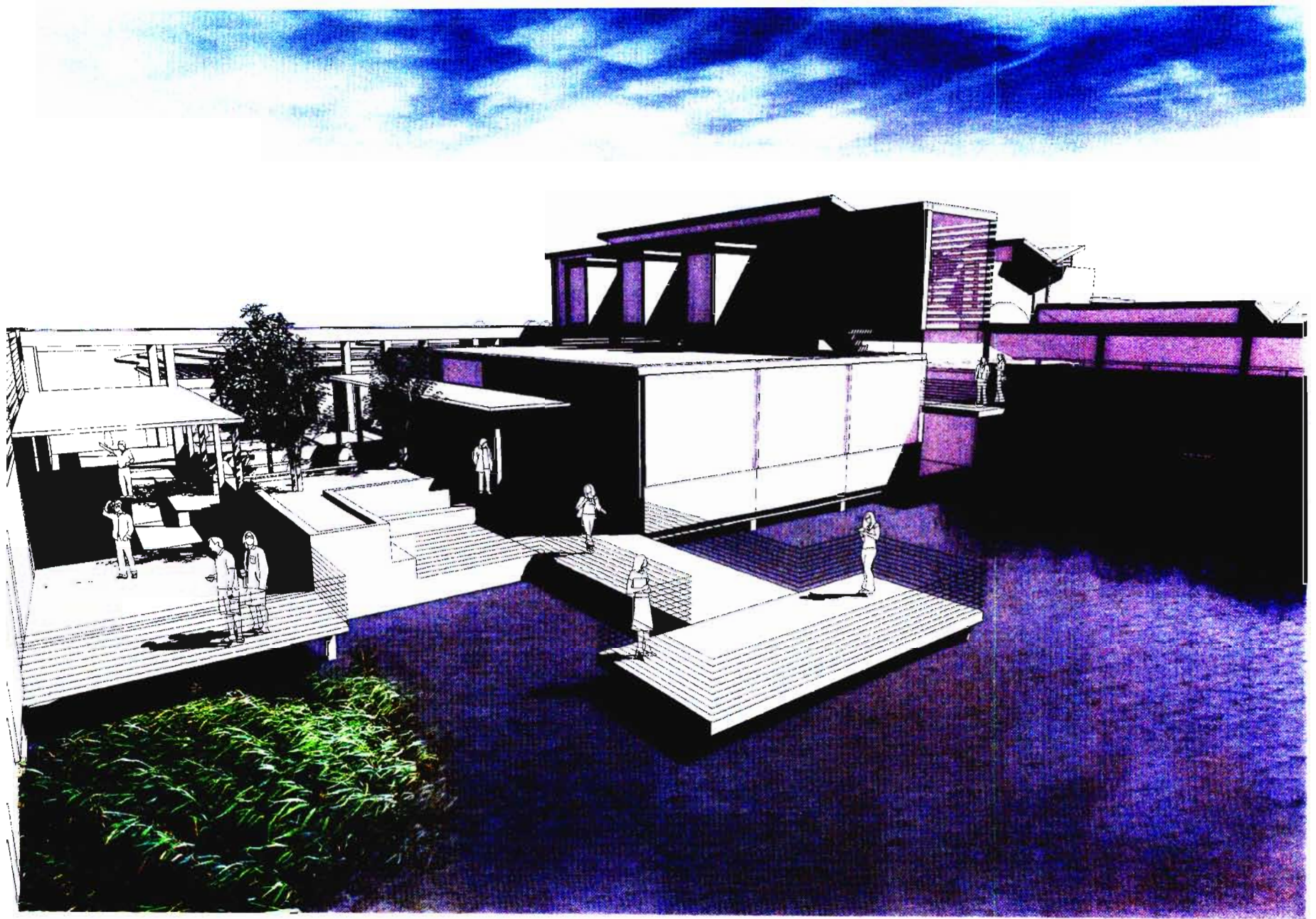




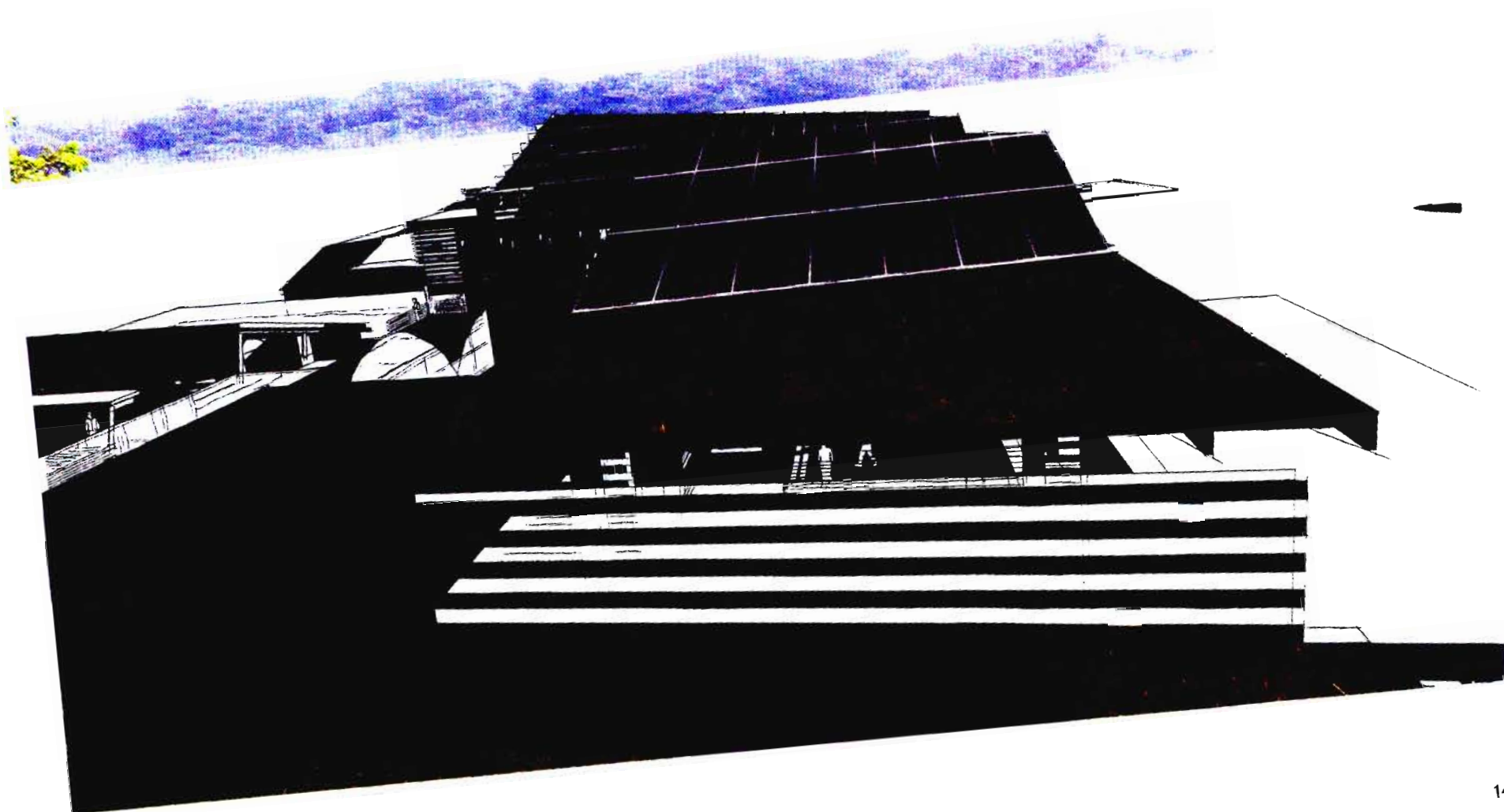
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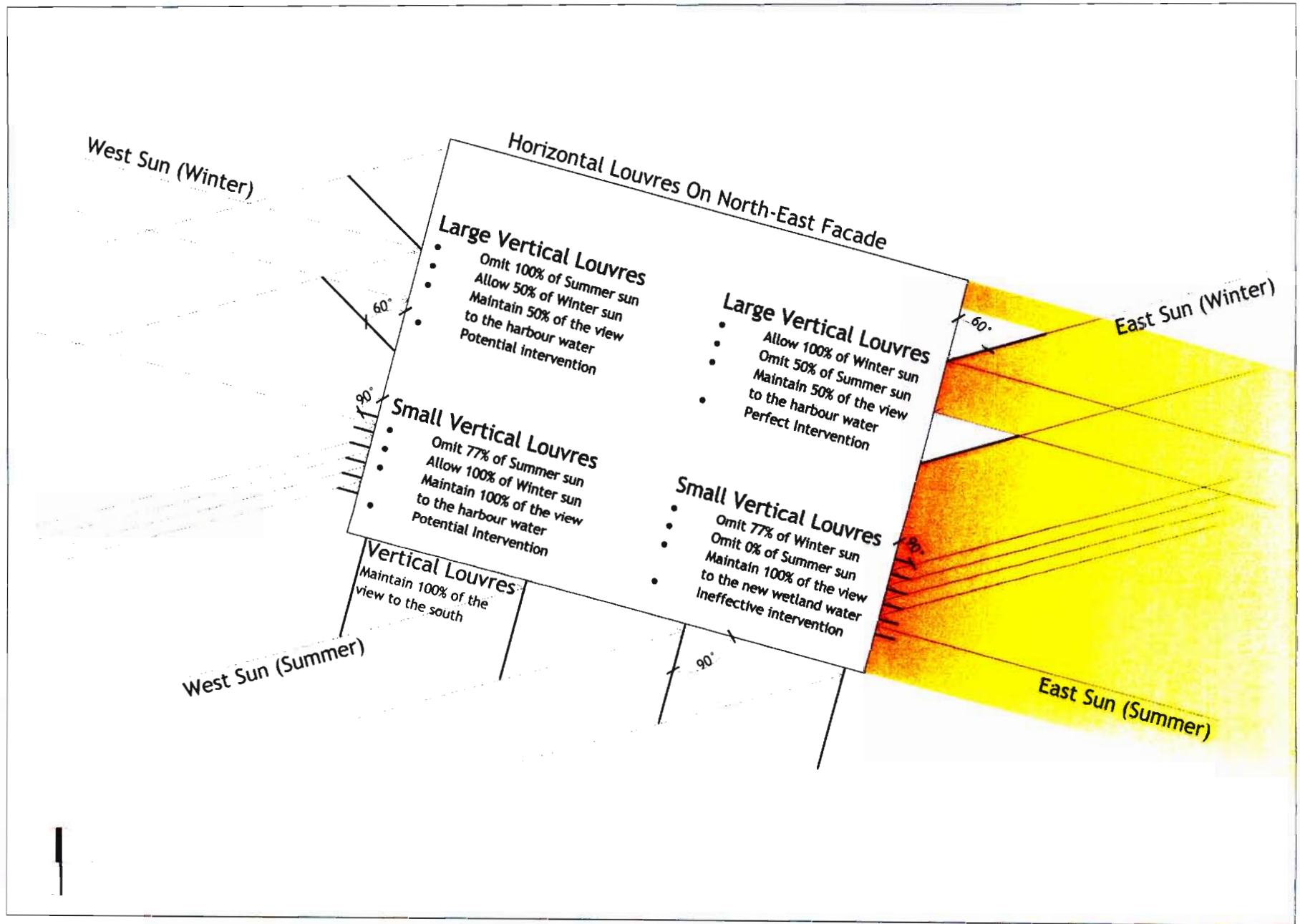


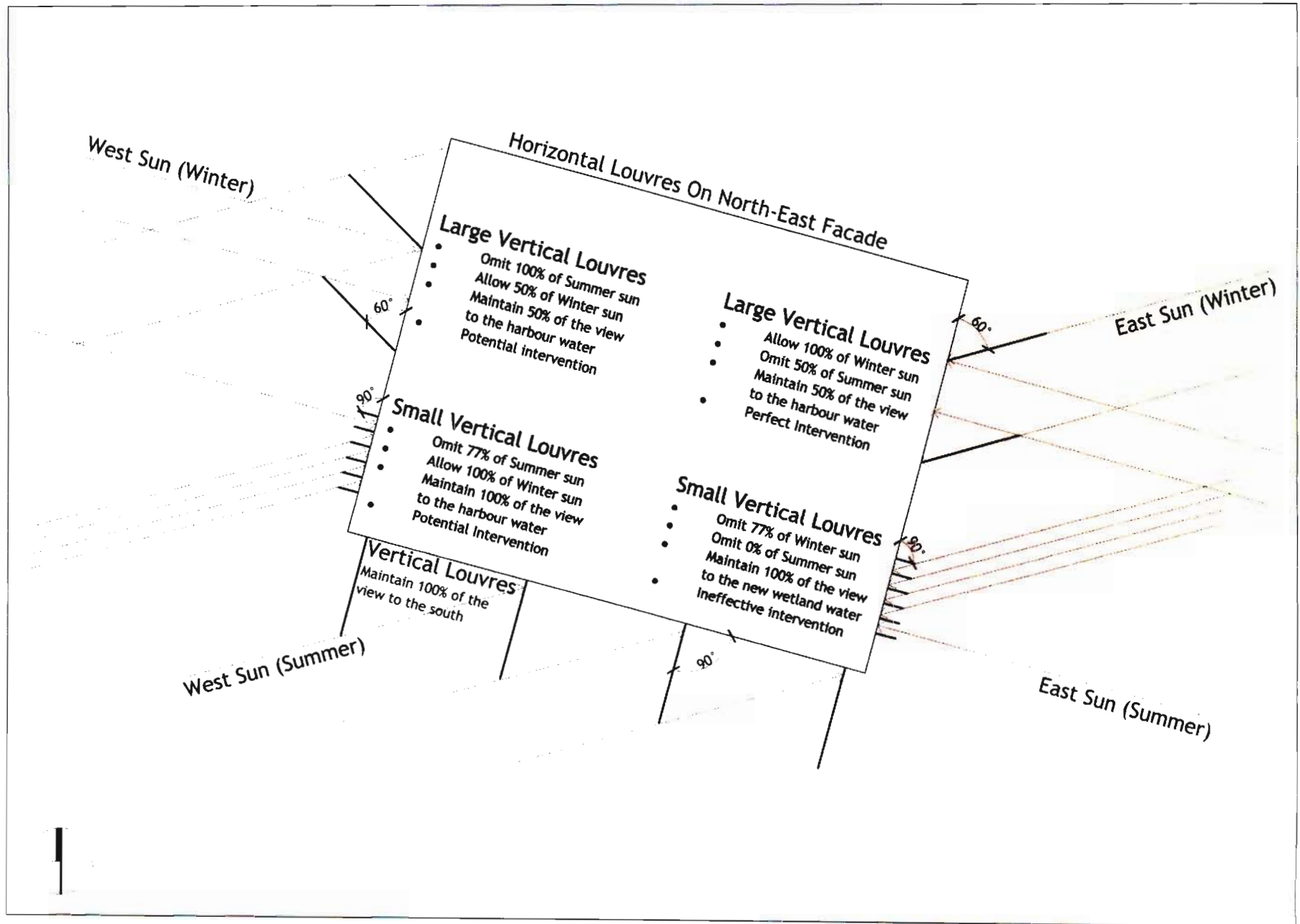




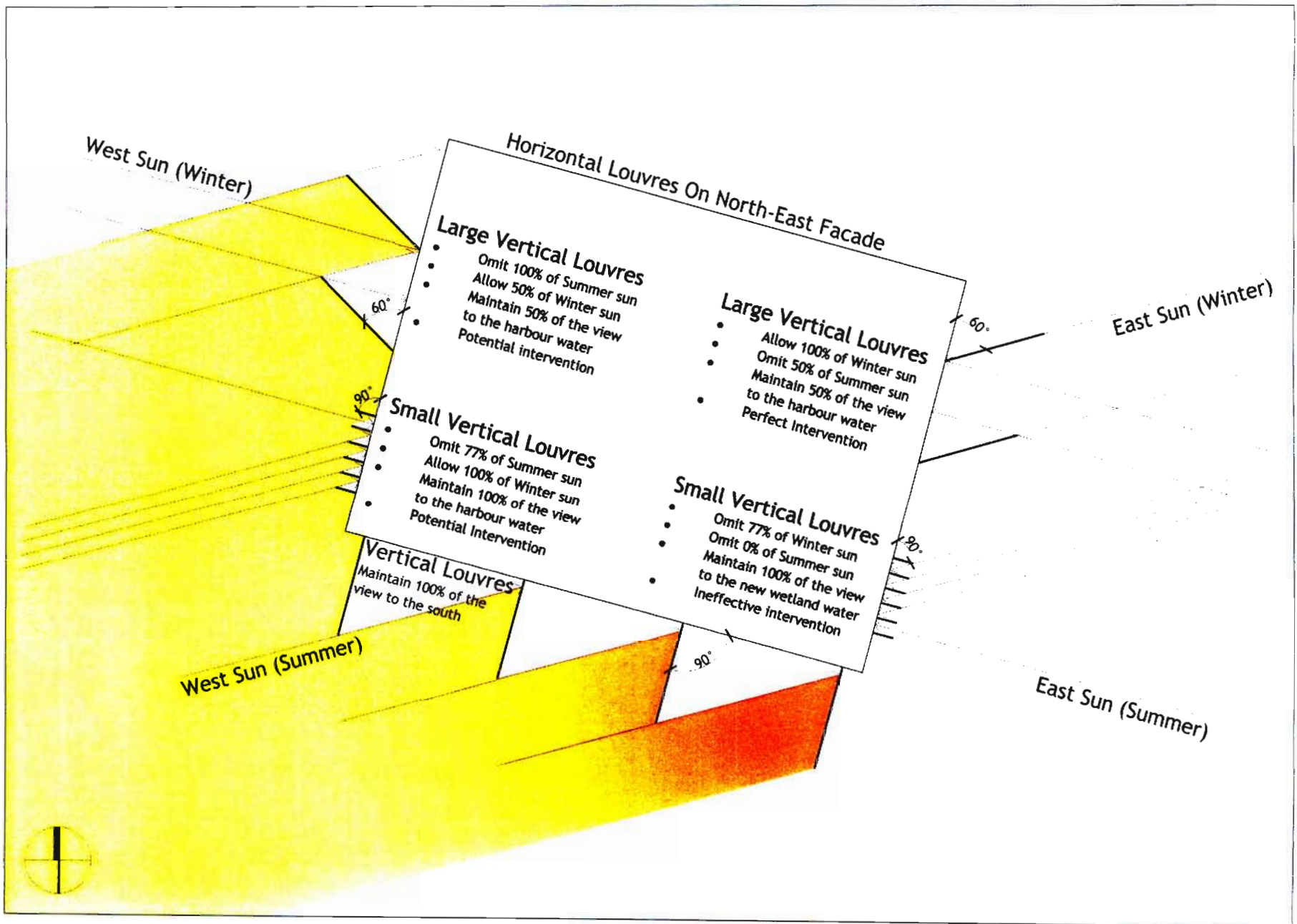


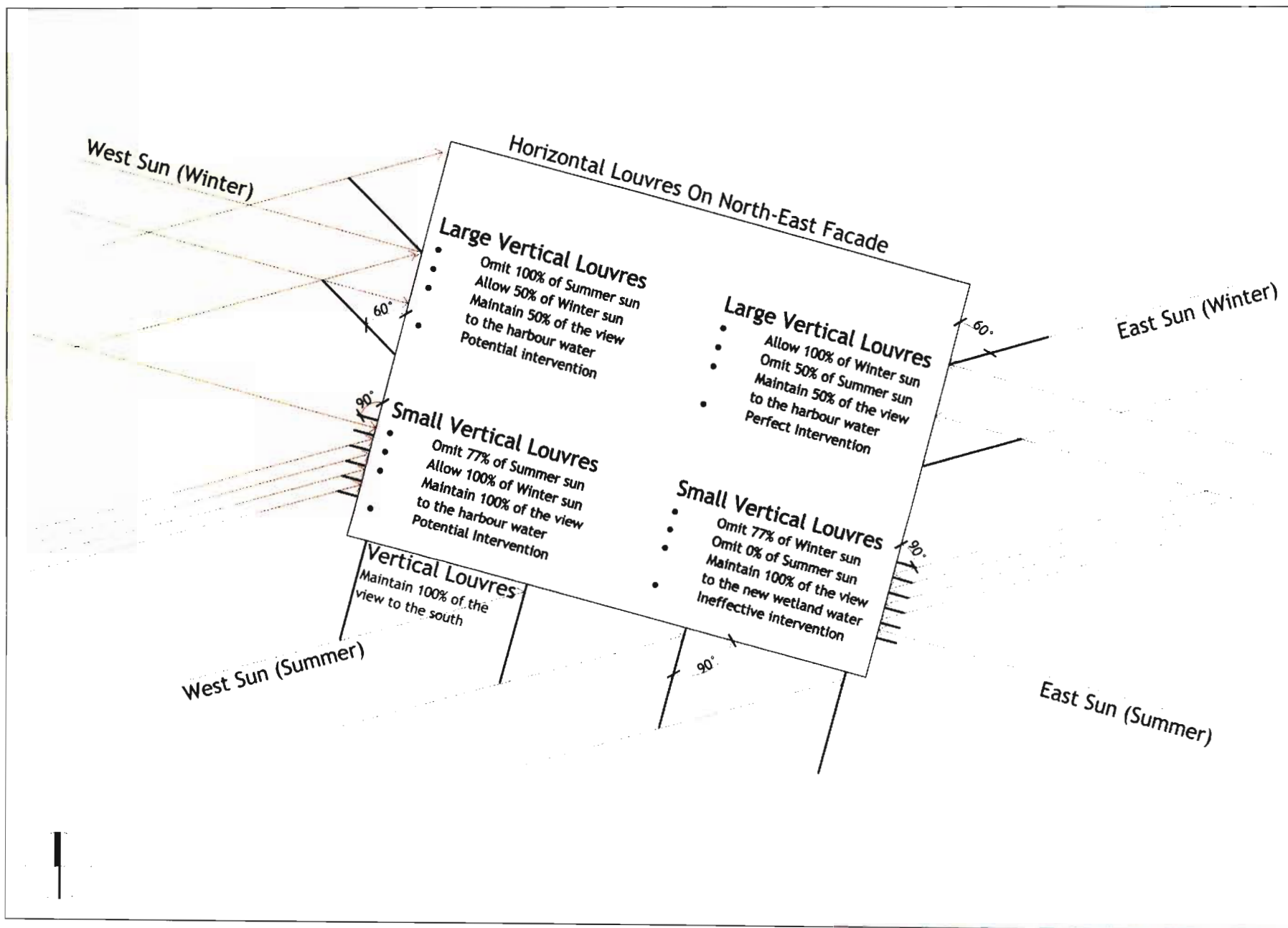












## Appendix 2: Sustainable Building Assessment Tool (SBAT) Report

### Building Performance - Social

	Criteria	Indicative performance measure	Measured	Points
<b>SO 1</b>	<b>Occupant Comfort</b>			<b>3.9</b>
SO 1.1	Daylighting	% of occupied spaces that are within distance 2H from window, where H is the height of the window or where there is good daylight from skylights	80	0.8
SO 1.2	Ventilation	% of occupied spaces have equivalent of opening window area equivalent to 10% of floor area or adequate mechanical system, with upolluted air source	90	0.9
SO 1.3	Noise	% of occupied spaces where external/internal/reverberation noise does not impinge on normal conversation (50dba)	100	1.0
SO 1.5	Thermal comfort	Temperature of occupied space does not exceed 28 or go below 19°C for less than 5 days per year (100%)	20	0.2
SO 1.5	Views	% of occupied space that is 6m from an external window (not a skylight) with a view	100	1.0
<b>SO 2</b>	<b>Inclusive Environments</b>			<b>3.8</b>
SO 2.1	Public Transport	% of building (s) within 400m of disabled accessible public transport	100	1.0
SO 2.2	Information	High contrast, clear print signage in appropriate locations (100%)	100	1.0
SO 2.3	Space	% of occupied spaces that are accessible to ambulant disabled / wheelchair users	75	0.8
SO 2.4	Toilets	% of space with fully accessible toilets within 50m	80	0.8
SO 2.5	Fittings & Furniture	% of commonly used furniture and fittings (reception desk, kitchenette, auditorium) fully accessible	20	0.2
<b>SO 3</b>	<b>Access to Facilities</b>			<b>3.0</b>
SO 3.1	Children	All users can walk (100%) / use public transport (50%) to get to their childrens' schools and creches	50	0.5
SO 3.2	Banking	All users can walk (100%) / use public transport (50%) to get to banking facilities	50	0.5
SO 3.3	Retail	All users can walk (100%) / use public transport (50%) to get to food retail	50	0.5
SO 3.4	Communication	All users can walk (100%) / use public transport (50%) to get to communication facilities (post, telephone and internet)	50	0.5
SO 3.5	Exercise	All users can walk (100%) / use public transport (50%) to get to recreation / exercise facilities	100	1.0
<b>SO 4</b>	<b>Participation &amp; Control</b>			<b>3.9</b>
SO 4.1	Environmental control	% of occupied spaces able to control their thermal environment (adjacent to openable windows/thermal controls)	90	0.9
SO 4.2	Involvement	% of users actively involved in the design process (workshops / meetings with models / large format drawings)	100	1.0
SO 4.3	Social spaces	Social informal meeting spaces (parks / staff canteens / cafes) provided locally (within 400m) (100%)	100	1.0
SO 4.4	Sharing facilities	% of facilities shared with other users / organisations on a weekly basis (100%)	100	1.0
SO 4.5	User group	Active representative user group involved in the management of the building / facilities / local environment (100%)	0	0.0
<b>SO 5</b>	<b>Education, Health &amp; Safety</b>			<b>5.0</b>
SO 5.1	Education	Two percent or more space/facilities available for education (seminar rooms / reading / libraries) per occupied spaces (75%). Construction training provided on site (25%)	100	1.0
SO 5.2	Safety	All well used routes in and around building well lit (25%), all routes in and around buildings (25%) visually supervised, secure perimeter and access control (50%), No crime (100%)	100	1.0
SO 5.3	Awareness	% of users who can access information on health & safety issues (ie HIV/AIDS), training and employment opportunities easily (posters/personnel)	100	1.0
SO 5.4	Materials	All materials/components used have no negative effects on indoor air quality (100%)	100	1.0
SO 5.5	Accidents	Method in place for recording all occupational accidents and diseases and addressing these	100	1.0



## Building Performance - Economic

	Criteria	Indicative performance measure	Measured	Points
<b>EC 1</b>	<b>Local economy</b>			<b>4.8</b>
EC 1.1	Local contractors	% value of the building constructed by local (within 50km) small (employees<20) contractors	100	1.0
EC 1.2	Local materials	% of materials (sand, bricks, blocks, roofing material) sourced from within 50km	80	0.8
EC 1.3	Local components	% of components (windows, doors etc) made locally (in the country)	100	1.0
EC 1.4	Local furniture/fitings	% of furniture and fittings made locally (in the country)	100	1.0
EC 1.5	Maintenance	% of maintenance and repairs by value that can, and are undertaken, by local contractors (within 50km)	100	1.0
<b>EC 2</b>	<b>Efficiency</b>			<b>4.1</b>
EC 2.1	Capacity	% capacity of building used on a daily basis (actual number of users / number of users at full capacity*100)	40	0.4
EC 2.2	Occupancy	% of time building is occupied and used (actual average number of hours used / all potential hours building could be used (24) *100)	70	0.7
EC 2.3	Space per occupant	Space provision per user not more than 10% above national average for building type (100%)	100	1.0
EC 2.4	Communication	Site/building has access to internet and telephone (100%), telephone only (50%)	100	1.0
EC 2.5	Material & Components	Building design coordinated with material / component sizes in order to minimise wastage. Walls (50%), Roof and floors (50%)	100	1.0
<b>EC 3</b>	<b>Adaptability</b>			<b>4.8</b>
EC 3.1	Vertical heights	% of spaces that have a floor to ceiling height of 3000mm or more	75	0.8
EC 3.2	External space	Design facilitates flexible external space use (100%)	100	1.0
EC 3.3	Internal partition	Non loadbearing internal partitions that can be easily adapted (loose partitioning (100%), studwall (50%), masonry (25%))	100	1.0
EC 3.4	Modular planning	Building with modular structure, envelope (fenestration) & services allowing easy internal adaptation (100%)	100	1.0
EC 3.5	Furniture	Modular, limited variety furniture - can be easily configured for different uses (100%)	100	1.0
<b>EC 4</b>	<b>Ongoing costs</b>			<b>4.6</b>
EC 4.1	Induction	All new users receive induction training on building systems (50%), Detailed building user manual (50%)	100	1.0
EC4.2	Consumption & waste	% of users exposed on a monthly basis to building performance figures (water (25%), electricity (25%), waste (25%), accidents (25%))	100	1.0
EC 4.2	Metering	Easily monitored localised metering system for water (25%) and energy (75%)	100	1.0
EC4.3	Maintenance & Cleaning	Building can be cleaned and maintained easily and safely using simple equipment and local non-hazardous materials (100%)	80	0.8
SO 4.5	Procurement	% of value of all materials/equipment used in the building on a daily basis supplied by local (within the country) manufacturers	80	0.8
<b>EC 5</b>	<b>Capital Costs</b>			<b>4.5</b>
EC 5.1	Local need	Five percent capital cost allocated to address urgent local issues (employment, training etc) during construction process (100%)	100	1.0
EC5.2	Procurement	Tender / construction packaged to ensure involvement of small local contractors/manufacturers (100%)	100	1.0
EC 5.3	Building costs	Capital cost not more than fifteen % above national average building costs for the building type (100%)	50	0.5
EC5.4	Sustainable technology	3% or more of capital costs allocated to new sustainable/indigenous technology (100%)	100	1.0
EC 5.5	Existing Buildings	Existing buildings reused (100%)	100	1.0

## Building Performance - Environmental

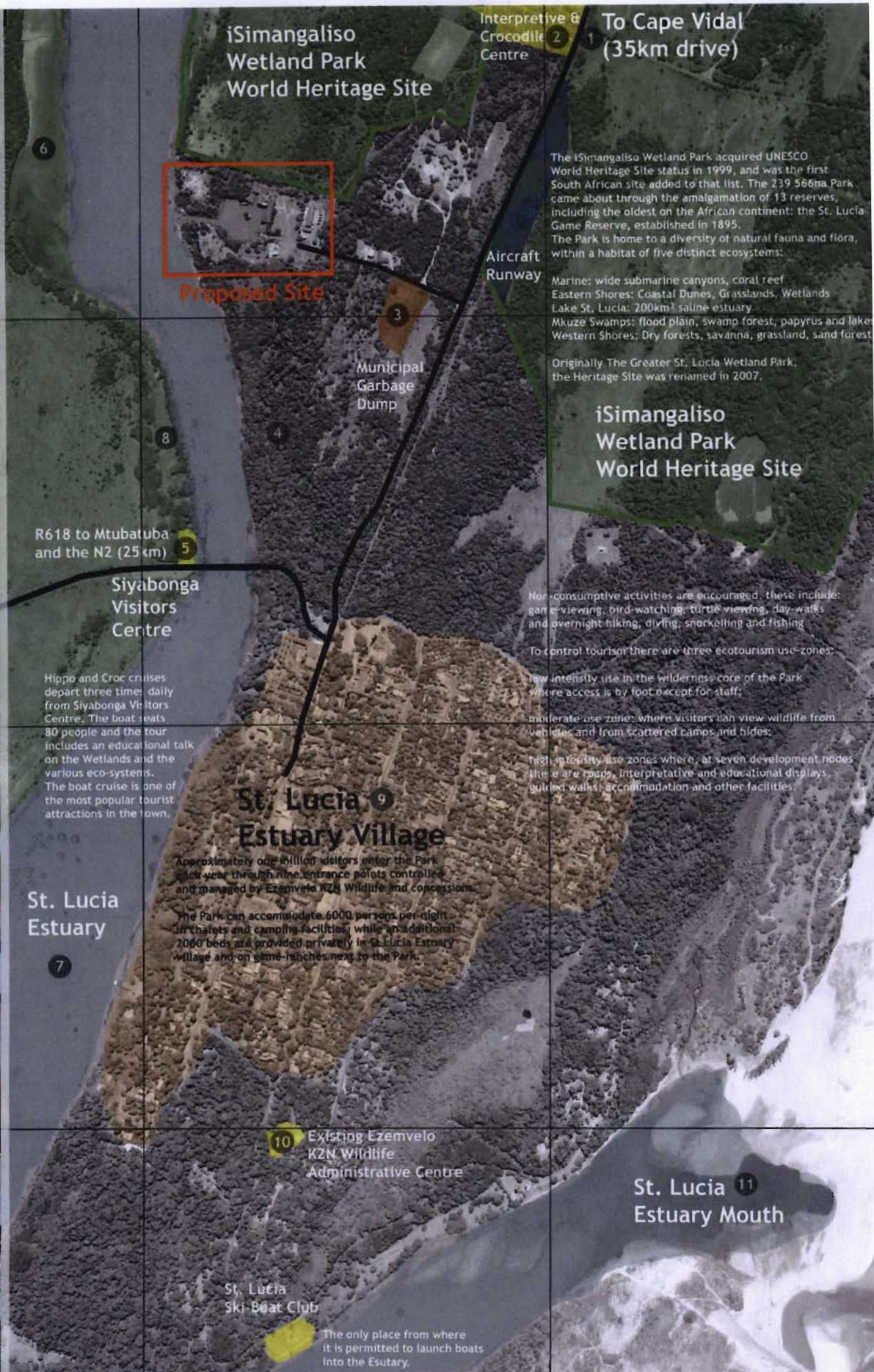
	Criteria	Indicative performance measure	Measured	Points
<b>EN 1</b>	<b>Water</b>			<b>4.8</b>
EN 1.1	Rainwater	% of water consumed sourced from rainwater harvested on site	80	0.8
EN 1.2	Water use	% of equipment (taps, washing machines, urinals showerheads) that are water efficient	100	1.0
EN 1.3	Runoff	% of carparking, paths, roads and roofs that have absorbant/permeable surfaces (grassed/thatched/looselaid paving/ absorbant materials)	100	1.0
EN 1.4	Greywater	% of water from washing/relatively clean processes recycled and reused	100	1.0
EN 1.5	Planting	% of planting (other than food gardens) on site with low / appropriate water requirements	100	1.0
<b>EN 2</b>	<b>Energy</b>			<b>4.9</b>
EN 2.1	Location	% of users who walk / use public transport to commute to the building	100	1.0
EN 2.2	Ventilation	% of building ventilation requirements met through natural / passive ventilation	95	1.0
EN 2.3	Heating & Cooling	% of occupied space which has passive environmental control (no or minimal energy consumption)	95	1.0
EN 2.4	Appliances & fittings	% of appliances / lighting fixtures that are classed as highly energy efficient ( ie energy star rating)	100	1.0
EN 2.5	Renewable energy	% of building energy requirements met from renewable sources	100	1.0
<b>EN 3</b>	<b>Waste</b>			<b>5.0</b>
EN 3.1	Toxic waste	% of toxic waste (batteries, ink cartridges, flourescent lamps) recycled	100	1.0
EN 3.2	Organic waste	% of organic waste recycled	100	1.0
EN 3.3	Inorganic waste	% of inorganic waste recycled.	100	1.0
EN 3.4	Sewerage	% of sewerage recycled on site	100	1.0
EN 3.5	Construction waste	% of damaged building materials / waste developed in construction recycled on site	100	1.0
<b>EN 4</b>	<b>Site</b>			<b>3.8</b>
EN 4.1	Brownfield site	% of proposed site already disturbed / brownfield (previously developed)	100	1.0
EN 4.2	Neighbouring buildings	No neighbouring buildings negatively affected (access to sunlight, daylight, ventilation) (100%)	100	1.0
EN 4.3	Vegetation	% of area of area covered in vegetation (include green roofs, internal planting) relative to whole site	80	0.8
EN 4.4	Food gardens	Food gardens on site (100%)	0	0.0
EN 4.5	Landscape inputs	% of landscape that does not require mechanical equipment (ie lawn cutting) and or artificial inputs such as weed killers and pesticides	100	1.0
<b>EN 5</b>	<b>Materials &amp; Components</b>			<b>3.5</b>
EN 5.1	Embodied energy	Materials with high embodied energy (aluminium,plastics) make up less than 1% of weight of building (100%)	90	0.9
EN 5.2	Material sources	% of materials and components by volume from grown sources (animal/plant)	100	1.0
EN 5.3	Ozone depletion	No materials and components used requiring ozone depleting processes (100%)	100	1.0
EN 5.4	Recyled / reuse	% of materials and components (by weight) reused / from recycled sources	10	0.1
EN 5.5	Construction process	Volume / area of site disturbed during construction less than 2X volume/area of new building (100%)	50	0.5

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## Appendix I. Design Drawings





**Site Analysis**  
1: 50 000 Aerial Photograph (2005)



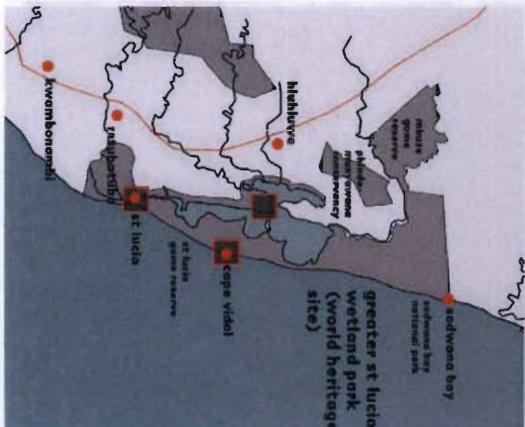
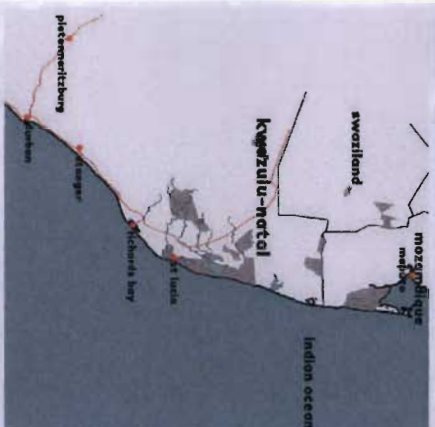
0m

500m

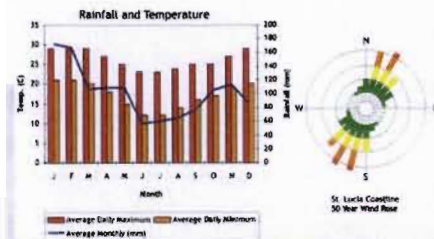
1500m

2000m









Proposed New Administrative Offices for iSimangaliso Wetland Park Authority

### Proposed Site:

A brownfield site surrounding a man-made harbour. Originally designed as a maintenance dock for the dredger boats used (until recently) to dredge out the St.. Lucia Estuary.

The Site contains 3 structures:

#### 1-Existing Boathouse:

Current used as a workshop.

Existing Infrastructure:

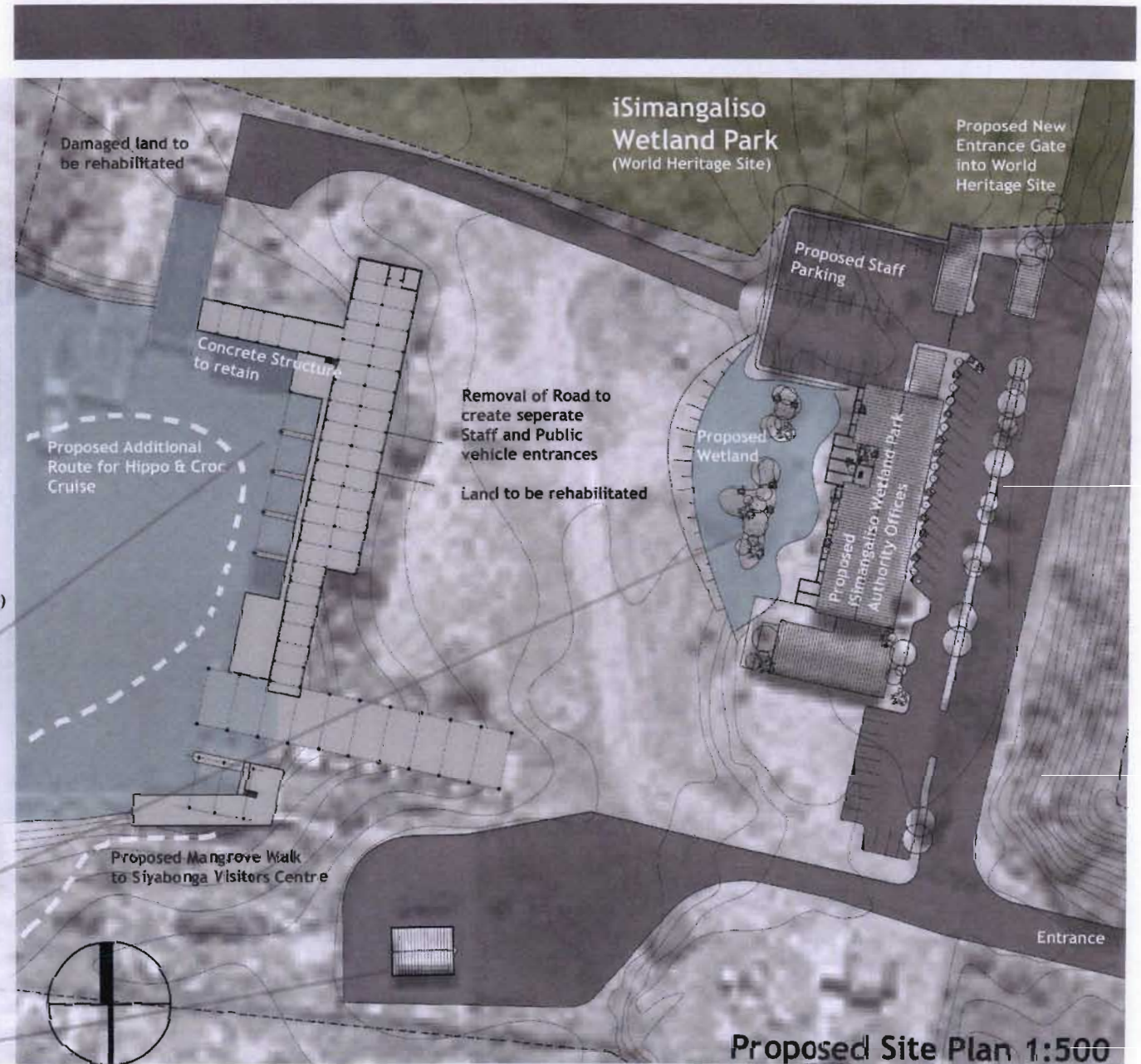
Concrete Stilt Structure  
Brick Infill  
Asbestos Roof  
Electricity Supply  
No Sewage pipes  
No Water Supply

#### 3-Warehouse & Admin. Office

Currently dilapidated

This structure will house the iSimangaliso Wetland Park Authorities offices, a small exhibition space and Park Museum.

#### 3-Dilapidated Petrol Station



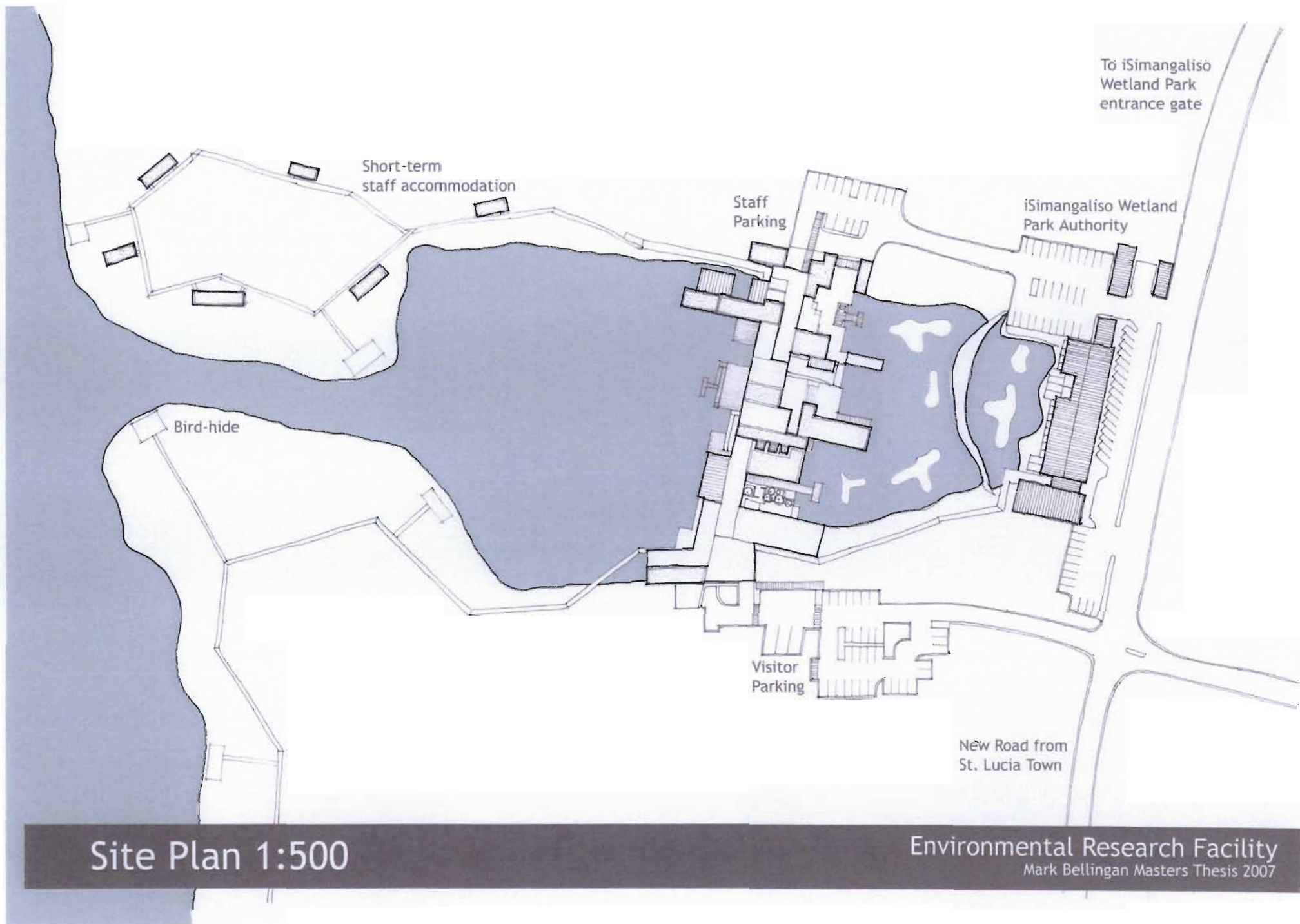


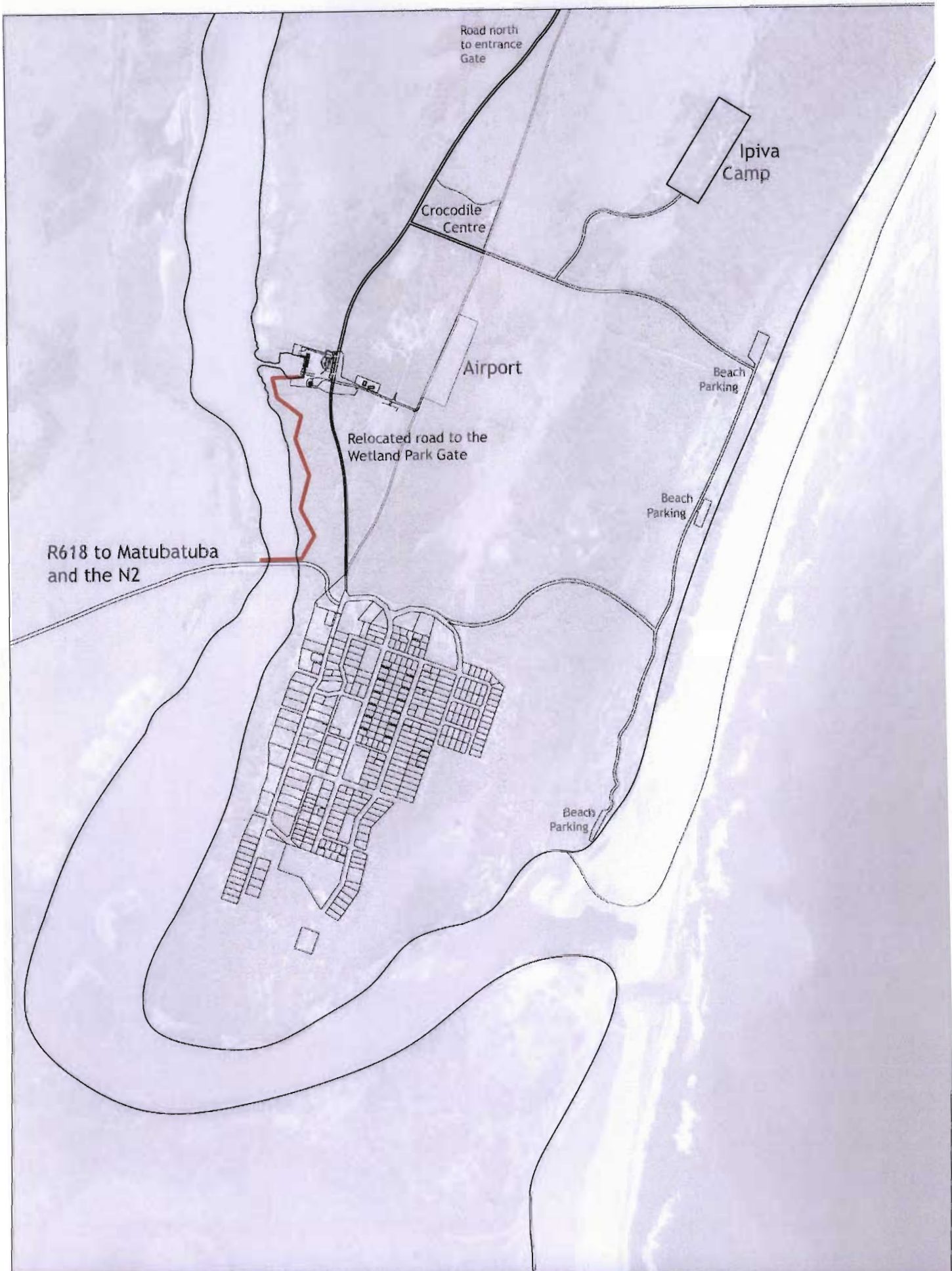




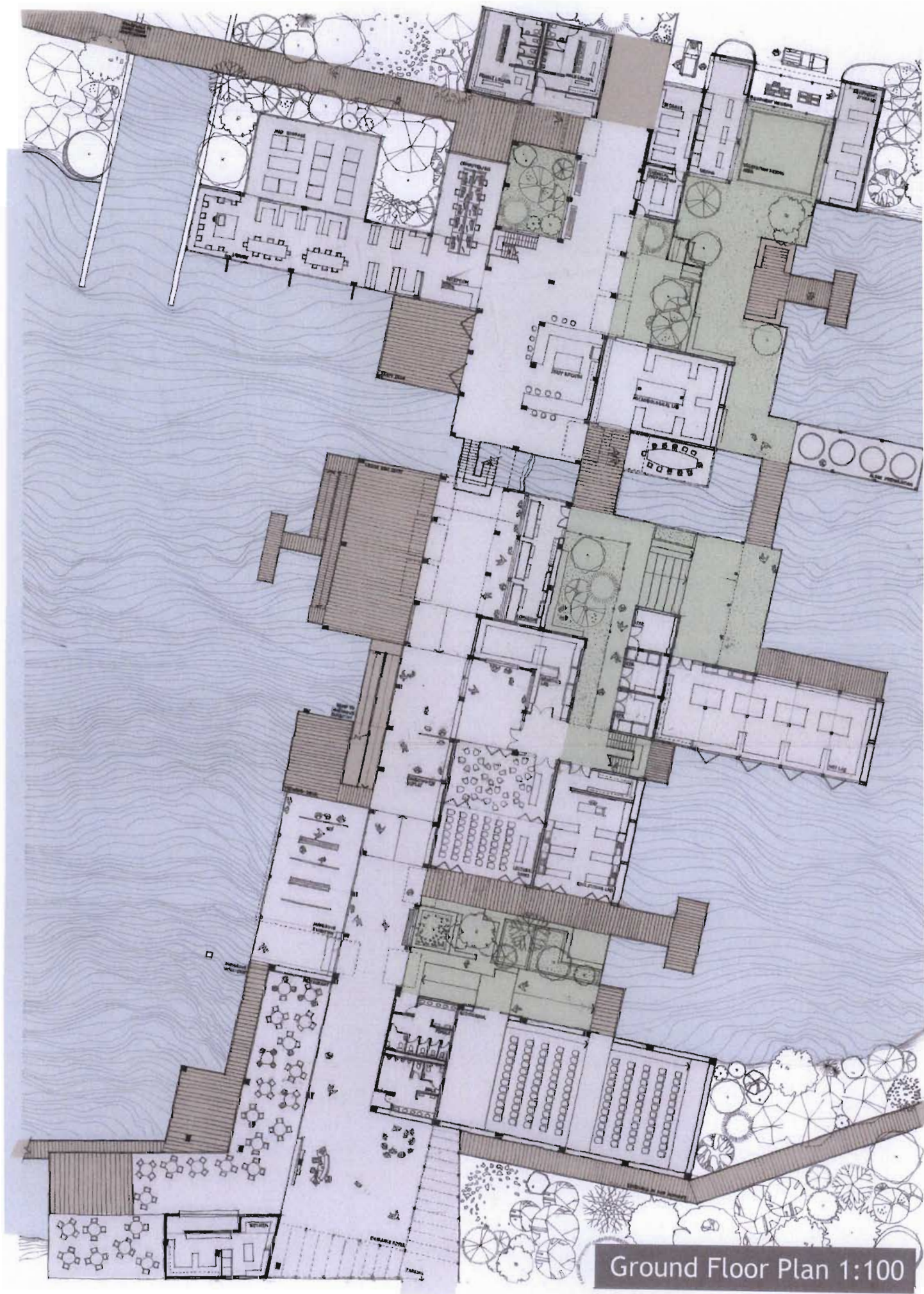












Ground Floor Plan 1:100





First Floor Plan 1:100

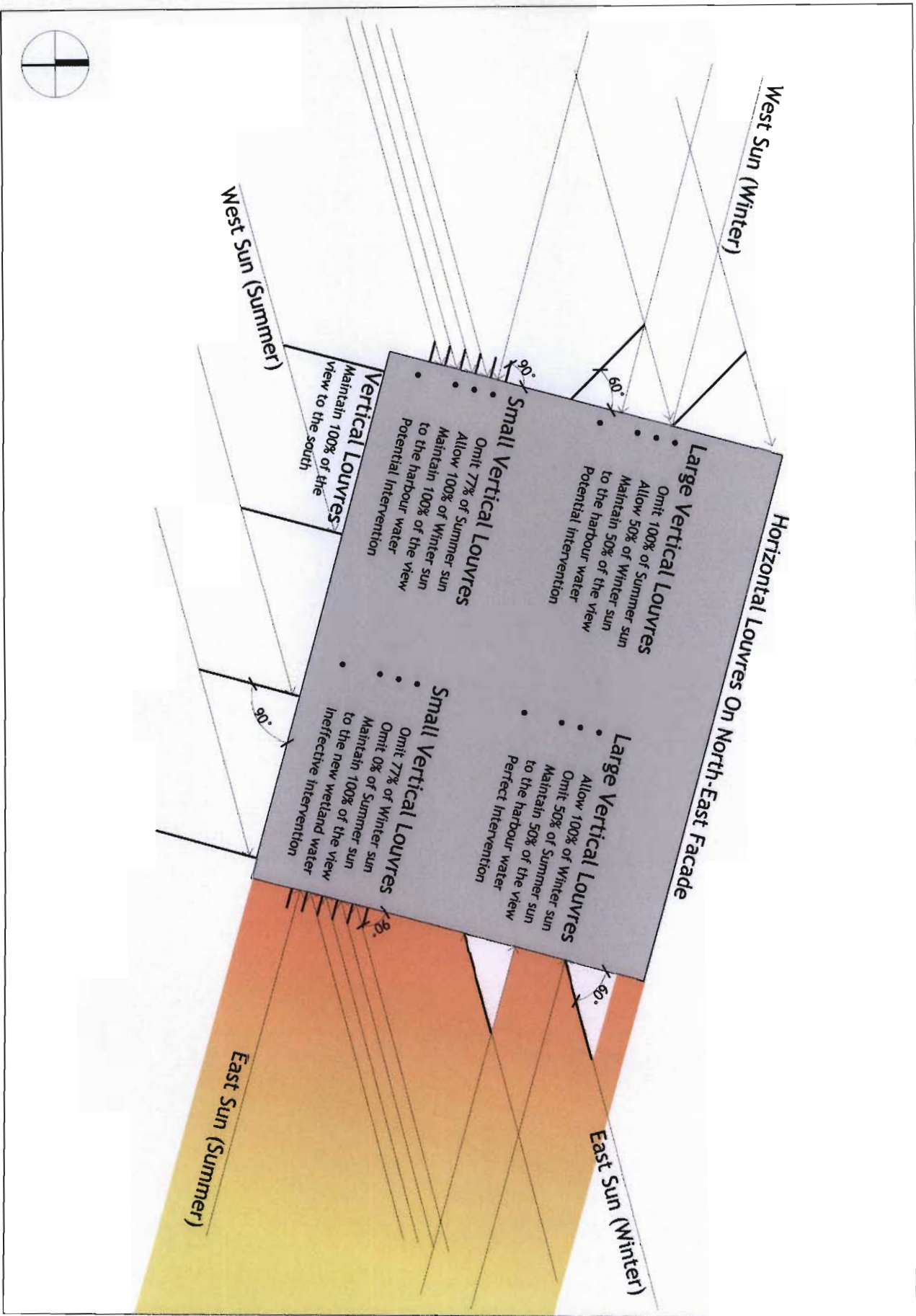
Environmental Research Facility  
Mark Beltingan Masters Thesis 2007

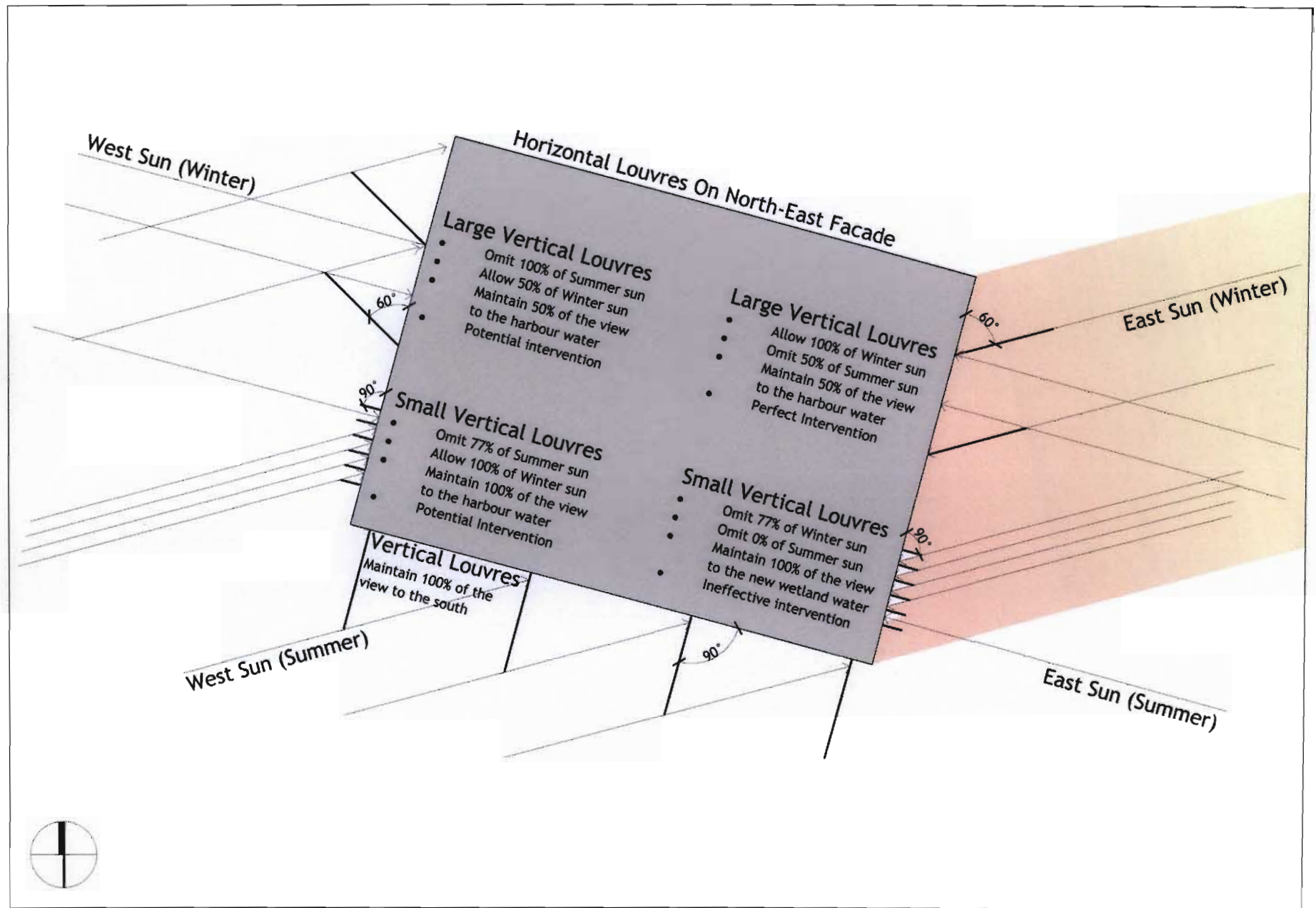




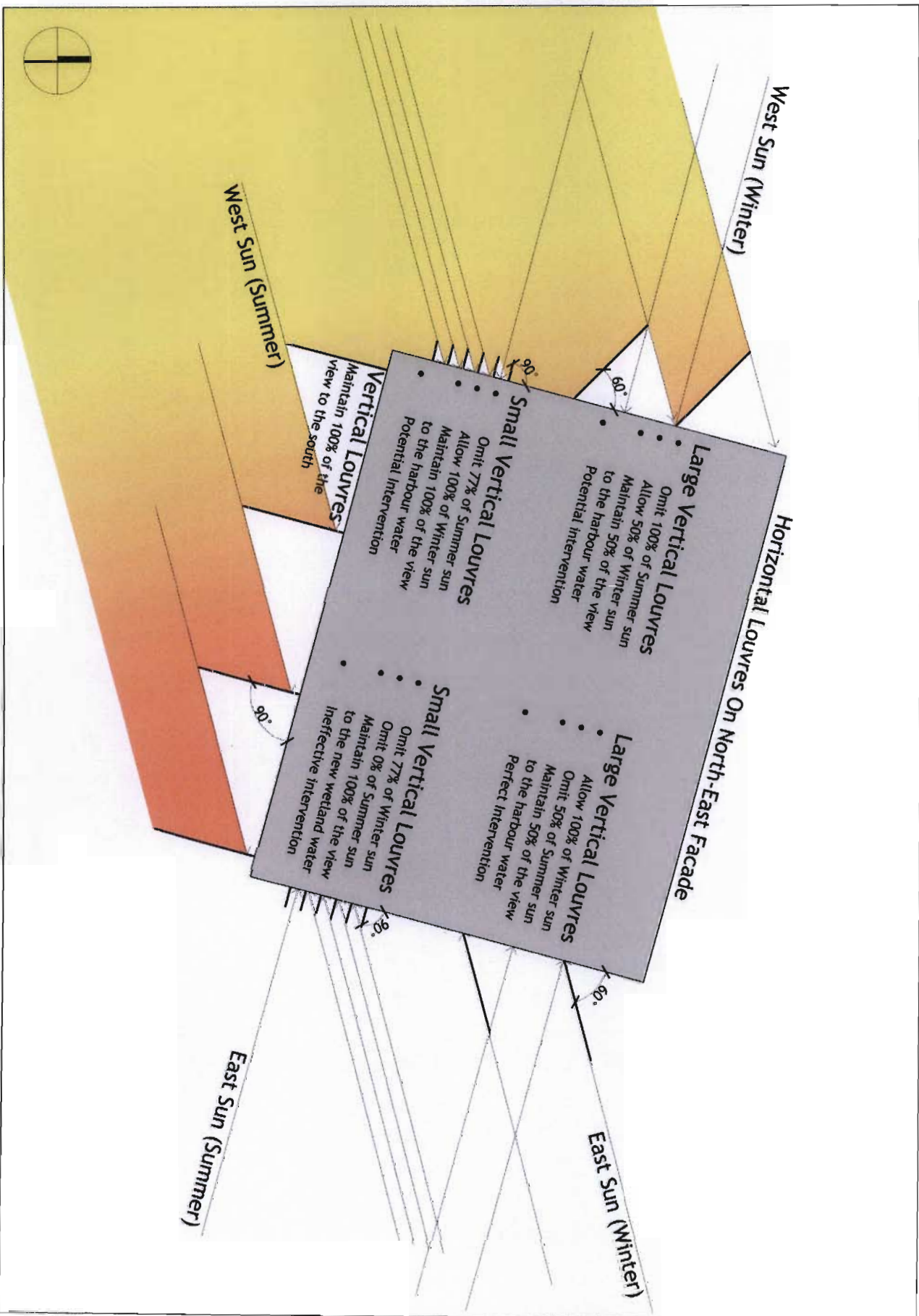


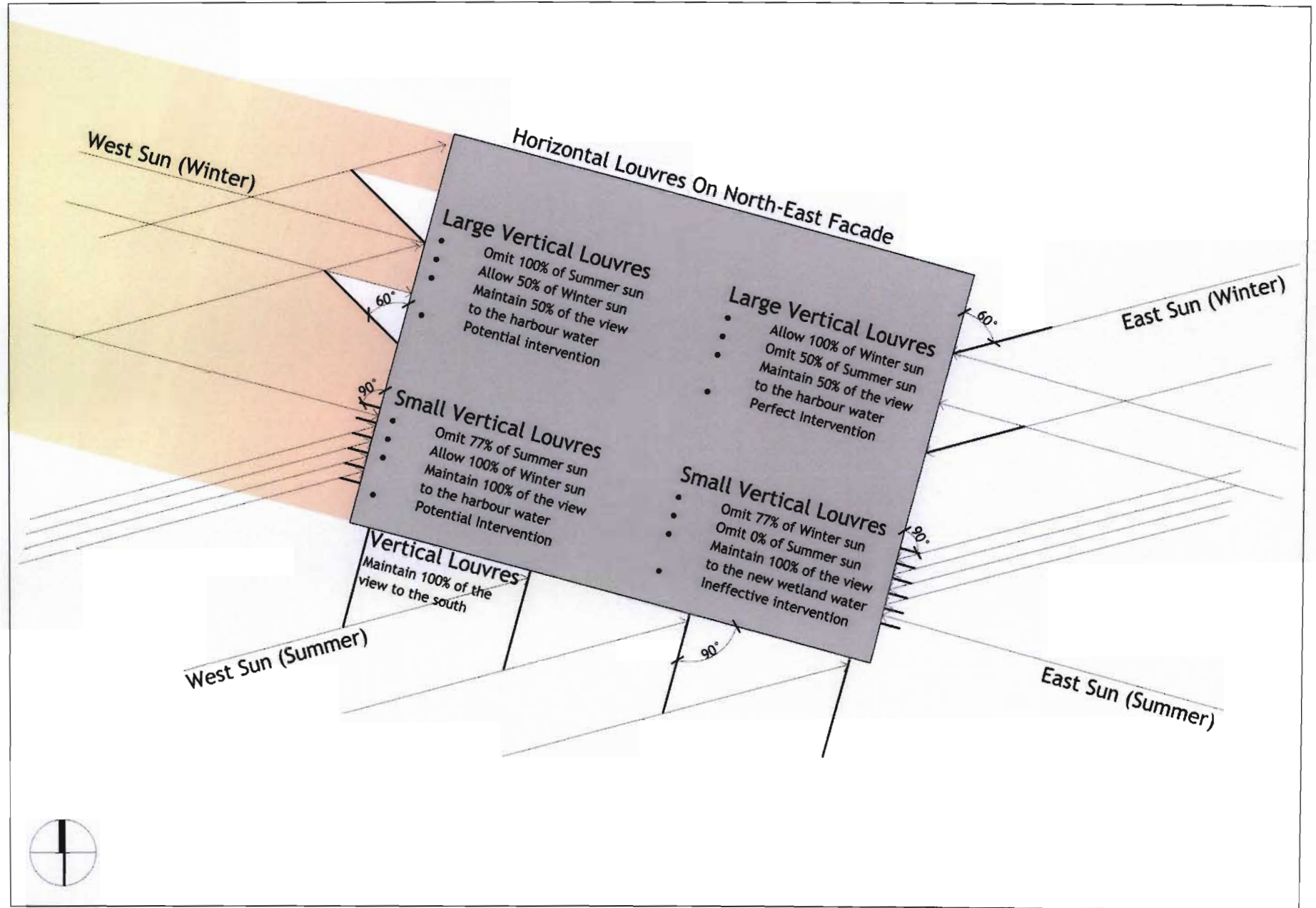














## APPENDIX 2. Sustainable Building Assessment Tool (SBAI) Report

### Building Performance - Social

	Criteria	Indicative performance measure	Measured	Points
<b>SO 1</b>	<b>Occupant Comfort</b>			<b>3.9</b>
SO 1.1	Daylighting	% of occupied spaces that are within distance 2H from window, where H is the height of the window or where there is good daylight from skylights	80	0.8
SO 1.2	Ventilation	% of occupied spaces have equivalent of opening window area equivalent to 10% of floor area or adequate mechanical system, with upolluted air source	90	0.9
SO 1.3	Noise	% of occupied spaces where external/internal/reverberation noise does not impinge on normal conversation (50dbA)	100	1.0
SO 1.5	Thermal comfort	Temperature of occupied space does not exceed 28 or go below 19°C for less than 5 days per year (100%)	20	0.2
SO 1.5	Views	% of occupied space that is 6m from an external window (not a skylight) with a view	100	1.0
<b>SO 2</b>	<b>Inclusive Environments</b>			<b>3.8</b>
SO 2.1	Public Transport	% of building (s) within 400m of disabled accessible public transport	100	1.0
SO 2.2	Information	High contrast, clear print signage in appropriate locations (100%)	100	1.0
SO 2.3	Space	% of occupied spaces that are accessible to ambulant disabled / wheelchair users	75	0.8
SO 2.4	Toilets	% of space with fully accessible toilets within 50m	80	0.8
SO 2.5	Fittings & Furniture	% of commonly used furniture and fittings (reception desk, kitchenette, auditorium) fully accessible	20	0.2
<b>SO 3</b>	<b>Access to Facilities</b>			<b>3.0</b>
SO 3.1	Children	All users can walk (100%) / use public transport (50%) to get to their childrens' schools and creches	50	0.5
SO 3.2	Banking	All users can walk (100%) / use public transport (50%) to get to banking facilities	50	0.5
SO 3.3	Retail	All users can walk (100%) / use public transport (50%) to get to food retail	50	0.5
SO 3.4	Communication	All users can walk (100%) / use public transport (50%) to get to communication facilities (post, telephone and internet)	50	0.5
SO 3.5	Exercise	All users can walk (100%) / use public transport (50%) to get to recreation / excersise facilities	100	1.0
<b>SO 4</b>	<b>Participation &amp; Control</b>			<b>3.9</b>
SO 4.1	Environmental control	% of occupied spaces able to control their thermal environment (adjacent to openable windows/thermal controls)	90	0.9
SO 4.2	Involvement	% of users actively involved in the design process (workshops / meetings with models / large format drawings)	100	1.0
SO 4.3	Social spaces	Social informal meeting spaces (parks / staff canteens / cafes) provided locally (within 400m) (100%)	100	1.0
SO 4.4	Sharing facilities	% of facilities shared with other users / organisations on a weekly basis (100%)	100	1.0
SO 4.5	User group	Active representative user group involved in the management of the building / facilities / local environment (100%)	0	0.0
<b>SO 5</b>	<b>Education, Health &amp; Safety</b>			<b>5.0</b>
SO 5.1	Education	Two percent or more space/facilities available for education (seminar rooms / reading / libraries) per occupied spaces (75%). Construction training provided on site (25%)	100	1.0
SO 5.2	Safety	All well used routes in and around building well lit (25%), all routes in and around buildings (25%) visually supervised, secure perimeter and access control (50%), No crime (100%)	100	1.0
SO 5.3	Awareness	% of users who can access information on health & safety issues (ie HIV/AIDS), training and employment opportunities easily (posters/personnel)	100	1.0
SO 5.4	Materials	All materials/components used have no negative effects on indoor air quality (100%)	100	1.0
SO 5.5	Accidents	Method in place for recording all occupational accidents and diseases and addressing these	100	1.0



## Building Performance - Economic

	Criteria	Indicative performance measure	Measured	Points
<b>EC 1</b>	<b>Local economy</b>			<b>4.8</b>
EC 1.1	Local contractors	% value of the building constructed by local (within 50km) small (employees<20) contractors	100	1.0
EC 1.2	Local materials	% of materials (sand, bricks, blocks, roofing material) sourced from within 50km	80	0.8
EC 1.3	Local components	% of components (windows, doors etc) made locally (in the country)	100	1.0
EC 1.4	Local furniture/fitings	% of furniture and fittings made locally (in the country)	100	1.0
EC 1.5	Maintenance	% of maintenance and repairs by value that can, and are undertaken, by local contractors (within 50km)	100	1.0
<b>EC 2</b>	<b>Efficiency</b>			<b>4.1</b>
EC 2.1	Capacity	% capacity of building used on a daily basis (actual number of users / number of users at full capacity*100)	40	0.4
EC 2.2	Occupancy	% of time building is occupied and used (actual average number of hours used / all potential hours building could be used (24) *100)	70	0.7
EC 2.3	Space per occupant	Space provision per user not more than 10% above national average for building type (100%)	100	1.0
EC 2.4	Communication	Site/building has access to internet and telephone (100%), telephone only (50%)	100	1.0
EC 2.5	Material & Components	Building design coordinated with material / component sizes in order to minimise wastage. Walls (50%), Roof and floors (50%)	100	1.0
<b>EC 3</b>	<b>Adaptability</b>			<b>4.8</b>
EC 3.1	Vertical heights	% of spaces that have a floor to ceiling height of 3000mm or more	75	0.8
EC 3.2	External space	Design facilitates flexible external space use (100%)	100	1.0
EC 3.3	Internal partition	Non loadbearing internal partitions that can be easily adapted (loose partitioning (100%), studwall (50%), masonry (25%)	100	1.0
EC 3.4	Modular planning	Building with modular structure, envelope (fenestration) & services allowing easy internal adaptaptation (100%)	100	1.0
EC 3.5	Furniture	Modular, limited variety furniture - can be easily configured for different uses (100%)	100	1.0
<b>EC 4</b>	<b>Ongoing costs</b>			<b>4.6</b>
EC 4.1	Induction	All new users receive induction training on building systems (50%), Detailed building user manual (50%)	100	1.0
EC4.2	Consumption & waste	% of users exposed on a monthly basis to building performance figures (water (25%), electricity (25%), waste (25%), accidents (25%)	100	1.0
EC 4.2	Metering	Easily monitored localised metering system for water (25%) and energy (75%)	100	1.0
EC4.3	Maintenance & Cleaning	Building can be cleaned and maintained easily and safely using simple equipment and local non-hazardous materials (100%)	80	0.8
SO 4.5	Procurement	% of value of all materials/equipment used in the building on a daily basis supplied by local (within the country) manufacturers	80	0.8
<b>EC 5</b>	<b>Capital Costs</b>			<b>4.5</b>
EC 5.1	Local need	Five percent capital cost allocated to address urgent local issues (employment, training etc) during construction process (100%)	100	1.0
EC5.2	Procurement	Tender / construction packaged to ensure involvement of small local contractors/manufacturers (100%)	100	1.0
EC 5.3	Building costs	Capital cost not more than fifteen % above national average building costs for the building type (100%)	50	0.5
EC5.4	Sustainable technology	3% or more of capital costs allocated to new sustainable/indigenous technology (100%)	100	1.0
EC 5.5	Existing Buildings	Existing buildings reused (100%)	100	1.0



## Building Performance - Environmental

	Criteria	Indicative performance measure	Measured	Points
<b>EN 1</b>	<b>Water</b>			<b>4.8</b>
EN 1.1	Rainwater	% of water consumed sourced from rainwater harvested on site	80	0.8
EN 1.2	Water use	% of equipment (taps, washing machines, urinals showerheads) that are water efficient	100	1.0
EN 1.3	Runoff	% of carparking, paths, roads and roofs that have absorbant/permeable surfaces (grassed/thatched/looselaid paving/ absorbant materials)	100	1.0
EN 1.4	Greywater	% of water from washing/relatively clean processes recycled and reused	100	1.0
EN 1.5	Planting	% of planting (other than food gardens) on site with low / appropriate water requirements	100	1.0
<b>EN 2</b>	<b>Energy</b>			<b>4.9</b>
EN 2.1	Location	% of users who walk / use public transport to commute to the building	100	1.0
EN 2.2	Ventilation	% of building ventilation requirements met through natural / passive ventilation	95	1.0
EN 2.3	Heating & Cooling	% of occupied space which has passive environmental control (no or minimal energy consumption)	95	1.0
EN 2.4	Appliances & fittings	% of appliances / lighting fixtures that are classed as highly energy efficient ( ie energy star rating)	100	1.0
EN 2.5	Renewable energy	% of building energy requirements met from renewable sources	100	1.0
<b>EN 3</b>	<b>Waste</b>			<b>5.0</b>
EN 3.1	Toxic waste	% of toxic waste (batteries, ink cartridges, flourescent lamps) recycled	100	1.0
EN 3.2	Organic waste	% of organic waste recycled	100	1.0
EN 3.3	Inorganic waste	% of inorganic waste recycled.	100	1.0
EN 3.4	Sewerage	% of sewerage recycled on site	100	1.0
EN 3.5	Construction waste	% of damaged building materials / waste developed in construction recycled on site	100	1.0
<b>EN 4</b>	<b>Site</b>			<b>3.8</b>
EN 4.1	Brownfield site	% of proposed site already disturbed / brownfield (previously developed)	100	1.0
EN 4.2	Neighbouring buildings	No neighbouring buildings negatively affected (access to sunlight, daylight, ventilation) (100%)	100	1.0
EN 4.3	Vegetation	% of area of area covered in vegetation (include green roofs, internal planting) relative to whole site	80	0.8
EN 4.4	Food gardens	Food gardens on site (100%)	0	0.0
EN 4.5	Landscape inputs	% of landscape that does not require mechanical equipment (ie lawn cutting) and or artificial inputs such as weed killers and pesticides	100	1.0
<b>EN 5</b>	<b>Materials &amp; Components</b>			<b>3.5</b>
EN 5.1	Embodied energy	Materials with high embodied energy (aluminium,plastics) make up less than 1% of weight of building (100%)	90	0.9
EN 5.2	Material sources	% of materials and components by volume from grown sources (animal/plant)	100	1.0
EN 5.3	Ozone depletion	No materials and components used requiring ozone depleting processes (100%)	100	1.0
EN 5.4	Recyled / reuse	% of materials and components (by weight) reused / from recycled sources	10	0.1
EN 5.5	Construction process	Volume / area of site disturbed during construction less than 2X volume/area of new building (100%)	50	0.5