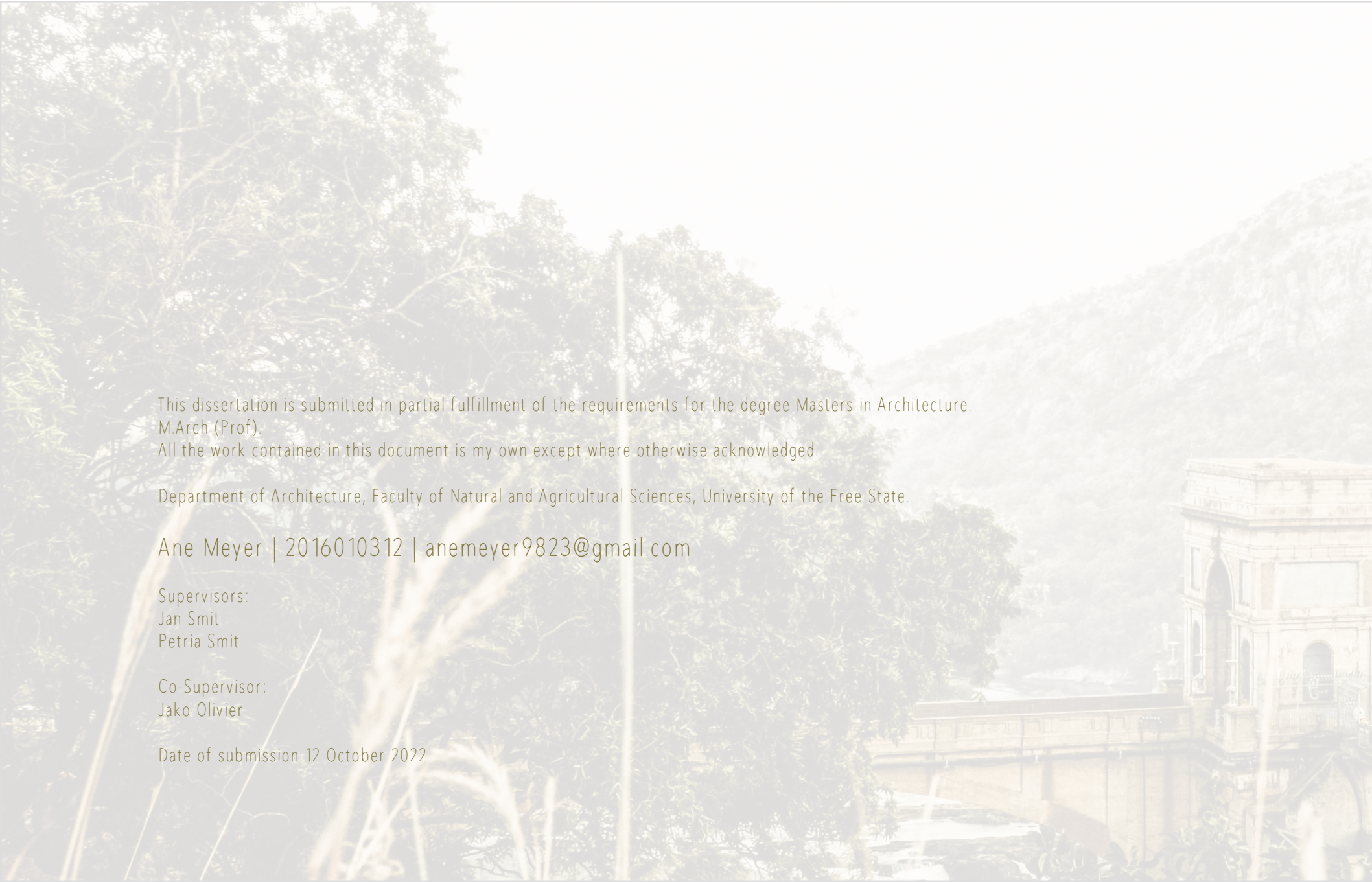
# Towards a reparational, relational, and respectful engagement with the temporal environment

## An algae research, design and manufacturing institute at Hartbeespoort Dam

Ane Meyer 2016010312





This dissertation is submitted in partial fulfillment of the requirements for the degree Masters in Architecture.
M.Arch (Prof).
All the work contained in this document is my own except where otherwise acknowledged.

Department of Architecture, Faculty of Natural and Agricultural Sciences, University of the Free State.

Ane Meyer | 2016010312 | anemeyer9823@gmail.com

Supervisors:
Jan Smit
Petria Smit

Co-Supervisor:
Jako Olivier

Date of submission 12 October 2022



for Mom, Dad and Mario

Thank you for your endless support,
love and understanding.

# 00

preface

# Abstract

Algal blooms, or the growth of algae in bodies of water, are a cause of concern around the world, with essential water supplies experiencing more frequent and dangerous blooms over the last decade. During a visit to Hartbeespoort Dam, I was struck by the natural gorge within the ancient Magaliesberg mountain range, the sun shaded by trees and burning red on the "kloof" walls' quartzites, shales, chert, and dolomite.

For more than 30 years, the Hartbeespoort Dam has been subjected to intense algal blooms. This design dissertation investigates the feasibility of establishing an Algae-related Research, Design and Product Manufacturing Institute at the dam, with a sincere concern for the environment, the permanence it emulates, and the fleeting moments it contains and entertains. The institute is a hypothetical collaboration between the University of Johannesburg, the Department of Water Affairs and the Wits Innovation Centre.

The Dam is a result of the division between human and the natural world. The design research seeks to physically and metaphorically expose the pre-existing natural wound, engage with nature to heal the injury under a protective scab and to naturally decay in place, leaving only a scar - a place of remembrance of the wound that was there.

Time, space and matter can fuse in great architecture to allow for profound human experiences. Time can literally and perceptually slow down under the right spatial conditions,which may provide an antidote to our instantaneous, speed-driven contemporary lives.

- METTE AAMODT

# PRELUDE

## A HOPEFUL MANIFESTO

Deep within the wounded landscape, algae is extracted from the Hartbeespoort Dam. To promote the growth of new skin, a temporary scab form over the wound. A healing body with ribs, flesh, and skin emerges from this scab. Through the healing body's rigid, consistent ribs, the algae wander and change before becoming a feature of the new, ephemeral skin that eventually replaces the old. An ever-evolving skin.

Every morning, the algae move through this healing body, and the ephemeral layer is constantly being renewed as something new is created within. As it serves to transform and renew itself every day, this ephemeral skin can be a platform for experimentation and discovery. The wounded landscape contrasts with the healing body.

Visitors can experience the landscape on natural, flowing footpaths and viewing platforms, emulating the monumentality of the dam wall, the arch, and the crest gates. The brittleness of the healing body's ribs and the strong linear lines imposed on the landscape translate, compliment and contrast with the transient qualities of the water, the growth of algae, and the changing of the seasons.

This dissertation is divided into two parts: a study of architectural approaches and writings on the nature of temporality and time within architecture; and a design project that attempts to use the research ideas to create an architecture that combines permanence, duration and ephemera into an experiential architecture of the place.

# 00
## Preface


Abstract.....

Index.....

Manifesto.....


# 01
## Setting the Scene


1. Setting the Scene: Introduction

1.1 Formulating the Brief

1.1.1 Metsi A Me Programme: the primary client's ideals

1.2. Algae: from hazardous infection to a renewable source and design catalyst

1.2.1 Textiles

1.2.2 Building component

1.3 Spatial and programmatic requirements: responding to client's needs and desires

1.3.1 Laboratory for Algae Research

1.3.2 Facility for Algae-based Design

1.3.3 Facility for Low Tech Algae based Manufacturing

1.3.4 Accommodation list


# 02
## The Wounded Landscape


2 The wounded landscape: a brief overview and analysis of Hartbeespoort

2.1 History and experience of the Context: from the perfect natural morphology to a dam wall

2.2 The context already there: Data of Place and a Sense of Place.

# 03
## Healing the Wound


3 Healing the wound of place and time: from theory to design tools

3.1 The Great Divide: disregarding and conquering natural system, places and time

3.2 Respecting and Repairing the temporal and permanent landscape

3.3 Respecting and Repairing architectural notions of permanence and ephemerality

3.4 Responding to the ephemerality of light, water and landscape elements

3.5 Synthesis of Concepts

3.6 Design Lessons and tools to consider


# 04
## Exploring the Ephemral Skin


4.1 Design exploration

4.1.1 Design Development

4.1.2 Towards a final design

4.1.2.1 Algae Research
4.1.2.2 Algae-based Design
4.1.2.3 Algae Based Manufacturing

4.2 Technical exploration

4.2.1 Living Systems
4.2.2 Algae Bioreactor Screen
4.2.3 Micro Algae harvesting


# 05
## Reflect


5.1 Research and Design Reflection

5.2 Conclusion

5.3 References



# 01

# Setting the scene

# 1. Introduction

This design investigation is rooted in a sincere concern for the environment, the permanence it emulates and the fleeting moments it contains and entertains.

During a visit to Hartbeespoort Dam, I could not but be struck by the natural gorge within the ancient Magaliesberg mountain range, the Crocodile river's natural flow held by the 1923 dam wall, the sun shaded in trees and burning red on the quartzites, shales, chert and dolomite of the 'kloof' walls.

As the sun travelled the dome, the blue-green algae on the water absorbed its glow.
I lamented the moments of reflection dulled by the hazardous blooms of pollution.

The increase in algae in water bodies, called algal blooms, is a cause of concern worldwide, with essetial water supplies witnessing regular and more hazardous blooms during the last decade. The rise in algal blooms results from the water's increased nutrients, a natural occurrence known as eutrophication.

Fig. 1.1 Hartbeespoort Dam (Author, 2021: Photograph).

Eutrophication can be aggravated by human nitrogen pollution, which leads to hazardous algal blooms. Climate change is a primary concern, with warmer weather and less rainfall reducing fresh water to water bodies and causing nutrient build-ups creating the ideal environments for algal blooms (Ndlela et al., 2016: online; Dower, S. 2003:13).

Algal blooms were not always considered dangerous in the past and tended to occur in summer. However, hazardous algal blooms have increased due to climate change and the discharge of sewage and wastewater effluents (Ndlela et al., 2016: online; Dower, S. 2003:13).

The Hartbeespoort Dam is certainly no exception to these blooms. The dam has witnessed intense algal blooms for more than 30 years.

This design dissertation explores the potential of an Algae-related Research, Design and Product Manufacturing Institute at Hartbeespoort Dam.

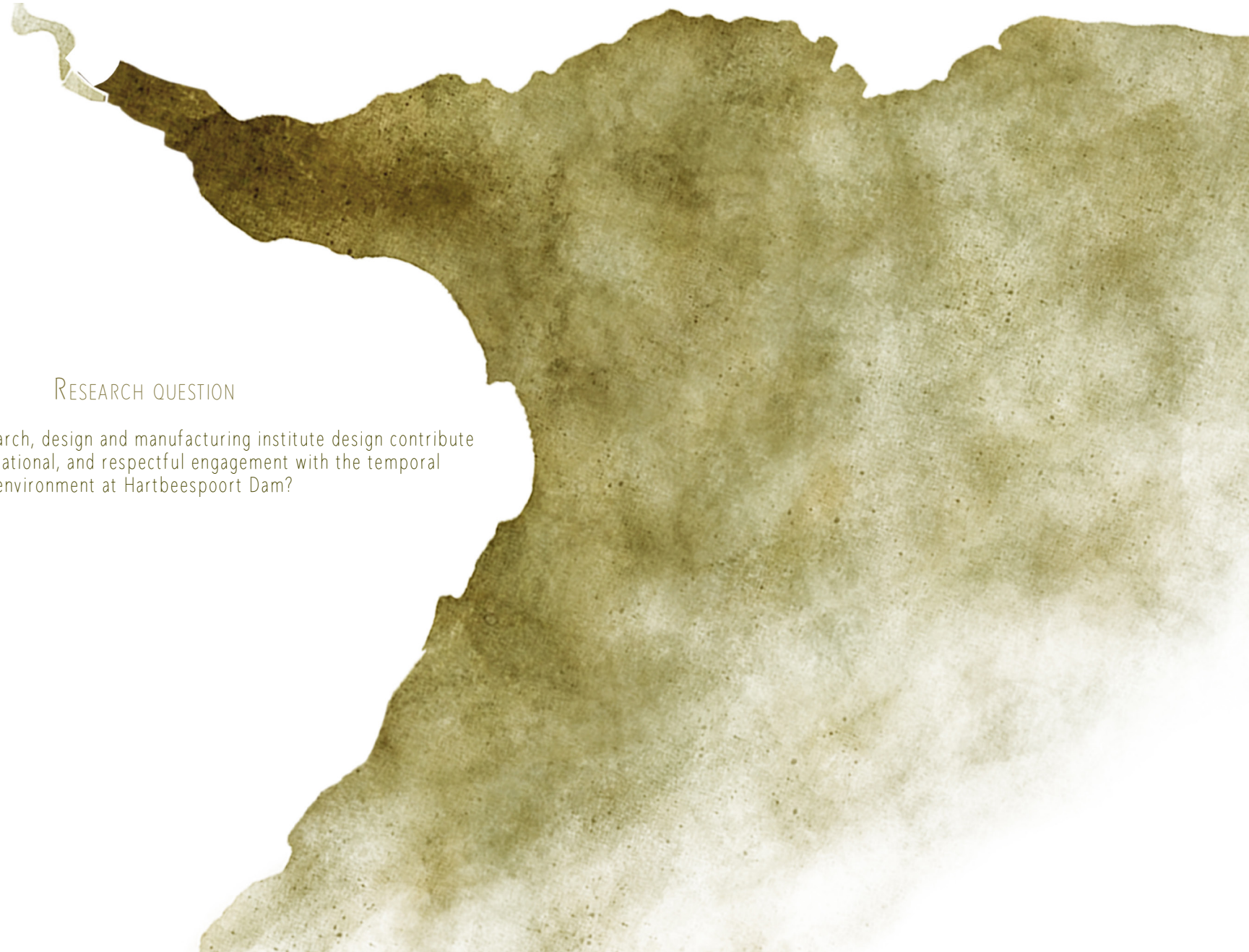
Hypothetically, the institute acts as a collaborative venture between the University of Johannesburg (UJ), the University of the Witwatersrand (WITS) and the Department of Water Affairs (DWA).

Funded by the primary client, the Department of Water Affairs (DWA) and the secondary client, the Wits Innovation Centre, the institute facilitates the harvesting of algae from the dam for:

- Algae research by the Department of Water Affairs (DWA), the Wits Centre in Water Research and Development (CIW) and UJ's Water and Health Research Centre
- Interdisciplinary Algae based design exploraions, conducted by different academic departments at UJ and WITS, including Architecture, Fashion Design, Industrial Design, and Visual Art
- Low technology manufacturing of algae-based textile production, supported by the entrepreneurship development program of the Wits Innovation Centre.

## Research question

How can an algae research, design and manufacturing institute design contribute to reparational, relational, and respectful engagement with the temporal environment at Hartbeespoort Dam?



## Title:

Towards a reparational, relational, and respectful engagement with the temporal environment

## Subtitle:

An algae research, design and manufacturing institute at Hartbeespoort Dam

## Implied research questions:

Can architecture mediate between permanence and temporality?
Can architecture promote attitudes of ecological and cultural sustainability?

## Research Tools

Historical and cognitive site analysis,
Conceptual exploration,
Analysis, interpretation and synthesis of theoretical notions and precedents are employed in the design research and creative design development.



Fig. 1.2 Nature on built structures (Author, 2021: Photograph).





Fig. 1.3 -1.5 Macro Algae processing (Lucking, 2019: Photograph).

# 1.1 Formulating the Brief

## Client's Needs and Desires

The main objective is to create a temporary public interface along the Hartbeespoort Dam that will serve as a public educational facility and functional laboratory for algae research and textile design.

Through the interface, the public will not only be informed about the uses of algae but will also be able to observe the practical and contextual integration of human and natural systems.

The building design, programme and materiality focus on education and research to benefit the environment and community.

The secondary programme aims to connect the user, infrastructure and environment in a closed loop system, creating spaces where humans and nature can reconnect through the establishment of blurred thresholds between the permanent and temporary, timeless and ephemeral experiences and the natural and cultured environments.

Ultimately, the design hopes to eventually disappear leaving a public park after the threat posed by hazardous algae blooms and the subsequent need for algae research is no longer adamant.







Fig. 1.6 - 1.8 Existing structures (Author, 2021: Photograph).

# 1.1.1 DWA's Metsi a Me Programme

THE PRIMARY CLIENT'S IDEALS

The integrated bioremediation programme for Hartbeespoort Dam was established by the Department of Water Affairs (DWA) in 2005.

In June 2006, the DWA selected Rand Water as the implementing agency for the programme after a detailed two-year assessment of the dam's condition.

The initiative was declared a national priority in May 2007 to enable rapid and comprehensive implementation. It is part of the South African government's goal to promote growth and development while creating jobs (Water Power and Dam Construction, 2013: online).

The objective was to identify, optimise and manage the physical and biological characteristics of the dam. This included lowering harmful algae, removing hyacinths and increasing fish biomass.

An information, communication, and knowledge centre were constructed near the dam wall to inform and educate the general public about the role they could play in reducing dam pollution. Over 7000 visitors and 6000 students have benefited from this thus far (Water Power and Dam Construction, 2013: online).

According to DWA, the initiative would focus on short-term outcomes that would be executed with longer-term difficulties.
A three-pronged approach was implemented:

First, symptomatic therapy, restorative action, and the establishment of a biological self-cleaning balanced ecosystem in the dam basin were developed.

This approach entailed restoring the dam's natural balance by eliminating most algae, hyacinths, undesirable fish, dead shorelines, trash traps, and trapped sediments (Water Power and Dam Construction, 2013: online).

Second, the natural filters of wetlands and riverbanks in the Hartbeespoort dam's local catchment area were to be restored and maintained (Water Power and Dam Construction, 2013: online).

Third, water use in the broader Hartbeespoort dam basin would be restricted. There would also be enforcement of illegal water usage and the integration of interdepartmental activities across the watershed to address the dam's implications.

Phase I of the dam's rehabilitation began in 2008 and has resulted in significant progress.
Since its inception in 2007, the initiative has employed up to 140 people and removed 11 6400 tonnes of hyacinth.

- 2400 tonnes of rubbish and waste
- 31 million litres of algae
- 11 190 tonnes of discarded fish

In addition, almost 8500 m2 of coastline was restored, and 4800 m2 of floating wetlands were built to serve as water filters. With the dredging of 50 tonnes, more than 11,500 tonnes of silt were also dredged. Plant material, rubbish and waste were recycled, and organic material was composted with the help of earthworms.

Residents have set up earthworm farms around the dam to support the initiative. The fish quality of the reservoir has also improved (Water Power and Dam Construction, 2013: online).

The Metsi A Me Programme has delivered many positive outcomes for the situation around the Hartbeespoort Dam, but was brought to a halt in 2016. Since then the problem of algae in the dam is still a very big concern with great risk to the environment.

# 1.2 Algae

## FROM HAZARDOUS INFECTION TO A RENEWABLE SOURCE AND DESIGN CATALYST

Humans have harvested algae for thousands of years throughout the earth's history. With the advent of new algae-based products in the 1970s, microalgae became commercially viable.

Algae are microscopic plants that, in their most primitive form, lack the characteristic elements of plants, such as branches, roots, leaves and seeds (Lee, 1980).

Microalgae cannot be seen with the human eye, but when sufficient nutrients are supplied, the colour of the water changes to a green, brown, blue or orange liquid due to a large number of microalgae present (Hemming, Sapounas, & Voogt, 2012).

They have a larger surface-to-volume ratio than crops, which allows them to absorb nutrients and carbon dioxide much faster (Tampier, Alabi, & Bilbeau, 2009).

Microalgae are responsible for 1/3 of the world's carbon fixation while producing about 70% of the oxygen in the atmosphere (Chinnasamy, Hanumantha, Bhaskar, Rengasamy, & Singh, 2012).

In recent years, there has been increasing interest in the commercial use of algae due to their valuable bioactive constituents, which can be used in various industries, including food, cosmetics, agriculture and horticulture, and human health.

Pigments, lipids and fatty acids, proteins and polysaccharides are among the bioactive chemicals of particular interest (Stengel et al., 2011).

Phycoerythrins and carotenoids, valuable pigments for textile finishing, are found in macroalgae. Phycoerythrin is a light-harvesting protein that specialises in the energy transfer chain and is water-soluble (Liu et al., 2005).

Many researchers have recently looked at the use of natural dyes in the dyeing of textiles as UV-protective and antibacterial agents.

Natural dyes could be used instead of synthetic dyes as an alternative, although most natural dyes are costly due to the extraction process.

This necessitates the development of cheaper natural dyes with a less complicated extraction technique.
Algal pigments could be suitable for this purpose and have some antibacterial properties (Mona et al., 2019).



## Fashion and textiles

Fig. 1.9  Textiles dyed using algal pigment (Vivian Hartung: Photograph).



## Bio plastics and packaging

Fig. x  1.10 printed bio-plastic made from algae (Florent Gardin, 2017: Photograph).



## Building materials

Fig. 1.11 Tiles with algae inset (University College London, 2019: Photograph).





Fig. 1.12 - 1.14 Alage textiles (Lucking, 2019: Photograph).

## 1.2.1 Textiles

Textile production is the second largest polluter in the world and causes various environmental problems. The traditional textile dyeing process pollutes 20% of the world's fresh water. In addition, 10% of the chemicals in our clothes end up on our skin and body.

Cotton, for example, is a natural fabric that needs water to grow (Nidhi, 2021: online).

By simply searching under the sea for an untapped resource in the form of algae, the *Algalife* team has addressed both the problems of water consumption and pollution.

Based in Berlin and Israel, this start-up is progressing rapidly in developing algae-based materials for the fashion and textile industries. *Algalife* uses algae to make fabrics and dyes.

Founded in 2018, the brand has won several awards, including H&M's *Global Change Award* in 2018, Fashion For Good's *Incubation Award* in 2018 and the Vision Award in 2018 (Nidhi, 2021: online).

Renana Krebs, CEO and co-founder of *Algalife*, has partnered with Israeli biotech start-up Algatech to make it all happen. *Algatech* is a provider of cosmetics and also an investor in *Algalife* (Nidhi, 2021: online). The raw materials are grown in a bioreactor facility in southern Israel.

Algae cultivation takes place in a closed cycle, is powered by solar energy, has no negative impact on nature or workers and does not require fresh water as salt water is used.

Wearing algae-based clothing has the added benefit of delivering antioxidants, vitamins, and other nutrients to the skin, depending on the type of algae used.

This gives the clothing antibacterial and anti-inflammatory properties without using chemicals.



## DECOMPOSITION OF MATERIALITY

- Scarlett Yang
- London, United Kingdom
- 2020

Scarlett Yang, a graduate of the prestigious Central Saint Martins design school in London, has designed a garment for her graduation collection that achieves just that. Yang created a sculptural, ephemeral high-fashion garment made from silk cocoon protein and algae extract. The fabric is fully biodegradable (Smith, 2020: online).

Although currently only a concept, it hints at the prospect of a fashion lifecycle in which clothing is intentionally eco-friendly. Therefore, Yang started looking for biomaterials as substitutes and eventually settled on algae extract and silk cocoon protein to make the garment waterproof (to a certain extent). Before deciding on the final result, Yang created hundreds of silhouettes using 3D models (Smith, 2020: online).

Yang puts the liquid mixture into a 3D mould, incubating it to make the 'textile'. The stiffness of the fabric is influenced by the ratio of algae extract to cocoon protein, as well as the temperature and humidity of the environment. Depending on the temperature and pH of the water, the fabric can dissolve at different rates: It can dissolve entirely in as little as 15 minutes or two hours. According to Yang, the mould's shape and the material's thickness also play a role (e.g. a tiny mesh or a sizeable open fabric) (Smith, 2020:online).



Fig. 1.15 The conceptual dress made from algae (Yang, 2020: online)

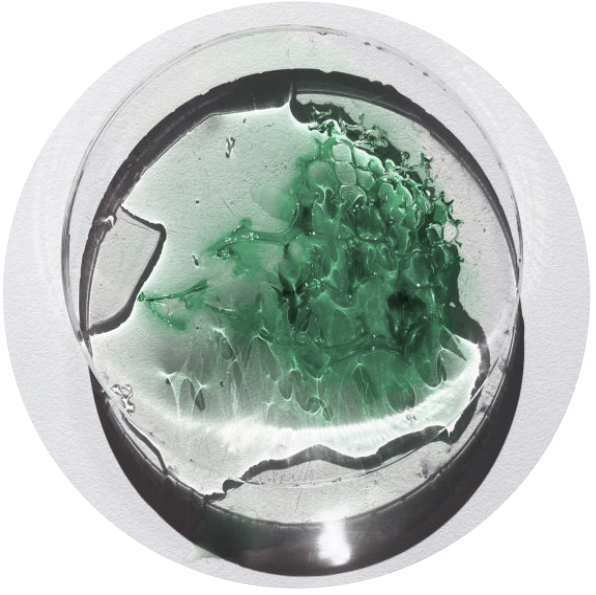







Fig. 1.16 - 1.18  3D printed lace made from algae (Yang, 2020: online).




## ALGAEMY TEXTILES

- Blond & Bieber
- Berlin, Germany
- 2014

*Algaemy* is an analogue textile printer that produces its own (fast-growing) pigment. Microalgae offer various applications, including nutrition, energy and oil production, filtration properties and even CO2 absorption.

The machine uses this capability to establish a self-sufficient production cycle that requires no additional energy or materials other than human labour and microalgae. Different microalgae species offer various colours, including blue, green, brown and red. The colours are not light-stable, as is often assumed in the industry.

When exposed to sunlight, the "biodynamic colour palette" of *Algaemy* fabrics changes over time, from green to an intense blue, from a faint pink to a bright red and finally to orange. Each textile tells a story that evolves, just like people. Blond & Bieber collaborated with Berlin fashion designer Ylenia Gortana to create two ensembles for the Milk and Sugar fashion show.

The garments were sewn without direct sunlight to avoid biodynamic colour change. They were first shown at the fashion show and immediately began their natural colour change. Blond & Bieber also designed the prototypes of the microalgae-printed shoes in collaboration with the German shoe manufacturer Trippen (Hobson, 2014: online).

Fig. 1.19 Patterns created by Algaemy (Blond & Bieber, 2014: photograph).







Fig. 1.20 -1.22 Process of creating algae textiles (Blond & Bieber, 2014: online).



Fig. 1.23 The analog printer (Blond & Bieber, 2014: online).



Fig. 1.24 Algae colours (Blond & Bieber, 2014: online).

## 1.2.2 Building Material

Algae is not only applicable in the creative design industry, as architecture students from across the globe have started to explore the idea of using this as a building material.

The following two precedent studies are some of the examples of projects that explore algae as a new material or system in the construction industry.

### Algae Textile

The thesis by Bogias combines the components of a classic photobioreactor into a lightweight device that can easily be incorporated into standard urban building assemblies and enclosures.

Traditional divisions or building screens can therefore be recreated as productive entities to create living buildings.

This thesis is a new hypothetic way of interpreting photobioreactors within the building industry as there are also built examples like the Bio Intelligent Quotient (BIQ) House.

Further details and information about the Bogias building screen will be discussed in the technical section.

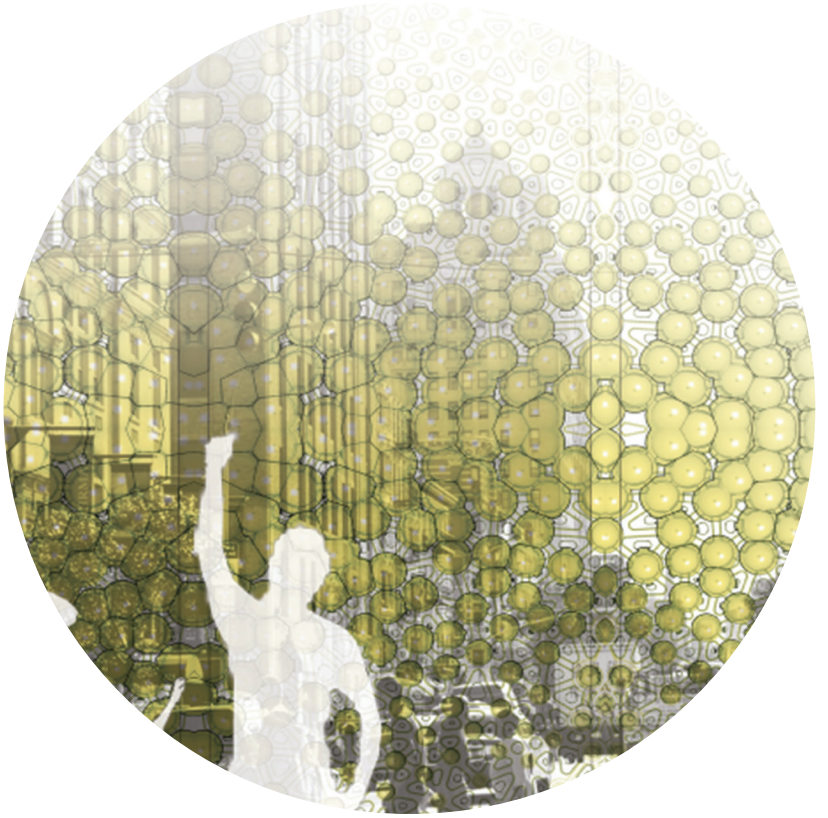


Fig. 1.25 Algae building screen (Bogias, 2018: image).



Fig. 1.26 Algaecrete (Riveira, 2018: Photograph).

## Algae(crete)

The *Algae(crete)* thesis project proposes the use of biomass from algae as a lightweight, hygroscopic and bio-receptive reinforcement for cementious composites, to derive materially-efficient fibrous constructs.

Matreial research was constructed through flexural beams and cylindrical samples to evaluate the structural, hygroscopic, rheological and bio-receptive performance of concrete mixes prepared with different volumetric ratios of added algae fibres and different proportions of fine aggregates.

The thesis aimed to improve the performance of fibrous components with the use of natural fibres from algae blooms. This is in an attempt to reduce the depletion of natural recources and reappropriate the organic by-products originated from the Harmful Algae Blooms phenomena.

The concept of reinforcing concrete with fibres is not new since horsehair was used in mortars in ancient times, dating back to 1870.

However little research has been done towards concrete composites with green filamentuous algae, making this proposal one of the first attempts to develop a new sustainable material system.

# 1.3 Spatial and Programmatic Requirements

## RESPONDING TO CLIENTS' NEEDS AND DESIRES

From the preceding aspirations of the  DWA's Metsi A Me Programme and the possibilities offered by algae based research, textiles and building materials, the client is situated as  the coming together of science, art-and-design, and entrepreneurship.

In collaboration different departments and programmes from UJ, WITS, unite with the DWA to form the Algae Research, Design and Manufacturing Institute at Hartbeespoort Dam. The spatial and programmatic requirements respond to the three aspects of the Institution:

- A laboratory facility for Algae research by the Department of Water Affairs (DWA), the Wits Centre in Water Research and Development (CIW) and UJ's Water and Health Research Centre

- A design facility for Interdisciplinary Algae based design explorations con ducted by different academic departments at UJ and WITS, including Architecture, Fashion Design, Industrial Design, and Visual Art

- Entrepreneur development facilities for Low technology manufacturing of algae-based textile production, supported by the entrepreneurship development program of the Wits Innovation Centre.








Fig. 1.28 -1.30 Processing of macro algae (Tjeerd Veenhoven, 2016: Photograph).

# 1.3.1 Micro-algae Research Laboratory



Fig. 1.31 Algae textile research (Yang, 2020: online).

## General Layout

The most crucial stage in laboratory design is ensuring that the laboratory facility has enough floor space for the desired laboratory activities. In every laboratory, adequate movement and working space are critical factors.

The area must be large enough to contain all of the necessary design elements of a core laboratory, such as hand-washing basins, benches, sinks, and workstations, as well as equipment such as refrigerators and freezers (World Health Organization, 2020).

Today's "open lab" concept is significantly different from that of the "closed lab" of the past, which was based solely on accommodating the individual principle investigators. In open labs, researchers share not only the open space itself, but also equipment, bench space, and support staff (Arizona State University, 2020).

The barrier between laboratory and non-laboratory area should be formed by a lobby (buffer space) at each laboratory exit. This will enable for sanitary, safe, and secure laboratory environments.

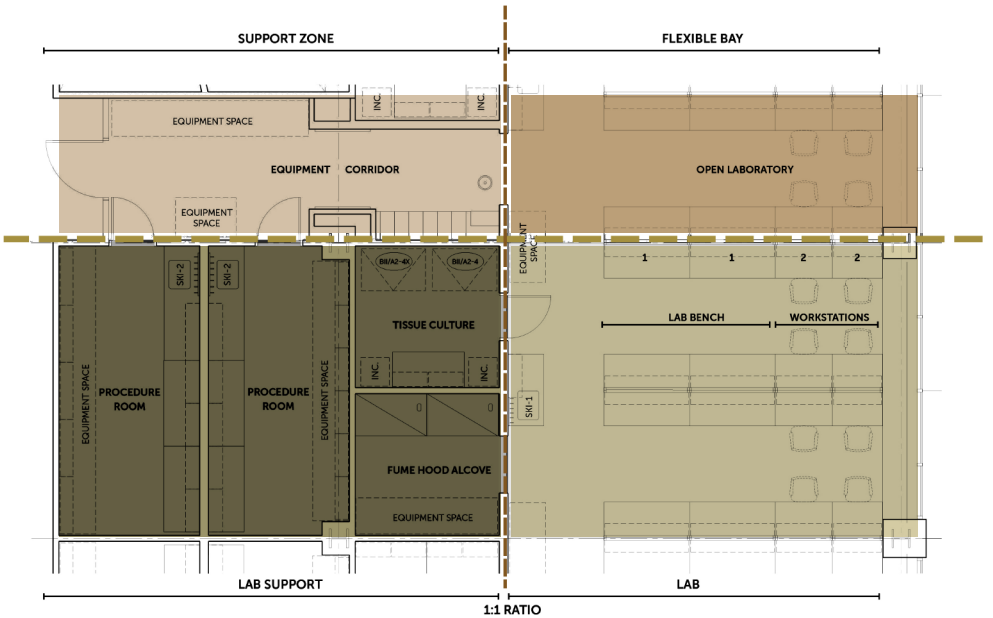



Fig. 1.32 General layout floorplan for a typical laboratory (Umeå University, 2021: online). edit by Author.

## Floors and walls

- The surfaces of the walls and flooring must be smooth and continuous. This may need the use of coving, which involves introducing curved edges.

- Wall and floor materials must be simple to clean, impermeable,and resistant to the chemicals and disinfectants used in the laboratory.

- Walls must be structurally sound and functionally finished. Wall protection, for example, may be necessary to avoid trolley damage, or splash backs may be required behind sinks and hand-washing basins.

- Floor drains in laboratories must have grills or water traps to keep insects, rats, and other pests out.

## Windows

- Windows should be sealed in most cases, however they may be openable if the laboratory is meant to be naturally ventilated.

- If they are openable, they must be constructe to keep insects and vermin out of the laboratory and be lockable.

- Openable windows should be simple to use and easily accessible so that they may be opened and closed as needed.

- Natural ventilation design should minimize excessive air movements and draughts that might interfere with equipment operation.

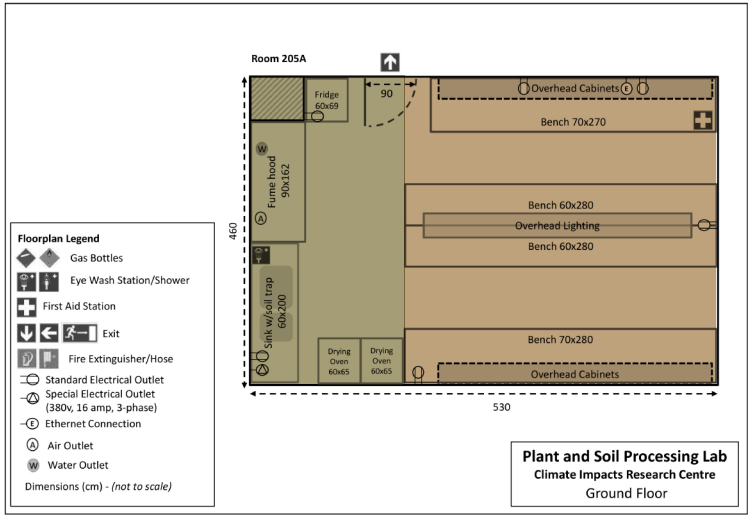



Fig. 1.33 Plant and soil processing lab floorplan layout. (Umeå University, 2021: online).

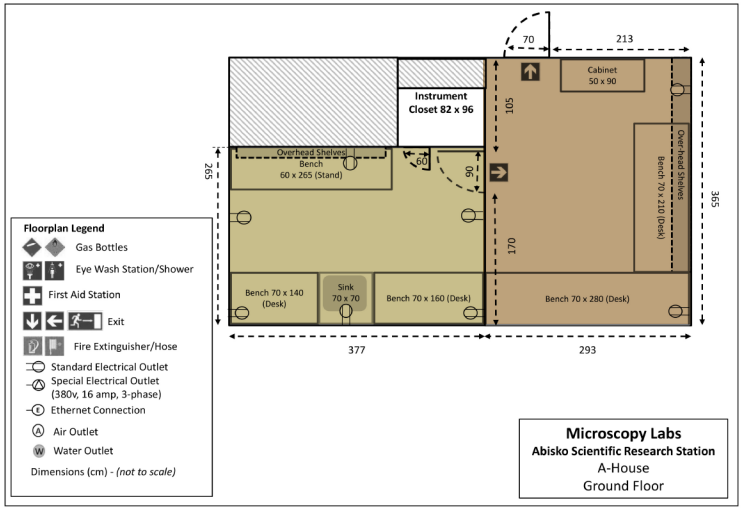



Fig.1.34 Microscopy lab floorplan layout. (Umeå University, 2021: online).

# Doors

- The doors to the essential components laboratory must be locked and equipped with a vision panel to provide visibility inside the laboratory.

- Internal laboratory doors must be equipped with vision panels to provide worker visibility and to avoid accidents.

- Doors must comply with applicable building codes (for example, fire ratings), be self-closing, and be broad enough to readily transport equipment, supplies, or garbage.

- Doors should be labeled correctly. At the very least, they should have:

    - the international biohazard symbols where bio- hazardous items are handled or kept,

    - the contact information for the laboratory's responsible person in the event of an emergency,

    - a signal that entry to the area is prohibited.

    - Depending on the local conditions, external doors and windows should be protected against pests and wildlife.

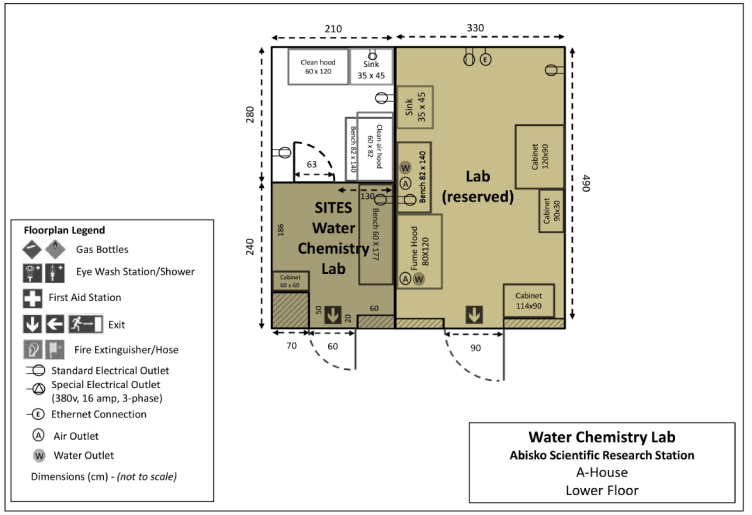



Fig. 1.35 Water chemistry lab floorplan layout. (Umeå University, 2021: online).

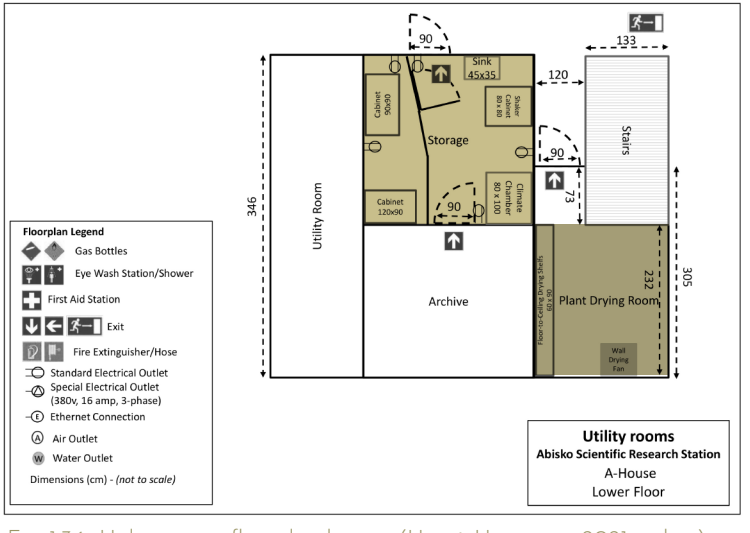



Fig. 1.36 Utility rooms floorplan layout. (Umeå University, 2021: online).

## Workbenches

- A workstation designed for working, writing, or typing while sitting should be 720 mm
- The optimal recommended setup for a workstation comprises one 750 mm work surface.
- 600 mm work surface, with the computer in the corner.
- It is suggested that a counter to counter clearance of 2150 mm be used.
- Workbenches should be built of non-absorbent, skid-proof, wear-resistant materials that are also resistant to the harmful effects of acids, solvents, and detergents in normal usage.

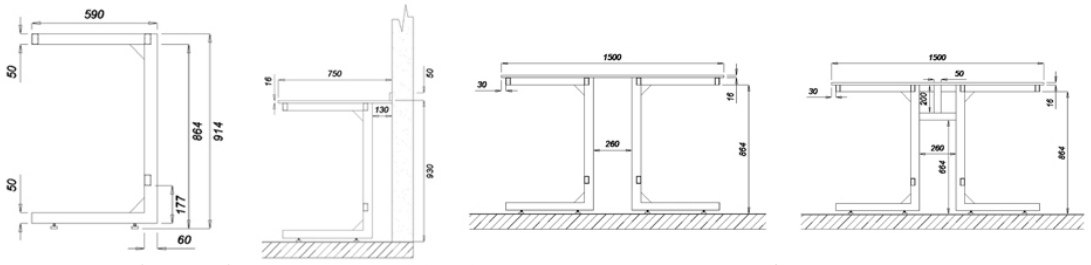



Fig. 1.37 Specifications for C-structure work benches (Umeå University, 2021: online).

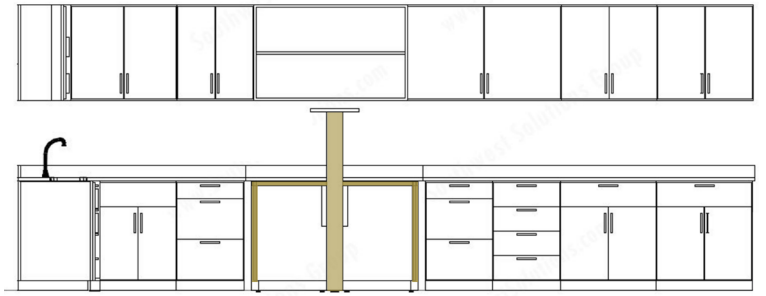


Fig. 1.38 Typical work benches in laboratory (Umeå University, 2021: online).

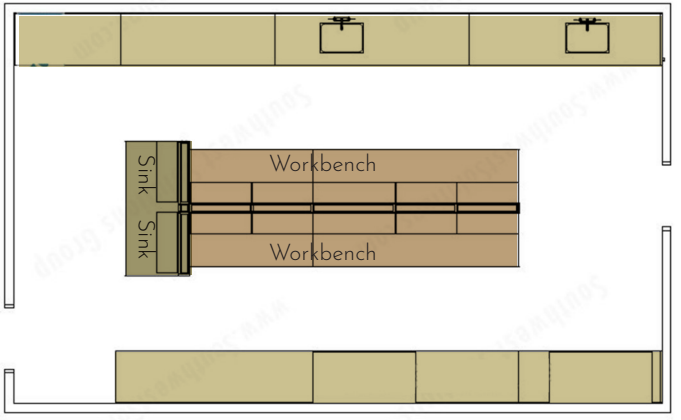



Fig. 1.39 Typical layout of work benches in laboratory (Umeå University, 2021: online).

## Emergency Shower

- opens in one second
- water remains on without use of hands
- delivers 113.5 liter of water per minute
- easy to locate and accessible controls
- head at 2 100 mm from floor
- adjustable water supply
- visible sign
- checked and flushed weekly

## Emergency Eyewash

- water remains on without use of hands
- goes from off to on in one second or less
- large and easy to operate controls
- delivers 1,5 liter of water per minute
- water nozzles 850 to 1 150mm  above floor
- visible sign
- checked and flushed weekly

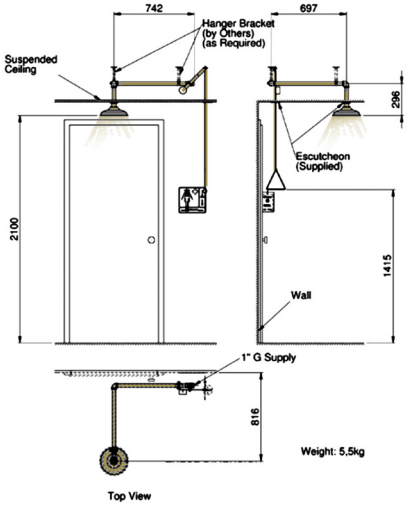



Fig. 1.40  Emergency shower specifications (Umeå University, 2021: online).

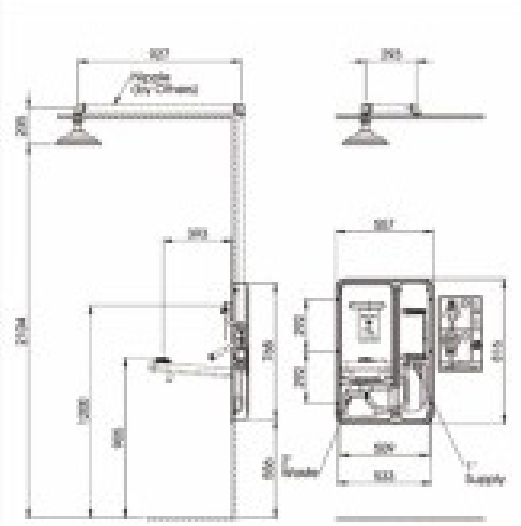


Fig. 1.41  Emergency eyewash spesifications (Umeå University, 2021: online).

# 1.3.2 Design facility for Interdisciplinary Algae based design explorations



Fig. 1.42 3D printed lace made from algae (Yang, 2020: online).

## General Layout

The interdisciplinary area for design explorations is a multifunctional space that can accommodate different workshops and work environments. This will allow the space to be used by various design disciplinarians, including but not limited to Architecture, Fashion Design, Industrial Design and Visual Art.

In order to design an adaptable space where all aspects of the creative industry can be accommodated the following should be considered:

- Create open, continuous spaces, paying close attention to the layout and design of storage.

- Include buffer zones that can absorb overflow brought on by frequent changes in closely spaced areas (which have important function and flow) while preventing any encroachment on adjacent areas.

- Planning internal circulation systems as a component of a larger architectural idea.

- Offer more space and higher ceilings than necessary to enable space adaptation to various uses and environmental factors.

- Spread out the design and construction of the building over several phases to better meet ongoing change and new needs and, as a result, maintain coherence with sociocultural, economic, and technological advancements.

- To maximise connections and interactions between the immediate natural and built environments, as well as to improve permeability and accessibility, the building should be designed as a series of interconnected spaces.

(Nakib,2010: online)

# 1.3.3 Entrepreneurship development for low-tech production of algae textiles

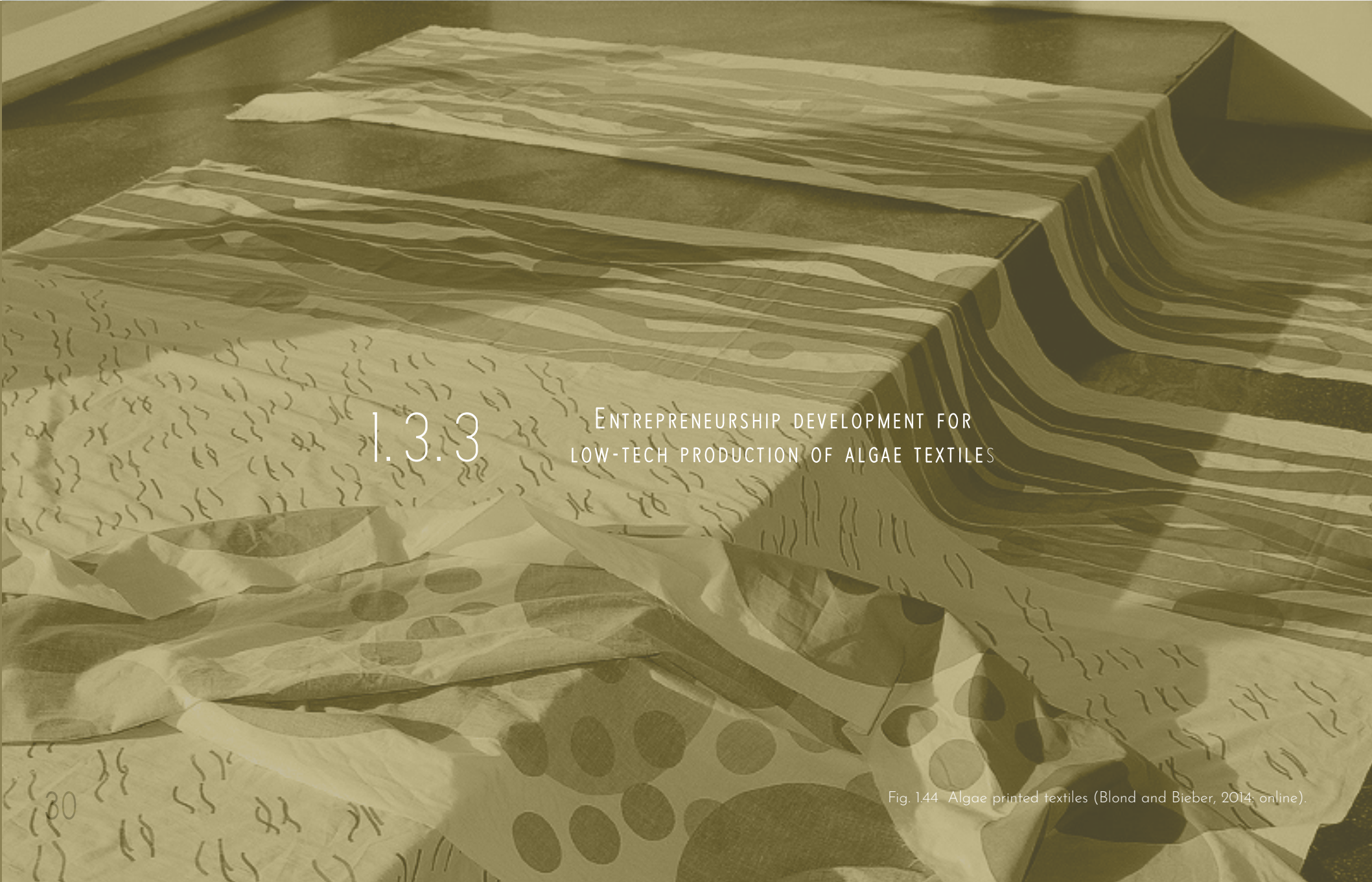


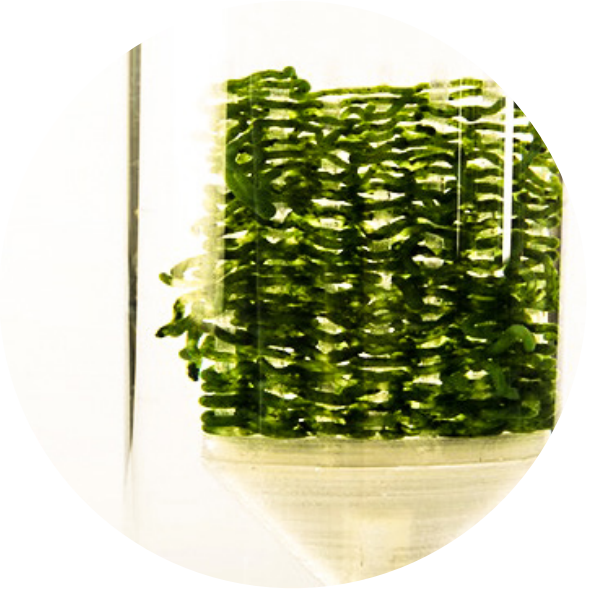
Fig. 1.44 Algae printed textiles (Blond and Bieber, 2014: online).

Algae-based textiles will be produced on a small scale, using low-tech and manual processing. This will allow for more inclusive development and practice within the community. The production will be divided into two main categories;



## Macro Algae

Fig. 1.45 Dried algae (Author, 2022: Photograph).



## Micro Algae

Fig. 1.46 Dried algae (Blond & Bieber, 2014: photograph).

# Macro Algae

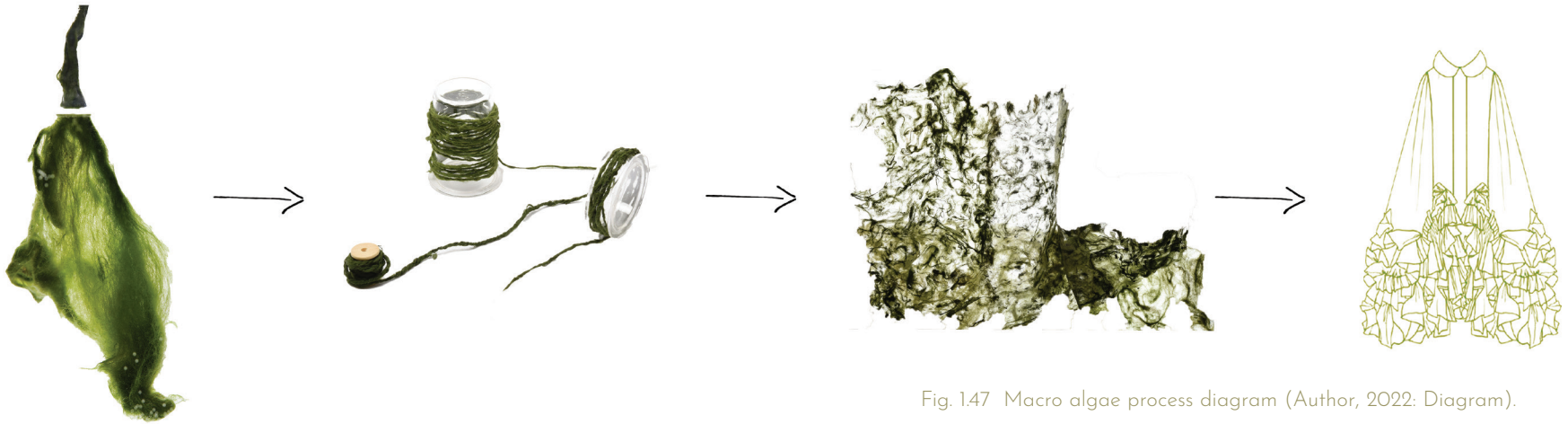


Fig. 1.47 Macro algae process diagram (Author, 2022: Diagram).

Macro algae is most commonly known as the green silt seen on water bodies. This can be used to create an almost paper like textile, when large pans are lowered into the water, pulled up into the air and the algae is allowed to dry.

This process is similar to the process of other natural fibre paper making.

Fashion designer, Malu Lucking, has developed another method of using these macro algae to create textiles. This process involves the spinning of macro algae fibres on a manual spinning machine that can easily be made using wood or other recycled materials.

This process has not yet been developed for mass production in textile mills. The spun algae fibres can then be used as a type of wool to create garments by weaving or other known methods (Lucking, 2019: online).



Fig. 1.48 Dried algae (Author, 2022: Photograph).

# Micro Algae

Microalgae are typically produced in either open systems such as open raceway ponds or closed systems such as photo-bioreactors (PBR), in which the cells are suspended in liquid medium but in a more regulated environment.

Microalgal biomass is harvested using sedimentation, flocculation, flotation, or centrifugation.
The several activities required to collect the biomass are time-consuming and inefficient.

Soaring demand for microalgae biomass has prompted plenty of studies aimed at improving conventional culture techniques, which has resulted in a cutting-edge cultivation technology of suspended biofilm cultivation (Podola et al., 2017:121:132).

This culture method provides a number of advantages over traditional systems, including lower water and energy requirements, excellent process controllability, and high biomass productivity.

The harvesting/dewatering process for biofilms is simpler because the cells can be easily scraped off the surface without the use of expensive separation techniques such as centrifugation or filtration, and there is no need to flocculate and settle/float the biomass (Johnson and Wen, 2010: 525:534).

In simple terms the micro-algae biofilm system uses vertically oriented conveyor belts that grow algae on their surface.

As the algae grow, it consumes nitrogen and phosphorus from the wastewater while it uses sunlight and carbon dioxide from the atmosphere to rapidly grow algae biomass.

The algae produced during this process can be harvested and used to make fertilizers, bioplastics, and biofuels, providing an additional revenue stream alongside an already more economical system.

In this case the Hartbeespoort Dam will act as the open pond system and a closed system will be implemented for a cleaner culture that can be used for research and development within the laboratory.

The harvested micro-algae sludge can be used as a raw material for textile printing or dyeing, as is the case with designers Blond & Bieber.

Alternatively, the micro-algae sludge is allowed to dry in the sun, and can then be stored in the form of dried powder. This is similar to the micro algae that can be bought in stores known as Spirulina or Moringa (both cultures of micro algae).

The possibilities with this powder is endless and range from food, to cosmetics and bioplastics.

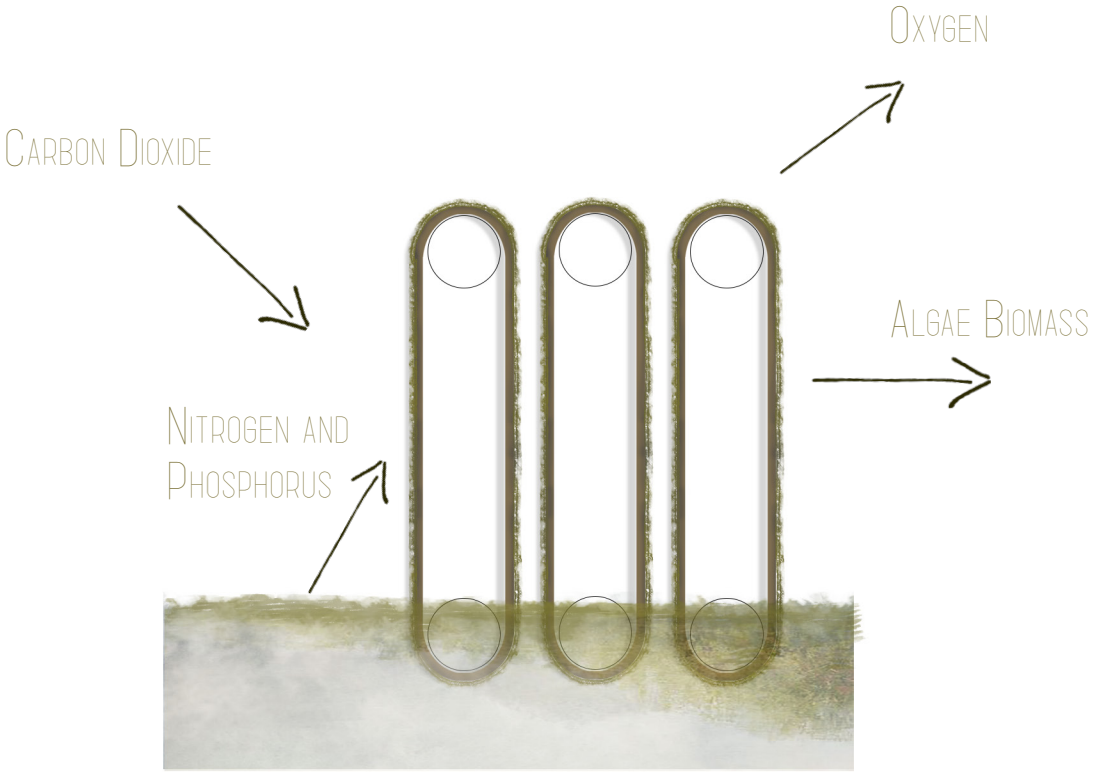



Fig. x Biofilm diagram (Author, 2021: image).

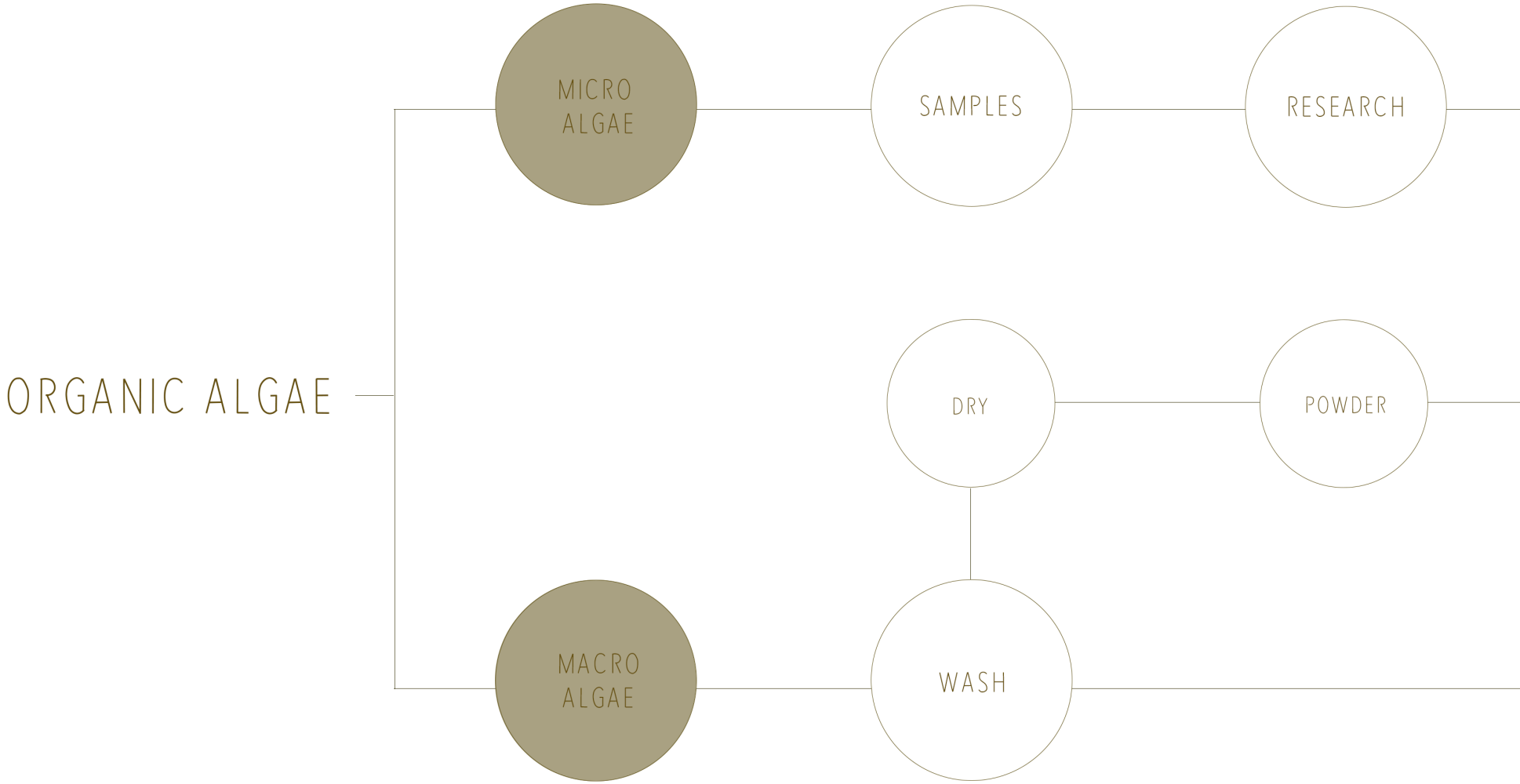
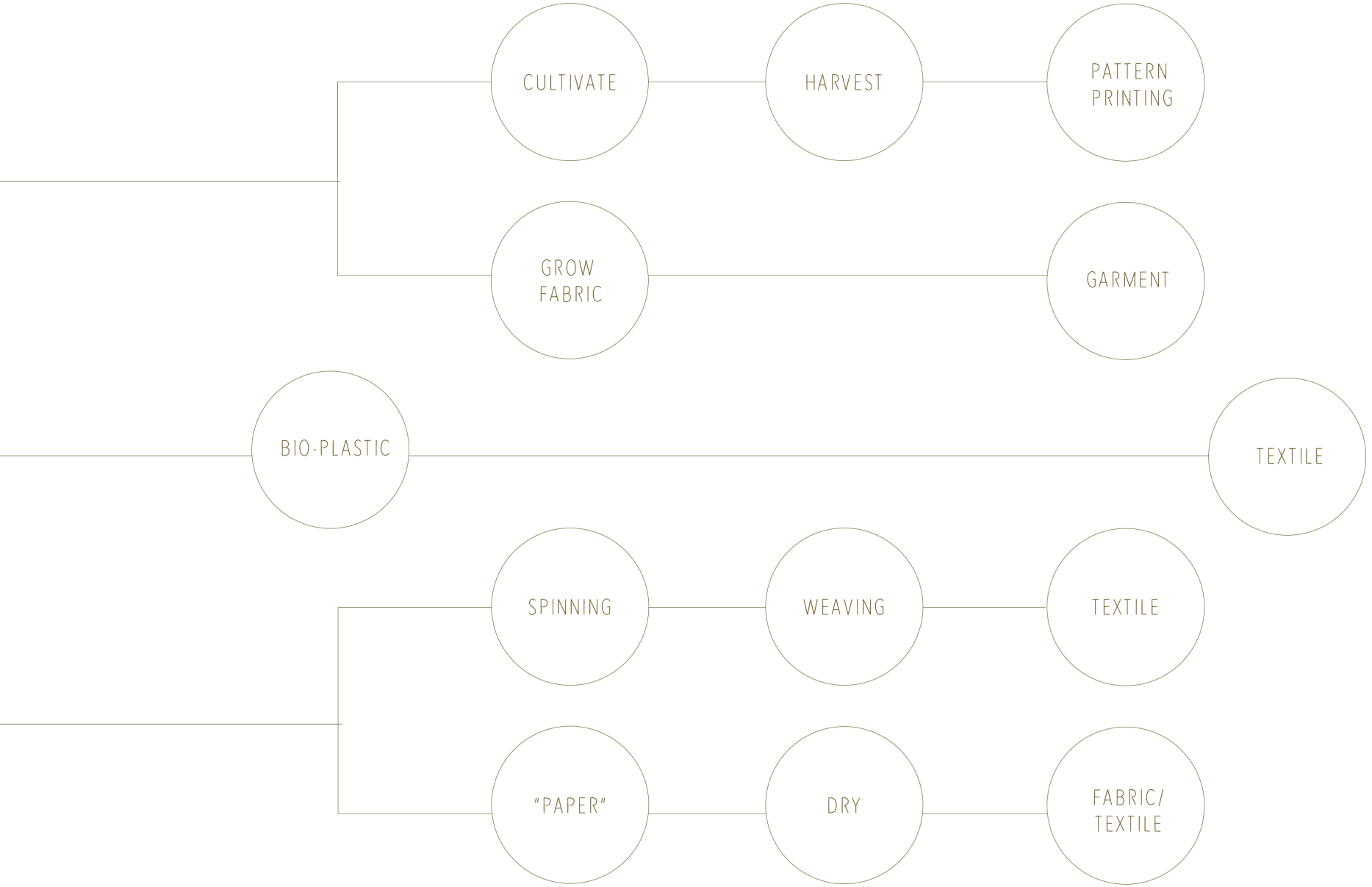



Fig. x Textile production diagram(Author, 2021: diagram).


CULTIVATE
HARVEST
PATTERN PRINTING
GROW FABRIC
GARMENT
BIO-PLASTIC
TEXTILE
SPINNING
WEAVING
TEXTILE
"PAPER"
DRY
FABRIC/ TEXTILE




# 1.3.4 Accommodation list

## Research

- Reception
- Office
- Clean Room
- Sample Preperation
- Open Lab
- Lab Support
- Chemical Laboratory
- Algae Culture Room
- Chemical Storage
- Equipment Storage

## Production

- Macro Algae
  - Drying
  - Spinning
  - Weaving
- Micro Algae
  - Dyeing
  - Bio-plastic
  - 3D Printing

## Design

- Reception
- Shop
- Multi-functional studio
- Public WC
- Storage
- Multi-functional hall



# 02



# The Wounded Landscape

Fig. 2.1 (Author, 2021: photograph).

# 2.1 The Wounded landscape

## a brief overview and analysis of Hartbeespoort



North West Province

Fig. 2.2 Province diagram (Author, 2021: diagram).

The Hartbeespoort Dam was initially built for irrigation purposes but also served as a job creation programme to alleviate massive poverty after the First World War.

It not only affected people's lives and led to the construction of settlements but also changed the entire landscape, the climate and, to a lesser extent, the vegetation.

Due to the significant change in the landscape, the dam is now a major factor in the region, second only to the mountains (Holm, 2015: online).

South Africa's North West and Gauteng Provinces share the 360 000 hectare Magaliesberg Biosphere, located between Rustenburg and Pretoria in the east and west of the Magaliesberg Mountains.

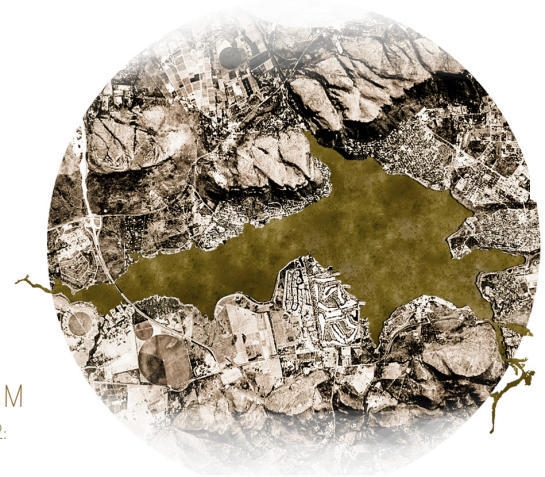
The region's roughly 40 km north-south extent is defined by the N4 Platinum Highway in the north and the N14 Pretoria-Krugersdorp Highway in the south, which also acts as Johannesburg City's northern boundary (Magaliesberg Biosphere 2019: online).

## Magaliesberg Biosphere

The Magaliesberg mountain ranges were created when vast intrusions of molten magma gradually created a 65000 km2 span of solid igneous rock over and between pre-existing sedimentary layers about 2000 million years ago (Magaliesberg Biosphere 2019: online).

The sedimentary layers, which were composed of a base layer of Black Reef, semi-soluble dolomite and chert, and later alternate layers of quartzite and shale, tilted upward through the magma at the edges of the igneous intrusion to create a series of semi-concentric mountain ranges of tilted sedimentary layers at the southern perimeter of the igneous mass.

The ridges of the Magaliesberg, Witwatersberg and other minor chains were produced by hard quartzite and shale during millions of years of weathering and erosion (Magaliesberg Biosphere 2019: online).



Hartbeespoort Dam

Fig. 2.4 (Google Earth, 2022: image) edited by Author.

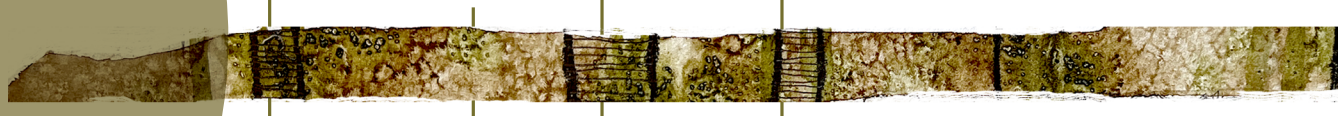


Dam Wall

Fig. 2.3 (Google Earth, 2022: image) edited by Author.

# 2.2 History of the Landscape

The Hartbeespoort Dam stands tall within this historic landscape as the Victory Arch is the only one found on any dam in South Africa. The dam is also rich in history and will be 100 years old in September 2023.

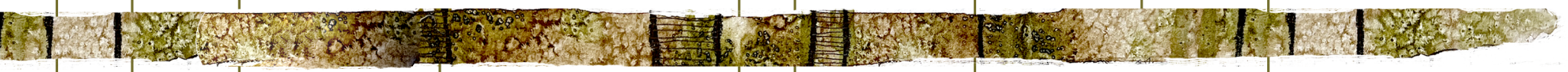


**1905** The history of the dam starts in 1905 when a Swedish engineer, August Karslon, suggested to the government that a dam be erected in Hartebeespoort

**1910** The plans were put on hold when the Union of South Africa was founded in 1910 because the government had more important concerns to deal with.

**1914** Public pressure on the government was so strong that in 1914, legislation was passed that approved the concept in principle.

**1918** Construction starting in 1918, when land was purchased. Roads, a 60-meter suspension footbridge, and a15-kilometer cocopan railway line was built from the Brits West side to supply cement, stone, and sand to the Poort.



**1921** By 29 July 1921, the first concrete had been put into the foundations of the wall, and by 7 September 1921, 7220 m3 of concrete had been laid, elevating the wall 2m above the riverbed.

**1922** The floods of the 1922/23 season were dammed, and the wall was finished in April 1923.

**1923** In September 1923, the route over the wall, which is currently the new main road connecting Pretoria and Rustenburg, was opened to the public.

**1925** In 1925, the dam flooded for the first time

**1970** In 1970, ten metal sluices known as "crown sluices" were installed on top of the over-flow. The dam water level was raised by 2,44 m due to the construction of ten crest gates on the spillway.

**1980** Eutrophication in the dam is rising due to nutrient build-up, as well as the unbalanced ecological system.

**2007** The Metsi a Me Programme wasinitiated and phase one of the dam's rehabilitation began.

**2014** Phase 3 of programme started with full scale activities including, vermiculture, removal of fish and creation of wetlands.

**2016** The Metsi a Me Programme was brought to a hault.

# Victory Arch




On the east side of the arch is engraved in large Roman letters, a phrase from Varro's "De re Rustica" ("Agriculture").

It reads as follows: *Without water, agriculture is withered and wretched* (Holm, 2015: online)

The saying on the west side is from Isaiah 44:3 in the Latin Bible. There it says:

*"DEDI IN DESERTO AQUAS FLUMINA IN INVIO"*
(For I will pour water on the thirsty land, and streams on the parched plain;...) (Holm, 2015: online).



The "Victory Arch" on the west side of the dam is unique and cannot be found anywhere else in South Africa on a dam wall. The justification for its construction for structural reasons seems somewhat surprising, as the dam was already completed when the arch was built.

The arch is a replica of the typical Roman triumphal arches and parallels the Arc de Triomphe in Paris.

The arch, mimicking the arch shape of the dam, is a replica of the form of the Union Building, completed shortly before the dam was built.

The dam is currently the primary water source for about 139 000 households in Brits and other surrounding areas. Cyanobacterial blooms were not a problem until the 1970s.

The growing popularity of the dam as a recreational area and the rapid expansion of towns upstream led to higher levels of nutrients in the water. These nutrients are usually found in fertilisers, industrial waste and sewage (Dower, 2003:15).

Fig. 2.5 Triumphant Victory Arch(Author, 2021: Photograph).

For many years, nine sewage treatment plants have been discharging 720 million litres of treated sewage into the Crocodile River daily, increasing phosphorus loads in the dam.

With the contaminated stormwater from the catchment, blue-green algae or cyanobacteria have increased, which poses a significant risk to human health and can negatively impact regional recreational and economic activities.

Rapid urbanisation has also increased runoff, sedimentation, erosion and solid waste into the reservoir (Water Power and Dam Construction, 2013: online).

Contrary to popular belief, sediments hold 15-20 years of pollution. This pollution is constantly being circulated, and the nutrients released from the sediment have affected the biodiversity of the reservoir.

Water hyacinth has spread extensively and unhindered in the dam and upper watershed for over 30 years.

The flood of rubbish and waste has increased drastically in the last three years and can no longer be ignored (Water Power and Dam Construction, 2013: online).



# 2.3 The context already there

## Data of Place and a Sense of Place

Fig. 2.6 Section through site (Author, 2021: image).







# Data of Place

Data of Place

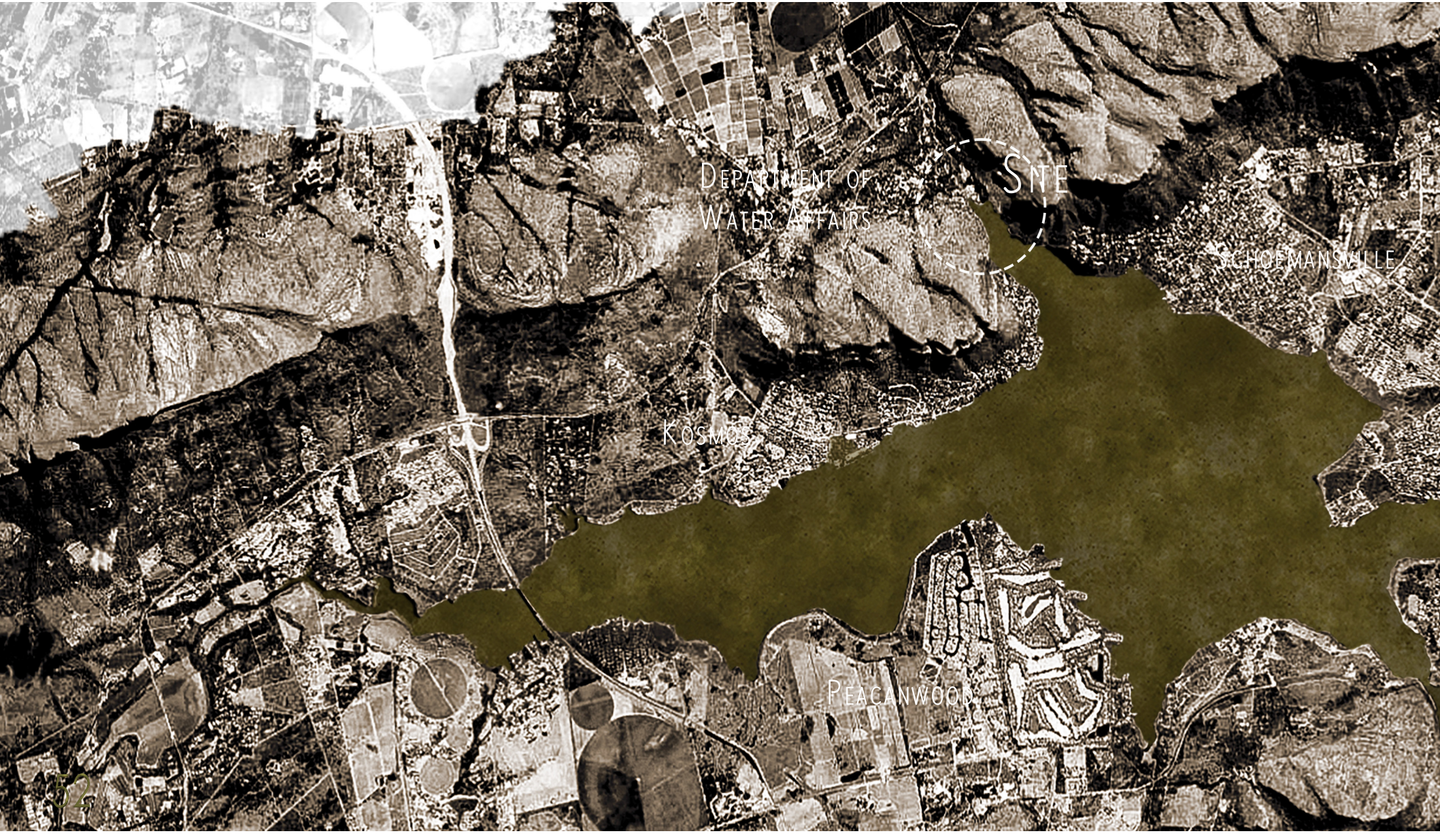

Department of
Water Affairs
Site
Sg.Hoemansville
Kosmos
Peacanwood









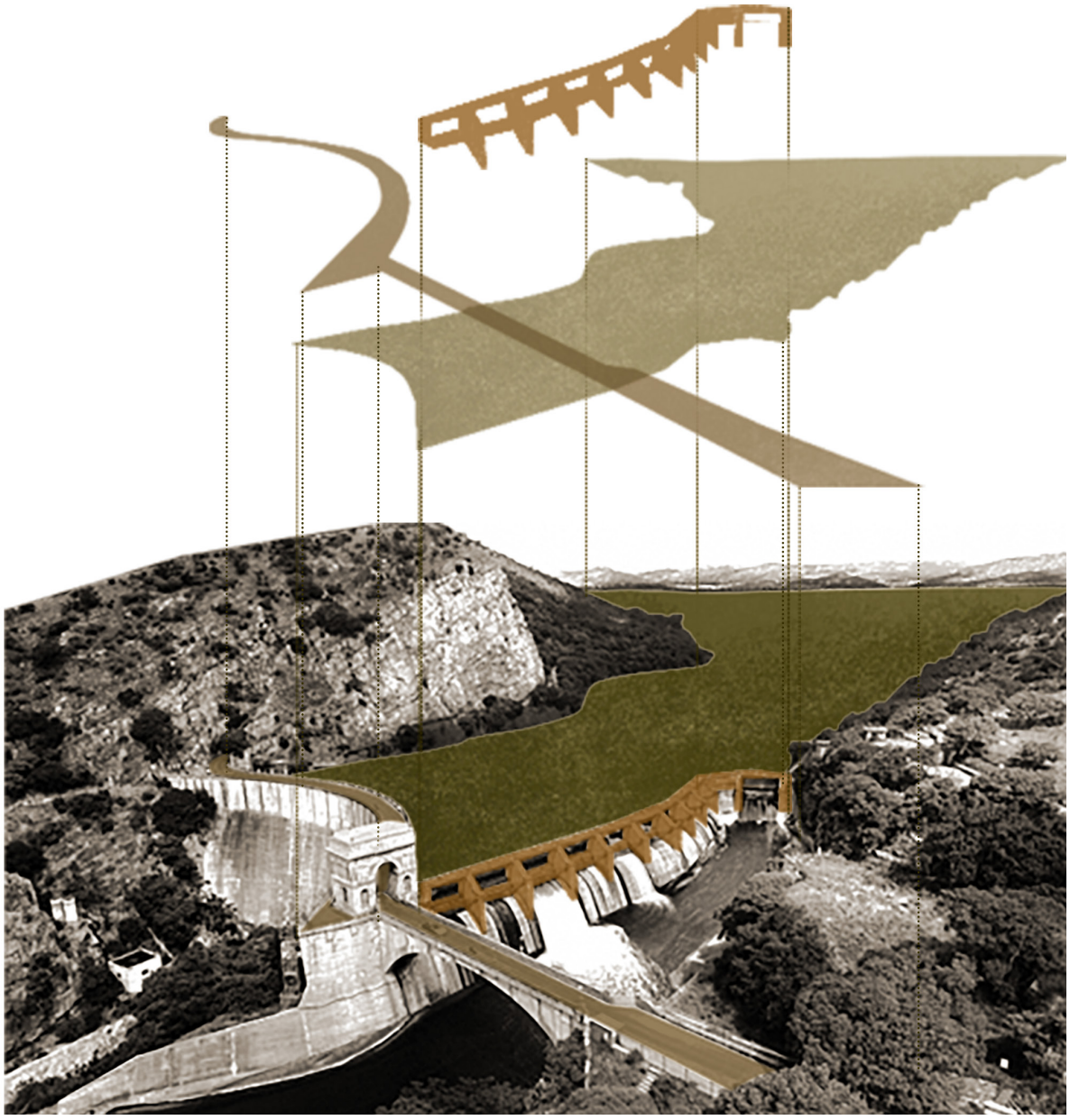






Fig. 2.7  Aerial view of site (Google Earth, 2021: image).

Fig. 2.8 - 2.13 Existing structures (Author, 2021: Photograph).



## Crest Gates

The Permanence of concrete retaining the water of Hartbeespoort

## Hartbeespoort Dam

The Changing colour of the Water as Algae and  Hyacinth increse and decrease

## Scott Road

The Portal through the Poort that is always flowing with Vehicle Movement

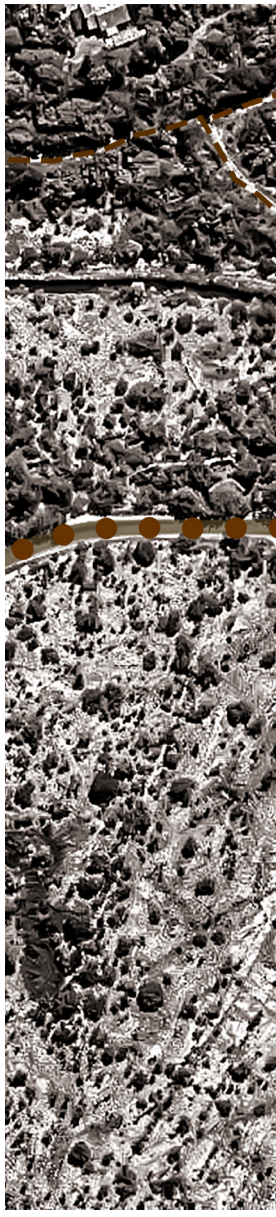
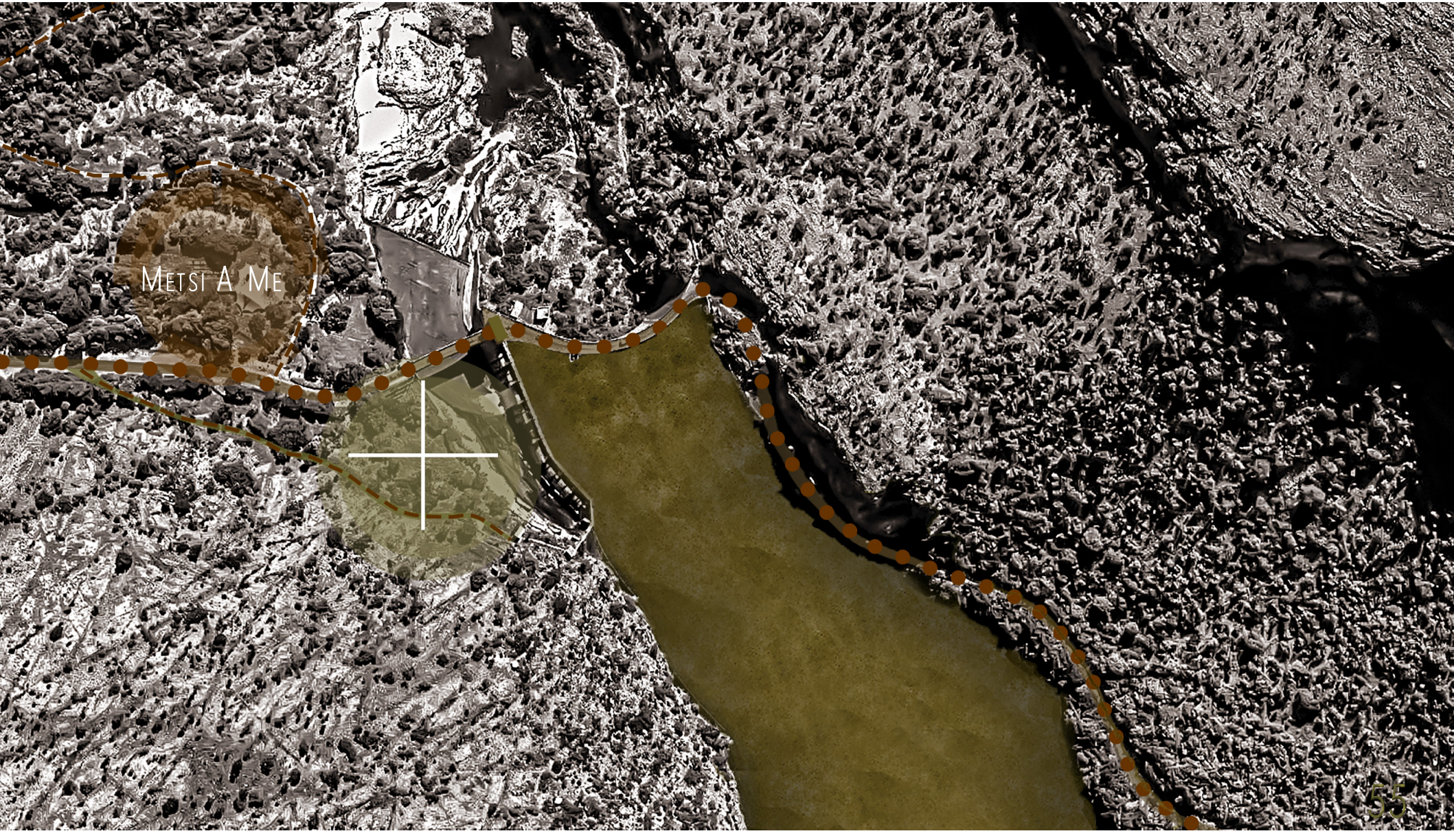


Fig. 2.14  The immediate context around the site (Google Earth, 2022: image)edited by author.


Metsi A Me

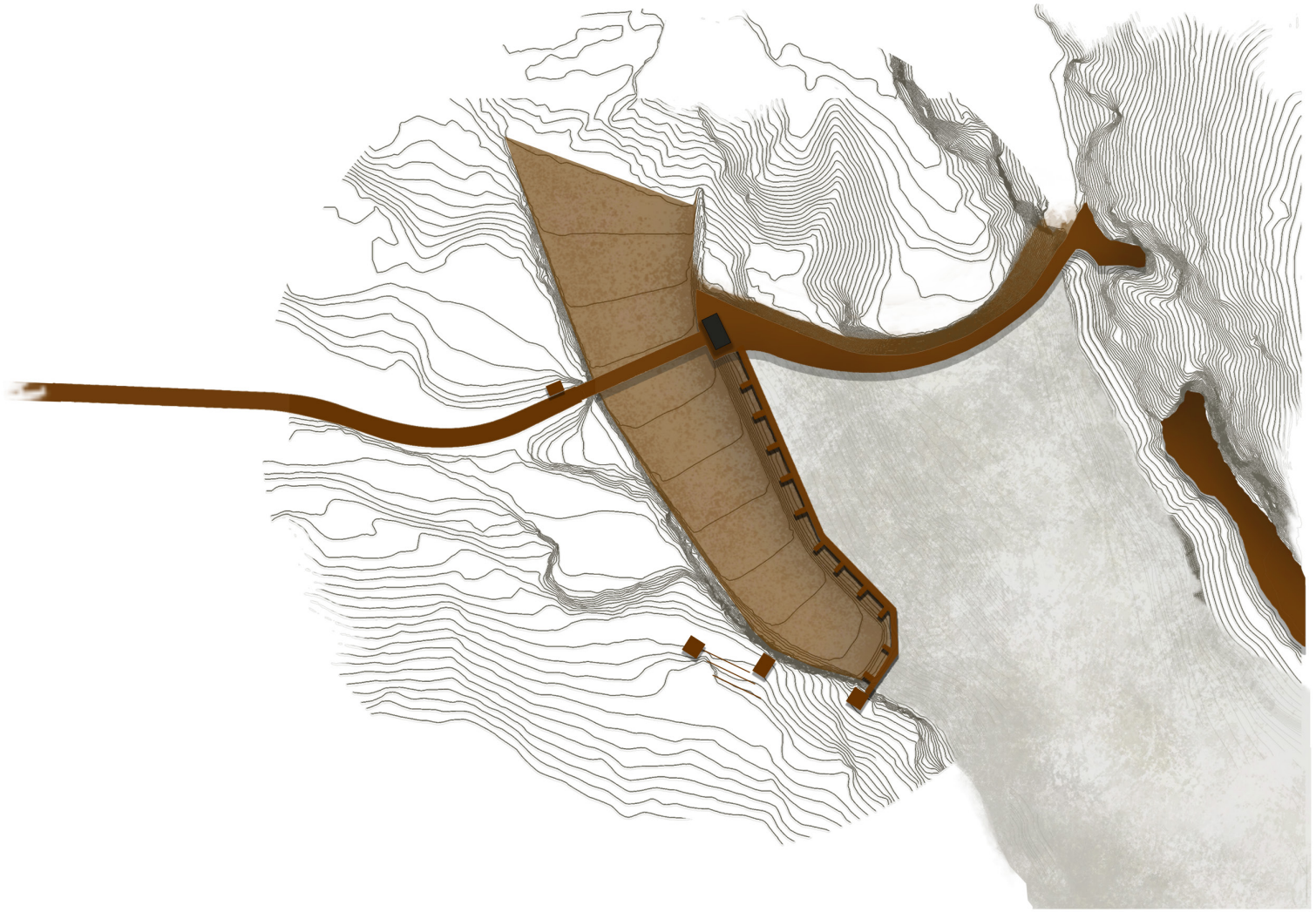


Fig. 2.15 Permanent man-made on site (Author, 2021: image).

## The Permanent Man-made



Concrete Barriers



Pump House




Existing Walkway

Fig. 2.16 - 2.18 Existing structures on site (Author, 2021: Photograph).



Fig. 2.19 Natural Ephemera on site (Author, 2021: image).



Natural Rock



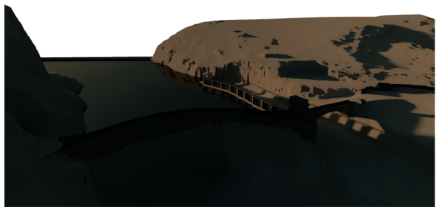
Algae over Crest Gates



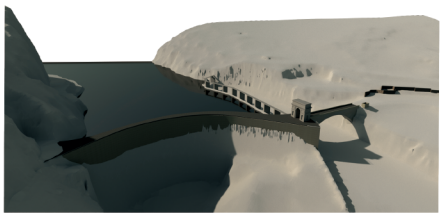
Stone Walls

Fig. 2.20 - 2.22 Existing materials in the landscape (Author, 2021: Photograph).

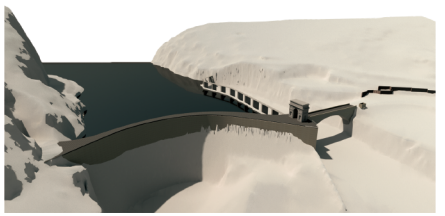
Summer Solstice



06:00



08:00

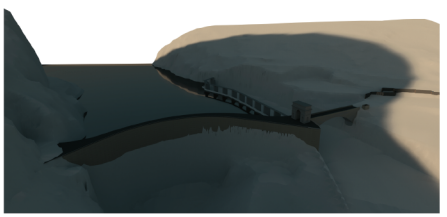


10:00

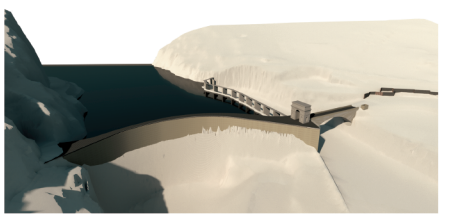
Winter Solstice



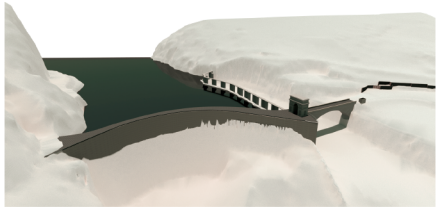
06:00



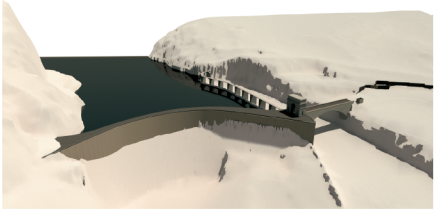
08:00



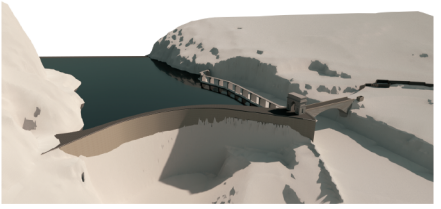
10:00



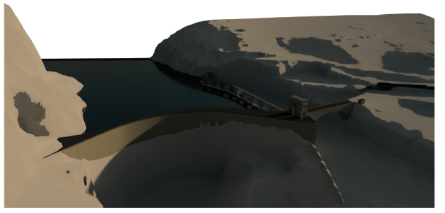
12:00



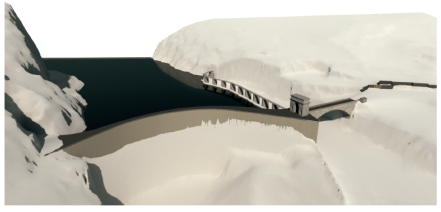
14:00



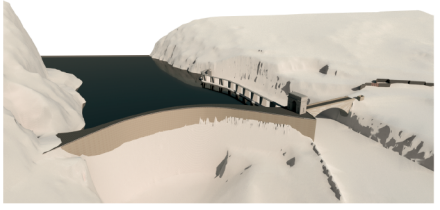
16:00



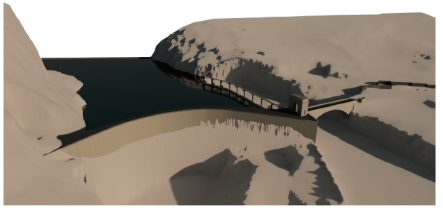
18:00



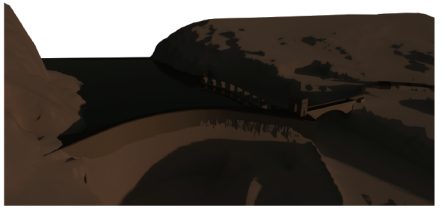
12:00



14:00



16:00



18:00

Fig. 2.23 Changing shadows on site (Author, 2021: image).

# MATERIALS








Fig. 2.24 - 2.29 Materials found on and around the site (Author, 2021: Photograph).








Fig. 2.30 - 2.35 Vegitation found on and around the site (Author, 2021: Photograph).



Fig. 2.36 Landscape interpretation  (Author, 2021: image).

# A Sense of Place

Constancy and Change creates a sense of space between the enclosure and extension of earthly things - the ageless canyon, rock outcrops, and tree trunks - and the changing sky - light and shadows, clouds, seasons, disappearing and reappearing leaves, grasses, and shrubs.

Hartbeespoort exists between earth and sky and is affected by time. On site, the hilly landscapes reflect a wavelike topography at times, and a dominant narrow valley or aspects of a horizontal plain at others.

The cosmic dome, along with trees and grasses, enclose the site; cloudless days make the natural hills appear boundless and imposing, while cloudy days make space fixed and melancholy. Norberg-Schulz (1980: 32) might have classified this landscape as Greek-like or Classical.

As the sun rises behind the Magaliesberg Mountain, the red and orange tones of the exposed rock are illuminated in the early morning.

A landscape as magnificent in its quietness as signs of the natural world is found in all unexpected places. For a brief moment, I am transported to a magical realm where humans and nature are in harmony.

Between the two ridges stands the triumphant Victory Arch as a visual representation of human power, an elusive Greek temple: edged as separate - dominant to the natural - only to react with plasticity as shadows plays on its surface.

The permanence of cast concrete retains the flowing waters of the surrounding rivers, once forceful and other times bending into the canyon, almost a giant's amphi-theatre.

Indeed, nature blends with human's desire to build by creating an unforgettable structure that is simultaneously a bridge and a monument.

On occasion the human and natural seems contradictory - competing for dominance in different ways:

the irregular the regular, the wavelike and the geometrically edged. Then again the natural and cultured seem to merge to form a sense of peace, movability, and togetherness.

But this landscape is not only a place with clear natural and human orders, and maybe a strange harmonious and meaningful meeting of opposites.

Driving across the arched concrete dam wall towards the proud Arch, the beauty of the Magaliesberg is interrupted by the green algal blooms on the water surface.

The green water, stretching south-east as far as the eye can see, finally meets with the green earth on the north-east horizon, where the curvilinear forms of the Magaliesberg Mountains rear their heads.

Suddenly, the beautiful is ripped away when my body becomes vulnerable to traffic movement across the dam wall, with only a small strip of walkway as protection, I realise that the algae represents more than the natural.

On the otherside of the dam, the lush green landscape is locked behind stark fencing and concrete barriers, almost as if we need protection from these green monstrosities, not realising that most of the time it is in fact the other way around.

In our attempt to take control over nature, we have in fact distanced ourselves from it and changed its natural cycles.

The temporal and fleeting rush of water over the crest gates is only visible from afar, and next to the supposed Victory Arch, we stand fragile to the effects and power of this magnificent landscape.

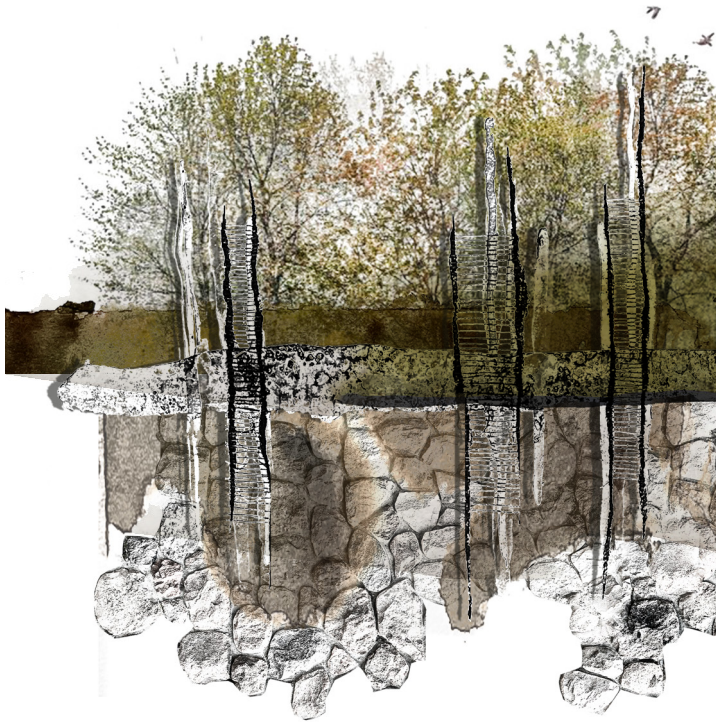




Fig. 2.37 Landscape interpretation (Author, 2021: image).


03

# HEALING THE WOUND OF PLACE AND TIME

## FROM THEORY TO DESIGN TOOLS

The Hartbeespoort Dam represents the wounds inflicted on the natural landscape by human activities and the mindless consumption of our natural resources.

This wound has only made the division between humans and nature so much clearer, to a point where we can no longer ignore our impact on the planet.

The Algae and Hyacinth on the Hartbeespoort Dam is a product of this Great Divide between the natural and the human-made. A product of our disregard and conquering of natural systems, place and time.

The algae becomes an opportunity to heal the wounded landscape of Hartbeespoort Dam for mutual benefit of both humans and nature.

In an attempt to respect and repair the temporal and permanent landscape, concepts of mutualistic and regenerative architecture view the environment as an equal partner with whom they must collaborate and co-exist for the sake of both parties.

Instead of encouraging non-contextual monumentalism that starkly contrasts to the permanent natural landscape, this way of thinking about architecture calls for sensitive architecture that enhances and supports the natural time and place.

Architectural notions of permanence and ephemerality record nature's effects in the language of decay, in which everything exposed to the elements decays. This could be interpreted as nature's rightful claim to the man-made, tracing the artificial back to the biological world in which it lives.

Rather than avoiding the inevitable, architects can take advantage of the opportunity to use natural features as design tools to tell a story that evolves over time.

Fig. 3.1 Photograph of the surrounding landscape (Author, 2021: photograph).



# 3.1 The Great divide

## DISREGARDING AND CONQUERING NATURAL SYSTEM, PLACES AND TIME

Fig. 3.2 Touchstone indicating divide between human and nature (Author, 2021: photograph).

The origin of the wound at Hartbeespoort might very well be ascribed to the human-nature divide. Anthropocentrism refers to a set of doctrines and practises that hold that humans are intrinsically superior in value to and separate from nature.

Instead of humans conceiving themselves as part of the natural world, all nature, including water, is seen as a resource or means to human ends. We have positioned ourselves at the centre of all living systems and only recognise an ecological imbalance when it impacts human activity (becoming) and existence (being).

The latter statement suggests that the human notion of time might be connected. Travelling through the work of writers, poets and scientists, Daniel Corrie (2001) postulate that the anthropocentric idea of time seems paradoxical, contradictory, and dualistic.

On the one hand, there is the idea of a finite being, of knowing there is a beginning and end, which leads to the desire to preserve and freeze time in history books, monuments, or statues - to keep alive in
memory.

On the other, there is the idea of infinite becoming, which promises potentiality through the acts of creation and lived experiences - to live in the waves of the moment: timelessly. Yet even these fleeting moments are retained in the work of the impressionist or family photographs (now in albums in the cloud).

Even if we become in the eternal moment or preserve the continuity of being throughout a finite lifetime or both, we seem to be preoccupied with the search for the meaning of time. In Corrie's words:

*"Whether being may be an illusion of misunderstood physical theory or becoming may be an illusion of deceptive human perceptions, both temporal poles are inextricable from the human psyche and imagination.*

*While some personalities deeply value becoming as the ground of human adventure and growth through action, other personalities cherish being for offering its deeply comforting ground of rest and preservation (Corrie, 2001:71)."*

Humans have placed themselves central to time, attempting to consciously utilise, understand, and demystify time.

Whether we regard time as finite or infinite, our science, psyche and imagination seem to want to define, if not conquer, time, as much as we do space, place, and nature.

The end of the Anthropocene may prove that when the last human has been decentralised, inhuman time, nature, and place will continue without illusion or conceptualising its mutability or immutability.

The greatest and worse of our human concepts and acts might very well stem from what Aristoteles calls, in his '*Nicomachean Ethics*', our final cause, innate end, purpose or, in his term, 'telos'.

For Aristotle, all of the natural world has a purpose, and the human purpose is to thrive: to understand and aim for a good life or our well-being.

In searching for our own survival and happiness, we have changed and manipulated not only notions of time, but the 'telos' of the others with which we share this world.

We domesticated animals, manipulated crops, upset ecosystems to extract steel and cement from the earth and change the natural flow of the river to support our cities and agriculture.

Constantly, we regard others as means to our ends of survival and happiness, in the process separating and classifying the world into things that have value in themselves and things that are only valuable because of their utility.

Following the anthropocentric viewpoint, the touchstone I conceived at the start of this dissertation represents this divide between the natural (excluding human) and the human-made and manipulated world.

# 3.2 Respecting and Repairing

## the temporal and permanent landscape







As much as our anthropocentric worldview has harmed the world, our human self-understanding is not, and has not always been, about egocentric humans alone.

From written history, humans have also relationally understood themselves as part of the natural environment. Ecological awareness can be dated to at least 4000 BCE, from a Sumerian Epic to "ancient [....] humanity's myths, sagas, and the world's religious scriptures." (Wahl, 2006:244)

In '*A Brief History of Environmentalism*', Weyler (2018: online) traces environmental consciousness back to Vedic sages and Plato lamenting the destruction of the natural landscape.

Ancient societies in China, India, and Peru attempting to redress erosion, the Greek Gaia myth and the physicians Hippocrates and Galen realising the impact of environmental pollution.

The relational respect and care of indigenous 'place-based' societies towards nature are well documented, showing "ecologically and socially responsible resource management and sustainable ways to meet human needs within the limits and opportunities set by the natural conditions of their particular region." (Wahl: 2006:246)

These cultures show that human nature is not reserved for the "exploitation, domination, and competition" with nature but can provide lessons in designing in "cooperative reciprocity with [the] natural environment." (Wahl: 2006:247)

Wahl (2006:245-246) warns: "To maintain human, ecosystems and planetary health (and wealth), we need to fundamentally re-design lifestyles in the developed world and enable people in the global North and South to meet their needs sustainably and equitably within the ecological limits of their local environment."

The key to re-designing our lifestyles and architecture is to engage, respect and repair our "interconnectedness [with other living creatures,] the land and natural forces" and natural processes (Wahl:2006:247).





Fig. 3.3- 3.6 Concept models by author (Author, 2021: photograph).

# The Natural Healing Process

As mentioned before, the natural healing process forms the conceptual basis for the dissertation.

The wound or diseased tissue triggers a reaction in the form of a healing scab that eventually fades into a scar: an almost invisible structure that merges so much with the surrounding tissue that it can be challenging to identify the boundary between healthy and damaged (and repaired) skin tissue.

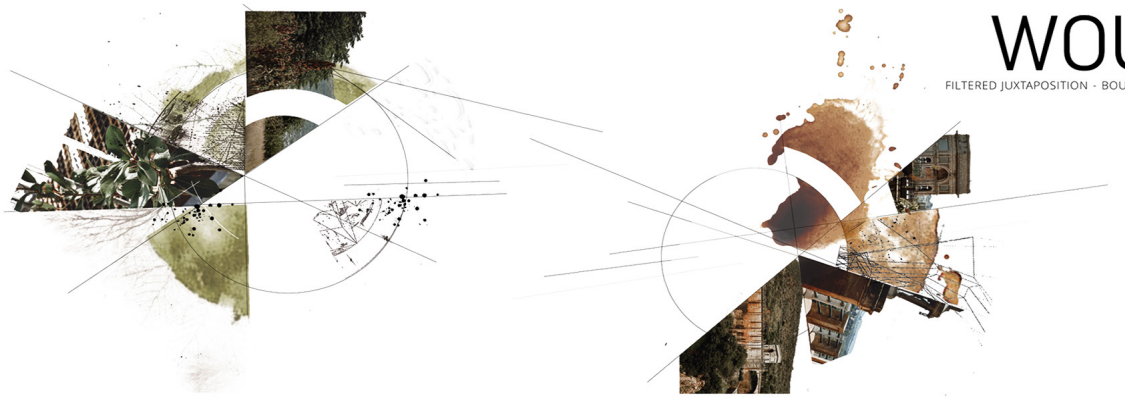
The architectural intent for this design dissertation is to design a scab under which the client can engage with research, design and production activities to ameliorate the landscape from hazardous algae built-up and blooms.

Although the scab will disappear, scars will be left on the landscape in the form of an open public park that respects the landscape and serves as a memory of the scab.

This park is constructed of natural materials found in the surrounding area to minimise the impact on the landscape and allow for interconnectedness between man and the existing landscape of Hartbeespoort.

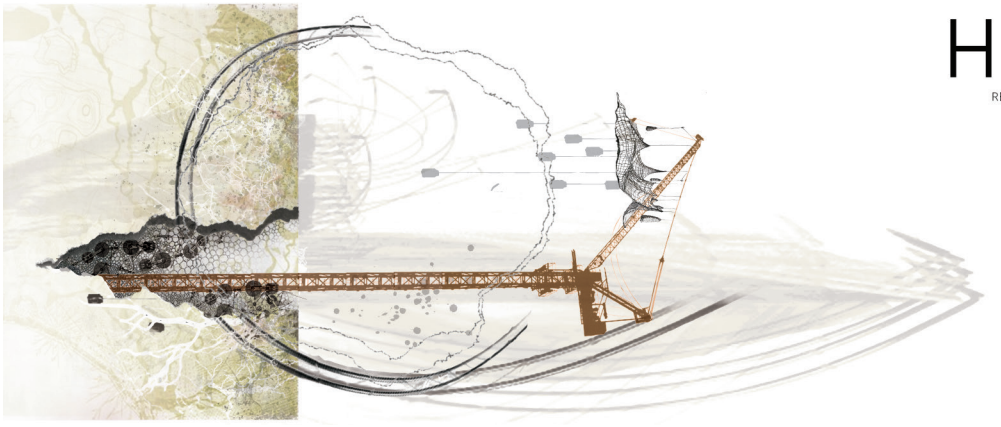
The design philosophy encompasses local materials and open spaces, context-sensitive interventions, responsiveness to the environment and a delicate relationship with the existing landscape.

Fig. 3.7 - 3.9 Concept ideas (Author, 2021: image).



WOUND

FILTERED JUXTAPOSITION - BOUNDARIES AND BORDERS



HEALING

REGENERATIVE BIOPHILLIA - NATURE AS MENTOR



SCAR

TEMPORAL INCISION- THE NATURAL CONTRACT

Apart from architectural 'style', comparing architectural understanding, concepts, intents or interventions to natural systems and processes has precedent. Sola-Morales (1997:38) describes architectural and urban processes in the city as a living, breathing organism, using terms such as skin, epidermis, nerves, arteries, acupuncture and prosthesis.

These metaphors allow Sola-Morales to shift the architecture paradigm away from the illusion of permanence to the ephemeral and temporal while associating architecture with the delicateness of a changing, relational, and vulnerable living body.

Frazer claims in *An Evolutionary Architecture (1995: 9)* that architecture is a living and evolving entity and that the basic form-giving processes in architecture can be explored by studying morphogenesis in nature. Architecture is "a form of artificial life that, like the natural world, is subject to the principles of morphogenesis, genetic coding, replication and selection".

Frazer employs the organic not only as a metaphor but as a way to understand the morphological design process involved in developing architectural spaces. Here it is not about mimicry and representation of the organic but a concern for the processes involved in determining spatial forms.

Frazer calls for an attentive reaction to the genetic code of the potential organism's (client and user) purpose, needs and desires and the specific environmental conditions.



Fig. 3.10 Concept models by author (Author, 2021: photograph).

Through the notion of architectural mutualism, the building form is not only relational to the evolutionary purpose, needs and desires of the organism and environment but also acts beneficially to the environment and the environment to it.

According to Ahmadjian and Paracer (2000: 6), mutualism is a symbiotic relationship in which both partners benefit from the relationship.

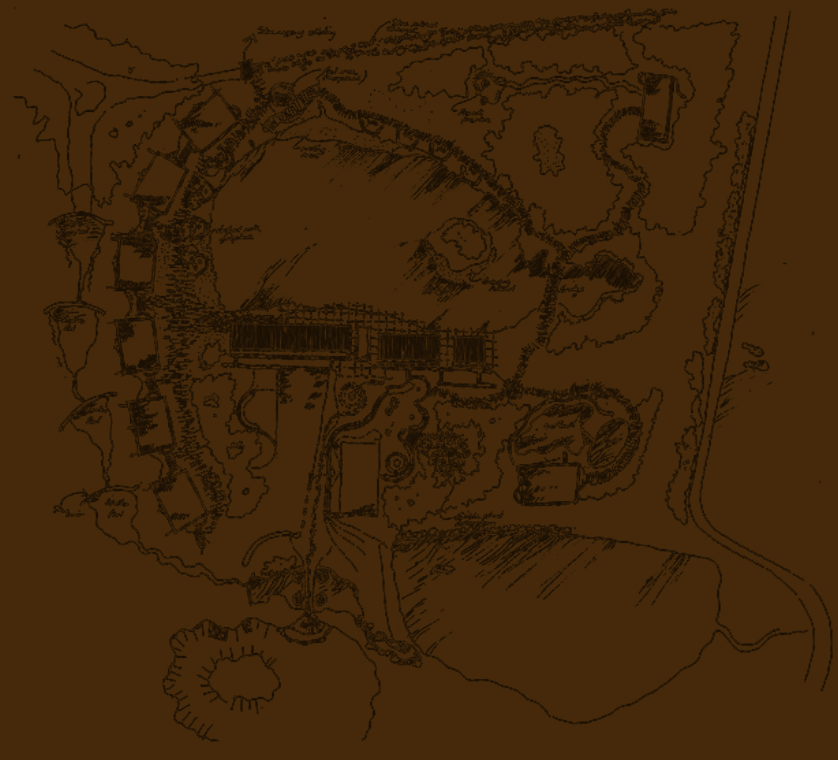
Mutualist architecture seeks to reverse the current trend of thoughtless consumption of non-renewable resources without regard for the environment.

Instead, it attempts to benefit the environment by limiting environmental harm and utilising local ecological phenomena. In elementary terms, this might restrict the design to using sustainable, recycled and local materials and challenge the design to find the potential within available natural and indigenous resources, the local seasons, and temporal events to shade, heat and protect the building.

The Forum Homini Boutique Hotel, located near the Sterkfontein Caves in the Cradle of Humankind, is an example of how the natural landscape and architecture can be fused together to create a seamless and effortless representation of surrounding landscape, architecture, and art.



Fig. 3.11 Forum Homini Hotel (GREEninc, 2009: online).



FORUM HOMINI BOUTIQUE HOTEL

- Activate Architects and GREENinc
- Cradle of Humankind, Gauteng, South Africa
- 2006

The Forum Homini Boutique Hotel is a delicate blend of heavy and light architecture, with the surrounding context informing and guiding the design process towards a final product.

The concrete cave-like mass of the complex is countered by the delicate timber structure and decking. The character of the architecture plays with accents of stone cladding, complementing the rocky outcrops and the grass-covered roofs seamlessly blending in with the savannah grassland (GREENinc, 2009:online).

The client desired a strong connection with adjacent palaeo-anthropological sites, and the architects and structural engineers reacted by constructing certain elements to look and feel nearly cave-like.

The concept was enhanced by reintroducing the "original" indigenous highveld environment up to the margins and over the roofs of the buildings on the part of GREENinc.

The structures emerge from the terrain in an almost surprising fashion across the property, and upon arriving at the parking lot, very little of the hotel can be seen.

The parking lot and service yard are arranged along a serpentine access road, and landscaped berms hide these unattractive services from the adjoining residential homes (GREENinc, 2009:online)

Exposed aggregate concrete paths and stone-clad retaining walls consistently connect the numerous structures. The Forum Homini Boutique Hotel speaks about this interconnectedness between architecture and the natural environment. The architecture, landscape and art become one.



Fig. 3.12 - 3.14 Forum Homini Hotel (GREEninc, 2009: online).

Mutualism and its advocacy of a both/and rather than an either/or requires the architect to analyse the nature and architecture benefits and make a more informed decision that is a mediation between the two interconnected and relational benefits.

It may not always be the same, but a greater focus on the natural will help stabilise the current momentum of consumption and exploitation (Workman, 2004: 3).

Workman (2004:7) mentions that the notion of mutualism asks for an investigation of an architecture that emerges through a sequence of processes rather than a particular "style".

By rejecting the concept of a defined "style", mutualist architecture is free to focus on the more critical questions of how natural and constructed patterns of form interact.

The form is an evolving feature, and beauty comes from synthesising circumstances and the concepts that emerge from them. Beauty is more than aesthetic pleasure; it is more than this simple concept (Workman, 2004: 7).

Mutualist architecture embraces complexity and is, therefore, uniquely capable of restoring the natural presence and its non-man-made physical qualities to the built landscape, resulting in the sense of harmony between the two.

Architecture must consider the complexity, diversity and individuality that exist between the built and natural forms in this day and age where the impact of human activity on the natural world is becoming increasingly apparent.

A mutualist structure combines architecture, landscape, science and environmental protection elements.

According to Workman (2004:7), mutualistic architecture allows both the value of the natural and the built form to exist within a project.

Adopting a mindset of this mutual relationship between building and nature will allow for the architecture to converse with and respect the surrounding landscape as an equal partner.

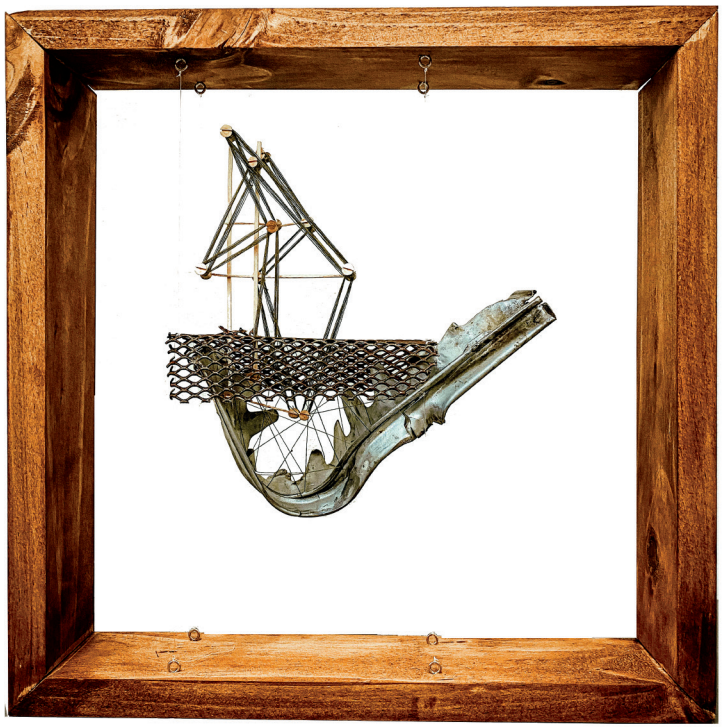


Fig. 3.15 Concept models by author (Author, 2021: photograph).

Everything we need in order to create has already been created by nature, and we use it. Nature is an extraordinarily complex and effective system for creating and cycling nutrients.

The alga at Hartbeespoort Dam is an example of how nature can regenerate itself.

Regenerative design is based on the idea that there is no essential difference between humans and nature and that humans do not rule over it but are a part of it. A concept that assumes that everything is interconnected as a single system and that each component is critical to the health of the whole system (Littman, 2009:15).

Regenerative architecture has two main focuses:

It is an architecture that focuses on conservation and performance by reducing the environmental impact of a building. The choice of materials, lower energy consumption and intelligent design, are examples of this (Littman, 2009:15).

Considering the environment as an equal participant in the building is regenerative architecture's second, more profound aspect. It is a building design method that thoroughly understands natural and living processes.

It is an architecture that is environmentally conscious and builds on millions of years of engineering and development to create a regenerative structure.

The idea of regenerative design is that everything we construct has the potential to integrate the natural environment into architecture as an "equal partner".

According to Littman (2009:15), it is regenerative whenever the term 'architecture' encompasses more than just the structure. The environment, the site, the systems, the energy, the building, the fauna, the flora, etc., are all part of the architecture.

It is an architecture that is fully integrated into the site. It exists as a single piece, a system that evolves as a single whole (Littman, 2009:15). The possibilities for regenerative design are almost unlimited once this concept of building is accepted.

The Omega Center for Sustainable Living in Rhinebeck, United States is an example of this regenerative architecture, where the building, environment systems and energy is fully integrated and connected.



## THE OMEGA CENTER FOR SUSTAINABLE LIVING

- John Todd Ecological Design
- Rhinebeck, NY, United States
- 2009

The Omega Center for Sustainable Living (OCSL) is arguably the world's most magnificent wastewater treatment facility. The building, which was created by Dr. John Todd, is run entirely by geothermal and solar energy.

As opposed to other wastewater treatment facilities, the OCSL uses a combination of microorganisms, algae, plants, gravel filtration, and sand to clean sewage water and return clean, drinkable water to the aquifer instead of using chemicals to treat the water.

In addition to all of this, the OCSL serves as a classroom to inform and motivate people about the ability of nature to solve problems (Tackett, 2018:online).

"The OCSL is a dynamic, living and breathing demonstration of how interconnected we all are with the world around us," says Backus.

"Our goal is to help people re-examine how they relate to the world by showing them what's possible in terms of environmental sustainability, green energy, and regenerative design."








This notion of a fully integrated system can be implemented by adopting ideas and processes that are found within nature.

This does not imply the direct mimicking of nature, as most understand the term Biomimicry, but rather innovation in architecture as inspired by nature. A regenerative and mutualistic architectural theory answers the apparent risk inherent to a weak and supervised stylistic reading of biomimicry.

Since science writer Janine Benyus introduced the term in the late 1990s, biomimicry has been a valuable and widely used idea. While she did not conceive the term, she popularised it in her book *Biomimicry: Innovation Inspired by Nature*.

Although biomimicry has many practical applications, this study is about more than just imitation. This field of study aims to learn how to harness natural processes rather than just copy them.

Julian Vincent, in his work: *Biomimetics: its Practise and Theory (2006:471)*, says that biomimicry is a "relatively young subject involving the practical application of biological scientific systems and functions in engineering, design, chemistry, electronics, etc.

Fig. 3.16 - 3.19 Omega Center for Sustanable Living (BNIM.com, 2022: photograph).

Rather than researching the properties of biological processes and developing new technologies to mimic them, forward-thinking architects and designers are seriously considering methods to utilise existing processes better and integrate them into the built environment.

Both mutualistic and regenerative architecture view the environment as an equal partner with whom they must collaborate and co-exist for the sake of both parties.

Lowering a building's environmental impact has the potential to integrate the natural environment while focusing on conservation to buck the current trend of careless consumption of non-renewable resources.

Instead of encouraging non-contextual monumentalism that starkly contrasts to the permanent natural landscape, this way of thinking about architecture calls for sensitive architecture that enhances and supports the natural time and place, even in a mutualistic way.

# 3.3 Architectural notions of PERMANENCE AND EPHEMERALITY

Throughout history, architects have explored themes of permanence and monumentality, seeking to construct and preserve meaning in structures and rituals. Such ways of thinking can be found worldwide and manifest themselves in different ways (Serres, 1995:12).

Inherent in many examples of architecture is the desire for timelessness. In the journal article: *Buildings and The Terror of Time (1982:60)*, Harries mentions that the absence of a temporal discourse in architecture can be traced back to the fundamental role architecture has played throughout history as a shelter to domesticate space and escape the effects of time and nature.

In the absence of time, architecture is misunderstood as static and permanent. Even if we no longer fear time, we are not exempt from its effects. Architecture is undoubtedly no exception (Harries, 1982:60).

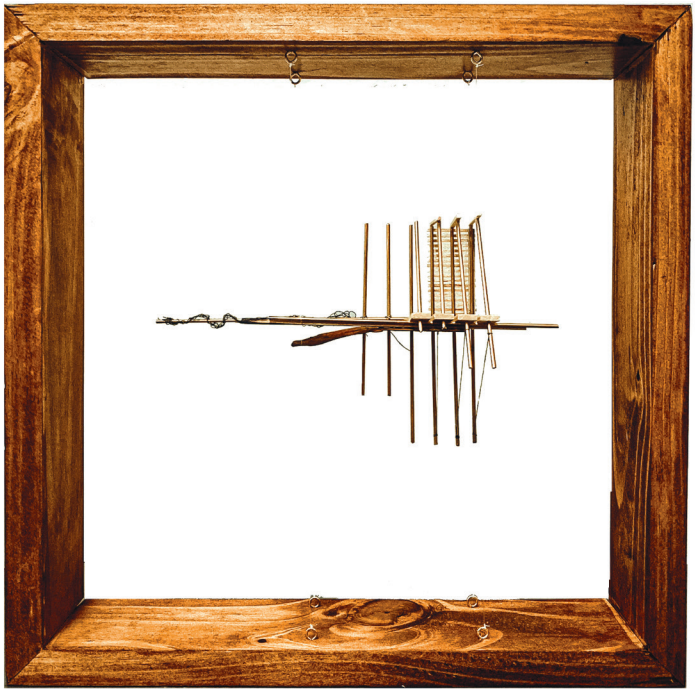


Fig. 3.20 Concept models by author (Author, 2021: photograph).

According to Juhani Pallasma (2006:38), contemporary architecture represents a "collapse of time", where projects focus on a fixed moment in time, an instant, rather than the continuous, where time is present in the matter, here Pallasma is supported by Holl and Perez-Gomes.

Moving matter implies the existence of time.
In her thesis, Jacobson (2019:24) states that races of weathering indicate a process in which nature and natural elements exert their influence layer by layer on exposed things.

Biological processes are documented as visible layers in which change is evident through the build-up of deposits.

Weathering shows the layer-by-layer influence of time, a metaphysical aspect that is sometimes overlooked in the design of buildings.

Mostafavi and Leatherbarrow (1993:64) consider weathering marks on the surface of a building as environmental features, as they indicate the changing weather conditions over time. The passage of time depicted in architecture strengthens a building's connection to its history and future by recording natural changes.

In his 2016 lecture on *The Philosophy of Architecture*, Karsten Harries vents himself to Hundertwassser's call for a more natural life.

Harries quotes Hundertwasser's *Mould Manifesto* against rationalism in architecture:

*When rust settles on a razor blade, when mould forms on a wall, when moss grows in the corner of the room and rounds off the geometric angle, we ought to be pleased that with the microbes and fungi life is moving into the house, and more consciously than ever before, we become witnesses of architectonic changes from which we have a great deal to learn (2016:144).*

Harries addresses architects directly:

*Has our reason not estranged us from ourselves as beings essentially belonging to nature? Here the ill will against architecture turns against rationalism. A longing for home, for a more natural mode of dwelling, feeds it that the lost paradise finds in tears and ruptures, rust and mould traces (2016:144).*

A naturally changing surface provides materiality that evolves while constructively adapting a structure to its surroundings. This concept of reworking through weathering is equivalent to regeneration through degeneration, as weathering is often considered harmful despite its potential to reshape a structure.

This entropic condition highlights the temporality inherent in natural processes (weathering) where surfaces constantly change, whether through the seasons or through markings that appear and disappear over time.

The features of weathering can therefore be characterised as nature's apparent control, allowing for an imperfect but natural, ever-changing state that conveys the essence of time through layers (Jacobson, 2019:24).

Like the wabi-sabi objects (objects that demonstrate the Japanese concept of celebrating decay), the architecture records the effects of nature in the language of decay.

Everything exposed to the elements decays.
This could be seen as nature's rightful claim on the man-made, tracing the artificial back to the biological that it inhabits and from which it arose (Mostafavi & Leatherbarrow, 1993:59).

Many efforts are made to remove all signs of life (nature) that have left their mark on architecture.

In On Weathering: *The Life of Buildings in Time (1993:112*), Mostafavi and Leatherbarrow plead for a change of mentality by stressing that it is not worth fighting natural processes.

After all, biological cycles have much to offer the built environment, such as architecture shaped by its surroundings and context, architecture that changes gracefully with the seasons, and architecture that is free from false claims of eternal perfection.

The imperfections are admired, the genuine and original qualities that man can never genuinely imitate. (Mostafavi & Leatherbarrow, 1993:112)

Rather than avoiding the inevitable, architects can seize the opportunity to use natural features as design tools to create a story that evolves over time.

Architecture exists in the realm of time. It manifests, narrates and is affected by time (Joshi, 2020:91). This is accomplished by translating it into our spatial fabric as permanence and temporality, both of which signify the act of defying and embracing time.

The Greek philosopher Heracleitus uses the metaphor of a river to define time.

He said, *"No man ever steps into the same river twice, for it is not the same river, nor is it the same man."* (Robinson, 1987)

Implying that time is constantly in flux, everything around it changes too. Time is change, and in the architectural realm, time translates into permanence and temporality.

The permanent erosion of the Magalies Mountains, the water flow over the ridge gates, and the fleeting shadows as the sun moves across the sky all convey a sense of temporality.

Contrast this with the monumental dam wall that holds a powerful natural resource and, above, the triumphant arch that symbolises our power over the water. Together with the crest gates, these historic landmarks convey a sense of permanence within the landscape.

Although the mountains are among the oldest in the world, they are still subject to the effects of time. We are, knowingly or unknowingly, constantly surrounded by the effects of time - the permanent and the temporal.

Nevertheless, how do we enable the body to perceive time through architecture?

Since the dawn of time, whether consciously or unconsciously, people have seen time embodied in their surroundings.

By creating time as a frame for everything we see around us and perceiving it as space, we have solidified our presence within that time boundary.

The tangible embodiment of time has always been within our built environment. It is a remnant of how people have seen and told the story of time (Joshi, 2020:61).

As explained in: *An Exploration of Architectural Temporalities*, the architecture of permanence, duration and ephemera are three distinct architectural temporalities, that respond to time and space differently (Landwehr, 2018: 107).

Permanence was historically the first approach to an architectural translation of time. Architecture stood for permanence and stability in turbulent times. The first buildings were examples of acts of time defiance.

The modern spatial fabric, while acknowledging the need for permanence, must also incorporate temporality to enhance the quality of a space (Joshi, 2020:35).

Aldo Rossi notes in: *Architecture of the City (1984:6)*, a permanence that refuses to acknowledge change becomes pathological, as does a spatial fabric. In a world becoming more dynamic by the day, we can afford neither a subdued time nor a stagnant urban fabric.

Temporality becomes increasingly essential for a spatial fabric. A restrictive framework separates individuals by elevating the value of constructed artefacts, while temporality makes the fabric more alive and human-centred. It distorts the lines created by the built mass and makes it easier for the space to evolve over time.

Architecture can translate time by creating ephemeral places in the built environment or transient, adaptable structures. Various meanings can be ascribed to temporality, but it is ultimately associated with accepting the change.

Our spatial fabric consists of both permanent and temporary translations of time. Temporality is often seen as short-lived, while permanence is seen as long-lived.

It would be wrong to assume that just because temporality is ephemeral, so is its meaning.
In today's digitised, fast-paced world, people demand life-changing experiences that evoke strong emotions and create lasting memories (Joshi, 2020:59).

In the book: *Kinetic City*, author Rahul Mehrotra states that people are obsessed with permanence.

*"We resist change, even though change is perhaps the only constant in our lives (...) in our cities, in our notion of urbanism, are we creating permanent solutions to temporary problems?*

*Are we committing resources to paradigms we do not know will be relevant in a decade? (...) Impermanence is bigger than permanence and more significant than all of us* (Mehrotra, 2019: online).

In *An Exploration of Architectural Temporalities*, the author explains that Ephemera attempts to stop time temporarily, duration attempts to exist within it, and permanence tries to resist it.

While there is no one 'right' way for architecture to respond to time, by overlaying these three different architectural temporalities, we can potentially create a plurality of space and time, or what is sometimes called the 'experiential architecture of place' (Landwehr, 2018; 107).




Fig. 3.21 Constructing with nature (Mehrotra, 2019: image).

Take, for example, the Kumbh Mela, a Hindu religious festival. Held every twelve years at the confluence of the Ganga and Yamuna rivers, the Kumbh Mela is considered an ephemeral megacity. Around 10 million people gather on 23.5 square kilometres to live in a temporary megacity for 49 days (Mehrotra, 2019: online).

In just eight weeks, a temporary city emerges on the banks of the river on a flood plain that was otherwise uninhabited and was under water only a month before construction began.

This temporary city provides shelter, food, and complete infrastructure, including roads, bridges, sanitation, an electricity grid, hospitals, seven train stations and a police force of over 6,000 personnel (Mehrotra, 2019:online).

On the main days of the 2013 festival, an estimated 30 million people came to the city. In the three weeks following the festival, the city is completely dismantled, and the plain is returned to the rivers, which will flood it a month later.

Architect, Rahul Mehrotra (2019: online) articulates that perhaps humility is the most important lesson from all this. No building, road or garden lasts, no matter how carefully planned, painstakingly built or lovingly tended; the act of creating must inevitably be followed, even supplemented, by letting go.

This is what attendees would mean when they say that the Kumbh Mela is "about renunciation"; The land taken from the river is merely on loan; it was formed from mud, and to mud, it must return.



Fig. 3.22 -3.23 Flowing of the river and constructing the ephemeral city edited by author (Google Earth: image).



“A pebble polished by the waves is pleasant in the hand, not only because of its pleasant shape but because of its formation; a perfect pebble on the palm materialises duration, it is time brought into form

- Juhani Pallasmaa (2005:12) The Eyes of the Skin: Architecture and the Senses.”

Temporality and permanence co-exist and are interlinked. Without permanence, no ephemerality can endure, and without acceptance of change, no civilisation can stand the test of time (Joshi, 2020:59).

The crucial question, however, is how people perceive these translations and time in the field of architecture?

Phenomenologists, such as Architect and Philosopher Juhani Pallasmaa, have for some time understood the relationship between time and space and how they can fuse to create powerful architectural moments. Pallasmaa, Zumthor and Ando have written about this type of architecture for the senses.

They understood something about the interconnectedness of human body and architecture, and how all senses should be accommodated in order for the body to perceive the whole of architecture.

Holl, Perez-Gomez and Pallasmaa (2006:41) underline that phenomenology can be understood by experiencing a place through the use of various architectural lenses, such as an enmeshed experience driven by intangible qualities, colour, light and shadows, time and perception and/or sounds and water.

What are these spatial elements whose nature of change traces time, and how does the body perceive them?

Elements such as natural materiality, light, water, and landscape holds memory to the human body and records our daily identification and orientation with the natural and cultural landscape.

Various literature has been written about spatial elements that influence the perception of time within a built structure, including materiality and functionality.







# 3.4 Responding to the ephemerality of light, water and landscape elements



Fig. 3.24 - 3.26 Ephemeral elements on site (Author, 2021: Photograph).

“When water, wind, light, rain, and other elements of nature are abstracted within architecture, the architecture becomes a place where people and nature confront each other under a sustained sense of tension. I believe this feeling of tension will awaken the spiritual sensibilities latent in contemporary humanity”

- Tadao Ando, Towards New Horizons in Architecture.

# Materiality

The materials that cover our environment are our very first point of contact. We observe objects and their very character and make inferences about the environment. Every piece of material has a narrative.

In *Hapticity and Time (2000: 2)*, Pallasmaa writes about this inherent narrative of materials and the perception we attach to them.

Rigid materials, like stone, speak of permanence and the past; fluid materials, like mud, speak of temporality; and materials, like concrete, speak of the life-changing changes brought about by the industrial revolutions and their aftermath.



Fig. 3.27 Architecture growing from the site by Smit Architects (Smit, 2019: image).

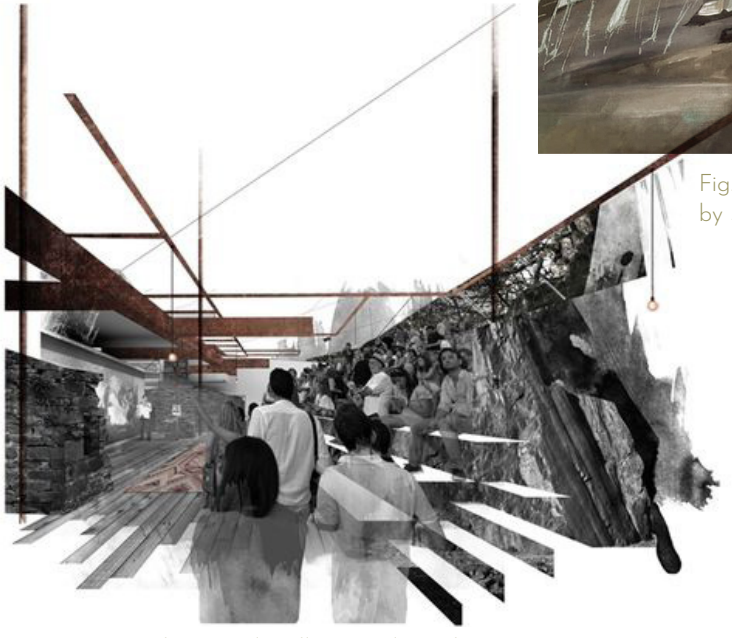


Fig.3.28 Natural materials collage (Milo Ayden De Luca, 2012: image).

# Water



Fig. 3.29 Water reflections in architecture (Patricia Ruiz: image).

In contrast to the past and future, which are only accessible via intellect, we can only connect with the here and now through our bodily senses.

According to Kevin Nute's article: *The Presence of Weather*, sensory cues from our environment make us aware of our surroundings.

At the same time, fluctuations in those stimuli assist in keeping us at the moment (Nute, 2016: 66-73).

A discernible shift in our immediate surroundings, then, is required for us to stay completely present. He explains how environmental factors such as natural light, wind, and water are needed to sense a shift in the present.

He discusses how architects might harness the impacts of shifting temporalities to enhance current experiences (Nute, 2016:66-73).

# Light

Natural light has been the most primordial and simple spatial element to understand the passage of time. Architect, Tadao Ando provide a critical understanding of light in his work.

The interaction between architecture and natural light is where the temporal experience is most powerful (Joshi, 2020:71). The changes in light (and shadow) accentuate the diurnal and seasonal changes within a space:

Natural light has a profound ability to convey a remarkable immediacy of "place" and, with its daily and seasonal transformations is a universally available, physical manifestation of the passage of time (Ando, 2003:471).

Natural light allows us to experience transience. It has been used a lot of essential structures throughout history to manipulate spaces. It can give us a fleeting sense of the passage of time and create a memorable experience (Joshi, 2020:71).

Natural light can, even for just a moment, leave a lasting impact. These experience invoke a sense of dynamic permanence, allowing us to experience time holistically.

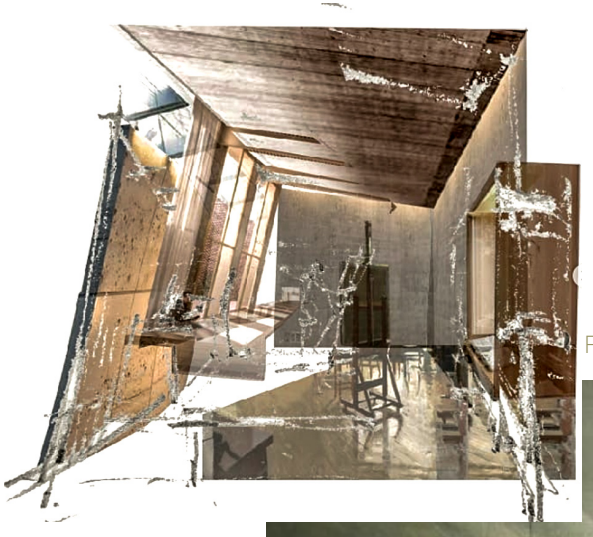


Fig. 3.30 Interior light by Smit Architects (Smit, 2019: image).



Fig. 3.31 Natural light from landscape (Josep Lluís Mateo, 2012: image).

# Landscape

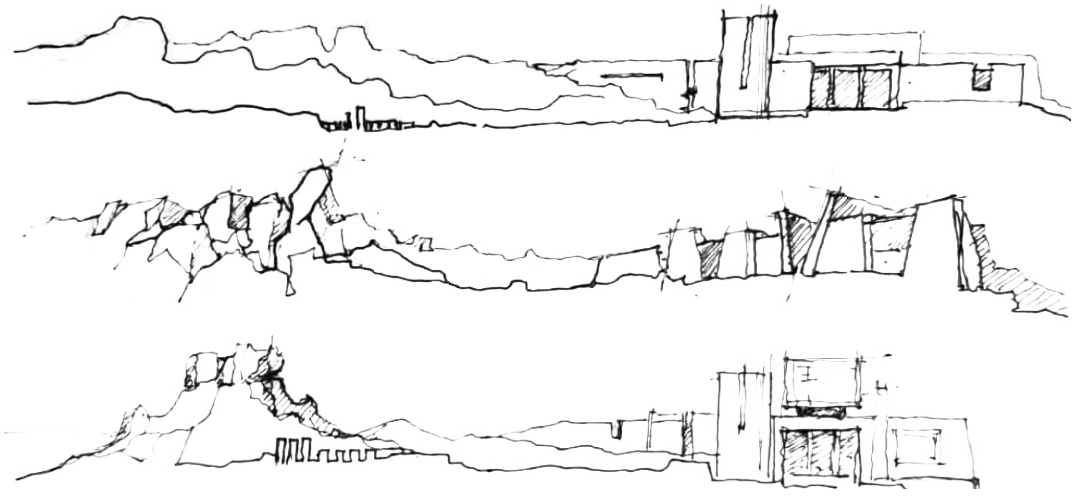


Fig. 3.32 Landscape interpretation drawings by Smit Architects (Smit, 2019: drawing).

Sue Anne Ware in *Knowingly Unfinished: Exploring the temporalities of a landscape (2016:74-81)*, uses case studies to analyse the relationship between time and landscape critically. Our external landscapes are in a harmonious state of natural change due to the climatic conditions.

Incorporating strategies to create experiences that flow through days, seasons, and years maintain the landscape's temporality.

Temporal narrativesassociated within a landscape form a cyclic connection to the past, at any moment, along with its future (Joshi,2020:74).

Space is encircled by time, yet architecture must embrace it. Our sensory, perceptual, and associational understanding of a landscape shapes how we comprehend time (Joshi, 2020:59).

Our impression of time is shaped by the shift in materiality, scenery, dynamic sensory experiences, and spatial structure.

Different permanence and temporalities are created by the integrated interaction of all these components and their resulting alterations.



Fig. 3.33 Natural elements and their effects on architecture (Milo Ayden De Luca, 2012: image).

In memorable experiences of architecture, space, matter, and time fuse into one singular dimension, into the basic substance of being, that penetrates our consciousness.

*We identify ourselves with this space, this place, this moment, and these dimensions become ingredients of our very existence.*

*Architecture is the art of reconciliation between ourselves and the world, and this mediation takes place through the senses.*

*Juhani Pallasmaa*
*(Pallasmaa, 2006: 32)*

# 3.5 Synthesis of Concepts

In large part, embracing time in architecture means embracing change. Franck in *Architecture Timed: Designing with Time in Mind (2016:17)* understand that to embrace time means to acknowledge that buildings are not fixed, static objects rooted to a single movement and impervious to change, but mutable subjects much affected by everyday use, intentional, and unavoidable material decay.

David Leatherbarrow and Mohsen Mostafavi (1993:16) hold that the most direct degree of acceptance of time involves the concept of weathering as "a sort of completeness." They regard weather as a constructive agent of transformation toward completion.

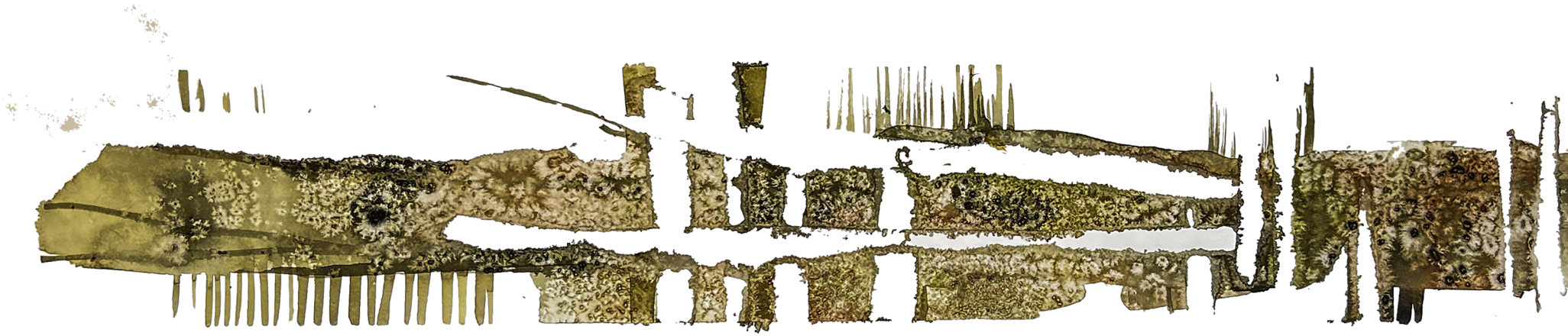


Fig. 3.34 Ephemeral qualities (Author, 2021: drawing).

The architecture acknowledges, represents, and reconsiders time by allowing the building to deteriorate and regenerate in response to its surroundings.

The unpredictability of decay and weathering acknowledges that the process of weathering not only subtracts from the building through deterioration but also adds to it through the accumulation of debris or markings on a surface.

Peter Zumthor (2006: 24) argues that materials have limitless possibilities since "materials react with one another and have their radiance so that the material composition gives rise to something unique".



Through staining, the edges and qualities of different materials begin to merge, while multi-layered and complex materials deteriorate, revealing new characteristics and aesthetics.

The transparency and uncertainty in weathering allow for a subjective reading of the building through ambiguity in both material rendering and meaning (Shing, 2010:21).

These surface changes are caused by natural elements taking on the qualities of the place over time and, in turn, modifying its surroundings to create a sense of harmony.

The objective and subjective perspectives change as the building evolves; architecture is then interpreted as an expression of time - the process of designing, constructing, and the life of the building.

When the weathering process is allowed to continue unhindered, the existing surface can be completely covered by a coating; a time-bound "growth of skin" that covers the new surface with an accumulation representing the relationships between the building and the conditions of its surroundings.

Kengo Kuma expressing his belief that architecture should not be limited to isolated objects but should be integrated to become a part of the entire environment:

"That is what I have always wanted to do. I want to erase architecture." (Bronwell, 2011: 38-39)

Mother nature has been here long before us and will always find a way to claim back power. In order to design a building that will act as a healing body within the wounded landscape of Hartbeespoort Dam, the architecture should resemble a scab, under which the temporal landscape can heal to form a new growth of skin.

The constant play between permanence and temporality should not only be left to Mother Nature but also be utilized by a new generation of architects, who will evolve the legacies of their predecessors through innovative and unorthodox architectural designs.

Allowing for an integrated architecture that respects the landscape and works in harmony with the natural world. Architecture will leave scars on our environment but we have the opportunity to learn from the natural world by adopting the ideas of a mutualistic and regenerative architecture to rebuild our damaged humanistic infrastructure.

# 3.6 Design Lessons and Tools to Consider

Weathering, the unavoidable natural process of erosion that discloses via subtraction and presence time through layers of addition, has been revealed to encapsulate characteristics identified to be inherent in architecture.

The envisioned design grows and devolves through time as a weathered condition, accomplished by converting the envelope components into transitory, semi-translucent screens that expand and disintegrate.

Changing materials are intrinsic in nature; we are used to observing but are also oblivious to growth in materials such as trees, corals, and dunes.

There are erosion patterns, crystallisation patterns, vitrification patterns, and fossilisation patterns. While humans use self-formed natural materials such as trees and rocks, the construction process prevents the material's evolutionary or devolutionary process.

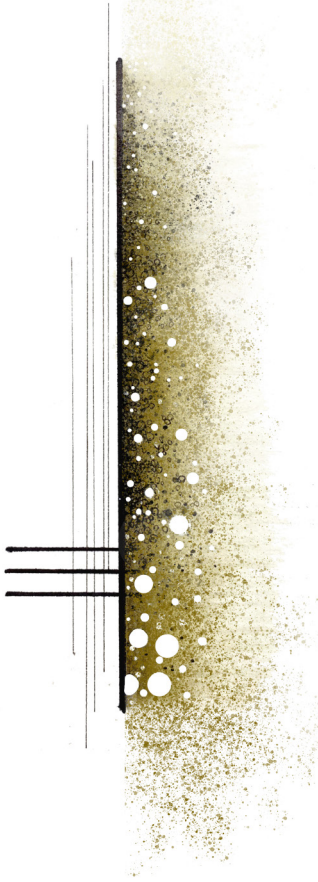
A fundamental element of architecture is that it is typically regarded as unfavourable for a structure to change after it has been built. Architects go to extreme lengths to prevent accretions like mould or mildew and detriments like cracking or deterioration (Irving-Beer, 2019).

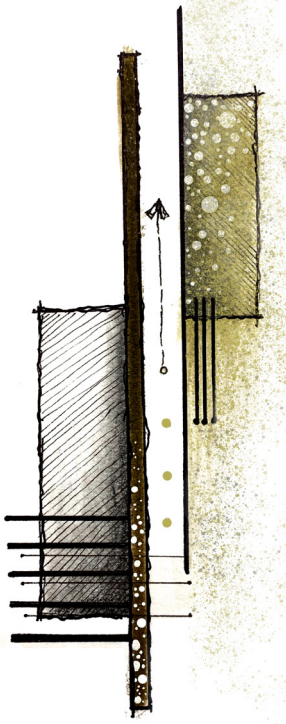
The design concept is driven by not only permitting but encouraging building materials to follow their natural tectonic forces, creating an architecture where degeneration and decay may be integrated into the built and constructive design.

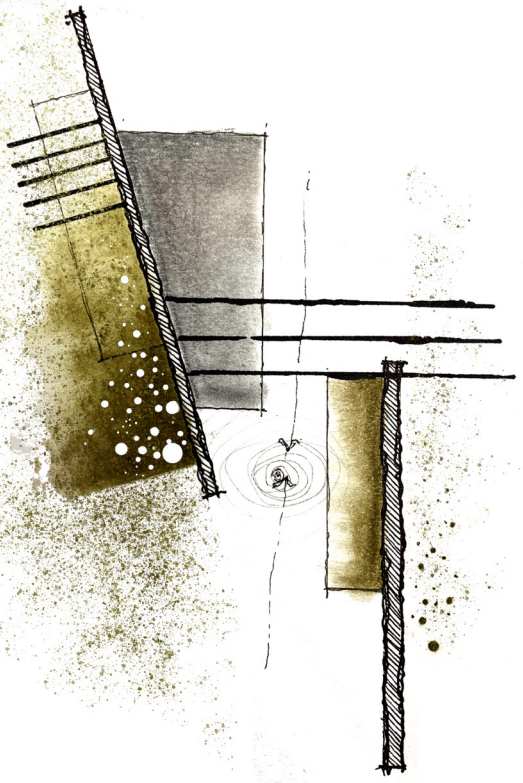
Therefore, the architecture, like the biodegradable products produced within its walls, will one day return to nature and leave only a trace of its existence.


ALGAE CRETE

# 01



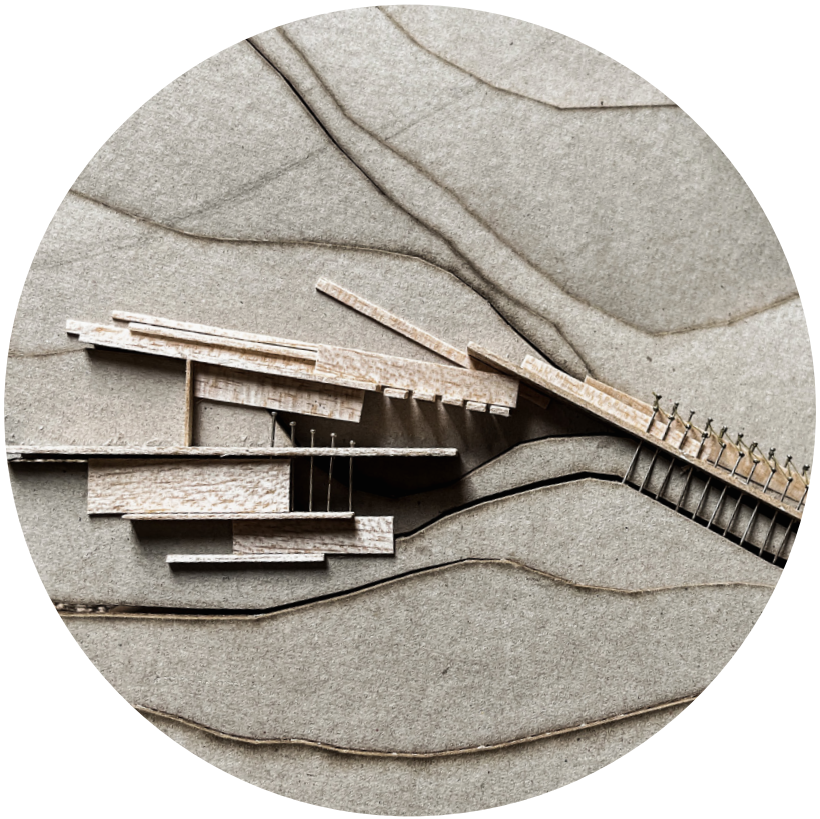




# 4.1 Design Exploration

Fig. 4.1 - 4.3 Concept drawings by author (Author, 2021:.drawing)

## 4.1.1 Design Development



CONCEPTUAL APPROACH

Fig. 4.4 Concept model (Author, 2021: photograph).



2 CONCEPTUAL APPROACH

Fig. 4.5 Concept model (Author, 2021: photograph).



3 CONCEPTUAL APPROACH

Fig. 4.6 Concept model (Author, 2021: photograph).





Fig. 4.7 - 4.9 Initial Concept model (Author, 2021: photograph).



# CONCEPTUAL APPROACH

The first conceptual approach tried to minimise the appearance of the building and simplify the structure down to three distinct walls within the landscape.

These lines were created by picking up on existing forms in the existing landscape. The programming focused on research being closest to the water source and progressing down from private to public.

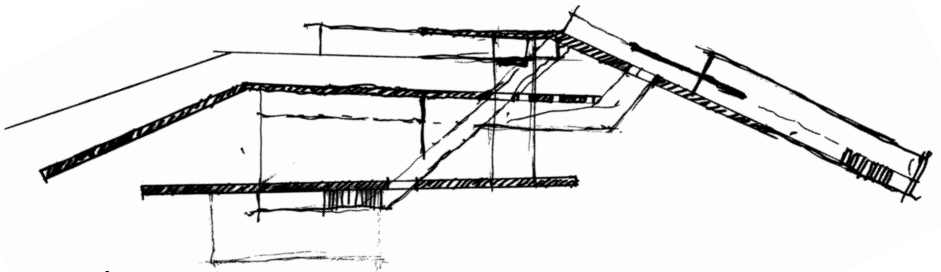


Fig. 4.10. Concept plan (Author, 2021: drawing).

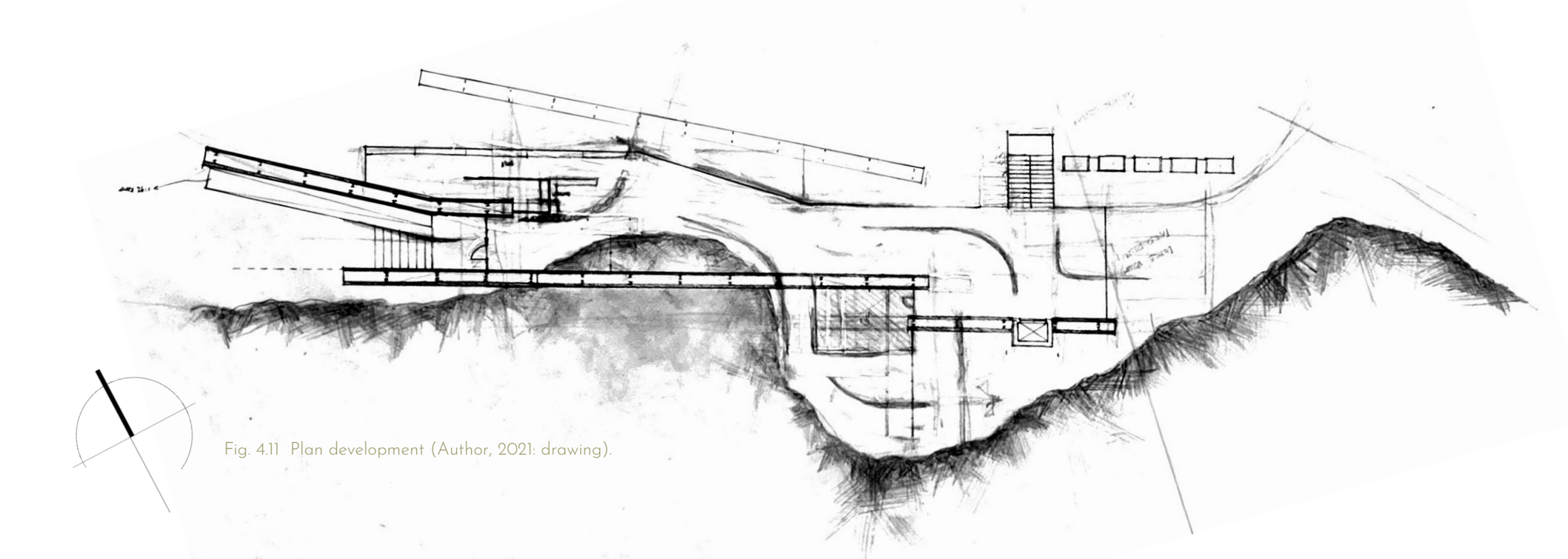


Fig. 4.11 Plan development (Author, 2021: drawing).

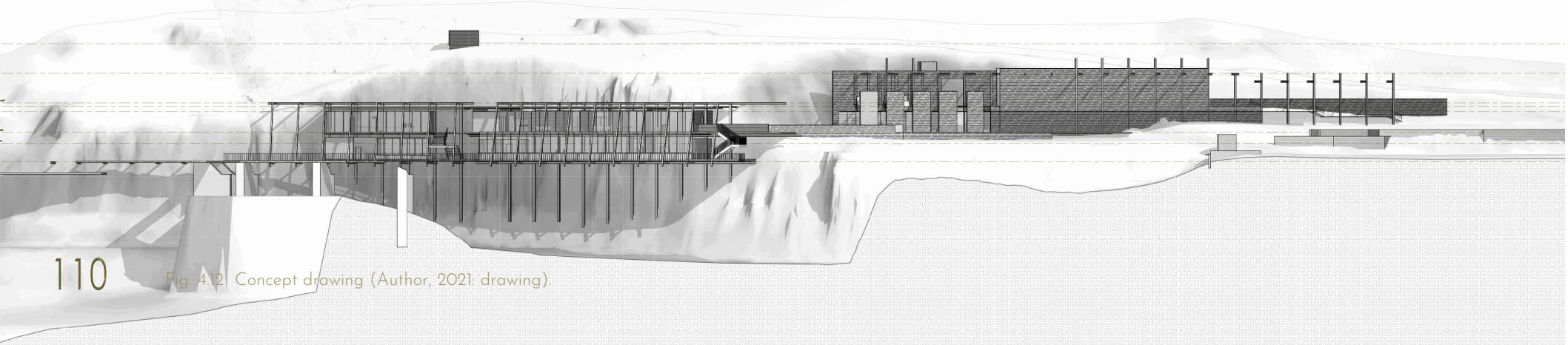




Fig. 4.12 Concept drawing (Author, 2021: drawing).

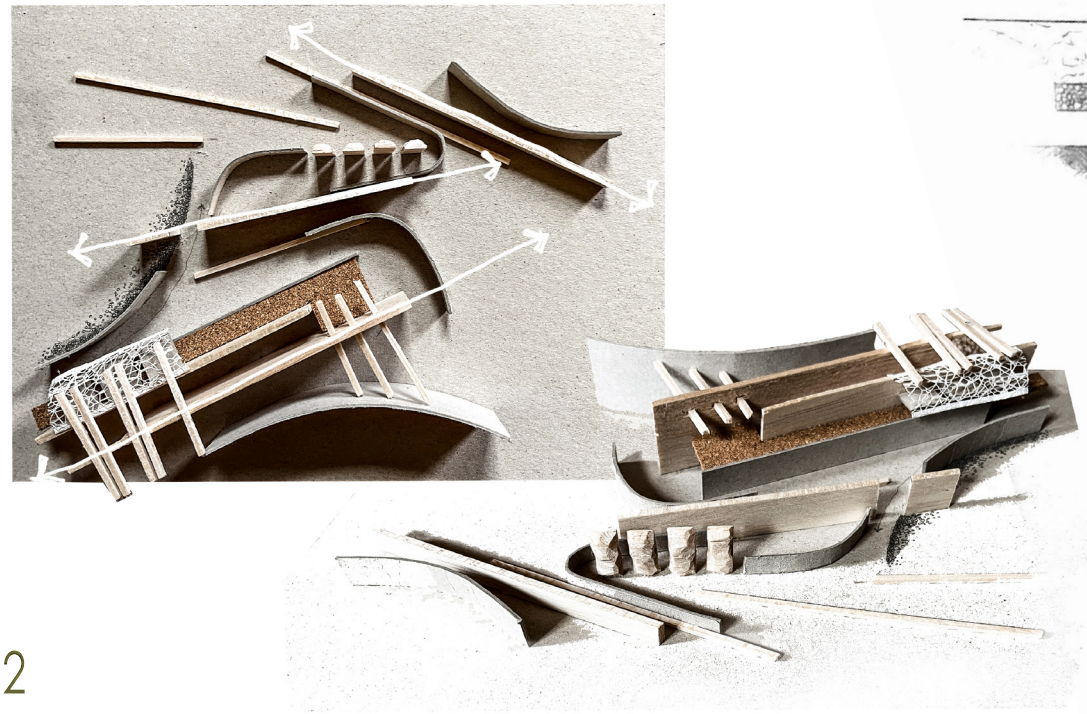



GROUND FLOOR PLAN

NOT TO SCALE

# 2 CONCEPTUAL APPROACH

The second conceptual approach focused on the research and design of textiles bound together by the production of textiles. This concept investigated the idea of cutting into the landscape in order to merge the architecture with the landscape.



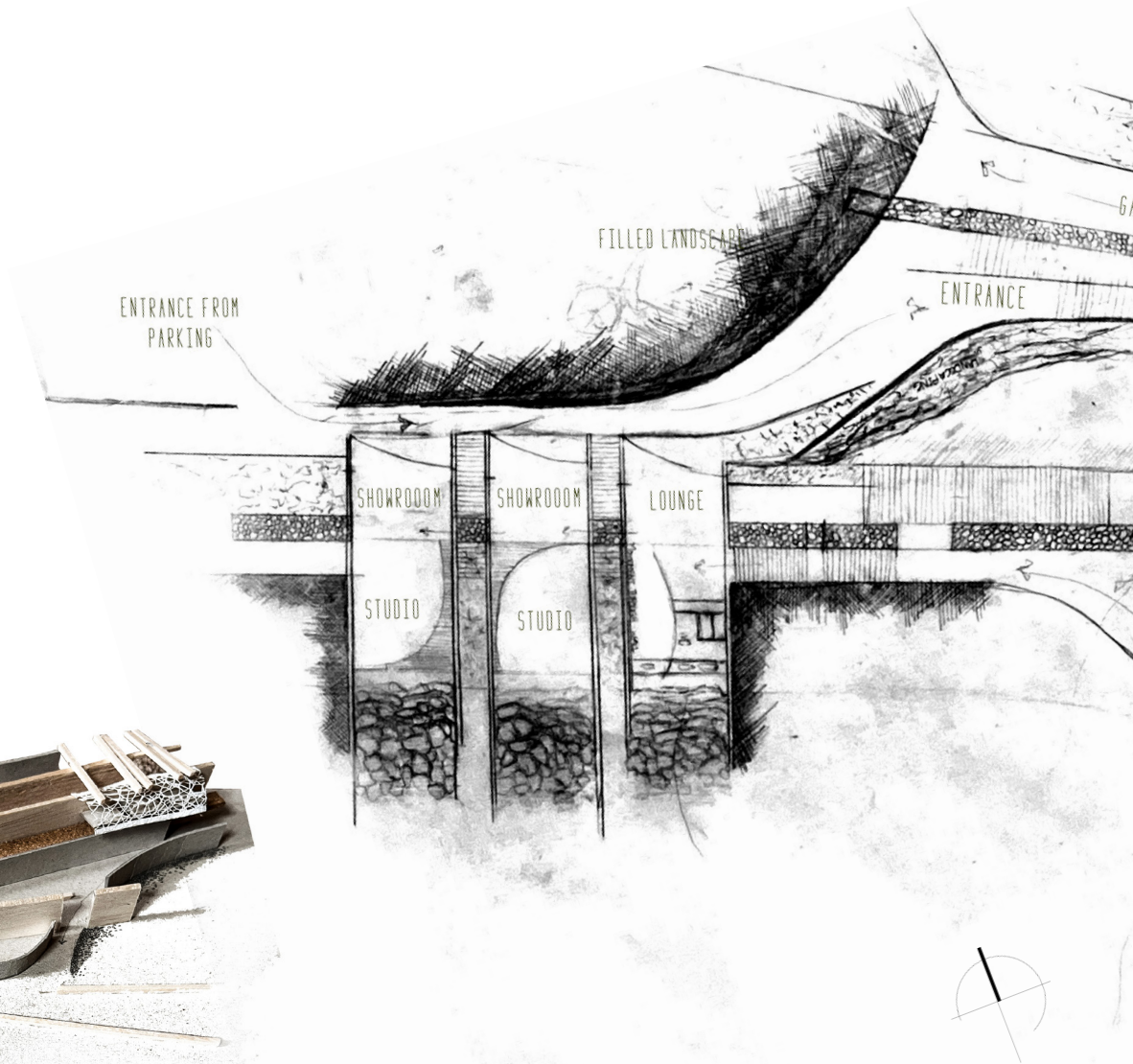



Fig. 4.14 - 4.15 Concept plan indicating placement on site. (Author, 2021: drawing).

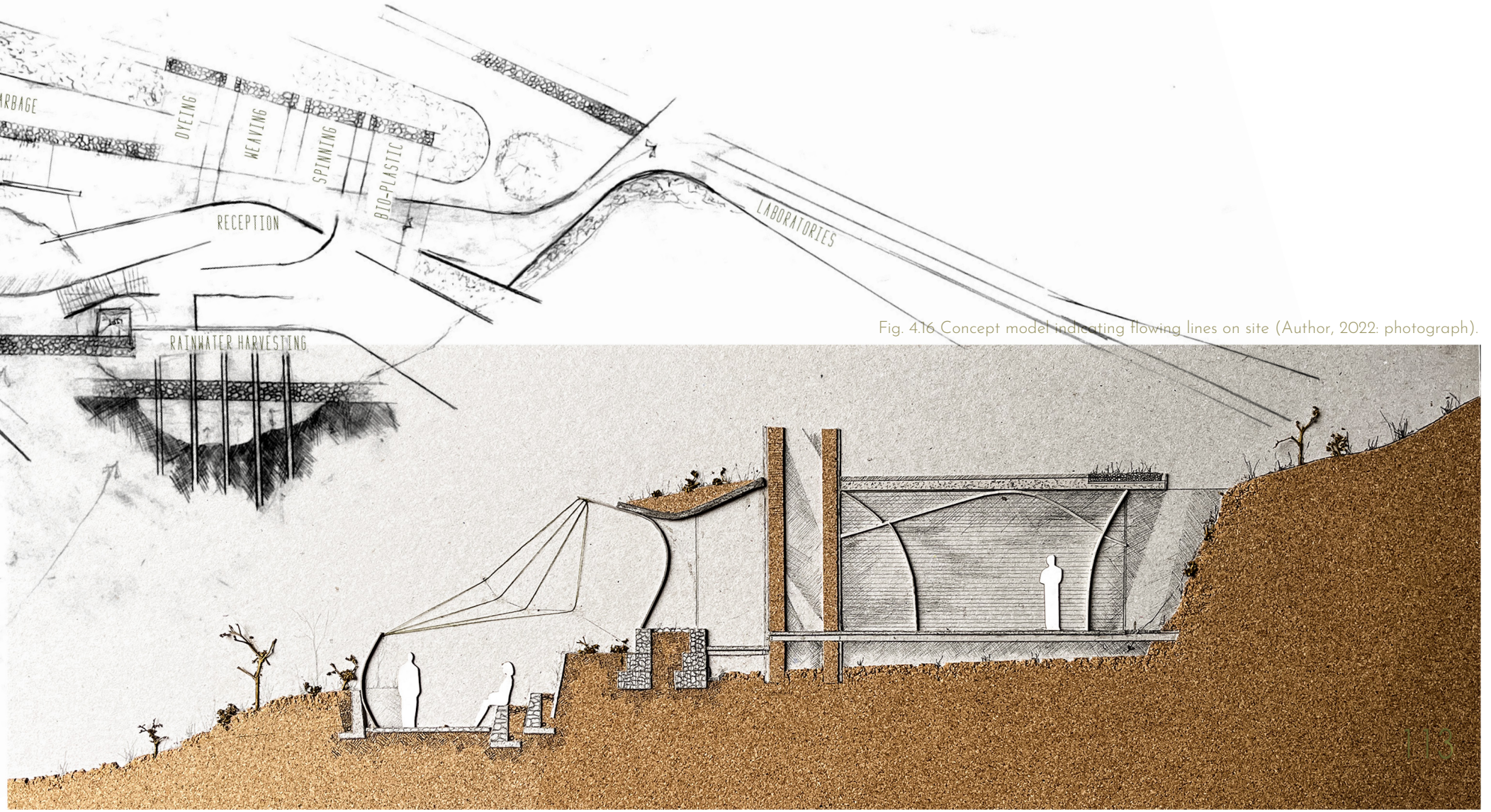
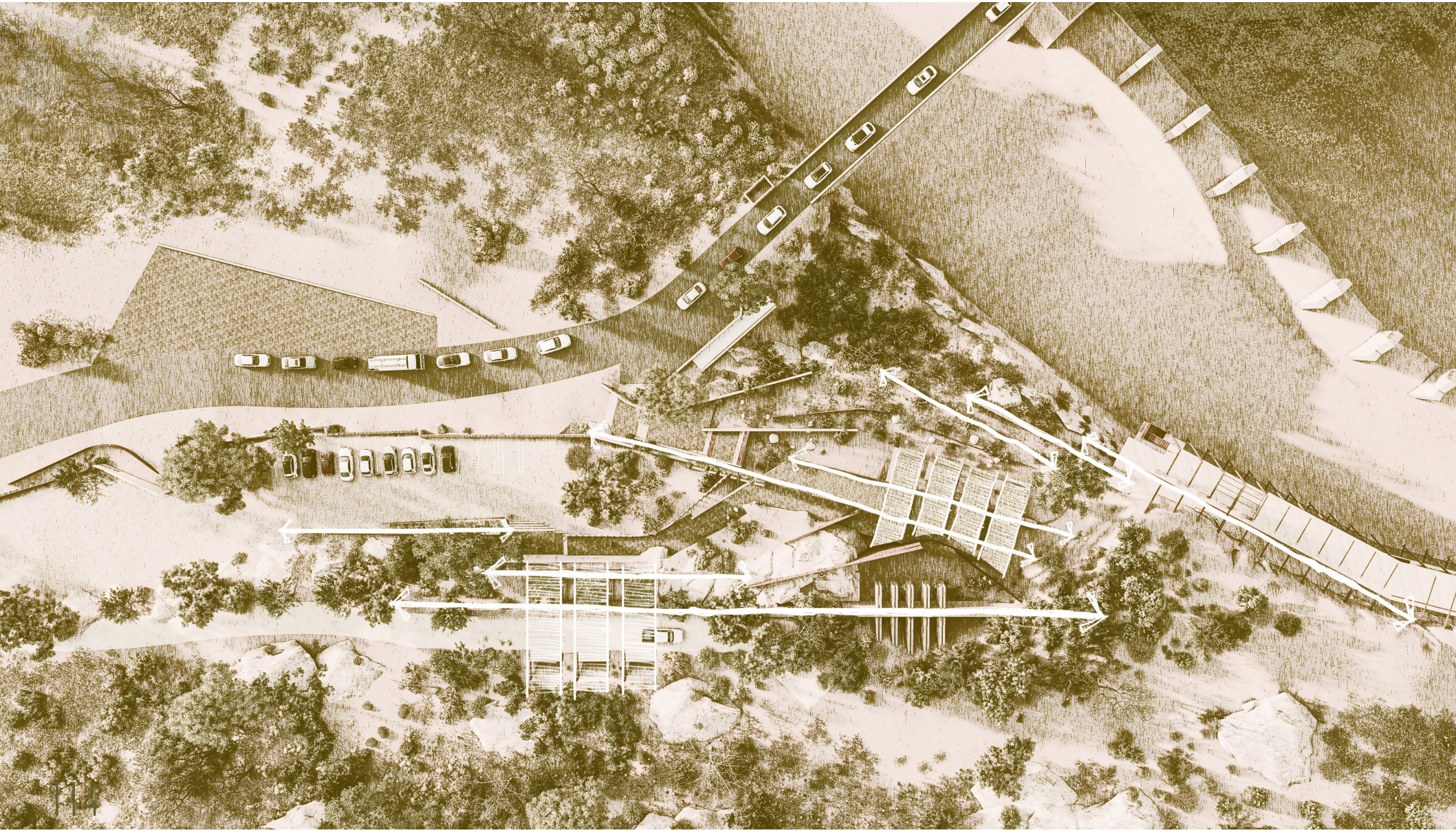
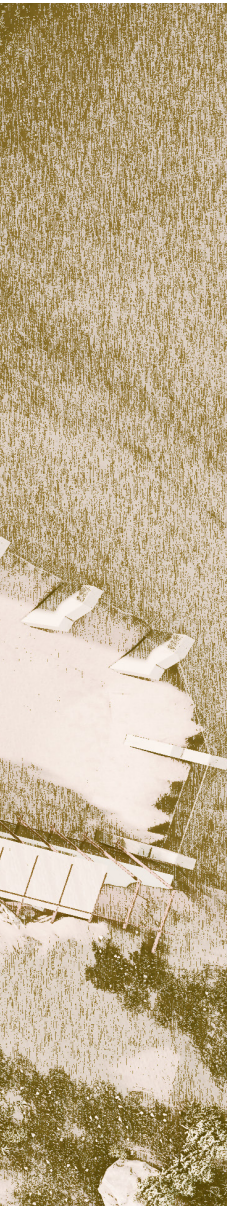
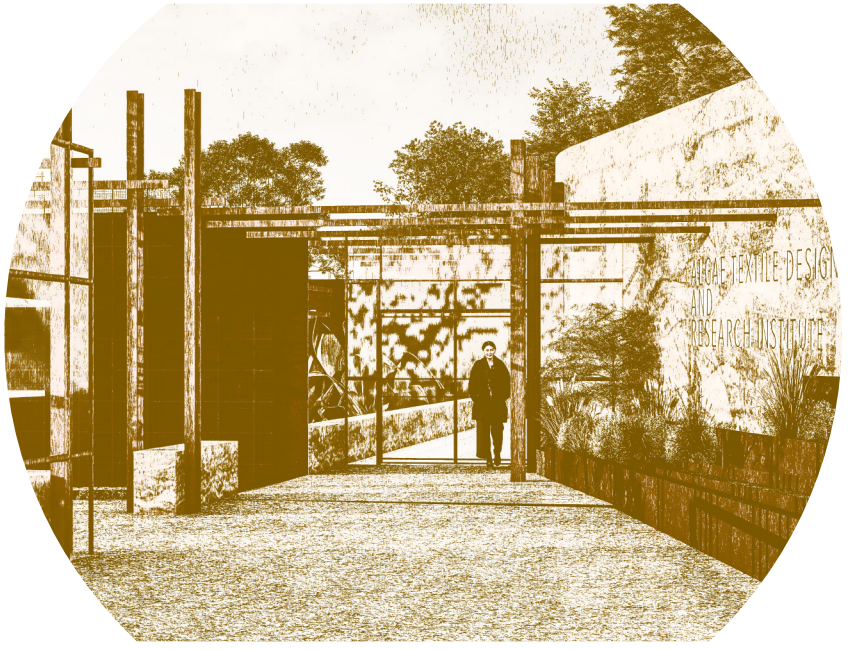



Fig. 4.16 Concept model indicating flowing lines on site (Author, 2022: photograph).







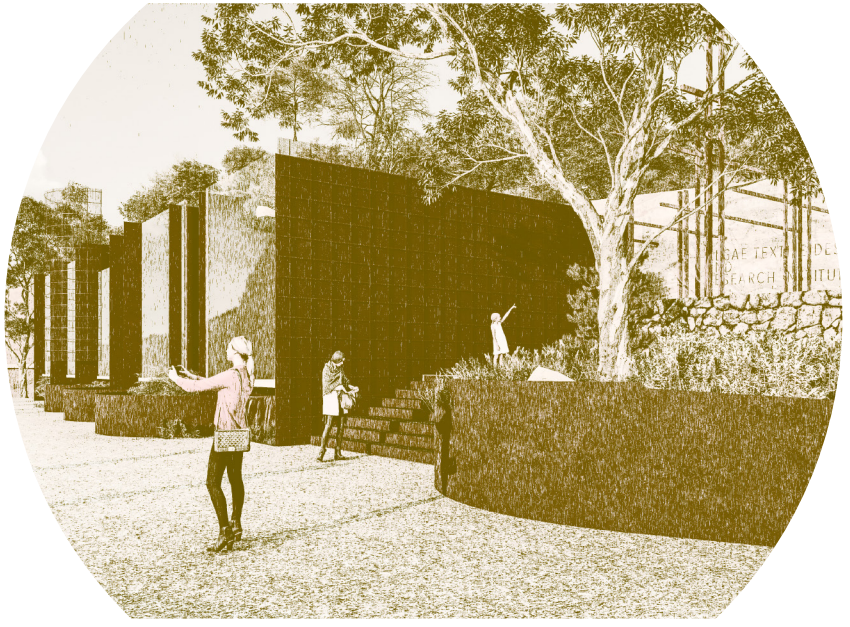


Fig. 4.17 - 4.19 Concept indicating placement on site. (Author, 2021: photograph).







Fig. 4.20 - 4.22 Concept models indicating placement on site. (Author, 2021: photograph).

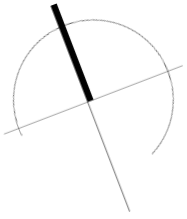


# 3 CONCEPTUAL APPROACH

The third conceptual approach took inspiration from existing structures on the surrounding site as natural stone walls are seen all over in many shapes and forms.

The design was simplified to allow for small retaining stone walls to create a sculpted landscape that would one day serve as a public park. The permanence of the concrete manmade structures is contrasted and translated into flowing natural footpath that will be left as a permanent scar.

The ephemeral qualities of shadows and seasonal changes found in the natural landscape is contrasted by the rigid form of the temporary building structure.



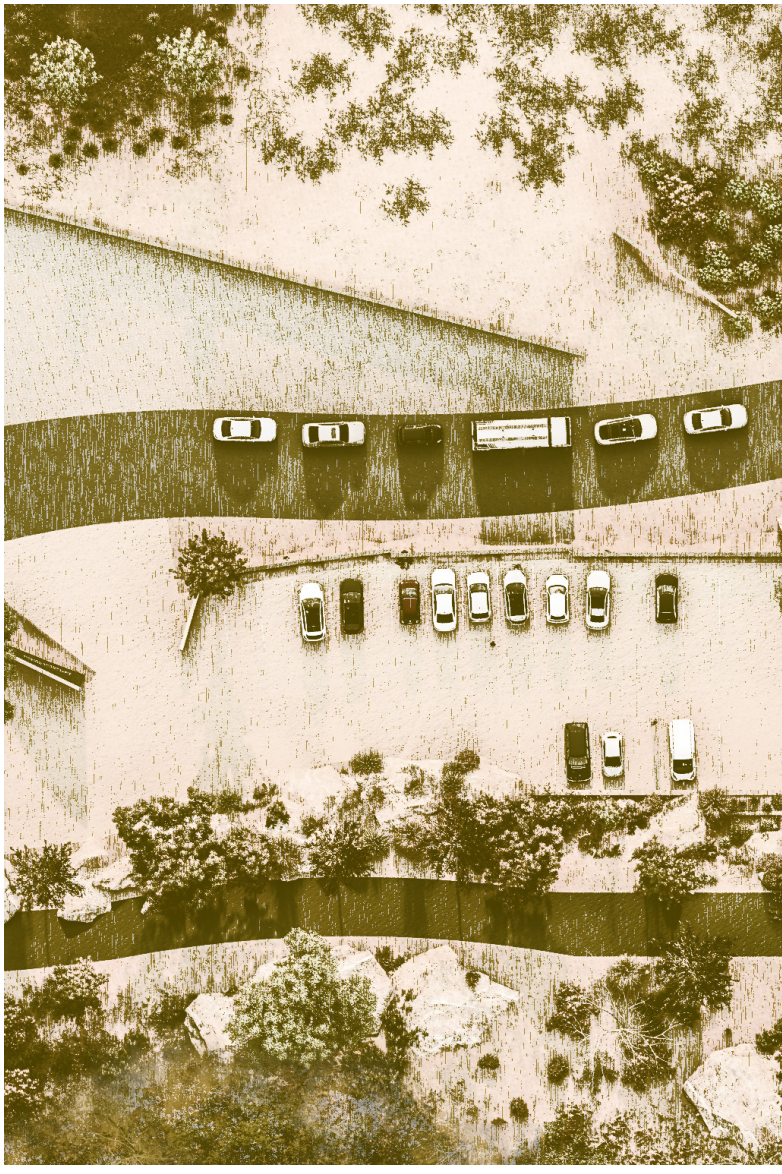


Fig. 4.23 Concept plan within the landscape (Author, 2021: photograph).







## 4.1.2 Towards a Final Design

Fig. 4.25 Concept models indicating placement on site. (Author, 2021: photograph).

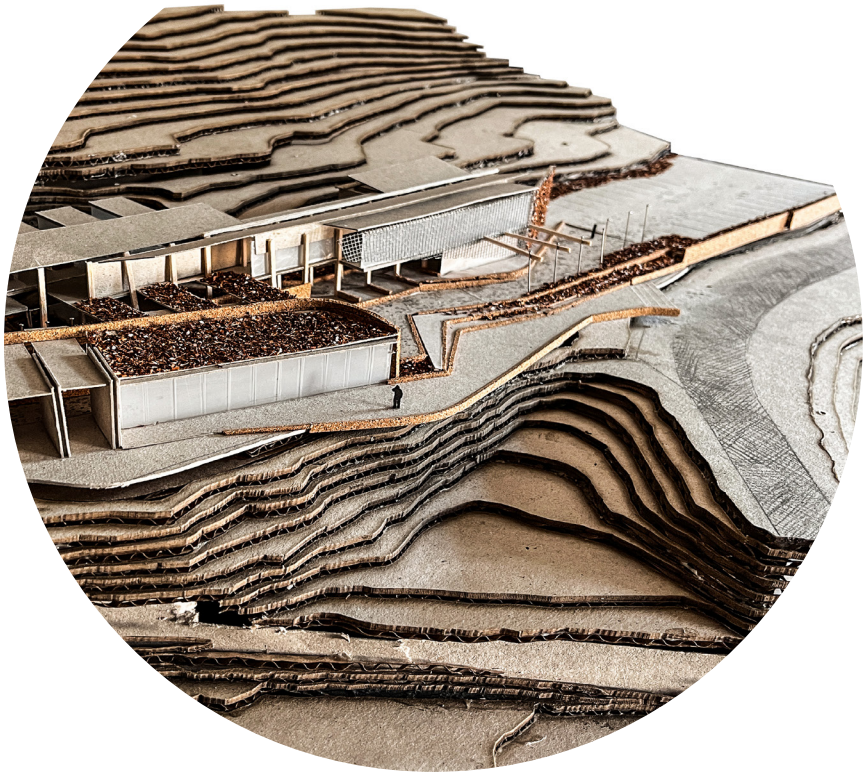
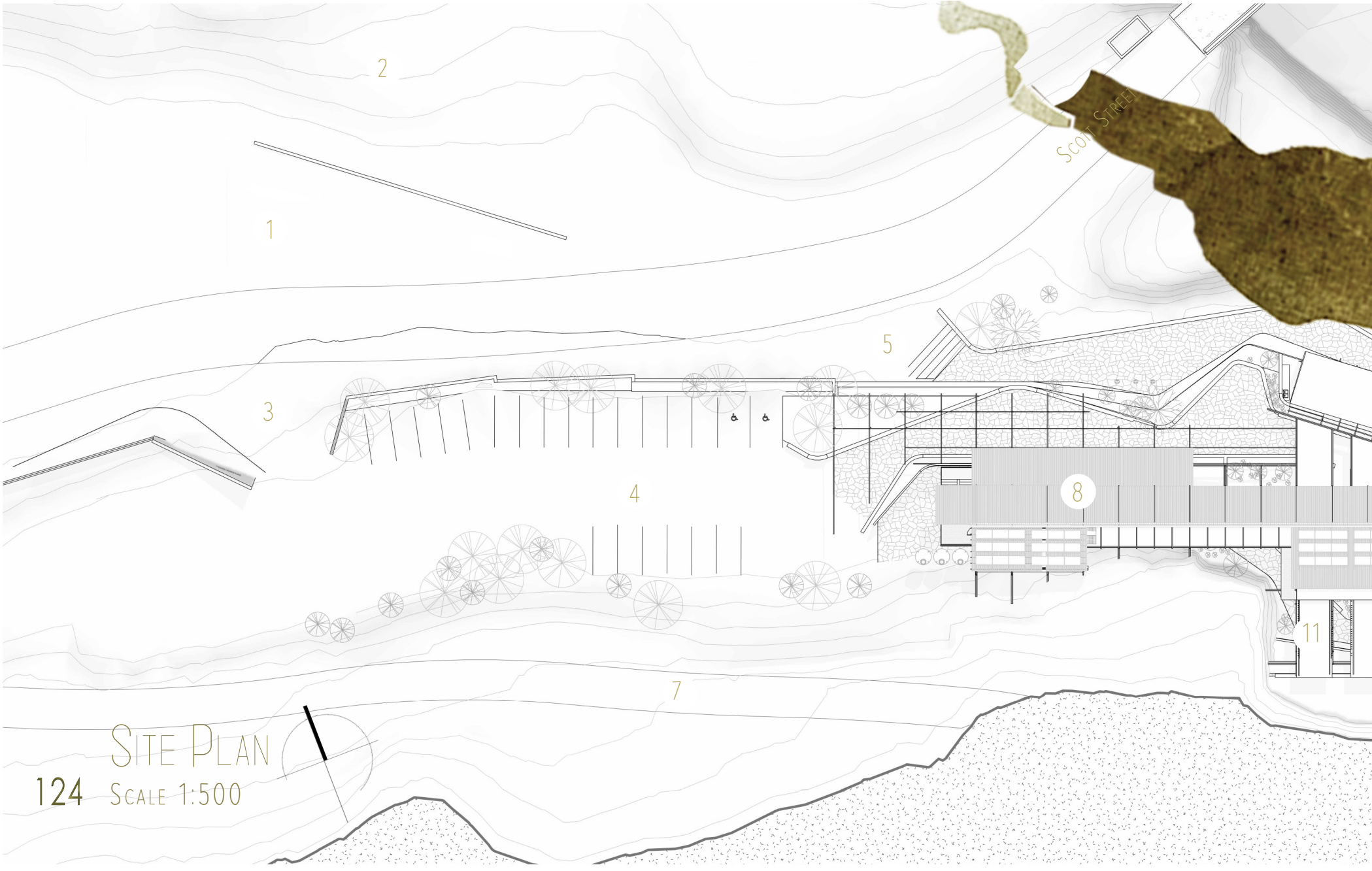




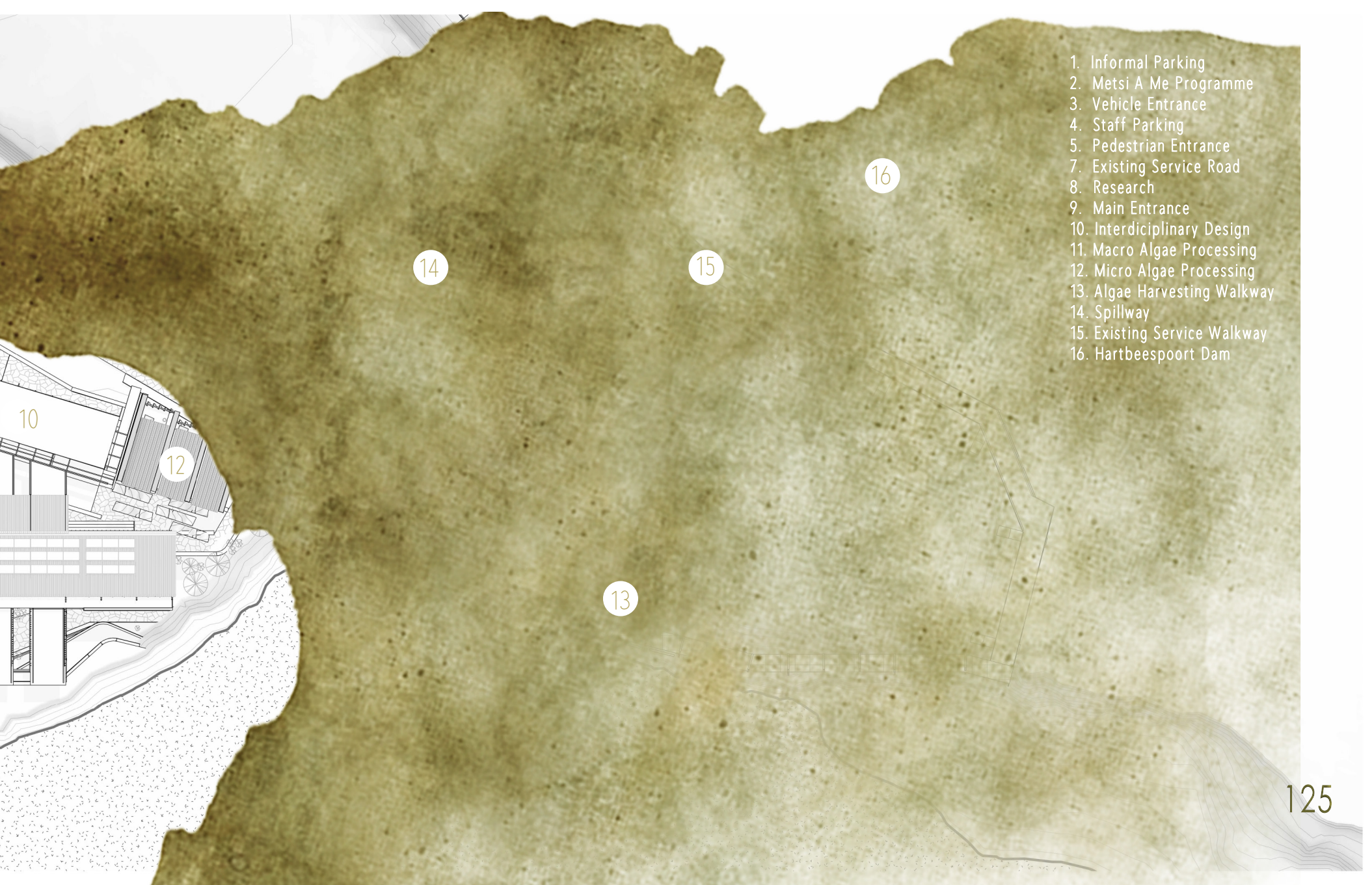


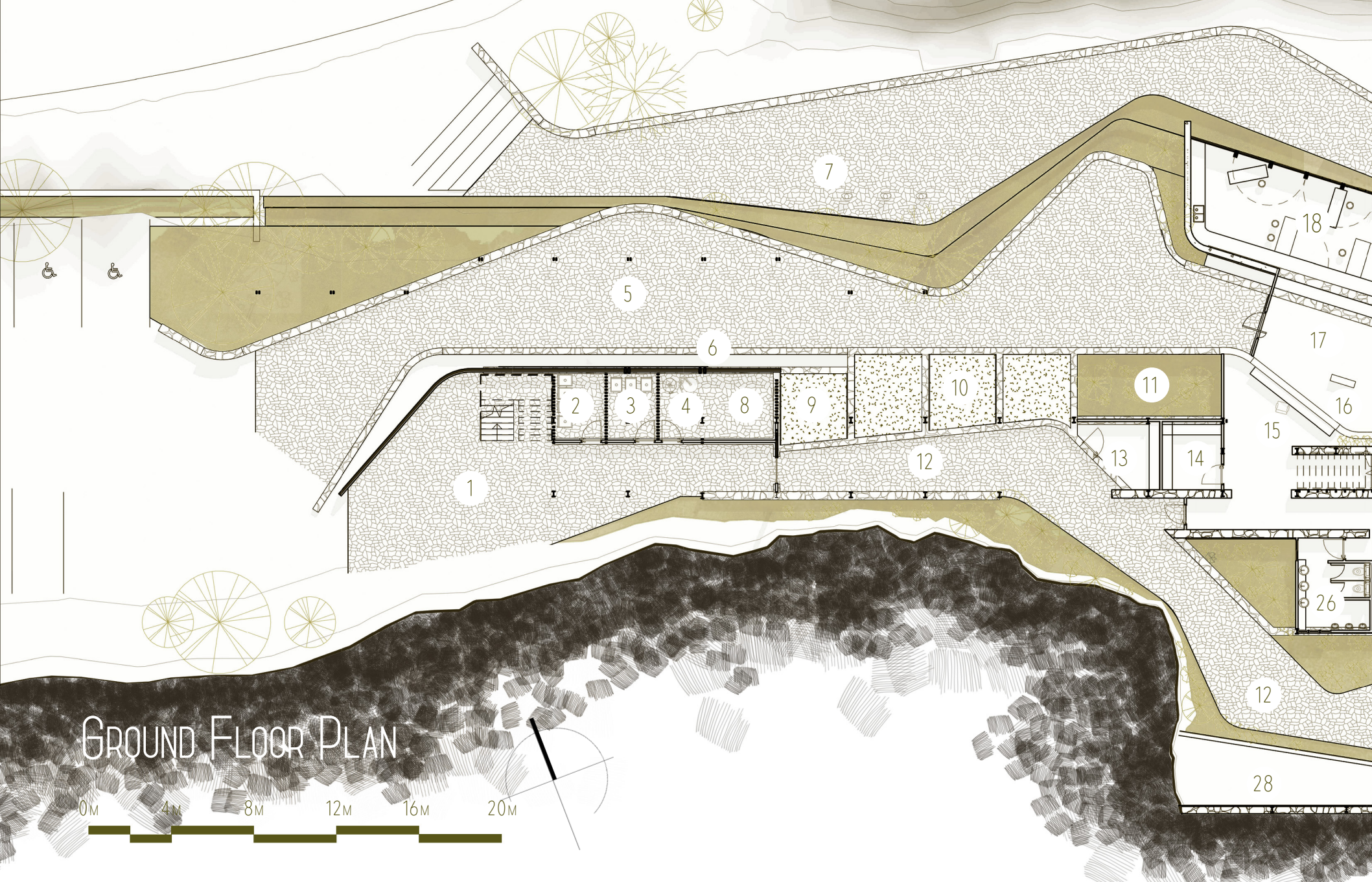
Fig. 4.26 - 4.28 Concept models indicating placement on site. (Author, 2021: photograph).



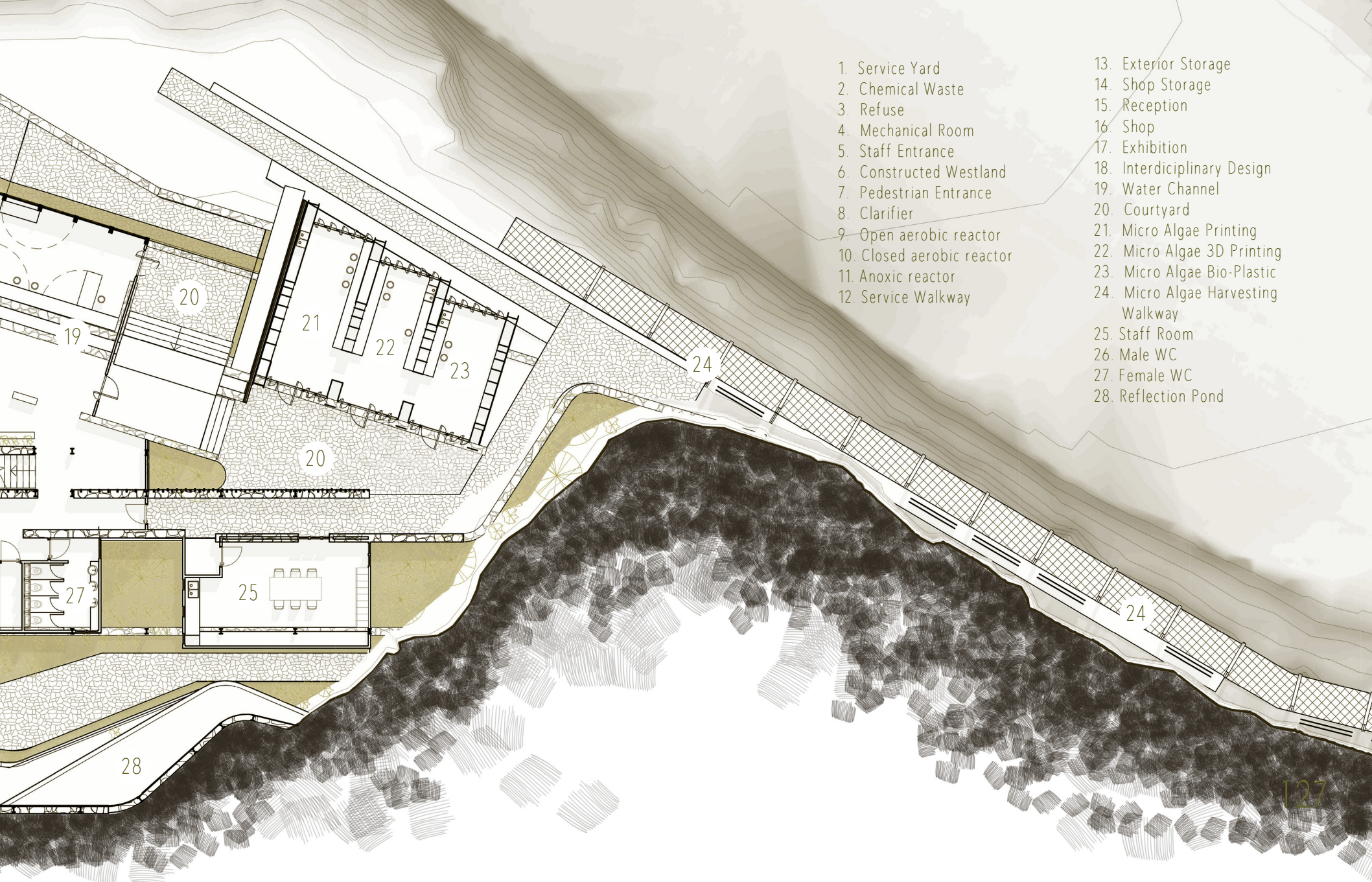

# Site Plan

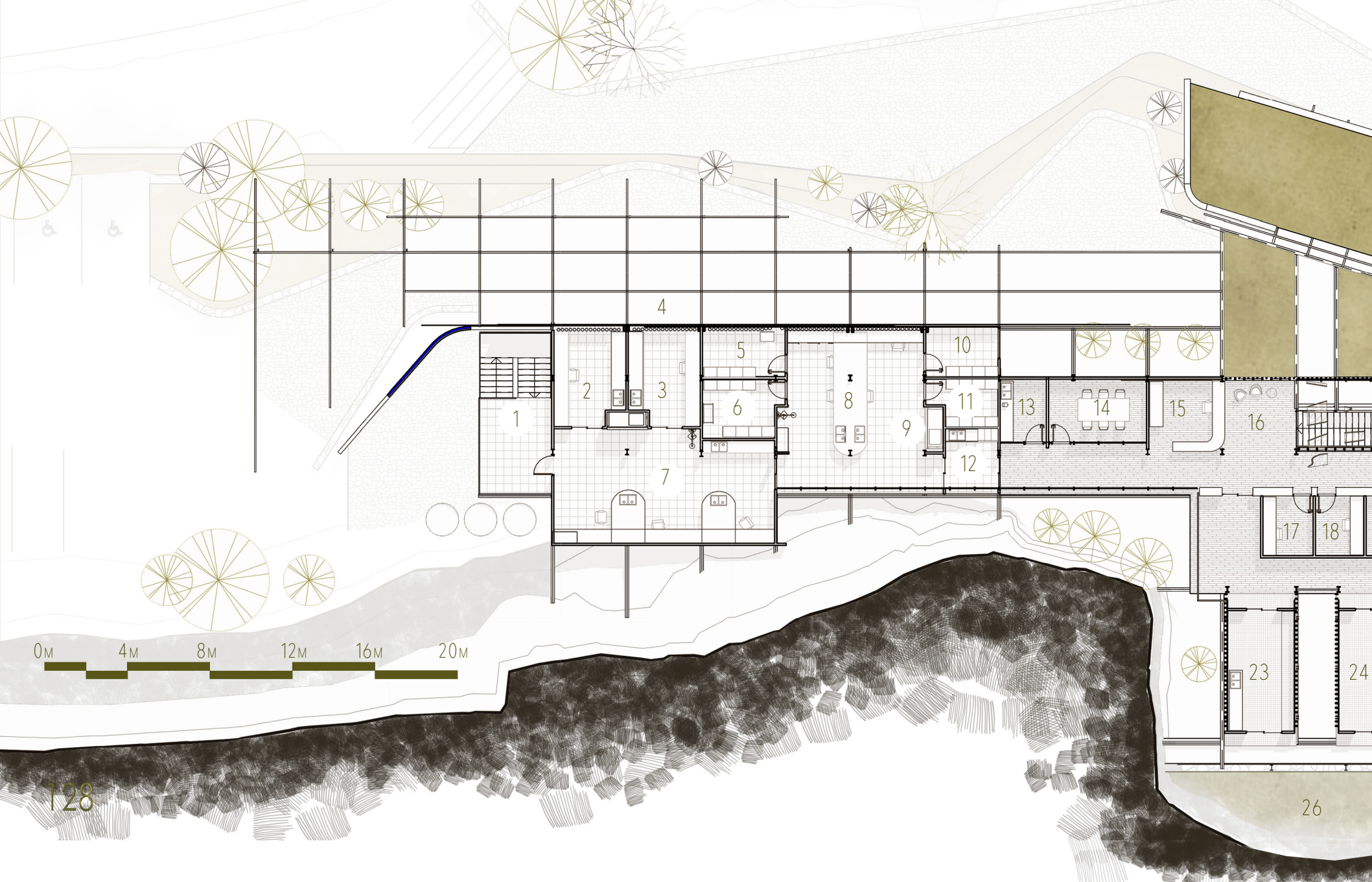
124 Scale 1:500

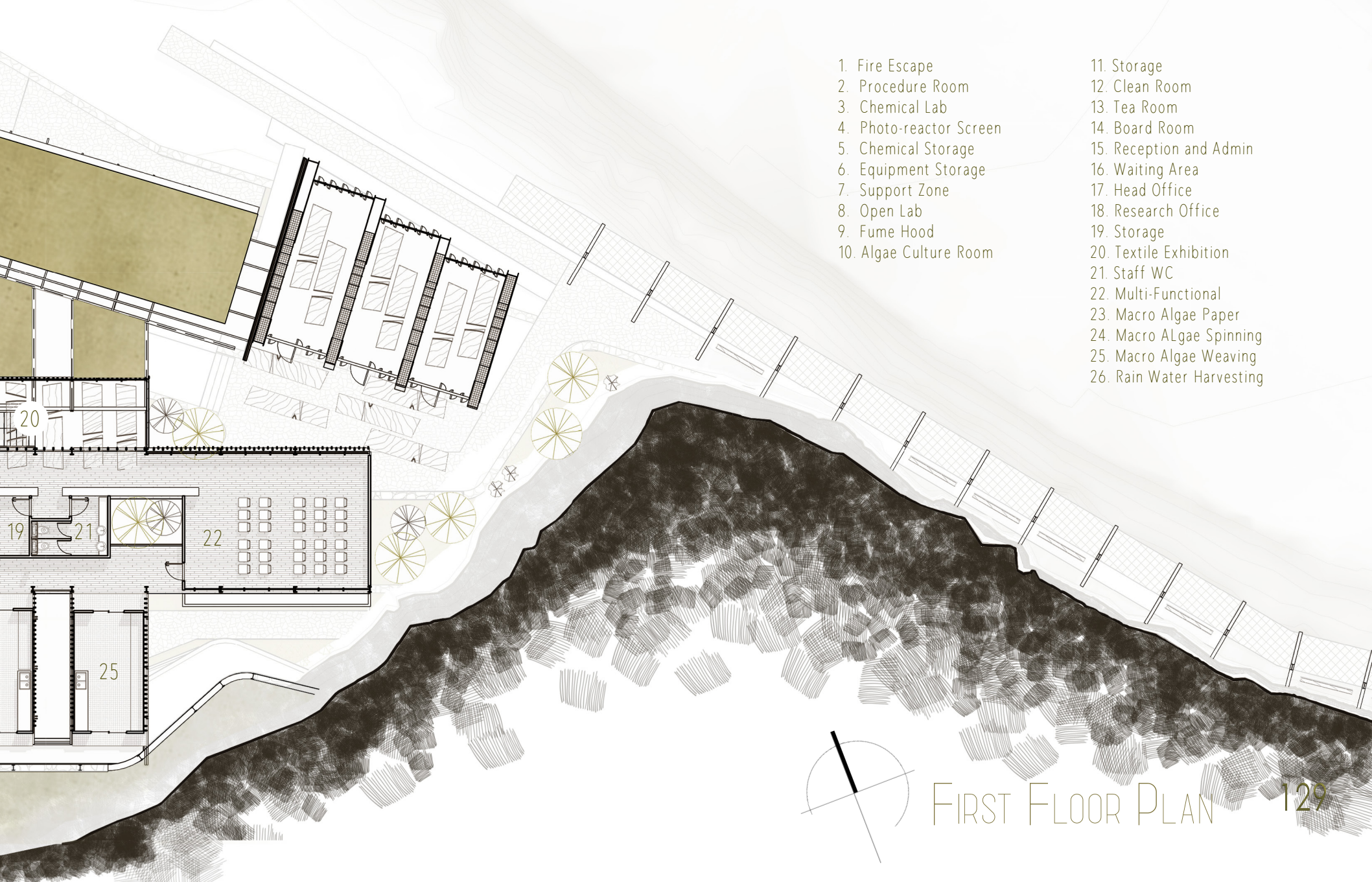

1. Informal Parking
2. Metsi A Me Programme
3. Vehicle Entrance
4. Staff Parking
5. Pedestrian Entrance
7. Existing Service Road
8. Research
9. Main Entrance
10. Interdiciplinary Design
11. Macro Algae Processing
12. Micro Algae Processing
13. Algae Harvesting Walkway
14. Spillway
15. Existing Service Walkway
16. Hartbeespoort Dam
10
12
13
14
15
16




# Ground Floor Plan

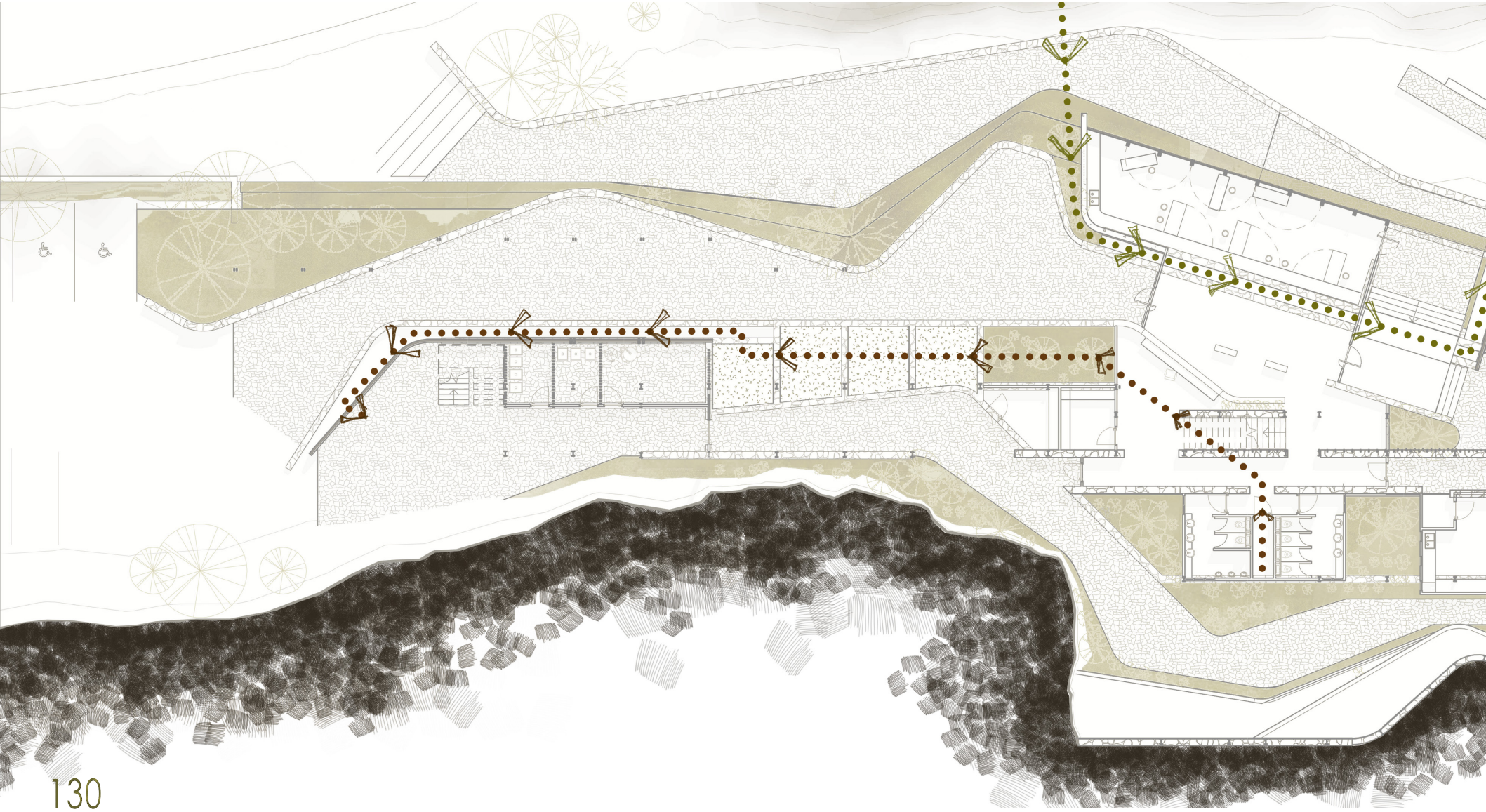

1. Service Yard
2. Chemical Waste
3. Refuse
4. Mechanical Room
5. Staff Entrance
6. Constructed Westland
7. Pedestrian Entrance
8. Clarifier
9. Open aerobic reactor
10. Closed aerobic reactor
11. Anoxic reactor
12. Service Walkway
13. Exterior Storage
14. Shop Storage
15. Reception
16. Shop
17. Exhibition
18. Interdiciplinary Design
19. Water Channel
20. Courtyard
21. Micro Algae Printing
22. Micro Algae 3D Printing
23. Micro Algae Bio-Plastic
24. Micro Algae Harvesting Walkway
25. Staff Room
26. Male WC
27. Female WC
28. Reflection Pond
19
20
21
22
23
24
20
24
27
25
28

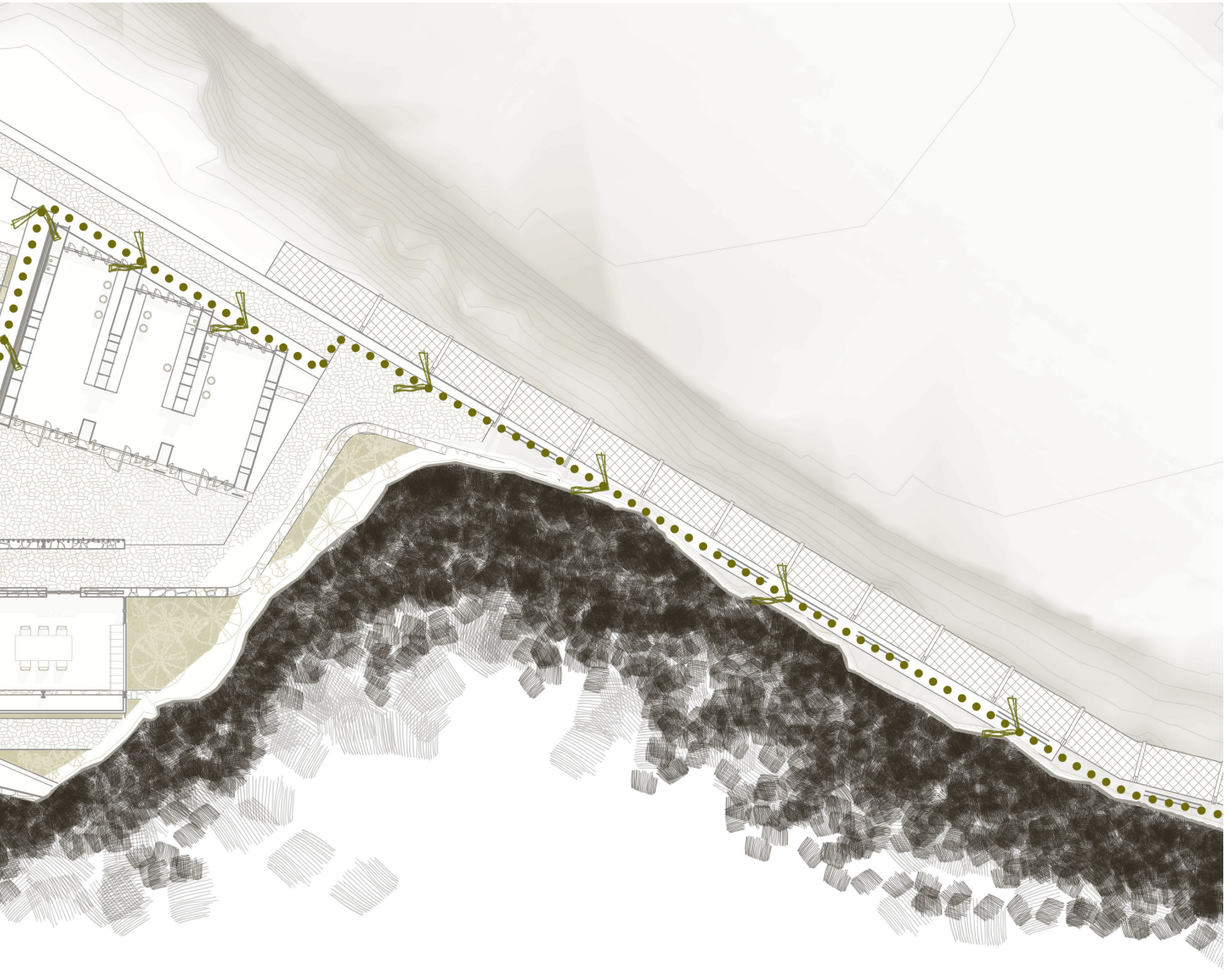

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
23
24
26
0м
4м
8м
12м
16м
20м




1. Fire Escape
2. Procedure Room
3. Chemical Lab
4. Photo-reactor Screen
5. Chemical Storage
6. Equipment Storage
7. Support Zone
8. Open Lab
9. Fume Hood
10. Algae Culture Room
11. Storage
12. Clean Room
13. Tea Room
14. Board Room
15. Reception and Admin
16. Waiting Area
17. Head Office
18. Research Office
19. Storage
20. Textile Exhibition
21. Staff WC
22. Multi-Functional
23. Macro Algae Paper
24. Macro ALgae Spinning
25. Macro Algae Weaving
26. Rain Water Harvesting

# First Floor Plan





# Water Diagram

The building acts as a living machine by using water from the dam to clean and rid the polluted water of nutrients like nitrogen and phosphorus.

Water is extracted from the Hartbeespoort Dam and pumped towards the building along the driveway across the dam.

The green line represents the water from the dam through reflection ponds within the building and towards the harvesting walkway on the cliff's edge. Here the algae biofilm is used to grow algae while also cleaning the water. The result is cleaner water that is returned to the Hartbeespoort Dam.

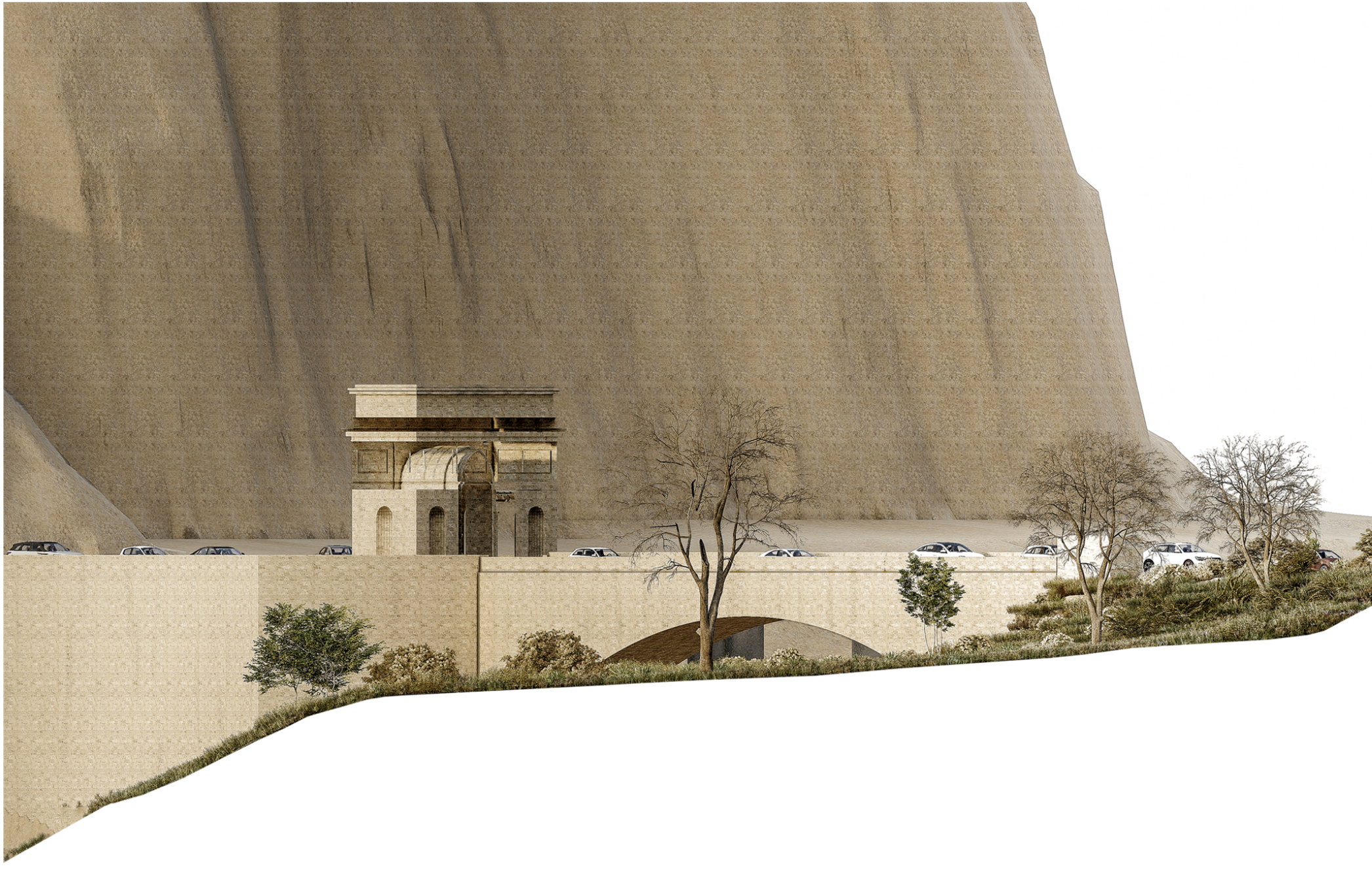
The brown line represents the cycling of water used within the building. The water is cleaned through a living machine (see technical chapter) and stored in tanks that supply the building with water, including harvested rainwater.



# North East Elevation

NORTH EAST ELEVATION
SCALE 1:100








# North West Elevation

# 4.1.2.1 Algae Research

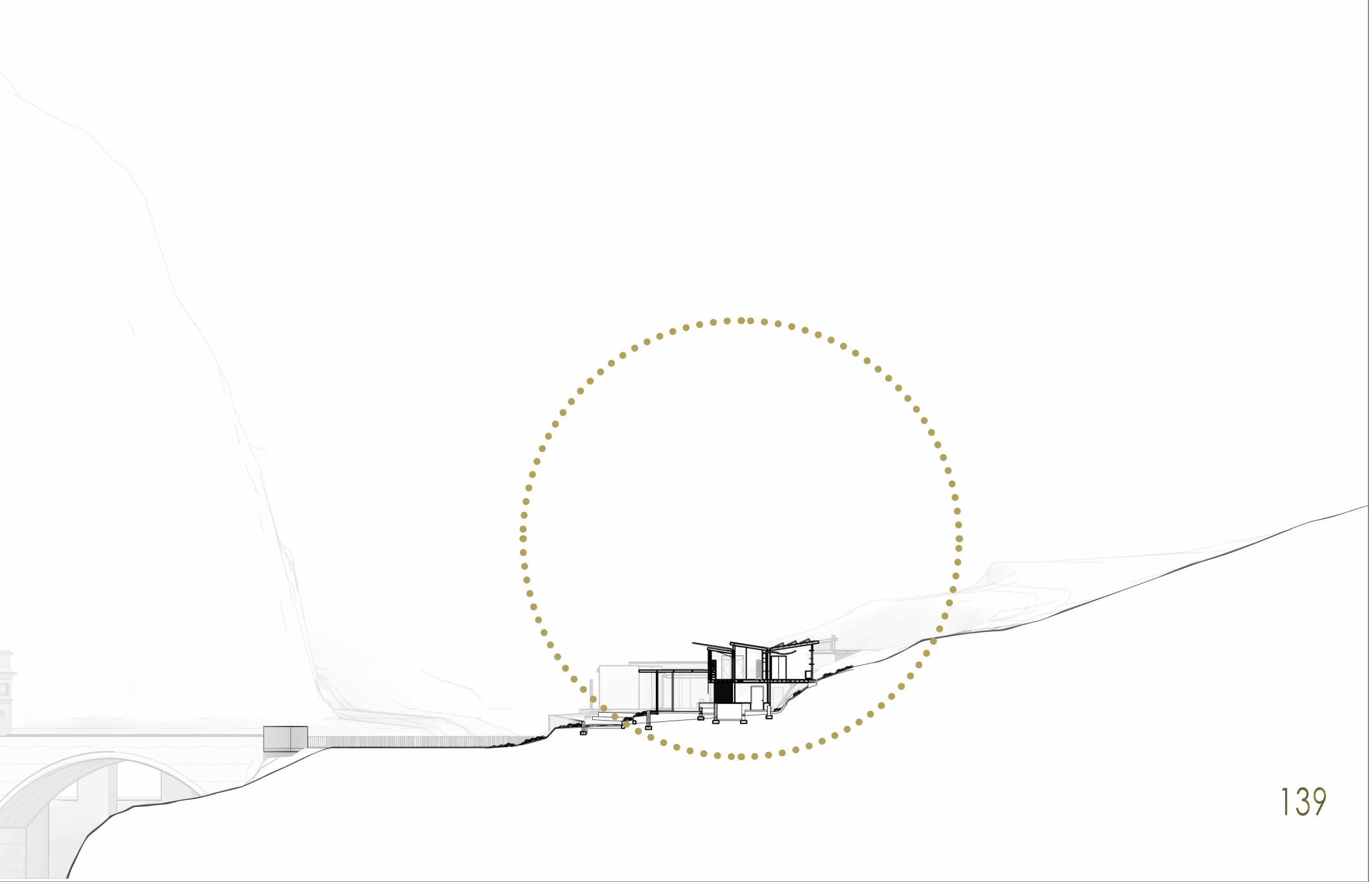
Fig. 4.35 Interior render of research laboratory
(Author, 2021: photograph).

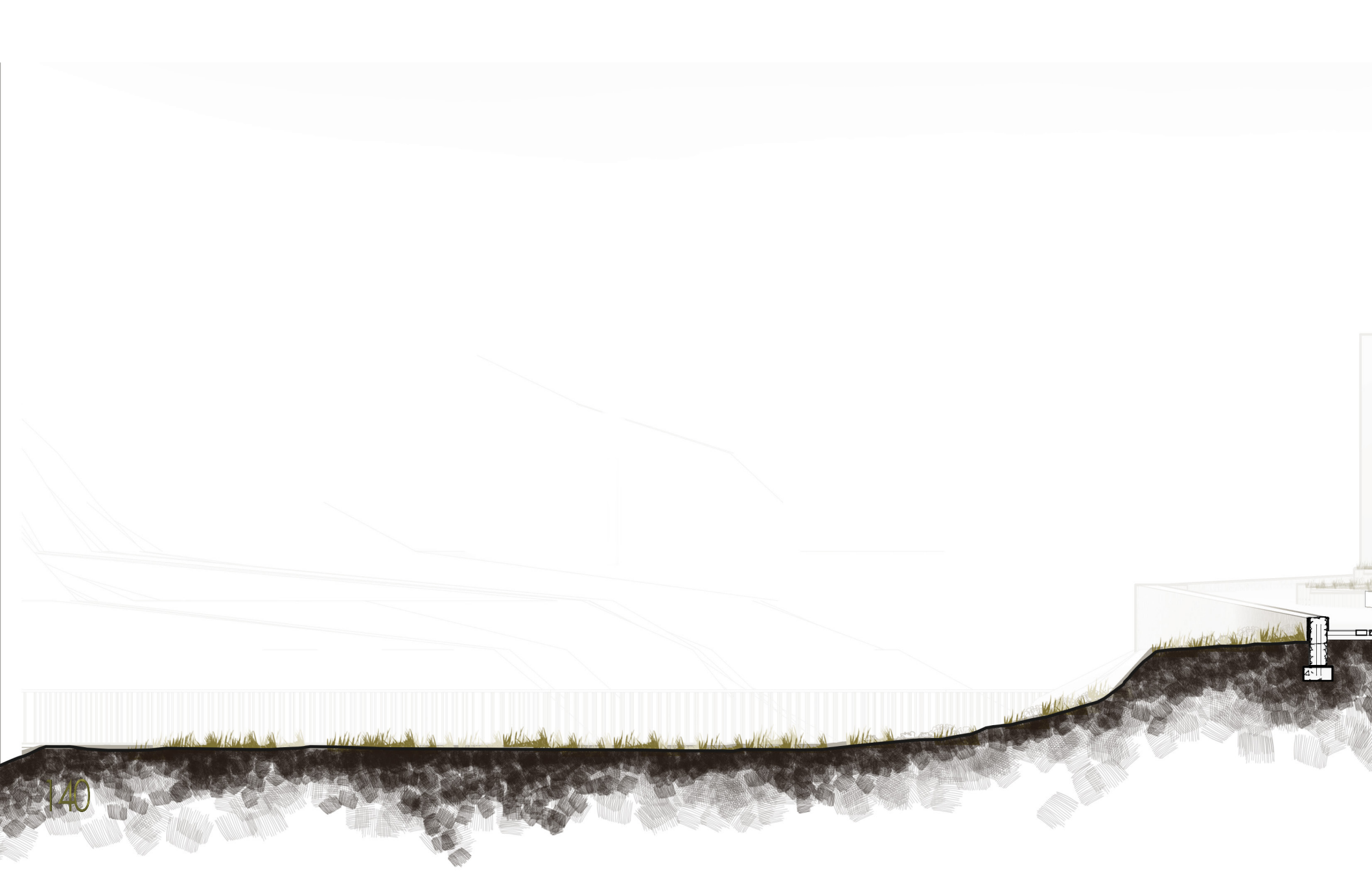


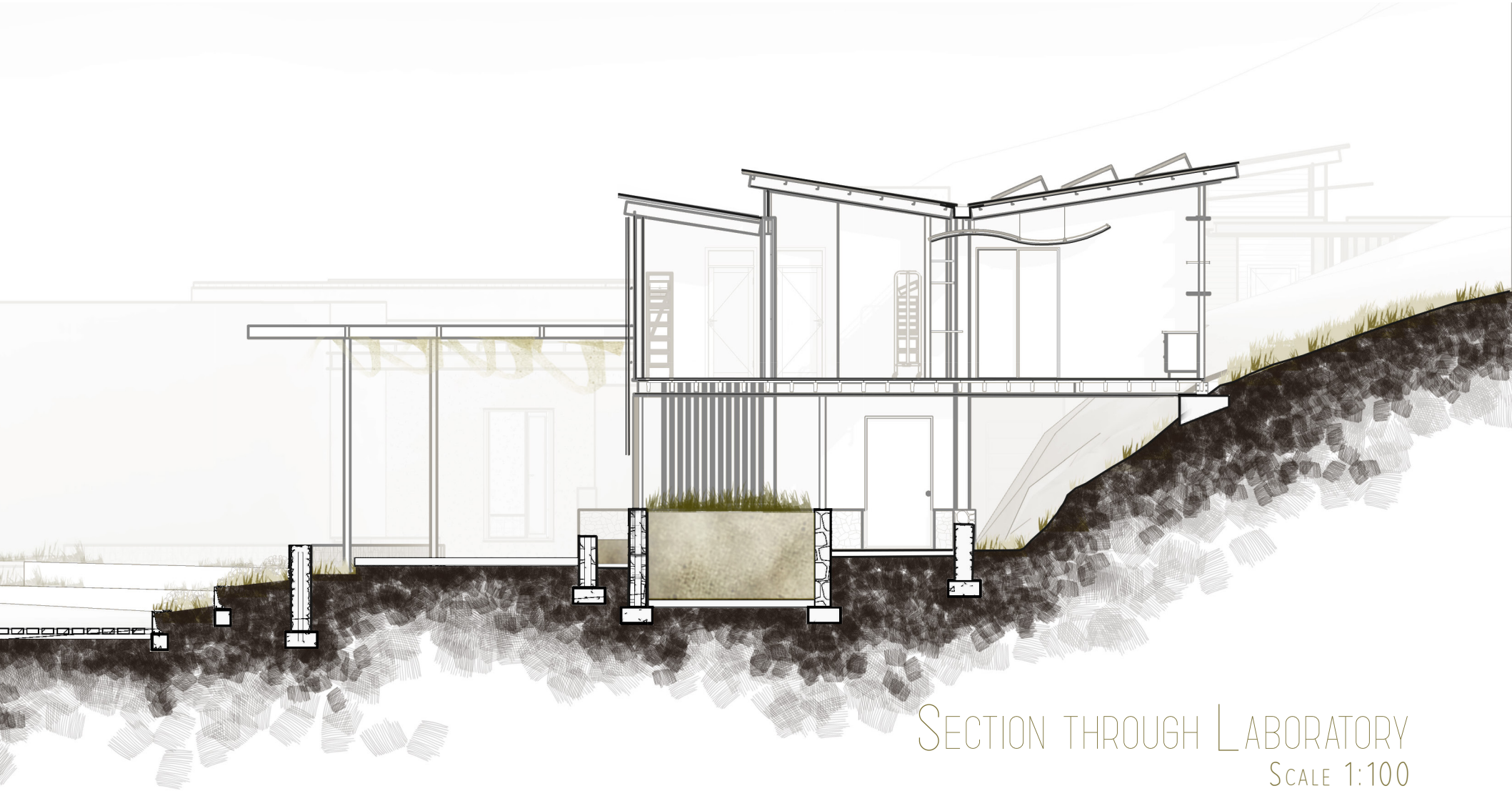


# Research Site Section

Scale 1:1000







# Section through Laboratory

Scale 1:100

# 4.1.2.2 Algae Based Design

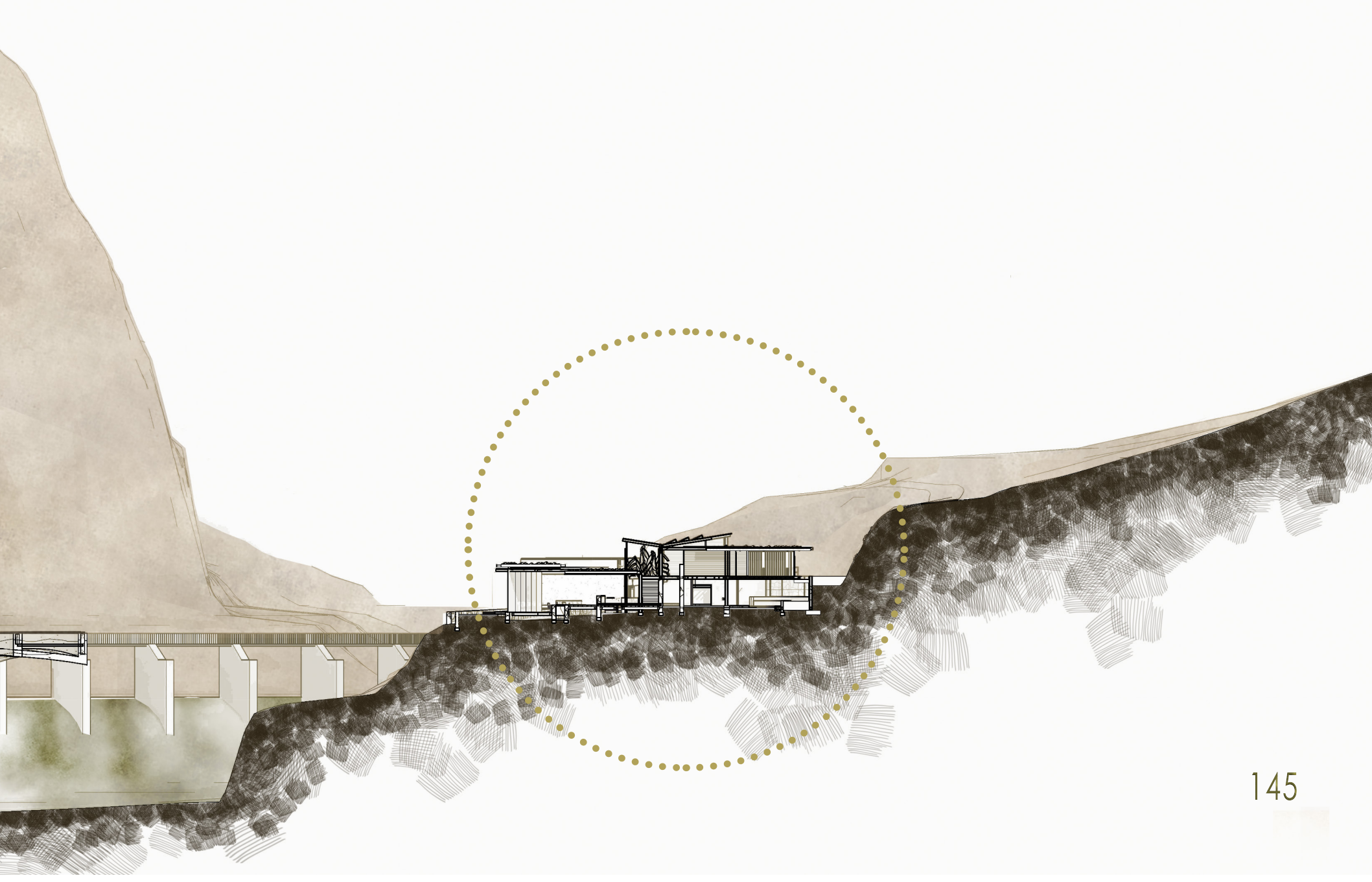
Fig. 4.35 Interior render of design studio
(Author, 2021: photograph).


Design museum Gent
History and collections
Historiek en collecties

# Design Site Section

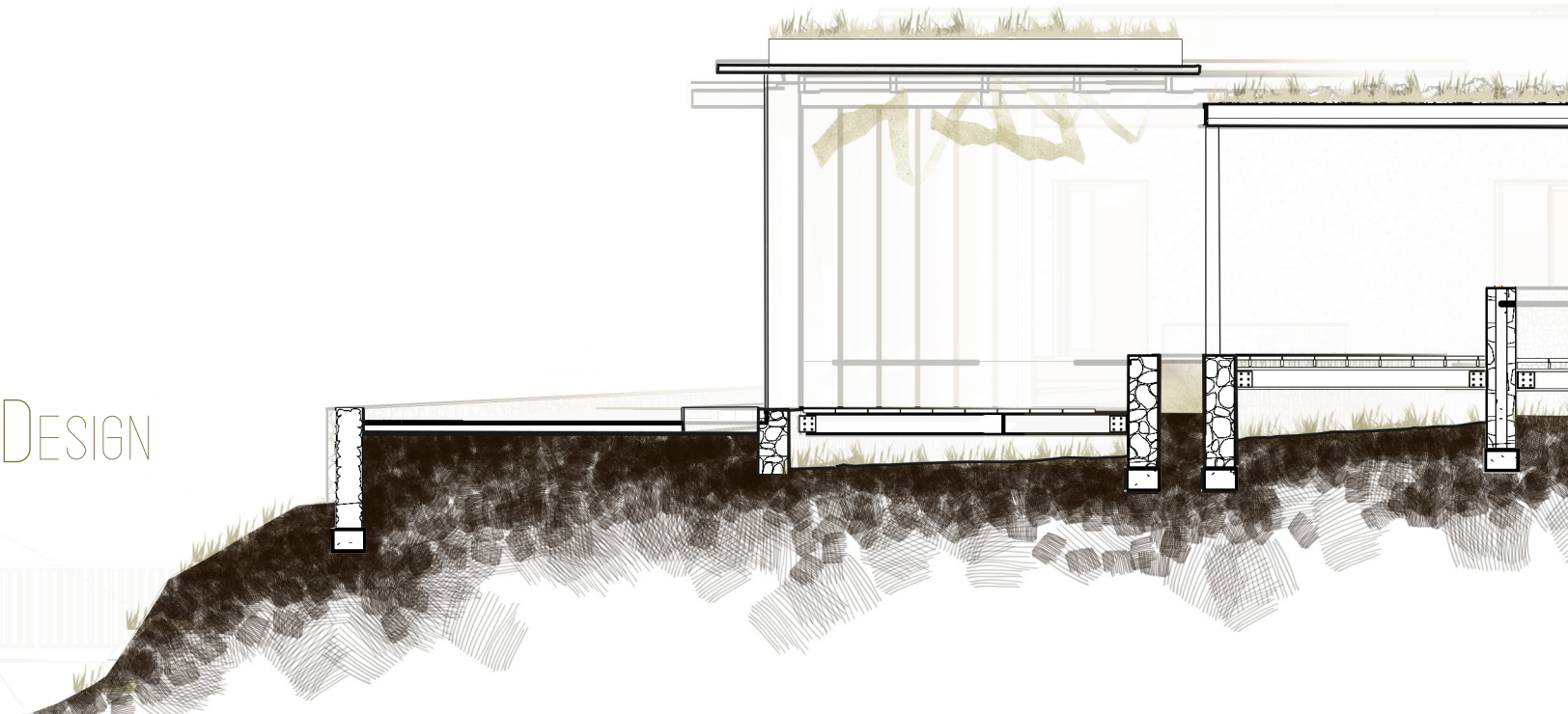
Scale 1:1000

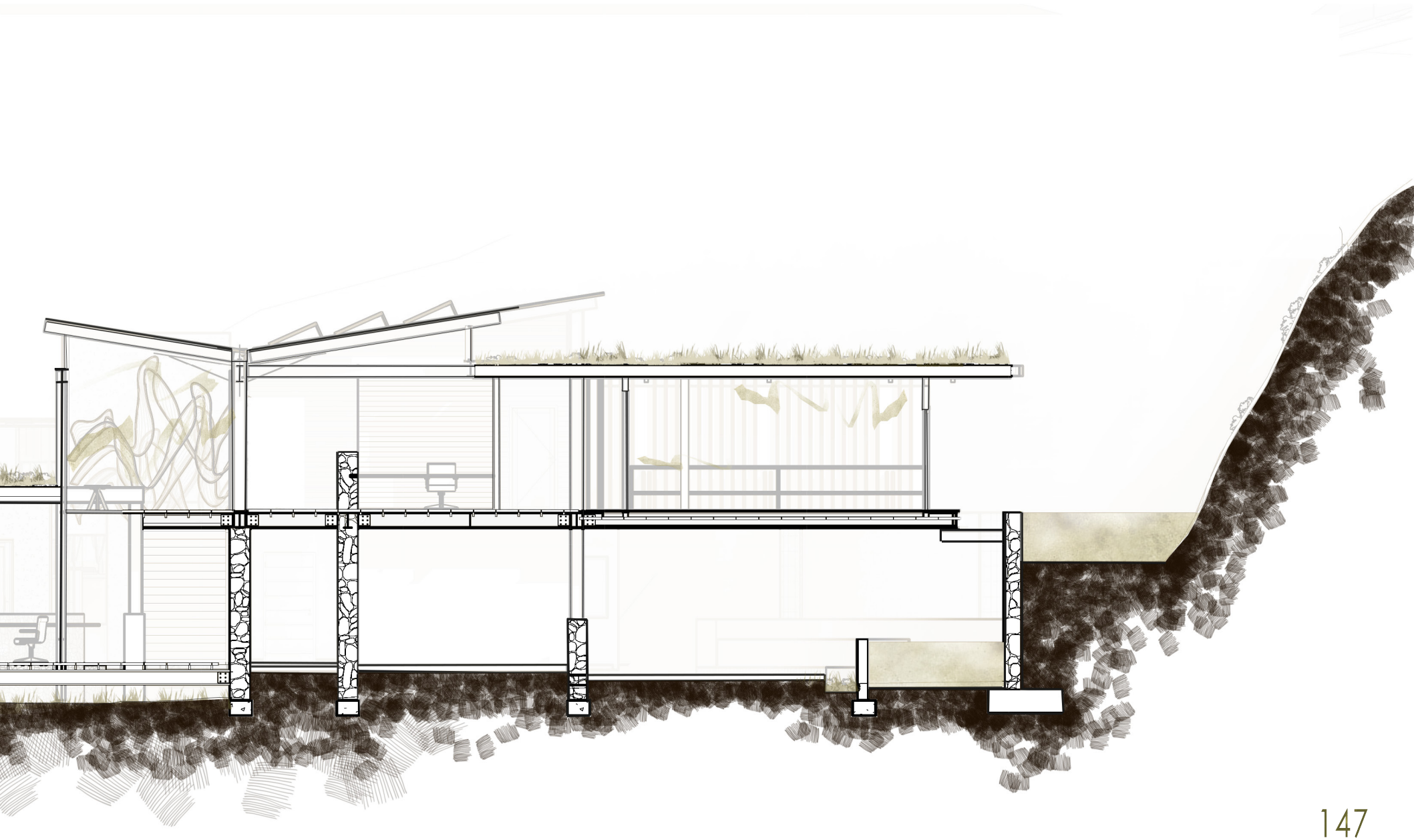




# Section through Design and Macro Algae

Scale 1:100

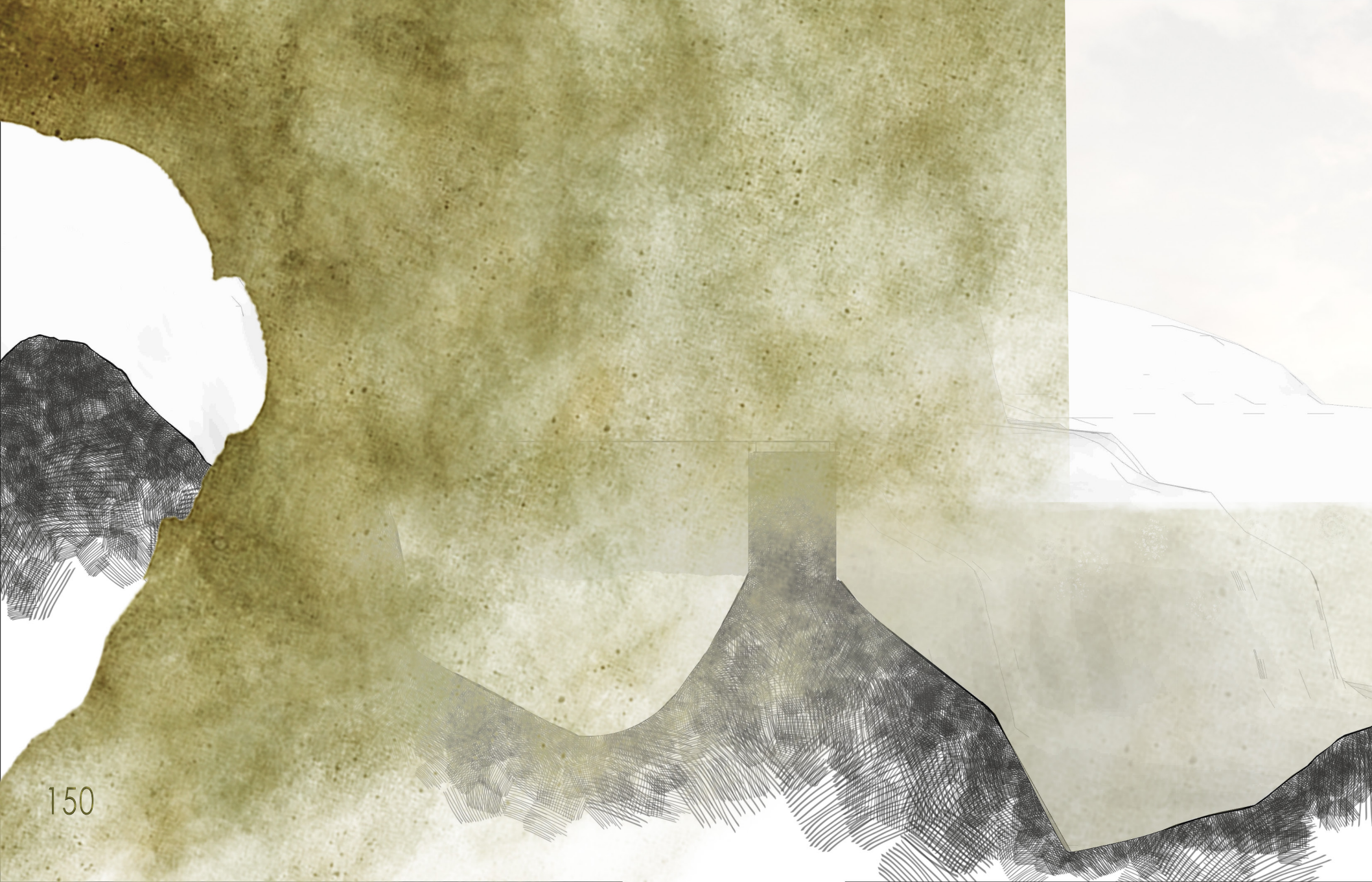


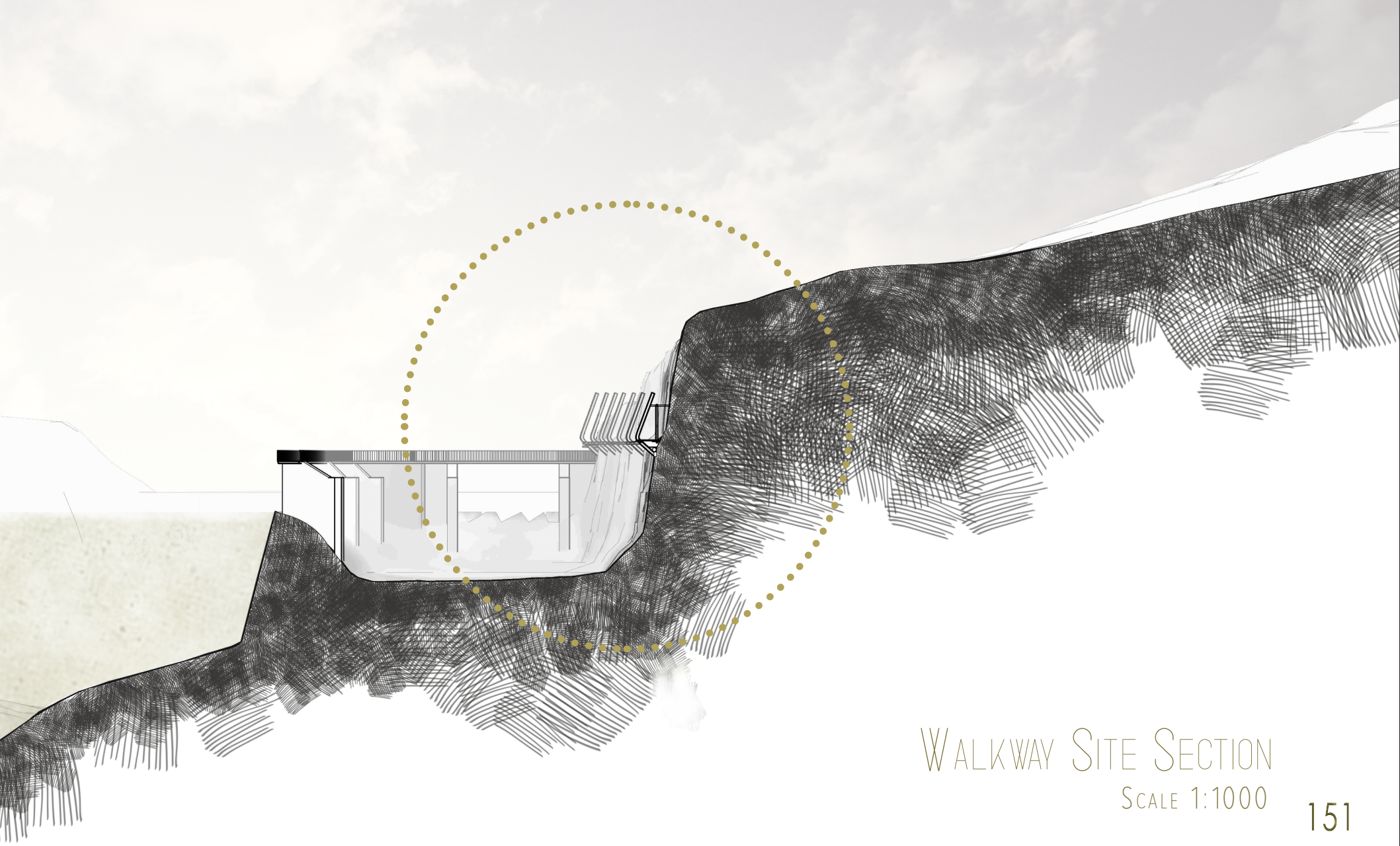


# 4.1.2.3 Algae Based Manufacturing

Fig. 4.35 Interior render of macro algae studio
(Author, 2021: photograph).

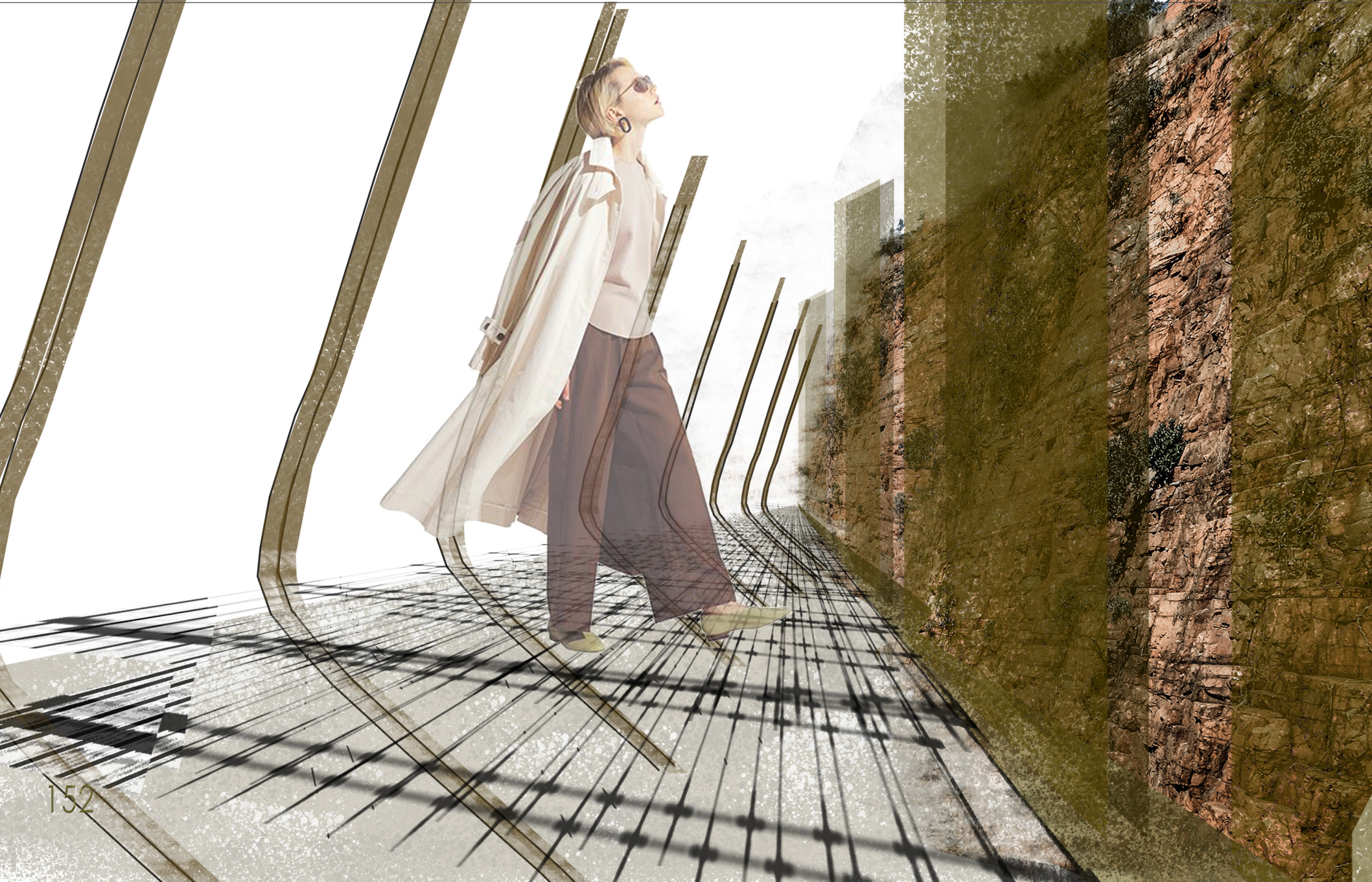






# Walkway Site Section

Scale 1:1000





# Micro Algae Harvesting Walkway

Scale 1:100

# 4.2 Technical Exploration

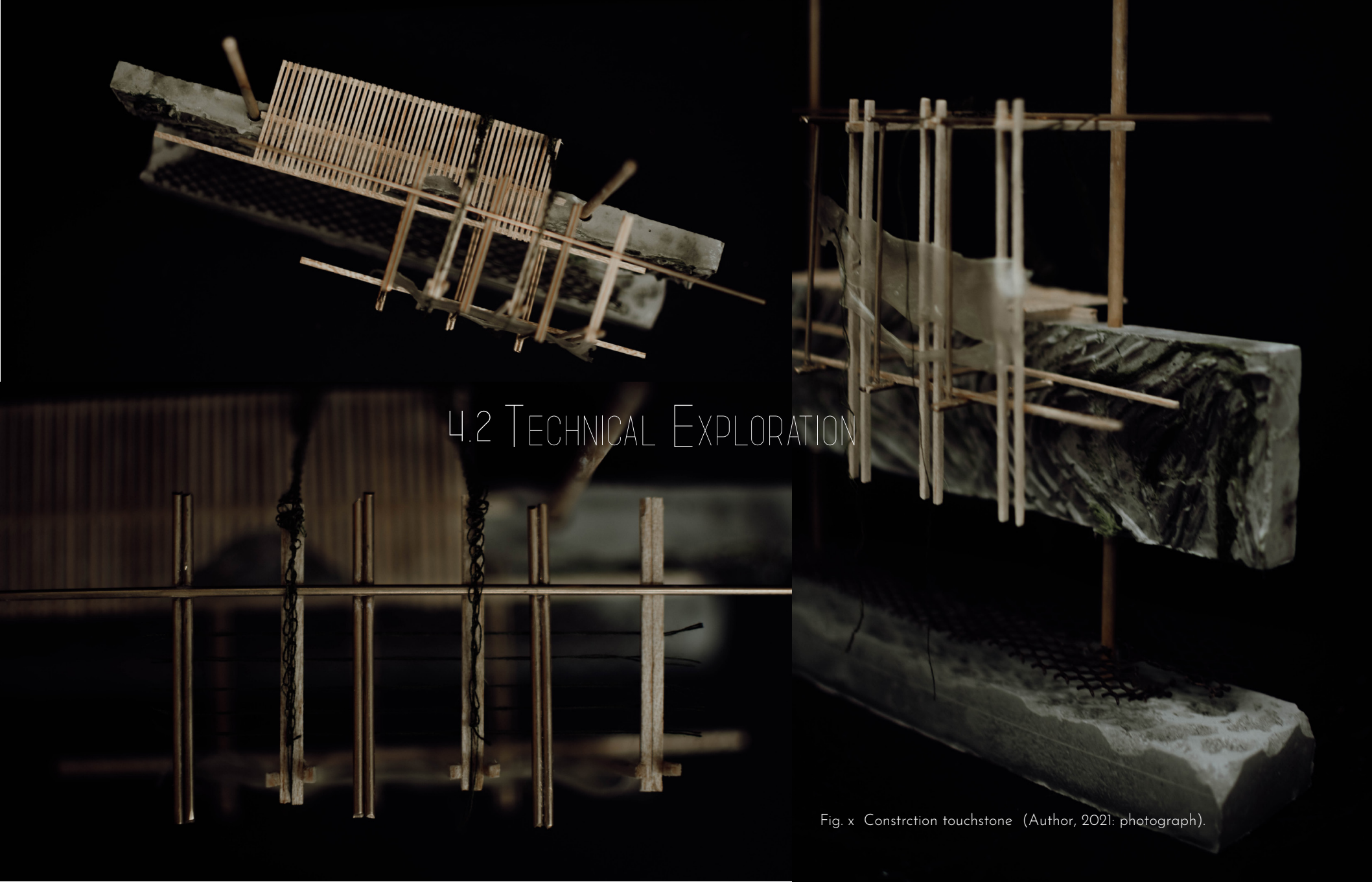


Fig. x  Constrction touchstone  (Author, 2021: photograph).

The construction touchstone investigated the ideas of ephemeral architecture by experimenting with algae(crete) and how incorporating algae into the building will allow for a more integrated architecture.

The touchstone also explored the idea of using massing walls on the site that will (hold) the rest of the building - making it easier for the building to be deconstructed and leaving only a trace of its existence on the site.

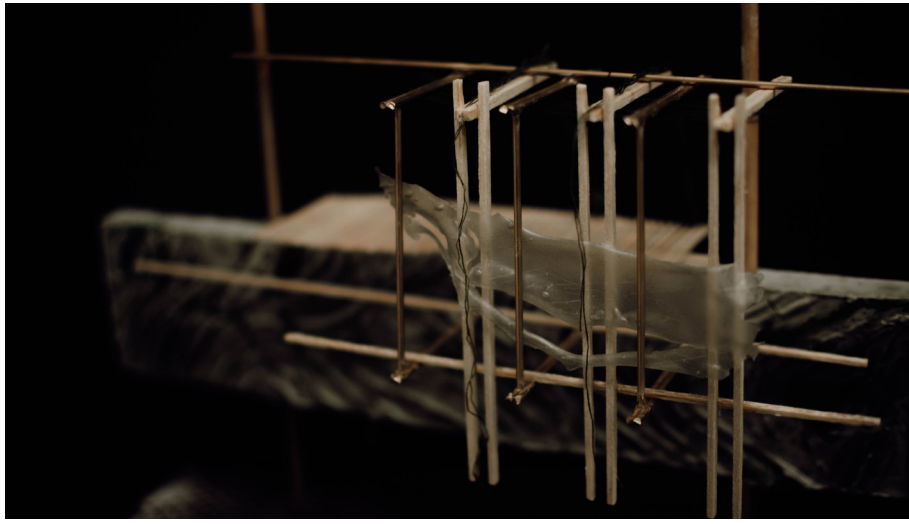
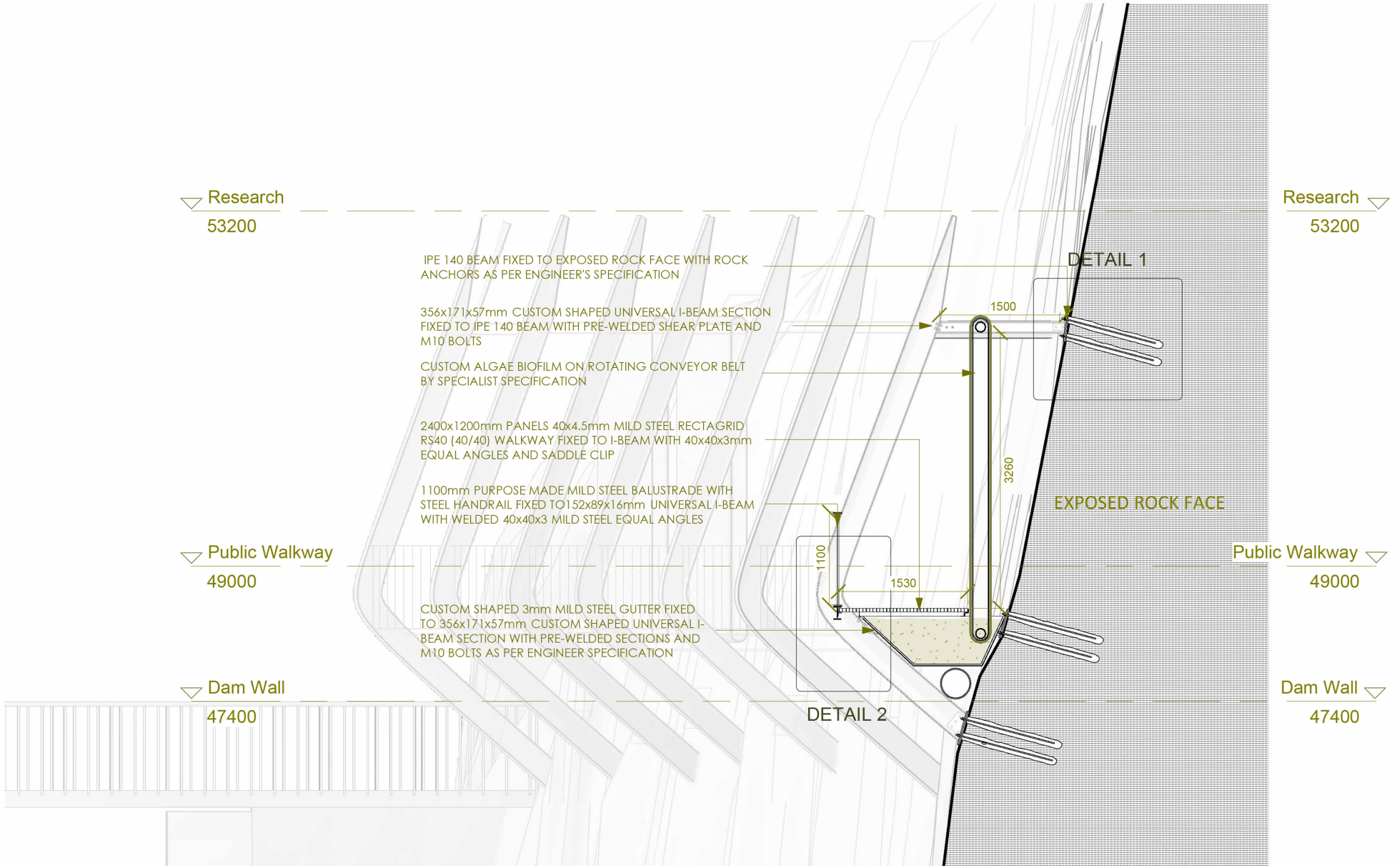


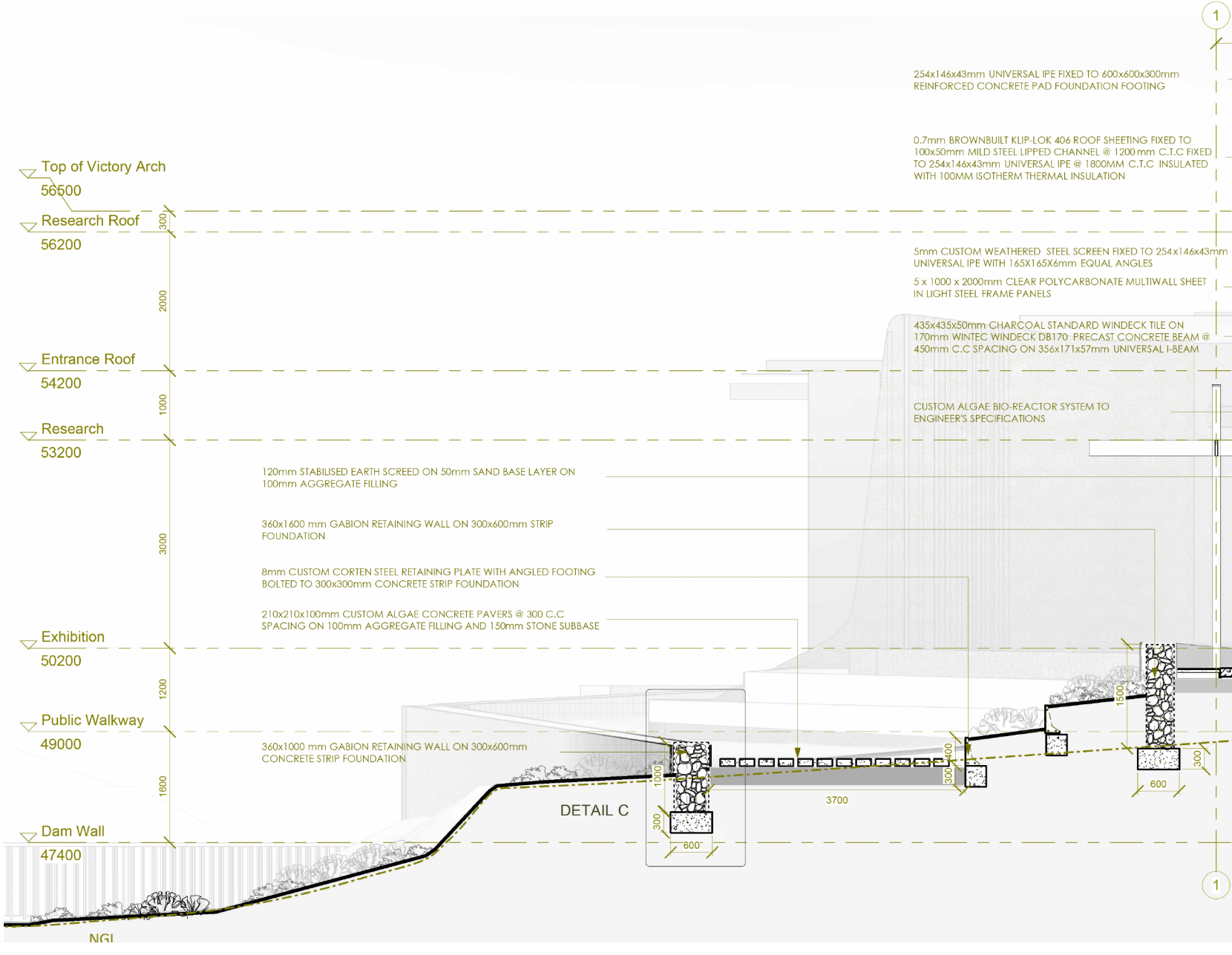


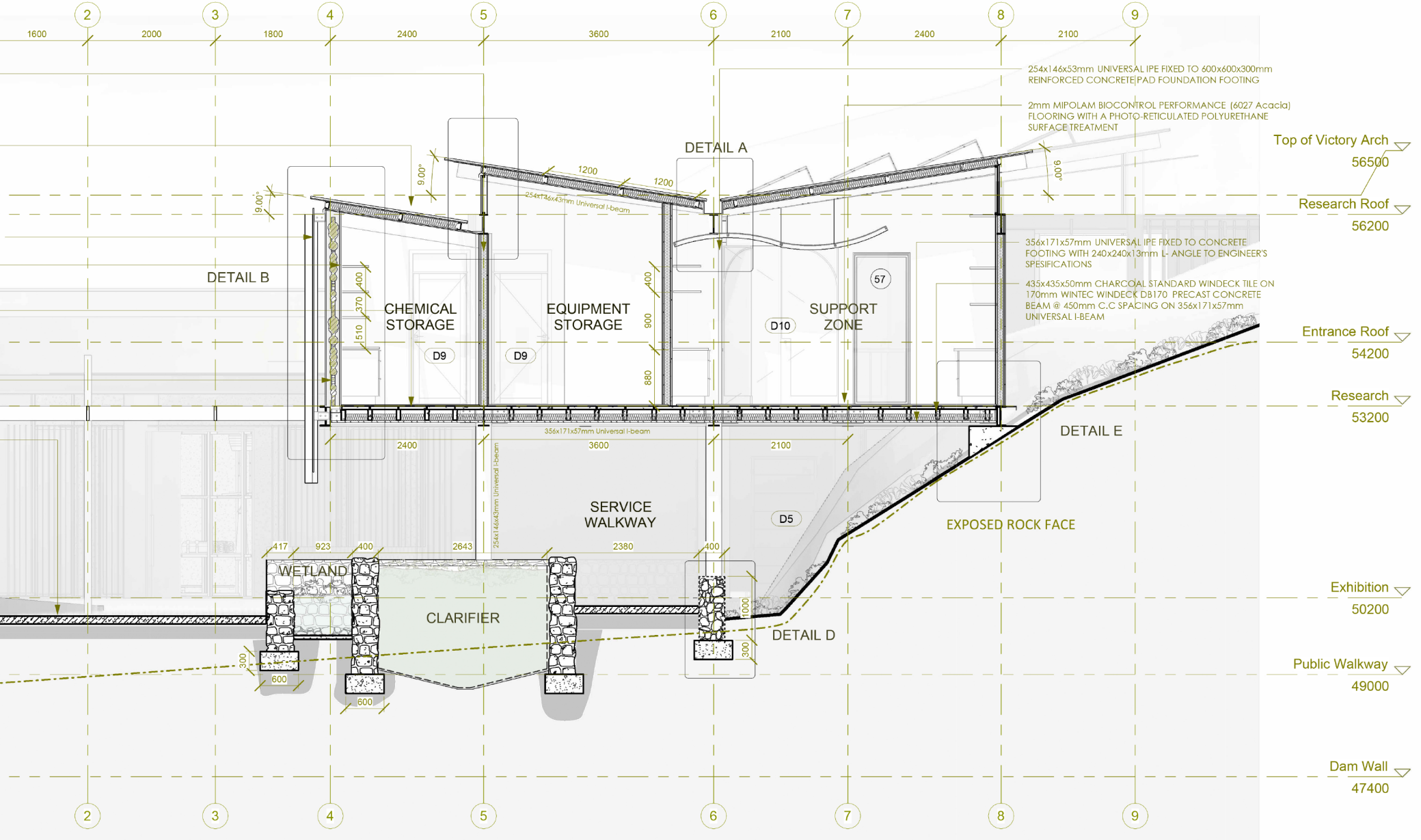
Fig. x  Constrction touchstone  (Author, 2021: photograph).

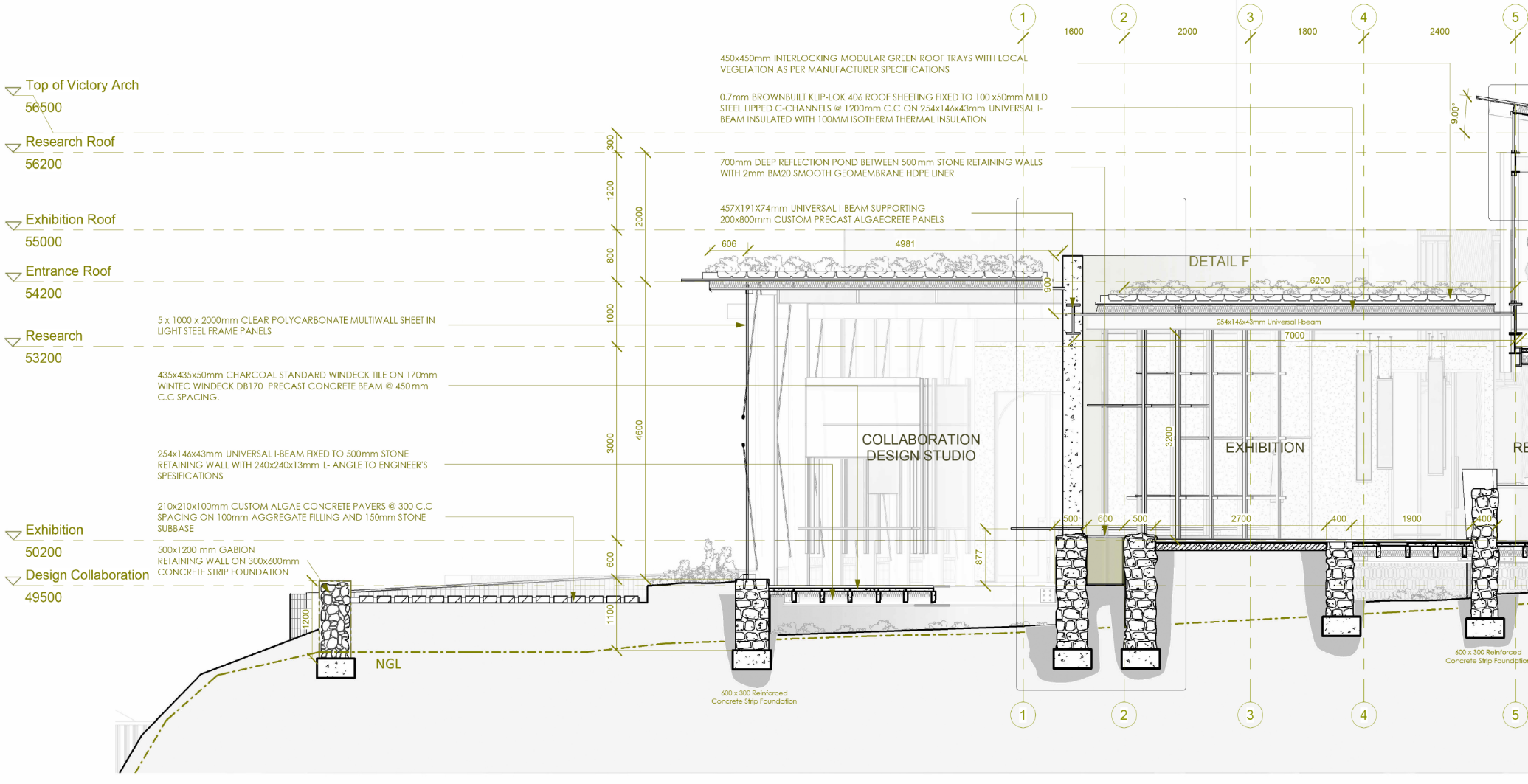


# Structure

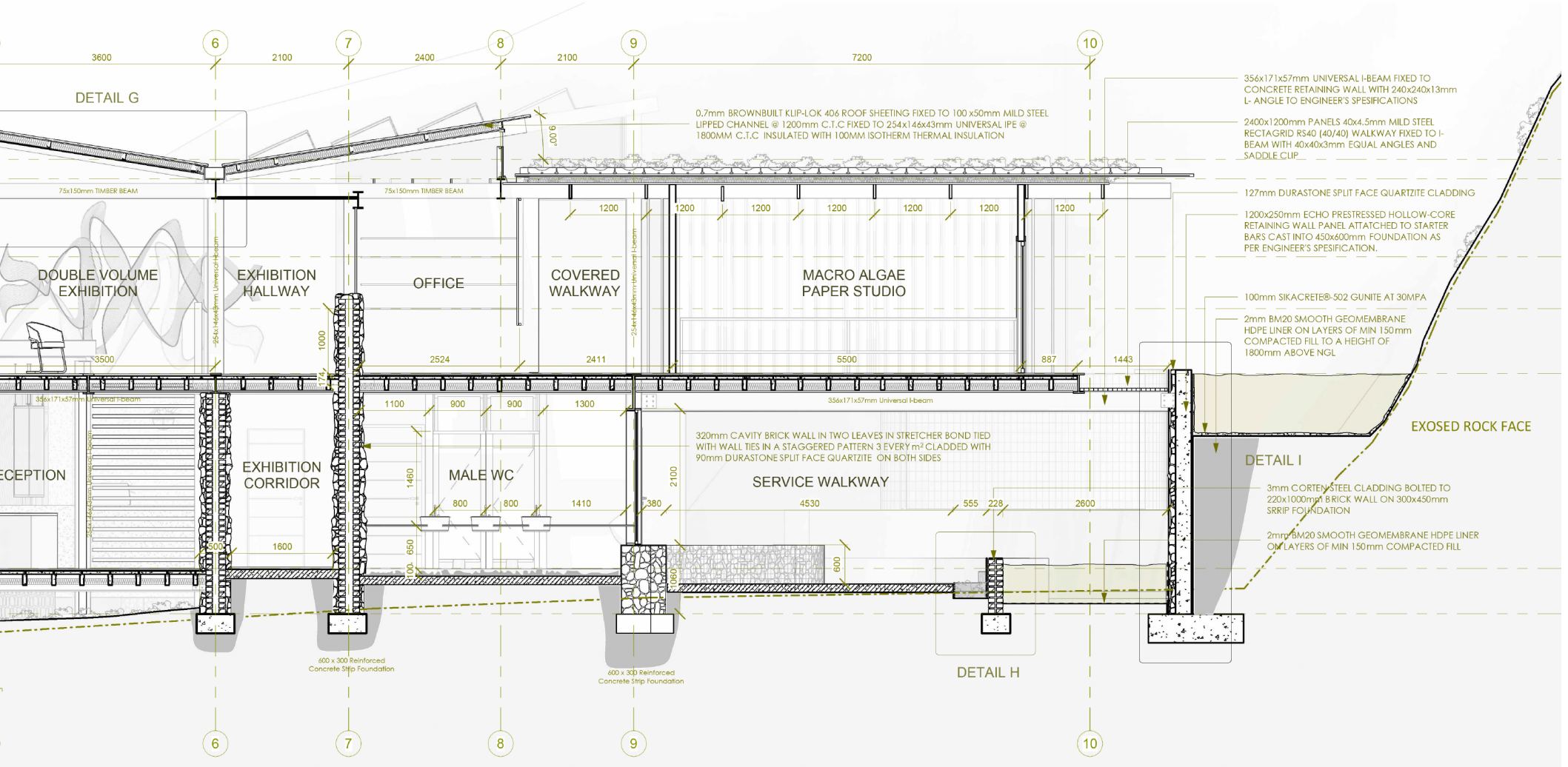

Research
53200
Public Walkway
49000
Dam Wall
47400
IPE 140 BEAM FIXED TO EXPOSED ROCK FACE WITH ROCK ANCHORS AS PER ENGINEER'S SPECIFICATION
356x171x57mm CUSTOM SHAPED UNIVERSAL I-BEAM SECTION FIXED TO IPE 140 BEAM WITH PRE-WELDED SHEAR PLATE AND M10 BOLTS
CUSTOM ALGAE BIOFILM ON ROTATING CONVEYOR BELT BY SPECIALIST SPECIFICATION
2400x1200mm PANELS 40x4.5mm MILD STEEL RECTAGRID RS40 (40/40) WALKWAY FIXED TO I-BEAM WITH 40x40x3mm EQUAL ANGLES AND SADDLE CLIP
1100mm PURPOSE MADE MILD STEEL BALUSTRADE WITH STEEL HANDRAIL FIXED TO152x89x16mm UNIVERSAL I-BEAM WITH WELDED 40x40x3 MILD STEEL EQUAL ANGLES
CUSTOM SHAPED 3mm MILD STEEL GUTTER FIXED TO 356x171x57mm CUSTOM SHAPED UNIVERSAL I-BEAM SECTION WITH PRE-WELDED SECTIONS AND M10 BOLTS AS PER ENGINEER SPECIFICATION
DETAIL 1
DETAIL 2
1500
3260
1100
1530
EXPOSED ROCK FACE
Research
53200
Public Walkway
49000
Dam Wall
47400


Top of Victory Arch
56500
Research Roof
56200
Entrance Roof
54200
Research
53200
Exhibition
50200
Public Walkway
49000
Dam Wall
47400
NGL
300
2000
1000
3000
1200
1600
254x146x43mm UNIVERSAL IPE FIXED TO 600x600x300mm REINFORCED CONCRETE PAD FOUNDATION FOOTING
0.7mm BROWNBUILT KLIP-LOK 406 ROOF SHEETING FIXED TO 100x50mm MILD STEEL LIPPED CHANNEL @ 1200mm C.T.C FIXED TO 254x146x43mm UNIVERSAL IPE @ 1800MM C.T.C INSULATED WITH 100MM ISOTHERM THERMAL INSULATION
5mm CUSTOM WEATHERED STEEL SCREEN FIXED TO 254x146x43mm UNIVERSAL IPE WITH 165X165X6mm EQUAL ANGLES
5 x 1000 x 2000mm CLEAR POLYCARBONATE MULTIWALL SHEET IN LIGHT STEEL FRAME PANELS
435x435x50mm CHARCOAL STANDARD WINDECK TILE ON 170mm WINTEC WINDECK DB170 PRECAST CONCRETE BEAM @ 450mm C.C SPACING ON 356x171x57mm UNIVERSAL I-BEAM
CUSTOM ALGAE BIO-REACTOR SYSTEM TO ENGINEER'S SPECIFICATIONS
120mm STABILISED EARTH SCREED ON 50mm SAND BASE LAYER ON 100mm AGGREGATE FILLING
360x1600 mm GABION RETAINING WALL ON 300x600mm STRIP FOUNDATION
8mm CUSTOM CORTEN STEEL RETAINING PLATE WITH ANGLED FOOTING BOLTED TO 300x300mm CONCRETE STRIP FOUNDATION
210x210x100mm CUSTOM ALGAE CONCRETE PAVERS @ 300 C.C SPACING ON 100mm AGGREGATE FILLING AND 150mm STONE SUBBASE
360x1000 mm GABION RETAINING WALL ON 300x600mm CONCRETE STRIP FOUNDATION
DETAIL C
1000
300
600
3700
300
1000
1500
300
600
1
1


2
3
4
5
6
7
8
9
1600
2000
1800
2400
3600
2100
2400
2100
254x146x53mm UNIVERSAL IPE FIXED TO 600x600x300mm REINFORCED CONCRETE PAD FOUNDATION FOOTING
2mm MIPOLAM BIOCONTROL PERFORMANCE (6027 Acacia) FLOORING WITH A PHOTO-RETICULATED POLYURETHANE SURFACE TREATMENT
Top of Victory Arch
56500
Research Roof
56200
Entrance Roof
54200
Research
53200
Exhibition
50200
Public Walkway
49000
Dam Wall
47400
DETAIL A
DETAIL B
DETAIL D
DETAIL E
9.00°
1200
254x146x43mm Universal I-beam
356x171x57mm UNIVERSAL IPE FIXED TO CONCRETE FOOTING WITH 240x240x13mm L- ANGLE TO ENGINEER'S SPESIFICATIONS
435x435x50mm CHARCOAL STANDARD WINDECK TILE ON 170mm WINTEC WINDECK D8170 PRECAST CONCRETE BEAM @ 450mm C.C SPACING ON 356x171x57mm UNIVERSAL I-BEAM
CHEMICAL STORAGE
EQUIPMENT STORAGE
SUPPORT ZONE
SERVICE WALKWAY
D9
D9
D10
D5
57
400
370
510
900
880
356x171x57mm Universal I-beam
254x146x43mm Universal I-beam
2400
3600
2100
EXPOSED ROCK FACE
417
923
400
2643
2380
400
WETLAND
CLARIFIER
1000
300
300
600
600



Top of Victory Arch
56500
Research Roof
56200
Exhibition Roof
55000
Entrance Roof
54200
Research
53200
Exhibition
50200
Design Collaboration
49500
450x450mm INTERLOCKING MODULAR GREEN ROOF TRAYS WITH LOCAL VEGETATION AS PER MANUFACTURER SPECIFICATIONS
0.7mm BROWNBUILT KLIP-LOK 406 ROOF SHEETING FIXED TO 100 x50mm MILD STEEL LIPPED C-CHANNELS @ 1200mm C.C ON 254x146x43mm UNIVERSAL I-BEAM INSULATED WITH 100MM ISOTHERM THERMAL INSULATION
700mm DEEP REFLECTION POND BETWEEN 500 mm STONE RETAINING WALLS WITH 2mm BM20 SMOOTH GEOMEMBRANE HDPE LINER
457X191X74mm UNIVERSAL I-BEAM SUPPORTING 200x800mm CUSTOM PRECAST ALGAECRETE PANELS
5 x 1000 x 2000mm CLEAR POLYCARBONATE MULTIWALL SHEET IN LIGHT STEEL FRAME PANELS
435x435x50mm CHARCOAL STANDARD WINDECK TILE ON 170mm WINTEC WINDECK DB170 PRECAST CONCRETE BEAM @ 450 mm C.C SPACING.
254x146x43mm UNIVERSAL I-BEAM FIXED TO 500mm STONE RETAINING WALL WITH 240x240x13mm L- ANGLE TO ENGINEER'S SPESIFICATIONS
210x210x100mm CUSTOM ALGAE CONCRETE PAVERS @ 300 C.C SPACING ON 100mm AGGREGATE FILLING AND 150mm STONE SUBBASE
500x1200 mm GABION RETAINING WALL ON 300x600mm CONCRETE STRIP FOUNDATION
DETAIL F
254x146x43mm Universal I-beam
COLLABORATION DESIGN STUDIO
EXHIBITION
NGL
600 x 300 Reinforced Concrete Strip Foundation
1600
2000
1800
2400
606
4981
6200
7000
3200
2700
1900
877


DETAIL G
6
7
8
9
10
3600
2100
2400
2100
7200
0.7mm BROWNBUILT KLIP-LOK 406 ROOF SHEETING FIXED TO 100 x50mm MILD STEEL LIPPED CHANNEL @ 1200mm C.T.C FIXED TO 254x146x43mm UNIVERSAL IPE @ 1800MM C.T.C INSULATED WITH 100MM ISOTHERM THERMAL INSULATION
9.00°
75x150mm TIMBER BEAM
75x150mm TIMBER BEAM
DOUBLE VOLUME EXHIBITION
EXHIBITION HALLWAY
OFFICE
COVERED WALKWAY
MACRO ALGAE PAPER STUDIO
1200
1200
1200
1200
1200
1200
1200
254x146x43mm Universal I-beam
254x146x43mm Universal I-beam
1000
3500
2524
2411
5500
887
1443
356x171x57mm Universal I-beam
356x171x57mm Universal I-beam
1100
900
900
1300
320mm CAVITY BRICK WALL IN TWO LEAVES IN STRETCHER BOND TIED WITH WALL TIES IN A STAGGERED PATTERN 3 EVERY m² CLADDED WITH 90mm DURASTONE SPLIT FACE QUARTZITE ON BOTH SIDES
ECEPTION
EXHIBITION CORRIDOR
MALE WC
SERVICE WALKWAY
1460
2100
800
800
1410
380
4530
555
228
2600
1600
650
600
1060
600 x 300 Reinforced Concrete Strip Foundation
600 x 300 Reinforced Concrete Strip Foundation
DETAIL H
356x171x57mm UNIVERSAL I-BEAM FIXED TO CONCRETE RETAINING WALL WITH 240x240x13mm L- ANGLE TO ENGINEER'S SPESIFICATIONS
2400x1200mm PANELS 40x4.5mm MILD STEEL RECTAGRID RS40 (40/40) WALKWAY FIXED TO I-BEAM WITH 40x40x3mm EQUAL ANGLES AND SADDLE CLIP
127mm DURASTONE SPLIT FACE QUARTZITE CLADDING
1200x250mm ECHO PRESTRESSED HOLLOW-CORE RETAINING WALL PANEL ATTATCHED TO STARTER BARS CAST INTO 450x600mm FOUNDATION AS PER ENGINEER'S SPESIFICATION.
100mm SIKACRETE®-502 GUNITE AT 30MPA
2mm BM20 SMOOTH GEOMEMBRANE HDPE LINER ON LAYERS OF MIN 150mm COMPACTED FILL TO A HEIGHT OF 1800mm ABOVE NGL
EXOSED ROCK FACE
DETAIL I
3mm CORTEN STEEL CLADDING BOLTED TO 220x1000mm BRICK WALL ON 300x450mm SRRIP FOUNDATION
2mm BM20 SMOOTH GEOMEMBRANE HDPE LINER ON LAYERS OF MIN 150mm COMPACTED FILL

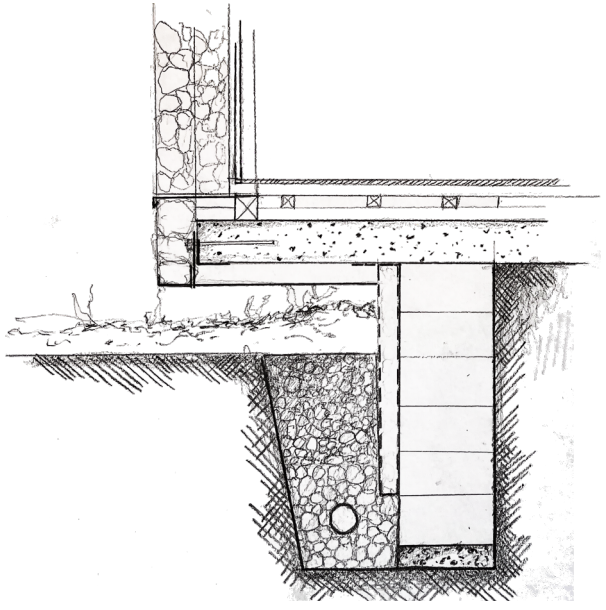
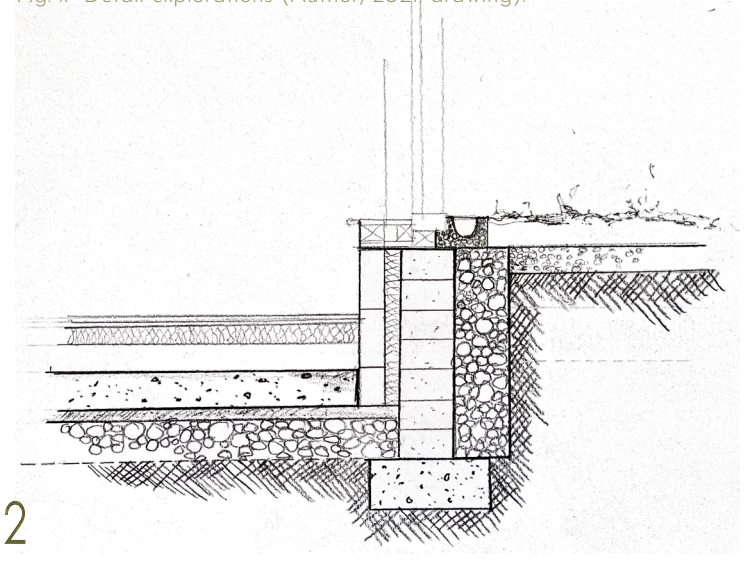


Fig. x  Detail explorations (Author, 2021: drawing).



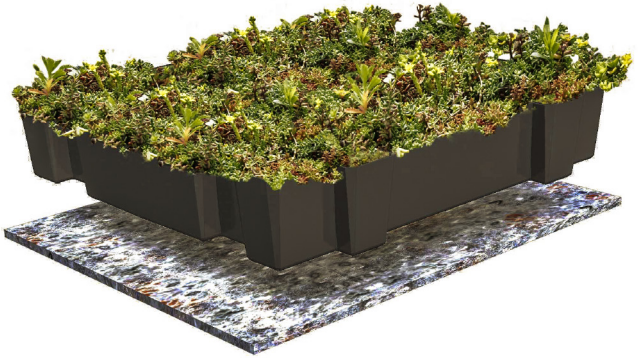


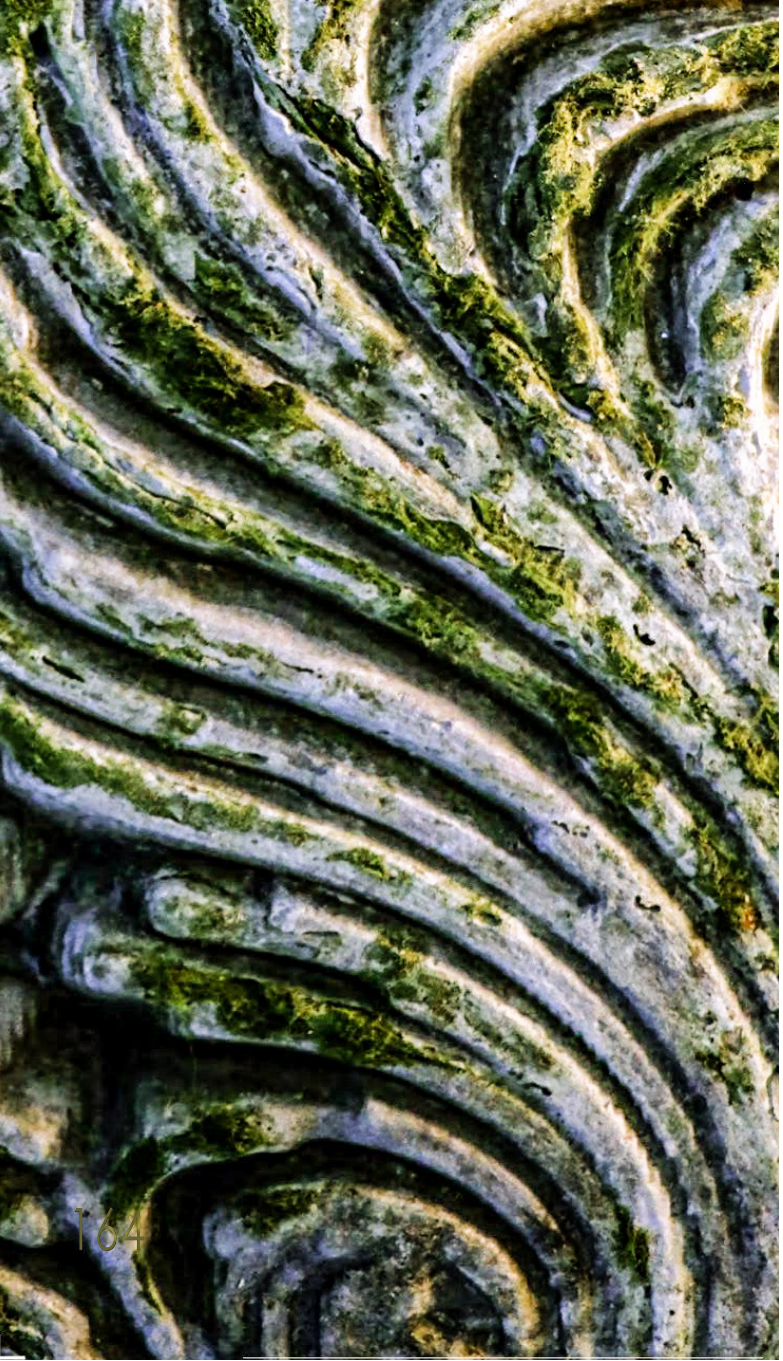
Fig. x  Modular Green Roof (Semper Green, 2022: image).

The structure of the building consists mainly of cladded rock walls that will allow for the steel structure to be attached to. These walls will be left on site as part of the scar of the building, after it has served its purpose and all steel structures have been removed and recycled as far as possible to create a fully closed circle.

The green roofs used in the design is a modular green roof system to allow for less concrete strutures to be cast on site. Once the building has served its purpose the plants from these green roofs can be planted on site as part of the public park that is left in its place.

Fig. x  Concept models indicating placement on site.  (Author, 2021: photograph).


MATERIAL
ALGAE



# Algae(crete)

Fabio Riveira, 2018.

The Algae(crete) thesis project proposes the use of biomass from algae as a lightweight, hygroscopic and bio-receptive reinforcement for cementious composites, to derive materially-efficient fibrous constructs.

Matreial research was constructed through flexural beams and cylindrical samples to evaluate the structural, hygroscopic, rheological and bio-receptive performance of concrete mixes prepared with different volumetric ratios of added algae fibres and different proportions of fine aggregates.

Fig. x Algaecrete (Riveira, 2018: image).

The thesis aimed to improve the performance of fibrous components with the use of natural fibres from algae blooms. This is in an attempt to reduce the depletion of natural recources and reappropriate the organic by-products originated from the Harmful Algae Blooms phenomena.

The concept of reinforcing concrete with fibres is not new since horsehair was used in mortars in ancient times, dating back to 1870. However scarce research has been done towards concrete composites with green filamentuous algae, making this proposal one of the first attempts to develop a new sustainable material system.

THICKNESS
60MM



ALGAE FIBERS
POSITIVE GEOMETRY
FOR WATER ABSORPTION &
BIORECEPTIVITY

GRIND ALGAE
INNER LAYER FOR LIGHTNESS

WATER CHANNELS
NEGATIVE GEOMETRY

1000 MM

500 MM

CEMENT + SAND + MARBLE + ALGAE FLEXURAL STRENGTH TEST

**TEST 28 DAYS**



**CONTROL**

**MATERIAL:** CONCRETE
**PROPORTIONS:** 1C : 1S : 1M : 0.7H2O
**RESISTANCE: +5.0 BAR**



**A1**

**MATERIAL:** ALGAECRETE
**PROPORTIONS:** 1C : 1A
**RESISTANCE: 1.0 BAR**



**A2**

**MATERIAL:** ALGAECRETE
**PROPORTIONS:** 1C : 2A
**RESISTANCE: 0.7 BAR**



**A1 GROUND**

**MATERIAL:** ALGAECRETE
**PROPORTIONS:** 1C : 1A
**RESISTANCE: 2.4 BAR**



**A2 GROUND**

**MATERIAL:** ALGAECRETE
**PROPORTIONS:** 1C : 2A
**RESISTANCE: 0.9 BAR**



**A1 PROCESSED**

**MATERIAL:** ALGAECRETE
**PROPORTIONS:** 1C : 1A
**RESISTANCE: 3.0 BAR**



**A2 PROCESSED**

**MATERIAL:** ALGAECRETE
**PROPORTIONS:** 1C : 2A
**RESISTANCE: 0.2 BAR**

Fig. x Algaecrete tests condcted by Riveira (Riveira, 2018: image)



**CONTROL**

**MATERIAL:** CONCRETE
**DRY WEIGHT:** 127GR | 126GR
**ABSORPTION WEIGHT:** 132GR | 131GR
**AVERAGE: 3.9%**



**A1**

**MATERIAL:** ALGAECRETE
**DRY WEIGHT:** 83GR | 77GR
**ABSORPTION WEIGHT:** 96GR | 96GR
**AVERAGE: 20.1%**



**A2**

**MATERIAL:** ALGAECRETE
**DRY WEIGHT:** 73GR | 73GR
**ABSORPTION WEIGHT:** 90GR | 90GR
**AVERAGE: 23.2%**



**A1 GROUND**

**MATERIAL:** ALGAECRETE
**DRY WEIGHT:** 78GR | 88GR
**ABSORPTION WEIGHT:** 86GR | 99GR
**AVERAGE: 11.35%**



**A2 GROUND**

**MATERIAL:** ALGAECRETE
**DRY WEIGHT:** 60GR | 66GR
**ABSORPTION WEIGHT:** 74GR | 81GR
**AVERAGE: 23%**



**A1 PROCESSED**

**MATERIAL:** ALGAECRETE
**DRY WEIGHT:** 73GR | 84GR
**ABSORPTION WEIGHT:** 88GR | 99GR
**AVERAGE: 19.15%**

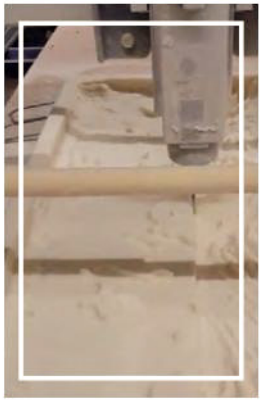


**A2 PROCESSED**

**MATERIAL:** ALGAECRETE
**DRY WEIGHT:** 63GR | 56GR
**ABSORPTION WEIGHT:** 84GR | 78GR
**AVERAGE: 36.25%**

# FABRICATION PROCESS







CNC MILLING FOAM MOULD



FINALIZED FOAM MOULD



ALGAE FIBERS DEPOSITION



UNCASTING THE PIECE

Fig. x Algaecrete tests condcted by Riveira (Riveira, 2018: image)

# Systems



# Bio. Tech Hut

EcoLogic Studio, 2017

The Living Hut, a hub of creative experience, is separated into two rooms: the Bio.light Room and a second room with H.O.R.T.U.S

The first is a dark and serene environment in which bioluminescent microorganisms release the only visible light when agitated and oxygenated by the air handling system.

H.O.R.T.U.S. (Hydro Organisms Responsive to Urban Stimuli) is an installation inhabited by photosynthetic colonies of cyanobacteria that visitors are invited to foster with carbon dioxide in order to create oxygen and a growing biomass in the second chamber, which is filled with natural light.

The Garden Hut, a facility for the development of superfood and bioenergy, is located in a more open atmosphere. Growing phototropic microorganisms employ photosynthesis to create biomass and oxygen while absorbing carbon dioxide in the Algae Photo-Bioreactor Room.

A harvest area for the processing and transformation of biomass into food and power is located at the heart of the Garden Hut.
In line with this attitude, the BIO.tech HUT's construction and interior represent the concept of symbiosis between human and non-human city occupants.

Fig. x The Garden Hut(EcoLogic Studio, 2017).

The photo-bioreactive cladding was created in partnership with marine biologists and algae growers. It is based on a first-of-its-kind innovative technique that employs high-speed air movement to raise the living medium into lab grade glass tubes.

The air flow forms eddies on the fluid inside the tubes, resulting in a stirring effect that catalyzes the necessary O2 / CO2 exchange. Gravity then pulls the fluid down to complete the loop. Several glass tubes are wrapped around the BIO.tech HUT and serve as architectural components.

The coils of glass tubes are structurally supported by a series of sections frames made of high-performance honeycombed polycarbonate.

The resultant structure is lightweight and entirely recyclable, with the unique function of scattering and improving solar energy penetration deep into the BIO.tech HUT.

Relevance to project

The Bio.Tech Hut serves as an investigation to understanding how algae can be merged and incorporated within architecture and built structures.

The glass tubes can be used both on the interior as well the exterior to cultivate and harvest biomass from the algae. These glass structures can be incorporated and designed to create abstract structures that serve as screens within the building.

The more abstract structures, like H.O.R.T.U.S allows for the public to have an active role in the building and the cultivation of algae.

This installation indicates how algae can be used as a visual way of incorporating sustainable algae farming in any building.

Using these installations as inspiration the dissertation could incorporate similar structures that will ultimately encourage the use of algae in other buildings in the community.

Fig. x Glas tubes used to harvest biomass (EcoLogic Studio, 2017).



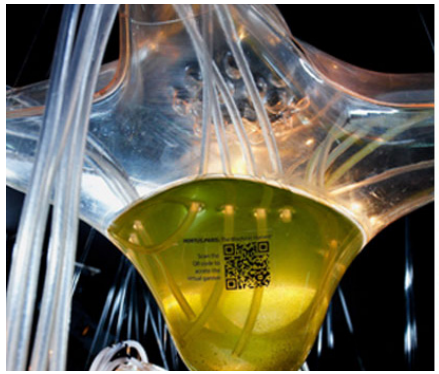




Fig. x H.O.R.T.U.S(EcoLogic Studio, 2017).





# Algae Textile

Petra Bogias, 2014

The thesis by Bogias combines the components of a classic photobioreactor into a lightweight device that can easily be incorporated into standard urban building assemblies and enclosures.

Traditional divisions can therefore be recreated as productive entities. The textile is made out of a flexible polymer membrane with a network of voids running through it. Due of its lightweight nature, this allows a developing algae culture to flow within it and provides the flexibility to link the system to existing structures using basic hardware (Bogias, 2014).

Given the spatial demands of a building's design, the textile also emphasizes form flexibility to allow the geometry of these internal voids to cooperate with contextual building circumstances such as program, light, or structure. When employed in an architectural context, these goals point to the necessity for a photobioreactor to be extremely adjustable (Bogias, 2014).

If a photobioreactor can meet the programmatic needs of a building's floor plan, its intended architectural aesthetic, and tenant comfort, then the use of algae in the built environment may become increasingly common. If used to create performative building skins, the textile might then be applied to any given building state to turn walls into productive surfaces.

Fig. x (Bogias, 2014)

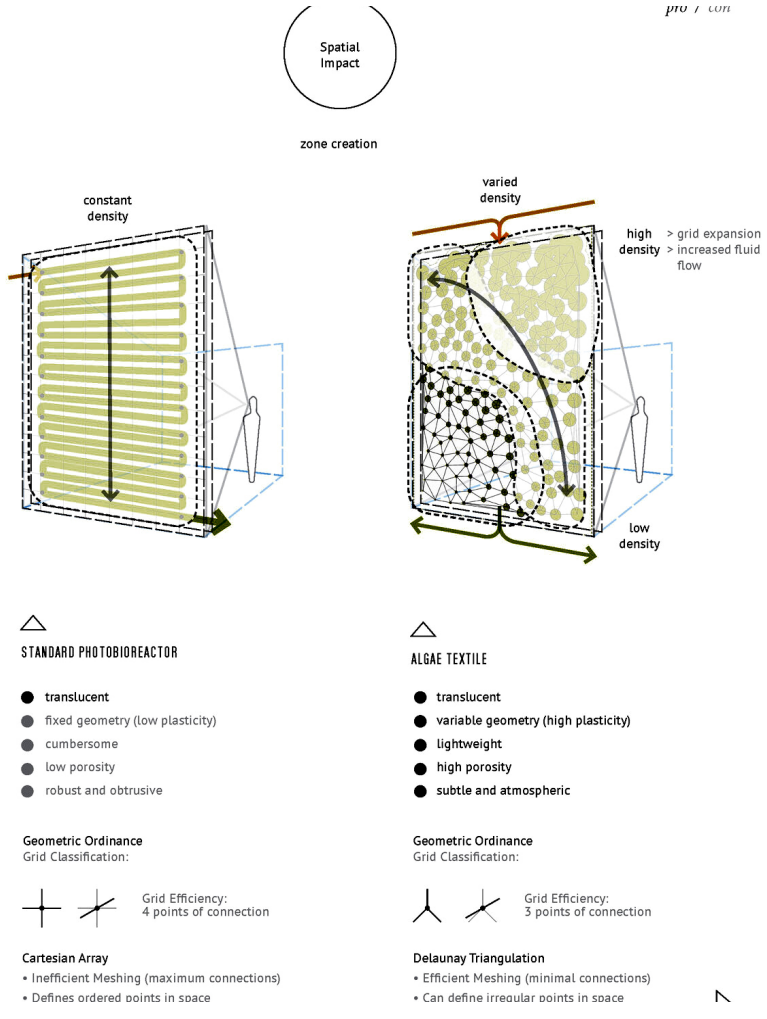



Fig. x (Bogias, 2014)

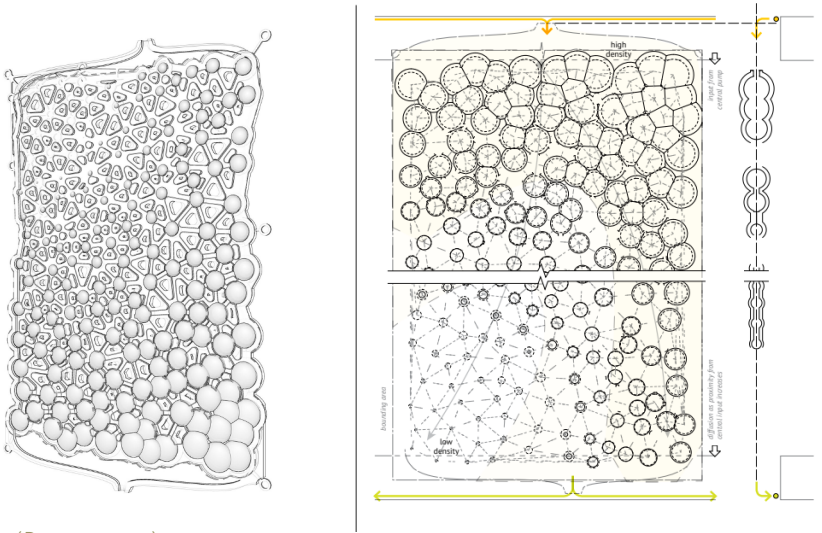
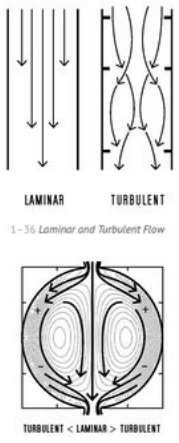


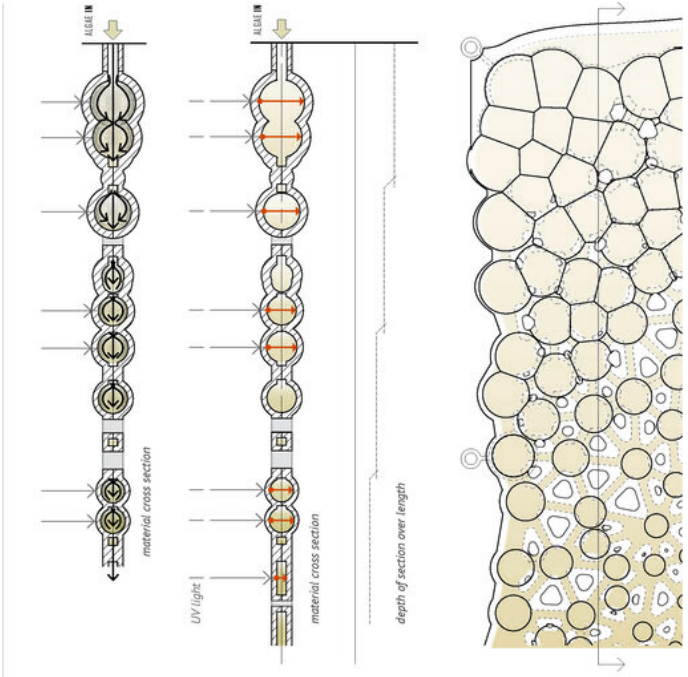

Fig. x (Bogias, 2014)

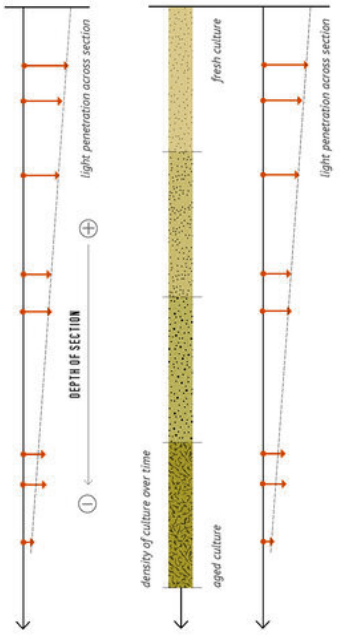
The algal textile recognizes the relevance of laminar and turbulent flows in bioreactors and attempts to incorporate them into their design. The design seeks to increase the agitation and aeration of the algae as it moves through the membrane to encourage its development by experimenting with its varied surface and uneven inner route (Bogias, 2014).

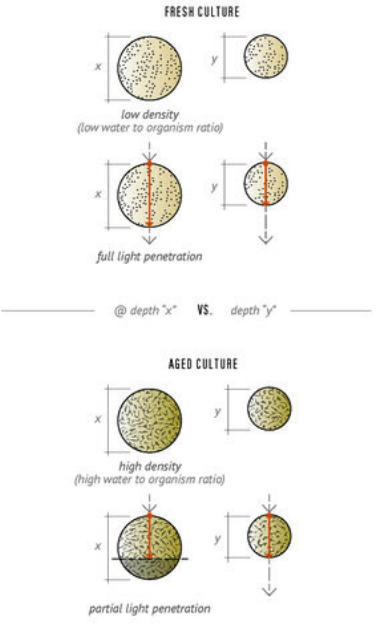
As a result, the textile's aggregated network of spherical shapes serves not only an aesthetic function in terms of architectural design, but also contributes to the textile's overall mechanical performance as a bioreactor.

This is accomplished by carefully examining the algal organism's reactive demands, which is not restricted to fluid dynamics concepts. The rate of proliferation is also affected by environmental factors like as light, temperature, and the surface-to-volume ratio of the developing vessel (Bogias, 2014).



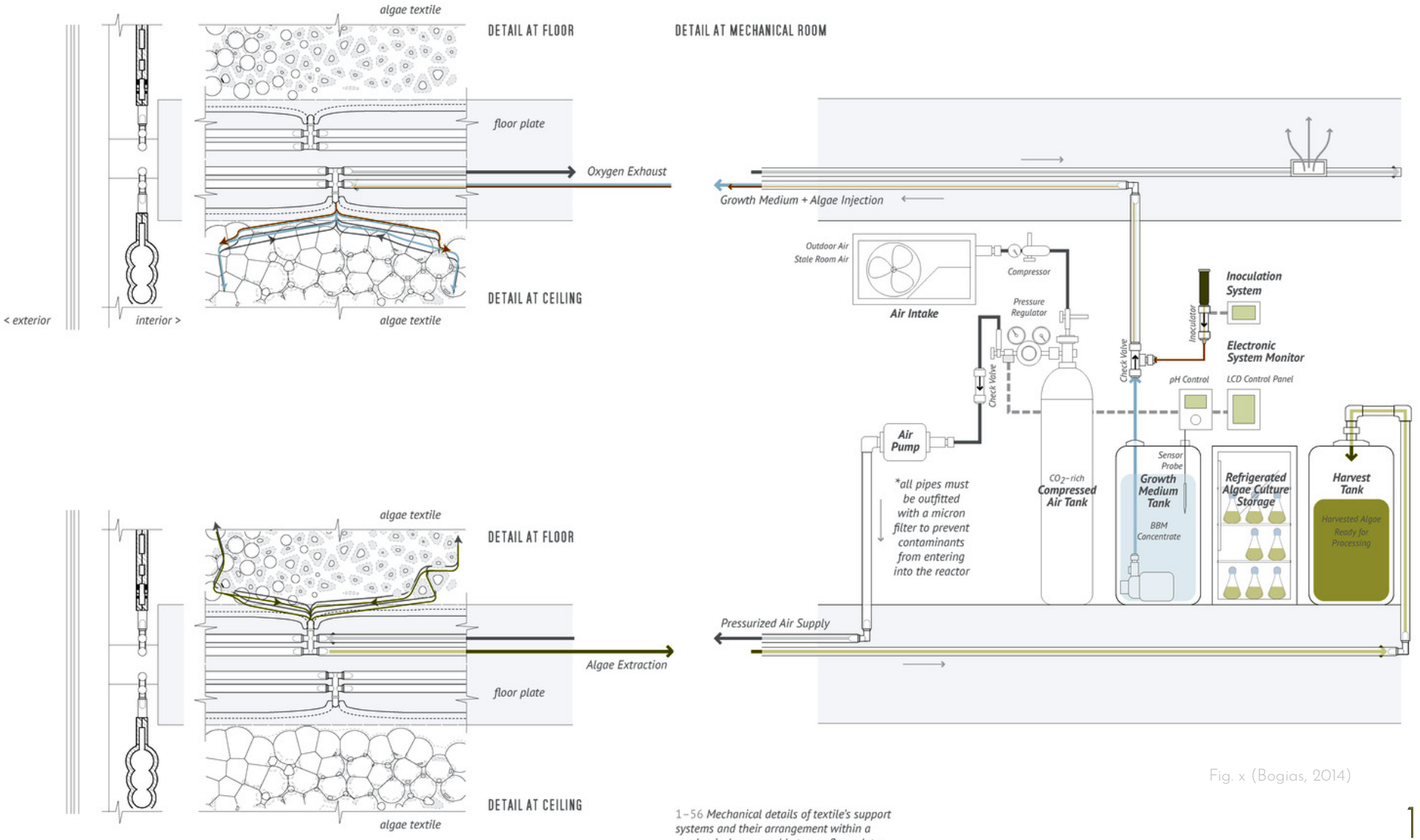




These figures show how the varied shape of the algal cloth accounts for environmental variables as well as the surface-to-volume ratio. Because of the textile's shallow depth, the algae are forced to develop in a thin and dispersed habitat. Because of the high surface-to-volume ratio, each algal cell suspended in the fluid receives an equal distribution of light and temperature. (Bogias, 2014)

Furthermore, moments of expansion and contraction in the depth of the textile can account for the culture's density change as it grows: a fresh culture, which is less dense, can handle greater depths without sacrificing full light penetration, whereas an aged culture, which is more dense, requires shallower depths to maintain full light penetration.

These requirements can be modified based on the location of input valves, which will influence where the spherical vessels gather and disperse. Algae clearly demands varying circumstances during its life cycle, and hence, diversity in its route inside the textile can assist to accommodate this. '' (Bogias, 2014)

The textile cannot work without the integration of a variety of support systems inside a building's plumbing and mechanical infrastructure, such as an inoculation (culture injection) system, an air processing system, a harvesting system, and a lighting system.''' (Bogias, 2014)




1–56 *Mechanical details of textile's support systems and their arrangement within a mechanical room and between floor plates.*

Fig. x (Bogias, 2014)

Fig. x (Bogias, 2014)



# The Omega Center for sustainable living

John Todd Ecological Design, 2009

The Omega Center for Sustainable Living is arguably the world's most magnificent wastewater treatment facility. The building, which was created by Dr. John Todd, is run entirely by geothermal and solar energy.

As opposed to other wastewater treatment facilities, the OCSL uses a combination of microorganisms, algae, plants, gravel filtration, and sand to clean sewage water and return clean, drinkable water to the aquifer instead of using chemicals to treat the water. In addition to all of this, the OCSL serves as a classroom to inform and motivate people about the ability of nature to solve problems (Tackett, 2018:online).

The procedure begins with all of the water from the Omega campus's toilets, sinks, and showers draining into storage tanks that collect human waste and "grey water" from showers or sinks. This water is delivered to the Eco Machine building and fed to "microscopic algae, fungi, bacteria, plants, and snails."

The first step consists of two 5,000 gallon Anoxic tanks buried below, where naturally occurring microbial species consume the effluent. They digest "ammonia, phosphorus, nitrogen, potassium, and a variety of other water-borne chemicals." The water then flows to the four man-made wetlands located behind the OCSL headquarters.

Fig. x Omega Center for Sustanable Living
(BNIM.com, 2022: photograph).




Fig. x Omega Center for Sustanable Living (BNIM.com, 2022: image).

Here's how Omega describes the wetlands on their site:

They are three feet deep, rubber-lined, and fully gravel-filled. Water travels from the anoxic tanks, via the splitter box, and into the upper two constructed wetlands about two inches beneath the gravel.

Microorganisms and native plants, such as cattails and bulrushes, are used in the wetlands to lower biochemical oxygen demand, eliminate odorous emissions, continue the denitrification process, and extract nutrients like phosphate. The bacteria and plants are fed as the wastewater travels through the wetlands.

The water is already very pure after passing through the four wetlands. According to Omega, simply passing through the anoxic tanks and wetlands results in "a 75% increase in water clarity and a 90% reduction in water odour."

The water is pumped inside to two aerated lagoons after passing through the wetlands (Tackett, 2018:online).

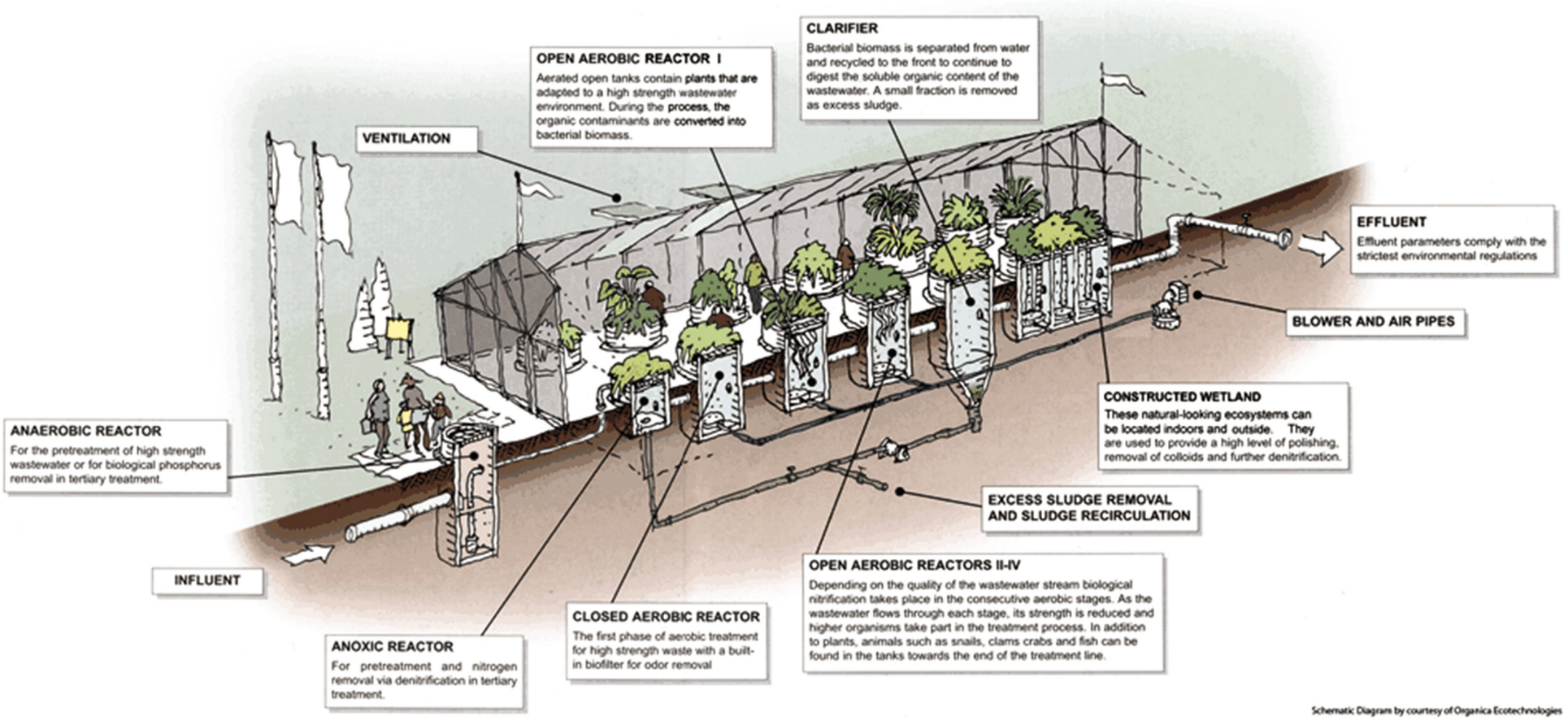



Fig. x The Living Machine Diagram (Organica Ecotechnologies: online).

Omega writes,

The aerated lagoons are separated into four 10-foot-deep units. The water looks and smells clean at this point, but it is not safe to touch. The aerated lagoons' plants, fungi, algae, snails, and other microorganisms are hard at work turning ammonia into nitrates and toxins into safe base elements. The OCSL's aerated lagoons have no soil, but gorgeous tropical flora grow there.

The plants are housed on metal racks, and their roots can reach as far as five feet into the water. The plants' roots provide a habitat for the species in the lagoon and nourish them. These tropical plants' blossoms demonstrate the beauty that organically treated "wastewater" may provide.

Following the lagoons, the water is directed outside to a sand filter. After passing through the recirculating sand filter, the water passes advanced wastewater standards and is as pure as water from your home's kitchen faucet.

This full-circle motion is what makes the Eco Machine so fascinating. It asks us to reconsider the concept of "waste" and reinterpret the concept of "throwing anything away."

There is no "way out." That is why the Eco Machine design serves as an inspiration for considering interconnection as a foundation for answers to the numerous difficulties we face. We can design solutions to meet our needs by assessing and measuring our impact on the world.

By assessing and measuring our impact on the world, we can look at how the environment would solve a problem, in this case cleaning water, and design solutions that use those natural processes to meet our needs.

That something so basic and natural is suddenly deemed radical and revolutionary demonstrates how far we've strayed from sustainable architecture.

However, the Eco Machine process does not end there. The water is returned to nature after sand filtration via two dispersal fields beneath Omega's parking lot.

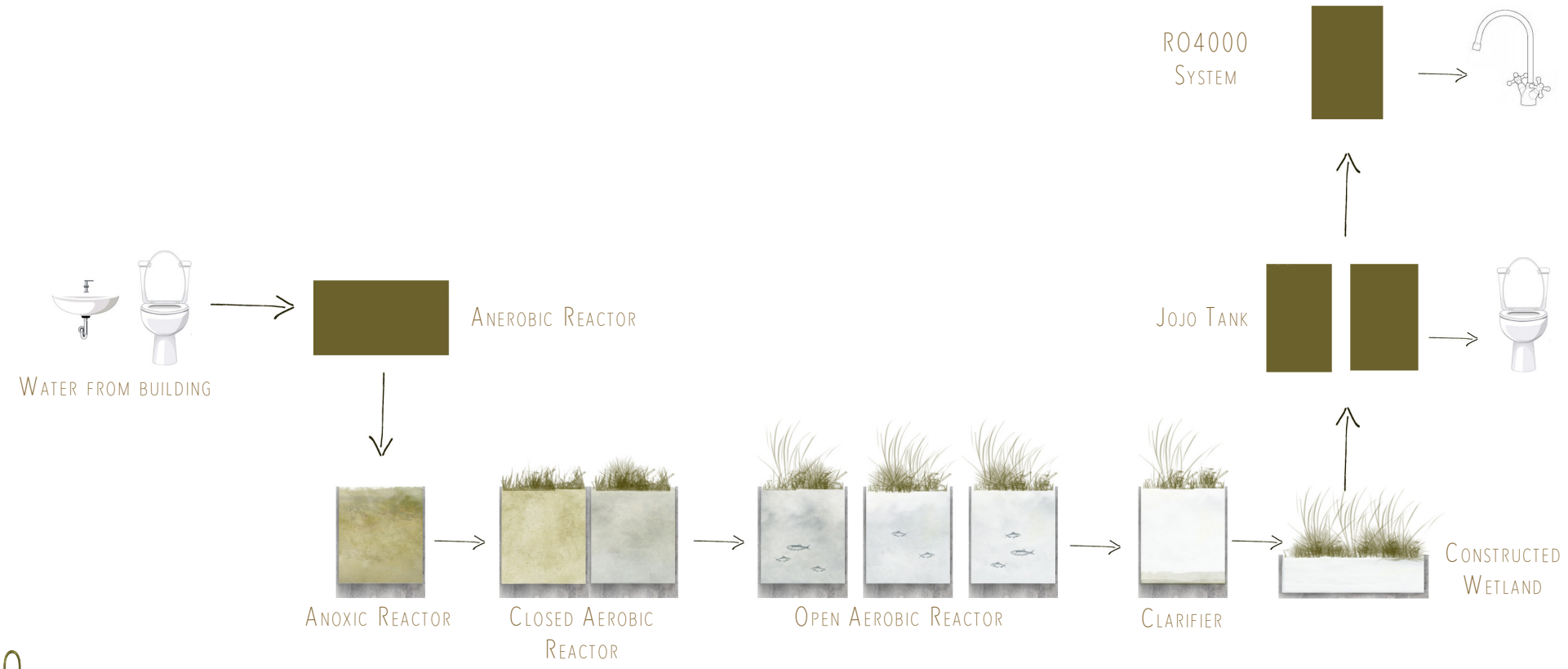
The reclaimed water is discharged back into the groundwater table, which is located under the surface, in the dispersal fields. Nature further purifies the reclaimed water as it flows down to the aquifer 250-300 feet beneath campus.

Omega Center for Sustainable Living completes a closed hydrological loop in our water consumption with this final phase in the Eco Machine process.

We extract water from deep wells that tap the aquifer, utilise it in sinks, toilets, and showers, naturally reclaim it using the OCSL Eco Machine, and then release the cleansed water (Tackett, 2018:online).

# Living System

## The application of systems within the design



Step 1 - Anaerobic Reactor:

A slump build-up tank, similar to a septic tank, is used to reduce the amount of solids that enter the succeeding filtration tanks.

Step 2 - Anoxic Reactor:

This tank uses an aerated pump that allows for floc-forming micro-organisms, which reduces the amount of dissolved oxygen needed by aeronic biological organisms to break down organic material for filtering.

Step 3 - Closed Aerobic Reactor:

The dissolved wastewater oxygen demand is lowered to remove odorless gasses. Moisture levels and odoris further controlled by the planted biofilter growing in each tank. Aeration is provided by fine bubble diffusers.

Step 4 - Open Aerobic Reactor:

These tanks are similar to closed aerobic reactors and also consist of a biofilter and aeration diffuser, but have an additional rack system that allows for a greater surface area for underwater vegetation. These racks allow for greater microbial growth and serve as a home for beneficial insects and micro-organisms. The number of these reactors varies from 2 to 4, and is determined by effluent intake.

Step 5 - Clarifier:

The last stem requires a polishing process where ecological fluidized beds are used for final treatment of the wate. One to three of these are used (epa.gov, 2002:2-3).

The RO4000 is a high quality Reverse Osmosis system ideal for water shops or industries where high volumes of purified water are needed.

Reverse osmosis is a water purification process that uses a semi-permeable membrane (synthetic lining) to filter out unwanted molecules and large particles such as contaminants and sediments like chlorine, salt, and dirt from drinking water.

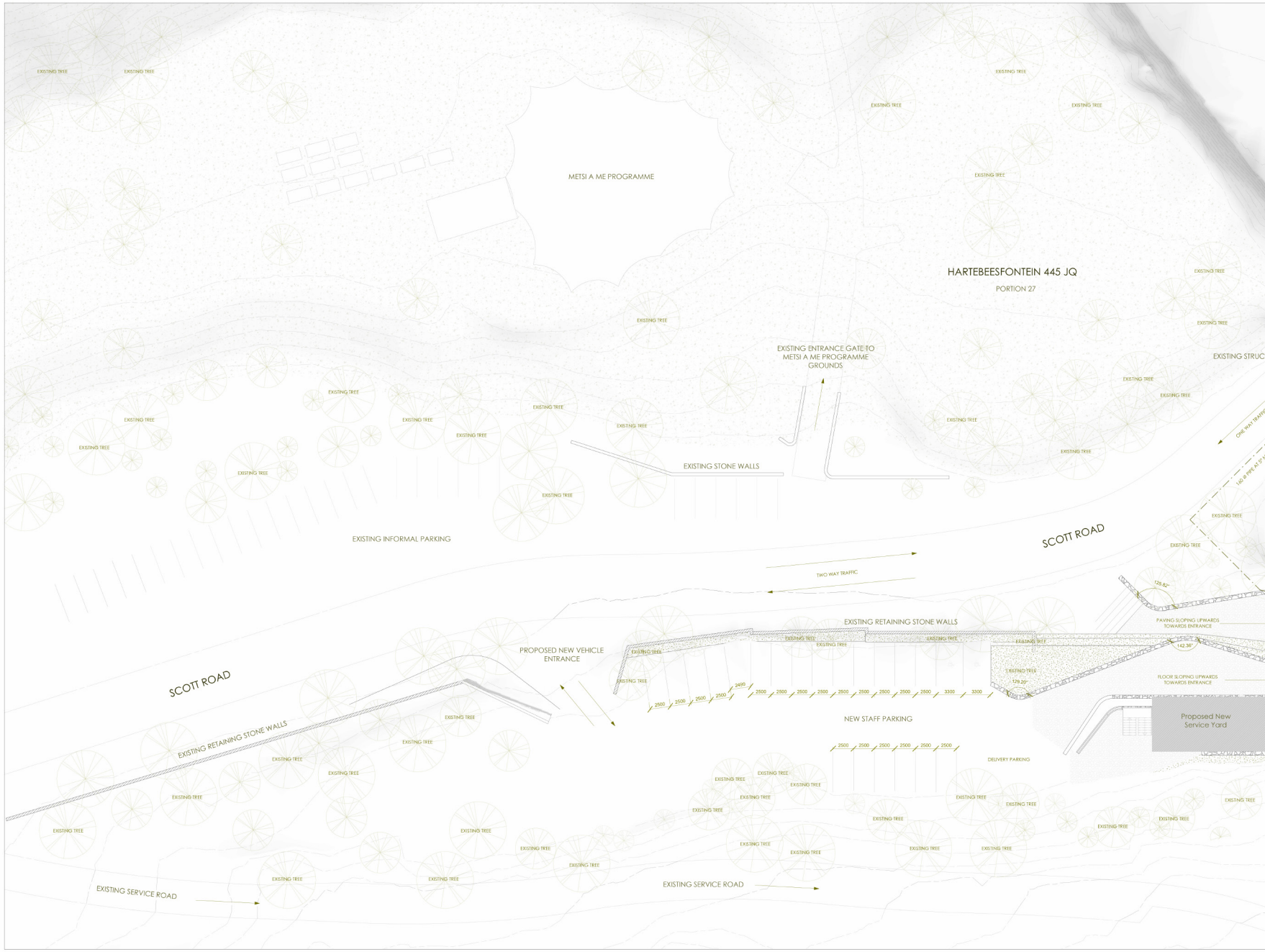
In addition to removing contaminants and sediments, reverse osmosis can also remove microorganisms. It gets water clean down to a molecular level, leaving only pure H2O behind.

The RO4000 unit produces 14 000 litres per day, depending on inlet water flow and quality.
It comprises of a high quality multistage pump, two flow meters (permeate and concentrate), two pressure gauges (inlet and operating), and two 4040 membranes in series.





# 5.1 Research and Design Reflection


METSI A ME PROGRAMME
HARTEBEESFONTEIN 445 JQ
PORTION 27
EXISTING ENTRANCE GATE TO METSI A ME PROGRAMME GROUNDS
EXISTING STONE WALLS
EXISTING INFORMAL PARKING
SCOTT ROAD
TWO WAY TRAFFIC
EXISTING RETAINING STONE WALLS
PROPOSED NEW VEHICLE ENTRANCE
SCOTT ROAD
EXISTING RETAINING STONE WALLS
NEW STAFF PARKING
DELIVERY PARKING
Proposed New Service Yard
EXISTING SERVICE ROAD
EXISTING SERVICE ROAD
PAVING SLOPING UPWARDS TOWARDS ENTRANCE
FLOOR SLOPING UPWARDS TOWARDS ENTRANCE
EXISTING TREE




ANNA MAY ARCHITECTS
079 517 8671
anemeyer@gmail.com

Project
Hartbeespoort Dam Algae Research, Design and Manufacturing Institute

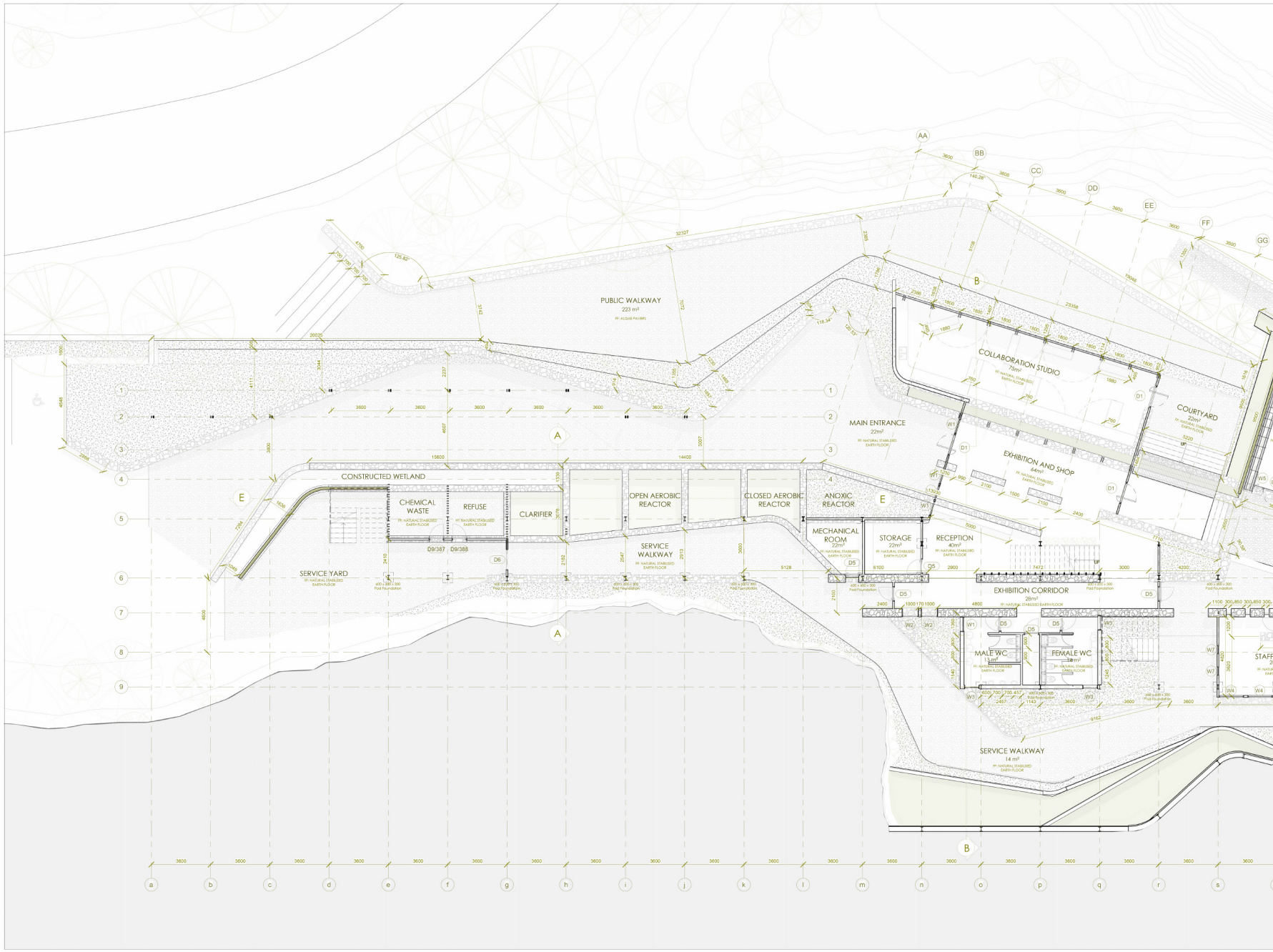
Location
Hartbeespoort Dam
North West

Notes

Submitted by:
ANé MEYER

Drawing Name
Site Plan
1 : 200

Drawing Nr.
A001


PUBLIC WALKWAY
223 m²
PF: ALGAE PAVERS
CONSTRUCTED WETLAND
CHEMICAL WASTE
REFUSE
CLARIFIER
OPEN AEROBIC REACTOR
CLOSED AEROBIC REACTOR
ANOXIC REACTOR
SERVICE WALKWAY
SERVICE YARD
MECHANICAL ROOM
22m²
STORAGE
22m²
RECEPTION
40m²
MAIN ENTRANCE
22m²
COLLABORATION STUDIO
56m²
EXHIBITION AND SHOP
64m²
COURTYARD
50m²
EXHIBITION CORRIDOR
28m²
MALE WC
13m²
FEMALE WC
13m²
SERVICE WALKWAY
14 m²
STAFF
D9/387
D9/388




GROUND FLOOR PLAN
SCALE 1:100

ANNA MAY ARCHITECTS
079 517 8671
anemeyer@gmail.com

Project
Hartbeespoort Dam Algae Research, Design and Manufacturing Institute

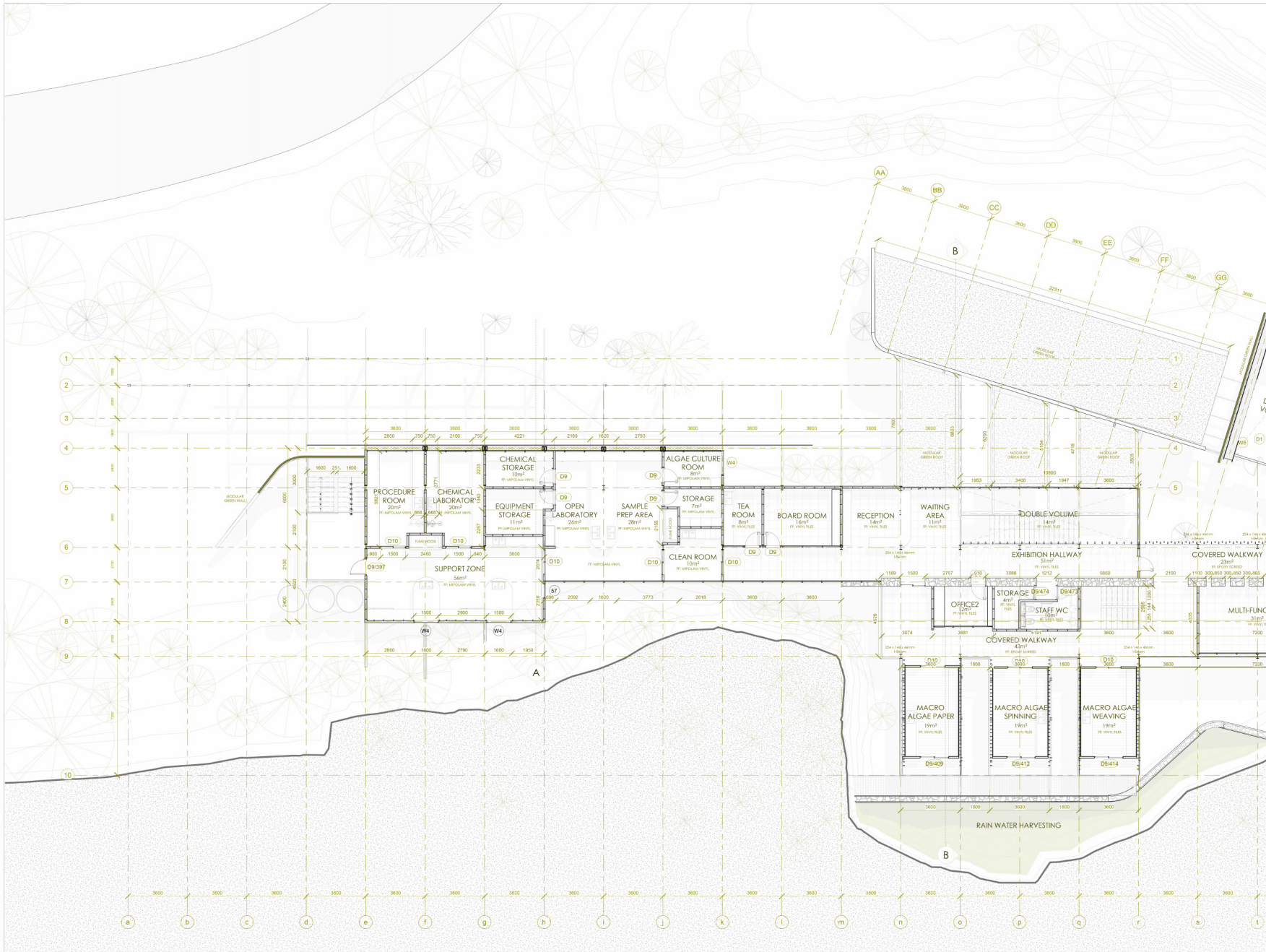
Location
Hartbeespoort Dam
North West

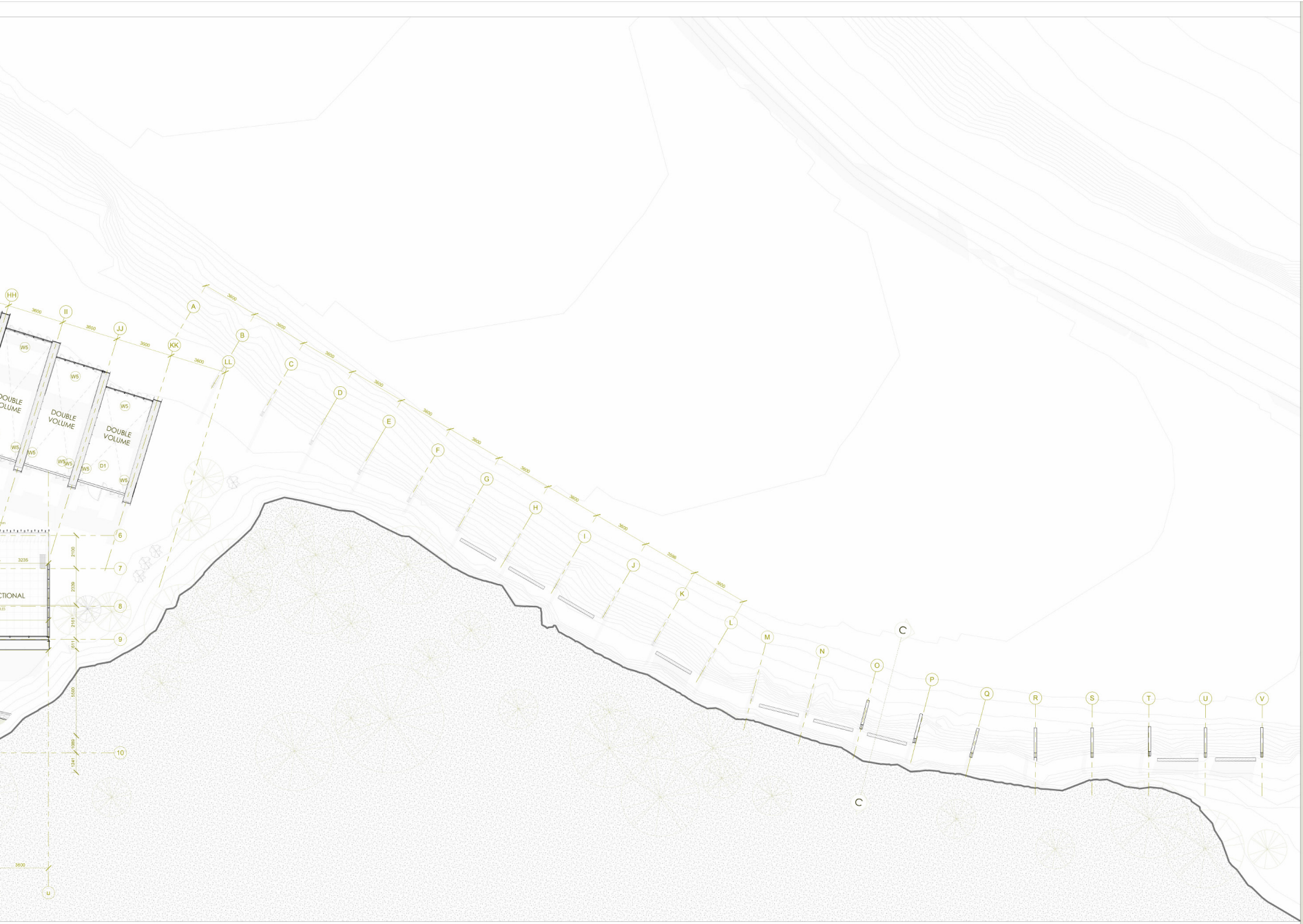
Notes

Submitted by:
ANé MEYER

Drawing Name
Plan
1 : 100

Drawing Nr.
A002


PROCEDURE ROOM 20m²
CHEMICAL LABORATORY 20m²
CHEMICAL STORAGE 10m²
EQUIPMENT STORAGE 11m²
OPEN LABORATORY 26m²
SAMPLE PREP AREA 28m²
ALGAE CULTURE ROOM 8m²
STORAGE 7m²
CLEAN ROOM 10m²
SUPPORT ZONE 56m²
TEA ROOM 8m²
BOARD ROOM 16m²
RECEPTION 14m²
WAITING AREA 11m²
DOUBLE VOLUME 14m²
EXHIBITION HALLWAY 51m²
COVERED WALKWAY 23m²
OFFICE2 12m²
STORAGE 4m²
STAFF WC 10m²
COVERED WALKWAY 43m²
MACRO ALGAE PAPER 19m²
MACRO ALGAE SPINNING 19m²
MACRO ALGAE WEAVING 19m²
RAIN WATER HARVESTING
MODULAR GREEN ROOF
MODULAR GREEN WALL




ANNA MAY
ARCHITECTS

079 517 8671
anemeyer@gmail.com

Project
Hartbeespoort Dam Algae Research, Design and Manufacturing Institute

Location
Hartbeespoort Dam
North West

Notes

Submitted by:
ANé MEYER

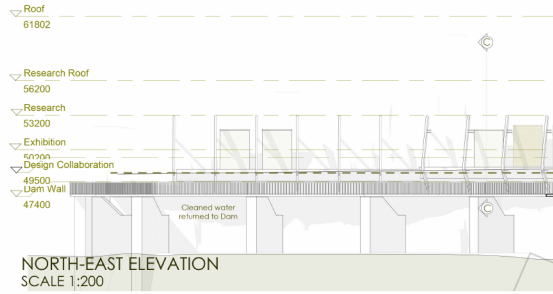
Drawing Name
First Floor
1 : 100

Drawing Nr.
A003

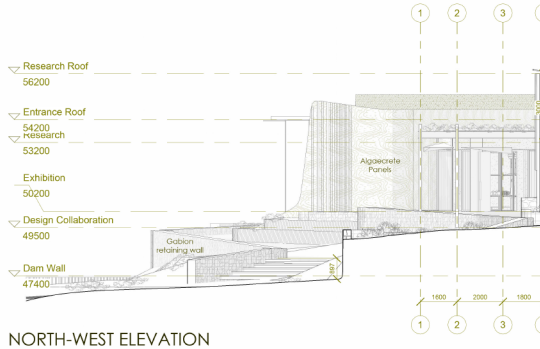




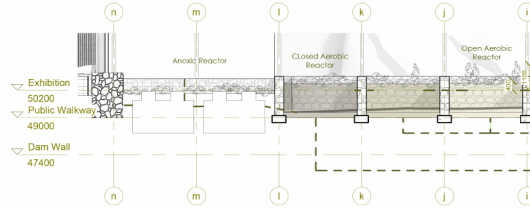




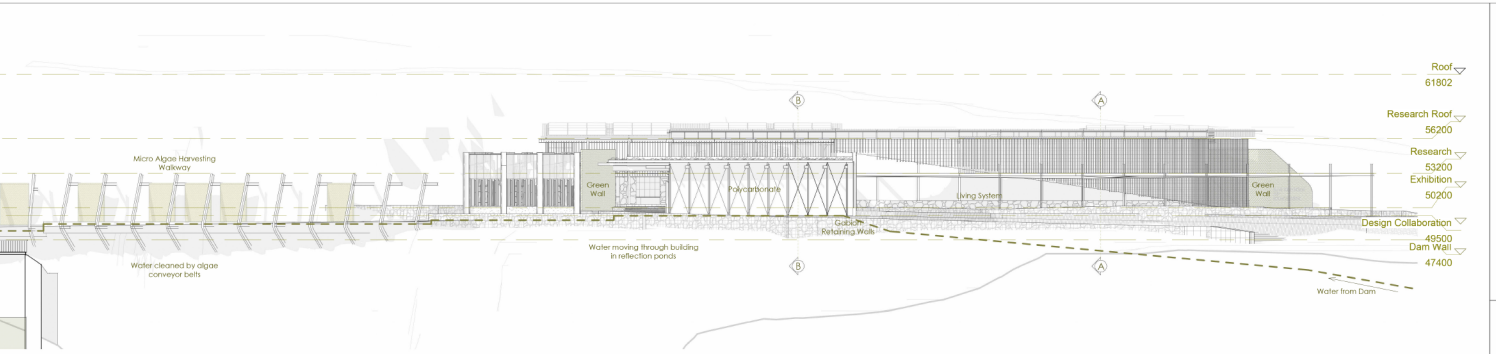

NORTH-EAST ELEVATION
SCALE 1:200

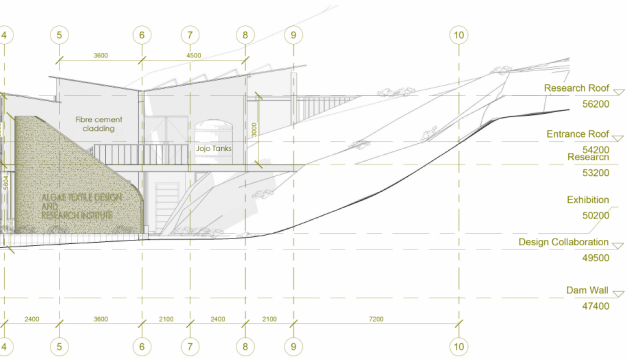


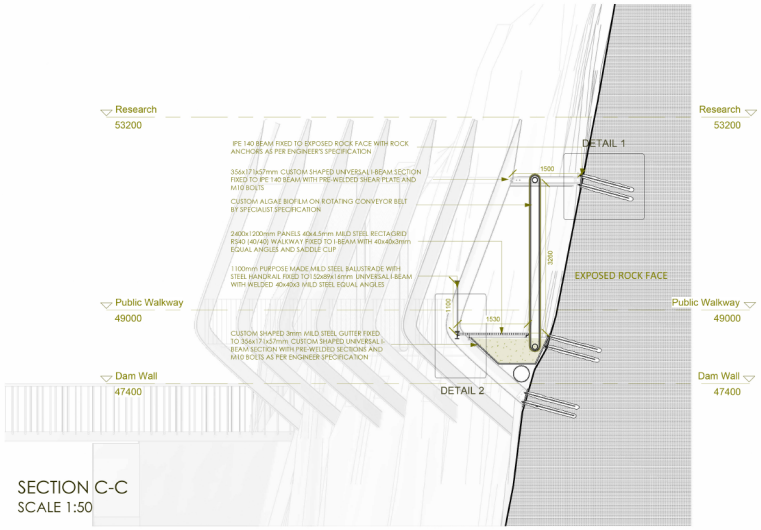

NORTH-WEST ELEVATION
SCALE 1:100



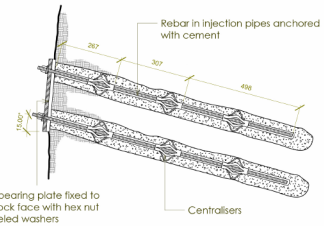

LIVING MACHINE SECTION
SCALE 1:100



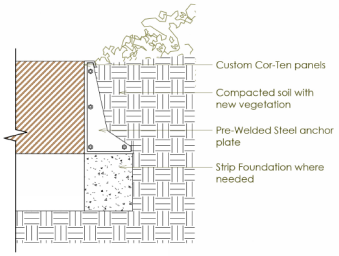



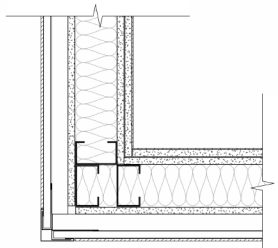

SECTION C-C
SCALE 1:50



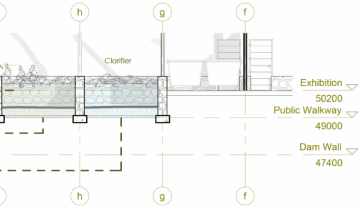

ROCK ANCHOR DETAIL
SCALE 1:10

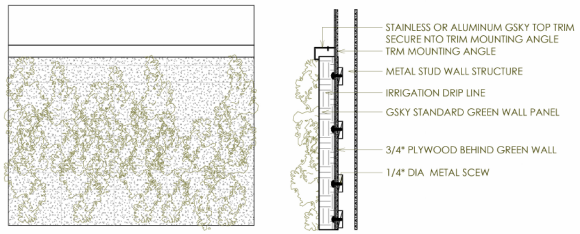



COR-TEN RETAINING WALL DETAIL
SCALE 1:10

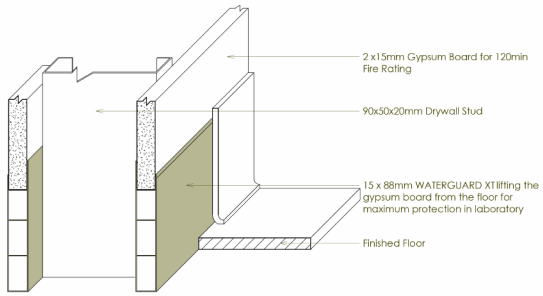


DRYWALL EXTERIOR CORNER DETAIL
SCALE 1:5




MODULAR GREEN WALL DETAIL
SCALE 1:20




DRYWALL TO FLOOR DETAIL
SCALE 1:2

ANNA MAY ARCHITECTS
079 517 8671
anemeyer@gmail.com

Project
Hartbeespoort Dam Algae Research, Design and Manufacturing Institute

Location
Hartbeespoort Dam
North West

Notes

Submitted by:
ANÉ MEYER

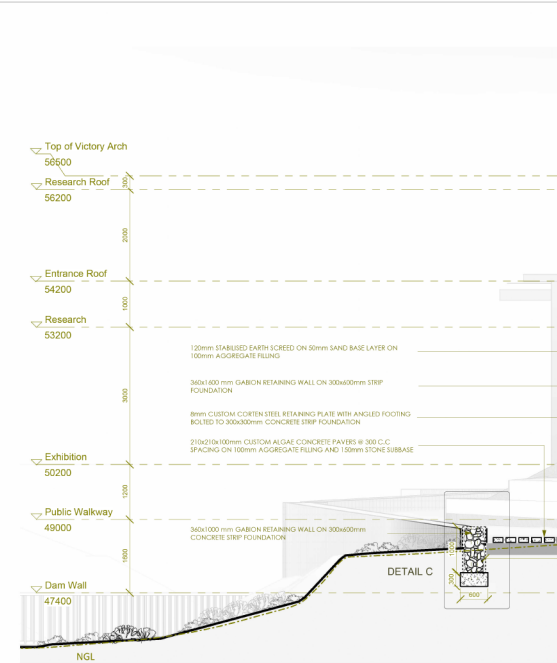
Drawing Name
Elevations
As indicated

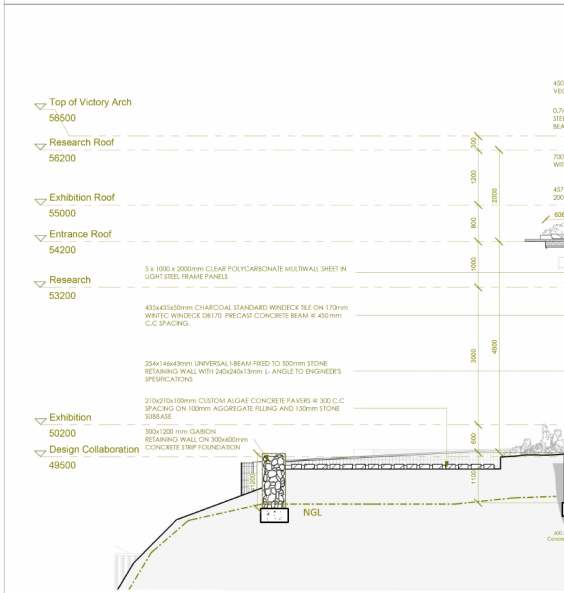
Drawing Nr.
A004

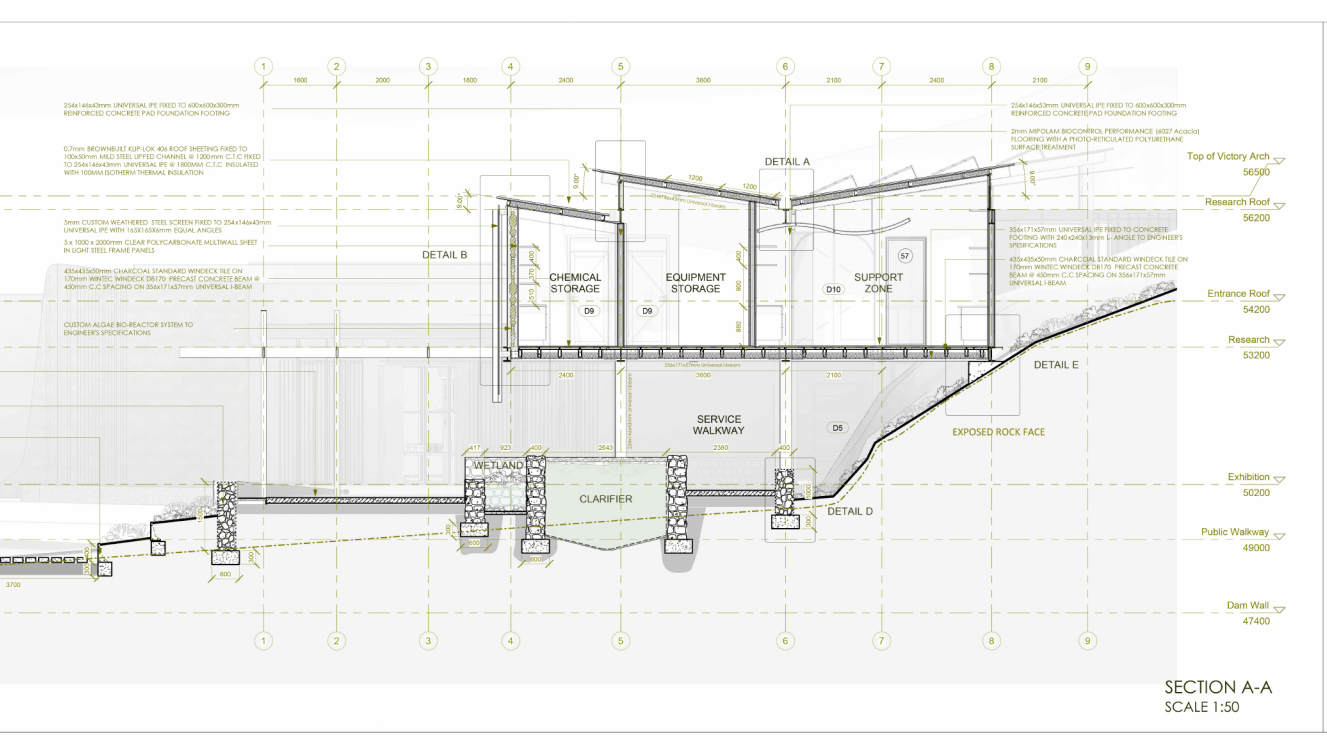




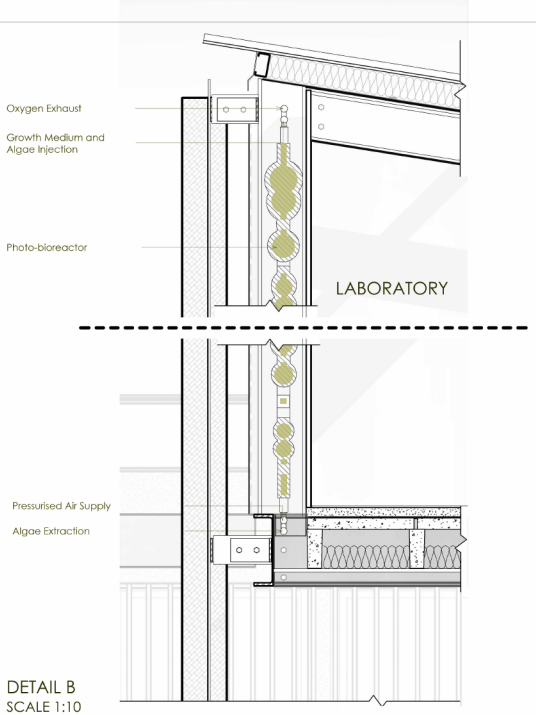



Top of Victory Arch
56500
Research Roof
56200
Entrance Roof
54200
Research
53200
Exhibition
50200
Public Walkway
49000
Dam Wall
47400
NGL
120mm STABILISED EARTH SCREED ON 50mm SAND BASE LAYER ON 100mm AGGREGATE FILLING
360x1600 mm GABION RETAINING WALL ON 300x600mm STRIP FOUNDATION
8mm CUSTOM CORTEN STEEL RETAINING PLATE WITH ANGLED FOOTING BOLTED TO 300x300mm CONCRETE STRIP FOUNDATION
210x210x100mm CUSTOM ALGAE CONCRETE PAVERS @ 300 C.C SPACING ON 100mm AGGREGATE FILLING AND 150mm STONE SUBBASE
360x1000 mm GABION RETAINING WALL ON 300x600mm CONCRETE STRIP FOUNDATION
DETAIL C

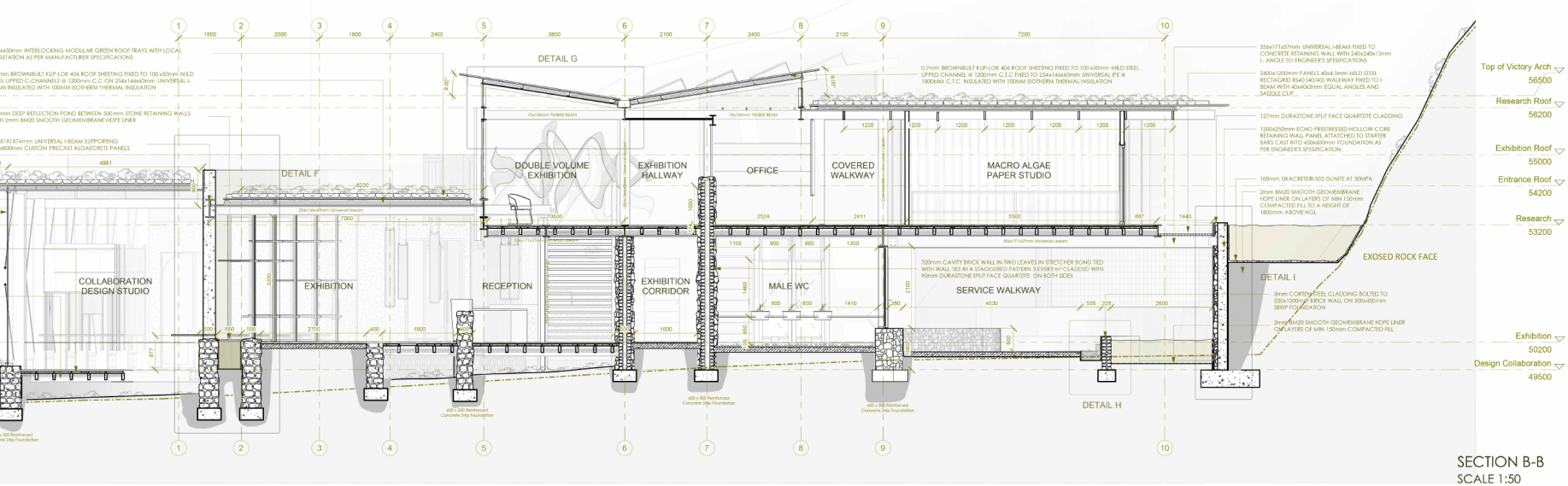

Top of Victory Arch
56500
Research Roof
56200
Exhibition Roof
55000
Entrance Roof
54200
Research
53200
Exhibition
50200
Design Collaboration
49500
NGL
5 x 1000 x 2000mm CLEAR POLYCARBONATE MULTIWALL SHEET IN LIGHT STEEL FRAME PANELS
435x435x50mm CHARCOAL STANDARD WINDECK TILE ON 170mm WINTEC WINDECK DB170 PRECAST CONCRETE BEAM @ 450 mm C.C SPACING.
254x146x43mm UNIVERSAL I-BEAM FIXED TO 500mm STONE RETAINING WALL WITH 240x240x13mm L- ANGLE TO ENGINEER'S SPESIFICATIONS
210x210x100mm CUSTOM ALGAE CONCRETE PAVERS @ 300 C.C SPACING ON 100mm AGGREGATE FILLING AND 150mm STONE SUBBASE
500x1200 mm GABION RETAINING WALL ON 300x600mm CONCRETE STRIP FOUNDATION




SECTION A-A
SCALE 1:50




DETAIL B
SCALE 1:10




SECTION B-B
SCALE 1:50

ANNA MAY ARCHITECTS
079 517 8671
anemeyer@gmail.com

Project
Hartbeespoort Dam Algae Research, Design and Manufacturing Institute

Location
Hartbeespoort Dam
North West

Notes

Submitted by:
ANÉ MEYER

Drawing Name
SECTIONS 1
As indicated

Drawing Nr.
A006





# 5.2 Conclusion

The dissertation investigated the design of an algae research, design and manufacturing institute at Hartbeespoort Dam concerned with a reparational, relational, and respectful engagement with the temporal environment.

Theories of mutualistic and regenerative architecture were researched in order to understand how architecture can be fully integrated within its natural landscape.

The design focused on permanence and temporality in both nature and the built form. This allowed for a design that grows and decays with the landscape, as the building will partly disappear in time, leaving just a scar on the landscape in the form of a public park.

The design utilised natural and recyclable materials, to allow for an architecture that temporarily heals the wounded landscape of Hartbeespoort Dam.

When the problem of eutrophication is addressed, the building will have served its purpose in the amelioration of the wounded landscape to clean the dam's water.

Architecture will always leave scars on our landscape, but the key is to not make permanent solutions for temporary problems, as Mehrotra stated.

The inspiration for this dissertation came from my interest and love for fashion. Realising that the fashion industry is one of the world's biggest polluters, and that I contribute to this every day, inspired the research into new methods of textile production. Algae is overlooked as a nasty green substance that appear in water bodies. The work of Lucking inspired me to do further research on the topic and even experiment with some of the ideas at home.

This dissertation and research made me aware of architecture's power and ability to integrate not only the built environment and the natural world, but also different industries to work together for the greater good of our environment.

# 5.3 References


Arizona State University. (2020, January 4). *Facilities Development and Management (FDM) Project Guidelines*. Arizona State University .

Ahmadjian and Paracer, 2000 *Symbiosis: an Introduction to Biological Associations*. Oxford University Press, Oxford (2000)

Bogias, P. (2014). *Algae Textile: A Lightweight Photobioreactor for Urban Buildings*. Waterloo: University of Waterloo.

Bronwell, B. (2011). *Matter in the floating world: Concersations with leading Japanese architects and designers*. New York: Princeton Architectural Press.

Buntrock, D. (2010). *Materials and Meaning in Contemporary Japanese Architecture*. New York: Routledge.

Chinnasamy, S., Hanumantha, R., Bhaskar, S., Rengasamy, R., & Singh, M. (2012). *Microbial biotechnology: energy and environment*. (pp. 224-240). Oxfordshire: CABI.

Corrie, D. 2001. What Is Human Time? *The Hudson Review* (Spring); 54:1. pp. 61-71

Dower, S. (2003, May 3). The Water Wheel. Hartbeespoort.

DuPlessis, C., & Edwards, B. (2001). Global Perspectives: Learning from the other side. *Architectural Design,* 152, 38-45.

Fernandez-Galiano, L. (2000). *Fire and Memory: On architecture and memory*. London: The MIT Press.

Franck, K. 2016. *Architecture Timed: Designing with Time in Mind*. London. United Kingdom: John Wiley & Sons.

GREENinc Landscape Architects, 2009. *Forum Homini Boutique Hotel by GREENinc* [online]. Landezine. Available from: https://landezine.com/forum-homini-boutique-hotel-by-greeninc/ [Accessed 17 Apr 2022].

Harries, K. 1982. Buildings and the Terror of Time. *Perspecta*: The Yale Architectural Journal 19(1982):60.

Hemming, S., Sapounas, A., & Voogt, W. (2012). *Algenteeltsystemen voor de tuinbouw - integratie*. Wageningen: Wageningen UR.

Henkinson, R., & Edwards, M. (2012). *Imagine our Algae Future*. Richmond: Ronore Enterprises. Holm, A. (2015, December 7). *The building of the Dam Wall*. Retrieved from Hartbeespoort: https://hartbeespoort.org.za/2015/12/07/how-we-manage-large-construction-projects/#

Hobson B. 2014. Blond and Bieber's dyes made from algae "don't harm nature at all". *Dezeen*. Available from: https://www.dezeen.com/2014/12/03/movie-blond-and-bieber-algaemy-dyes-made-from-algae-video-interview/

Irving-Beer, R. (2019). *Staging Impermanence: Material Theatres*. Ontario: Charleton University.

Jacobson, M. 2019. *Weathering Architecture - a saline centre for research and creativity at the old salt river mouth*, Engineering and the Built Environment ,School of Architecture, Planning and Geomatics. http://hdl.handle.net/11427/32106

Johnson, M. B., and Wen, Z. (2010). Development of an Attached Microalgal Growth System for Biofuel Production. Appl. *Microbiol. Biotechnol*. 85 (3), 525-534

Juniper, A. (2003). *Wabi Sabi: The Japanese Art of Impermanence*. Tuttle Publisher.

Koren, L. (2008). *Wabi-Sabi for Artists, Designers, Poets & Philosophers*. California: Imperfect Pub.

Littman, J. (2009). R*egenerative Architecture: A Pathway Beyond Sustainability*. Amherst: University of Massachusetts.

Lucking, M. 2019. Malu Lucking. Available from: https://maluluecking.pb.design/non-woven

Magaliesberg Biosphere [online], 2019. *Magaliesberg Biosphere Geology and Topography*. Available from: https://magaliesbergbiosphere.org.za/geology-topography/

Mehrotra, R., 2019. *The architectural wonder of imperishable cities*. [Video]
Available at: https://www.youtube.com/watch?v=Kc6hkHGHQQc

Mona, S., Yazhini, M., Maya, S., Fakhruddin Shaukat, P., & Chandra Sekarenthiran, S. (2019). Extraction of algal pigments and their suitability as natural dyes. *Journal of Algal Biomass Utilization*, 10(2), pp. 1-4.

Mostafavi, M., & Leatherbarrow, D. (1993). *On Weathering: A Life of Buildings in Time*. Cambridge: The MIT Press.

Nakib, Faiza. 2010. *Toward an Adaptable Architecture: Guidelines to Integrate Adaptability in the Building*. Salford Quays, United Kingdom.

Ndlela, L., Oberholster, P., Van Wyk, J., & Cheng, P. (2016). An overview of cyanobacterial bloom occurences and research in Africa over the last decade. *Harmful Algae*, 60(11-26). Elsevier.

Nel, J. (2016, February 24). *Bit of South African History in pictures: Hartbeespoort Dam*.
Retrieved from Dinge & Goete: http://dingeengoete.blogspot.com/2016/02/bit-of-south-africa-history-in-pictures.html

Nidhi, A. (2021). *Algalife: Eco-Friendly Fabric from Algae*. Retrieved July 2, 2021,
https://appareltalksbyapurva.wordpress.com/2021/01/15/algalife-eco-friendly-fabric-from-algae/

Nkosi, N. (2016). *Sewage shock at Hartbeespoort Dam*. Retrieved July 2, 2021, from The Department of Water Affairs

Norberg-Schulz, C, 1980, *Genius Loci: Towards A Phenomenology of Architecture*, Academy Editions, London.

Nute, Kevin. 2016. *The Presence of the Weather*. Architectural Design. 86. pp. 66-73

Omega Institute for Holistic Studies. 2022. *The Living Building*. Eomega.Org.
Available from https://www.eomega.org/center-sustainable-living/the-living-building

Pallasmaa, J. 2000. *Hapticity and Time:* Notes on Fragile Architecture.

Pallasmaa, J. 2005. *The Eyes of the Skin*. Chichester: John Wiley & Sons Ltd.

Pallasmaa, J. 2006. *An Architecture of the seven senses*. San Francisco: William Stout Publishers.

Plagemann, G. 2010. *An Architecture of Amelioration*. University of Tennessee.

Podola B, Li T, Melkonian M. 2017. *Porous substrate bioreactors: a paradigm shift in microalgal biotechnology*. Trends Biotechnol. 35(2): 121-132.

Prigogine, I., & Stengers, I. 1984. *Order out of Chaos*. New York: Bantam.

Qui, F. 2013. *Algae Architecture*. Delft: Architectural Engineering Lab.

Quiros, L., MaKenzie, S. and McMurray, D., 2022. *Enric Miralles: Architecture of Time* . [online] Quirpa.com.
Available at: http://www.quirpa.com/docs/architecture_of_time__enric_miralles.html#:~:text=Miralles%20believed%20that%20an%20architecture,of%20experiencing%20layers%20of%20time%20.&text=It%20is%20movement%20through%20space,space%20found%20in%20Miralles%20architecture.

Serres, M. (1995). *The Natural Contract* (1 ed.). (E. MacArthur, & W. Paulson, Trans.)
United States of America: The University of Michigan
Press. Retrieved April 4, 2021, from https://monoskop.org/images/d/d0/Serres_Michel_The_Natural_Contract.pdf

Shing, R. (2010). *WEATHERING ARCHITECTURE: A STUDY OF CONTINGENCY AND ENTROPY IN OUR BUILT ENVIRONMENT*.
Toronto: Ryerson University.

Smith, L. (2020). *The clothing of the future completeley dissolves after use*. Retrieved June 15, 2021.
https://www.fastcompany.com/90544924/the-clothing-of-the-future-completely-dissolves-after-use

Sola-Morales, I. 1997. *Liquid Architecture*. Anyhow. pp. 36-43

Stofko, M. (2018). *The Temporal Nature of Architecture*. Toronto: Ryerson University .

Tackett , C. 2018. *The World's Most Beautiful Wastewater Treatment Plant*. Treehugger.
https://www.treehugger.com/omega-center-sustainable-living-eco-machine-living-building-water-treatment-4857905

Tampier, M., Alabi, A., & Bilbeau, E. (2009). *Current Technology, Suitability & Barriers to Implementation.*
The British Columbia Innovation Council.

Wahl, D.C. 2006. Unpublished PhD Thesis: *Design for Human and Planetary Health: A Holistic/Integral Approach to Complexity and Sustainability*.
University of Dundee.

Ware, SueAnne. (2016). *Knowingly Unfinished: Exploiting the Temporality of Landscapes*. Architectural Design. 86. 74-81. 10.1002/ad.2004.

Water Power and Dam Construction. (2013). *Healing South Africa's ailing dams*.
https://www.waterpowermagazine.com/features/featurehealing-south-africas-ailing-dams/

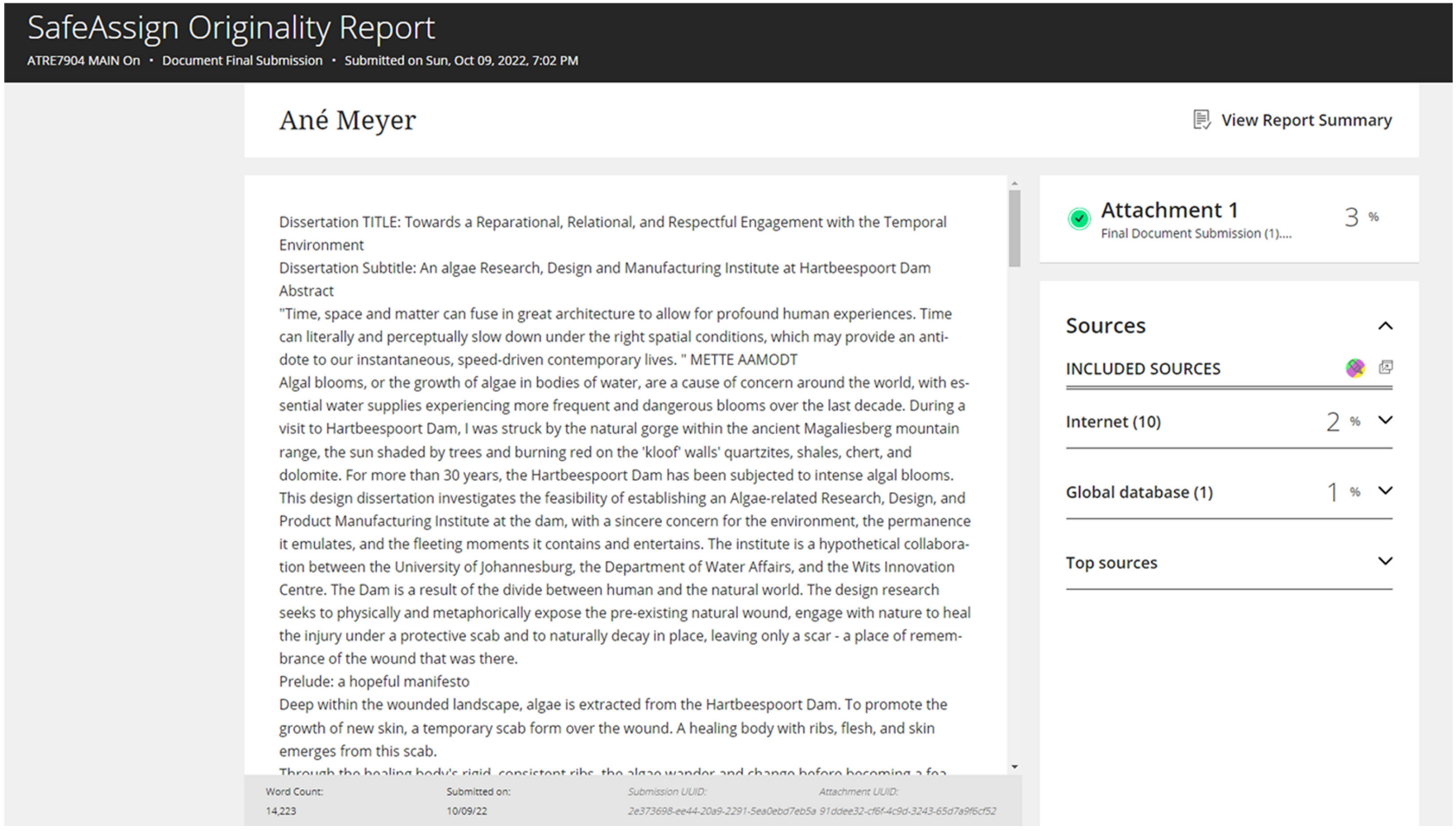
Weisman, A. (2007). *The World Without Us*. Harper Collins Publishing.

Wellinger, A. (2009). *Algal Biomass. Does it save the world?* IEA Bioenergy.

Weyler, R. 2018. A Brief History of Environmentalism. *Greenpeace International.*
Accessed: https://www.greenpeace.org/international/story/11658/a-brief-history-of-environmentalism/

Workman, V.A. 2004. *Mutualism in Architecture: An Architecture of the In-Between*. Knoxville, Tennessee: University of Tennessee.

World Health Organization. (2020). *Laboratory Design and Maintenance* . Geneva: World Health Organization.


SafeAssign Originality Report
ATRE7904 MAIN On • Document Final Submission • Submitted on Sun, Oct 09, 2022, 7:02 PM
Ané Meyer
View Report Summary
Dissertation TITLE: Towards a Reparational, Relational, and Respectful Engagement with the Temporal Environment
Dissertation Subtitle: An algae Research, Design and Manufacturing Institute at Hartbeespoort Dam
Abstract
"Time, space and matter can fuse in great architecture to allow for profound human experiences. Time can literally and perceptually slow down under the right spatial conditions, which may provide an antidote to our instantaneous, speed-driven contemporary lives. " METTE AAMODT
Algal blooms, or the growth of algae in bodies of water, are a cause of concern around the world, with essential water supplies experiencing more frequent and dangerous blooms over the last decade. During a visit to Hartbeespoort Dam, I was struck by the natural gorge within the ancient Magaliesberg mountain range, the sun shaded by trees and burning red on the 'kloof' walls' quartzites, shales, chert, and dolomite. For more than 30 years, the Hartbeespoort Dam has been subjected to intense algal blooms. This design dissertation investigates the feasibility of establishing an Algae-related Research, Design, and Product Manufacturing Institute at the dam, with a sincere concern for the environment, the permanence it emulates, and the fleeting moments it contains and entertains. The institute is a hypothetical collaboration between the University of Johannesburg, the Department of Water Affairs, and the Wits Innovation Centre. The Dam is a result of the divide between human and the natural world. The design research seeks to physically and metaphorically expose the pre-existing natural wound, engage with nature to heal the injury under a protective scab and to naturally decay in place, leaving only a scar - a place of remembrance of the wound that was there.
Prelude: a hopeful manifesto
Deep within the wounded landscape, algae is extracted from the Hartbeespoort Dam. To promote the growth of new skin, a temporary scab form over the wound. A healing body with ribs, flesh, and skin emerges from this scab.
Through the healing body's rigid, consistent ribs, the algae wander and change before becoming a foa
Word Count: 14,223
Submitted on: 10/09/22
Submission UUID: 2e373698-ee44-20a9-2291-5ea0ebd7eb5a
Attachment UUID: 91ddee32-cf6f-4c9d-3243-65d7a9f6cf52
Attachment 1
Final Document Submission (1)....
3 %
Sources
INCLUDED SOURCES
Internet (10) 2 %
Global database (1) 1 %
Top sources