CULTIVATION OF PLANTS IN RESTORED URBAN WETLANDS FOR INCOME GENERATION IN LOCAL COMMUNITIES

Abbott Grobicki (Pty) Ltd

WRC Report No. 1054/1/02

Water Research Commission

NOTE

The "**new green**" database referred to and associated with this report is available as downloadable software from the Water Research Commission's website at: **http://www.wrc.org.za/wrcsoftware/default.htm** The steps as described in the report for a CD installation, will apply.

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WRC REPORT NO K5/1054. ORIGINAL PROJECT TITLE "CULTIVATION OF HIGH VALUE AQUATIC PLANTS IN RESTORED URBAN WETLANDS FOR INCOME GENERATION IN LOCAL COMMUNITIES"

EXECUTIVE SUMMARY

INTRODUCTION AND PROJECT AIMS

Wetlands in urban environments are under great pressure due to competition for land resulting from poverty, inadequate infrastructure and services and particularly a lack of housing. An important function of urban catchment management is to preserve and restore urban wetlands where possible. However, under South African conditions, the pressing needs of people for jobs and housing often take precedence over environmental considerations. Hence projects which can provide tangible benefits from wetlands to the local community are set to become an important focus for responsible urban catchment management. Urban wetland conservation and restoration would be encouraged if wetlands could be turned into sustainable economic assets, by the cultivation of economically valuable plants in wetlands.

As a result of these considerations the Water Research Commission (WRC) initiated this project on the cultivation of aquatic plants in restored urban wetlands for income generation in local communities.

The original vision for the project was to carry out a more detailed monitoring of actual wetland projects, and in particular to examine any such projects being carried out within the urban stormwater systems of South African cities. The project proposal accepted by the Water Research Commission did not include the development of a database of wetland plants. Within the first year of project research, however, the following constraints emerged:

1. There were no suitable wetland projects being undertaken in the South African stormwater systems examined, such as there are in cities in Holland and Australia, for instance;

2. Existing wetland projects in South Africa tended to be small and based in rural areas;

3. The establishment of the Cape Town wetland pilot project (Inyibiba) which was linked to this project was slow, and the prognosis for the success of the project was poor, given the unsuitable site location and the low level of funding. Furthermore the project was not located within the stormwater system.

In order to compensate for these drawbacks, the proposal was made to the WRC to develop the database of wetland plants with potential economic value as an additional deliverable from the project.

The aims of the project were therefore:

1. To create a stand-alone database with information on economically valuable plants appropriate for cultivation in urban wetlands;
2. To evaluate projects and to develop guidelines to select wetlands and optimise their design for urban agricultural activities and wetland rehabilitation;
3. To develop methods to turn urban wetlands into economic assets though the cultivation of high-value plants;
4. To evaluate the improvement in water quality in terms of litter control and microbial and nutrient loading as a result of urban wetland horticulture;
5. To assess the ecological benefits of urban wetland horticulture schemes;
6. To assess the economic benefits of urban wetland horticulture schemes to communities and to local authorities, and to evaluate the sustainability of such schemes;
7. To develop training procedures to assist communities and local authorities in setting up and maintaining wetland horticulture schemes.

Accordingly, this project has resulted in the following outputs:

1. Part A, which consists of the Project Guidelines and Decision Support for selecting wetlands for cultivation.
2. Part B, which reports on the results of the Inyibiba pilot project which was implemented to test the feasibility and effects of cultivation in an urban wetland.
3. The new green database of wetland plants with economic potential. Part C of this report is the User Manual for the new green database. new green itself is a stand-alone Microsoft Access database.

PART A

PROJECT GUIDELINES AND DECISION SUPPORT

Part A consist of Project Guidelines and Decision Support for assessing wetland sites for their suitability for cultivation of economically valuable plants, and for planning cultivation or other economically productive projects in wetlands. The motivation behind producing the Guidelines is to facilitate the conservation and restoration of wetlands, by promoting their economically productive and sustainable use through cultivation of suitable plant species.

The Guidelines cover the planning and implementation phases of wetland cultivation projects, developed during the course of the Inyibiba pilot project to cultivate an altered urban wetland. The Guidelines are generically applicable whenever cultivation in a wetland is contemplated. Thus they are applicable to project planning and implementation in urban, peri-urban or rural wetlands.

The first stage of planning entails a site assessment that will enable the user to identify whether the wetland under consideration is pristine or whether it has been altered already. The Guidelines differentiate between three types of wetlands, and the use to which a wetland may be put will depend on the type of wetland, and the prevailing legislation and local authority regulations.

1. Altered wetlands: The Guidelines and `new green` database deal mostly with plants that can be cultivated in already altered and degraded wetlands, where planting will enhance the ecological and hydrological functioning of the wetland.

2. Pristine wetlands: It is recommended that pristine wetlands be used non-invasively or with minimal invasion (e.g. for recreation).

3. Constructed wetlands: This type of wetland can be constructed at a wastewater or stormwater discharge point, in order to prevent the release of nutrients and other pollutants into the environment. Constructed wetlands have been shown to be an efficient and economical means of purifying wastewater or stormwater, while at the same time displaying ecological and hydrological functionality within a stormwater system.

Once a wetland has been classified, the Guidelines outline the further planning steps for deciding on the appropriate cultivation or other use for the wetland. The important factors that should be taken into consideration during each step of planning and implementation of the project are also identified.

The Guidelines are ideally used together with the database new green, which is discussed in Part C, and which is a collection of data on wetland plants with economic potential along with their respective growing conditions.

PART B

IMPLEMENTATION OF WETLAND CULTIVATION PROJECTS

This part of the report discusses the planning and implementation of a pilot wetland cultivation project, the Inyibiba Pilot Project, which tested the ability of wetland cultivation to turn an urban wetland into an economic asset. Three other wetland cultivation projects under way in South Africa are also discussed and compared.

The Inyibiba Pilot Project

The Inyibiba Pilot Project was used to develop methods for turning wetlands into economic assets, and the ecological, economic and social effects of the project were monitored.

The planning and budget of the Inyibiba Pilot Project was based on growing arum lily plants for their flowers, which were to be sold to the export market.

The urban wetland site authorized for use by the Inyibiba Pilot Project, the Greenpoint site in Khayelitsha, Cape Town, was the least suitable of six potential wetland cultivation sites evaluated in the Cape Town area. Nevertheless a decision was taken to proceed with the Inyibiba Pilot Project on this site, taking it on as a challenge while understanding the many constraints which could hamper the success of the project.

- The Inyibiba Pilot Project was not funded by the WRC, although it was initiated as a means of addressing the aims of this WRC project on wetland cultivation. Thus the planning and progress of both projects needed to be synchronised as closely as possible.

- The pressure of having two separate projects, the WRC project and the Inyibiba Pilot Project, and trying to synchronise their progress required compromises to be made that adversely affected the Inyibiba Pilot Project in terms of planning and monitoring time frames, and eventually plant productivity. The project started before obtaining all the necessary authorisations, and had to adapt to the constraints as it went along.

- The site was not ideal, as predicted. It was not wet enough, and was wind exposed, placing stress on the plants.

- The business plan set ambitious goals of production, particularly given the other contraints.
- Limited funding was available, not enough to achieve the goals of the business plan.
- The time and funding constraints compromised the public consultation and subsequent hiring of staff. Funding constraints eventually led to loss of key staff, affecting project implementation.
- The speed of implementation contributed to the various stakeholders neglecting to adequately articulate their roles and responsibilities. For this reason the interface between this WRC Project and the Inyibiba Pilot Project was not always clear to all parties.
- A shortcoming of the planning was that no contingency plans were put in place to cope with the possibility of the site becoming dry and requiring irrigation.

COMPARISON WITH OTHER WETLAND CULTIVATION PROJECTS

The Inyibiba Pilot Project had goals to produce flowers for export within the first season, and had established itself on a relatively large area immediately, thereby stretching the limited budget. A comparative survey of three other wetland cultivation projects in South Africa revealed that they set more conservative goals, to progress slowly while developing skills and learning from experience, to cultivate a relatively small area initially, and to sell their products on the local domestic market.

KEY FINDINGS

Planning

- The planning phase should not be rushed, but should allow time for comprehensive negotiations, and for all necessary legal and other requirements to be met before project implementation.
- In planning a project, the business goals should be kept modest to begin with, so that a small budget will suffice to support capacity building while experience is gained and productivity established. Once skills and productivity are established and the project has become financially sustainable, goals can be further expanded.

- The business plan must allow for all foreseeable eventualities and worst-case scenarios, such as periods of drought or disease which may interfere with productivity. Contingency plans should be made to deal with these events.

- Staff continuity is important, and it is important to budget to retain key staff.

- Care must be exercised in selecting plants suited to local soil, water and climatic conditions. This will reduce the need for supplementary management measures such as irrigation or pesticide application.

- Sufficient funding and time must be allowed for the public participation processes to be comprehensive and to ensure that all concerns have been dealt with to the satisfaction of all parties.

- The lines of authority and the roles and responsibilities of all parties should be carefully defined during the planning phase.

Implementation

- It is important to have a manager who is on site each day, and who is able to train staff in proper procedures.

- It may be necessary to manage the nutrient status of the soil to maximise crop productivity.

- Monitoring of surface and groundwater is necessary to predict changes that might occur to the site when the river rises and floods the wetland, and to select a suitable (least polluted) water source to use for irrigation.

- A long-term soil and water monitoring programme is essential to reveal any significant changes associated with cultivation, and allow steps to be taken to manage the changes.

- Staff and consumers must be protected from polluted water and soil, and suitable measures taken to ensure the safety of all personnel and consumers when cultivating in an area with high levels of faecal contamination.

Ecological effects. The immediate ecological benefits of wetland cultivation consisted of cleaning the area of litter, human waste, and alien invasive plants. Cultivation and management of the area prevents new dumping, alien plant growth, and grazing and trampling by domestic stock, which preserves the wetland area from further degradation.

Economic effects. Although the Inyibiba Pilot Project did not become economically sustainable in its 12 months of operation, in that time it provided employment and wages to members of a community with high levels of unemployment. It also established an area of 1 hectare containing over 36 000 arum lily plants which can be harvested for flowers in future seasons.

Social effects. Staff were employed from the local community and trained in all aspects of planting, growing and harvesting arum lilies.

Setting up of the Inyibiba Pilot Project contributed to the capacity of the local authorities, particularly the Tygerberg Administration and Cape Metropolitan Council, to set up and administer projects such as this.

CONCLUSIONS

- It is possible to cultivate economically valuable plants at high density in an altered urban wetland, and if growing conditions are optimized then it should be possible for such a project to become a sustainable source of employment and wetland protection.
- Wetland cultivation projects can provide at the very least the ecological benefit of preserving the wetland from further degradation or from settlement, and create an opportunity to rehabilitate the wetland in the future.
- Cultivation of economically valuable plants creates a source of employment and skills development for communities near the wetland. Wetland cultivation projects have the potential to become a focus for other business and entrepreneurial activities in the surrounding communities.
- Thus cultivation of economically valuable plants in wetlands can provide the economic incentives needed to ensure the continued preservation and rehabilitation of wetlands.

RECOMMENDATIONS

- As a means of preserving urban wetlands and maintaining their environmental services, steps to create economic value out of urban wetlands should be actively pursued.
- The Project Guidelines and Decision Support (Volume 1 of the HVAP project) should be used in determining the suitability of wetland sites for cultivation.

- The New Green plant database should be used to identify a suitable mix of plant species for growing on site.

- Cultivation practices should be promoted which rehabilitate wetland function.

- Wetland cultivation should ideally incorporate plants (in addition to the primary crop) which can fulfil multiple functions. However the environmental management requirements for wetlands will need to be relaxed where possible to allow for cultivation of a number of useful plant species, some of which may not occur naturally in the wetland.

- The cultivation site must be actively monitored over the long-term, to detect and manage the environmental impacts of the project.

- A comprehensive process of public consultation and participation should be initiated early in the planning process, before plans have hardened. It is important also that consultation takes place with all interested individuals in the community, and not merely with their representatives.

- The public participation process should be conducted by independent persons who are expert in conducting the participation and negotiation process.

- A relaxation of the stringent standards of environmental protection imposed by the authorities will be required if altered wetlands are to become economically sustainable assets.

- Simple and low-cost solutions to irrigation, fertiliser and pesticide requirements should be used where possible.

PART C

NEW GREEN USER MANUAL

Part C is composed of two sections, the first section giving background information about new green, and the second section being the operating manual for new green. The latter includes technical information on opening and navigating around the database, as well as on adding your own information and data, and creating your own queries for searching the database.

The database `new green` is a collection of information on wetland plants which due to their usefulness have a potential economic value. The plants are listed by species name, by category of use, and by geographical area. The categories of use to which plants have been assigned are as follows: ornamental, utilitarian, essential oils, medicinal, food, water purification. The plants are linked to specific geographical regions of South Africa, where they may grow.

The `new green` database should ideally be used together with Part A, the Project Guidelines and Decision Support. Used together, they will assist in deciding on whether or not to cultivate within a particular wetland, and in the selection of plants which are suited for cultivation in that wetland.

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PART A

PROJECT GUIDELINES AND DECISION SUPPORT FOR SUSTAINABLE USE, CULTIVATION AND CONSTRUCTION OF WETLANDS

PART A

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1
INTRODUCTION

1.1 WETLAND DEFINITION

The Convention on Wetlands of International Importance Especially as Waterfowl Habitat 1971 (Ramsar Convention) defines wetlands as follows:

> *"areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters"*
>
> (Article 1.1, Ramsar Convention)

1.2 PRESENT STATUS OF WETLANDS IN SOUTH AFRICA

Wetlands have been identified as the third most important life support system on Earth (The World Conservation Strategy, IUCN, 1980). Because of South Africa's narrow coastal strip, there are few lowlands and associated wetlands. Yet over half of the few wetlands of South Africa have been already destroyed (Breen and Begg, 1989). Because wetlands act as vast sponges to hold water run-off, wetland loss is of serious concern for a country which is essentially arid (the average annual rainfall of ~500 mm is ~350 mm below the world average, (Cowan, 1995)). In consequence of wetland and general water mismanagement, it has been estimated that SA will run short of water by the year 2030 (Lindley, 2001).

1.3 PRESENT STATUS OF NATIONAL POLICY ON WETLAND USE

Considering the present rate of wetland loss in SA, it is crucial to have a national policy to guide management and conservation of remaining pristine wetlands, and the sustainable use of other types of wetlands. Broad objectives of the Ramsar Convention include that each contracting party (of which SA is one) should stem loss of wetlands and promote wise use of wetlands (Cowan, 1995).

The Sub-directorate Ecosystems of the Department of Environmental Affairs and Tourism is responsible for the South African Wetlands Conservation Programme. One of their eight sub-programmes include forming a national policy on wetlands. The Ramsar Convention will be accepted into South African legislation through the Wetland Conservation Bill after amendments. Another important subprogramme is that on interdepartmental co-ordination where the state departments most obviously involved would be the Department of Water Affairs and Forestry, the Department of Environmental Affairs and Tourism, and the Department of Agriculture.

1.4 EXISTING LEGISLATION AND GUIDELINES ON WETLAND USE

Although a broad variety of wetlands exist in South Africa, and South Africa has acknowledged the importance of wetlands by acceding to the Ramsar Convention, its legislation is not comprehensive, and a dedicated wetlands protection Act is lacking.

The National Water Act 36 of 1998 makes specific provision for the protection of wetlands. The Conservation of Agricultural Resources Act 43 of 1983 also covers wetlands, but this Act does not apply to land situated in any urban area. It is also arguable that the Sea Shore Act 21 of 1935 is applicable in the case of those wetlands in coastal waters, such as tidal lagoons and estuaries. The Environment Conservation Act 73 of 1989 and Regulations are relevant in the case of 'reclamation' of land in wetlands and below the high-water mark in coastal waters. A national policy on wetlands is in preparation.

To date, the following informal guidelines exist on wetland management in South Africa:

- **WETLAND-USE** - a wetland management decision support system exist which assists agricultural and nature conservation extension workers by providing advice for agricultural land-use (cropping, grazing, burning) in wetlands (Kotze *et al.*, 1994). The system helps identify what was defined as acceptable land-use for a particular site based mostly on soil characteristics as an indication of wetland zone (open water, marsh, wet meadow and wet grassland). The system is ideally consulted in conjunction with a document on land -use impacts on wetlands (Kotze and Breen, 1994). Recommendations on burning may not be in keeping with a future national policy (see Section 4).

- **WETLAND FIX** – a publication of field guides emerging from four years of the Rennies Wetlands Project, and discussions with farmers and agriculture/conservation extension

officers in KwaZulu-Natal, the Eastern Free State and Mpumalanga. Wetland Fix is South Africa's first illustrated set of field guides on the assessment, management and rehabilitation of wetlands. Reports on rehabilitation and wise use of wetlands are also presented (http://www.wetland.org.za/). The series includes:

- Part 1: Introduction and wetland assessment.
- Part 2: Wetland burning and grazing guide.
- Part 3: Streambank stabilization and channel plug development.
- Part 4: Indigenous plants suitable for rehabilitation.
- Part 5: Spring protection guide.
- Part 6: Alien plant control guide.

It should be remembered that the guides mentioned above, as well as these WRC project Guidelines, are merely intended to direct the user towards the appropriate decision for the particular wetland in question. No one guide is a replacement for a multi-face ted, site-specific approach which entails gathering information, using the appropriate guide(s), consulting people involved and applying the results to the local situation.

Although there is no national policy on wetland use as yet, it is clear that any cultivation -use of wetlands should be limited to altered or constructed wetlands, be sustainable, and maintain or restore the functionality, i.e. ecology and hydrology, thereof.

1.5 WISE USE OF WETLANDS: SITE ASSESSMENT AND DESIGN

Wetlands have been used actively for water purification, for the cultivation of aquatic and semi-aquatic plants (medicinal, building and textile materials) and for recreation, including tourism. Wetlands are in any case a source of food (fish, shellfish, crustaceans and plants), water (domestic, agricultural and industrial) and recreation for people.

In these Guidelines, a clear distinction is made between the appropriate uses of altered, pristine and constructed wetlands. The Guidelines help the user to identify the type of wetland in question. From there, practical guidelines are given mostly on cultivation in altered wetlands. Regarding pristine wetlands, this guide recommends non-invasive use. On the rehabilitation of wetlands and construction of wetlands, there is a wealth of detailed literature and the reader is

referred to this. While the content of this document is mostly on cultivation in altered wetlands, current opinion and policy on use of pristine wetlands and reference to sources for constructing and rehabilitating wetlands are included for completeness.

Regarding cultivation in altered wetlands, the key to proper wetland site assessment and design is through obtaining the relevant information and making the necessary on-site observations and measurements. Ways of finding this information are given in these guidelines. In addition there is a database of wetland plants with economic potential, new green, which is designed to be used together with these guidelines. The new green database is available on the world-wide web at the site: www.wrc.org\newgreen.

2
HOW TO USE THIS GUIDE

This guide is to be used together with the new green database on wetland plants with economic potential (see Main Form in Figure 1), and with the flow diagram in Figure 2. Each section of this guide is essentially an explanation of the relevant step shown in the flow diagram. The steps in the flow diagram cross-refer to the relevant section of this guide.

Although details are given for plant cultivation methods, it is stressed again that cultivation is only appropriate in altered wetlands where such cultivation would be rehabilitative, that is by cultivating wetland plant species.

This guide and new green provide decision support when cultivation in a wetland is being contemplated. However, they do not provide the last word, and their use should be accompanied by consultation with local wetland and plant experts, relevant environmental organisations, as well as by consultation with local and national authorities administering land use, environment and water affairs.

3
INTERFACE BETWEEN NEW GREEN AND THESE GUIDELINES

Four options for searching new green are presented in the main form of the database (Figure 1):

1. SITE QUIZ search, which allows the user to characterise the type of wetland and provides a list of the viable species for a wetland with those characteristics;

2. SPECIES search, provides information about a particular species;

3. USE search, provides a list of species which have a particular use (e.g. Medicinal, weaving, etc); OR

4. REGION search, provides a list of species for the region of interest.

Figure 1 Main form of the database new green

The four options for starting a search to assess sites and species are explained more fully below in relation to these guidelines:

1 SITE QUIZ

This search option goes hand-in-hand with the Site Assessment step described in these guidelines below at 4.1.1.

The first stage of enquiry involves making a preliminary asse ssment to determine whether the particular wetland is in a pristine condition, or whether it has been altered. Pristine wetlands must not be altered in any way by cultivation or introduction of additional plant species, and the only option is for non-invasive and sustainable uses of the wetland and the plants occurring there naturally.

If a potential site is an altered wetland, site assessment based on visual inspection, historical data, digital data, and ground-truthing will provide the data for the site quiz.

Ways to find this information (regional and metropolitan scale) are provided in these Guidelines at 4.1.1. Once a site has been environmentally characterised in this way, the new green Site Quiz search provides a list of plant species appropriate to the site.

2 SPECIES

If the desired plant species is selected first, an appropriate site may be found based on the optimal environment displayed in the database for that plant species.

3 USES

If the potential uses of the plant and the site are known (e.g. growth of medicinal aquatic plants, sustainable harvesting of *Typhus* reeds), the database provides a list of potentially suitable species together with their optimal environmental conditions. This makes it possible to choose a suitable site in which to grow them.

4 REGION

If the user is not sure where to start, the database can provide a list of species which occur naturally in a given region of South Africa.

Whether the user chooses the new green SITE QUIZ initially or has to assess the site after selecting plant species or use, some site assessment will be necessary.

4
CULTIVATION IN WETLANDS

The following definition of the wise use of wetlands was accepted at the third meeting of contracting parties to the Ramsar Convention:

> *"The wise use of wetlands is their sustainable utilization for the benefit of humankind in a way compatible with the maintenance of the natural properties of the ecosystem."*

In accepting this definition of the wise use of wetlands, the Ramsar Convention recommends that all contracting parties prepare national wetland policies. Policy on use of wetlands falls mostly within the spheres of environmental affairs, agriculture, water affairs and nature conservation. The most recent discussion document for agricultural policy in SA (Ministry for Agriculture and Land Affairs, 1998) states the following regarding natural wetlands:

> *"in accordance with the Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983), there are control measures governing certain agricultural activities.* ***A land owner may not use the vegetation in a wetland in such a manner that it causes deterioration; cultivation and drainage of wetlands are not permissible****; the flow pattern of water may not be changed; and permission must be obtained to burn wetland, and this will only be given under special circumstances."*

It is clear that draining, clearing and burning of wetland areas for conventional dryland crop production is inappropriate and not in keeping with the above policy statement. However, there would be a large difference between the impact of conventional crop production on wetlands and that of a more sustainable approach that did not involve drainage or alteration of flow. There have been no statements specifying to what degree wetlands may be cultivated if cultivation maintains the ecological and hydrological functioning of the wetland. The Ministry for Agriculture and Land Affairs should include a clear statement on different modes of cultivation and their acceptance in their national policy on wetlands, which is in preparation.

A project dealing with cultivation in wetlands will pass through two broad stages, planning and implementation (see flow diagram). Both stages can be broken down into a number of steps, as has been done in these Guidelines. The first step of planning requires an assessment as to whether it is an altered wetland or whether it is still in a pristine natural state, since the potential use to which it can be put depends firstly upon this factor. Once this has been established, the planning stage may proceed through further steps culminating in project implementation.

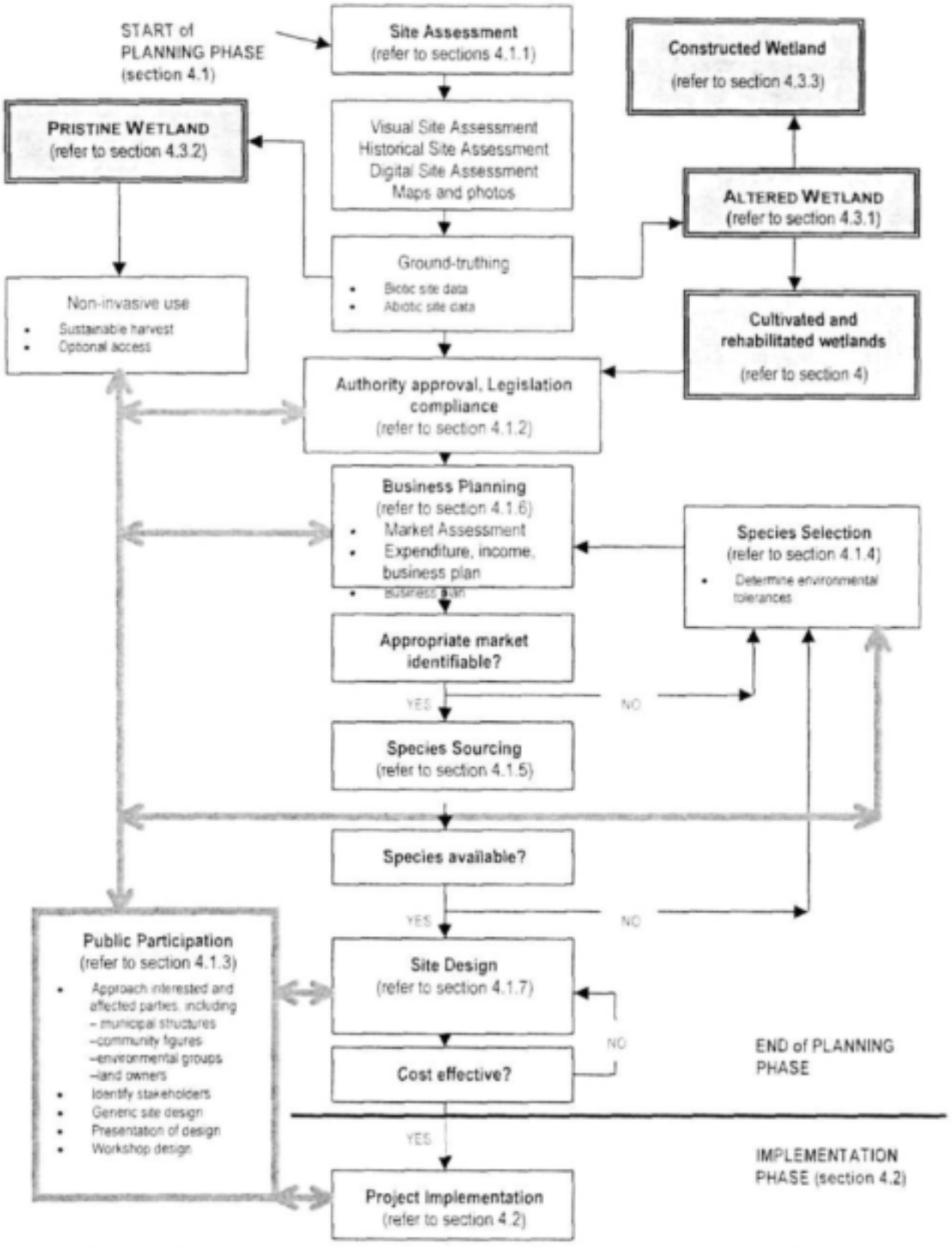


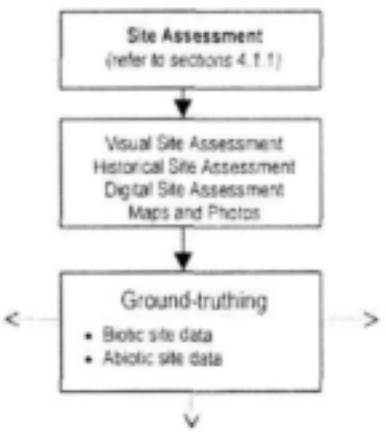
Figure 2 Flowchart outlining generic site assessment and design procedures for sustainable use of wetlands

The steps of planning and implementation are described below at section 4.1 and 4.2.

4.1 PROJECT PLANNING

4.1.1 SITE ASSESSMENT

This step will allow the user to decide whether the wetland site is in pristine condition, or whether it has been altered and is thus suitable for cultivation. Wetland sites can be assessed by one or more of the following routes:



1. By visual inspection;
2. From historical data or existing data-sets on wetlands;
3. Using digital site assessment, maps and photos;
4. By ground-truthing (i.e. measurement on site)

The types of information of relevance to the assessment include the following:

- Topography and geology;
- Climatic data for the site and its catchment area;
- Catchment conditions;
- Soil characteristics;
- Water characteristics;
- Water and soil nutrients;
- Water and soil pollutants;
- Wet and dry cycles, and flooding levels and patterns;
- Vegetation characteristics and species inventory;
- Animals and insects present;
- Prior and present land uses.

The four broad methods of acquiring this type of information are discussed further below. Site assessment using any of these methods will require the help of appropriate environmental experts. Local environmental consultants can be approached. Other expert information is freely

available on the Internet, for example at the Wetland Fix site http://www.wetland.org.za/. The site has a series of six field guides including one on site assessment (Part 1: Introduction and wetland assessment). Wetland Fix guides provide a simple method of wetland evaluation for use by an agency extension official and others who are unfamiliar with wetlands and who are not wetland specialists. It is intended to be used for education, simple impact assessments, management or restoration, and wetland inventory purposes.

1. *Visual site assessment*

This is quite literally a process of walking though the site, and noting the following:

- signs of pollution of the water, litter, industrial waste, human or animal wastes;
- species of plants present;
- species of animals, birds and insects present;
- artificial drainage ditches, pipelines, channel or weir construction;
- signs of overgrazing, trampling, ploughing or other cultivation methods; and
- any other signs of alteration or over-use

2. *Historical data and existing data sets on wetlands*

Historical environmental data can provide broad and large-scale information on e.g. topography, floodlines and vegetation. This facilitates the site design and planning of the placement or modification of various structures (e.g. weirs, water retention trenches, irrigation and diversion channels) if these are to be used.

There are also inventories of SA wetlands available from the Department of Environmental Affairs and Tourism (South African Wetlands Conservation Programme, 1997). These provide data sets on marine, estuarine, riverine, lacustrine and palustrine wetlands. This can assist those in need of data as an interim substitute for a full wetland survey .

3. *Digital site assessment, maps and photographs*

Digital information sets can be obtained from the Department of Land Affairs, Maps and Surveying in Mowbray, Cape Town. These are suitable for GIS-based assessment.

Maps and aerial photographs of areas in S.A. can be obtained from the Department of Land Affairs, Maps and Surveying in Mowbray, Cape Town. Small-scale aerial photographs (e.g. 1:2000 or 1:5000) with data overlays such as floodlines can be obtained from the survey branch

of city administrations or regional service councils. In addition, urban and environmental planners/consultants may be commissioned to survey an area.

Environmental data and maps are also available from government and educational institutions (see below for examples). The following are some of the important environmental parameters and the common sources of this data:

Soil data

Information about soils is available from a number of sources.

A. Environmental Potential Atlas (ENPAT)

ENPAT is a CD-based digital geographic and environmental database for South Africa which utilizes GIS (Geographic Information Systems) technology (Van Riet *et al.*, 1997). ENPAT draws together on one CD environmental information for South Africa that was originally spread across a variety of media from many different organizations. It should be noted that ENPAT can only give a very general idea of the soil type of the area, with resolution at the metropolitan scale. Even at better resolution, however, it is important to note that wetland soils may differ from the surrounding soils, and wetland soils should be ground-truthed.

Other data available on ENPAT concerns rainfall, geology, catchment area, vegetation types and land use, amongst others. Maps are also available which combine data sets in a unique way (e.g. a map of areas with potential for environmentally sustainable development was constructed by combining data on environmental resources and population density).

ENPAT provides information at national, provincial and metropolitan scales (Gauteng, Cape Town, Port Elizabeth, Durban Functional Region and Bloemfontein). It is available from the ENPAT Steering Committee, Department of Environmental Affairs and Tourism.

B. University Soil Science Departments

Soil science experts at local university and agricultural colleges should be able to act in an advisory capacity and provide soil maps of the relevant area.

Climatic data

South African Weather Bureau (SAWB)

The SAWB provides monthly and annual rainfall and temperature maps (in millimetres of rainfall, or percentage of normal). Maps are available as hard copies or files of these can be downloaded directly from their Internet site http://www.weathersa.co.za. Data are available

regarding temperature, rainfall, humidity and days of sunshine. Data are available for national, regional and metropolitan levels.

Biome and vegetation data

Vegetation maps are available from the Department of Land Affairs, Maps and Surveying, Mowbray, Cape Town, and are also available on ENPAT. In addition, the user should note the biome of the site and the existing vegetation to determine which plant species grow naturally in the area. Consequently, some existing species may be added to the desired species list. Aerial photographs, if of a sufficiently high resolution, and low-level remote sensing technology can also be extremely accurate and informative, but must be ground-truthed.

Animal and insect data

Information about animal distribution can be found in standard reference works. Insect distribution tends to be quite localised, and ground-truthing will be the primary way to ascertain this.

At this stage of the site assessment it should be possible to evaluate the wetland site, and decide whether or not it has been altered. If it is in an unaltered state then the options for its future use are limited to those that are sustainable and non-invasive.

On the other hand, if it has clearly been altered then more options exist regarding its future use . In this case, it will be necessary to ascertain the physical condition of the wetland components, so that plants can be chosen for cultivation which will tolerate the on-site conditions.

4. *Physical site assessment and Ground -truthing*

Biotic data

A survey of existing plant, animal, bird and insect life should be carried out, noting the presence of any endangered or red data species. Their presence may preclude cultivation on all or part of that site. An assessment of the existing biota will also reveal whether any useful indigenous species are present, as well as the presence of exotic and invader species .

Assessments can be conducted using field guides and or with the help of botanists, zoologists and environmental consultants. Leaf samples may be taken from plants in order to compile a species list, which can be done by the local herbarium.

If a species present on the site is also a species desired for cultivation, leaf samples can be taken for analyses of macronutrients (Nitrogen , Phosphorus, Magnesium, Calcium, Potassium) in order to assess the fertility of the site for that species. Also, other elements that may be

important on that site can be analysed, such as heavy metals, micronutrients or sodium (on saline sites). Results of analyses are only useful if standard or reference values are available for the desired plant species to be cultivated. Certified laboratories for soil, plant and water analyses can be consulted.

Abiotic data

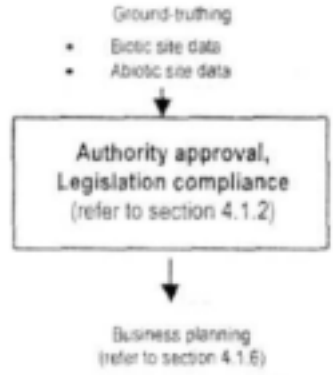
The following baseline measurements should be obtained on- site:

- soil types;
- soil nutrients (carbon, nitrogen, phosphorus, magnesium, calcium, potassium);
- other soil parameters (soil type, texture, pH, electrical conductivity);
- water nutrients (nitrate, nitrite, ammonium , phosphate, magnesium, calcium, potassium);
- other water parameters (pH, temperature, electrical conductivity, chemical oxygen demand, suspended solids, levels of faecal coliform bacteria and *E.coli*);
- daily maximum and minimum air temperatures;
- water availability and seasonality.

This data will provide the user with the actual growing conditions which can be expected on site, and will assist in selection of suitable species for cultivation. For example a site heavily contaminated with faecal coliforms and/or heavy metals would not be suitable for harvesting either medicinal or edible plants, since these would be unsafe for human use and consumption. Certified laboratories for soil, plant and water analyses can be consulted prior to taking samples, and having them analysed.

4.1.2 AUTHORITY APPROVAL AND LEGISLATION COMPLIANCE

This is an integral part of the broader public participation process.



During or immediately after the site assessment process outlined above the user must initiate discussions with the national, provincial and local authorities. Determine the level of support of the authorities for your plans. Look for areas of synergy between your plans and the policy, plans and projects underway already. The national, local and provincial authorities will also be able to advise you as to the relevant legislative instruments with which your plan must comply, and the various authorisations which will be required before the plan can become reality.

At the national level the relevant authorities would be the Departments of Environmental Affairs and Tourism, Water Affairs and Forestry, and Agriculture and Land Affairs. Relevant national legislation would be those laws which are administered by these national departments - National Environment Management Act 107 of 1998 and the Environment Conservation Act 73 of 1989, National Water Act 36 of 1998, Development Facilitation Act 67 of 1995 and various other statutes dealing with agriculture, land reform and development. For further information refer to Environmental Law in South Africa by Glazewski (2000).

Once it has been determined that the plan can be accommodated in principle within national, provincial and local legislative and policy contexts, you must comply with the following two Acts with regard to environmental assessment procedures to be undertaken and the environmental approvals required:

1. The National Environmental Management Act
2. The Environmental Conservation Act

It is only after environmental approval has been obtained that it then becomes possible to apply for any approvals required by national and provincial land-use planning laws and local by-laws. For more information about relevant provincial planning laws see Planning Law by van Wyk (1999).

4.1.3 PUBLIC PARTICIPATION

In addition to consulting with local authorities, the communities surrounding the site, local land-owners, and other stakeholders must be informed and consulted as an integral part of the assessment, and subsequent design of the site. Even if the surrounding communities are not to be directly involved in the wetland cultivation project, they must nevertheless be consulted at least in the initial stages of the project. Stakeholders include land owners, municipalities, community figures and environmental and botanical organisations.

Public Participation
(refer to section 4.1.3)

- Approach interested and affected parties, including
  - municipal structures
  - community figures
  - environmental groups
  - land owners
- Identify stakeholders
- Generic site design
- Presentation of design
- Workshop design

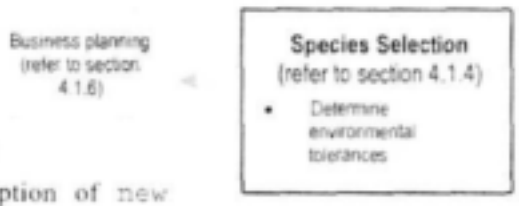
A process of public participation should inform each stage of the project planning from authority approval to species selection, business planning, site design, and land use. It is highly recommended that the assistance be obtained of someone experienced in public participation processes. Furthermore it is important that the public participation process be carried out in a clearly independent manner, ideally by someone who is not associated with either the project planning, the community or the local authority interests.

If any of the surrounding communities are to be directly involved in the wetland cultivation project as stakeholders, then the following should be ascertained:

- What is the extent of community interest in the project?
- Are there any conflicts in land use by the community?
- Will the project affect living conditions of the community, e.g. in terms of water quantity or quality?
- Will the community benefit from the project, e.g. in terms of income generation
- Is the community cohesive enough to contribute to or manage the project?
- Does the community provide a secure environment?
- Does some social structure already exist that could be used as a platform for the project (e.g. some existing environmental or self- help group)?
- Can interest and/or financial support from other community organisations and the regional council be obtained?
- Who will be the direct beneficiaries of the project?

4.1.4 SPECIES SELECTION

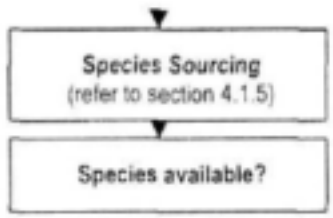
Once a site has been environmentally characterised, the new green database provides a means of selecting plant species appropriate to the site. These can be accessed via the SITE QUIZ search option of new green.



Alternatively, as mentioned in Section 3, the potentially suitable plant species may be selected first via the new green SPECIES search option, or by narrowing the search by using the REGION option. After this selection, an appropriate altered wetland site may be found based on the optimal environment displayed in the database for the desired plant species. Similarly if the user knows what products are to be marketed, the database provides a USES search which will select the species which have the relevant use, and give the optimal environmental conditions of the species so that a site may be chosen or evaluated based on this. In all cases, the database provides information on the range of environmental tolerance of the species, which should correspond to the site chosen.

The selection of species for cultivation is simultaneous with the market assessment stage, and in the early stages of planning a range of species may be assessed for marketability, before narrowing them down to the best or most promising candidate/s.

4.1.5 SPECIES SOURCING



The following factors should be considered in sourcing suitable plant material for the project:

- Search and rescue of plants from new development sites is a low-cost alternative to purchasing plants from nurseries, but this can only take place if the necessary legal collection permits have been obtained first, usually from the provincial nature conservation department;
- Growers and suppliers of the plant species selected should be located;
- new green has some information on plant sources (see below);
- Choose a supplier who is close to the site to reduce transport costs;
- Ensure that the most suitable and marketable varieties of the chosen species have been identified;
- Make sure adequate plant supplies are available before planting begins.

The new green database provides plant species' availability where possible. Another database, NURSERY, was used to obtain some of this information. Both NURSERY and a similar database, INDPLANT, were designed for use with Microsoft Access. NURSERY provides propagation and plant availability information for all species that might be of interest to nurserymen, i.e. not only indigenous SA plants are listed. INDPLANT has a similar structure but provides information on only desirable indigenous plants for the garden (i.e. poisonous indigenous plants are excluded). Both NURSERY and INDPLANT can be obtained from Prof. JF de Wet, PO Box 13145, Humewood, 6013, Port Elizabeth. It is recommended that only indigenous SA plants be used for cultivation in natural wetlands, while other species could be used in constructed wetlands (see Section 6).

4.1.6 BUSINESS PLANNING

Business planning requires the assessment of the potential market for the product, and estimation of the income stream once the project is up and running. It is also necessary to plan in detail the expenditure required in setting up and operating the project. Successful planning also requires identifying potential pitfalls and risks, and building in contingency measures to the budgeting and planning process, in order to deal with these eventualities in ways that will allow the business to remain operational.

Market assessment is an important factor which can influence project sustainability. Market assessment should be carried out in parallel with species selection, site assessment and public participation.

new green provides a USES search option, allowing the user to search for plants which have a particular use, for example medicinal or craft use. In this way various markets can be assessed, based on the various uses to which plants or parts of plants can be put. Alternatively, plants species can be selected to supply material for a particular market which is known to exist, and about which there is reliable information available.

Provided that the plant species under consideration are marketable, the calculated revenue per hectare must be greater than the costs incurred per hectare in order for the cultivation project to be financially viable.

1. Market assessment

Local and foreign markets should be investigated and buying prices obtained for the pot ential product, and for similar products. Amongst the factors which must be taken into account are the following:

- Market demand and size of the market;
- Fluctuations in the market, due to seasonality, competition, and changes in consumer preferences;
- The need to establish a market or to educate consumers about the product;

- Quality level required in order to enter the market;
- Marketing costs and barriers to entry.

2. *Expenditure, Income and Business Planning*

Once the existence of an attractive market for the proposed product has been identified, a generic business plan should be drawn up to determine whether the scheme is broadly viable. This involves estimating the expenditure and income of the proposed project, and identifying potential problems so that contingency plans can be made for dealing with these.

Expenditure

The following factors must be considered in determining expenditure :

Set-up costs and capital expenditure:

- Site assessment (experts' and consultants' fees, laboratory analyses);
- Site preparation (earthworks, soil preparation);
- Plant material purchase;
- Materials (fencing, walls, pipes, hosing, pumps);
- Tools;
- Structures (sheds, offices);
- Transport, labour, and training costs involved in site establishment ;
- Community liaison costs;

Running costs:

- Cost of project finance (interest charges);
- Depreciation of capital items;
- Site lease or purchase costs;
- Site management and office and administration running costs;
- Site services such as electricity and water charges ;
- Transport (also for delivery of produce);
- Labour (permanent and casual);

- Training of staff;
- Site maintenance (compost, fertilizer, plants);
- Seasonal costs of production (packaging, storage of produce).

Income

The predicted running expenses are offset against the gross income from sale of the produce. Gross income will depend on the market value of the product, yield per hectare of the plant product, and total area under cultivation. Information on plant yield per hectare for some plants is available from the new green database. However, for most species this is highly site-dependent. Some market prices are available from new green as well, but in general market prices for produce at local and foreign markets will have to be determined for each specific situation. This information may be found through the local Chamber of Commerce, farmers' co-operatives, and on the Internet.

Cash flows can be calculated for a number of years after planting (depending on plant life-cycle and seasonality). The business plan should allow for initial lags in production, and increasing production with plant maturity. For instance production costs may exceed income in the first few years of cultivation but as yield and income increases the project may become self-sustaining in subsequent years. This scenario must be included in the business plan.

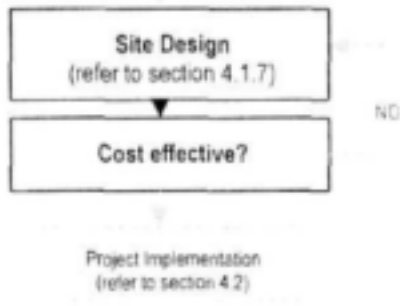
Business planning

Once the market has been assessed and the cash flow spreadsheet prepared, the planning should identify the critical risks and potential problems that the project will face. Contingency plans, together with a contingency budget, must be made in order to handle these situations and delays which inevitably arise. The business plan must also make allowance for inflation, and for the effects of exchange rate fluctuation in the case of an export project.

It is also advisable to develop business plans for sites of different sizes, since a project that is not financially viable on a small site may turn out to become so on a larger one. In general it is best to choose a site size that is manageable but which can be extended as finance allows, i.e. start small, but plan for expansion.

4.1.7 SITE DESIGN

Site design will depend on various criteria listed below:



1. *Biophysical criteria*

1. The size of area available for cultivation. Site establishment costs may be such that a site less than a given size will not be financially viable straight away. However, a smaller site could be financially viable after a number of years and is less risky than investing large amounts in cultivating a large area, particularly in a market that is not completely known.

2. Physical characteristics of the site: climate, water availability, water quality, soil types.

3. Site topography and flood risk. Depending on the nature of the plant species, this may have more or less significance for the project design.

4. Wind exposure.

5. Local wild fauna and domesticated animals.

6. Provision for setting aside fallows. Extensive weed invasion can be typical of cultivated wetlands after a few years (Nebel, 2001).

2. *Economic criteria*

1. Distance from roads and airport, if relevant .

2. Investment in security measures on site .

3. *Social criteria*

1. Current land use, including informal uses. Significant conflicts may arise if this is not correctly assessed from the very beginning of the project .

2. Zoning and proposed future land use. Included here is the existence of any Land Development Objectives (in terms of the Development Facilitation Act) and Integrated Development Plans (in terms of the Local Government Transition Act 209 of 1993). In u rban areas in particular, it is important to determine if such long-term master plans exist for the area, which may involve new or redesigned stormwater flows, transportation networks, housing settlements, or specific economic development objectives.

3. Land ownership. Cultivation projects may be established on municipal land, private land, or other (e.g. communal) land, and in each case the nature of the negotiation with the stakeholders and the relationship with the community will be different.

4. Community stability. Where a community is recently established, or significant social conflict exists, this type of long-term cultivation project may not be appropriate. Stable communities and strong community structures will tend to promote the project's long-term viability.

5. Distance from potential labour force. It will be socio-economically more beneficial if jobs can be made available close to communities which have high unemployment levels.

Criteria such as those listed above can be used to evaluate several competing cultivation sites. Each site is assessed for how well it meets the various criteria, and by assigning a final numerical value to each of the sites they can then be ranked in order of suitability for a particular cultivation proposal.

An example of an evaluation carried out specifically for the cultivation of arum lilies is given in Table 1. **Please note** that characteristics of a site that have been allocated a negative ranking for the cultivation of arum lilies may not be relevant in the case of cultivating a different plant. For example arum lilies do not tolerate heat well, therefore sites with a hot climate receive a negative ranking. Also note that some of the criteria of relevance in one project may not be relevant in the case of a different project.

Table 1 Site ranking for arum lily cultivation project in Cape Town wetlands .
Primary and secondary criteria are listed along with explanation of what would be considered positive, acceptable and negative attributes of each for purposes of arum lily cultivation.

Characteristic	Positive (+)	Acceptable (0)	Negative (-)
Primary criteria			
Available area	>15 000 m^2	10 000–15 000 m^2	<10 000 m^2
Current land use	Unused/ Public open space	Informal recreation	Used: housing, formal recreation, farming, industry, or nature conservation
Zoning and availability (Proposed land use)	Public open space Available immediately	May be rezoned within the next 5 years/ Not available immediately	Zoned for other purposes/ Zoning contested
Land ownership	Local, provincial or national government	Communal	Private
Flood risk	Low flood risk	Moderate flood risk	High flood risk
Topography	Flat floodplain	Not flat	Significantly higher than channel
Climate	Cool, no frost	Warm/ Cool with frost	Hot
Water availability	Suitable wetland/ Infrastructure for irrigation in place	Infrastructure for irrigation and flow control required	Water not available
Water quality in terms of plant requirements	Unpolluted	Pollution levels within tolerance limits	Pollutants a risk to plant health
Water quality in terms of human requirements	Unpolluted	High faecal coliform counts- worker protection required	Unacceptably hazardous to human health
Ecosystem condition	Moderately disturbed (1)	Highly disturbed (2)	Severely polluted/ Undisturbed (3)
Community stability	Stable community organizations exist with some environmental capacity	Stable community organizations exist	Unstable due to community divisions or conflicts
Secondary criteria			
Distance from road	Direct vehicular access	Access could be inexpensively provided	No vehicular access
Distance from work force	<2 km	2 km	>2 km
Distance from airport	<20 km	20–50 km	>50 km
Security	Protected/ Already fenced in	Could be protected	Difficult to protect

(1) Litter, human waste; (2) industrial waste, heavy metal contamination; (3) undisturbed sites qualify as pristine, therefore cultivation inappropriate.

4. *Ecological design criteria for altered and constructed wetlands*

The most effective way to develop and manage such wetlands is so as to mimic the functional ecological components of a natural wetland (Williams, 1994).

It is imperative therefore that wetland cultivation projects strive to maintain the nature and function of a wetland, and that they do so in a sustainable manner.

Sustainability

In natural systems, the components of a wetland are multifunctional and many functions are therefore also served by several components (Mollison, 1988). T his contributes to system stability and reduces the management requirements of the site. The following generic procedures can be adopted when designing a site:

- Make a list of site components and intended site components (crop, existing vegetation, river, dunes, reeds, workers, etc.);
- Assemble and choose these components in such a way that each component is multifunctional and each function (e.g. water purification, floriculture) is served by several components;
- Try to establish the requirements (including energy input) and products (including pollutants) of each component;
- Try to arrange each component in such a way that each serves the requirements and accepts the products of other components.

An example of this approach is given in Table 2 below.

Table 2 Requirements and products of components in a hypothetical wetland site that is cultivated and producing cut flowers

Component	Requires	Produces
Flower crop	Water, nutrients, shelter from sun and wind	Flowers (income), bio- filtration, compost
Vetiver grass	Water, nutrients	Erosion control, water infiltration, root pest control, weed/invasive grass control
Reeds	Water, nutrients	Bio-filter, thatch, wind shelter, compost
Trees	Water, nutrients	Shade, retards run-off, litter
River	Possible filtration	Water, nutrients, floods
Structures :		
Rain tank	Money, labour, available space	Water storage and supply
Swales	Labour	Flood/drought protection, water infiltration
People	Wages	Labour, money, maintenance
Animals :		
Waterfowl	Water, nutrients, shelter from sun, wind, and predators	Manure, weeding behaviour

Examination of Table 2 shows that some of the products of one component are required by another component. For example, both vetiver grass and waterfowl may prevent weed invasion for the flower crop. In turn, the flower crop provides wages for the people and can act as a bio-filter for the river. The river in turn provides water and nutrients for the plant crops.

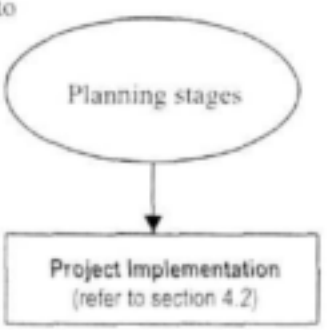
The actual site layout should position those components that are inter-linked through resource and product close to one another, e.g. swales for flood/drought protection should be along the river, protecting the field. Trees should surround the flower crop to provide shade and reduce run-off, vetiver grass or reeds could provide windbreaks and reinforcement to the swales, and the vetiver grass could be grown in between the flower crop to control root pests and reduce weed occurrence.

Maintenance of the wetland nature of the site

Maintaining the wetland nature of a site means maintaining the ecological and hydrological functioning of the site or restoring these functions to a site. Care should be taken in selecting wetland plants so that the water budget of the area is not exceeded. The ground-water levels on the site should be monitored, if the site is not always inundated. Some form of water storage and an irrigation system may need to be planned accordingly.

4.2 PROJECT IMPLEMENTATION

Once authorisation has been given by the relevant authorities to proceed with a particular project design, and following site assessment and the preparation of a business plan, the following steps are recommended for project implementation on a specific site:



1. Earthworks and any construction necessary may then proceed, with appropriate supervision to ensure that all development is environmentally responsible and within the limits set by the authorities.

2. The manager appointed to oversee the project will take responsibility for planting, cultivation, harvesting and marketing of the produce. Should several sites be involved, a centralized marketing organization may be formed to reduce competition between sites, to facilitate marketing of produce and to reduce costs in areas associated with produce transport, packing and shipping.

3. The organizational structure and ownership of the project should be formalized. The full range of options should be considered, for instance :

- a community-driven organization (a co-operative, community trust or section 21 company);
- a local authority-driven organization;
- a partnership (between some of the role-players, e.g. local authorities, the workers and local communities, community organisations, private investor).
- a private sector organization/entrepreneur.

In any case, it is important that the roles of the various players be defined carefully, that the nature of rights of ownership or use be clearly understood.

4. Following project implementation there must be ongoing monitoring and evaluation of the environmental (ecological, social and economic) impact of the cultivation and harvesting project. The following are amongst the factors which should be monitored:

- Ecological indicators such as water quality, soil nutrient levels, levels of organic matter, invasiveness of wetland plants, any signs of soil erosion;
- Social indicators of the impact of the cultivation project;
- Economic indicators of the financial sustainability of the project.

4.3 WETLAND TYPES

4.3.1 ALTERED WETLANDS

Example of use of an altered wetland for water purification

Wetlands have properties that make them especially suitable for wastewater purification and have been used for this purpose since the 1950's (Verhoeven *et al.*, 1999). Natural altered wetland systems used for wastewater purification include marginal lake wetlands, fens and floodplain marshes. *Phragmites* species grow especially on margins of tidal salt marshes, brackish marshes of river deltas, alkaline or saline inland wetlands and river banks (Gessner, 2001). It is recommended that only slightly polluted water be used (i.e. >500 mg l^{-1} COD). Sometimes wetlands are used to polish the effluent from a conventional water purification plant (Verhoeven *et al.*, 1999).

Characteristics that make wetlands suitable for wastewater purification are:

- Wetlands support very productive vegetation capable of taking up large nutrient loads;
- Wetlands are semi-aquatic and the flooding that would occur with wastewater supply is a normal feature of such a system;
- Organic matter breakdown also takes place via anaerobic pathways (in the anaerobic parts of the soil) and so alternative electron acceptors to oxygen are used (nitrate, sulphate, iron).

A negative characteristic of using wetlands to purify effluent or to discharge treated effluent into is that a year-round inflow of effluent water disrupts any natural seasonality of the wetland water regime. For example, the water level can remain higher than normal and the wetland can become permanently inundated rather than drying out in the dry season as it would have done naturally. This can lead to other negative impacts on the surrounding environment. For an example of this see the case of Wildevoëlvlei in the Noordhoek Catchment, Cape Town (Noordhoek Catchment Forum, 2001).

Design criteria for water purification

Some of the important criteria are the following:

1. Physical characteristics of the site: suitability of plant species for water purification; climate; water availability; water quality; and soil types.

2. The size of available area relative to the area being supplied with water and the quantity of water to be purified.

3. Zoning and proposed future land use: in urban areas in particular, it is important to determine if long-term master plans exist for the area, which may involve new or redesigned storm water flows, transportation networks, housing settlements etc.

4. Land ownership.

5. Opportunity to employ workers from surrounding communities.

6. Funding availability for monitoring water quality upstream and downstream of the wetland.

Site implementation

Site implementation for using a wetland for water purification would be similar to that described in section 4.2.

Examples of wetland cultivation and rehabilitation

Spekboomspruit wetland (1 ha) is a small restored wetland that will now supply clean water to the local community – rehabilitation was planned by Mpumalanga Parks Board (Lindley, 2001).

Zoar wetland (300 ha in extent, > 500 ha planned) was rehabilitated by a landowner near Piet Retief, Mpumalanga (Lindley, 2001).

Upper Mokolo River was rehabilitated by a landowner near Nylstroom, Northern Province – funded by Working for Water (Lindley, 2001).

4.3.2 PRISTINE WETLANDS

1. *Direct-use and non-use functions of wetlands*

Wetlands are essential for certain ecological and hydrological functions (e.g. habitat for many animal species, and purification/storage of water). However, wetland loss rates remain high as people are unaware of the full value served by wetlands (Breen *et al.*, 1994) and may not care because wetlands are not marketable assets.

Wetlands have some obvious direct uses appreciated by most people:

- Water storage, also in terms of being integral to other ecosystems;
- Water provision;
- Supporting the food chain of the fisheries industry (Bell, 1997);
- Option to have access to the wetlands;
- Food supply (fish, shellfish, crustaceans);
- Building materials (reeds).

Besides these uses, the public may be encouraged to see the non-use benefits of wetlands, such as:

- Existence of wetlands (having the satisfaction of knowing that a wetlands is vital to their environment, without needing to directly access the wetland);
- Bequest value of wetlands (benefit of the existence of wetlands for future generations).

2. *Economic valuation of pristine wetlands*

Some benefits of preserving wetlands (optional access, existence and bequest value) are intangible to many people because wetlands are not assets traded on markets and it is therefore difficult to price them (Breen *et al.*, 1994). Nevertheless, the desire and preference of people to preserve wetlands can be converted into monetary terms. This was done in the Wakkerstroom vlei in Kwazulu/Natal, using the so-called Contingent Valuation Method (Breen *et al.*, 1994). This method takes the form of a questionnaire where people are asked to visualise hypothetical markets (e.g. how much would one be willing to pay into an exclusive fund to have exclusive access to a particular wetland).

This would seem a very useful educational tool, especially for people in an income bracket able to allocate surplus funds to such a hypothetical fund. For example, the study of Breen and colleagues (1994) found that a median household (gross annual income R 80 000 – R90 000) was willing to pay R17.51 – R20.00 per month for the option of visiting a wetland.

3. *Recommendations for using pristine wetlands*

Any use of these environments will have to comply with legislative requirements applicable to such areas, and will have to be preceded by obtaining the necessary authorisations. Any use must comply with any conditions imposed by the authorities.

What degree of land-use is permissible, given that pristine wetlands must firstly be conserved as an integral life support system?

Little information is available on the impact of land-use on the ecological value of pristine wetlands in South Africa (Kotze *et al.*, 1994). An assessment of the wetlands of the Lake Victoria basin in Tanzania showed that land-use for agriculture and settlement was irrational, creating problems of sedimentation, hydrological changes and subsidence of land due to the excessive water extraction (Kassenga, 1997). Since an excess of water is the dominant feature determining biota in a wetland, it can be assumed that the greater the disruption of the hydrological regime, the greater the loss of the ecological value (Kotze *et al.*, 1994) as well as the hydrological value.

Therefore, for pristine wetlands, this guide recommends wise use to be the minimal- or non-invasive use of pristine wetlands, such as the following uses:

1. Water storage;

2. Sustainable harvesting of reeds or other plants (with appropriate studies on plant re-growth and nutrient depletion rates of the soil);

3. Recreation and associated controlled and limited building of structures:

    - bird watching trails and structures;

    - hiking trails and structures;

4. Low-impact water sports that do not disturb wetland birds, mammals etc., particularly the breeding areas of these wetland inhabitants.

In keeping with a wise-use policy for wetlands, and in the absence of any official national policy, the following should be considered by individual land owners and land-use decision makers:

- More research is required on the impacts of land-use on ecological function of wetlands;
- Education is required - where people are encouraged to understand that :
    - only pristine wetlands naturally supply clean drinking water;
    - wetlands provide not only vital ecological and hydrological services , but also benefits of a personal and general nature;
- Compensation should be negotiated for land-owners who are willing to maintain or rehabilitate wetlands rather than cultivate them (planting of crops is tempting because crop yields on wetlands can be higher than on surrounding veld (Breen *et al.*, 1994)).

4. *Example of the wise use of pristine wetlands*

Kosi Bay Nature Reserve – approximately 10 ha of incema (*Juncus krausii*) sedge is sustainably harvested by local women. In 1992, there was a ban on the use of sickles and this has made collecting less commercially viable and curbed the large number of people that used to over-exploit the sedge resource (Kyle, 1995).

4.3.3 CONSTRUCTED WETLANDS

Constructed wetlands have been used extensively for water purification and growing economically important aquatic plants. The site chosen need only be near a source of water or wastewater. Common plant species that act as bio-filters are *Phragmites spp.*, *Typha spp.* and *Scirpus spp.* and these have all been used for wastewater purification (Verhoeven *et al.*, 1999). These reed species have a high biomass production rate of 1-4 kg/year dry mass per m^2 of stand (Gessner, 2001). *Phragmites* spp. in particular have a high nutrient loading capacity (Ostendorp *et al.*, 2001). Hence constructed wetlands are often referred to as reedbeds. The sedges, *Juncus spp.*, could also be used.

1. *Efficiency of constructed wetlands*

From a practical standpoint, constructed wetlands offer better opportunities for wastewater treatment than natural wetlands, since they can be designed for optimal removal of BOD, COD and nutrients with simultaneous control over the hydrological and vegetative components of the wetland (Verhoeven and Meuleman, 1999). Constructed wetlands have been used successfully for treating domestic wastewater (Mandi *et al.*, 1998; Kern and Idler, 1999), agricultural wastewater (Kern and Idler, 1999) and industrial wastewater (Vrhovšek *et al* ., 1996).

Constructed wetlands can be not only efficient but also low-cost solutions for rural areas in third world countries (Denny, 1997) and there have been successful examples, e.g. in Uganda (Okurut *et al.*, 1999). Constructed wetlands may be further optimised by integration into agricultural and fish production systems where the products of the latter are re-cycled or re-used (Denny, 1997).

2. *Nutrient and pathogen removal*

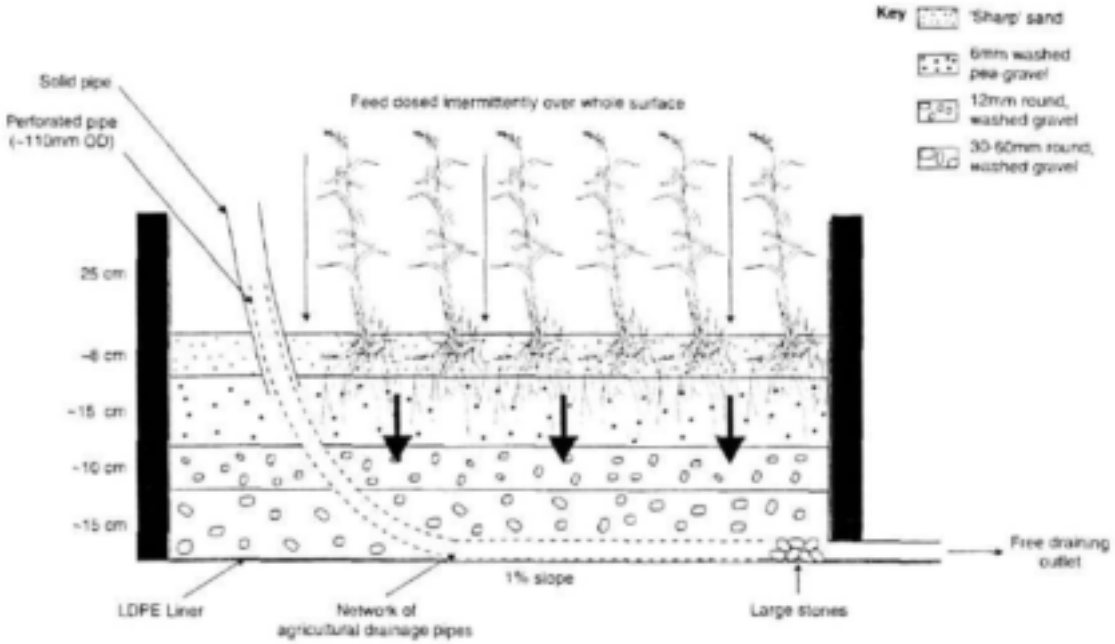
In general, constructed wetlands can be designed to remove more than 90% BOD, COD, suspended solids and bacteriological pollution from the through- flowing wastewater, while the removal of N and P is only around 50% (Verhoeven and Meuleman, 1999). According to Kern and Idler (1999), the conditions in constructed wetlands need to be improved to favour both denitrifying and nitrifying bacteria to enhance the removal of N.

3. *Types of constructed wetlands*

There are two main types of constructed wetlands:

- Infiltration or vertical flow wetlands (water flows vertically through highly permeable sediment and is collected in drains);
- Surface or horizontal flow wetlands (water flows horizontally over wetland sediment).

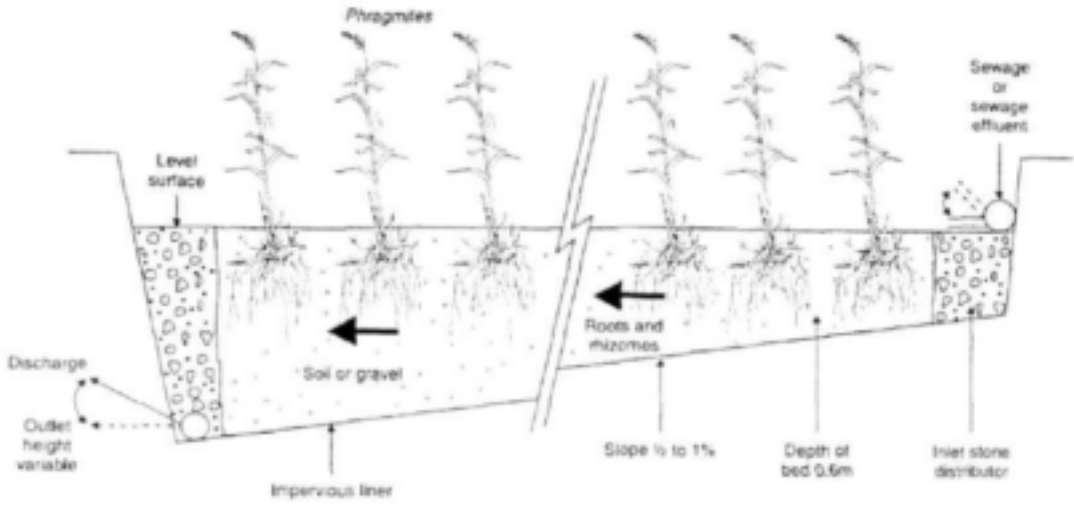
Vertical Flow Reed Beds (VFRBs)



Typical arrangement of a vertical-flow reed bed system

(Cooper et al. 1996)

VFRBs can process a high load of wastewater, but can only be used intermittently. The liquid floods the surface and then percolates downwards and out. The bed then drains completely, allowing air to refill the bed. The next batch of liquid traps these air spaces, thus oxygenating the water. This in turn increases the efficiency of the bed. More than one VFRB bed is necessary so that one bed can drain free while another is in use. VFRBs are less good at removing suspended solids than soluble loading, and therefore in most cases need to be followed by a HFRB as part of a multi-stage treatment system.



Typical arrangement for a horizontal-flow reed bed treatment system

(Cooper et al., 1996)

HFRBs process a lower load of wastewater, but are good at removing suspended solids. The liquid flows through the bed horizontally, beneath the surface of the gravel. Because the wastewater fills all the spaces between the gravel, HFRBs are generally oxygen limited and consequently less efficient then VFRBs. They can, however, be used continuously, so only one is required and they are simpler to operate.

4. How do constructed wetlands work?

First, the wastewater passes through a settling tank (or septic tank) to remove any solid material. Then it flows into the reed beds for cleansing. Organic material and fine particles are removed from the water as they are filtered out by the soil.

From here, micro-organisms (fungi and bacteria) which develop in the planted soil are responsible for most of the treatment. The root and rhizome systems of the reeds bring air into the soil immediately surrounding them, providing ideal growth conditions for aerobic bacteria, which form very high populations on the plant roots and rhizomes. Further away from the roots, the environment is anaerobic. Thus there is a mosaic of treatment spheres, allowing the reed bed to act as a self-contained aerobic/anaerobic digester. This facilitates the impressive ability of reed beds to remove complex and refractory pollutants and reduce them to

environmentally neutral outputs. The majority of treatment is by soil microbes, but certain contaminants (such as heavy metals, sulphur and phosphorus) are removed via soil processes.

The plants are also extremely important in the functioning of the reed bed. As well as providing oxygen and taking up certain nutrients from the water, the plants ensure that water can continually flow through the soil. Soils subjected to COD (Chemical Oxygen Demand) loading tend to degrade either through ion exchange or by neutralisation of the charges on the clay structure, which maintain the particulate nature of the soil. Without plants becoming established, the reed bed would soon block.

Table 3 lists the most important removal mechanisms in reed bed treatment systems.

Table 3 Predominant removal mechanisms in reed bed treatment systems
(taken from Cooper *et al.*, 1996)

Wastewater constituent	**Removal mechanism**
Suspended solids	Sedimentation Filtration
Soluble organics	Aerobic microbial degradation Anaerobic microbial degradation
Nitrogen	Ammonification followed by microbial nit rification and denitrification Plant uptake Matrix adsorption Ammonia volatilisation
Phosphorus	Matrix sorption Plant Uptake
Metals	Adsorption and cation exchange Complexation Precipitation Plant uptake Microbial oxidation/reduction
Pathogens	Sedimentation Filtration Natural die-off Predation UV irradiation Excretion of antibiotics from roots of macrophytes

It takes up to 18 months for establishment of the correct biological matrix. Within this period there is a possibility of partial load removal. After approximately 18 months, the system should be up and running.

5. *Maintenance*

It has been found that remarkably little maintenance is required by HFRBs. The system should be checked regularly to ensure the water is flowing properly and there are no blockages. Once or twice a year, the plants should be harvested and the surface organic material removed. Periodically, solids should be cleared out from the settling tank and composted. In a VFRB, the flow needs to be switched between the parallel beds each week, to allow for drainage.

6. *Effectiveness of constructe d wetlands*

Primary settled sewage: Richmond, Australia

Table 4 Summary of performance of pilot plant at Water Resea rch Laboratory, Richmond Australia.
All values are mg/l averages. (taken from Cooper *et al.*, 1996)

Parameter	influent	effluent	% removal
Biological oxygen demand (BOD)	110	1.6	99
Total suspended solids (TSS)	43	4.8	89
Ammoniacal-nitrogen (NH_4-N)	43	3.2	93
Total Nitrogen	54	43.7	19
Total Phosphorus	8.8	0.06	99

Stormwater treatment

Table 5 Summary of performance of storm sewage overflow treatment plant, Lightmore Heath, Warwickshire.
All values are kg averages. (taken from Cooper *et al.*, 1996)

Parameter	influent	effluent	% removal
Biological oxygen demand (BOD)	14	3.1	78
Total suspended solids (TSS)	34.6	6.2	82
Ammoniacal-nitrogen (NH_4-N)	1.5	0.7	51
Total Oxidised Nitrogen (TON)	1.7	1.1	38

Urban runoff

Table 6 Summary of performance of urban runoff treatment beds. Data combined from Europe, Australia, US, Canada and laboratory experiments (taken from Cooper *et al.*, 1996)

Parameter	% removal
Biological oxygen demand (BOD)	89.5
Chemical oxygen demand (COD)	83.1
Faecal coliforms	99.9
Total extractable Hydrocarbons	96
Lead	27 to 98
Total Nitrogen	27 to 90
Total Phosphorus	0 to 90

Chemical effluent treatment

Table 7 Summary of performance from a reed bed constructed to treat effluent from a chemical plant, UK
(data taken from Rootzone Soil Filters Website)

Parameter	Average Inlet Load (kg)	Average Reduction (%)
Phenol	35	95
COD	624	80
Methanol	118	> 99
Ethanol	270	85
MMA	13	97
DMA	17	> 96
TMA	27	95

Agricultural effluent treatment

Table 8 Summary of performance from a reed bed constructed to treat effluent from a pig farm, Nordhausen, Germany
(data taken from Rootzone Soil Filters Website)

Parameter	Inlet	Outlet	Current Elimination (%)
Total Nitrogen	1574	173.8	88.9
Ammoniacal-nitrogen (NH_4-N)	1364	92.70	93.2
Nitrates (NO_3)	34.10	2.300	93.2
Phosphates (PO_4^{2-})	133.5	0.490	99.6
Potassium (K^+)	884.6	116.5	86.8
Copper (Cu^{2+})	1.140	0.080	93.0

7. *Useful guides for constructing wetlands*

The following are useful guides for constructing wetlands:

Centre for Alternative Technology Website. http://www.cat.org.uk

Cooper, P.F., Job, G.D., Green, M.B. and Shutes, R.B.E. (1996) Reed beds and constructed wetlands for wastewater treatment. WRc, Wiltshire. pp 186.

Kadlec and Knight (1996) give a review on the current state of the art in constructing wetlands. This review explains not only principles of water purification but also detailed engineering guidelines for the construction and management of constructed wetlands.

North American Data Base with data from over 100 wastewater wetlands compiled by Knight *et al.* (1992).

Rootzone Soil Filters Website. http://www.wetlands.com.au/industrialwaste.htm.

5
CONCLUDING REMARKS

In these guidelines, a clear distinction has been made between the use of pristine and altered wetlands. In brief, pristine wetlands should be conserved as a valuable resource, with limited access and use of the wetland that is largely non-invasive and allows the wetland to maintain ecological and hydrological functions. Altered wetlands can be preserved from further degradation or destruction, and rehabilitated at the same time, through providing income from cultivation of economically valuable wetland plants. The wetland will simultaneously provide the local communities with clean water, flood attenuation, and a certain level of biodiversity.

Wetlands are inter-linked and dependent on their catchment areas for their continued health. Polluted water entering a wetland can destroy its functioning over time. Therefore, for the maintenance of pristine wetlands or the rehabilitation of wetlands, it is essential that the catchments upstream of the wetlands are also properly managed.

The new green database of wetland plants with economic potential should be used in conjunction with the Guidelines to select suitable potential wetland cultivation plants and sites.

REFERENCES

Bell F.W. 1997. The economic valuation of saltwater marsh supporting marine recreational fishing in the south-eastern United States. Ecological Economics 21, 243-254.

Botha M. 2001. The Botanical Society of South Africa, Kirstenbosch, Cape Town

Breen C.M., Begg G.W. 1989. Conservation status of southern African wetlands. In: Biotic Diversity in South Africa: Concepts and Conservation, BJ Huntley (ed), Oxford University Press, Cape Town.

Breen C.M., Kotze D.C., Klug J.R., Darroch M.A.G., Oellermann R.G. 1994. Wetland preservation valuation and management practises applied to wetlands and management plans for: Wakkerstroom vlei, Ntabamhlope vlei, Mgeni vlei, Blood river vlei, Boschoffsvlei. WRC Report No. 501/5/94. Institute of Natural Resources and Department of Grassland Science, University of Natal.

Centre for Alternative Technology Website. http://www.cat.org.uk

City of Cape Town. 2001. Noordhoek Catchment Forum, Report 2001.

Cooper, P.F., Job, G.D., Green, M.B. and Shutes, R.B.E. 1996. Reed beds and constructed wetlands for wastewater treatment. WRc plc , Swindon, Wiltshire, U.K.

Cowan G.I. 1995. South Africa and the Ramsar Convention. In: Wetlands of South Africa, GI Cowan (ed), pp 1-11, Department of Environmental Affairs and Tourism, Pretoria.

Denny P. 1997. Implementation of constructed wetlands in developing countries. Water Science and Technology 35, 27-34.

Gessner M.O. 2001. Mass loss, fungal colonisation and nutrient dynamics of *Phragmites australis* leaves during senescence and early aerial decay. Aquatic Botany 69, 325 -339.

Glazewski, J. 2000. Environmental Law in South Africa. Butterworths, Durban.

Kadlec R.H., Knight R.L. 1996. Treatment Wetlands, Lewis Publishers, CRC, New York.

Kassenga G.R. 1997. A descriptive assessment of the wetlands of the Lake Victoria basin in Tanzania. Resources, Conservation and Recycling 20, 127-141.

Kern J., Idler C. 1999. Treatment of domestic and agricultural wastewater by reed bed systems. Ecological Engineering 12, 13-25.

Knight R.L., Rubles R.W., Kadlec R.H., Reed S.C. 1992. Wetlands for wastewater treatment performance database. In: Constructed wetlands for wastewater treatment, Moshiri G (ed.), pp 35-58, Lewis Publishers, Boca Raton, Florida, U.S.A.

Kotze D.C., Breen C.M. 1994. Agricultural land-use impacts on wetland functional values. WRC Report No. 501/3/94. Institute of Natural Resources and Department of Grassland Science, University of Natal.

Kotze D.C., Breen C.M., Klug J.R. 1994. WETLAND-USE. A wetland management decision support system for the Kwazulu/Natal Midlands. WRC Report No. 501/2/94, Institute of Natural Resources and Department of Grassland Science, University of Natal.

Kyle R. 1995. Wise use of wetlands by rural indigenous peopl e. The Kosi Bay Nature Reserve: A case study. In: Wetlands of South Africa, GI Cowan (ed), pp 273 -291, Department of Environmental Affairs and Tourism, Pretoria.

Lindley D. 2001. Wetland Fix. In: Rennies Wetland Project (http://www.wetland.org.za)

Ministry for Agriculture and Land Affairs. 1998. Wetlands. In: Agricultural Policy in South Africa. A discussion document, p 76, CTP Book Printers, Cape Town.

Mandi L., Bouhoum K., Ouazzani N. 1998. Application of constructed wetlands for domestic wastewater treatment in an arid climate. Water Science and Technology 38, 379-387.

Morris J., Gowing D.J.G., Mills, J., Dunderdale J.A.L. 2000. Reconciling agricultural, economic and environmental objectives: the case of recreating wetlands in the Fenland area of eastern England. Agriculture, Ecosystems and the Environment 79, 245-257.

Nebel G. 2001. Sustainable land-use in Peruvian flood plain forests: options, planning and implementation. Forest Ecology and Management 150, 187-198.

Okurut T.O., Rijs G.B.J., van Bruggen J.J.A. 1999. Design and performance of experimental constructed wetlands in Uganda, planted with *Cyperus papyrus* and *Phragmites mauritianus*. Water Science and Technology 40, 265 -271.

Ramsar Convention. 1990. Convention on Wetlands of International Importance especially as Waterfowl Habitat. Proceedings of the Fourth Meeting of the Conference of Contracting

Parties held in Montreux, Switzerland, 27 June to 4 July 1990, Ramsar Convention Bureau, Gland.

Rootzone Soil Filters Website: http://www.wetlands.com.au/industrialwaste.htm

South African Wetlands Conservation Programme. 1997. South African National Wetland Inventory: Catalogue of Inventories. Department of Environmental Affairs and Tourism. Pretoria.

Van Wyk, J. 1999. Planning Law. Principles and Procedures in Land -use Management. Juta & Co. Ltd. Kenwyn.

Verhoeven J.T.A., Meuleman F.M. 1999. Wetlands for wastewater treatment: Opportunities and limitations. Ecological Engineering 12, 5-12.

Vrhovšek D., Kukanja V., Bulc T. 1996. Constructed wetlands (CW) for industrial waste water treatment. Water Research 30, 2287-2292.

PART B

IMPLEMENTATION OF WETLAND CULTIVATION PROJECTS

PART B

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1
INTRODUCTION

1.1 BRIEF BACKGROUND

Wetlands in urban environments are under great pressure due to competition for land resulting from poverty, and inadequate infrastructure and services, particularly housing. As a way to remedy this situation it has been suggested that wetland conservation and rehabilitation would be encouraged if wetlands could be turned into economic assets, and the cultivation of economically valuable plants in wetlands has been suggested (Abbott Grobicki, 2001).

The suggestion that economic incentives are needed to ensure the continued preservation and rehabilitation of urban wetlands resulted in this WRC project. Allied to this was an independently commissioned and funded pilot project to test the concept of cultivation in an urban wetland.

1.2 RELATIONSHIP BETWEEN THE WRC PROJECT AND THE INYIBIBA PILOT PROJECT

The Inyibiba Pilot Project was implemented to test the hypothesis that we tland conservation and rehabilitation can be achieved by turning wetlands into economic assets. As such it formed the practical implementation phase of this WRC project, underpinning many of its aims. The Inyibiba Pilot Project was however not funded by the WRC, which does not fund implementation, but a privately-funded partnership between City of Tygerberg and Abbott Grobicki (Pty) Ltd. It is described in detail in this volume, together with a less detailed description of three other wetland cultivation projects.

The role-players and events associated with the WRC project and the Inyibiba Pilot Project are listed below:

- Water Research Commission;
- Abbott Grobicki (Pty) Ltd, carrying out the WRC project;
- Biotechnology Plant Products (Pty) Ltd, carrying out the Inyibiba Pilot Project;

- City of Tygerberg, which is now the Tygerberg Administration of the City of Cape Town involved with the Inyibiba Pilot Project. This is referred to as the Tygerberg Administration in this report;

- Cape Metropolitan Council (CMC), now the City of Cape Town, involved with the Inyibiba Pilot Project. This is referred to as the CMC in this report;

- Community, and community organisations around Greenpoint (now Sabata Dalindyebo Square), Khayelitsha, involved with the Inyibiba Pilot Pr oject.

The Department of Environmental Management of the CMC commissioned and provided funding for a feasibility study to assess the market potential of growing a particular economically valuable wetland plant, the arum lily (*Zantedeschia aethiopica*), in the urban wetlands of Cape Town (Abbott Grobicki, 1999a and 1999b). Phase 2 of the feasibility study set out to develop a business plan for a wetland cultivation project using the arum lily, and to identify potential sites within the Cape Metropolitan Area where the project could be implemented. The process was supported by a Steering Committee drawn from the Departments of Environmental Management, Catchment Management, and Social and Economic Development of the CMC. Funding for the implementation phase was provided by Biotechnology Plant Products (Pty) Ltd. The outcome of the process was the establishment of the Inyibiba Pilot Project in Khayelitsha.

Details of the interdependence between the WRC project and the Inyibiba Pilot Project are contained in Appendix 1.

2
WETLAND CULTIVATION PROJECTS

2.1 URBAN WETLAND MANAGEMENT

Rivers and wetlands in the Cape Metropolitan Area (CMA) have in the past not been developed as urban features and have usually become degraded. This is largely a function of the industrialization and urbanization of the CMA. Natural drainage of the Cape Flats prior to urbanization was by way of natural wetlands that drained into rivers and streams. Many of these natural wetlands have been drained and filled in, and their environmental functions and ecological value have been lost to the catchment.

The urban stormwater drainage system that was implemented during the urbanization process was purely functional. Urban water courses were canalized, and were often lined with concrete, in order to serve chiefly as conduits for rapid removal of storm water. This approach to urban planning and design has resulted in a reduction of the natural ability of river systems to purify themselves, in the introduction of much waterborne pollution in runoff into urban drainage systems, and in an increase in the volume of runoff.

The water quality of urban runoff from the CMA is generally low. Major problems are as follows:

- Macro-nutrient pollution (in particular forms of nitrogen and phosphorus that are available to plants, causing eutrophication);
- High faecal coliform counts (indicative of faecal contamination of water, and commonly associated with water-borne disease);
- Solid wastes and litter (especially plastics); and
- Hydrocarbon wastes (derived from petroleum products and in particular motor oil).

Fortunately toxic pollutants such as heavy metals do not seem to be a major problem in the surface waters of the CMA, although localized heavy metal contamination of groundwater has been recorded.

Wetlands are now recognized to be extremely desirable in catchment systems, both for their functions in reducing runoff and increasing water infiltration, and for their capacity for water purification. Canalized systems like those of urban areas tend to devalue wetlands, a nd view them as areas requiring improved drainage. The advantages of de -canalising regions of urban rivers and preserving and restoring wetlands include increased infiltration of water and reduction in pollution loads. Wetlands are also areas of great biodiversity and can serve as islands of biodiversity in an otherwise impoverished urban environment, where the numbers of species of plants, animals, insects and birds is very low.

An important function of urban catchment management is therefore to preserve a nd restore urban wetlands where possible (Abbott Grobicki, 2001). However, in South African conditions the pressing needs of people for jobs and housing often take precedence over environmental considerations. Hence projects which can provide tangible bene fits from wetlands to the local community are set to become an important focus for responsible urban catchment management.

This conclusion is based upon the principles and the approach of Integrated Catchment Management (ICM). ICM is a systems approach to the management of natural resources, in particular water resources, based around the catchment area of a river system. In its broadest sense, ICM attempts to integrate all environmental, economic and social issues within or related to a particular river ba sin into a sustainable management philosophy, process and plan.

One outcome of the ICM approach is to view stormwater itself, as well as the land used for the urban stormwater system, as a potential asset to the city and to the local communities (Grobicki and Griffin, 2000).

Stormwater detention ponds and urban wetlands are often managed and maintained solely from the aspect of maintaining their function within the stormwater system, that of ameliorating flood peaks. For the majority of the time these lands cape features are therefore unused. In high-income urban areas, where the wetlands are well -maintained, their aesthetic aspect may be valued for recreational purposes, such as walking or bird -watching. However, in low-income areas the usually degraded and polluted nature of these areas renders them a liability to surrounding communities. There are also public health hazards associated with urban wetland areas, especially for children who are attracted to the water, thus risking physical injury or the contraction of water-borne diseases.

Best management practices (BMPs) in urban catchment management around the world now require local authorities to consider the beneficial re -use of stormwater within the design of urban drainage systems (Thomas *et al.*, 1997), including the creation of wetlands, ponds and recreational facilities. Earlier approaches to BMPs focused upon the use of vegetation to reduce

the level of pollutants found in stormwater run-off (Urbonas, 1994), but without considering the benefits that this practice could have in terms of the urban environment, aquatic ecosystems, and local communities. The major aims of stormwater BMPs should be to:

- control pollution at its source, thereby reducing pollution loads downstream;
- increase infiltration upstream, thereby reducing flood peaks downstream;
- treat stormwater run-off containing pollutants; and
- enhance the urban environment and quality of life for local residents.

In low-income areas there is seldom the finance available within the local authority stru cture to design and maintain the urban drainage system according to such BMP criteria. Through cultivation of high-value plant species, however, an income stream may be generated which allows the municipal land to be managed as an asset, rather than as a liability to the local authority. There are many existing detention ponds and urban wetlands in South African cities which potentially lend themselves to being redesigned for such beneficial use.

2.2 BACKGROUND TO INYIBIBA PILOT PROJECT

The motivation behind the cultivation of wetlands is to promote their conservation and rehabilitation by giving them some economic value. The Inyibiba Pilot Project shared this motivation, and furthermore aimed to contribute to the integrated development of poor communities through facilitating sustainable income-generating environmental projects at the local level, driven by local communities. The feasibility studies leading up to the Inyibiba Pilot Project (Abbott Grobicki, 1999a and 1999b) stated its economic, environmenta l and social objectives as follows :

Economic objectives:

- Turning degraded urban wetlands on publicly-owned land into economic assets, to generate income for local communities;
- Testing the marketability and exportability of the arum lily, with the long -term view of developing arum lily cultivation as an export industry.

Environmental objectives:

- Enhancing the aesthetic of the urban environment;
- Maintaining or increasing the permeable area available for the infiltration of urban run - off;
- Improving the downstream water quality and reducing pollution levels.

Social objectives:

- Providing local recreational amenities and contributing to environmental awareness within the local community;
- Facilitating the establishment of positive working relationships between loc al communities and local government;
- Providing community development through capacity building of local organisations.

The Inyibiba Pilot Project, in adopting an ICM approach, created the opportunity for a methodology to be developed for turning a wetland into an economic asset. It could also determining whether and to what extent the cultivation of a wetland might benefit the

ecological, economic and social aspects of the environment. The monitoring and evaluation of the Inyibiba Pilot Project project are therefore highly pertinent to this WRC project.

2.3 DESCRIPTION OF INYIBIBA PILOT PROJECT PLANNING PHASE

2.3.1 Site Selection

While the Project Guidelines and Decision Support (Volume 1 of this report) were being developed for selecting wetland sites suitable for cultivation, they were used to weigh up the relative merits of 6 wetland sites in the greater Cape Town area as potential cultivation sites.

Table 1 shows the wetland site selection criteria used in evaluating the sites, and Table 2 shows the comparative ranking of the six sites, based upon the selection criteria in Table 1. The sites were assessed for how they satisfied each of the chosen criteria, on a scale ranging from +2 (highly suitable), through Neutral, to –2 (very unsuitable).

The six most important characteristics were taken to be size, current land use, zoning/proposed future land use, land ownership, channel characteristics, and community stability. The score for each site for these six criteria was used to rank the sites for suitability: the higher the positive score, the more suitable the site. Any site scoring –2 for any of these criteria was excluded from further consideration.

Table 1 Site ranking criteria for arum lily cultivation project in Cape Town wetlands.

Primary and secondary criteria are listed along with explanation of what would be considered positive, acceptable and negative attributes of each for purposes of arum lily cultivation.

Characteristic	Positive (+)	Acceptable (0)	Negative (-)
PRIMARY CRITERIA			
Available area	>15 000 m^2	10 000–15 000 m^2	<10 000 m^2
Current land use	Unused/ Public open space	Informal recreation	Used: housing, formal recreation, farming, industry, or nature conservation
Zoning and availability (Proposed land use)	Public open space Available immediately	May be rezoned within the next 5 years/ Not available immediately	Zoned for other purposes/ Zoning contested
Land ownership	Local, provincial or national government	Communal	Private
Flood risk	Low flood risk	Moderate flood risk	High flood risk
Topography	Flat floodplain	Not flat	Significantly higher than channel
Climate	Cool, no frost	Warm/ Cool with frost	Hot
Water availability	Suitable wetland/ Infrastructure for irrigation in place	Infrastructure for irrigation and flow control required	Water not available
Water quality in terms of plant requirements	Unpolluted/ Hypotrophic	Pollution levels within tolerance limits	Pollutants a risk to plant health
Water quality in terms of human requirements	Unpolluted	High faecal coliform counts- worker protection required	Unacceptably hazardous to human health
Ecosystem condition	Moderately disturbed	Highly disturbed	Severely polluted/ Undisturbed
Community stability	Stable community organizations exist with some environmental capacity	Stable community organizations exist	Unstable due to community divisions or conflicts
SECONDARY CRITERIA			
Distance from road	Direct vehicular access	Access could be inexpensively provided	No vehicular access
Distance from work force	<2 km	2 km	>2 km
Distance from airport	<20 km	20–50 km	>50 km
Security	Protected/ Already fenced in	Could be protected	Difficult to protect

Table 2 Ranking of potential wetland cultivation sites

Importance value	Characteristic	Brown's Farm	Hanover Park	Khayelitsha 1 Greenpoint	Khayelitsha 2	Noordhoek	Sunset Park
1	Size	Neutral	Neutral	+1	+1	+1	+1
1	Current land use	+1	+1	Neutral	Neutral	+1	Neutral
1	Zoning/future proposed land use	+2	-2 (excluded)	Neutral	Neutral	Neutral	+1
1	Land ownership	+1	+1	+1	+1	+1	+1
1	Channel characteristics	+1	+1	-1	+1	-1	Neutral
1	Community stability	Neutral	+2	Neutral	+2	+1	+1
SCORE		**5**	**3 (excluded)**	**1**	**5**	**3**	**4**
2	Topography	+1	Neutral	Neutral	Neutral	+1	+1
2	Distance from work force	+1	+1	+1	+1	-1	+1
2	Distance from road	+1	+1	-1	+1	-1	+1
3	Distance from airport	+1	+1	+1	+1	Neutral	+1
3	Security	Neutral	Neutral	-1	+1	Neutral	Neutral
3	Water quality (in terms of plant requirements)	+1	+1	+1	+1	+1	+1
3	Water quality (in terms of human requirements)	Neutral	Neutral	Neutral	Neutral	+1	Neutral
3	Useful plants already present	+1	+1	+1	Neutral	+1	+1
3	Protection from wind	Neutral	Neutral	-1	-1	-1	Neutral

The 4 most suitable of the assessed sites were not authorized for use by the local authorities within the project time frame, while one (Hanover Park) was excluded due to its unsuitable zoning. This wetland was zoned for transport, and in due course will be filled in and paved over, to create a taxi rank. The only site which received authorization timeously, the Greenpoint site in Khayelitsha, was unfortunately the least suitable of the 6 sites assessed (Table 2. Abbott Grobicki 1999a). Nevertheless a decision was taken to proceed with the pilot project on this site, taking it on as a challenge while understanding the many constraints which could hamper its success.

The constraints were as follows:

- The site was not ideal, as predicted. It was not wet enough, and was wind exposed, placing stress on the plants.
- The business plan set ambitious goals of production
- Limited funding was available, not enough to achieve the goals of the business plan. Funding constraints also led to loss of key staff, affecting project implementation.
- The intention was that this WRC project and the Inyibiba Pilot Project would run concurrently, allowing the objectives of the WRC project to be addressed through the process of implementing the Inyibiba Pilot Project. In practice, the pressure of having two separate projects and trying to match their progress required compromises to be made that adversely affected planning and monitoring time frames, and eventual plant productivity. Further delays were caused in meeting legal requirements and other authorization requirements.
- The time and funding constraints compromised the public consultation and subsequent hiring of staff. The speed of implementation also contributed to the various stakeholders (Abbott Grobicki, BPP, Tygerberg Administration, WRC, and Inyibiba staff) neglecting to adequately articulate their roles and responsibilities. For this reason the interface between the WRC project and Inyibiba Pilot Project was not always clear to all parties.
- A shortcoming of the planning for the Inyibiba Pilot Project was that no contingency plans were put in place to cope with the possibility of the site becoming too dry and requiring irrigation. The project was started without obtaining authorization to irrigate.
- When it became evident that irrigation was needed, time constraints precluded applying for the necessary permits.

Lessons learned:

- The disappointing performance of the Inyibiba Pilot Project at Greenpoint underlines the functionality and predictive capacity of the guidelines for cultivation in a wetland in uncovering the limitations of potential cultivation sites. The practical applicability of the site assessment guidelines is thus evident in this case, and the guidelines should be adhered to when planning a project.

- In planning a project, the business goals should be kept modest to begin with, so that a small budget will suffice to support capacity building while experience is gained and productivity established. Once skills and productivity are established, goals can be further expanded.

- The lines of authority and the roles and responsibilities of all parties should be carefully defined during the planning phase.

- The planning phase should not be rushed, allowing time for all necessary legal and other requirements to be met before project implementation.

- Project planning should cater for all foreseeable eventualities. Even though low rainfall is not usually a pressing concern when one is dealing with cultivation in a wetland, application should be made as a matter of course for an irrigation permit.

- Sufficient funding and time must be allowed for the public participation processes to be comprehensive, preferably run by independent consultants, and to make sure that all concerns have been dealt with to the satisfaction of all parties.

- Staff continuity is important, and it is important to budget in order to retain key staff.

2.3.2 Site Assessment

The Greenpoint cultivation site is in Khayelitsha, Cape Town. It is close to the intersection of Spine and Lansdowne Roads, and adjacent to a wetland area (Figs. 1 and 2). The site is situated between a small dune ridge within the floodplain, and the edge of the wetland area.

The site was characterized from historical meteorological data and from information on the vegetation type characterizing the site. These steps followed the guidelines for site assessment.

The area is no longer in a natural state, but has been disturbed and manipulated for more than two decades (Low, 1998).

An informal settlement (part of the surrounding Greenpoint community) is located on the dune ridge. Parts of the wetland area surrounding the informal settlement had been used for dumping of waste and for sanitation purposes by the neighbouring community, who live in unserviced dwellings. As a result the wetland area was contaminated with human faeces, which posed a health hazard, and with general litter. This community was due to be rehoused shortly after the project start date.

The area available for cultivation was 10 325 m^2. The cultivation area did not have an appreciable flow of water through it, the nearest culvert under Spine Road being some 100 m away. The site falls within the 1:50 year floodline as defined in the Khayelitsha Wetlands Management Plan, and lies on average some 500 mm above the summer (dry season) water level of the adjacent wetland area.

It was estimated that the average rise in the water level of the wetland area between summer and winter would be 200 - 300 mm (M. Shand, pers. comm.). Since the groundwater level was at, or slightly above, the level of the water in the wetland area, it was anticipated that the arum lily bulbs would be planted in the soil at a height slightly above the water ta ble, which would allow their roots to access the groundwater.

As a result of the site location, there was a possibility that water stress to the plants might occur during the drier summer months, and that too much water in winter might damage the arum lily plants. It was proposed to actively manage water levels in the wetlands to avoid flooding (M. Shand, pers.comm.) Irrigation was recommended in the original feasibility study (Abbott Grobicki 1999b). However, the level of project funding did not allow for the installation of an irrigation system. Secondly, a 6 to 9 month delay would be caused to the project by seeking authorisation for such a system from the Department of Water Affairs and Forestry. It was therefore decided within the project Steering Committee to start the project without an irrigation system in place.

Figure 1 Aerial photograph of the Inyibiba Pilot Project site at Greenpoint, Khayelitsha.
The Kuils River channel and *Typha capensis* stands are to the right of the photograph.
Scale: 1:5000

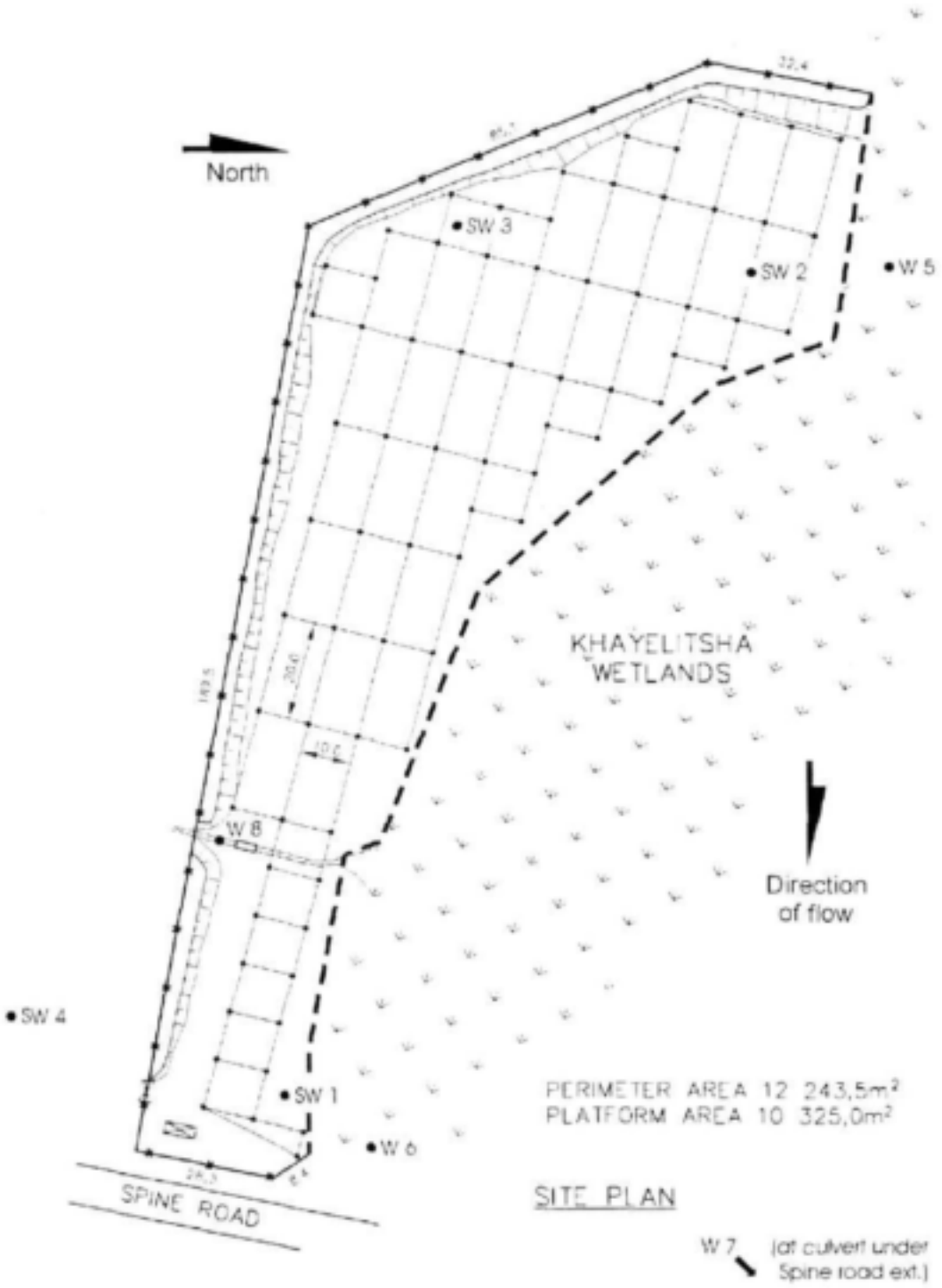

Figure 2 Inyibiba Pilot Project site at Greenpoint, Khayelitsha showing sampling sites.
SW = soil and groundwater sample sites, W = water sample sites.

The wetland flora consist of a Marshy Flats community, a Channel Bank community and Floodplain communities, dominated by the reed *Typha capensis* and the invasive kikuyu grass, *Pennisetum clandestinum* (Table 3).

Table 3 Plant communities and dominant species recorded at the Inyibiba site before arum lily cultivation. Species and community data are from Low, 1998.

Community	Dominant species	Common name	Comments
Marshy Flats	*Bersia erecta*	Water parsnip	May have medicinal use: analgesic.
	Persicaria spp.	Snake root	
	Zantedeschia aethiopica	Arum lily	
	Cyperus spp.		
	Cyperus cf. *haspiglatus*		
	Mentha aquatica	Water mint	Several medicinal uses.
Channel Bank/Floodplain	*Stenotaphrum secundatum*	Buffalo grass	Grazing
	Cynodon dactylon	Fine quick	Grazing
	Paspalum sp.		
	Bolboschoenus maritimus		
	Chondropetalum tectorum	Cape thatching reed	Thatching
	Pennisetum clandestinum	Kikuyu	Grazing

Day & King (1998) reported that the invertebrate fauna of the water body immediately below the site indicate that the rivers have become perennial. Nutrient discharge into the river at this point and upstream suggests that eutrophication may be a problem with the relatively recent appearance of large stands of *Typha capensis* supporting this conclusion. As a result of changes from a seasonal to a eutrophic perennial system, the current wetland is not considered to be of regional or international importance (Day & King 1998).

2.3.3 Authority Approval

Although six sites were initially evaluated within the feasibility study (Abbott Grobicki, 1999b), only one of them was timeously approved by the authorities, and negotiating for authorization caused delays with project implementation.

As a means of managing the Khayelitsha wetlands, the Khayelitsha Wetlands Management Plan makes provision for river maintenance programmes to be implemented. The Inyibiba Pilot Project was viewed as part of such a river maintenance programme.

Since the project fitted within the objectives of the Khayelitsha Wetlands Management Plan, it was supported by the local government authorities with jurisdiction over Khayelitsha. These authorities included the Environmental Committee of Tygerberg Municipality, the Planning Department of Tygerberg Municipality, and the Environmental Management and Catchment Management Departments of the Cape Metropolitan Council, as well as the CMC Department of Social and Economic Development.

As a result of this support, the use of the Greenpoint site in Khayelitsha for the Inyibiba Pilot Project was formally authorized by the CMC Catchment Management Department (environmental authorization) and the Tygerberg Municipality (land use authorization).

Lessons learned:

- The in-principle support and authority approvals must be obtained as early as possible in the planning process, and allowance made for possible delays in project implementation while the authorization procedures are followed.

2.3.4 *Public Participation*

Support for the Inyibiba Pilot Project was established at a caucus meeting of ANC councilors from the Khayelitsha area. The three local councillors whose wards a re immediately adjacent to the area were all contacted personally, and all supported the concept of a job -creation project in the wetland area. These were Councilors Kula, Kuthe, and Makhelani.

Meetings with community leaders and representatives were held on three occasions before the launch of the Inyibiba Pilot Project in May 2000 (Abbott Grobicki, 2000). One of the organisations consulted was the Homeless People's Federation (HPF), and it was agreed that women workers only would be recruited from within HPF. This agreement was made public, together with the gender aspect of the project. When the project commenced, staff were therefore sourced through HPF and not directly from the surrounding Greenpoint community. This became a source of conflict between the Greenpoint community organisations (RDP and SANCO) and the HPF -sourced staff.

A meeting was held to resolve the conflict. It emerged that the Greenpoint community viewed the HPF-sourced staff as 'outsiders' who had no right to work on a project in Gre enpoint.

Secondly, the HPF was not viewed as the correct organization to be facilitating job-allocation in Greenpoint. It was felt that the local RDP was the correct organization to handle this. Thirdly, the RDP and SANCO insisted upon gender equity in the project, i.e. equal numbers of women and men workers. This meeting was documented by a community development worker who attended the meeting (Mokoena, 2000, pers. comm.).

The outcome of the meeting was that the local RDP undertook to provide replacement staff through its own selection process, which appeared to be a random process of selecting the names of jobless community members out of a hat.

The difficulties described above highlight how fraught the process of entering a community can be, albeit with the very best of intentions. As observed by the community development worker present at the meeting, '*the situation in the community reminded me of an important aspect of community work, that is, the process of negotiating entry or access in a community.*'

Lessons learned:

- An important aspect of entry to a community is that the individuals within the community are the ones who must be informed of the planned project and be allowed to articulate their concerns. Full-scale public participation can be a very slow process, but in order to fully ensure the community's commitment to the project it is a necessary procedure which must be carried out with meticulous attention to detail. This may mean that a project has to be delayed while community concerns are explored and addressed.

2.3.5 Species Selection

At the outset the project philosophy was to adopt a cultivation strategy that would allow a range of plants in addition to the main crop to be grown. This was based on elements of the permaculture system of Mollison (1988). The supplementary plants would be chosen for the multiple functions they could provide, such as supplementary income, water and soil retention, wind shelter, shade, and ground cover.

Several high-value plant species have potential for cultivation in urban wetlands. Of the number of types of plant that may be cultivated in eutrophic urban wetland systems such as that at Greenpoint, food and medicinal crops are potentially the least appropriate. Urban runoff is commonly contaminated, and on the Cape Flats a combination of faecal contamination and hydrocarbon runoff make the water unsuitable for production of food or medicinal crops. Faecal coliform counts in the Lotus River Catchment and Kuils River exceed the South African Water

Quality Guidelines for domestic use, full-contact recreation, irrigation of crops for consumption (raw and cooked) and irrigation for dairy cow grazing (DWAF, 1996).

The contamination of the Greenpoint site and of the water led to a search for high- value plant species with other uses to provide economic benefits and jobs in the local community while facilitating the maintenance of wetland function.

Whilst arum lilies for flower production would provide the economic backbone of the project, it was also intended to grow a range of other useful plants on the site (Abbott Grobicki, 1999b). Most of these additional plants were investigated due to their ability to provide more than one benefit.

Arum lily

Zantedeschia (arum lily or inyibiba) were selected for their capacity to produce flowers, and because their methods of cultivation and marketing are well established. The flowers were intended mainly for export sale. Arum lilies are becoming increasingly popular on the local and the international flower markets. Between 1995 and 1997 arum lily species were the only crop to move into the top 30 of flowers sold at the massive Netherlands Flower Auction at Aalsmeer. Locally, sales of arum lilies have tripled over the last three years. The arum lily therefore seems a plant with enormous potential for commercial cultivation, and being a wetland plant it was selected for cultivation in the Inyibiba Pilot Project. The potential market value of the arum lily was investigated and reported in Abbott Grobicki (1999a).

Reeds

Water purification was also an aim of the wetland cultivation project, and it was intended that reeds would also be cultivated.

The reedbeds would serve several functions: to provide a windbreak; to offer some shade to other plants; to maintain ecological wetland functions (including water purification and the provision of a habitat for birds); and to allow the assessment of various reeds as commercial crops. A reed with well-known capacity for water purification, *Typha capensis*, was growing in the immediate area and was to be introduced to the site. Another potential crop plant, *Juncus kraussii*, was of interest as it is indigenous to the Cape Flats wetlands (Low, 1998) and nationally is an important source of fibre for handcraft (Heinsohn, 1991; Mander *et al.*, 1995). Reeds can also be used to produce hand-made paper. Other reed crops that were under consideration were *Phragmites australis* and various *Cyperus* species.

Vetiver grass

It was planned to plant lines of *Vetiveria zizanioides* (vetiver) along contours. Vetiver contours planted in this way could reduce erosion and stabilize the banks (World Bank, 1993). Essential oils produced in the roots of vetiver grass are used as a carrier oil by the perfume industry (Guerlain even produces a fragrance: Vétiver), and vetiver could prove to be a valuable supplementary crop. Vetiver is non-invasive (it does not set seed under South African conditions), and has been used successfully for bank stabilization in the Western Cape. Vetiver is also tolerant of both drought and inundation, requiri ng little upkeep.

Luffa

Luffa aegyptica and *L. cytindrica* were to be planted along the fences. The fruit of luffa is a gourd, edible when the plant is young. As they age, the gourds develop a network of tough fibres to which the seeds are attached. It is these fibres, once the seeds and skin have been removed, that make "vegetable sponges". There is a large market for Luffa sponges. Growing them around the site perimeter would provide wind protection, enhance site aesthetics, and provide a supplementary crop at very little cost.

However, it was not possible to obtain authorization, from the then Department of Cape Nature Conservation, for cultivating any plants other than those which occurred naturally on the site (see Table 3), due to the sensitive nature of wetland environments in general. Therefore the plant selected for cultivation was *Zantedeschia aethiopica* which is indigenous to the area, together with other *Zantedeschia* cultivars.

Lessons learned:

- The problems around obtaining permission to grow certain useful plants highlight again the necessity to consult with the authorities as early as possible in the planning phase to ensure that enough time is provided to explore all avenues for obtaining necessary authorizations.

2.3.6 Business Planning

1. Market assessment

The South African and international market for arum lily flowers was investigated.

The South African market for cut flowers is centered around Gauteng and Pretoria, though informal markets exist at least in Cape Town and Durban. The export potential of arum lily species is high. Producers are scattered around the world, while markets are biggest in Europe (the Netherlands especially), the United States and Japan. The Netherlands is the largest market

for cut flowers, and is simultaneously a major exporter of flowers (mostly by re-export following import from producers, though many flowers are also produced in the country).

The arum lily is one of the 30 most popular flowers at the Aalsmeer market, and is increasing in popularity relative to most other cut flowers. Exporters in South Africa stated that they could sell all the arums that could be produced, provided the product was of sufficient quality. Expected prices for exported blooms were R7.00 compared to 80 cents - R1.00 for local sales. The street value of arum lily blooms in Europe averages R25.00 per bloom.

The Western Cape floriculture industry is small, employing about 5000 people seasonally. The market is limited by inexperience, lack of market penetration, lack of start- up finance for small growers, and the absence of organized flower markets in the region. Thus there was an opportunity to enter this market.

2. Expenditure, Income and Business Plan

Set-up Capital Expenditure

The estimated set-up capital expenditure for a 2 hectare site are shown below. The estimates include all delivery, installation and labour costs.

Cost of plants	R655 000
Cost of fencing	R80 000
Site excavation	R35 000
Irrigation equipment	R85 000
Site infrastructure (a)	R70 000
TOTAL SET-UP CAPITAL COST	**R925 000**

(a):This figure includes a tool shed, with shelving, gardening tools, planks, plastic chairs and a table, buckets, brazier, and any other items necessary for the gardeners and security guards, together with the installation of a 3-phase supply of electricity for the pump station.

The Inyibiba Pilot Project was undertaken on a 1 ha site, reducing the set -up costs accordingly. The actual set-up costs for the Inyibiba Pilot Project 1 ha site were as follows:

Cost of plants	R129,556.68
Cost of fencing – Tygerberg	R32,720.74
Site excavation – Tygerberg	R35,000.00
Irrigation equipment	N/a
Site infrastructure (a)	R10,256.57
TOTAL CAPITAL SET-UP COST	**R207,533.99**

(a):This includes container hire and all tools, equipment, protective clothing.

The site excavation and fencing was funded by the Tygerberg Administration. No irrigation system was installed.

The business plan was drawn up for a 2 ha arum lily cultivation site (Abbott Grobicki 1999a; 1999b). The business plan for cultivating a 2 ha site over 5 years is shown below.

Table 4 Business Plan for Arum Lily Cultivation for Export

For *Zantedeschia aethiopica* cultivation at Khayelitsha - basic scenario

						125
						R 0.30
Planting Area (m^2)	22 476.0					R 70.00
Planting Density per m^2 (5-6)	5					R 1,540.00
No. of plants in 32 units	112,350					R 4,620.00
No. of plants per unit	3511					R 6,000.00
						R 3,500.00
						R 3,000.00
Packaging costs :						R 2,000.00
Price per box	R 7.00					R 6,000.00
No. of cut stems per box	50					R 4,000.00
Value of cut flower (average)	R 1.10					R 4,000.00
22 average units	231721.875	463443.75	463443.75	463443.75	463443.75	
6 high-yield units	0	168525	315984.375	315984.375	315984.375	
4 experimental/mixed units	50024	100132	100132	100132	100132	
Total number of cut stems	281,746	732,101	879,560	879,560	879,560	
Reduce by 20% for spoilt flowers	225,397	585,681	703,648	703,648	703,648	
TOTAL INCOME	**R 338,095**	**R 878,521**	**R 1,055,472**	**R 1,055,472**	**R 1,055,472**	
No. of Seasonal Flower Pickers	34	89	107	107	107	
No. of Seasonal Flower Packers	3	8	5	9	9	
Total picker wages	R 67,619	R 175,704	R 211,094	R 211,094	R 211,094	
Total packer wages	R 13,860	R 36,960	R 41,580	R 41,580	R 41,580	
Training for Pickers and Packers	R 3,000	R 6,000	R 6,000	R 6,000	R 6,000	
Packaging	R 31,556	R 81,995	R 98,511	R 98,511	R 98,511	
Transport - truck hire, insurance for 3 months	R 18,000	R 18,000	R 18,000	R 18,000	R 18,000	
Truck driver - code 10	R 10,500	R 10,500	R 10,500	R 10,500	R 10,500	
Office Costs (rent,elec.,water)	R 36,000	R 36,000	R 36,000	R 36,000	R 36,000	
Site lease costs						
Site maint. (water channels, pest control etc.)	R 24,000	R 24,000	R 24,000	R 24,000	R 24,000	
Staff Salaries	R 168,000	R 168,000	R 168,000	R 168,000	R 168,000	
TOTAL RUNNING COSTS	R 372,534	R 557,159	R 613,685	R 613,685	R 613,685	
ANNUAL CASH FLOW	**R -34,440**	**R 321,361**	**R 441,787**	**R 441,787**	**R 441,787**	
Cumulative Cash Flow	**R -34,440**	**R 286,922**	**R 728,709**	**R 1,170,496**	**R 1,612,283**	

Running costs were estimated as part of the project budget discussed above. For the 1 ha site of Inyibiba Pilot Project (half of the area budgeted for) it was estimated that the running costs would be slightly more than half of those for a 2 ha site, because of the economies of scale inherent in working on a 2-ha site.

3. Institutional arrangements

The Inyibiba Pilot Project was established as a partnership between Biotechnology Plant Products (BPP) and Tygerberg Administration. This partnership was initially a verbal understanding, and later formalised only by an exchange of letters. BPP provided funding, and carried out project planning and management. Tygerberg Administration provided the site and funded the site preparation and fencing.

The Cape Metropolitan Council, which funded the feasibility studies, and the Water Research Commission, which funded the monitoring and evaluation of the site as part of this report, are acknowledged on all project publicity material as co-partners.

2.3.7 Species sourcing

Arum lily rhizomes were purchased from commercial nurseries. Three cultivars of rhizomes were purchased - Pink Marshmallow, White Mischief, and Indigenous Whites. In addition, wild arum lilies growing within 300 m of the site were foraged and replanted on site.

The cost of plant purchase was in excess of R120 000.00.

Lessons learned:

- Every attempt should be made to collect plants from the wild, and to rescue plants from sites slated for development. This reduces capital expenditure and avoids needless destruction of wild plant material.
- Ensure that the appropriate plant collection permits have been obtained from the provincial conservation authorities.

2.3.8 Site design

The design for the site involved clearing and flattening the site to remove humps, tussocks and alien vegetation. The level of the site is 500 mm above the summer water level of the adjacent wetland area. It was felt that the groundwater wou ld probably be sufficient for the plants.

It was estimated that the average rise in the water level of the wetland area between summer and winter is between 200 and 300 mm. Since the groundwater in the area is at or slightly above the level of the water in the wetland area, the arum lily bulbs would therefore be planted in the soil at a height slightly above the water table, which would allow their roots to access the groundwater. It was therefore not envisaged that any additional irrigation of the plants would be required for their growth. The site was fenced in order to ensure the security of the plants and flowers.

The cultivation site is shown in Figure 1 and 2 above.

2.4 DESCRIPTION OF INYIBIBA PILOT PROJECT IMPLEMENTATION PHASE

2.4.1 Site preparation

The Inyibiba Pilot Project was officially launched by the Mayor of Tygerberg. Site establishment (site preparation and planting) and the official launch were recorded on video, and a short clip of the launch ceremony was screened on SATV.

After being graded and cleared of all alien vegetation and trees by Tygerberg Administration the site was prepared for planting by removal of tree stumps, spreading of compost and digging of drainage channels. Depressions were filled and berms created. The site was demarca ted into 300 m^2 plots using nylon string.

Five channels were dug for the planting of windbreaks of *Typha capensis* . The reedbeds in these channels were to have several functions: to provide a windbreak; to offer some shade to plants; to maintain ecological wetland functions (including water purification and the provision of a habitat for birds); and to allow the assessment of reeds as commercial crops. The reeds for the windbreaks were taken from plants in the adjacent wetland. Access pathways and "dune - scaping" was conducted to make the site accessible for weeding, planting and watering.

2.4.2 Planting

Three cultivars of rhizomes were purchased and planted as indicated below.

Cultivar	Number of rhizomes planted
Indigenous white ex Bloemendal Nursery	5 625
Pink Marshmallows ex Umpukane Flora Nursery	24 153
White Mischief ex Malanseuns Nursery	3 000 split into 6 875 rhizomes

Due to delays experienced in authorisation of the site, the rhizomes were planted later than the ideal, in May and June 2000. This gave them very little time (2 – 3 months) to establish themselves before they began to flower, with the result that flower production was lower than anticipated by the business plan. These problems were exacerbated by the unexpectedly low winter rainfall experienced in 2000.

Lessons learned:

- Do not compromise on ideal planting times.

- Make allowance in the business plan for a low productivity in the first season due to delays in implementation or other unforeseen circumstances.
- Plan for irrigation so that it is available to boost production.

2.4.3 Irrigation on site

After planting it became evident that irrigation was necessary for several reasons;

- The winter season had below average rainfall;
- The water table fell much lower than had been expected;
- The pink marshmallow variety required summer rainfall to break dormancy.

Although irrigation from a borehole would require only general authorization (DWAF representative) the groundwater itself was unsuitable as irrigation water. Tests revealed that it was highly saline, and using it for irrigation would have added to the salinity problems on the site.

Hence the Kuils River was the only suitable source of irrigation water. However, even small - scale extraction of river water could not be carried out without a permit. Since it was anticipated that this process could take up to six months, by which time the flowering season would have passed, permission to irrigate from the Kuils River was not requested.

Lessons learned:

- Project planning should cater for all eventualities, and all necessary permits must be applied for timeously, before project implementation. This is particularly important when the crop has specific water or other growth requirements which do not match the local climate.
- Growers should avoid using plant varieties unsuited to local conditions.

2.4.4 Flower production

The terms of the environmental authorisation stated that there could be no use of fertiliser or herbicides and pesticides on site. This constraint placed limits on the production which was achievable, since the soil was nutrient-poor, and therefore rhizomes did not receive adequate nutrients to optimize their growth and productivity. As a result the yield of flowers was lower than anticipated by the business plan.

Cut flowers were picked and sorted over the flowering period to assess the yields. The table below shows flower production.

Table 5 Flower production from 27 October to 24 November 2000
(source B. Digby).

Cultivar	No of rhizomes planted	Flower Stem length (cm)	Number of flowers cut	Flowers produced
Indigenous white	5625	20cm and less	109	566 per 5625 or 1 per 10 rhizomes
		30-40	349	
		50-60	108	
Marshmallow	24153	20cm and less	863	1048 per 24163 or 1 per 24 rhizomes
		30-40	175	
		50-60	12	
White mischief	6875	0	0	0
Total	36 653			1 614 flowers

The environmental authorisation required that the risk of cross -pollination between indigenous arum lilies and the other cultivars be minimised by harvesting the flowers of Marshmallow and White Mischief before they produced pollen. This placed constraints on the quality of flowers which were produced. Thus a large majority of the Marshmallow flowers harvested were less than 20cm in length. Under normal cultivation circumstances, Marshmallow flowers would be left to flower fully, and the stems would have lengthened further before reaching harvest condition. Under normal circumstances, exporters require Marshmallow flower stem lengths to be at least 35cm.

Indigenous White flowers were picked once they were ready to be sold. While exporter s require stem lengths of at least 50cm the local market will readily accept shorter stem lengths.

Lessons learned:

- Growers must ensure that plants are given the best possible treatment to foster maximum productivity.
- Growers must give preference to robust plant varieties which can thrive under local conditions.
- Plant varieties which attract restrictive management constraints that may interfere with optimal productivity should be avoided.

- If the plan is to produce export-quality flowers from plants growing at a high density, then in cultivation in a wetland, the grower needs to obtain permission to feed the crop with fertiliser in order to keep up the production levels. Alternatively, other methods of feeding the plants must be adopted that meet with the approval of the authorities.

2.4.5 Site maintenance

During the clearing of the Inyibiba Project site, a large quantity of litter and human waste was cleared from the wetland area, and removed to a municipal landfill site. Thereafter, the site was maintained by project workers on a daily basis, being kept free of wind-blown litter. The surrounding area was also periodically cleared of litter by project workers. The Tygerberg Municipality provided toilets for the use of site staff, and refuse removal was carried out on a regular basis. Hence a large, formerly degraded urban wetland area (over 1 hectare in size) was kept waste- and litter-free for the duration of the project.

Lessons learned:

- It is important for local authorities to be made aware of this aspect as one of the key benefits of this type of project. Litter and human waste are often the most visible form of wetland degradation. The presence of staff on the cultivation site every day facilitates labour-intensive methods of litter control. For instance, where there is a single inflow into the site such as a stormwater canal, a cheap, labour-intensive litter trap such as a wire basket can be installed (Armitage 1998), eliminating or reducing the need for a costly, capital-intensive type of litter trap further down the stormwater system.

2.4.6 Staff

Three permanent site workers and two security staff were employed on the Inyibiba Pilot Project. The project also employed a full-time manager-horticulturist. In addition, casual work was provided for 758 person-days.

The manager-horticulturist was responsible for site preparation, staff training and general site management. Staff were trained in site maintenance, planting, flower picking and packing. When funding constraints forced the resignation of the manager-horticulturist, it was found that the site workers were unwilling to manage the site themselves, despite the training received. The project was then temporarily abandoned, pending restructuring and fund-raising, after just 1 year in operation.

Lessons learned:

- It is important to have a manager who is on site each day, and who is able to train and supervise staff in proper procedures.

2.5 COMPARISON WITH OTHER WETLAND CULTIVATION PROJECTS

Having made an analysis of the Inyibiba Pilot Project and the lessons to be learned from it, it is useful to examine some other wetland beneficiation projects in South Africa. Site visits were carried out to three projects carrying out cultivation in a wetland, two in KwaZulu -Natal, and one in Cape Town, Western Cape. These projects are discussed below, and compared in the table.

2.5.1 Peace Lily Project

Extensive discussion was held with the Project Manager, Brett Young (pers.comm.), as well as with the implementing agency, Abalimi Bezekhaya (R. Small, pers.comm.).

The project, funded by British Petroleum (BP), has a manager and two staff. The manager is on site each day, for a part of the day. At the moment the manager works at no cost to the project, with the agreement that when the project becomes profitable, the profits will be shared equally between him and the HPF. Although the two staff are 'employed' by the Homeless Peoples Federation, they are paid through Abalimi Bezekhaya from the BP fund. The project costs are also covered by the same fund. However, the project in come is now providing an additional source of revenue which is used to pay project costs and staff salaries, effectively supplementing the BP fund.

The two staff are responsible for all the site work, beginning with preparing the ground for planting, to planting, tending and weeding, and finally picking and packing the flowers for sale. All the plants were rescued at no cost (other than transport and labour) from the surrounding areas of Cape Town, from sites slated for development. The bulbs of these plant s were split whenever possible before planting. Planting took place in early 2000. Fertilisation of the plants by kraal manure took place only at planting. Irrigation was supplied during planting, to assist the plants in establishing themselves.

The area under cultivation is currently 4000m^2 including pathways. Although there are 6 plants per m^2, the density is less than this in some places due to die -back. Thus a total of

approximately 15 000 plants are available for harvesting. However, because of the occ urrence of periodic flooding of portions of the site, less than the full complement of available plants are harvested at any one time.

For example, in August 2001 only 2 500m^2 was available for harvesting. The plants on the remainder was not producing flowers due to having been inundated with water at various stages of their growth in the 2001 season. Nevertheless, a total of 5 500 flowers were harvested and sold locally during August 2001, producing an income of R3 500.

The total costs of the project since the inception in 2000 are R106 500, while income to the project to date has been R11 000 from bulb sales and R4 300 from flowers. The project manager is of the opinion that this project will become sustainable in another 2 -3 years. By sustainable he means it will cover its costs without requiring external funding, and will be able to employ a manager as well.

Whilst informal skills training has taken place on site, a more important factor has been a natural development of skills based on experience gained in planting, growing, harvesting and marketing of Arum Lilies over an eighteen -month period. This has been possible because the flowers are sold to the less -exacting domestic market. In the future, the skills developed through this hand-on experience will provide a firm foundation for the production of flowers that satisfy the rigorous quality standards required for success in the export markets.

2.5.2 Mondi Fairbreeze Ncema Project

The project is taking place on the KwaZulu-Natal north coast, on a wetland on the Mondi - owned property Fairbreeze.

Extensive discussion was held with the managers, Gavin and Albert Eichler (pers.comm.). The site is within a rural area, and although on a forestry plantation it is surrounded by sugarcane fields. The project entails growing ncema plants (*Juncus kraussii*) for production of crafts for the domestic market. The first ncema was planted in 1997, and there is now an area of 3000m^2 planted with ncema.

Mondi have at no charge made a building available for use by the group of crafters, and also provide the wetland cultivation site at no charge. The site establishment and management is funded by the Department of Arts, Culture, Science and Technology (DACST) and Mondi. However, the management is only for the establishment phase , and thereafter there will be no management input and it will be up to the workgroup to manage themselves.

There are currently five people, four women and one man, who do all the tasks, such as caring for the plants, harvesting the ncema, and creating cra fts from the harvested ncema. I have called them the 'share-holder' workers, since they are not paid except for planting and weeding, and their income will be derived from the ncema directly. The group is responsible for its own structure, functioning, and profit sharing. The members of the group were selected from amongst established crafters in the area. Local crafters had been purchasing ncema from far afield since there was none available locally. This ncema cultivation project will provide a local source of ncema to the group as well as to other crafters in the area.

Income from the cut bundles of ncema (should any be sold instead of being used for craft production), and from the craftwork produced, goes directly to the five 'share -holder' workers in mutually-agreed proportions. They have formed an Association, and regulate their affairs themselves without outside influence. This may be a benefit of operating outside of the highly - populated urban settlements. In urban areas many people tend to compete fo r the few economic opportunities that may become available through project such as those under discussion, and the very creation of economic opportunity can become a source of conflict in the 'community'. In rural areas, on the other hand, this is likely to be less of a factor in the success of the project.

There has not yet been any income from the ncema. The project had barely started in 1997 and 1998 when it stopped for various reasons. It was only re -started in 2000, when ncema seed was planted and the overgrown 1997 plants were weeded. Both the 1997 plants and the 2000 plants are now ready to be harvested. The INR estimates that the ncema area will be able to generate R36 000 per season if the ncema is used for making mats (INR, 2001).

2.5.3 Groutville Ncema Project.

The third site is peri-urban, located on land belonging to the Albert Luthuli Trust at Groutville near Stanger. The Trust is involved with training in agriculture, and has a medicinal plant nursery and the ncema project, both in their early stages. As is the case for the Mondi project, the ncema is for craft production for sale on the domestic market (D. Kotze, pers. comm.).

The pilot project is being implemented by the Institute of Natural Resources (INR) at University of Natal – Pietermaritzburg. Start-up funding was provided by Landcare to plant an area of $100m^2$ of ncema in 1999. The Department of Environmental Affairs and Tourism (DEAT) has since provided additional funding to expand the pilot project.

The project is managed by a Trust sta ff member, and technical assistance is provided by INR staff. The Trust staff member is on site most days of the week, at no cost to the pilot project. The Trust also makes the land available at no cost.

There is now a formally constituted group of 10 who are planting ncema on a further 1000m^2. The group are paid for planting the ncema by the DEAT fund. Once planting is complete their income will be derived solely from their ncema crop, either through selling cut bundles, or through manufacturing and selling ncema crafts. Income of R12 000 per year is expected if the ncema is used to make mats.

Table 6 Comparison of Inyibiba Pilot Project and three others

Project	Starting Date	Funding Source	Implementing agent	Crop/ Use/ Market	Manager/ cost to project	Workers	Legal status of workers	Project Income/ Year/ Area	Impact on Bio-Physical Environment	Impact on Local Economy
1. Peace Lily	2000	BP: R218 000 HPF: land	Abalimi Bezekhaya	Arum lily/ Ornamental/ Domestic	Yes/ No	2 women	Employees of HPF	Actual: R16 000/ 4000 m^2	Conserves wetland in urban area	2 jobs
2. Fairbreeze Neema	1997	DACST: R36 000 Mondi: R15 000, land and facilities	Mondi and INR	Neema grass/ Crafts/ Domestic	Yes/ Yes	4 women, 1 man	Association	Projected: R36 000/ 3000 m^2	Neutral	Creates opportunity for income to 5 people
3. Groutville Neema	1999	Landcare: R10 000. DEAT: R10 000	INR and Albert Luthuli Trust	Neema grass/ Crafts/ Domestic	Yes/ No	8 women, 1 man	Informal Group with Constitution	Projected: R12 000/ 1000 m^2	Conserves wetland as peri-urban area	Creates opportunity for income to 10 people
4. Inyibiba Arum Lily	2000	Private donor: R310 000 Tygerberg City: site preparation and fencing	Biotechnology Plant Products	Arum lily/ Ornamental/ Export	Yes/ Yes	1 woman, 4 men	Employees of Biotechnology Plant Products	Actual: R428/ 10 000 m^2	Conserves wetland in urban area	5 permanent jobs; 758 temporary day jobs

2.5.4 What lessons can be learned from this comparison?

The main differences between the three projects and Inyibiba Pilot Project are that the Inyibiba Pilot Project had set high goals for itself, that of producing flowers for export, and had established itself on a large area immediately, thereby stretching the limited budget. The other projects have all set more modest goals for themselves, namely to progress slowly while developing their skills and learning from their experiences, to cultivate a relatively small area initially, and to sell their products on the domestic market, specifically to the local domestic market.

Whilst it is true that the Inyibiba Pilot Project failed to achieve its own goals of exporting flowers, it nevertheless has the immediate potential to achieve the more modest goal of selling flowers on the local market, along the lines of the Peace Lily Project. Althoug h flower production on the Inyibiba Pilot Project was unexpectedly poor during the first cultivation season, there is no reason why productivity can not be improved sufficiently to supply flowers locally.

A further difference is that while Inyibiba Pilot P roject chose to plant cultivars of arum lily in addition to the indigenous plants, the other projects make use of only indigenous plants occurring naturally in the area and which are thus fully suited to local conditions.

On the positive side, the Inyibiba Pilot Project provided a large number of person-days of employment (far more than the other three projects), injecting significant income into a community that has a high unemployment level.

As far as ncema cultivation is concerned, the INR is at pains to point out that this is not an easy way to make money, and recommends that a small area be cultivated to begin with (INR, 2001). This caveat could well be applied to most other agricultural enterprises, including Arum Lily cultivation. In dealing with natural systems whose functioning depends on interactions between plants and the bio-physical environment, allowance should be made for an initial period of build-up during which experience is gained and skills are built.

3
EFFECTS OF CULTIVATION IN A WETLAND

This section describes the effects of cultivation in a wetland on biophysical, economic and social environmental criteria.

3.1 BIOPHYSICAL EFFECTS

Although most of the biophysical effects discussed below may be expected to be slow to manifest, there were some more immediate and obvious physical effects and these are noted first:

- Litter and human waste was cleared from the site, and new dumping prevented.
- Alien invasive plants were removed, and new infestations prevented.
- The wetland area was preserved from additional degradation.
- Grazing and trampling of the wetland by domestic stock was prevented.

The biophysical indicators monitored were soil, groundwater and surface -water. The detailed results of soil and water monitoring are described in Appendix 2.

3.1.1 Sampling sites and schedules

The sampling sites are shown in Figure 2. Soil and groundwater samples (SW) were taken at four sites. A control sampling site was located outside the cultivated area. Surface water samples (W) were taken upstream and downstr eam of the site to facilitate observation of any change in the surface water quality as influenced by planting the site. Another surface water sample was taken at the run-off channel from Sabata Dalindyebo Square (W8), as this was an additional source of water for the site. Another surface water sample outside the site at the culvert under Spine Road extension was taken as a control.

Monitoring took place over a 12 month period. The sampling schedule for soil, ground and surface water (Kuils River) analyses was adhered to as closely as possible. The parameters selected for monitoring are those commonly measured when assessing levels of pollutants and

nutrients in soil and water. Tables 7 and 8 list the parameters and sampling intervals for soil and water.

Table 7 Soil sampling programme

Parameter	Monthly	Quarterly
Routine compounds *	X	
Copper		X
Zinc		X
Manganese		X
Electrical conductivity	X	
Sulphur	X	
Ammonium & nitrates	X	

*Routine compounds include: Carbon; % Stone; Texture; pH; KCl; P (Bray mg.kg^{-1}); K (mg.kg^{-1}); Ca (mg.kg^{-1}); Mg (mg.kg^{-1}); Na (mg.kg^{-1}).

Table 8 Water sampling programme

Parameter	Surface water		Groundwater	
	Monthly	Quarterly	Monthly	Quarterly
Ammonium		X		X
Nitrates & nitrites		X		X
Total Phosphorus	X		X	
Potassium	X		X	
Sodium	X			X
Magnesium	X			X
Calcium	X			X
Sulphates	X		X	
Electrical conductivity	X		X	
pH	X		X	
Chemical Oxygen Demand	X		X	
Total N (persulphate oxd.)	X		X	
Suspended solids	X		X	
Faecal coliforms and *E. coli*	X		X	

3.1.2 Results of Soil Monitoring

Generally, the soil could be described as sandy (95% sand), low in organic matter, alkaline and sodic and deficient in phosphorus and nitrogen (depending on time of year).

While the total phosphorus levels are low in agricultural terms, they are adequa te to support plant growth. However, intensive production would require higher phosphorus levels. Also, less total phosphorous is probably available to the plant than indicated by these results since the alkaline soil reduces availability of phosphorous to the plant (Marschner, 1988).

Sodium saturation in the topsoil increased over the sampling period and is near to plant -toxic levels (above 15% saturation). This increase could possibly be as a result of cultivation. The acceptable limit for sodium is 15%, and higher levels could result in soil dispersion, poor water infiltration, and possible sodium toxicity to plants. The high levels of calcium could ameliorate this sodicity to some extent (Hawkins and Lewis, 1993).

In general, salt concentrations were higher in the topsoil compared to subsoil, consistent with high evaporative demand on site. The soil has poor nutrient holding capacity as indicated by low Cation Exchange Capacity measurements.

There was no obvious effect of planting arum lilies on soil nutrient levels during the sampling period. The possible exceptions are sodium, discussed above, and the heavy metals copper and zinc, which decreased in level over the sampling period.

Lessons learned:

- Only a longer-term monitoring programme will reveal any significant changes associated with cultivation.
- However, the levels of the parameters monitored are relevant to the cultivation project in that they highlight the constraints which the environment can place on the success of a project such as the Inyibiba Pilot Project. Sandy, nutrient-poor soil with a low capacity to hold nutrients indicates that a cultivation project must firstly select plants which grow in, and preferably which thrive in, this type of environment. Secondly, in order to achieve high levels of plant production, and thus achieve profitability, the project must plan to supplement the low nutrient levels with added fertilisers. This will require the appropriate authorization.

3.1.3 Results of Water Monitoring

Generally, the surface water quality (Kuils River) was better than that of the groundwater in terms of pH, lower Chemical Oxygen Demand and lower sodium.

Cultivation had no appreciable effect on the water parameters measured. Both the ground and surface water were alkaline. The groundwater was particularly saline, at levels detrimental to plant growth, but the salinity decreased towards the end of winter, possibly as a result of rain infiltration and dilution of the groundwater. The Chemical Oxygen Demand was higher in groundwater compared to surface water.

Total phosphorus in the surface water remained stable at about 1 mgl, which is low in terms of plant nutrition. The groundwater total phosphorus concentration rose from 0.1 mgl in winter to about 10 mgl in summer. The summer level is low but sufficient for plant uptake (Marschner, 1998).

The most significant water parameter measurement was that for total faecal coliform bacteria, and *Eschericia coli (E.coli)* faecal bacteria. These parameters indicate the level of faecal contamination in the water, which has important implications for the health of staff and of consumers.

The World Health Organisation recommends a count of 0 bacterial counts per 100 ml for drinking water. The US Environment Protection Agency recommends a maximum level for swimming water of 200 bacterial counts per 100 ml.

Tentative DWAF guidelines recommend that water with more than 1000 faecal coliforms per 100 ml may not be used for irrigation of crops for consumption, but may be used for irrigation of animal fodder, tree plantations, nurseries, parks, etc., providing no contact is allowed to take place with humans.

Faecal coliform and *E. coli* counts ranged between 1000 and 5000 bacteria per 100 ml for most samples and were lower in the surface water compared to the groundwater. The faecal coliform count comprised mostly of *E. coli* which is normal (DWAF, 1996). After rainfall the groundwater for the sample outside the site had counts of 20 000 bacteria per 100ml. While doses of 10 – 1000 bacteria per 100 ml raise the risk for infection by bacterial pathogens, virus and protozoan parasites can cause infection at much lower doses (DWAF, 1996).

A site worker contracted infectious hepatitis during the course of the project, and this may have been contracted while taking a water sample in the margins of the river, adjacent to the cultivation area.

Lessons learned:

- It is imperative that staff are informed of the dangers associated with working in water which is high in faecal coliforms. Staff must be trained to adopt protective measu res to prevent contact with the water, and equipped with gloves and other protective devices.

- Knowledge of surface and groundwater parameters has implications for a wetland cultivation project when the river rises and floods the wetland. It also is relevan t when deciding on which water source to use for irrigation. In the present case river water would be preferable to borehole water for irrigation.

- Where groundwater is saline, it is important to plan for cultivation practices which minimise soil salinisation.

3.2 ECONOMIC EFFECTS

The Inyibiba Pilot Project made a loss of R420,675.99 in its first year of operation. In monetary terms there was no economic benefit to the project. However the budget did predict this loss in the first year, with a profit only ex pected from the second year onwards. The budget and actual income and expenditure of the Inyibiba Pilot Project are listed in Appendix 2.

Nevertheless, potential economic benefit has been created in that the area is planted and the project can proceed. The plants already established will be used in the coming years to generate income either by selling flowers to the local or the export market, or to both. Most of the first year expenses have been written off, and the income in coming years will with good management result in economic benefit and an economically sustainable project.

Although the project ran at a loss, other economic benefits accrued to the Greenpoint community in the form of employment and wages. The total amount paid out as wages to members of the Greenpoint community who were employed on site was R103,130.00. This is a substantial cash injection into a community which suffers from a high unemployment level. And whilst the economic benefits of this are quantifiable, the unquantifiable psychol ogical benefits of having employment and an income are of no less importance.

3.3 SOCIAL EFFECTS

During the Inyibiba Pilot Project preparatory phase, negotiations were held with the local community. Meetings were held with the local RDP branch, discussing all aspects of the project

in full. Other local organizations, the Homeless People's Federation and SANCO were also involved. These organizations thus acquired experience in negotiating the terms of a proposal.

A formal launch of the site was held in May 2 000, at which the mayor of Tygerberg, Mr Clifford Sithonga, planted the first lily bulb. The launch was attended by representatives of community organizations and members of the local community, as well as the media and a number of other people. The launch was televised and shown on SA-TV on the programme Cape at Six.

During the planting phase ten workers from the local community (Greenpoint) were employed and trained to plant arum lilies. This involved training in a number of aspects including site layout and measurement, and horticultural aspects. All of this training took place on -site.

During the growing phase, a number of workers from the local community were involved in the maintenance of the site. Training during this phase was informal but on -going, on a number of aspects including monitoring of water depth in the Kuils River, site and plant maintenance, scouting for pests, and composting.

During the flower-picking phase, training was given in the procedure for post-harvest processing of the flowers. A considerable amount of research was put into defining the optimum procedure, and this was then formalised.

Towards the end of BPP involvement with the Inyibiba Pilot Project, the permanent staff on the site were assisted to open a business bank account, Inyibiba Pilot Project, through which all future payments were to be made. This presented difficulties of its own, when it became apparent that the Khayelitsha branch of Standard Bank only serviced private account -holders and not business-account holders. The Inyibiba staff were required to use the Mitchell's Plain branch whenever they dealt through their account, making it difficult for the account -holders to manage their affairs. It would have been encouraging had the banking sector taken the necessary steps to foster an enabling environment for small businesses to develop in areas such as Khayelitsha.

Setting up of the Inyibiba Pilot Project has also contributed to the capacity of the local authorities, particularly the Tygerberg Administration and Cape Metropolitan Council, to set up and administer projects such as this.

4
KEY FINDINGS

The key findings will be discussed in relation to the project planning and implementation phases.

4.1 PROJECT PLANNING

1. The planning phase should not be rushed, allowing time for all necessary legal and other requirements to be met before project implementation.

2. Obtain the in-principle support and authority approvals as early as possible in the planning process. Ensure that enough planning time is provided to explore all avenues for obtaining the necessary authorizations if non-indigenous plants are to be grown, or if irrigation, herbicide or pesticide application is planned. For example, the authorities may require an Environmental Impact Assessment of the proposals.

3. In planning a project, the business goals should be kept modest to begin with, so that a small budget will suffice to support capacity building while experience is gained and productivity established. Once skills and productivity are established and the project becomes financially sustainable, goals can be further expanded. This is the strategy used by three other wetland cultivation projects investigated. All have set modest goals for themselves, namely to progress slowly while developing their skills and learning from their experiences, to cultivate a relatively small area initially, and to sell their products on the domestic market first.

4. Make allowance in the business plan for all foreseeable eventualities and worst-case scenarios, such as periods of drought or disease which may interfere with productivity. Measures must be planned for dealing with these eventualities. Make allowance for unexpected delays in project implementation while the authorizations procedures are followed.

5. Care must be exercised in selecting plants suited to local soil, water and climatic conditions. Make full use of indigenous plants occurring naturally in the area and which are thus ideally suited to local conditions. This will reduce the need for supplementary management measures such as irrigation or pesticide application. Avoid selecting plant varieties which attract restrictive management constraints that may interfere with optimal productivity.

6. It may be necessary to manage the nutrient status of the soil to maximise crop productivity. This is particularly important when the crop has specific water or other growth requirements which do not match the local climate.

7. Sufficient funding and time must be allowed for the public participation processes to be comprehensive and make sure that all concerns have been dealt with to the satisfaction of all parties.

8. An important aspect of entry to a community is that the individuals within the community are the ones who must be informed of the planned project and be allowed t o articulate their concerns. Full-scale public participation can be a very slow process, but in order to fully ensure the community's commitment to the project it is a necessary procedure which must be carried out with meticulous attention to detail. This may mean that a project has to be delayed while community concerns are explored and addressed.

9. The lines of authority and the roles and responsibilities of all parties should be carefully defined during the planning phase.

4.2 PROJECT IMPLEMENTATION

In general, it is important to have a manager who is on site each day, and who is able to train staff in proper procedures. Staff continuity is also important, and it is important to budget to retain key staff.

4.2.1 Ecological effects

1. The immediate ecological benefits of cultivation in a wetland consisted of cleaning the area of litter, human waste, and alien invasive plants. Cultivation and management of the area prevents new dumping, alien plant growth, and grazing and trampling by domestic stock, which preserves the wetland area from further degradation.

2. Monitoring of surface and groundwater parameters is necessary to predict changes that might occur to the site when the river rises and floods the wetland. It also is relevant when deciding on a suitable (least polluted) water source to use for irrigation.

3. A long-term monitoring programme will reveal any significant changes associated with cultivation.

4.2.2 Economic effects

1. Although the Inyibiba Pilot Project did not become economically sustainable in its 12 months of operation, in that time it provided employment and wages to members of a community with high levels of unemployment. It also established an area of 1 hectare containing over 36 000 arum lily plants which can be harvested for flowe rs in future seasons.

4.2.3 Social effects

1. Staff were employed from the local community and trained in all aspects of planting, growing and harvesting arum lilies.

2. Setting up of the Inyibiba Pilot Project contributed to the capacity of the local authorities, particularly the Tygerberg Administration and Cape Metropolitan Council, to set up and administer projects such as this.

3. Ensure that staff and consumers are protected from polluted water and soil, and that suitable measures are taken to ensure the safety of all personnel and consumers when cultivating in a wetland with high levels of faecal contamination.

5
CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

Economic incentives are required for urban wetland preservation or rehabilitation. Wetland s are under great pressure in urban environments due to competition for land resulting from poverty, inadequate infrastructure and services and in particular lack of housing. This has led to the conclusion that, should wetlands become economic assets throu gh the cultivation of economically valuable plants, wetland conservation and rehabilitation would be encouraged.

A project which is capable of creating real sustainable economic value out of a degraded wetland at the same time as it conserves or enhances t he wetland's functioning offers a win:win scenario that is undoubtedly worth pursuing. The Inyibiba Pilot Project has demonstrated that these goals are achievable. Although the Inyibiba Pilot Project did not become sustainable during the project's duration, it provides encouragement that it is possible to create sustainable enterprises in wetlands, given sufficient time, comprehensive planning, adequate funding, and committed management.

Wetland cultivation projects can be not only of ecological benefit (even if the only benefit is to preserve the wetland area from any further degradation), but also of social benefit as a source of employment. If successful, they have the potential to become a focus for other business and entrepreneurial activities in the surrounding community.

The term 'sustainability' is a broad one. Sustainability encompasses social and ecological criteria in addition to economic criteria. Consideration of the economic, ecological and social effects of a project is crucial to the determina tion of this broadly-defined sustainability.

While the Inyibiba Pilot Project provided some direct physical benefits to the ecological environment, other ecological impacts (measured during soil and water monitoring) attributable to arum lily cultivation were not definitively detected during the year of monitoring.

One trend which might be emerging is of increased salinization of the soil. Another is a decrease in certain heavy metal levels in the soil. These may both be attributable to the cultivation in the wetland. It will be necessary to take a longer series of readings before real

trends, positive or negative, become apparent above the background variability of the biological systems around the site.

However, it has been demonstrated that plants can be grown in a degraded urban wetland, and if growing conditions are optimized then the aims of a project such as the Inyibiba Pilot Project should be achievable.

The Inyibiba Pilot Project was not economically sustainable over the time period of its implementation, running at a loss and failing to produce any income of note. However, the number of jobs created, although they were temporary and not sustainable, was an economic benefit of the Inyibiba Pilot Project. The job creation demonstrates what may be poss ible over the longer term by wetland cultivation projects.

A project such as the Inyibiba Pilot Project builds the capacity of staff and communities, by providing jobs and training. There are now a number of individuals from the Greenpoint community who have some experience of and knowledge about arum lily cultivation.

Finally, the Inyibiba Pilot Project provided the opportunity to test and record the procedures for planning and implementation of a wetland cultivation project. As such it can be of use to an y organization, local authority or individual who is interested in setting up a similar type of wetland horticulture project.

5.2 RECOMMENDATIONS

Steps to create economic value out of urban wetlands should be actively pursued, if urban wetlands are to be preserved and their environmental services are to be maintained.

The Project Guidelines and Decision Support (Volume 1 of this report) developed during the course of this project should be used in the initial stages of determining the suitability of wetland sites for cultivation.

The New Green plant database should be used to identify a suitable mix of plant species for growing on the site. However, the environmental management requirements will need to be altered where possible to allow for cultivation of o ther useful plant species, including non-indigenous (non-invasive) species such as vetiver grass which have been tried and tested in agriculture.

Cultivation practices should be promoted which rehabilitate wetland function. In the long run, judicious cultivation in a wetland can provide an opportunity for the wetland to fulfil in a more

natural way its function as a sponge and water purification system. Judicious cultivation serves to preserve the specific area, in whatever state it may be, and this provide s an opportunity for rehabilitation measures to be taken in the future.

If water purification is high on the agenda – especially with respect to degraded urban water courses and polluted water from urban run-off and seepage – then a more holistic approach would be advisable, such as that originally planned for Greenpoint. Cultivation in a wetland should ideally utilize plants which can fulfil multiple functions:

1. Reeds are known for their function in water purification and should be cultivated as a matter of course to maintain wetland functioning and improve water purification in wetlands with polluted water.

2. Trees retard run-off and loss of topsoil, and increase soil-water infiltration. In addition, trees are a natural feature of some wetlands, contributing to the oxygenation of the soil and sediment (Hollis 1994). It is suggested that trees be planted and that some trees be left on site during the site preparation, even if these trees are aliens. Aliens can be removed once other trees are established.

3. Swales or water-retention ditches serve similar purposes to trees and protect against flooding while increasing water infiltration (Mollison, 1988). It is important that swales are bordered by vegetation to prevent the ditch disappearing in time. Planting ditche s also decreases run-off even further because of the presence of the plant roots. Vetiver grass is suggested for this purpose.

4. Inter-cropping would prevent soil-water loss by evaporation and prevent invasion by kikuyu grass which chokes the arum lily plant s. It is recommended that a competing, useful grass be used as a border around the site, and that another plant should be grown which is successional to the grasses, to prevent grass invasion into the primary crop (van Wyk *et al.*, 1998; Mollison, 1988). Vetiver grass is suggested for the former and nasturtium or comfrey/douwurmbos (*Lobostomon fruticosus*) for the latter. Vetiver grass also provides erosion control in the event of bank flooding, increases soil moisture retention, is a windbreak and is sterile, i.e. not invasive (World Bank, 1996). Mollison, 1988). Also, douwurmbos has similar medicinal properties to comfrey (*Symphytum officinale*) and may be used as a medicinal crop. Other possible inter-cropping plants are any nitrogen-fixers (*Gunnera* spp., which is also medicinal). The same plants, especially vetiver grass, could be used as field borders.

The cultivation site must be actively monitored over the long -term, to detect the environmental impacts of the project. Any negative impacts must be detected early so that the contributing activities can be stopped. Likewise any positive impacts must be identified and enhanced if possible, with the goal of rehabilitating the wetland.

It is imperative that a project such as this gains the support of the surround ing people, and provides meaningful benefits to them. This is particularly true if the project is to be in an urban environment. A comprehensive process of public consultation and participation should be initiated early in the planning process, before plans have hardened. In this way the life circumstances, opinions and concerns of the ordinary people can be accommodated within the project vision and objectives. Without such a process it is not possible to know what they would regard as a meaningful benefit. For example, if a share of the profit is given to the surrounding community, it is important for them to explore the possible uses for this money.

It is important also that consultation takes place with all interested individuals in the community, and not merely with their representatives. Placing too much reliance on community organizations and structures to speak for individual members in a community (often adopted in the belief it will hasten the public participation process) often serves to further ma rginalise individuals who may already have been marginalised by the organizations ostensibly created to speak for them. These officially or semi -officially appointed bureaucrats serve to legitimize plans drawn up outside the community. Their authority allows them to direct neighbourhood activities and perform as spokespersons to higher authorities. With the locus of power residing in these bureaucrats, the grass-roots citizens find themselves far removed from decision-making even if they participate by choice or otherwise in the community activities designed for them (Hollnsteiner, 1976).

A Community Development Worker involved with the Inyibiba Pilot Project referred to this aspect as follows: '*...I could not help but wonder about whether or not the process of empowerment does take place within the RDP structure itself. Ms. Matomela commands a great deal of authority; of course she is their leader.* ***However I kept asking myself about their (fellow executive members in particular) participation*** .'

It is advisable when planning a project to put the public participation aspects into the hands of independent persons who are expert in conducting the participation and negotiation process. If at all possible, the conceptualization of a scheme should occur with ordinary people sitting in and expressing their opinions (Arnstein, 1969). This early involvement in the planning process not only leads to more suitable outcomes for those most affected; it also gives people an appreciation of the complexity of the process and an awareness that issues are rarely simple or

clear-cut. While this may result in more time spent on the beginning phases of planning a project, it will usually save a great deal of time by minimizing conflict during project implementation and enhance community buy-in to the project.

A major category of constraints were those imposed by Cape Nature Conservation in compliance with environmental legislation and in an effort to keep the wetland in as natural a state as possible. Thus fertilisation was prohibited, as was the use of herbicides to control the weeds. Also prohibited was the planting of any non-indigenous vegetation (such as Vetiver grass) which could have been used to provide multiple benefits such as shade and windbreak. Such inter-cropping was an integral part of the original site design. However, this was disallowed by CNC, in compliance with the obligations of article 19.4 of the 1992 Rio Convention on Biological Diversity to reduce the use of organisms which are likely to have adverse impacts on the conservation and sustainable use of biodiversity. The implemented design therefore did not include trees or other potentially useful plants.

Clearly if wetlands (particularly altered wetlands) are to be put to economic use, and if this is being done to conserve the threatened remnants of once-functional wetlands, then some relaxation of the stringent standards of environmental protection will be advisable. If not, it could make wetland beneficiation projects just too difficult and marginal. The degraded wetland which is being 'protected' by the idealistic environmental standards imposed is seen by the surrounding community to be of no value and allowed to degrade further anyway, thus defeating the object of wetland beneficiation.

There are simple and low-cost solutions to irrigation, fertiliser and pesticide requirements. These should be investigated and adopted where possible. For example, a simple and low -cost irrigation system has been developed for market gardening projects in other areas of Khayelitsha (Abalimi Bezekhaya pers. comm.). This involves gravity feed to drip- irrigation pipes from a large elevated drum which can be filled by hand. This system could provide a low -cost solution to the water needs on a cultivation site.

There needs to be both logistical and financial support from the local authorities, in co -operation with project staff, in order to maximise the benefits to the surrounding area, such as the litter and human waste control which was achieved by the Inyibiba Pilot Project.

Postscript

It is important to build on the positive aspects of the Inyibiba Pilot Project, now that the hard work of preparing the site and planting the arum lilies has been achieved, and the areas of

difficulty have been revealed. This is a mission which is being pursued by the Tygerberg Administration in conjunction with the Greenpoint community.

As a result of their desire to build on the early promise of the Inyibiba Pilot Project, Tygerberg Administration are now engaged in finding a suitable organization who will carry the Inyibiba Pilot Project into the future. There has been an ongoing effort to source additional funding which will enable the project to continue.

REFERENCES

Abbott Grobicki. 1999a. *Feasibility study: Arum Lily cultivation for income generation from urban wetlands*. Cape Metropolitan Council, Cape Town.

Abbott Grobicki. 1999b. *Arum Lily cultivation for income generation from urban wetlands: phase II*. Cape Metropolitan Council, Cape Town.

Abbott Grobicki. 2000. *Scoping Report. Pilot Scale arum lily cultivation in Greenpoint, Khayelitsha, for income generation in the local community*. Submitted to Cape Nature Conservation.

Abbott Grobicki. 2001. *Integrated Catchment Management in an urban context (WRC project no. K5/864)*. Water Research Commission, Pretoria.

Armitage N.P., Rooseboom A., Nel C. and Townshend P. 1998. *The removal of urban litter from stormwater conduits and streams*. Water Research Commission. Report No. TT 95/98, Pretoria, South Africa.

Arnstein, S. 1969. "A ladder of citizen partic ipation." *Journal of the American Institute of planners*. Vol 35, 216 – 224.

Day E. and King J.M. 1998. *The Khayelitsha wetlands study: Invertebrate fauna*. Specialist report to Ninham Shand. Ninham Shand, Cape Town.

DWAF. 1996. *South African Water Quality Guidelines*. Vol. 4, Agricultural use: Irrigation, Pretoria, ISBN 0 7988 5342 5.

Grobicki, A.M.W. and Griffin, N.J. 2000. "Turning liabilities into assets : the beneficial use of polluted urban stormwater in degraded wetlands." Paper presented at the IWA conference on Management of Water and Waste in the New Millenium, Midrand, 23-26 May 2000.

Hartsock, N.J., Mueller, T.G., Thomas, G.W., Barnhisel, R.I., Wells, K.L. and Shearer, S.A. 2000. Soil electrical conductivity variability. In: *Proc. 5th international conference on precision agriculture*. P.C. Robert *et al.* (eds.), ASA Misc. Publ., ASA, CSSA, and SSSA, Madison, USA.

Hawkins, H.J. and Lewis, O.A.M. 1993. "Effect of NaCl salinity, nitrogen form, calcium and potassium concentration on nitrogen uptake and ki netics in Triticum aestivum L. cv. Gamtoos." *New Phytologist* 124, 171-177.

Heinsohn R-D. 1991. *The potential for cultivation of Juncus kraussii and other wetland species used for craftwork in Natal/Kwazulu.* Department of Development Aid, Pretoria.

Hockey P. 1998. *The Kuils River wetlands; ornithological status, importance and implications for management.* Specialist report to Ninham Shand. Ninham Shand, Cape Town.

Hollis G.E. 1994 "Estuarine management: the advantages of an integrated policy analysis approach." In: *Wetland Management*, pp 181-196, RA Falconer and P Goodwin (eds.), Thomas Telford Services, London. ISBN 0 7277 1994 7.

HolInsteiner, M.R. 1976. "People Power. Community participation in the planning of human settlements." *Phillipine Studies* Vol 24, 11 – 36.

Institute of Natural Resources. 2001. *How to grow iNcema.* Compiled for Department of Arts, Culture, Science and Technology.

Low, A.B. 1998. *Plantlife of the Khayelitsha wetlands.* Specialist report to Ninham Shand. Ninham Shand, Cape Town.

Mander, M., Heinsohn, D. and Mander, J. 1995. *Catchment action: how to grow incema.* Share - Net, Howick.

Mokoena, V. 2000. *Report: Greenpoint Project.* Prepared for Abbott Grobicki.

Morris, M-J. 2001. *Review of the Invibiba – Lilies for Export – Project.* Cape Metropolitan Council, Environmental Management Department.

Marschner, H. 1998. *Mineral nutrition of higher plants.* Academic Press, London. ISBN 0 12 473543 6.

Mollison B 1988. "Methods of design." In: *Permaculture: A Designers' Manual*, pp 35 -69, RM Slay (ed.), Tagari Publications, Tyalgum, Australia.

Neori, A., Ramesh Reddy, K., Číšková-Končalová, H. and Agami, M. 2000. "Bioactive chemicals and biological-biochemical activities and their functions in rhizospheres of wetland plants." *The Botanical Review* 66, 350-373.

Ninham Shand 1999. *Khayelitsha Wetlands Management Study. Draft Report.* Cape Metropolitan Council, Cape Town.

South African Weather Bureau homepage: http://www.weatherza.co.za/

Thomas, 1. F., Gomboso, J., Oliver, 1. E., and Ritchie, V. A. 1997. "Stormwater Manage ment." *Wastewater Re-use, Stormwater Management, and the National Water Reform Agenda.* CSIRO Land and Water. Black Mountain, ACT. Report to Sustainable Land and Water Resources Management Committee and the Council of Australian Governments National Water R eform Task Force.

Urbonas, B. 1994. "Assessment of Stormwater BMPs and their technology." *Water Science & Technology*, 29: 347-353.

van Wyk, B-E. and Gericke, N. 2000. *Peoples' Plants.* Briza Publications, Pretoria ISBN 1 875093 19 2.

van Wyk, B-E., van Oudtshoorn, B. and Gericke, N. 1998. *Medicinal plants of Southern Africa.* Briza Publications, Pretoria ISBN 1 875093 09 5.

Williams P.B. 1994. "From reclamation to rehabilitation – changing perspectives in wetland management." In: *Wetland Management*, pp 1-6, RA Falconer and P Goodwin (eds.). Thomas Telford Services, London ISBN 0 7277 1994 7.

World Bank. 1996. *Vetiver Grass; The hedge against erosion.* ISBN 0 8213 1405 X.

PERSONAL COMMUNICATIONS

Dr. M. Shand.	Ninham Shand.
B. Digby.	Inyibiba Pilot Project site manager/horticulturist.
C. Matomela	Inyibiba Pilot Project staff member/community leader.
L. Steel.	Bergflora.
R. Small.	Abalimi Bezekhaya.
B. Young.	Peace Lily Project.
G. Eichler.	Mondi Fairbreeze Project.
A. Eichler.	Mondi Fairbreeze Project.
Dr. D. Kotze.	Institute of Natural Resources.
M-J. Morris.	Environmental Consultant.
O. Asmal.	Planning and Economic Development, Tygerberg Administration.
Dr. N. Gericke.	Plant use expert.

PUBLICATIONS

The list below contains publications submitted and accepted during the period of the HVAP Project.

Abbott Grobicki. 1999a. *Feasibility study: Arum Lily cultivation for income generation from urban wetlands*. Cape Metropolitan Council, Cape Town.

Abbott Grobicki. 1999b. *Arum lily cultivation for income generation from urban wetlands: phase II*. Report to Cape Metropolitan Council, Cape Town.

Abbott Grobicki. 1999c. *Pilot scale arum lily cultivation in Brown's Farm detention pond for income generation in the local community*. Scoping Report submitted to Cape Nature Conservation, Cape Town.

Abbott Grobicki. 1999d. *Growth of Zantedeschia spp in KwaZulu-Natal: assessment of sites and cultivars*. Report to Umgeni Water, Pietermaritzburg.

Abbott Grobicki. 2000. *Pilot scale arum lily cultivation in the Khayelitsha wetlands for income generation in the local community*. Scoping Report submitted to Cape Nature Conservation, Cape Town.

Abbott Grobicki. 2001. *Integrated Catchment Management in an urban context*. WRC project no. K5/864. Water Research Commission, Pretoria.

Griffin N.J. and Grobicki A.M.W. 2000. *Community income generation through cultivation of high value plants in degraded urban wetlands*. Paper presented at WISA2000 Biennial Conference, Sun City, 29 May–1 June 2000.

Grobicki A.M.W. and Griffin N.J. 2000. *Turning liabilities into assets: the beneficial use of polluted urban stormwater in degraded wetlands*. Paper presented at the IWA conference on Management of Water and Waste in the New Millenium, Midrand, 23 –26 May 2000.

Grobicki A.M.W. 2000. *Urban catchment management in a developing country: the Lotus River project, Cape Town, South Africa*. 1st International Conference of the International Water Association (IWA), Paris, July 2000.

APPENDIX 1

INTERDEPENDENCE BETWEEN THIS WRC PROJECT AND INYIBIBA PILOT PROJECT

Six of this Project's aims depend partially or fully on two collateral objectives: the location and availability of a suitable site for cultivation, and the implementation of the cultivation project. But although these two objectives were necessary conditions for the implementation of the WRC project, they did not fall within the WRC's direct area of influence, since the project funding is purely for research, not for implementation. These objectives were satisfied separately by Abbott Grobicki and the local authorities of Cape Town. It was only once these two objectives had been satisfied that the WRC project could achieve many of its aims. Thus the WRC project was always going to be impacted on by these parallel developments despite the fact that they did not fall within the WRC's express area of concern.

In the interval between the February 1999 inception of this WRC project and May 2000 when a pilot arum lily cultivation project got underway efforts were directed at satisfying the two collateral objectives mentioned above. These are described below.

Locating a wetland site suitable for growing arum lilies. The site assessment guidelines were developed (one of the aims of the WRC project) in the process of selecting the most suitable cultivation site from amongst six potential sites in Cape Town. The site so identified, Brown's Farm, fell under the authority of the CMC. These results were contained in the Phase 1 Feasibility Report compiled for the CMC (Abbott Grobicki, 1999a). Thereafter, in compliance with the Environmental Conservation Act a Scoping Report for the Brown's Farm was prepared and submitted to Cape Nature Conservation. This was a preliminary step to the site being made available by the City of Cape Town.

The second phase of a feasibility report was then prepared for the CMC (Phase 2 Feasibility Report, Abbott Grobicki, 1999b) which addressed in more detail the feasibility of cultivating arum lilies at Brown's Farm and at a second site, Greenpoint, which was under the authority of City of Tygerberg. The Phase 2 report included a business plan for arum lily cultivation at both these sites. A second Scoping Report was submitted for the Greenpoint site.

Once suitable sites had been located, the next step was to have them authorised for arum lily cultivation by the relevant authorities, in this case City of Tygerberg and City of Cape Town.

City of Tygerberg recognised that the planned arum lily cultivation offered the multiple benefits of wetland conservation, social uplift, and economic development, and were anxious to turn the planning into reality. In an effort to expedite the arum lily cultivation project when it became apparent that the preferred site of Brown's Farm was not going to become available soon, the City of Tygerberg made the Greenpoint site available.

The arum lily cultivation project was named Inyibiba: Lilies for Export (Khayelitsha), and adopted as a Mayoral Project by the City of Tygerberg, a clear indication of the support it enjoyed within the administration (CMC Steering Committee Minutes. 2 May 2000).

Funding. Difficulties were experienced in raising sufficient funding for the arum lily cultivation project. CMC was not able to fund the implementation of projects. Approaches were made to the DANCED and the IDC, as well as to Dutch and German sources (CMC Steering Committee Minutes. 19 October 1999), to no avail. Finally a limited amount of R310 000 was sourced from a private donor, at about the same time as the Greenpoint site was authorised for arum lily cultivation. In addition, City of Tygerberg budgeted an amount of R75 000 for the Inyibiba Pilot Project (CMC Steering Committee Minutes. 4 September 2000).

Funding and a site having been secured, a site manager and staff were appointed, and planting commenced in May 2000. Monitoring and evaluation of the site and the Inyibiba Pilot Project began, in line with the aims of the WRC project.

The privately-sourced funds were exhausted in December 2000, and although Tygerberg Administration used additional funds from their budget to pay the staff for January and February 2001, the Inyibiba Pilot Project essentially came to a halt after less than a full year of operation.

The arum lily plants continue to grow at the site, albeit they are partially overgrown with weeds due to a lack of site maintenance, and the Tygerberg Administration are presently negotiating with a suitable organisation to continue with the Inyibiba Pilot Project.

Table 1 Implementation Time Frame for HVAP Project

Date	Water Research Commission	Cape Metropolitan Council and Tygerberg	Cape Nature Conservation	Abbott Grobicki	Reference
1997-1999	Integrated Catchment Management in an Urban Context				Abbott Grobicki. Integrated Catchment Management in an Urban Context. 2001
1998 October		Commissioning of: Feasibility Study: Arum Cultivation for Income Generation from Urban Wetlands.			Abbott Grobicki. Feasibility Study: Arum Cultivation for Income Generation from Urban Wetlands. February 1999
1999 February		Feasibility Study: Arum Cultivation for Income Generation from Urban Wetlands. Phase 1 report submitted			Abbott Grobicki. Feasibility Study: Arum Cultivation for Income Generation from Urban Wetlands. February 1999
1999 15 February	Signing of agreement: Cultivation of high-value aquatic plants in restored urban wetlands for income generation in local communities				WRC Project K5/105: Memorandum of Agreement between Abbott Grobicki and WRC. 15 February 1999
1999 May	Progress Report 1 submitted to Steering Committee				Progress Report to the Water Research Commission. Abbott Grobicki (Pty) Ltd. 19 May 1999
1999 June			Scoping Report submitted: Brown's Farm Site		Abbott Grobicki.
1999 September		Final Report: Phase 2 submitted			Abbott Grobicki. Final Report: Arum Lily Cultivation for Income Generation from Urban Wetlands: Phase 2. 1999
2000 01 March		No funds available from CMC. Brown's Farm and Khayelitsha both under consideration for arum lily cultivation.			CMC Steering Committee Minutes. 1 March 2000

Date	Water Research Commission	Cape Metropolitan Council and Tygerberg	Cape Nature Conservation	Abbott Grobicki	Reference
2000 10 April		Recommendation that pilot arum site at Greenpoint, Khayelitsha be approved			Tygerberg City. Report for Executive Committee. 10 April 2000
2000 April			Scoping Report submitted for Greenpoint, Khayelitsha Pilot Arum Lily cultivation site		Abbott Grobicki. Scoping Report: Pilot Scale Lily Cultivation in Greenpoint, Khayelitsha, for Income Generation in the Local Community. April 2000
April 2000	Progress Report 2 with revised aims				Progress Report. Water Research Commission. Abbott Grobicki (Pty) Ltd. 18 April 2000
2000 02 May				Funding from private donor provided	Environmental Impact Management Unit Minutes. 2 May 2000
2000 05 May		Go-ahead given for Arum Lily Cultivation Project at Greenpoint, Khayelitsha			Tygerberg City: Urban Planning Committee Meeting. 14 April; and Corporate Services Committee Meeting. 5 May
2000 10 May		EIA compliance approval for Greenpoint, Khayelitsha arum lily cultivation site			CMC Catchment Management Department. 10 May 2000
2000 18 May		Greenpoint Khayelitsha. Site Launch by Mayor		Greenpoint Khayelitsha. Site Launch	Tygerberg City. 18 May 2000
2000 23 May – 14 June				Planting of Arum Lilies	
2000 May – November	Water and soil sampling at Greenpoint, Khayelitsha			Planting, management and harvesting of first season Arum Lily flowers	

Date	Water Research Commission	Cape Metropolitan Council and Tygerberg	Cape Nature Conservation	Abbott Grobicki	Reference
2000 15 December				Site manager no longer available	
2000 December				Private funding depleted end December 2000	Letter of 13 Dec 2000 from Abbott Grobicki to S. Solomon, Director, Planning and Economic Development, City of Tygerberg.
2001 January		Project re-constituted as Inyibiba Pilot Project (workers group)		Future funding to be channeled through Abbott Grobicki to Inyibiba Pilot Project account	Letter of 8 May 2001 from Abbott Grobicki to O. Asmal, Planning and Economic Development, City of Cape Town Tygerberg Administration.
2001 January		Tygerberg Administration finds additional funds for January and February 2001 for workers to continue site maintenance			Letter of 12 Jan 2001 from City of Cape Town Planning and Economic Development Directorate to Abbott Grobicki (Pty) Ltd.
2001 March		No more funding for site upkeep			
2001 April	Progress report 3				Progress Report. Water Research Commission. Abbott Grobicki (Pty) Ltd. 20 April 2001
2001 June		Independent review of project			Review of the Inyibiba – Lilies for Export – Project. M-J Morris, June 2001

APPENDIX 2

DETAIL OF BIOPHYSICAL AND ECONOMIC EFFECTS OF THE INYIBIBA PILOT PROJECT

1 BIOPHYSICAL EFFECTS

1.1 Results of Soil Monitoring

Soil and water samples were analysed by Cal-Labs (previously Kynoch Fertiliser Ltd., Milnerton) and CMC Scientific Services/ CSIR Environmentek (Stellenbosch) respectively.

Water and soil samples were analyzed using prescribed standard methods. Extraction methods for soil samples were as follows: Cl in 1M KNO_3, S in $Ca_3(PO_4)^2$, B in hot water, Al in 1 M KCl, NH_4^+ and NO_3^- in 1 M KCl, cations in ammonium acetate. Most elements were measured using ICP (inductively coupled plasma) analysis.

Texture

Soil texture remained constant over time with little difference between sa mples and controls (data not shown). Soil is mostly sand (about 95%), with some clay (2 -4%) and silt (1 -4%) and no stone.

Percentage carbon (C)

The percentage C in both top and subsoil is low, between 2.5 and 0.25% (Fig. 1a). This low percentage of organic matter was to be expected in the sandy soil on site. Changes over time were relatively small except for subsoil sample 1, which is near the river so that soil water here was probably connected and influenced by the river course.

pH

All soil pH values were alkaline between 8.5 and 9 with little difference between top and subsoil (Fig. 1a). An exception was subsoil sample 1, which is near the river so that soil water here was influenced probably by the lower pH of the river course (Fig. 2a). Above pH 8.4, the availability of P and some micro-nutrients becomes limiting for plants.

Cation exchange capacity (CEC)

The CEC was low in all samples (i.e. below 20 cmol.kg-1, except sub sample 1 which was slightly higher). This was to be expected for a sandy soil with little clay or organic matter. The low CEC is an indication of the reduced ability of the soil on site to hold nutrients, notably positively charged cations.

Electrical conductivity (EC)

The EC was estimated using electrical conductance of soil in ohms. Th e EC generally increased from April 2000 to August/October 2000, i.e. peaked over the rainfall period, and thereafter decreased (Fig. 1a). This is understandable considering soil EC is directly related to soil water content (Hartsock et al., 2000). Otherwi se, EC can be an indirect indication of CEC, water holding capacity, organic matter and salinity. The low EC values are consistent with a dry, sandy soil with implications as mentioned above for CEC.

Base saturation

Base saturation of the soil samples was 100% (i.e. no exchangeable acidity) with Ca2+ occupying most of the cation exchange sites (Fig. 1b). The Na+ saturation varied between 2 and 16% (being lower in subsoil samples) and increased in the topsoil over the sampling period. The acceptable base saturation limit for Na+ is 15%. Sodium levels higher than 15% on the exchange site could result in soil dispersion, poor water infiltration, and possible sodium toxicity to plants. These levels indicate increasing soil salinity, possibly as a result of cultivation.

Total phosphorus (P)

Total P in the soil was consistently low around 1 -5 mg.kg-1 (Fig. 1c). (The higher value for the control topsoil sample may have been related to a rainfall event in August). While these values are low in agricultural terms (us ually between 20-50 mg.kg-1 for fertilised fields), they are adequate to support plant growth. However, intensive production would require higher P values. Also, less total P is probably available to the plant than indicated by these results since alkaline soil pH values lower P availability to the plant (Marschner, 1988).

Ammonium and nitrates

For both ammonium and nitrates, there is a very obvious trend with values peaking around August /October 2000 (Fig. 1c). This may be a seasonal trend, due to rains washing nutrients into the river and field. This will become obvious as sampling continues over the year 2001.

When values peaked, these were in the region of those found in agricultural fields (about 100 mg N.kg-1) but were very low otherwise.

Ammonium was lower in topsoil samples, consistent with ammonia volatilization at pH >8 (Marschner, 1998), while nitrate was mostly higher in the topsoil compared to the subsoil, consistent with leaching of this ion (Marschner, 1998).

Cations and chlorides

Levels of calcium were extremely high in the soil as were sodium levels, especially towards mid summer 2001 for the latter (Fig. 1c). Generally, cation concentrations were higher in the topsoil compared to the subsoil, consistent with evaporative demand at the site, i.e. salts being drawn up to the surface by capillary action. Concentrations of chlorides were very high, probably as a result of Cl⁻ being the major counter-ion to calcium, which was high, as mentioned.

Heavy metals

There was an overall decrease in the heavy metals Cu and Zn over the sampling period, while Mn levels rose after an initial decline (Fig. 1d). This may be related to rainfall events (dilution effect) and or planting of the arum lilies in June 2000. This needs to be confirmed by more sampling over the year 2001.

Faecal coliforms and *E. coli*

Data is limited to samples taken in November 2000. Values in the soil varied between a few counts and 6000 (data not shown). See Water monitoring for comments on recommended limits.

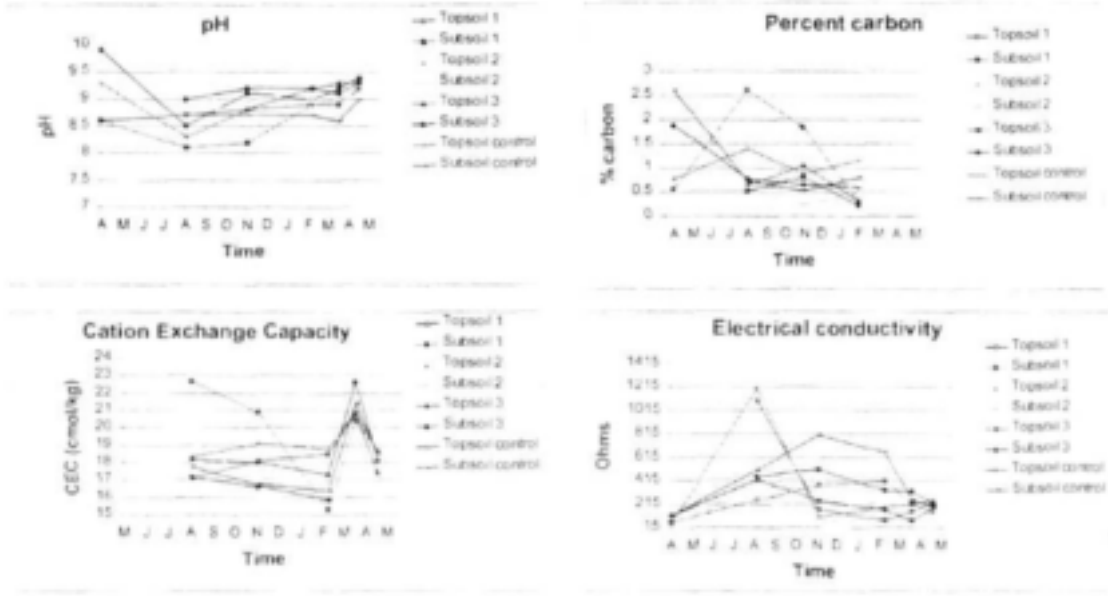

Figure 1a Soil analysis: pH; % carbon; Cation exchange capacity; Electrical conductivity. Inyibiba Pilot Project (year 2000 -2001)

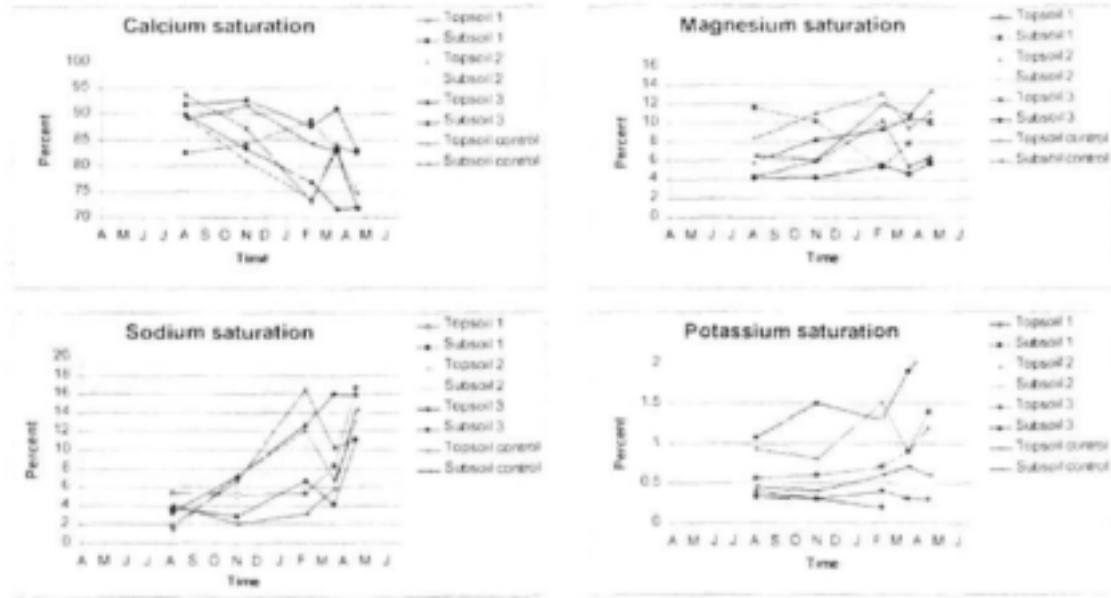

Figure 1b Soil analysis: base saturation. Inyibiba Pilot Project (year 2000 to 2001)

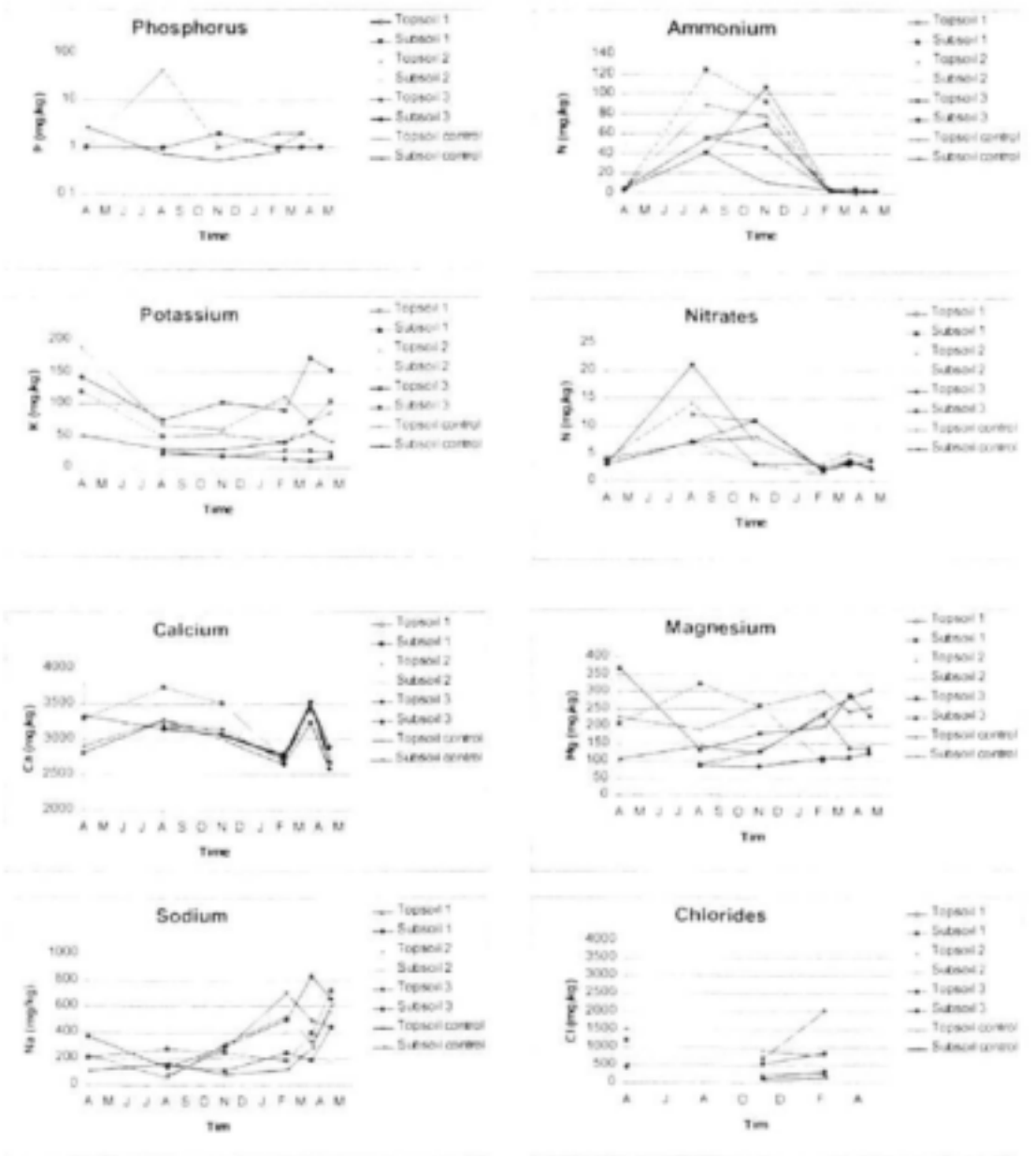

Figure 1c Soil analysis: Total Phosphorous; Nitrogen; Cati ons; Chlorides. Inyibiba Pilot Project
(year 2000-2001)

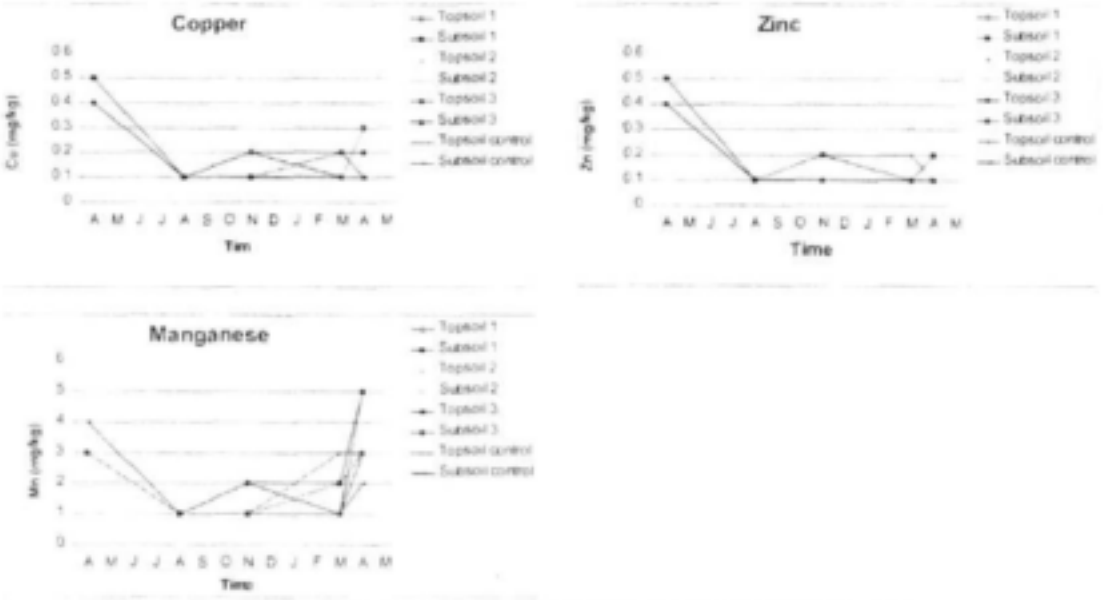

Figure 1d Soil analysis: Heavy metals. Inyibiba Pilot Project (year 2000 to 2001)

1.2 Results of Water Monitoring

Monitoring of nutrients, suspended solids, bacteria and other physical properti es was intended to determine the effect of planting arum lilies, on the water quality of the groundwater of the site as well as the water downstream on the Kuils River (refer to Fig. 2). Planting appeared to reduce suspended solids and sodium but these may have been seasonal effects and need to be confirmed by long-term sampling.

The variation in water depth in the Kuils River during the implementation of the Inyibiba Pilot Project is shown in Fig. 2a.

pH

In general, the ground and surface water is alkaline (7.5-8.5) and was not affected by planting (Fig. 2b). The pH was high in the ground and surface water before planting (June) and dropped significantly during the dry summer months (Feb – May). The run-off culvert showed little or no seasonal variation in pH. There was no discernable effect of planting on the pH of the groundwater relative to the control. The pH of the Kuils River downstream of the site was slightly higher, especially in November.

Suspended solids

Suspended solids in the Kuils River increased over the period July to October (Fig. 2b). This may be due to increased evaporation of the Kuils River during spring and summer and/or flushing of waste from surface areas. An informal settlement located within the site floodplain is part of the Greenpoint community but has not been provided with sanitation, waste or management service because of plans to re-locate. Suspended solids decreased, after an initial rise, to below initial levels (July) at the site downstream of the site, as well in the runo ff from the culvert going through the site. This indicates a possible bio- filtering action of the plant roots.

Chemical oxygen demand (COD)

The COD was clearly higher in groundwater compared to surface water samples (Fig. 2b). The COD in the surface water remained stable over the sampling period around 100 $mg.l^{-1}$. The plant roots did not have any discernable effect on the COD of the groundwater; if anything the COD increased. Rhizospheres (soil surrounding plant roots) of wetland plants are often limited in oxygen, which is supplied almost exclusively by the plant root itself (Neori *et al.*, 2000). This provides a favourable environment for both macro- and microorganisms in the soil. The lack of effect of planting on the COD is likely due to oxygen not being limiting within the time frame of sampling since the flooding in winter was of short duration.

Electrical conductivity (EC)

The EC of the groundwater was higher than that of the surface water (Fig. 2b), owing to a greater concentration of electrolytes (Figs. 2c and d).

Total phosphorus (P)

Total P in the surface water remained stable at about 1 $mg.l^{-1}$ P, which is low in terms of plant nutrition, over the sampling period, being slightly lower downstream of the site (Fig. 2c). There was an obvious increase in total P after September in all the groundwater samples from about 0.1 $mg.l^{-1}$ – 10 $mg.l^{-1}$ (3 μM - 300 μM) over the sampling period. This increase may have been due to evapotranspiration over spring and summer. Since the plant roots were above the water table for most of summer, increased P concentration was probably mostly due to evaporation. The P concentration in summer (about 300 μM) is low but sufficient for plant uptake (Marschner, 1998).

Total nitrogen (N), nitrate and ammonium

Total N in the surface water was fairly constant and low (about 0.3 mM) while the groundwater ranged between 10-70 $mg.l^{-1}$ or 0.6-4.2 mM (Fig. 2c). The N form in the groundwater is predominantly nitrate *versus* ammonium. The N concentration in the groundwater was high enough not to inhibit N uptake systems of plants (Marschner, 1998). However, when the concentration rises above 30 $mg.l^{-1}$ most crops become affected (DWAF, 1996). High levels of N are also detrimental to human health. Nitrate concentrations over 20 mg $N.l^{-1}$ cause methaemoglobinaemia in infants, and mucous membrane irritation in adults (DWAF, 1996).

It is to be expected that the N concentrations in the groundwater sites would be highly variable because N, especially nitrate, is very mobile in the soil, especially sandy soil. Rains from August to September may have accounted for the reduced N in the groundwater which may have been leached to levels lower than 0.5 m. This was confirmed by lower nitrate in subsoil compared to topsoil (Fig. 1c)

Sulphates

Sulphates were higher in the groundwater compared to surface water (Fig. 2d). There were no discernable changes in sulphate concentrations in surface or ground water as a result of planting arums.

Cations and sodium absorption ratio (SAR)

Cations in the groundwater were two to ten times more abundant than in the surface water (Fig. 2d). Sodium in the surface water was about 100 $mg.l^{-1}$ in September, which is below saline

levels. However, groundwater levels were much higher and saline at around 400 -1000 $mg.l^{-1}$ at the beginning of sampling in July. Concentrations above 500 $mg.l^{-1}$ are detrimental to plants, especially shoot growth (Hawkins and Lewis, 1993). These levels dropped in all groundwater samples. This drop was likely the result of rainfall events and not plant uptake since sodium concentrations also dropped in the groundwater control. Groundwater concentrations of sodium were three times higher than those of calcium, 10 -20 or more times higher than those of potassium and magnesium. The SAR was notably higher in the grou ndwater compared to surface water (Fig. 2c).

Faecal coliforms and E. coli counts

Faecal coliforms and *E. coli* counts (as indicators of faecal pollution and bacterial pathogens) varied between 1000 and 5000 for most samples and were lower in the surface wa ter compared to the groundwater (Fig. 2e). According to counts, faecal coliforms were comprised mostly of *E. coli* which is normal (DWAF, 1996). Higher counts of 20 000 were observed after rains for the groundwater sample outside the site (Fig. 2e). While h igh infective doses (10 - 1000) are required for bacterial pathogens, much lower counts of virus and protozoan parasites can cause infection (DWAF, 1996).

DWAF guidelines on faecal coliforms states that water with counts >1000 may be used in irrigation for the production of fodder, tree plantations, nurseries, parks, etc., providing no contact is allowed to take place with humans (DWAF, 1996).

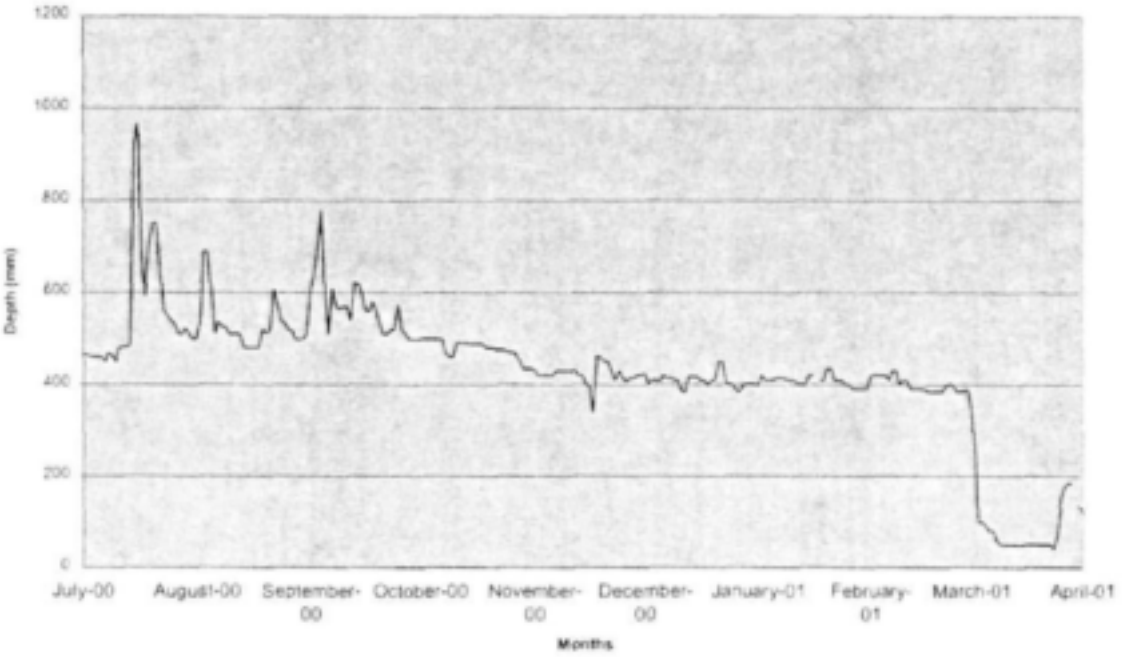

Figure 2a Water depth in the Kuils River. Inyibiba Pilot Project (July 2000 – April 2001)

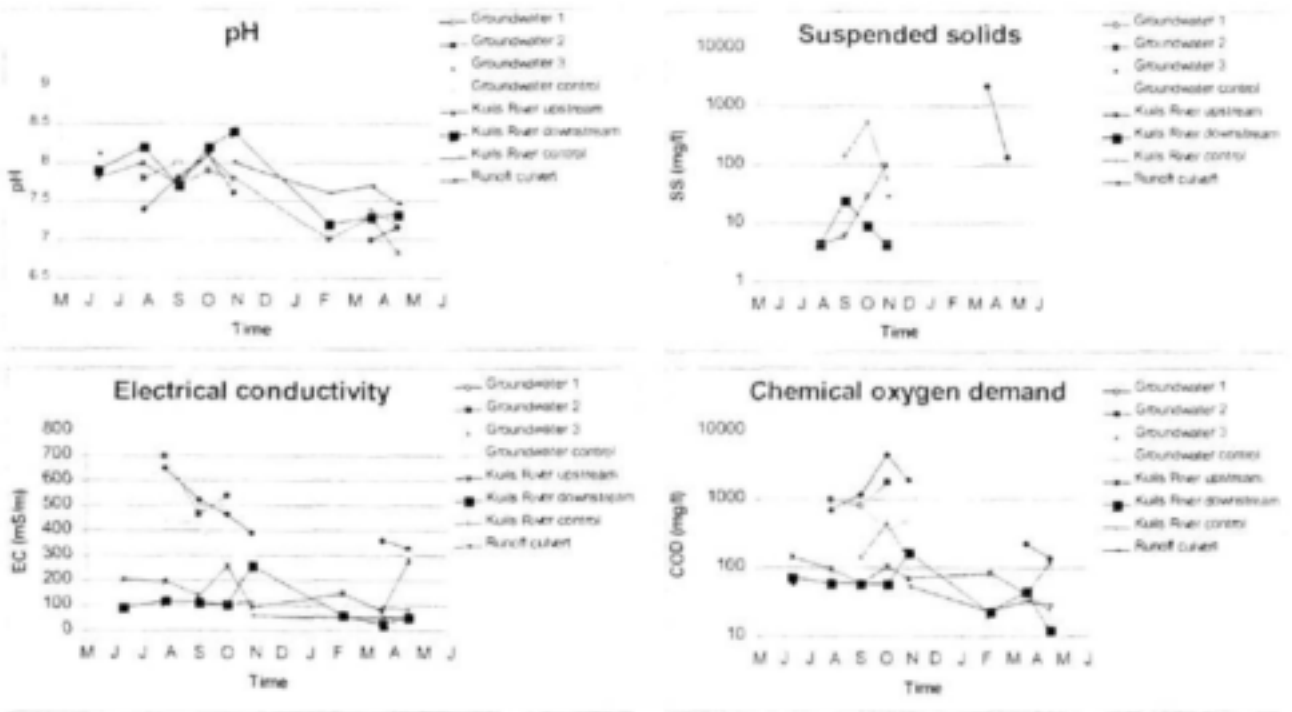

Figure 2b Water analysis: pH; Suspended solids; Electrical conductivity; Chemical oxygen demand. Inyibiba Pilot Project (year 2000-2001)

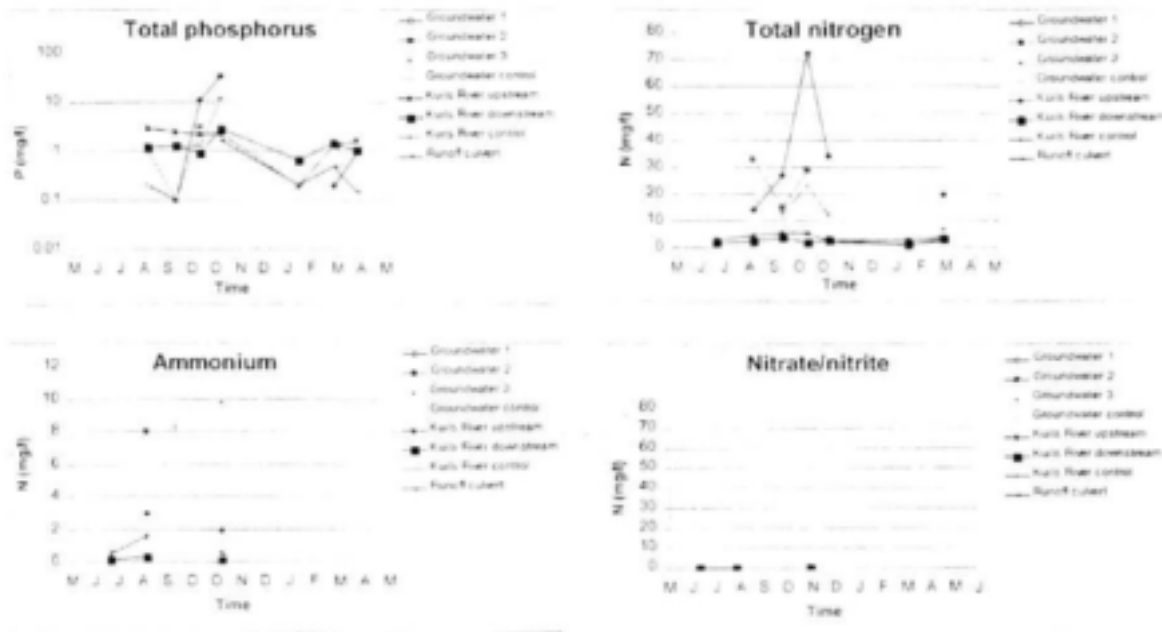

Figure 2c Water analysis: Phosphorus; Nitrogen; Ammonium: Nitrate. Inyibiba Pilot Project (year 2000 to 2001)

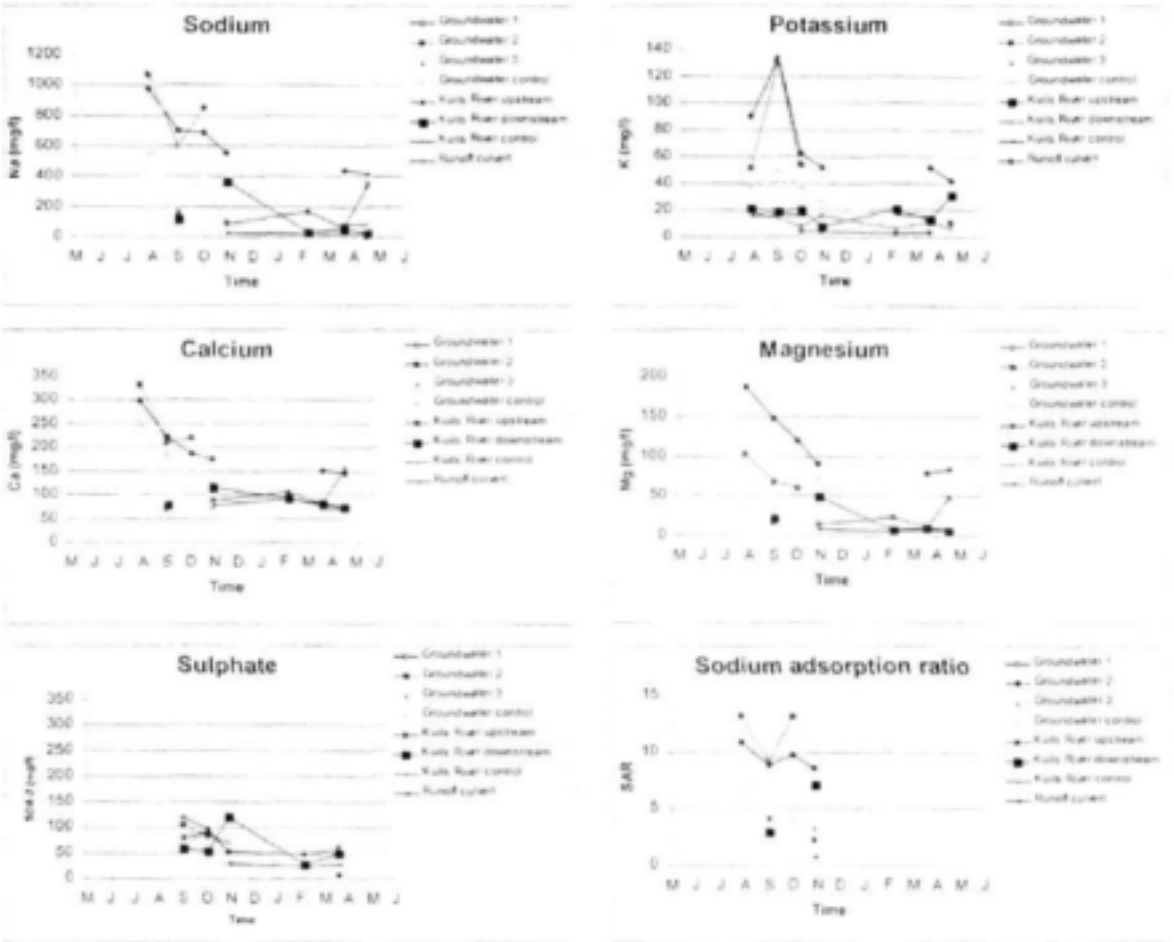

Figure 2d Water analysis; Sulphates; Cations; Sodium absorption ratio.
Inyibiba Pilot Project
(year 2000 to 2001)

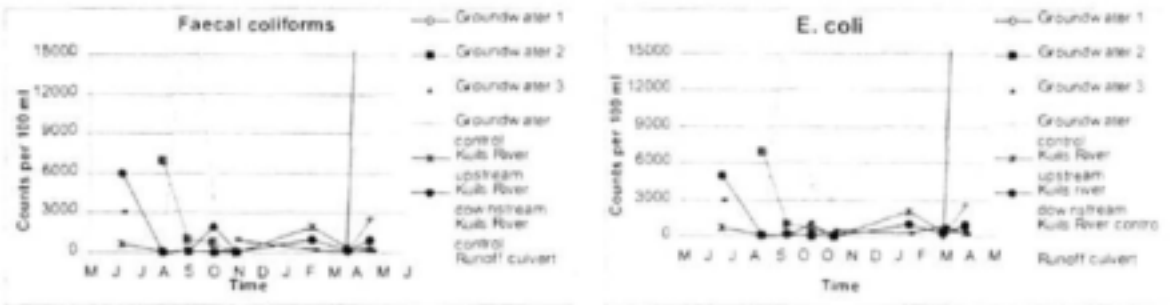

Figure 2e Water analysis: Faecal coliform and E. coli levels in water samples.
Inyibiba Pilot Project
(year 2000-2001)

2 ECONOMIC EFFECTS

The total cost of the project, including all capital set-up and running expenses, was R421,103.99. This amount includes the donor fund of R310,000.00, the Tygerberg Administration contribution for fencing and site excavation of R67,720.74, and the office services and adminis tration which were provided to the project by the BPP office infrastructure (Table 2.1).

The Inyibiba Pilot Project was funded largely by BPP from a donation, and ran from 15 May until 31 December 2000, when the BPP donor funding was depleted.

STAFFING

- The project began on 15 May with 10 casual employees. The site manager-horticulturist was self-employed and paid by the project as a consultant. She was employed for 7 months.

- On 1 October, three full-time staff positions were created until the project ended on 31 December. Additional casual labour continued to be employed for weeding and foraging.

- In total, casual employment was created for 758 person-days.

- Two security staff were also employed for the project duration.

- The BPP office and staff provided office and administration services, and project management.

Table 2.1 Comparison of Budget and Actual Income and Capital Expenditure of the Inyibiba Pilot Project

	Item	Actual	Budget	Budget
Area planted		10 325m^2	10 325 m^2	22 470 m^2
Rhizomes planted		36 653	51 625	112 352
Flowers produced		1 614	129 463	281 751
Flowers sold		300	103 570	225 401
Price/flower		R1.43	R1.50	R1.50
Total Income		**R428.00**	**R155 355**	**R338 101**
Set-up costs	Cost of plants	129556.68	327500	655000
	Cost of fencing	32720.74	40000	80000
	Site excavation	35000.00	17500	35000
	Centrifugal pumps (x3),	0	42500	85000
	[illegible]	10256.57	35000	70000
Total Set-up costs	TOTAL	**R 207,533.99**	**R 462,500.00**	**R 925,000.00**
Running costs	Site staff wages	85730	31071	67620
	Manager/horticulturist	27877	6930	13860
	[illegible]	2893	18000	18000
	Office costs	60670	36000	36000
	Site maintenance	19000	24000	24000
	Site security	17400	168000	168000
	Training	0	3000	3000
	Packaging	0	14500	31556
	Truck driver	0	10500	10500
Total Running costs	TOTAL	**R 213,570.00**	**R 312,001.00**	**R 372,536.00**
Total Capital Required		**R 421,103.99**	**R 774,501.00**	**R 1,297,536.00**
Total cost of project first year (income-capital)		R-420,675.99	R-619,146.00	R-959,435.00

APPENDIX 3

Review of the Inyibiba – Lilies for Export – Project

Final Report – August 2001

CMC Administration

Environmental Management Department

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1 INTRODUCTION AND BACKGROUND

The Inyibiba : Lilies for Export project was launched by the then City of Tygerberg (now the Tygerberg Administration) and Biotechnology Plant Products (represented by Dr Ania Grobicki) in May 2000. The feasibility study for the Inyibiba project was undertaken by Abbott Grobicki (Pty) Ltd and was implemented by an associated compa ny, namely Biotechnology Plant Products. It was established as a pilot demonstration project aimed at integrating wetland conservation, economic development and social upliftment objectives. These are expressed as follows in the feasibility study (September, 1999) undertaken by Abbott Grobicki (Pty) Ltd.

Economic objectives
Converting degraded wetland on public land in urban areas into assets that generate income for local communities.
Promoting the South African floriculture industry.
Environmental objectives
Enhancing the aesthetics of the urban environment.
Increasing, or at least maintaining, the permeable land area available for infiltration of urban run-off.
Improving run-off water quality.
Social objectives
Encouraging local environmental awareness and improving the aesthetics of the area.
Improving working relations between local communities and regional government structures.
Capacity building through interactions with local organisations and skills transfer.
Providing a local recreational amenity.

Tygerberg Administration viewed the project as a Local Agenda 21 Project, since its principles are aligned with those of sustainable development. This made the project attractive from a local government perspective and consequently it received a high -level of support from various departments and at a political level within the CMC Administration of (formerly the CMC) and the Tygerberg Administration. Whilst the project has had several positive spin offs a number of limitations and problems have also been experienced. Consequently, the CMC Administration has commissioned an independent review of the project with the following terms of reference:

- Establish whether the project is viable from a socio-economic perspective;

- Find potential partners to implement the project.

1.1 Scope of Work

The CMC Administration identified a number of aspects that needed to be addressed in the independent review:

- Review of the original business plan;
- Identify challenges and problems that affected the on-site implementation of the project;
- Review of the management of the project;
- Investigation into opportunities for partnering with other funders, businesses, NGOs and CBOs to further project implementation;
- Hold meetings to establish these potential partners.

For the purposes of fulfilling the brief, two key tasks were identified in the proposal to undertake the independent review of the Inyibiba project.

- *Task 1* : Review of issues relevant to the business plan, the on-site implementation of the project and the management of the project.
- *Task 2* : Investigation of partnership opportunities.

The rationale for dividing the review into two key tasks is that it was considered essential to have an understanding of the performance of the project in order to determine the most appropriate partnership opportunities to be investigated. During the course of the review it was decided to refocus the scope of work for Task 2 to focus on developing a strategy and action plan to determine the way forward for the project. This workshop will take place in July 2001. Additional information on this change in the focus of the independent review is given in Section 4 of this report.

1.2 Project Approach

The review involved the following activities:

- Review of documentation including:

- The feasibility studies (Phase 1 and 2) undertaken by Abbott Grobicki (Pty) Ltd;
- The progress report prepared for the Water Research Commission (WRC) entitled "The Cultivation of High Value Aquatic Plants in Restored Urban Wetlands for Income Generation in Local Communities by Abbott Grobicki (Pty) Ltd;
- Documentation from the Tygerberg Administration (such as the item for the Corporate Services Committee of April 2000, Scoping Report dated April 2000 which was submitted to the Department of Environmental and Cultural Affairs and Sport – DECAS).

- Interviews with organisations covering the following:
  - Members of the project Steering Committee;
  - Representatives from Abbott Grobicki (Pty) Ltd including past employees;
  - Individuals and organisations with expertise that could assist with the review (e.g. Bergflora, South African Arum Lily Society, Table Mountain Fund).

- Consultation with specialists on particular issues (e.g. Deloitte & Touche on issues relating to the business plan).

1.3 Report Structure

The report is structured as follows:

- Successes and Challenges - Key Findings
- Lessons Learnt
- Recommendations

2 Successes and Challenges - Key Findings

The successes and challenges (strengths and weaknesses) have been determined on the basis of discussions with roleplayers involved in the project, discussions with external experts and

on the review of documentation. Clearly, participants in the project have various views on its the strengths and weaknesses. The full range of opinions has been recorded in this section of the report. Often a success or strength has a "flip side" which means that there are strengths and weaknesses associated with the same issue - both have been noted in this report. All viewpoints have been considered insofar as these are indicative of material effects or root causes in relation to the performance of the project (i.e. its successes and shortcomings).

2.1 WHAT WERE THE KEY STRENGTHS OR SUCCESSES OF THE PROJECT?

2.1.1 Community benefits

Initially, problems were experienced with the local community. This was primarily related to the fact that people from outside the neighbouring communities were being employed by the project. This issue was resolved through a process of consultation. In general, therefore, the project was well supported by the local community (i.e. they supported the establishment of the project). Specific benefits that accrued to the community were as follows:

- Although the project only provided employment opportunities on a small scale, it did result in jobs for individuals that had not been employed for several years. A total of 6 permanent jobs were created. Seasonal employment opportunities also exist. For example, during the period when the bulbs were being planted and when the flowers were being harvested an additional 4 jobs were created.

- All employees were drawn from the local community located closest to the site, namely Sabata Dalindyebo Square (formerly Greenpoint). The community was involved in the selection of individuals who were employed by the project.

- Training was provided to employees of the project. There was a positive and enthusiastic response to the training programme.

- The principle of community organisations benefiting from the profits generated from the project is positive.

- Abbott Grobicki has assisted the staff in setting up their own bank account as a first step in establishing a structure/entity for the project that includes them.

- The fact that the project was implemented is positive. This can be seen as providing "a spark of hope". Although the project has not delivered yet, if it can be sustained and if export quality flowers can be produced it will have demonstrated that it is possible to produce export quality products from a community-based project.

2.1.2 Sound principles

The principles (environmental improvement, social upliftment, job creation, use of wetlands for economic benefit) that underpinned the project were widely acknowledged as being sound and were strongly supported. They are closely aligned with the priorities of local government.

2.1.3 Commitment to the project

There was a high-level of commitment to the project both on the part of the local authorities (the CMC Administration and the Tygerberg Administration) and from the project consultant (Abbott Grobicki). It has been acknowle dged by various members of the Steering Committee that it is unlikely that the project would have taken place without the commitment and enthusiasm of Abbott Grobicki, particularly Ania Grobicki. In this sense, therefore the project had a driver champion.

2.1.4 Technical know-how

The expertise that was brought to the project on the biophysical side was of a high standard. Hence, this technical know-how could be used and applied to other initiatives or to improve the success-rate of the Inyibiba project. The horticulturalist was on-site on a regular basis and undertook training of staff. She also gave day-to -day technical advice. For instance staff were advised not to remove grass from the site since it serves to shade the soil, thereby improving soil conditions for the arum lilies.

2.1.5 Benefits to local government

- The project had good inter-Directorate support. It is a cross cutting project involving several functions. At the metro-level, the CMC Administration Departments that were involved included environmental management, economic and social development and catchment management, whereas at the local level (Tygerberg Administration), the environmental management, economic development and planning functions participated in the project. Hence, the project provided a practical demonstration of "co-operative governance" in action at the local government level.

- The project was well supported at a political level. The principles on which the project was based are aligned with priority issues for local government and provided a vehicle to give practical effect to these principles.

- The fact that the project was fast-tracked and that it was implemented provided a concrete demonstration of delivery by local government.

2.2 WHAT WERE THE KEY WEAKNESSES OF THE PROJECT?

2.2.1 Funding requirements

- The project did not kick-off with the required funding. In the business plan it was estimated that set-up costs (i.e. capital expenditure) would be R925 000 and that running capital would be R350 000 for the first two years, based on establishing the project on a 2,2ha site in Khayelitsha. This excludes costs for the rental of land. When the project was set-up only 1,1 ha was developed. Costs for establishing the project on a site of this size are given in the business plan for Browne's Farm. Capital requirements were estimated as being R465 000 and working capital of R250 000. This amounts to a total of R715 000. The following adjustments need to be made to this figure:

    - Inclusion of costs for pumping, an item given in the Khayelitsha set-up costs but not for Browne's Farm. The amount budgeted for a 2,2ha site is R85 000 (for 3 pumps and associated pipework). A discounted amount can be assumed since only a 1,1ha was being developed. For the purposes of this review, 50% of this cost has been used as being a conservative estimate of this cost item.

    - Exclusion of the costs of a retaining wall and litter trap which are required for Browne's Farm but not for Khayelitsha. The budgeted amount for this item is R20 000.

Taking account of the above factors, the total amount required for the set-up and running of the Khayelitsha project for 1 year is R737 500 (excluding costs for the rental of land). The funding that was available for the commencement of the project was as follows:

- A commitment to provide R400 000 to the project was obtained from a private funder.

- The Tygerberg Administration (formerly the City of Tygerberg) agreed to cover the costs of earthworks (estimated at R35 000) and fencing (about R36 000).

- The CMC Administration (formerly the CMC) funded the feasibility studies (Phases 1 and 2), but this cost is not included in the expenditure items in the business plan and has therefore not been taken into account.

Hence, just over half the required funding (i.e. 54%) had been committed by the private investor. With the inclusion of the Tygerberg Administration funding, the shortfall was R266 500. If the costs for pumping infrastructure are excluded, the shortfall is R224 000. Consequently, the project was subject to financial constraints from the outset. This is confirmed by the set-up expenditure summary given in the WRC Progress Report (dated April 2001) which amounted to R205 000 of which R155 000 was spent on rhizomes – this is less than half of that required, as per the business plan, for a 1,1 ha site.

- Funding ran out because the private funder was unable to provide the amount originally intended for the project (R310 000 instead of the R400 000) promised. Additional funding was therefore provided by the Tygerberg Administration (R18 000) to cover wages for two months. This money was granted by the Tygerberg Administration once it became apparent that the private funder would no longer be able to provide the full amount originally promised, in order to secure the jobs of the project's employees.

- According to Dr Ania Grobicki, the private funder has provided an additional R40 000 which will sustain the project until the flowering season (i.e. May 2001).

- The business plan is based on the premise that the project would become financially sustainable by the second year. However, since it only produced a limited number of blooms (300 were sold on the local market and 500 were used in tests by a cut flower exporter), the income that has been generated is well below that predicted in the business plan. Consequently, the project has not met expectations with regard to income generation and hence a sharing in profits by the beneficiary non-governmental organisations and the project's site employees.

2.2.2 Project structure and ownership

The project is described as a public-private partnership between the Tygerberg Administration and Biotechnology Plant Products (WRC Progress Report, April 2001). The CMC Administration saw their role as one of facilitation and support. Several concerns emerged regarding project structure and ownership:

- The structure of the project was not formalised at the outset – it was to have been a public-private partnership but was not formally set-up as such. The Memorandum of agreement between the Tygerberg Administration and Biotechnology Plant Products was never signed by the latter. According to Dr Ania Grobicki this was related to the question of rental for the site, which was considered to be too high for the scale of the project, and this issue remained unresolved.

- There was a lack of groundrules. Administrative issues and guidelines, roles and responsibilities of the respective parties were not clear at the outset of the project. Although some groundrules were developed as the project progressed (e.g. identification of a single contact person at Tygerberg Administration), these were not fully adhered to by the project consultant.

- The ownership of the project was not clarified upfront in terms of the following:
    - Who should own it?
    - Should the Tygerberg Administration be a shareholder in the company, if a company is formed for the project?
    - Who should the beneficiaries be (i.e. in terms of profits generated)?
    - What share should employees have in the project?
- There was a difference of opinion about the beneficiaries of the project. Certain beneficiaries had been selected by Abbott Grobicki and the Tygerberg Administration did not agree with these. This was resolved and it was agreed that the beneficiaries would be Abalimi Bezekhaya, Learn to Earn, St Michael's Anglican church and the workers on site. The Tygerberg Administration was of the view that the people employed by the project should share in the profits and this has also been agreed.
- The relationship or boundaries between the Inyibiba project and the WRC-funded project on the cultivation of high value aquatic plants was not clear to members of the Steering Committee. This is both from a financial point of view (which project is paying for what) and with regard to how the scope of these projects interact.

2.2.3 Communication and information flow

- Information flow from the project consultant was considered to be inadequate. A number of members of the Steering Committee made this point. In particular, concern was expressed about lack of information on financial management of the project. According to those interviewed, no financial reconciliation has been provided to date and there has been a lack of information on expenditure control.
- Furthermore, detailed information on the success of sales and the use of income from sales (a small number of lilies were sold on the local market) is outstanding. According to Abbott Grobicki, this income was absorbed by the running costs of the project.
- The flow of information in relation to project management issues was also lacking. Having stated this, several members of the Steering Committee recognise that the project was running well whilst the horticulturalist, who visited the site every day, was involved. The main concern expressed about the flow of information related to project management issues is that problems were not communicated timeously.

- A further concern is that when information has been requested, it has not been forthcoming (e.g. a summary of the "lessons learnt" from the project).

- Feedback on issues such as findings on the export quality of the blooms was scanty and was not backed up by written confirmation. Hence, members of the Steering Committee do not have a clear understanding on what progress was made with regard to producing export quality flowers.

These factors have led to discomfort. Different participants from the public sector feel more or less strongly about the relationship with Abbott Grobicki, but generally there is a lack of trust. This situation is not healthy in the context of a public-private partnership.

2.2.4 Pace of the project

- The feasibility study was developed over several months and there is no indication that inadequate time was spent on this phase of the project. Conversely, the view on the implementation stage of the project is that it was rushed and that the pace of the project was driven by the consultant. This has led to a feeling of being "pushed" to implement the project which resulted in several disadvantages:

    - Options for partners in the project were not fully explored due to the timeframe for project implementation.

    - The implementation process was not adequately "unpacked" into a sequence of actions or steps. Consequently the process of implementation was not clear.

    - The groundrules for the participants in the project were not clarified upfront.

- According to Biotechnolgy Plant Products, the key factor in the time pressure in initiating the implementation of the project was that of planting the bulbs in time to allow flowering. If the bulbs were not planted in time it would have been necessary to delay it for another year.

- It is important to note that the private funder did not specify that the funding had to be utilised within a particular timeframe. This means that the pace of the project was not being directed by funding but by practical considerations such as the growing and flowering season.

- From the project consultant's perspective (Biotechnology Plant Products) the timeframe involved in the decision-making process for the project was protracted. This meant that the project was commenced later than was ideal (e.g. bulbs planted in May when ideally they should have been planted in February/March).

2.2.5 Project management

In the feasibility study, Abbott Grobicki recommended that a public -private partnership would be the most preferable structure "to allow the project to go forward successfully."(Refer to Executive Summary in September 1999 feasibility study). Furthermore, it was recommended that management of the sites should be outsourced. A detailed project management structure and system is not given in the feasibility study and based on feedback given in interviews, this is an issue that was not clarified during the set- up phase of the project.

- The project management role was fulfilled by the consultant. Members of the Steering Committee noted that site operations progressed well while the horticulturalist, who was contracted to Biotechnology Plant Products, was involved (until December 2000) as she was on site each day.

- The monitoring of the project by the Tygerberg Administration was not sufficiently rigorous. This is related to lack of capacity within the organisation. Although there were individuals within Department's that championed the project, the fact that an "overarching" champion on the local government side was not identified probably contributed to lack of effective monitoring.

- Whilst the technical side of the project (e.g. planting, training of staff) seemed to operate well, the management of the implementation process is considered to be poor. In other words, the understanding of the process required to deliver income was not fully unpacked and hence participants (community, public sector and private sector) were not adequately prepared with regard to what the project would entail. Furthermore, there was no early-warning system so that corrective action could be taken timeously when problems arose. This means that no "what if" scenarios were examined in the feasibility study (i.e. prior to project implementation) which meant that no proactive contingency plans were formulated.

- Currently there is no hand-on project management on site. Staff are uncertain about the future of the project and this has impacted on their motivation. There are reports of no staff being present on site or staff taking sick leave, when not actually ill. This is a serious concern, since local government have contributed to salaries for two months. According to site staff, visits from a staff member from Biotechnology Plant Products are infrequent.

- According to Dr Ania Grobicki the WRC is paying for one site visit per month for monitoring purposes. This is related to the WRC research project being undertaken by Abbott Grobicki and the Inyibiba project results provide input into this research project. Additional visits and management input is not possible due to lack of funding. The funding that has been made available by the Tygerberg Administration is only to cover salaries of the site staff (i.e. project employees).

- In the absence of a project manager, such as the horticulturalist, there has been little activity on site. Staff have not maintained the site and it is untidy in appearance and weed growth is such that it is difficult to locate the lilies. This has led to the effectiveness of training and skills transfer being questioned.

2.2.6 Site appearance

The site is currently in a poor state. It is infested with weeds and it is difficult to find the position of the lilies. There is a fair amount of litter entering the site. In addition, runoff from the neighbouring residential area is nutrient rich. There is stagnant water on site, which is green (algal bloom) and filled with litter. Whilst it is recognised that it is not the growing season for the lilies, the site appears as if "nothing is happening". Moreover, it does not have the appearance of a project that is endeavouring to produce an export quality product.

2.2.7 Technical know-how

Although the technical know-how that was brought to the project on wetlands was of a high standard, specialist expertise on arum lilies during the implementation phase of the project was lacking. Notwithstanding this comment, a horticulturalist was employed who was thorough and which brought valuable expertise on general horticultural matters to the project. According to the Arum Lily Society of South Africa, the mass cultivation of arum lilies is highly specialised. This view has also been expressed by Bergflora. The Arum Lily Society is involved in giving advise to arum lily growers. Their view is that a project such as this requires an experienced arum lily specialist, because the growth and flowering of the plants is sensitive to soil conditions, water quality, fertiliser and climatic conditions, to name a few. In addition, requirements differ according to species and cultivars. For example, some species are sensitive to the pH of water. The cultivars that have been planted at the Khayelitsha site do vary in their requirements.

At the outset of the project, there was a lack of certainty about which arum lily cultivars would be the most successful. This was a consequence of the WRC research project being undertaken in parallel with the pilot project (Inyibiba project). Consequently the pilot project did not have the benefit of research findings to build on for the selection the arum lily cultivars or in understanding the vulnerability of the species selected to physical factors such as lack of water and soil conditions.

2.2.8 Business plan

The business plan was based on the assumption that funding for the set-up costs and the operating capital would be raised at no cost to the project. As mentioned elsewhere in this report, the amount required was not obtained (less than half the money required was raised from a private funder). Even with the in-kind and financial contribution from the Tygerberg Administration, the project was initiated with just over 50% of the required funding.

In considering the business plan, there are two questions that need to be addressed:

- Is the business plan comprehensive and achievable?
- What are the reasons for the project not reaching its financial targets?

In this regard it is important to assess the business plan assumptions. Relevant details are given in the table below:

Issue	Comments and Findings
What was the degree of certainty that the capital would be raised?	The fact that funding became available at "the last moment" suggests that there was no certainty that the necessary capital would be raised. Several funding options were explored such as the IDC's Community Job Creation Fund and the Local Economic Development fund. These applications were unsuccessful. It is not known why, but both funds receive numerous applications – many more than the funds they have available. If capital needs to be raised the cost of capital to the project must be taken into account in the business plan. The private funder has indicated that the funds he has provided are available as an interest-free loan. Should the project become profitable, he would expect this money to be repaid. In this event, cost of capital would need to be taken into account.
What was spent relative to what was budgeted? In other words, were the estimates in the business plan confirmed (or not) by the actual cost of plant material etc. when purchased?	This expenditure picture is not clear, as a detailed financial reconciliation has not been provided by Abbott Grobicki. A brief summary of expenditure for the set-up of the project is given in the progress report prepared for the Water Research Commission (dated April, 2001), which shows that the budgeted amounts were not spent, presumably because the required set-up and operating capital amount was not available. A comparative analysis of budgeted and actual expenditure has not been provided. According to Abbott Grobicki this could be determined by going through their accounts for the project and these have been audited. Given that a comparative analysis of predicted and actual expenditure is not readily available, it is not possible to assess whether the budget provided in the business plan is realistic or not.

Issue	Comments and Findings
	budget provided in the business plan is realistic or not.

Issue	Comments and Findings
What is the basis for the assumption that 80% of the flowers would be exported? A related question is whether the product should have been tested in the local market first?	According to Abbott Grobicki this assumption is based on some growing information from Umpukane Flora which used to export the Pink Marshmallow arum lilies. According to the South African Arum Lily Society, environmental conditions have a significant bearing on the growth and flowering of arum lilies. Hence, it cannot be assumed that the number of flowers per plant being achieved by Umpukane Flora can be transposed to the Inyibiba project, particularly as the similarity between the environmental conditions of the two projects is unknown. A project can be established solely for the purposes of export. However, this generally requires several years of testing and research. It is common practice in the agricultural sector to test the local market first because if the quality criteria of the local market cannot be met, it is extremely unlikely that the product would be acceptable in the export market.
Was it foreseeable that export-quality blooms would not be produced, particularly in the first flowering season of the project?	One of the objectives of the pilot project was to test whether export quality blooms could be produced. However, the income stream in the business plan is based on the production and sale of export quality blooms. A fall back position was not considered such as the impact on the income stream of not producing export quality blooms and having to sell to the local market. A worst-case scenario (i.e. having no blooms or only a small volume of blooms to sell to the local market) was not included in the business plan. According to Bergflora, a company involved in cut flower export, the project is not producing "exciting" cultivars. Bergflora assisted the Inyibiba project with testing the blooms (shelf life and quality) for export purposes. They have not seen any products from the project approaching what is required for export quality. Whilst some blooms had stem lengths close to that required, shelf life was a problem. In addition, the blooms were not of an appropriate quality from an appearance point of view. Bergflora did state that should blooms be produced of the appropriate quality, they would be interested in exporting them. It must be noted that Abbott Grobicki's understanding is that the quality of the blooms was close to that required for export purposes in terms of shelf life, stem length and appearance for some of the cultivars.
Were the set-up costs estimated for a pilot project or for a commercial venture?	According to Abbott Grobicki the costs were estimated in the context of a pilot/trial project.
Is the assumption that a site double the size of the base case (i.e. the proposed Browne's Farm project) will produce double the number of flowers valid? Stated differently, are the physical conditions at the two sites sufficiently similar that this assumption can be made?	Given the comments from the South Africa Arum Lily Society about the sensitivity of these plants to environmental conditions, particularly when planted for mass cultivation, this assumption is considered simplistic.

Issue	Comments and Findings
be made?	
Are the assumed yields of the plants realistic?	The comments given above apply to this issue. Flower quality and yields are strongly influenced by environmental conditions such as shade, water and nutrients. The environmental conditions on the site probably had a negative effect on plant growth and flowering.
How does the number of bulbs planted correspond to yield, that is, has account been taken of the fact that some bulbs may not grow?	The business plan does not include provision for loss and replacement of bulbs. It is based on the assumption that all bulbs planted will produce a certain number of blooms in the first year and productivity would increase thereafter. It has been confirmed in discussion with the horticulturist who worked on the project and with the South African Arum Lily Society, that it is realistic to assume that fewer flowers will be produced by the lilies in the first year, as stated in the business plan. Some allowance was made in the business plan for lifting and separation of the bulbs in the forth/fifth year after planting. The point is made that this would impact negatively on the productivity of the plants and hence income.

A business plan is a tool to provide guidance in planning a business venture. Accordingly it is a means for considering the execution, costs, returns and risks associated with a business venture, thereby demonstrating the potential for success. With this in mind, the following comments are relevant to the questions posed at the beginning of this section:

1. *Is the business plan comprehensive?* Certain aspects of the business plan are comprehensive. For example, the technical aspects of setting up the project (e.g. planting layout etc.) have been dealt with in detail in the feasibility studies. Research into the cutflower market was undertaken which included some investigation on the pricing structure for the arum lilies. Key gaps in the business plan are as follows:

   - Lack of detail on the marketing strategy and contingency plans (type of market, size of market, market demand, market fluctuations, etc.);
   - Lack of detail on the organisational structure and ownership (roles and responsibilities, management approach, management system etc.);
   - Lack of detail on financial controls and reporting;
   - Lack of information on critical risks and potential problems;
   - Lack of consideration of the effects of inflation and the exchange rate. This is considered important in business planning for an export project – if only the local

market was being considered an inflation neutral scenario (such as that presented) is appropriate.

2. *Is the business plan achievable?* The premise on which the business case had been developed, that of producing an export quality product was unproven. In this sense the ability to achieve the predicted income streams was an unknown quantity. The objective of the pilot project was to test whether export quality arum lilies could be produced. Assuming that this had a positive outcome, it is possible that the business plan may be achievable (given the correct funding, project management and technical inputs). In a sense the business plan is pre-emptive in that it is based on a "positive outcome" assumption, the key limitation being that risks and problems were not anticipated in the business plan.

3. *What are the reasons for the project not reaching its financial targets?* The financial forecasts given in the business plan have not been achieved due to a number of factors that are covered in the various subsections in Section 2. In summary, factors that led to financial targets not being achieved were lack of financial resources and various technical constraints and problems. This is to some extent linked to the question of comprehensiveness, particularly relating to lack of information on business risks and potential problems.

2.3 WHAT CONSTRAINTS WERE EXPERIENCED BY THE PROJECT?

In the context of this review, constraints have been defined as external factors that influenced or affected the implementation of the project. These factors are generally unforeseen or difficult to anticipate. Not all constraints fall into this category. Where project implementation has proceeded despite known constraints, this is generally because the benefits are considered to outweigh these risks.

2.3.1 Site selection

A number of sites were evaluated by Abbott Grobicki during the feasibility stage of the project. Ultimately the site that was selected was less than ideal from the point of view of soil and water conditions for the lilies. Two factors contributed to the selection of this site:

- When funding became available, of the two local authorities that were considering implementing the project, only Tygerberg was in a position to proceed.

- Although various sites had been evaluated in the Tygerberg municipal area, the site that was selected was easily available to lease to the project because it is under the ownership of the Tygerberg Administration.

Both the project consultant and the local authorities were involved in the site selection process.

2.3.2 Site facilities and infrastructure

The site is not fully equipped. A drinking water supply is needed and only bucket toilets are available. Other practical problems that have been experienced relate to access/security, although the site was fenced. Security personnel were employed and they guard the site at night.

In terms of access, problems were experienced with goats moving onto the site for grazing. They trampled the plants and blooms. The fencing was improved with the result that goats can no longer enter the site.

2.3.3 Requirements of the Department of Environmental and Cultural Affairs and Sport (DECAS)

Apparently DECAS had requirements relating to the project that posed several constraints. This was related to the fact that the site is located next to a natural wetland. Accordingly, DECAS's requirements were based on what are considered to be appropriate management practices adjacent to a natural wetland, even though in a degraded state. There is no Record of Decision from DECAS in which requirements are stipulated. In correspondence from the CMC Administration it is stated that the management and monitoring proposals given in the Scoping Report "shall be adhered to at all times". These proposals relate to the contamination of the gene pool (Scoping Report dated April 2000). Notwithstanding, in terms of the manner in which the horticulturalist operated the site, herbicides, pesticides and fertilisers (other than on planting of the bulbs) were not used as this was understood to be in accordance with the requirements of the environmental authorities.

Essentially this meant that there were conflicts between the horticultural requirements and those pertaining to a natural wetland. For example, pesticides, herbicides and fertiliser (other than some compost when the bulbs were planted) could not be applied. This impacted on the growth of the plants and on their flowering. In addition, a virus infection was noted on some of the blooms (Pink Marshmallow) which may not have occurred were it possible to apply pesticides.

Limitations were also placed on the types of plants that could be cultivated on the site. This meant that the cultivation of other aquatic plants/wetland species for commercial purposes could not be tested. It also affected the sustainability and viability of the project, since its

success is linked to a single type of plant (the arum lilies). This is compounded by the fact that arum lily species are seasonal.

2.3.4 Factors related to the biophysical environment

- It was assumed, on the basis of the work undertaken by Ninham Shand on the Khayelitsha wetland and on the Kuils River River, that there would be sufficient water available for the cultivation of arum lilies. The drought (lack of water) had a major impact on the growth and flowering of the lilies.

- The issue of irrigation requirements was not addressed in detail in the feasibility report, although reference is made in the set-up costs to centrifugal pumps, mounting and pipework. This infrastructure was considered necessary to divert water from the Kuils River to recreate a wetland area. Irrigation was not considered necessary since the arum lily bulbs were planted at a height slightly above the water table (Abbott Grobicki WRC Progress Report, April 2001). When it became apparent that irrigation was required (due to the drought), it was found that various permits were required. Since such applications take time to process this placed the project at risk since water supplies could not be readily supplemented.

- This problem was exacerbated by the fact that permission to extract irrigation water from the Kuils River could not be readily obtained. It is necessary to obtain a licence from the Department of Water Affairs and Forestry (DWA&F) to extract water from the Kuils River since none of the rivers in the metro area fall under the general exemption. In order for DWA&F to grant a licence the reserve requirements of the river need to be determined. This means that it could take up to 6 months before a licence is granted.

- DWA&F did suggest that groundwater be considered for irrigation purposes, but the quality is reported to be saline and it is therefore not appropriate.

- The soils on the site are of a poor quality and are therefore require fertilisation. This was not possible due to the conditions imposed by DECAS. It is likely that the poor quality of the soil has been worsened by increased salinity resulting from the drought combined with a hot dry summer.

- There is a well-established weed seedbank in the soils. Weeds grow prolifically on the site. Whilst they do assist in shading the soil and in stabilising it, they compete with the arum lilies for water and nutrients. Weed killer cannot be applied (due to DECAS requirements) and site staff (4) are not able to overcome the weed problem. Additional staff may be required for such ongoing maintenance activities.

- The fact that bulbs of the indigenous lilies had to be foraged within a 300m radius was problematic because of the environmental conditions. Employees came across

numerous snakes and some of the areas from which bulbs needed to be removed were polluted with human excrement, which is a health problem.

3 LESSONS LEARNT

Discussions with roleplayers in the project and various experts have been drawn on in determining the "lessons learnt". In addition, "lessons learnt" that have become apparent from the assessment (by the reviewer) of the strengths and weaknesses of the project have been included. The purpose of identifying the "lessons learnt" is to put forward the issues that need to be addressed should the project continue as well as to assist in the planning and setting up of other similar projects.

3.1 ENSURING LOCAL COMMUNITY BENEFITS

The success in involving the local community in the project has been positive. Hence, the process whereby this was achieved needs to be fully documented so that it can be applied or replicated in other similar circumstances. A critical aspect of the community involvement was the manner in which employees for the project were selected is a valuable lesson for other community based economic development programmes. The selection of employees involved a high-level of community participation where consideration was given to the period for which people had been unemployed. These names were put forward and employees were selected from this pool of people.

3.2 INTERROGATING PROJECT CONCEPTS

Based on discussions with various parties, particularly within local government structures, it is evident that the project was not interrogated from all perspectives. Whilst the project was viewed as being feasible, it appears that this judgement was made on largely technical considerations. In particular, the business plan, the market research and hence the assumptions that underpinned the financial viability of the project were not fully probed. Critical questions that need to be explored in a project such as this include:

- Is the investment in proportion to the expected/predicted benefits of the project (e.g. is the level of investment for a project acceptable given the uncertainties/certainties and risks involved)?

- Where the assumptions that underpinned the business plan well researched?

- Was adequate research into market demand and competitors undertaken?

The "lesson learnt" in relation to this issue is that local government needs to implement a more rigorous review process and more stringent review criteria for project proposals, particularly where these require funding and logistical support from local government.

3.3 PROJECT STRUCTURE

Local government was not sufficiently proactive in resolving the project structure. It is important that the shares, responsibilities and roles of the different participants are clarified upfront. These must be recorded in a formal manner (e.g. a founding document). The question of ensuring that clear groundrules are put in place is linked to this issue.

3.4 TAKING CARE WITH COMMUNITY EXPECTATIONS

The community expected more in terms of job creation. Currently, job security is at risk because of the funding situation. Furthermore, there was an expectation that the project would generate profits. Hence, community expectations have not been realised.

One of the factors that contributed to the raising of community expectations was the project launch. It was a high profile event and received positive media coverage. The launch involved representatives from local government and from the community; it was well supported by the community. Arguably, however, the launch served to raise expectations regarding employment creation and income/profit generation. For example, one of the newspaper reports refers to the project dealing with unemployment. Whilst the principle of contributing to job creation is of critical importance, at the time that the project was launched it had not been tested "in the field". Hence, whether or not the project would produce a saleable product and whether or not it would contribute to job creation in the long -term, was unknown.

It can be expected that a high profile launch of a project will lead to high, possibly unrealistic expectations, no matter how carefully communication about the project has been undertaken. The lesson to be learnt, therefore, is to consider launching projects once the feasibility has been tested or demonstrated practically (i.e. more than theoretically); hence once there is a story to tell.

3.5 SETTING THE GROUNDRULES

The importance of having agreed groundrules at the outset of a project has be en demonstrated in the difficulties experienced in the relationship between the private sector and public sector parties involved in the project. This is not to say that it is inappropriate to work on the basis of a professional understanding, rather that groundrules are also required to provide a framework within which the professional understanding should operate. Groundrules are of critical importance because of the following:

- They are agreed by both parties and as such are binding on the way the parties conduct themselves in the working/professional relationship.
- They provide clarity on what is expected from each party.
- They provide a framework within which to deal with disagreements and conflicts.
- They can also include the conditions under which the relationship will be dissolved/discontinued and how this process should be conducted.

3.6 AVOIDING AN "IDENTITY CRISIS"

There is confusion about what the project actually is:

- Is it a pilot project aimed at testing whether an export quality product can be achieved from a community-based initiative? or
- Is it a project that will generate income through the sale of the product to the export market.

It appears that the project was "sold" as both of the above. In particular the business plan reflects the latter scenario. Arguably, the business plan is not a realistic reflection of the initial stage of the project. This means that there needed to be a "set -up and test phase" business plan and then assuming successful results a business plan for the ongoing operation (i.e. the existing business plan is suited to a post-test phase scenario). It has been a failing of the Inyibiba project that a stepwise approach was not followed.

3.7 ASSESSING THE RISKS TO AND COMMITMENT REQUIRED FROM LOCAL GOVERNMENT

The project has highlighted the need for local government to fully assess the financial risks involved in funding projects. Typically local government would not get involved in the funding of a private commercial venture, except in the format of a public-private partnership. A factor that needs to be considered, however, is funding commitment beyond the feasibility stage, as the success of the project is likely to stand or fall on the adequacy of funding for implementation. Clearly, a commitment to implementation support should be dependent on the outcome of the feasibility stage.

From a slightly different perspective, the project has highlighted the need for local government, at the decision-making level, to consider the practical implications of political support for a project (e.g. provision of funding, access to land, provision of infrastructure). This relates to the need for local government to examine the basis of its support for projects carefully and to prioritise and allocate resources in accordance with this support. This is important, because otherwise local government could find itself in the position of supporting an initiative without a proportional commitment of resources, "will be set up to fail". This poses a risk to local government in terms of its image with regard to delivery.

This is not to say that local government did not provide practical and logistical support to the Inyibiba project. Rather the question relates to whether this investment of resources adequately reflected the level of political support. Hence, in cases where there is strong political support for a project, it is important to fully assess what local government needs to provide in terms of practical support, taking account of the budget cycles and financial constraints. In other words the level of political support needs to be reflected in the level of practical support, with the ultimate objective of ensuring the project's success.

3.8 DETERMINING RISKS AND CRITICAL SUCCESS CRITERIA ARE ESSENTIAL INGREDIENTS

The factors that are critical to the success of the project must be identified in the feasibility stage of projects. In the case of a project such as this, this should be addressed in the business plan. The identification of these factors is part of the process of determining business risks and problems (as described in Section 2.2.8). In the case of the Inyibiba project, the fact that business risks and problems were not anticipated (i.e. identified and addressed in the business plan through contingency plans) proved to be a key factor in the lack of success of the project.

Furthermore, critical success factors were also not identified. Such tools are extremely valuable in the implementation of projects:

- *Identification of business risks* allows for a proactive response to address potential problems. The process of risk identification (i.e. anticipation) and contingency planning (response or corrective action) is the core of business risk management. In the case of Inyibiba, problems that arose (e.g. lack of water) were dealt with reactively and this had an adverse effect on successful project implementation.

- *Identification of critical success factors* allows for a basis against which to evaluate project success on an ongoing basis. If the critical success factors are not being realised, this indicates to the manager of the project or business that a re-evaluation is necessary which could involve:

    - Establishing the root cause of lack of success;
    - Determining whether there are solutions or not;
    - Deciding on the way forward (which solution to implement).

    Critical success factors can also be used as a basis for report -back on project progress and in fact provide a systematic way of doing so. In the case of the Inyibiba project, the key critical success factors could include:

    - Financial performance – are financial targets being achieved?
    - Expenditure – are expenses in line with what was anticipated?
    - Productivity – are adequate numbers of flowers being planted and harvested?
    - Skills transfer – what ongoing training and skills development is being undertaken?
    - Staff turnover – what is the level of staff turnover?
    - Product quality – how many blooms are being accepted into the local and export markets?
    - Community benefits – what income has accrued to beneficiaries?

4 RECOMMENDATIONS

It is clear from the review that the project has not been a success when considered against what it was intended to achieve. A number of factors contributed to this situation which have been described in Section 2 of this report. The following factors p layed a key role in the project's failure:

- Limitations in the feasibility study, particularly with regard to the business plan. Of particular concern in this regard is the lack of analysis of business risks and problems and of detailed market analysis.
- Lack of rigorous project management and reporting procedures and systems.
- Inadequate funding in terms of set-up costs and running capital.

These factors, in particular led to a situation where a reactive approach was taking to addressing problems and this had a significant impact on the success of implementation. Consequently, the core purpose of the project – that of testing the thesis that high value aquatic plants could be cultivated as an income generator, with associated environmental and social benefits – was unsuccessful, largely because the management procedures and structures required to support the project were inadequate. Hence, the result is that the thesis is neither proven nor unproven. What is clear is that unless detailed planning (including contingency planning), financial resources and an appropriate management structure are in place a project such as this has little chance of success.

The fundamental conclusion, therefore, is that:

- The project cannot continue in its current format.
- The project concept and principles are positive and are aligned with the priorities of local government and from this perspective should remain on the agenda of potential local government initiatives.

Hence, the future of the project needs to be resolved as a matter of urgency. Once this has been determined, and assuming that it is decided to continue the project, the question of potential partners should be addressed. This recommendation is based on the fact that the partners that could be approached, is larg ely dependent on the manner in which the project is packaged. The nature and objectives of the project are key factors in determining which potential partners to approach. For example, whereas a business-orientated project could

appeal to a private-sector partner, a community-based non-profit-making project would be more appropriate for a NGO partner.

4.1 DETERMINE THE FUTURE OF THE PROJECT

There are two key options in this regard – continue the project or shut it down. It should be noted that a number of people that were interviewed felt that too much had been invested in the project to discontinue it. It is important to consider the process that will be required, that is, the strategy or action plan to be followed. The options need to be evaluated i n terms of a comprehensive set of issues/concerns. Some relevant issues are summarised below:

Option	Issues to be addressed
Discontinue the project	Impact on local community Impact on employees (i.e. loss of job and therefore income) Impact on local government in terms of local community perceptions Decommissioning of the site Ownership of the assets (bulbs, fencing etc.) Relocation of project to another site
Continue the project	Costs of further investment in the project versus chances of success Scale of project (perhaps downscale) Role of the current private sector partner Project structure and groundrules Purpose of project (test/pilot) Relationship between project purpose, project scale and investment required Packaging of the project: o Research project to test a hypothesis (i.e. that a saleable product can be produced for the export and/or local market) o Commercial enterprise o Community/social investment project Funding – dependent on how project packaged Implementation process (research/pilot project to a fully fledged sustainable project) Cost-benefit analysis Revisit business plan

4.2 Resolve the irrigation issue and constraints related to DECAS requirements

Assuming that it is decided to continue the project the following issues must be resolved as a priority:

- Discuss the irrigation issue with DWA&F. They have indicated a willingness to discuss an interim solution that could be put in place until the information necessary for the granting of a license is in place. An interim solution will be evaluated by DWA&F in terms of the potential to set an unfavorable precedent.

- The limitations that apply because of the location of the project adjacent to a natural wetland need to be discussed with DECAS as it may be possible to reach a compromise on some of these requirements. It needs to be borne in mind that if irrigation water is obtained from the Kuils River, this may improve the nutrient situation (since water from the sewerage works is discharged to the river). This needs to be discussed with DECAS as well.

4.3 Immediate Next Steps

The final draft report was discussed at a meeting on 20 June 2001. It was decided that the project should be salvaged. To this end immediate action steps were identified, in addition to which it was agreed that a workshop should be held with stakeholders to develop a longer term action plan for the project, including the identification of exit points. The immediate next steps are:

- To approach the Arum Lily Society of South Africa to request whether they would be prepared to visit the site and provide some preliminary advice on its suitability for continuing the project. (Responsibility : M-J Morris)

- To identify the requirements for Dfid Challenge Fund projects and Flora International to ascertain whether it would be worth making an application for funding for the project. (Responsibility : M-J Morris).

- To notify community representatives and employees of the project that a workshop will be held to discuss the future of the project, the focus being on what is required to salvage the project. (Responsibility : Tygerberg Administration).

- To speak to employees on the site about the responsibilities that they are required to fulfil given that they have been paid a salary. (Responsibility : Tygerberg Administration).

- To identify a date for the workshop and notify the CMC Administration (Ms V Ntshinga) and the Tygerberg Administration (Mr O Asmal and A Geldenhuys). (Responsibility : M -J Morris).

- To invite relevant participants from the local authority Departments to the workshop. (Responsibility : V Ntshinga and O Asmal/A Geldenhuys respectively).

- To invite community representatives to the workshop (Responsibility : Tygerberg Administration).

- To arrange a venue for the workshop (Responsibility : Tygerberg Administration).

PART C

NEW GREEN

HANDBOOK FOR NEW GREEN DATABASE OF WETLAND PLANTS WITH ECONOMIC POTENTIAL

Table of Contents

1
NEW GREEN BACKGROUND INFORMATION

1.1 INTRODUCTION AND SYSTEM REQUIREMENTS

The new green database of wetland plants with economic potential should be used in conjunction with the *Wetland Site Assessment Guidelines* to select potential wetland cultivation plants suited to the wetland site of interest.

The new green database has been created in Microsoft® (MS) Access. The database thus requires the user to have MS Access installed on the computer system. MS Access is a component program of the MS Office program package. The new green database is suitable for use with either MS Office 1997 or MS Office 2000. The system hardware requirements are those required for operating the relevant MS Office program package.

1.2 INTEGRATION OF NEW GREEN DATABASE AND WETLAND SITE ASSESSMENT GUIDELINES

The *Wetland Site Assessment Guidelines* refer to the new green database, and the two should be used together to provide decision support when enquiring into the feasibility of wetland cultivation. Whilst the *Wetland Site Assessment Guidelines* direct the user in the enquiry as to whether a particular wetland site may be suited for cultivating, the new green database provides the plant options for cultivation at the wetland site under consideration.

1.3 STRUCTURE OF NEW GREEN DATABASE

The user-friendly interface of the new green database (the main form) is designed to guide the user through the process of identifying species which may be suited to the particular wetland under consideration. The skeleton design of the new green database (Fig. 1) shows the four routes of database enquiry. The new green database main form (Fig. 2) presents the user with these four routes for accessing information on species suitable for cultivation in wetlands:

- Via the species name;
- Via the uses of the plant components;

- Via the geographic region;
- Via a site quiz of the characteristics of the potential cultivation site.

The four routes of enquiry on the main menu are structured to dovetail with the *Wetland Site Assessment Guidelines*, and will lead the user through a site - or species-assessment towards a choice of plants for cultivation.

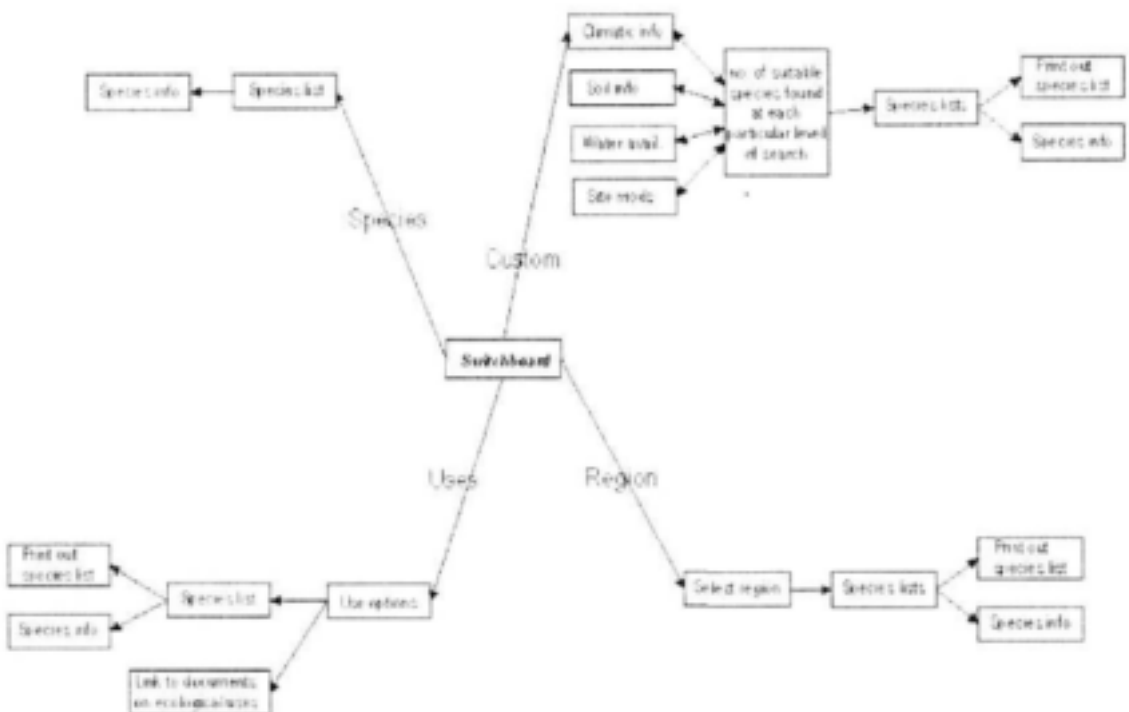


Figure 1 Skeleton design of the `new green` database starting at the main form

Figure 2 The `new green` database main form presents the user with four options for accessing information on wetland cultivation.

1.4 INFORMATION INCLUDED IN THE NEW GREEN DATABASE

Information on plants and their respective environmental preferences are the main components of the database.

Information is available about the following plant characteristics:

- Scientific and vernacular common names;
- Distribution by biome and province within South Africa;
- Plant growth form;
- Plant habitat;
- Plant climatic and soil preferences;
- Plant environmental tolerances;
- Plant uses;
- Cultivation and harvesting methods;
- Market values.

Data has been included in the various categories where available.

The database serves as a guideline to direct the user to potentially useful wetland plants. Non-wetland plants are not included in the database. While the database provides a limited amount of information about the individual species, it is emphasised that the user will need to make his/her own more detailed enquiry to find out all relevant information about cultivating, harvesting, and marketing criteria for the chosen species.

1.5 SPECIES INCLUDED IN THE NEW GREEN DATABASE

There are 38 species listed in the database. These are a mix of indigenous as well as non-invasive exotic species. Each species which has been included in the database was selected because it meets two criteria:

- the species is known to have a preference for wetlands or water-inundated areas such as the margin of dams and rivers; and
- the species has recognised uses and thus has a potential economic value.

Whether or not a species is suitable for cultivation is not a criterion for species' inclusion in the database. The possibility of cultivating a species will be a separate enquiry after the species has been identified through the database to be of potential use in a given wetland situation.

Cultivation potential will be related to an enquiry into the economic value and market demand for the species.

1.6 SPECIES NOT INCLUDED IN THE NEW GREEN DATABASE

Although the database is predominantly composed of indigenous plants, a few exotic species are also included which are known to be non-invasive. However, exotic species of aquatic plants such as those used for the tropical aquarium market are not included in the database at this stage. These species were excluded due to concerns about their invasive potential.

1.7 RANGE OF SPECIES USES AVAILABLE

Table 1 summarises the species included in new green, listing their scientific and common names, indigenous or exotic status, and their categories of use.

Table 1 Summary of plant species included in new green

SPECIES NAME		STATUS	USES					
Genus species	**English (or isizulu) common name**	**Indigenous (I) / Exotic (E)**	**Ornamental**	**Utilitarian**	**Essential oils**	**Medicinal**	**Food**	**Water purification**
Acorus calamus	Sweet flag	E			☒	☒	☒	☒
Aponogeton distachyos	Cape pondweed	I				☒	☒	
Artemisia afra	African wormwood	I			☒	☒	☒	
Colocasia esculenta	Coco yam / taro potato	E					☒	
Crinum bulbispermum	Orange River lily	I	☒			☒		
Crinum campanulatum	Water crinum / vlei lily	I	☒					
Crinum macowanii	River crinum	I	☒			☒		
Cyperus fastigiatus		I		☒				
Cyperus latifolius	(Ikhwane)	I		☒				
Cyperus marginatus	(Incema)	I		☒				
Cyperus natalensis	(Induli)	I		☒				
Cyperus papyrus		I		☒				
Cyperus sexangularis	(Imuti)	I		☒				
Cyperus textilis	(Imuti)	I		☒				
Drimia robusta		I				☒		
Gunnera perpensa	River pumpkin	I				☒	☒	
Hyphaene coriacea	(Ilala)	I	☒	☒				

SPECIES NAME		STATUS	USES					
Genus species	**English (or isizulu) common name**	**Indigenous (I) / Exotic (E)**	**Ornamental**	**Utilitarian**	**Essential oils**	**Medicinal**	**Food**	**Water purification**
Juncus effusus		I		☒				
Juncus kraussii	Salt marsh rush	I		☒				
Miscanthus junceus	Wire leaf dahi grass	I		☒				
Nymphaea capensis		I	☒					
Phragmites australis	Common reed	I	☒	☒		☒	☒	☒
Phragmites mauritianus	Lowveld reed	I		☒				☒
Pteris vittata		E						☒
Raphia australis	Kosi palm / raphia palm	I		☒				☒
Salix mucronata	Cape willow	I				☒		☒
Sansevieria hyacinthoides	Bowstring hemp	I	☒	☒		☒		
Schizostylis coccinea	Scarlet river lily	I	☒					
Schoenoplectus corymbosus	(Mxobesi)	I		☒				
Schoenoplectus litoralis	(Indidi)	I		☒				
Scirpus sp.		I						☒
Spirulina sp		I				☒	☒	☒
Typha capensis	Bulrush	I		☒		☒		☒
Vetiveria nigratana	Vetiver grass	E	☒	☒	☒		☒	☒
Vetiveria zizanioides	Vetiver grass	E	☒	☒	☒		☒	☒
Wachendorfia thyrsiflora	Blood root	I	☒					
Zantedeschia aethiopica	Arum lily	I	☒			☒		
Zantedeschia albomaculata	Spotted-leaf arum lily	I	☒					

1.8 ECONOMIC VALUE OF SPECIES

Where possible, the market values of the plants have been included in the database. However, many of the indigenous species have not yet been grown commercially, and there is no reliable source of information about market values in many cases. Furthermore, plants grow in specific habitats and geographic areas, and some tend to be perceived a 'free' resource, available to anyone who makes the effort to search them out and harvest them. Thus the actual street or market value of a plant depends to a large extent on the scarcity of the plant and on the distance between the market and the plant habitat. It follows that the market value can vary widely from place to place.

Added to this variability is the variability in demand, partly because many of the uses of plants are still tied to cultural practices and knowledge, both of which vary from place to place. Accordingly, a plant may be in great demand in one place but of little value in another place. This variability can make it a risky enterprise to cultivate plants for traditional uses.

A third variable results when cultivators of useful plants end up competing with others who are harvesting the 'free' plants from the wild. The harvesters will generally be able to charge lower prices than the cultivators (in the short term), creating substantial risks for the cultivators as a result of downward pressure on the market price.

For all of these reasons, it is not possible to determine a reliable general market value for a particular useful plant product, and the database accordingly does not do so except in a few instances where reliable information has been published. Furthermore, in the light of the above discussion the market values given in the database should be viewed as rough guides only.

As regards the cost of cultivating a particular plant, most of the species in the database have not been formally cultivated except perhaps on a very small scale, and the cost of cultivation is therefore not known.

Cultivation of indigenous plants for traditional uses is not an easy way to make a living, and this cautionary note should be kept in mind in all cases of indigenous plant cultivation. Given all the variables mentioned above, it is advisable that any cultivation project should start as a low-key trial during which cultivation methods and costs, product requirements, market values, and other factors are investigated.

1.9 DATABASE UPDATES

A unique feature of the database is that users can update it with information of their own, making it into a customizable database. Using MS Access allows the database to be shared and to be updateable by multiple users, either through the internet or by allowing for all the individually-modified databases to be incorporated into the master database. The database replication function is used to make special copies — called replicas — of a database so that users at different locations can all work on their own copies at the same time and share, or synchronize, their changes. In these ways, the master copy is able to reflect the cumulative input of many separate users, and in turn the separate inputs can be shared by the many users. In other words, each user gets to share the updated information provided by many separate users.

The corollary of this multi-user updateability is that the database can continually become more comprehensive. Users with different specialisation will tend to make their best contributions from within their speciality area. In this way the database makes the best use of the best available experience and information from many users.

However, the downside of this is that the on-site modifications may go unnoticed by the collective users. In order to remedy this, it may be useful to create a centralized database which is updated with the information of all known users. In this way a comprehensive database will develop which makes use of the individual expertise and experience of many users. An updated version can be provided annually at a reasonable fee to the users.

1.10 SOURCES OF INFORMATION USED FOR NEW GREEN DATABASE

The new green database has been populated with data from books, other databases and personal communications. Other databases used were NURSERY (Prof. JF de Wet, PE, South Africa) and Plants for a Future (Registered Charity Number 1057719, England). All information sources are acknowledged in the database, and references are listed in the database.

2
NEW GREEN USER MANUAL

Introduction

Welcome to new green, the database of developing green crops!

This user manual will guide you through new green, showing you how to maximise your search for information.

Conventions in this Manual

- Words indicated in ***bold italic*** are contained in the Glossary.
- Words indicated in `fixed sys` represent information typed into the computer
- new green command buttons are represented as: [Button]
- Titles of forms are in *CAPITAL ITALICS*

SECTION A USING AND UNDERSTANDING THE NEW GREEN INTERFACE

A.1 HOW TO OPEN NEW GREEN

The new green program cannot be run directly from the CD; you must first move all the contents of the CD into your hard drive.

A.1.1 Prepare the files for first use (installation)

1) Place your CD in the CD drive and close the drive.

2) Open Windows Explorer.

3) Locate the **X:\NewGreen** folder (where X indicates the drive designation of your CD drive).

4) Drag and drop this **X:\NewGreen** folder onto the root folder of your **C:** hard drive.

Everything from the CD should now be installed on your hard drive, with the following files in their corresponding folders:

C:\NewGreen\readme.txt

C:\NewGreen\Data\NGdata.mdb

C:\NewGreen\forOffice97\NGcode97.mdb

C:\NewGreen\forOffice2000\NGcode2000.mdb

C:\NewGreen\UserManual\new green user manual.doc

However, the files will all be in a "read-only" state, and this must be changed for **each** file:

1) right-click on the file

2) select Properties

3) in the General tab of the properties window, un-check the Read-only attribute

4) click Apply, then click Close

A.1.2 Start the new green Program

To start new green, you have to Open the code file designed for the version of Microsoft Access® which is installed on your PC.

If you are using Microsoft Access® v 8 (which comes with Office 97 professional) then open the code file **NGcode97.mdb**

If you are using Microsoft Access® v 9 (which comes with Office 2000 professional) then open the code file **NGcode2000.mdb**

new green will open in Microsoft Access. Wait until the loading is complete. Your screen should look like Figure A-1.2. new green is now open and ready for use.

Figure A1.2-1: A successful start -up – The *MAIN* form of new green

A.2 HOW TO VIEW INFORMATION IN new green

All the data in new green are stored in sets of inter-linked spreadsheet tables. You, the user, primarily have access to these data through the ***graphical interface***. This graphical interface, which opens automatically, consists of a series of pages called "***forms***" and simply provides a clear way of viewing and searching the data.

On every Form, there are several ***command buttons***. It is strongly recommended that users use these command buttons to navigate between the forms of the graphical interface rather than opening forms from the ***database window*** and closing forms using the close window button (☒). The command buttons have a functionality (e.g. updating records, checking indices, closing relevant forms, passing parameters etc.) that generalised menu buttons do not have.

new green has several ***pre-programmed functions*** to aid you in your search for useful information. These functions are all accessed by clicking command buttons on the *MAIN* form of the graphical interface. These functions are discussed in detail in "SECTION B: Functions in new green".

There is **Help** available on most forms which explains the outcome of clicking each command button on the form.

Figure A2-2: The *MAIN* form from the graphical interface showing Command Buttons which should be used to navigate through new green

Should you wish to view the tables directly, or modify aspects of the database, you can click Database view on the *MAIN* form. The database window will then open and the graphical interface will close. **NOTE: This is NOT recommended for users not familiar with MS Access!** Modification of objects in the database could corrupt the database! For experienced

users who wish to use the database window, please refer to "SECTION C: Advanced Users Guide".

A.3 HOW TO PRINT OUT INFORMATION FROM new green

In database terminology, any printed information ge nerated by the database is called a "***report***".

When the user creates a report in new green by clicking Print, a report preview window opens. In this window the user can preview the report created before printing it out. To print the report from this window, click the print button on the toolbar ( ) or select " Print" from the File Menu. To return to the new green graphical interface, the user must click the close button on the tool bar (Close).

A.3.1 Types of reports in new green

There are two main types of reports that can be generated in new green, information reports and species-list reports.

Information reports can be generated from the *SPECIES* form and the *SITES* form. In these reports, all the information pertaining to the selected species or site is printed out in a single report.

Species-list reports can be generated from the pre -programmed functions (see Section B for more details). These reports provide a list of suitable species based on information the user supplied or selected. These reports are primarily intended to be used as reference material for consulting the *SPECIES* form.

Section B FUNCTIONS IN NEW GREEN

new green has several pre-programmed functions to aid you in your search for useful information. These functions are all accessed by clicking command buttons on the *MAIN* form, or *EXTENDED OPTIONS* form of the graphical interface. We will discuss each of these functions in turn.

B.1 STANDARD BUTTONS USED IN new green FUNCTIONS:

All functions use the following standard buttons.

Submit – performs the search based on the criteria entered by the user

Clear – clears all the search results and the criteria on that form

Back – steps back to the previous form

Print list – generates a report preview of the search results or species information that can be printed out.

Print – on the *SPECIES* and *SITES* form, this generates a report preview of the species information

View details – shows all the details of the searched species in a form similar to the SPECIES form

Only in the SiteQuiz:

Use ONLY these criteria – acts the same as Submit. It performs the search for species based on the criteria entered on that form only (i.e. no previous criteria are included).

Use ALL search criteria – acts the same as Submit. It performs the search for species based on the all criteria entered in the SiteQuiz so far.

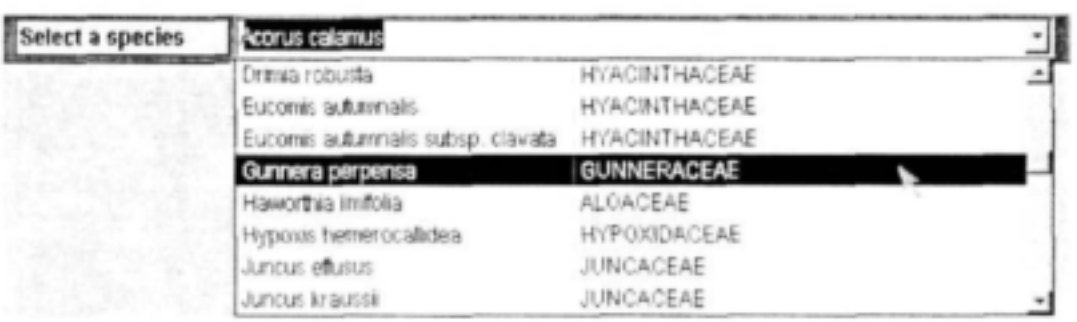
Continue – moves to the next form in the SiteQuiz.

B.2 *MAIN* FORM FUNCTIONS

B.2.1 Species

This function opens the *SPECIES* form. In this form the user can select any species in the database and view all of the information on that species. In order to see any information, the user must click on a species in the "Select a species" drop- down box.

Figure B2.1-1: Clicking on a species in the "Select a species" drop-down box



Once a species is selected, the information for that species becomes visible. The information is contained on several pages accessed by **Tab Controls** found just below the "Select a species" drop-down box. By clicking on the tab controls, the user can view the information contained on each of these pages.

In order to print out all the information for the selected species, click Print.

B.2.2 Uses

This opens the *CUSTOM SELECTION OF USES* form. On this form the user can select any number of plant uses from the list provided. Once a selection has been made, clicking Submit creates a species list of plants corresponding to those uses. This list can then be printed out for reference (click Print), or the details of the plants viewed in the *SPECIES* Form (click View details).

Tips for selecting uses: Click once on a use to select it. Selection is indicated by the item being highlighted. To deselect a use, click the item again, the highlighting will disappear. To clear all selections click Clear.

There are also some links to informative documents at the bottom of the form. Clicking these command buttons will open the relevant documents in Microsoft Word, where they can be printed out.

B.2.3 Region

This opens the *CUSTOM SELECTION OF REGION* form. On this form the user can select any number regions in South Africa from the list provided. Once a selection has been made, clicking Submit creates a species list of plants corresponding to those regions. This list can then be printed out for reference (click Print), or the details of the plants can be viewed in the *SPECIES* form (click View details).

Tips for selecting regions: Click once on a region to select it. Selection is indicated by the item being highlighted. To deselect a region, click the item again, the highlighting will disappear. To clear all selections click Clear.

B.2.4 SiteQuiz

This opens the SiteQuiz Wizard, starting with the *SITE QUIZ: CLIMATIC LIMITS* form.

The SiteQuiz Wizard is designed to help the user find suitable species for his/her site. The SiteQuiz Wizard consists of a series of forms that asks the user for information about his/her site. Each time new information is submitted by the user it is added to the previous search criteria and the search is narrowed. At every stage of the SiteQuiz, the user can see how many species in the database are suitable for his/her site and may choose to view or print out those species. Please note: careful interpretation of the SiteQuiz search results is required (see "Interpreting search results" below).

Interpreting search results

For all of the searches in the SiteQuiz, any ***null values*** have been included into the search ***parameters***. Including null values into the search parameters gives the user much more flexibility in viewing potentially suitable species. Species that might otherwise have been excluded due to a null value in a key criterion, are now returned. These ***"null-searched" species*** are easily identifiable as they have blanks in the specific criteria for which they have no information. It is up to the user to determine whether up not these "null-searched" species are suitable for the site in mind.

For example - The user enters values for rainfall and temperature limits on the first SiteQui z form:

On clicking Submit, species are returned by two pathways:

1) all species that fall within the climatic limits specified above are returned.

2) any species in the database for which rainfall and temperature limits have not been entered are also returned.

The Site Quiz: Step-by-Step

Tips for successful searching:

When asked for values, only type in numbers, units are not required (i.e. if your average annual Rainfall is 800 mm, enter 800, not 800mm, in the rainfall box)

You do not have to enter information for all of the criteria. If you leave a field blank, the SiteQuiz will simply ignore that criterion.

Step 1 Site Quiz: *Climatic Limits*

Overview

This form asks the user to enter the average annual rainfall (in mm) and temperature limits (in °C) for the site in mind. The user types in the relevant information and the clicks Submit to view the search results. The user can generate a report of the search results (click Print list) or can view all the details of searched species listed (click View details). To continue to the next form in the SiteQuiz, click Continue. The search criteria will be passed on to the *SITE QUIZ: SOIL INFORMATION* form and will be shown at the bottom of this form. If the user wishes to skip this form in the SiteQuiz he/she can click Continue without entering any criteria.

Tips for successful searching:

- only type in numbers, units are not required (i.e. if your average annual Rainfall is 800 mm, enter 800, not 800mm, in the rainfall box)

- you do not have to enter information for all of the criteria. If you leave a field blank, the SiteQuiz will simply ignore that criterion

- if you click Submit without entering any criteria, all the species in the database will be returned

- Note: the user-defined criteria are used to exclude species that are not suitable from the search results. Thus, when entering climatic information, the user should be wary of entering extreme recorded values. Rather, annual or 5-year averages should be used so as to include as many potential species as possible in the search results

Specific search logic

On this form, species are returned that have:

- a minimum rainfall requirement **less than** the ***user -defined*** rainfall value **AND**

- a maximum rainfall requirement **greater than** the user-defined rainfall value **AND**

- a minimum tolerated temperature **less than** the user-defined minimum site temperature **AND**

- a maximum tolerated temperature **greater than** the user-defined maximum site temperature **AND**

Algorithm = ([RainfallMin] <= User(Rainfall) **OR** Is Null)

AND ([RainfallMax] >= User(Rainfall) **OR** Is Null)

AND ([TempMin] <= User(minimum Temperature) **OR** Is Null)

AND ([TempMax] >= User(maximum Temperature) **OR** Is Null)

Note: for all algorithms the variable "User(description)" is the user-defined value or selection entered on the form.

Step 2 Site Quiz: *Soil Information*

Overview

This is the second form in the SiteQuiz. On this form, the user is asked to enter the average soil pH and all the soil textures that are found in the site in mind. The procedure is exactly the same for this form as for the *SITE QUIZ: CLIMATIC INFORMATION* form except Submit has been replaced by Use ONLY these criteria and Use ALL search criteria.

Use ONLY these criteria – performs the search for species based on the criteria entered on that form only (i.e. no Climatic Information criteria are included). Thus, the user is able to generate a list based on the soil information alone.

Use ALL search criteria –performs the search for species based on the Climatic Information and the Soil Information.

To skip this form of the SiteQuiz, simply click Continue.

Tips for successful searching:

- you do not have to enter information for all of the criteria. If you leave a field blank, the SiteQuiz will simply ignore that criterion
- if you click Use ALL search criteria without entering any criteria, all the species from the previous Climatic Information search will be returned

Specific search logic

If you click Use ONLY these criteria species are returned that have:

- a minimum tolerated soil pH **less than** the user-defined minimum pH **AND**
- a maximum tolerated soil pH **greater than** the user-defined maximum pH **AND**
- soil textures in common with the ***user-defined*** soil textures

Algorithm = ([Soil pH Min] <= User(Soil pH) **OR** Is Null)

AND ([Soil pH Max] >= User(Soil pH) **OR** Is Null)

AND ([Soil textures] = User(Textures) **OR** [All Soil textures] Is Null)

If you click Use ALL search criteria species are returned that have:

- been returned by the previous search **AND**
- a minimum tolerated soil pH **less than** the user-defined minimum pH **AND**
- a maximum tolerated soil pH **greater than** the user-defined maximum pH **AND**
- soil textures in common with the ***user-defined*** soil textures

Step 3 Site Quiz: *Water Availability*

Overview

This is the third form in the SiteQuiz. On this form, the user is asked to select the type/s of habitat in terms of water availability found in the site in mind. The water availability criterion is used to eliminate species from the search results that have higher water requirements than exist on the site.

The procedure for this form is exactly the same as for the *SITE QUIZ: SOIL INFORMATION* form. To skip this form of the SiteQuiz, simply click Continue.

Tips for successful searching:

- it is important to select all the types of water availability that occur on your site, and not just the predominant one.
- if you click Use ALL search criteria without entering any criteria, all the species from the previous two searches will be returned

Specific search logic

If you click Use ONLY these criteria species are returned that have:

- water requirements in common with the user-defined water availability

Algorithm = ([Water Requirements] = User(Water Requirements) **OR** Is Null)

If you click Use ALL search criteria species are returned that have:

- been returned by the previous searches **AND**
- water requirements in common with the user-defined water availability

Step 4 Site Quiz: *Site Modifications*

Overview

This is the last form in the SiteQuiz. On this form, the user is asked:

Are you able to modify your site through excavation or the construction of dams?

Are you able to irrigate you site with ground water, river water or runoff water?

If the answer to either of these questions is "Yes" then the user should click Yes next to the relevant question. The user can then enter information in the boxes that become visible.

Site Modifications:

If the user clicks Yes, the Modifications box appears. This box is similar to the Water Availability box on the previous form. The user should select the options that will reflect the **new** situation on the site, **after** the modifications. Note: if Use ALL search criteria is now clicked, the selections in the Modification box will replace the selections of the Water Availability box.

Irrigation:

If the user clicks Yes, the Irrigation box appears. The user should enter the amount of water that can be added to the site, exclusive of rainfall. The amount of irrigated water is then added to the amount of rainfall entered on the first SiteQuiz form. This new "Total water" amount is then used to search the database in the same manner Rainfall was used in the first site.

Tips for successful searching:

- it is important to select all the types of water availability that will occur on your site. The criteria selected in this box replace those selected in the *SITE QUIZ: WATER AVAILABILITY* form
- for the irrigation input: only type in numbers, units are not required (i.e. if your irrigation input is 1200 mm, enter 1200, not 1200mm, in the Irrigation box)
- if you click Use ALL search criteria without entering any criteria, all the species from the previous two searches will be returned

Specific search logic

If you click Use ONLY these criteria species are returned that have:

- water requirements in common with the user-defined site modifications **AND**
- a minimum rainfall requirement **less than** the new total water value **AND**
- a maximum rainfall requirement **greater than** the new total water **AND**

Algorithm = ([RainfallMin] <= [User(Rainfall) + User(Irrigation)] **OR** Is Null)

AND ([RainfallMax] >= [User(Rainfall) + User(Irrigation)]**OR** Is Null)

AND ([Water Requirements] = User(Modifications) **OR** Is Null)

If you click Use ALL search criteria species are returned that have:

- a minimum rainfall requirement **less than** the new total water value **AND**
- a maximum rainfall requirement **greater than** the new total water **AND**
- been returned by the temperature criteria of the Climatic Information search **AND**
- been returned by the Soil Information search **AND**
- water requirements in common with the user-defined site modifications

Algorithm = ([RainfallMin] <= [User(Rainfall) + User(Irrigation)] **OR** Is Null)

AND ([RainfallMax] >= [User(Rainfall) + User(Irrigation)]**OR** Is Null)

AND ([TempMin] <= User(minimum Temperature) **OR** Is Null)

AND ([TempMax] >= User(maximum Temperature) **OR** Is Null)

AND ([Soil pH Min] <= User(Soil pH) **OR** Is Null)

AND ([Soil pH Max] >= User(Soil pH) **OR** Is Null)

AND ([Soil textures] = User(Textures) **OR** [All Soil textures] Is Null)

AND ([Water Requirements] = User(Modifications) **OR** Is Null)

Step 5 Site Quiz: *Conclusion*

You have finished the SiteQuiz. Click Return to Main Menu to end the SiteQuiz and return to the *MAIN* form.

B.2.5 Extended Options

This opens the EXTENDED OPTIONS form, which looks similar to the MAIN form, and operates in exactly the same way. A detailed description of these functions is provided in "Section B-2: Extended options functions".

B.3 EXTENDED OPTIONS FUNCTIONS

B.3.1 Sites

This opens the *SITES* form. On this form the user can view information pertaining to specific site locations. The sites are linked to the species that occur in that site and to any relevant references. These can be viewed by using the tab controls positioned below the "Select a Site" drop-down box. To view the details of either a linked species or reference, highlight the relevant item and click View. Either the *SPECIES* form or the *REFERENCES* form will open with the relevant details. To return to the *SITES* form click Back.

The user can also add new sites to the new green database (discussed in "SECTION C: Advanced users Guide").

B.3.2 Images

This opens the *IMAGES* form. On this form the user can view images of various species that ar e stored in the new green database. To view the details of the species concerned, highlight that species in the "Species for Image" window and click View. The SPECIES form will open with the details of that species. To return to the *IMAGES* form click Back.

The user can also add new images (discussed in "SECTION C: Advanced users Guide").

B.3.3 References

This opens the *REFERENCES* form. On this form the user can view information pertaining to specific references cited in the new green database. These references are linked to the relevant species. To view the details of a referenced species, highlight that species and click

View. The *SPECIES* form will open with the details of that species. To return to the *REFERENCES* form click Back.

The user can also add new references (discussed in "SECTION C: Advanced users Guide").

Section C ADVANCED USERS GUIDE

C.1 HOW TO ADD YOUR OWN INFORMATION TO new green

new green is designed to be an expandable database. As new information becomes available so it can be entered and the database can be kept current. Below are discussed the main ways of updating existing information or adding new information.

C.1.1 Editing existing information

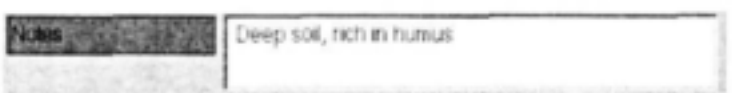
All the forms of the new green graphical interface are editable. This means the user can permanently alter the stored data in the underlying tables of new green by editing specific data on a form. For example, if the family name of a particular species changed, the user could call up that species on the *SPECIES* form, select the family name field and type it to the new name. This new name would be permanently stored in the database and the old name lost. For this reason, the user must exercise caution not to alter information by accident on any forms.

Information can be edited in different ***controls*** in new green. These controls behave in slightly different manner and are discussed below:

Text boxes

Information can be edited in a text box as one would edit any text document. Click on the text at the desired location and perform the edit. A scroll bar on the right -hand side of the text box can be used to scroll down the document.

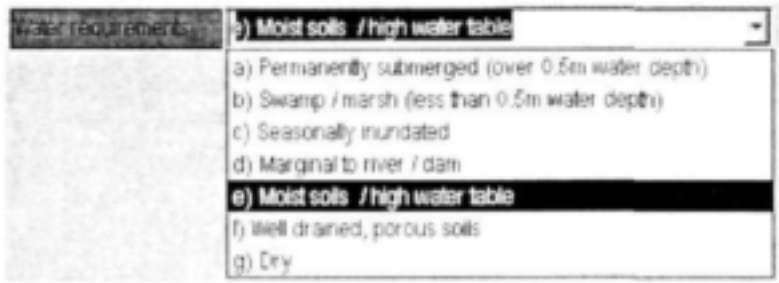
Figure C1.1-1: An example of text box



Combo boxes

Combo boxes are a combination of a list box and a text box. In a combo box the user can either type in a value or select one from the list. It is recommended that a value be selected from the list. This is so that data can remain comparable and can be more easily categorised. However, the user can enter a new value if there is nothing suitable on the list. To do this, the user can type in a value and press ENTER. A message box will appear notifying the user that this item is not on the list. The user should choose to add it to the list.

Figure C1.1-2: An example of a combo box

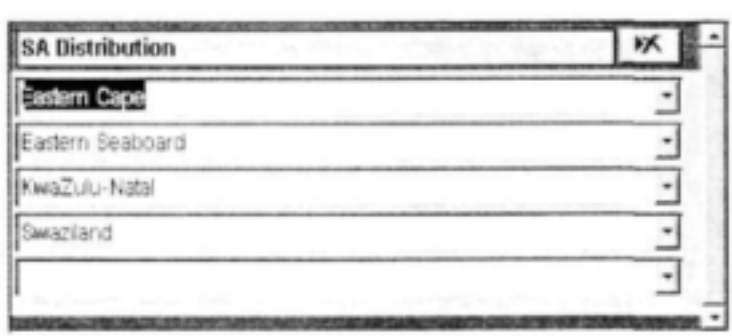


Sub-forms

Sub-forms are forms within forms. They are used to capture multiple entry data. For example: SA Distribution in the *SPECIES* form. As a species may occur in more than one area, the user must be able to select more than one region per species. Sub-forms allow this by replicating a control the moment it is filled in. The new, empty control appears directly below the old one, and can then be assigned a different value. A scroll-bar appears on the right-hand side to allow the user to scroll down to the new control.

Sub-forms use textboxes and combo boxes and they can be edited as described above. Deleting information from a sub-form is achieved by highlighting the item to be deleted and clicking Del.

Figure C1.1-3: An example of a sub-form. Note the new blank fields below the ones containing data



C.1.2 Adding a new species

On the *SPECIES* form, click Add. A blank form will be opened and the user can then fill in all the details for that new species in the manner described in "Editing existing information" above.

C.1.3 Adding a new reference

On the *REFERENCE* form click Add. A blank form will be opened and the user can then fill in all the details for that new reference in the manner described in "Editing existing information" above.

On the *SPECIES* or *SITES* form click the "References" tab control. Type in the name of the author, if the database does not recognise this author, a message box will appear asking you if you want to add this author to the list of references. On clicking yes, a sub-form will open that allows the user to type in the details of his new reference. These details will be added to the `new green` reference table.

C.1.4 Adding a new site

On the *SITES* form click Add. A blank form will be opened and the user can then fill in all the details for that new site in the manner described in "Editing existing information" above.

On the *SPECIES* form, the user can add a new site name by clicking the "Sites" tab control and typing a new name into the "Site" combo box. However, the user must then go to the *SITES* form to add the other details of the new site.

C.1.5 Adding a new image

Images must be in Bitmap format.

On the *IMAGES* form click Add. A blank form will be opened and the user can then fill in all the details for that new image in the manner described in "Editing existing information" above. The image can then be added by clicking Insert or link Image file. A window will open that asks the user to specify the location of the image.

C.2 WHERE DATA ARE STORED IN `new green`

All the data in `new green` are stored in sets of inter-linked tables. A list of all the tables can be viewed by clicking the "Tables" tab control in the database view. The relationships between these tables can be viewed by clicking "Tools" and then "Relationships" on the MS Access menu. It is extremely important that these relationships are not destroyed or disrupted. It is these relationships that allow the `new green` database to function.

For all the tables in `new green`, the naming protocol is as follows: The first letter of the name describes the type of object (i.e. Table). The next word describes the object's content (i.e. "Species" information, "Site" information, "aList" of names etc.). A second word attached to the name (optional) refers to the subset of information contained in that particular object. These words are all separated by an underscore ("_").

e.g.	T_aList_Biome	a list of all Biomes used in the database
	T_Species	the table storing the basic species information

T_Species_Geology the table storing the Geology component of the species information

C.3 HOW TO CREATE YOUR OWN SEARCHES (QUERIES) IN new green

It may be useful for the user to create his/her own queries in new green to search for specific information. Queries can be created as follows:

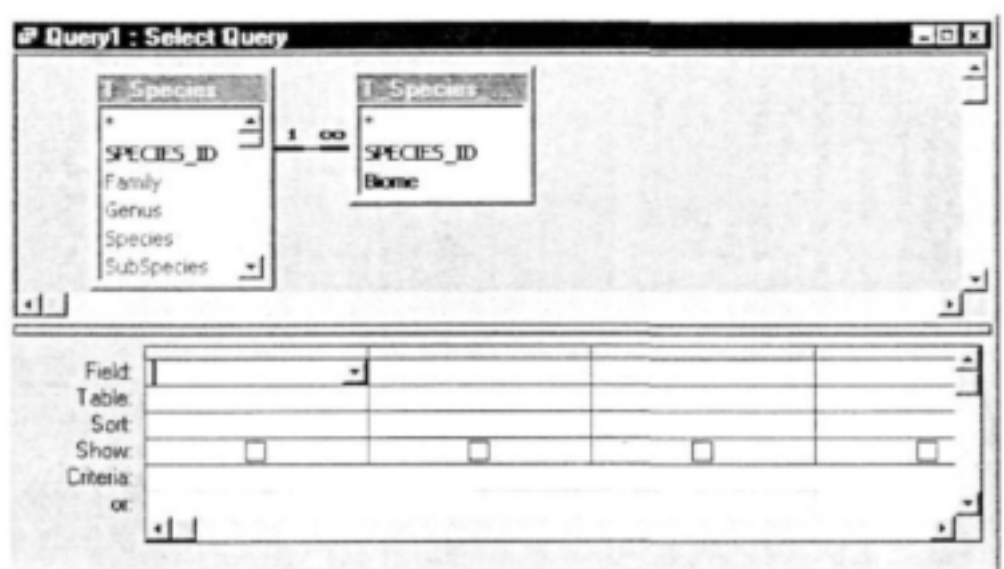
1) Click Database view on the *MAIN* form, click "Query" on the database window and then "New".

2) Select "Design View" and click "Ok". The query design window comes up and asks the user to select the table/s on which the query should be based.

3) Select the relevant table and click "Add".

4) If the user had selected T_Species and T_Species_Biome, the screen should now look something like the figure below:

Figure C3-2: Query design grid



5) The next step is to decide what fields are to be involved in the query. Fields can be involved in 2 ways: those that are displayed as columns in the resulting table, or those in which certain criteria have to be met.

6) Double-clicking on a field adds it to the query. Fields should be added in the sequence that the user wishes to see in the results table. In this example SPECIES_ID, Genus and Species are added from the T_Species table, and Biome is added from the T_Species_Biome table.

Each field is added with a tick in the "Show:" check box. This indicates that the field will be displayed in the table. In this example we do not want SPECIES_ID to appear in the results table, so its Show check box is cleared.

7) The results can be sorted by one or more fields, by click "Sort:" and selecting Ascending or Descending. In this example, the query is sorted by Genus in ascending order and by Biome in descending order.

8) The search criteria are entered in the appropriate column/s of the "Criteria" row. In this example we only wish to see species that occur in the "Fynbos" biome.

   Syntax for the search criteria:

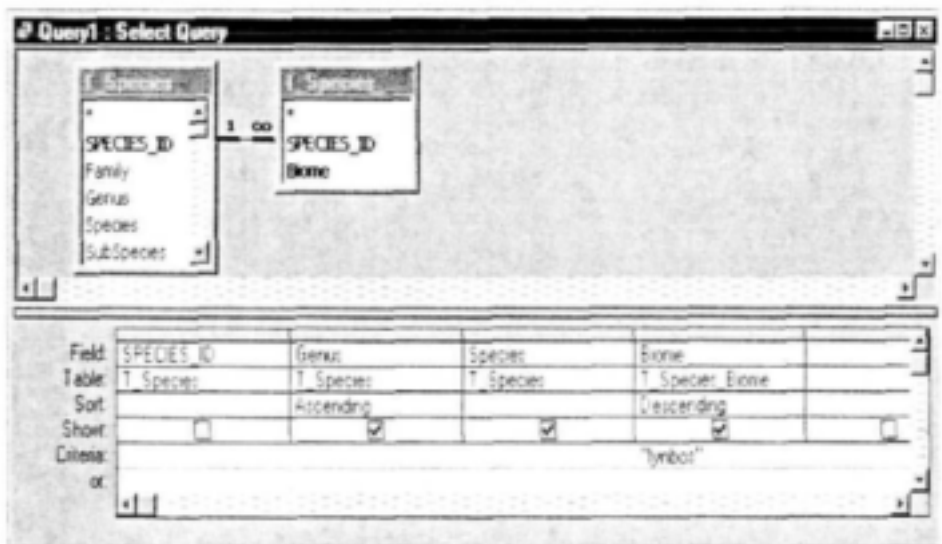
   - if text in the field has only a few alternatives then you can enter the alternative you want in inverted commas

   - if the search text might be embedded in other text, such as "grows in **wet** places", then the text must be surrounded by the any text indicator (*) and the concatenation symbol (&). Thus to search for "wet" in the above phase, your criteria would look be: `Like "*" & "wet" & "*"`

   - numeric operators can also be included. Thus, searching for plants less than 2m tall would have the following criteria in the height column: `>= 2` (or less than or equal to 2)

9) You query design should look like the figure below. To test your query, click t he datasheet view button (▾) on the standard toolbar. To go back to the design view click the design view button (▾).

Figure C.3-3: Final query design



Section D GLOSSARY

Command Buttons buttons located on forms that perform commands when clicked. Navigating through the new green interface should be done by using command buttons. All of the pre-programmed functions can be accessed by using command buttons. Command buttons are identified by …

Controls All the information on a form or report is contained in controls. Controls are objects on a form or report that display data, perform actions, or decorate the form or report. For example, you can use a text box on a form or report to display data or a command button on a form to perform an action.

Database window The MS Access window that gives direct access to the Tables, Queries, Forms, Reports, Macros and Modules of the new green database.

Drop-down box the ▼ associated with combo boxes. Clicking on this symbol opens a list box below the control.

Fields Categories of information in the database. Each species entered in the new green database, has numerous fields attached to it. Examples of these fields are minimum rainfall, maximum temperature, water requirements etc.

Forms are a graphical way of displaying data more conveniently. Forms are used to present filtered and sorted data from one or more tables in a clear and simple manner.

Graphical interface the collection of forms that allows the user to view and search the new green database in a visually convenient manner. Without this graphical interface, the user would have to search and filter the database manually before any useful information could be extracted.

Null refers to the absence of any data. When a field is left blank, with no information entered, that field is said to contain a "null" value.

Null-searched species refers to a species returned by a search that was selected on the basis of not having a value in the specific criterion that was searched.

e.g. Species X tolerates a minimum rainfall of 550mm per annum. The minimum rainfall limit for Species Y is not known, or has not been entered into the new green database. If a search is conducted for all species that can tolerate a minimum rainfall of 600mm per annum, both Species X and Species Y will be returned in the search results, Species Y being a "null -searched species".

Pre-programmed Functions To simply the search for information, new green has numerous pre-programmed functions that are available to the user. These functions are all run by clicking command buttons on the graphical interface. These functions typically ask the user to select or enter some information before searching the database for relevant species.

Queries are the MS Access term for "Searches". You use queries to view, change, and analyse data in different ways. You can also use them as the source of records for forms and reports.

Reports	are the way data is presented in a printed format. Reports operate in a similar manner to forms, presenting filtered and sorted data from one or more tables in a clear and simple manner, and can be printed out.
Parameters	are values that can be passed to a search or query. Parameters allow the same search to be run for different items simply by changing the parameters and without having to change the structure of the search.
Tab Controls	are buttons on a form that toggle between different sets of information when clicked.
Tables	contain all of the data in a database
User-defined	refers to anything that has been entered or selected by the user. This differs from "pre-defined", where the value has been pre-programmed into the new green database.

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MJ Freeman, MR Howard and HNS Wiegers

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The purpose of the Guideline Manual is to assist those responsible for, or with an interest in, the management of the water quality of urban impoundments. It is thus aimed predominantly at those persons in local authorities who must manage the water bodies in their areas. The Manual should also be of value, however, to developers, planners, design engineers, community-based and non-governmental organizations, academics and consultants, as well as the recreational users of urban impoundments and concerned individuals who may reside close to or within the catchment of an urban impoundment.
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