

BIOPHILIC PLACEMAKING

Rooting Aquaponics in the landscape of the Eastern Free State

2016035103 | Carissa Viljoen | 2021

EXAMINER COMMENTS ...





ACKNOWLEDGEMENTS

To my Parents for all your love, support and prayers

Professor Jan Smit, Petria Smit, Hein Raubenheimer,
and Mr Ras for their advice and guidance throughout the year.
My loved ones for understanding and supporting me

Our Heavenly Father for never leaving me alone.
Psalm 9: 1 ” I will praise you, O Lord, with all my heart; I will tell
of all your wonders.”



DECLARATION

This dissertation is submitted in partial fulfilment of the requirements for the degree M. Arch. (Prof.) at the University of the Free State. All the work contained in this document is my own, unless otherwise acknowledged.

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The work contained in this dissertation has been submitted for proof-reading and/or editing by Yolande Botha.

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ABSTRACT

How can we as architects build a new world of sustainable beauty? This thesis posits that it is possible by learning from nature. Biomimicry and permaculture look at nature as a catalogue of products that have undergone a 3.8 billion year period of research and development. Given this level of sophistication, biophilic and permaculture theory argues that it makes sense to break down the patterns and principles of the natural environment into building blocks that can be applied to the built environment. This thesis explores the notion of how these sustainable design strategies, can be applied to the design of a site (an aquaponic Lifestyle Farm) to create a sense of place, or genius loci, that can connect us with the wider natural world in order to break down the human-nature dichotomy. By creating an evocative, emotional connection and interaction with the natural environment, the aim of this project is to bring humans into alignment with the natural world and the sustainable practices that we need to adopt in order to ensure our survival within it.

Key words: Sense of place; permaculture; biophilia; aquaponics; agriculture; landscape

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INTRODUCTION

"As an architect you design for the present, with an awareness of the past for a future which is essentially unknown." – Norman Foster

We are living in a historical paradox – while the pandemic has upended our lives and uncertainty reigns supreme, we are also facing a future of almost certain demise, should we not make the changes that can potentially reverse the effects of centuries of environmental degradation. The green agenda is the most important issue of the day because our survival depends on it. Perhaps then, we are not in a situation where we are designing for a future that is unknown as the above quotation suggests, but rather we have shifted to a climate in which we have to design within the confines of the present to make our continued existing a future possibility. In other words, we need to design within present parameters to create the future we want.

The purpose of the design of the aquaponic Lifestyle Farm that is mapped in this paper touches on the various facets of sustainability for this reason. It aims to explore the nature of sustainability, how we can anticipate what technologies can create more sustainable local environments, what design decisions follow from that, and what the challenges and opportunities are of designing with nature as the guiding principle.

This project also challenges the notion that more sustainable buildings will lead to a more sustainable future. Instead, it sees building as one proponent of a much bigger picture. You cannot separate the building from the landscape, you cannot separate the landscape from nature, and you cannot separate the human from the natural world. While buildings often separate us from nature, we are of nature, not distinct from it and, as this thesis will explore and as will be embodied by the design, it is through creating a sense of place that reconnects us with the natural environment that we can re-establish our symbiotic relationship with nature, and in doing so, take greater responsibility for the care of the natural world which has been bestowed on us.

By creating a building that is guided by nature and that aims to connect the human with nature throughout its various different touchpoints, it will be argued that an architecture underpinned by the principles of biophilia and the patterns of permaculture can help us create sustainable buildings, but more than that, can reconnect us with the wider non-human world in an effort to inspire us to create more sustainable lives.

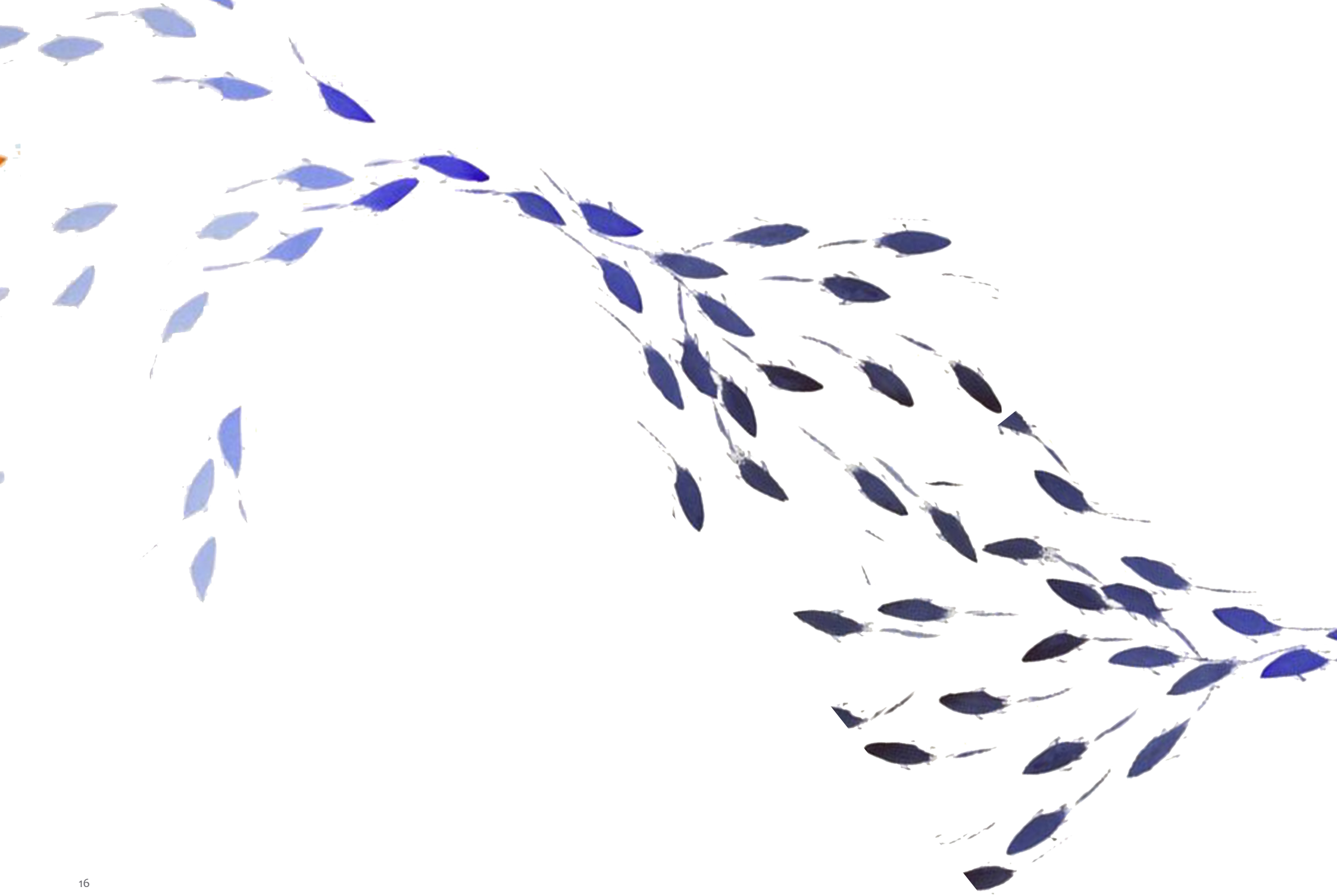
While aquaponics takes centre stage in this project as a sustainable agriculture technology, in many ways the use of aquaponics is also a metaphor for the symbiotic relationships we find in mature ecosystems. By immersing ourselves in the natural

symbiosis found in nature, it is possible to find a lot of solutions to today's problems, as the realms of biophilia and permaculture illustrate.

Far too much talk about the environment and sustainability is framed in negative language. This thesis will steer away from applying sustainability merely as a lens or linguistic tool but will work with it as a necessity for design – a basic principle that ought to naturally underpin all modern design. This thesis will speak of synergies and optimising to create abundance.

The design of the Lifestyle Farm will not be about sacrifice in the name of sustainability, instead it will be a great celebration of the naturally occurring beauty of the site, the potential of this landscape to guide design decisions and, ultimately, of the deeply human connection to almost unspoilt sites like these that remain of primal importance.







PROJECT RATIONALE

Given the global environmental crisis, this project will explore the potential of sustainable design (architecture underpinned by aquaponic technology) to create a true sense of place (a Lifestyle Farm) that can catalyse income generation through tourism and agriculture, as well as contribute to cultivating and strengthening an ethos of environmentally conscious living within the community living around the site and visitors to it.

While the farm's produce can feed bodies and its design can feed curiosity, in allowing us to connect with the natural world and one another, both of which are so vital to our survival, it can also feed souls and a hope for a more sustainable future.

PART 01

RESEARCH QUESTION AND AIMS

1.1 RESEARCH QUESTION
1.2 PROJECT AIMS

1.1 RESEARCH QUESTION

Sense of place is the main conceptual theme used to guide this project. Throughout the dissertation the term will be operationalized in a manner that denotes its original meaning as the "spirit of the place" or genius loci (CURL, 2018: online). As Edward T. McMahon defines it, "A sense of place is a unique collection of qualities and characteristics 'visual, cultural, social, and environmental' that provide meaning to a location. Sense of place is what makes one city or town different from another, but sense of place is also what makes our physical surroundings worth caring about" (Mc Mahon cited in Hsiao, 2012).

The secondary theme for the project will be centred around the sustainable design technology of aquaponic farming. Aquaponics combines aquaculture (rearing of fish and other aquatic animals) with hydroponics (growing of plants without soil).

The final key theme that will be explored is that of biophilic design and permaculture. Biophilic design and permaculture increases human connectivity to the natural world through the use of direct nature, indirect nature, and space and place conditions. This approach holds health, environmental, and economic benefits with few drawbacks (Muir, 2021: online).

From these three central themes, follows the research question that will guide this project and its design:
How can biophilic design and permaculture principles be used to guide the design of an aquaponic Lifestyle Farm in the Eastern Free State and, in doing so, create a true sense of place?

In relation to this main guiding research question, some sub-questions that will be unpacked include:
1. What type of architecture is necessary for an aquaponic Lifestyle Farm to function?
2. How can biophilic and permaculture principles be incorporated into the chosen site and project?
3. How will designing a space that is independent of the landscape challenge and supplement the notion of sense of place?

1.2 PROJECT AIMS

The architectural aim will be to design a space where the aquaponic farm can establish a sense of place by responding sensitively to the landscape.

In practical terms, the aquaponic Lifestyle Farm will extend the farm's agricultural capabilities while at the same time add ing a hospitality wing to the farm's current activities. The accommodation list is thus, divided into three branches that create specific genius loci.

Firstly, eat: deli shops, a restaurant-venue space. Secondly, relax: accommodation and thirdly learn: the aquaponic farm (consisting of a greenhouse, loading dock, fish tanks, planter pipes, storage, fish/plants processing, and overall administration). Besides the built accommodation list, the farm will provide outside activities such as 4x4 routes, horseback riding, fishing, hiking, cycling and adventure activities like abseiling.

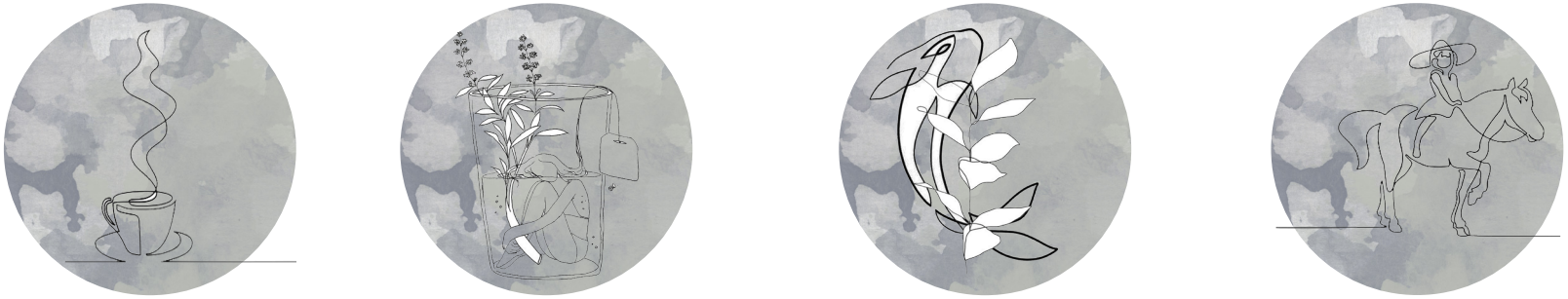


Figure 1 Compiles vector illustrations, illustrating the different parts of the accommodation list (Freepik, 2021: online)

PART 02

THEORETICAL GROUNDING: GENIUS LOCI

2.1 TOUCHSTONE
2.2 THE CONCEPTS
2.3 CONCEPTUAL FRAMEWORK
2.4 LITERATURE
2.5 THEORETICAL PRECEDENTS

INTRODUCTION

This section deals with establishing informed design parameters based on the research set as part of the conceptual framework.

The research takes the form of various precedent and case studies and a literature review to provide a theoretical discourse on which to base further design decisions that will inform the approach to designing the aquaponic Lifestyle Farm. This investigative process is spearheaded by an initial conceptual approach, as illustrated by the design touchstone where the interaction between agriculture, architecture and the landscape was explored.

The touchstone continues to generate several concepts, which in turn direct further research into specific conceptual fields. These conceptual underpinnings and the readings will formulate specific design parameters that guide the design process. These conceptual explorations will be taken into consideration for the design.

2.1 TOUCHSTONE

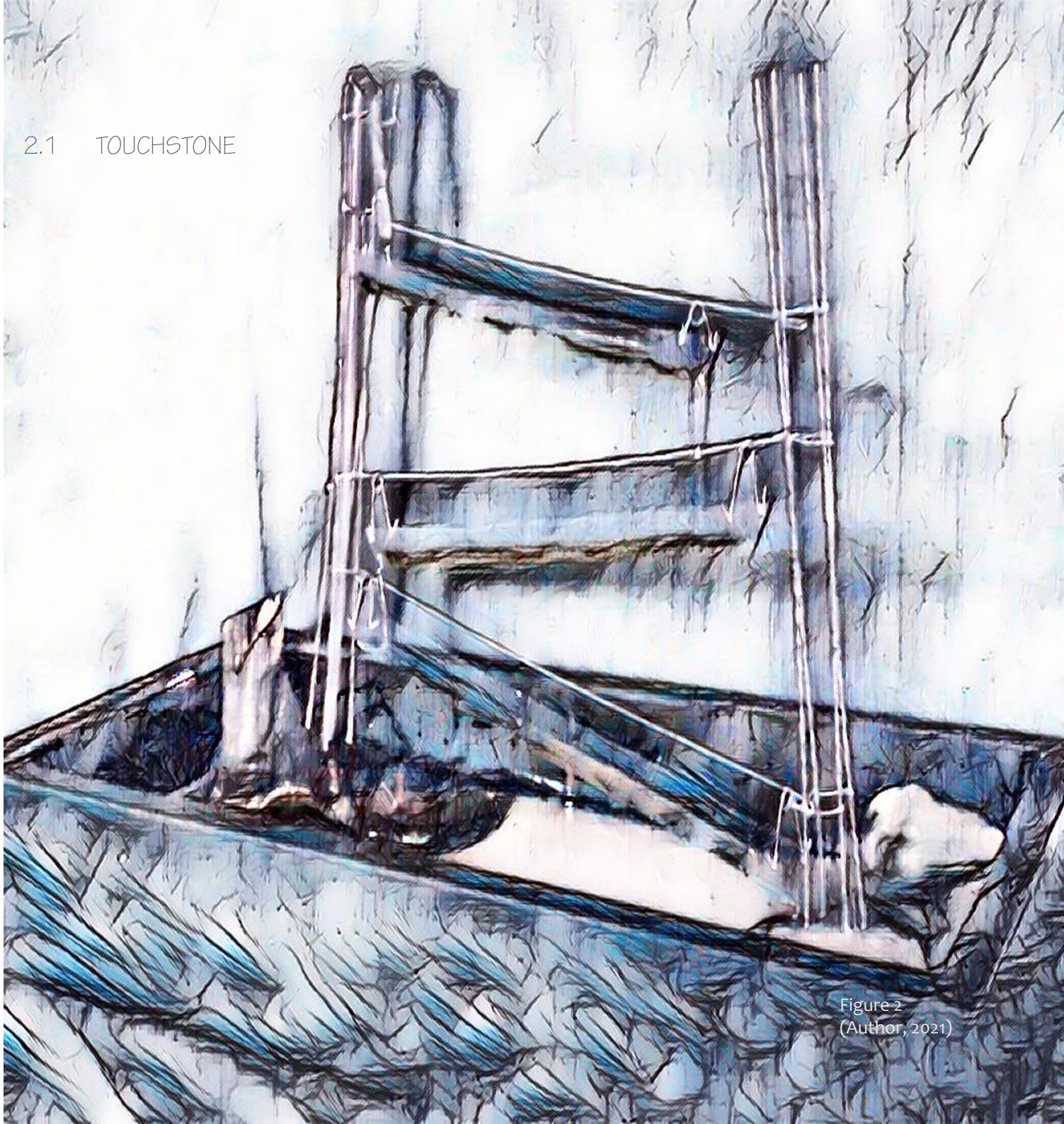


Figure 2
(Author, 2021)

Figure 2
Representation of touchstone model
Figure 3 -5
Photos taken from model at different angles
Figure 6
Representation of touchstone model showing the water interaction

The touchstone of the design is the starting point for the investigation. Investigating the true essence of what the peace of architecture wants to be. A touchstone is seen as a metaphor by which the design intent can be measured—the suggestive presentation of the project's aspirations.

The heart of the project is rooted in two main themes, namely agriculture and landscape. Agriculture links with aquaponics and tourism links with the landscape. Together these two themes become the catalyst for the architectural aim.

The two identified themes are interdependent. Together they can be read as agricultural landscapes. On a macro scale, the landscape attracts users with its picturesque beauty—curiosity taking overdraws the user to the aquaponics creating a meso level from the macro landscape. When the user experiences the aquaponic system, the landscape's micro-level unfolds, creating another level of experience. Thus, there is constant interaction between the two themes.

The base of the touchstone represents the landscape, featuring found materials gathered from the site such as wood, sand, and sandstone rocks. The water circulation system represents the agricultural theme of the design and denotes the use of aquaponics within the design. The system can be understood as being vertical in orientation as one stream of water flows on top of the other. This verticality links with the context of the landscape in which the design is located seeing as the silos and barns found on the site read as vertical in the surrounding context.

The plants featured in die tubes depict organic growth. The design of the touchstone creates an illusion of glass representing the modern farming methods (aquaponics) that the design of the Lifestyle Farm incorporates. The water flowing in such a way that one can touch it symbolises the experiential and interactive elements the user will enjoy at the Lifestyle Farm, allowing them to become immersed in the landscape and the architecture.



Figure 3
(Author, 2021)

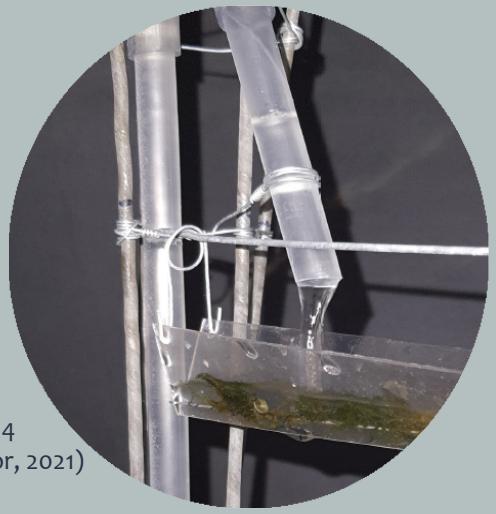


Figure 4
(Author, 2021)



Figure 5
(Author, 2021)

The sound of the water creates a sense of tranquility and peace which is representative of the serenity found within the landscape with the fountain found on site. The wire used to build the structure of the touchstone represents the materiality obtained from the context as most barns are constructed with corrugated iron, which also reads as a tectonic structure. From a theoretical point of view, the touchstone represents biomimicry (an attribute of the Biophilic element 'Natural shapes and forms') through its imitation of some of the main elements found in the natural environment that envelopes the design site. The theory of biophilia will be explored in further detail in the following sections.

The philosophy of permaculture is about working with and not against nature. In other words, the landscape is used as a guide to reveal what interventions should be taken from an architectural point of view. The whole touchstone links with the notion of permaculture where the user observes and interacts with the design, connecting and interacting with the context through their senses – the ability to touch elements featured in the touchstone design and by listening to the sound of the water.

Lastly, all the experiences encapsulated on the touchstone design act together to metaphorically represent the spirit of the place where the design will be located, also known as the genius loci. The different elements work together to capture the atmosphere of the site, giving the user a taste of the qualities of the environment. The aim is of this sense of place to create an attraction to the site and to bestow an indefinable sense of well-being on the user.

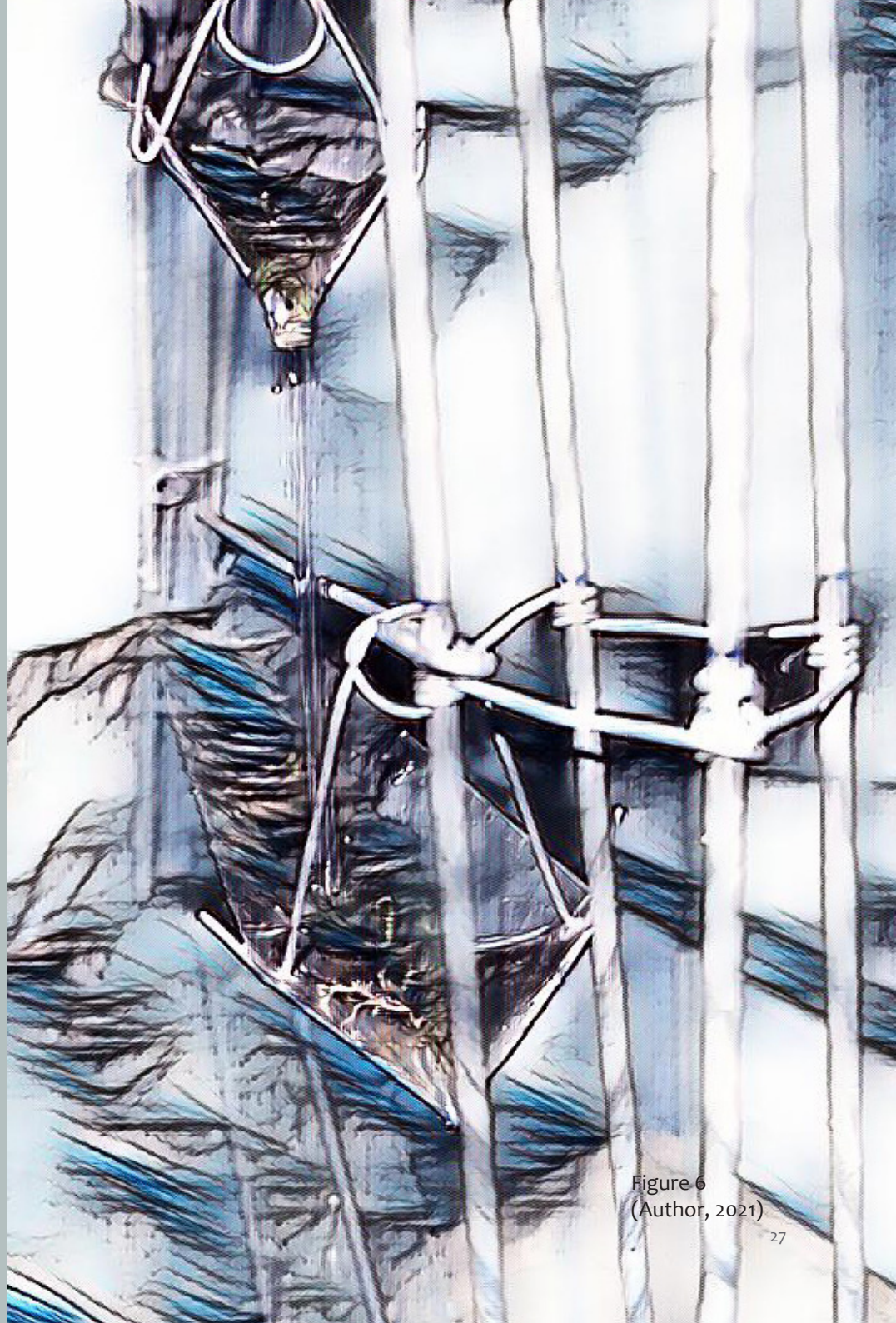


Figure 6
(Author, 2021)

FUNCTION: TRANSPIRING THE LANDSCAPE



Figure 7 Model showing the interpretation of the levels of the landscape (Author, 2021)

By employing a subjective approach to experiencing a space, a deeper understanding can often be revealed, however, this is of course dependent on how you look and what draws your attention within a landscape.

In order better understand the chosen site, the landscape was transpired in levels. The macro level is based on a core point of focus found in the plains, that of the built environment which is seen as the starting point for all activities related to the design. On a Meso level the attraction leans toward the willow trees at the creek. Here a transitional space between the shade and the water is experienced. At the micro level individual elements invite a closer look. A bush can be seen as a mass of green, but when looking closer it becomes a dance of multi coloured-leaves, branches and berries. The model shows how these levels of perceiving are connected to each other and how they come together to form the transpiration of the landscape, in other words, factual knowledge of the area is merged with subjective sensory data.

In this way the function of the landscape is revealed which can then be mimicked in the functional design of the Lifestyle Farm to create a synergy between the current place and the space that will be created on it.



Figure 8 Interpretation sketch revealing the different levels based on personal experience on site (Author, 2021)

ATTRIBUTES: TOPO – EDIFICE



Figure 9 Model based on the materiality of space (Author, 2021)

The second conceptual model speaks to the materiality of the space, not just in terms of the materials intended to be used for the design of the farm, but also in relation to the particular geographical space the site occupies and its specific attributes.

Each topography has its own agricultural characteristics. Looking at the Eastern Free State the agricultural methods used reveal the deeper composition of the farmlands around the site. The way in which the farms are 'constructed' takes a myriad of topographical and environmental factors into consideration.

From contours to regulate the flow of water, to the direction in which crops are planted to shield them from the wind, and the golden ackers planted for movement. All these factors create a certain edifice in the countryside that reveals form, order and a process.

The contours of the farmlands read as a permanent solid mass that protect the temporary planted rows in prepared soil. The grid-like rhythmic planted rows fill a great space with a rigorous geometry, while transmitting an ephemeral sense of weightlessness against the solid soil mass. The form giving and masses from the agriculture sector reveal the specific structure and establish an opportunity to react on it.



Figure 10 Interpretation sketch revealing the topography experience on site (Author, 2021)

AN DEPENDENT| INDEPENDENT UTILISATION

David Holmgren, co-inventor of the permaculture design system, once said that an ability to read the landscape provides the architect with the opportunity to work with the processes of nature (Rosenfeldt, 2014: online).

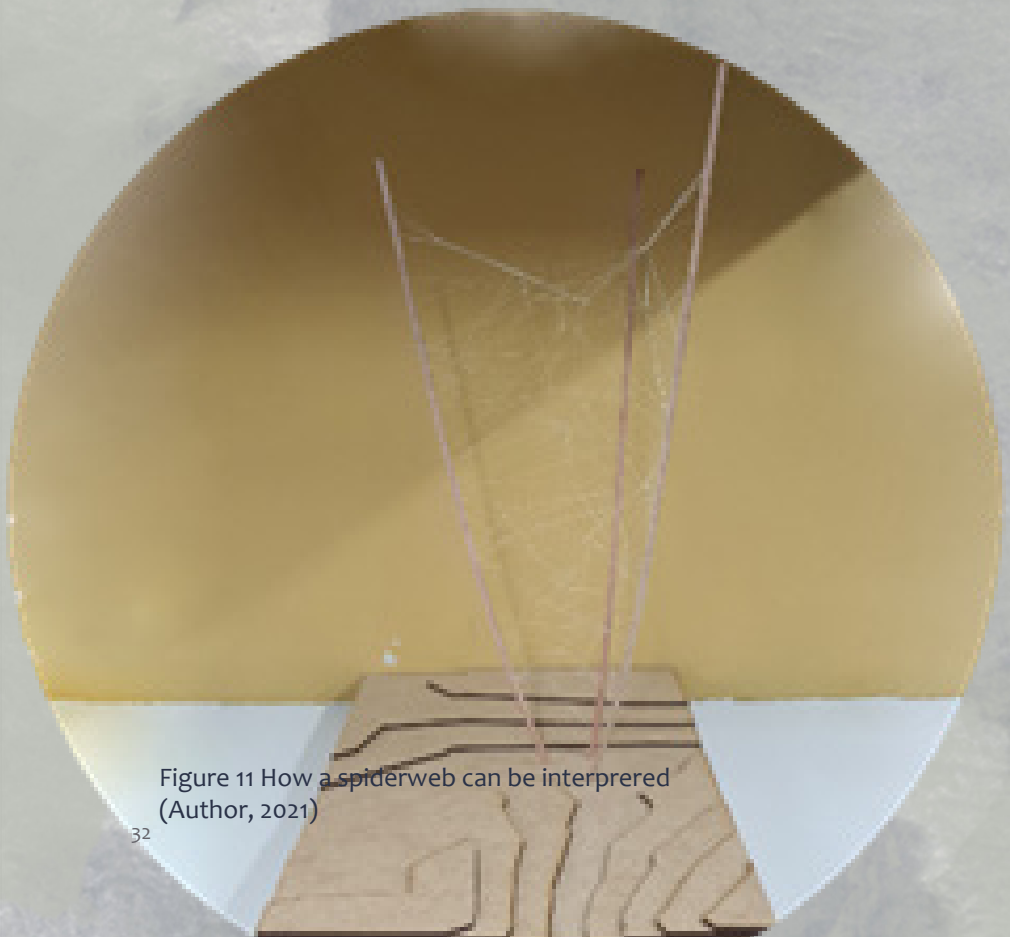


Figure 11 How a spiderweb can be interprered (Author, 2021)

Tying into Holmgren's idea, the final concept is based on a metaphorical exploration of a spiderweb found on the site. When looking at a spiderweb a certain structure can be identified. The web only connects to the landscape at critical structural support points, the rest the web is a self-sustaining system, that does not really use the landscape. It almost sits softly in the landscape creating a type of invisibility.

Aquaponics is not dependent on the peace of land, the soil, the climate, or the rainfall of the specific site. This farming method can thus be seen as a 'spiderweb' with its own self-sustaining system that sits gently on the existing landscape. While at first glance the spiderweb-like qualities of the aquaponic farm may make this kind of endeavor seem devoid of a sense of a place, after all it creates its own ecosystem rather than being dependent on the naturally occurring environment upon which it rests, the ability of the farm to be a sustainable source of plants and animal protein speaks to the needs of the much larger human ecosystem and thus denotes a greater sense of meaning.

While on the surface the Lifestyle Farm is a hub for agriculture and tourism, at a deeper level it also takes up a place within the much larger ecosystem of the human experience in which it becomes a node that symbolises our dependence on nature for our continued existence.

In this sense the Lifestyle Farm can be understood as being biophilic, in other words, a site that gives both life and meaning (Browning, Ryan & Clancy, 2014: 9). In this way a real sense of place is created by the farm's spiderweb-like design – while its produce can feed our bodies and its design can feed our curiosity, in allowing us to connect with the natural world and one another, both of which are so vital to our survival, it also feeds our souls and our hope for a more sustainable future.



Figure 15: Interpretation sketch revealing the spider web (Author, 2021)

2.3 CONCEPTUAL FRAMEWORK

The conceptual framework aims to explore the potential of sustainable design (architecture underpinned by aquaponic technology) to create a true sense of place (a Lifestyle Farm) that can catalyse income generation through tourism and agriculture, as well as contributing to cultivating and strengthening an ethos of environmentally conscious living within the community living around the site and visitors to it.

The sustainable design technology that will be deployed as the primary tool for this project is aquaponic farming. Aquaponics combines aquaculture (rearing fish and other aquatic animals) with hydroponics (growing plants without soil). What is revolutionary about this approach is the symbiotic relationship between the aquatic life and the plants – the fish, along with their waste, provide the plants with vital nutrition while the plants, in return, clean the water fed back to the plants fish. Not only do aquaponic farms use 1/10th of the amount of water required for soil-based farming, but they are also organic (pesticides would be harmful to the fish, and the plants are not exposed to soil-based infections due to being rooted in water), and they can be established in arid and semi-arid areas (typical of the majority of South Africa) due to not being dependent on the availability of fertile soil. This makes aquaponic farming an attractive option as we look towards the future in which ensuring food security despite environmental challenges will be crucial (North, 2016: online).

Precedent & case studies:
· Sustainable Buildings Research Centre
· Babylonstoren

Themes:
· Sense of place
· Permaculture
· Biophilia



Figure 13 Interpretation of the conceptual framework (Author, 2021)

Sense of place is the main conceptual theme used to guide the design. From a theoretical point of view, this requires a deep-dive into sense of place as the leading theme of the research project, supported by the following sub-theories:

- Biophilic design or Biophilia, where the human connection to nature and the landscape is investigated.

- Permaculture which entails working with and not against nature and allowing the landscape to reveal what decisions should be made from an architectural point of view.

2.4.1 Sense of place

The primary conceptual theme used to inform the proposed design is based on uncovering sense of place as an architectural principle and how this can be applied to the Lifestyle Farm design. Sense of place can be understood as the "spirit of the place" or genius loci (CURL, 2018: online).

Each specific space has a particular character that reflects the precursors of the area, whether in a large region like the countryside or the urban networks of the city. This character can be seen as the genius loci (Conzen, 1966: 56–57).

When a place carries a unique character, this can often give it a special meaning in the hearts and minds of its users. This implies that sense of place can further be defined as "the collection of meanings, beliefs, symbols, values, and feelings that individuals and groups associate with a particular locality" (Williams & Stewart 1998).

The main goal of architecture is to reveal the true potential of a place and to place your design into perspective with its surroundings. Norberg-Schulz (1980: 23) implies that an essential role of architecture is to provide the physical features of a place that allow a person to dwell. When a person feels safe he/she will remain there and this allows a peaceful place to be established.

Architecture "belongs to poetry, and its purpose is to help man dwell". Giving man the opportunity to dwell enables him to concretise the world in buildings and things. In essence, the role of architecture is to concretise genius loci (Norberg-Schulz, 1980: 23).

We can distinguish between the natural world and that which is created through human intervention. This is also true in genius loci, where these two different kinds of space take their spirit from the differing attributes found within each realm.

Our landscape is shaped by nature, and this includes all the natural cycles that continually change and flow as time goes on. (Norberg-Schulz, 1980: 25–32).

Spaces that humans create have strict boundaries and enclosures, unlike the natural environment. The very character of human spaces is defined by what is enclosed and what is left outside of the boundaries of the constructed space. As Humans we tend forget to think outside the box, all man-made structures follow specific patterns, we have vertical and horizontal lines, we create centre pieces and focal points as why try to imitate our natural surroundings. The landscape extends from this central space with varying continuity (rhythm) (Farshadi, 2017:18).

In his book *Existence Space and Architecture* (1971), Norberg-Schulz mentioned that people need "symbols" to have spiritual sustenance. Through the process of "concretisation", humans put meaning and feeling into their lived environment

in order to create a sense of identification and self-affirmation in the universe. Concretization also helps tie people, and their existence to a specific geographic location that is often enthused with anger, grief, joy, and happiness – the entire array of complex emotions arise when humans gather and live together (Yiran, 2009: 10).

To use Norberg-Schulz's approach, the contributions of topography, natural conditions and variations, and symbolic meanings tend to weigh less than built form. Although this approach may result in a place with an identifiable character, people integrate features through value systems to form a sense of place (Jiven & Larkham, 2003: 78).

Norberg-Schulz seeks meaning and essence and symbolic function by understanding the systematic patterns and conceives of people's lifeworld as a basis for orientation and identity (Jiven w& Larkham, 2003: 71).

All the combined qualities of nature can be seen in human feelings and emotions and this is how humans create a sense of place that is one with nature. This feeling or emotion is connoted by something that initially might seem intangible, but it is not superficial.

Places created by humans are related to nature in three ways:

1. To visualise the human understanding of nature,
2. To complement the natural environment, and
3. To create a symbolic interpretation of the natural world

(Farshadi, 2017:18).

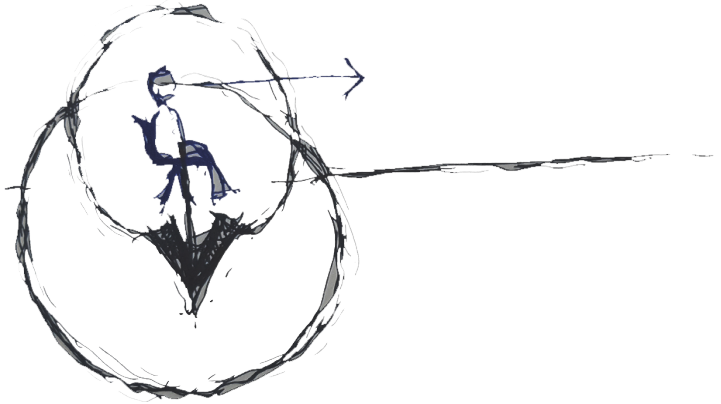


Figure 14 How humans connect to place (Author, 2021)

Investigating Genius loci beyond the thematic levels of Norberg-Schulz, the Gestalt theorists can see the Sense of place as a harmonious interaction between three different components that make up the overall Sense of space:

1. The functional use or purpose of the space
2. The physical attributes of the space
3. The meaning behind the space

(Slocombe, 2018: online).

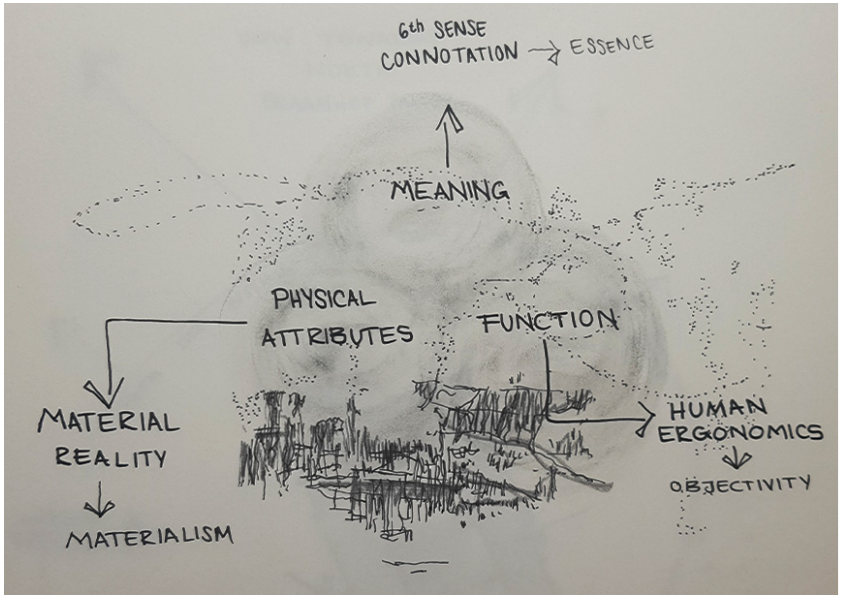


Figure 15 Harmonious interaction between different components to make up Sense of space
(Author, 2021)

The physical attributes are founded in materialism, the function is founded in objectivity, and meaning is founded in essence (Slocombe, 2018: online).

The Gestalt interaction of these three essential components creates a desirable, sublime and subconscious human emotional response one can call a sense of place. When everything in the space is in harmony, the whole (place) can be seen as a holistic whole and not separated parts, and it speaks to our subconscious in a language, not of words, but universally understandable.

Two of these three components are simple to understand and facilitate: practical use or purpose and physical attributes, but one of them, meaning, is somewhat esoteric in its application (Lynch, 2020: online). Functional use barely needs explanation. This concept is based on functionality and a logical approach (Slocombe, 2018: online).

Sense of place speaks to us in what might be described as the 6th Sense. We can see with our eyes the materials that define the space: walls, buildings and plants, and we can touch them to feel their texture; we can use the functional items of the space, but something else remains, a sense, an intrigue or perception, something not born entirely, or even at all of the five primary human senses – this is the Sense of place (Slocombe, 2018: online).

The physical attributes of the building materials ‘soft’ and ‘hard’ delineate and furnish the space. Vernacular ‘hard’ building materials convey a sense of place connecting the space to its local geographical and historical environment (Slocombe, 2018: online).

The ‘soft’ materials (planting) are equally powerful in connoting a portion of the Sense of Place, especially regarding geographic regions (Slocombe, 2018: online).

Creating architecture with meaning, physical attributes, and function with the main focus on the Sense of place creates a particular interaction with space and how people interact with it.



Figure 16 Experience of soft maerials (Author, 2021)

Edward Relph explores the experience of space by looking at how people interact with space in his book *Place and Placelessness*. His findings unfold modes of experience, namely:

- Pragmatic space - an organic and primitive space rooted in a fundamental objective. Its structure is unconscious and starts with the actual experiences of early childhood.

- Perceptual space is a sense of place filtered through the individual experience and personal sensory engage ment with space.

- Existential space - this is an inner structural space formed through our experiences. It is inter-subjective and is constantly being actively created by human activities, predominantly in culture.

- Pattern language spaces – this concept describes how spaces are converted into meaningful places with high potential for attachment and tightly held emotional bonds (Farshadi, 2017: 18).

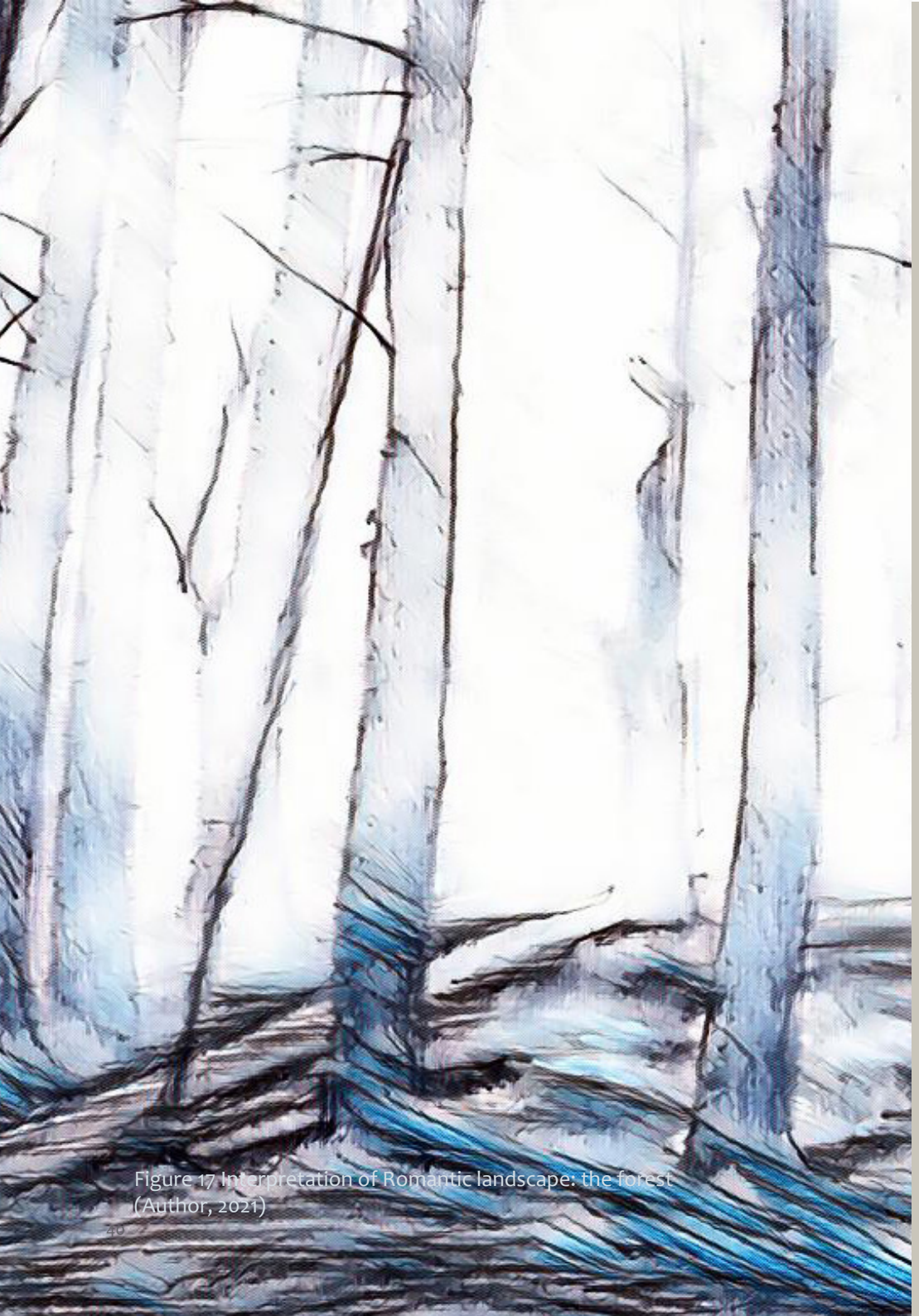


Figure 17 Interpretation of Romantic landscape: the forest (Author, 2021)

The Primary Landscapes Identified in Sense of Place Theory

Norberg-Schulz distinguishes between three primary landscape characters: romantic, cosmic and classical (Norberg-Schulz, 1985: 48). To correctly identify the landscape for the aquaponic Lifestyle Farm, a clear understanding had to be formed about the distinction between the romantic, cosmic and classical landscapes.

This classification system establishes a four-fold typology of natural places phenomenologically. Each of the ideal landscape types mapped by Norberg-Schulz is grounded in terms of its spatial character, light, daily and seasonal rhythms, atmosphere, water, land, and life. When all of these qualities are present together in one place it is then that a specific sense of place is created (Farshadi, 2017: 4).

According to Norberg-Schulz, the romantic landscape can be seen as an environment typified by change, variety, and detailed forests (Seamon, 1984: 242). The atmosphere and character of a romantic landscape are marked by complexity and contradiction. The inside and outside relationships are complex (Seamon, 1984: 242).

The cosmic landscape can be seen as more monotone, like the kind of landscape observed in deserts. Uniformity and complete order are the main features of this ideal type. One of the only surprise features observed in the desert is the sandstorm, but it is also monotonous because it does not represent order; it obscures the world and does not change it.

The cosmic landscape is comprised of forms that are static rather than dynamic. This landscape has no room for imagination, it sticks to its known boundaries and responds well to uniformity. (Farshadi, 2017: 12).

Therefore, cosmic landscapes are not defined as goal-oriented, but instead considered inversion and labyrinthine-like spaces. The labyrinthine space can be interpreted as space with no beginning and end. When large cosmic spaces are designed it is very important to take note of what is required of the space created, often the surroundings are not taken into consideration when designing a cosmic space, (Farshadi, 2017: 12).



Figure 18: Interpretation of Cosmic landscape: Desert
(Author, 2021)



Figure 19 Interpretation of Classic landscape: the Aquapoe Lifestyle Farm (Author, 2021)

The landscape which speaks to the spirit of human beings, is that of the Classical landscape. This type of landscape is characterized by special and unique features and is easily distinguishable from other landscapes. This is because the classical landscape encompasses an organised composition of individual elements which gives human dwellers a feeling of belonging and freedom. All parts of a classical landscape have an identifiable character that forms part of a family character related to human qualities (Farshadi, 2017: 13).

Reconciliation, or the harmonious equilibrium of the earth and sky, is manifest in the classical landscape. It has imaginability, an articulate order, and logical organization. The forms found within the classical landscape can be seen as organic (Farshadi, 2017: 13).

A classical landscape mixes topological and geometric properties. The Classical landscape use light and shadow to emphasise the parts and the whole (Farshadi, 2017: 13).

Attributes of landscapes: Natural landscape and manufactured places		
Romantic landscape	**Cosmic landscape**	**Classical landscape**
• Forms are not organised, seems the result from growth, configurations are free; • Geometrical boundaries are undefined and uncontained; • Has complexity and contradiction in volumes and its character; • Has a substantial atmosphere and does not seem logical (it is more mysterious and subjective); • It is more topological rather than geometrical; • Original forces are still strongly felt; • Ground is rarely continuing, and microstructures and place are dominated by earth; • Man has direct participation with nature (not social); • General unifying order is lacking (Farshadi,2017:12).	• Uniformity and absolute order; • Its monotone, and it does not have complexity; • It has a logical system and seems rational and abstract; • It is geometrical and concretised with a regular grid giving it a uniform and isotropic quality; • No defined goal direction, but it has clear visualization of the system; • It has an open relationship with its surroundings and does not have local microstructures; • Has abstract character, tries to dematerialize volumes (carpet-like); • Interior space uses ideal world elements (Farshadi,2017:13).	• Has coherency and Imaginable order; • Has logical organisation; • Forms are like organic life (neither static nor dynamic); • Good composition of individual elements and places; • Mixes topological and geometrical properties (democratic freedom); • All parts have their identity; every part conserves its identity within the totality (Gestalt); • Equilibrium of earth and sky is manifest in this landscape (Farshadi,2017:13).

(Table composed by author, information gathered from Farshadi)

The identified site for the aquaponic Lifestyle Farm (figure 19), can be characterised as a classical landscape. This characterisation is further investigated during the microsite analysis. Norberg-Schulz distinguished between three primary landscape characters: romantic, cosmic and classical (Norberg-Schulz, 1985: 48).

The proposed Lifestyle Farm will have a classical character for its coherency and Imaginable order; logical organisation; good composition of individual elements and places; democratic freedom (mixed topological and geometrical properties) (Farshadi, 2017:13).

All parts of the design will have their identity within the totality (Gestalt). The equilibrium of earth and sky will be manifest in the landscape of the proposed Lifestyle Farm (Farshadi, 2017:13).





Figure 20 Photo of the site (Author, 2021)

Conclusion

Each specific space has a particular character that reflects the precursors of the area which can be seen as the genius loci (Conzen, 1966: 56–57).

The essential role of architecture (in this case the proposed Lifestyle Farm) is to add physical features to a place that allow a person (visitor) to dwell in the space. Norberg-Schulz (1980: 23) believed that allowing a moment for a person to dwell in a space is to create a moment of peace within that protected place.

Sense of place is a harmonious interaction between three different components, namely the functional use or purpose of the space, the physical attributes of the space and the meaning behind the space. The physical attributes are found in materialism, the function is founded in objectivity, and meaning is found in essence and the 6th Sense. These components make up the overall sense of space (Slocombe, 2018: online).

The Biophilic design principles that will be used to support the creation of a sense of place will be briefly discussed next.

For this thesis, Kellert's 6 elements and the 14 patterns of biophilic design have been explored to help with planning and decision-making and to bring greater clarity to why some interventions are replicable and why others may not be. The elements and patterns of Biophilic design will be briefly explained.

Biophilia means "a love of nature." Biophilic design is focused on how architects incorporate nature into architecture to Add value to the people who will dwell in the structure by accessing all of the natural surroundings whilst still being to dwell in a certain confined space. By using building materials and features that mimic and respect the surrounding ecosystem, through biophilic design architects create spaces that resonate within the human souls who seek always to be at peace with nature first and secondly to dwell within (HMC Architects, 2019: online).

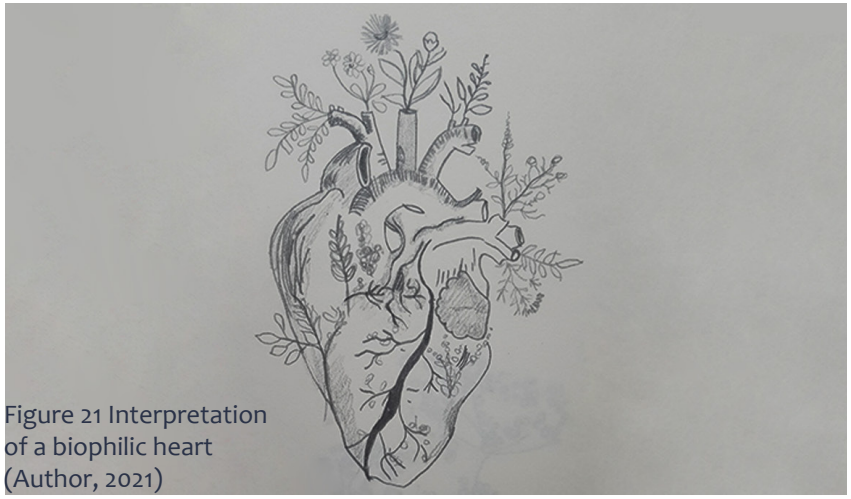


Figure 21 Interpretation of a biophilic heart (Author, 2021)

The term biophilia was popularized by the American biologist, Edward O. Wilson, during the 1980s. Wilson observed how increasing rates of urbanisation resulted in a disconnection between humans and the natural world. With high rates of migration to urban settings in the developed world and soaring rates of urbanization in developing countries biophilia is of ever-increasing importance to our health and well-being as we now primarily inhabit the built environment while finding ourselves within a climate crisis which necessitates that we see ourselves as part of nature and not separate from it (Oliver Heath Design, 2021: online).

Wilson postulated that human beings have a need to connect with living structures in the natural environment. He argued that this is neither a matter of simple liking or aesthetic preference, but rather a physical requirement, equivalent to the need for air, water, and food (Salingaros, 2015: 8). Wilson's "Biophilia hypothesis", which outlined the tendency in humans to seek out a connection with nature, inspired many theorists to research this phenomenon in the various guises through which it manifests (Salingaros, 2015: 8).

One of them was Stephen R. Kellert, professor emeritus at Yale University, who explored biophilic applications within the design world. Through his research Kellert developed the theory of Restorative Environmental Design which posits that the tranquility that natural elements elicit has the power to enrich the urban environment and create a multi-sensory experience within human-built spaces (Marchese, 2021: online).

Kellert studied the different ways through which nature can transform a space into a pleasant and multi-sensory experience through incorporating elements like water and light, vegetation, organic shapes, and even the patina of time. These different elements form part of his biophilic design principles, which explain how nature can promote well-being and a sense of place (Marchese, 2021: online).

While nature can support mental and physical health, Kellert also believed that incorporating natural facets into a design could enhance our emotional attachment to settings. Biophilia is therefore also related to sense of place and our ethical responsibility for the care and sustainability of the natural world (Marchese, 2021: online).

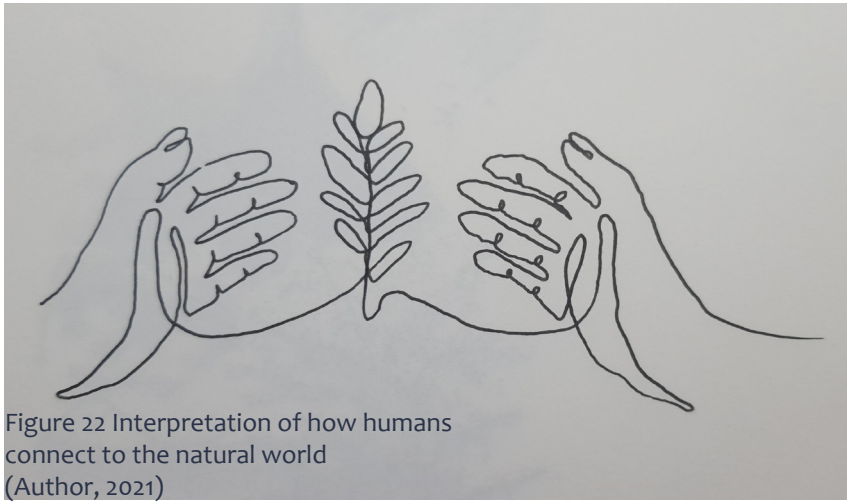


Figure 22 Interpretation of how humans connect to the natural world (Author, 2021)

Kellert details three ways in which nature can be experienced within the built environment. These are:

- the direct experience of nature, such as contact with plants or landscapes,
- the indirect experience of nature, which might include natural materials or motifs, and
- the experience of space and place, referring to a more abstract experience of nature, like a feeling of refuge or a space imbued with cultural or ecological meaning (Marchese, 2021:online).

To classify Restorative Environmental Design, Kellert created a set of rules or values that one can revert to, it is based on 6 x elements and 75 special characterisics He called this "a pattern language to help people who want a checklist." Kellert's (2012, online) six elements of biophilic design are the following:

Kellert's biophilic design elements		
1. Environmental features	2. Natural shapes and forms	3. Natural patterns and processes
4. Light and space	5. Place-based relationships	6. Evolved human

(Table composed by author, information gathered from Kellert)

Biophilic design elements and their corresponding attributes		
Environmental features	Natural shapes and forms	Natural patterns and processes
• Color • Water • Air • Sunlight • Plants • Animals • Natural materials • Views and vistas • Façade greening • Geology and landscape • Habitats and ecosystems	• Botanical motifs • Tree and columnar supports • Animal (mainly vertebrate) motifs • Shells and spirals • Egg, oval, and tubular forms • Arches, vaults, domes • Shapes resisting straight lines and right angles • Simulation of natural features • Biomorphy • Geomorphology • Biomimicry	• Sensory variability • Information richness • Age, change, and the patina of time • Growth and efflorescence • Central focal point • Patterned wholes • Bounded spaces • Transitional spaces • Linked series and chains • Integration of parts to wholes • Complementary contrasts • Dynamic balance and tension • Fractals • Hierarchically organized ratios and scales
Light and space	Place-based relationships	Evolved human-nature relationships
• Natural light • Filtered and diffused light • Light and shadow • Reflected light • Light pools • Warm light • Light as shape and form • Spaciousness • Spatial variability • Space as shape and form • Spatial harmony • Inside-outside spaces	• Geographic connection to place • Historic connection to place • Ecological connection to place • Cultural connection to place • Indigenous materials • Landscape orientation • Landscape features that define building form • Landscape ecology • Integration of culture and ecology • Spirit of place • Avoiding placelessness	• Prospect and refuge • Order and complexity • Curiosity and enticement • Change and metamorphosis • Security and protection • Mastery and control • Affection and attachment • Attraction and beauty • Exploration and discovery • Information and cognition • Fear and awe • Reverence and spirituality

(Table composed by author, information gathered from: (THE INTERNATIONAL LIVING FUTURE INSTITUTE, 2018: online)

1. Environmental features.

People yearn to be within a place which is at one with it surroundings, studies have shown that being in a more green environment can help to relieve stress, it is more comfortable, people feel happier and this all promotes a healthy lifestyle. (Bochart, 2021: online).

2. Natural shapes and forms.

This refers to the simulation and the mimicking of shapes and forms found in nature. These include featuring botanical and animal forms such as leaves, shells, trees, foliage, ferns, honeycombs, insects, other animal species, and body parts (Kellert, 2012, online).

Natural environments show complexity at varying scales, from the vast openness of the sky to the dense complexity in the pattern of a single leaf. This range of variance feeds our need for the diverse forms found in nature— it is something to which we humans are attuned (Bochart, 2021: online).

3. Natural patterns and processes

This relates to Natural patterns are what distinguish nature from man-made structures, they have their own set of rules and these also play a role in the way in which humans have evolved and developed.

The natural senses of the human being are unconsciously tuned in with nature and the surroundings and this must always be taken into consideration in any design process.

It is thus of the utmost importance to seek to explore all prospects of connection with our sensory systems and the environment (Bochart, 2021: online).

4. Light and space

This biophilic design element focuses on light and spatial relaThe biophilic design that takes light and space into consideration is very important as the correct interpretation of light and space can create a natural sense rather than a rigid, confined sense.



Figure 23 Interpretation of place baced relationships like a forest and light (Author, 2021)

5. Place-based relationships

When one takes a place into consideration it can be seen as the doorway to caring, this element focuses on our link with our eco-system and bio-geographical features (e.g., mountains, deserts, estuaries, rivers, and plants (Bochart, 2021: online).

This principle further draws on connections between The methology behind place based designs relate to the geography and ecology of the surroundings. One must incorporate similar features that will string the design together with it natural surroundings (Kellert, 2012, online).

6. Evolved human relationships to nature

This principle refers to the basic inborn inclinations to affiliate with nature, such as the feeling of being in a coherent and legible environment, the sense of prospect and refuge, the simulation of living growth and development, and evoking various biophilic values (Kellert, 2012, online).

The need to incorporate biophilic features are ever increasing in a world where more cities are expanding and in the process decreasing our natural surroundings. The incorporation of biophilic substances has proven to help us be more peaceful, less stressful, more creative and improve our overall well being.

For decades people have been trying to pin point those features in nature that satisfies humans within a built environment.

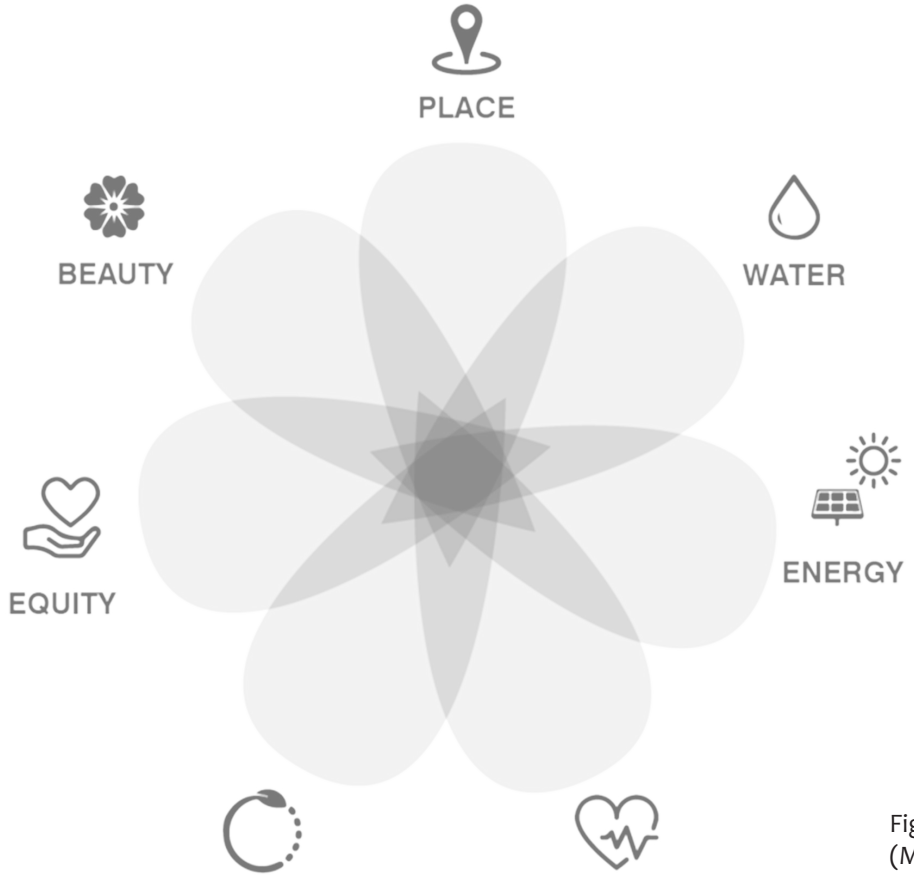


Figure 24 Interpretation of Biophilic patterns (MCLENNAN, 2021: online)

The 14 Patterns of Biophilic Design

The 14 Patterns of Biophilic Design articulate the relationships between nature, human biology, and the built environment design so that one may experience the human benefits of biophilia in the design (Browning, Ryan & Clancy, 2014: 3).

The 14 Patterns of Biophilic Design defines the process systematically, creating three strategies to incorporate nature into the built environment. These strategies are 'Nature in the Space, Natural Analogues and Nature of the Space' (Browning et al., 2014: 9).

Three strategies and 14 patterns of biophilic design (Browning et al., 2014: 10).		
A Nature in the Space Patterns	**B Natural Analogues Patterns**	**C Nature of the Space Patterns**
1. Visual Connection with Nature A view to elements of nature, living systems and natural processes. [overlaps with patterns: 2,3,5, 6,7,8,9,10,13 and 14]	**8. Biomorphic Forms & Patterns** Symbolic references to contoured, patterned, textured or numerical arrangements that persist in nature (Browning, Ryan & Clancy, 2014: 10). [overlaps with patterns: 1,2,6,10]	**11. Prospect** An unimpeded view over a distance, for surveillance and planning. (Browning, Ryan & Clancy, 2014: 10). [overlaps with patterns: 1,5,12,14,13]
2. Non-Visual Connection with Nature Auditory, haptic, olfactory, or gustatory stimuli that engender a deliberate and positive reference to nature, living systems or natural processes. [overlaps with patterns: 1, 5,7,9,10, 13]	**9. Material Connection with Nature** Materials and elements from nature that, through minimal processing, reflect the local ecology or geology and create a distinct sense of place (Browning, Ryan & Clancy, 2014: 10). [overlaps with patterns: 2,11]	**12. Refuge** A place for withdrawal from environmental conditions or the main flow of activity, in which the individual is protected from behind and overhead. [overlaps with patterns: 11, 13]
3. Non-Rhythmic Sensory Stimuli Stochastic and ephemeral connections with nature that may be analyzed statistically but may not be predicted precisely. [overlaps with patterns: 1,2,4,6,7, 13]	**10. Complexity & Order** Rich sensory information that adheres to a spatial hierarchy similar to those encountered in nature (Browning et al., 2014:10). [overlaps with patterns: 3,8,9,13]	**13. Mystery** The promise of more information, achieved through partially obscured views or other sensory devices that entice the individual to travel deeper into the environment. [overlaps with patterns:2,3,4,7,10,11,12]
4. **Thermal & Airflow Variability** Subtle changes in air temperature, relative humidity, airflow across the skin, and surface temperatures that mimic natural environments. [overlaps with patterns:2,3,6,7,12]		**14. Risk/Peril** An identifiable threat coupled with a reliable safeguard (Browning, Ryan & Clancy, 2014: 10). [overlaps with patterns: 5,10,11]
5. Presence of Water A condition that enhances the experience of a place through seeing, hearing or touching water. [overlaps with patterns:1,2,3,4,6,7,10,11,12,14]		
6. Dynamic & Diffuse Light Leverages varying intensities of light and shadow that change over time to create conditions that occur in nature. [overlaps with patterns: 4,7,12,13]		
7. Connection with Natural Systems Awareness of natural processes, especially seasonal and temporal changes characteristic of a healthy ecosystem. [overlaps with patterns: 4,5,6,13]		

(Table composed by author, information gathered from: (Terrapin , 2014: online)

A Nature in the Space

This principle enables the design to be at one with nature and allow interactions that can be thermal, visual, olfactory, or anything else where the natural presence is clear and direct.

Nature in the space considers the design elements that provide direct physical contact with nature from within an interior.

Interaction with the natural world can come in the form of a stimulating view of nature, the presence of plants, water features, fountains, natural airflow or breezes, bird feeders, butterfly gardens, aquariums, courtyards gardens, walls or vegetated roofs, sounds and scents.

When the design is able to encompass core natural features humans can experience a space where all our senses speak to the surroundings (Interface, 2020: online).

The most emotional experiences are achieved through the creation of meaningful, direct connections with The best way to do this is by incorporating natural features in the design to allow a flow of these features within the design, such as to feel a breeze, to incorporate water flowing over rocks, all of these release a sense of smell and a feeling of being in nature mainly through diversity, movement and multi-sensory interactions (Browning, Ryan & Clancy, 2014: 9).



Figure 25 Interpretation of meaning through connecting with nature
(Author, 2021)

1. Visual connection with nature.
This refers to stimulating views to elements of nature, living systems and natural processes, these could include a window with a garden or sea view, potted plants, flower beds, courtyard gardens, green walls and green roofs (Interface, 2020: online). This could be with a naturally occurring like a view or a body of water, or it might be achieved by simulating nature. Plants or exposure to natural imagery through wallpaper, art or even a wall painted in green promotes concentration and reduces stress (Marchese, 2021: online).

A space with an excellent visual connection with nature feels whole; it grabs one's attention and can be stimulating or calming. The objective of the visual connection with nature pattern is to provide an environment that helps the individual shift focus to relax the eye muscles and cognitive temper fatigue. The effects of these interventions will improve as the quality of a view and the amount of visible biodiversity each increase (Browning et al., 2014: 24-25).

Naturally Occurring
- Natural flow of a body of water
- Vegetation
- Including food baring plants
- Animals
- Terrain
- Soil
- Earth (Aquaponics and hydroponic)

Simulated or Constructed
- Mechanical flow of a body of water
- Fish ponds
- Wall, Artwork depicting nature scenes
- visual connection with nature pattern provides an environment that helps the individual shift focus to relaxation (Browning et al., 2014: 24-25).

This Biophilic principle provides an environment that helps humans view what happens in nature and form an oasis for the human presence. The proposed design can address the human connection to the natural environment (world of living things) by locating living and working areas next to a window overlooking the landscape. A variety of animals, birds and insects will be part of the proposed Lifestyle Farm, creating breakaway spaces enriched by the landscape.

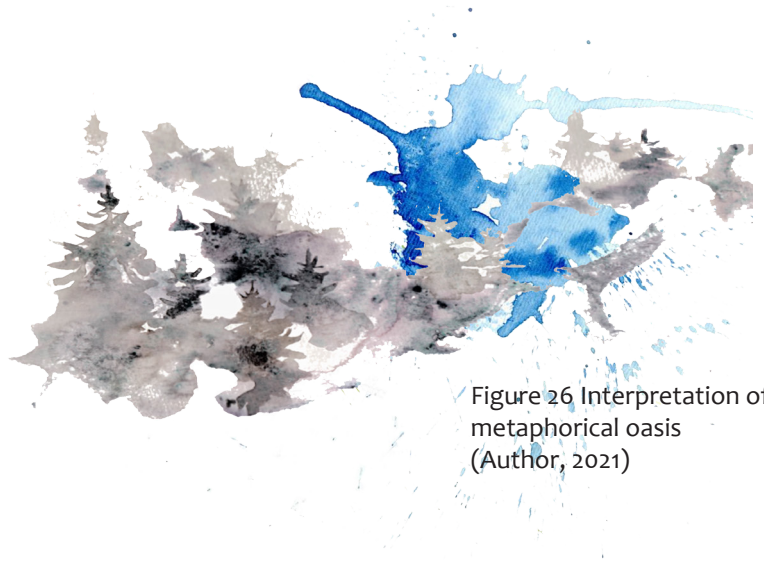


Figure 26 Interpretation of a metaphorical oasis (Author, 2021)

2. Non-visual connection with nature.

Non-visual connection with nature is the auditory, haptic, or olfactory that "engender a deliberate and positive reference to nature, living systems or natural processes" (Browning et al., 2014: 26). Biophilic design is not limited to what can be seen or even touched. Sound, smell, taste and movement are all senses to consider. For example, hearing water, smelling flowers and sensing the air movement within a space are great ways of promoting a perception of the natural world (Marchese, 2021: online).

The non-visual connection with nature pattern aims to provide an environment that uses sound, scent, touch and possibly even tastes to engage the individual in a manner that helps reduce stress and improve perceived physical and mental health (Browning et al., 2014: 27).

The principle of non-visual connection with nature can be applied to the proposed design for people visiting the farm to touch, smell and taste the plants from the production line. In addition, visitors to the Lifestyle farm will also be exposed to different textured materials (stone, wood, steel), sun patches, natural ventilation (open windows and breezeways), the sound of water, smelling flowers and sensing the movement of crackling fire/fireplace (winter) within the space.



Figure 28 Interpretation of poetics of nature (Author, 2021)

Non-rhythmic sensory stimuli does not occur by will, normally it is experienced on a subconscious level and it makes use of all our sensory systems (Browning et al., 2014: 29).

Rogers likes to call this the "Campfire Effect," that movement you see out of the corner of your eye when a candle flickers or leaves rustle. We cannot predict these movements but can analyse them later (Marchese, 2021: online).

The idea of non-rhythmic sensory stimuli is to focus an individual's mind on features which tend to relieve stress and fatigue on a subconscious level (Browning et al., 2014: 29).

The principle of non-rhythmic sensory stimuli can be applied to the proposed design for people visiting the Lifestyle Farm who will be exposed to varying clouds, fresh air, the sound of a river and different sounds of animals and birds.

4. Thermal & Airflow Variability

The subtle changes in air and surface temperature, humidity and airflow across the skin mimic natural environments (Interface, 2020: online). Therefore, the objective of the Thermal & Airflow Variability pattern is to provide an environment that allows users to experience the sensory elements of airflow variability and thermal variability.

This principle suggests that people want to feel refreshed and invigorated, as though they are on the top of a mountain (Rogers, 2021: online). The intent is also for the user to control thermal conditions, either by using individual controls or allowing occupants access to variable ambient conditions within a space (Browning et al., 2014: 30).

Providing variable conductance materials, seating options with differing levels of solar heat gain (indoors and outdoors) or proximity to operable windows – as welcome as catching a cooling breeze on a sunny day or leaning one's back on a warm rock on a calm day – could improve the overall satisfaction of a space (Browning et al., 2014: 30).

The principle of Thermal & Airflow Variability can be applied to the proposed design for solar heat gain and operable windows will be utilized.

5. Presence of Water

A condition that enhances the experience of a place through the seeing, hearing or touching of water.

The objective of the Presence of Water pattern is to capitalise on the multi-sensory attributes of water to enhance the experience of a place in a manner that is soothing, prompts contemplation, enhances mood, and provides restoration from cognitive fatigue (Browning et al., 2014: 32).

Water is a physiological stimulant and enhances the engagement in the space if one can see, hear, and touch the water. In interiors, touch is more difficult to achieve too due to safety concerns, but the mere potential to get one's hands wet can be positive (Rogers, 2021: online). Water plays a tremendous role in the design of the aquaponic Lifestyle Farm. People visiting the Lifestyle Farm will be able to see, hear and even touch the water. The visitors will be able to observe the aquaponic fish tanks as part of the proposed design.

6. Dynamic & Diffuse Light

This principle involves leveraging varying intensities of light and shadow that change over time to create lighting conditions like those found in nature. The objective of the Dynamic & Diffuse Light pattern is twofold: to provide users with lighting options that stimulate the eye and hold attention in a manner that engenders a positive psychological or physiological response and to help maintain circadian system functioning.

Dramatic lighting differences may be significant for some religious, socialisation and circulation spaces. However, they are not a good idea on work surfaces. Diffuse lighting on vertical and ceiling surfaces provides a calm backdrop to the visual scene (Browning et al., 2014: 34-35).

The movement of light and shadows along a surface can attract our attention. For example, the dappled light under the canopy of an aspen tree or the reflections of rippling water on a wall. These patterns tend to be fractals, and the brain is particularly attuned to moving fractals, such as those created by dappled natural shadows (Browning et al., 2014: 34-35).

The principle of Dynamic & Diffuse Light will be applied to the proposed design through the pergolas on the stoep area which will be used to create dappled shadows.



Figure 29 Light and shodow in nature (jagoanskdo, 2021: online)

7. Connection with Natural Systems

A space with a good connection with natural systems evokes a relationship to a greater whole, making one aware of seasonality and life cycles. Awareness of natural processes, mainly seasonal and temporal changes, are characteristic of a healthy ecosystem and a healthy space (Browning et al., 2014: 36). This joins people in the seasons and changes during natural life cycles (Rogers, 2021: online).



Figure 30 Interpretation of seasonal patterns (Author, 2021)

The strategy for working with this pattern may be as simple as identifying semantic content in nature (e.g., deciduous trees in the back yard or blossoming orchids on the windowsill), or it may be a more complex integration of systems, such as by making evident the relationship between building occupant behaviour and rainwater infrastructure capacity (e.g., rain gardens bioswales, storm sewers) by regulating domestic activities (e.g., showering, laundry) during rain events. In either case, the temporal component is usually the critical factor in pattern recognition and the triggering of a deeper awareness of a functioning ecosystem (Browning et al., 2014: 36-37).

The aquaponic Lifestyle Farm will make use of rainwater harvesting systems to create an awareness of water scarcity. The landscape and gardens will join people in the seasons and the changes during natural life cycles. Using native plantings on the site—those that grow and die with the seasons—can further help connect people and nature. Therefore, the principle of Connection with Natural Systems will be part of the proposed design.

B Natural Analogues Patterns

8. Biomorphic Forms & Patterns

Biomorphic forms and patterns are symbolic representations within the design of the patterns, shapes, textures, or numerical arrangements found in nature (Interface, 2020: online).

The objective of biomorphic forms and patterns is to provide representational design elements within the built environment that allow users to connect with nature. The intent is to use biomorphic forms and patterns to create a more visually appealing environment that enhances cognitive performance while helping reduce stress. While our brains know that biomorphic forms and patterns are not living things, we may describe them as symbolic representations of life. There are two approaches to applying biomorphic forms and patterns: either as cosmetic, decorative components of a larger design or as integral to the structural or functional design. Both approaches can be utilised in tandem to enhance the biophilic experience (Interface, 2020: online).

9. Material Connection with Nature
This pattern refers to using materials, grains, textures, and elements from nature that, through minimal processing, reflect the local ecology or geology and create a distinct sense of place (Browning et al., 2014:40-41).

The material connection with nature pattern explores the characteristics and quantities of natural materials optimal for engendering positive cognitive or physiological responses. In some cases, there may be several layers of information in materials that enhance the connection, such as learned knowledge about the material, familiar textures, or nested fractals that occur within a stone or wood grain pattern (Browning et al., 2014:40-41).

Natural materials can be decorative or functional and are typically processed or extensively altered (e.g., wood plank, granite countertop) from their original 'natural' state. While they may be extracted from nature, they are only analogous to their natural state (Browning et al., 2014:40-41).

Natural materials, like wood plank and sandstone will be used as biophilic pattern to create a material connection with the surrounding landscape and, in doing so, to enhance the sense of place.

10. Complexity & Order
The complexity and order pattern is linked to the rich sensory information that adheres to a spatial hierarchy like those encountered in nature (Browning et al., 2014: 42- 43).

The objective of the complexity and order pattern is to provide symmetries and fractal geometries configured within a coherent spatial hierarchy to create a visually nourishing environment that engenders a positive psychological or cognitive space. Fractals can exist at any scale, from desktop trinkets or textile patterns to façade design to a city grid or regional transport infrastructure (Browning et al., 2014: 42- 43).



Figure 31 Sandstone construction (Author, 2021)

C Nature Of The Space
The nature of the space principle addresses spatial configuration. This includes our innate and learned desire to be able to see beyond our immediate surroundings, our fascination with the slightly dangerous or unknown; obscured views and revelatory moments; and sometimes even phobia inducing properties when they include a trusted element of safety (Browning et al., 2014: 10).

The nature of the space is about mimicking or being inspired by the spatial configuration of nature. This is about replicating the feelings that natural spaces give us, such as a sense of refuge, mystery, prospect, or peril.

It relates to how obscured views trigger curiosity and how phobia-inducing features like heights or getting wet are presented alongside a trust component like a railing or steppingstones in water (Browning et al., 2014: 10).

11. Prospect
Humans have an intrinsic desire to see beyond their immediate surroundings or over long distances, dating back to prehistoric times, viewed through an anthropological theory of survival. Therefore, prospect patterns consider a big-picture view of an environment (Browning et al., 2014: 43-44).

Elements of interior design that best represent this include the addition of balconies, oversized windows or skylights, mezzanine levels, open plan spaces or transparent partitions that provide uninterrupted views (Interface, 2020: online).
The Lifestyle Farm design will include elements like oversized windows that will create a prospective space to reveal the picturesque landscape.

12. Refuge
The refuge pattern refers to a place for withdrawal from environmental conditions or the main flow of activity, the individual is thus protected from behind and overhead (Browning et al., 2014: 10). Like prospect, the refuge pattern focuses on the ability to look out over one's surroundings, but from the safety of a protected position away from the buzz of central areas of activity (Interface, 2020: online).

The proposed design will include elements that can create a quality refuge space that offers shade or protection from natural or man-made environmental conditions. The Lifestyle Farm will offer visitors places for reflection or meditation as well as rest and relaxation in a safe and protected environment. The accommodation units will also enable visitors to enjoy privacy while having the feeling of being immersed in nature.

13. Mystery
The mystery pattern is primarily based on the idea that people have two basic needs in environments: to understand and to explore (Browning et al., 2014: 48-49).

The mystery pattern holds the promise of more information, which is achieved through partially obscured long-distance

views, design revelations, surprising installations, unexpected architectural features, or other sensory devices that entice the individual to travel deeper into the environment (Browning et al., 2014: 10).

The success of the mystery pattern is in anticipation that it generates – a sense of curiosity about what might be around the corner, which creates an intense and undeniably pleasurable human response (Interface, 2020: online).

The proposed Lifestyle Farm design will enable visitors to discover panoramic views of the Maluti Mountains and different outdoor spots in nature, for example the 4x4 trail and hiking trails. Curious visitors will also be able to visit and explore the aquaponic wing of the Lifestyle Farm.

14. Risk/Peril

Here an identifiable threat is coupled with a reliable safeguard (Browning et al., 2014: 10). Evolution geared human beings towards survival. Whether it is a high walkway or a glass wall overlooking a city skyline, the Risk/Peril pattern triggers the rush of living on the edge from within a place of safety (Interface, 2020: online).

Risk can be generated through a learned or biophilic response triggered by a near and present danger. This danger, however, is inert and unable to cause harm due to a trusted element of safety (Browning et al., 2014: 50-51). Glass railings, cantilevers, and steppingstones in a pool of water entail small elements of risk that is easily manageable (Rogers, 2021: online).





Figure 32 4x4 Activities in the landscape (jagoanskdo, 2021: online)

Conclusion

Kellert's six elements and the 14 Patterns of Biophilic Design have been investigated in order to determine which elements/patterns of biophilic Design can connect the human to natural in the design of the Lifestyle Farm.

As mapped here, the 14 Patterns of Biophilic Design defines a systematic process for incorporating natural elements into the design, establishing three strategies to incorporate into the built environment. These strategies are 'Nature in the Space, Natural Analogues and Nature of the Space'. These strategies are used together to connect the built environment with natural world in the design of the Lifestyle Farm. The three strategies create a beautifully balanced experience, giving users a complete mind-body experience through cognitive, psychological and physiological stimulation (Browning et al., 2014: 11). Kellert's six elements were covered in the 14 Patterns of Biophilic Design.

The 5 elements of Kellert (1,3,4,5,6) and the 11 patterns (1,2,3,4,5,6,7,9,11,12,13) of biophilic design chosen for the proposed design will strengthen the sense of place seeing as it links to the functional use of the place, physical attributes of the space and the meaning behind the space. By placing the human in direct contact with nature, through the use of the biophilic design principles identified in this section, an emotional connection to this particular piece of land and piece of architecture will be established.

Permaculture as support of sense of place will be briefly discussed (2.4.3) next.

2.4.3 Permaculture

Permaculture is a design science rooted in the observation of natural systems. Permaculture principles teach us how to design ways of living that have the stability and resilience of natural systems. Permaculture's proponents argue that through the observation of nature, we can find positive solutions for creating and managing systems for food, medicine, water, shelter, and more (Regenerative Design Institute, 2021: online).

Bill Mollison and David Holmgren from Australia developed permaculture in the 1970s and first taught permaculture as an applied design system in 1981. There was no term at the time for "sustainable culture", so they coined the term "permaculture" to articulate the notion of "permanent agriculture." The term has evolved into the notion of "permanent culture," reflecting a broader definition, including a more holistic spectrum of human needs beyond agriculture (Regenerative Design Institute, 2021: online).

Mollison and Holmgren described permaculture as "an integrated, evolving system of perennial or self-perpetuating plant and animal species useful to man" (Holmgren, 2007: 1). Holmgren later expanded the definition to include "consciously designed landscapes which mimic the patterns and relationships found in nature, while yielding an abundance of food, fiber and energy for provision of local needs" (Holmgren, 2007: 1).

Joel Glanzberg, a regenerative design and ecological restoration expert, described permaculture as a holistic design approach for all human needs that works by shifting underlying patterns to create change (Brain and Thomas, 2013: 1). Permaculture is a design system that develops and applies the ability to discern the patterns that structure natural and human systems and generates new patterns that weave the human and natural together into a dynamic whole (Mang& Reed, 2012: 12). This patterning skill enables the assessment and articulation of the distinctive character or essence (sense) of a place, which is then reflected in a wide array of optimised design solutions and management techniques that have the



Figure 32 Plants to be grown in on site (jagoanskdo, 2021: online)



effect of beneficially linking elements that are often treated as being discrete (e.g. road systems that serve as water harvesting structures and erosion control features while supporting windbreak, wildlife habitat, and firebreak functions) (Mang & Reed, 2012: 12).

Permaculturists find practical solutions using nature-inspired principles to create productive ecosystems with the stability, diversity, and resilience of those found in the natural world (Regenerative Design Institute, 2021: online).

When creating or re-designing a home site, a permaculture designer may for example look for ways to integrate water catchment, existing buildings, and energy systems with tree crops, edible and useful perennials, self-seeding annuals, domestic and wild animals, and aquaculture.

In this scenario, excess or waste products from plants, animals and human activities are used as nutrients to benefit other elements in the system (Regenerative Design Institute, 2021: online). Therefore people, their buildings and how they organise themselves are central to permaculture: the original permaculture vision of permanent or sustainable agriculture has evolved into permanent or sustainable culture (Holmgren, 2007: 1).

The conclusion can be drawn that permaculture can be seen as a design approach for creating sustainable, food-producing landscapes that mimic the diversity and resilience of natural ecosystems. With this characteristic in mind, the idea of permaculture supports the theory of biophilia.

Permaculture literature often contains listed principles. Most of the principles have core similarities among various authors and experts.

Listed below are ethics and twelve principles of permaculture adapted from Dave Holmgren:

The ethical underpinnings that guide permaculture are simple yet powerful (Regenerative Design Institute, 2021: online):

- take care of the earth - rebuild nature's capital,
- take care of the people - show a willingness to build a community for individual and collective well-being (You matter, 2019: online), and
- share the surplus - set limits to consumption and repro duction, and redistribute the surplus

(Holmgren, 2007: 8).

Principle 1: Observe And Interact

'Reading the Landscape' to understand the pre-existing and often subtle but persistent patterns created by nature and ancestral use of the land is the foundation of permaculture design (Holmgren, 2007: 10-11).

Permaculture designers use careful observation and thoughtful interaction to make effective use of human capabilities, reduce dependence on non-renewable energy, and consciously and continuously develop systems of land use and living that can sustain people through the era of energy descent (Holmgren, 2002: 13).

Good design depends on a free and harmonious relationship between nature and people, in which careful observation and thoughtful interaction provide the design inspiration, repertoire and patterns (Holmgren, 2007: 10). Design should consider different seasons, times of day, and cultures. Ways to work and design within existing patterns in nature should also be considered (Brain and Thomas, 2013: 3).

The principle also applies to learning from animals and plants to inform our design of systems. Plants growing in healthy soil have roots that actively explore water and nutrients and develop relationships and exchanges with beneficial microorganisms, and through them, other plants. Therefore, the design should not be generated in isolation but through continuous and reciprocal interaction with the subject (Holmgren, 2007: 10).

The aquaponic system of the Lifestyle Farm will focus on the interaction between people and nature (fish and organic plants). The proposed Lifestyle Farm's aquaponic design will facilitate learning for visitors/tourists by allowing them to observe the interaction between fish and organic plants.

Principle 2: Catch and Store Energy

Renewable ways of capturing and using energy should be a priority as traditional energy sources are dwindling and become increasingly unsustainable. Energy, which gives humans the ability to work, should never be wasted. Actual costs (i.e., negative externalities, human welfare, habitat protection) should be a central part of the energy dialogue. Infrastructure improvements, retrofitting, passive design, and alternative storage techniques should be prioritized (Brain and Thomas, 2013: 3).

Holmgren (2007: 11) believes that humans need to learn how to save and reinvest most of the wealth they are currently consuming or wasting and invest in systems that will sustain them and their descendants through scarcity and disruption. Sources of energy that permaculture designers aim to catch include: sun, wind and runoff water wasted resources from agricultural, industrial and commercial activities (Holmgren, 2007: 11).

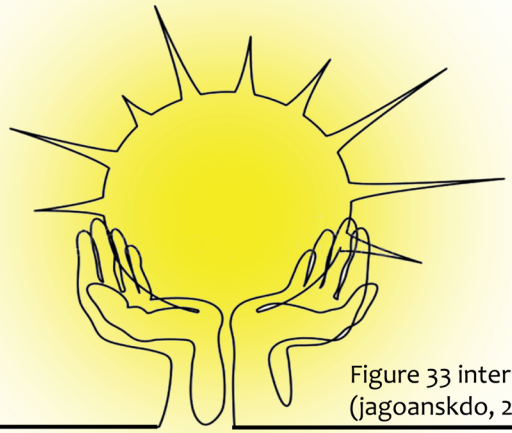


Figure 33 interpretation of princaple 1 (jagoanskdo, 2021: online)

Important stores of energy that could be of future value that permaculture designers explore include:

- fertile soil with high humus content
- passive solar buildings
- seed banks and arboreta of valuable species and varieties
- run-off water: irrigation, aquaculture and power gener ation
- solar energy (Holgrem, 2002: 30)
- water bodies and tanks
- perennial vegetation systems, especially trees that yield food and other useful resources
- libraries and information systems (Holmgren, 2007: 12).

Over time these energy stores will help sustain modest systems once the flow of unsustainable energy from fossil fuels is spent or unavailable. This principle focuses our attention on the need to use the existing wealth of the natural world to make long-term investments in natural capital (Holmgren, 2007: 12).

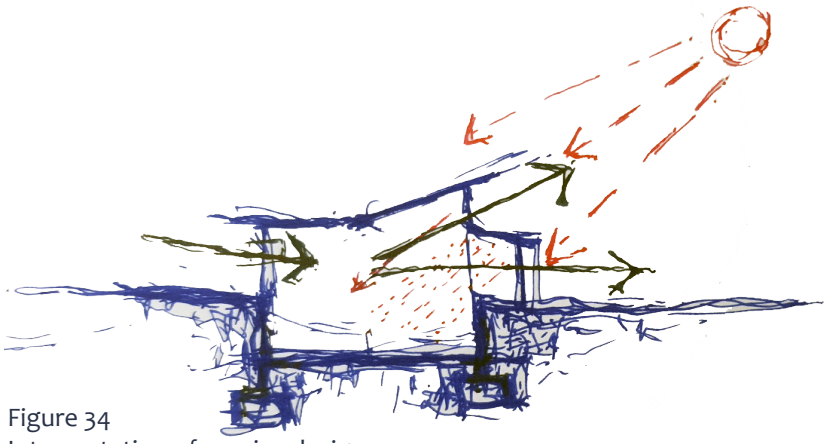


Figure 34
Interpretation of passive design
(Author, 2021)

The location of the Lifestyle Farm is of such a nature that the sun can be used in the form of energy by installing solar panels. Compost will be generated from the restaurant's waste products, which will then be incorporated into the courtyard garden soil between the buildings and orchard for fertilization. Aquaponics is an autonomous system, but with its connection to tourism through the proposed design, visitors to the farm are encouraged to learn more about sustainable systems. The runoff water will be canalized to the Lifestyle Farm's courtyard gardens and orchard. Water tanks will be used to collect rainwater. The orchard's fruit will be used in the restaurant and the rest of the fruit yield will be processed and offered for sale to visitors. Natural ventilation and cooling and heating techniques will be employed in the accommodation units to keep the additional energy resources needed for artificial temperature control to a minimum.

Principle 3: Obtain a Yield

The permaculture approach posits that design should focus on the principle of self-reliance. Producing an agricultural yield is necessary for independence and continuity—a yield/profit functions as a reward that encourages, maintains, and replicates the yield system.

Sustainable design solutions can be achieved by aiming for rewards that encourage success, growth and replication of those solutions, and in this way, create 'positive feedback loops' (Holmgren, 2007, 13). The orchard's fruit yield will be processed and offered for sale to visitors. The aquaponic Lifestyle Farm's surplus end products will also be sold to visitors.

Principle 4: Apply self-regulation and accept feedback

The apply self-regulation and accept feedback principle deals with the self-regulatory aspects of permaculture design that limits or discourage inappropriate growth or behaviour (Holmgren, 2007, 14). Holmgren (2007: 15) believes that the designers' goals should be to create plant guilds and animal associations that are more harmonious and self-regulating to reduce the workload needed.

In nature, predators maintain the balance in the habitat when they hunt, kill and eat a proportion of prey animals, while in society, the law works to regulate and, where necessary, punish behaviour that would threaten or destabilise the system. This negative feedback is essential in all systems to maintain health and balance (Holmgren, 2007, 14-15).

Negative feedback needs to be well-targeted and robust enough to bring about corrective change, but not so strong that it damages further development of the system. For example, if a wooden stove produces a smoky taste to water, this negative feedback encourages corrective action (Holmgren, 2007: 16).

Good management of the Lifestyle Farm's restaurant and the aquaponic unit is vital to ensure a sustainable supply of fresh fish and organic food. Any negative feedback regarding food freshness (fish and organic plants) needs to be well-targeted and robust enough to bring about corrective action and change. With a better understanding of how positive and negative feedback works in nature, systems can be designed to become more self-regulating, thus reducing the work-load involved in repeated and harsh corrective management.



Figure 35
Self regulating system
(Author, 2021)

Principle 5: Use and Value Renewable Resources and Services

Renewable resources are renewed and replaced by natural processes over reasonable periods without the need for significant inputs of fossil fuels and mined minerals (Holmgren, 2007: 16).

Permaculture design makes the best use of renewable, natural resources to manage and maintain yields, even if some non-renewable resources are needed to establish systems. For example, all forests generate surplus low-value wood as a by-product of sustainable management. This by-product can be used as a local fuel source for heating, cooking in well-designed stoves, and herbal medicine (Holmgren, 2007: 17).

Renewable services are those we gain from plants, animals and living soil and water, without them being entirely consumed in the process. For example, when we use a tree for wood, we use a renewable resource, but when we use a tree for shade and shelter, we benefit from the living tree that is non-consuming and requires no harvesting energy. Diversified use of renewable resources, at an appropriate level of use, can help us limit our consumption (Brain & Thomas, 2013: 3).

The surplus low-value organic and fruit yield can be processed and sold as a by-product at the Lifestyle Farm's shop/restaurant. Every accommodation unit will have its own solar geyser to generate hot water, as well as solar-sourced electricity for human use.

Principle 6: Produce No Waste

By valuing and making use of all the available resources, as nature does, nothing goes to waste (McManus, 2010: 163). The industrial processes that support modern life can be characterised by an input-output model, in which the inputs are natural materials and energy, while the outputs are valuable products and services. In nature, the opposite is accurate, and output also provides valuable input for another facet of the system, and therefore no waste is generated – everything, including waste, has a function. For example, earthworms live by consuming plant litter (waste), converting them into humus that improves the soil environment for themselves, soil microorganisms, and plants. Like all living things, the earthworm is a part of a web where the outputs are the inputs for another (Holmgren, 2007: 18-19).

Humans should look for ways to turn our waste into a valuable input in systems, rather than just an output. Recycling, composting, and reducing waste is increasingly essential as the size of the population increases (Brain & Thomas, 2013: 3). With aquaponics, a bio-integrated farming system for sustainable food production is integrated with hydroponics, where the use of nitrogen-rich effluent produced by fish (input) is utilised for plant growth and development, creating a bio-integrated modern agriculture practice that develops a symbiotic relationship between aquatic animals (fish) and plants (output).

Principle 7: Design From Patterns To Details

By stepping back, we can observe patterns in nature and society. These patterns can then form the backbone of our designs, with the details filled in as we go (McManus, 2010: 163). Thoughtful design is a big-picture design that addresses many of our problems at the source (Brain & Thomas, 2013: 3).

A spiderweb shows a clear pattern with its concentric and radial design, even though the details always vary. Zone and sector site planning are important aspects of permaculture design. Designating zones of the intensity of use around an activity centre, such as a farmhouse, helps place elements and subsystems. Similarly, environmental factors such as sun, wind, water and fire can be considered in sectors around that same focal point. These sectors have a bioregional and site-specific character that the permaculture designer carries through throughout the design to make sense of a site and help organise appropriate elements into a workable system (Holmgren, 2007: 20-21).

The aquaponic Lifestyle Farm will be designed according to the special requirement for each functional space. As the site is identified as a classical landscape; it is thus essential to place the landscape in such a way that it relates to the groundings the landscape has to offer. Essential elements/ sector (sun, fire, wind and water) are taken into account for placing the design in the landscape and creating different zones (public vs private served vs serve spaces) taken into account is where the viewpoints, public vs private, accessibility, the functioning of the buildings, and its service yards will be located.

A sense of place can be created for the worker and the visitor by placing the design sensitively.

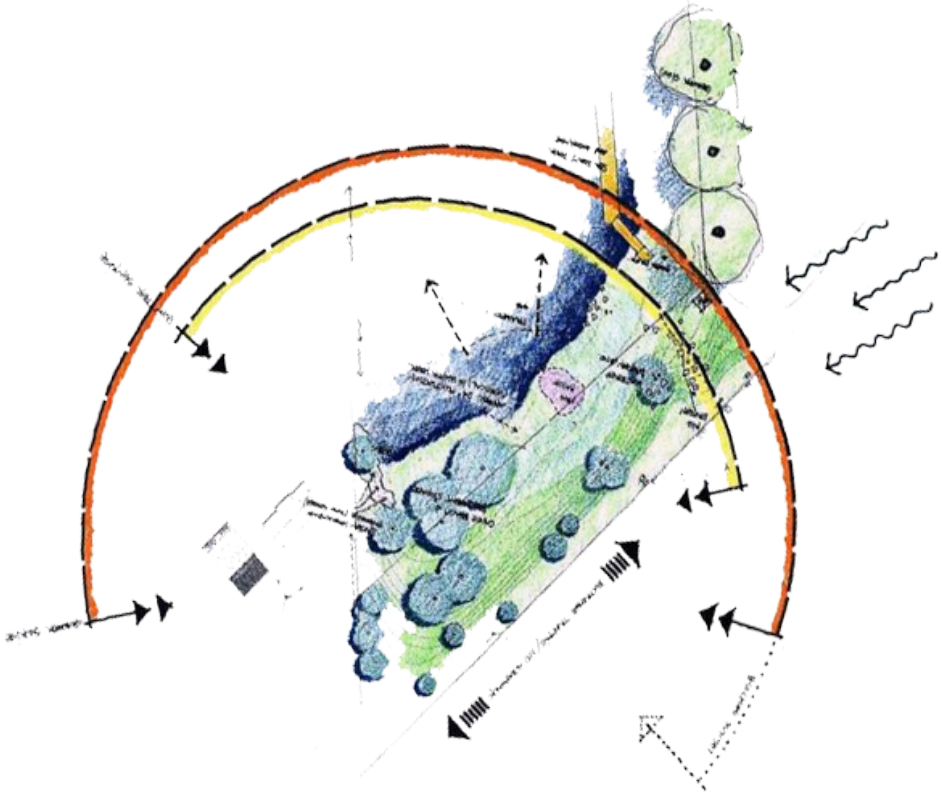


Figure 36 Analysing patterns (Mulongo, 2021: online)

Principle 8: Integrate rather than segregate

The integrate rather than segregate principle focuses on the relationships that draw elements together in more closely integrated systems and on improved methods of designing communities of plants, animals and people to benefit from these relationships (Holmgren, 2007: 20-21). This requires the recognition of complex connections in nature and making beneficial use of those interactions. Therefore, the many functions that each element can perform should be identified (Brain & Thomas, 2013: 3).

McManus (2010: 163) describes integrate rather than segregate as follows - "by putting the right things in the right place, relationships develop between those things, and they work together to support each other."

With the correct placement of plants, animals, earthworks, and other infrastructure, they develop a higher degree of integration and self-regulation without the need for constant human input in corrective management (Holmgren, 2007: 22).

For example, by allowing poultry to scratch in foraging forests, their waste can then be harvested to downslope garden systems. Herbaceous and woody weed species in animal pasture systems often contribute to soil improvement, biodiversity, and medicinal and other particular uses.

A conclusion can be drawn that the correct placement of animals, plants, earthworks and infrastructures can develop a higher degree of integration and self-regulation without the need for constant human input in corrective management.

Therefore plants, animals and people will gain benefits from these relationships. At the proposed lifestyle, farm plants will be arranged in patterns that can catch water, filter toxins, absorb nutrients and sunlight, and block the wind. Particular associations of trees, shrubs and ground covers, known to nourish and protect one another, will be clustered together.



Figure 37 Integrating nature into the design
(Freepik, 2021: online)

Principle 9: Use Small and Slow Solutions
Smaller systems are easier to maintain than big ones, making better use of local resources and producing more sustainable outcomes (McManus, 2010: 163). Taking time to seek local knowledge can also aid in finding solutions (Brain & Thomas, 2013: 3).

Systems should be designed to perform functions at the most miniature scale that is practical and energy-efficient. The fruit orchard (apples, peaches, figs and apricots) will be planted on a small scale to ensure reasonable control (including weed management and pruning) and management.

Principle 10: Use and value diversity
The use and value of diversity in nature, culture and permaculture is complex, dynamic, and seemingly contradictory. Diversity needs to be seen as being due to the balance and tension between variety and possibility, on the one hand, and productivity and power. This principle, along with several others, act together to balance the tendency in nature and society for powerful elements to dominate systems (Holmgren, 2007: 25). Permaculture seeks to understand past, present, and potential biological and cultural diversity (Brain & Thomas, 2013: 3).

Diversity reduces vulnerability to various threats and takes advantage of the unique nature of the environment in which it resides (McManus, 2010: 163).
A society rooted in monoculture is vulnerable to unexpected change. Polyculture is one of the most important and widely recognised applications of this principle, reducing vulnerability to pests, adverse seasons, and market fluctuations. Polycultures also reduce reliance on market systems and bolster household and community self-reliance by providing a more comprehensive range of goods and services. Diversity fosters resilience and provides insurance against the vagaries of nature and everyday life (Holmgren, 2007: 26). Therefore, the proverb 'Do not put all your eggs in one basket' applies here.

The proposed design aims to create multiple organic products that fall within different nutritional categories for restaurants (marketing) and sales to tourists/visitors. The proposed Lifestyle Farm will be rooted in polyculture, which will provide various goods (organic food) and services (restaurant, venue, accommodation, leisure and sharing of information) to visitors/public.



Figure 38
Proposed leafy greens
(Pixabay, 2021: online)

Principle 11: Use edges and value the marginal
A point where two systems meet is often a place where productivity and stability can be found. Rather than disregarding the marginal, we should look for ways to make use of its potential diversity and productivity (Brain & Thomas, 2013: 3).

This principle works from the premise that the value and contribution of edges, as well as the marginal and invisible aspects of any system, should not only be recognised and conserved, but also expanded to increase productivity and stability. In aquaculture, increasing the edge between field and pond can increase the productivity of both. In broadacre farming, shelterbelt forestry increases the edge between field and forest with gains in productivity and resilience for the whole farm (Holmgren, 2007: 27).

McManus (2010: 163) states that the interface between things is where the most exciting events occur. These are often the most valuable, diverse, and productive elements in the system.

A conclusion can be drawn that increasing the edge between fish and plants (Aquaponics) at the Lifestyle farm can increase the productivity of both. At the proposed Lifestyle Farm a fountain and other elements will also be constructed in patterns that maximise their edges to take advantage of the increased biological activity at the intersection of two ecosystems.

Principle 12: Creatively use and respond to change
According to McManus (2010: 163), humans can positively impact inevitable change by carefully observing and then intervening at the right time. Brain & Thomas (2013: 3) believes that caution should be exercised not to take away from the self-determination of the land in the process of this intervention.

This principle has two threads: designing to make use of change deliberately and cooperatively and creatively responding or adapting to large-scale system changes beyond our control or influence.

The acceleration of ecological succession within cultivated systems is the most common expression of this principle in permaculture literature and practice and illustrates the first thread. For example, the use of fast-growing nitrogen-fixing trees to improve soil and provide shelter and shade for more valuable slow-growing food trees reflects an ecological succession process from pioneers to climax systems dominated by long-living valuable tree crops.

The management of the aquaponic system at the proposed Lifestyle Farm will play an essential role in ensuring the availability of fish and plants throughout the year.

Summary

Permaculture is a design science rooted in observing and recognising patterns in natural ecological systems. Permaculturists find practical solutions by using nature-inspired principles to create productive ecosystems with the stability, diversity, and resilience of those found in the natural world.

The ethical underpinnings that guide permaculture are simple yet powerful and present the three roots that hold together the twelve principles namely, take care of the earth, take care of the people, and share the surplus. The twelve principles encompass: Observe and interact, catch and store energy, obtain a yield, apply self-regulation and accept feedback; use and value renewable resources and services; produce no waste; design from patterns to details; integrate rather than segregate; use small and slow solutions; use and value diversity; use edges and value the marginal and creatively use and respond to change.

Permaculture aims to look at the whole system or problem; observe how the parts relate and connect; and, from this insight, design ways to fix the systematic problem in a long-term sustainable manner. This includes recognizing patterns in natural ecological systems. Therefore, the permaculture approach focuses on what can be observed in the objective, physical realm of nature, effectively a community of organisms or ecological web of life (McManus, 2010: 163).

Permaculture provides a framework for generating and evaluating the site and situation-specific solutions necessary to move beyond the limited successes of 'sustainable development to a reunion of culture and nature' (Holmgren, 2007: 30).

By connecting a closed system based on natural cycles (aquaponic farm) to the public through creating a Lifestyle Farm for tourism, an interconnection can be found in the planned architectural design. The people will feel connected to the given community and environment, creating a sense of place. This sense of place can be achieved by observing the patterns, processes, and cycles within nature (Mang& Reed, 2012: 12).



Figure 39 System of Permaculture
(Author, 2021)

SUSTAINABLE BUILDINGS RESEARCH CENTRE

WOLLONGONG, AUSTRALIA
2013
COX ARCHITECTS

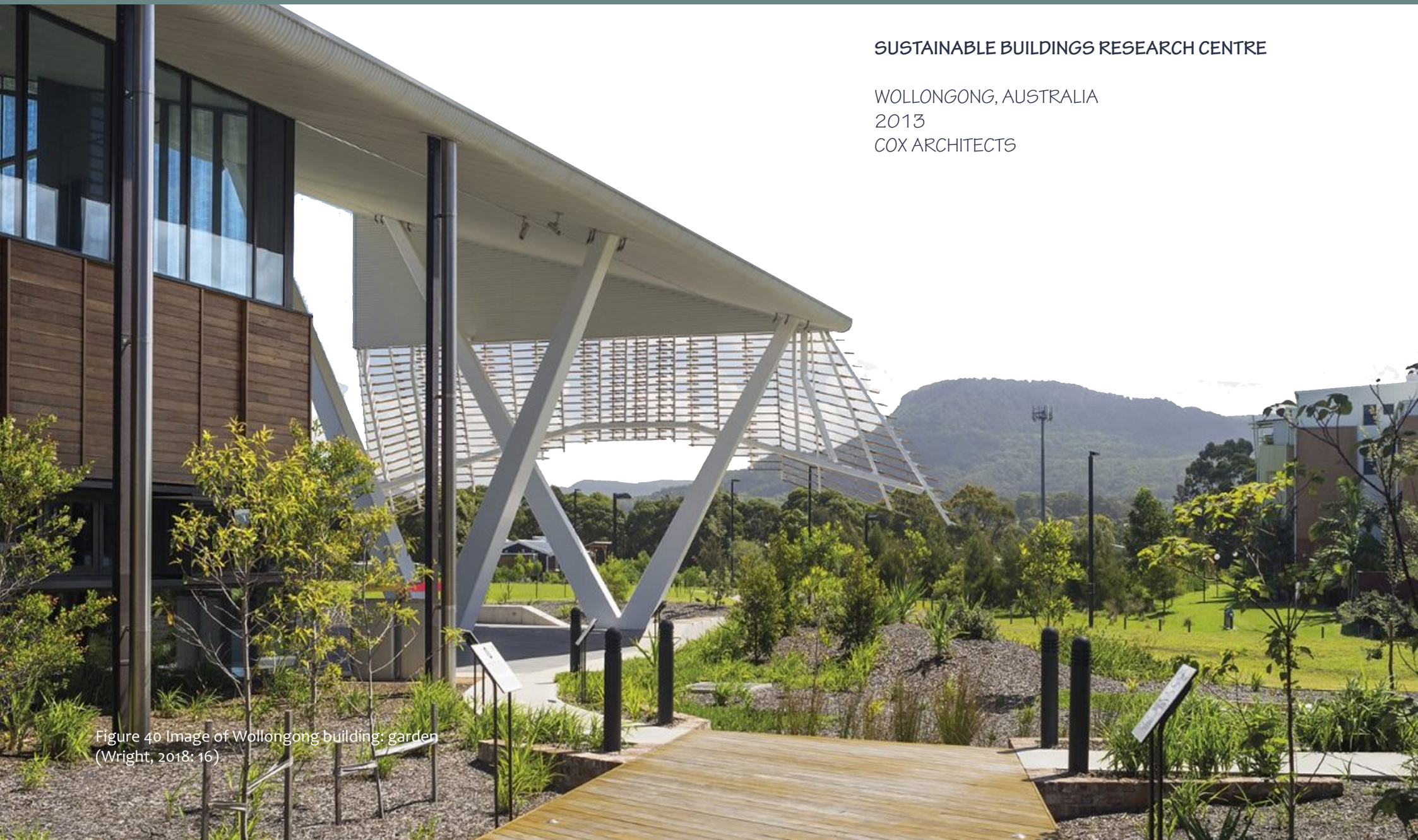


Figure 40 Image of Wollongong building: garden (Wright, 2018: 16)

Facilities:
- End of trip facilities
- Bicycle-friendly amenities
- Meeting spaces
- Bookable event spaces
- Picnic area
- Walking tracks
- Breakout spaces

Key points identified:
- Building derived from the site
- Vision: push boundaries
- Local materials
- Low maintenance building
- Roof shape = natural ventilation
- Extensive shading = cross ventilation + Controlling light + prohibit glare

The Sustainable Buildings Research Centre (SBRC), part of University of Wollongong's Innovation Campus, was created to test and demonstrate technologies to inspire the green building movement in Australia (Wright, 2018: 16). Composed of two buildings linked by a landscaped courtyard and bridge, the Centre demonstrates the practices and research it supports and responds to the climate and coastal breezes. In materiality and design, the Centre reflects the beauty and resilience of the Australian coastal landscape and connects occupants with nature, no matter where in the buildings or surrounding environment they may find themselves (Agius, 2019: online).

The design creates journeys to engage all the senses and invites students, staff, and visitors to explore and experience the centre. The varied textures and patterns in the building materials and landscape plants encourage people not just to look, but to touch and feel. Occupants are encouraged to harvest and taste the fruits and vegetables from the garden. The courtyard is filled with birdsongs and sounds of the wind rushing through the landscaping plants (Wright, 2018:16).

During spring and summer, building interiors fill up with the fresh fragrances from the mountains, the tang of coastal dune plants, and the scent of citrus blossoms (Wright, 2018:16).

The programme (functions) is divided between two buildings, with landscaped areas in between, ensuring that occupants will spend at least part of their day outside. These pedestrian journeys combined with framed views and long vistas from the interior foster direct and indirect connections with nature (Wright, 2018: 16).

The north building includes a high-bay laboratory, and the south building includes research, education, exhibition, and workspaces. The space between the two provides for outdoor learning and social interaction, as well as endemic landscape amenity, extended to an indigenous urban agriculture bush-tucker garden. This provides a powerfully simple connection to place, and past site uses (Cooper, 2021: online).

The new campus' structure was based upon an existing north-south pedestrian spine. The SBRC's roof form actively engages and envelopes this spine, creating a covered public space inviting open social interaction between the SBRC and the broader campus community (Cooper, 2021: online).

The building is dynamic, adaptable and retrofittable. Thin north/south floorplates and optimal orientation ensures effective natural ventilation and sunlight. The building's forms capture south-westerly afternoon and north-easterly sea-breezes, while eaves and sunshades are implemented to control solar gain. The roof to the southern workspace and exhibition building acts as the primary energy wing, while the northern high-bay curved profile ensures solar access to the landscape space between buildings accommodating a rooftop test area that provides a north-facing solar testing armature (Cooper, 2021: online).



Figure 41 Image of Wollongong building: solar system (Wright, 2018: 16)

Materiality
The material palette seeks to reveal the textural richness of the SBRC's coastal setting and celebrates the overall geographic location. Reused bridge timbers, steel railway tracks, abandoned telegraph poles and four generations of brick and local timbers were all used. This fundamentally contributed to a handcrafted building that is inherently of its place with dense textural richness (Cooper, 2021: online).

Biophilic design is about connecting people to nature—keeping this objective in mind the design strategies engage with the building form, materials, spatial responses, and psychological responses to space rather than simply inserting green walls or providing natural daylight (Wright, 2018: 16).

Biophilia is found in the building in the following ways:

Integration and Connection:
Biophilic design that reinforces design interventions for a direct connection to the project setting/ space (Barn, 2019: online).

Expression and Emotion:
Biophilic design that demonstrates and stirs affection toward project setting or space (Barn, 2019: online).

Experience of Nature:
Biophilic design that fosters positive, everyday interactions and relationships with the natural environment (Barn, 2019: online).

Physiological Benefit:
Biophilic design that emphasizes human health, fitness, and well-being (Barn, 2019: online).

The building encapsulates the following seven principles of biophilic design:
1. Visual Connection with Nature.
2. Non-Visual Connection with Nature.
3. Non-Rhythmic Sensory Stimuli.
4. Thermal & Airflow Variability.
5. Presence of Water.
6. Dynamic & Diffuse Light.
7. Connection with Natural Systems
(Browning et al., 2014: 9).



Figure 42 Image of Wollongong Building: entrance (Barn, 2019: online)

figure 41
(Barn, 2019: online)



Figure 43 Image of Wollongong building: interior (Barn, 2019: online)

posed installations, revealing the natural processes of weathering and staining (Agius, 2019: online).

Variegated bricks; horizontal and vertical wood siding and shade structures; the ribbing on the underside of the metal overhangs—all of these contrasting textures and colours come together to create visually stimulating façades that complement the native landscape. Similarly, the blooms of colour that ebb and flow throughout the year mark the seasons and contrast beautifully with the timber and unfinished brickwork (Atchley, 2016: online).

4. Light, space and shadow

In response to the harsh Australian sun, the building carefully controls light with shading and overhangs while still providing abundant daylight in all the working spaces. Daylight in the transitional and public areas is brighter and vivid, with contrasting shadows that enliven the spaces. The dramatic shade structure with its biomorphic curve protects the building's west side while casting complex shadows into the spaces below (Trends, 2015: online).

5. Inside- outside spaces

The building is integrated into the landscape, with outdoor courtyards that blur the lines between inside and outside. Splitting the campus into two buildings, with plants and wetlands in between, naturally encouraging people to engage with the landscaping (Trends, 2015: online).

Large open decks between the buildings provide places to gather and dwell, while floor-to-ceiling walls of glass connect the interior public spaces to the outside. The atrium, with its green walls and high ceiling, creates a light-filled space that feels like it is as much outdoors as indoors, and sheltered benches along an outside wall provide places to work that are protected from the sun (Trends, 2015: online).



Figure 44 Image of Wollongong building: passive solar system (Trends, 2015: online)

7. Ecological connection to place

With climate modulated by the Pacific Ocean, the region enjoys warm summers that hover in the 26.67°C and mild winters with temperatures that rarely drop below 10°C. The building form responds to climate and ecology with a dramatic roof structure that reaches out to the Illawarra escarpment to the west; generous overhangs elsewhere prevent the spaces from overheating and minimize energy use.

Large operable windows provide occupants with fresh air and views of the native coastal plants in the courtyard. From almost anywhere in the building, people can witness the daily and seasonal variations in weather, changing quality of light, and the passing of clouds (Atchley, 2016: online).

8. Landscape

Native landscaping, including a wetland corridor, integrates the building with the site and extends beyond it to the greater campus. Flora adapted to the coastal environment soften the building edges, allowing the centre to merge and mature with the landscape (Agius, 2019: online).

A garden dominated by bush tucker, a bush species valued by indigenous people for food and medicine, connects staff, students and visitors to the indigenous cultural heritage and instructs occupants on how landscaping can provide food as well as beauty. Sheltered spaces around and between the building provide opportunities to rest and appreciate the wider landscape, including the escarpment views to the west, Puckeys

Estate to the east, and the more intimate environs of the bush tucker garden (Agius, 2019: online).

9. Spirit of place (sense of place)
The Centre is oriented between the Pacific Ocean and the striking Illawarra escarpment. The grand steel canopy at the building entrance, inspired by vernacular Australian sheds, protects visitors from the sun while framing and echoing this distinctive landmark. Steel supports saved from old rail lines, weathered timber recycled from old bridges, and reclaimed bricks salvaged from some of Sydney's buildings ground the Centre in its particular place and tie it in with stories from Australia's past (Agius, 2019: online).

The landscape plantings and hardscape materials complement the building, creating a project that is at once harsh and beautiful, much like the Australian landscape itself (Agius, 2019: online).



Figure 45 Image of Wollongong building: front facade (Agius, 2019: online)



Figure 46 Image of Wollongong building: summer garden (Agius, 2019: online)

BABYLONSTOREN

PAARL, SOUTH AFRICA
2007
MALHERBE RUST ARCHITECTS



Figure 47 Babylonstoren: areal view
(Skok, 2015: online)



Babylonstoren is an organic farm in Paarl, South Africa, located in the Drakenstein Valley. The farm was developed a few years ago and has been flourishing ever since. The simple, geometric layout has clear walkways with accompanying pause areas throughout, allowing visitors to meander their way through the greenery at their leisure, or until they find themselves at the tearoom (Roos, 2021: online).

This farm is situated on a remaining piece of a 1692 VOC land grant. It includes the historic werf of the original farm. The farm and several its buildings thus form part of the history of the original Dutch colonisation of the Cape (Roos, 2021: online).

The iconic horizon line of the mountain ranges in this part of the world overshadows whatever manmade places occupy the landscape. On the lower-lying and flatter terrain, the landscape is dominated by the geometric precision of intensive agriculture, in the form of vineyards and orchards. Architecture often acts as the man-made intermediary between the larger-scale natural elements, such as the mountain ranges and the smaller-scale agricultural activities. On this farm the buildings often take a low-slung, small-scale and relatively simple form with whitewashed walls and thatched roofs. This is what Malherbe Rust Architects has achieved for the owners. Despite a relatively large capital investment in the farm, the architecture and new spaces created have retained a delicate character, whilst maintaining its rustic working-farm qualities (Roos, 2021: online).

What is most striking about the work done on the farm is precisely this uncovering and strengthening of a continuous line of development. In some other instances of the restoration of Cape Dutch farms, there has been an effort to fossilize the buildings within a certain period of time. In this case, a different approach has been taken (Murphy, 2021: online).

The owners and their architects understood that the life of any building - or group of buildings is, in reality, something that evolves over time. It is also the continuous process of cultural evolution that keeps a building ‘fresh’ and pertinent, while taking the weight of history seriously, but at the same time not too seriously - in this way, it can be renewed and reinterpreted (Murphy, 2021).

The other aspect that is truly impressive is Babylonstoren's quality of authenticity as a no-nonsense working farm. Some principles incorporated into the design of the farm are:

1. Observe nature

The first principle is focused on the observation of nature, in order to understand the elements of the system in which we are working, before acting on it. Attempts to understand and really engage with the situation we face should naturally lead to a deep reflection that allows us to deliver an appropriate response (Kotze, 2004: online).

This principle is achieved in the constant interaction with the public and the vegetable gardens. The experience of walking through the gardens is intended to connect with the user and to allow them to interact with the context of the project while facilitate conscious processes when engaging with the commission.

2. Catch and store energy

"By developing systems that collect resources when they are abundant, we can use them in times of need."
- David Holmgren (Franco, 2016: online).



Figure 48 Babylonstoren: garden
(Ryan, 2017: online)

3. Obtain a yield

"Ensure that you are getting truly useful rewards as part of the work that you are doing."
- David Holmgren (Franco, 2016: online)

An architecture project can greatly influence the context in which it operates, and we can't lose the opportunity to identify and develop its potential benefits to the greatest extent possible (Kotze, 2004: online).

The garden comprises 15 clusters spanning vegetable areas, stone and pome fruits, nuts, citrus, berries, bees, herbs, ducks and chickens, a prickly pear maze, and more. Gravity feeds water from a stream by rills into the garden, flowing through ponds planted with edible lotus, nymphaea lilies and waterblommetjies. Every one of the more than 300 varieties of plants in the garden is edible or has medicinal value (Joubert, 2015: 86).

They are also grown as organically as possible and in a biologically sustainable manner. The fruit and vegetables from the garden are harvested all year round for use in two farm-to-fork restaurants.

Along the edge of the garden, a natural fountain flows from the Simonsberg Mountain to the Berg River, creating a space for indigenous wild olives to flourish. In their shade a collection of some 7000 clivia lilies explode in a spectacular display every spring (Joubert, 2015: 86).



Figure 49 Babylonstoren: greenhouse (Vinerons, 2016: online)

4. Apply self-regulation and accept feedback

"We need to discourage inappropriate activity to ensure that systems can continue to function well." - David Holmgren (Franco, 2016: online).

This principle is represented by the planet earth, with the idea of showing the most visible "example of a self-regulating 'organism' which is subject to feedback controls, like global warming." The proverb used to describe it suggests that this negative feedback usually takes time to emerge, and the impact of our actions are not immediately visible (Franco, 2016: online).

5. Produce no waste

The old structures on the farm, namely the manor house, cellar and koornhuis, have been carefully restored, new guest accommodation and facilities have been built on the footprint of previous workers' housing (now rebuilt elsewhere on the farm), dilapidated outbuildings have been recycled as restaurants and a large new wine cellar has been constructed (Joubert, 2015: 86).

A beautifully designed and impressively productive fruit and vegetable garden has also been created. Within this garden, traditional irrigation furrows have been reintroduced. In addition, a somewhat playful and idiosyncratic glasshouse and a shade structure for plants have been added to the ensemble (Ryan, 2017: online).





Figure 50 Babylonstoren: reusing the old structures (Roos, 2021: online)

In the general layout of all these elements, great care has been taken to reinforce and enhance the existing, while adding new elements along similar principles. For example, the new elements added to the overall design create a much more pronounced focus on the Babylonstoren Hill, which is in proximity to the farm. The larger-scale elements, such as the wine cellars, have been sunken into the ground to reduce their bulk and possible spatial impact (Ryan, 2017: online).

In all the architectural work that has been done to the historic core of the farm buildings, care has obviously been taken to restore them as sensitively as possible, to reveal previous layers, to emulate the previous scale and to add the new in a bold and confident manner. Previous changes that were deemed insensitive and incongruent architecturally were removed. Everything was done to restore a line of continuous development that is in sympathy with the original buildings, while still remaining true to the sensibilities of its time (Joubert, 2015: 88).

6. Design details from patterns

"By stepping back, we can observe patterns in nature and society. These can form the backbone of our designs, with the details filled in as we go." - David Holmgren (Franco, 2016: online).

The architecture on the farm, the buildings are consciously used in relation to natural elements, and to enclose space by means of low walls. These environments are born out of necessity, mostly the necessity of agricultural needs and the limitations imposed

by building materials and technology. In this way, a cultural landscape has been produced that is of national and international importance.

Many of these historic farms have experienced a constant evolutionary and natural change since inception. Within this process, the architectural question has always been one of how to obtain a balance between the historic and the contemporary. This balance, specifically in a globalised world, can only be achieved by a sure and secure vision of the past and the future and, obviously, by architectural restraint (Franco, 2016: online).

7. Integrate rather than segregate

The buildings, functions and harvest are integrated together. This integration creates a sense of sustainability (Franco, 2016: online).

8. Use small and slow solutions

"Small and slow systems are easier to maintain than big ones, making better use of local resources that produce more sustainable outcomes."
- David Holmgren (Franco, 2016: online).

The biggest example of where the farm makes use of this principle is in the gardens. By implementing a system of vegetables and plants that grow in all four seasons the solutions can be identified.

9. Use and value diversity

"Diversity reduces vulnerability to a variety of threats and takes advantage of the unique nature of the environment in which it resides." - David Holmgren (Franco, 2016: online).

There are more than 300 varieties of plants in the garden is edible or has medicinal value. They are also grown as organically as possible and in a biologically sustainable manner. By growing sustainable with a wide diversity, the value enhances (Ryan, 2017: online).

10. Use edges and value the marginal

"The interface between things is where the most interesting events take place. These are often the most valuable, diverse and productive elements in the system."
- David Holmgren (Franco, 2016: online).

Looking at the site analysis of the farm, each space is optimized to create a marginal profit.

11. Creatively use and respond to change

"We can have a positive impact on inevitable change by carefully observing, and then intervening at the right time."
- David Holmgren (Franco, 2016: online).

By introducing the public to the organic farming methods of the Babylonstoren farm creates a sense of change in the eyes of the visitors (Ryan, 2017: online).



Figure 51 Babylonstoren: greenhouse tearoom (McCarthy, 2021: online)

PART 03

ESTABLISHING A SENSE OF PLACE: UNDERSTANDING THE SITE

3.1 TYPOLOGY
- 3.1.1 investigation of client and user
- 3.1.2 accommodation list

3.2 TOPOLOGY
- 3.2.1 macro site analysis
- 3.2.2 meso site analysis
- 3.2.3 micro site analysis
- 3.2.4 experiential investigation

3.3 MORPHOLOGY
- 3.3.1 discourse

Introduction

In this section the characteristics of the site – technical, emotive, and experiential – will be explored. The purpose of this discovery is to foster a greater contextual understanding of the site within its wider geographic and social location and to use this understanding to apply the principles of biophilia, permaculture, and sense of place to the site. The macro site analysis will uncover the features of the landscape, including its climatic attributes. This will allow for the application of a design that is sensitive to the environmental realities of the site. A SWOT analysis of the surrounding towns will also be conducted as part of the macro analysis, from which it will gleaned that there is market- readiness in the area for a Lifestyle Farm of this kind. The beauty of the Maluti mountains and the potential of this backdrop to establish a very distinct sense of place for the Lifestyle Farm will also considered. Finally, the micro site analysis takes a deeper dive into the historical and social features of the surrounding area. From Basotho huts to traditional Afrikaner limestone farmsteads, the area has a rich architectural history. These attributes are drawn on in terms of choosing materials that are typical of the area for the design of the Lifestyle Farm and the communal structure of the Basotho huts serves as further inspiration for creating a space that is interconnected while consisting of disparate parts, much like a traditional village structure (and as also explored more fully in the use of Noma 2.0 as a precedent).

In terms of unearthing what to design (typology), for whom to design it (typology: the clients and users), where to design it (topology), and how to respond to the site and user requirements through architectural considerations (morphology and tectonics), experiential and exploratory research was essential.

Figure 52 S217 road experience from road (Author, 2021)

The clients of the site consist of three entities:
· The owners of the farm
· The Department of Environment, Forestry and Fisheries
· FEDHASA, the national trade association representing the South African hospitality industry.

The farm owner, Mrs Verhoeven, see potential in the underutilized portion of their farm that has been identified as the site for this project. While this section of the farm is not suited to traditional farming, they want to put it to good use and additionally generate an income from it.

Aquaponics is a relatively new farming method in South Africa. Therefore, the Department of Environment, Forestry and Fisheries would likely fund, or partially fund, this development as a pilot project from which to draw observations about the further development and application of aquaponics in South Africa and to create awareness around this innovative farming technology.

FEDHASA would act as the hospitality partner, linked to the tourism arm of the project. The Association is the driving force that promotes growth, development, sustainability, and inclusivity in the tourism industry.

In terms of the users of the site, these can be divided into two main categories – the businesses that would buy fresh products from the farm and, secondly, tourists who would visit the farm and make use of its services including the accommodation, outdoor activities, and the restaurant.



Figure 53 Client: owner of farm
(Author, 2021)

forestry, fisheries & the environment
Department:
Forestry, Fisheries and the Environment
REPUBLIC OF SOUTH AFRICA

Figure 54 Client: Dep of forestry, fisheries and the environment
(Department of Environment, 2020)

FEDHASA
Federated Hospitality Association of Southern Africa

Figure 55 Client: FEDHASA
(FEDHASA, 2020)

Challenges
Based on the clients and users identified for the site, several challenges can be deduced:

· Income generation

· Encouraging and enhancing the application of aquaponics in South Africa.

· Creating a site that will contribute towards growth, development, sustainability, and inclusivity in the tourism industry.

· Producing a yield of sustainably grown produce.

· Establishing a sense of place at the site that will make it attractive to tourists while at the same time fostering a greater connection to the natural environment.



Figure 56 S217 Road view of the landscape from road (Author, 2021)

3.1.2 ACCOMMODATION LIST



The accommodation list is divided into three branches that create specific genius loci.

Firstly, eat: deli shops, a restaurant-venue space, cocktail lounge and a big stoep.

Secondly, relax: accommodation

Thirdly learn: the aquaponics farm (consisting of a greenhouse, loading dock, fish tanks, planter pipes, storage, fish/plants processing, overall administration, main reception, orientation space and a staff breakaway).

Besides the built accommodation list, the farm will provide outside activities such as 4x4 routes, horseback riding, fishing, hiking, cycling and adventure activities like abseiling.



Figure 57 View of landscape from R26 Road
(Author, 2021)



Topology entails where to design, spatial-order and organisation, admittance, spatial interrelationship and planning when designing a site for a user.

This included looking at maps and aerial photographs of the site, but most of all, this facet was reliant on visiting the site and allowing the existing landscape to dictate design decisions through careful observation and analysis, in keeping with the sub-themes of permaculture and biophilic design. By employing a subjective approach to experiencing the space, a deeper understanding of the space was gleaned.

The primary aim of the site analysis for this dissertation can be divided into two parts. The first part of the site analysis was focused on uncovering the analytical information necessary for a successful design. This analytical information can be further divided into a macro-, meso-, microanalysis.

The second part of the site analysis was focused around developing a deeper understanding of the site. This is related to the experiential and emotive elements of the site.



3.2.1 MACRO SITE ANALYSIS

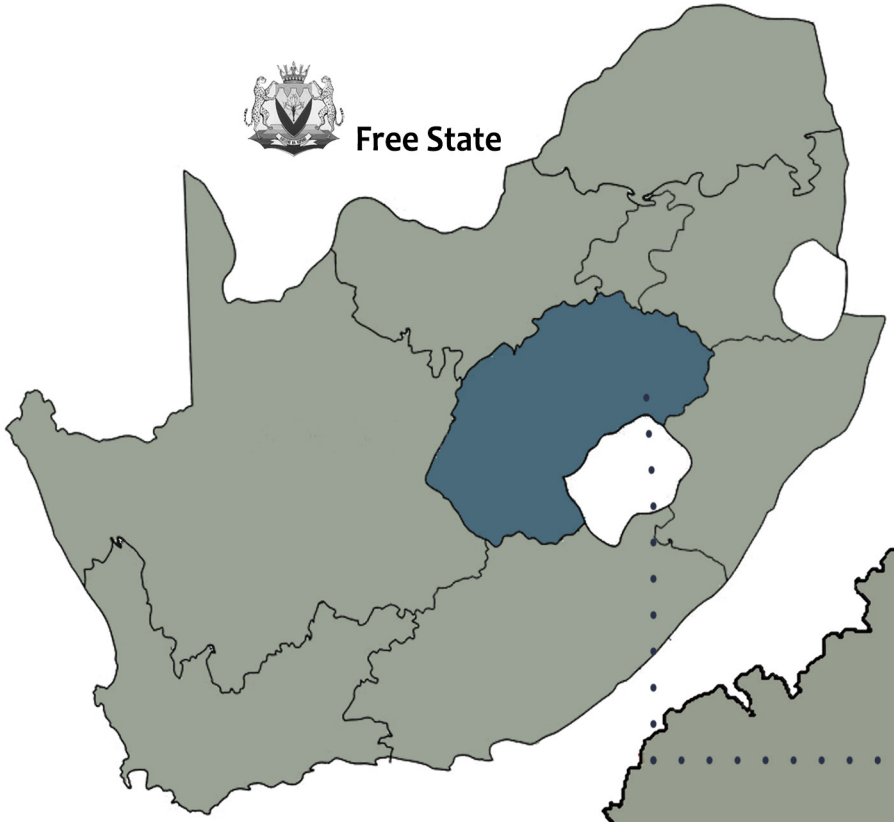
In the macro analysis, the general climatic information was analysed. This analysis was conducted using climatic graphs and statistics.

In addition to understanding the climate, and how this will affect the design and activities of the Lifestyle Farm, it was also essential to conduct a SWOT analysis of the surrounding areas to understand how the Lifestyle Farm will supplement and complement the existing activities found in the area while also filling opportunity gaps.

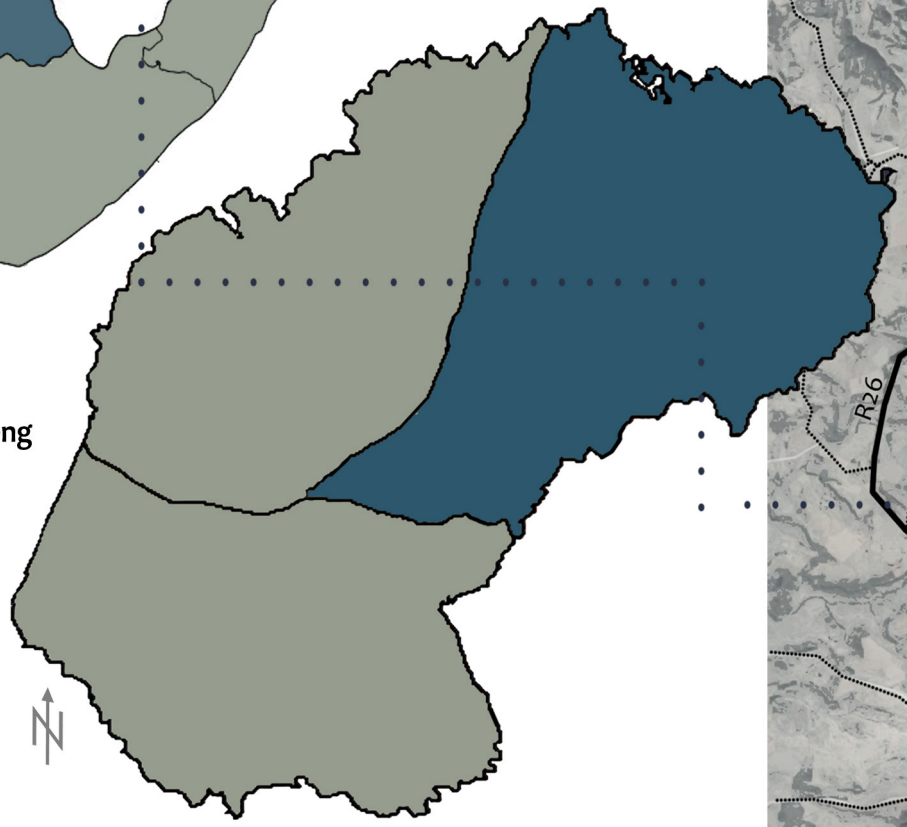
The site is found on a gravel road named the S217 which is connected to two main routes, namely the R26 road that connects Bethlehem to Fouriesburg and the R712 road that connects Bethlehem to Clarens. The farm on which the site is located is called Lorina (-28.378603, 28.275218).

This part of the Eastern Free State is situated within in a mountainous romantic landscape. The scenic mountains are a big tourist attraction. While tourism is a growing revenue source in the area, the Eastern Free State, also known as Dihlabeng, is predominantly agricultural, yielding approximately 29.4% of the country's produce (Stats SA, 2011: online).

Because the site lies between Fouriesburg, Clarens and Bethlehem, it was important to understand each surrounding town's characteristics, strengths, weaknesses, opportunities, and threats. This SWOT analysis was undertaken based on the experience of visiting each town on multiple occasions.



The site is located in the Eastern Free State on the S217 between Bethlehem, Fouriesburg and Clarens. The natural beauty of the Eastern Free State is a big tourist attraction. The Lesotho border is found 45km from the site via the R26.



Eastern Free State | Dichlabeng
Population: 128704
Agricultural 29.4 %
Private businesses: 17%
Social services: 15%
Trade: 11%
(Stats SA, 2011: online)

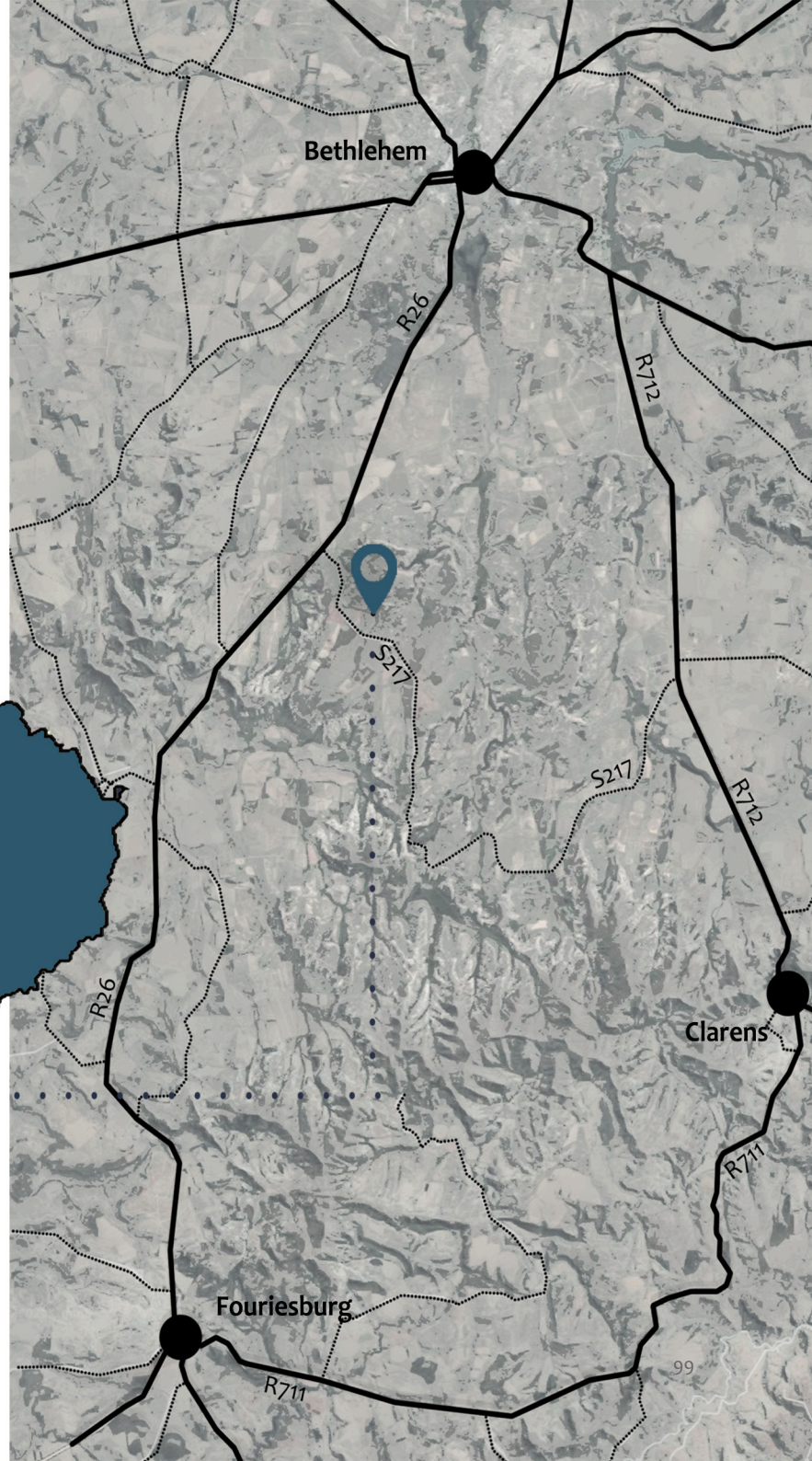


Figure 58 Location collage of site
(Author, 2021)



Figure 59 Areal view of Bethlehem
(Badsha, 2019: online)

Bethlehem | Bohlokong

28.2329 S, 28.3066 E
Population: 51 239
Established: 1860's

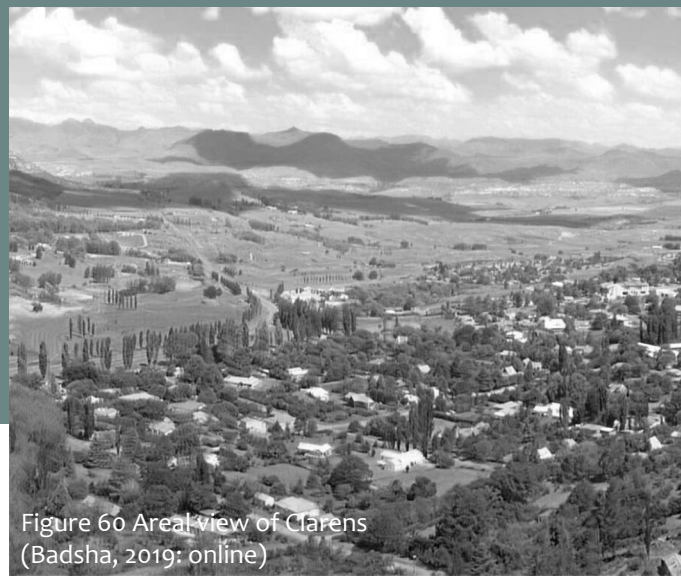


Figure 60 Areal view of Clarens
(Badsha, 2019: online)

Bethlehem is nestled in the Maluti Mountains. The town grew rapidly after it was founded as a service centre in the 1860s connecting Johannesburg, Harrismith and Bloemfontein by rail. The town's name is of Hebrew origin and means "house of bread" (Badsha, 2019: online).

Bethlehem's biggest strength is that it has a growing economy and continues to see development thanks so its central location. The town's core weakness is that it has fallen into infrastructural disrepair due to a lack of road maintenance and service delivery by the local municipality. An opportunity identified in Bethlehem is that it is a contraction point for agriculture. A threat identified in this town is the high crime rate (Cele, 2020: online). In addition, unemployment figures are also high (Cele, 2020: online). While there is urban development in the area, this attracts a large amount of job seekers who cannot necessarily find employment in the town, necessitating survival from whatever meagre means are available to the people of the town.

Clarens, nicknamed the "Jewel of the Eastern Free State", is a small town situated on the foothills of the Maluti Mountains. The tranquil village ambience combined with scenic views and a mild climate has made Clarens an artists' haven and a popular getaway for city dwellers from Johannesburg, Bloemfontein and Durban, all of which are located within driving distance. The tourism industry acts as the primary income source for this town, especially for the businesses located on what is marketed as the 'arts and crafts route' (Mount Rouge, 2017: online).

One of the biggest strengths of this small village is its strong tourism economy. The downside of this for locals is that goods and services in the town tend to be more expensive than in the surrounding towns. A more expensive environment creates a threat where only a particular class of people can enjoy Clarens in its totality. Clarens allows unique products to be sold thanks to its reputation as an artistic hub. A significant weakness is that the village is overly dependent on tourism. As the effects of the recent pandemic-related lockdowns have shown, when the demand for



Clarens | Kgubetswana

28.5146 S, 28.4175 E
Population: 6 379
Established: 1912



Figure 61 Areal view of Fouriesburg (Badsha, 2019: online)

Fouriesburg | Mashaeng

28.6184 S, 28.1966 E
Population: 12 974
Established: 1892

tourism services dries up, so do the jobs associated with it, creating employment and income insecurity. Clarens is the main tourism hub in the area and this strength will be an important driver in the design of the Lifestyle Farm, while also focusing on establishing multiple revenue streams to shield the farm from being reliant on tourism alone.

Fouriesburg is a small town situated at the junction of the R711 and R26 routes in the Eastern Free State. The town is located near the Maluti Mountains and only 10km from Caledon's Poort border post, which gives access to Lesotho (Sa-venues: 2020).

Fouriesburg (Grootfontein farm) was established in 1892 and named after Christoffel Fourie, the owner of a farm named Groenfontein. The Fouriesburg area served as the temporary seat of the Free State government during the Anglo-Boer War. It was declared the capital of the Orange Free State Republic – a proclamation that was yet to be rescinded at the time of its naming.

This town is full of rich history but also caters for adventure enthusiasts. Fouriesburg has a fantastic view of the Maluti Mountains (Tucker, 2021: online).

The Maluti Mountains is a key element in the 'Genius Loci' or spirit of Fouriesburg. The proposed design will maximise the awe-astounding effect of the mountainous landscape by offering breathtaking views of the Maluti Mountains and, in doing so, allowing a constant connecting element between earth and sky to run through the space.

The biggest strength identified in Fouriesburg is its rich history and the activities found around the town, such as Meiringskloof Nature Park. Meiringskloof is a beautiful kloof surrounded by sandstone cliffs with open caves, thick indigenous bush and abundant bird life. Fouriesburg is near the Lesotho border (11km) and allows easy access for visitors to Afri-Ski (located in the Maluti Mountains and one of two ski resorts in southern Africa) or Katse Dam (163km) (Meiringskloof Nature Park: 2021: online).

Fouriesburg's weak economic growth over the past 15 years has been identified as a weakness.

Conclusions from the Macro Site Analysis

Some farms in the Eastern Free State that traditionally focused solely on food production have introduced restaurants, venues for hire and accommodation. The Eastern Free State has become a tourist hub in the province. This illustrates that a market exists for the Lifestyle Farm and that it should be a viable source of revenue.

Currently, there is no lifestyle aquaponics farm in the Fouriesburg /Bethlehem/ Clarens area that can be visited by the public. The Proposed Lifestyle Farm will give the public the opportunity to spend the night, visit the aquaponics section, eat organic food at the restaurant, explore the beautiful surroundings (by hiking, horse riding, 4x4 routes, cycling and fishing) and book the reception venue for events. The Lifestyle Farm could serve as a much-needed economic injection for the Fouriesburg area. Thus, by connecting a closed system based on natural cycles (aquaponic farm) to the public through creating a Lifestyle Farm for tourism, an interconnection can be found in the planned architectural design.

The people will feel connected to the given community and environment, creating a sense of place. This sense of place will be achieved by observing the patterns, processes, and cycles within nature (Mang & Reed, 2012: 12).

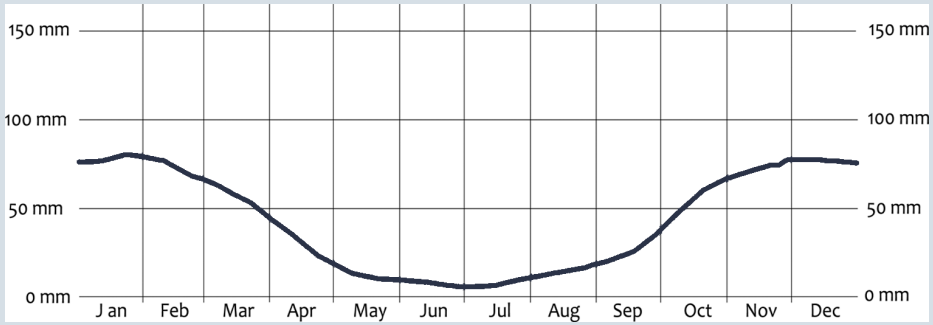


Figure 62 View from R711 of the landscape (Badsha, 2019: online)



Climate Analysis

The climate analysis reveals the average, rainfall, wind, temperature, wind direction, the growing season, hours of daylight and twilight, and the associated agricultural activities.



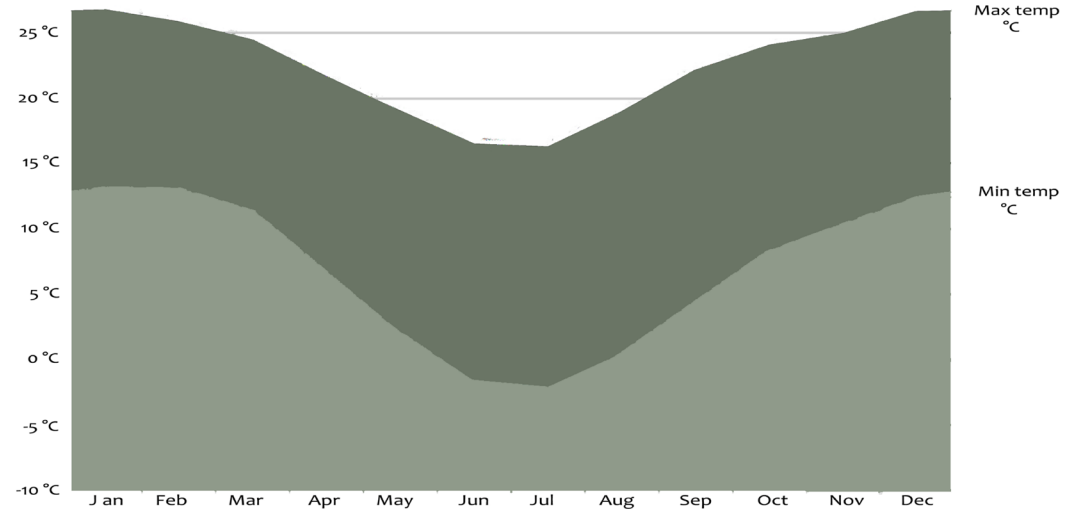
Average Rainfall
(Diebel, 2016: online)

Rain fall

The average rainfall shows the rainfall accumulated over a sliding 31-day period centred around each day of the year. The site experiences significant seasonal variation in monthly rainfall (Diebel, 2016: online).

On average, rainfall is spread across 9 months, the summer months with a rainfall of rainfall of at least 13 millimeters. Most of the rain falls during the 31 days centred around January, with an average total accumulation of 80 millimeters (Diebel, 2016: online).

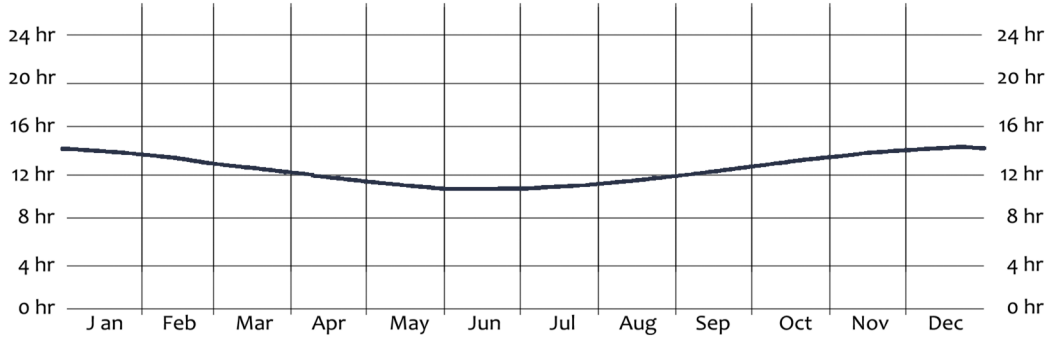
The rainless period of the year lasts for 3 months, from May to August. The least rain falls during July, with an average total accumulation of 6 millimeters. This part of the country is a summer rainfall area (Diebel, 2016: online).



Average Temperatures
(Climate-Data, 2021: online)

Temperature

The average summer temperature for this location is 23°C, while the average winter temperature is +/- 8°C. December and January are the hottest months, with a temperature ranging between 15 - 32°C, while June is the coldest month with temperatures ranging between -1 and 17 (Climate-Data, 2021: online).



Hours of Daylight and Twilight
(Diebel, 2016: online)

Hours of Daylight and Twilight

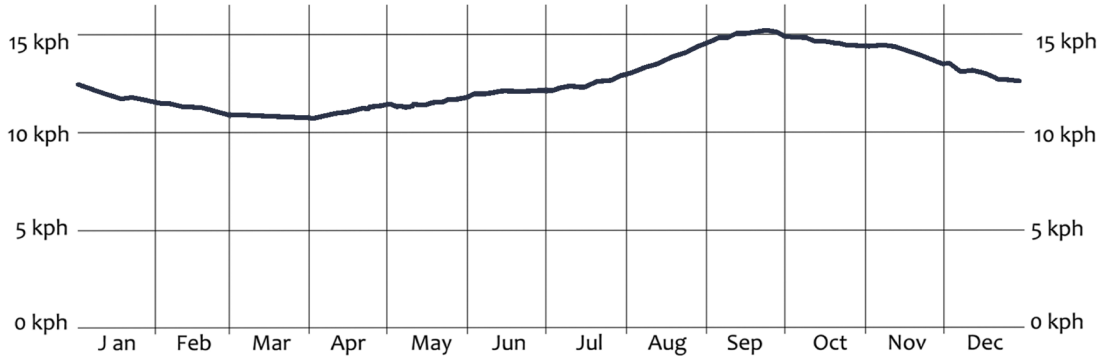
The earliest sunrise is at 5:01 AM on December 2, and the latest sunrise is 1 hour, 58 minutes later, at 6:59 AM on July 2. The earliest sunset is at 5:17 PM on June 10, and the latest sunset is 1 hour, 51 minutes later, at 7:08 PM on January 10 (Diebel, 2016: online).

The average wind and direction

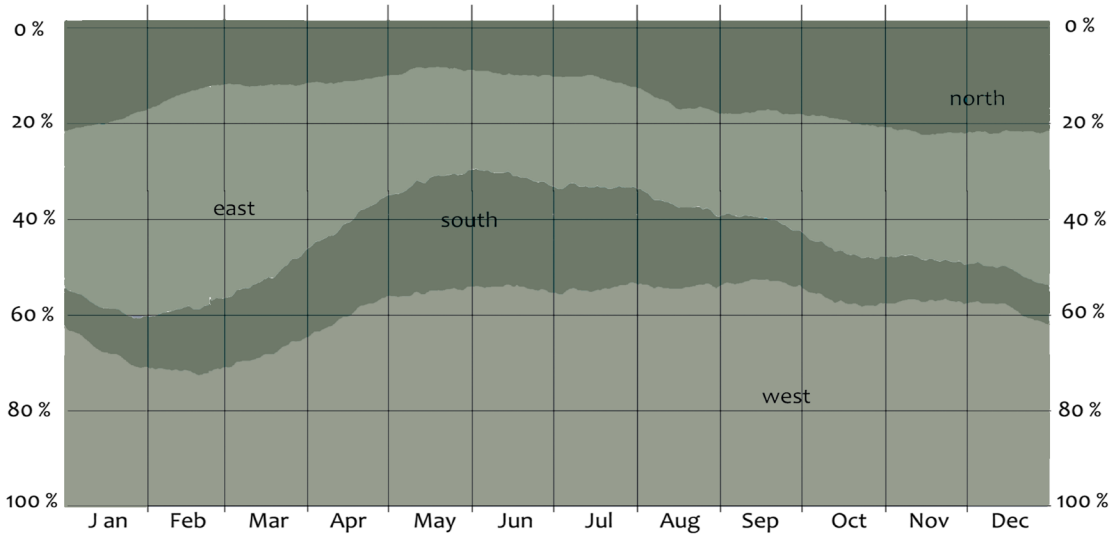
This section discusses the wide-area hourly average wind vector (speed and direction) at 10 meters above the ground. The wind experienced at any given location is highly dependent on local topography and other factors, and instantaneous wind speed and direction vary more widely than hourly averages (Diebel, 2016: online).

The average hourly wind speed at the site experiences mild seasonal variation during the year. The windier part of the year lasts for 4.5 months, from July 31 to December 15, with average wind speeds of more than 13.2 kilometres per hour. The windiest day of the year on average is September 24, with an average hourly wind speed of 15.5 kilometres per hour (Diebel, 2016: online).

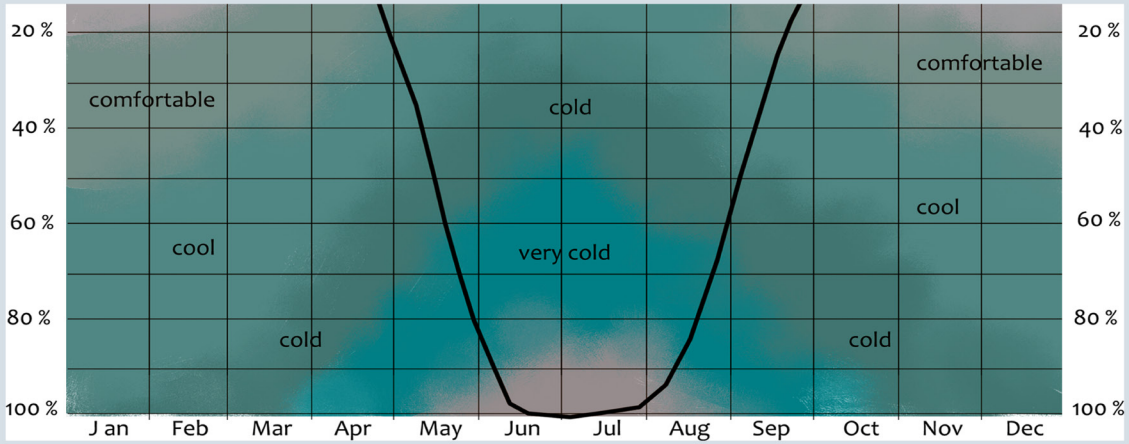
The relatively wind still timeframe lasts for 7.5 months, from December to July. The calmest day of the year is March 31, with an average hourly wind speed of 10.9 kilometres per hour. The predominant average hourly wind direction at the site varies throughout the year. The wind is most often from coming from the east for 2.7 months, from January to March, with a peak percentage of 46% on February 19. The wind is most often coming from the west for 9.3 months, from March 30 to January 7, with a peak of 37% on January 1st (Diebel, 2016: online).



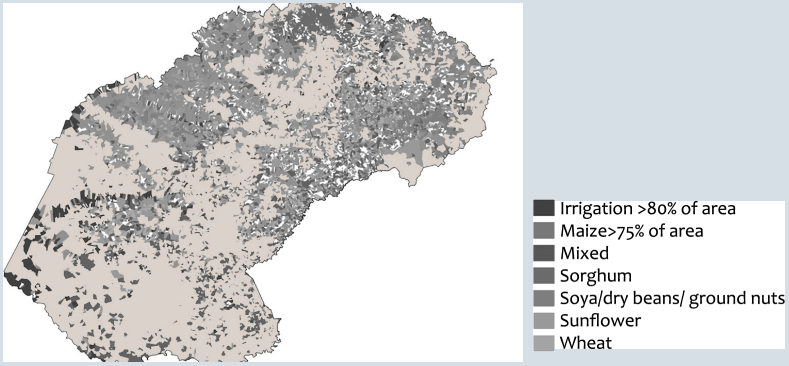
Average Wind Speed
(Diebel, 2016: online)



Average Wind Direction
(Diebel, 2016: online)



Growing Season
(Diebel, 2016: online)



Growing Season
(Diebel, 2016: online)

Growing season and types of farms in the Free State

The growing season can be defined as the longest continuous period of non-freezing temperatures (≥ 0°C) in the year (Diebel, 2016: online).

The growing season around the site typically lasts for 8.4 months (253 days), from around September 4 to around May 15, rarely starting before August 12 or after September 30, and rarely ending before April 22 or after June 6 (Diebel, 2016: online).

In the Free State irrigation more than 80% of the area is irrigated. The main crops are Maize, which accounts for more than 75% of the yield in the area, followed by sorghum, soya/dry beans/ groundnuts, sunflower and lastly, wheat (Crespo, 2012: online).

3.2.2 MESO SITE ANALYSIS

The area surrounding the site is home to unique historical, cultural and indigenous features. In the meso site analysis, a closer look will be taken at how these features influence the surrounding communities.

Historical landmarks
Given South Africa's past ruling government pre-1994, the historical landmarks that are most prominent in the area are related to the Anglo Boer War.

Retiefsnek
During the Anglo Boer War, Retiefsnek formed one of two crucial routes to join the Basin and provide access from the basin to the coastal line and the rest of South-Africa. The Brandwater Basin forms a natural fortress within the Witteberge in the west and the Roodeberge to the east. This natural fortress encloses the area in a half-circle with Fouriesburg approximately in the middle (de Bruin, 2011: 3).

West of the site, a small British graveyard can be found. This Graveyard dates to the Anglo Boer War in the early 1900s where soldiers lost their lives during the battle of Retiefsnek. The cave of Oshoek, found in the military base to the east of the site, was a hiding place for the women and children during the Anglo Boer War. Today this cave is also known as Piet se Gat (Viljoen, 2021).



Figure 63
Retiefsnek
(Author, 2021)



Figure 64
Boerwar graveyard
(Author, 2021)

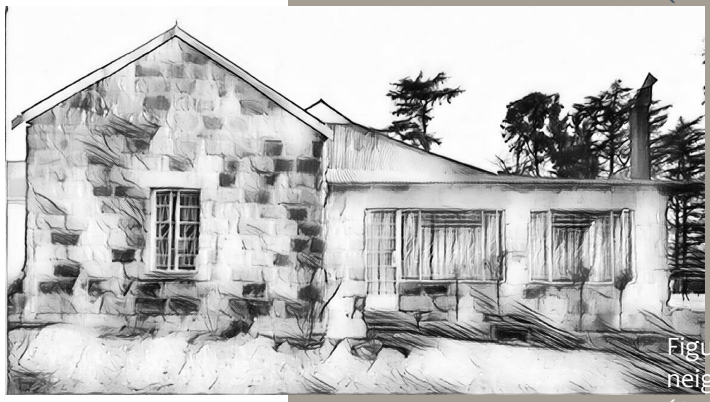


Figure 65
neighboring house
(Author, 2021)



Figure 66 identified Basotho patterns
(Author, 2021)

The site rich in history and in a diverse culture.

Basotho Houses

Not only is the site rich in history, but also in cultural diversity.

The Basotho Cultural Group uses Litema Patterns on their houses. These Sotho houses dot the Eastern Free State grasslands.

Basotho houses are usually earth-constructed houses decorated with Litema patterns. Litema patterns signify cultivation which is donated through patterns that imitate a ploughed field. The designs are comprised of soft and flowing geometric patterns applied with fingers, forks and sticks to the walls. Traditionally the women decorate houses after the men have finished constructing the house (de Lange, 2021: online).

The main functions of the traditional Basotho hut were to keep its inhabitants warm and dry. In addition the huts were used as a space for acquiring and keeping food and water, fuel and artefacts, cooking, sitting while eating, defecating, sleeping and procreating, defense against enemies, asserting military or political and commercial power, fighting and competing, worshipping and performing rituals, exchanging goods and services, story-telling, dancing and acting, teaching and learning, discussing and socializing, suffering, enjoying life and lastly dying (Gerald, 2021: 57).

The full gamut of life's activities thus take place in these beautifully adorned walls. As time progressed, the Basotho hut changed and developed. Typically, the structure evolved to become round with a thatched roof and stone or earth constructed walls (Gerald, 2021: 57).



Figure 67 Basotho houses
(Author, 2021)

Context Exploration of the Farmsteads

The context exploration revealed the scenery, farms, agriculture, and landmarks found on the roads leading to the site. A personal photo analysis assisted in gathering information for the context exploration.

By exploring the context, the typical farmstead layout can be identified. Generally, each farm features the main house, a cement dam, a lane of trees leading up to the farmstead, a big barn, silos, and smaller outbuildings. The primary materials from which the farmsteads are constructed include sandstone, corrugated iron, and exposed concrete.

A typical farmhouse design consists of a main bedroom with a big stoep (veranda) circling the house. As time progressed, farmers added rooms to the house. The houses feature ceilings that are higher than the standard height and broad windowsills. The houses consist primarily out of sandstone walls, pitched roofs and a large stoep. Extensive gardens surround most houses.

The house consists of a main bedroom with a big stoep (veranda) circling the house. As time progressed, farmers added rooms to the house. The houses consist of a higher ceiling than usual and broad window sills. The houses consist primarily out of sandstone walls, pitched roofs and a big stoep. Extensive gardens surround most houses.

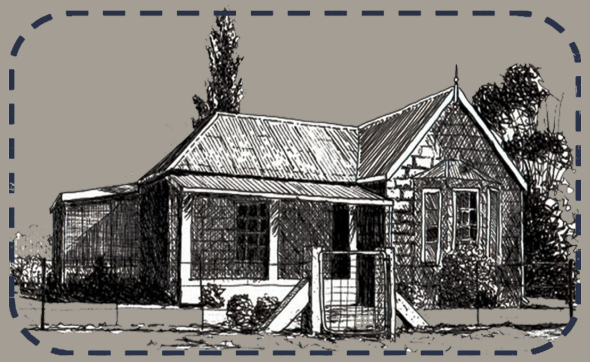


Figure 68 House in Fouriesburg
(Author, 2021)



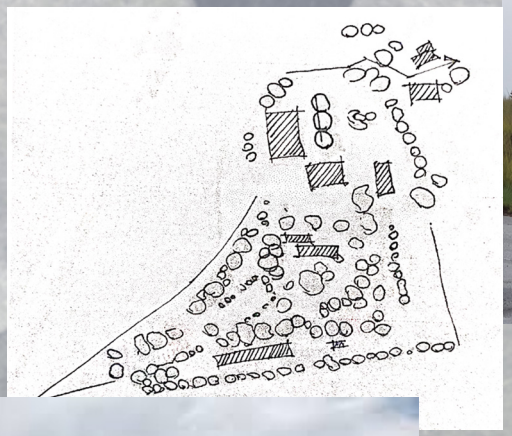
Figure 69 Farm intrepretation
(Author, 2021)

Tourists Attractions

- Cherry festival
- Bethlehem Air show
- Lush
- Clarens Craft Beer Festival
- Maluti Double90
- Golden Gate Challenge
- The park run
- Meirings kloof hiking trail
- South African Slalom Canoe Championship
- Myl 8 Hiking trail
- Mountain climbing
- Abseiling
- River rafting
- Horseback riding
- Wine farm
- Cheese farm
- Game farms
- Cheetau lion farm
- The Fouriesburg Caste
- Union house
- Guest farms
- Golf Estate
- Meiringskloof
- Golden Gate Highlands National Park
- 4x4 trails
- Fishing
- Day spa
- Flight routes

Context Exploration

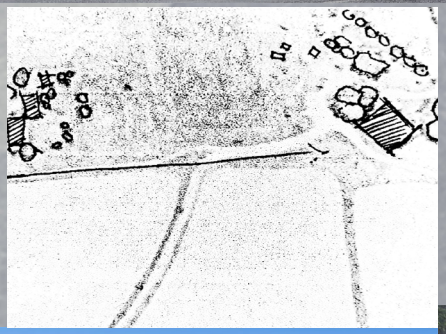
Context exploration reveals the scenery, farms, agriculture, and landmarks found on the roads leading to the site, with a personal approach toward exploring a photo analysis assisted in gathering information in the context exploration.

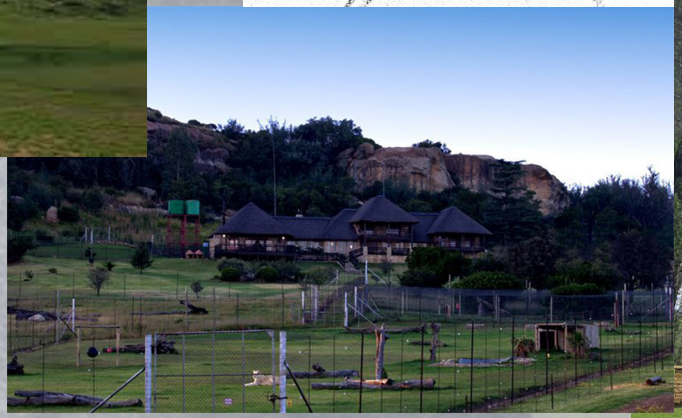










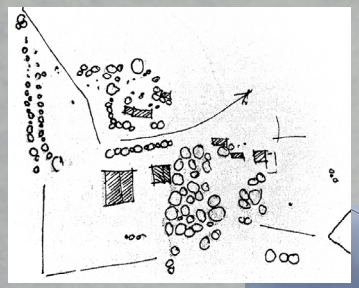
















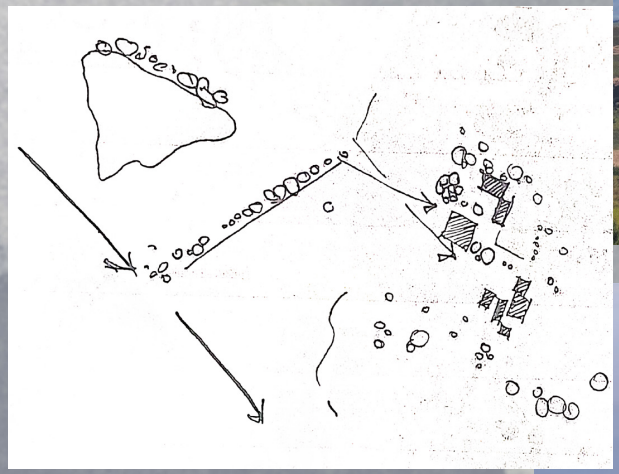









SLABBERTS







































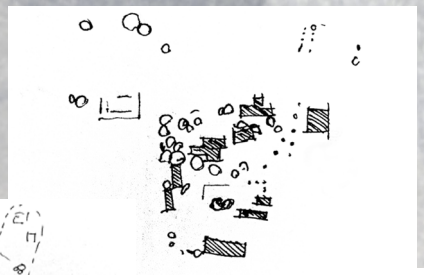







CLARENS,SOUTHAFRICA
GPS 20° 30' 44"S,28° 25' 36"E



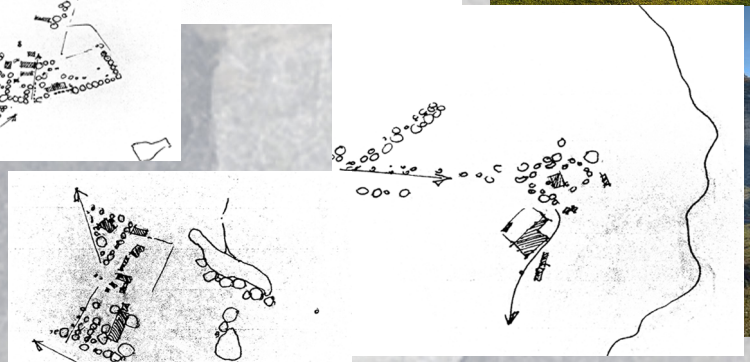


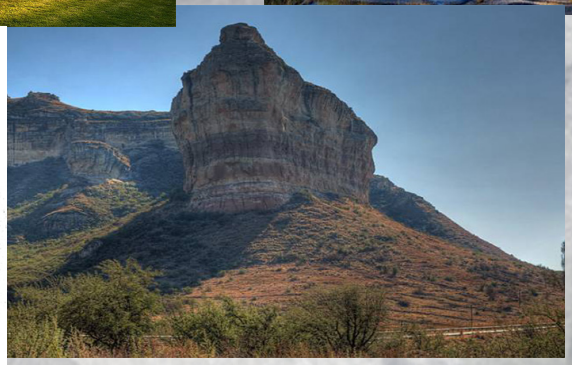




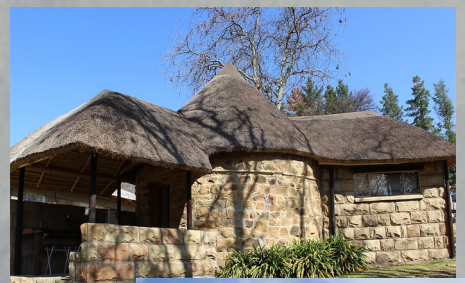

Surrender Hill
PARKING PARKERING











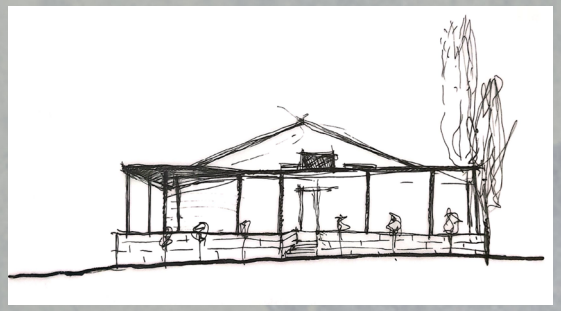












Figure 70 Photo analysis (Author, 2021)



Figure 71
(Author, 2021)



View West

Figure 72
(Author, 2021)



Figure 73 Location interpretation series
(Google Earth adapted by author, 2021)

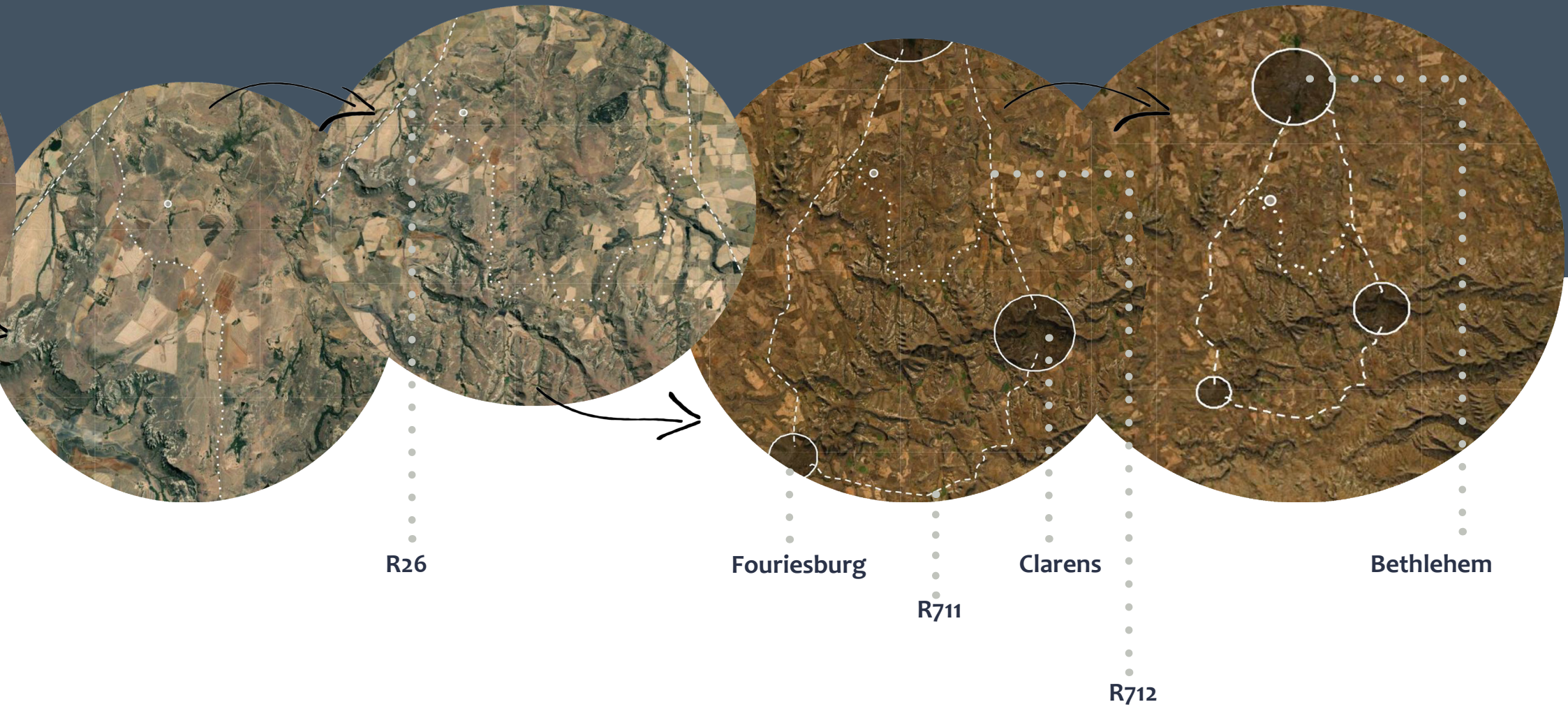

R26
Fouriesburg
R711
Clarens
R712
Bethlehem



Figure 74
(Author, 2021)

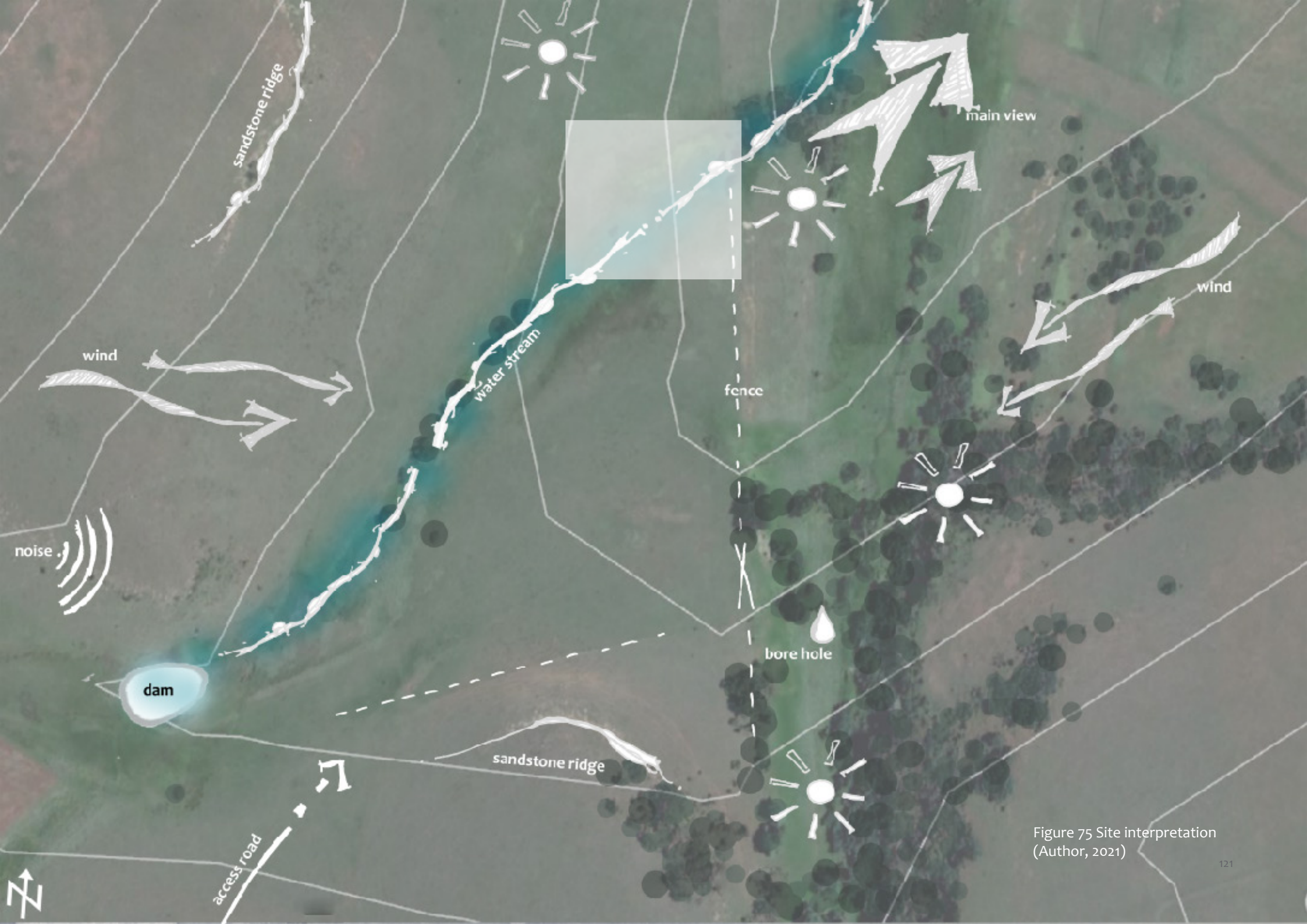


Figure 75 Site interpretation (Author, 2021)

3.2.3 MICRO SITE ANALYSIS

The immediate site location is dependent on the influences of the topology and the surrounding environment. In the micro context the possibility of opening the pristine countryside to new opportunities was explored.

Different topographies determine the basic character of the site. The site is in a wetland area. The site is a typical classical landscape. The characteristic of a classical landscape is that it combines the features of romantic and cosmic landscapes. Clear natural elements, meaningful order, and harmonious space can further be seen as characteristics of such a landscape (Norberg-Schulz, 1996: 45).

Looking at the site from a bird's eye perspective a natural triangle is formed with the river, trees, and contour lines of the hill towards the south.

The classical landscape is characterized by monotony not by multifariousness. Rather we find an intelligible composition of distinct elements: clearly defined hills and mountains which are rarely covered by shaggy woods, clearly delimited, imageable natural spaces such as valleys and basins, which appear as individual "worlds", a strong and evenly distributed light and a transparent air which give the forms a maximum of sculptural presence (Norberg-Schulz, 1996: 45).

The ground is simultaneously continuous and varied, and the sky is high and embracing without however possessing the absolute quality encountered in the desert. A true microstructure is lacking, all dimensions are human and constitute a total, harmonious equilibrium.

The environment thus consists of palpable "things" which stand out (exist) in the light. The classic landscape receives light without losing its concrete presence (Norberg-Schulz, 1996: 45). In general, the classical landscape may be described as a meaningful order of distinct, individual places (Norberg-Schulz, 1996: 45).

The site is located between two rocky mountains. The soil in the wetland is thus shallow and does not allow for commercial farming methods. A constant flowing fountain (20 000l p/hour) is found on the site. Salix Babylonia (willow trees) form a rhythmic pattern along the fountain.

The site consists of a rich diversity of flora. During a site visit, different plants were gathered to compile a vegetation analysis for the site (figure 77 & 78).



Figure 76 Fountain found on site
(Author, 2021)

Textures found on site



Figure 77 Texture analysis (Author, 2021)



Figure 78 Plants identified on site (Author, 2021)



3.2.4 EXPERIENTIAL INVESTIGATION



Figure 79 Experiential investigation drawing based on experiences on site (Author, 2021)

3.3 MORPHOLOGY

3.3.1 DISCOURSE

Morphology can be seen as the process of taking clues from the surroundings, identifying and creating a character and developing a mass or building profile that embodies the memories of the meeting of earth and sky. Therefore it can be considered as an exploration of the idea that all localities have a “genius loci” or spirit which can inform the architect on how to respond to the site to convey the original phenomenological experience thereof through architecture. The conceptual idea and inspiration behind the built form (proposed Lifestyle Farm) is to combine the landscape with the architecture - the natural with the human.

The relevance of the theoretical, experiential, and exploratory research for this project was to establish a clear understanding of the sense of place, the nature of the particular site, and how design can create a biophilic sense of place at the chosen location.

This analysis was helpful in terms of establishing a deeper understanding of how one can create architecture that is responsive to current needs, such as economic and environmental sustainability, while also being in beautiful harmony with the natural landscape.

For the broader community, this kind of project will be beneficial in terms of showcasing how sustainable technologies can be deployed in ways that address immediate concerns while at the same time fostering a deeper connection to the natural environment and, in doing so, creating greater sensitivity to the needs of the environment.

PART 04

STRUCTURAL CONSIDERATIONS: AQUAPONICS APPLIED TO THE SITE

4.1 TECTONICS
- 4.1.1 technical investigation
- 4.1.2 structural touchstone
- 4.1.3 structural philosophy

4.2 AQUAPONIC TECHNOLOGY

4.1 TECTONICS

In this section the structural elements that will be incorporated into the design will be discussed. This will include looking at how the precedent Noma 2.0 can provide inspiration for operationalizing biophilic and permaculture principles. Following this, aquaponic technology will be discussed in detail in order to provide a technical deep-dive into how this technology will be applied to the site.



4.1.1 TECHNICAL INVESTIGATION

NAM0 2.0

BIG [BJARKE INGELS GROUP]
COPENHAGEN, DENMARK
1290 m²
2018

Figure 80 Namo 2.0 : main view with landscape
(Ingels, 2018: online)



Figure 81 Namo 2.0 : main view close up (Ingels, 2018: online)

Introduction

This precedent study will consider the design of a garden village in Copenhagen, which houses one of the world's best restaurants.

The design dissolves the traditional idea of a restaurant by deconstructing its constituent parts and reassembling them to put the chefs at the heart of the building's functionality.

This study of the Noma 2.0 will primarily focus on the materiality of the design, particularly its use of materials to reflect the landscape and the local Danish culture.

From a structural perspective, the building's in-between spaces will be discussed and how the structure interacts with the landscape to enhance the visitor experience.

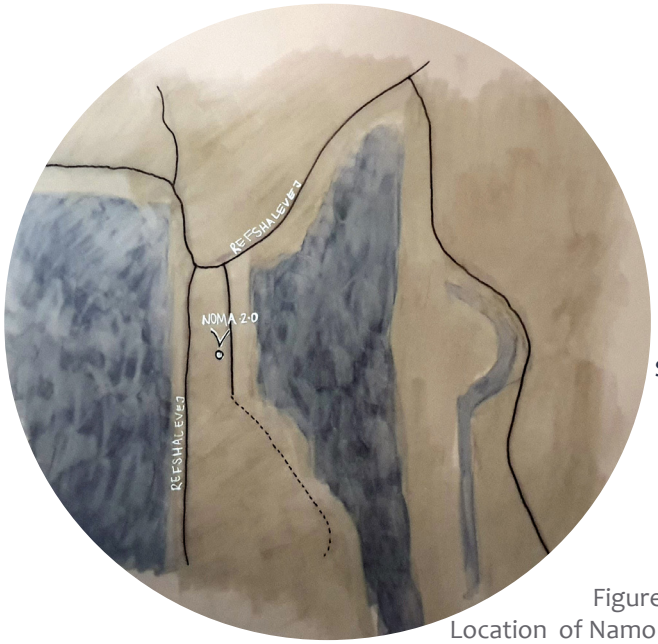


Figure 82
Location of Namo 2.0
(Author , 2021)

Location:

Noma 2.0 is located in Co¬penhagen, Denmark. The restau¬rant is built in the middle of two lakes on a site located in Christiana, which forms part of a protect¬ed ex-military warehouse [SØminedepotet] once used as a storage facility for the Royal Danish Navy. The site has been reimagined as an intimate culinary garden village with the SØminedepotet form-ing Noma's new home after undergoing a partial renovation and extension towards the end of Christian-havnsVold as the holistic heartland of Copenhagen.



Figure 83
Areal view of site
(Google Earth, 2021: online)

Climate

Copenhagen has relatively mild weather conditions due to the surrounding ocean. The hottest month is July, while the coldest month is February. The wettest month is June, and the windiest is January. Copenhagen has a very mild and moderate summer climate with temperatures between 18-24 0°C. During the winter they make use of adjusted hours to accompany day-light savings techniques, as the sun only rises at about 08:30 a.m. and already starts to set at around 3:30 p.m. (DARA, 2020: online).

Site accessibility

Noma 2.0 is located East and West of the site. The village only has vehicular access from the North (via Refshalevej road), although Refshalevej road continues towards the South of the site where a pedestrian path can be found.

The site is located in an urban settlement, but it is designed to fit in with the natural landscape due to its surroundings (the lakes and natural footpath). The west facade is completely closed off from Refshalevej road's urban activities. This sheltered effect is accom¬plished through the design of the existing building on the site.

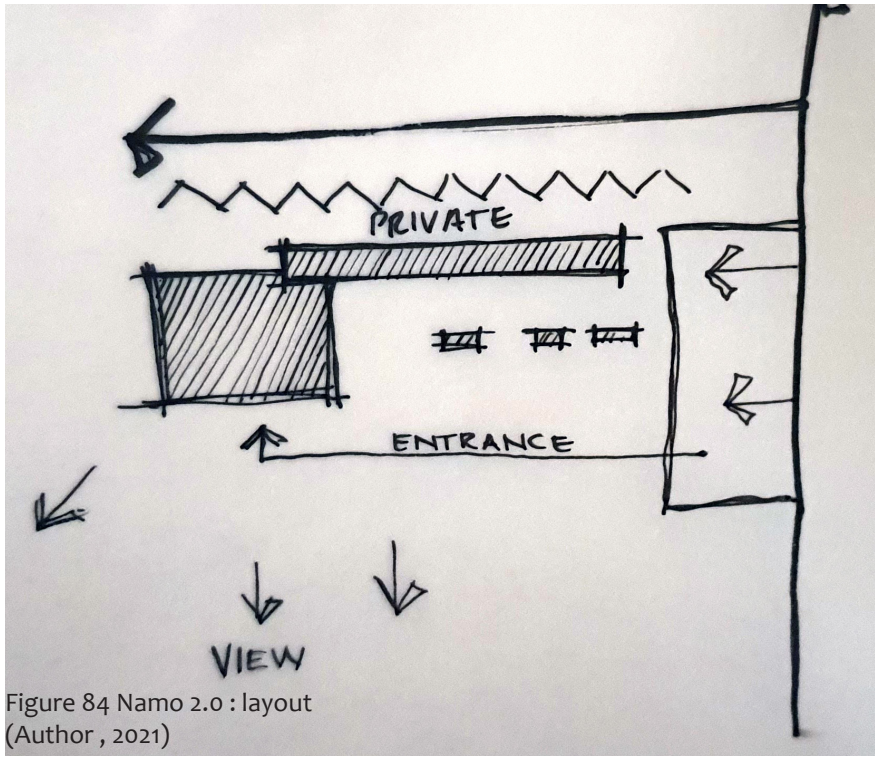


Figure 84 Namo 2.0 : layout
(Author , 2021)


Figure 85 Copenhagen
(Climate Action, 2015: online)

User requirements

The co-owner of Noma 2.0, Peter Kreiner – an expert in the experience economy, wanted to create a restaurant where users can connect with nature and with one another to feel a true sense of being at home.

In order to achieve this, the founders and the architects drew inspiration from the surround-ing neighborhood of Christiana, where building regulations allow for residential develop¬ment to take place organically, leading to the warm conviviality the peaceful neighborhood is known (Chan, 2018: online).

Drawing on the contextual references found in Christiana, the architects created a cluster of seven small buildings that form a living, breathing village envel-oped by nature rather than creating one solid mass to house the restaurant.

As seen in figure 6, this kind of organizational structure is also found in the traditional Nordic farm Typology, typified by a loose cluster of individual buildings housing single functions spread across the landscape. Noma's organizational structure is further inspired by the archetype of the Arctic village, where buildings are closely related but visually diverse with basic variations in their design.

The idea of separating the different functions of the restaurant and changing them into a group of separated, but still interconnected buildings, is brought into operation (Chan, 2018: online).

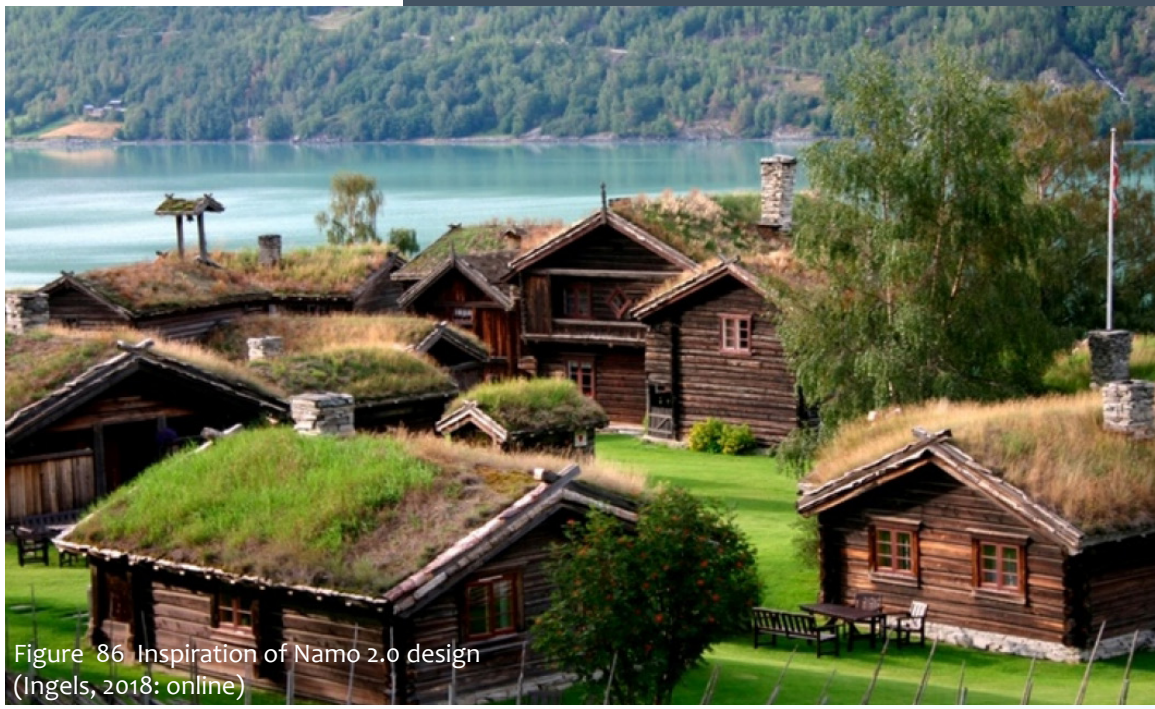


Figure 86 Inspiration of Namo 2.0 design (Ingels, 2018: online)



Figure 87 Insperation of Namo 2.0 design (Ingels, 2018: online)



Figure 88 Existing military storage building - repurposed (Ingels, 2018: online)



Figure 89 The abandoned building before Namo 2.0 (Ingels, 2018: online)

Layout

The existing building

The floorplan is designed within the parameters of an existing historic building. As mentioned, the existing building named SØminedepotet was a military storage facility built in the 20th century. The building fell out of use and became overgrown, covered with graffiti and worn down. Today the structure is protected as a national landmark (Ingels, 2018: online).

The building is constructed out of concrete and stretches 100meters over the site (Wang, 2018: online).

Floorplan

TThe floorplan is laid out according to the restaurant's functions. The restaurant has specific functions, each function is first analyzed so that they can be reorganized to fit into one connected space. The restaurant boasts a total of 11 inter-connected spaces (Hjortshoj, 2018: online).

The existing building's heritage status lim¬ited the redevelopment of the site and al¬lowed for small extensions to be built where previous structures once stood.

Figure 90 Orientation of old vs new
Figure 91 Plan for new stuctures
Figure 92 Plan for existing structures

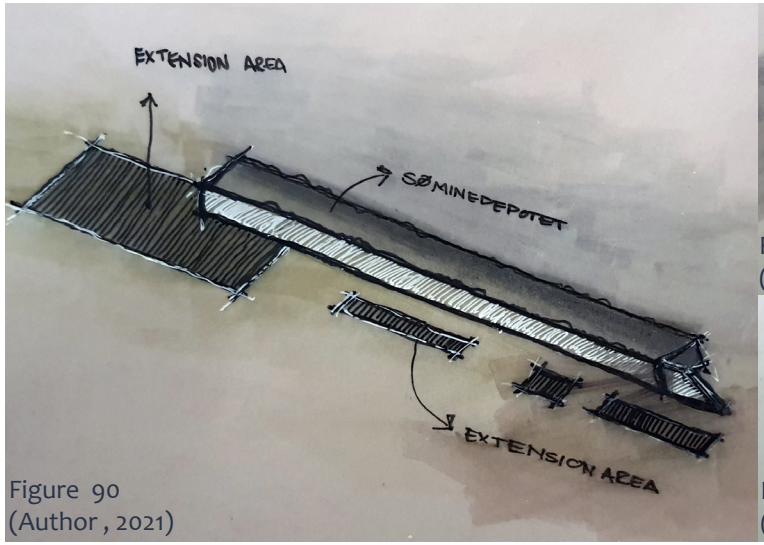


Figure 90
(Author , 2021)

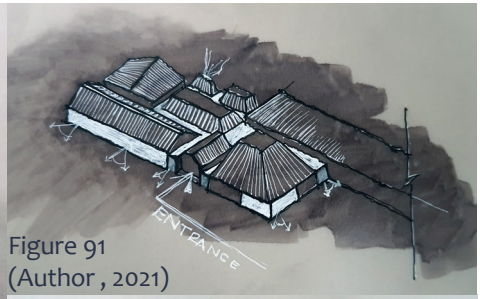


Figure 91
(Author , 2021)

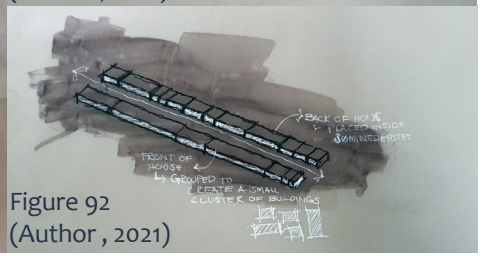


Figure 92
(Author , 2021)

Program

The Noma program is divided into two parts. The first part is the front-of-house, where the experience is focused on the guests visiting the restaurant. This guest-driven part is further divided into individual units that house the different functions needed to accommodate guests (Ingels, 2018: online).

The second part is the back-of-house program. This program is designed to fit within the existing structure of the original building. With a long passage on the Eastside, the different functions are connected inside the existing structure through glass-domed passages (Ingels, 2018: online).

The front-of-house program is arranged into small buildings on the expansive existing footprint to the South-end of the original building. Together this group of small buildings creates the village, which forms the essence of the architectural experiences for the building users. Each tiny building is designed under its function, with the view, light and atmosphere being central facets to the design (Ingels, 2018: online).

Three additional existing footprint structures can be found on the site, and these glass structures are used to house the greenhouse, a bakery and a test kitchen (Wang, 2018: online).


Figure 93 Existing building hallway
(Hjortshoj, 2018: online)



Figure 94 Main front door
(Elisa, 2019, online)



Figure 95 Glass greenhouse
(Elisa, 2019, online)



Figure 96 : Interioir of main foyer
(Elisa, 2019: online)

Entrance

Guests arrive at a basic front door that gives the ap¬pearance of being cut out from the slatted wooden facade of the building. The main entrance of the building is constructed from tombac, which will corrade to a matt brown as the building ages (Dinesen, 2021: on¬line).

The terrazzo floor is sandblasted so the users can experience the natural river stones embedded within the material. Natural oak panels line the ceiling and walls of the foyer building, with an integrated wardrobe embedded within the panels (Dinesen, 2021: on¬line). These panels create a sense of warmth and comfort, typical of the Danish notion of Hygge.

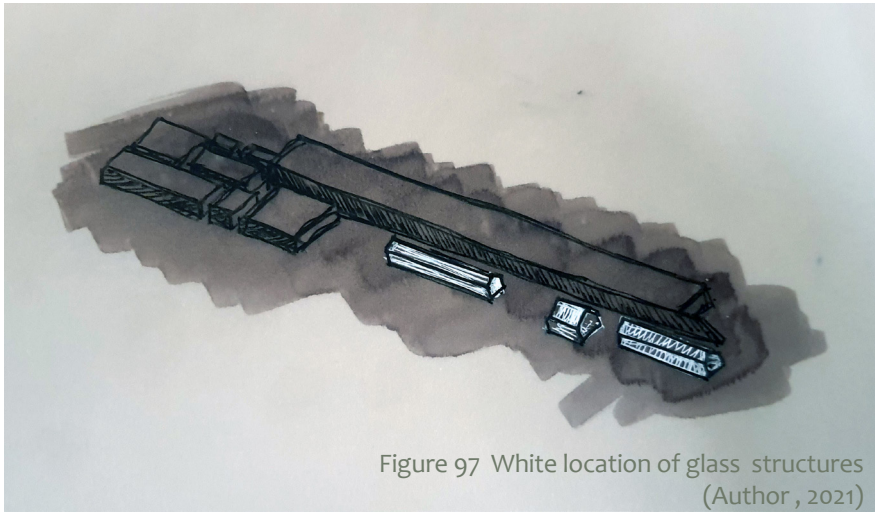


Figure 97 White location of glass structures
(Author , 2021)



Figure 98 Main kitchen
(Hjortshoj, 2018: online)

Chef's headquarters

The head chef's headquarters are found at the heart of the cluster of villages. As seen in figure, the location of the chefs' headquarters allows the chefs to have a visual and physical connection with all the different functions of the village.

This centralised position also allows guests to have a birds-eye view of the restaurant to follow what happens in the kitchen, unlike in an ordinary restaurant where the kitchen is concealed. This adds to the home-like atmosphere of the restaurant, as the kitchen is the literal heart-of-the home in traditional Danish houses. Surrounding the chefs' headquarters, the arrival foyer, the lounge, grill area, the wine cellar, and a private company can be found (Hjortshoj, 2018: online).

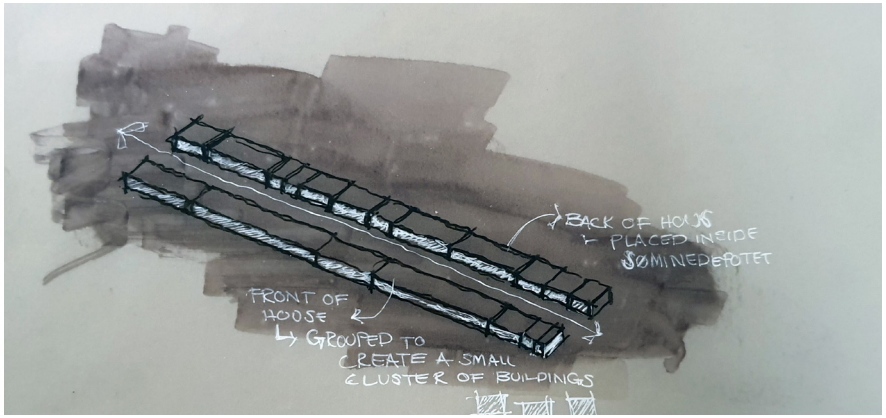


Figure 99 Interpretation of how buildings are divided
(Author, 2021)



Figure 100 Glass connections
(Hjortshoj, 2018: online)

Materiality

Materials identified in the construction of Noma 2.0

- Existing building – Concrete
- Entrance building – Tombac + Oak Timber
- Kitchen – Steel
- Barbecue – Steel
- Main Dining hall – Oak Timber
- Private Dining Room - Pine Timber
- Lounge – Bricks
- Greenhouses – Glass + steel

Glass

Frameless glass is used to connect different parts of the building seamlessly, creating a transparent interface. Internal supports are required below the structural silicone joints that connect the glass panels to form the roof of Noma 2.0.

Glass connections

Glass-framed passages connect the structures and cover the paths and in-between spaces, linking the separate buildings and functions to form a cohesive whole.

The use of glass as an inter-connecting material allows the guests to feel part of the culinary experience. It also plays an important role with change of seasons and allows the space to be inviting of all seasons and weather (Chan, 2018: online).



Figure 101 Glass connections roof to glass
(Hjortshoj, 2018: online)



Figure 102 Glass connections roof to glass
(Hjortshoj, 2018: online)



Figure 103 Glass connections roof to glass
(Hjortshoj, 2018: online)



Figure 104 How Namo2.0 introduce the landscape to the intertior (Hjortshoj, 2018: online)

The village buildings

Each building in the village has its material character. Guests can meander through each of the surrounding buildings, providing them with the opportunity to experience various Nordic materials and building techniques (Chan, 2018: online).

The interiors are accurate to the structure, echoing the exterior materials of each build¬ing, creating a natural, simple and modern feel. Using different materials such as oak, brick, steel, glass, concrete and tombac shows that the design is eco-friendly and organic, yet playful (Singhal, 2018: online).

Each site is comprised only out of one material type (both the interior and exterior) and has a single purpose. However, the dining room, entrance foyer, lounge and private din-ing room en¬compass multiple functions, and this is also expressed in the various indi-vidual materials coming together to form a powerful statement (Singhal, 2018: online).

The glass-topped connections between the buildings ensure that each building has its roof system structure and ample natural light infiltration.

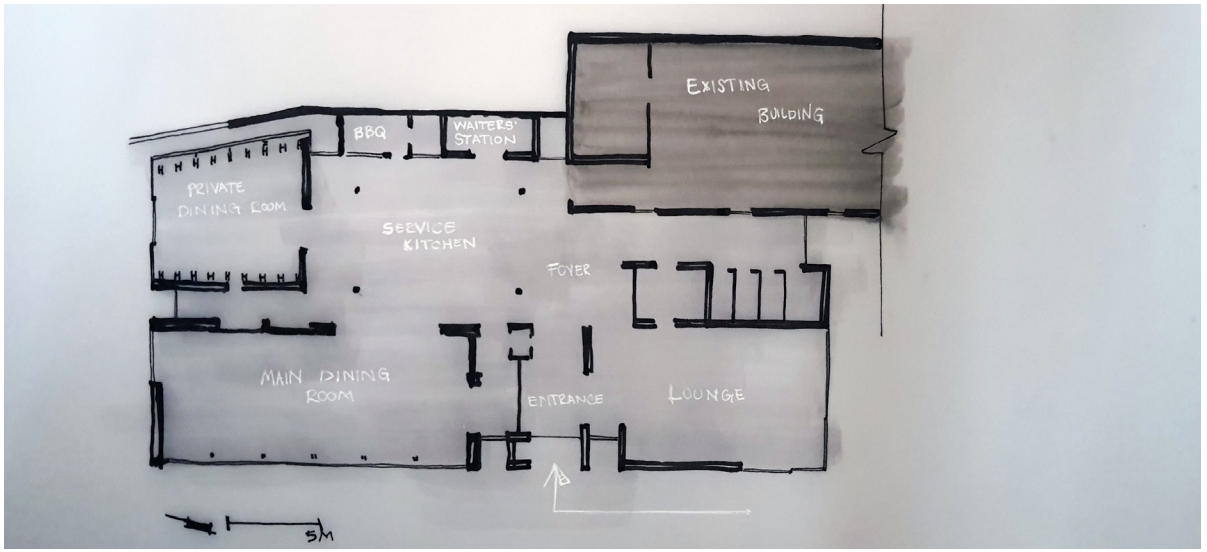


Figure 105 Floorplan of Namo 2.0 (Hjortshoj, 2018: online)

Service kitchen

The kitchen is designed in a panopticon style, with an oversized hood hovering over the chefs for ventilation. The entire ceiling offers ventilation; this allows the chefs to cook openly in the centre of the kitchen. The kitchen is the only building with enclosing walls, using steel support for the roof only.

The heart of the home is the Kitchen. It is designed with a steel and glass roof allowing the natural flow of light to fall on the oak-clad islands. The floor is made up of a polished river stone terrazzo (Dinesen, 2021: online).



Figure 106 Service kitchen
(Chan, 2018: online)

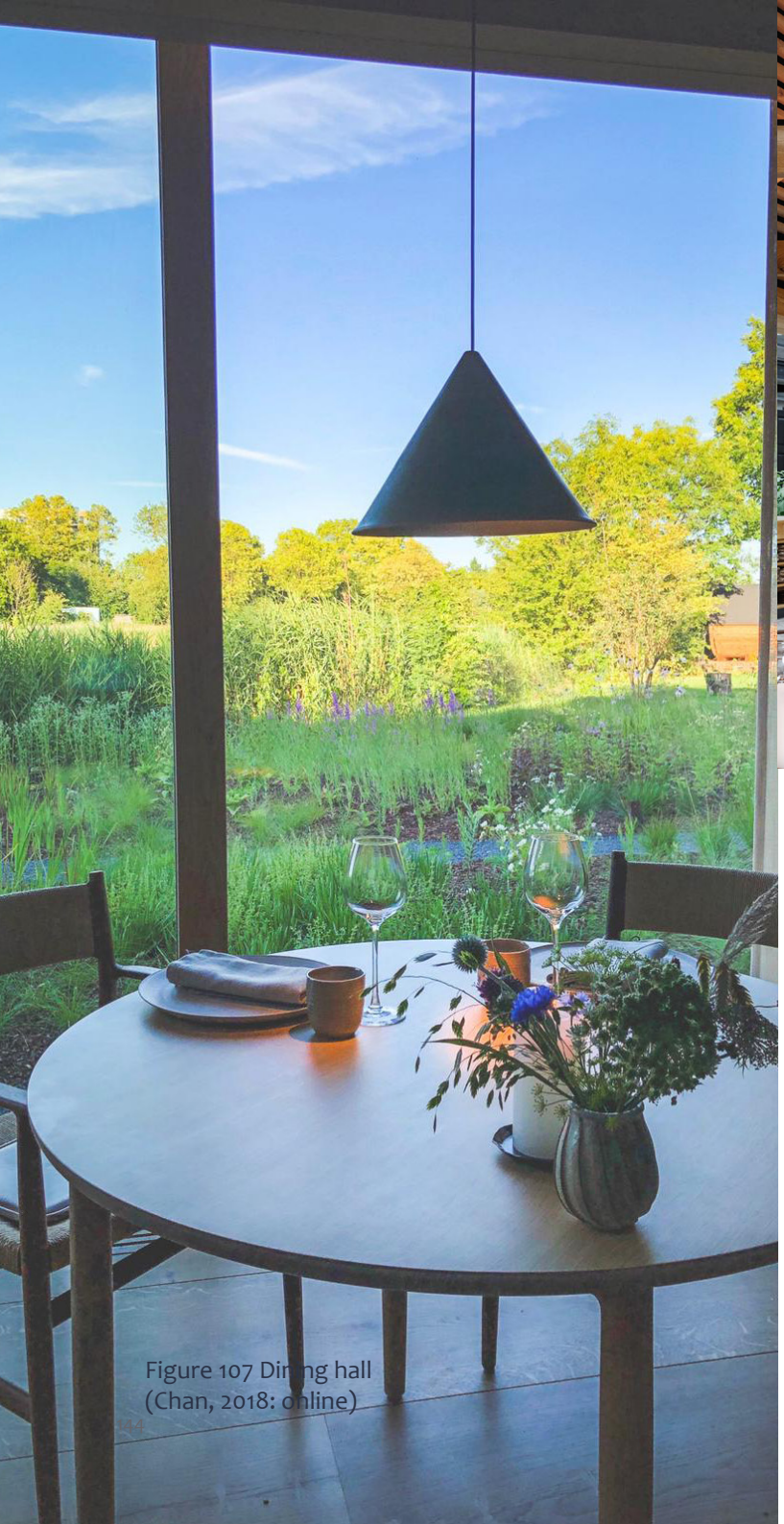


Figure 107 Dining hall
(Chan, 2018: online)



Figure 108 Dining hall
(Chan, 2018: online)

The dining hall

The garden can be viewed from the dining hall as it is designed with a beautiful skylight and an array of sliding windows showing off the serenity of the environment (Chan, 2018: online).

The entire building, inside and out, consists of oak. The oak is used in different styles to from the floor, walls and ceiling. An array of stacked timber planks line the walls and everything is held together with 250'000 invisible screws (Dinesen, 2021: online). The entire facade can open up into the landscape, creating an inside-outside space. The main dining room is fitted with Dinesen Heart Oak flooring. As a result of nearly 200 years of harsh winters and hot summers the Dinesen Oak Floors have cracked, however, this imperfection has perfectly been restored with the designers signature butterfly joints.



Figure 109 Exterioir facade: timber room
(Chan, 2018: online)



Figure 110 Interioir stone room
(Chan, 2018: online)



Figure 111 Interioir stone room
(Chan, 2018: online)

In creating the walls of the main dining room, 46 cubic meters of oak was used with roughly 250,000 invisible screws holding it all together. A counter crafted out of 200-year-old timber beams is located at the centre of the space. The timber is left deliberately unadorned to create a conversation point in the room (Dinesen, 2021: online).



Figure 112 Interioir floorwork
(Chan, 2018: online)



Figure113 Chimney
(Chan, 2018: online)

The Barbecue

The barbecue consists of an enormous walk-in hut (Chan, 2018: online). The grill is cross-ventilated to allow the chefs to cook over an open fire inside the building.



Figure 114 Interioir BBQ
(Author 2021)

Private Dining Room

The Private Dining Room can host 20 guests at its smoked oak table. The expansive windows enable guests to view the age old trees outside the property (Dinesen, 2021: online).

The entire room is cladded with Dinesen Douglas pine. Furthermore, the Douglas planks also cover the pillars supporting the roof, adding to the architectural experience of the room (Dinesen, 2021: online).

The shelving on the wall forms part of the overall construction. Because pine cannot be left untreated, the exterior facades of the building are treated by the process of scorching the wood with a flame.



Figure 115 Timber scorch
(Author 2021)



Figure 116 Interioir formal dine
(Chan, 2018: online)



Lounge
The lounge looks and feels gigantic due to the use of white brick in the interior (Chan, 2018: online).

Figure 117 Lounge (Chan, 2018: online)



Figure 118: White brick brick (Chan, 2018: online)

Natural oak planks are used on the ceiling, creating a stepped effect to evoke the clean, modern lines remi¬niscent of the 70s Danish style.

The ceiling rises to a skylight right above the open dark-shaded brick fireplace. The open fireplace, also constructed entirely out of brick inside and out, creates a cosy atmosphere in the space (Dinesen, 2021).

Materiality is kept honest and straightforward. The entire corner of the building can be opened to allow the elements to enter and form part of the space.



Figure 119 - 21: Materials and textures (Chan, 2018: online)

Greenhouses

The greenhouses are constructed out of frames crafted from steel and glass. The first greenhouse functions as a waiting space for the guests to be seated and also as a perma-garden for the kitchen. The second and third can be seen as extensions of the kitchen, with one serving as an experimental kitchen and the second as a bakery.

The existing building

As mentioned, the original building is constructed from concrete. Featured in the interior of the building is a 70-metre-long wooden cabinet and shelving system designed to function as an ordering device in the current refurbishment. Exposed service pipes can be found in the existing building, and a long skylight is inserted throughout to provide lighting for the functions housed inside this structure.

Technology

An exciting feature found at Noma 2.0 is the lighting system. Each lighting fixture can be adjusted digitally to provide a warm, fireplace-like experience during the winter and cold light in summer—this change of lighting allows for interaction between light inside and outside the building.



Figure122 Greenhouse waiting area
(Hjortshoj, 2018: online)



Figure 123 Staff break away
(Dinesen, 2018: online)



Figure 124 Exposed mechanical systems
(Dinesen, 2018: online)

Landscape

Minimal landscaping has been applied to the garden to fit in with the natural landscape and the informal design approach. Instead, it is designed to be a fluid, organic extension of the natural landscape. A single footpath allows guests to meander past the building from the North to the South. By walking alongside the building, guests get a glimpse of the restaurant is behind scenes activities. Indigenous flora is used for the garden spaces, and instead of neat cut-grass courtyards, natural field grass is used. This design gives the user the experience of dining in the original landscape that is typical of the area. A perma-garden is also incorporated into the design as a source of organic produce for the kitchen.



Figure 25 Garden
(Cogley, 2018: online)



Figure 126 Walkway in garden
(Hornshoj, 2018: online)



Figure 127 Quinine spring (Redzepi, 2019: online)

Why Noma 2.0 is a Relevant Precedent

The theories identified for the design of the aquaponic Lifestyle Farm can be observed in the design of Noma 2.0. The architectural aim of the aquaponic Lifestyle Farm is to establish a sense of place by responding sensitively to the landscape.

The Noma 2.0 typifies this approach through how the building is designed to interact with the surrounding natural environment, in both its interior and exterior. A sense of place is created through a variety of certain features and characteristics spanning the visual, cultur¬al, social, and environmental realms to provide meaning to a location (Hsiao, 2012). The Noma 2.0 addressed all these aspects in the design.

Biophilic design can be identified in Noma 2.0 with the constant interplay between guests and the broader landscape. Permaculture, which entails working with and not against nature and allowing the landscape to reveal the decisions that should be made from an architectural point of view, is revealed at Noma 2.0, where the original landscape is utilised to complement the built structures of a formal garden.

Biomimicry refers to an architecture in which the built environment imitates some of the main elements of nature and, in doing so, creates an architecture that reacts to the ele¬ments. The use of traditional materials that are typically used in Danish construction creates a holistic mimicry of the natural environment.

By looking at the method of integrating the materials used with the naturally occurring landscape, certain design clues can be identi¬fied for the design of the aquaponic Lifestyle Farm. Like Noma 2.0, the farm will use indigenous materials to its landscape, traditions and culture.

The methods employed in the design of Noma 2.0 can also be echoed in the design of the farm. The design of both the aquaponic Lifestyle Farm and Noma 2.0 is premised around the central idea. Both designs draw on the different functions fulfilled by a farm and how these functions can be tied together through the built environment to form a cohesive unit.

The landscape design at Noma 2.0 also reveals an approach to how the aquaponic Lifestyle Farm can incorporate the more remarkable natural landscape into an informal design for its surrounding gardens.



Figure 128 Quinine summer (Redzepi, 2019, online)

Conclusion:

By analysing Noma 2.0, the use of different materials was investigated and how they work together to create harmony in both form and function. The analysis of this precedent has been primarily focused on materiality and how this structure uses materials that fit in with its landscape and the local Danish culture.

By designing with biophilia principles in mind, open space is created to cultivate the produce used at the restaurant. From the layout to the materials, furnishings and fabrics, all of the design elements Noma 2.0 comprises in perfect keeping with Copenhagen's landscape, climate and sense of place.

4.1.2 STRUCTURAL TOUCHSTONE

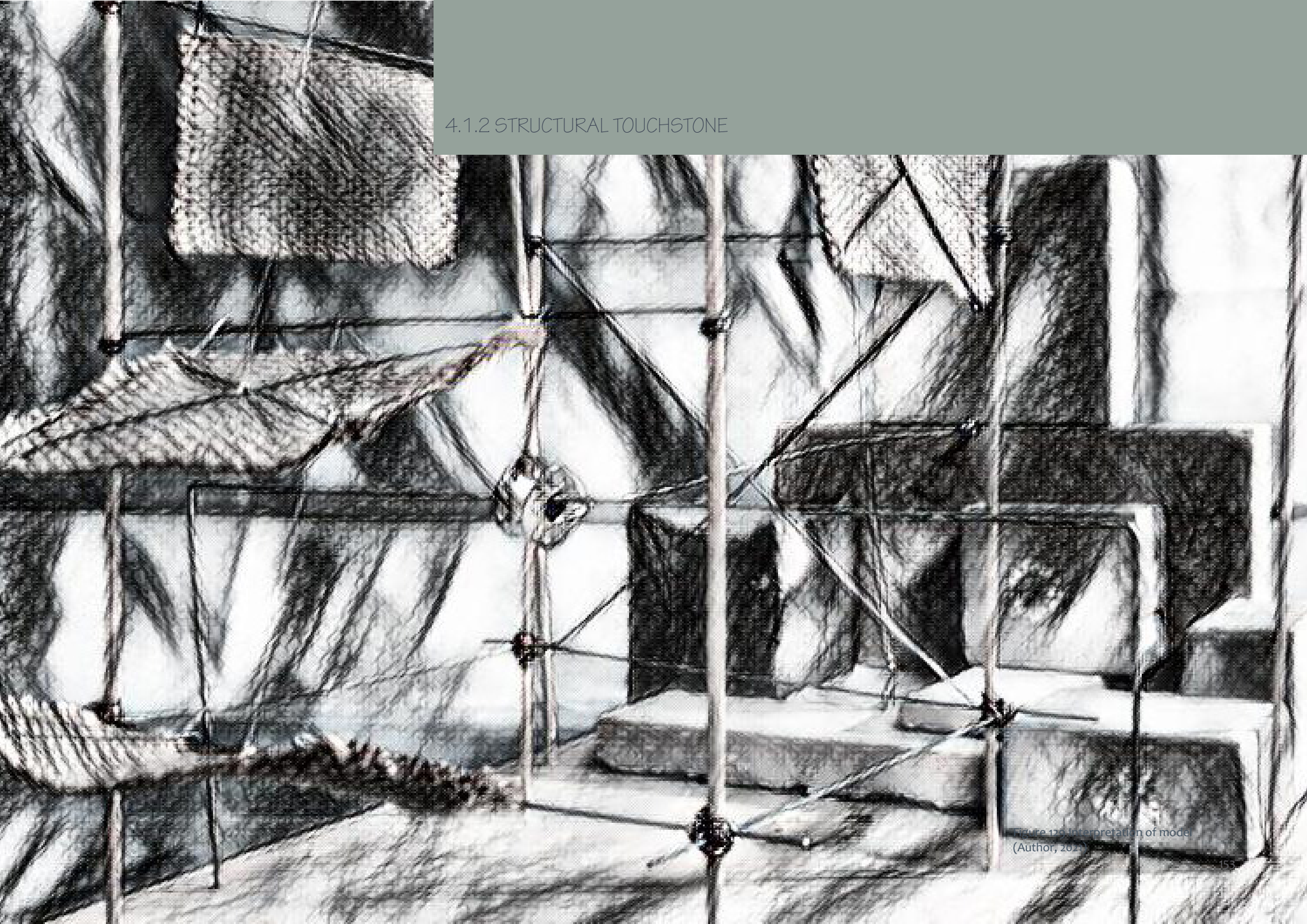


Figure 120: Interpretation of model
(Author, 2021)

A structural conception exploring the Genius loci in a biophilic placemaking.

The structural conception is rooted in the true essence of the proj¬ect namely Agriculture and landscape. These two themes become together the catalyst for the 3 conceptual design models which is rooted in the theoretical discourse.

The result of the catalyst is an integrated conceptual design that merged the 3 conceptual approaches together. From the integrat¬ed concepts. The key identified elements are light, solid layering vs frames, and transitional space. The structural conception aims to explore the intended materiality, function and structural systems in the proposed built form.

The character of a building consists out of a floor, wall and roof with a structural system acting as the glue. The site conditions, context, function of the building and identified theoretical approach helps in determining what type of system best fits the design.

The intended materials are based on the applicability to the con¬text. What materials are found in the Eastern Free State?

The materials identified are
1. Steel (fences, gates)
2. Cement (silos, dams)
3. Sandstone (farm houses mountains)
4. Corrugated iron (barn)

The design is dependant on the structural system that the designer hopes to achieve. The elements will be intertwined to form the construction of the design and reacts on the semi-public | semi-private part of the design. The Aquaponic farm will use a Traditional skeleton structural system that can also be seen in the barn construction in the surrounding context.

Braced frames will be used in the structures subject to lateral loads of the sessional climatic conditions. The planned members for the structure will be structural steel to obtain tension and compres¬sion. The vertical loads will be held up the frame created through the use of beams and columns, whilst the bracing system was built to support the lateral loads.

Infill panels will be utilized to form walls between columns and beams as they will be non-load bearing. The position of the structural frame will determine the external appearance, whether the panels will be located behind, in front of, or flush with the frame.

Ventilation and light penetration are an important factor for the design of the aquaponic farm. A mechanical system can be intro¬duced to adapt to the seasons, temperature, ventilation and light penetration for the plants.

The roof will be designed according to the context. The plan is to utilize IBR sheeting with its associated support structure.



Figure 130 Structural Parti
(Author, 2021)

Frame structure and Solid layering

The restaurant deli and venue space read as an in-between transitional space where frame structure and solid layering structures will be used, such as sandstone and frame systems. The roof structure will connect with the aquaponic farm. The walls will be a combination of braced frame structures and sandstone loadbearing structures that read as the solid layering mass.

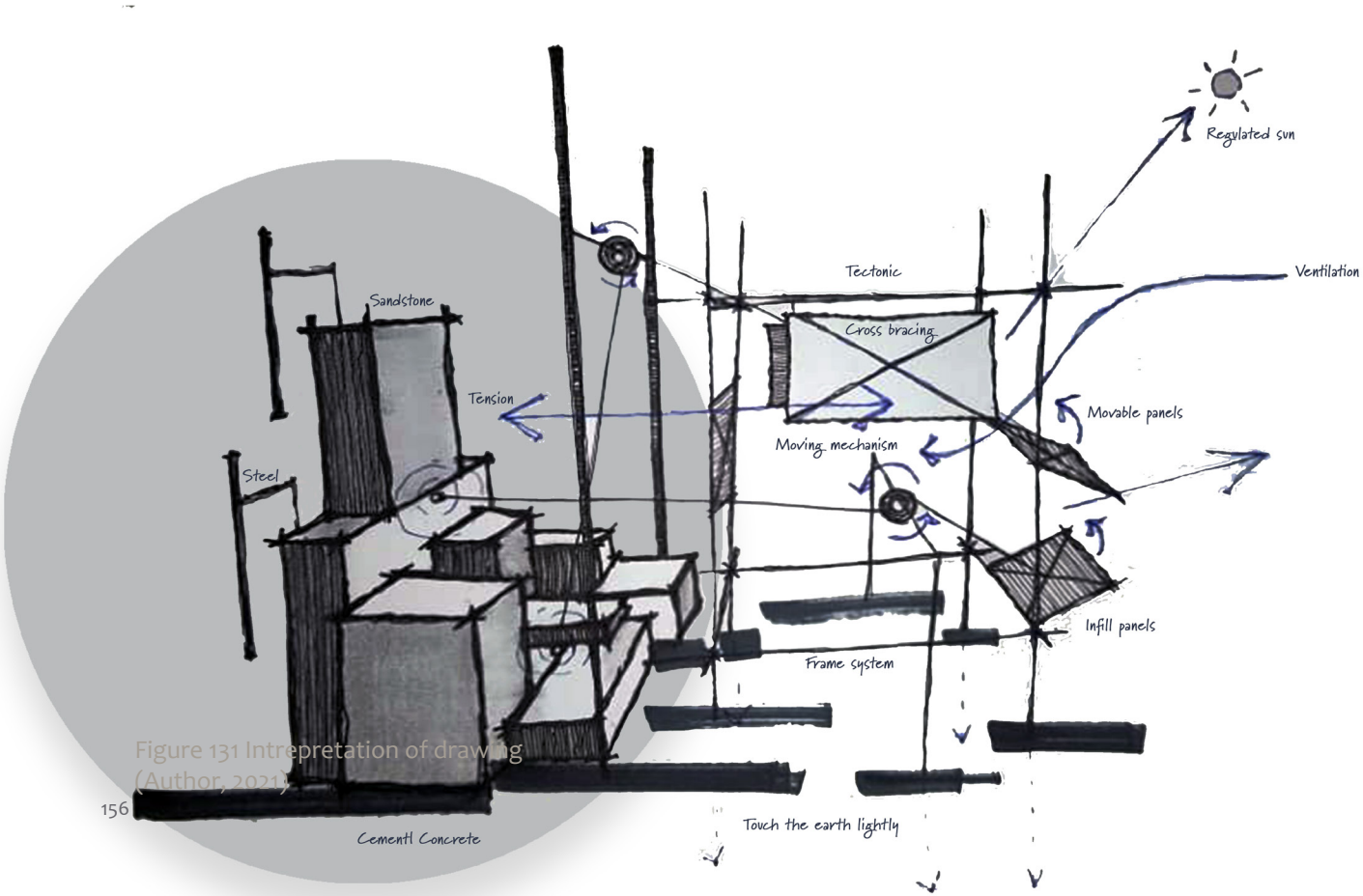


Figure 131 Intrepretation of drawing (Author, 2021)

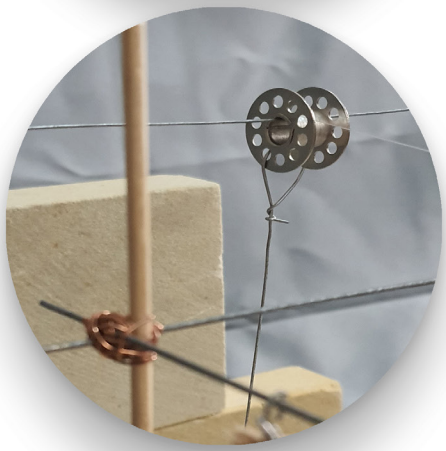
Solid layering

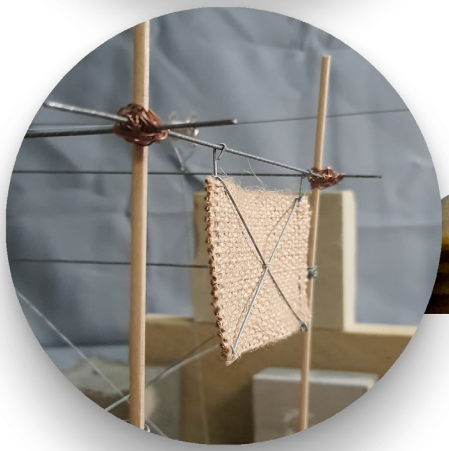
The accommodation part can be seen as the solid layered struc¬tures. Sandstone load bearing materials will act as the structural system for this part of the design.

A direct connotation will be made with the construction and the landscape to create a sense of place. The accommodation will be on a smaller scale than the aquaponic farm with smaller spans. The proposed roof structure for the accommodation is planned to form part of the landscape, thus a green roof system.

The interplay of light and heavy construction, therefore, creates curiosity in the design and space-making process. By combining these procedures through material, light and detailing, the poetics of space is created.







Tectonics of the frame, in which lightweight, linear components are assembled so as to encompass a spatial matrix.

Stereotomics of the sandstone and cement, wherein mass and volume are conjointly formed through the repetitious piling up of heavyweight elements.

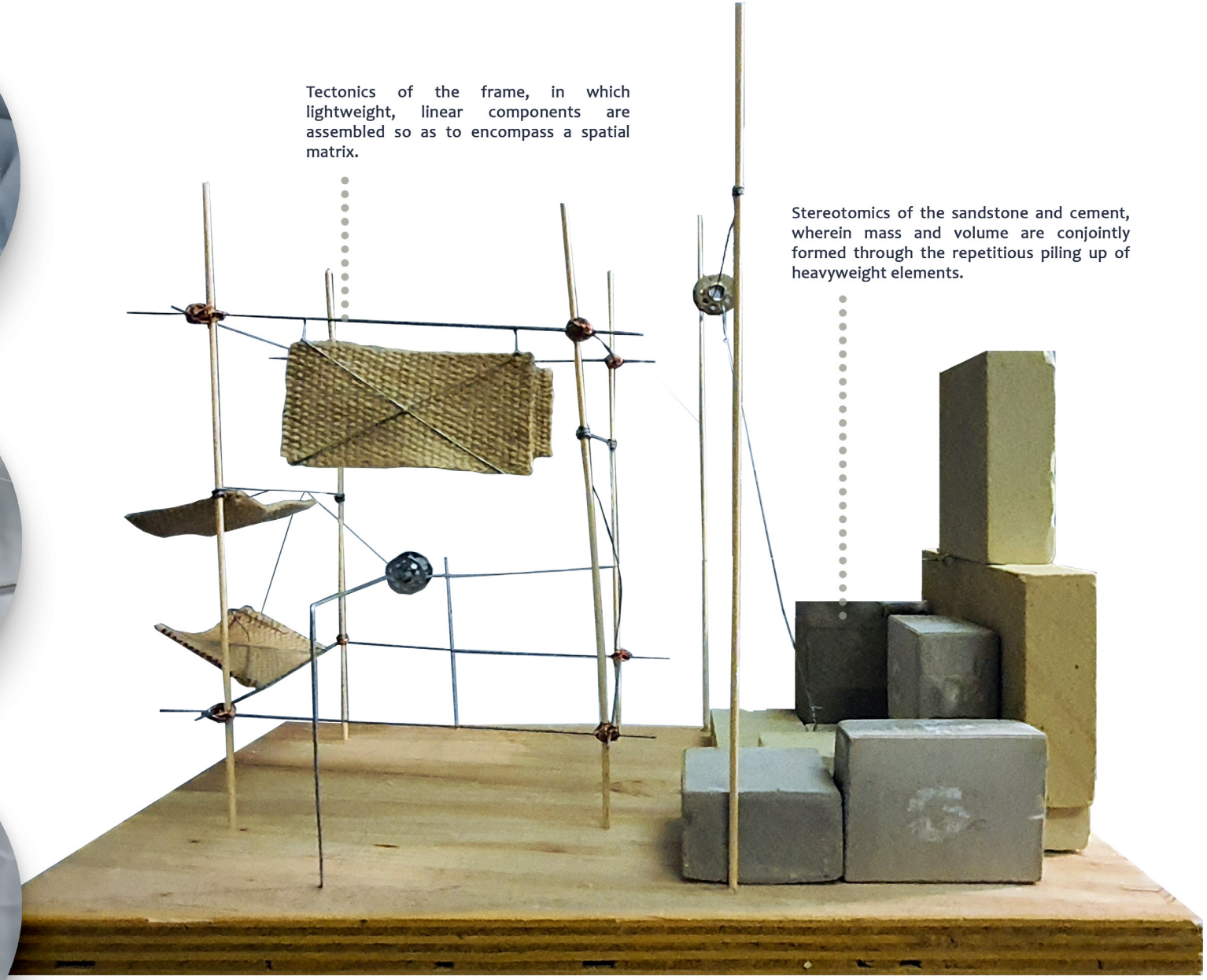


Figure 132 Intrepretation of model (Author, 2021)

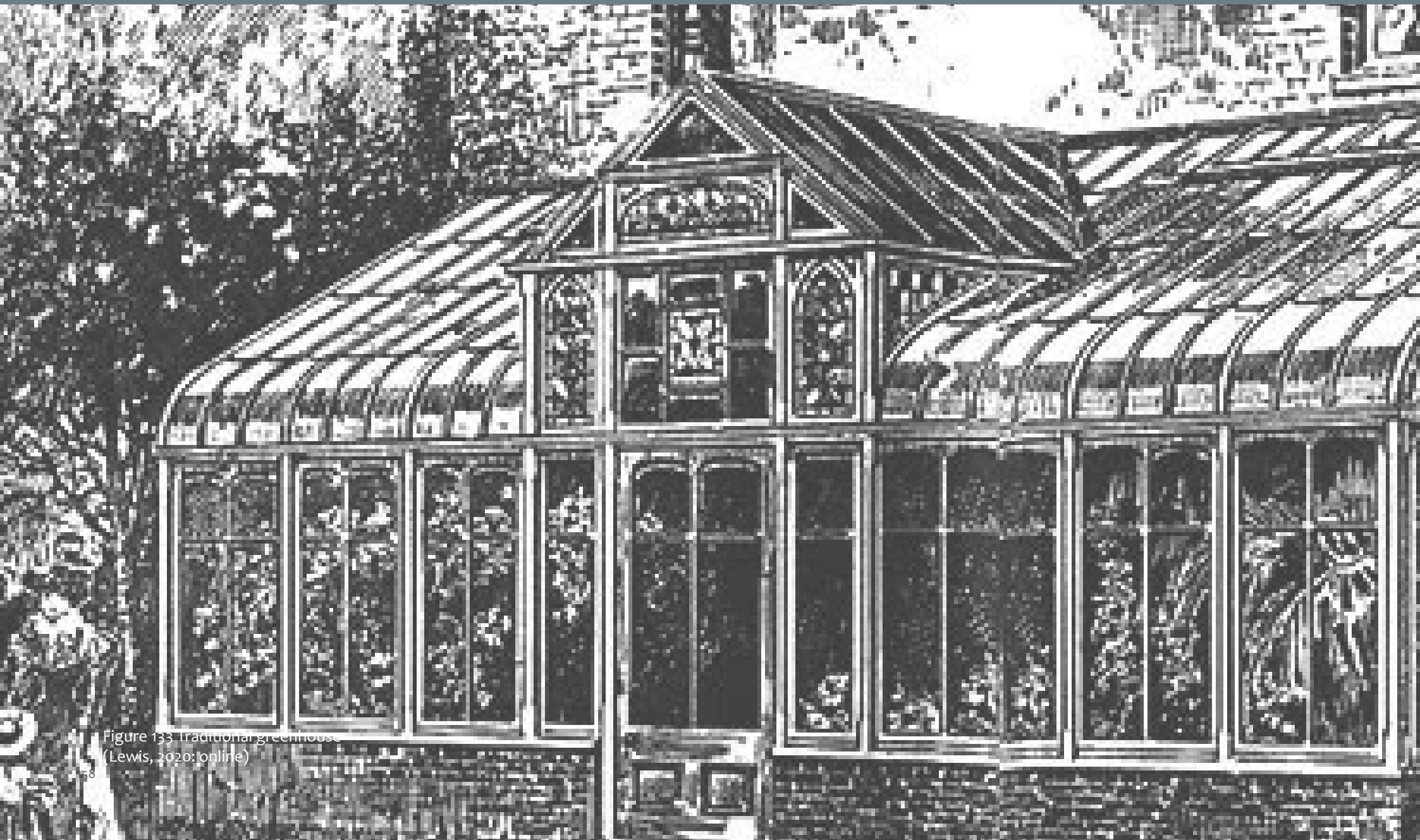
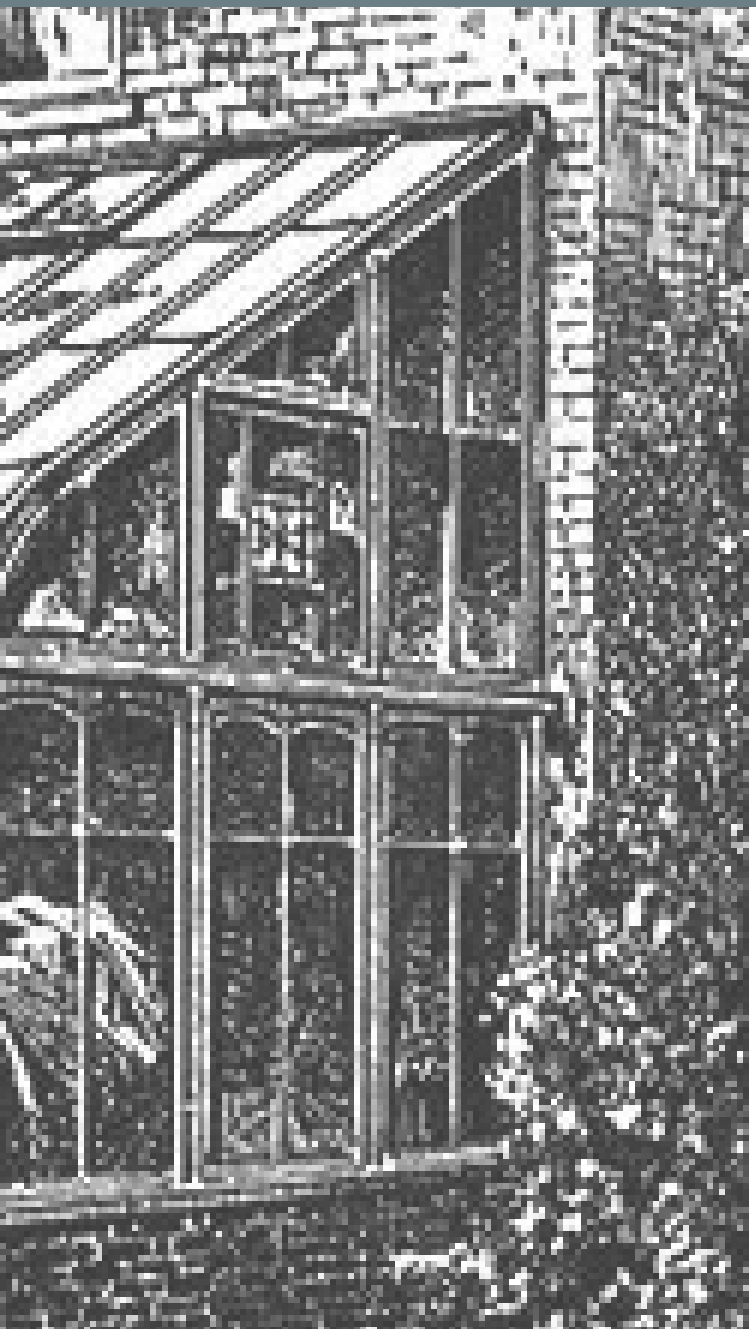


Figure 133 Traditional greenhouse
(Lewis, 2020: online)



The structural philosophy is based on greenhouse construction—a prominent feature in the design of the aquaponic Lifestyle Farm.

A greenhouse is a construction where plants are cultivated. The skin of the building can be glass or different types of plastic. The interior temperature rises due to the sun's incoming ultraviolet radiation that warms the inside of the building. Air warmed by the heat from hot interior surfaces is retained by the roof and wall in the building. The glass used for a greenhouse works as a selective transmission medium for different spectral frequencies, and its effect is to trap energy within the greenhouse, which heats both the plants and the medium it is planted in (Anem, 2010: online). In the case of the aquaponic Lifestyle Farm, the medium the plants grow in is water.

A specific feature of the greenhouse structure is that the environment may be controlled to obtain optimal growing conditions. The climatic conditions in a greenhouse comprise a complicated dynamic system of many environmental conditions that will be explained in short (Shamshiri and Redmond, 2007: 5).

The greenhouse structure was one of the fascinating structures in the 19th century. John Claudius Loudon, trained as a professional gardener, established fundamental principles of greenhouse construction. With his early writings in the 19th century, he searched to define the ideal characteristics (Schittich, 2015: 114).

According to Loudon, the most critical point for a greenhouse needs to be the plants. This means allowing the most significant possible amount of light to enter the greenhouse's interior. Loudon insists that the ratio of structure to the glass be kept as low as possible and loadbearing members be kept as slender as possible. Furthermore, the proposed orientation of a greenhouse skin should be parallel to the sun's path so that the rays of both high-altitude summer sun and low altitude winter sun would strike the surfaces. In this manner, the amount of reflected light is minimized (Schittich, 2015: 114).

Greenhouse construction

Greenhouses can be constructed in many ways. There are many different ways to erect greenhouses, some are freestanding, which creates more space and allows for greater flexibility in the design, whilst others are attached to existing buildings, allowing for less flexibility and a bit more restrictive designing (Shamshiri, 2007:13).

According to Gnome's Greenhouse Guide, the advantages of a freestanding greenhouse far outweigh the disadvantages.

Advantages

- It can be designed in any manner as the designed sees fit
- The greenhouse is more flexible and can be positioned correctly so optimize light intake from the north
- Location is an independent factor even though the location of a freestanding greenhouse is flexible, one must keep in mind the winter winds and ensure the soil is well drained.
- A freestanding greenhouse is expandable and can be expanded as needed.
- The size of a freestanding greenhouse is dependent on the need of the user.

Disadvantages

- The greenhouse will have to be connected to water and perhaps a power source. A water pipe and an electrical extension cord may have to be added.
- Heat loss can be problematic if not addressed from the beginning stages of the construction, due to the fact that all sides of a freestanding greenhouse is exposed to all the elements, one may experience heat loss if not insulated correctly.
- Security of a freestanding greenhouse can be a problem if not kept secure and locked.

The greenhouse of the aquaponic Lifestyle Farm will be a freestanding structure surrounded by secondary buildings for protection from wind. The greenhouse will be orientated East to west, with the long side facing the north for light penetration. The greenhouse's spot will be constructed will have a level soil level with treaded floors for draining control. The construction size is based on the dimensions of the waterbeds and the number of fish tanks planned to be used.

The disadvantages are also taken into consideration. Power and water are managed by connecting the greenhouse to the aquaponic lifestyle farms water and electricity supply. Heat loss

will be managed in the winter with secondary internal covering. By placing the greenhouse between other buildings, a certain level of protection can be reached from wind that causes heat to be lost. This placement also creates a level of security for the greenhouse.

There are many types of freestanding greenhouses. A free-standing greenhouse does not have a rule for its appearance and construction, only guidelines on what works best for the plants.

The type of freestanding greenhouses that can be identified is:
1- Quonset,
2- tri-penta,
3- dome,
4- gothic arch,
5- slant- ide,
6- A-frame and
7- gable roof (Shamshiri, 2007 :13).

The greenhouse used in the aquaponic Lifestyle Farm will be a gable roof shape with extensions on the North and South.

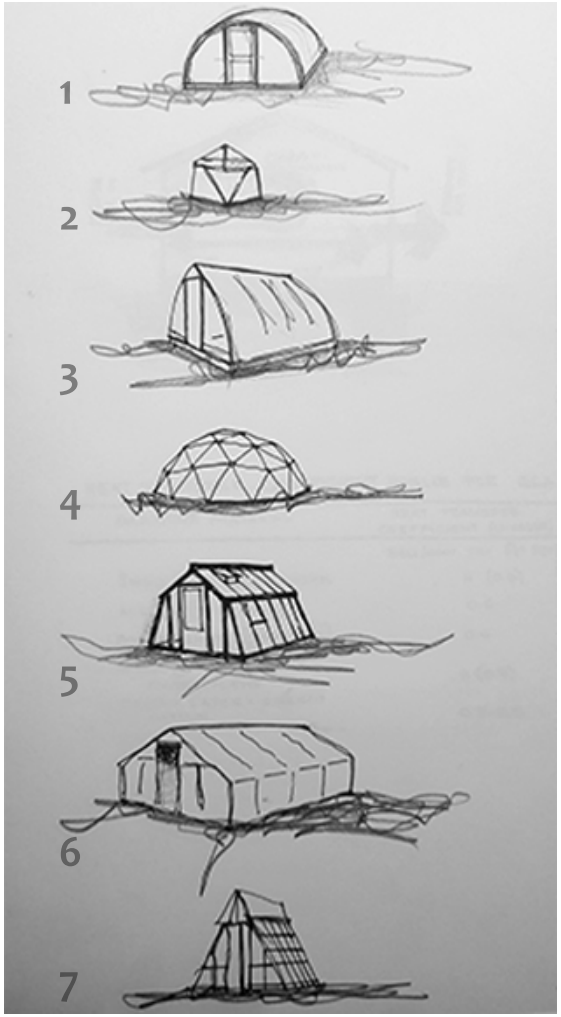


Figure 134 Greenhouse types (Author, 2021)

Foundation

The foundation must resist overturning and vertical pressure from structural loads and snow and extend below the frost line.

Concrete is the most appropriate material for permanent structures. A 2,500 PSI or more excellent mix should be chosen when ready-mix concrete is used (Schnelle and Dole, 2021:1).

The Aquaponic foundation will be constructed from compressed earth fill, concrete and brick pavers, taking water drainage into account.

Framing Materials

Steel is the most economical material for constructing the greenhouse frame. Steel framing also has the longest life span and allows for light reflectance. Wood was once a common framing material, but it has steadily lost popularity for several reasons. The main disadvantage of wood is that it deteriorates over time. Pressure-treated lumber should be purchased and treated with commercially available coatings (Schnelle and Dole, 2021: 2).

Due to the size of the greenhouse needed for the aquaponic Lifestyle Farm, the best framing system identified is a steel portal frame system. This framing structure allows for optimal light to enter and allows a robust frame system for the skin.



Figure 135 Cement
(Author, 2021)

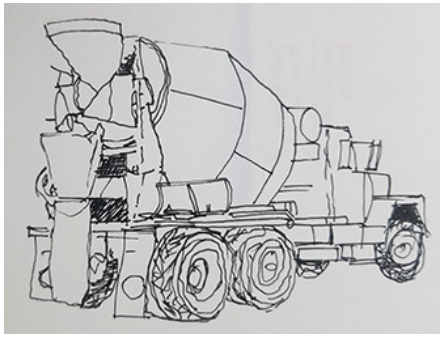


Figure 136 Ready-mix
(Author, 2021)



Figure 137 Paving
(Author, 2021)

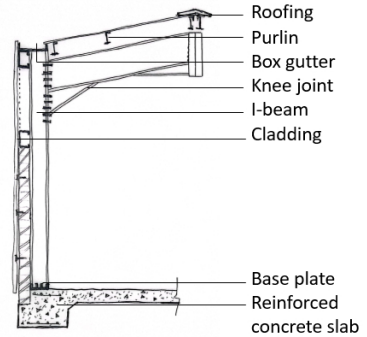


Figure 138 Potal Frame
(Author, 2021)

Orientation

The orientation of a greenhouse is one of the most critical aspects of the building. Most plants require full sun to perform well; thus, a freestanding style can be seen as the best fit. Depending on the type of plants grown inside the greenhouse, the height of the plants and their leaves, a greenhouse must be constructed according to the needs of the plants (Shamshiri, 2007:15).

Plants that require full sun to perform well can experience optimal growth with the sides of the building facing North to South. Plants that require less sunlight grow better in a greenhouse facing the sides faced East to west. It is essential to take note that Western exposure can be too hot in the summer, and the South does not receive enough exposure (Shamshiri, 2007:15).

Best locations considered for the placement of a green house
Firstly - North / North East
Secondly - East
Thirdly - North West
Lastly - South (Shamshiri, 2007:15).

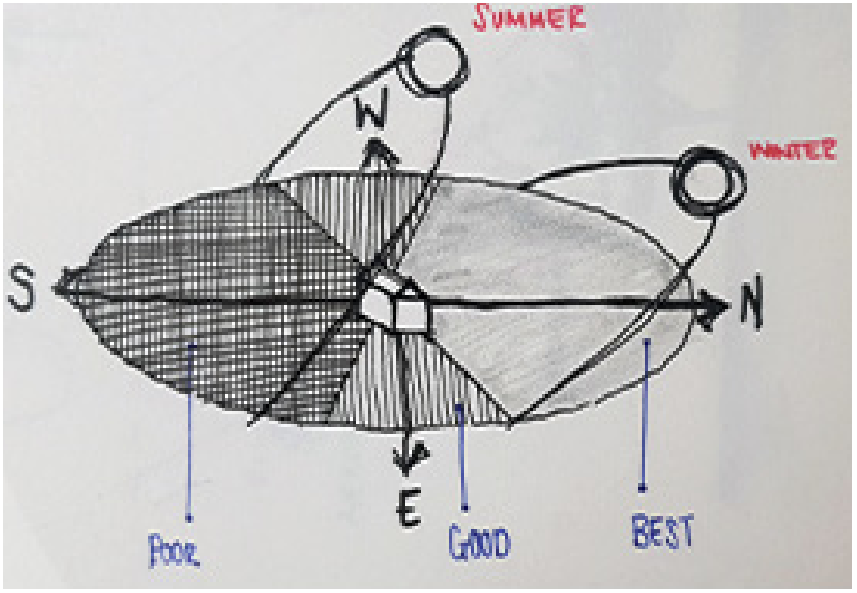
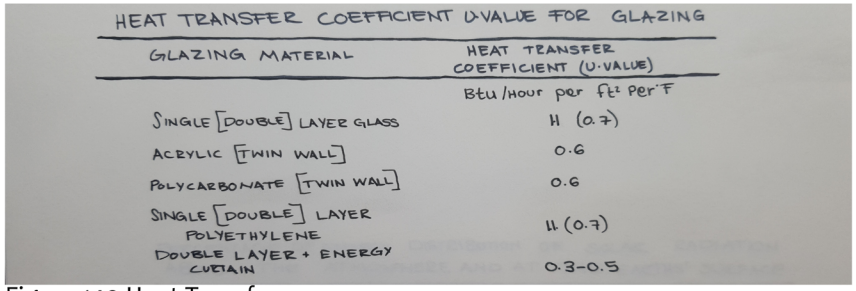


Figure 139 Interpretation of orientation (Author, 2021)

Greenhouse Covering
Glazing
The glazing influences the amount and type of solar radiation at the plant canopy directly affect plant growth. The glazing system indirectly affects the microclimatic factors, such as air humidity or carbon dioxide concentration (Giacomelli and Roberts, 1993:8).

There are three general types of coverings typically used for greenhouses:
Glass,
plastic films and
rigid plastic panels.

Most greenhouses are either single- or double-glazed; triple-glazing materials are also available but used in long term cold weather. Double-glazing consists of either two layers of greenhouse-grade polyethene film, double glass, or acrylic or structured polycarbonate sheets (Roberts, 2005: 3).


HEAT TRANSFER COEFFICIENT U-VALUE FOR GLAZING

GLAZING MATERIAL	HEAT TRANSFER COEFFICIENT (U-VALUE) Btu/hour per ft² per °F
SINGLE [DOUBLE] LAYER GLASS	H (0.7)
ACRYLIC [TWIN WALL]	0.6
POLYCARBONATE [TWIN WALL]	0.6
SINGLE [DOUBLE] LAYER POLYETHYLENE	H (0.7)
DOUBLE LAYER + ENERGY CURTAIN	0.3-0.5

Figure 140 Heat Transfer
(Author, 2021)

Single glazing often consists of single glass, single film plastic, used chiefly in warmer climates, or corrugated fibreglass or polycarbonate panels. Laboratory tests of each material indicate differing heat transfer coefficients (Roberts, 2005: 3).

For good environmental control practice, the heat transfer coefficients listed in the table can assist in the design, including values of well-constructed greenhouse infiltration (Roberts, 2005: 3).

Thermal screens have variable properties, but reasonable design U-values for double-glazed greenhouses range between 0.3 and 0.5 Btu/hr per ft2 per °F. For single-layer glasshouses, a value of 0.8 Btu/hr per ft2 per °F is used. These coefficients usually apply only to the heat loss through the roof and not the area of the sidewalls unless a thermal screen is used there. Also, these coefficients include an allowance for infiltration and radiation loss (Roberts, 2005: 4).

The geographic location of the greenhouse, grower experience, and the local industrial support, all have an essential influence on the design and selection of a glazing system for a greenhouse operation. The decision on selecting a glazing system must include its physical properties of radiation transmission and heat transfer and its construction, maintenance, and operational requirements (Giacomelli and Roberts, 1993:9).

Types of Greenhouse Coverings

1. Glass
The glass allows maximum light transmission in greenhouse production. Despite this, there are several disadvantages to consider. glass is expensive and, because it is fragile, has to be replaced more often than many other materials on the market today (Giacomelli and Roberts, 1993:10).

2. Polyethylene film
Polyethene film (PE) is suitable for home-built greenhouses because less structural support is required, costing much less than other materials. However, the PE film only lasts about two years. A double layer of polyethene, inflated with air, is another option to cover the greenhouse (Giacomelli and Roberts, 1993:10).

3. Fiberglass reinforced
Fibreglass reinforced panels (FRPs) are rigid plastic panels made from acrylic or polycarbonate in large corrugated or flat sheets. It is rigid and available in various light transmission levels. However, ultraviolet light will cause fibreglass to deteriorate from swelling and fraying of the fibres (Giacomelli and Roberts, 1993:10).

4. Polycarbonate
Polycarbonate is one of the newest materials available on the market and is still being evaluated. This material is rigid but also flexible enough to be used in a Quonset style greenhouse. Although the initial cost of polycarbonate is very high, a ten-to-15-year life span can be expected (Giacomelli and Roberts, 1993:10).

5. Acrylic
Acrylic is also a new material and is identified as the most expensive. The material has a minimum ten-year warranty from some manufacturers. Although many advantages exist, such as high light transmittance, high impact resistance and great strength, costs and availability have proven prohibitive in most cases.

The aquaponic Lifestyle Farm will make use of glass for the covering. The decision is based on the availability of the product and how easily it can be replaced. The glass is not only aesthetically pleasing but also the material that allows for maximum light penetration. There are however, more considerations to take into account for choosing the applicable covering system, such as the solar radiation transmission, temperature, humidity and ventilation.

Solar Radiation Transmission

The primary purpose of a greenhouse covering is to create an internal environment conducive to plant growth regardless of the external environment. The capability of the covering to transmit light in wavelengths helpful to plants, of which only a portion is visible, is therefore essential. The intensity of these wavelengths (400 - 700 nanometers) of photosynthetically active radiation (PAR) directly influences growth and development in plants. Other non-visible solar radiation wavebands include ultra-violet (UV), infrared (IR) and Far-Red (FR) wavebands (Giacomelli and Roberts, 2021: 2).

The atmosphere acts as a filter to reduce the absolute amount of solar energy which can pass. It also changes the proportion of the PAR waveband compared to the other wavebands by selectively filtering more of the ultra-violet region of the total solar energy spectrum (Table below) (Giacomelli and Roberts, 2021: 3).

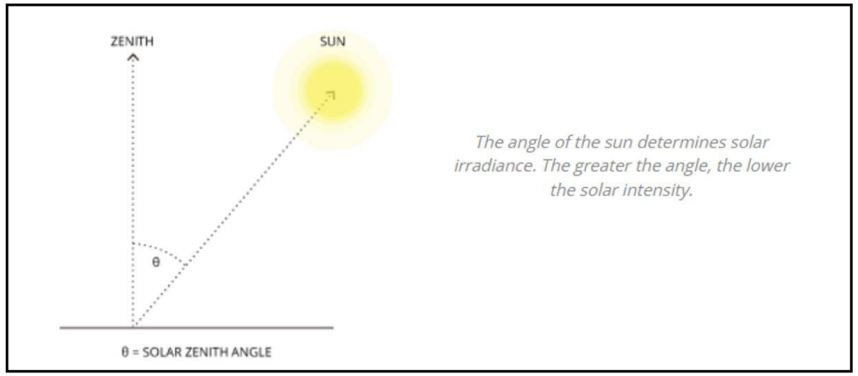
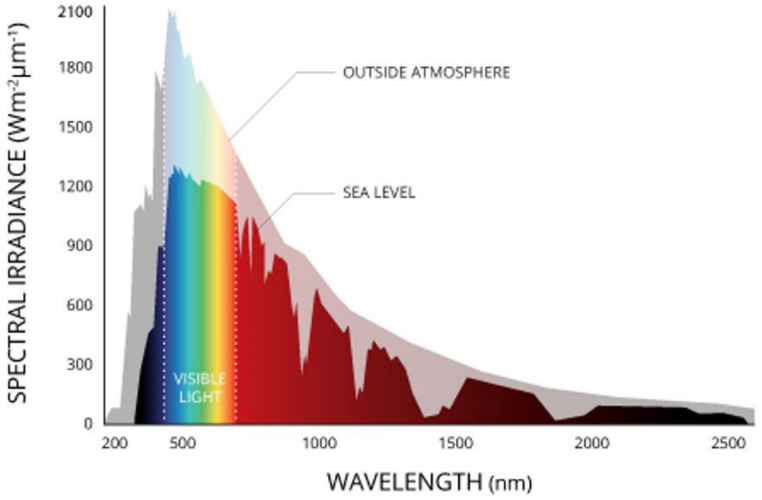


Figure 141
(Fondriest Environmental, 2021: online)



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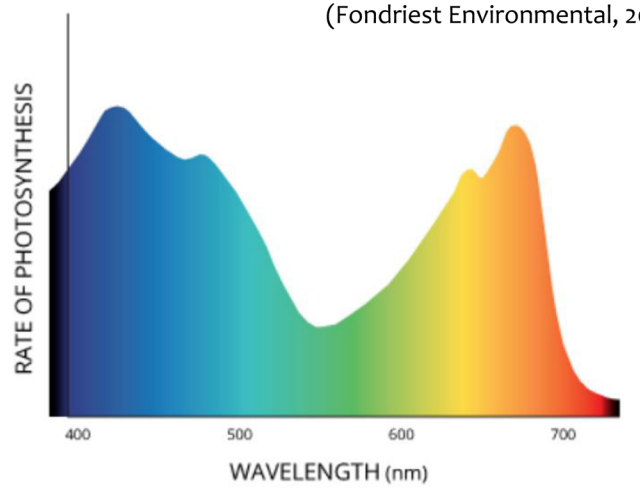


Optimal photosynthetically active radiation is the band from 400-700 nm, which encompasses the visible light spectrum.

(Fondriest Environmental, 2021: online)

PERCENTAGE OF ENERGY DISTRIBUTION OF SOLAR RADIATION ABOVE THE ATMOSPHERE AND AT THE EARTHS' SURFACE

WAVEBAND	ABOVE ATMOSPHERE	EARTH'S SURFACE
UV (390-400nm)	8.6	6.4
PAR (400-700nm)	38.2	42.9
FR (700-850nm)	16.5	15.2
IR (850-2800nm)	33.9	34.2
THERMAL (>2800nm)	2.7	1.3

Figure 142 Energy distribution (Author, 2021)

Solar energy can be transmitted, reflected or absorbed by the atmosphere and the greenhouse covering. The transmitted portion is needed for plant growth, but the plant utilizes only a fraction (1 - 5%). The remainder is absorbed and re-emitted as thermal radiation (heat), thereby warming the greenhouse air. This "greenhouse effect" is the welcome result of radiation transmission into a closed space, although subsequent air cooling is required to maintain desirable plant growth temperatures. Therefore, the heat transfer capability of the covering system becomes a crucial secondary factor to consider when designing the greenhouse (Giacomelli and Roberts, 2021: 3).

The two types of radiation are:

- Direct: Radiation received directly from the sun, without prior reflection
- Diffuse: results from the scattering of direct radiation within the atmosphere (or by the cover) and can be received by the plant from all directions.

The greenhouse cover transmits both direct and diffuse radiation, but because of its physical properties, the cover may alter the proportions of each. The diffuse component will increase while the direct component is reduced. This is particularly true for many plastic films.

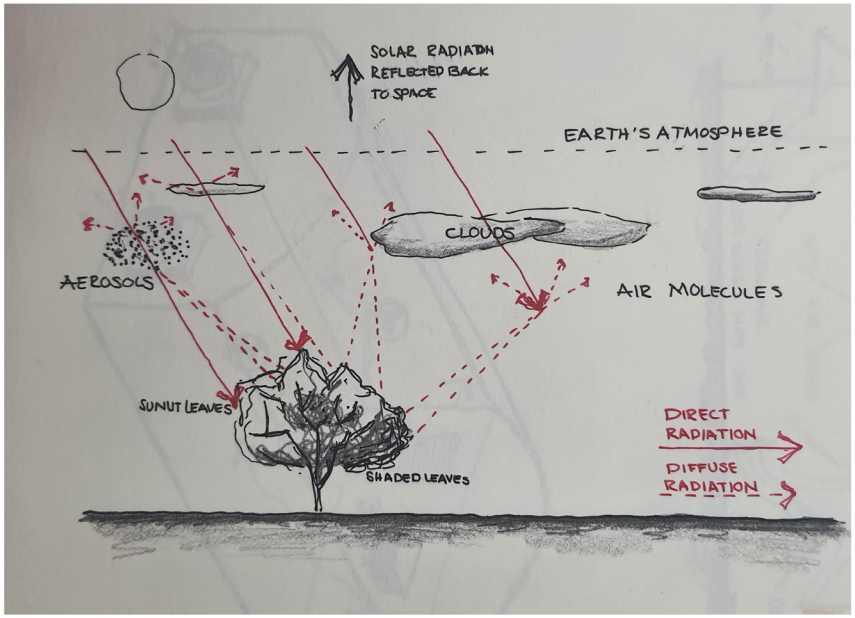


Figure 143 Sunlight direct vs ndirect (Author, 2021)

Temperature

In general, the temperature parameter is the primary focus of most climate control systems. This may include the air temperature surrounding the aerial portion of the plant and root zone and leaf temperatures. The changes in external climatic conditions strongly influence the inside air temperature. For example, the decrease of the temperature outside the greenhouse or the increase of the wind speed will decrease the temperature inside the greenhouse (Wang, 2005: 4).

Temperature is the most easily measured aerial environmental parameter. However, each plant species has its optimum range and timetable for features such as productivity, flowering, and timing to market (Wheeler and Both, 2021:2).

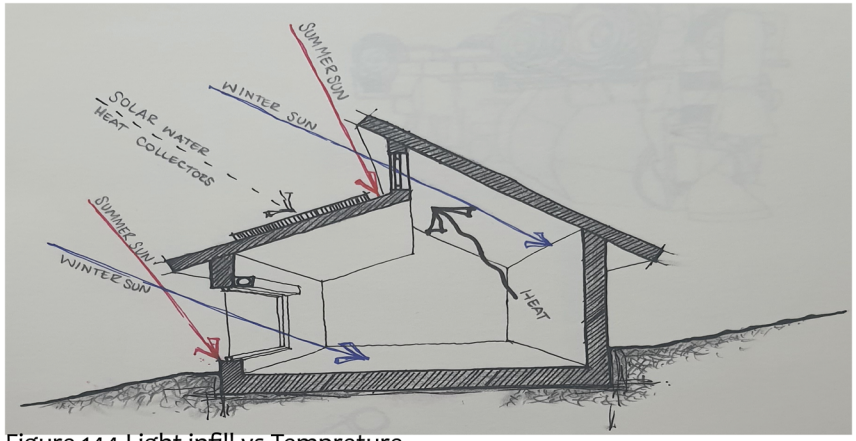


Figure 144 Light infill vs Tempreture
(Author, 2021)

Temperature Control

Temperature Control (Cooling) cooling techniques can be organized into several categories; each utilizes the evaporative cooling process to reduce air temperature and fan ventilation for exchanging the moist air with dry outside air. Greenhouse cooling reduces plant stress caused by high leaf and air temperatures. The root and stem system may not supply adequate water to the leaves, thereby limiting transpiration, the plant cooling mechanism. Also, hot and humid air around the leaves will reduce the effectiveness of transpiration at the leaf surface (Wheeler and Both, 1994: 2).

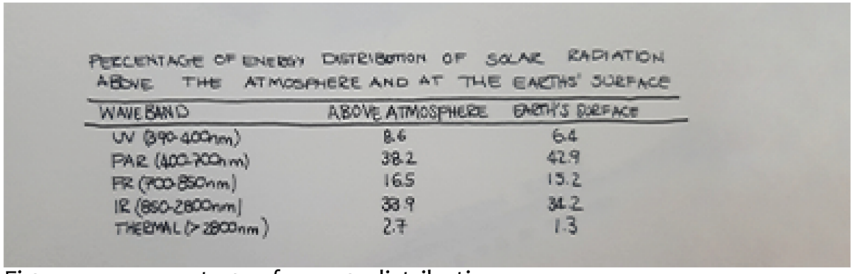
Greenhouse temperature control can be accomplished in several ways:

1. Ventilation (Natural / Mechanical)
2. Evaporative cooling
3. Shading (Wheeler and Both, 1994:2).

Humidity

The ideal level for humidity depends on the type of crop to be grown. Plants from tropical climates will need higher humidity than those native to arid regions. Most greenhouse crops favour relative humidity between 60% and 80% RH (Autogrow, 2021: online).

Plants require higher humidity when the temperature is high and lower humidity when it is low. This helps to moderate the plant's transpiration rate, i.e., when it is hot, the plant will tend to transpire heavily, so by making the RH high, this will tend to reduce transpiration and delay the point at which the plant starts to wilt. The converse is also true, i.e. when temperatures are low, then RH should be reduced. At low temperatures, the plant will tend to reduce transpiration (with consequently reduced growth), but reducing the RH will tend to raise transpiration back up again (Autogrow, 2021: online).



PERCENTAGE OF ENERGY DISTRIBUTION OF SOLAR RADIATION ABOVE THE ATMOSPHERE AND AT THE EARTHS' SURFACE

WAVE BAND	ABOVE ATMOSPHERE	EARTH'S SURFACE
UV (290-400nm)	8.6	6.4
PAR (400-700nm)	38.2	42.9
FR (700-850nm)	16.5	15.2
IR (850-2800nm)	33.9	34.2
THERMAL (>2800nm)	2.7	1.3

Figure 145 persentage of energy distribution
(Author, 2021)

It is evident from the table to the left that the higher the temperature is, the higher the humidity should be thus, makes it difficult to specify control parameters as different RH settings are required at different temperatures (Autogrow, 2021: online).

Another measure called VPD —vapour pressure deficit is gaining popularity in the greenhouse industry as it combines both temperature and humidity effects in a way that better reflects how the plant —feels. Controllers are increasingly implementing venting controls based on VPD rather than just RH and temperature (Autogrow, 2021: online).

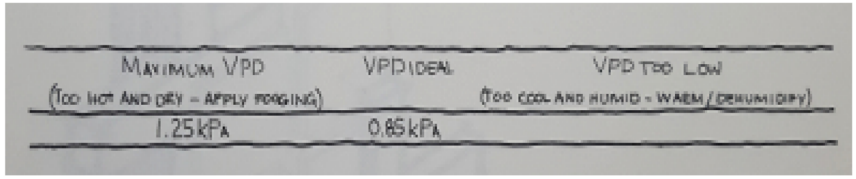


Figure 146 VPD vs RH
(Author, 2021)

As a general rule, most plants grow well at VPDs of between 0.8 to 0.95 KPa. Fogging or other humidification is usually applied at VPDs above 1.25KPa and heating and dehumidification at VPDs below 0.45KPa (Roberts, 2005: 4).

Ventilation

Ventilation is the controlled exchange of ambient air with the conditioned atmosphere within the greenhouse (Giacomelli, 2002: 5). Greenhouse ventilation is required to control temperature and moisture levels and provide CO2 for good crop production (Roberts, 2005: 7).

The two main functions of a ventilation system are to provide air exchange, which is simply fresh air in and stale air out, and air distribution, which provides air movement throughout the entire structure. Sidewall fans provide air exchange, while air distribution is most influenced by the ventilation inlets (Wheeler and Both, 1994: 1). A passive ventilation system can be created by adding adjustable openings in the greenhouse where natural fresh air can distribute through the building pushing the exhaust air out with cross ventilation.

Other environmental parameters directly influenced by the ventilation process are the concentration of gasses within the greenhouse air, including carbon dioxide (CO2), oxygen, and water vapour. Undesirable concentrations of gasses such as ethylene and carbon monoxide will be prevented as a result of adequate ventilation (Giacomelli, 2002: 7).

Atmospheric moisture content, typically measured as relative humidity, can at times be reduced by proper ventilation, although it may be necessary to provide supplemental heating to offset excessive air cooling (Giacomelli, 2002: 7).

In brief, the three main functions of greenhouse ventilation are:
1. Temperature control (cooling)
2. Humidity control
3. C02 control (Wheeler and Both, 1994:1).

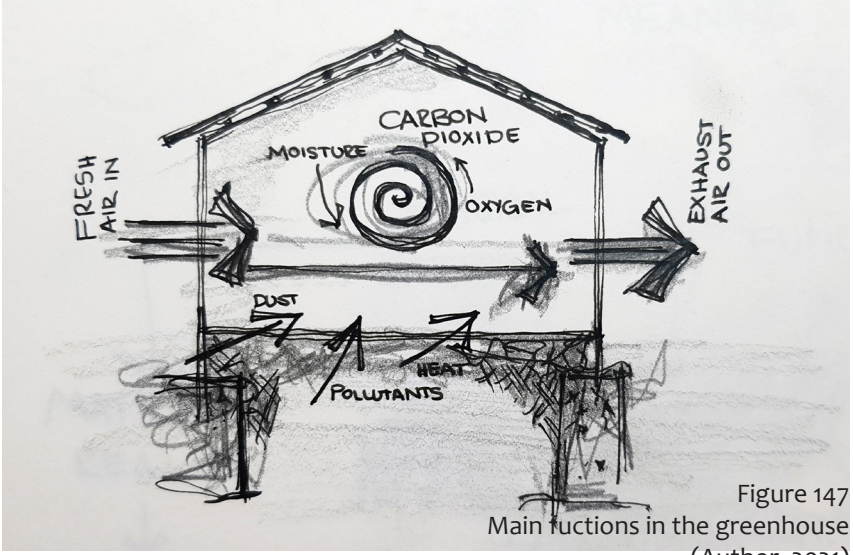


Figure 147
Main fuctions in the greenhouse
(Author, 2021)

Ventilation Techniques

There are two basic ventilation systems used in greenhouse production systems, natural and mechanical ventilation systems. In any ventilation system, the size and location of the inlets and outlets are the most critical design consideration (Roberts, 2005: 12).

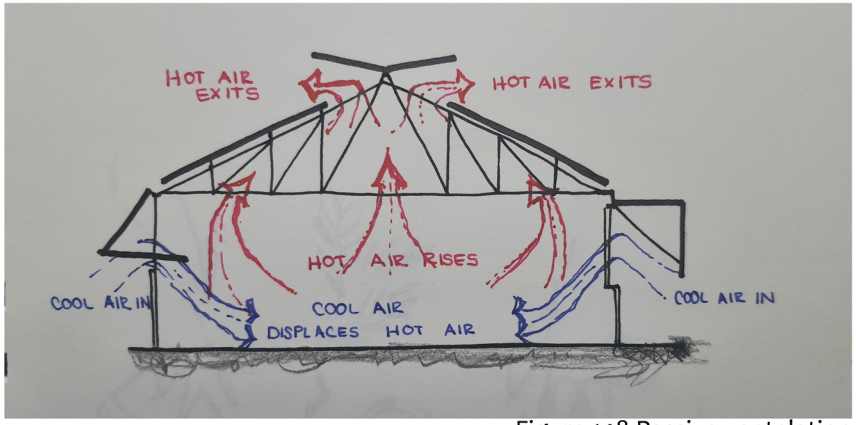


Figure 148 Passive ventelation
(Author, 2021)

Natural ventilation depends upon normal air movement created by wind pressures or gradients induced by air temperature differences between the growing area and the outside environment. Natural ventilation is driven by temperature differences (the so-called stack or chimney effect, also known as thermal buoyancy) and wind conditions creating minor air pressure differences around the greenhouse (the so-called wind effect).

The most significant potential for natural ventilation driven by the stack effect is during the cold days when the temperature difference between inside the greenhouse and outside is the greatest (Roberts, 2005: 13).

Natural ventilation system designs include roll-up sides, either hand or automatically operated, side vents, roof vents, and ridge vents constructed as an integral part of the greenhouse structure (Roberts, 2005: 13).

An essential point to concern in natural ventilation is that the inside air temperature of the greenhouse can never be less than the outside air temperature. Unless the winds are consistent and the greenhouse is oriented correctly, the inside air temperature will always be greater than the outside temperature. This can become a significant problem during the warm season when the maximum cooling is required, but the temperature difference is the least (Giacomelli, 2002: 2).

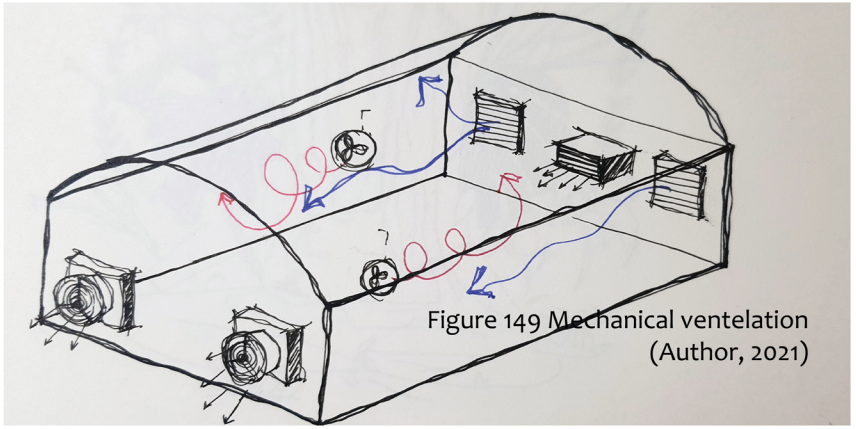


Figure 149 Mechanical ventelation
(Author, 2021)

Mechanical ventilation is defined as the air movement created by fans that bring air into the growing area through controllable openings built into the greenhouse walls and exhaust it through the fan assembly. The negative aspects of mechanical ventilation systems are the higher installation and operating costs and the associated noise levels (Roberts, 2005: 13).

There are three primary features to check when evaluating a mechanical ventilation system:
1. Static pressure difference:
2. Fan capacity
3. Inlet function.

An essential factor for designing a greenhouse in the Eastern Free State is the thunder and hail storms. The hail storms always come from mainly the South and sometimes southwest and southeast. The glass thus should be thicker to avoid cracking and shattering. The thickness of the glass is also dependant on the Solar Radiation Transmission levels and should be calculated by plant biologists, horticulturists, ecologists, or other environmental scientists.

The temperature will be controlled with the constant flowing waterbeds the plants grow in. The other factor is the passive system allowing for cross ventilation. In terms of ventilation, the aquaponic Lifestyle Farm will try to use passive/ natural ventilation methods. Adjustable window vents are placed throughout the length of the north and south straightforward story, allowing the hot air to escape and fresh air to enter.

4.2 Will explain in more depth the aquaponic technology linking with the greenhouse construction.

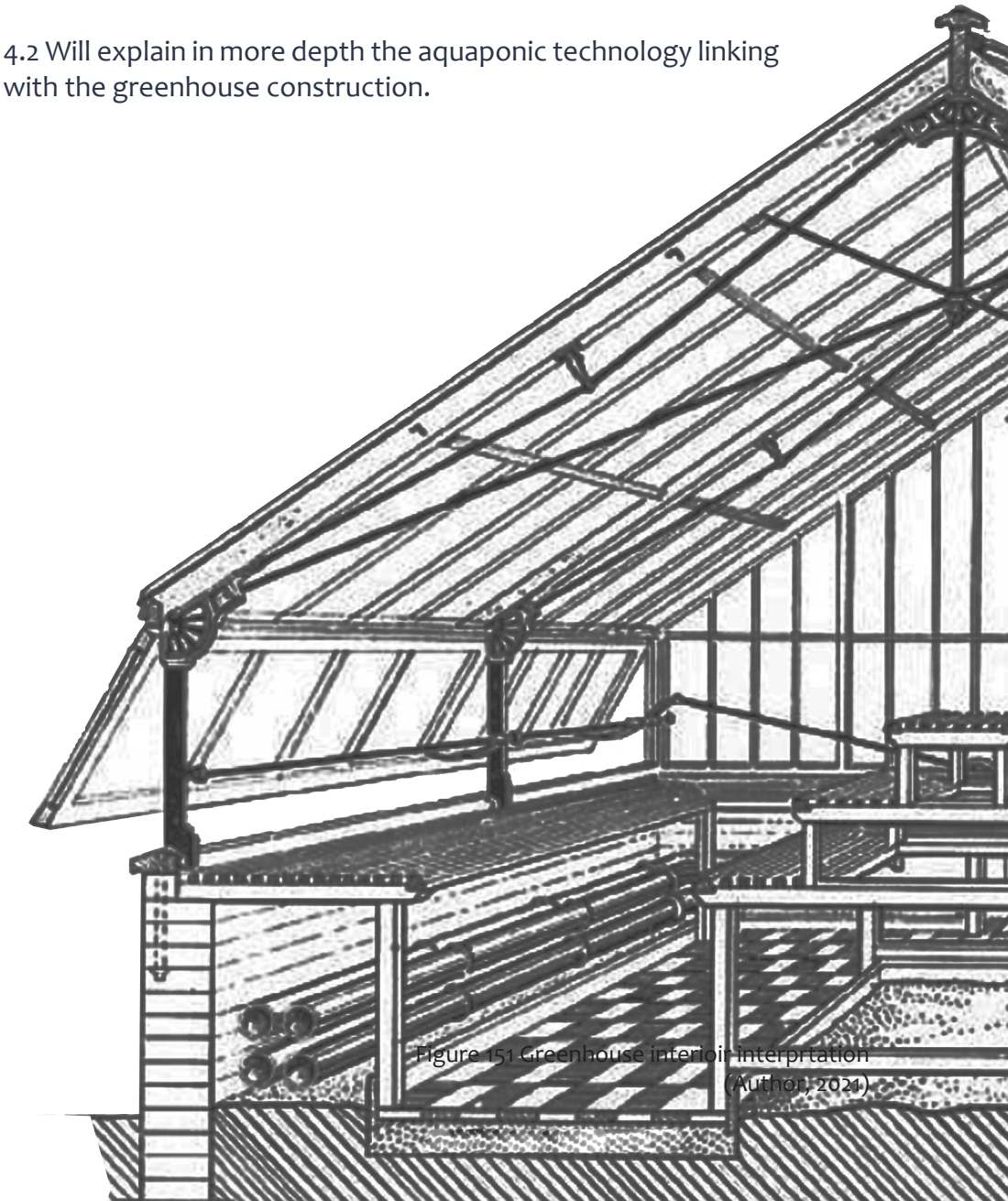


Figure 151 Greenhouse interioir interprtation (Author, 2021)

Introduction

The exciting new technology called aquaponics is aimed at producing a sustainable way in which to cultivate fish and vegetable growth in water, therefore making it independent from factors such as land pollution and droughts. Aquaponics has the potential to address food security challenges particularly in South Africa (Editorial Board, 2018: online).

Aquaponics is a combination of aquaculture (fish farming) and hydroponics (growing plants in a nutrient solution, without soil). Aquaponics uses these two in a symbiotic combination in which plants are fed the 'aquatic animals' discharge or waste. The waste is then cleaned by the plants, which results in clean water being fed back to the fish. The bacteria that is set off by the fish in turn act as growth supplements for the plants and so the circle of life and sustainable growth is cultivated (North, 2016: online).

According to, Denise McGregor (2013: 59) one of Biomimicry's Life Principles (see chapter --) is that everything can be recycled; as everything has a usage. Waste ought to be a useful resource, as it will be reused again for another reason. This means that nature needs this waste; as it needs to sustain itself as waste is considered as food or sustenance. In fact, nature doesn't produce waste, and it doesn't foul its own nest since it needs to live in it. Therefore, in closed systems, like aquaponics, each co-existing element consumes the waste of another as its lifeline (McGregor, 2013: 59). Aquaponics systems also follow the sixth principle of the twelve principles of Permaculture, namely "Produce No Waste" (Holmgren, 2007: 9). The water in an aquaponics system needs only to be filled up, not replaced. This system of collaboration between fish and plants continuously cleans the water and creates a sustainable eco-system (Permaculture New, 2016: online).

A conclusion can be drawn that aquaponics mimics a natural ecosystem that represents the relationship between water, aquatic life, bacteria, nutrient dynamics, and plants which grow together. The technology of aquaponics is borrowed from nature – it combines individual components which supplements each other's growth and sustainability by ex-changing waste for food and food for bacteria and fertilizer to create a clean environment for all species present (youmatter, 2020: online). Aquaponics is therefore an environmental friendly, natural food-growing technique that uses all the best features of aquaculture and hydroponics combined to yield growth and to sustain clean environments without the use of chemicals.

How Does Aquaponics Work

As mentioned Aquaponics is a combination of aquaculture and hydroponic systems. Plants are grown in what is called a grow bed, whilst the fish are placed in a fish tank. The input for the system to work is generated by food which is placed in the tanks for the fish, once the fish consume their food, they produce waste which is rich in ammonia (youmatter, 2020: online).

The now, ammonia rich water, then flows through a filter, together with any food that may have been left-over as well as plant matter that has already started to decay. The filter breaks down the material into organic nutrient matter, which is rich in nitrogen.

The nutrients and nitrates are absorbed by the healthy plants which assist in their growth, the plants in return clean the water, as do trees in our atmosphere, and this clean water returns to the fish to start the cycle all over again (youmatter, 2020: online).

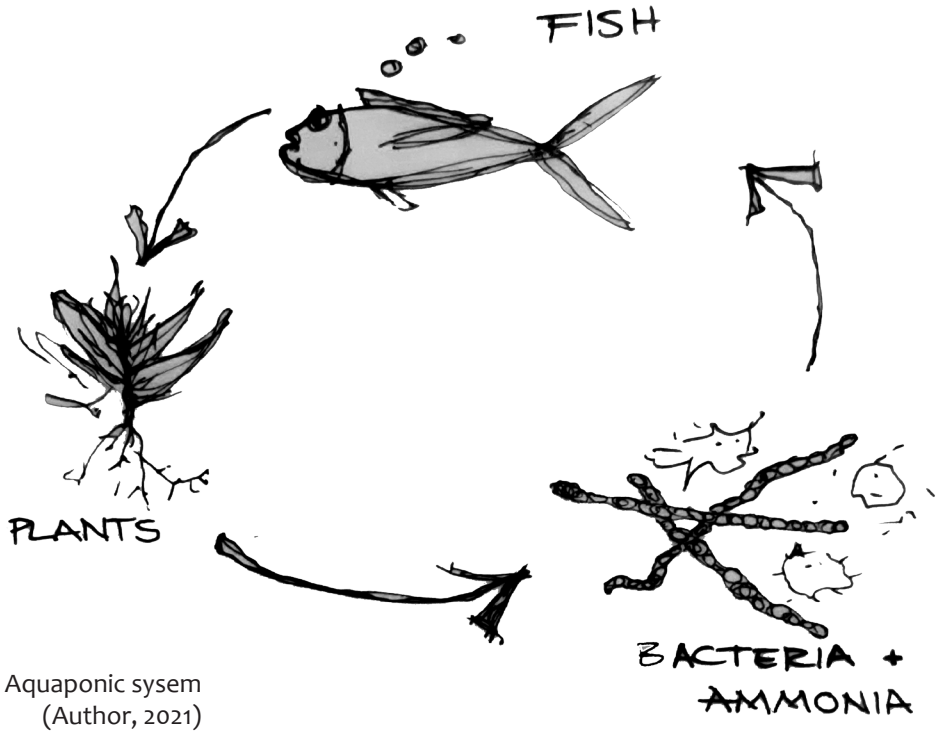


Figure 152 Aquaponic sysem
(Author, 2021)

The Aquaponic Lifestyle Farm will utilize Tilapia as the aquatic animals (fish). Vegetable plants will be identified to fit with the temperature of the water of the fish tanks, as well as the PH levels.



Figure 153
Talapia Fish
(Shetler, 2020: online)

According to FAO (Food And Agriculture Organization) report, there are many benefits of growing food in an aquaponic system. The benefits are as follows (Vergeer, 2019: online; Youmatter, 2020: online):

The benefits are as follows (Vergeer, 2019: online; Youmatter, 2020: online):

1. It enables a sustainable food production line that does not require a lot of space.
2. One source (i.e. nitrogen) produces healthy fish and vegetables.
3. Aquaponics allows 10 times more plants in the same space. The roots of the plants are always in nutrient rich water which means plants can grow much closer to gether than any other system.
4. Aquaponics is an extremely water-efficient system. Aquaponics has a low water usage and uses approximately 90% less water than conventional farming. The water used is recycled, so it is rarely changed or discarded.
5. Since the plants are not grown on arable land, this system is not dependant on healthy soil, nor can it be infected by soil-borne diseases/ pesticides.
6. No chemicals nor fertilizer is required.
7. It focuses on both quality and quantity yields.
8. There is little risk from contamination and this in turn means a higher level of bio-security.
9. The environment can be more easily controlled, which results in better yields and less chances of unnecessary losses.
10. The system is not dependant on arable land, therefore deserts, land with degraded soil and even salty and sandy islands can be used.
11. Aquaponics farms use up to 50% - 60% less energy than other farms. Lower heating bills because the water keeps the plants at the right temperature.
12. This type of technology is not labour intensive, as there is no soil preparation required before the system can be implemented.
13. Food security and livelihoods can be achieved through t he use of aquaponics farming.
14. Fish protein is a daily dietary need for all humans, and this is achieved through these systems
15. Aquaponics is a completely natural process that mimics nature's circular approach without producing waste.
16. Aquaponics provides food (fish and vegetables) that can be grown all year round and be sold in the organic market.

17. Plants grow fast in the aquaponics system for they don't have to compete with other plants for nutrients (North, 2016: online; Vergeer, 2019: online).

The FAO identified the following weaknesses of aquaponics:

1. The very high initial start-up costs (compared with both hydroponics or soil production systems) of aquaponics is one of its weaknesses;
2. Aquaponics requires deep expertise in the natural world. In order to be successful, farmers need to have knowledge not only on growing vegetables but also on how fish and bacteria work. And technical skills regarding plumbing or wiring are also needed;
3. As a follow up from the previous point, it's often hard to find a perfect match between the needs (such as pH, temperature, substrate) of fish and plants;
4. Fish feed needs to be purchased on a regular basis;
5. The products of aquaponics alone aren't enough to ensure a balanced diet (youmatter, 2020: online).

Aquaponic system

Aquaponics freshwater systems rely on three main components that depend on each other to survive, namely:

- Freshwater aquatic animals (the fish)
- Nitrifying bacteria
- Plants

The nutrients required by the plants, which are created by the waste produced by the fish is a crucial part of the system to work, also since the plants in return clean the water, the fish can enjoy a clean environment (Vergeer, 2019: online).

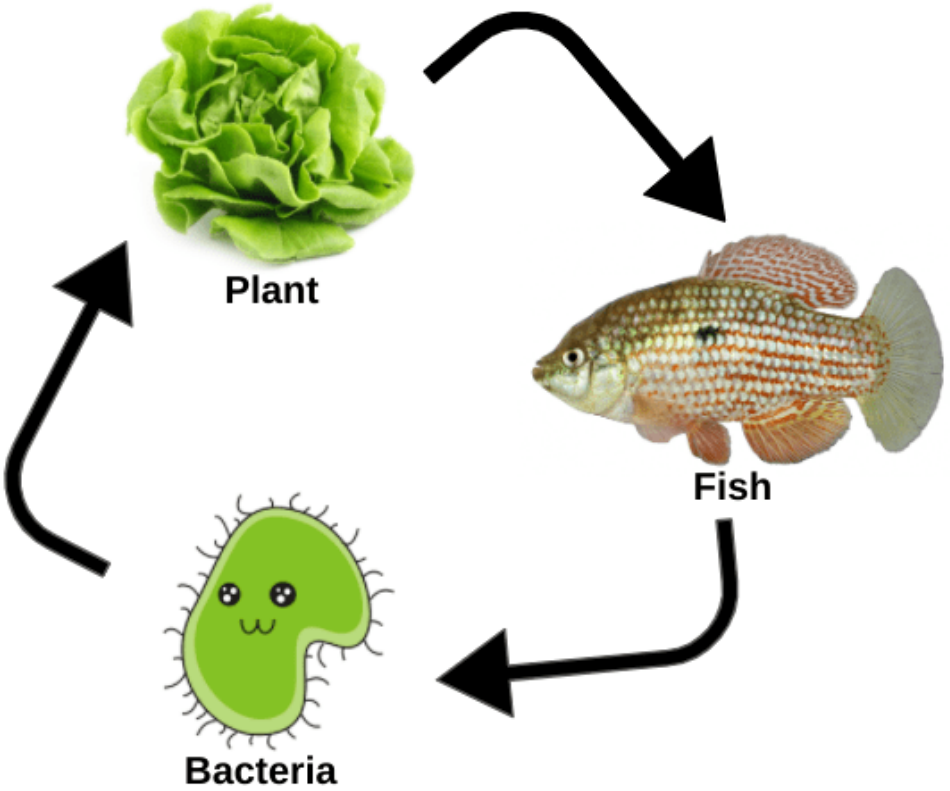


Figure 154
Aquaponic system
(AquaSprouts, 2021: online)

Follows a brief discussion of the three main components.

Fish

Fish play an integral part in an aquaponics system for their waste acts as a natural fertilizer for the plants. In order to have maximum growth output from the fish, it is important to identify fish that are not fussy to raise, that are easily available and resistant to diseases (Vergeer 2019: online).

For the purpose of the Lifestyle Farm's aquaponics system, Tilapia will be the best option for it's disease tolerance, large size, easy and rapid breeding, fast growth, omnivorous diet, tolerance to poor water conditions, and palatability makes them ideal species for aquaponics. They can live over 10 years and gain weight of over 10 pounds. Their growth rate is 600 grams in 6 to 8 months (Leaffin, 2019: online; Vergeer, 2019: online).

Tilapia are a great source of protein for human. Their mild flavor makes them adaptable to many culinary styles. They are produced in outdoor ponds as well as indoor systems for sale as live food fish to the restaurant and supermarket trade (Leaffin, 2019: online).



Figure 155
Cooked Talapia
(GORE, 2018: online)

Tilapia needs the following conditions (Leaffin, 2019: online):

Vital temperature range:	15°C – 35 °C
Dissolved Oxygen:	3-10 mg/l
Ph:	7.0 - 8.0
Unionized Ammonia:	<0.04 mg/l
Nitrite:	<0.8 mg/l
Hardness:	50-350 mg/l
Diet:	Omnivore: requires only 26

- 32% protein

The following benefits makes Tilapia an ideal candidate to use in the Lifestyle Farm's Aquaponics system:

- Adapt very well to tanks
- Function well in very high stocking densities (3/4 lb/gallon) within the fish-tank part of the system.
- Efficient feed conversion ratio of 1.3 – 1.8.lbs feed/lbs fish
- Good dress out percentage (86% with head, 66% without head and 33% fillet)
- Adapt to their environment and are able to withstand less than ideal water conditions
- Tilapia grow fast and can reach fingerling size (50g) to maturity (600g) in about 6-9 months.
- Tilapia culture is profitable. (Variables include market price, feed costs, survival rayes, technical ability and geographic location).
- Market acceptability and recognition and low production costs (Leaffin, 2019: online).

Water Quality and temperature

Although tilapia is considered a freshwater species, they can live in brackish conditions and are tolerant of poor water quality conditions and handle different water conditions from temperature, pH, nutrient, oxygen levels and more. They are often farmed in facilities where other fish would die. Tilapia needs warm water and therefore during winter seasons a good fish tank heater is needed to maintain the temperature of water (Leaffin, 2019: online).

Tilapia can tolerate temperatures extremes of 14 and 36 °C for a brief period of time but they stop feeding or growing below 17 °C, and die when it drops lower than 12 °C. The ideal range to ensure good growth rates is 27–30 °C. They are immune to many parasites and pathogens. They also handle stress very well. However, for optimal growth and health this species, like most others, prefer DO >6ppm; pH>6; and low ammonia and nitrite levels.

For the purpose of the proposed Lifestyle farm solar energy will be used to maintain the temperature of water.

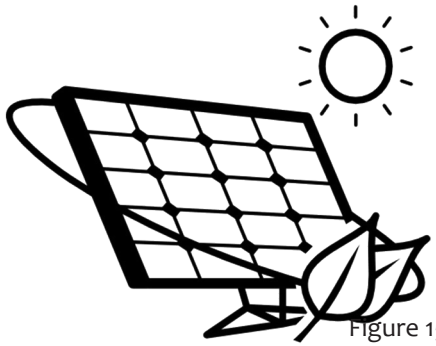


Figure 157 Interpretation of water heating (Get Drawings, 2021: online)

Fish Feed

Tilapia are omnivores and eat anything from microscopic organisms through their gills, (they literally "filter" them out of the water), to algae, weeds, vegetable scraps, bugs, worms, tadpoles, etc. They also eat many alternative feeds like duckweed, Azolla spp., and other high-protein plants which makes them important in aquaculture (Leaffin, 2019: online). Fish should be fed properly (at least twice a day) to keep them healthy. The formula: 20g of feed can be used to calculate the amount of feed needed in the aquaponics system (Vergeer, 2019: online).

During breeding, tilapia eat their own young, therefore, they need to be separated by size.

Breeding will not be part of the Lifestyle Farm's aquaponics system. The Lifestyle Farm will buy tilapia at fingerling size (50g) and give it the opportunity to reach maturity (600g).

The tilapia will mainly be used in the restaurant or sold by the time it reaches maturity (600g). The proposed Lifestyle farm would favour tilapia males over females seeing as males grow larger in size at a faster rate, they don't spend energy to develop ovaries or stop eating during spawning, unlike females(Leaffin, 2019: online).



Figure 158 Leafy Greens
(Berkheiser, 2019: online)

Plants

Choosing the best plant to grow in the proposed Lifestye Farm is important for its aquaponics system's overall success. Plants should be selected that grow easily and are suited to the environment and climate. Nutrient-hungry plants like tomatoes should be avoided for they require a lot of nutrients. Easy-to-grow plants like leafy greens, lettuces, and herbs should rather be considered (Advising, 2021: online). Avoid growing plants that need acidic or alkaline water, because those levels of pH can definitely harm the fish (North, 2016: online; Vergeer, 2019: online). Commercial growers most often grow tilapia, lettuce and leafy greens for the crops have a long-term, proven track record of profitability in commercial aquaponics (Nelson & Pade Aquaponics, 2021: online).

At the proposed Lifestyle Farm the plants (lettuce and leafy greens) , which grow organically, will be used mainly for 3 purposes, namely to maintain the aquaponics system's overall cycle by cleaning and oxygenating the water before recirculating back to the fish, provide the restaurant with fresh stock and sell it to the public.

Plants in Aquaponics are planted in the grow bed, pipes, or floating rafts. For the purpose of the proposed Lifestyle Farm's aquaponics system floating rafts will be used for it is one of the most efficient aquaponics system designs which is often used in large-scale or commercial aquaponics systems because of its mass production capacity (Advising, 2021: online). In a raft system, also known as Deep Water Culture or Floating System, the nutrient-rich water circulate through the long canals, usually at a depth of about 20cm. Plants are grown on rafts boards (poly-

styrene or foam boards) that are supported within holes by net pots and float on top of the water in the raft bed. Plant roots hang down in the nutrient-rich, oxygenated water, where they absorb oxygen and nutrients to grow quickly. The cycle flows non-stop from the fish tank through the filters to the raft tank and back to the fish tank (Advising, 2021: online; Vergeer, 2019: online).

Normally the raft tank and the fish tank are separated. This method is most appropriate for growing salad greens and other fast-growing, relatively low-nutrient plants (North, 2016: online).

According to Vergeer (2019: online) it is important to make sure that the floating foam is lightweight and strong enough to keep the growing plants in a upright position and to prevent them from sagging and lying on the floor.

It is advisable that net pots are used to allow plants to absord enough nutrients, whilst still holding them tightly, yet gently in place.Commercialized aquaponics farms use floating rafts to enable fast growth leading to better crops yields.



Figure 159 Planter beds
(Go Green Aquaponics, 2019: online)

Advising (2021: online) considers the following to be advantages and disadvantages of Raft System:

Advantages

- Low intensity labour with high productivity.
- Enough root to water exposure, leading to higher nutrients intakes.
- Plants can easily be removed when they are ready to be harvested, unlike soil harvesting.
- Rafts can be kept clean on a regular basis.
- Shown to be best suited for commercial farms.
- More fish can be stocked in this manner.

Disadvantages

- Be cautious for mosquitos, as it creates a possible breeding groud.
- Due to the fact that the roots are entirely submerged in water all the time, the filtration system is inevitable.
- It requires ample space for the tanks, etc. to be erected.

Bacteria

The bacteria released by the fish waste play an integral role in the aquaponics system, because they transform waste into nutrients. This is known as the nitrification of the water. This is essentially what enables the plants to grow (Vergeer, 2019: online).

Therefore it is important to monitor and maintain the bio-filter in order to maintain a healthy bacterial colony in the proposed Lifestyle Farm's aquaponics system.

The most crucial part of a successful aquaponics system is learning how to create a balance between the plants, the fish and the bacteria, this will ensure a sustainable and consistent design (Advising, 2021; online). For the purpose of the proposed Lifestyle Farm the raft tanks will be separate from the 6 fish tanks. In the raft system the fish would be fed.

As previously explained the biofilter will be on the receiving end of fish waste as well as un eaten food and plants that have started to decay, the biofilter will decompose all of the above and it will result in organic nutrient rich solutions.

The new water, filled with the organic nutrients, will flow through canals at about 30cm deep. The plants to be grown on raft beds / boards made from foam / polystryrene, supported by net pots. Ideally one would grow lettuce and other leafy greens in such a system.

Thedisadvantages regarding the Raft system will be taken into account and overcome with the design of the proposed aquaponic system.

6 Fish tanks

Diameter:	3200mm / 1600mm
Hight:	1300mm
Water level:	1100mm
Volume water per tank:	8850.29m ³

Raft system

6 Rafts float boards
6 long canals/ raft beds

Lenght:	23000mm
Width:	12000mm
Hight:	400mm
Water level:	300mm
Volume water per canal/bed:	8280L
Total volume water (6 canals):	49 680L
Amount of fish (1 fish/11liter):	4516.36

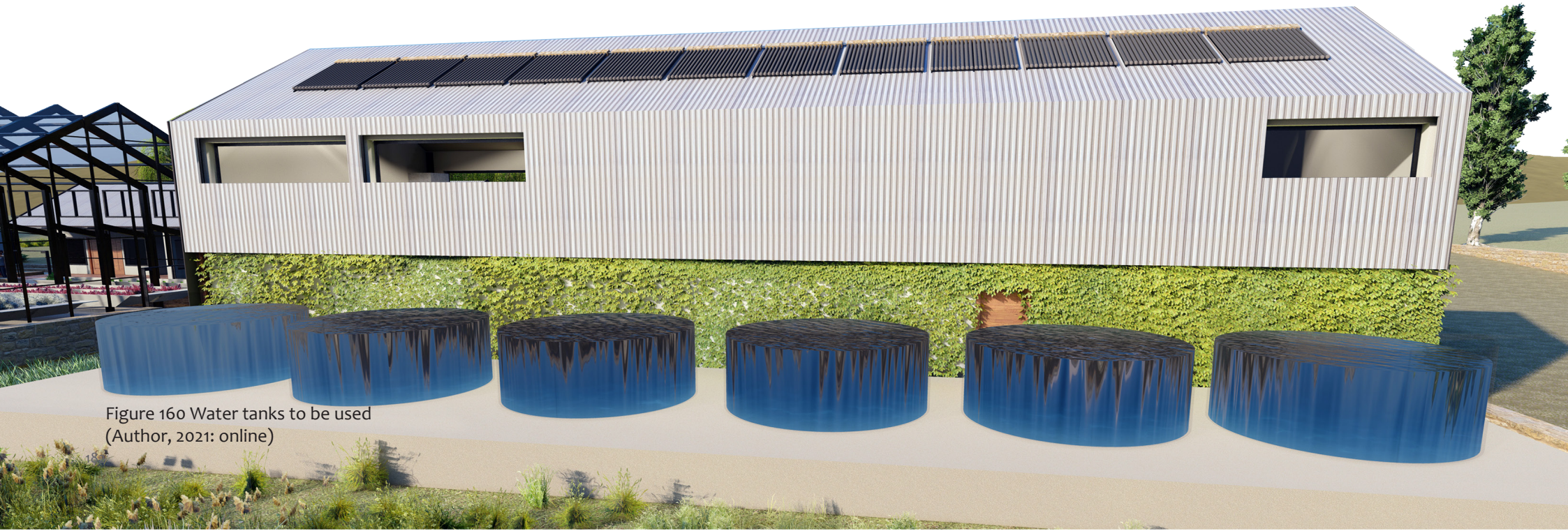


Figure 160 Water tanks to be used
(Author, 2021: online)

Managing an Aquaponics System

As with any sustainable method to grow and cultivate food sources, it must be well managed and controlled.

To ensure that the circle keeps running smoothly, the farmer / the designer must keep certain key factors into consideration to ensure plants, water, fish and bacteria are always at balanced levels (youmatter, 2020: online):

1. Air temperature;
2. Water temperature;
3. The concentration of macro and micronutrients;
4. Dissolved oxygen in air and water – which depends on the filtration method used;
5. CO_2 concentrations in air and in the water;
6. pH levels;
7. Lighting

To obtain the correct pH levels in an aquatic environment is both tricky and important. Since there is not only one living organism to take into consideration, but three, i.e. fish, plants and the bacteria. A healthy pH should be between 6.8 and 7.2.

The fish waste can cause the water to become more acidic. There are ways to adjust the pH level. When pH levels are too acidic, the plants will not be able to properly function and absorb the nutrients as they should, this will lead to the failure of the system and both fish and plants will die. The pH levels must be checked daily to avoid a system failure.

The pH adjusters are specifically designed to prevent a situation where the water is either too acidic or too alkaline.

According to North (2016: online) it is important to keep the water's hardness in mind since fish do not respond well to sudden changes in the water, it is always best to add adjusters slowly, rather than to add it rapidly and in so doing causing harm to the entire system.

Plants, like any life form, require energy to grow. Plants obtain their energy via photosynthesis, which is the natural process where light, normally sunlight, oxygen and water are converted into useable energy, also known as carbohydrates (Vergeer, 2019: online).

The plants use this energy to grow. Fish require a combination of light and shade. Even though fish may not grow from sunlight, studies have shown that without it fish can become depressed which will result in illness and even death.

By keeping a close watch on these factors one can prevent imperfections in the system and tereby produce healthier plants, fish and water (Vergeer, 2019: online).

For the purpose of the Lifestyle Farm the parameters will be daily monitored and adjust to maintain the suitable balance between fish waste and vegetable nutrient.

Filtration

The two main filtration types used in aquaponics farming are biological filtration and mechanical filtration. For the Aquaponic Lifestyle Farm the Biological filtration will be utilized.

- Biological filtration also known as bio-filtration is the natural way to filter the water, hence it is also the best for the fish. Basically the bacteria, which is found in the waste produced by the fish, convert toxic ammonia, into nitrates, which ultimately feed the growth of the plants.

- Bio-filtration is achieved in a number of ways in these systems, but all work on the same basic principal of moving oxygenated water through an inert material with high surface area in which the nitrifying bacteria colonize. One type of bacteria, Nitrosomonas, converts ammonia to nitrite, then a second type of bacteria, Nitrospira, converts that nitrite into nitrate which is in turn utilized by plants, or in the case of aquaponics, by the vegetables you are growing (ECOLIFE, 2021: online).

- Mechanical: Man-made barriers like foam or sponge through which the water passes enables solid waste to be trapped and removed before being naturally broken down. This filter must be removed and cleaned constantly. The mechanical filter can aid the bio-filter, in that it takes some of the strain off the bio-filter to constantly produce clean water, they can thus work together to provide more oxygen to the fish (ECOLIFE, 2021: online).

The bio-filter cannot necessarily degrade solid waste fast enough, this may lead to lowering of oxygen levels which places the entire system in danger.

System Components and Supplies

Two basic components make up an aquaponics system – i.e. the initial materials to build it and the supplies to maintain it (Vergeer, 2019: online).

Materials (Vergeer, 2019: online):

- Fish Tank - The fish tank is the home of the fish and one of the most important materials of the aquaponics system.
- Grow Bed - Will hold the plants and grow media. Depending on the system, the grow bed can be PVC pipes, floating rafts or any food grade containers.
- Grow Bed Support - Frame that will support the weight of the grow bed.
- Sump Tank - Optional. Using a sump tank will depend on the design of the system.
- Plumbing pipes and fittings - Depends on the type of the grow beds, system, and other factors.
- Bell Siphon - A bell siphon is required for a flood and drain media bed.
- Water pump - The size depends on the desired tank exchange rate and several grow beds.
- Aerator, air stones - This is used in the fish tank and media beds.
- Grow Lights - Optional. This is mostly used in indoor systems.
- Heater - Optional. Using a water heater will depend on the location, fish species, and target water temperature.
- Monitoring System - Optional. It depends on the situation and way of managing the system.
- Timers and Controllers - This is mostly used for lighting, pumping and controlling the temperature (Vergeer, 2019: online).

Conclusion

Aquaponics is an environmental friendly, natural food-growing method that harnesses the best features of aquaculture (fish farming) and hydroponics (growing plants in a nutrient solution, without soil) without wasting water or having to clean water by using chemicals.

Aquaponics is the perfect balancing act between different living organisms in the same environment who sustain and feed each other, in this instance the waste from the fish becomes the food for the bacteria, which turns into a natural fertilizer for the plants to grow, who in return clean the water which flows back to the fish (youmatter, 2020: online).

A successful aquaponics system requires proper research, planning and knowledge regarding the advantages and disadvantages of the different aquaponics systems. Aquaponics freshwater systems rely on three main components that depend on each other to survive, namely: Freshwater aquatic animals (fish), Nitrifying bacteria and Plants.

A number of different types of fish can be used in aquaponics farming. Tilapia is ideal for large scale aquaponics systems because it easy to breed, grow fast, need optimum temperature range between 65° - 85°F and can be harvested to eat and are a great source of lean protein. Tilapia, lettuce and leafy greens have proven to be of great value in commercial farming and will therefore fit in well with the proposed Lifestyle Farm's setup (Nelson &Pade Aquaponics, 2021: online).

As previously discussed, there are certain key features that must be maintained and controlled in the environment to ensure optimal conditions for all living organisms in the system. Among others they include air temperature, water temperature, macro-and micronutrients, the pH levels and light.

Aquaponics has the potential to address food security challenges. Many regions in South Africa are considered arid and dry. If one can introduce a system that is not soil nor weather dependant there will always be a way to provide food security in times of distress, aquaponics farming has this potential and must be implemented as such.



Figure 161 Leafy greens
(Elenathewise, 2018: online)

PART 05

DESIGN AND TECHNICAL SYNTHESIS: A BIOPHILIC SITE OF PLACEMAKING

5.1 FROM CONCEPT TO FORM
5.2 STRUCTURAL IMPLICATIONS
5.3 DESIGN DEVELOPMENT
5.4 FINAL DESIGN SOLUTION
5.5 TECHNICAL RESOLUTION
5.6 DOCUMENTATION

Introduction

In this section the theory of placemaking is operationalized by applying the patterns of permaculture and the principles of biophilic design to the design of the aquaponic Lifestyle Farm. The language of the design is thus developed from theory, structural observations, and experiential readings of the site. The design unfolded organically and underwent several iterations in order to arrive at a point where it would read as being in harmony with the overall landscape and the principles of sustainability while still capturing a sense of place that users could connect to on an emotional level as they became immersed in the unique beauty of the Eastern Free State.

5.1 FROM CONCEPT TO FORM

The first step in developing the design was to identify the primary landscape that the Lifestyle Farm would be situated in. During the site analysis it was determined that the Lifestyle Farm would be situated within a classical landscape as distinguished by Norberg-Schulz (1885:48) as one of the three primary landscape characters. According to Norberg-Schulz (1985:48) a classical landscape is grounded in terms of its spatial character, light, daily and seasonal rhythms atmosphere,water, land and life. A classical landscape encompasses an organised composition of individual elements which gives human dwellers a feeling of belonging and freedom and contribute to a sense of place (Feashadi, 2017: 13).

Figure 162 Site interpretation
(Author , 2021)

Seeing as classical landscapes features both topological and geometrical properties, it was essential to situate the design of the Lifestyle Farm within the landscape in such a way that it could relate to the existing grounding that the landscape has to offer. Important elements that were taken in account in terms of the placement of the design were the viewpoints, creating public and private spaces, accessibility, the functionality of the buildings and its service yards. Through sensitive placement, a sense of place can be created for the worker and the visitor.



Figure 163 Site main features
(Author , 2021)

The aquaponic Lifestyle Farm will aim to provide visitors with a visual experience of nature by integrating the environmental features into the design.

Secondly, the aquaponic Lifestyle Farm will aim to complement the natural environment through a design that is in sensitive alignment with the surrounding environment, thus establishing a genius loci.

Lastly the aquaponic Lifestyle Farm, will create a symbolic interpretation of the natural world by introducing an innovative eco-friendly farming method to the Eastern Free State.

By drawing on elements that can be universally understood and by promoting a free-flowing connection with nature, the building will endeavor to evoke an emotional response from its users, and in doing so, create a sense of connection to the site.

By understanding the type of landscape and utilizing the factual knowledge gathered in the analysis of the topology (3.2), the design will strive to mimic and create a place that is functional and authentic to the Eastern Free State.

From experiential site visits, personal groundings of the landscape were identified and interpreted. By reflecting on these experiences, a personal understanding was established, and the language of the design was developed. The identified site was chosen due to its location (between the tourist attractions the surroundings offer) secondly, the site is found between hills and mountains and a constantly flowing fountain, creating a picturesque view for the user and revealing a sense of place that only can be experienced on that peace of earth.

Lastly, because conventional farming methods do not work on the site, aquaponic farming was identified as a technology that can put the land to productive agricultural use.



Figure 164 Site main features interpretation
(Author , 2021)







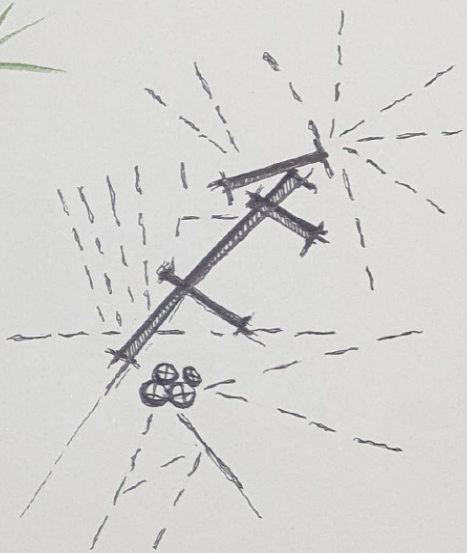


Figure 165 Site investigation - zoomed in
(Author , 2021)







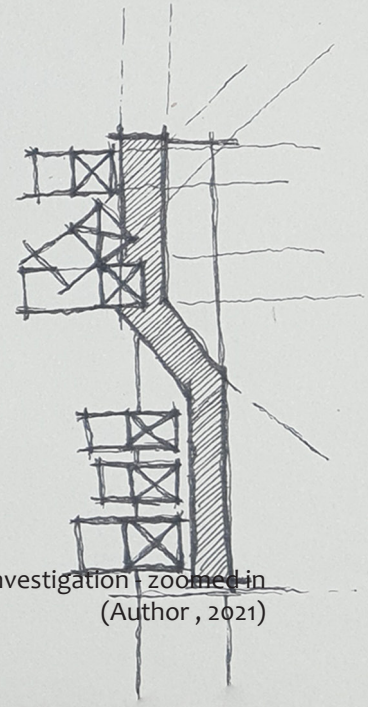


Figure 166 Site investigation - zoomed in
(Author , 2021)



Figure 167 Site investigation - zoomed in
(Author , 2021)

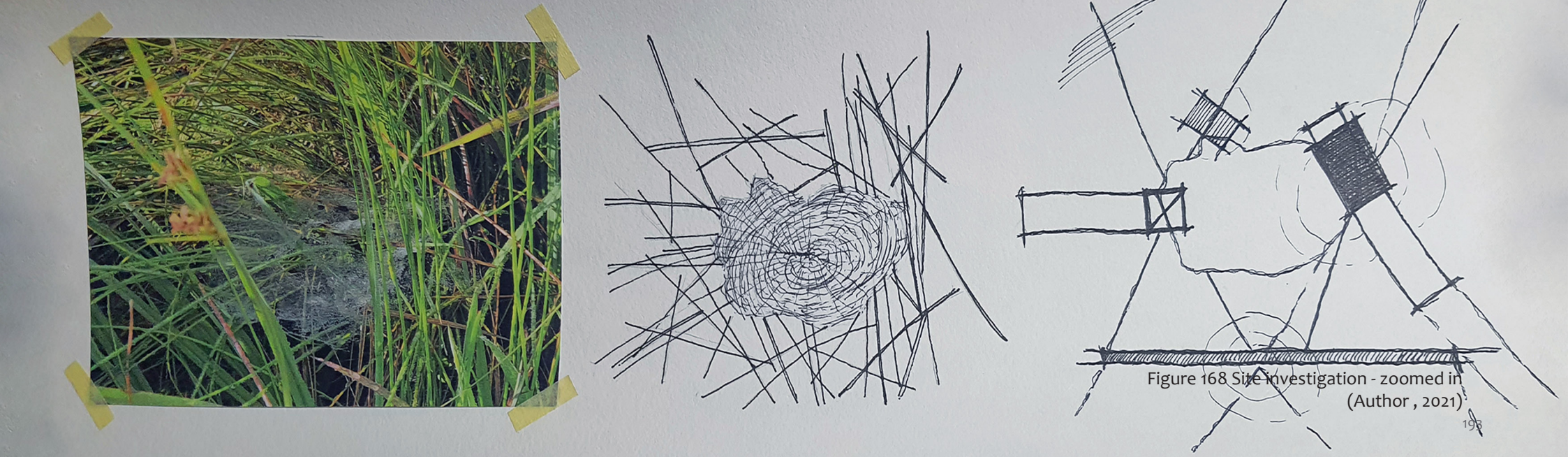


Figure 168 Site investigation - zoomed in
(Author , 2021)







Figure 169 Site investigation - zoomed in
(Author , 2021)





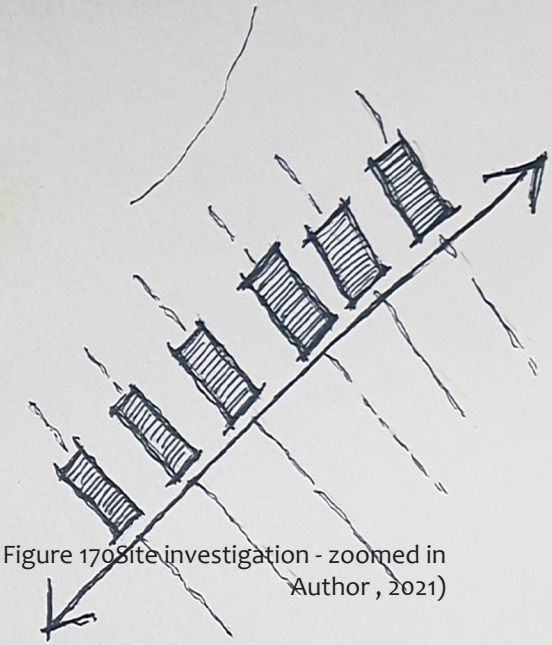


Figure 170Site investigation - zoomed in
Author , 2021)

The language of the design

Architectural language is subjective and differs from one individual to another. According to Rimizova, Architectural language can be defined as a language of architectural shapes which allow for the embodiment of an idea and an artistic intent in the material of the composition (Remizova, 2015: 2).

The procedures of compositional work, rules of artistic construction, methods, and techniques of working with space and shape comprise the syntax of architectural art. The term morphology also forms part of the language of architecture. Architectural morphology can be seen as a set of rules for the formation of primary semantic units and outlines to shape the formation of a constructed site into meaningful combinations (Remizova, 2015: 3).

To form a true understanding of the architectural language that will be used to inform that of the aquaponic Lifestyle Farm a regional approach has been taken. This has been achieved by looking at the Eastern Free States' existing architectural types and forming an understanding of the architectural language that it offers.

The two languages identified in the Eastern Free State geography are firstly that of the traditional farm homes found on the surroundings farms and secondly the functional outbuildings the farms utilize, such as barn and shed structures.

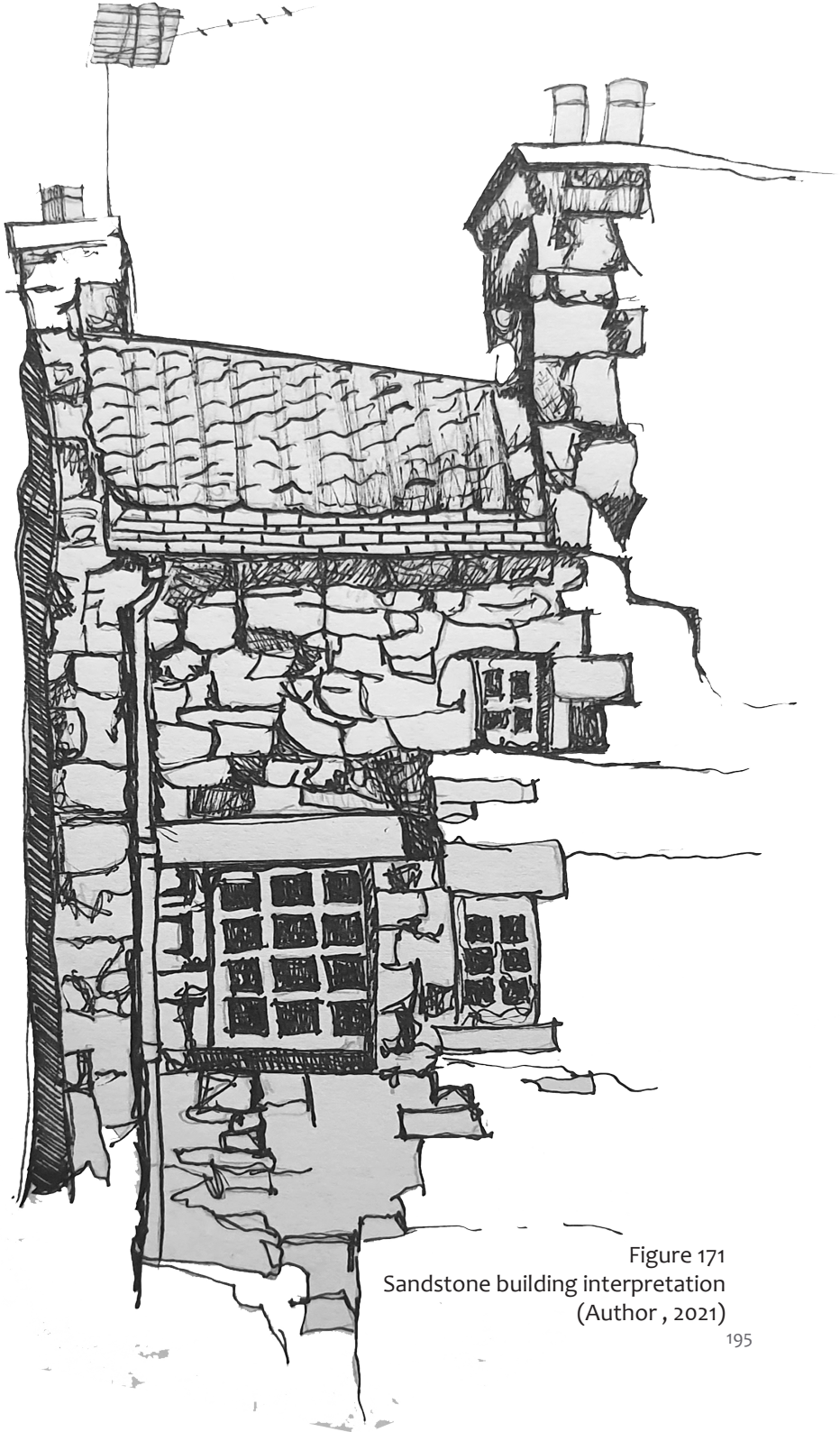


Figure 171
Sandstone building interpretation
(Author , 2021)

Farmhouse is Lusthof

The precedent identified as an aid to understanding the characteristics of a farmhouse is Lusthof. Lusthof is a farmhouse in the Braam Valley between Fouriesburg and Clarens. The most prominent characteristic of this house is its iconic big stoep which wraps around the house. While the stoep offers a striking architectural feature and provides an inside/outside leisure space for the home's inhabitants, it is also located on the north side of the house and therefore steals all the northern light that could have penetrated the rooms of the house, resulting in a dark interior (du Preez, 2012: 42,44).

The big stoep assists in the circulation of the home. The main building materials identified are locally sourced sandstone and corrugated iron roofing. The sandstone is left exposed on the outside of the building (du Preez, 2012: 42,44).

Columns can be found around the stoep. These serve multiple functions. Firstly, the columns act as structural support beams for the roof and secondly as decorative elements as they are carefully crafted with detail. The roof connection from the stoep to the main roof reads as a unit although the angles differentiate. Windows in the house are small allowing little light to penetrate in addition to the low-light conditions created by the stoep (du Preez, 2012: 42,44).

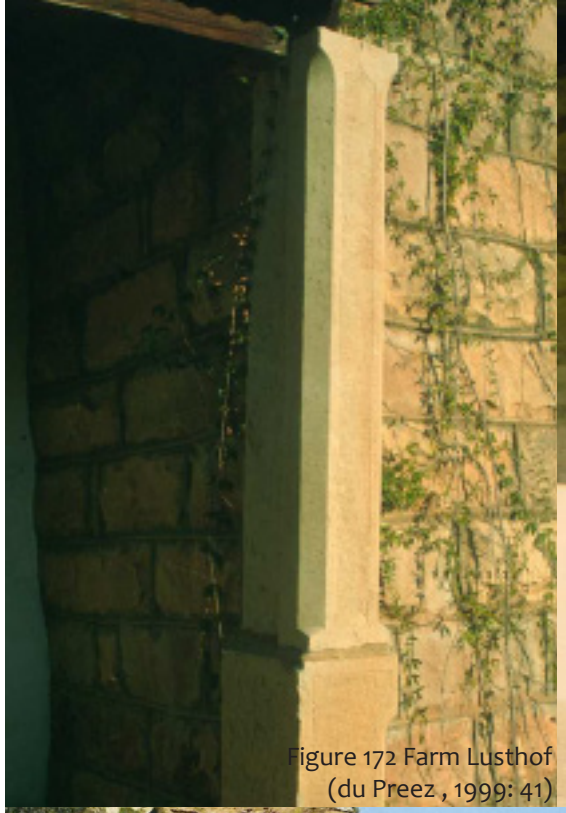


Figure 172 Farm Lusthof
(du Preez , 1999: 41)



Figure 173 Farm Lusthof
(du Preez , 1999: 41)

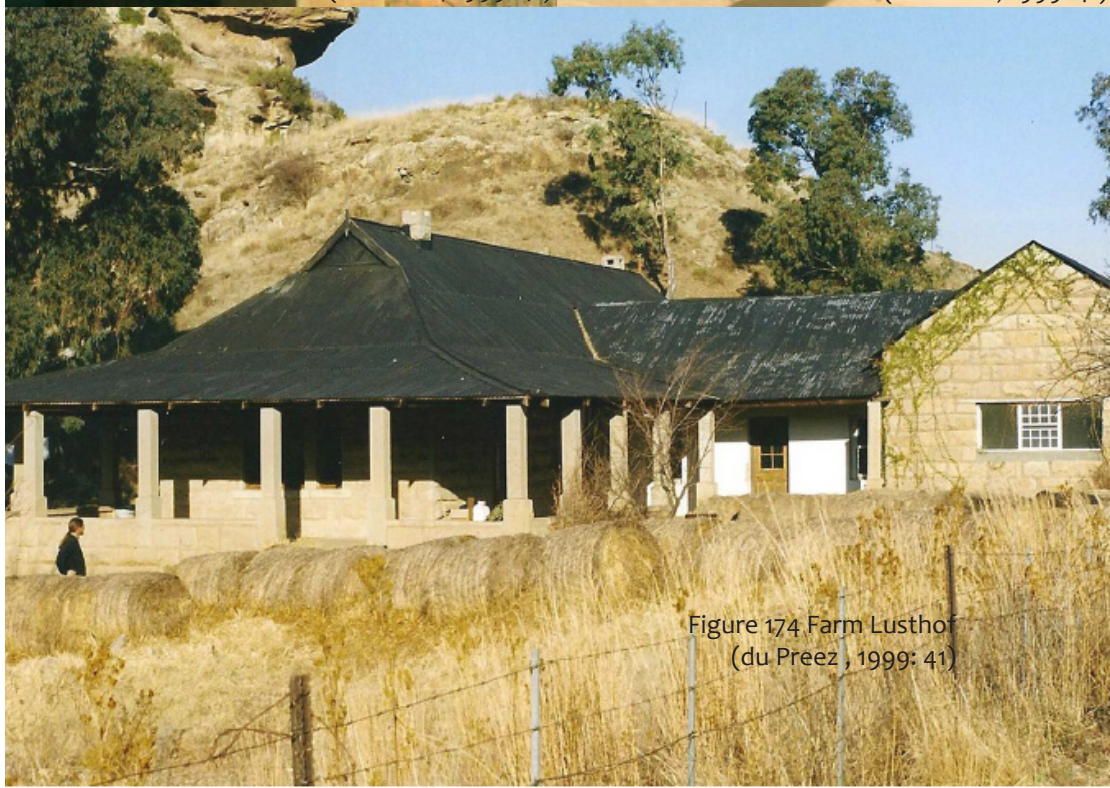


Figure 174 Farm Lusthof
(du Preez , 1999: 41)

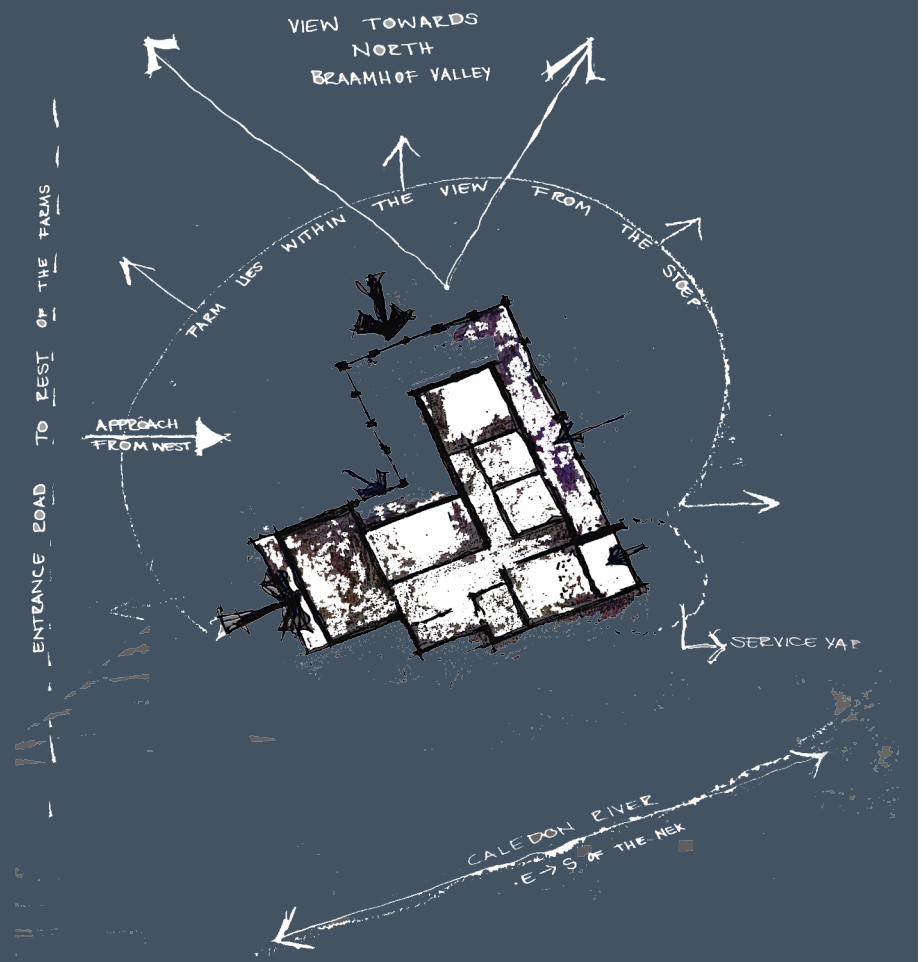


Figure 175 Farm Lusthof- plan
(Author, 2021)

Although the traditional farmhouse typology that has been identified here acts is that of a domestic space, it is important to consider how this typology can be translated into a public space such as the restaurant-venue for the Lifestyle Farm.

Although the big stoep is an important characteristic of the architectural language identified here, it does also present the problem of limiting light penetration into the building. Thus, it is important to consider how a large stoep can be added as a feature to the buildings from which the aquaponic Lifestyle Farm will be comprised while still allowing optimal light penetration.

The roof structure is an interesting feature of the Lusthof farmhouse, but it appears that articulation is lacking from the main roof towards the stoep roof. An important quality identified that will be utilized in the design of the aquaponic Lifestyle Farm is the building materials: making use of sandstone and corrugated iron sheeting.

Through the use of vernacular materials, a connection can be made with the physical attributes of the wider surrounding area, thus contributing towards establishing a sense of place.

Barn Weltevrede

The second precedent identified is the functional outbuilding (barn/ shed) found on the neighbouring farm, Weltevrede, which is also located on the S217. The building is designed according to its function. The building is constructed from of a steel frame system with sandstone infill walls and further corrugated sheeting to wall and roof the structure.

On the two ends of the structure huge doors can be found for storing big farming equipment. The volume of the barn is large, and it is designed according to the needs of the farmer. The barn is transformed into a multifunctional space by adding and removing temporary structures such as fences. By making the barn adaptable the objectivity can be changed, thus a multipurpose space is created for different harmonious interactions.

The characteristics that can be identified for the design of the aquaponic Lifestyle Farm are the pitch roof structure, corrugated iron sheeting and simple yet functional design and structural systems.

An interesting observation taken from both precedents is that the construction process is informal - the farm owner builds as the need for an extension to the buildings arise, whether it is temporary or permanent.



Figure 175 Weltevrede
(Author, 2021)



Figure 176 Weltevrede
(Author, 2021)

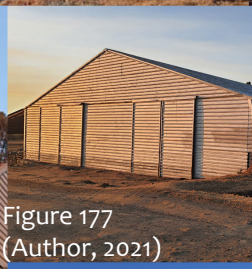


Figure 177
(Author, 2021)



Figure 178 Weltevrede
(Author, 2021)

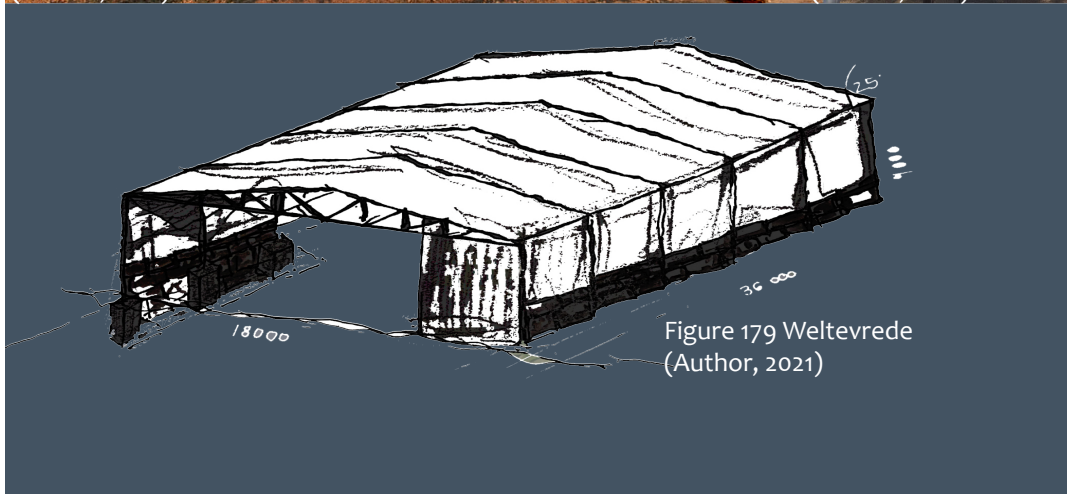


Figure 179 Weltevrede
(Author, 2021)



Figure 180 Barnhouse
(GA Architects, 2017: online)



Figure 181 Barnhouse
(GA Architects, 2017: online)

With the precedents in mind, the aquaponic Lifestyle Farm will speak to the language of the regional architecture by drawing on the existing design principles in the area and making use of vernacular materials that are typical of the area. Simple farm style design is thus a feature of the design while making use of sandstone and corrugated roof sheeting.

In terms of the design; however, it became important to consider how the regional architecture could be adapted and changed according to the needs and user requirement that are relevant to the aquaponic Lifestyle Farm.

Looking at a few precedents that have been constructed in more recent times a better understanding of the language the aquaponic Lifestyle Farm aims to achieve can be formed.

Taking the vernacular architecture like the barn into consideration and drawing further afield to look at relatable precedents elsewhere, The Barn House from Gottsman Architects constructed in 2017 was identified as a relevant precedent.

This precedent provides a modern interpretation of the traditional barn structure, like the way in which the design of the Lifestyle Farm's structures will aim to update the vernacular architecture of the Eastern Free State for modern needs, functionalities, and aesthetics.

The Barn House was inspired by the simple forms observed in a traditional barn structure. Lightweight steel was used as an alternative building material to traditional corrugated iron. Steel cladding was used which gave the building an industrial aesthetic.

The layout of the house was fragmented so as to create privacy between the rooms and the programme, while also allowing the house to fully use the large stand appropriately. With the industrial look, the family home typology can be related to the industrial farming aesthetic that the design of the aquaponic Lifestyle Farm aims to achieve. This precedent is thus relatable to the aquaponic part A of the project.

Both the Weltevrede barn and the Barn House make use of steel cladding and steel frame structures in their construction. Infill walls are used for some parts of The Barn House which is like the sandstone infill walls observed at the Weltevrede barn. The roof pitch of both precedents is similar.

The Barn House makes use of the entire site it is given according to the functions the user requires enabling a sense of place for the design.



Figure 182 Barnhouse
(GA Architects, 2017: online)



Figure 183 Barnhouse
(GA Architects, 2017: online)



Figure 184 Barnhouse
(GA Architects, 2017: online)



Figure 185 Barnhouse
(GA Architects, 2017: online)



Figure 186 Barnhouse
(GA Architects, 2017: online)



Figure 187 Barnhouse
(GA Architects, 2017: online)

The Barn House combines a lightweight steel structure with concrete and bricks, creating material diversity. Green roof systems are introduced at the main entrance creating a connection point between the main building and the garage. By implementing horizontal long window slips between the ground and first floor an articulation can be identified between the levels.

In the precedent different spaces are demarcated through design across the site. This can be related back to the farm building which is adjusted and extended as the need arises.

The precedent thus acts as a fresh take on the industrial aesthetic the farm shed offers. The traditional barn found at Weltevrede farms is typical of the area and relates to the landscape, while being multifunctional in use. This typology is adopted in the design of the Lifestyle Farm, but like the Barn House, it is updated and interpreted anew to speak to the architectural language of sustainability that is articulated by the Lifestyle Farm. In reinventing this traditional form in ways that provide greater connection with the natural landscape, the design forms a sense of place.

To implement this kind of design, the structural implications of the chosen form have to be investigated.

One of the main functions of a structure is to direct the load of the materials towards its supports. Engel has described this as load reception, load transfer and load discharge (Engel, 2009: 25). This concept introduces a direction of load, going from where the load is received to where the load is discharged at the supports: a flow of forces, or load path (Millais, 2005: 30).

Structural grid

Developing a structural order is an essential part of structural design. It requires an architect and engineer to identify the loads, supports, structural elements and their interdependency (Balmond 2002: 5).

The aquaponic Lifestyle Farm makes use of three different grid systems. Each system is designed according to the functions of the spaces. The systems are comprised of evenly spaced blocks to organise the structure and organisation of the design.

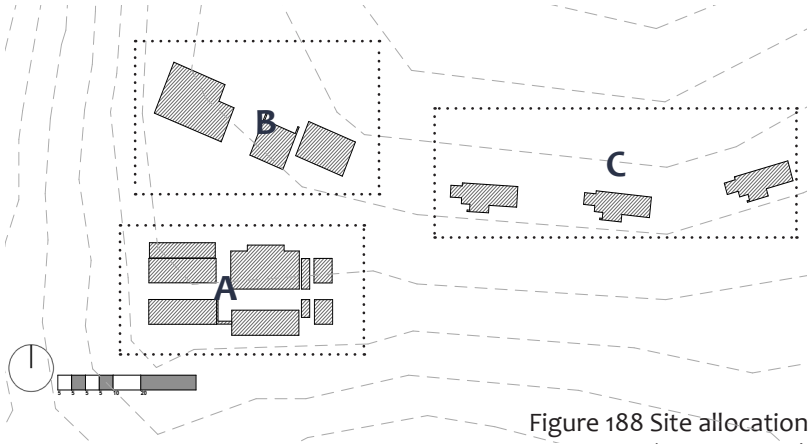


Figure 188 Site allocation
(Author, 2021)

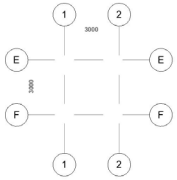


Figure 189
Grid 1
(Author, 2021)

In part A the first grid system can be found. Part A is where the aquaponic farming side of the lifestyle farm is located. The grid system for this part is spaced 3000mm X 3000mm at a 90° angle.

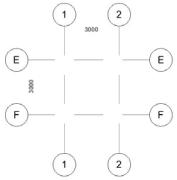


Figure 190
Grid 2
(Author, 2021)

Part B also makes use of the 3000mm X 3000mm grid system but is angled at 22°.

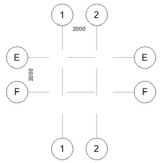


Figure 191
Grid 3
(Author, 2021)

Part C makes use of a 2000mm X 2000mm grid placed at different angles.

Portal frame systems

The aquaponic Lifestyle Farm mostly makes use of the portal frame structural system with infill walls.

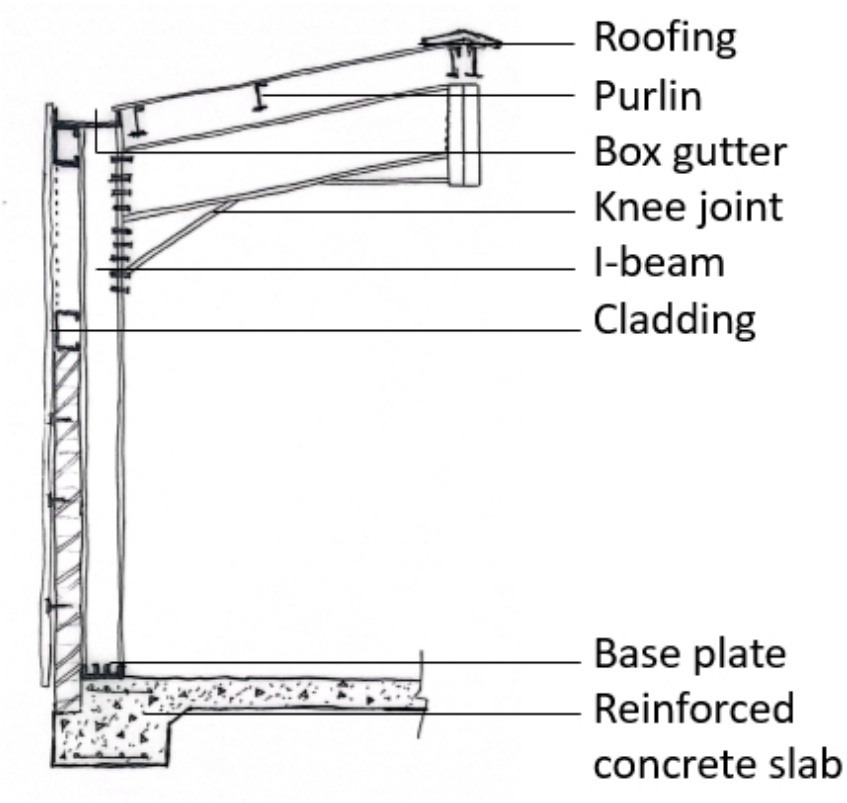


Figure 192 Portal frame System
(Author, 2021)

Greenhouse & cocktail lounge glass construction

As mentioned in the structural philosophy (4.1.3.) plant biologists, horticulturists, ecologists, or other environmental scientists will determine the thickness of the glass used in the green house.

The construction of the greenhouse and the cocktail lounge will however be comprised of a steel frame structure with a glass envelope.

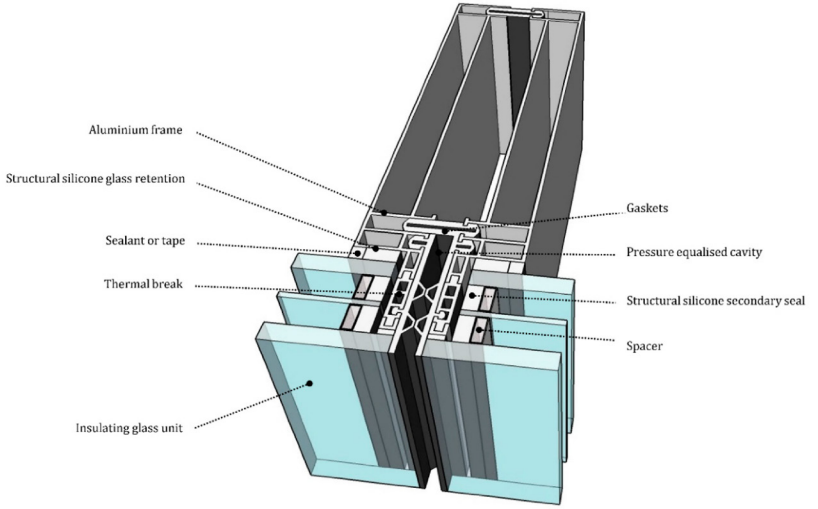


Figure 193 Window connections
(Gargallo, 2021: online)

Green roof

Where the corrugated pitched barn roofs are not used mono pitched green roofs and flat green roofs are used.

A green roof or living roof is a roof of that is partially or completely covered with vegetation and a growing medium, planted over a waterproofing membrane. It may also include additional layers such as a root barrier and drainage and irrigation systems (Özyavuzz, Aytin and Tezgör, 2015: 1).

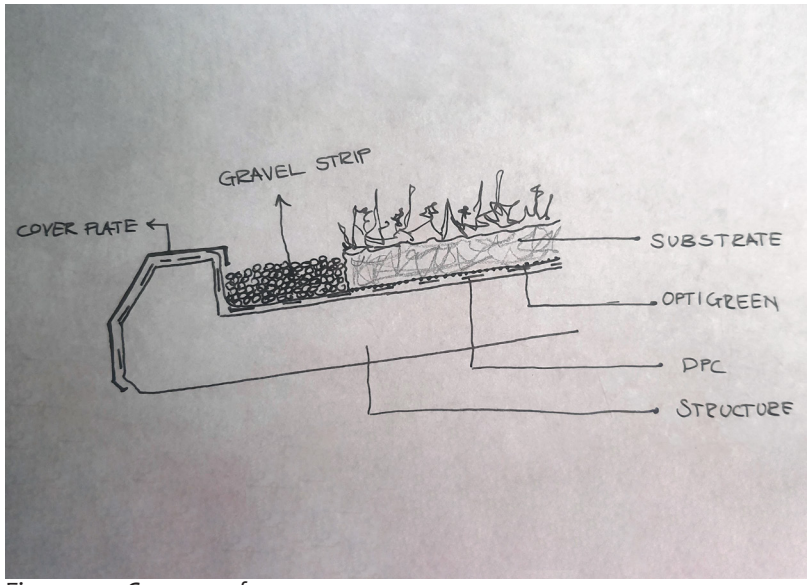


Figure 194 Green roof
(Author, 2021)

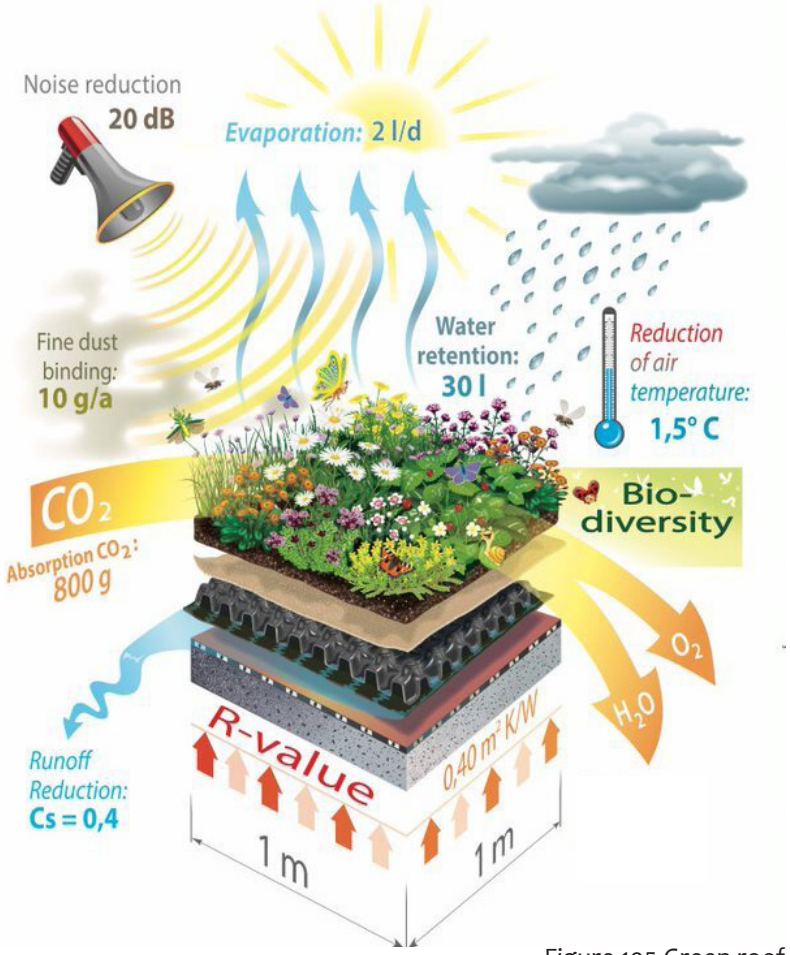


Figure 195 Green roof
(EFB, 2021: online)

Addressing the rain
Gutter systems

There are multiple gutter systems utilized in the design of the aquaponic Lifestyle Farm. Part A mostly uses hidden gutter systems. The down pipe will be placed behind the corrugated cladding.

Secondly regular gutter systems will be used in Part B and C. Instead of using regular downpipes, chains will be utelised to add to the modern industrial aesthetic of the design.

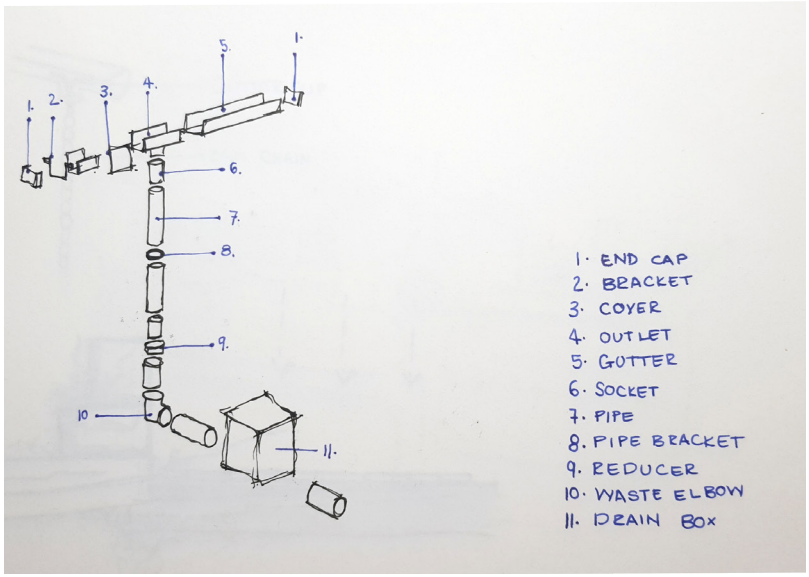


Figure 196 Gutter system
(Author, 2021)

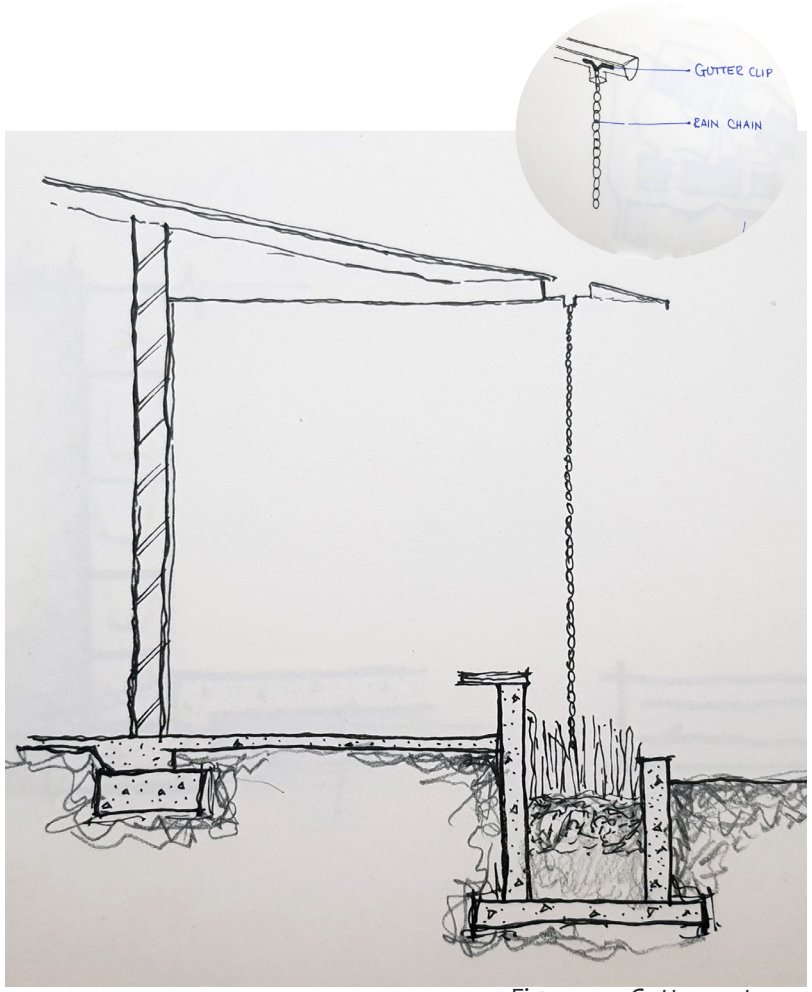


Figure 197 Gutter system 2
(Author, 2021)

Storm water

Biomimicry principles will be applied to the treatment of stormwater. Permaculture principle 2 will also be applied to canalize runoff water to the life style farm's courtyard gardens and orchards. In other words, the stormwater drainage system will mimic the system that can be found in the natural environment. Because the fountain stream flows with the contours, excess water naturally flows away. By enabling the storm water to connect to the fountain stream the water will naturally flow away.

The sucked deck spaces used in Part B and C require a different approach to make sure the water does not flood the design. Propper drainage systems must be laid to allow water to easily flow away.

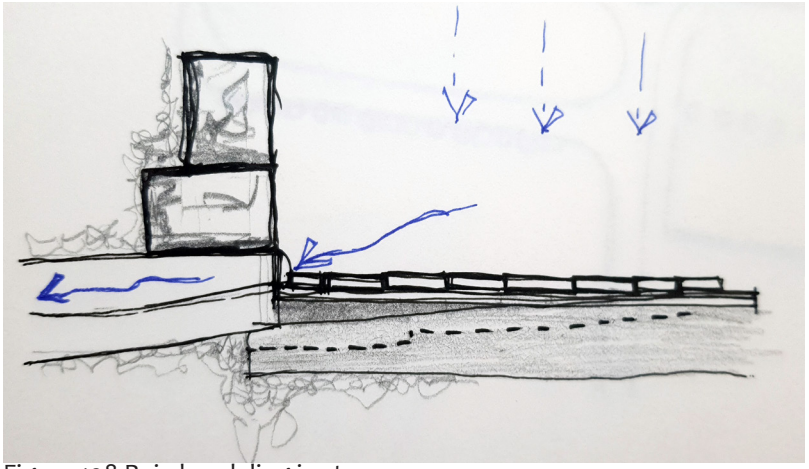


Figure 198 Rain handeling in stoep
(Author, 2021)

Semi-basement constriction

Part A and C are partially underground and thus should be treated for damp control.

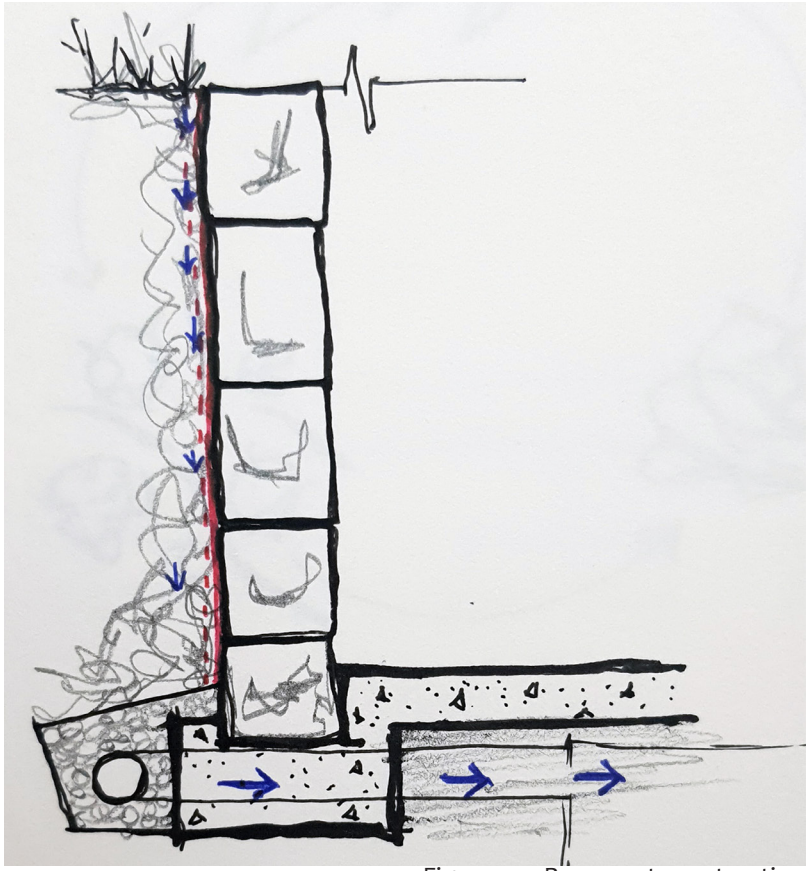


Figure 199 Basement construction
(Author, 2021)

Retaining walls

Due to the sites' slope, retaining walls will be implemented at some locations on site. A retaining wall is a structure designed and constructed to resist the lateral pressure of soil, when there is a desired change in ground elevation that exceeds the angle of repose of the soil. The walls must resist the lateral pressures generated by loose soil.

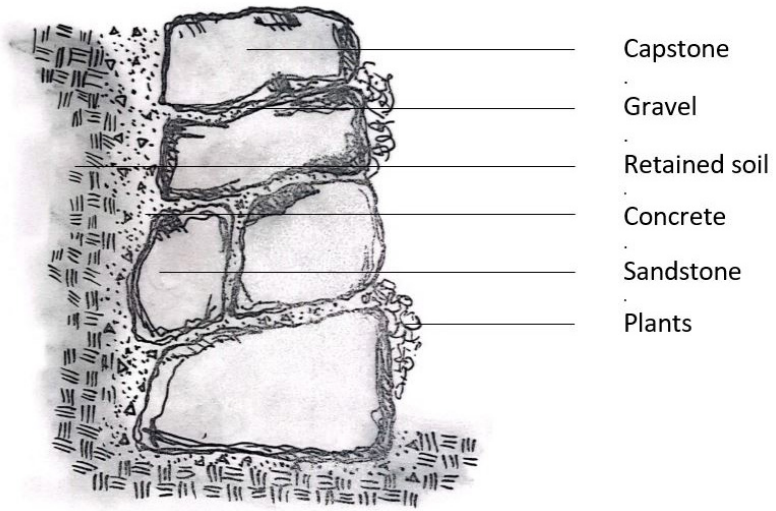


Figure 200 Retain wall
(Author, 2021)

Electricity

The power supply will be connected to Eskom. Solar paneled heating systems will be used to save electricity in the aquaponic fish tanks.

Water

Water supply will be attained from a borehole and the multiple fountains found on site.

Dam construction

Two dams form part of the construction of the aquaponic Lifestyle Farm. The first is constructed from sandstone and the second brick and mortar. Waterproofing the dams is a very important aspect as the dams are in close proximity to the buildings and sandstone is not waterproof for long periods.

The dams will be lined with Casali membrane and then further treated with Stock of Waterblok.

Sewer system

Due to the location of the site a traditional sewer that connects to the municipal services will not be effective. Given the fountain flowing through the site, a French drain system will also not be the best fit due to the possibility of intoxicating the clean water. The best solution identified for the site is a Biorock sewage treatment plant (The Solarzone, 2016: online).

The All-In-One Wastewater Treatment Solution is a sewage treatment plant that is designed for rural dwellings, permanent and seasonal, which are not connected to the main municipal sewage system (The Solarzone, 2016: online).

These extremely compact purification units are completely pre-assembled and ready for quick installation. The MONOBLOCK units are available in 2000 or a 3000 Liters Primary Tanks and available in a Gravity Outlet (Low Outlet) or a Pumped Outlet (High Outlet) (The Solarzone, 2016: online). This treatment plant will be utilised in Part C.

ECOROCK, A Non-Electric Two Stages Wastewater Treatment Plant will be installed in Parts A and B. The ECOROCK unit is a small wastewater treatment plant that caters from 6 to 30 people per application (The Solarzone, 2016: online).

The ECOROCK-system functions as a two-stage treatment plant. The raw sewage first enters a Primary tank to provide pre-separation and initial breakdown of organic solids. The wastewater then passes through an effluent filter before discharging into the BIOROCK unit itself which incorporates the aerobic filtration process (The Solarzone, 2016: online).

Part A and B will each have their own ecorock sewage treatment plant. This system is identified due to the size of the sewage system needed in part A and B.

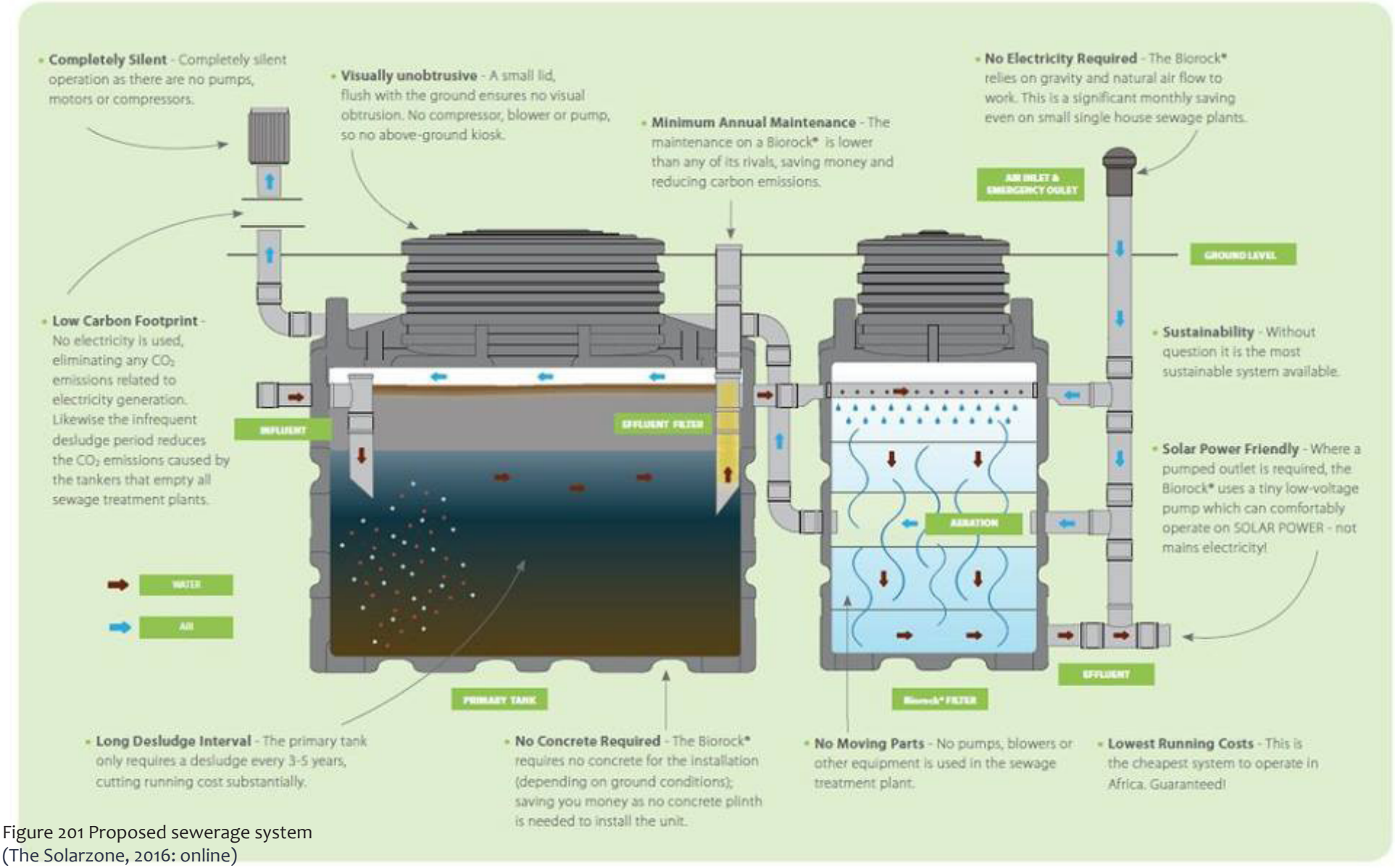


Figure 201 Proposed sewerage system
(The Solarzone, 2016: online)

5.3 DESIGN DEVELOPMENT

Touchstone to concepts to parti

A long road was taken to decide on the layout of the design. The design was predominantly reliant on undergoing constant development, with overall changes and tweaks made during the process. Consequently, the design process saw significant changes in form-giving and detailing relevant to that original idea, with drastic layout changes. The touchstone of the design was the starting point for the investigation and the design methodology.

The main elements kept in mind for the way forward from the touchstone were the backbone themes, namely agriculture and landscape. Agriculture linking with aquaponics and tourism linking with the landscape. Together these two themes became the catalyst for the architectural aim and creating a sense of place in the Eastern Free State.

In the touchstone development certain materials were revealed that could be used for the design, relating to the architectural language of the aquaponic Lifestyle Farm.

Three concepts developed and revealed clues to use in the design. Instead of using one concept and developing it further, all three concepts were combined and developed as a unity, enhancing the qualities each concept revealed.

The first concept, Transpiring the Landscape, revealed the function of the space. By transpiring the landscape information for the design was gathered to design within the context. In this way, the function of the landscape was revealed, which could then be mimicked in the functional design of the Lifestyle Farm to create a synergy between the current place and the space that will be created on it.

With this concept the question of how you look and what draws your attention within the landscape was addressed. The attention towards detail between stereotomic and tectonic structures was revealed. The second concept assisted in the attributes of the materiality of the space, not just in terms of the materials intended to be used for the design of the aquaponic Lifestyle Farm, but also with the particular geographical space the site occupies and its specific attributes. Sanlingaros' biophilic element can be identified in this concept based on the Fractals element, as it links to the encoded geometrical structure on many different levels (Salingaros, 2015: online).

The main idea revealed by applying this concept was to design with the contours on site. This also links to the classical landscape Norberg-Schulz describes. By working with what the site offers a particular interaction with space can be created.

The third concept is based on meaning. Dependant|independent utilisation reveals how a permaculture design, in keeping with the natural processes can be incorporated into the design of the aquaponic Lifestyle Farm. The spider-web-like qualities of the aquaponic Lifestyle Farm create an independent space.

By looking at the framework permaculture provides, a framework for generating and evaluating the site and situation (specific situations that are unique to the aquaponic Lifestyle Farm) for developing a reunion of culture and nature in the Eastern Free State.

To conclude, the following were used from the concepts:

- Light infiltration
- Tectonic vs steriotomic masses
- Transitional spaces
- Light filtration
- Materials
- Site positioning on the contours
- Creating a space in the landscape that creates a site-specific architecture

To achieve a successful design, the design constantly underwent a process of change and development. The initial parti layout was developed and changed and changed again and developed to get a layout that fit within the landscape to create the ultimate sense of place.

The biggest challenge was finding a placement that is sensitive towards the site but that also meets the needs of the future users. By acting with sensitivity towards the site, the site creates a sense of place and gives the opportunity to uncover the meanings potentially present in the environment (Norberg-Schulz, 1980:18).

Phase 1

The Parti was planned to potentially be designed as a long building with a central entrance point dividing the different parts of the plan. The contours identified would shape the layout of the building. By designing with the physical features of the landscape, the user gets access to the opportunity to dwell within the landscape while passing through the built structure (Norberg-Schulz, 1980, 23).

The initial idea was to divide the farm wing (aquaponics) into tectonic structures and then the accommodation into stereotomic structures, creating privacy for the guests. The Deli, Restaurant and Venue space would then be a combination of tectonic and stereotomic structures. The Foyer would acts as a hierarchical focus point.

- During the model building, a realization was obtained that the building is too long and awkward in the landscape.

- The orientation is not as successful as hoped, and the view was obscured for the farm wing and accommodation wing.

- The parti thus needed to change and develop into a more compelling layout and possibly take another route.

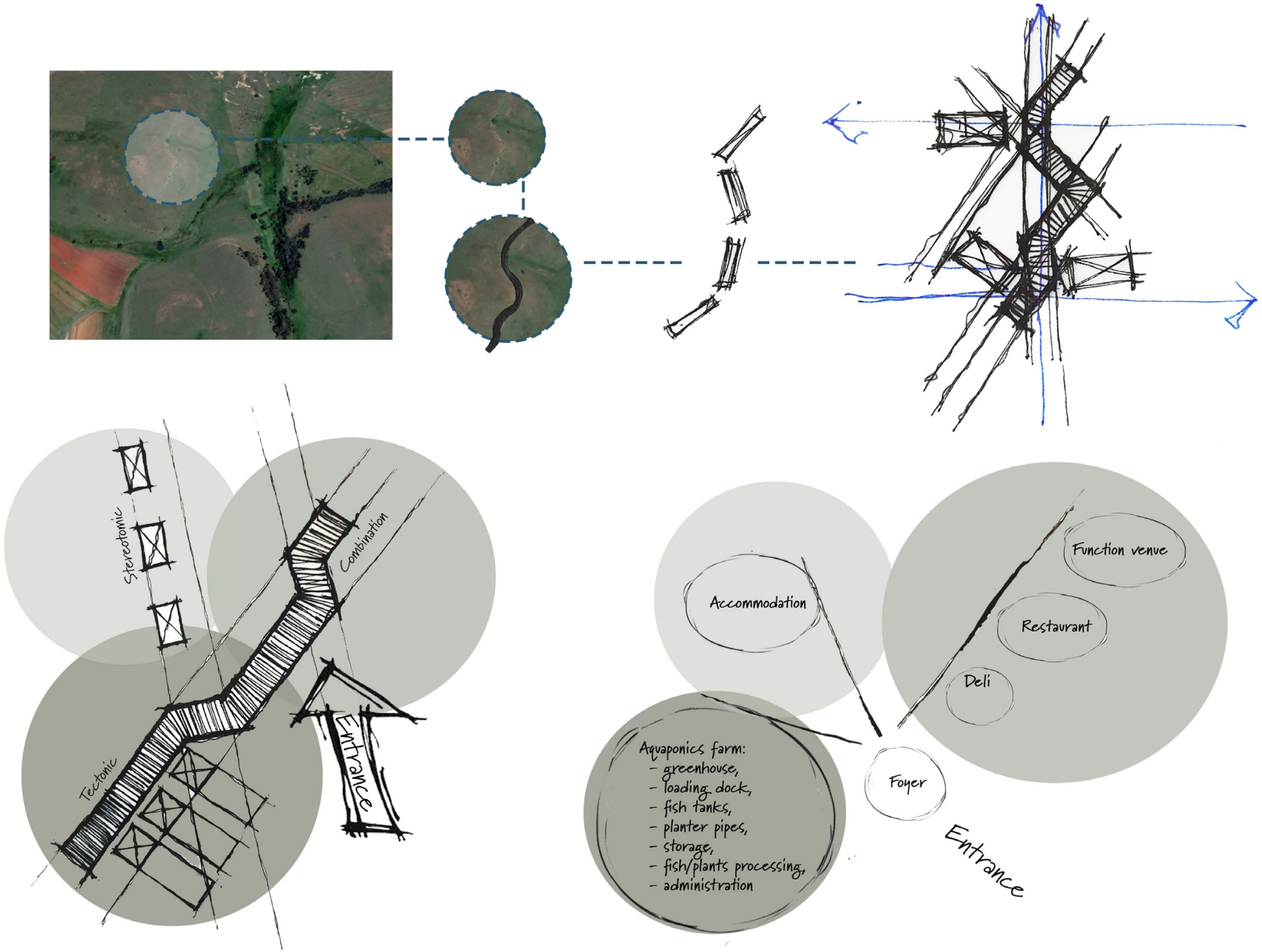


Figure 202 Phase 1
(Author, 2021)

Phase 2
Splitting up the wings
Following this initial parti design, the three wings were split up to form three different functional spaces. The venue space and accommodation were split into separate spaces. The aquaponic farm wing was grouped together with the restaurant and tourist shops creating a public space. As the site is in a classical landscape, an imaginative and articulable order with a logical organization is best suited to relate to the sense of place in the specific landscape type (Farshadi, 2012:13). By splitting up the wings a more logical organization could be achieved, creating a logical flow from the farming section to the venue to the private accommodation.

The layout, however, read as different designs that were not integrated. The scale was not sensitive to the landscape and the scale did not relate well to the different functions of the buildings.
The views from each building were still a problem, as well as the service yards and privacy.

The overall placement of all the buildings did not relate to the site, landscape and environment. The insensitivity to the landscape resulted in a period of pause and reflection and a few steps back had to be taken in order to rethink the design approach based on the original guiding concepts and principles.

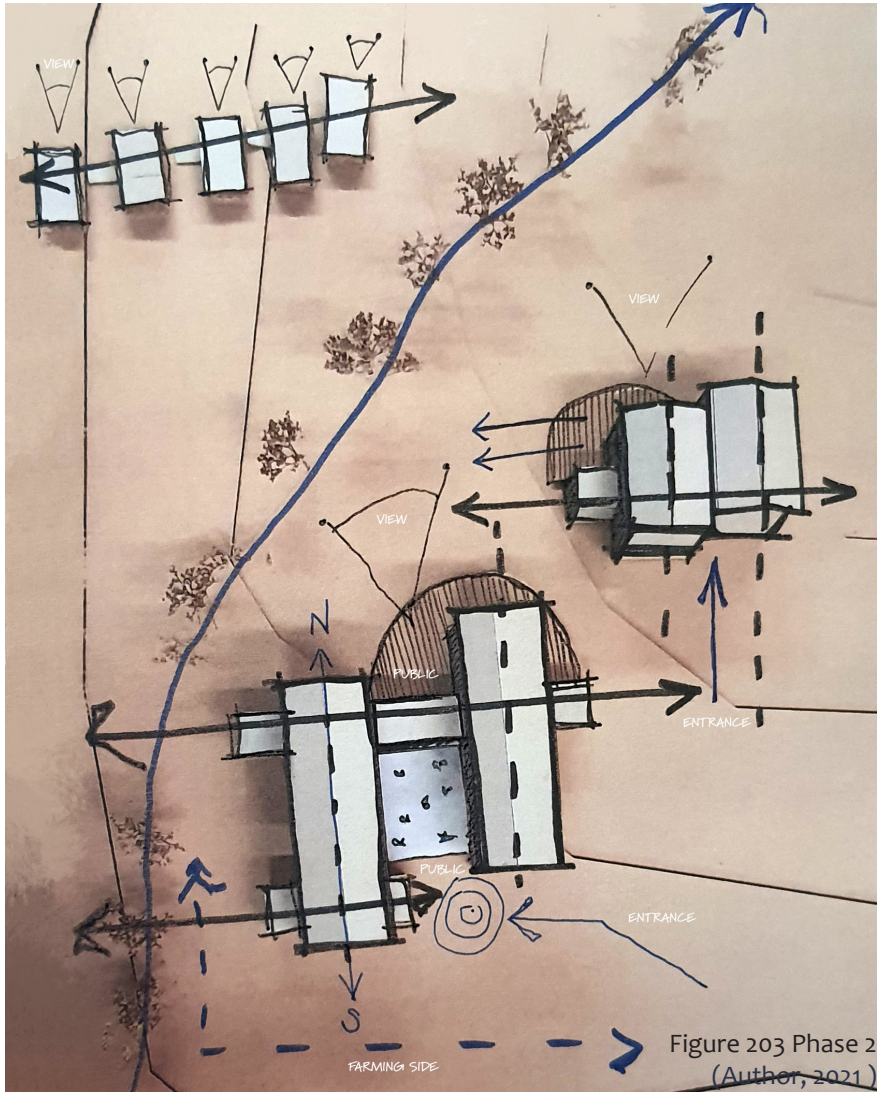


Figure 203 Phase 2 (Author, 2021)

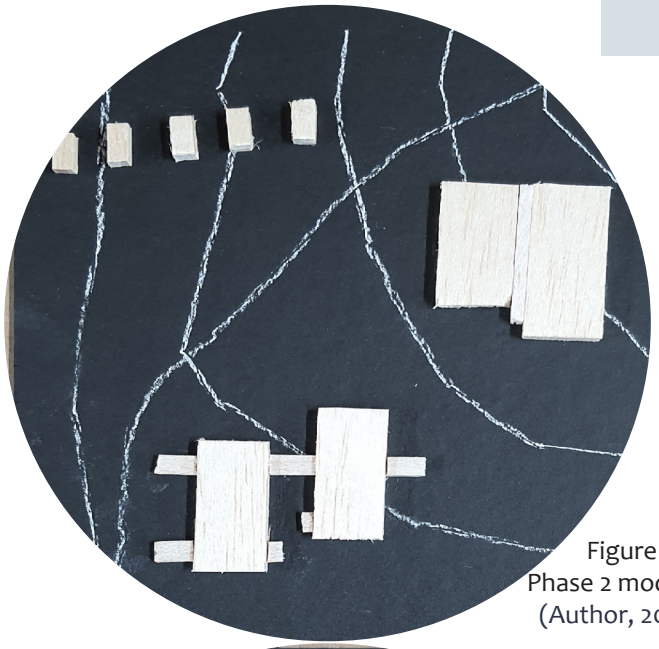


Figure 204
Phase 2 model 1
(Author, 2021)

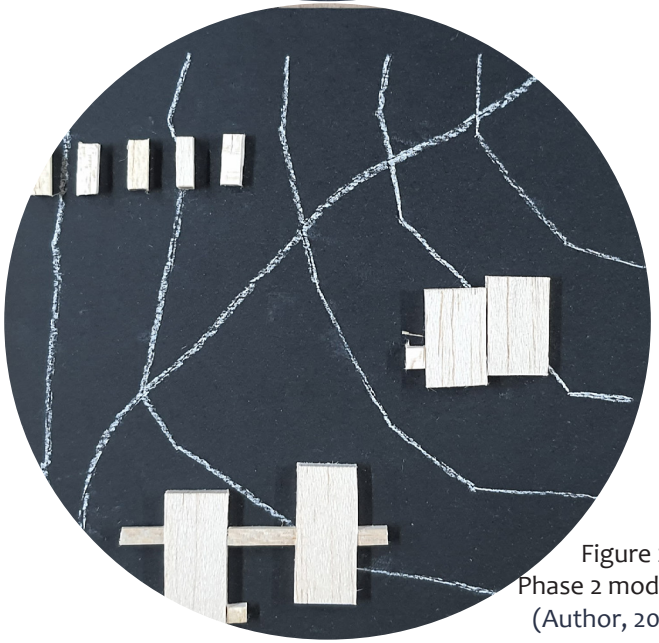


Figure 205
Phase 2 model 2
(Author, 2021)

Phase 3

The design approach moved on and the focus shifted more towards the typical farm design found in the Eastern Free State. During the photo analysis of the farmsteads in the area, a few similarities were identified. By looking at the already established architectural language that is articulated by the surrounding farms, a better grasp of language for the design in the specific landscape was ascertained.

In the traditional approach to farmstead design, the placement of the buildings on the site is not conducted according to a formal plan, instead it unfolds organically as buildings are added according to the user's need (the farmer), adding layers of function and form to the space. By studying this approached a link can be made between The Barn House precedent and the design of the aquaponic Lifestyle Farm. Yard spaces, or "werwe" as they are colloquially known, can thus be found in-between the buildings.

When approaching a farm, the entrance is usually from the backdoor, creating a casual feeling. When looking at the farmsteads of the different farms in the area, it was observed that each house has a big stoep overlooking the farm. The farmhouse of Lusthof, as mentioned, is a clear example of the vernacular style of the stoep, designed to suit the indoor/outdoor lifestyle typical of the Eastern Free State environment.

Taking the similarities into account and how the buildings will sit on-site serval layouts were investigated to find different ways of acting more sensitively towards the landscape. A classical landscape makes use of light and shadows to emphasise the parts and the whole (Farshadi. 2017: 13), thus the focus here is on designing a space which emphasizes each part of the design while also reading as being in union with the landscape.

Several design challenges were deduced during this stage of the design process:

- Design a building with multiple front facades
- Enhance the design of a stoep
- How will the in between spaces be designed, creating "werwe" or courtyard spaces.
- How to change the homestead typology to be reminiscent of that found on Lusthof, in other words, a typology that fits in with the design of the aquaponic Lifestyle Farm as well as the larger surrounding area.

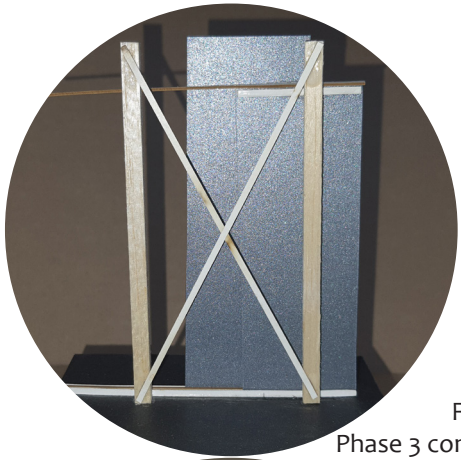


Figure 206
Phase 3 construction
(Author, 2021)

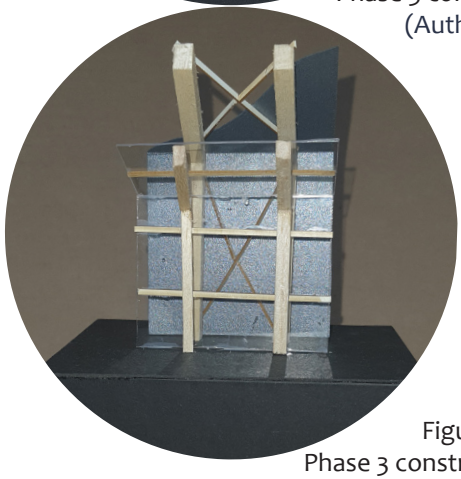


Figure 207
Phase 3 construction
(Author, 2021)

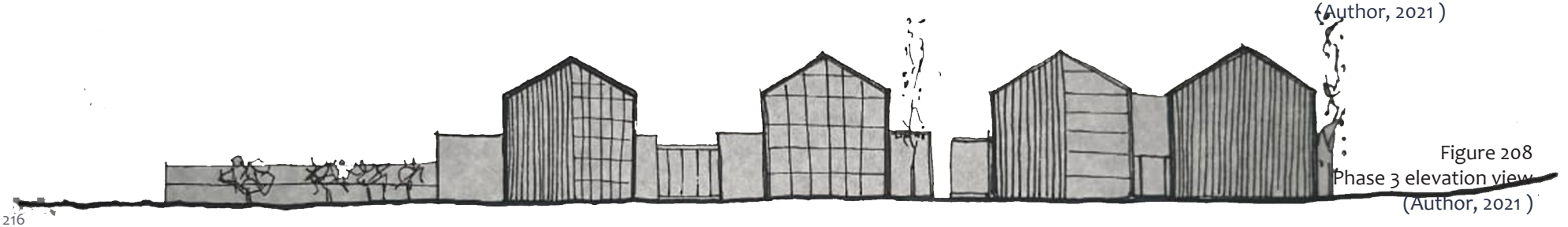


Figure 208
Phase 3 elevation view
(Author, 2021)

Phase 4
The idea of in-between spaces between the buildings created "werf" spaces. The contours were considered once again with a focus on how the buildings would be placed in the landscape. Big deck spaces were created for "stoep" spaces. The possibility of one single wall linking the entire design was revisited from phase 1. At some points, the wall disappeared and at other points became a functional wall forming the service yards and feature walls in some buildings.

This layout still had problems to resolve
The accommodation was still awkwardly placed, looking like an afterthought, the shape of the buildings was irregular, creating odd-shaped roofs.

The main aquaponic building did not connect to the language that the other buildings were attempting to reveal.
On the planning side of the building, the service spaces were a problem in terms of accessibility.

The main entrance of the scheme was not planned to fit in with the idea of entering from the backdoor, in other words in keeping with the kind of informal main entrance typically found in the area.

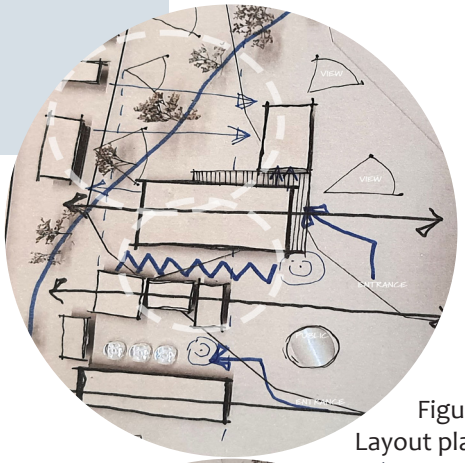


Figure 209
Layout planning
(Author, 2021)

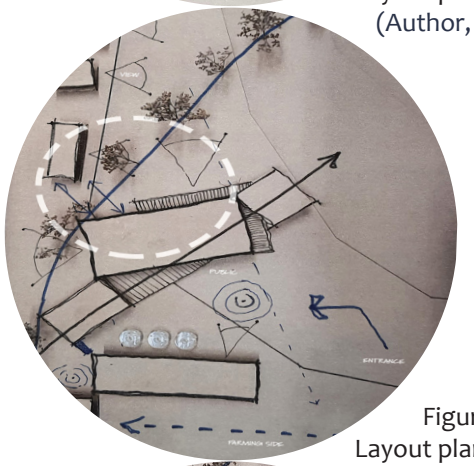


Figure 210
Layout planning
(Author, 2021)

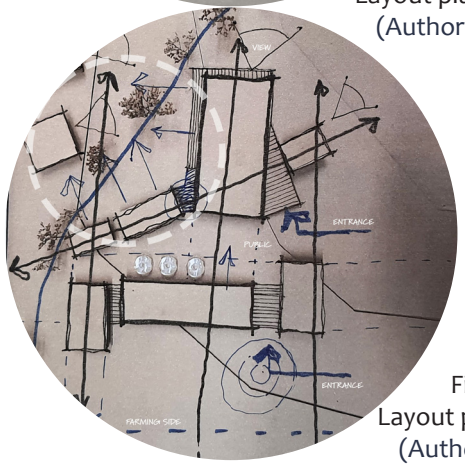


Figure 211
Layout planning
(Author, 2021)

Phase 5

The idea developed further, and a more evolved version of the layout was developed. By changing the irregular shaped buildings, a more authentic feel could be achieved. Stoep spaces were integrated with the buildings creating breakaway space throughout the design and establishing a connection point with the landscape.

By moving the dam (fish tank) to the in-between space of the werf, the dam not only functions as the aquaponic farm, but also becomes a feature point for the in-between spaces, linking tourism and agriculture to enhance the sense of place.

Instead of designing the main entrance, the idea of multiple entrances for each building was investigated, with the cement dam as an orientation point.



Figure 212
Concept model
(Author, 2021)



Figure 213
Phase 5 render
(Author, 2021)



Figure 214
Phase 5 render
(Author, 2021)



Figure 215
Phase 5 render
(Author, 2021)

Saint Mark Square

Saint Mark Square in Venice acts as a precedent for this approach. The geometry and organization of each object reveals a direction and amplitude upon the radiance. The direction is legible in the geometry of the volume of the modulation of its façade. The amplitude can be seen as an act of appreciation (Meiss, 2011:96). The "L" shape of the square creates a difficult entrance for the buildings found in the square creating a spatial weakness. By adding additional objects, articulation is improved. Each building is given a hierarchy point to draw the visitors eye towards the buildings.

The idea is to create points of attraction towards that will create a sense of flow through the different functioning buildings that together comprise the aquaponic Lifestyle Farm. The visitor first gets orientated by the cement dam when approaching from a distance. Once the visitor has parked, the eye gets drawn to the main façade of the scheme. A long water feature leads visitors to the "Werf" space, where different hierarchy points are mapped out.

The first hierarchy point shows the entrance to the aquaponic farm. The second hierarchy point reveals the restaurant, and the third is the venue space. This more informal and self-orientating entrance approach connects with the idea of entering from the backdoor.

The service yard for each building is designed to be hidden from the public, yet easily accessible for service vehicles.

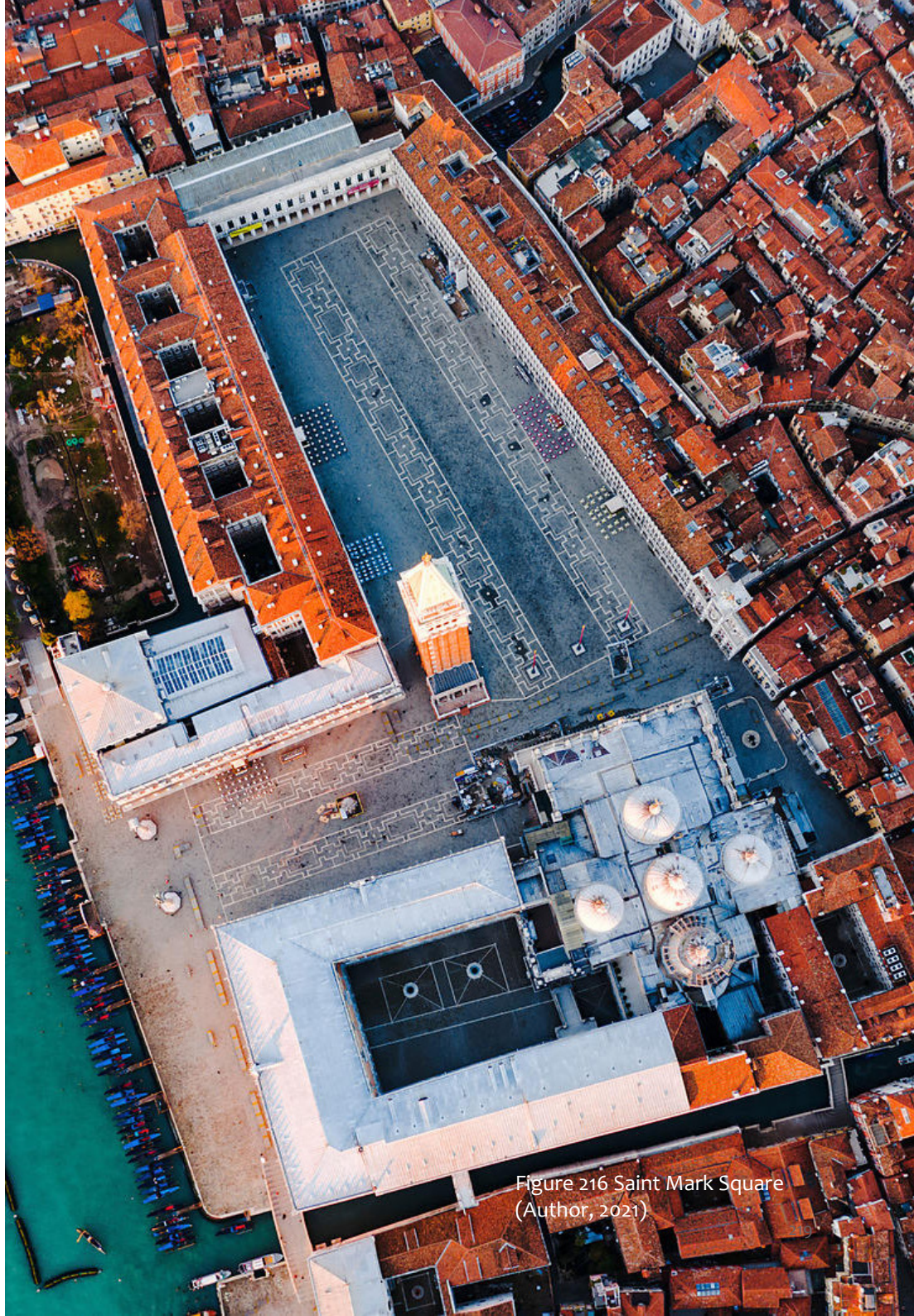


Figure 216 Saint Mark Square (Author, 2021)

Phase 6

Permaculture is a design system that develops and applies the ability to discern the patterns that structure natural and human systems and generate new patterns that weave the human and natural world together into a dynamic whole (Mang & Reed, 2012: 12).

The first principle addresses how one interacts with and observes nature. The entire accommodation wing was moved to the East, creating a better view for each accommodation unit and the restaurant/ venue space.

By moving the accommodation, a better link was formed to the landscape. A sense of public and private spaces could also be established by moving the accommodation units to the east.

- Service yards remained a problem.
- The parking was too formal for a farm typology.
- The accommodation units read as urban units not emphasising the views the terrain offers its users.
- The processing side of the Aquaponic farm lacked proper service passages that could be easily followed.

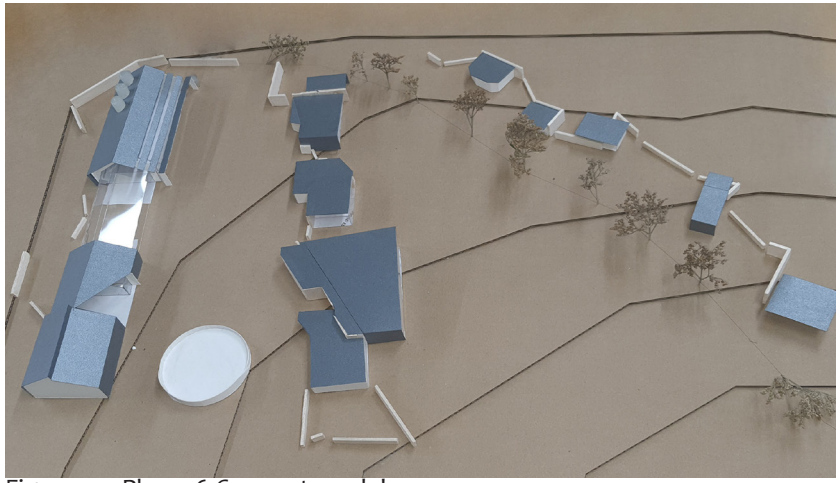


Figure 217 Phase 6 Concept model
(Author, 2021)



Figure 218 Phase 6 plan of dam
(Author, 2021)

Phase 7

At this stage a critical reflection on the design was taken. By investigating the function of each wing, a proper accommodation list was created for each part of the building. This took into consideration how the workers would interact with each part of the design and the experience they would have of the space. The experience from the visitor's perspective was also considered in terms of their use of the spaces. Most essentially, it was considered whether visitors would truly feel a sense of place when visiting the Lifestyle Farm.

From this vantage point, the aquaponic Lifestyle Farm expanded into a more user-friendly building from the workers' perspective and the visitors' perspective creating a better experience for the building's overall users.

Although the plan created a better flow from the process driven point of view, the language of the buildings did not change according to the viewpoint and experience of the designer.

Phase 8

During this phase, a step back was taken and the initial aim of the design was revisited so that a clear view of what the building wants to be (Heidegger, 1971: 149) could be better formulated. The aquaponic Lifestyle Farm is a building that wants to create a sense of place for its users whether they are permanent or temporary users. In addition, the building wants to enhance the classical landscape and be site specific.

The specific landscape reveals certain clues that can be related to the design, thus reacting to the sense of place. Farshadi (2017: 12) mentions attributes of a classical landscape that can assist in understanding the classical landscape, including the coherency and natural order of the landscape.

The aquaponic Lifestyle Farm's natural order and coherency relates to overall elements connecting each part as a unity to the landscape. Further, this will allow the entire design will be anchored in the landscape. The Logical organisation is created by dividing the different functions of the design into parts.

A classical landscape does not only make use of static or dynamic shapes (Farshadi, 2017: 12). The aquaponic Lifestyle Farm introduces organic shapes and forms as a design element that act as connection points between parts A, B, and C. Together with this organisation and use of shapes a good composition of individual elements is established. This can be seen in the way the accommodation units are handled.

By combining the topological and geometrical properties of the site, a site-specific design is created that not only creates a sense of place but also reacts to the language of critical regionalism, the progressive approach to design architecture that seeks to mediate between the global and local languages around the site.

As the Gestalt interaction of the three essential components create a desirable sublime and subconscious of human and emotional response a sense of place can be created that is in harmony with the landscape and the users.

The whole place is greater than the sum of its constituent parts and thus speaks to our subconscious in a language, not of words, but the universal emotive language each being understands (Slocombe, 2018: online). As mentioned, the physical attributes are founded in materialism, the function is founded in objectivity, and meaning is founded in essence (Slocombe, 2018: online).

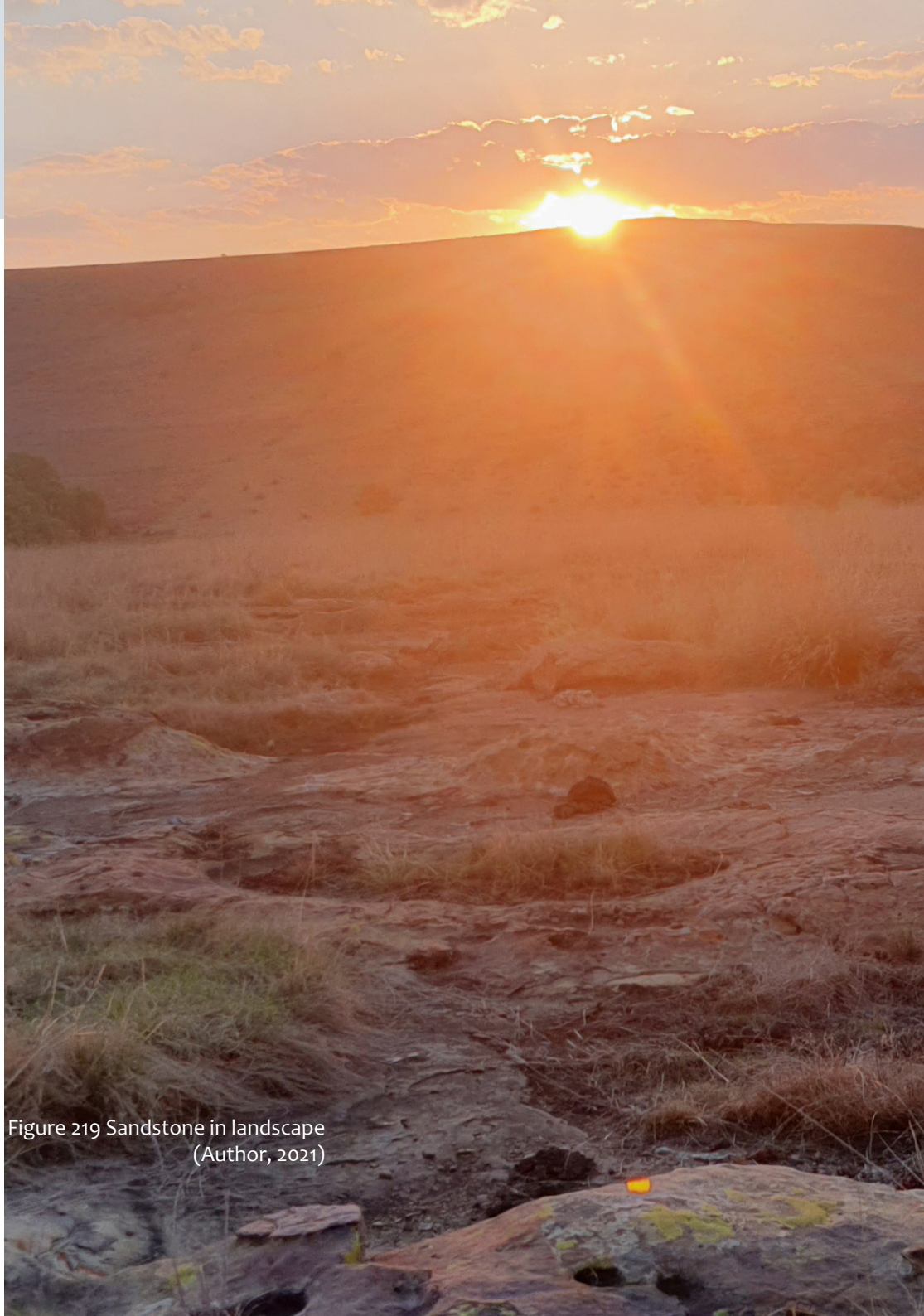


Figure 219 Sandstone in landscape
(Author, 2021)

The physical attributes used in the aquaponic Lifestyle Farm can be divided into materials. Hard building materials connect a space to the geographical and historical environment making the building site and region specific. The identified materials as mentioned during the in the vernacular precedents of Lusthof house and Weltevrede barn/shed are sandstone and corrugated roof sheeting/ cladding a steel frame construction.

Secondly, the soft materials are found around the hard materials. By making use of local plants, a site-specific sense of place can further be enhanced. During the micro analysis different plants found at the site were identified. Indiginous plants will be used exclusively in the landscaping of the courtyard spaces, except for the use of lavender which, although not indigenous, has become a hallmark of the Eastern Free State and therefore is in keeping with the aesthetic of the broader area. The pleasant smell from these bushes will also enhance the biophilic experience of guests as they dwell on the courtyard paths.

By designing courtyard spaces, the site specific natural landscape is drawn into the design. Instead of designing formal courtyard spaces the aquaponic Lifestyle Farm makes use of these soft materials and a naturally-occurring experiences.

The fountain flows through this space, playing with the senses. The pathways through the courtyard are sandstone blocks, referencing the stonework that is typical of the area and which is found penetrating the soil as one treks across the landscape. These elements allow visitors to constantly experience and indirectly interact with the landscape all around them.



Figure 220 New proposed courtyard
(Author, 2021)

Instead of formal parking bays, informal parking was demarcated using stone and grass in the landscaping of the parking space. This references the kind of parking that would typically be found on a farm and means that the parking space can easily be adapted and expanded should more parking be required. This informal approach is typical of the kind of parking arrangements found at festivals where parking spaces expand and contract as demand rises or falls.



Figure 221 Proposed parking
(Author, 2021)

The courtyard spaces support permaculture principle 8 - integrating rather than segregating. The correct placement of animals, plants, earthworks and infrastructures can develop a higher degree of integration and self-regulation without the need for constant human input in corrective management. Therefore plants, animals and people will gain benefits from these relationships. At the proposed lifestyle, farm plants will be arranged in patterns that can catch water, filter toxins, absorb nutrients and sunlight, and block the wind. Particular associations of trees, shrubs and ground covers, known to nourish and protect one another, will be clustered together.

The function of the aquaponic Lifestyle Farm can also be divided into parts A, B and C.

- Part A's function is to grow plants and fish and to educate the visitors by teaching them how aquaponics work.
- Part B's function is to create an experience of reflection from what one has learned in part A by buying the products from the store and enjoying the restaurant with the view of the landscape.
- Part C's function is to relax and enjoy the landscape.

Kellert's 6 elements and 14 patterns of biophilic design play an important role in the planning and decision-making for the aquaponic Lifestyle Farm. By designing with nature, nature can promote well-being and a sense of place (Marchese, 2021: online).

Section 2.4 of this report covered the 6 biophilic design principles. From these principles important attributes are identified that are utilized in the design of the aquaponic Lifestyle Farm.

Environmental features play a role in what characteristics are used from the gathered information during the site analysis. Elements that were identified for consideration in the design of the aquaponic Lifestyle Farm include:

- How the sunlight penetrates each building and creating passive solar systems
- The choice of plants used in the design
- Natural colours found on site that can aid in creating a colour scheme for the design.
- Reacting on the soil conditions for the construction process- type of foundations to use.
- Natural materials that create an indigenous design.
- Lastly, using the natural water sources in the design.

Light and space

- Each space has a different function and space. It is thus important to design so that the poetics of each space gets revealed.
- Creating different sculptural qualities with shadows like on the patio spaces.

Place-based relationships

This element is directly linked to the distinctive geographical characteristics of the Eastern Free State and the materials that can be drawn from it, namely sandstone.

By designing with nature emotional experiences are achieved through the creation of meaningful, direct connections with natural elements. visual connection with nature is achieved with the fountain flowing naturally through the courtyard space and passing the accommodation units in Part C.

The aquaponic Lifestyle Farm address the human connection to the natural environment by locating living and working areas next to a window overlooking the landscape, like the kitchen featuring a north-facing window. A variety of animals, birds and insects will be part of the proposed Lifestyle Farm, creating breakaway spaces enriched by the landscape.

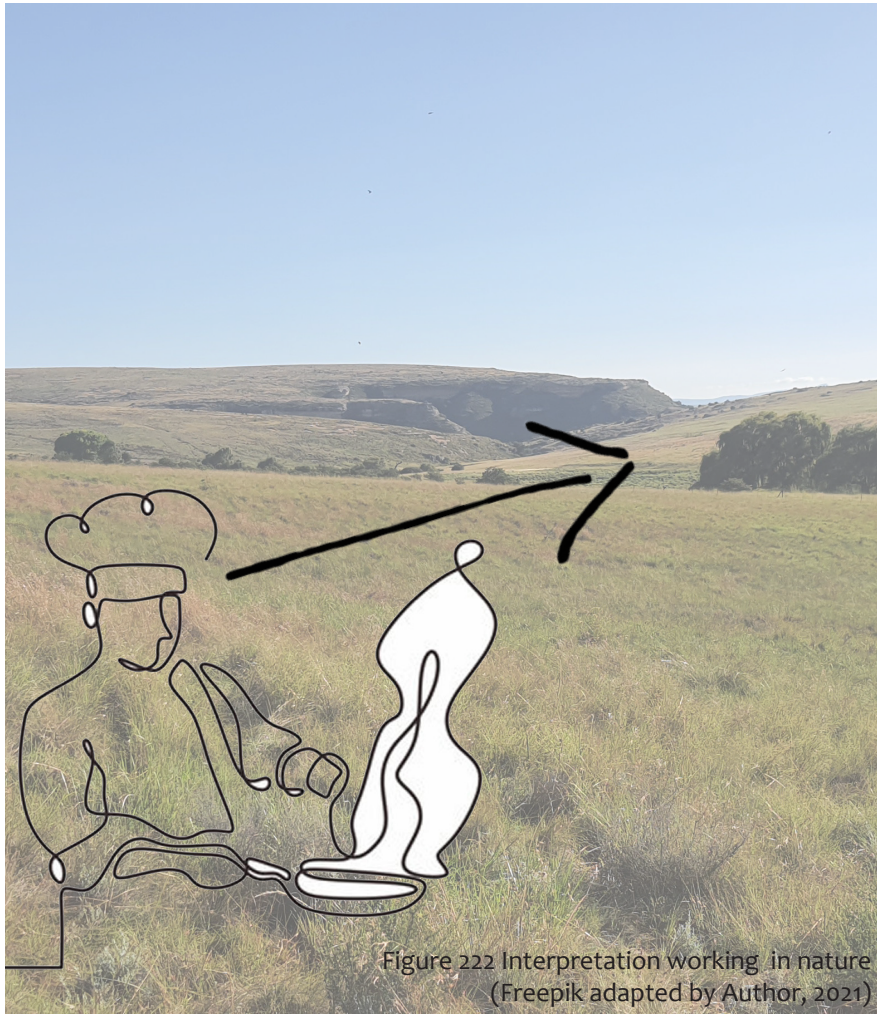


Figure 222 Interpretation working in nature
(Freepik adapted by Author, 2021)

Non- visual connections with nature are achieved when an opportunity is created for learning. The principle of 'non-visual connection with nature' can be applied to the design for people visiting the farm to touch, smell and taste the plants from the production line.

In addition, visitors to the Lifestyle Farm will also be exposed to different textured materials (stone, wood, steel), sun patches, natural ventilation (open windows and breezeways), the sound of water, smelling flowers and sensing the movement of crackling fire/fireplace (winter) within the space.

Non-rhythmic sensory stimuli differs from a non-visual connection with nature in that it is inclusive of all sensory systems and is most commonly experienced at a subconscious level through momentary exposure that is not typically sought out or anticipated (Browning et al., 2014: 29).

The principle of non-rhythmic sensory stimuli can be applied to the proposed design for people visiting the Lifestyle Farm who will be exposed to cloud movements, breezes, plant life rustling, water babbling, birds chirping, insect and animal movement and fragrant plants. In addition, the garden will be designed to provide enough shadows or dappled light that will change with movement or time for the visitors.

Thermal airflow is created in the passive solar systems included in the design. As already mentioned, water plays a tremendous role in the design. Dams and fish tanks contribute to calming atmospheres. People visiting the Lifestyle Farm will be able to see, hear and even touch the water.

The visitors will be able to observe the aquaponic fish tanks as part of the proposed design. The principle of dynamic & diffuse light will be applied to the proposed design for pergolas on the stoep area which will be utilized to create dappled shadows as mentioned.

The aquaponic Lifestyle Farm will make use of rainwater harvesting systems to create an awareness of water scarcity. The landscape and gardens will join people to the seasons and the changes during natural life cycles.

Using native plantings on the site—those that grow and die with the seasons—will further help connect people and nature. Therefore, the principle of 'connection with natural systems' for example will be a large part of the proposed design.

Big Little Rock

A precedent that assists in incorporating nature into the design is the Big Little Rock, 2014, by Minarc Architects. Big Little Rock was shortlisted for the SBID International Design Awards 2013. Residential Sector. Category: Intelligent Design (Minarc, 2014: online).

Big Little Rock is situated in Iceland, where summers are filled with endless sun while the winters are very cold, snow-filled and dark.

Big Little Rock is a modest house designed to blend into the beautiful Icelandic natural landscape. It is intended for use as an easy lifestyle vacation home or all year-round family home. It features simple eco-conscious design that focuses on functionality and creates a healthy living environment for visitors/ family. Big Little Rock is designed to integrate with the landscape and blends in with the 'body' of the natural environment.

Natural materials are used in their most organic form to reduce their environmental impact on the natural surroundings. Further, the design also embraces history by incorporating forms found in traditional mud houses and the sod roof and walls form the solid building. Sustainable design practice has been implemented using recycled materials such as rubber tires that are used on the kitchen wall (Minarch, 2014: online).



Figure 223 Big Little Rock (Minarc, 2014: online)



Figure 224 Big Little Rock (Minarc, 2014: online)



Figure 225 Big Little Rock (Minarc, 2014: online)



Figure 226 Big Little Rock (Minarc, 2014: online)



Figure 227 Big Little Rock (Minarc, 2014: online)



Figure 228 Big Little Rock (Minarc, 2014: online)

Big Little Rock uses open design features that are naturally established by uniting concrete, wood, and glass. Openings and large and expansive windows are used in the living area to provide abundant natural light and frame the beautiful landscape and enable a seamless connection with nature.

This helps filter in the natural features of the Icelandic seasons by allowing light to infiltrate into the space during the summers that are filled with endless sun while during the winter the glow of the Northern Lights reflected from the bright snow is invited into the home (Minarch, 2014: online).

Design application

The proposed design will aim to create the same integration with the landscape by blending with the environment. In the accommodation section of the development large and expansive windows will also be used in the living areas, bedrooms, and bathrooms to provide abundant natural light and to allow nature to be visually drawn into the building.

The proposed design will also open-up into the natural landscape and utilize the same materials (wood and glass) as the precedent, but sandstone will be used instead of concrete. The climate conditions of the precedent and

proposed design correspond, namely sunny summers and cold winters, although the site enjoys more daylight hours which will allow natural light to filter into the accommodation spaces year-round.

The nature of space is revealed in the design by including elements that can create a prospective space that reveals picturesque beauty of the landscape. The idea of focusing on the view created the opportunity to rethink the accommodation units.

If one visits the aquaponic Lifestyle Farm the focus will be on the view, allowing the visitor to experience what the landscape reveals and offers. Instead of designing a unit that could potentially be found and function anywhere, like in the city, this design is landscape-led and responsive to the environment and thus the form and function is unique to the piece of land each unit is placed on. By sinking the building into the landscape, the building and the landscape become one.

Green roofs allow the building to further blend into the landscape. By opening the entire northern façade, the view can be experienced from the living space to the bathrooms and the units benefit from natural light year-round.



Figure 229 Big Little Rock
(Minarc, 2014: online)





Figure 230 Big Little Rock
(Minarc, 2014: online)



Figure 231 Big Little Rock
(Minarc, 2014: online)



Figure 232 Dullstroom home
(Dook, 2016: online)



Figure 234 Dullstroom home
(Dook, 2016: online)

Studio's Dullstroom home

A precedent assisting in understanding how the building can become one with the landscape in the design is W Design Architecture Studio's Dullstroom home design which truly captures the elements of biophilia.

Dullstroom, situated on the Steenkampsberg mountain range, is one of the most elevated towns in South Africa, at 2100m above sea level. It is well known for its sub-alpine climate and cool, often misty atmosphere. Walkersons farm is situated in a beautiful valley 10km's East of Dullstroom. The landscape can also be typified as being classical in nature and is dominated by rocky hillsides and slightly undulating terraces and plateaus, punctuated by clear streams, quiet lakes and thundering waterfalls.

The site on which the precedent is located has a gentle slope towards the Lunsklip river and various dams and lakes on its Eastern boundary. Together with the majestic views, the grassed landscape of the valley formed the conceptual departure points for the design of this house. These natural elements, the inspiration found in 'the great outdoors' and the idea of creating an escape from a busy urban life, were used to shape this weekend home. The conceptual idea and inspiration were to merge the landscape with the architecture - the natural with the human.

The owners associate strongly with Frank Lloyd Wright's idea of the Prairie Style which was born out of his belief that we needed fewer, but larger rooms which flow more easily into one another. His design philosophy is in antithesis to the rigid, confined and closed-in Victorian era architecture. In this design the architectural form consists, essentially, out of the 'liberated' barn like living room structure and two native stonework boxes housing the bedrooms. The playful philosophy of lifting the carpet or rug of the natural veldgrass and placing the bedrooms underneath ensures that these 'above ground, earth covered structures' provide the cosy shelter associated with a mountain cottage while still allowing a contemporary perch with panoramic connections to the landscape from all areas of the home (ArchDaily, 2020: online).

All functions are positioned along the natural contours of the site, keeping the built form as low profile as possible and thus in effect allowing the landscape to eventually cover and merge with the man-made forms. The absolute focus for these spaces - part building, part landscape - is to celebrate and be aware of the fantastic natural surroundings and views. As the indigenous vegetation and natural beauty recovers over the next few summer seasons this home will be allowed to seamlessly adapt and fuse with its natural habitat (ArchDaily, 2020: online).

"No house should ever be on a hill or on anything. It should be of the hill. Belonging to it. Hill and house should live together each the happier for the other."- Frank Lloyd Wright
(Published on April 17, 2020)



Figure 235 Dullstroom home
(Dook, 2016: online)



Figure 229 Dullstroom home
(Minarc, 2014: online)



Figure 236Dullstroom home
(Dook, 2016: online)



Figure 237 Dullstroom home
(Dook, 2016: online)



Figure 238Dullstroom home
(Dook, 2016: online)



Designing with the theory of biophilia in mind a new characteristic was revealed, creating a design that is more sensitive towards the site and its placement within the landscape. By linking permaculture to the design, a more sustainable design can be created that not only address environmental problems but also creates a sense of place visitors want to experience.

Design application

The proposed site also has a gentle slope towards the fountain and majestic views into the grassed landscape that form the basis of the conceptual departure point for the design of the accommodation units. The concept of merge the landscape with the architecture was also adopted from the precedent and will be incorporated into the design.

All the functions of the proposed design will also be positioned along the natural contours of the site. The proposed accommodation units with green roofs will be sunk, in effect allowing the landscape to eventually cover and merge with the man-made forms. As with the Dullstroom precedent, the focus here will be on celebrating to potential of the human-made buildings and the landscape to integrate into a single form from the outside while highlighting the fantastic surrounding views from the interior of the accommodation units.

MAIN BUILDING PERSPECTIVE



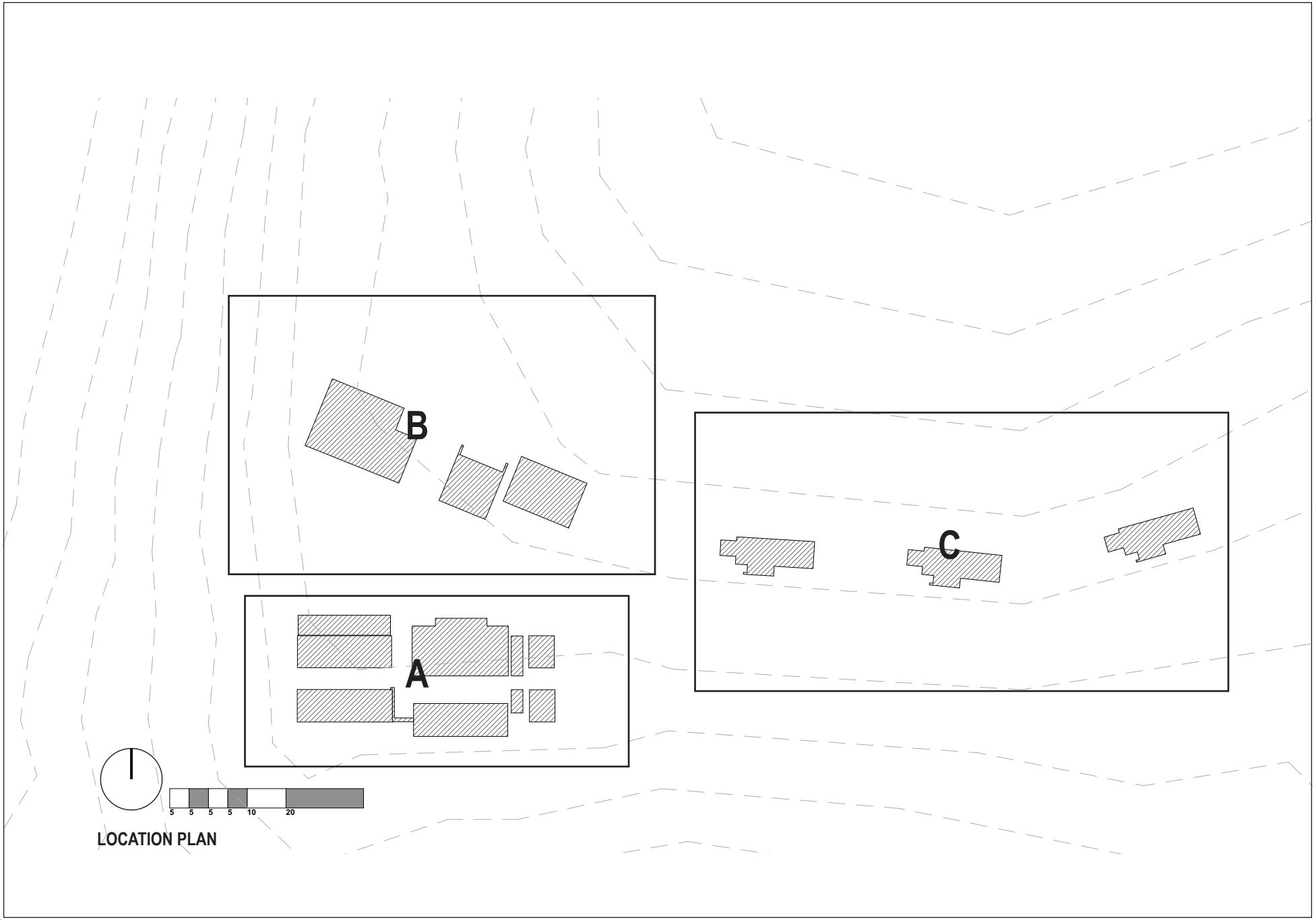
5.4 FINAL DESIGN SOLUTION



AERIAL VIEW







LOCATION PLAN

SCHEDULE OF AREAS

GROUND FLOOR LEVEL

Block A

Greenhouse	346
Reception	55
Orientation space	55
Administration	206
Aquaponic plant	1 206
Aquaponic plant	2 206
Total	**1073**

Block B

kitchen +	
Restaurant/ Venue	446
Shop & Deli +	107
Wc Public	97
Cocktail Lounge	170
Total	**824**

Block C

Unit 1	145
Unit 2	145
Unit 3	145
Total	**434**

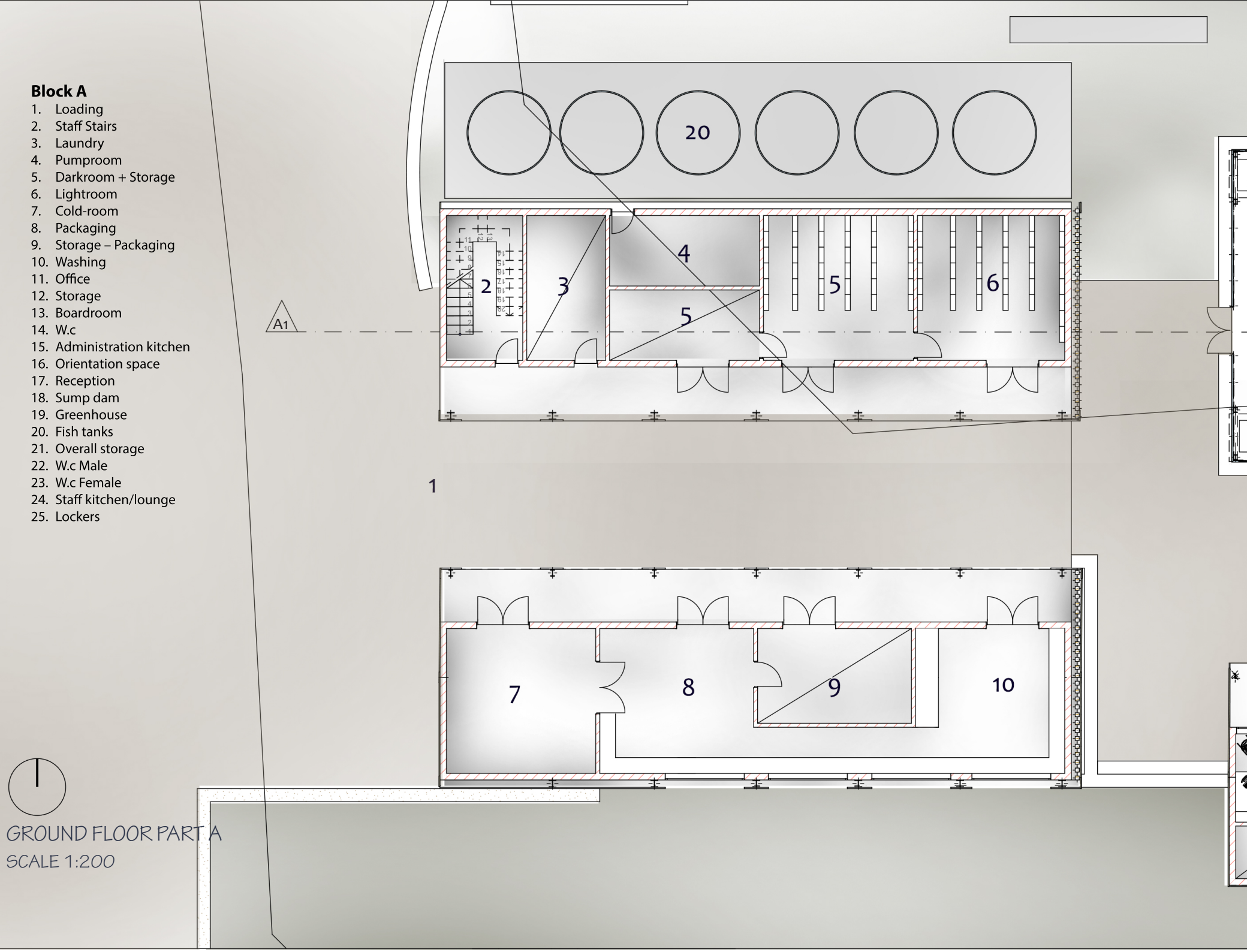
FIRST FLOOR LEVEL

Staff Breakaway Room	**200**

Total	**2531**

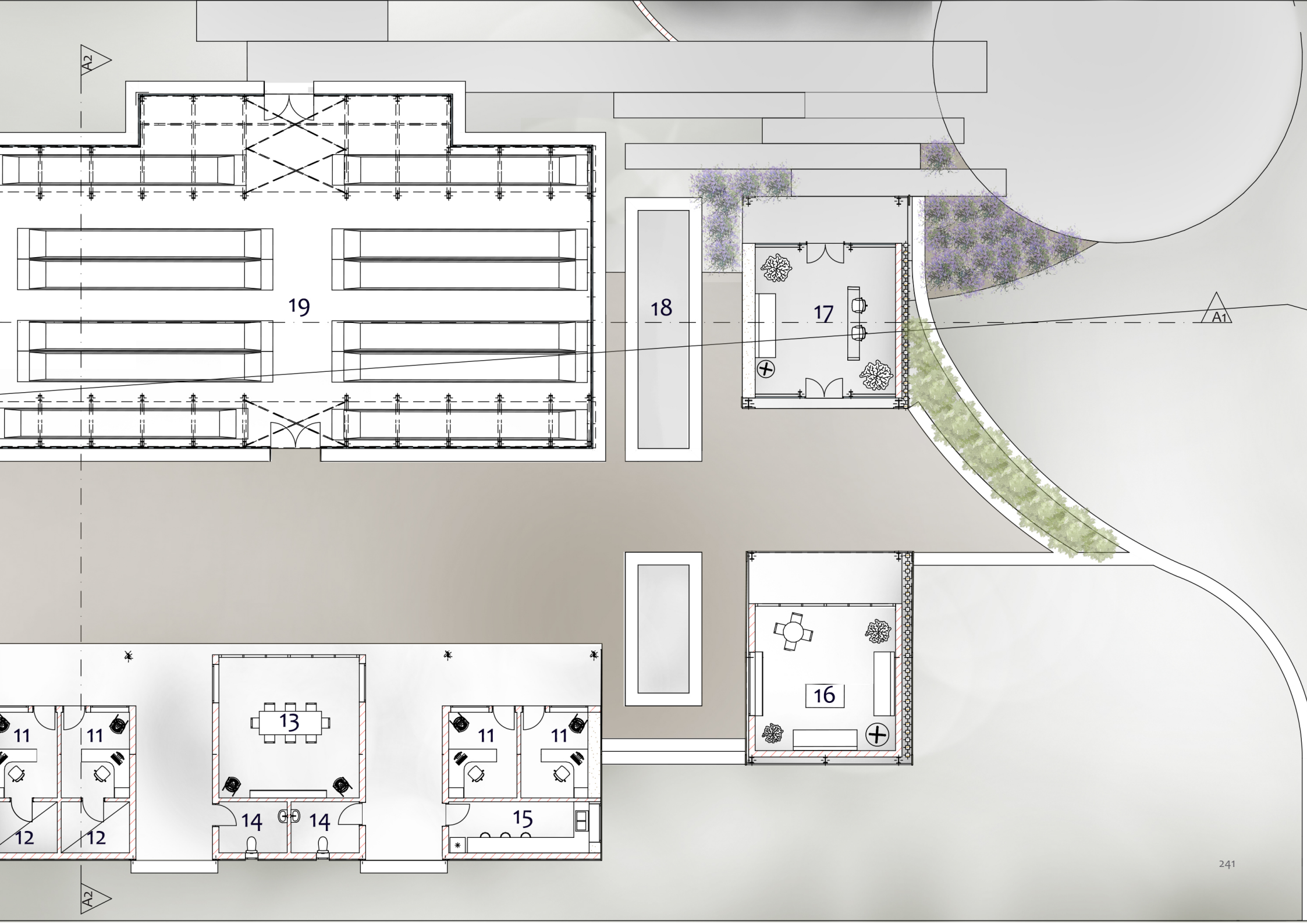
Block A

1. Loading
2. Staff Stairs
3. Laundry
4. Pumproom
5. Darkroom + Storage
6. Lightroom
7. Cold-room
8. Packaging
9. Storage – Packaging
10. Washing
11. Office
12. Storage
13. Boardroom
14. W.c
15. Administration kitchen
16. Orientation space
17. Reception
18. Sump dam
19. Greenhouse
20. Fish tanks
21. Overall storage
22. W.c Male
23. W.c Female
24. Staff kitchen/lounge
25. Lockers



GROUND FLOOR PART A

SCALE 1:200


A2
19
18
17
A1
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A2

Block A

1. Loading
2. Staff Stairs
3. Laundry
4. Pumproom
5. Darkroom + Storage
6. Lightroom
7. Cold-room
8. Packaging
9. Storage – Packaging
10. Washing
11. Office
12. Storage
13. Boardroom
14. W.c
15. Administration kitchen
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18. Sump dam
19. Greenhouse
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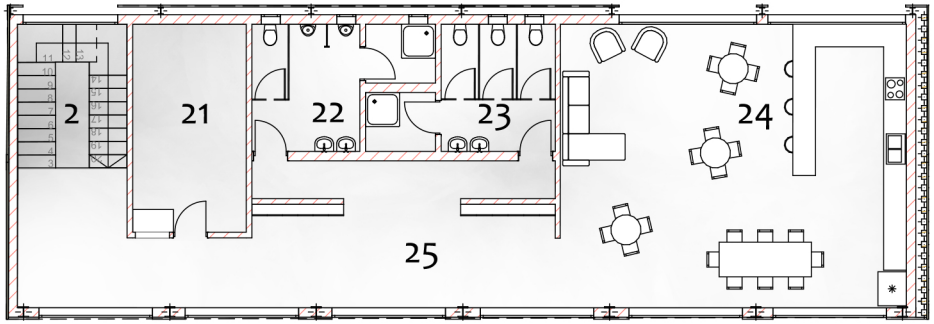


FIRST FLOOR PART A

SCALE 1:200

SECTION A2
SCALE 1: 200



SECTION A1

SCALE 1:200




Glass sheeting @ 30° slope
0.6 Galvanised Sheet Steel Ridge Plate
0.6 Galvanised Corrugated Steel Roof Sheeting
20 X 50 X 75 Lipped Channel Attached To Symmetrical- High Pitch Steel Truss
0.25 Polyolefin under-roof membrane
Steel Roof Truss Spaced @ 750 c.c
SANBOARD - Pine Finish -Extruded Polystyrene ISO Ceiling Boards
Thermal Insulation
150mm x 150mm Timber Screen
75mm x 75mm Timber Tie Hot dipped galvanised stirrup
0.5mm Concealed Fix Klip-Lok 700 Roofsheeting @ 30° slope
1,800
1,800
SUMP DAM
3,600
600
600

NORTH ELEVATION PART A





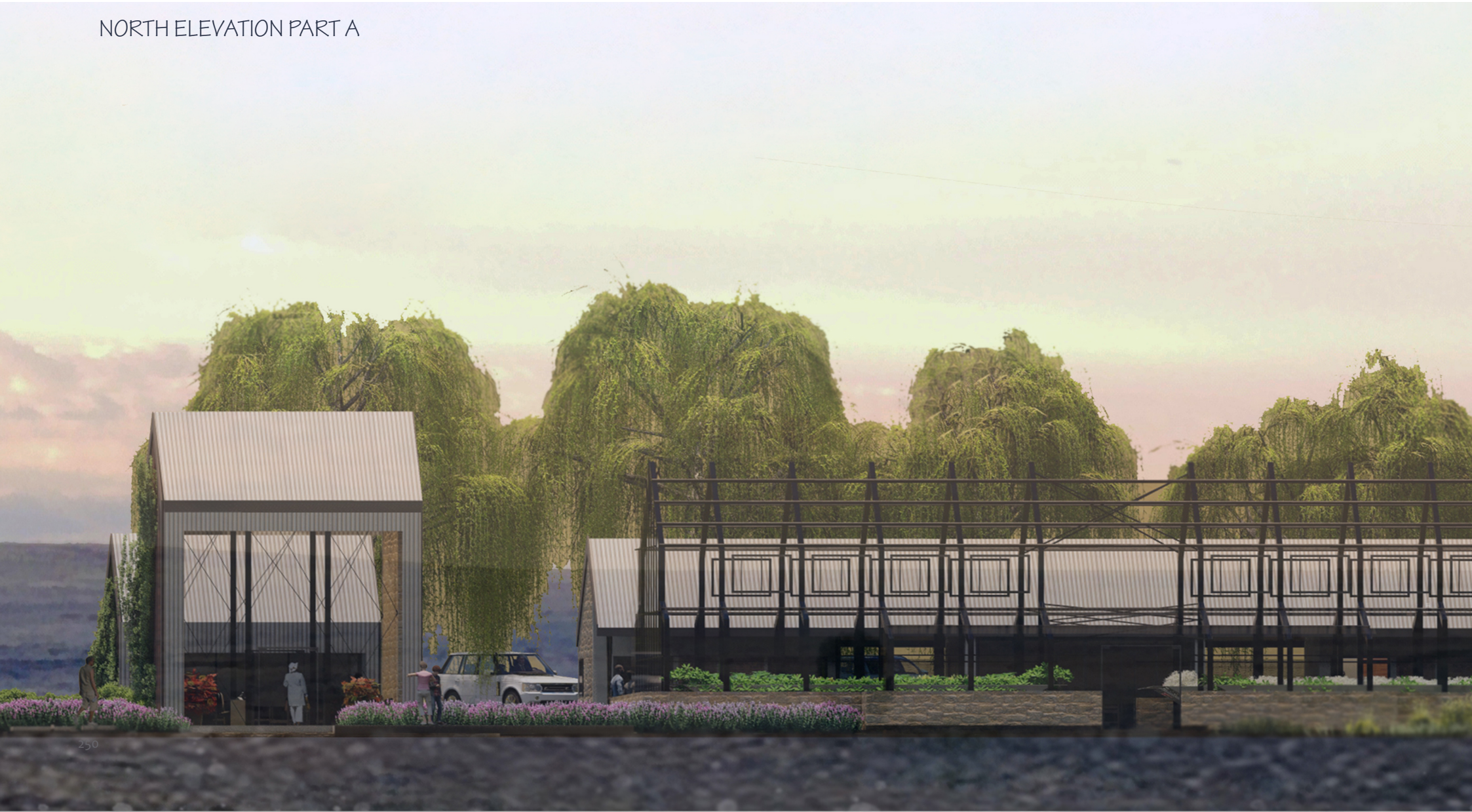






Orientation Room

NORTH ELEVATION PART A



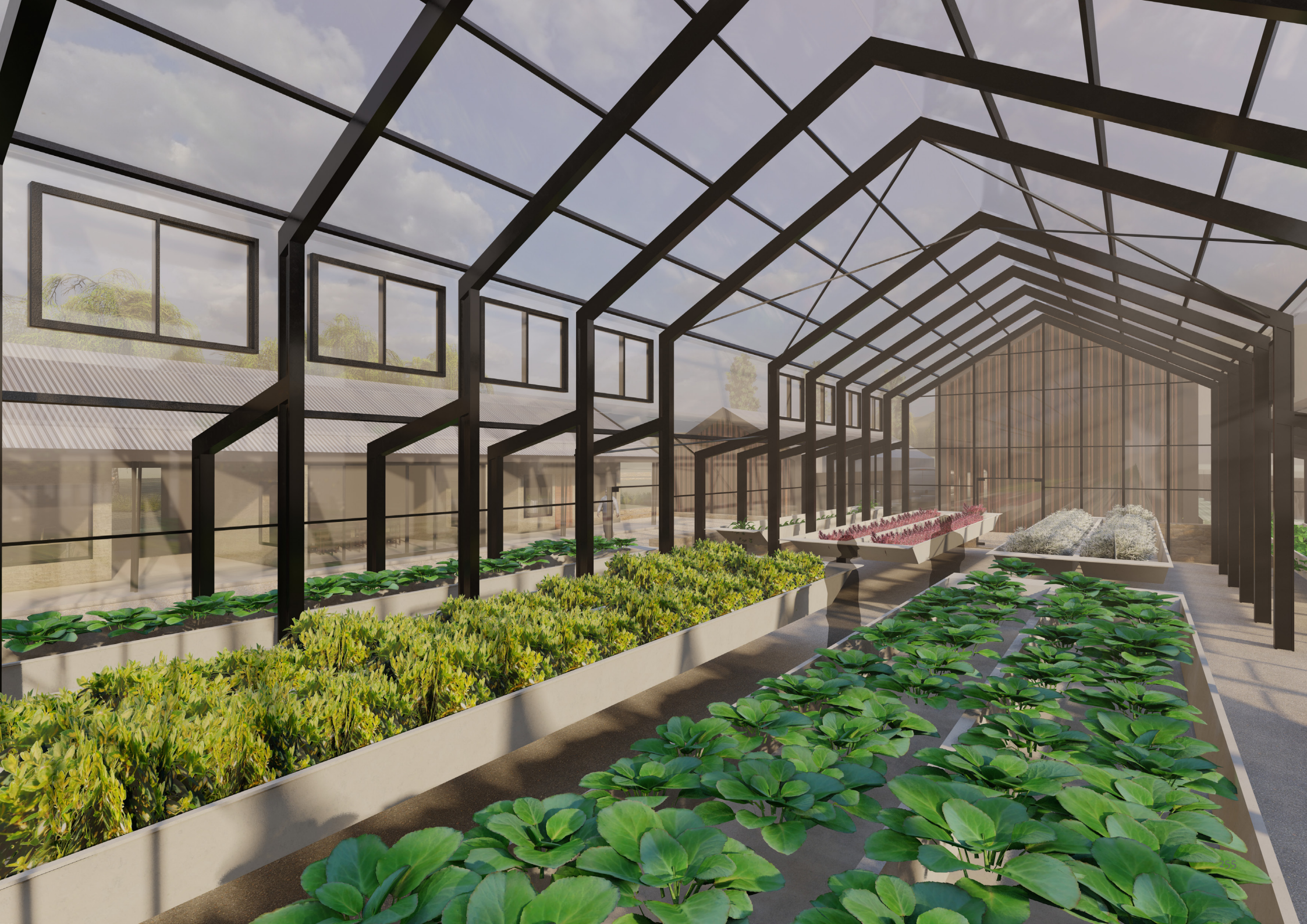


WEST PERSPECTIVE PART A





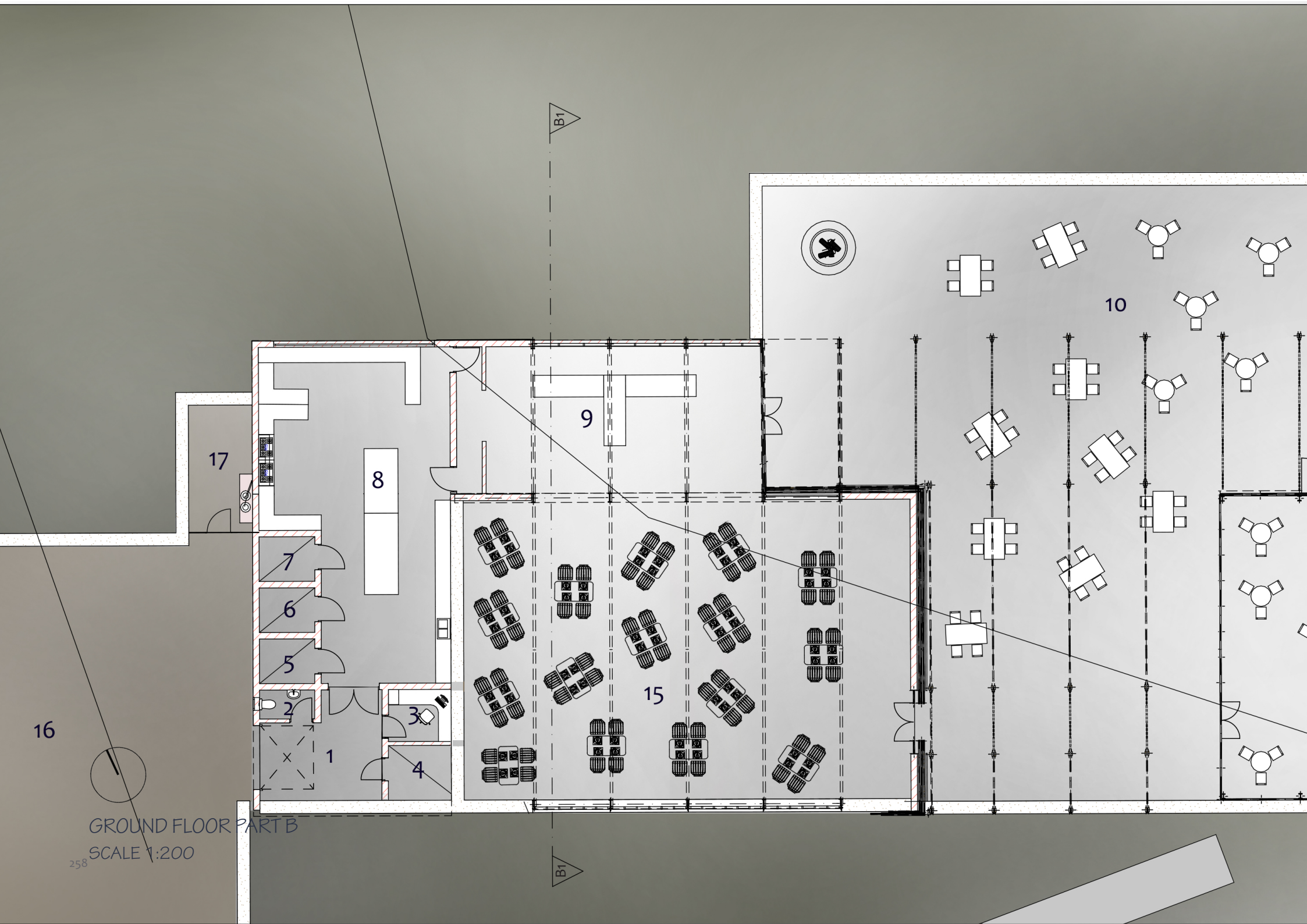




EAST PERSPECTIVE PART A

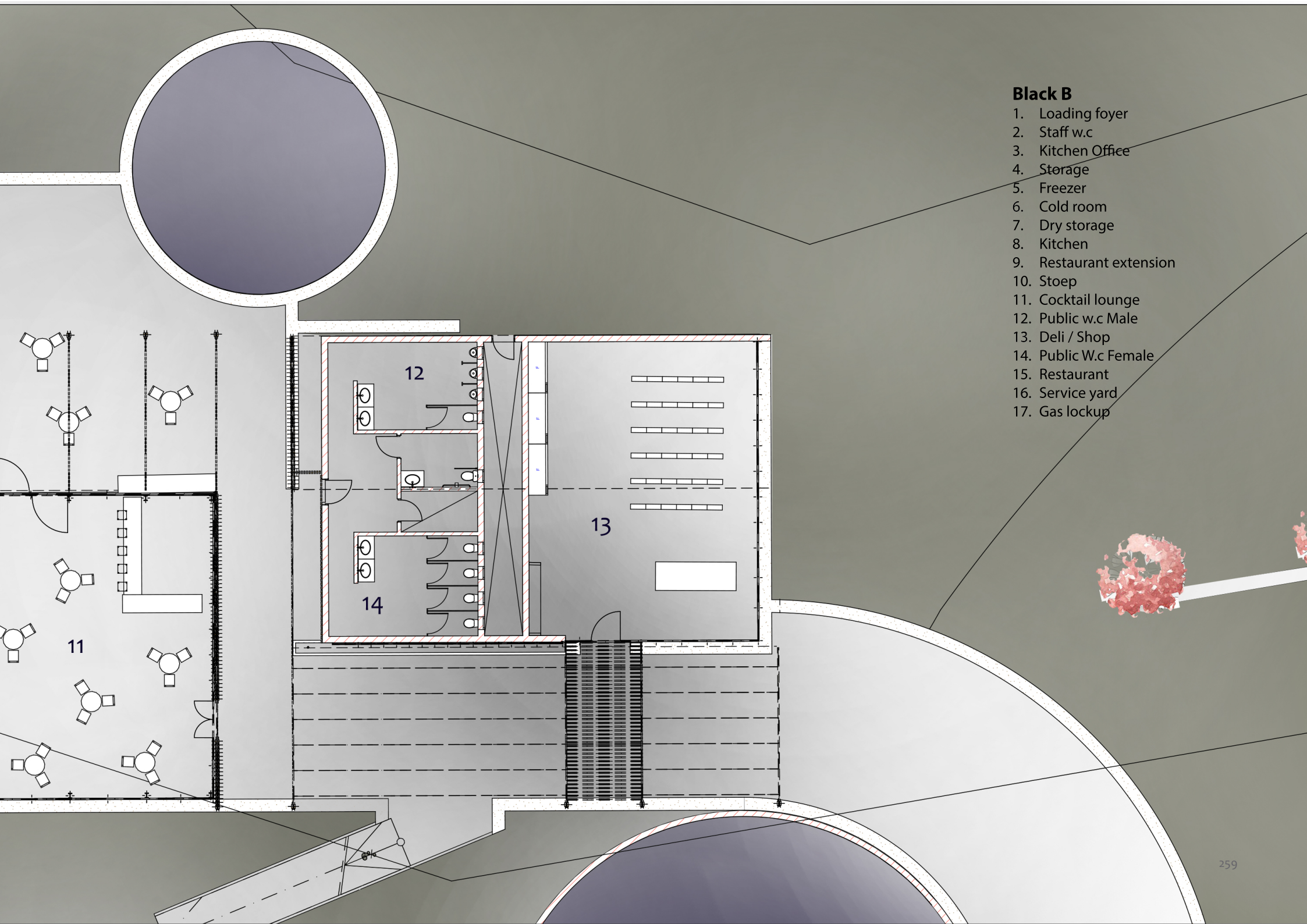






GROUND FLOOR PART B

SCALE 1:200



Black B

1. Loading foyer
2. Staff w.c
3. Kitchen Office
4. Storage
5. Freezer
6. Cold room
7. Dry storage
8. Kitchen
9. Restaurant extension
10. Stoep
11. Cocktail lounge
12. Public w.c Male
13. Deli / Shop
14. Public W.c Female
15. Restaurant
16. Service yard
17. Gas lockup

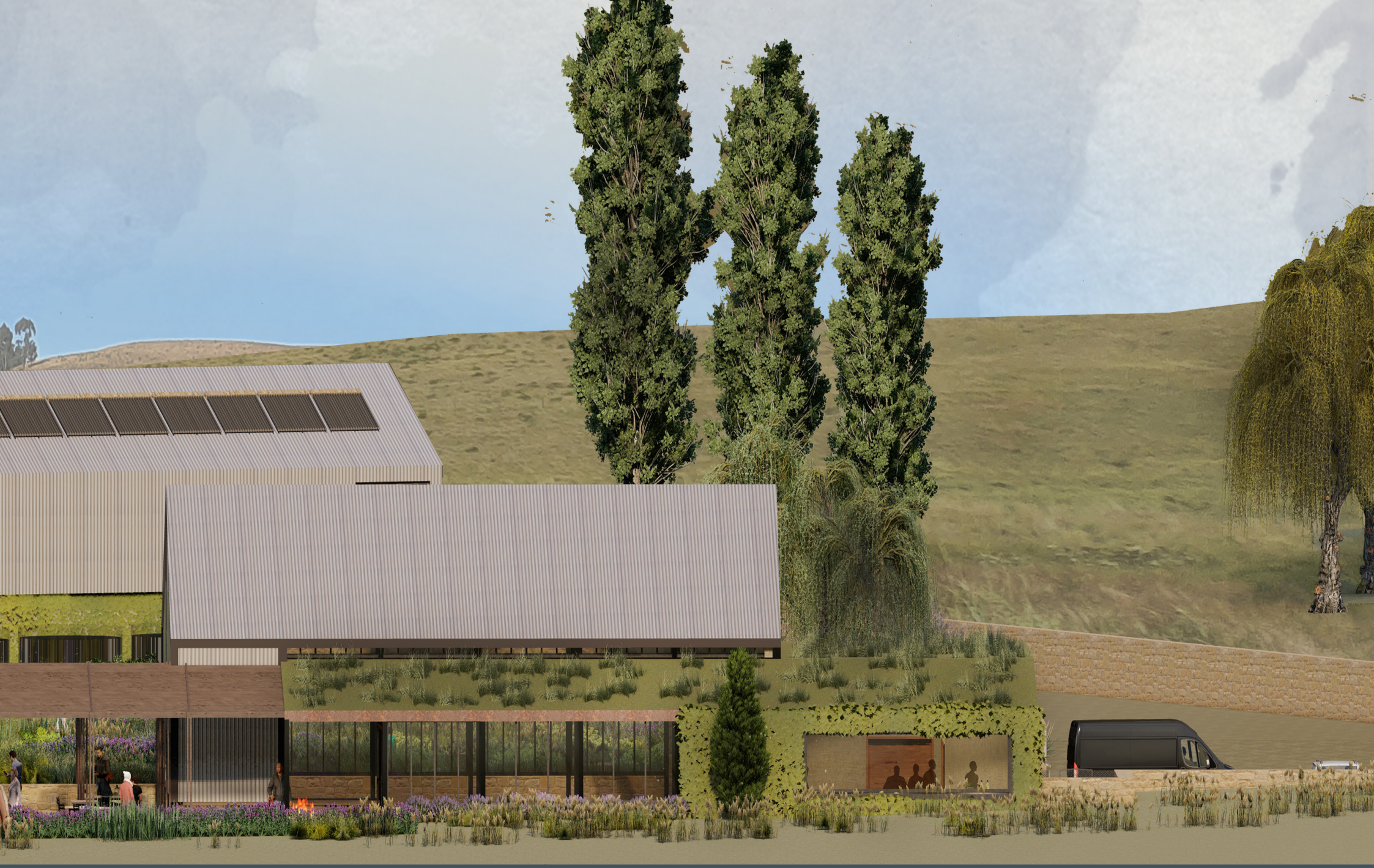
SOUTH ELEVATION PART B





NORTH ELEVATION PART B





EAST ELEVATION PART B





SECTION B1
SCALE 1: 200




RESTAURANT/ VENUE
Plaster & Paint + Sandstone









NORTH WEST PERSPECTIVE PART B



NORTH EAST PERSPECTIVE PART B





ENTRANCE PART B





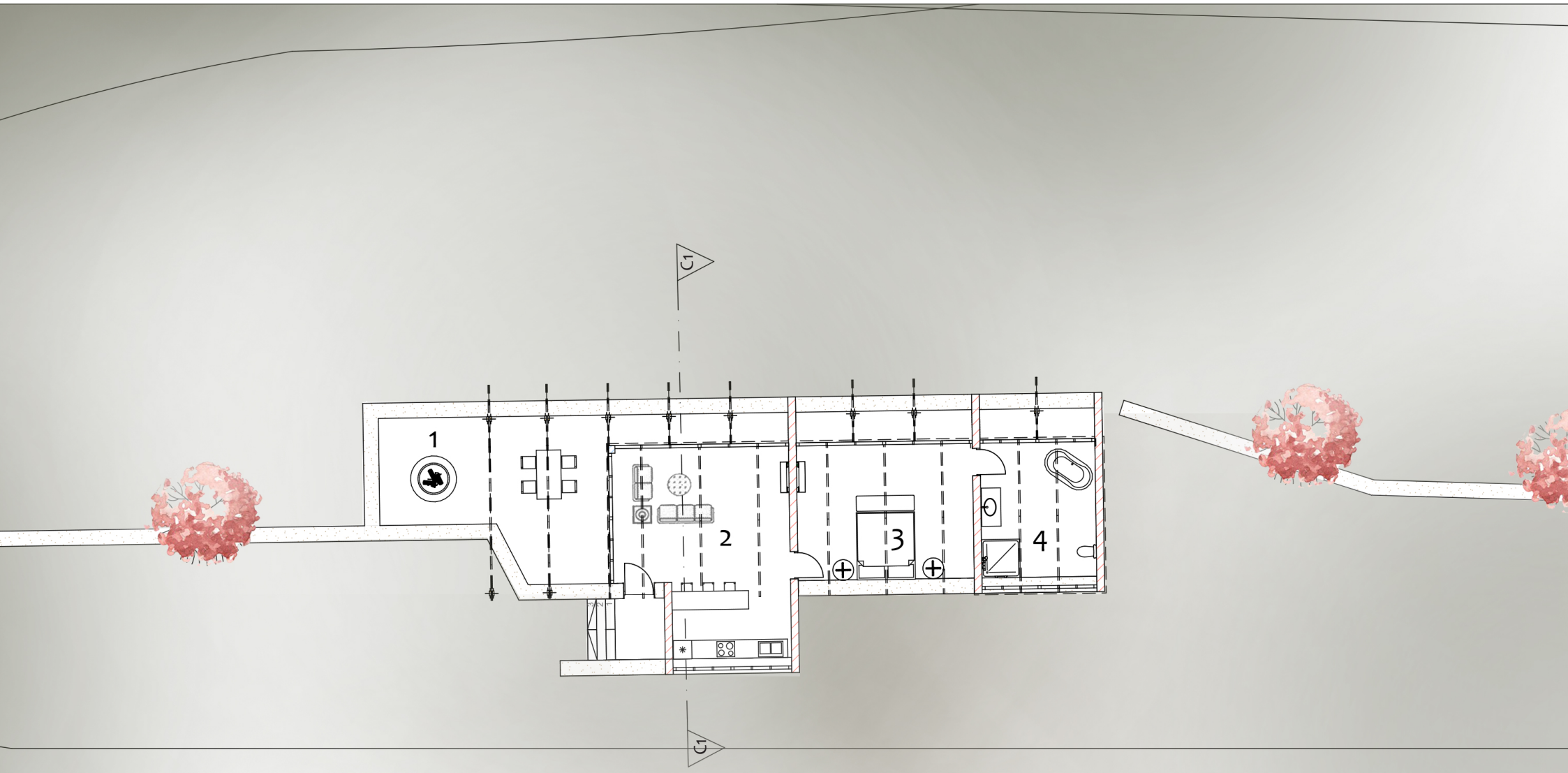
COCKTAIL LOUNGE



RESTAURANT/ VENUE INTERIOR

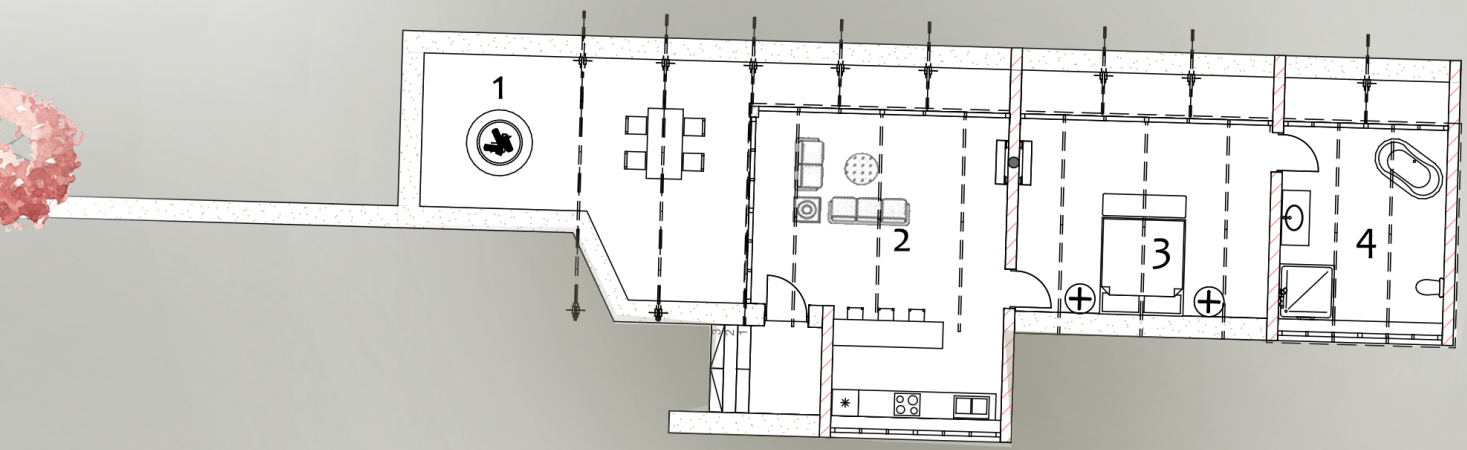






GROUND FLOOR PART C

SCALE 1:200



Black C

1. Boma
2. Open plan living room
3. Bedroom
4. Bathroom

SECTION C1

SCALE 1:100




Growing medium
Non-woven continuous filament needle punched polyester geotextile with minimum 150mm side laps.
Woven synthetic sheet
Zipcore Pro cuspated sheet by kaytech
One layer of bitumen waterproofing membrane, with 75mm side laps and 100mm end laps, sealed to primed surface to falls and crossfalls.
50mm cement screed with 75mm fillets on ends 100mm expanded polystyrene (eps) insulation with a density of 20kg/m2 faced on both sides with bitupaper, laid with edges butt-joined on concrete slab.
250mm Reinforced concrete slab
Mild steel Circular hollow tube
Rain water drip
Window built into sandstone wall
254 x 254 x 107 H-section parallel flange supporting roof structure
500mm thick sandstone wall
Nu-Vinyl Hazel Vinyl Flooring
75mm concrete screed on 0.25 polyolefin membrane
Raft foundation

NORTH EAST PERSPECTIVE PART B







North Elevation
Scale 1:100





West Elevation
Scale 1:100



South Elevation
Scale 1:100







SOUTH EAST PERSPECTIVE PART C

5.5 TECHNICAL RESOLUTIONS

This technical investigation will attempt to briefly dissect the structural composition and overall assembly of the proposed dissertation project (pending a more thorough investigation with the formal documentation 5.6).

Addressing the climate

Sustainable buildings are designed to reduce the impact of the built environment on human health and the natural environment. As mentioned in the literature (2.4.3), the aquaponic Lifestyle Farm will use principles of permaculture which entails working with the landscape. This design approach for creating sustainable, food-producing landscapes that mimic the diversity and resilience of natural ecosystems assists in designing with the climate in mind.

This can be done by making use of permaculture's ethical underpinnings that entails: taking care of the earth – rebuilding natures capital, taking care of the people by showing a willingness to build a community for individual and collective well-being and sharing the surplus by setting limits to consumption and reproduction, and redistributing the surplus (Holmgren, 2007: 8; You matter, 2019: online).

This the Lifestyle Farm is focused on:

- The efficient usage of energy, water and other resources such as geothermal energy.
- The protection of the health of the occupants of the building and at the same time improving the productivity of the occupants in the building.
- The reduction of waste, pollution and anything harmful to the environment.

South Africa alone has multiple climate zones. Climate responsive design contributes to human thermal comfort. Thermal comfort connects directly to whether a building is passive or active (natural or mechanical).

The aquaponic Lifestyle Farm lies in the coldest climate zone where low humidity and an extensive range of daily temperatures are reached; the experience of four different seasons with cold winters and summer rainfall are the main characteristics (as seen in the climate analysis 3.2).

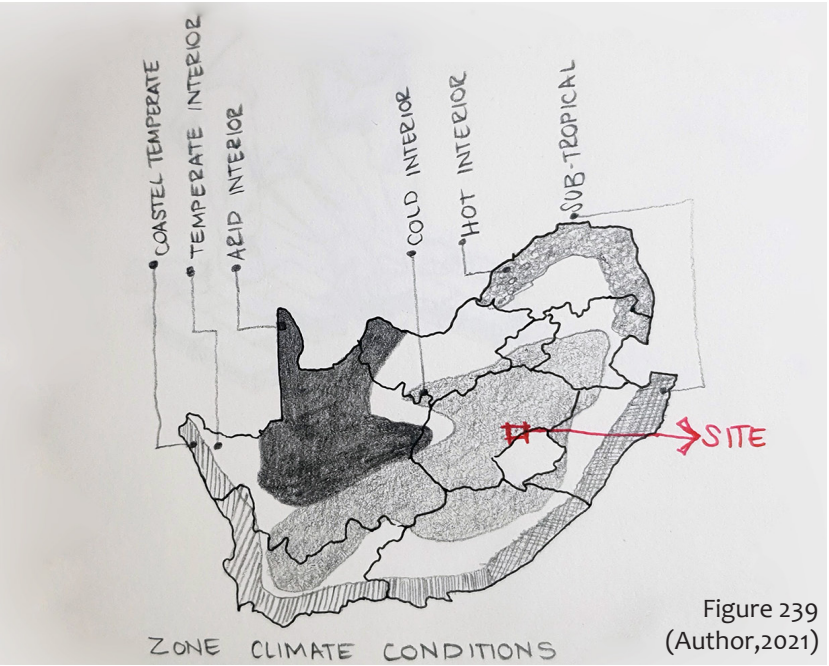


Figure 239
(Author,2021)

Addressing the landscape

Landscaping forms a large part of the site's rehabilitation and is seen as a critical element in the overall design of the aquaponic Lifestyle Farm. If it forms part of a larger integrated site design, landscape architecture can dramatically reduce energy costs over the long term while also creating a healthy environment for the site's users. For example, a green roof system can significantly reduce the heating and cooling costs of a building, As seen in Part B and C.

At this site, the contours were considered for controlling stormwater and were planned in alignment with the fountain stream. Because the site is located within the landscape, stormwater should be handled differently. Instead of stormwater pipes, the site will manage water like nature. In other words, it will mimic nature's water management capacity. The multiple dams and fountain streams also contribute to the effect of evaporation for cooling. As water evaporates, energy is lost from the air and this lowers the temperature (Sustainablesites.org, 2014: online).



Figure 240
(Author,2021)

Passive design methods

The proposed aquaponic Lifestyle Farm will primarily be self-sufficient where energy consumption is concerned. Ventilation is an essential factor for maintaining acceptable indoor air quality.

Ventilation includes the exchange of inside air to the outside, the circulation of fresh air within the building, and the removal of unpleasant odours.

When thinking of energy efficiency, passive ventilation strategies such as the naturally occurring airflow patterns and fans can be applied in the heating and cooling of a building. Following these strategies turns out to be more cost-effective than the of use air- conditioning systems. Architectural features such as the building shape also influence airflow. The building shape also plays a role in the distribution of natural light. With long narrow buildings daylight can penetrate the building more effectively, and the sun can heat more of the building during winter.

This orientation is implemented in the design to achieve a constant temperature in the buildings. By protecting the west façade and opening the North façade, the temperature can be regulated. Pergolas that are partly constructed from plants and partly from timber create an opportunity for heat to escape and create shading for cooling.

Heat is collected from the sun through north-facing windows and materials that store thermal mass, such as sandstone. Shading devices assist in keeping spaces cool. Cross ventilation is also considered in each part of the aquaponic Lifestyle Farm.

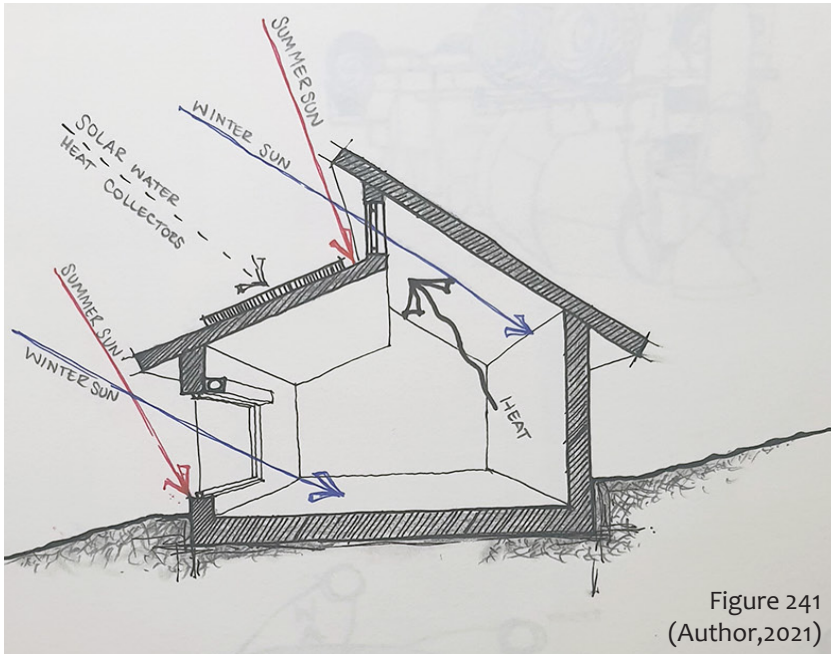


Figure 241
(Author,2021)

Materials

As previously mentioned, the intended materials for the aquaponic Lifestyle Farm will be locally sourced. The sandstone building material is identified as one of the most critical and complicated construction elements.

Sandstone must be cut and quarried in a specific way to prevent deterioration. During construction, the main advantage of using sandstone is the ease with which it can be split along its sedimentary planes using hand tools and the natural cleft face is highly desired (Hunt, 2013: online). In the case of this design, the organic quality of the sandstone will further enhance the biophilia elements of the design.

Sandstone varies like the constituent grains which it is comprised of. These can differ in size, composition, shape, roughness and decree of dissolution. The main disadvantage of sandstone compared with most other stones is the presence of different matrixes that can affect various properties.

A small amount of carbonate in the matrix can dramatically decrease resistance to acidic effects. Many sandstones batches contain small amounts of clay minerals, which are often inert, but which can sometimes swell leading to damage under persistent wet and dry cycles. In some instances, clay-rich inclusions or zones weather rapidly (Hunt, 2013: online).

One of the primary considerations when using sandstone for any form is the bedding. In most cases, the stone must be laid with the bedding plane oriented horizontally. Sandstone should not be face-bedded as whole surfaces may delaminate, and if it is laid vertically on edge, it can suffer rapid and uneven denudation. This property of sandstones means that some of the stones are only used for paving or relatively short masonry units (Hunt, 2013: online).

A working sandstone quarry is located close to the site of the aquaponic Lifestyle Farm. This allows stonework to be sourced that directly links with the site and provides easy access to the building material.

The traditional building method of building with sandstone will be utilized as a construction method; thus, an expert in sandstone construction will be needed for this phase of the construction.

Transport of building equipment and building materials
As the site is located on a farm, transport can be problematic in some cases where delivery is not included; however, vehicles and delivery transportation can easily reach the site via the S217 and then take the farm road to the site.

5.6 DOCUMENTATION

ARCHICAD EDUCATION VERSION

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA
UFS UV

Department of Architecture, Faculty of Natural and Agricultural sciences, University of the Free State. Bloemfontein, South Africa.

Carissa Viljoen | 2016035103
2016035103@ufs4life.ac.za

CLIENT
- Mev I Verhoeven
- Department of Environment, Forestry and Fisheries
- FEDHASA

PROJECT	TITLE
ALF	Site plan
DRAWN	SCALE
C Viljoen	1: 500
DRAWING NO.	
1	2021 - 12 - 01

SITE DETAILS
Lorina farm
Eastern Free State
5217
-28.378603, 28.275218.

SCHEDULE OF AREAS

GROUND FLOOR LEVEL

Block A	
Greenhouse	346
Reception	55
Orientation space	55
Administration	206
Aquaponic plant 1	206
Aquaponic plant 2	206
Total	**1073 m²**
Block B	
kitchen +Restaurant/Venue	446
Shop & Deli	107
Wc Public	97
Cocktail Lounge	170
Total	**824 m²**
Block C	
Unit 1	145
Unit 2	145
Unit 3	145
Total	**434 m²**

FIRST FLOOR LEVEL

Staff Breakaway Room	200
Total	**2531 m²**

NOTES
- The proposed site is found on farm Lorina, thus no municipal boundaries found on site.
- A servitude is described as a limited real right over immovable property. This right is registerable and allows the holder of the servitude to exercise some right over another person's property. Because the site is located on a farm not close to the neighbors property a servitude is not found on the site plan.
- No setbacks for the proposed structure are found on the site, thus no distances of structures from boundary lines.
- The topography of the site is set with contours at 500mm intervals.
- Due to the rural location, gradients are used to set out any important points.

Parking: Informal parking is implemented with landscaping. Provision is made for 5 administrative staff parking and 13 informal guests parking. In the case where more parking is needed vehicles may park in the field next to the informal guests parking.
Services areas of the main buildings (A & B) are found to the west and public areas found to the north, East, South. The 3 accommodation units (C) are handled separate from the main buildings.
Earthworks: Building B will be excavated 1000mm into the site and Building A filled to create a leveled surface. Buildings C will also be excavated 500mm into the site.
Water drainage: Due to the natural flowing fountain that flows 20 000L/per hour, no flood lines are found on site. Water drainage are handled with the slope of the site. Storm water drainage connects with the fountain and where differently allocated channeled away from site.
All structures found on site are newly proposed structures.

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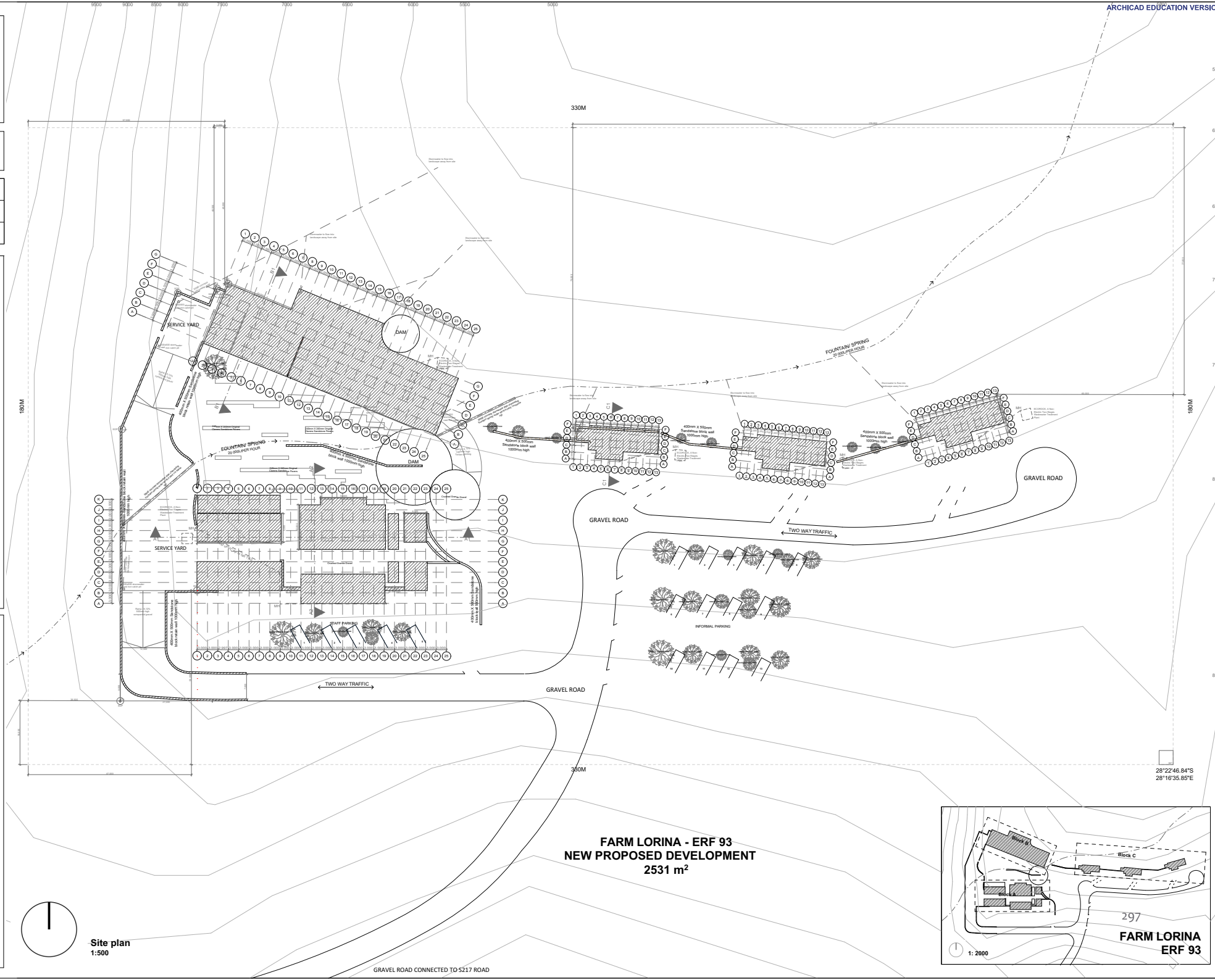


FARM LORINA - ERF 93
NEW PROPOSED DEVELOPMENT
2531 m²

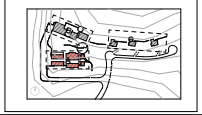
Site plan
1:500

GRAVEL ROAD CONNECTED TO S217 ROAD

297

FARM LORINA
ERF 93

ARCHICAD EDUCATION VERSIO



SCHEDULE OF AREAS

GROUND FLOOR LEVEL

Block A	
Greenhouse	346
Reception	55
Orientation space	55
Administration	206
Aquaponic plant 1	206
Aquaponic plant 2	206
Total	**1073 m²**

Block B	
Kitchen +Restaurant/Venue	446
Shop & Deli	107
Wc Public	101
Cocktail Lounge	170
Total	**824 m²**

Block C	
Unit 1	145
Unit 2	145
Unit 3	145
Total	**434 m²**

FIRST FLOOR LEVEL

Staff Breakaway Room	200
Total	**2531 m²**

Lorina farm
Eastern Free State
5217
-28.378603, 28.275218.

GENERAL:
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PROJECT
Mev I Verhoeven
Department of Environment, Forestry and Fisheries - FEDHASA.

DRAWN BY: ALF	TITLE: Ground floor A
CHECKED BY: C Viljoen	SCALE: 1: 100
PAPER SIZE: 2 A	DATE: 2021 - 12 -01

Department of Architecture, Faculty of Natural and Agricultural sciences, University of the Free State. Bloemfontein, South Africa.
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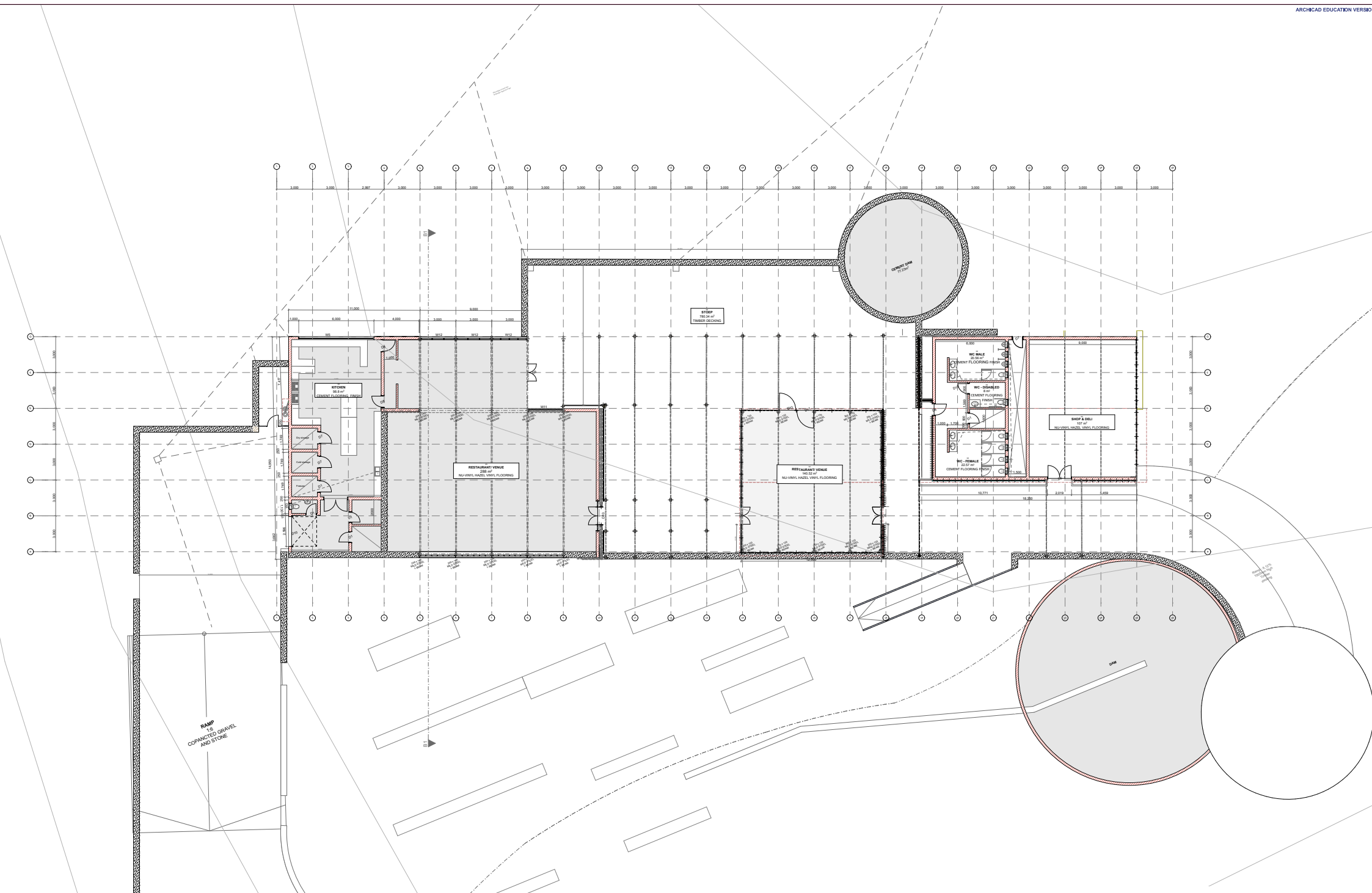
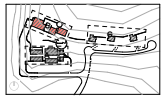
2016035103@ufs4life.ac.za

ARCHICAD EDUCATION VERSIO





SCHEDULE OF AREAS

GROUND FLOOR LEVEL			
Block A		**Block C**	
Greenhouse	346	Unit 1	145
Reception	55	Unit 2	145
Orientation space	55	Unit 3	145
Administration	206	**Total**	**434 m²**
Aquaponic plant 1	206		
Aquaponic plant 2	206		
Total	**1073 m²**	**FIRST FLOOR LEVEL**	
Block B		Staff Breakaway Room	200
kitchen +Restaurant/Venue	446		
Shop & Deli	107	**Total**	**2531 m²**
Wc Public	97		
Cocktail Lounge	170		
Total	**824 m²**		

Lorina farm
Eastern Free State
5217
-28.378603, 28.275218.

GENERAL:
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CLIENT
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- Department of Environment, Forestry and Fisheries
- FEDHASA

ALF	Ground floor B
C Viljoen	1: 100
2 B	2021 - 12 -01

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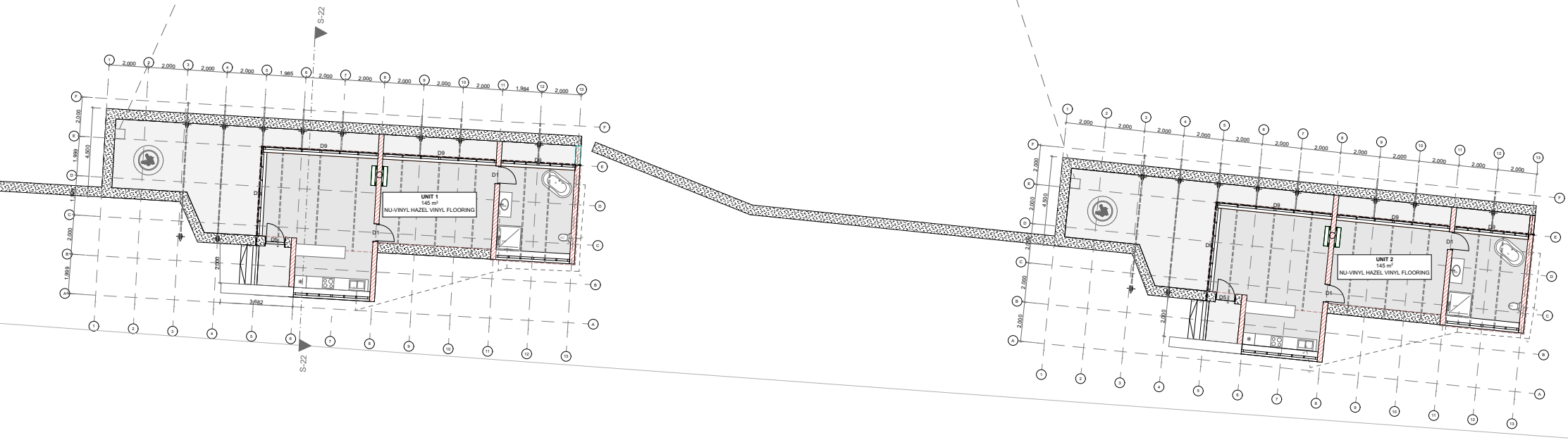
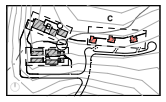
ARCHICAD EDUCATION VERSIO



Gravel Road



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LOCATION
Lorina farm
Eastern Free State
5217
-28.378603, 28.275218.

SCHEDULE OF AREAS

GROUND FLOOR LEVEL	
Block A	
Greenhouse	346
Reception	55
Orientation space	55
Administration	206
Aquaponic plant 1	206
Aquaponic plant 2	206
Total	**1073 m²**
Block B	
Kitchen +Restaurant/Venue	446
Shop & Deli	107
Wc Public	97
Cocktail Lounge	174
Total	**824 m²**
Block C	
Unit 1	145
Unit 2	145
Unit 3	145
Total	**434 m²**
FIRST FLOOR LEVEL	
Staff Breakaway Room	200
Total	**2531 m²**

CLIENT
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- Department of Environment, Forestry and Fisheries
- FEDHASA

PROJECT ALF	DRAWING Ground floor C
DESIGN C Viljoen	SCALE 1:100
DRAWING NO. 2C	DATE 2021 - 12 - 01

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PROJECT	TITLE
ALF	**First floor**
DRAWN	SCALE
C Viljoen	**1:100**
DRAWING NO.	DATE
2 A.1	**2021 - 12 - 01**

SITE DETAILS
Lorina farm
Eastern Free State
5217
-28.378603, 28.275218.

SCHEDULE OF AREAS

GROUND FLOOR LEVEL	
Block A	
Greenhouse	346
Reception	55
Orientation space	55
Administration	206
Aquaponic plant 1	206
Aquaponic plant 2	206
Total	**1073 m²**
Block B	
kitchen +Restaurant/Venue	446
Shop & Deli	107
Wc Public	97
Cocktail Lounge	170
Total	**824 m²**
Block C	
Unit 1	145
Unit 2	145
Unit 3	145
Total	**434 m²**
FIRST FLOOR LEVEL	
Staff Breakaway Room	200
Total	**2531 m²**

NOTES

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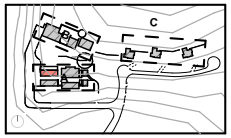
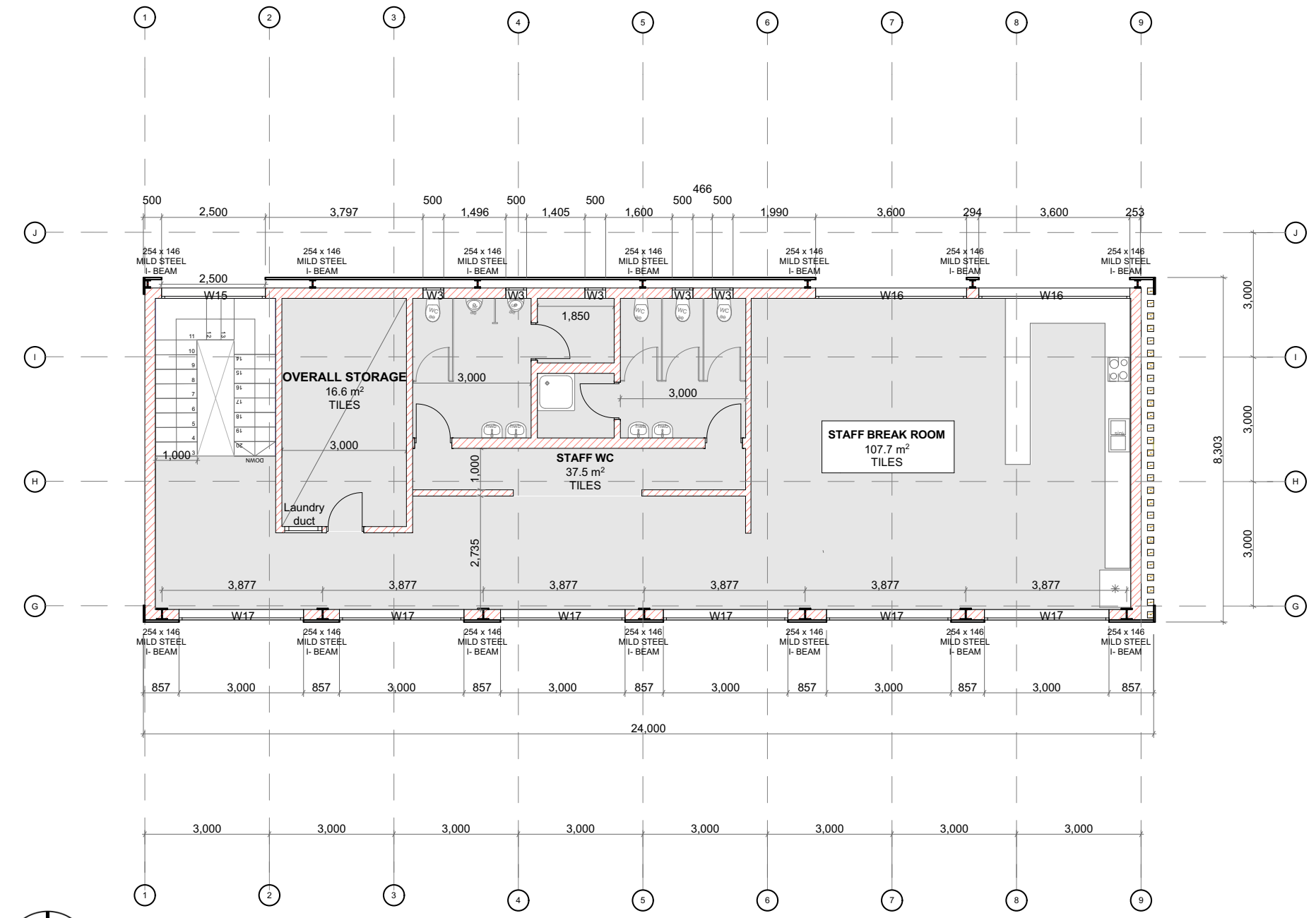
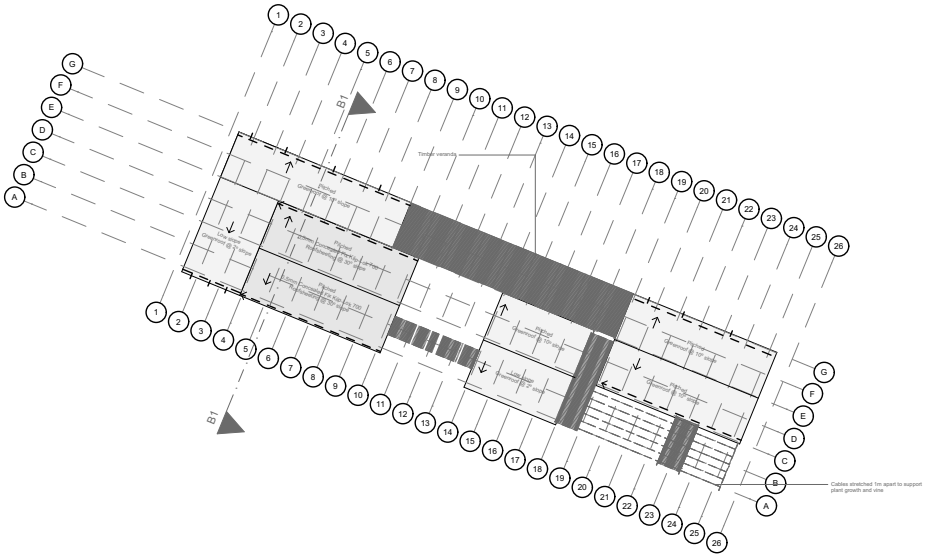
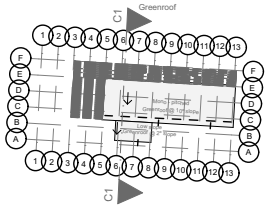


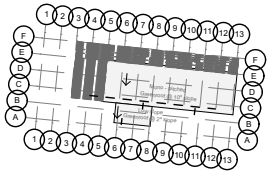


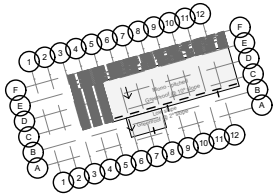
First floor
1: 100

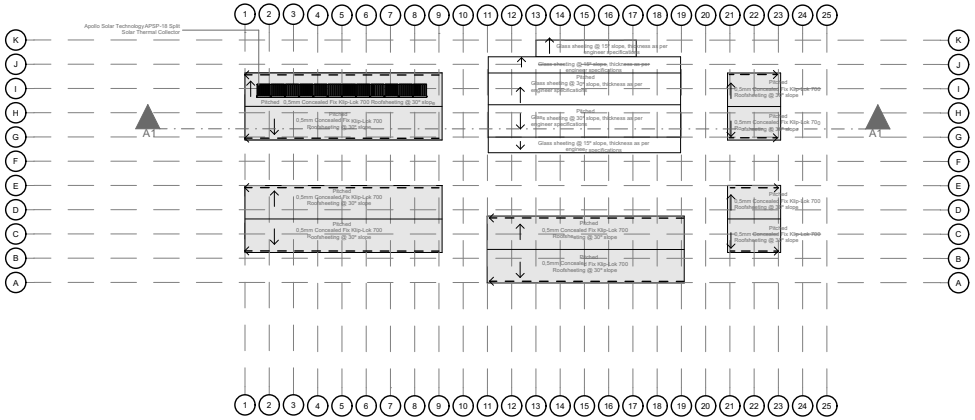
ARCHICAD EDUCATION VERSIO











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SITE DETAILS
Lorina farm
Eastern Free State
S217
-28.378603, 28.275218.

NOTES

- Each roof system is insulated as required for the function of building as seen in sections and details.
- Different roof overhangs are utilized in each roof structure as seen in the sections and details.
- Waterproofing is found in each roof structure according to and is placed according to the construction of the specific roof structure.

KEY

- Rainwater system
- Roof pitch/slope
- Corrugated roof sheeting
- Green roof
- Glass roof

SCHEDULE OF AREAS

GROUND FLOOR LEVEL	
Block A	
Greenhouse	346
Reception	55
Orientation space	55
Administration	206
Aquaponic plant 1	206
Aquaponic plant 2	206
Total	**1073 m²**
Block B	
Kitchen +Restaurant/Venue	446
Shop & Deli	107
Wc Public	97
Cocktail Lounge	170
Total	**824 m²**
Block C	
Unit 1	145
Unit 2	145
Unit 3	145
Total	**434 m²**
FIRST FLOOR LEVEL	
Staff Breakaway Room	200
Total	**2531 m²**

CLIENT
- Mev I Verhoeven
- Department of Environment, Forestry and Fisheries
- FEDHASA

PROJECT: **ALF**	TITLE: **Roof plan**
DRAWN: **C Viljoen**	SCALE: **1: 500**
DRAWING NO.: **2 D**	DATE: **2021 - 12 - 01**

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ALF	Sections + Elevations
C Viljoen	1: 100, 1:50
3 A . 2	2021 - 12 -01

Lorina farm
Eastern Free State
5217
-28.378603, 28.275218.

SCHEDULE OF AREAS

GROUND FLOOR LEVEL	
Block A	
Greenhouse	346
Reception	55
Orientation space	55
Aquaponic tank	206
Aquaponic plant 1	206
Aquaponic plant 2	206
Total	**1073 m²**
Block B	
Kitchen +Restaurant/Venue	446
Shop & Deli	107
Toilets	101
Cocktail Lounge	170
Total	**824 m²**
Block C	
Unit 1	145
Unit 2	145
Unit 3	145
Total	**434 m²**
FIRST FLOOR LEVEL	
Staff Breakaway Room	200
Total	**2531 m²**

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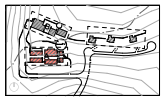
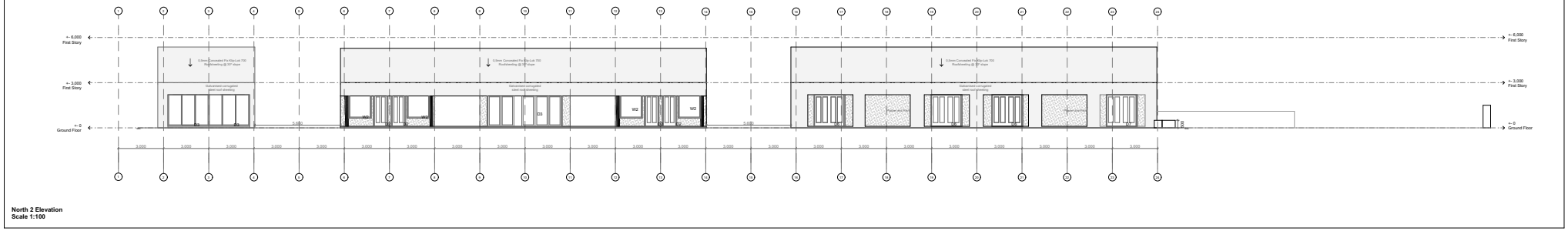
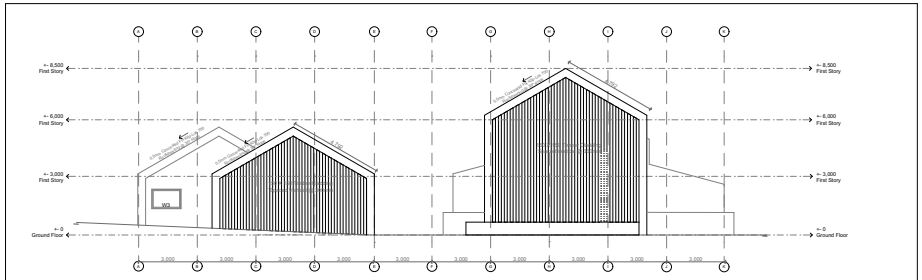
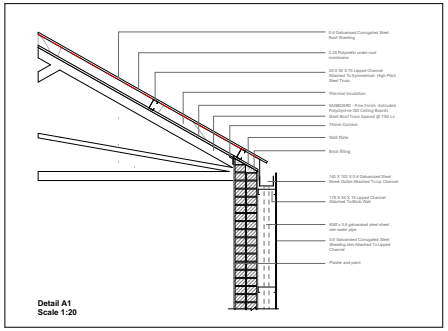




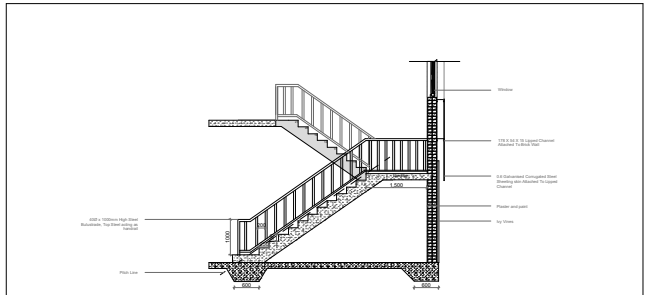
North 2 Elevation
Scale 1:100



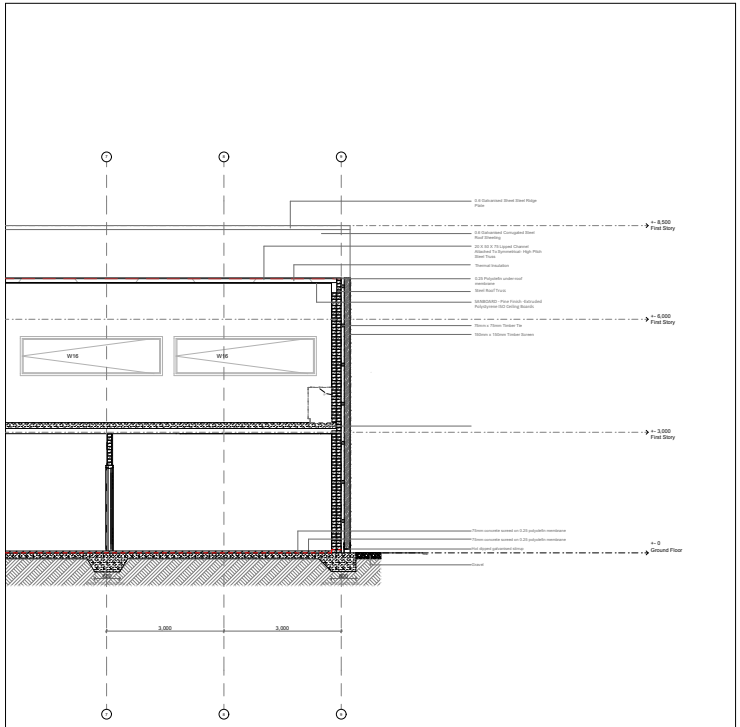
East Elevation
Scale 1:100



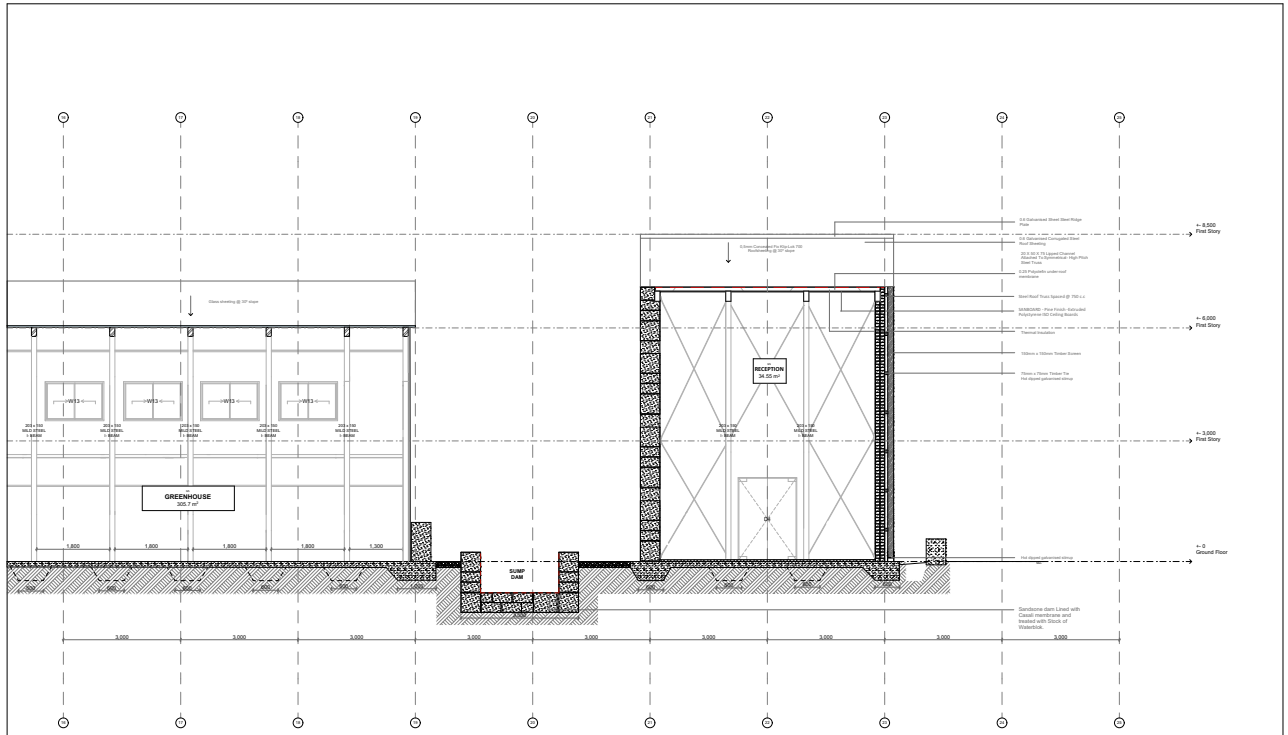
Detail A1
Scale 1:20



Detail A2
Scale 1:50



Section A1
Scale 1:50



Section A1
Scale 1:50

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CLIENT
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- Department of Environment, Forestry and Fisheries
- FEDHASA

ALF	Sections + Elevations
C Viljoen	1: 100, 1:50
3 A . 1	2021 - 12 -01

Lorina farm
Eastern Free State
5217
-28.378603, 28.275218.

SCHEDULE OF AREAS

GROUND FLOOR LEVEL	
Block A	
Greenhouse	346
Reception	55
Orientation space	55
Aquaponic pump	256
Aquaponic plant 1	206
Aquaponic plant 2	206
Total	**1073 m²**
Block B	
Kitchen +Restaurant/Venue	446
Shop & Deli	107
Toilets	101
Cocktail Lounge	170
Total	**824 m²**
Block C	
Unit 1	145
Unit 2	145
Unit 3	145
Total	**434 m²**
FIRST FLOOR LEVEL	
Staff Breakaway Room	200
Total	**2531 m²**

GENERAL:
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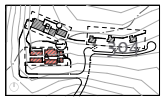
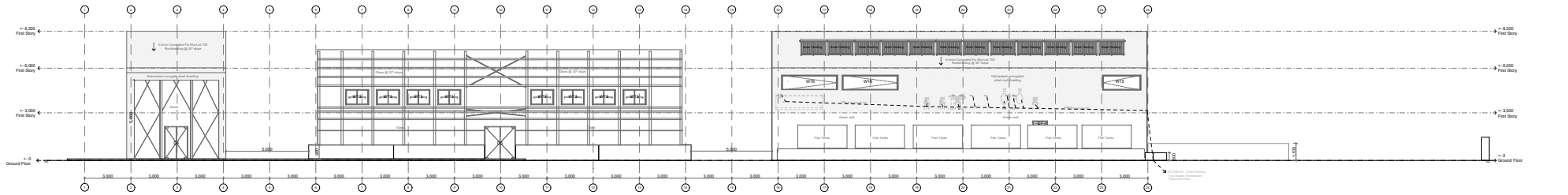
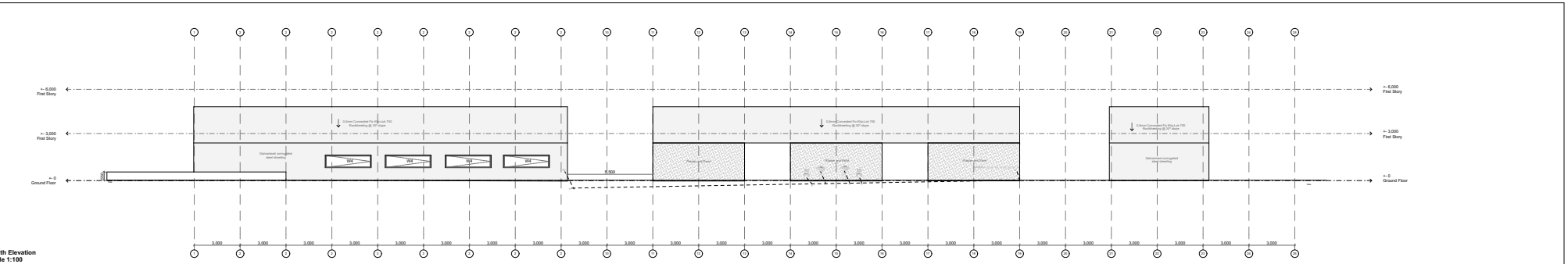
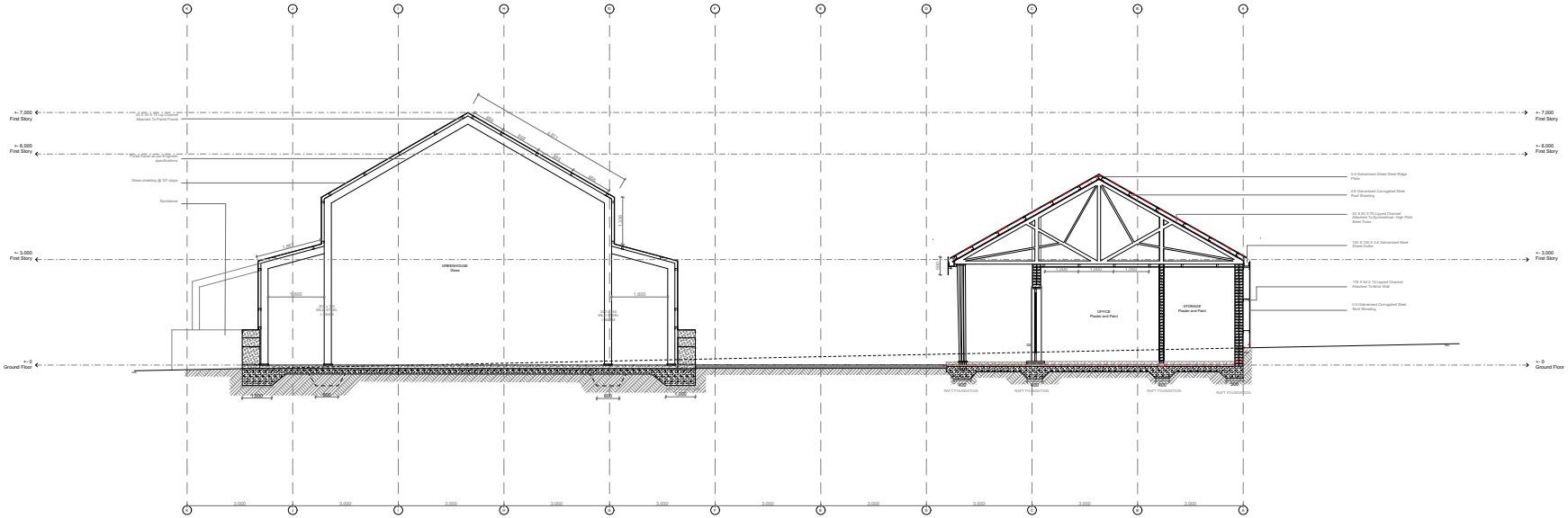




North Elevation
Scale 1:100



South Elevation
Scale 1:100



Section A2
Scale 1:50

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UFS UV

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Supervisor:
- Mev I Verhoeven
- Department of Environment, Forestry and Fisheries
- FEDHASA

Project: ALF	Drawing: Ground floor B
Author: C Viljoen	Scale: 1: 100
Drawing number: 3 B	Date: 2021 - 12 -01

Location:
Lorina farm
Eastern Free State
5217
-28.378603, 28.275218.

SCHEDULE OF AREAS

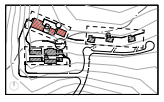
GROUND FLOOR LEVEL

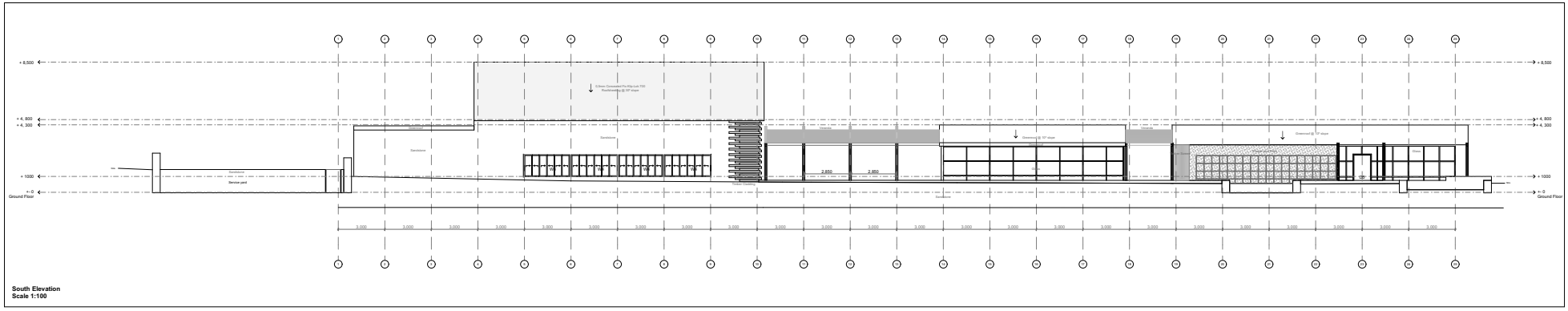
Block A	
Greenhouse	346
Reception	55
Orientation space	50
Administration	165
Aquaponic plant 1	200
Aquaponic plant 2	200
Total	**1073 m²**
Block B	
kitchen +Restaurant/Venue	446
Shop & Deli	107
WC Public	97
Visitor's Lounge	174
Total	**824 m²**
Block C	
Unit 1	145
Unit 2	145
Unit 3	145
Total	**434 m²**

FIRST FLOOR LEVEL

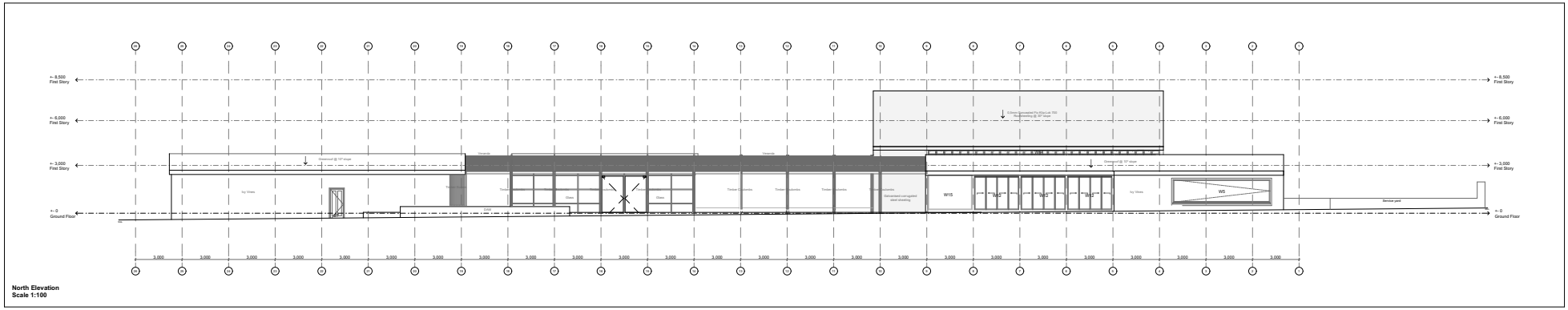
Staff Breakaway Room	200
Total	**2531 m²**

GENERAL:
ALL MATERIALS AND CONSTRUCTION METHODS TO COMPLY WITH THE NATIONAL BUILDING REGULATIONS (ACT No. 103 OF 1997) INCLUDING ALL REVISIONS AND ALL APPLICABLE BYLAWS OF THE CONCERNED LOCAL AUTHORITY. ALL DIMENSIONS TO BE VERIFIED ON SITE AND NO DRAWING IS TO BE SCALED. ANY DISCREPANCIES OR CONTRADICTIONS MUST IMMEDIATELY BE POINTED OUT TO THE ARCHITECT FOR CORRECTION OR EXPLANATIONS BEFORE ANY CONSTRUCTION PROCEED.

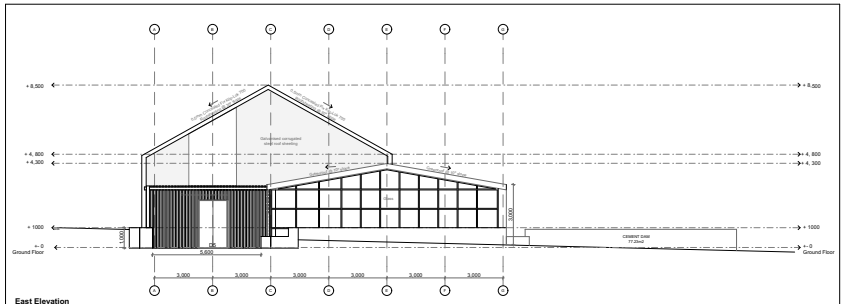




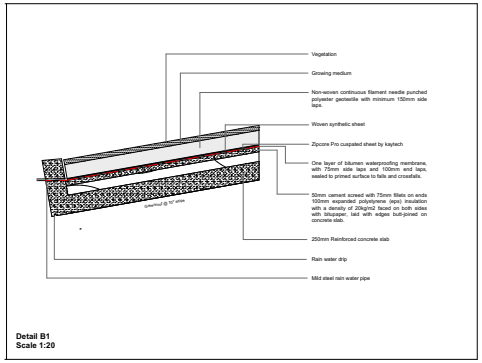
South Elevation
Scale 1:100



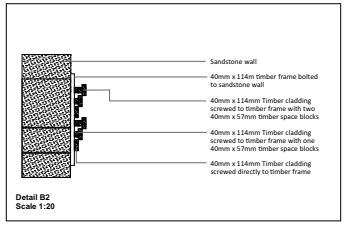
North Elevation
Scale 1:100



East Elevation
Scale 1:100



Detail B1
Scale 1:20



Detail B2
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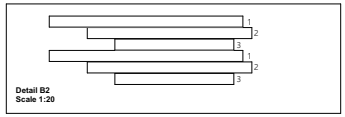

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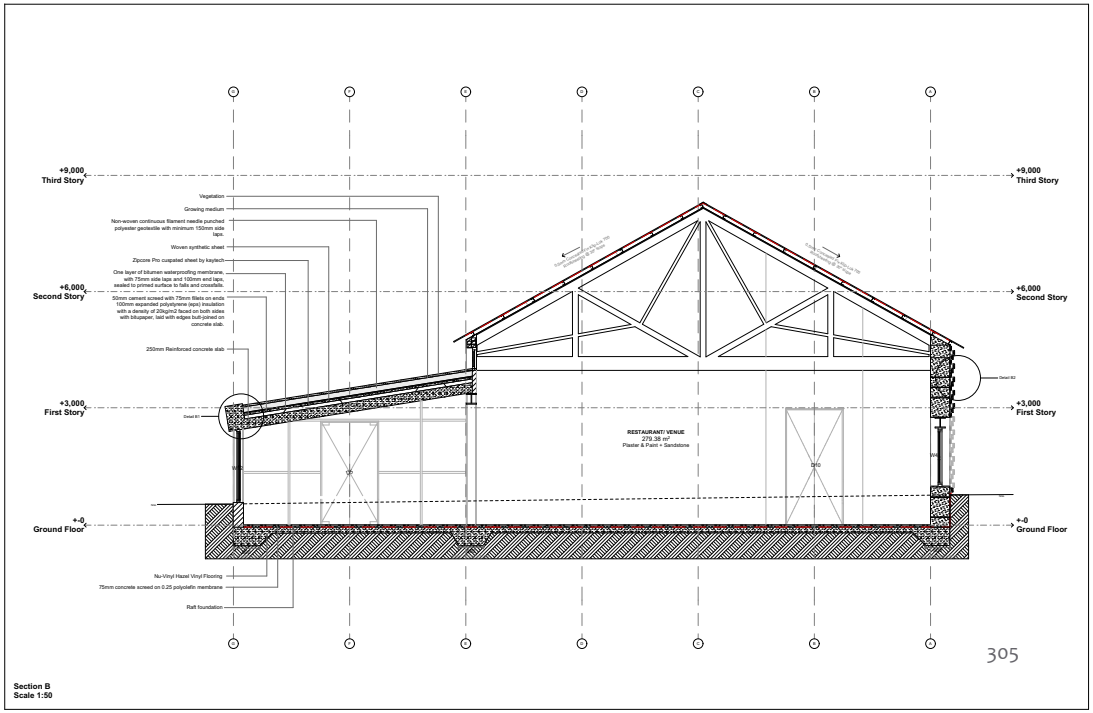


Section B
Scale 1:50

ARCHICAD EDUCATION VERSION

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA

UFS
UV

Department of Architecture, Faculty of Natural and Agricultural sciences, University of the Free State. Bloemfontein, South Africa.

Carissa Viljoen | 2016035103
2016035103@ufs4life.ac.za

- Mev I Verhoeven
- Department of Environment, Forestry and Fisheries
- FEDHASA

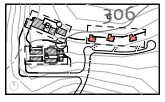
ALF	**Part C: Section + Elevations + Details**
C Viljoen	**1:100, 1:50, 1:20**
3C	**2021 - 12 - 01**

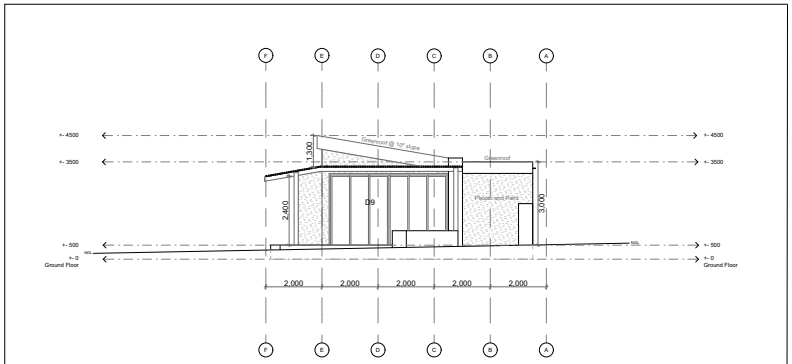
Lorina farm
Eastern Free State
5217
-28.378603, 28.275218.

SCHEDULE OF AREAS

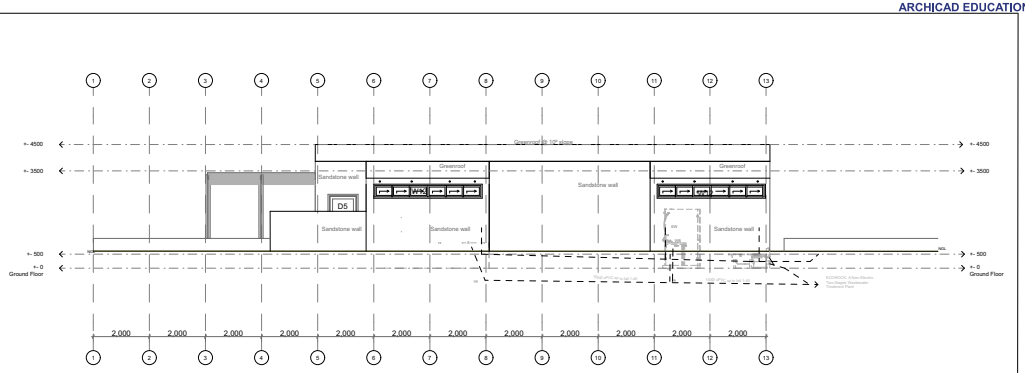
GROUND FLOOR LEVEL	
Block A	
Greenhouse	346
Reception	55
Orientation space	55
Administration	206
Aquaponic plant 1	206
Aquaponic plant 2	206
Total	**1073 m²**
Block B	
Kitchen +Restaurant/Venue	446
Shop & Deli	107
Wc Public	97
Cocktail Lounge	179
Total	**824 m²**
Block C	
Unit 1	145
Unit 2	145
Unit 3	145
Total	**434 m²**
FIRST FLOOR LEVEL	
Staff Breakaway Room	200
Total	**2531 m²**

GENERAL:
ALL MATERIALS AND CONSTRUCTION METHODS TO COMPLY WITH THE NATIONAL BUILDING REGULATIONS (ACT No. 103 OF 1997) INCLUDING ALL REVISIONS AND ALL APPLICABLE BYLAWS OF THE CONCERNED LOCAL AUTHORITY. ALL DIMENSIONS TO BE VERIFIED ON SITE AND NO DRAWING IS TO BE SCALED. ANY DISCREPANCIES OR CONTRADICTIONS MUST IMMEDIATELY BE POINTED OUT TO THE ARCHITECT FOR CORRECTION OR EXPLANATIONS BEFORE ANY CONSTRUCTION PROCEED.

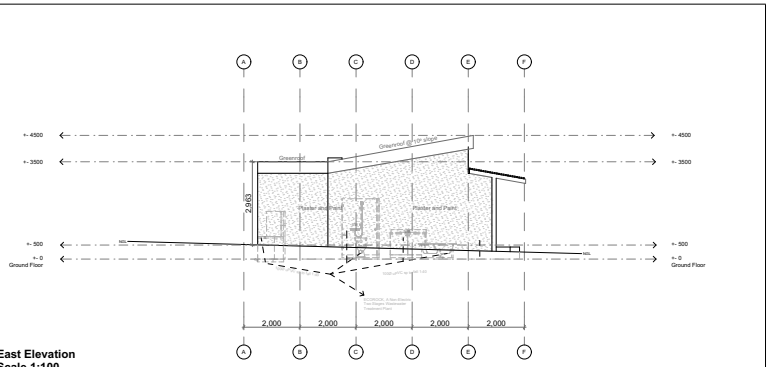




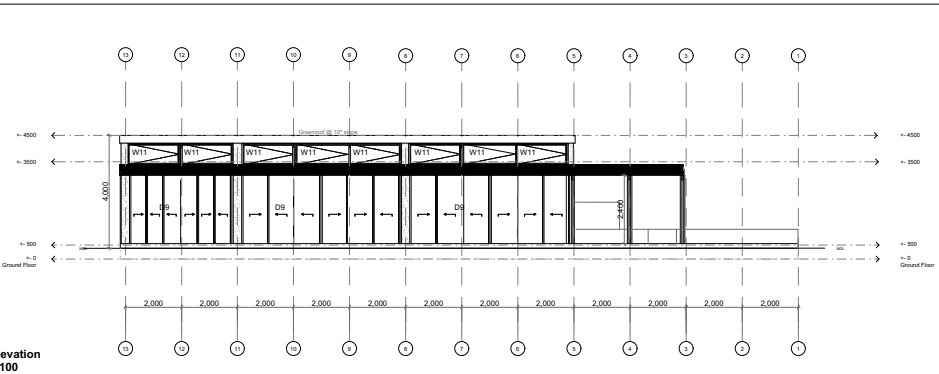
West Elevation
Scale 1:100



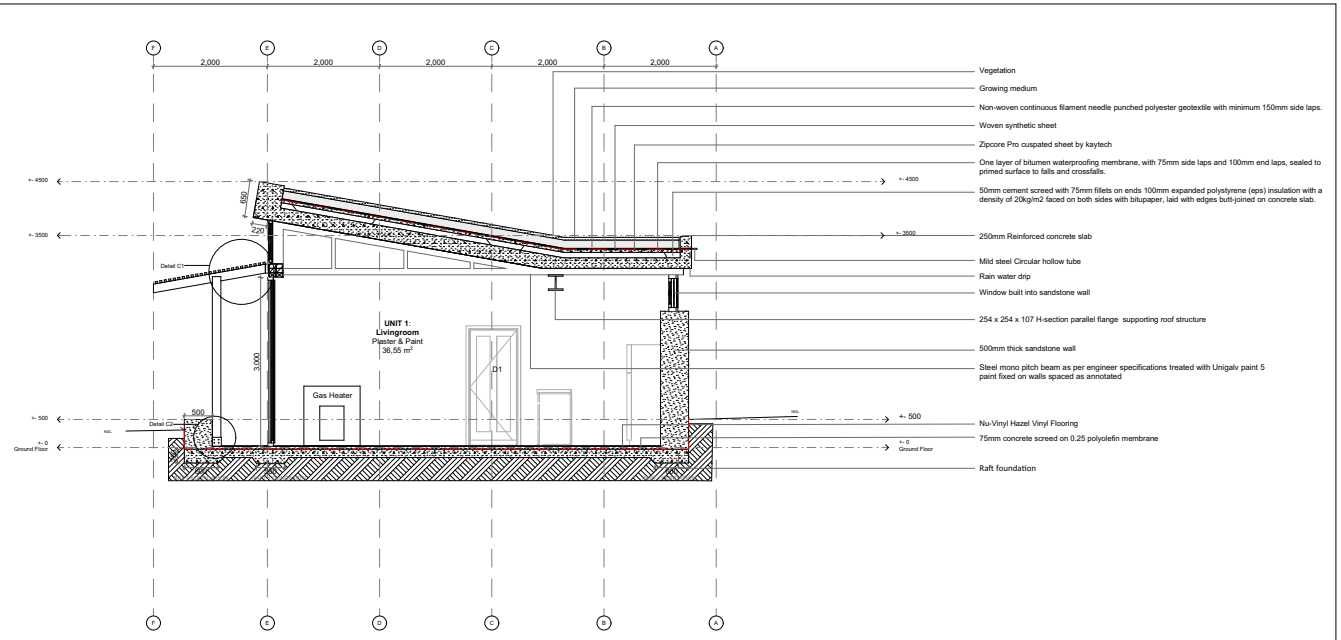
South Elevation
Scale 1:100



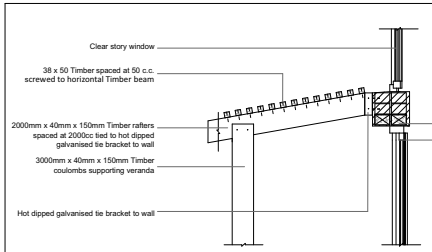
East Elevation
Scale 1:100



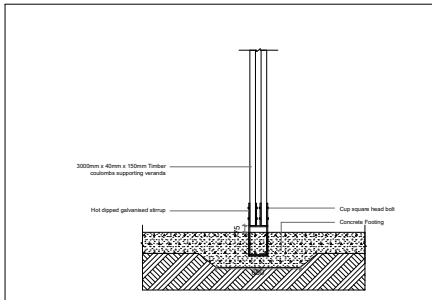
North Elevation
Scale 1:100



Section C
Scale 1:50



Detail C1
Scale 1:20



Detail C2
Scale 1:20

ARCHICAD EDUCATION VERSION

Window and Door schedule

Windows

Widow name	Description	Dimensions	Amount windows
W1	Aluminum window - openable	2500 x 1000	1
W2	Aluminum window	1500 x 1500	7
W3	Bathroom Window	500 x 600	18
W4	Sliding Windows	3000 x 1500	8
W5	Sliding Windows	6000 x 1500	1
W6	Aluminum window	2500 x 1000	1
W7	Aluminum window	3600 x 1000	2
W8	Aluminum window	3000 x 1500	6
W9	Sliding Windows roof to floor	6000 x 3000	12
W10	Sliding Windows	500 x 3800	6
W11	Aluminum window	1800 x 600	24
W12	Sliding Windows	3000 x 2200	3
W13	Sliding Windows	1000 x 1500	16
W14	Sliding Windows	300 x 500	29
W15	Aluminum window	3000 x 3000	1
W16	Aluminum window	3600 x 1000	2

Doors

Door name	Description	Dimensions	Amount windows
D1	Timber interior door	900 x 2100	14
D2	Timber exterior door	900 x 2100	4
D3	Folding Glass door	5000 x 2500	2
D4	Glass front door	1500 x 2100	2
D5	Glass front door	2600 x 1500	10
D6	Double door industrial	2000 x 2100	6
D7	Isolated door	1000 x 2100	6
D8	Timber door	1000 x 2100	3
D9	Glass front door	1500 x 3000	2
D10	Garage door	2500 x 2100	1
D11	Glass front door	1500 x 3000	1

SCHEDULE OF AREAS

GROUND FLOOR LEVEL

Block A

Greenhouse	346
Reception	55
Orientation space	55
Administration	206
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Block C

Unit 1	145
Unit 2	145
Unit 3	145
Total	**434 m²**

FIRST FLOOR LEVEL

Staff Breakaway Room	200
Total	**2531 m²**

PROJECT: ALF	TITLE: Window and Door schedule
DRAWN: C Viljoen	SCALE: -
DRAWING NO.: 4	DATE: 2021 - 11 - 05

SITE DETAILS:
Lorina farm
Eastern Free State
S217
-28.378603, 28.275218.

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA
UFS UV

Department of Architecture, Faculty of Natural and Agricultural sciences, University of the Free State.
Bloemfontein, South Africa.

Carissa Viljoen | 2016035103
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CLIENT:
- Mev I Verhoeven
- Department of Environment, Forestry and Fisheries
- FEDHASA

PART 06

6.1 REFLECTION
6.2 EVALUATION



6.1 REFLECTION

The year 2021 can be described as an ocean. The dissertation being the ocean and me, the student, swimming to try to get to shore. The past year was no playful splash in the small waves, but rather a storm of big turbulent waves with a force so mighty they could drown anyone in their way.

Emotionally the year was filled with mental struggles. The pandemic, strikes, and uncertainties about what would come dotted my emotional landscape and punctuated what was already a confronting year in terms of design challenges. Constantly not feeling good enough, doubting myself, being stressed and being overworked are a few of the most dominant emotions I experienced during the year.

The biggest realization that I made during 2021 was that everyone sees almost everything differently. Besides that, all of us experience everything differently. Everyone has their own opinions about everything. I realized that everyone looking at my design and the idea behind my design has their own point of view, vision and image of what it should be, how the design should look in the landscape and how it should react to it.

Reflecting on the year with this realization in mind, I realized that I tried to create architecture that could appeal to everyone. With strong, opinionated, and diverse supervisors, each with their own style and perspective, I tried to create a design that would please the supervisor that gave me feedback that day or week, constantly changing my design to fit with the "flavour of the week". I lost track of what I wanted my piece of architecture to represent and look like.

In the process, I learnt that I must back myself – my own design and the decisions I made to get there. This doesn't mean that I didn't take constructive feedback to heart, but rather that I reflected on this and thought about how I could use it to improve the design after my own vision of what it should be. Being critical of all the advice and only using that which was relevant to the problem assisted me in developing my design and myself further. I realized that it is normal to have different views about something, like a sandstone wall. No design and no person will be to everyone's liking, but we each find those pieces of architecture and designers that speak to the essence of who we are, and these are the spaces that become places for us – our own personal map of genius loci. I thank my supervisors for never being soft on me and helping to guide my design to what it is today and for teaching me to hold onto my own aesthetic and functional design orientations in the process.

Swimming to reach shore is hard, and it took a lot of hard work, buckets full of tears, blood literally flowing (thanks to the box-cutter blade) and sweat. I survived a very challenging year - only a person who has been in the shoes of an architecture student in a pandemic will understand the emotions I experienced while swimming ashore through the storm. More than anything, I am grateful I made it this far and that I can submit this book.

6.2EVALUATION

As with any design project, there is always room for improvement. Subjectively, I feel the architectural aim was reached when the design of the aquaponic Lifestyle Farm is measured against its core objective of establishing a sense of place and responding sensitively to the landscape.

The touchstone continued to generate several concepts throughout the process, which guided the development and broadening of the design into further conceptual fields. These conceptual underpinnings and the readings formulated the specific design parameters that guided the design process.

The challenges gathered from the client were met by creating an overall design that could generate an income by drawing on all the different elements from which the aquaponic Lifestyle Farm is constituted. This was achieved by introducing the aquaponic Lifestyle Farm to the Eastern Free State, close to existing tourism hotspots. Lastly by using materials, plants and building methods found in this region, growth, development, sustainability, and inclusivity in the tourist industry could be created. Furthermore, these elements combined to create a sense of place where sustainability could take centre stage, through the design and use of the space.

Ultimately, the natural beauty and tranquillity of the Eastern Free State were celebrated. Metaphorically speaking, the Lifestyle Farm was designed to be evocative of a sense of place so emotionally stirring that it would resonate through all the senses, including the echoes of meaning that would travel through the landscape, allowing visitors to literally hear the music in the landscape of the Eastern Free State.

“Listen, can you hear it? The music. I can hear it everywhere. In the wind, in the air; in the light, it is all around us. All you have to do is open yourself up. All you have to do is listen…”

- Freddie Highmore

(August Rush, 2007: online)

Thank you for taking the time to read through my dissertation document and to follow my design process throughout the document. Your time and consideration are much appreciated.

CONCLUSION

By creating an evocative, emotional connection and interaction with the natural environ¬ment, the aim of this project was to bring humans into alignment with the natural world and the sustainable practices that we need to adopt in order to ensure our survival within it. In creating an aquaponic Lifestyle Farm, guided by nature and aimed to connect the human with nature, the principles of biophilia and the patterns of perma¬culture were utilized to create sustainable buildings.

The main goal of architecture is to reveal the true potential of a place and to place your design into perspective with its surroundings. Norberg-Schulz (1980: 23) implies that an essen¬tial role of architecture is to provide the physical features of a place that allow a person to dwell. When a person feels safe he or she will remain there and this allows a peaceful place to be established.

The aquaponic Lifestyle Farm's design aimed to provide visitors with a visual experience of nature by integrating the environmental features into the design. Biophilic design principles were applied to transform nature into a space of pleasant and multi-sensory experience through incorporating elements like water and light to explain how nature can promote well-being and a sense of place.

The aquaponic Lifestyle Farm design aimed to complement the natural environment and to establishing a Genius Loci, a specific space with a particular character. Designing the aquaponic Lifestyle Farm made it possible to create a symbolic interpretation of the natural world by introducing an innovative eco-friendly farming method (aquaponics) to the Eastern Free State and therefore relate to sense of place and human being's ethical re-sponsibility for the care and sustainability of the natural world.

Permaculture, a design science rooted in observing and recognising patterns in nat¬ural ecological systems, contributed in finding practical solutions by using nature-in¬spired principles in designing the aquaponic section of the Lifestyle Farm (a productive ecosystem with the stability, diversity, and re¬silience of those found in the natural world).

PART 07

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7.2 REFERENCES

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