# 05

CHAPTER THREE

# *PROGRAMME*

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# 5.1
# A RESILIENT APPROACH

The programme has been developed from an understanding of the dynamic relationship between man and the natural landscape. A Regenerative approach is adopted for this intervention; the idea of using natural systems becomes the dynamic alternative infrastructure for the treatment of the contaminated water. The success of a natural system as permanent infrastructure requires an understanding that the system needs to have the ability to cope with pressures or environmental stress the system might encounter, referred to as the resilience of the system. The adaptive capacity of a system to perform its function (in this case a natural heavy metal removal system) is determined by its ability to regenerate and flourish, or spiral into collapse. Diversity, Redundancy and Modularity are resilient concepts which improve the adaptive capacity of a system. These concepts can be applied on an urban scale to the tiniest microorganisms of a system. (Peres, 2016:160)

## 5.1.1
## DIVERSITY

The more diverse a system, the better its chances for survival. Diversity has a variety of supportive elements which makes the system more flexible. Flexibility strengthens and stabilizes the system, ensuring it will still function even if the system experiences a shock. A level high diversity however doesn't necessarily mean a healthy system. An appropriate diversity needs to be developed that considers the required resources for the specific environmental intervention in within the complementary systems, bringing the correct level of diversity required for resilience. (Peres, 2016:162)

The function of this intervention is the removal of heavy metals via several systems. The diversity is attained through the use of settling detention dams, the algae biofilm system, as well as phytoremediation in the wetland. Diversity must also be applied and exist within the respective systems. This means that the resilience of the algae/ phytoremediation system is dependent of the level of diversity maintained within it. Practically this implies that ideally several complementary strains of algae and species of plants should form part of the ultimate intervention. Instead of depending on a single species, multi-species are proven to have a higher uptake than a single species. (Malik, 2004)



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## 5.1.2
## *REDUNDANCY*

Diversity and redundancy are interlinked, redundancy increases diversity (it's important to note though that diversity does not necessarily increase redundancy). Redundancy is considered a backup which replaces an element of the system,but without a backup a system becomes vulnerable and cannot fulfill its function. Profit-driven systems that run at a most efficient state will exclude redundancy as it is seen as a waste of resources. With natural, regenerative systems it makes sense to incorporate redundancy. It secures the system's reliability and functionality, thus providing a long tern solution. (Peres, 2016:173)

The algae and phytoremediation processes provide diversity and effectively redundancy in the system as there is a backup system in place. The wetland will serve its traditional role of removing organic pollutants, but if the need arises, it can replace and/or complement the algae system and perform the same function of heavy metal removal through the plants ability of phytoremediation. The detention dam and reservoir also at times operate as redundant systems.

## 5.1.3
## *MODULARITY*

Modularity in simple terms prevents a failure in one part of the system from affecting the entire system's performance. It also allows the system to be adapted to increase or decrease capacity as required. By breaking the system up into smaller parts, it is possible to shut down or localize a crisis. Referring to the systems methodology, the elements of a system can be divided into sub-groups which perform exactly the same role as the whole, but have the ability to be removed if the need arises. In essence sub-groups are strongly linked internally, but loosely linked to the rest of the system, although they are performing the same function. (Peres, 2016:178)

In this intervention modularity can be seen in the sub-group systems of algae and the phytoremediation wetland combination. The whole system as infrastructure has been broken up into 5 smaller, identical sub-systems. The interconnection is the contaminated water which links all 5 systems, capable of flowing where it is directed.



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# *INTERPRETATION*

## AN UNDERSTANDING OF THE SPATIAL REQUIREMENTS

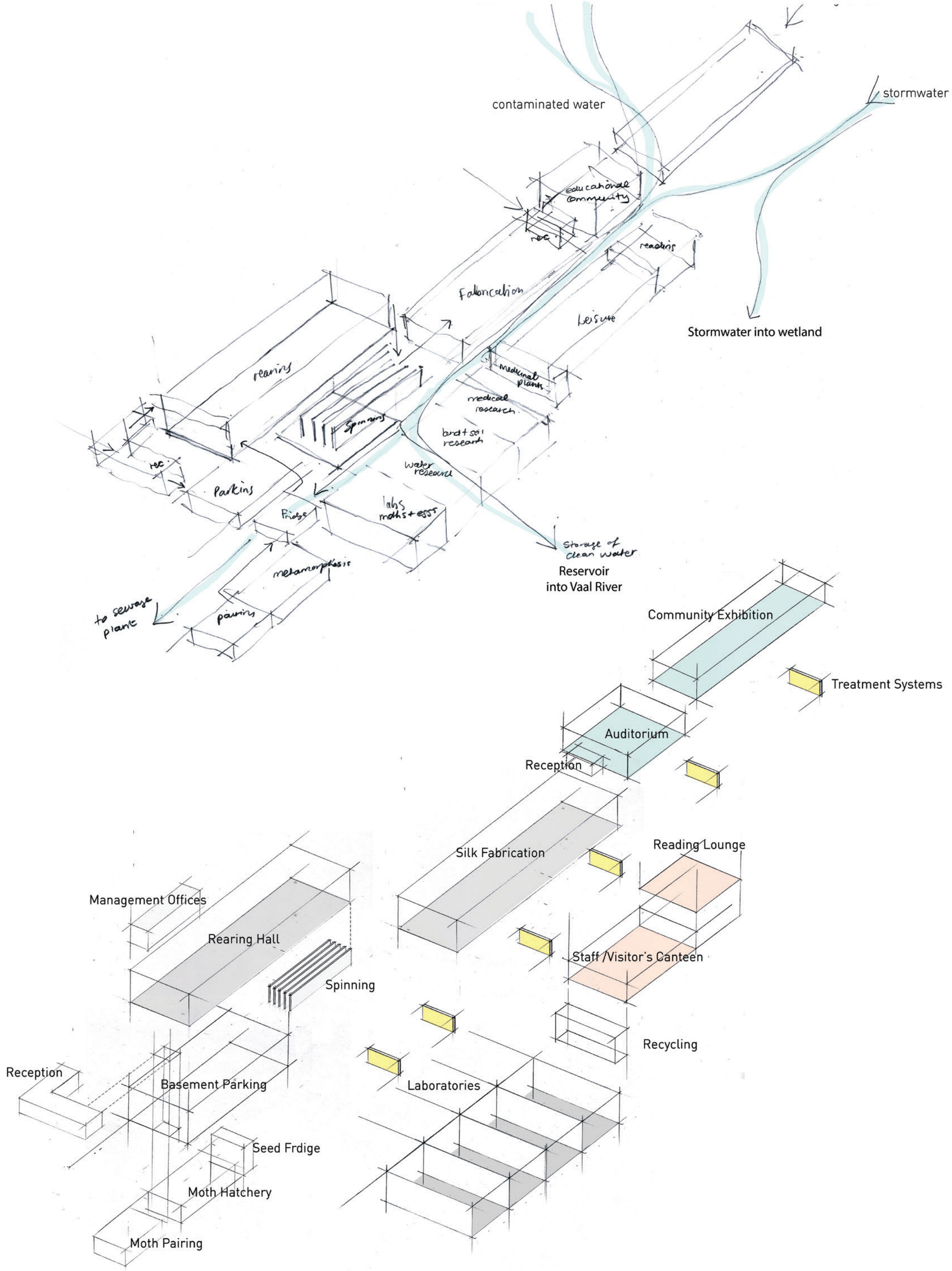


Figure 5.1: Programme and spatial planning. (Auathor,2016)



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## 5.2
## HEAVY METAL REMOVAL PROCESS

The industrial effluent and storm water will be stored in a detention dam which will regulate the water entering the revolving algal biofilm. The contaminated water remains in the troughs with the revolving algal biofilm for a complete cycle which will remove the heavy metals from the contaminated water. The metal free water will then enter a constructed wetland – this wetland also deals with the buildings grey water. The treated water will then flow directly into the river.

The plants selected for the constructed wetland system in the facility will be a secondary, redundant treatment method for the removal of heavy metals using the process of phytoremediation.

The intention is for the phytoremediation plants to become an established, dense network, which can replace the algae treatment method if a crisis arises or maintenance needs to be done on the algae system. The phytoremediation plants will be used as an experimental ground for research and community educational platform.

## 5.3
## SYSTEMS LABORATORIES

Four different Laboratories are required:

1. Algae Culturist Laboratory
The growing of algae takes place in the laboratory. Testing and samples of metal resistant strains ensure the optimal performance of the system.

2. Silkworm Geneticist Laboratory
The moths required for mating and laying eggs are tested for diseases. The eggs laid by the selected moths are also tested to ensure the batch will produce good quality silk.

3. System Ecologist Laboratory
The plants, insects and micro-organisms are all monitored and tested to ensure a holistic system is working efficiently.

4. Hydrologist Laboratory
The quality of the water is tested and monitored to ensure the metal removal processes are working effectively.



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# 5.4
# *BIOFILM FABRICATION*

The programme for silk production includes:

1. Rearing Hall
The growth of the silkworms from 1st to 5th phase begins when the eggs enter the rearing hall. The hatching of the eggs takes place in complete darkness and then the eggs are exposed to moderate light. The silkworms are placed on trays, monitored and fed as they grow through phases 1-5. Each successive phase requires more tray space as the silkworms grow, from 18 to 360 trays - practically increasing the space requirement and employees needed for the management of the silkworms life cycle. The trays are 1.2x0.9m, the size allows the rearers to clean and move the worms easily.

2. Spinning
At the end of phase 5 the silkworms are placed on screens to spin cocoons which are harvested. The 1.8x1.2m screens have small compartments for each worm and are hung from the ceiling structure.

3. Grainage Hall
Cocoons enter the grainage hall for reproduction, the moths mate and lay eggs for the next cycle of silk production.

4. Reeling and Weaving Room
This is where the cocoons are processed for the weaving of the cocoons into fabric and the fabrication of the biofilms.



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Figure 5.3: Spinning of coccoons. (Women in Sericulture,2016)

Figure 5.4: Soaking of coccoons. (Women in Sericulture,2016)

Figure 5.5: Reeling of coccoons. (Women in Sericulture,2016)



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The spaces required involve specific considerations:

1. Rearing Hall
The silkworms are reared in a rearing hall, special care is taken to ensure the environmental conditions of temperature and humidity are kept within the recommended values. The process is relatively sensitive as both temperature and humidity affects the quality of the cocoon. The silkworms release CO2, requiring proper ventilation to keep these toxic gases at a low level and to ensure that the silkworms do not experience any growth retardation or abnormalities. Silkworms are photosensitive to light, it is imperative that the hall caters for indirect, moderate lighting to encourage optimal growth cycles.

2. Spinning
When worms enter into their 5th phase, close to the time of spinning, they become more sensitive to the elements; temperature, humidity, light. The spinning phase requires that respective conditions should be optimal and moderate. The halls would need close monitoring of the elements, as these effect the worm's growth, spinning rate and strength of the silk filament.

3. Reeling and Weaving Room
Requires a large open area for the machinery used for soaking and processing of the cocoons. An automated reeling machine is used to convert the coccoons threads onto reels which is used to make the fabric. The making of the biofilm's custom sized film from the silk fabric produced will require a workbench and sewing machines.

4. Grainage Hall
A grainage hall is necessary for the pairing and laying of eggs. The grainage hall's location within the facility should be accessible from the geneticist laboratory as well as spinning room. The moths selected for the next cycle are tested in the labs for diseases which would affect the eggs/seeds. Unsuitable moths and eggs are incinerated to stop the spread of the disease. The moths prefer dim light for mating. After the eggs/seeds are laid, they too are tested for diseases before they are frozen. The grainage hall should have a large fridge for the storage of the eggs. (Rahmathulla, 2012: online)



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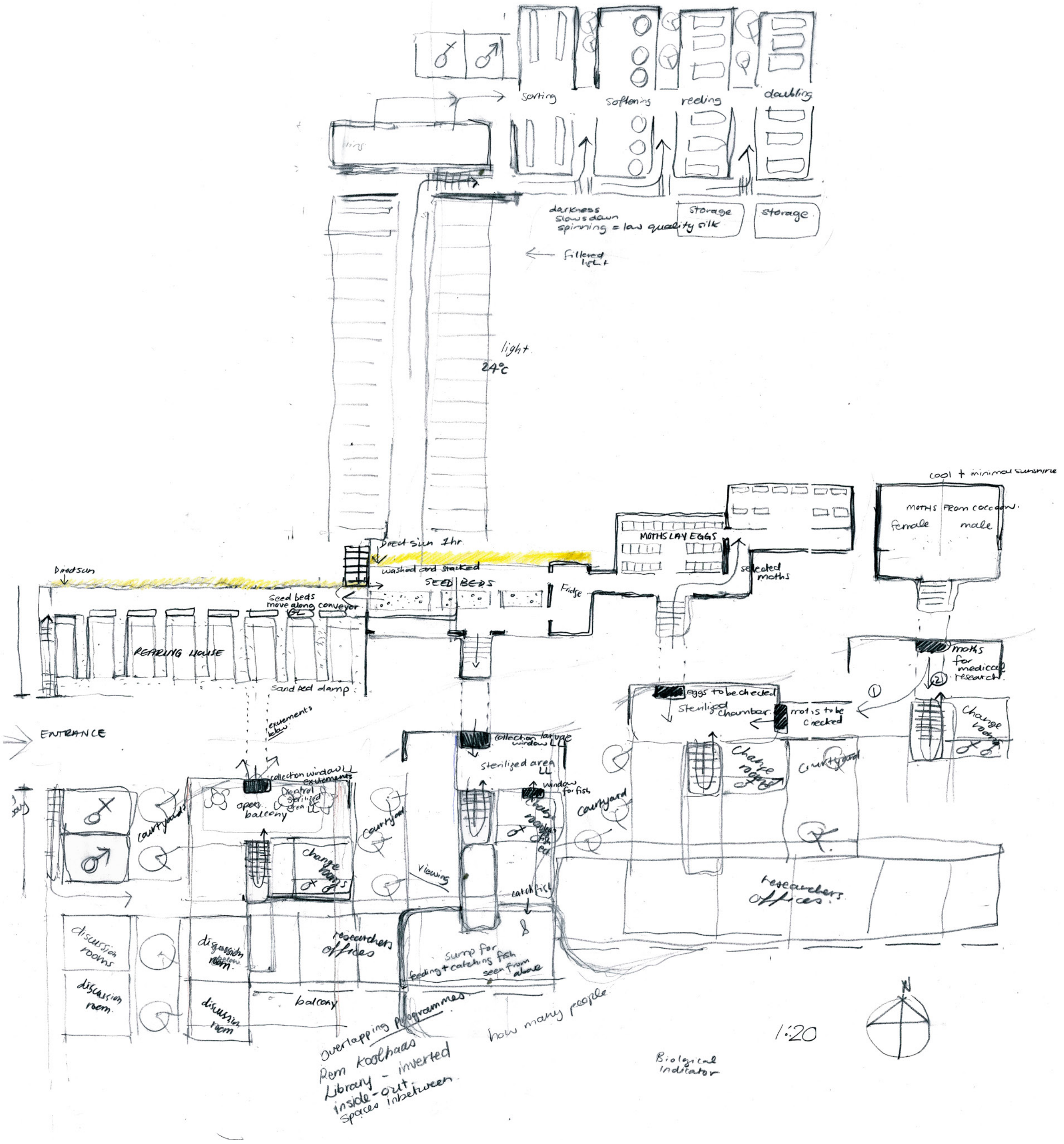


Figure 5.2: Diagram of spaces needed for silk production. (Author, 2015)



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## 5.5
## *COMMUNITY DEVELOPMENT*

The women from Bophelong will be responsible for the rearing of the silkworms and the fabrication of silk for the biofilm. The community auditorium is accessible to the public, and the exhibition hall also functions as the overflow area which is available for community talks, exhibitions and community events.

## 5.6
## *CANTEEN & LEISURE*

The visitors and employees have access to a large canteen and lounge area for lunch and tea during their visit or daily routine.

## 5.7
## *SCHEDULE OF OCCUPANCY*

Silkworm Rearers -60 workers
Biofilm Fabrication -10 workers, 1 manager
Algae and Wetland System – 7 workers, 1 manager
Researcher Department -4 scientist, 1 receptionist
Canteen/Leisure – 7 workers, 1 receptionist
Permanent Employees = 92 people
Learners and Visitors – 50 guests

*Refer to Annexure A for a breakdown of the detailed occupancy schedule.



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## 5.8
## *TRANSPORT*

Of the 92 permanent employers, 80-90% are expected to use the existing pedestrian footpaths and public transport as they will be employed from the adjacent community of Bophelong which is within a 3km radius. The facility will make provision for transport infrastructure on site for visitors, employees and local community to easily access the public facilities. Basement parking will be provided for 10-15% using vehicles and additional visitor parking will be provided on ground level within walking distance from the facility.

## 5.9
## *ABLUTIONS & SERVICES*

The occupancy classification according to SANS 10400 is as follows:

A2- Canteen, Community auditorium and exhibition hall
D1 - Offices
F2- Silk fabrication, rearing hall and laboratories

**TABLE 6**

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| For a population of up to — | Number of sanitary fixtures to be installed relative to the population given in Column 1 | | | | |
| | Males | | | Females | |
| | WC pans | Urinals | Washbasins | WC pans | Washbasins |
| 15 | 1 | 1 | 1 | 2 | 1 |
| 30 | 1 | 2 | 2 | 3 | 2 |
| 60 | 2 | 3 | 3 | 5 | 3 |
| 90 | 3 | 5 | 4 | 7 | 4 |
| 120 | 3 | 6 | 5 | 9 | 5 |
| | For a population in excess of 120 add 1 WC pan, 1 urinal and 1 washbasin for every 100 persons | | | For a population in excess of 120 add 1 WC pan for every 50 persons | For a population in excess of 120 add a washbasin for every 100 persons |

Figure 5.6: Table 6 - Ablution requirements. (SANS 10400,2011)



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