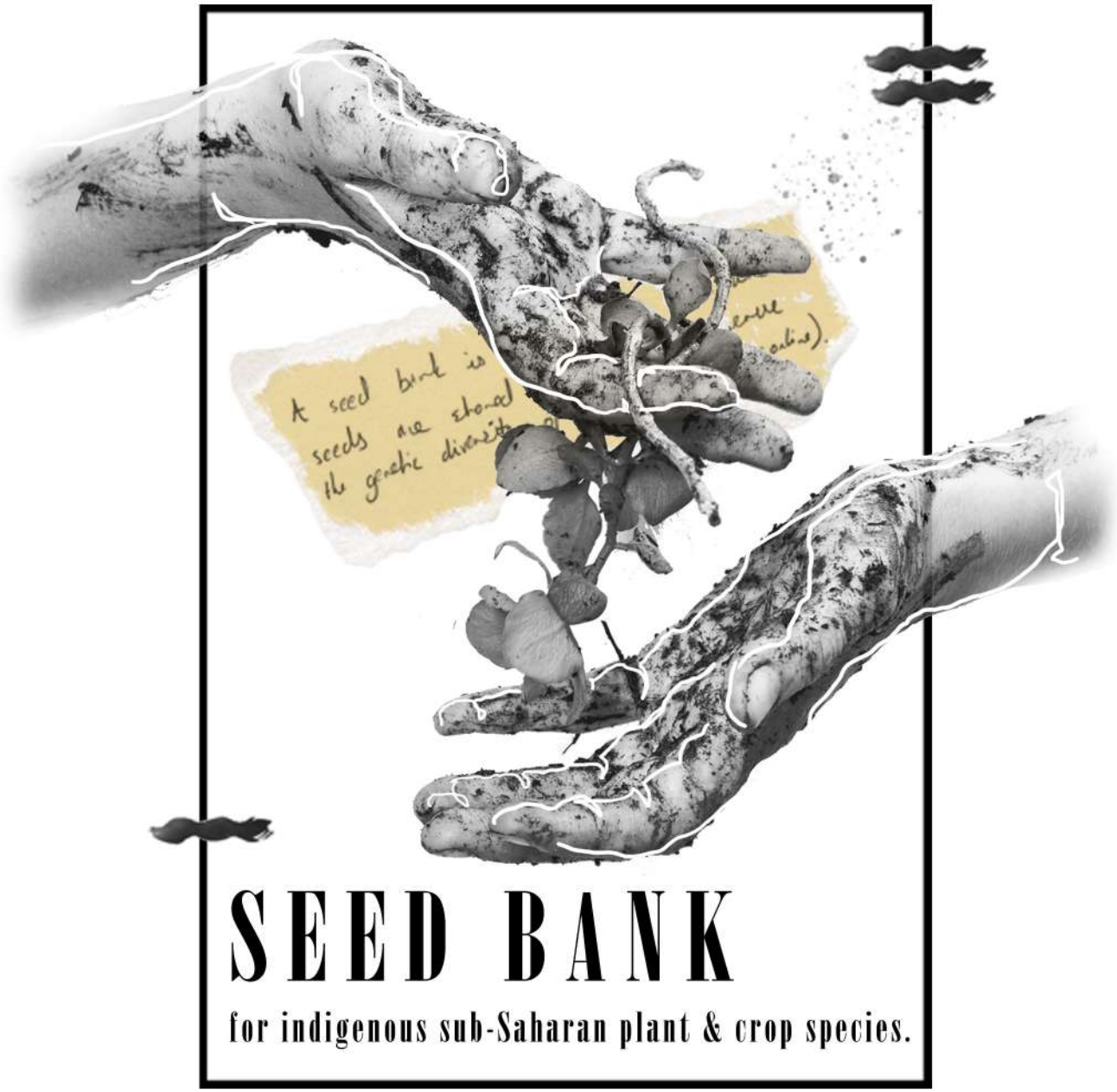

Phillip du Preez | 2015043983

Figure 1 - Book cover (Rees: online. Adapter by author).
Figure 2 - Landscape with alonestanding house inserted (online. Adapter by author).

“It is as though the picture of this
house
had fallen into me from an infinite height
and had
shattered against my
very ground.”

- Rilke in Imagination and Imagery in Architecture *(Pallasmaa, 2011: 126).*

- Phillip du Preez, Author

Figure 2 - Photograph of self (Du Preez, 2021).

Firstly, to the orange cubicle of 2021-
Thank you for an unforgettable year of laughter that I'll look back upon
with the utmost of fondness.

Lastly, to **my parents**-
Your unending encouragement, love and sacrifices made so that I can
pursue my dream means the world to me.
I dedicate this to you and the rest of my family,

with love.

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

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

Supervisors: Jan Ras, Prof. Jan Smit, Mrs Petria Smit
Date of submission: 15 October 2021

Declaration of original authorship:
The work contained in this dissertation has not been previously submitted to meet requirements for an award at this or any other institution of higher education. To the best of my knowledge, this dissertation contains no material previously published or written by another person except where otherwise stated.

Signature:

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"For a seed to flourish as nature intended it needs to be buried in soil. From the ground it then rises up as new life promising future, hope and the continuation of its species. For human however, its the exact opposite. We live above the soil, hide things in it, utilize the natural landscape and when our time comes we return to it.

As human we are dependant on the very resource that grow from many people's final resting place. It is a grave and thus symbolizes death and holds no promise for the future. By preserving a food/life source underground within its own temporal grave gives meaning to a place with contrasting meaning for itself and humans. Thus this temporal grave now hold within its borders a promise of life and the continuation of plants and human species."

- Author

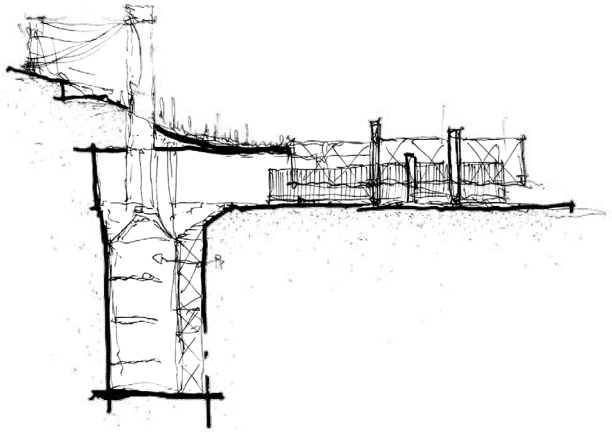

Figure 3 - Conceptual development sketch (Du Preez, 2021).

Figure 4 - Tafelkop Farm (Du Preez, 2021).

INTRODUCTION

The proposed design aims to create a Seed Bank for indigenous sub-Saharan plant and crop species that will be located on the outskirts of Bloemfontein, Free State. This facility integrates on-site preservation processes in parallell with research on the preservation of seeds.

The Seed Bank will function as a proactive catalyst for combatting climate change, food shortages, natural and made disasters pertaining to agriculture. It will be a point of exchange where the farmer can contribute seed samples and also have access to alternative seed species and research that can increase yield and preserve soil integrity. The facility is a statement of the importance that seed biodiversity holds for the survival of future generations that is in dire need of food security. Furthermore, the greenhouses will ensure the education and viability that non-indigenous plant species could contain as growing conditions will be simulated within a controlled environment. Local plant and crop species will be planted on large scales so to continuously retrieve new seed samples.

The design is placed amidst already existing agricultural activities and will aim to be critical regionalist whilst ensuring a humane design as it will stand for many generations and serve as a beacon of hope in the open landscape. Ensuring the spirit of place is emphasized and embodied the design will strive to be identifiable, but timeless in relation to its function and context.

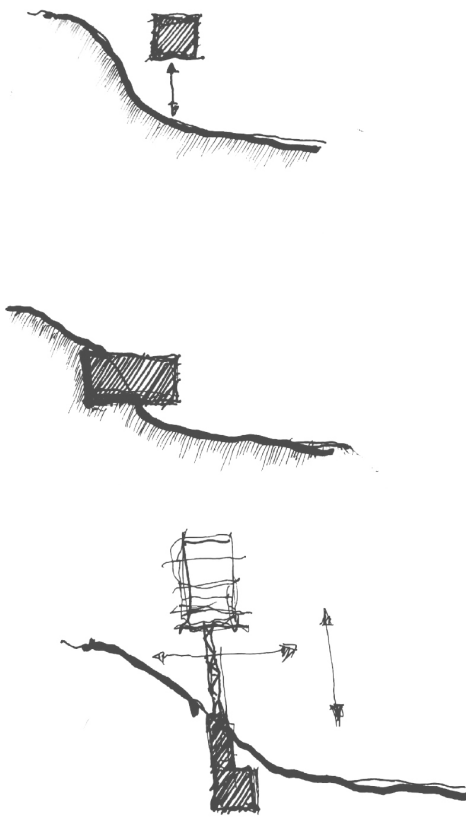

Figure 5 - Initial site investigation (Du Preez, 2021).

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PROJECT RATIONALE

1.1 Chapter outline
1.2 Project rationale
1.3 Statistical data
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- Topology
- Morphology

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- Aim

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- Aim
- Site justification

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Project references

Part 01

PROJECT RATIONAL

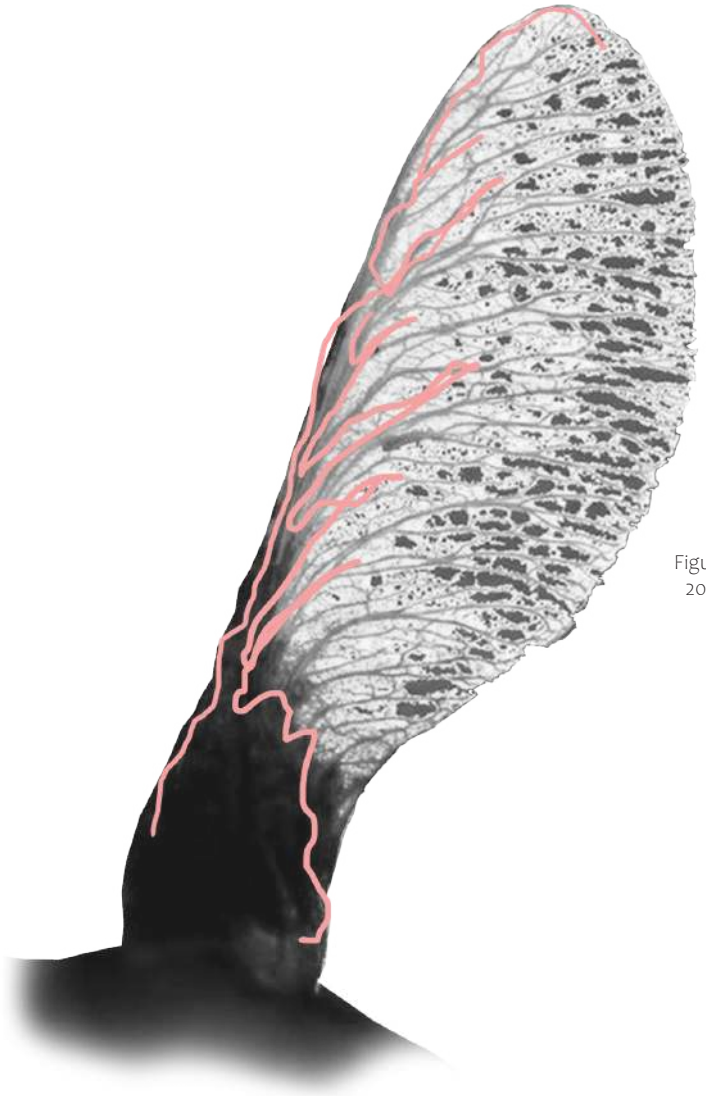


Figure 6 - Sycamore seed (Schoeny, 2014: online. Adapter by Author).

How may a critical regionalist architectural approach facilitate the prolonging of natural life cycles in Sub-Saharan Africa through the design proposal of a seedbank, with the aim of facilitating the adaptation of flora in the planet's ever-changing climate conditions, whilst enriching food security and plant diversity for future generations?

RESEARCH QUESTION

1.2 PROJECT RATIONALE

The project rationale will aim to orientate the reader as to the intentions and explorations of this dissertation, mainly pertaining to the design proposal of a Seed Bank on Tafelkop farm in Bloemfontein, Free State. Furthermore, the site and context in which the Seed Bank is grounded in is explored. Through illuminating site conditions and existing infrastructure as well as statistical research pertaining to the agricultural landscape this section will not only showcase why a Seed Bank is a valuable investment, but also why it has become a necessity for our future survival.

Aims:

Provide a general overview of a Seed Banks' purpose and the impact such a facility will have in our environment.

Africa as a continent has predominantly always been dependant on its natural resources and agricultural practices in order to provide for its populations. Through research on contemporary farming practices' lack of crop diversity and the dependency on agriculture to provide food security, it becomes evident that the need for securing and safeguarding genetic material has become paramount.

The establishment of a research facility which will assist in combatting the growing climate crisis being faced worldwide through preserving and researching plant and crop species that can flourish in changing conditions.

A Seed Bank cannot only be contingent on indigenous plant and crop species if it is to fully realize its purpose. This section will also illustrate the various regions within sub-Sahara Africa where seeds are to be gathered from.

1.2.1 PURPOSE OF A SEED BANK

1.2.2 CROP DIVERSITY IN CONTEMPORARY FARMING PRACTICES

1.2.3 RESEARCH & PRESERVATION COMBATTING CLIMATE CRISIS

1.2.4 REGIONS OF SEED SAMPLING AND GATHERING

WHY

Currently on earth there is an approximate of 390,900 plants known to science (excluding algae, hornworts, liverworts and mosses) with 21% of current plant life at risk of extinction (Morelle, 2016: online). Plants and crops are at the base of our food intake and way of life and if there is nothing left to plant the world would go hungry. They also provide us with resources such as medicines, food and combat climate change (Morelle, 2016: online). Seeds promote biodiversity, enable ecosystems to adapt to change and have the capability to regenerate an entire species. Furthermore the preservation of seed biodiversity is another way of preserving historical and cultural values for future generations. A Seed Bank can thus be seen as a living library containing genetic information on the evolution of plant life on earth (TraceSource, 2021: online). When addressing the functionality of a Seed Bank on present day societies it is of extreme value in ensuring our futures. Seed Banks and research facilities are able to use plant genes to increase yields, nutritional value, disease resistance and drought tolerance in agriculture (TraceSource, 2021: online).

In order to illustrate an overview of the benefits of Seed Banking here are five core aspects to serve as an overview that will be elaborated on in following paragraphs.

1. Preservation of crop diversity

Due to the adaptive nature of plants there exist variants versions of same species due to its adaptive nature. Preserving this diversity is of critical importance for life on earth's adaptation to continuous change.

2. Protection from climate change

In the last century and even decades radical changes in climate was accelerated by factors such as industrial pollution. With such extreme changes in conditions plant species cannot adapt fast enough and extinction is inevitable. To prevent the extinction of plants and crops essential to life on earth Seed Banks are a necessity.

3. Protection from natural and man-made disasters

Natural and man-made disasters have devastating effects on plant life on earth. Tsunami's, hurricanes, wildfires, civil wars etc. are all events that could wipe out crops. In these cases Seed Banks have the capacity to provide stored seeds so that replanting can take place securing food security and diversity.

4. Disease resistance

The same principle applies to diseases that can completely decimate farmer's crops leaving nothing to start over from.

5. Provision of seed material for research purposes

Seed Banks have the capacity to scientifically research and study seeds that could lead to better understanding and utilisation of crops being better adept in certain conditions. It can assist with better crop yields and species that are disease resistant mitigating the need for artificial pesticides and more (Bethany, 2017: online).

The geographical pattern of modern extinction in seed plants.
Hawaii stands out as having the most recorded extinctions (79), followed by the Cape Provinces of South Africa (37) and Mauritius (32), with Australia, Brazil, India and Madagascar also being among the top regions (Humphreys, et al. 2019: online).

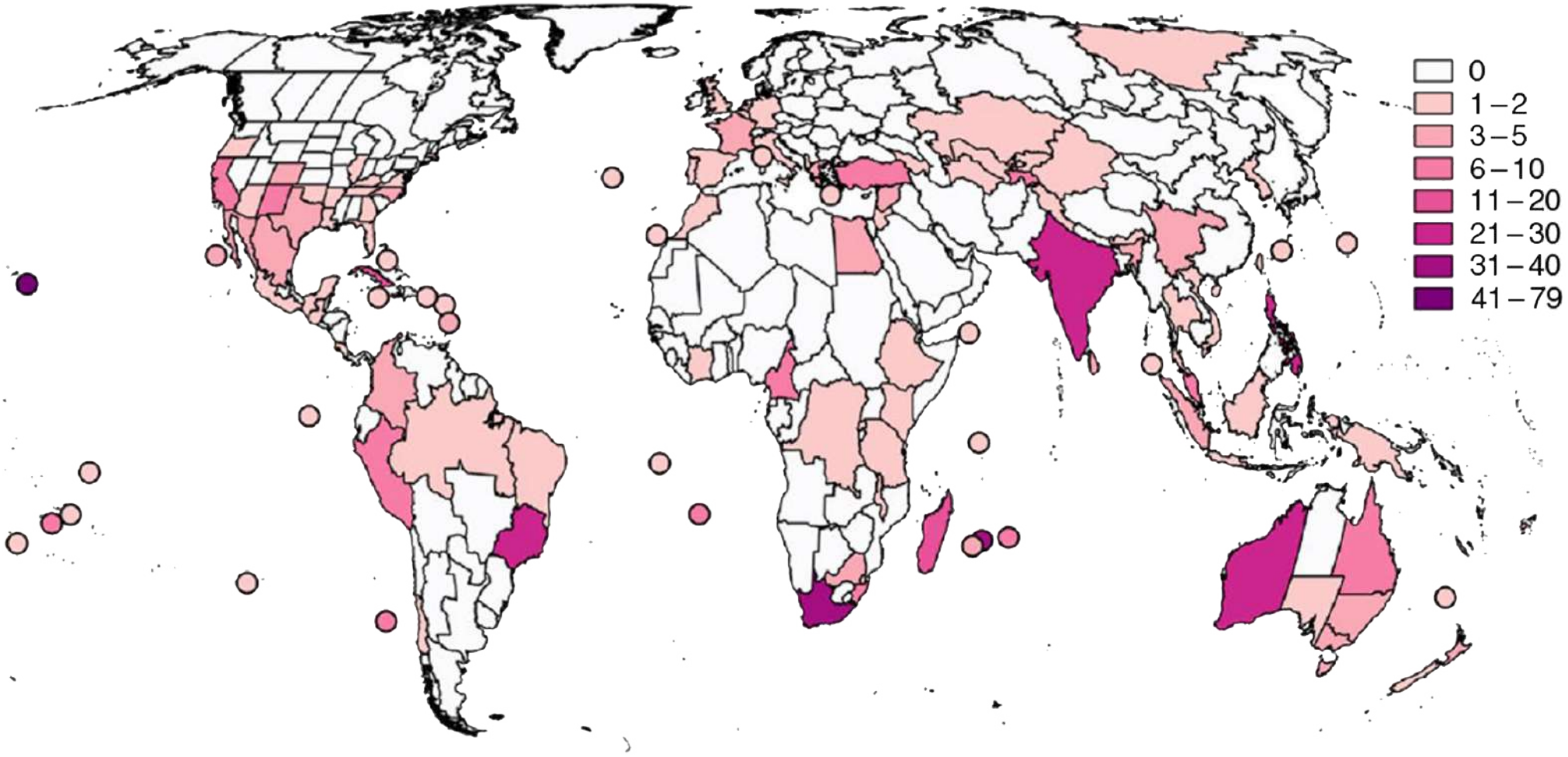


Figure 7 - Modern world map illustration of areas where seed plant species have gone extinct (Humphreys, et al. 2019: online).

In recent decades, Sub-Saharan Africa (SSA) had to overcome a variety of challenges such as population growth, food insecurity, urbanisation, climate change and natural disasters (Jayne et al, 2021: 47). Despite these challenges agriculture play a core role in SSA and has achieved the highest rate of growth in the agricultural sector globally since 2000. This growth however is largely attributed to the expansion of cropped area and not productivity growth (Sakho-Jimbira and Hathie, 2020: 2). Currently worldwide the diversity in agricultural crop yields has drastically decreased with humanity's calorie intake 90% reliant on just wheat, maize and rice (Kimbrough, 2020: online). This is an alarming figure because as populations increase, land availability tends to get scarcer and food demands go up. The end result is large scale farming operations focusing on only a few specific market oriented crops in order to satisfy demands. Furthermore, Sub-Saharan Africa is largely dependent on its cereal produce to meet demands of food security and the aim of being food self-sufficient by 2050. This seems highly unlikely as by this date its population will have increased 2.5-fold, tripling cereal demands. Current consumption of cereals are already dependent on large scale imports which suggests that the only way this demand is going to be met is with major expansion of agricultural areas leading to biodiversity loss and increased greenhouse emissions (Van Ittersum et al, 2016: online).

In terms of food demands and growth it is important to understand that Africa is the fastest growing region in terms of population globally. By 2050 it is expected to reach 2.2 billion people and over 4 billion by 2100. Africa will not have reached its maximum population size within the century. Sub-Saharan Africa could accounvt for growth of 1.05 billion people between 2019 and 2050 which would account for more than half the world's population growth within that time period (Sakho-Jimbira and Hathie, 2020: 5). With such an unprecedented growth in population there is also larger strain on agriculture to ensure food security. Africa has the youngest population worldwide with 70% being under the age of 30. Of this figure about 40% work in agriculture of all scales. Therefore the link between crop diversity, agriculture, job opportunities and food security cannot be mistaken (FAO, 2015: 39). One relies on the other and without sustainable farming practices that embraces diversifying crop yields ensuring soil quality persists, none of the other factors can continue under current demands (Sakho-Jimbira and Hathie, 2020: 3-7).

Within South Africa just as in the rest of SSA the health of our agricultural sector depends on sustainable farming methods (Goldplatt: online). The combination of climate conditions and usable soil leaves only 12% of the country suitable for crops that are rain fed. A mere 3% is actual fertile land suitable for planting. This have seen the sector move towards intensified agriculture to meet demand, however, these practices are mostly non-resilient and negatively impact the environment. Long term soil fertility is drastically reduced due to dependence and over usage of pesticides, herbicides and synthetic fertilisers resulting in soil erosion, polluted water supplies and damages ecosystems. For example, it is estimated that only about 0.1% of sprayed pesticides actually reaches the target pest. The pest ends up in the environment having a devastating effect on biodiversity and can persist for generations to come. Farmers are thus unable to adapt to climate change and contribute negatively to the environment through toxins and greenhouse gas emissions (Goldplatt: 9 - 15).

South Africa currently has a highly market oriented agricultural economy which consists of all the major grains (except rice) (ITA: online), but is still not food self-sufficient (Greyling, 2015: online). The local grain industry contributes to more than 30% of the total gross value within the agricultural sector (ITA: online). The region furthermore faces large challenges in terms of being a rain deficit country and having to deal with extremely variable rainfall (Goldplatt: online). Maize is a staple grain throughout SSA and South Africa is one of its largest producers however, alternative crops will need to be utilised as climatic conditions become more unstable. Studies suggest that in future growing maize will be unviable despite 40% of SSA producing the crop. Other crop species such as millet and sorghum have higher heat and drought tolerances are good examples of alternate crop investigations (Goldplatt: online).

Figure 8 - Tea plantation worker, Uganda (Geographic travel blog: online. Adapted by Author).

Wheat is another staple grain in South Arica, but has considerable fluctuations in produce annually due to a downward trend in supply and increase in demand. South Africa has become dependent on imports almost three times the amount of local yields in order to meet demands. Furthermore with declining wheat prices and changing climate conditions farmers tend to move on to other crop varieties -thus the downward trend of area planted to wheat in recent years. There are also forecast that this trend will be continuing into the foreseeable future with South Africa's wheat consumption being the highest in Sub-Saharan Africa (ITA: online).

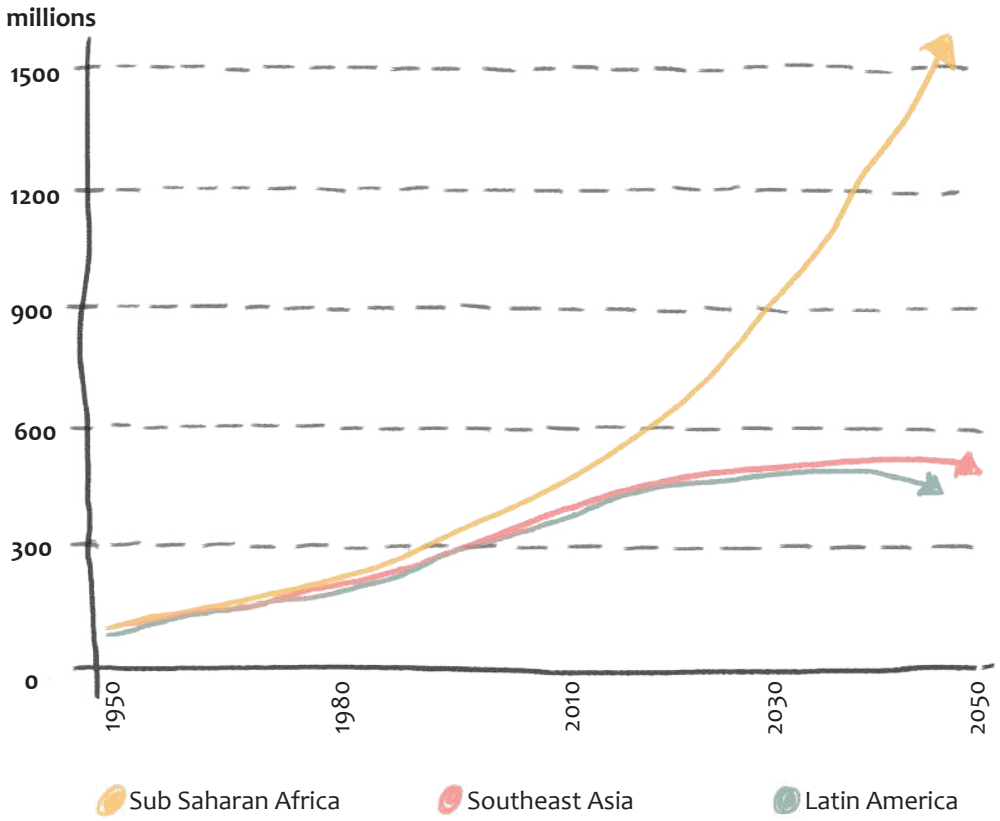
With the aforementioned data it is plausible to state that along with population growth, climate change is one of the major factors driving food insecurity and biodiversity loss. Seed Banks have the capacity to prevent species loss and assist the adaptation of crops in these areas. The following chapter will explore the impact climate change continues to have on the agricultural sector showcasing the importance of preservation and proactivity in this sector.

*Agriculture has done more to reshape the **natural world** than anything else we humans do, both its landscapes and its **fauna and flora.** Our eating also constitutes a **relationship** with dozens of other species - plants, animals and fungi - with which we have co-evolved to the point where our fates are deeply **intertwined.***

-Michael Pollan, The Omnivore's Dilemma (Goldplatt: online).

Trend in working age population (15-64) in Africa

Figure 9 - (World Economic Forum, 2017: 5. Adapted by author).



Within the African continent increasing populations live below the poverty line and are affected by acute food insecurity, malnutrition and famine. These food shortages are the result of varying factors such as climate change, prolonged droughts, civil wars, political challenges and diseases such as HIV/AIDS and currently COVID-19. Drought frequency and intensity have generally increased globally which poses a great threat to world food security (Ngcamu and Chari, 2020: 1).

Southern Africa is frequently confronted by a debilitating water deficit. Within the SSA region South Africa is classified as a water-scarce country and characterised by variable rainfall (Goldplatt: 10). Studies forecast that if the country is to meet growing food demands water use will have to be doubled by 2050 which means water use efficiency will have to be increased (Goldplatt: 11).

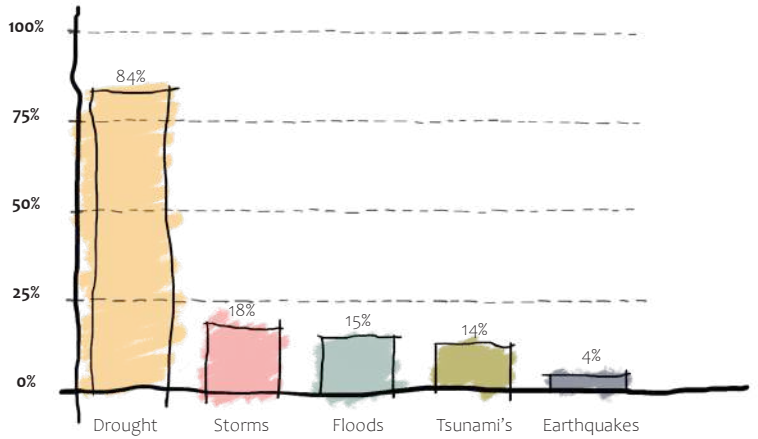
Studies indicate that drought and water scarcity has some of the most devastating impacts of agriculture and specifically crop yields. Roughly the crop subsector absorbs 42% of the total damage and losses caused by disasters such as droughts (FAO, 2015: 12). During the 1991/92 drought in Southern Africa the region received less than 70% of the average rainfall and up to 70% of crops failed. This resulted in food imports six times higher in volume than normal. In South Africa alone the drought resulted in 49 000 agricultural jobs being lost and a further 20 000 jobs in related sector (FAO, 2015: 41). Just over two decades on in 2015 South Africa found itself in the grip of yet another devastating drought attributed to the El Niño phenomenon, recording its lowest rainfall since 1904. As the main agricultural producer in the region the drought put tremendous strain on food production. Furthermore despite being a naturally dry country five of its nine provinces were declared disaster zones (Piesse, 2016: 1-3). Thus illustrating the devastating and far reaching effects of drought on society as a whole (FAO, 2015: 41).

Agriculture is highly susceptible to climate variability and change. If no risk reduction and adaptation measures are put in place, enhanced exposure to drought will further compromise food security in sub-Saharan Africa
(FAO, 38: 2015).

*Agriculture is highly susceptible to **climate variability and change.** If no risk reduction and adaptation measures are put in place, enhanced exposure to drought will further compromise **food security** in Sub-Saharan Africa*
(FAO, 38: 2015).

Damage and losses to the agriculture sector by type of hazard

Figure 10 (FAO, 2015: 13. Adapted by author).



***Drought** is regarded as a prolonged period where the normal rainfall drops below the average and which results in a **decline of water** in reservoirs, a decrease in stream flow, and damage in crop plantations. Drought is broadly defined as "a deficiency of precipitation over an extended period, usually a season or more, which results in a water shortage for some activity, group, or environmental sectors"*
(Ngcamu and Chari, 2020: 2).

Trend in working age population (15-64) in Africa

Figure 11 (FAO, 2015: 45. Adapted by author).

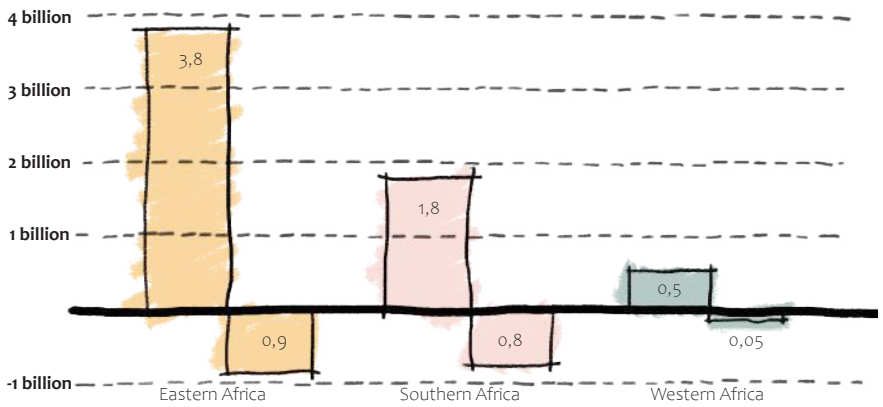


Figure 12 - Working hands (Rehahn Photography: online).

- Worldwide humanity's calorie intake is 90% reliant on just three crops; wheat, maize and rice (Kimbrough, 2020: online).
- Long term soil fertility is on the decline due to contemporary farming practices (Goldpatt: 6 – 15).
- South Africa is not food self-sufficient and has become dependent on wheat imports three times the amount of local yields (Goldplatt: online).
- Five out of Nine South African provinces declared disaster zones in 2015 due to the El Nino phenomenon and is still considered a water scarce country within the SSA (FAO, 2015: 41).
- The crop subsector absorbs 42% of losses caused by natural disasters such as drought (FAO, 2015: 12).
- Africa has the fastest growing population globally placing tremendous strain on the agricultural sector and food security (Sakho-Jimbira and Hathie, 2020: 5).
- 21% of current plant life is at risk of extinction (Morelle, 2016: online).

The following is a list of countries (refer to figure 13) that are grouped as 'Sub-Saharan Africa' and will form the collective corpus where seeds are retreived from (The Royal Society: online).

1. Angloa
2. Benin
3. Botswana
4. Burkina Faso
5. Burundi
6. Cameroon
7. Cape Verde
8. Central African Republic
9. Chad
10. Comoros
11. Republic of the Congo
12. Democratic Republic of the Congo
13. Cote d'Ivoire
14. Djibouti
15. Equatorial Guinea
16. Eritrea
17. Ethiopia
18. Gabon
19. The Gambia
20. Ghana
21. Guinea
22. Guinea-Bissau
23. Kenya
24. Liberia
25. Madagascar
26. Malawi
27. Mali
28. Mauritania
29. Mauritius
30. Mozambique
31. Namibia
32. Niger
33. Nigeria
34. Rwanda
35. Sao Tome and Principe
36. Senegal
37. Seychelles
38. Sierra Leone
39. Somalia
40. South Africa
41. South Sudan
42. Sudan
43. Swaziland
44. Tanzania
45. Togo
46. Uganda
47. Zambia
48. Zimbabwe

Figure 13 - African continent showcasing countries in the SSA (Author, 2021).

01 PART

The project rationale should orientate the reader to comprehending the dissertation outline in terms of typology, topology, morphology and structural application. This section should serve as a justification as to why this is a suitable project addressing a problem within its immediate and broader context leading to formulating the main research question.

02 PART

Through elaborating on problem statements and aims for concepts mentioned in the project rationale this chapter will cast light on the investigative process. Clients, users, site conditions and overall aims are discussed in order to gain a more complex understanding of the project.

03 PART

The exploration and grounding will explore the project's design process from conceptual stage up to its theoretical grounding. This will thus be done again according to typology, topology and morphology. The section's outcome will be to have addressed underpinned issues in Part 1 and 2 through the various stages of design development.

Figure 14 - Document framework (Author, 2021).

04 PART

This part explores the final outcome of the dissertation as to how the theoretical grounding and relevant research has translated into a poetic interpretation and work of architecture. Relevant drawings and documentation are also included.

05 PART

This section serves as a critical analysis on the development of the dissertation and reflects on the implementation of aforementioned chapters' success into a final design solution.

06 PART

A comprehensive bibliography of sources utilized for this dissertation document will enable the reader to use aforementioned information for further research and reading.

HOW

RESEARCH IN DESIGN METHODOLOGY

RESEARCH METHODOLOGY

The research method followed can be divided into two key parts. The first is research through design and the second is a more theoretical approach. The various investigations will be guides to arrive at a suitable architectural solution. Refer to figure 12.

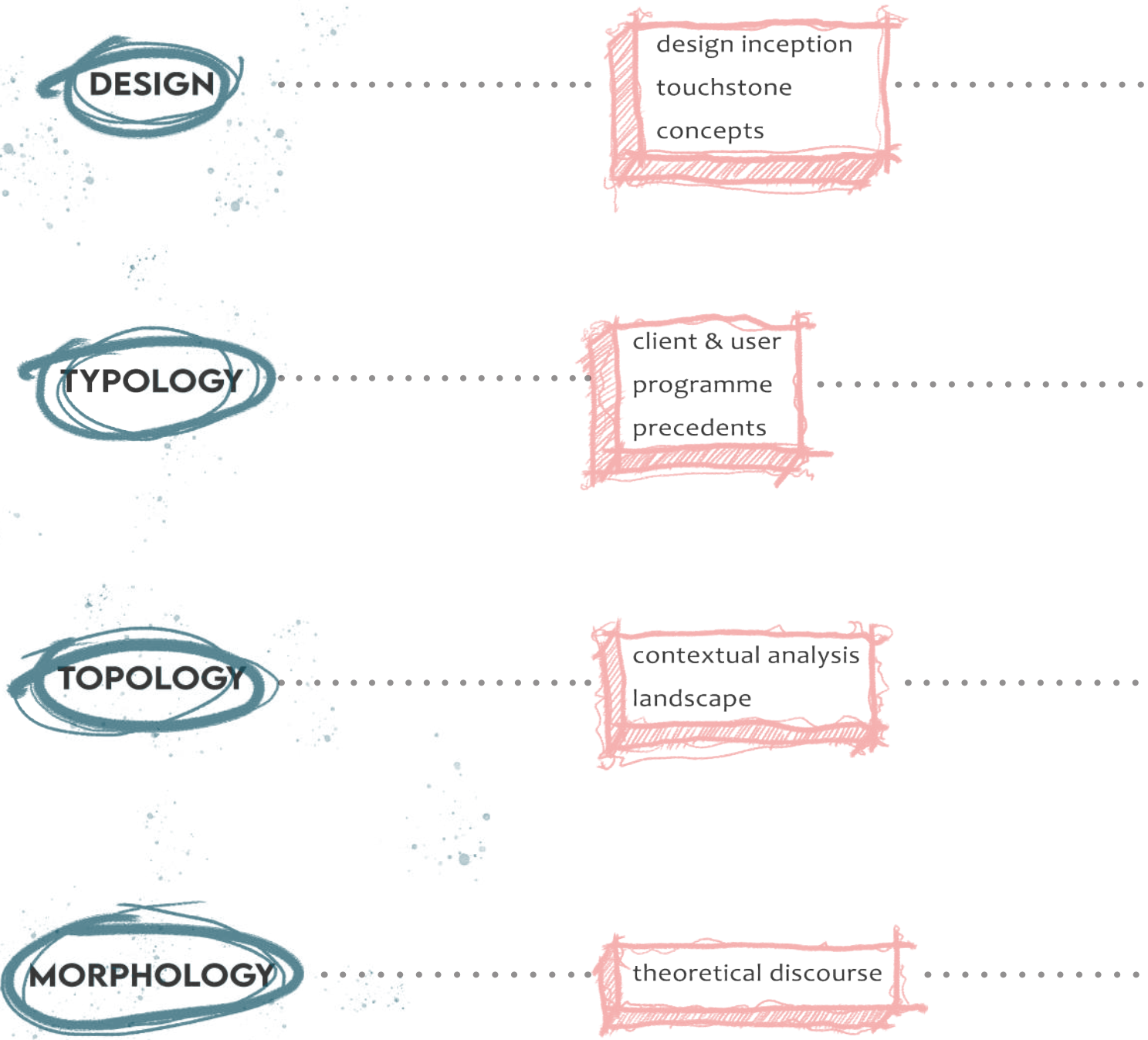
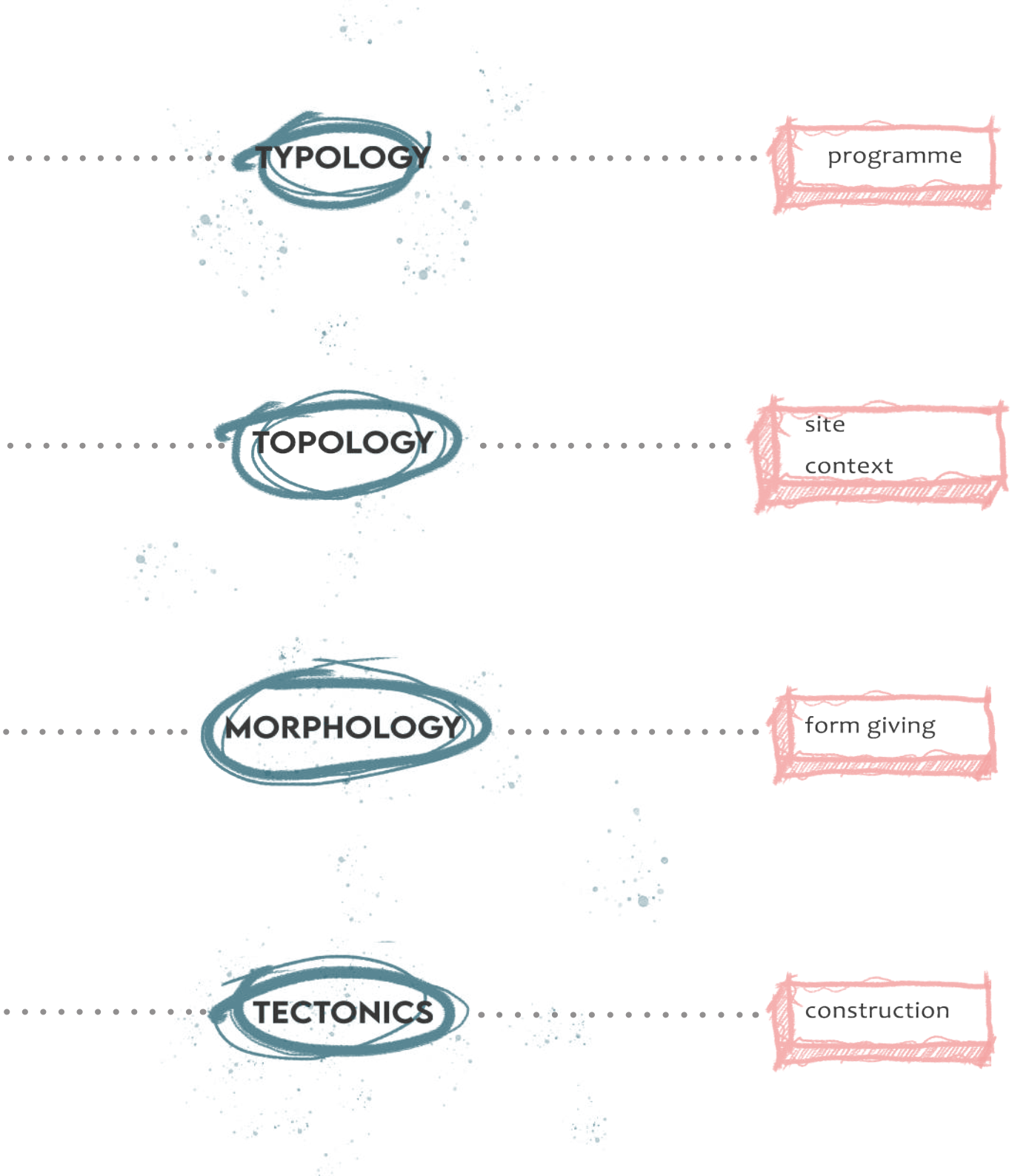


Figure 15 - Research methodology flow diagram (Du Preez, 2021).

DISSERTATION RESEARCH METHODOLOGY



Typology

Precedent and case studies that explore functions in order to arrive at a suitable programme that will best address the project rationale. This ultimately impacts the character of the building and the arrived at programme should align with the needs of the users and core functions.

Topology

Surrounding context greatly impacts the design as a topological investigation question the buildings relationship with its environment. Surrounding built structures and infrastructure is looked at to underpin the relevance of the chosen site. This also include being climatically responsive to the chosen site's conditions.

Morphology

The morphological exploration of built form and the effect it has on spatial quality as well as the relationship with the outside world will be a pivotal indication of design appropriateness within the landscape. Built form is explored through physical models, hand drawn sketches and also 3D modelling technology.

Tectonics

Within a building that is highly functional in its design the structural approach is a physical expression of context and culture. Tectonics thus speaks of structural systems, construction methods and an understanding of materiality.

Part 02

CHALLENGES & AIMS

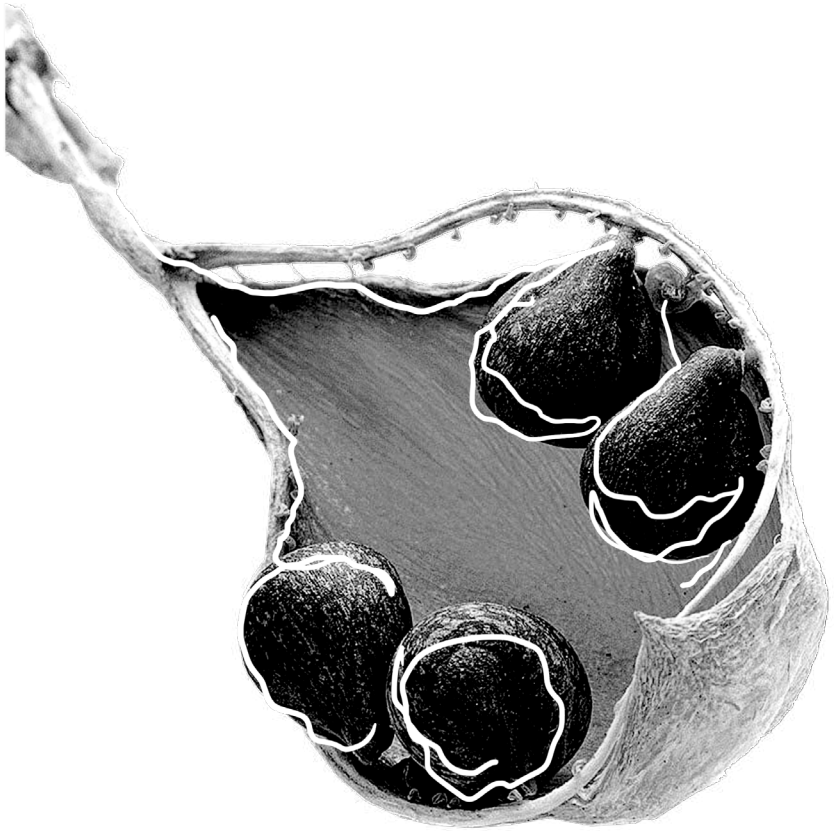


Figure 16 - Isomeris arborea (Laurent, 2014: online. Adapted by Author).

PROJECT CHALLENGES AND AIMS

In order to accurately inform the architectural intervention a client and user profile is investigated. By understanding the various practical outcomes achievable with current brief a more comprehensive list of accommodations can be formulated. This forms a pivotal part of the project's investigative process to arrive at a well-rounded architectural approach

USER

The users of the proposed building will be researchers, scientists, horticulturalists and farming communities. The building should act as a platform for information sharing and cultivating trust between local as well as international communities that is beneficial to the environment. All of these groups work together towards the goal of protecting biodiversity for future generations.

CLIENTS

The client profile is pivotal to realising the goal of preservation and conservation. The client body consist of three entities each crucial within their respective roles. A well rounded and diverse organisation will ensure the successful integration and continuation of research within the agricultural and conservationist community. Refer to figure 17.

Figure 17 - Client profile diagram (Du Preez, 2021).

AGRI SA

The history of Agri SA span over a century originating in 1896. It was at the Natal Farmers' Conference (also known as 'Kwanalu') where farmers expressed their need for an organisation structured to meeting their requirements and protect their interests within the industry. Following this in 1903 in Bloemfontein agricultural stakeholders voiced their support for greater unity within the broader farming community. This resulted in the forming of The South African Agricultural Union at a Pretoria conference that same year. In 1999 SAAU transitioned into what is now known as Agri SA.

The vision on Agri SA is to create an inclusive and thriving agricultural sector by cooperating with its nationwide members and accommodating their needs whilst protecting the interests of the broader community.

Agri SA consists out of a Corporate, -Commodity and Provincial Chamber that enables the organisation to be at the forefront with their members and develop the sector from the ground up.

The Provincial Chamber consists of:

- Agri Western Cape
- Agri Eastern Cape
- Kwanalu
- Mpumalanga agriculture
- Limpopo agriculture
- Agri North West
- Agri Northern Cape
- ***Free State Agriculture***
- Agri Gauteng

Agri SA along with the provincial branch will be the connection to the independent private sector. They will be the link to the farmers' communities and stand as a reputable organisation instilling trust within the people. Agri SA's role is also pivotal as an independent organisation from government institutions ensuring high quality control, sustainable practice, continuity and a connection into farming communities across the country (Agri SA, 2021: online).

Figure 18 - Agri SA logo (online, 2021).

SANBI

SANBI stands for 'The South African National Biodiversity Institute'. SANBI's history stretches from the early twentieth century and was formed out of the National Botanic Gardens (NBI) organisation.

It became SANBI on 1 September 2004 in terms of Act 10 of 2004 as signed by then president Thabo Mbeki. It is one of the foremost contributors of South Africa's sustainable development. The organisation facilitates access to biodiversity data which is vital in generating knowledge and shared information. They're primary focus is also on conserving and preserving the country's natural biodiversity in botanical and zoological gardens. Thus they lead research expeditions, coordinate research and engage in ecosystem rehabilitation. The institution believes that continuously bettering our knowledge of biodiversity leads to a greater comprehension of conservation and preservation of biological resources.

The organisation's mandate is to; *"explore, reveal, celebrate and champion biodiversity for the benefit and enjoyment of all South Africans"*.

SANBI's role is to facilitate a voice and access to the global seed preservation community. Currently the institute is already partnered with the Millenium Seed Bank Project (MSBP) allowing shared research and cooperation in collection and seed storage (SANBI, 2021: online).

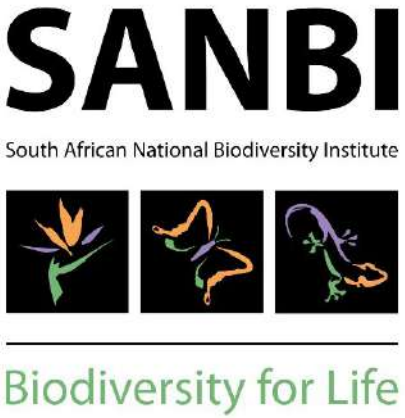


Figure 19 - SANBI logo (online, 2021).

MILLENNIUM SEED BANK PROJECT (MSBP)

The MSBP is a program run from Kew Gardens' Millennium Seed Bank in the UK. The program collaborates with conservation and preservation organisations across 50 countries. Previously it has been partnered with SANBI for 15 years and through this partnership a variety of diverse flora has been safeguarded from extinction. Furthermore the MSBP collects and banks seeds of indigenous plant species from South Africa with specific concern on species in danger of extinction.

Through this partnership 10% of South Africa's flora (2 500 species) has been protected and documented. This also ended up in the rediscovery of plant species thought to have been extinct.

The MSBP along with SANBI will allow the Seed Bank access to global databases and documented material vital for research. It will furthermore be another safety measure for Sub-Sahara African seeds to be collected, duplicated and sent for preservation in the UK (SANBI, 2021: online).

Figure 20 - MSBP logo (online, 2021).

PROJECT CHALLENGES RELATING TO TYPOLOGY

Worldwide plant and crop species are in danger of going extinct and Sub-Saharan Africa is no exception. As a result of habitat loss, invasive species and various other threats several plant species are endangered. In this project the marriage of science and conservation with agriculture and its community will have to be sensitively articulated. This comes from the design's relationship with the site and its method of construction as well as material use. The typology is thus determined also according to client and user requirements including specific requirements of seed storage and research facilities.

Relevant precedent studies that helped guide the design and technical process:

- Svalbard Global Seed Vault
- Millenium Seed Bank
- Zeitz MOCAA
- UFS Greenhouses
- Centre Georges Pompidou

AIMS RELATING TO *TYPOLOGY*

The typological aim is to communicate the buildings essence whilst relating to user and landscape alike. The building should be a critical regionalist response with a sense of place respectful of landscape. The project will furthermore aid in job creation and establish ties within the community spreading awareness when it comes to protecting bio diversity. Farmers, community leaders, academics etc. will have access to the building and be able to receive data, knowledge and learn better methods within contemporary farming and conservation practices.

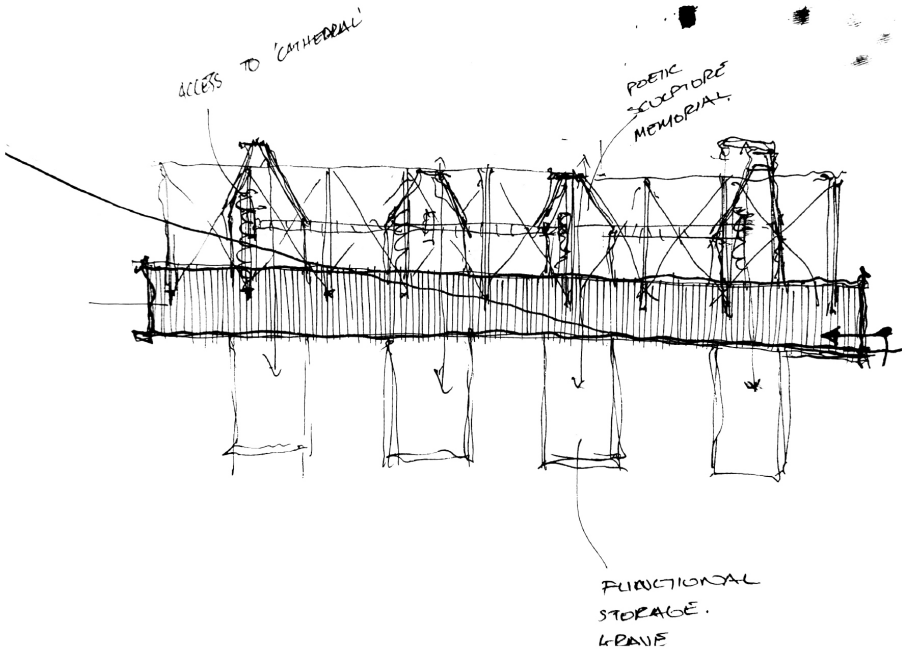


Figure 21 - Development sketch for typology (Du Preez, 2021).

PROJECT CHALLENGES RELATING TO *TOPOLOGY*

A topological challenge is the translating of context and landscape into a functional industrial-like building. Another challenge is highlighting the relationship between interior and exterior in a manner that emphasises the natural wonder of the Free State landscape. Accessibility to the facility are of pivotal importance as it is situated within a natural landscape and access will have to come in the form of a new entrance and exit road. Furthermore the building's connection to the landscape must be sensibly and carefully considered. A larger challenge is sustainability in terms of services such as new drainage systems and electricity due to no existing municipal connection on site.

PROJECT AIMS RELATING TO *TOPOLOGY*

A topological aim would be a clear point of entry for staff, guests and most importantly- the transportation of seeds. As this is a more industrial process driven design a challenge is to install services that operate as sustainable and sensitive to the environment as possible. Furthermore the rehabilitation and effective usage of land in order to cultivate crops within the site parameters that serves as research fields for scientists.

CHOSEN LOCATION FOR PROJECT

The chosen site is located on the outskirts of Bloemfontein on Tafelkop Farm. It is amidst flourishing agricultural activity within the Free State province and adjacent to grain storages for various companies such as Senwes and Icon Foods International.
The chosen location for the seedbank is based on technical aspects important to project viability. Firstly is accessibility as the site is located a mere 14,6km / 20min from Bram Fischer International Airport (Google Maps, 2021: online). Thus ensuring secure and easy international travel or seed transports, but still remote enough for proper safeguarding of resources.

Further key aspects considered for site location is:

- A socially stable area within reach of security and emergency personnel
- Suitable for adequate drainage and an absence of flooding
- No chemical or fuel storage facilities in nearby vicinity
- Easy access to facility from existing road infrastructure
- Undeveloped site

(Cromarty, et al, 1982: 18)

Due to chosen location being a virgin landscape it ensures the ability for future expansion and space to cultivate fields for research on-site. Farming equipment needed for cultivation and infrastructure maintenance can be kept on-site and alternative electrical/energy solutions such as solar energy can also be implemented on site.

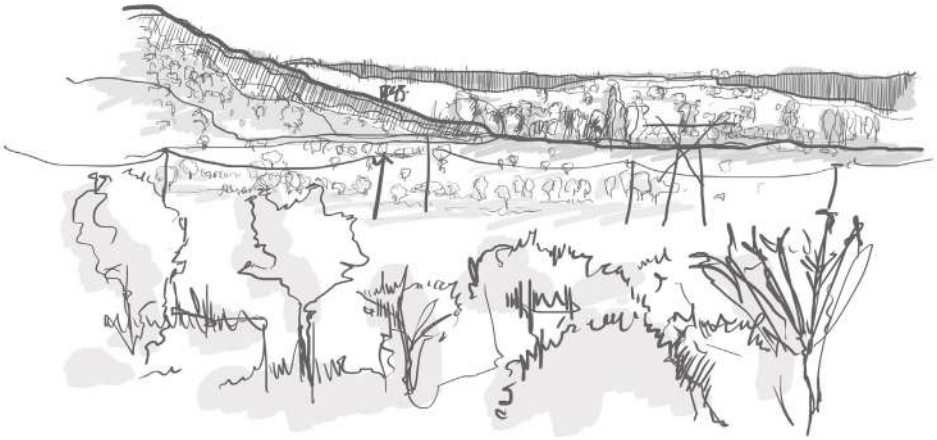


Figure 19 - Drawing of site landscape (Du Preez, 2021).

PROJECT CHALLENGES RELATING TO *MORPHOLOGY*

A morphological challenge is the sensitive interpretation of an open landscape into a truly functional design. Capturing the essence of preserving genetic material crucial to humanity's survival in form and structure will be greatly considered. Furthermore, the symbolic impact of its typology must be readable as a functional and agricultural building.

PROJECT AIMS RELATING TO *MORPHOLOGY*

A key aim into the building's morphology is that the form and structural expression should communicate the building's workings. Structurally it should be readable and comprehendible emphasizing traditional construction techniques and the design principles of order, rhythm, datum and symmetry. These elements should aid in honouring the spirit of place and context driven design.

RESEARCH QUESTION

How may a critical regionalist architectural approach facilitate the prolonging of natural life cycles in Sub-Saharan Africa through the design proposal of a seedbank, with the aim of facilitating the adaptation of flora in the planet's ever-changing climate conditions, whilst enriching food security and plant diversity for future generations?

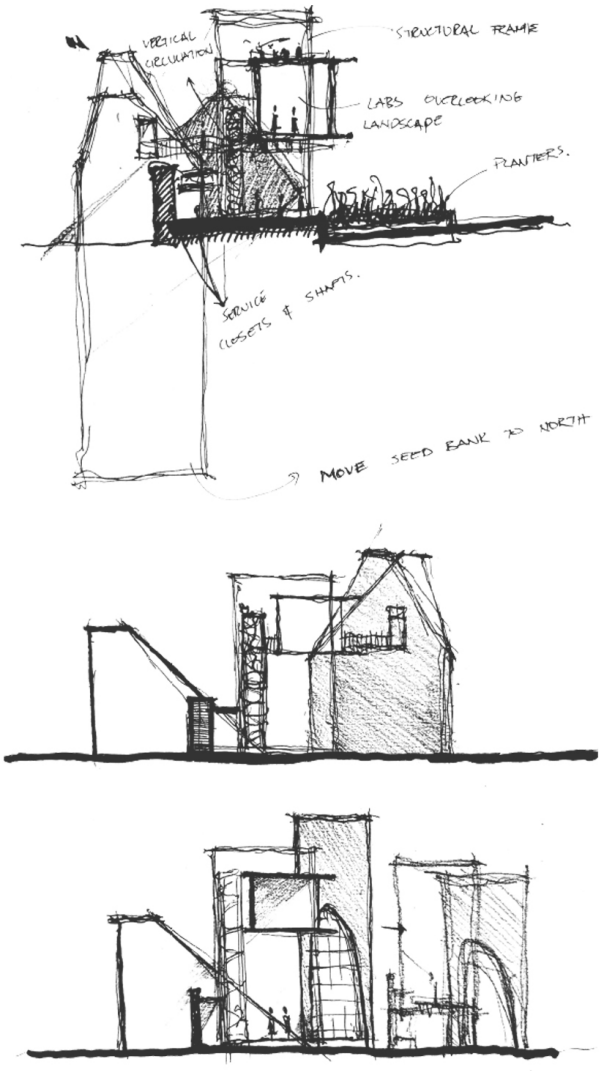


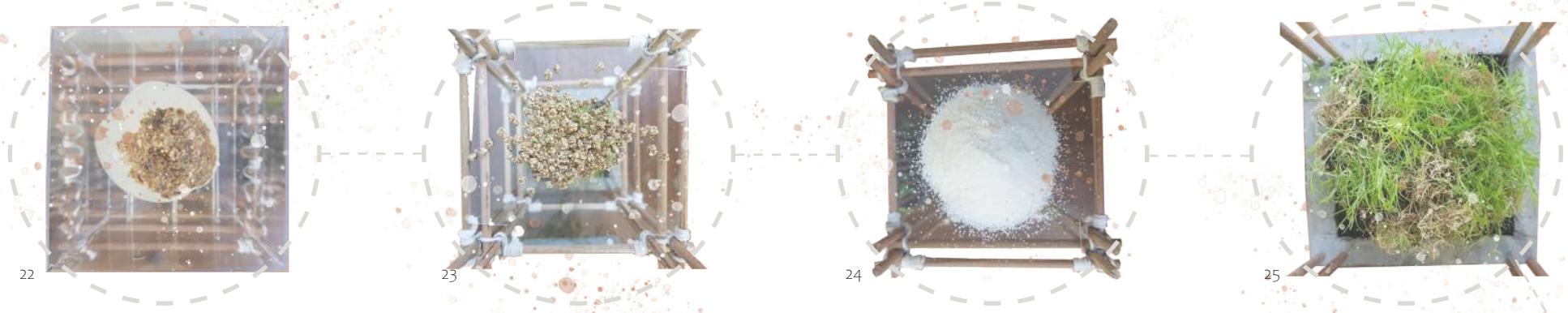
Figure 20 - Development sketch for morpohlogy (Du Preez, 2021).

Part 03

GROUNDING & EXPLORATION

Figure 21 - Dried Acacia Seed Pods Long Seed Pods (online. Adapted by Author).

The design inception commences by utilizing information attained from the project rationale investigations. By further expanding new found comprehensions of issues requiring consideration the design inception attempts to translate this into built form. Providing a platform for the design methodology to transform into physical entities of architectural intervention it is an emergence of a design process which transpires into a medium for problem solving.



Figures 22-25 - Close up photographs of touchstone(Du Preez, 2021).

Figure 26 - Touchstone (Du Preez, 2021).

WHAT IS THE *TOUCHSTONE* ABOUT?

The touchstone is a representation of pure functionalism of process and the celebration of its construction. A Seed Bank is a very technical and functionalist facility that has broad implications on the continuation of bio diversity within nature. The design is an engineer's aesthetic and agricultural typology seeking a marriage through its inner purpose within nature. The touchstone attempts to connect the two contrasting elements by creating a structural frame carefully interwoven as a celebration of detail. Within this frame sits nature figuratively inhabiting the structure through all of its various life cycles.

FUNCTIONING OF THE *TOUCHSTONE*

The touchstone consists of four wood framed structures that each represents a process in Seed Banking. Within the wood structure there are platforms that support Perspex boxes with a natural element inside. Phase 1 shows the soil of context in its container and below it seeds frozen and in a separate box. This is a visualisation of two key elements- the seeds and the landscape. A timber frame and perspex boxes are representations of a scientific process, separation and preservation. Phase 2 sees the landscape and soil being separated further as time passes on. Phase 3 is the reintroduction of seeds and soil which flourishes into a plant preserved over decades. Finally, phase 4 is the showcasing of plant, seeds and also food source gained from the aforementioned two. Seeds are also how life keeps flourishing on earth and phase 4 shows redistribution, gathering as well as productive yield on its various platforms. The design aims to facilitate these natural cycles to continue, but to expand them over decades ensuring preservation, conservation and food security.

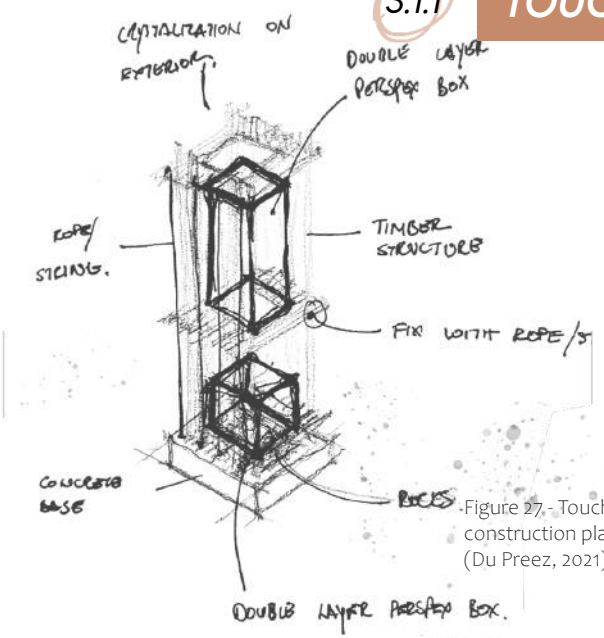


Figure 27 - Touchstone construction planning (Du Preez, 2021).

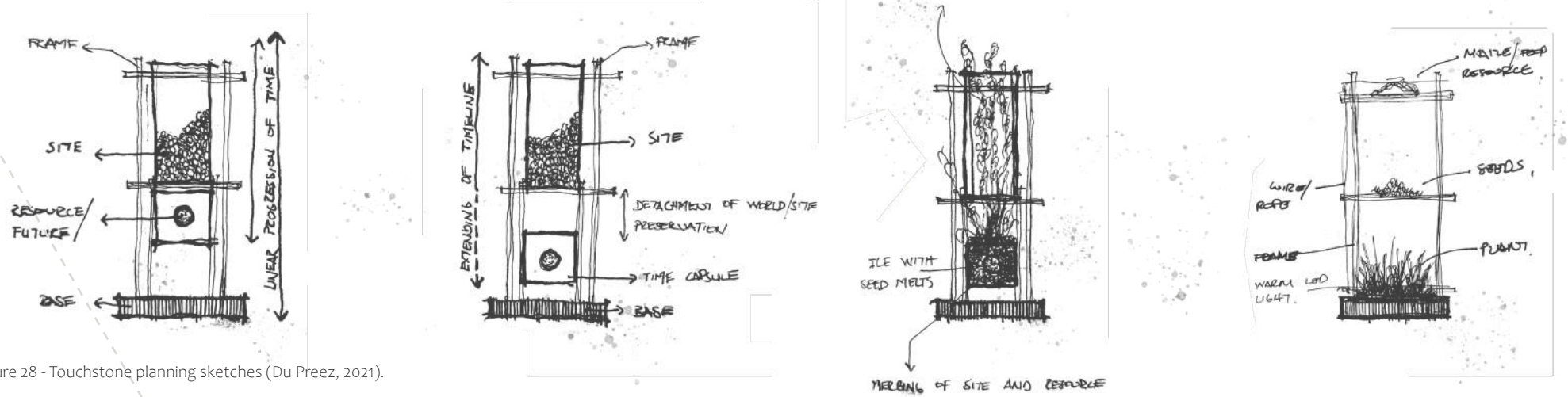
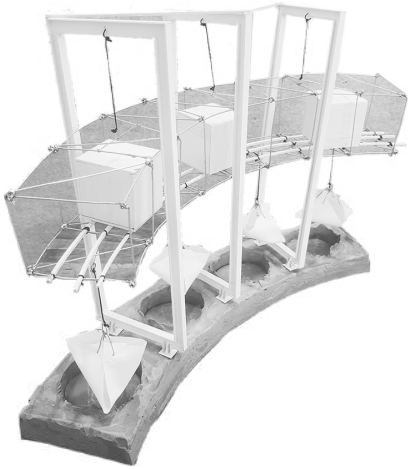
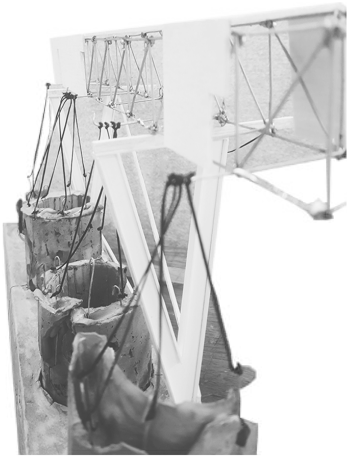


Figure 28 - Touchstone planning sketches (Du Preez, 2021).



THE GATHERING



THE SHED

STILLNESS & CHANGE

Figure 32 - Concept 1 photograph (Du Preez, 2021).
Figure 36 - Concept 2 photograph (Du Preez, 2021).
Figure 41 - Concept 3 photograph (Du Preez, 2021).

Following the touchstone investigtion the design process evolved into creating three concepts to ground the design creating an anchor point for the project. These concepts evolve into actual architectural applications and these transformations are outlined in detail within the design process chapther.

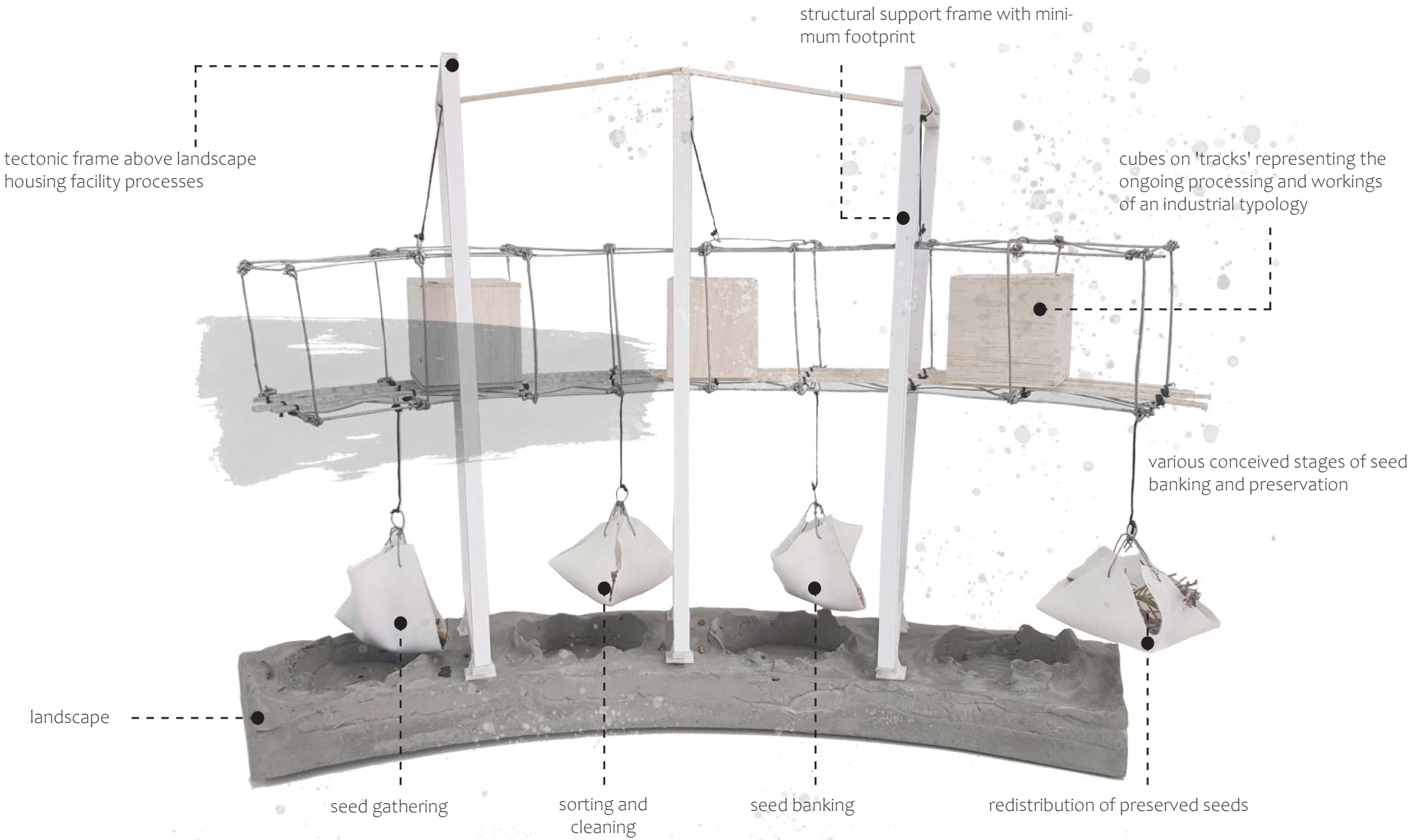


Figure 29 - The Gathering (Du Preez, 2021).

Figure 30 - Concept 1 perspective (Du Preez, 2021).

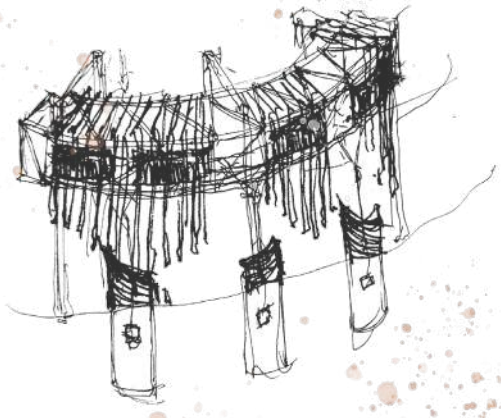


Figure 31 - Concept 1 development (Du Preez, 2021).

3.1.2 CONCEPT 1

The Gathering showcase how the function, processes and structure of the building can be translated into architectural form. Pure and honest structure explicitly showed communicating the building's purpose. There are four openings within the base signifying the four major processes in seed banking. It also signifies the four seasons in a year cycle as they are a key element of nature which is being manipulated and extended. Furthermore there is a strong vertical element to suggest that the building's workings will take place above and below the site's natural ground level. This is an attempt to respect and preserve not only the seeds, but also the landscape that houses them.

Key words: *Structure as form, seasonal change, preservation, rhythm, verticality*

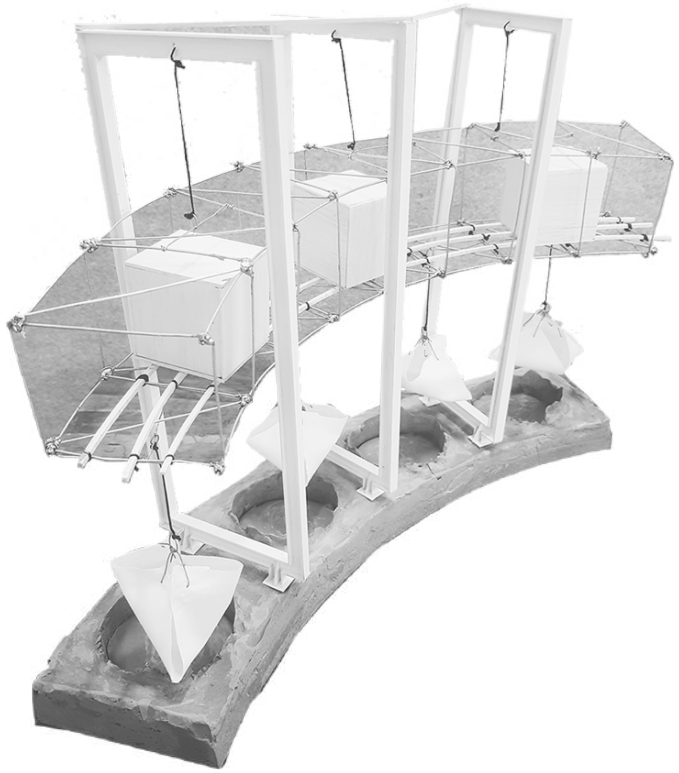


Figure 32 - Concept 1 photograph (Du Preez, 2021).

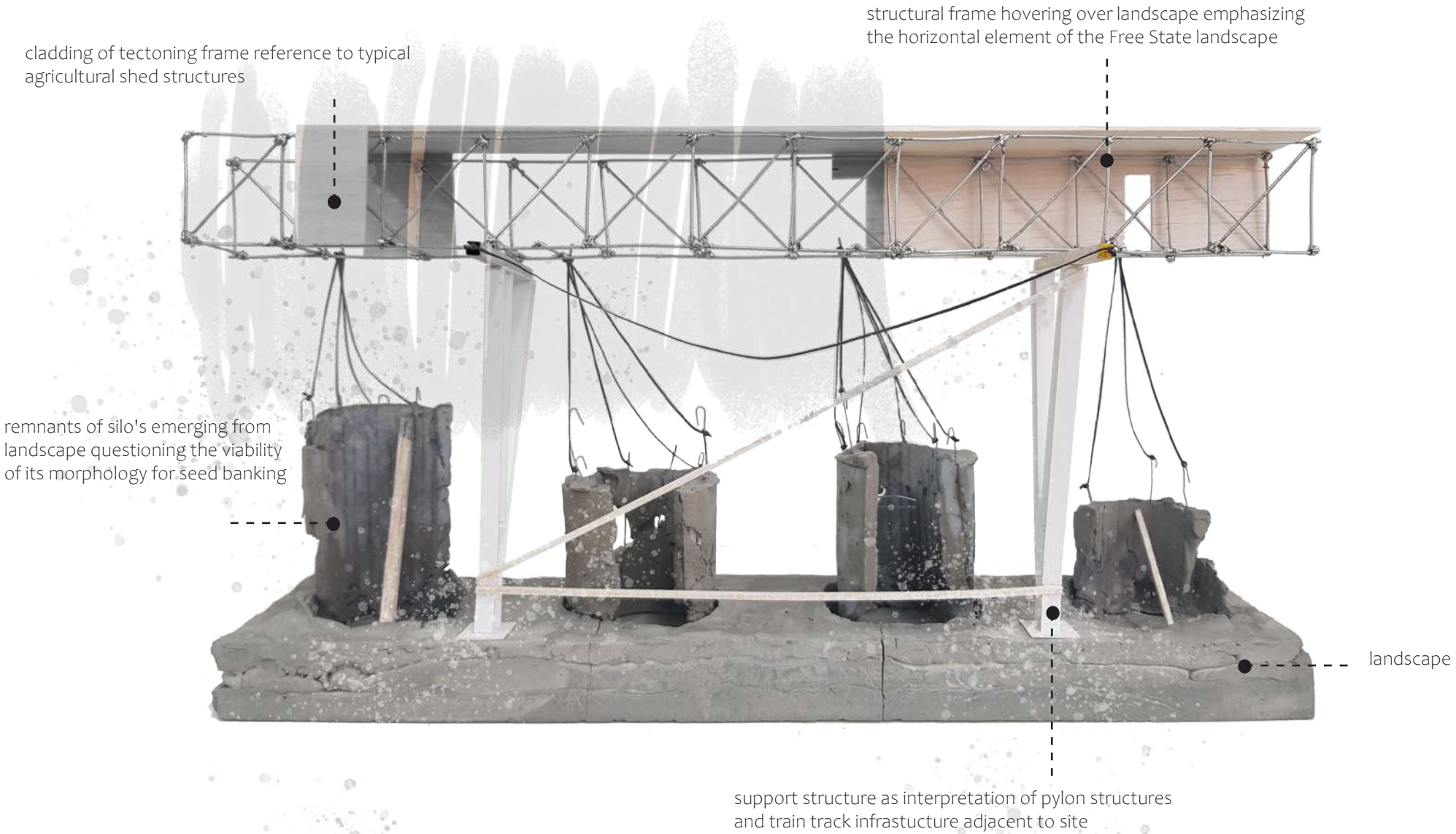


Figure 33 - The Shed (Author, 2021).

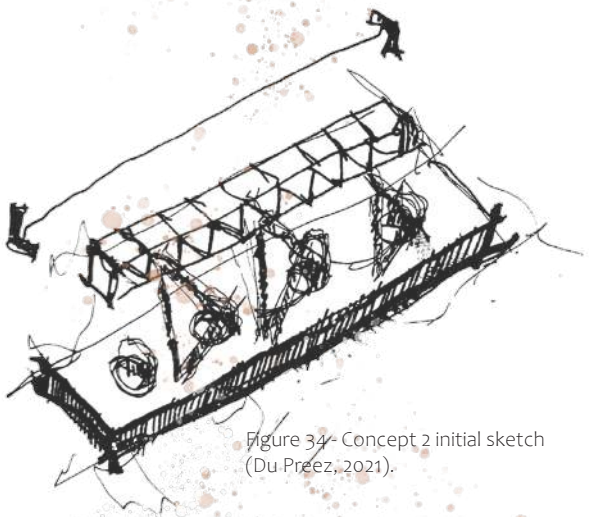


Figure 34 - Concept 2 initial sketch (Du Preez, 2021).

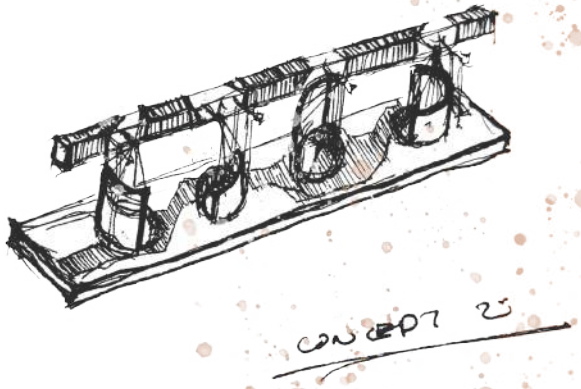


Figure 35 - Concept 2 development (Du Preez, 2021).

CONCEPT 2

The Shed, is an interpretation of the traditional agricultural storage building/ structure. Traditionally structures housing natural resources (within agricultural context) are shed-like structures or stronger typologies such as silos. Thus, there is a juxtaposition of heavy stereotomic and lighter tectonic typologies. The model showcases these elements such as framework with cladding, enclosure, heavy concrete and metal that degrades over time. Furthermore, the model also interprets the site's context with reference to adjacent silos, train tracks and large scale steel frame storage facilities.

Key words: *Structural framework, enclosure, tension, degradation, tectonics*

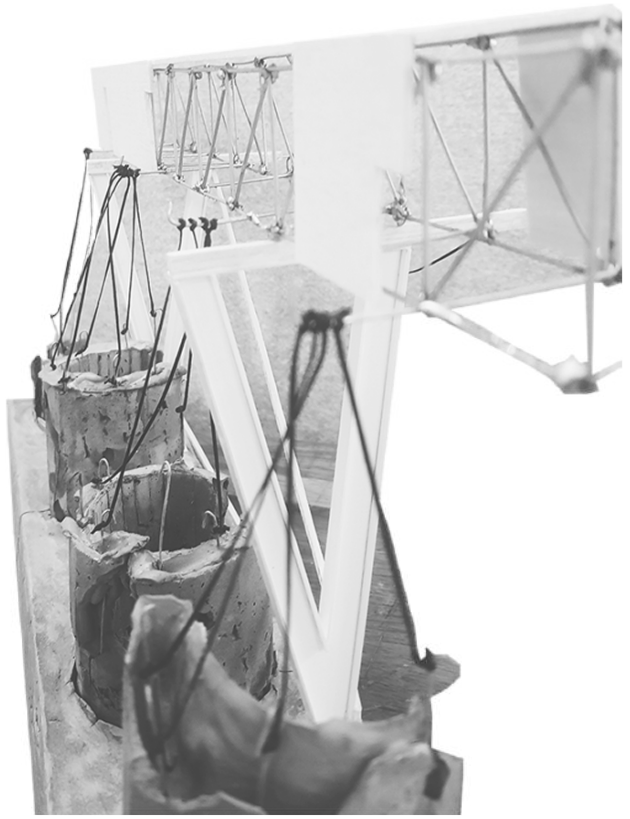


Figure 36 - Concept 2 photograph (Du Preez, 2021).

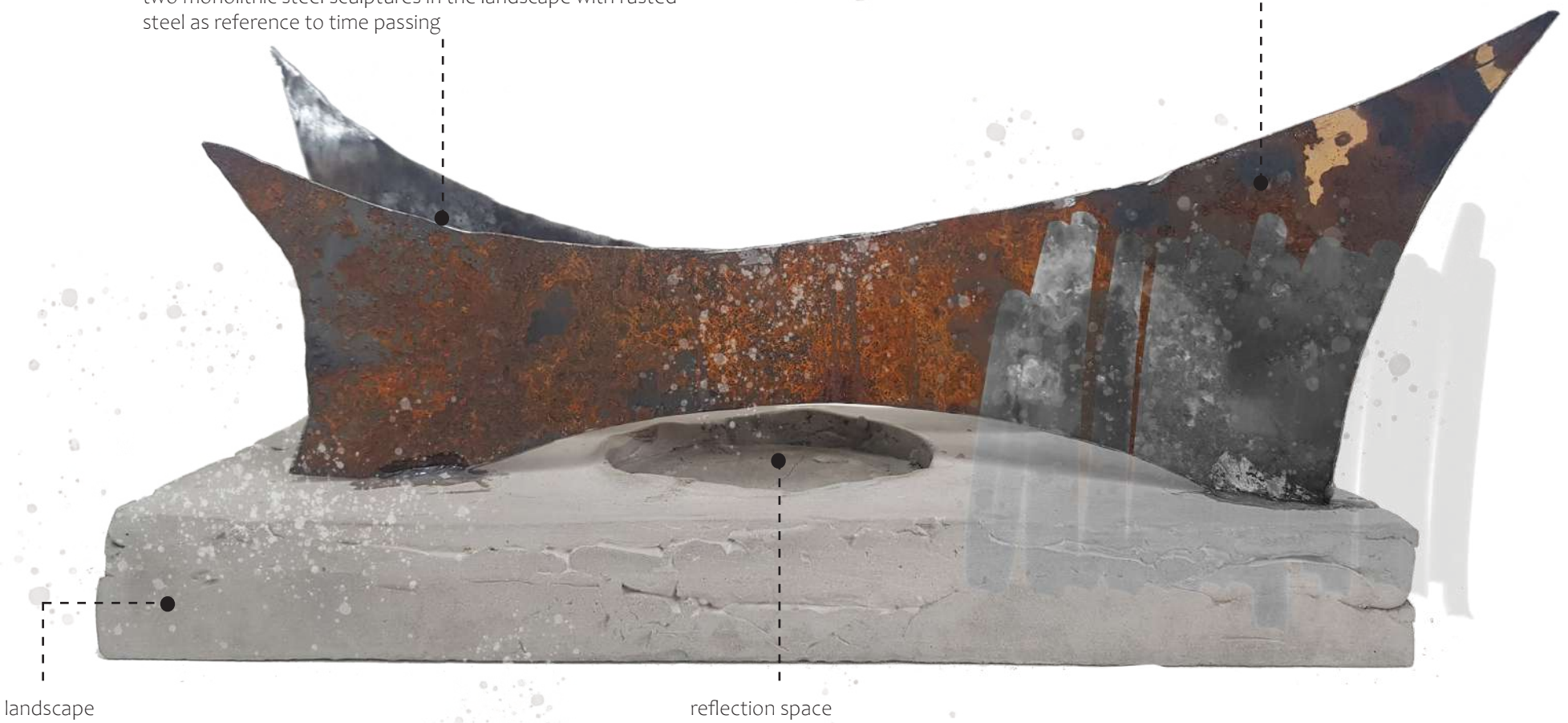


Figure 37 - Stillness & Change (Du Preez, 2021).

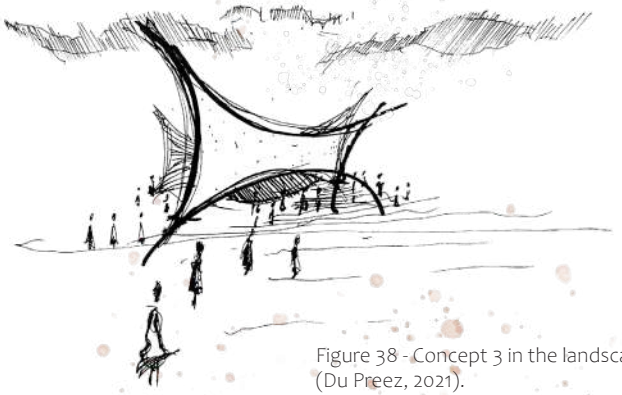


Figure 38 - Concept 3 in the landscape (Du Preez, 2021).

Figure 39 - Development sketch (Du Preez, 2021).

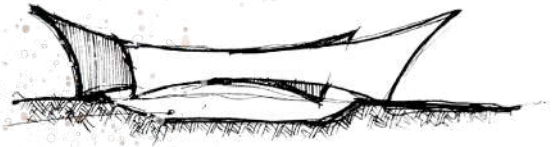


Figure 40 - Section elevation imagined (Du Preez, 2021).

CONCEPT 3

Stillness & Change is a more symbolic and metaphorical form giving attempting to interpret what sculptural intervention could take place within an untouched landscape. The design has a monumental aspect to it, sitting quietly in the field for generations. It embraces the horizontal element of the Free State landscape with its outer layers continuously evolving as time passes. It is a dormant giant at a large scale waiting for the vault to be opened. Furthermore, the interior space of the model looks to embrace the ever changing light quality that befalls it.

Key words: *Elusiveness of time, monumentality, light quality, dormancy, scale*

Figure 41 - Concept 3 photograph (Du Preez, 2021).

BASEMENT FLOOR

- Generator space
- Emergency backup equipment
- Growth labs
- Seed Processing
- x3 Seed Storage dry rooms
- Seed chillers room
- Seed Bank entry
- x2 Elevators
- x2 Stairs
- x2 Service rooms with dessiccant dehumidifiers for seed dry rooms

GOUND FLOOR

- Reception + conference facility
- Reception kitchenette
- Reception toilets
- Labs x4
- 2x Open plan work spaces
- X4 Enclosed offices
- X1 Main office
- x2 Kitchenette and coffee station
- Herbarium
- Access to exterior elevators
- x2 Stairs
- x2 Elevators
- x2 Disabled toilets
- Male and female toilet block
- Cleaning and maintenance staff service room
- Workshop
- Service yard
- Trash storage
- Fertilizer and soil storage
- Gantry pickup area
- Secondary garage and workshop
- Parking and service route

FIRST FLOOR

- Greenhouse Soil delivery storage
- Trash storage
- X3 Greenhouse A
- X3 Greenhouse B
- X3 Greenhouse C
- Service corridor
- Water tanks 5250lt
- Herbarium
- Recreation room and lounge with kitchenette
- Male and female toilet block
- Conference/multifunction room
- Equipment storage room

SECOND FLOOR

- Herbarium

LAB 1

- Microscopy and images
- Moisture determination

LAB 2

- Seed germination

LAB 3

- Bio-Physics
- Molecular Analysis
- Chemical Analysis

LAB 4

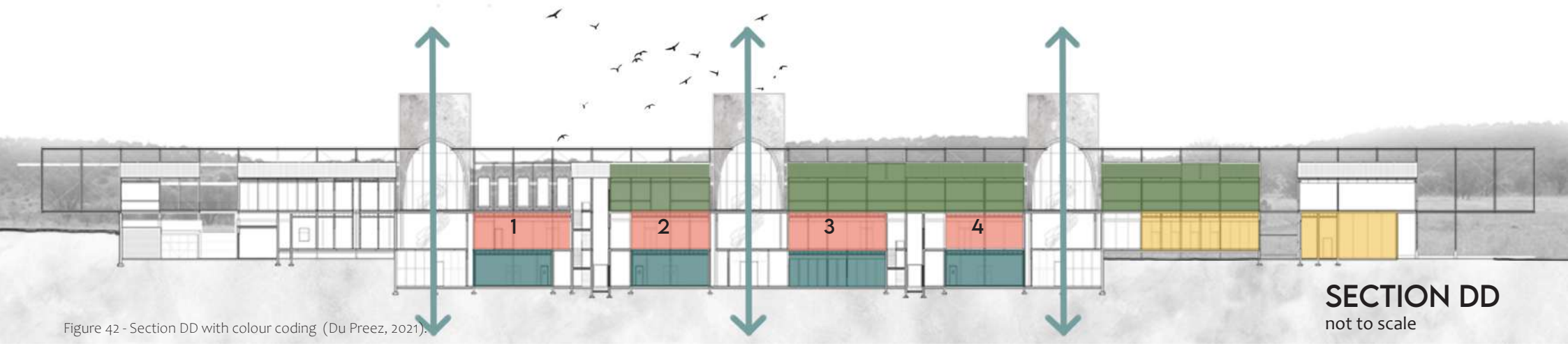
- Liquid Nitrogen lab

GREENHOUSES

LABORATORIES

RECEPTION AND OFFICES

SEED DRY STORAGE AND SEED BANKS



SECTION DD
not to scale

Figure 42 - Section DD with colour coding (Du Preez, 2021).

SVALBARD GLOBAL SEED VAULT

Building: Svalbard Global Seed Vault
Architect: Peter Søderman
Location: Spitsbergen, Norway

"Inside this building is 13,000 years of agricultural history"
-Brian Lainoff, Crop Trust (Duggan, 2011: online).

PRINCIPLES EXTRACTED

- Establish a clear relation between building and landscape.
- Functional plan layout with clear circulation.
- Space for artistic expression through structural and functional elements.
- Importance of climate control.
- Storage methods and scale for seeds.
- Seed delivery and packaging is a fairly small and uncomplicated procedure.
- Accessibility and readability of building layout is important.
- Uncompromisingly functional.

WHY THIS PRECEDENT?

Svalbard Global Seed Vault is regarded as one of the top examples of how safeguarding genetic resources can result in a pure functionalist architecture. The value in this precedent is its uncompromisingly functional approach with little to no poetic aspirations. It is also the irony of how this structure then truly fits into this desolate landscape by staying true to the very conditions it has to function in. It would seem that the building could be interpreted as critically regionalist within its given program and context.

This is the only visible part of the 146m long Seed Vault that extends into the mountain (Duggan, 2011: online).

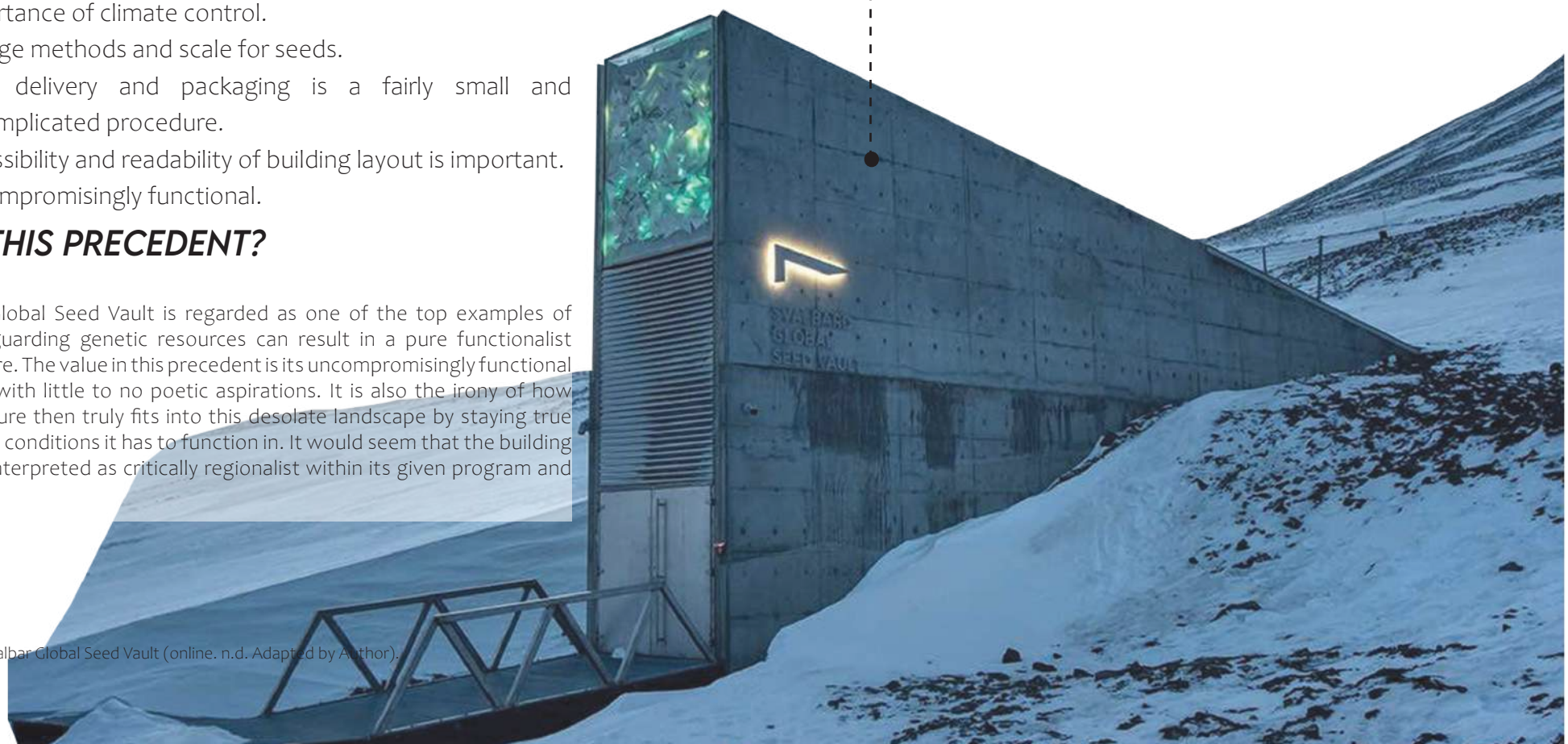


Figure 43 - Svalbar Global Seed Vault (online. n.d. Adapted by Author).

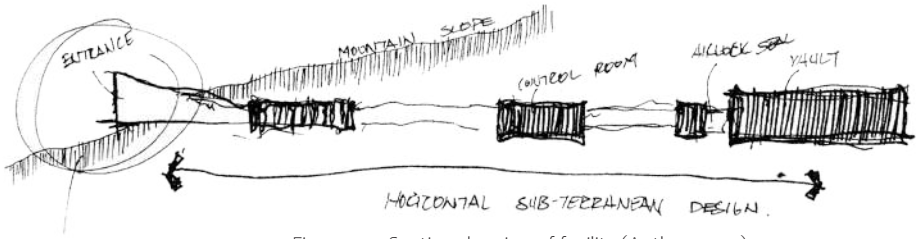


Figure 44 - Section drawing of facility (Author, 2021).

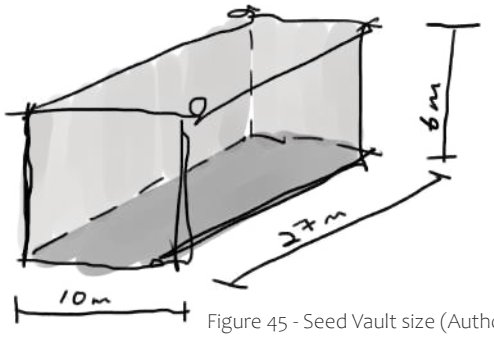


Figure 45 - Seed Vault size (Author, 2021).

Figure 46 - Svalbar Global Seed Vault from mountain (Sean Gallup: online. Adapted by Author).

Between Norway and the North Pole within the bowels of an icy mountain is situated the Svalbard Global Seed Vault. It is a resource vital for food security and preservation of biodiversity for all of mankind.

The vault stores over 930 000 varieties of food crops and can essentially be seen as a safety deposit box for the largest collection of agricultural biodiversity.

The chosen location for the Seed Vault is based largely on its remoteness and climate conditions. Finding a place more desolate and remote than the frozen wilderness of Svalbard would be quite difficult. No commercial airline fly's further north than this and there is only a small town nearby called Longyearbyen which also produces its own electricity on account of being a coal mining town. Furthermore it is far away from hostile environments such as civil wars, unrest, natural disasters or security threats (Duggan, 2011: online).

"There are big and small doomsdays going on around the world every day. Genetic material is being lost all over the globe" according to Marie Haga who is an executive director of the Crop Trust (Duggan, 2011: online).

Equally important, The Seed Vault was constructed to be above even the worst possible scenario for rise in sea levels. There are currently three seed chambers each carved out of solid rock within the mountain and the access tunnel leading to it is constructed from waterproof concrete. Moreover, the facility is engulfed with permafrost within the mountain ensuring low energy requirements and stable temperature control. (NordGen, 2021: online) If the facility undergoes a power outage the permafrost would keep temperature inside the vaults stable for another two weeks (Van Staden, 2018: 115). The temperature needed to effectively store the seeds for the long term is -18 degrees Celsius (NordGen, 2021: online).

The Seed Vault storage capacity is 4.5 million seed samples. Each sample can contain up to 500 seeds which totals the seed storage capacity at 2.25 billion seeds. Currently there are only just over one million seed samples stored at the facility. Important to note is that seed samples are stored under "black-box conditions". This means that even though it is stored within the Seed Vault legal ownership is not transferred and still belongs to the depositor. The depositor is also the only entity that can withdraw the seeds again. Furthermore only NordGen personnel are allowed to handle seed samples ensuring the safety of the seeds (NordGen, 2021: online).

MILLENNIUM SEED BANK

Building: Millennium Seed Bank
Architect: Stanton Williams Architects
Location: Kew Gardens, Wakehurst Place. West Sussex, UK.
Year: 2000
Cost: £14.0m
Size: 5,500m²

WHY THIS PRECEDENT?

The Millenium Seed Bank is a functioning seed bank that not only safeguards seeds, but also conduct daily research and cultivate seeds in their greenhouse facility. There is much to learn from such a pragmatic design as it blurs the line between functional and poetic architectural intervention. The design's interpretation of the local vernacular show a great degree of sensitivity for its natural surroundings. Also, there are daily visitors and staff that operate in laboratories visible to the curious eye which is valuable knowledge for the design of these type of facilities. Contrastingly Heatherwick's seedbank immediatey also comes to mind as a very poetic structure that holds the promis of growth however, the Millenium Seed Bank is chosen for its blend of the poetic and the functional.

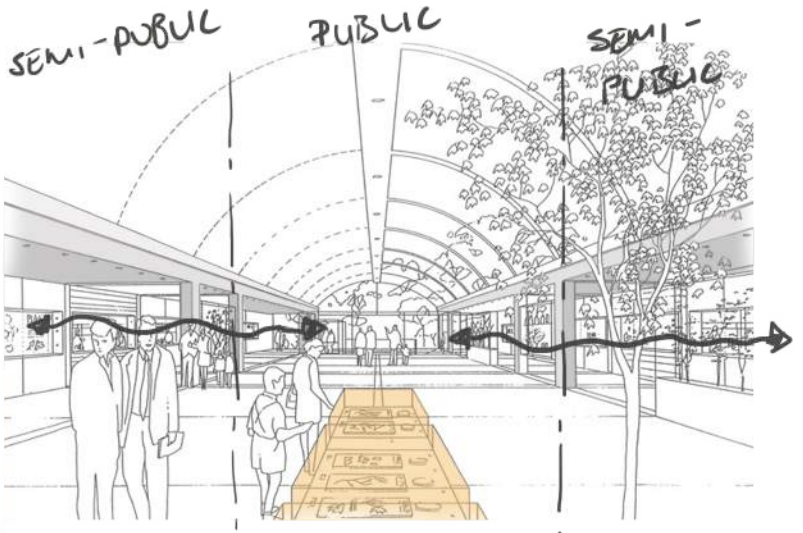


Figure 48 - Atrium exhibition sketch (Stanton Williams Architects: online. Adapted by Author).

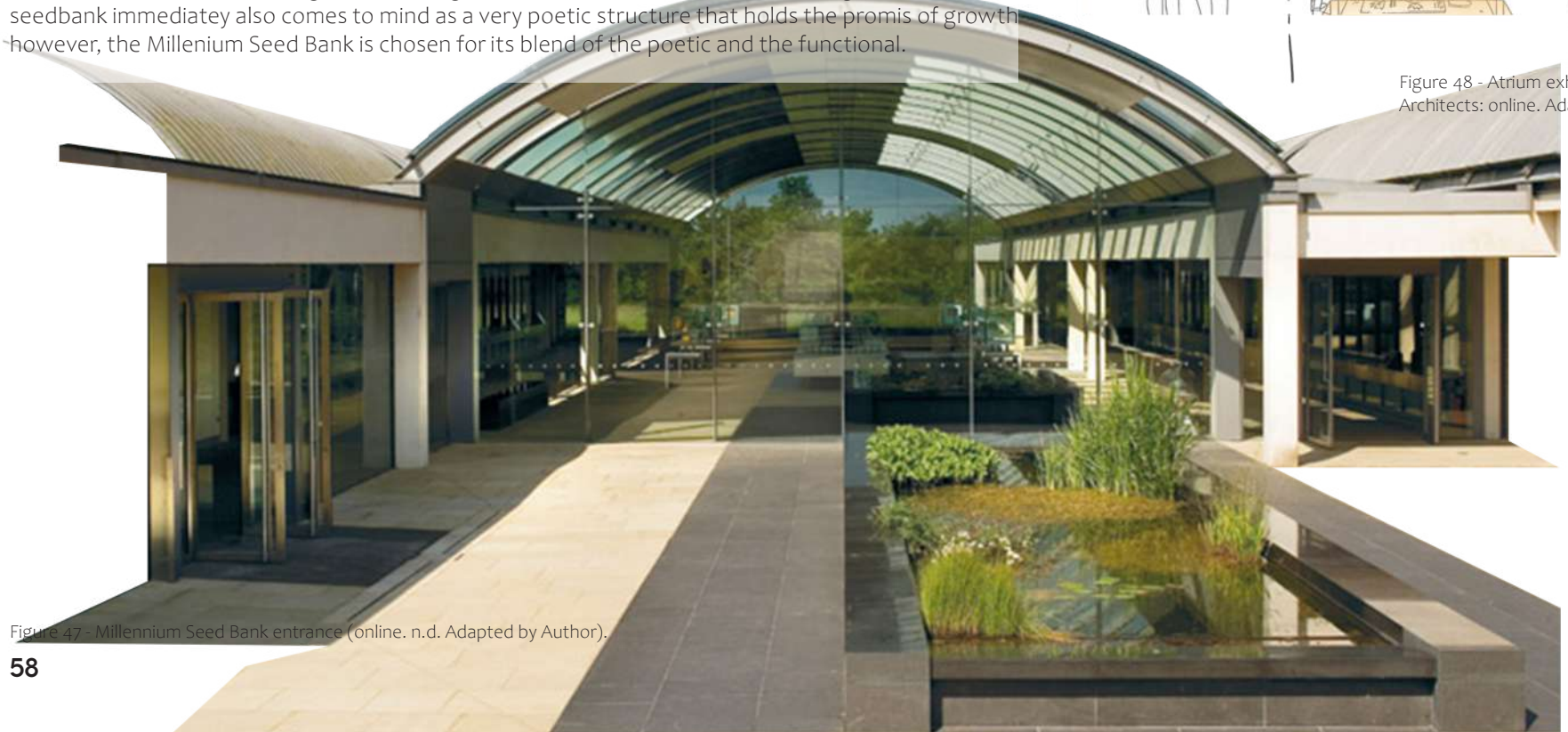


Figure 47 - Millennium Seed Bank entrance (online. n.d. Adapted by Author).

The Millennium Seed Bank is located within Kew Gardens in rural Sussex. The site and surrounding environment has been classified as an Area of Outstanding Natural Beauty (AONB) which is also adjacent to a Site of Special Scientific Interest (SSSI) on the Sussex High Weald. The building's design and materials was conceived to minimise its impact on its surroundings. On the exterior of the building planted parterres showcase the eight different threatened habitats of the British Isles.

The building's morphology consists of six barrel-vaulted masses as a reference to traditional barn typologies of the area measuring at 5,500m². Furthermore in order to meet local height restrictions coupled with energy usage efficiency and security measures the seed storage vaults were situated underground. This was accommodated by the already sloping site and the need for strictly temperature controlled environments and humidity levels. The sub-zero vaults are flood, fire and bomb proof and currently stores over 2.4 billion seeds from all around the world (StantonWilliamsArchitects, 2021: online). The vault measurements are 35m x 32m x 7m (R B Construction Group, 2021: online).

The building's design was conceptualized as an 'inside-out' layout. Scientists are situated on either side of the public exhibition atrium space and winter garden. This enables visitors to not only be inspired by exhibitions, but also witness the processes as they unfold within the labs. Visitors can track a seed's journey from drying chambers, seed cleaning, processing all the way to research stations. The seed vaults entrances are also visible from the public exhibition area (StantonWilliamsArchitects, 2021: online). Figure 50 illustrates different circulation routes for visitors (yellow) and staff (blue) members (Van Staden, 2018: 125).

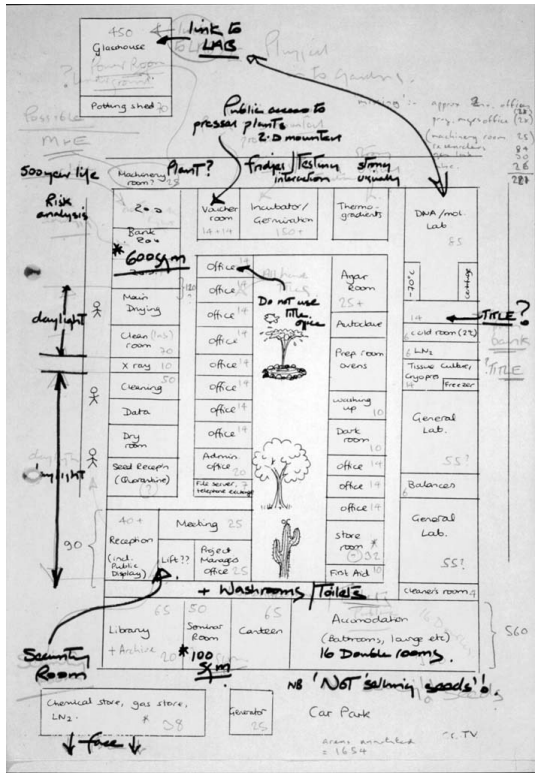


Figure 49 - Plan layout development (Stanton Williams Architects: online).

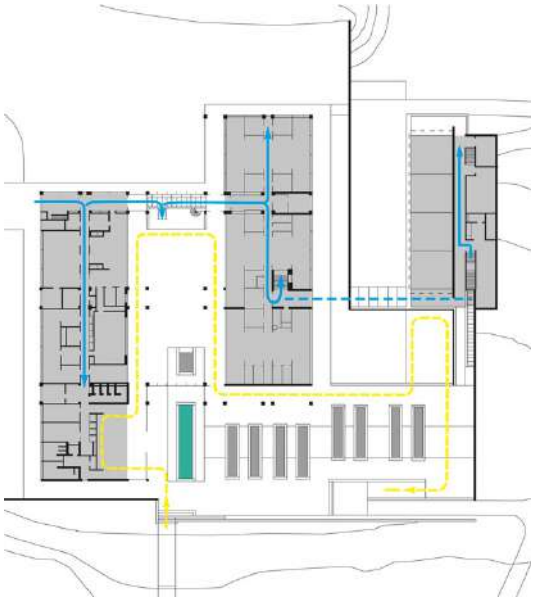


Figure 50 - Plan layout circulation (Stanton Williams Architects: online).

PRINCIPLES EXTRACTED

- Importance of referencing local agricultural typologies.
- Visual reading of building and internal processes.
- Structure emphasizes its environment through sunroof element.
- Importance seed vault location for climate control.
- Storage vault scale for seeds.
- Integration with site's natural slope to accommodate building functions.
- Circulation routes are effective threshold spaces.

Figure 51 - Greenhouse (Stanton Williams Architects: online. Adapted by Author).

ZEITZ MOCAA

Building: The Zeitz Museum of Contemporary Art Africa
Architect: Heatherwick Studio
Location: Cape Town, South Africa
Year: 2017
Cost: R500 million

PRINCIPLES EXTRACTED

- Structural honesty can convey historical and cultural relevance.
- Reinterpretaion of traditional silo typology.
- Space for artistic expression through structural and functional elements.

WHY THIS PRECEDENT?

Adaptively reusing the silo's in The Silo District is a formidable example of what can be achieved with strong and rigid typologies transforming them into something totally different and new.

Contextually the chosen site for this dissertation is very agricultural with quite a few silo's adjacent to the proposed site. A more regionalist approach will be taken and through defamiliarization the design intends to utilize the silo typology in order to keep its essence, but poetically utilize it in a different way.

Figure 52 - Zeitz MOCAA atrium (Iwan Baan, 2017: online. Adapted by Author).

PRECEDENT STUDY 03

The Zeitz Museum of Contemporary African Art is set within the historical working harbour in Cape Town's V&A Waterfront. Table Mountain ensures a dramatic backdrop on one side and the vast ocean expanse on the other- the museum is located within historical relevance and outstanding natural beauty. It is to date the world's largest Museum dedicated to contemporary art from the African continent (ArchDaily, 2017: online).

Spread over nine floors, the museum consists of 9,500m² of newly designed space. The interior of the building is what truly grabs the attention. Its internal structure has been carved out of the historical Grain Silo Complex showcasing its inner workings and skeletal structure. The internal cylinders of 42 carved silo's allowing light to protrude into the atrium are somewhat cathedral-like in the atmosphere it creates. The program includes 80 gallery spaces, rooftop sculpture garden, conservation areas and storage, a bookshop, restaurant, bar and reading rooms (Keller, 2017: online).

From the onset, preserving the building's history was crucial. Therefore the atrium was crucial as architect Thomas Heatherwick stated:

"We felt strongly that we needed to give the space a heart"

This is moreover an attempt to attract visitors into the space and shy away from architecture where the exterior is the highlight. Visitors need to be drawn inside to experience history, culture, art and architecture (Keller, 2017: online).

The building's protruding geodesic dome windows is an interpretation of how the grain was once stored. It's a representation of grain compressing inside the structure and then bulging out of the openings. The architects did not want the exterior to signify an office or apartment building and now it looks like the internal workings waiting to spill over into the city (Keller, 2017: online).

Figure 54 - Zeitz MOCAA uneven cutaway (Iwan Baan, 2017: online. Adapted by Author).

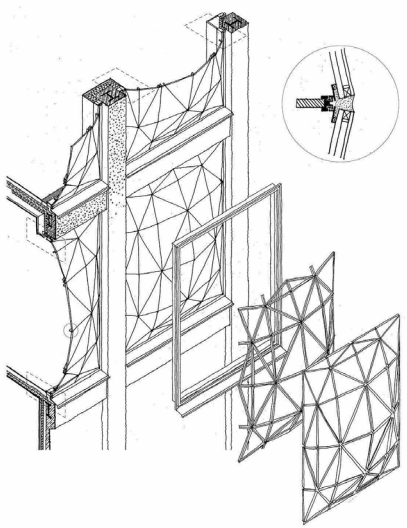


Figure 55 - Geodesic window design (Heatherwick Studios: online).

Figure 53 - Historical Cape Town Harbor (Heatherwick Studios: online).

Figure 56 - Glass greenhouse interior (Du Preez, 2021).

UFS GREENHOUSES

Building: UFS Greenhouses
Location: UFS Campus, Bloemfontein, South Africa
Size: 1000m² (250m² x 4)

PRINCIPLES EXTRACTED

- Basic elements needed to facilitate a greenhouse.
- Technical aspect of climate control and spatial implications.
- Seed storage methods.
- Fragility of glass as construction material.
- Importance of maintenance capabilities.
- Storage for unseen elements such as mechanical components and tools contribute largely to a facilities success.
- Dividing large space into multiple spaces allow flexibility in planning layout and enhances research capabilities.
- Water runoff and supply points need to be adressed.

Figure 57 - UFS Plant Research seed storage method in cold room (Du Preez, 2021).

Figure 58 - Water supply, storage and basin situated in close proximity to one another (Du Preez, 2021).

Figure 59 - Evaporative cooling system on building exterior (Du Preez, 2021).

The University of the Free State's faculty of Natural and Agricultural Sciences currently houses four greenhouses of 250m² each and one more contemporary greenhouse completed shortly after 2013 (Steyn, 2021: personal correspondence).

The older four structures are glass greenhouses with aluminium frames and internal glass divisions allowing for specific temperature control. The greenhouses have a free standing shade mesh structure approximately 500mm above the roof covering the each of the structures protecting the roof glass panes from hail and other harmful occurrences. Each of these greenhouses has controlled rooms where plants are kept, circulation through the centre and water points internally. Each space within the greenhouse has its own internal temperature control unit which is manually set. The HVAC unit is placed on the exterior and protrudes to the inside with air ducts that circulate air flow and control humidity as well as temperature (Steyn, 2011: personal correspondence).

Furthermore every room has a JOJO tank connected to a small scale compressor to ensure water pressure. Water supply is standard municipal water and gets purified before usage as treatment chemicals often found in the water is detriment to the plants. Rain water is the ideal natural resource however, these facilities do not have the necessary infrastructure to collect and store it. Internal waterways and sinks for specimen cleaning are essential to ensure a fluid working space along with a few electrical outlets (Steyn, 2021: personal correspondence).

Figure 60 - Plant material and seed storage cold room (Du Preez, 2021).

Figure 61 - Growth chamber for strict climate conditions (Du Preez, 2021).

WHY THIS PRECEDENT?

A greenhouse is a very technical building to design. There are various detailing elements needed for a successful operation. By analyzing a facility utilized by academics continuously a clear indication of requirements can be made.

This is also an excellent way decide on material use and the construction thereof so to maximise productivity and servicing of interior spaces. This includes water usage, water disposal, air flow and temperature control.

UFS GREENHOUSES

Building: UFS Greenhouse
Architect: Theunissen Jankowitz Architects
Location: UFS Campus, Bloemfontein, South Africa
Size: 160m²

PRINCIPLES EXTRACTED

- Steel trolleys for plant stands that can be rotated on wheels assist with functionality.
- Structure must be strong enough to hang service elements from.
- Electricity is essential for temperature control light sources.
- Water drainage system must catch all soil and filter water to ensure no blockages occur.
- Polycarbonate sheeting is stronger than glass, easier to install and replace.
- No secondary structure need to protect sheeting on exterior.
- Soil, fertilizer etc. delivery and storage space contribute greatly to the greenhouse's success.

Figure 62 - Polycarbonate greenhouse interior (Du Preez, 2021).

The latest addition to the ensemble of greenhouses was design by Theunissen Jankowitz Architects and is situated opposite the existing structures. It is built from brick and steel loadbearing structures with 10mm thick polycarbonate sheeting and a more advanced thinner aluminium strip joining between sheets. Unlike the glass panes, polycarbonate sheeting has further spans and is more durable for events such as hail and strong winds. Thus, there is no need for a secondary mesh structure over the roof. Replacing and maintaining this type of construction is much less labour intensive. Moreover polycarbonate sheeting come in various thicknesses that impact the amount of sunlight entering the building and can be a custom specification. The greenhouse also boasts with smaller temperature control environments which yield more accurate results (Steyn, 2021: personal correspondence).

The building's exterior has services yards that accommodates soil deliveries and refuse bags pickup. External basins and work tops at an ergonomic height and space for tools to be stored. A critical issue has been the drainage design that is situated underground. The soil runoff within the water gets left behind in the drainage channels once water has cleared, thus blocking the system. Since it is underground accessibility is limited and causes problems (Steyn, 2021: personal correspondence).

Figure 63 - JOJO tank, compressor and water filter mounted on wall (Du Preez, 2021).

Figure 64 - Wash basins in service courtyard (Du Preez, 2021).

Figure 65 - Cold room seed and plant material storage (Du Preez, 2021).

Figure 66 - Climate control panels on the exterior of greenhouse (Du Preez, 2021).

Figure 67 - Greenhouse exterior illustrating approx 1800mm brick wall with HVAC penetrating into interior space (Du Preez, 2021).

CENTRE GEORGES POMPIDOU

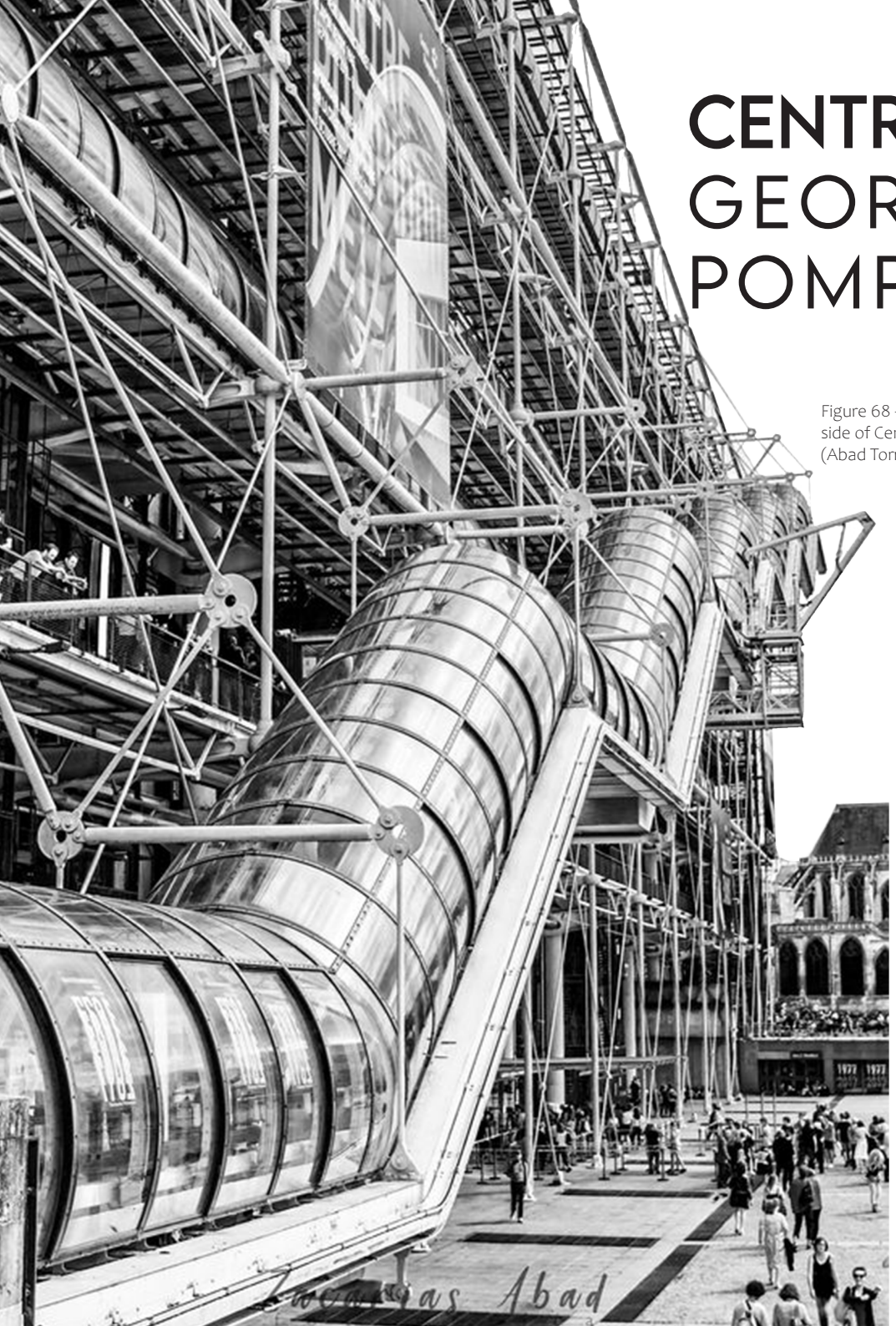


Figure 68 - Escalator scaling the side of Centre Georges Pompidou (Abad Torres, 2017: online).

PRINCIPLES EXTRACTED

- High tech architecture enables readability of structure and better exploration within design.
- Maintenance and upkeep is made simpler if treated as architectural language and method of expression within design.
- Climate can take its toll on exposed services.
- Colour is a good medium to soften industrial typology.
- Scale can be manipulated through structural elements and allow a measurable scale for the viewer enhancing their interaction.
- Exo-skeleton structures enable internal flexibility.

WHY THIS PRECEDENT?

Centre Georges Pompidou stood out as a building with an exoskeleton that holds services, is readable from outside and maximizes internal space. A good amount of structural application and detailing will be needed in this dissertation especially with circulation scaling the building's exterior.

This precedent showcases the beauty in explicit structural detailing and application which humanizes its scale and interacts with its users.

Building: Centre Georges Pompidou
Architect: Renzo Piano Building Workshop, Richard Rogers
Location: Paris, France
Year: 1977

Figure 69 - Street view of Centre Georges Pompidou (Ruggero Poggianella, 2014: online).

PRECEDENT STUDY 05

The 1970's, Paris, France, saw the birth of one of the most controversial and also influential architectural styles in history. Known as high-tech architecture the Centre Georges Pompidou is still today one of the most famous and radical buildings since its inception. It is a building that turned the understanding of architectural function inside out and placed all its service and structural elements on the exterior of the building. Since its completion in the 70's the centre has received more than 150 million visitors over the past thirty years (Perez, 2010: online).

The design is a conceptual exercise using its workings, circulation and services as movement clearly displaying the users' interaction with one another and the environment. The approach to have the buildings skeleton on it exterior allows for clear readability of services and function. Each service element is painted a different colour aiding in this endeavour. The red escalator of the building's façade is one of the prominent 'movement' elements and provides users with breath taking views across Paris (Perez, 2010: online).

"The centre is like a huge spaceship made of glass, steel and coloured tubing that landed unexpectedly in the heart of the Paris, and where it would very quickly set deep roots"

- Renzo Piano (Perez, 2010: online).

Due to structural elements situated on the exterior the design contains six-storeys of large column-free spaces maximizing interior flexibility of space and programme without internal interruptions. Thus, it is the largest museum in Europe for modern art and caters for an abundance of library, music and research functions (Crook, 2019: online). The building is a great example of structural detailing and expressing the inner workings of a design. It allows the viewer and user to interpret and explore more meaningfully when interacting with the building.

AFRICA

SOUTH AFRICA

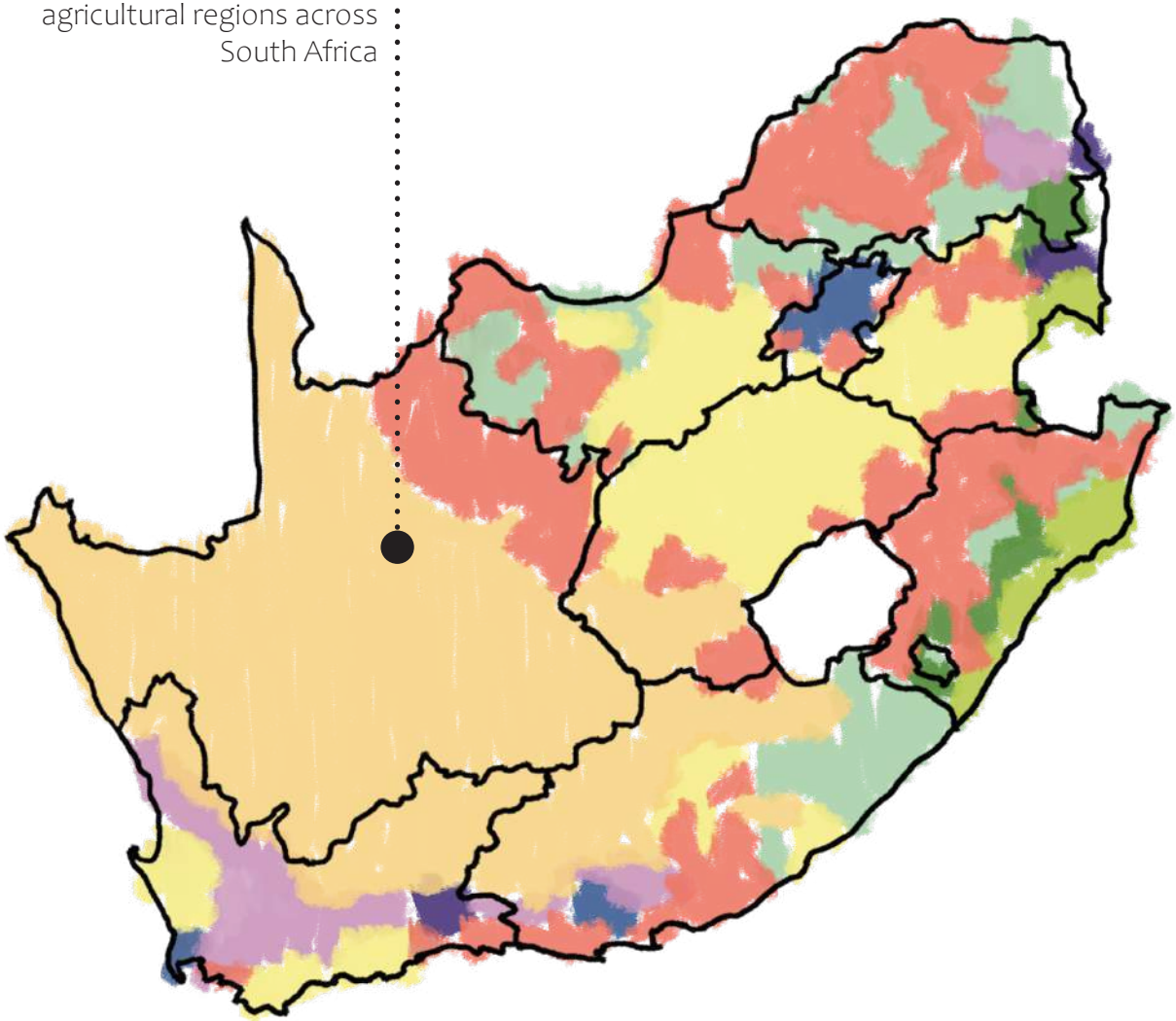
Figures 70 - 73 - Macro analysis inception (Du Preez, 2021).

FREE STATE PROVINCE

TAFELKOP FARM, BFN

TOPOLOGY

Breakdown of provincial agricultural regions across South Africa



GRAINS
SUGAR
FORESTRY
VEGETABLES
FRUITS
CATTLE
SHEEP
DIVERSE
SUBSISTENCE

When referring to figure 74 it is evident that the Free State province can be seen as the grain capital of South Africa. Thus, it is also vulnerable to drought, wildfires and climate change that can influence food security long term locally and on international level.

Furthermore figure 74 also illustrates a diverse climate and agricultural sector across South Africa which can benefit from a Seed Bank to ensure the continuation of this sector.

Figures 74 - Breakdown of provincial agricultural regions across South Africa (Waldner et al, 2017: online. Adapted by Author).

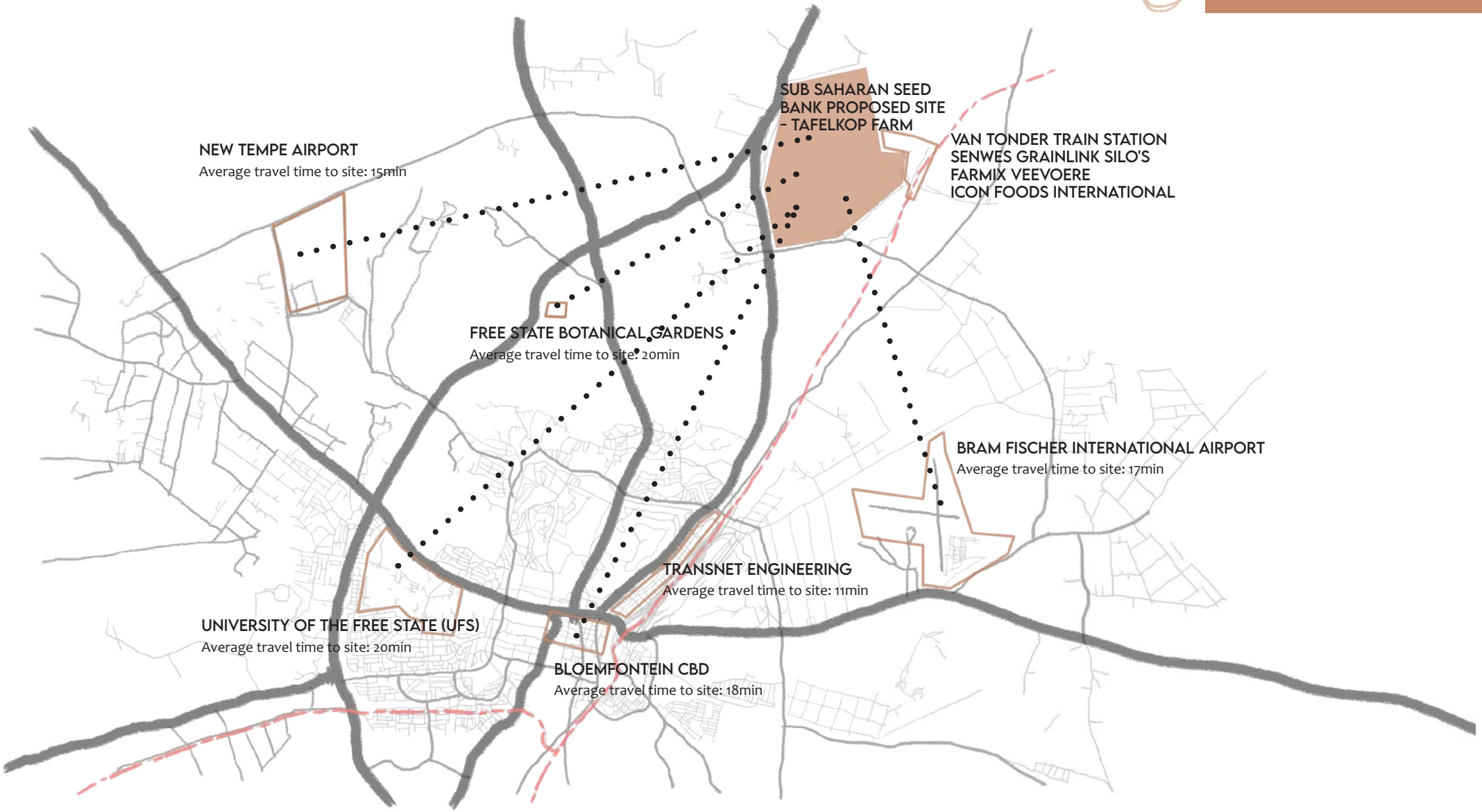


Figure 75- Bloemfontein map sketch illustrating sites of importance within and around the city (Du Preez, 2021).

Figure 77 illustrates the annual rainfall per month in Bloemfontein, Free State. Bloemfontein is falls within a summer rainfall window where the precipitation reaches its peak at an average of 85mm rainfall. July is contrasting with an average of 9mm rainfall which by average makes it the driest month of the year. As South Africa is a rain scarce country the average total rainfall a year in Bloemfontein is 545mm (Climate-Data, 2021: online). Due to this deficit in water supply the building should be responsive and collect its own rain water supply for storage.

Bloemfontein is classified as a semi-arid cold climate with an average temperature of 17.1 °C. Temperatures will reach its peak between December and January with averages upwards of 23.4 °C. July will thus again be contrasting to this as the coldest month of the year with an average of 8.9°C (Climate-Data, 2021: online).

Figure 76 - Photograph of open landscape as chosen site (Du Preez, 2021).

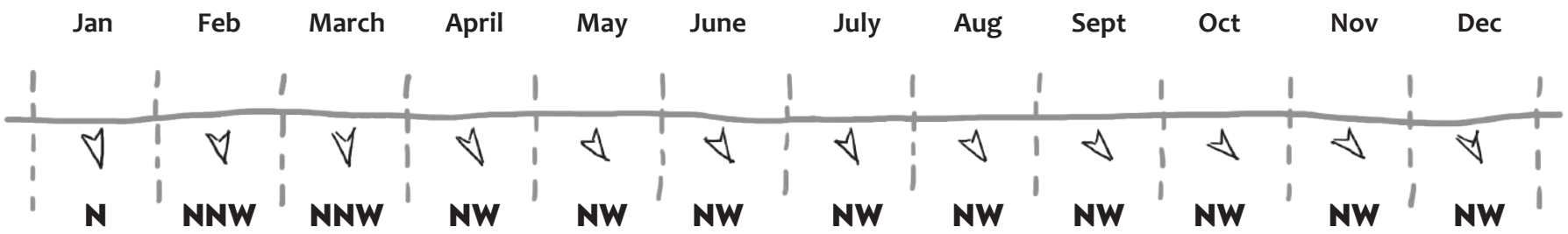


Figure 78 - Average monthly wind directions (Windfinder, 2021: online. Adapted by Author).

Dominant wind direction for the Bloemfontein area as illustrated in figure 78 is NNW. Average wind speeds of 7kts per year and gusts reach up to 26kts. Stronger winds usually are between October and December as the seasons transition from winter to spring and ultimately summer (Windfinder, 2021: online).

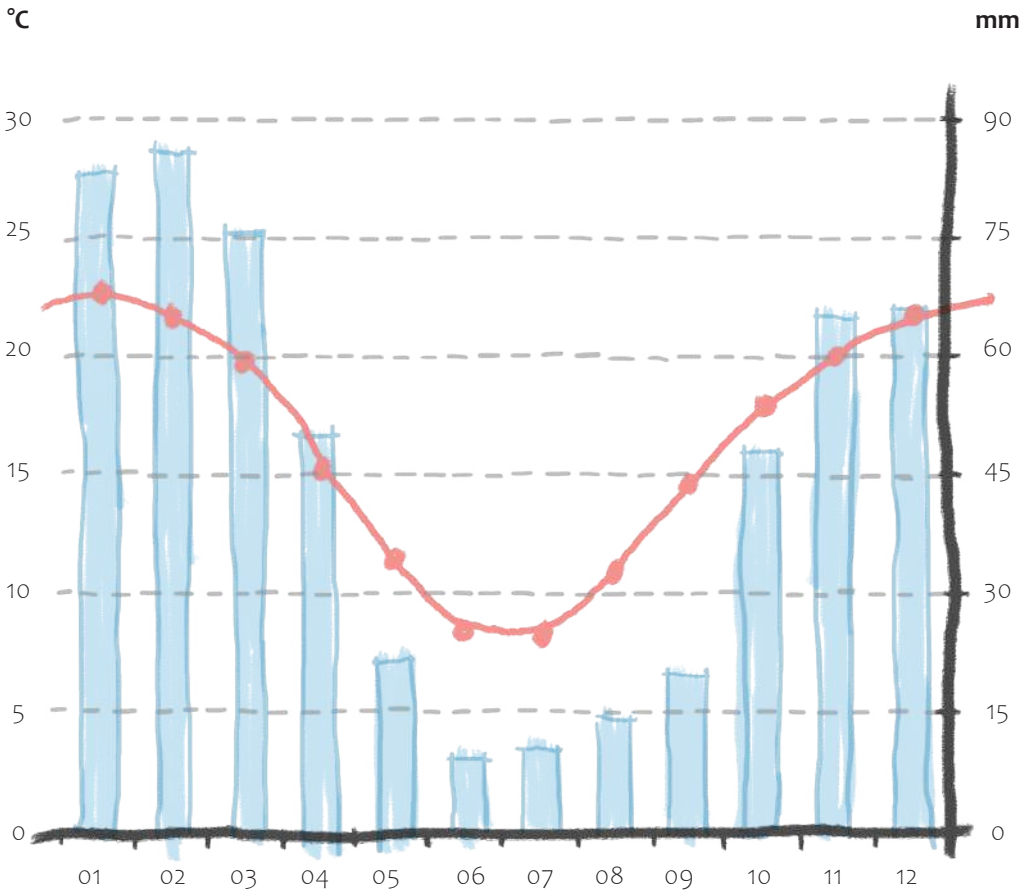


Figure 77 - Graph showing annual rainfall and temperature averages (Climate-Data, 2021: online. Adapted by Author).

The sun angle and temperature indicators are of importance to assist in design orientation and building materials. In order to securely bank seeds whilst being climatically responsive the seed banks will likely have to be of a subterranean typology. Greenhouses will be constructed from a custom specified thick polycarbonate sheeting to keep out harmful UV rays and more effectively insulate the interior space for accurate climate control.

Bloemfontein receives an average of 9.6 hours of sunlight daily (Weather atlas, 2021: online) which can become quite uncomfortable during summer. Laboratory placement will be carefully curated to ensure adequate light along with proper insulation. Winter sun should be able to penetrate the Northern facade to heat up the building's interior. The summer sun angle is increased posing opportunity for laboratory spaces to be cooled effectively whilst threshold spaces are sunlit during daytime. The structural frame and open landscape poses the opportunity for solar power to be integrated into how the building functions.

SUN ANGLES

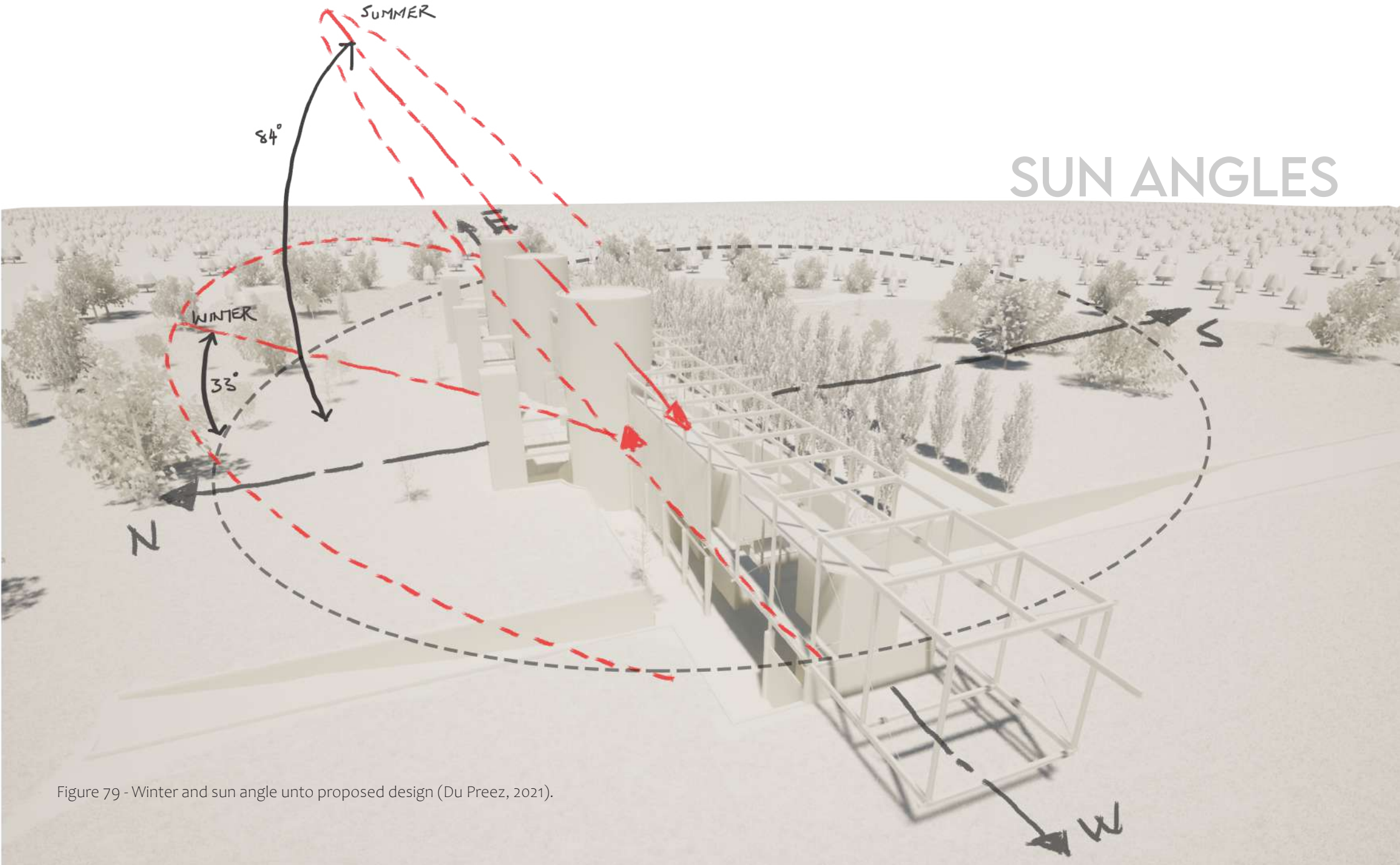


Figure 79 - Winter and sun angle unto proposed design (Du Preez, 2021).

Figure 80 - Erf 2876 (Google Earth, 2021: online. Adapted by Author).

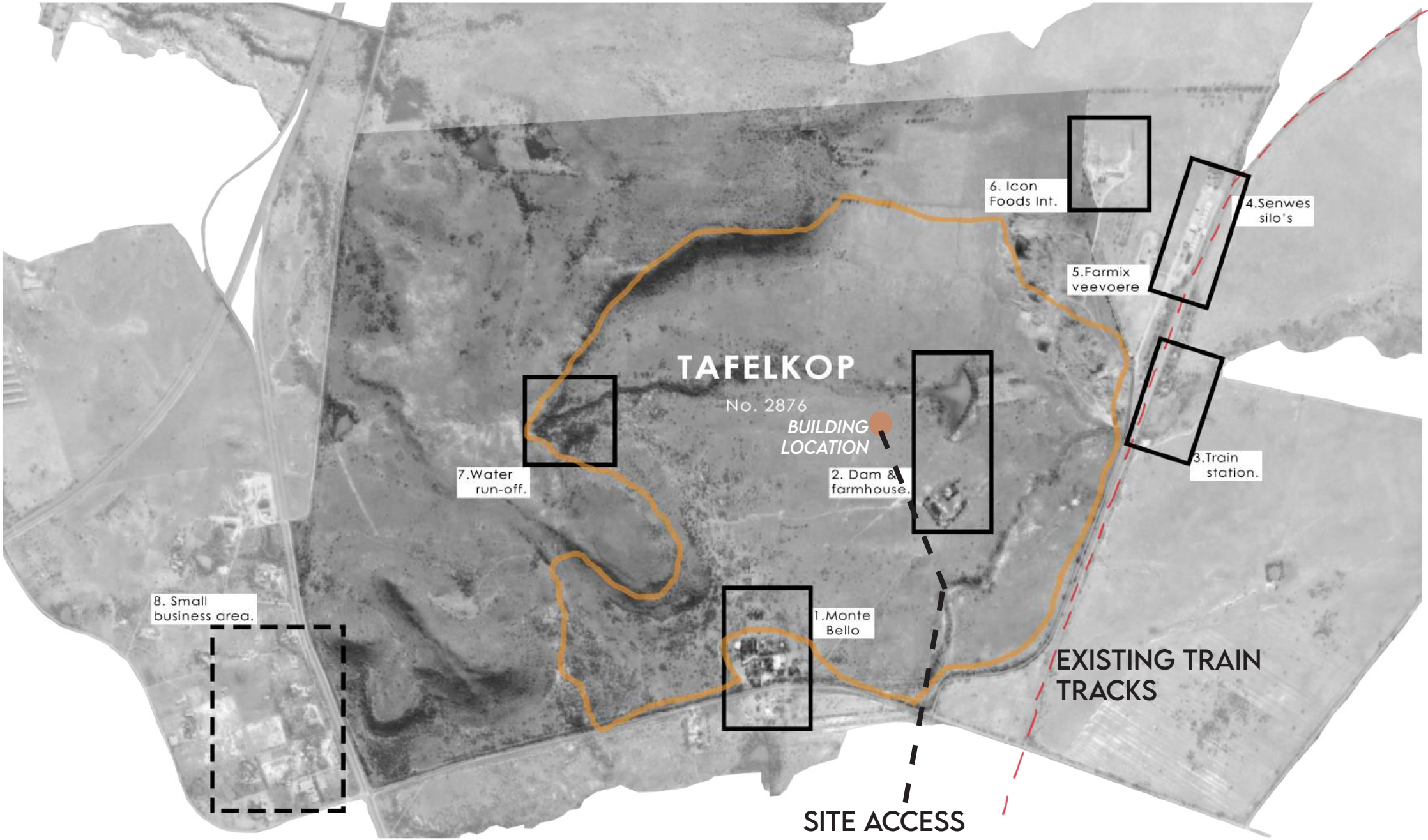


Figure 81 - Monte Bello (2021: onine).

1. Monte Bello is an events estate and specialises in weddings. They also have a spa, guesthouse and restaurant.

Its site is a small subdivision of the Tafelkop farm.

2. There is an old farmhouse on-site. It is however of no real consequence or heritage value. There is no land cultivation taking place either and only a few cattle can be seen grazing. The structure will thus likely be removed.

Figure 82 - Train tracks infrastucture (Du Preez, 2021).

3. The Van Tonder Train Station is still very much in use, however it is assumed for mostly transporting of agricultural materials.

This potentially is a very good way to gain access to the site for building materials, seeds transportation and possibly even people.

The station is embedded within older railway homes and some are being used by the local work force.

Figure 83 - Entrance to Senwes' silo's (Du Preez, 2021).

4. Senwes Grainlink has a well-established infrastructure in both the summer and winter grain cultivation areas to its disposal.

Senwes thus specialises in the procurement and distribution of various grain types. They could make an excellent client/partner in preserving our grain bio-
diversity.

This facility also establishes good accessibility for all vehicle sizes.

Figure 84 - Farmix Veevoere (2021: onine).

5. Farmix Veevoere specialises in producing high quality animal feeds. They have a rather big facility adjacent to the site and could be a possible client.

Figure 85 - Icon Foods Int (2021: online).

6. Icon Foods Int is a company that produces Teff on a large scale. Teff is a gluten-free product and they export this world wide. Teff is like any other grain, planted and harvested. Thus, seeds are involved and preserving a grain that some of the population rely on is of great importance.

7. Due to the rock formation this point is where water will flow towards to make its way down from the koppie and into a dam. The dam is man-made and with improved infrastructure it could assist the proposed Seed Bank be more sustainable in water use.

8. This is a small area with a variety of businesses operating in close proximity to the chosen site. It is behind the koppie and has no influence either visual or auditory on the site.

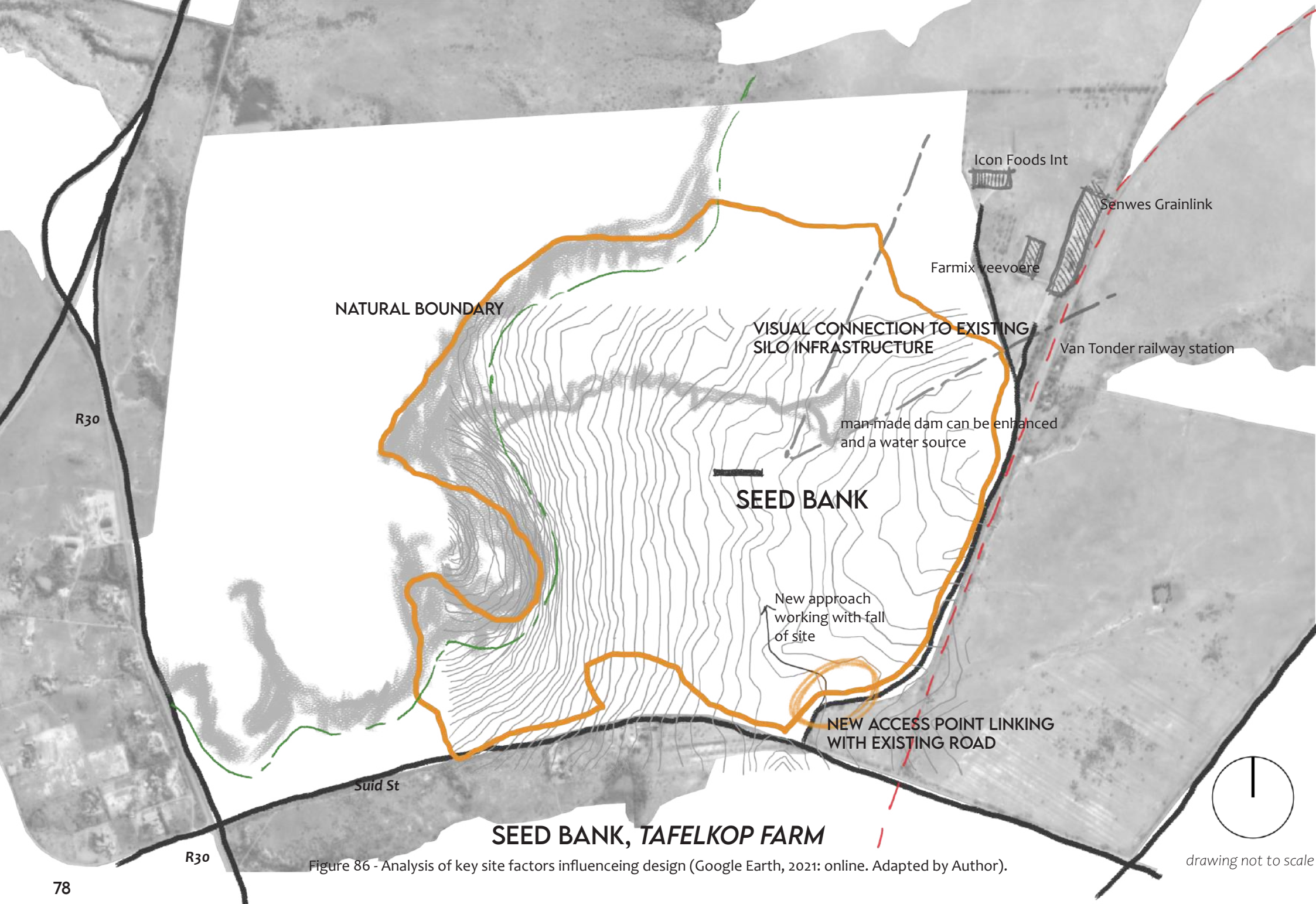


Figure 86 - Analysis of key site factors influenceing design (Google Earth, 2021: online. Adapted by Author).

Tafelkop farm, outline on figure 86, is the chosen site for the proposed Seed Bank. There is small koppie to the West acting as a natural barrier suggesting an entry point from the South. A new entrance would link well with already established routes used by Senwes, Farmix veevoere and Icon Foods International. An old, but still intact railway runs adjacent to the site and is outlined in red.
Due to the fall on the site there is a natural water run-off channel that ends in a man-made dam which will prove a valuable resource. The building is situated not far from this dam, but still at a safe distance to not be prone for flooding or water damage to structural elements.

Concluding the site analysis section of this chapter many thoughtful findings were made. The climate, site slope, existing entrances and surrounding context are all key elements that influence the proposed architectural building.

Figure 88 below attempts to illustrate the buildings relationship with it landscape with a red line showing the site's natural slope. The structure is nestled into the landscape ensuring a layered approach as to its functions. The design aims to respond to climate conditions and typological considerations to arrive at a thoroughly considered end result that respects its landscape and emerges from it. An approach that aims to thoroughly ground the building within its context.

Materiality also plays a big role in terms of having a critical regionalist methodology and material choices must thus reflect that.

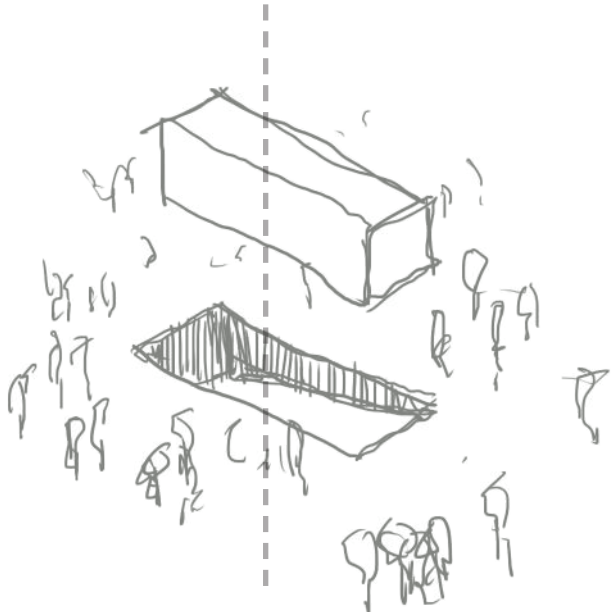
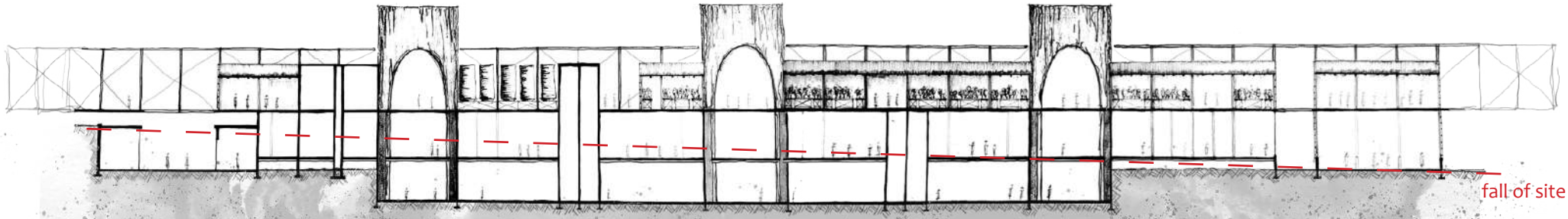


Figure 87 - Diagram of design grounded in landscape (Du Preez, 2021).



LONG SECTION *not to scale*

Figure 88 - Long section drawing of seed bank (Du Preez, 2021).

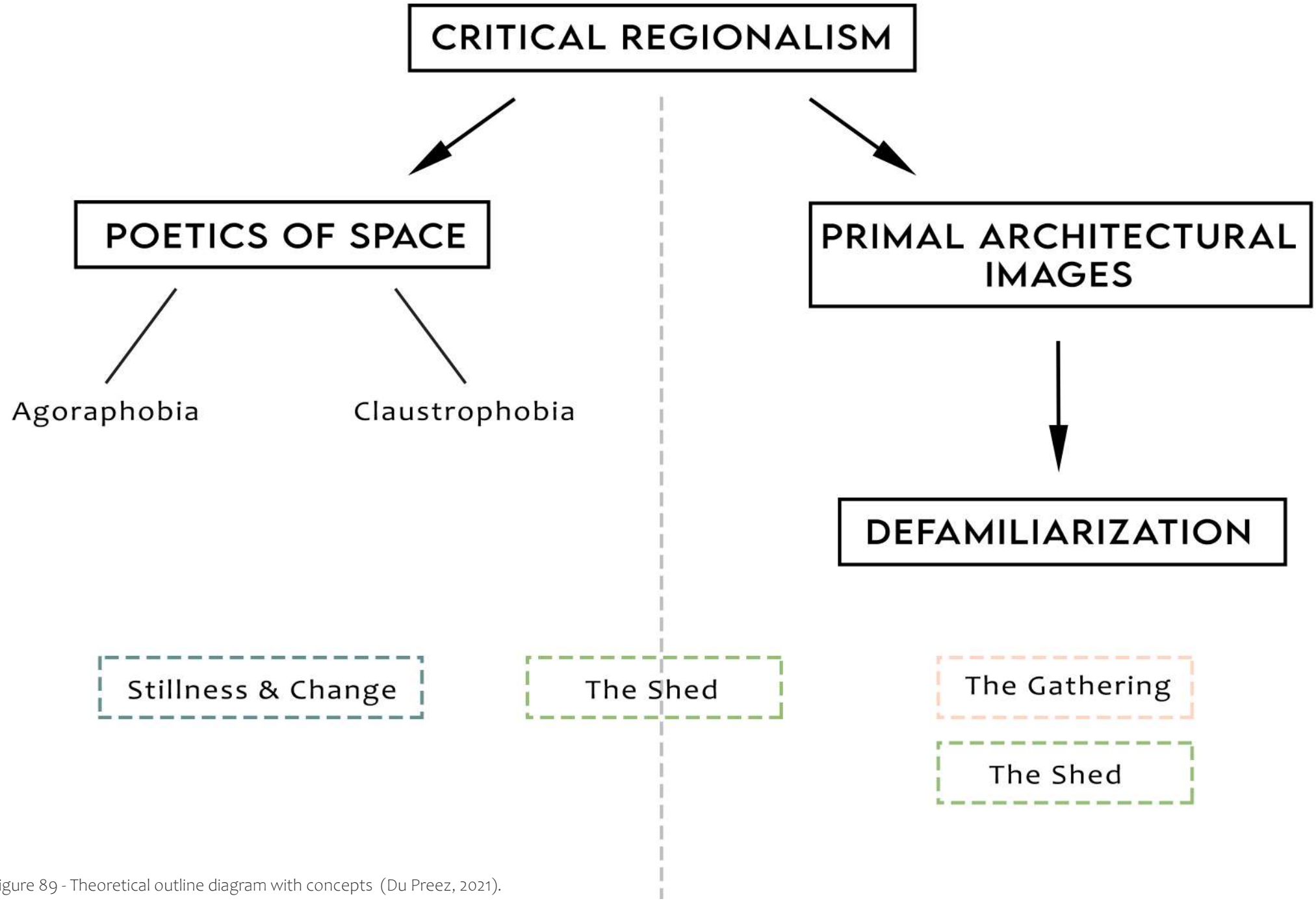


Figure 89 - Theoretical outline diagram with concepts (Du Preez, 2021).

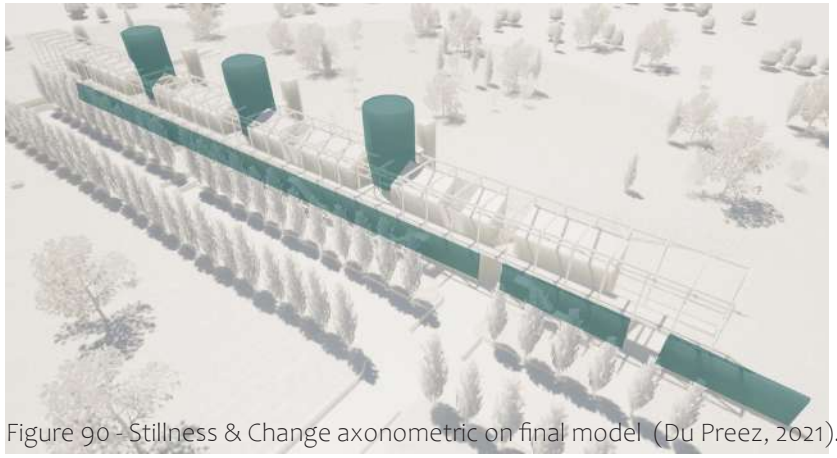


Figure 90 - Stillness & Change axonometric on final model (Du Preez, 2021).

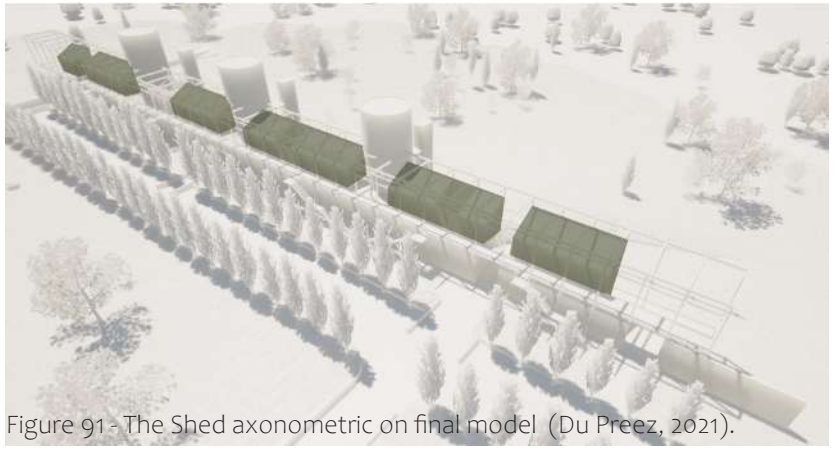


Figure 91 - The Shed axonometric on final model (Du Preez, 2021).

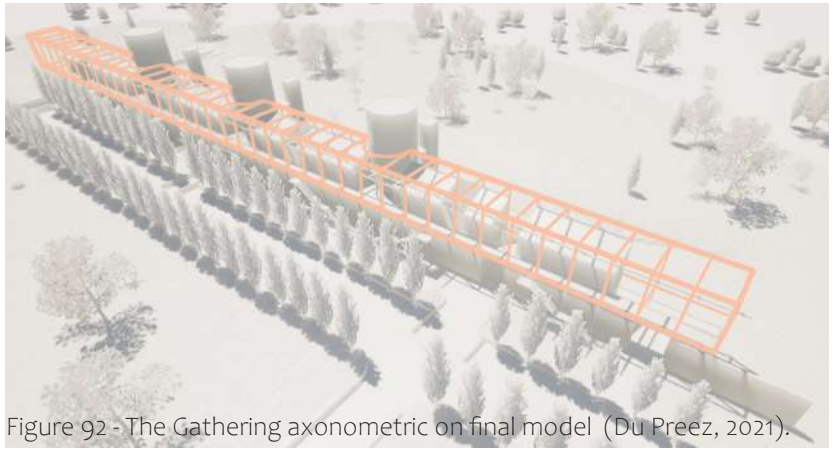


Figure 92 - The Gathering axonometric on final model (Du Preez, 2021).

Attempting to theoretically ground the project this section will explore theoretical constructs of architecture and implement them visually. Figure 89 illustrates theoretical constructs used and how they tie in with design concepts previously analysed. The site, concepts and theory aim to come together in this section so to come to a clear understanding of what this design will end up being. Figures 90-93 are axonometric models of the design showcasing where the concepts evolved into architecture.

In his book "Towards a Phenomenology of Architecture" (1979) Christian Norberg-Schulz aims to dig deeper into the psychic implications of architecture. His point of departure is acknowledging that if we only analyse architecture scientifically and analytically we do not address the importance of existential space. 'Existential space' deals with the complex relationships that exist between man and the environment he aims to dwell within (1979:5).

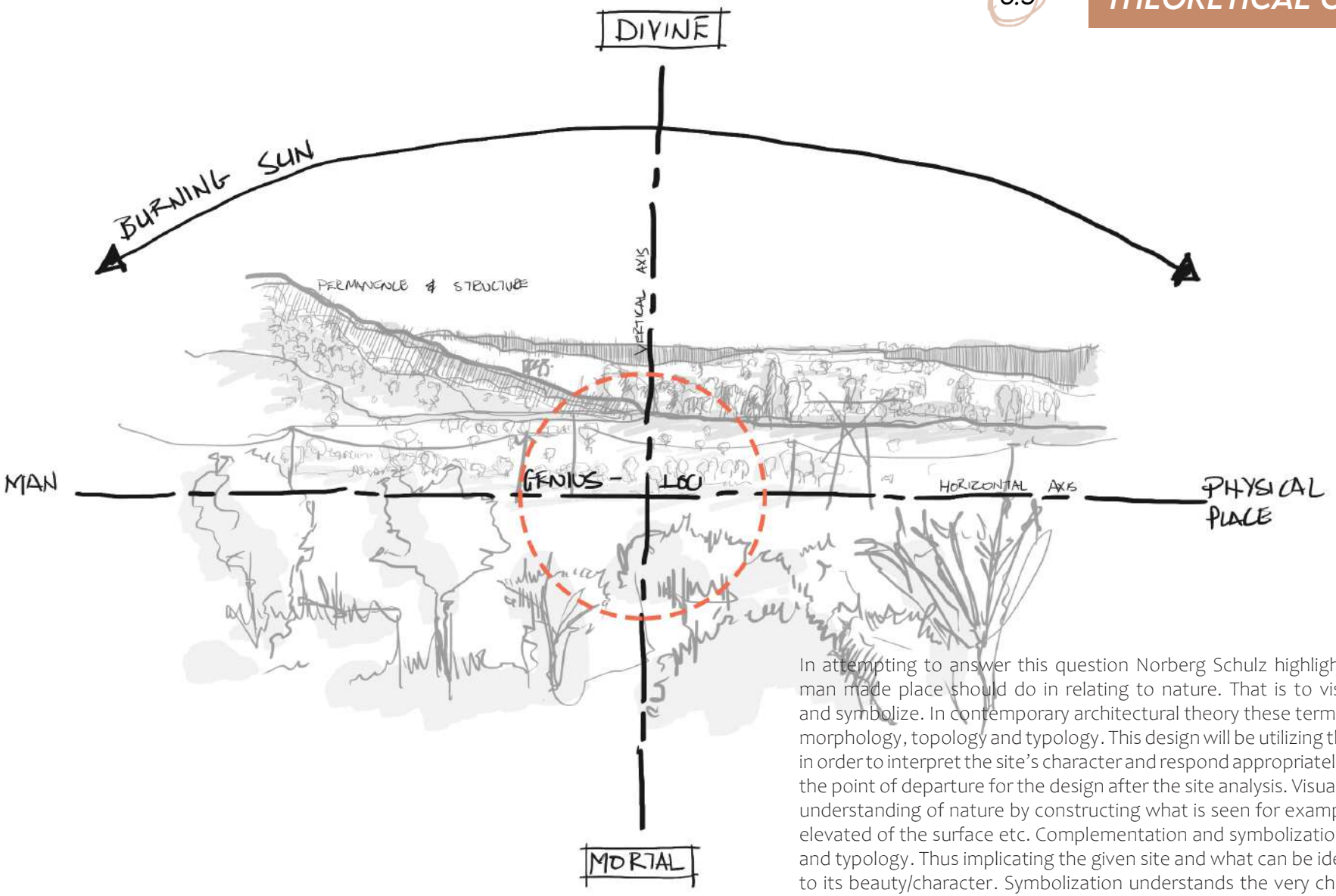
Norberg-Schulz acknowledges the late Martin Heidegger (1889-1976) and his work as influential in formulating his theory of existential space and the genius loci. He further states that architecture is merely the concretization of existential space and 'concretization' can be understood as 'gathering' and 'thing'. "A thing gathers the world" as Heidegger said. If concretization can be understood as a thing that gathers and its meaning is derived from what it gathers in then existential space is understood as space, character, orientation and identification. Furthermore, if man is to experience his environment as meaningful he must be able to orientate within- and identify with that environment (1979:5).

Therefore dwelling implies a specific space where life-happenings occur. Thus a space is understood as 'place' with a certain genius loci man can identify with. The aim of architecture goes beyond a mere shelter, but to visualize the essence of a space to create meaningful place. Only then can man dwell and experience the environment as meaningful (Norberg-Schulz, 1979:5). As previously stated in the document the proposed design is a Seed Bank for sub-Saharan Africa. Seed Banks are very functional typologies where there are clear goals to be achieved and very practical ways to do so. This however may not always necessarily translate into architecture that addresses existential space. Unearthing the essence of such a building and the impact it will have on society will ultimately transcribe into meaningful place making.

This dissertation takes place within the natural South African environment of the Free State landscape just outside of Bloemfontein on a farm known as Tafelkop farm (Chief Surveyor General – Spatial Data, 2021: online). If a virgin landscape is to be used to create meaningful place an understanding of its essence (genius loci) is paramount. There are various types of landscapes in this world and they each have distinct characteristics contributing to it essence and understanding them will form the point of departure for this investigation (Norberg-Schulz, 1979: 45).

Norberg Schulz identifies four main landscape categories namely; Romantic-, Cosmic-, Classical-, and Complex landscapes (1979: 45-47). The Free State landscape is considered to be a cosmic landscape with classical traits. This is a desert-like environment with scattered hills where life complexities are reduced to but a few simple phenomena (1979: 45). A seemingly infinite expanse of earth that is beautifully embraced by an overwhelming presence of the sky along with the constant burning of the sun and dry air is characteristically cosmic. It is a world characterized by permanence and structure. There is a strong emphasis on the relationship between the divine and the mortal on a vertical axis. Equally noticeable is the aforementioned wide expanse of fields ground grounding one amidst its horizontality (1979: 45).

Upon identifying the environment and its characteristics the question remains that if there is little to no built context where does one begin to define a building as suitable for its environment? It needs to still visualize the landscape's essence in order to create meaningful place.



In attempting to answer this question Norberg Schulz highlights three things any man made place should do in relating to nature. That is to visualize, compliment and symbolize. In contemporary architectural theory these terms are translated into morphology, topology and typology. This design will be utilizing these three concepts in order to interpret the site's character and respond appropriately. This will formulate the point of departure for the design after the site analysis. Visualization refers to the understanding of nature by constructing what is seen for example; enclosure, path, elevated of the surface etc. Complementation and symbolization refers to topology and typology. Thus implicating the given site and what can be identified that will add to its beauty/character. Symbolization understands the very character of the place and its translation into built form (1979: 17).

MORPHOLOGY

Figure 93 - Site diagram showing various elements (Du Preez, 2021).

It has now been established that the Seed Bank will be built within a cosmic landscape with classical traits through analysing its very essence thus responding appropriately through visualization, complementation and symbolization. This implies that the building will take form between heaven and earth and if man is to dwell meaningfully the interaction of these elements need to be understood (Norberg Schulz, 1979: 23).

In attempting to analyse these two elements one can say that creation could be seen as a marriage between heaven and earth (Norberg Schulz, 1979: 24). Earth, the very basis of existence from which life grows and manifests. The sky, the divine and inaccessible experienced as transcendence and outlined by embracing the path of the sun. The sky is the divine and experienced from afar, but unattainable whereas the earth provides man with shelter, protection and satisfy the need for intimacy. It is on and within the earth that dwelling takes place (Norberg Schulz, 1979: 24). Even though these elements are in a 'marriage' they are two separate entities continuously reaching for one another. The earth reaches for the heavens through the mountain/hill. It reaches out and forms a meeting point for these two elements whereas the sky and sun reach for earth on the horizon hoping to touch beloved ground upon sunset and sunrise (Norberg Schulz, 1979: 25).

It would seem that another challenge has presented itself. Two vast natural elements in continuous balance and interaction with a man-made structure caught within the in-between. The structure thus sits within the 'in-between' of heaven and earth, divinity and mortality. A new relationship then comes to the fore where the design will aim to adequately emphasize the vertical and horizontal orders so to respond to the elemental complexities, rhythms and patterns within the in-between. Settling in this position need to clearly reflect understanding of the natural environment and its inherent essence. A new man-made place needs to have a natural basis taking the environment and landscape as its starting point (Norberg Schulz, 1979: 50).

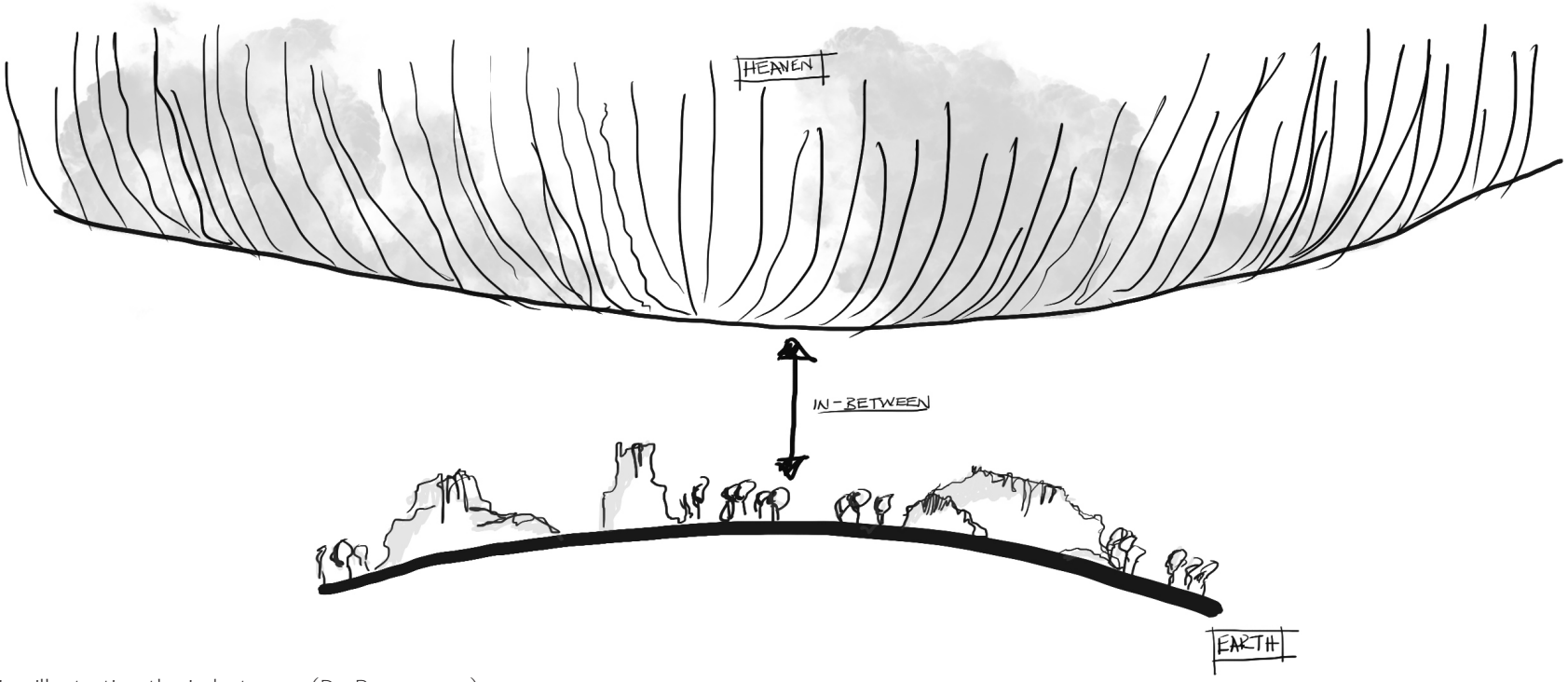


Figure 94 - Drawing illustrating the in-between (Du Preez, 2021).

In parallel to Christian Norberg Schulz's 'spirit of place' argument is that of the International Journal of Humanities and Social Sciences (2011). The authors describe place as a "dimension formed by people's relationship with physical settings, individual and group activities and meanings." Furthermore they derive that if a space is imbued with meanings and values from its users, place-making has occurred (Najafi & Shariff, 2011: 1054). Spaces and places change over time, however it does not mean that its essence has changed. This is important to realize as the Seed Bank will transcend many generations and its essence would have played a role in human behaviour (to an extent) and group identity (Najafi & Shariff, 2011: 1054). The group identity referred to can be seen as the agricultural community that will benefit directly from this facility. The Seed Bank not only aims to provide food security and protect biodiversity for future generations, but also to foster a community that works together to combat the effects of climate change and also natural and man-made disasters -a beacon of knowledge, education, resources and hope.

As stated in the previous section; if man is to dwell meaningfully he must be able to orientate himself within- and identify with the given environment (Norberg Schulz, 1979: 5). This is firstly understood and interpreted in terms of a natural landscape, but what happens when built form is inserted within this domain that man dwells within?

Critical Regionalism as coined by architect ***Alexander Tzonis*** and historian ***Liane Lefaivre*** addresses this question (Nesbitt, 1990: 483). Critical Regionalism aims at challenging the existing world-views in architecture. According to them it is done when a building is able to be self-reflective and self-referential. It furthermore carries within itself explicit statements and implicit meta-statements. The key element within this architectural method that differentiates it from movements such as Romantic Regionalism is its concern for place and the genius loci. It considers place and utilizes 'defamiliarization' in order to create regional elements in a new unfamiliar light that is still recognizable and identifiable. Another key element of theory is a moving away from sentiment and overfamiliarity- especially where cultural relevance is strong (Tzonis & Lefaivre, 1965-1995: 485).

"The fundamental strategy of Critical Regionalism is to mediate the impact of universal civilization with elements derived indirectly from the peculiarities of a particular place ... Critical Regionalism depends upon maintaining a high level of critical self-consciousness. It may find its governing in such things as the range and quality of the local light, or in a tectonic derived from a peculiar structural mode, or in the topography of a given site."

-Kenneth Frampton (Tzonis & Lefaivre, 1965-1995: 490).

THEORETICAL GROUNDING

A universally recognized example showcasing critical regionalism is the work of Renzo Piano Building Workshop with the Jean-Marie Tjibau Cultural Centre in Noumea, New Caledonia (1993-98). Piano managed to address historical relevance, place, site specific climate, culture and modernity in his design for the cultural centre (Tzonis & Lefaivre, 2003: 82). The commission came in memory of assassinated political leader Jean-Marie Tjibau in 1989 which in turn meant the centre had to pay homage to this significant figure. The end result saw Piano create a new synthesis between local traditions and global modernity. To do this the architect had to reach a thorough understanding of the Kanak culture enabling him to respect and critically respond to place, culture and traditions (Tzonis & Lefaivre, 2003: 82).

Through defamiliarization of the Caledonian huts in this culture, the structure and functionality of these huts were architecturally and socially adapted. This meant meaningful dwelling was made possible through addressing the essence of place. The use of recognizable materials, modern construction techniques addressing local climate and an element of monumentality enables the design to visualize, orientate and complement its environment appropriately (Tzonis & Lefaivre, 2003: 82).

With an understanding of critical regionalism the Seed Bank design will aim to address the essence of place. This is effectively done by considering the structural, cultural, climatic and historical context of the chosen site and defamiliarizing these elements to arrive at a new solution with a sense of familiarity and identity.

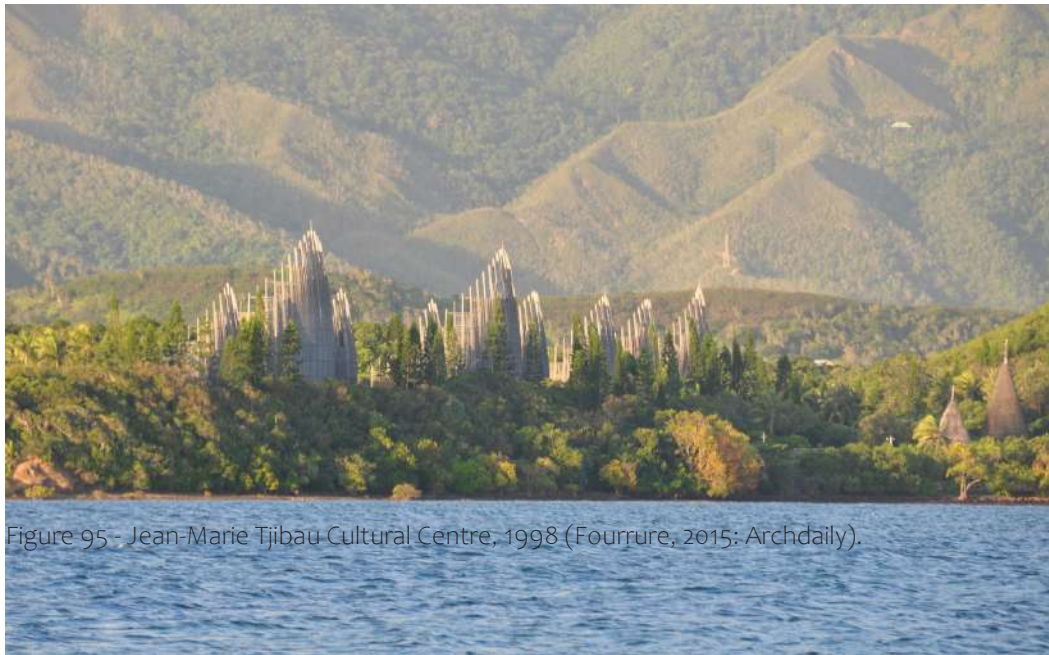


Figure 95 - Jean-Marie Tjibau Cultural Centre, 1998 (Fourrure, 2015: Archdaily).

Figure 96 - Jean-Marie Tjibau Cultural Centre facade (Fourrure, 2015: ArchDaily).

Man's need to dwell meaningfully and comprehending the complexities of landscape, place and environment makes this possible was explored in the previous section. Furthermore, it looked at how architecture plays a role in this endeavour within the in-between through orientation, defamiliarization and identification.

Thus, this section delves deeper into the built structure/building and its impact on the users and inhabitants. Doing so will assist in critically evaluating various design decisions so to address outlines of previous sections and outlines/borders still to come. Point of departure is with Bachelard's Poetics of Space (1969) and his view of inhabited space transcending geometrical space, the house as metaphor for humanness and meanings within the thresholds in built form.

"For our house is the corner of the world"
- Bachelard (1958: 4).

According to Bachelard (1969: 3) the house furnishes us with images, dispersed, and also a whole body of images concurrently. Poetically the author elaborates by saying that the house is an enclosure of sorts allowing the inhabitants to dream in peace- it protects the dreamer implying a level of intimacy and care within this geometrical space. However if dreaming can be seen as dwelling then the geometrical space becomes inhabited place where memories are created. Furthermore it is said daydreaming (a form of dreaming) constitutes humanity in its depths thus encapsulating human values. These dreams and memories remain within us long after we leave that house for us to relive for as long as we can manifesting inhabited space not as rooted, but transcendence (Bachelard, 1969: 6).

If man is to dream and dwell within the house what of the outside? Inside and outside is seen as "one" or "the other". It is thought of as being and non-being, being put up against one another (Bachelard, 1969: 211, 212). The author describes space as a "horrible outside-inside" where both sides of the line can be intimate. However, being only happens in one and they are always ready to be reversed. It can be understood in terms of Henri Michaux's "claustrophobia" and "agoraphobia". The one always opposing the other thus posing the question of where must one's dwelling take place amidst this demarcation of space? (Bachelard, 1969: 217-220) When applying this question to the open vastness of the Free State landscape it would seem that agoraphobia is to stand out.

"Too much space smothers us more than if it were not enough"
- Supervielle (Bachelard, 1958: 221).

The earth and sky are entities within a cosmic landscape that are in some sense constant. Elements characterized by permanence and structure (Norberg Schulz, 1979: 45). Therefore it would seem that in attempting to mediate this hard border between inside and outside could result in a forgiving threshold embracing both entities within one another.

Bachelard points out a poem delicately showing the importance of the threshold;

I find myself defining a threshold
As being the geometrical place
Of comings and goings
In my Father's House

- Unknown (Bachelard, 1958: 223).

This design then aims to be a building of opening and closing, grounded within its landscape and horizontality. Whilst reaching and inviting the divine into its midst allowing for mediation between inside and outside. It offers protection and safety to dream, but also with an acute awareness of the world on the other side. Elements such as light quality, transparency as opposed to solid mass, construction methods, scale and also materiality could assist in this mediation between claustrophobia and agoraphobia.

Bachelard (1958: 4) stated that the house is our first 'corner of the world'. Elements of the house such as windows, doors, doorframes and veranda are our first threshold with the outside world. They are some of the first mediators between inside and outside. Pallasmaa (2011: 118) continues with this notion explaining that the works of architecture should be connected to its culture, context, users, and social reality. Architectural works are metaphorical representations of these elements that guide our thoughts and perceptions. It is thus vital that a work of architecture must not be detached from these notions for then it cannot fully be identified with and dwelled within. To elaborate on this Pallasmaa (2011: 118) deals with architecture in various categories that attempts to encompass the idea that architecture and architectural images are essentially verbs. This meaning a building is an invitation and leads to specific acts relating to its function. The architectural image must thus be clear to the viewer and user.

This means that works of architecture is there to be used, felt, touched and experienced. It is the acts within that give true meaning such as being an invitation to enter. Therefore the design cannot merely be a visual exercise in the attempt of being critically regionalist. Providing a deeper architectural experience is what the design strives to deliver through the acts that are performed within the building (Pallasmaa, 2011, 123).

"A building is encountered, not only viewed ... A building directs, scales and frames actions, interrelations, perceptions and thoughts. Most importantly, it articulates our relations with other people as well ..."
- Pallasmaa (2011, 214).

An influential part of Pallasmaa's (2011: 129) work is his explanation of 'primal architectural images and architypes'. According to him images evoke certain emotions and connotations within the viewer. Similarly architectural images evoke not meanings, but memories of experiences as emotions.

That is why the acts that take place within the design are to lead to a deeper architectural experience. The primary elements of architecture such as floor, wall, ceiling, column, window, archway, stairs, table, bed etc. are all acts more than they are mere objects or physical entities. The floor invites movement and circulation (Pallasmaa, 2011: 129) whereas the roof protects, but also provides intimacy whilst in dialogue with the divine. The column reaches for the heavens and the window invites the outside in.

The fascination with agricultural architypes is that in terms of Pallasmaa's (2011) aforementioned work they can be interpreted as good works of architecture. They are functional; there is a reason for each element and an action that runs parallel to it. The structure and usage as a whole is a series of acts. Traditionally they are lacking in humanness for it is the functionality that is important. This Seed Bank merges the poetic aspect of architecture with the functionality of agricultural archetypes. There is a humanness to it that tells of its context, culture, importance and usage.

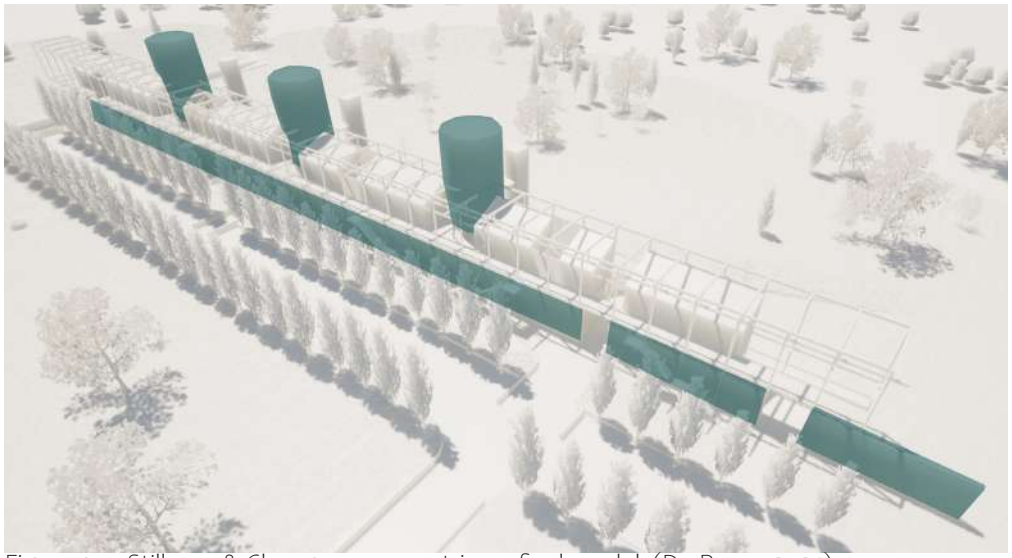


Figure 90 - Stillness & Change axonometric on final model (Du Preez, 2021).

Figure 91 - The Shed axonometric on final model (Du Preez, 2021).

As architecture is the interpretation of our natural environment into the realm of man (Pallasmaa, 2012: 44) it also enables us to settle within its space. In a way architecture domesticates the limitless expanse of the landscape (Pallasmaa, 2012: 35). However, as human beings we have a need to be rooted within the continuity of time and it is also the job of architecture to facilitate this need. Therefore the design needs to be rooted in place and enable its users to inhabit the continuum of time (Pallasmaa, 2012: 35). The building's essence will transcend many generations in the quest to food resource security. In conveying this essence materiality is quite important. Material usage and aging over time adds to the experience as it tells the history of its human usage and origins (Pallasmaa, 2012: 35). The aging patina is tangible, visible and a reflection of its surroundings. It is thus a humane threshold from the exterior into the interior of the building.

Gotthard Booth once said; ***"... nothing gives man fuller satisfaction than participation in processes that supersede the span of individual life."*** *(Pallasmaa, 2012: 35).*

The mental need to be rooted in place and context should be facilitated by the design and building functions. The rammed earth wall is such a key configuration to link the inhabitants with context and also witness its change over time. Similarly, the building witnesses the inhabitants over generations. As Booth said – it is satisfactory when participating in actions and activities that will last longer than oneself. It is a form of leaving some sort of legacy if you will. Therefore understanding the building from within is important for the user to find meaning in his or her actions beyond just the banking of seeds. The very seeds scientists examine and store away will most likely be in the seed bank for decades after the scientist has passed on. The building gives meaning beyond the ordinary and its users give meaning to the building by utilizing it to save genetic material from extinction so that humanity can live on.

Running along the rammed earth wall is the service corridor showcasing the wall to the user and vice versa. Moreover, it also showcases how the building functions bringing landscape together with functional element of engineering and services. The one compliments the other and serves as a reminder that the building is not a mere white cube filled with sterile labs. It has materiality, honesty, texture and character rooted in place.

In the aforementioned various elements were positioned adjacent and opposing one another ultimately relating to a multisensory experience for the user. Architecture facilitates this experience by extending nature into the realm of man providing perspective to comprehend and fully experience the world (Pallamaa, 2012: 44). Thus, nature has an enormous role to play in uncovering the spirit of place as it's an integral part of it. The relationship between building and context illuminates this not only through material use and cultural reference, but also through orientation and integration with site conditions.

Interpreting the existing slope on site as opportunity to nestle the building into the earth makes the user acutely aware of its existence. It strengthens the existential experience by emphasizing passing hours of the day, course and angle of the sun and changes in colour as seasons rotate. The user's sense of being is strengthened merely by observing what was always there and merely illuminated by architecture (Pallasmaa, 2012: 45).

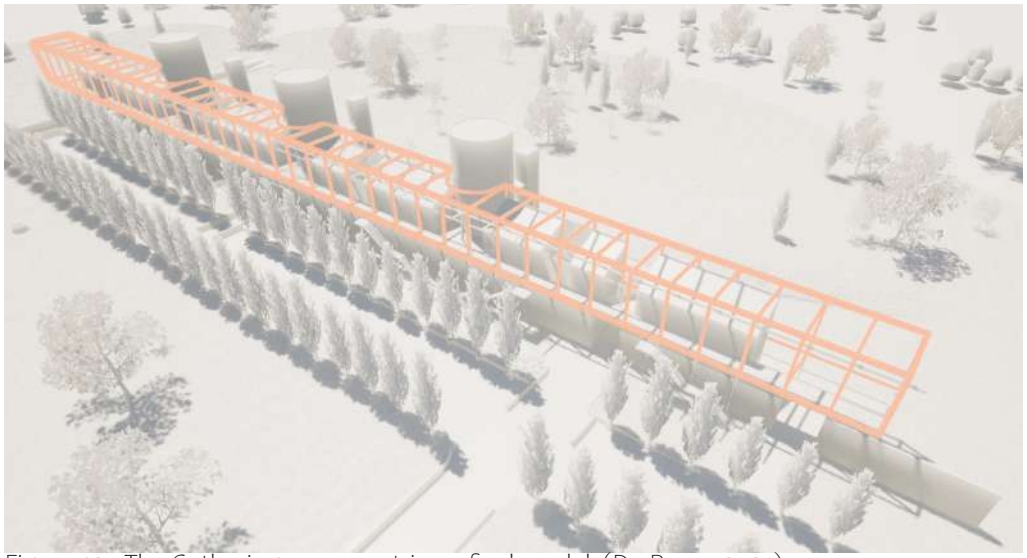


Figure 92 - The Gathering axonometric on final model (Du Preez, 2021).

Part 04

DESIGN & TECHNICAL SYNTHESIS

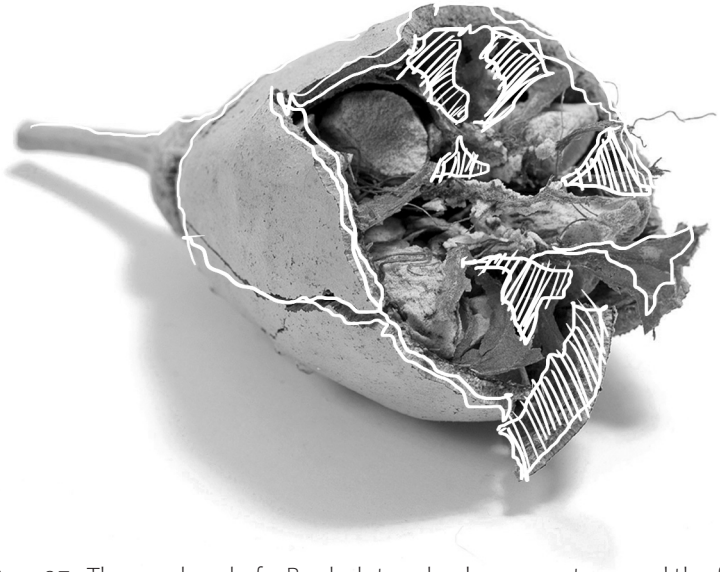


Figure 97 - The seed pod of a Baobab tree broken open to reveal the flesh within (Hall, 2006: online. Adapted by Author).

4 DESIGN DEVELOPMENT

Design development is a crucial step within the design process of this project. This chapter will aim to shed light on the decisions made along the way and explain various developments. Ultimately the project's end result is the culmination of various sketches and models. The process will be illustrated chronologically as it unfolded to allow an honest look into challenges faced.

As important as the design development is the project's viablility truly lies within its technical synthesis. Plans, materiality choices, sections and elevations are all crucial to fully realise a design. Technical information such as equipment needed and their measurements formed a big part of the process and will also be outlined in this section.

Figure 98 - First concept model in the landscape (Du Preez, 2021).

Development 1 saw a concept model sitting on top of the hillside of Tafelkop Farm as observed in figure 98. It was envisioned as an engineers typology that grows out of the hillside with an internal body digging into the subterranean level.

Figures 99 - 100 illustrates the thought process on a two dimensional plane of plan and elevation. A monolithic mass nestled into the landscape with a structure hovering over and encapsulating it. Slender towers pierce the horizontal plane extending to the heavens indicating something above and below. Within the climate a seed bank was imagined to be below the natural ground level as a form of a secretive vault. Cladding on the sides of the building including the hovering frame embody rhythm and datum with reference to typical shed-like construction of farms in the area.

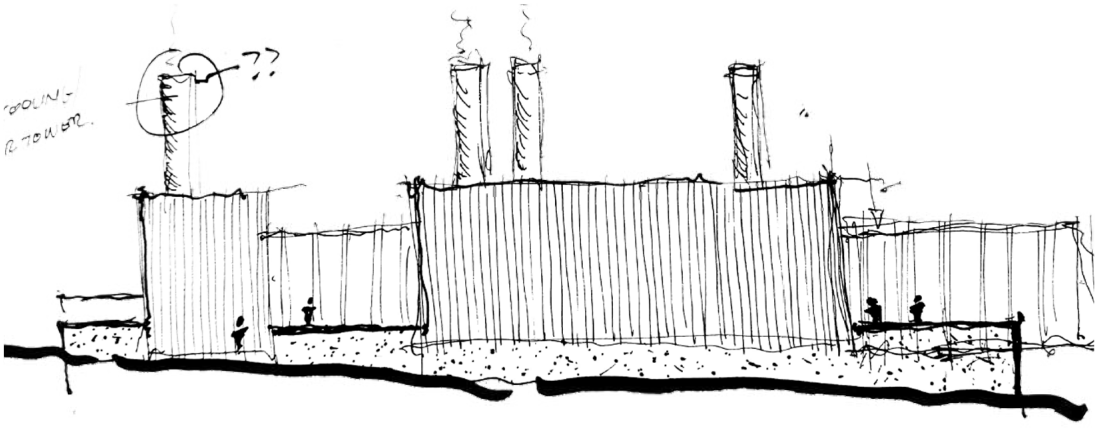


Figure 99 - Development elevation (Du Preez, 2021).

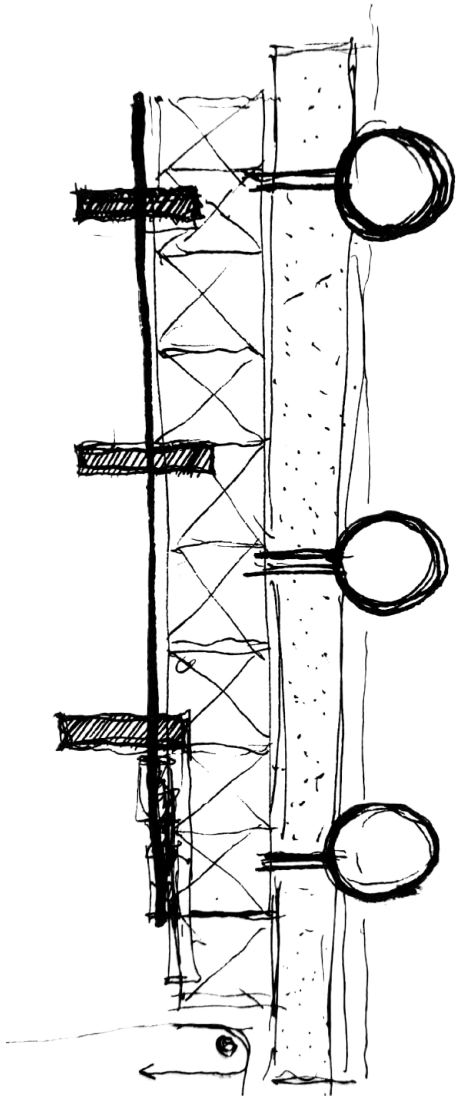


Figure 100 - Development plan parti (Du Preez, 2021).

Figure 101 - First concept model in the landscape 2 (Du Preez, 2021).

The drawings evolved into a subterranean investigation as to how the building will bridge the in-between. This established the theoretical link spoken of in the theory section where the design inhabits the in-between of heaven and earth. A hovering steel structure dematerializing the mass acting as mediator for the user between agoraphobia and claustrophobia so that place making can take place.

While looking to embody the open vastness of cosmic landscapes and working with a slope the design stayed true to its linear origins. By keeping its linearity the building dissapears into the slope creating a dynamic visual and physical experience as the building does not reveal all of itself at once. Seed Banks remained below ground where there are more stable temperatures and safety can be managed alot easier.

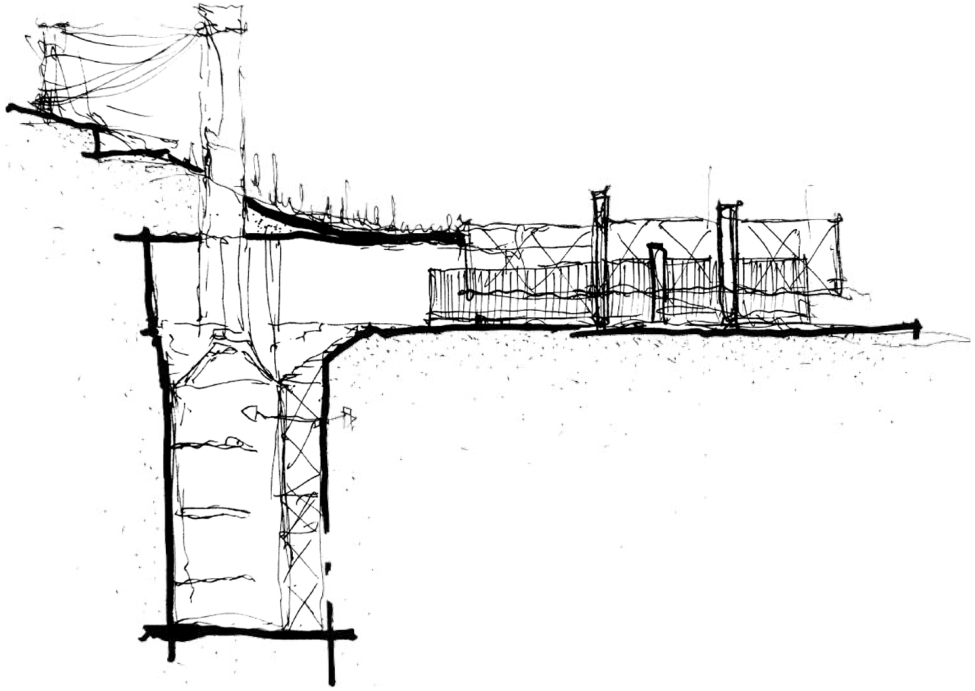


Figure 102 - Section concept model (Du Preez, 2021).

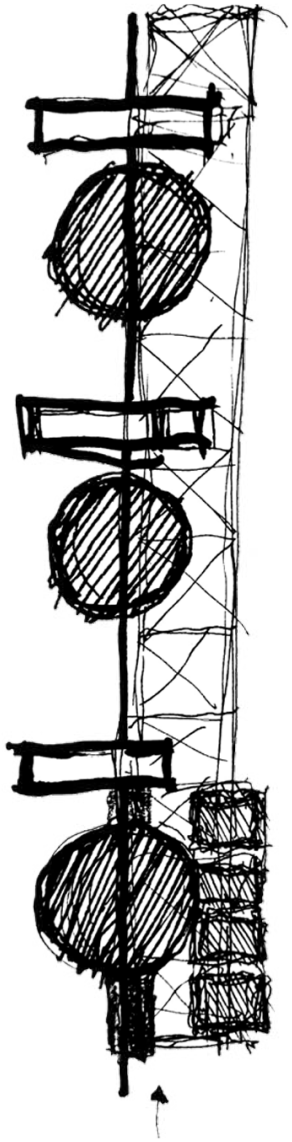


Figure 103 - Developed plan parti 2 (Du Preez, 2021).

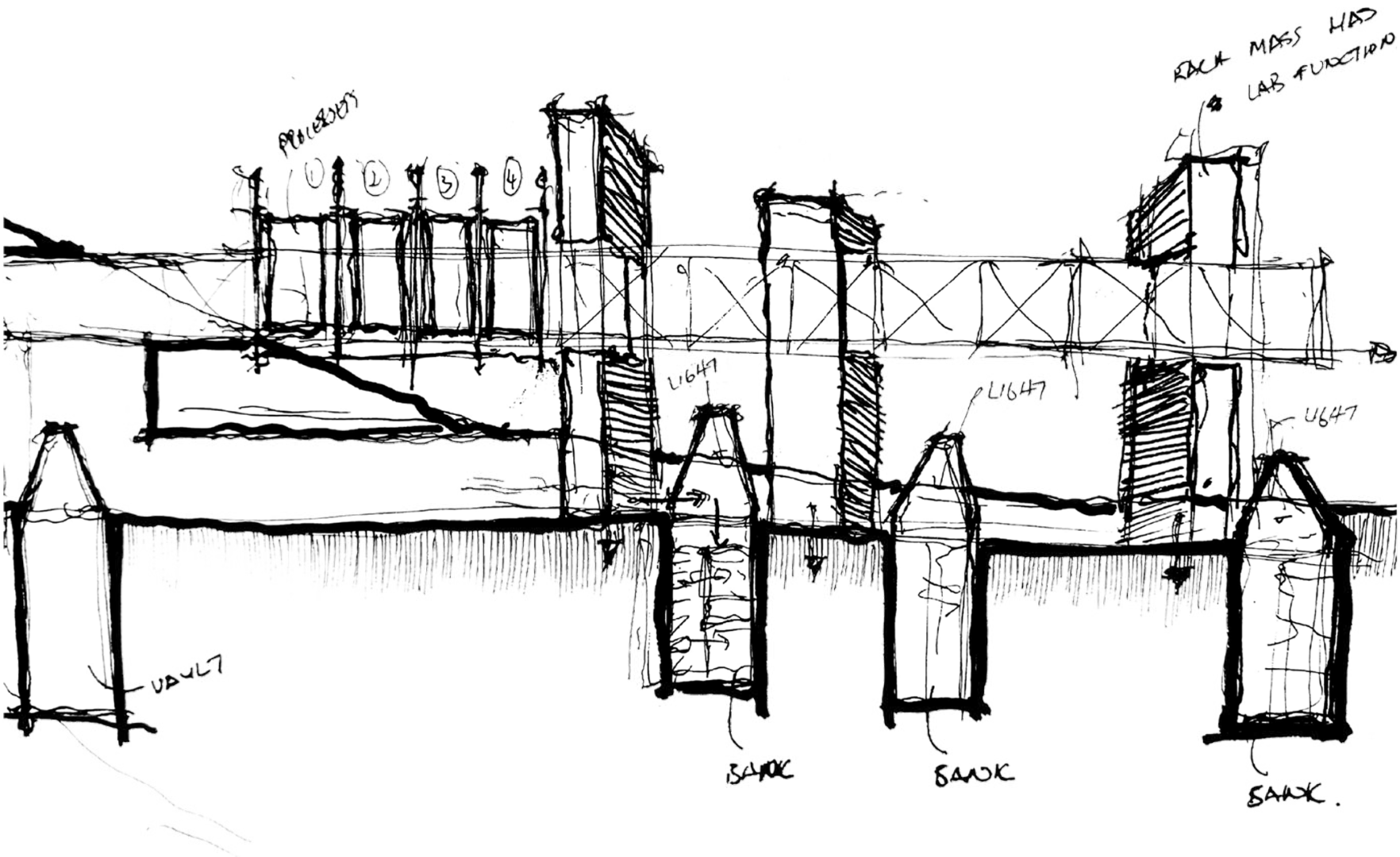


Figure 104 - Development 2 (Du Preez, 2021).

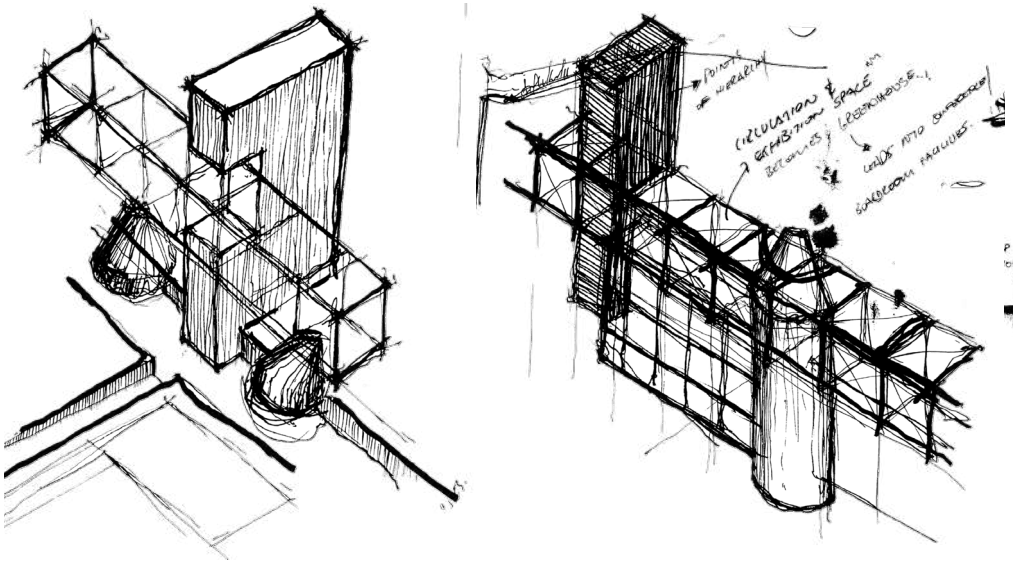


Figure 105-106 - Massing exploration (Du Preez, 2021).

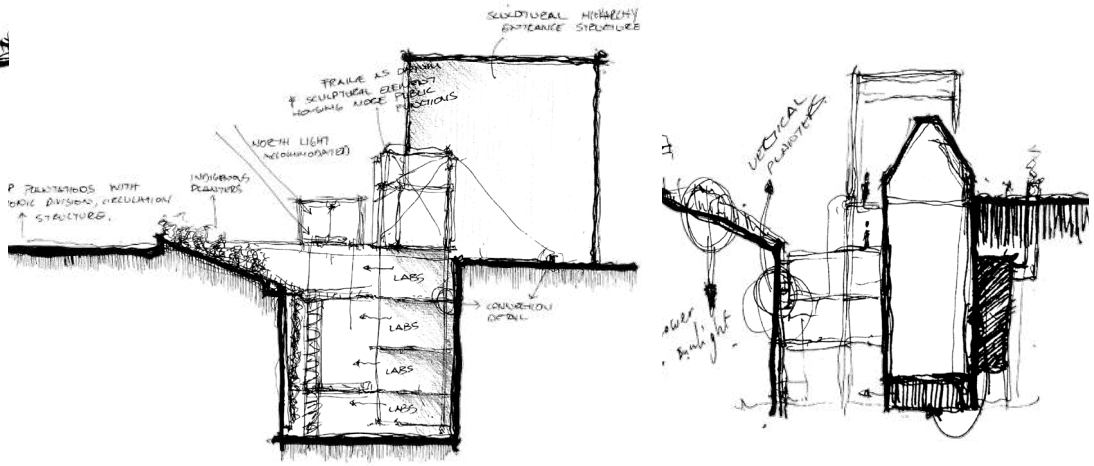


Figure 107-108 - Sectional exploration (Du Preez, 2021).

Development 2 was perhaps not very successful for the project. It did however render some valuable insights into how the site could to be utilized. This development worked with the structural frame as the mediator between ***claustrophobia*** and ***agoraphobia*** by moving it around on the horizontal plane. At first it was elevated with monumental monoliths holding it up in the air. A sculptural piece within the landscape communicating the concept of permanence and structure.

The latter part of the development saw the frame and stereotomic elements move into the landscape and unearth a big part of its soil. Laboratories and work areas were placed in the crevice with the seed bank silo's piercing the horizontal to meet the viewer in the landscape as sculptural 'cones'. This approach however radical and exciting was deemed too harsh on the very people that will utilize the structure and also the landscape. Intimicy will have been lost and the engineer's aesthetic will have remained exactly that and nothing deeper to its inhabitants.

Figure 100 - Model 3 (Du Preez, 2021).

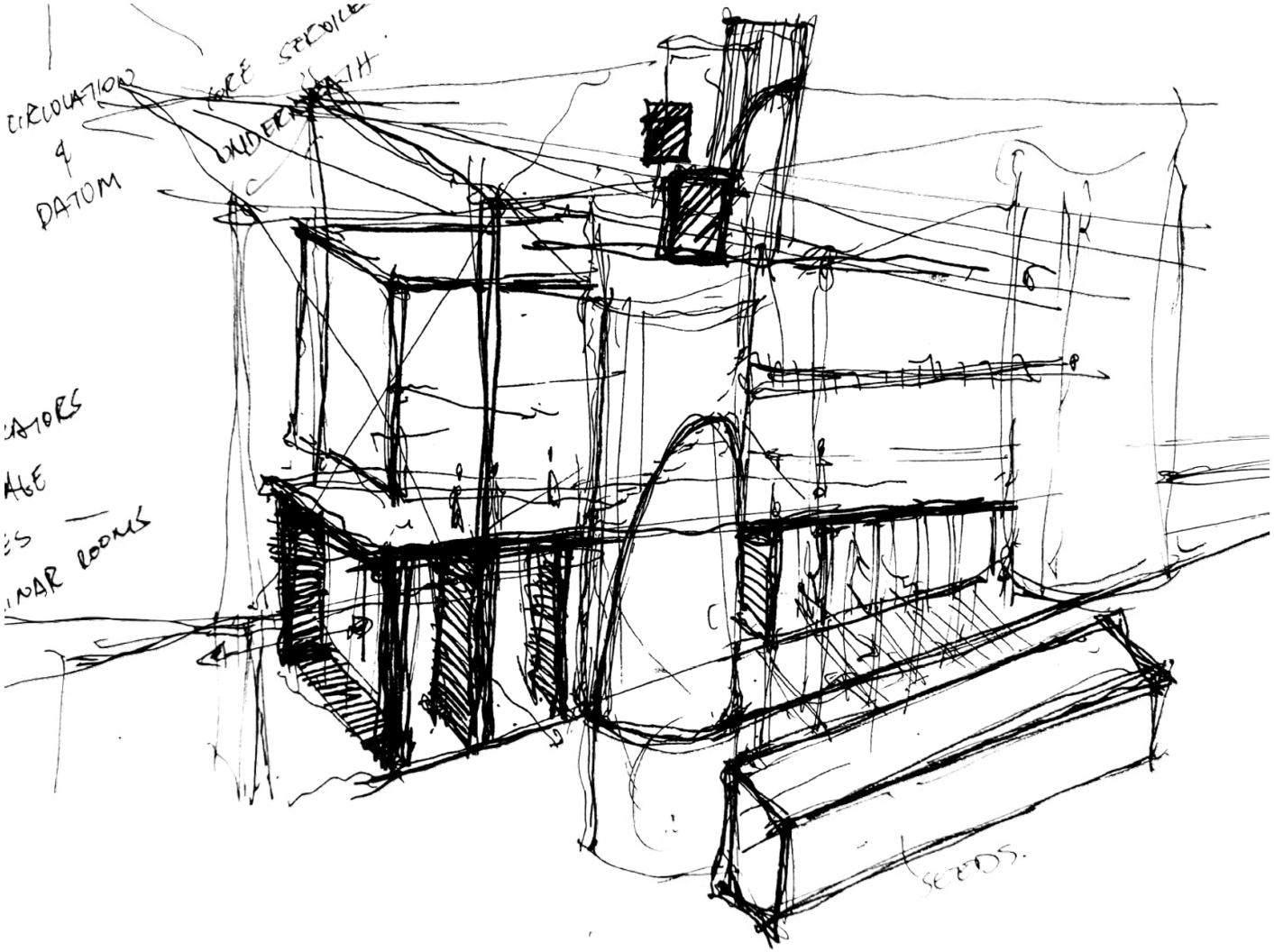


Figure 109 - Final stage development axonometric (Du Preez, 2021).

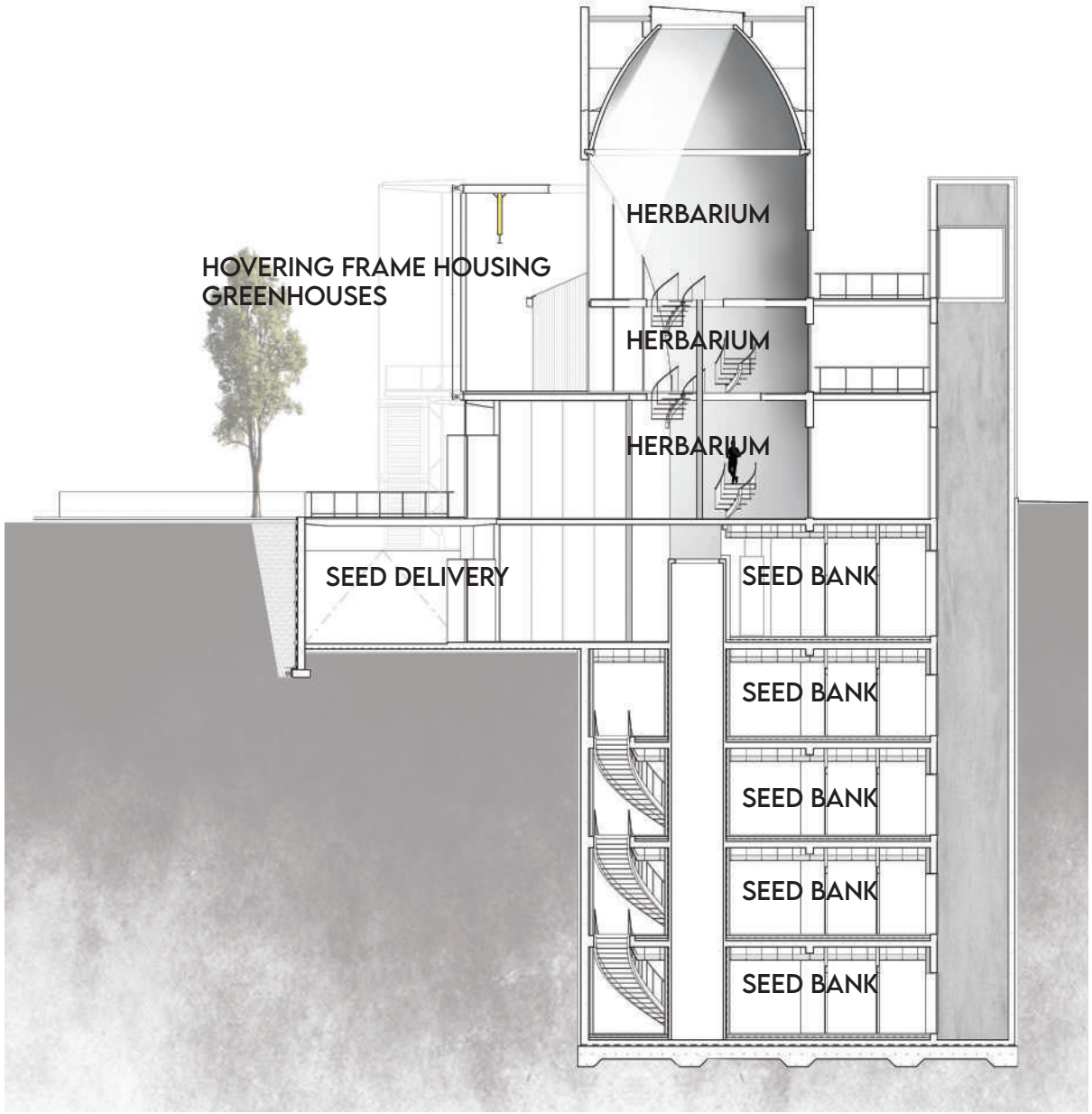


Figure 110 - Final section AA (Du Preez, 2021).

Final development stages saw the formulation of a structural system that enables the slope of the site to form around the building as it anchors itself in place. A grid system was used with ground floor stereotomic concrete elements that support a lighter tectonic frame hovering above it.

There are three seed banks in silo's as a reference to agricultural typologies that sit within the structural frame that anchors to it. A service corridor was envisioned to run along the length of the building that is easily accessable from the interior and adding good air circulation for climate control of labs. Enclosing this corridor is a rammed earth wall that anchors the building into the hill and is visible from the interior as services expose themself anywhere possible.

The seed banks are located on the basement floors for climate and security reasons. There are four seed bank storage rooms in each silo that is cooled to -18 degrees Celcius. The top part of the silo will form a herbarium that display all field notes, specimens and artifacts gathered from expeditions. The silo then becomes a symbol of knowledge and wealth of a different manner. It not only safeguards our genetic history and future, it also houses knowledge and extensive research of these materials.

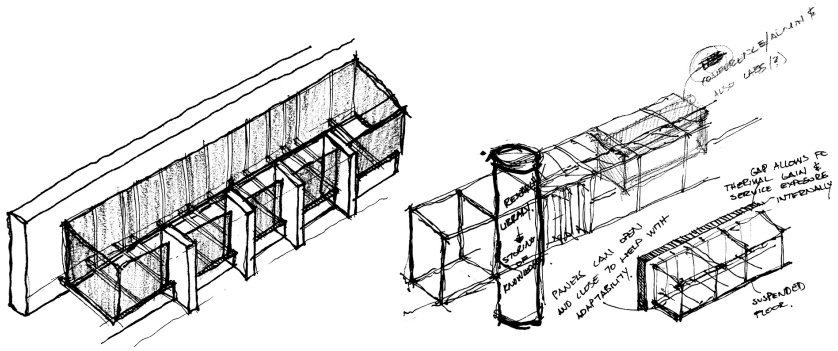
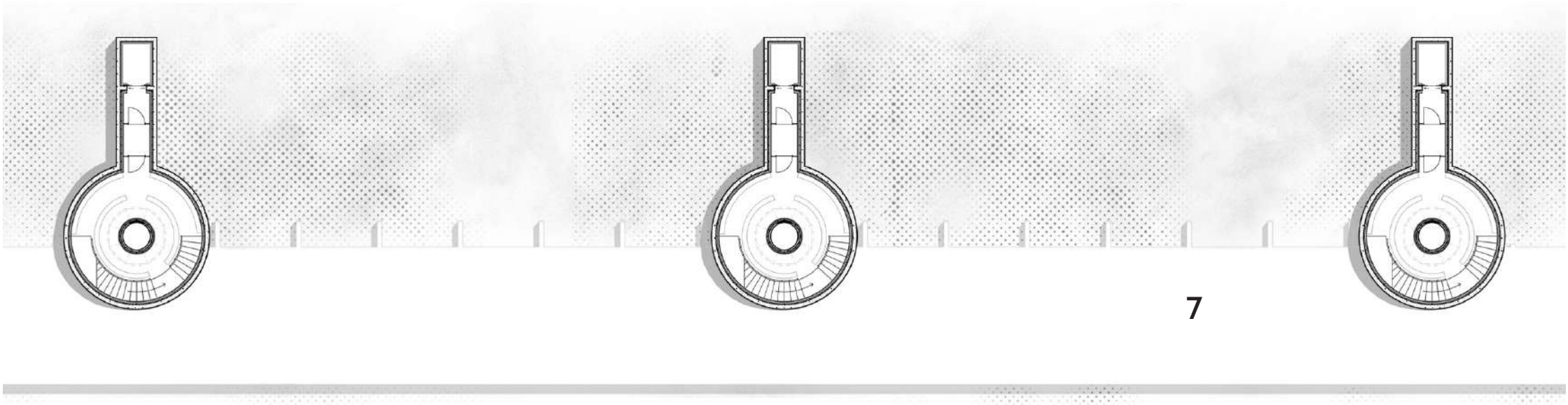


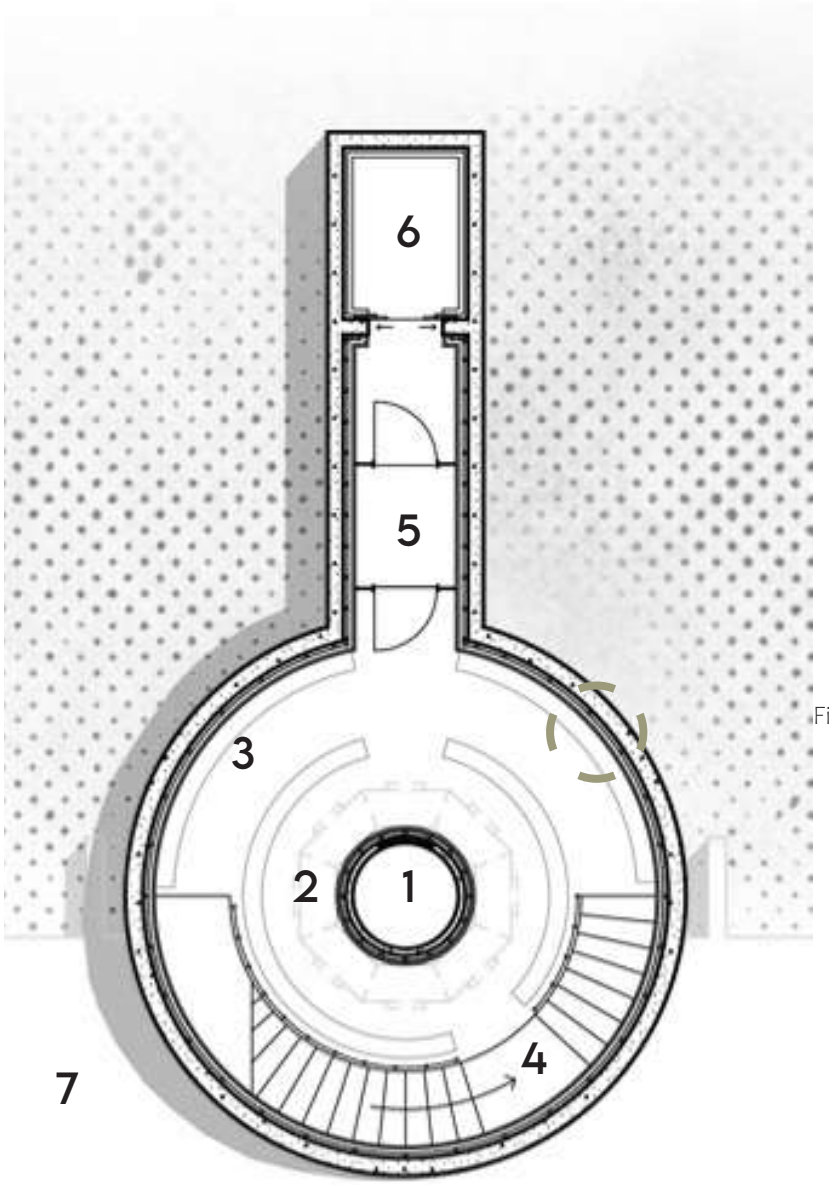
Figure 111 - Thought process on key structural elements (Du Preez, 2021).



SUBTERRANEAN SEED BANK FLOOR PLANS
NOT TO SCALE

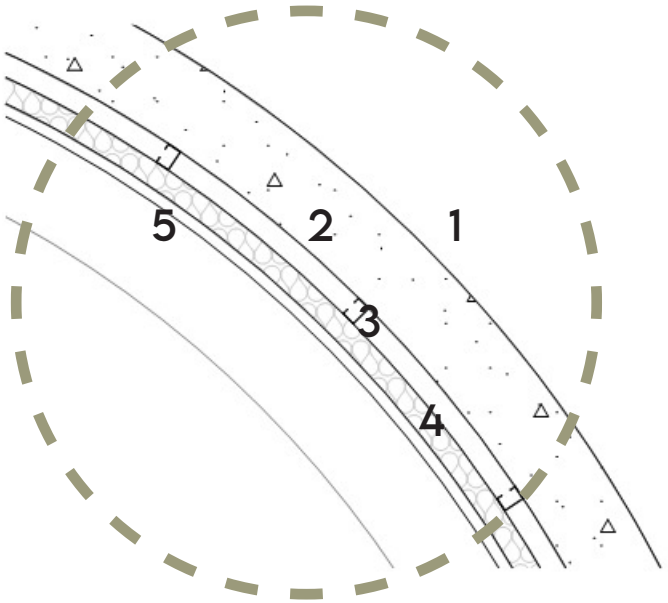
Figure 112 - Subterranean seed bank floor sketch plans (Du Preez, 2021).

Figure 113 - Subterranean seed bank floor plan enlarged (Du Preez, 2021).



1 - SERVICE SHAFT
2 - COLD ROOM EVAPORATORS
3 - 300MM WIDE MODULAR STEEL SHELVING
4 - LANDING AND STAIRS
5 - CLIMATE CORRIDOR
6 - ELEVATOR
7 - LARGER FACILITY FOOTPRINT

SUBTERRANEAN SEED BANK FLOOR PLAN
NOT TO SCALE



1 - OUTER LAYER TO BE TANKED WITH 110MM BRICK WALL AND DPM LAYER

2 - 300MM REINFORCED IN-SITU CONCRETE SILO

3 - 75X50X20X2MM COLD FORMED LIPPED CHANNEL FIXED TO CONCRETE SILO

4 - 100MM BULK INSULATION

5 - 50MM THICK POLYURETHANE PANEL. INTERIOR FINISHED WITH LAYER OF CHECKERED ALUMINIUM

SEED BANK WALL DETAIL
NOT TO SCALE

Figure 114 - Seed bank wall detail (Du Preez, 2021).

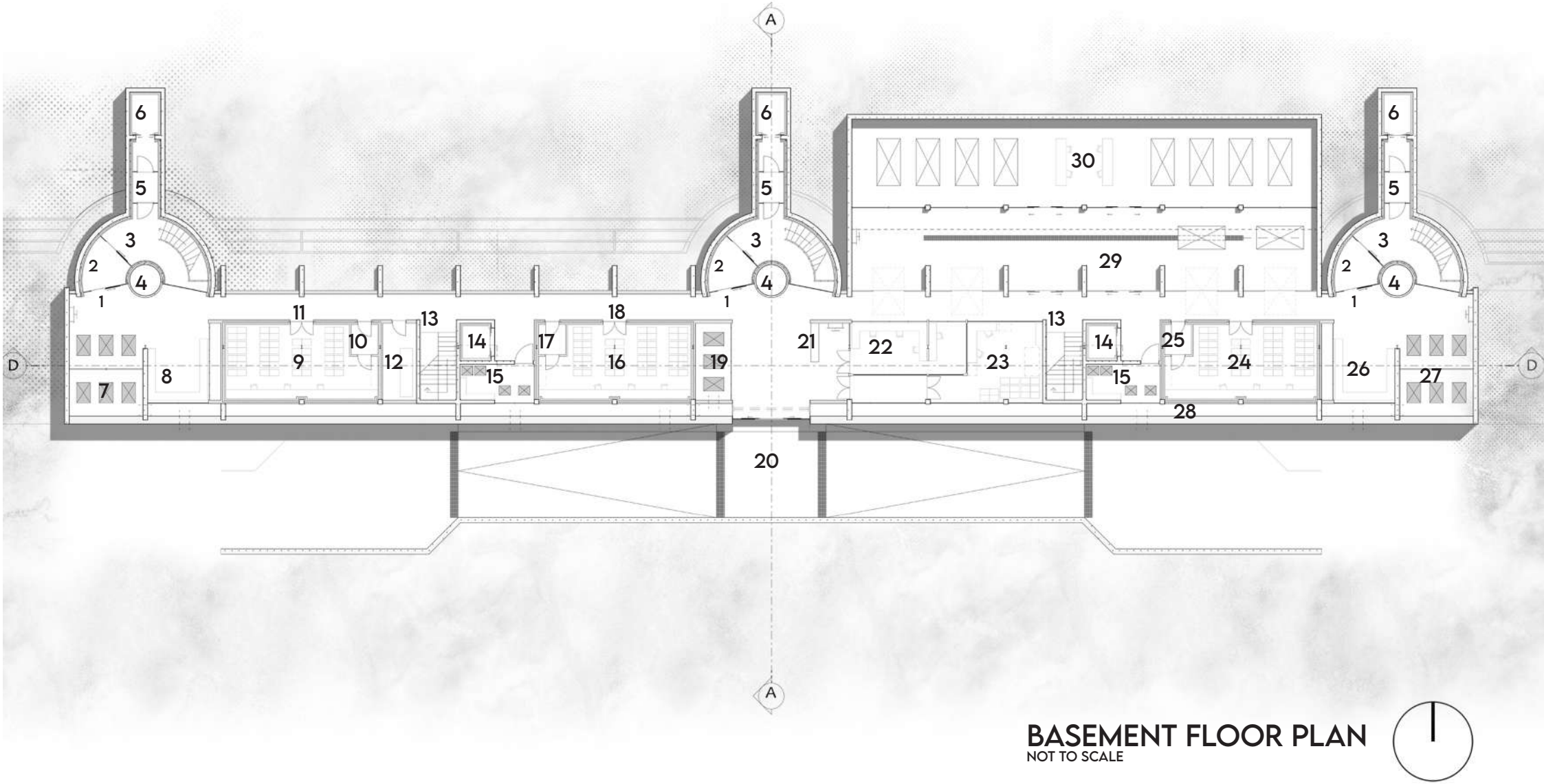
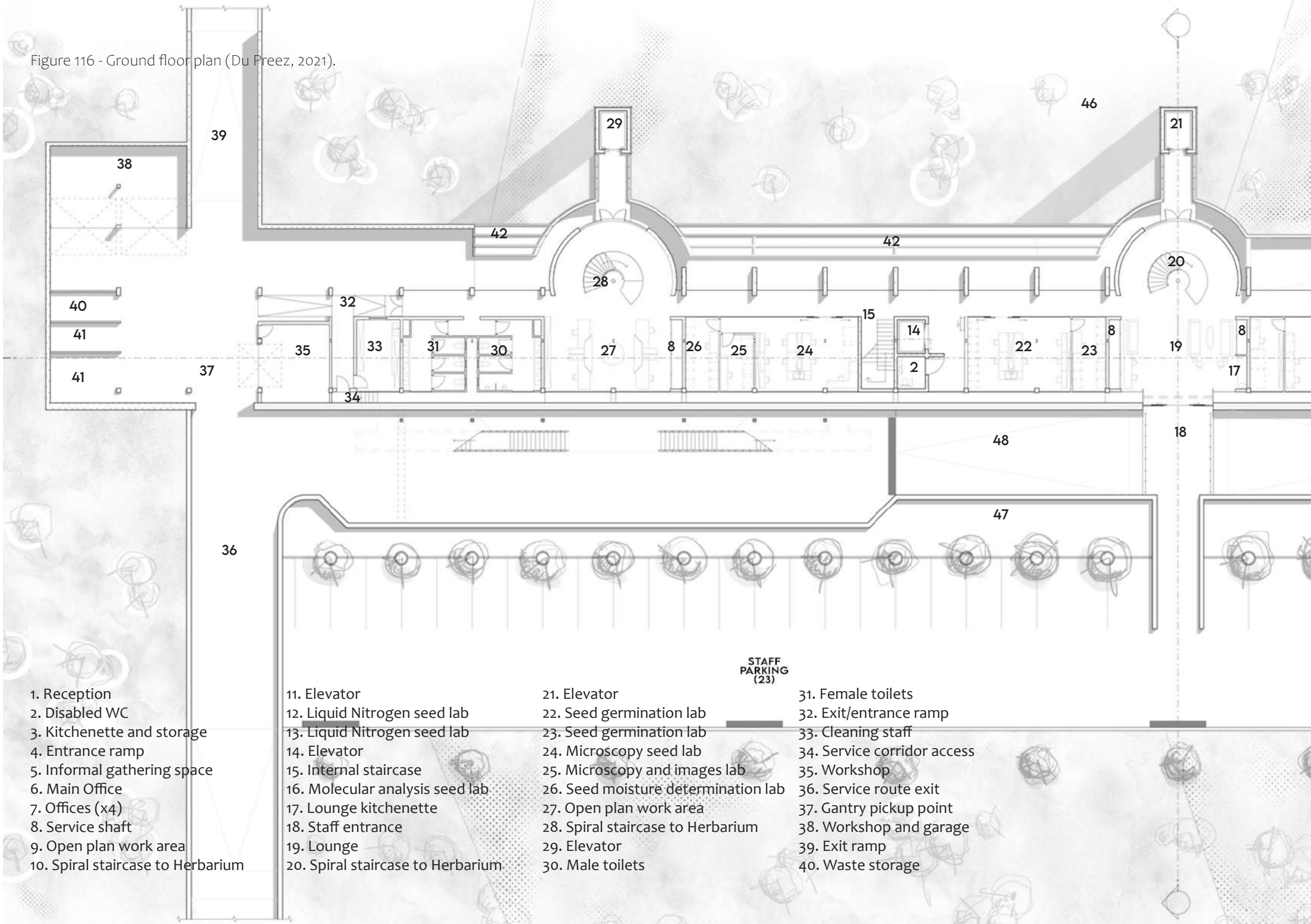


Figure 115 - Basement floor plan (Du Preez, 2021).

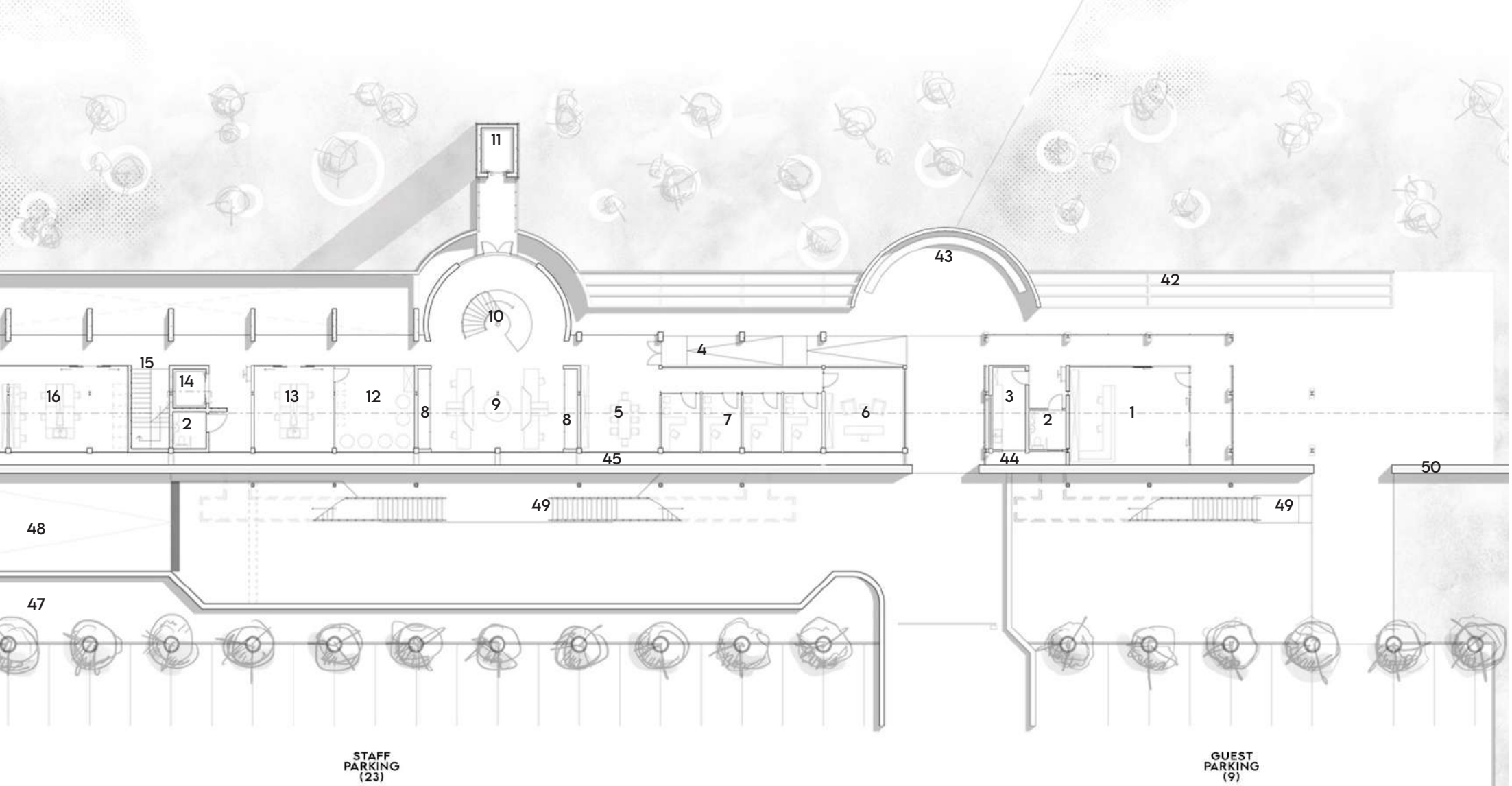
LEGEND

1. CLIMATE CORRIDOR ENTRANCE
2. CLIMATE CORRIDOR
3. SEED BANK ENTRY LEVEL
4. VENTILATION SHAFT
5. CLIMATE CORRIDOR
6. ELEVATOR
7. SEED BANK COLD ROOM CONDENSERS
8. SEED CONTAINER STORAGE
9. DRY ROOM 1
10. CLIMATE CORRIDOR
11. EMERGENCY EXIT
12. SERVER ROOM
13. INTERNAL STAIRCASE
14. INTERNAL ELEVATOR
15. SERVICE ROOM WITH DEHUMIDIFIERS
16. DRY ROOM 2
17. CLIMATE CORRIDOR
18. EMERGENCY EXIT
19. SEED BANK COLD ROOM CONDENSERS
20. SEED DELIVERY ENTRANCE
21. SEED INTAKE COUNTER
22. SECURITY AND FACILITY CONTROL ROOM
23. SEED PROCESSING
24. DRY ROOM 3
25. CLIMATE CORRIDOR
26. SEED CONTAINER STORAGE
27. SEED BANK COLD ROOM CONDENSERS
28. SERVICE CORRIDOR
29. FACILITY GENERATORS
30. SEED CLIMATE CONTROLLED CHAMBERS

Figure 116 - Ground floor plan (Du Preez, 2021).



1. Reception
2. Disabled WC
3. Kitchenette and storage
4. Entrance ramp
5. Informal gathering space
6. Main Office
7. Offices (x4)
8. Service shaft
9. Open plan work area
10. Spiral staircase to Herbarium
11. Elevator
12. Liquid Nitrogen seed lab
13. Liquid Nitrogen seed lab
14. Elevator
15. Internal staircase
16. Molecular analysis seed lab
17. Lounge kitchenette
18. Staff entrance
19. Lounge
20. Spiral staircase to Herbarium
21. Elevator
22. Seed germination lab
23. Seed germination lab
24. Microscopy seed lab
25. Microscopy and images lab
26. Seed moisture determination lab
27. Open plan work area
28. Spiral staircase to Herbarium
29. Elevator
30. Male toilets
31. Female toilets
32. Exit/entrance ramp
33. Cleaning staff
34. Service corridor access
35. Workshop
36. Service route exit
37. Gantry pickup point
38. Workshop and garage
39. Exit ramp
40. Waste storage

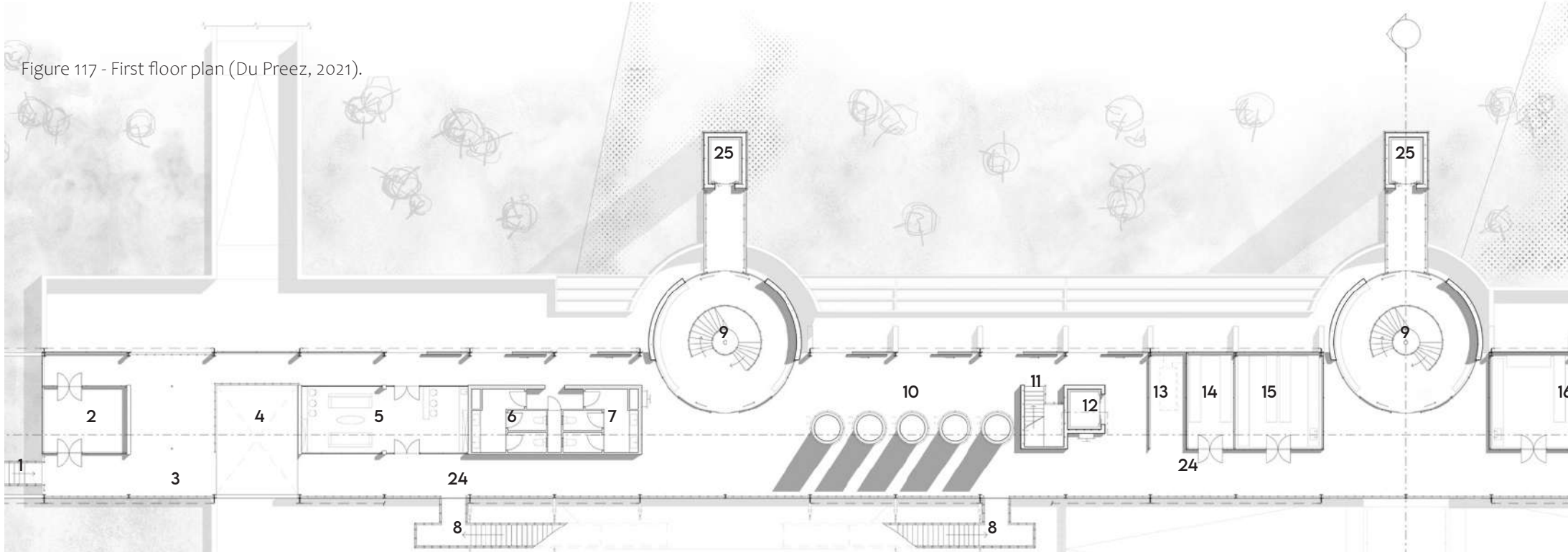


41. Greenhouse soil/fertilizer storage
42. Indigenous planters
43. Memorial wall
44. Service corridor
45. Service corridor
46. Natural landscape
47. Planter
48. Service ramp to basement
49. External steel staircase
50. Rammed earth wall

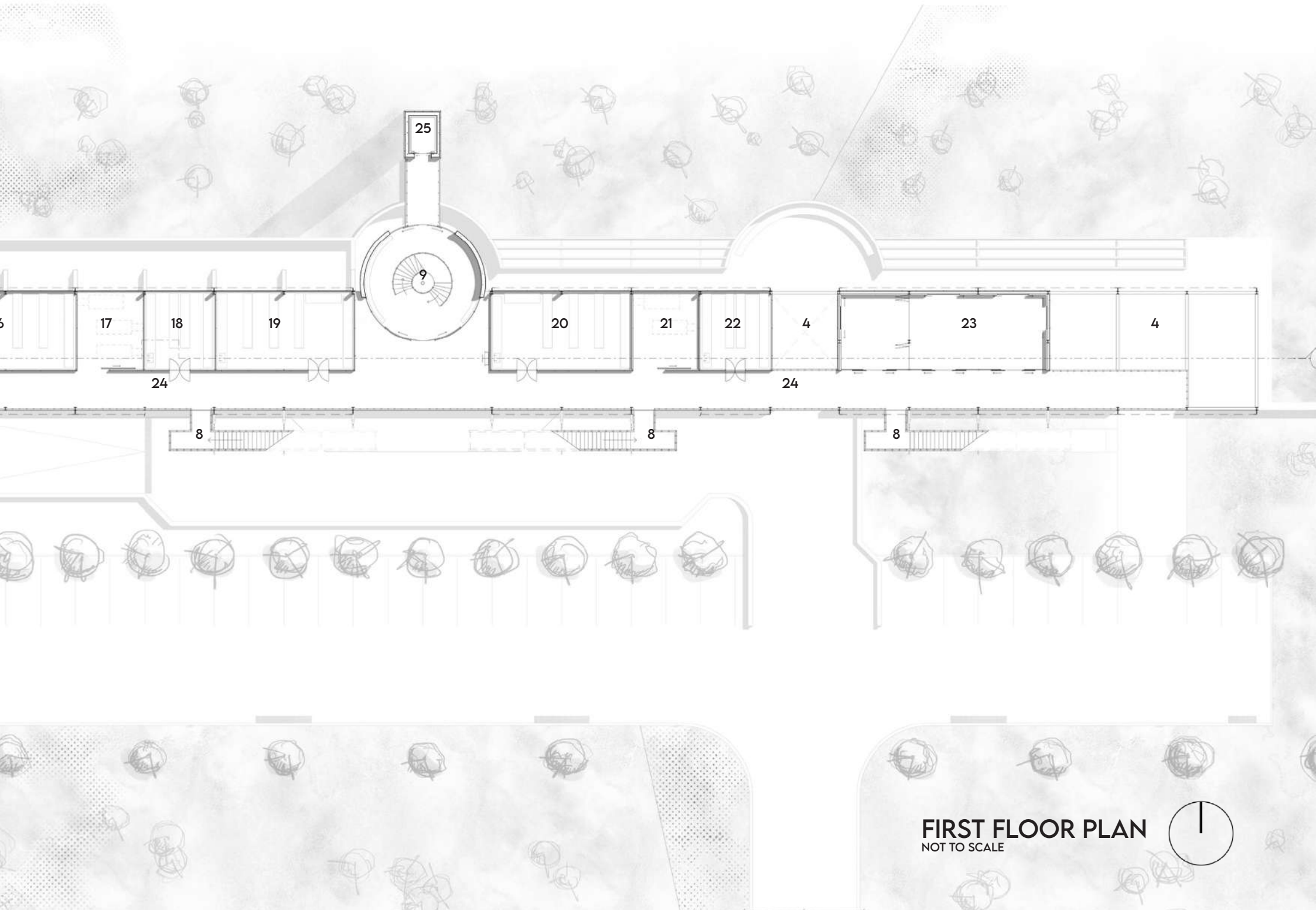
GROUND FLOOR PLAN

NOT TO SCALE

Figure 117 - First floor plan (Du Preez, 2021).



1. Emergency exit
2. Equipment storage
3. Service platform
4. Service platform void
5. Break room
6. Female toilets
7. Male toilets
8. External staircase
9. Herbarium
10. Water storage tanks
11. Internal staircase
12. Elevator
13. Maintenance space
14. Greenhouse 1
15. Greenhouse 2
16. Greenhouse 3
17. Maintenance space
18. Greenhouse 4
19. Greenhouse 5
20. Greenhouse 6
21. Maintenance space
22. Greenhouse 7
23. Conference/Multi-function facility
24. Walkway & Gantry route
25. Elevator



FIRST FLOOR PLAN

NOT TO SCALE

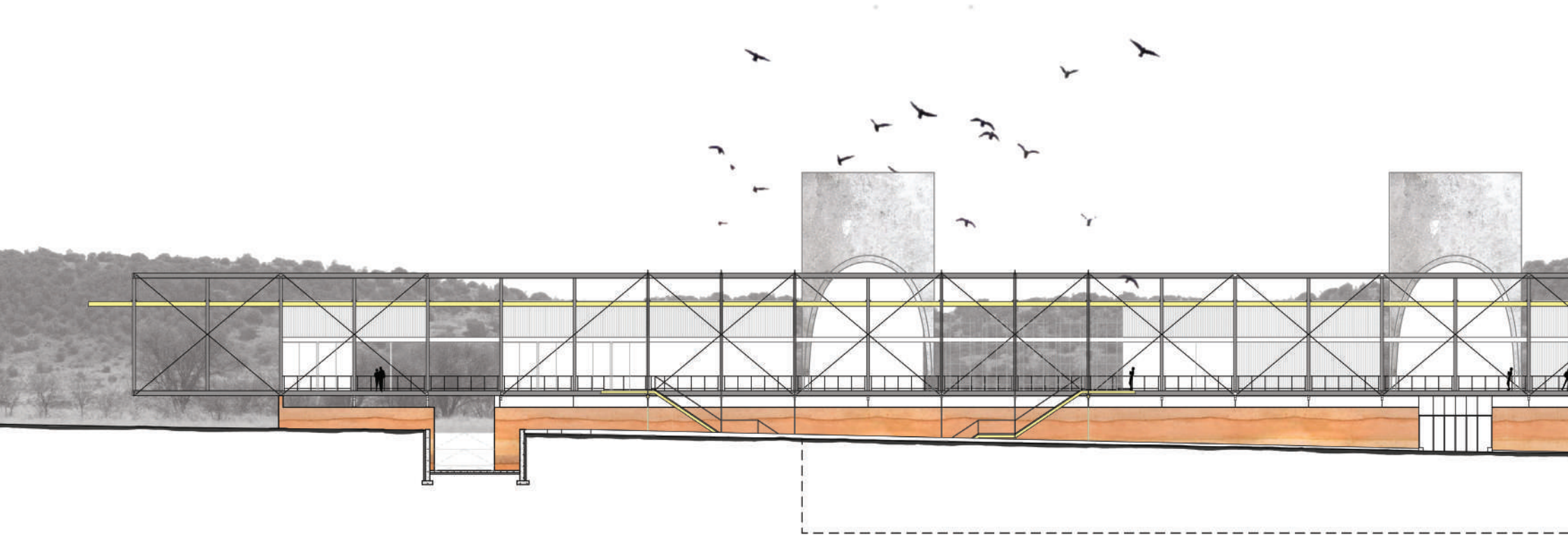
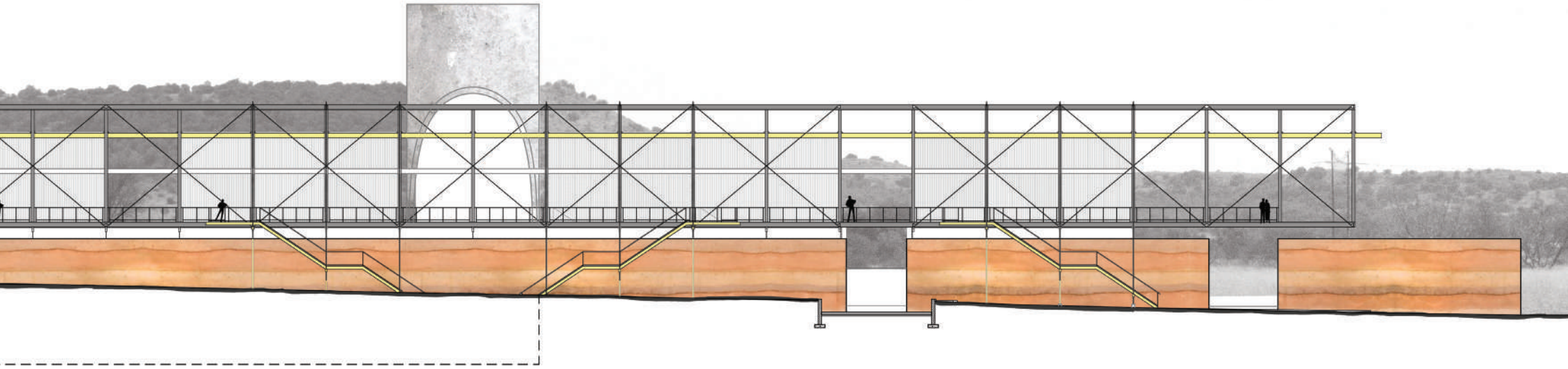


Figure 118 - South Elevation (Du Preez, 2021).



SEED BANK SOUTH ELEVATION

NOT TO SCALE

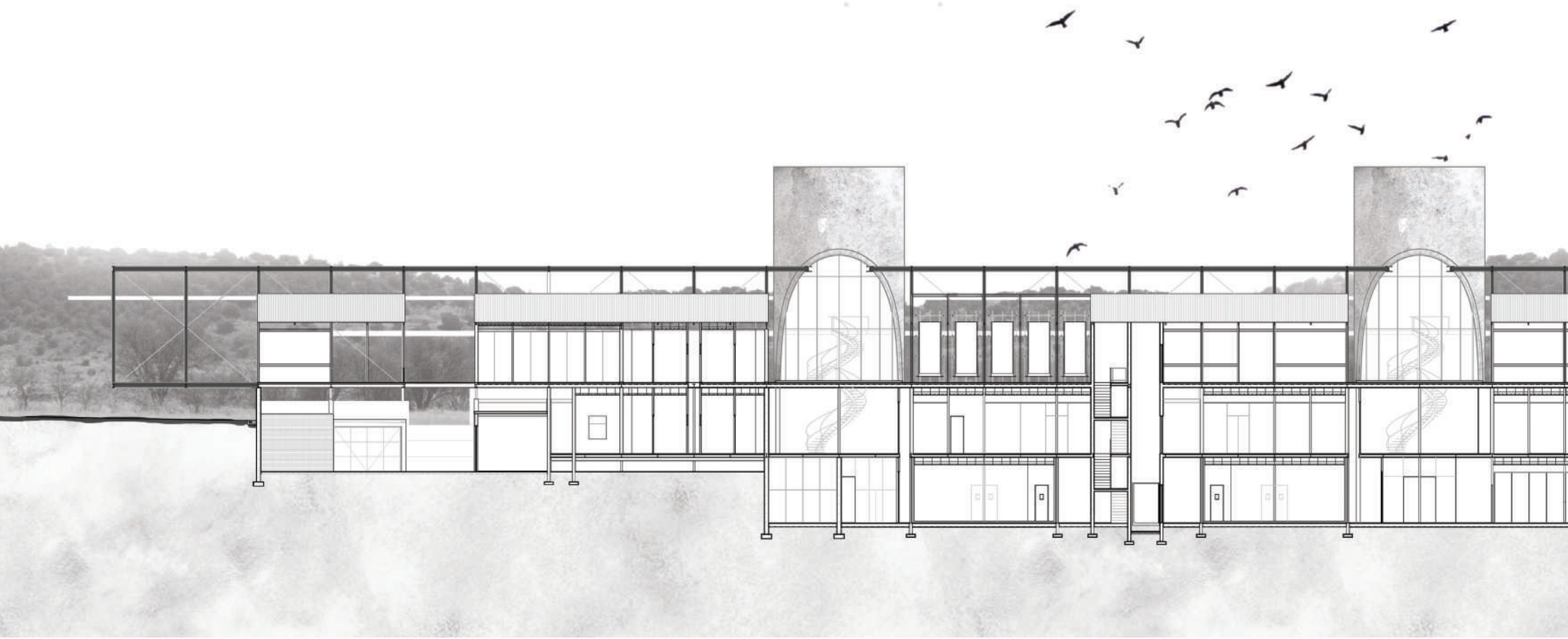
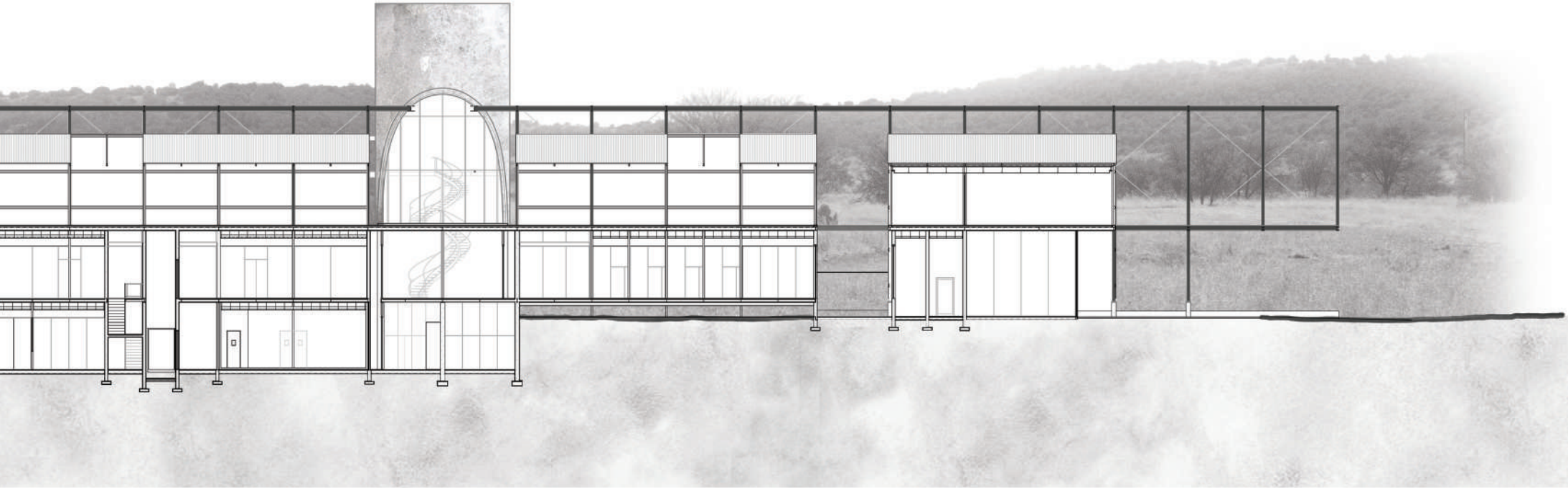


Figure 119 - Section DD (Du Preez, 2021).



SECTION DD
NOT TO SCALE

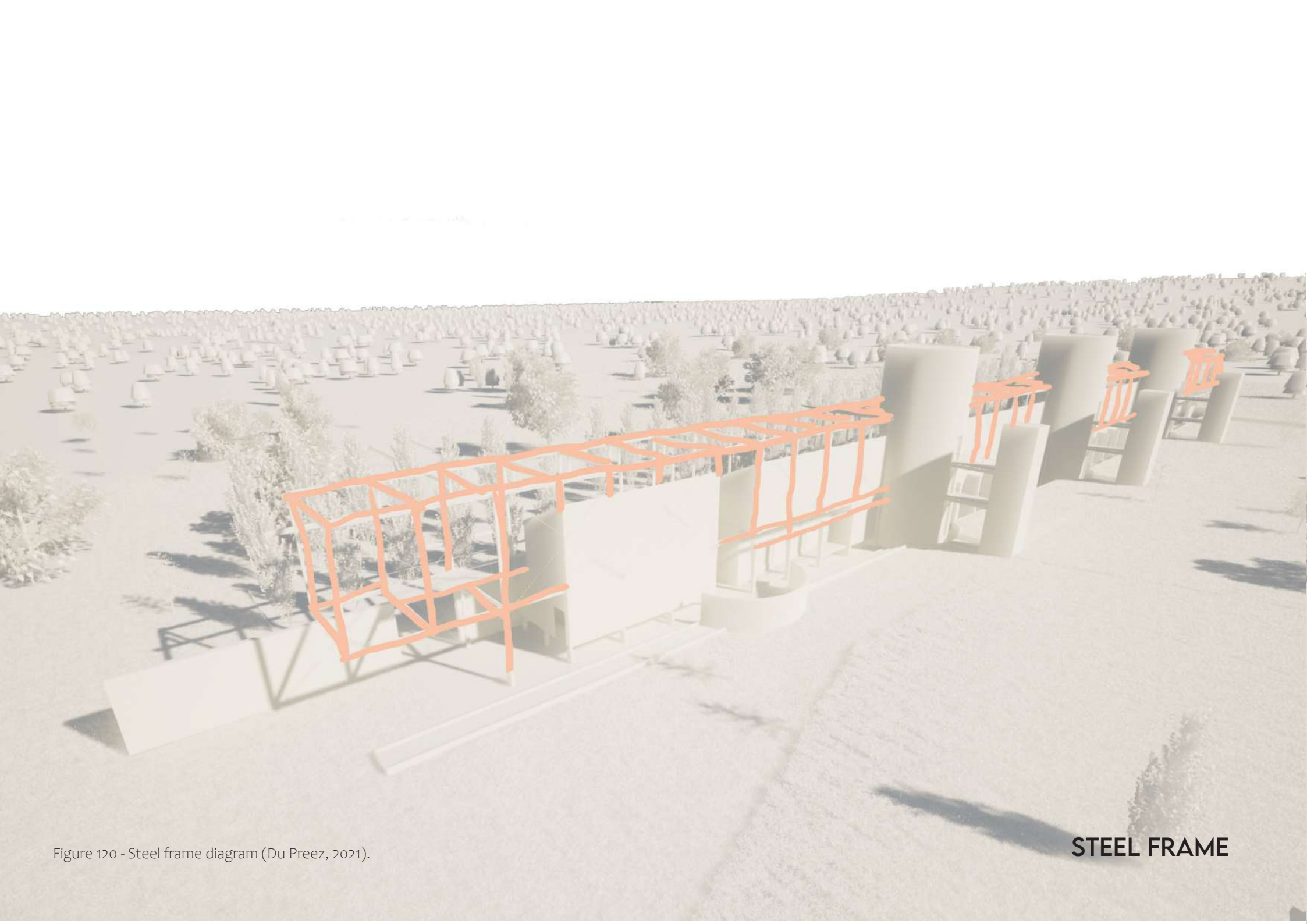


Figure 120 - Steel frame diagram (Du Preez, 2021).

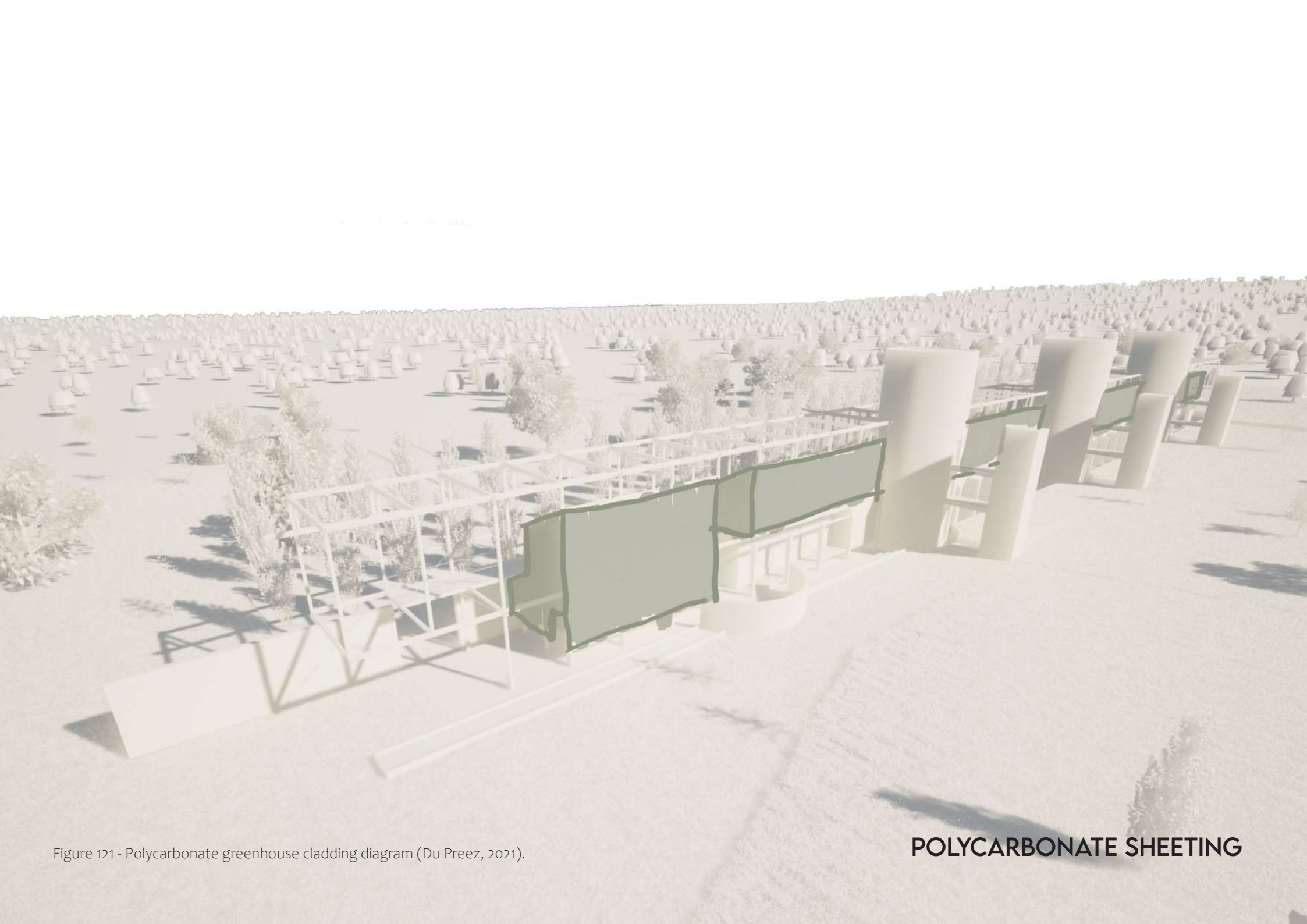


Figure 121 - Polycarbonate greenhouse cladding diagram (Du Preez, 2021).

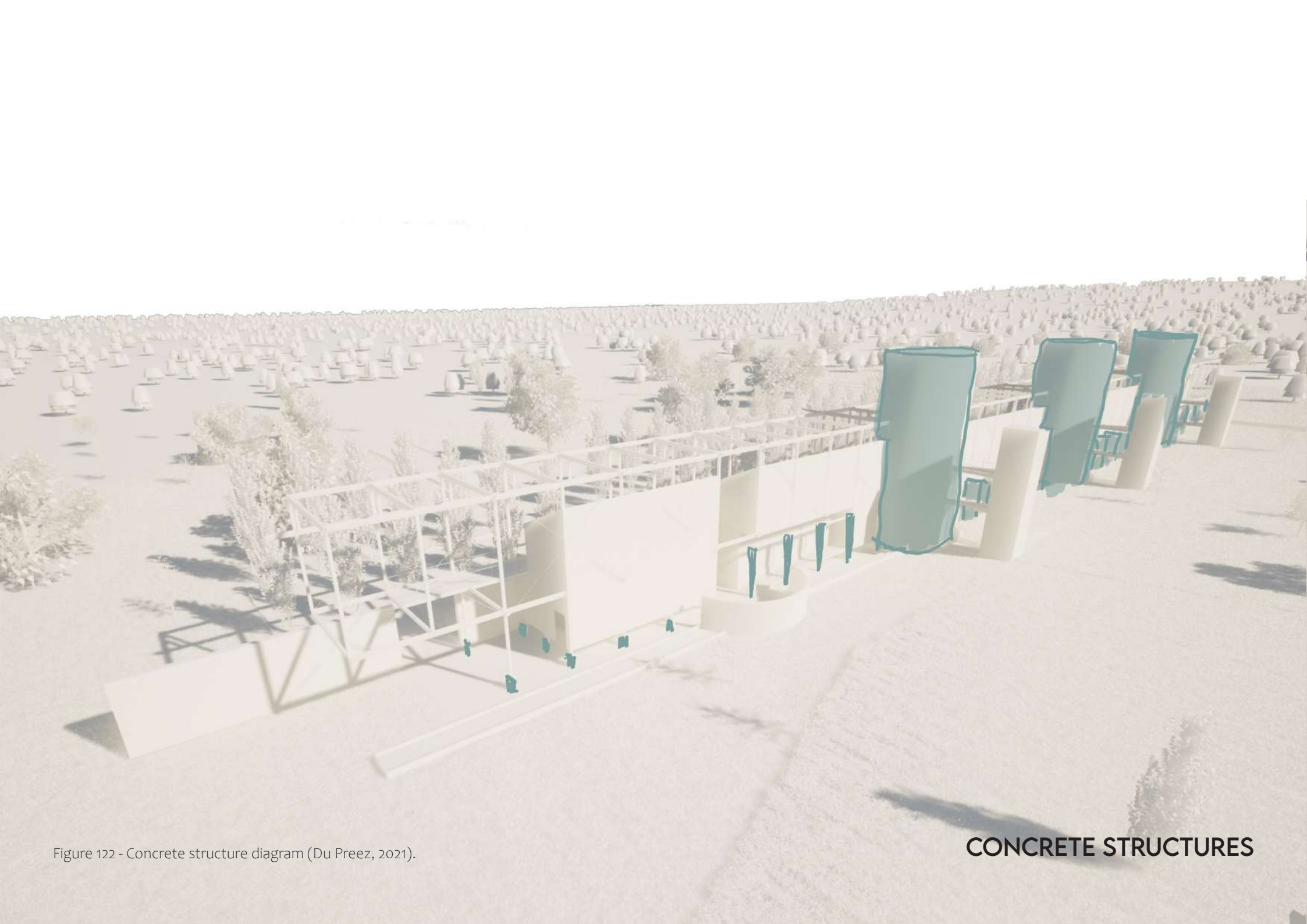


Figure 122 - Concrete structure diagram (Du Preez, 2021).

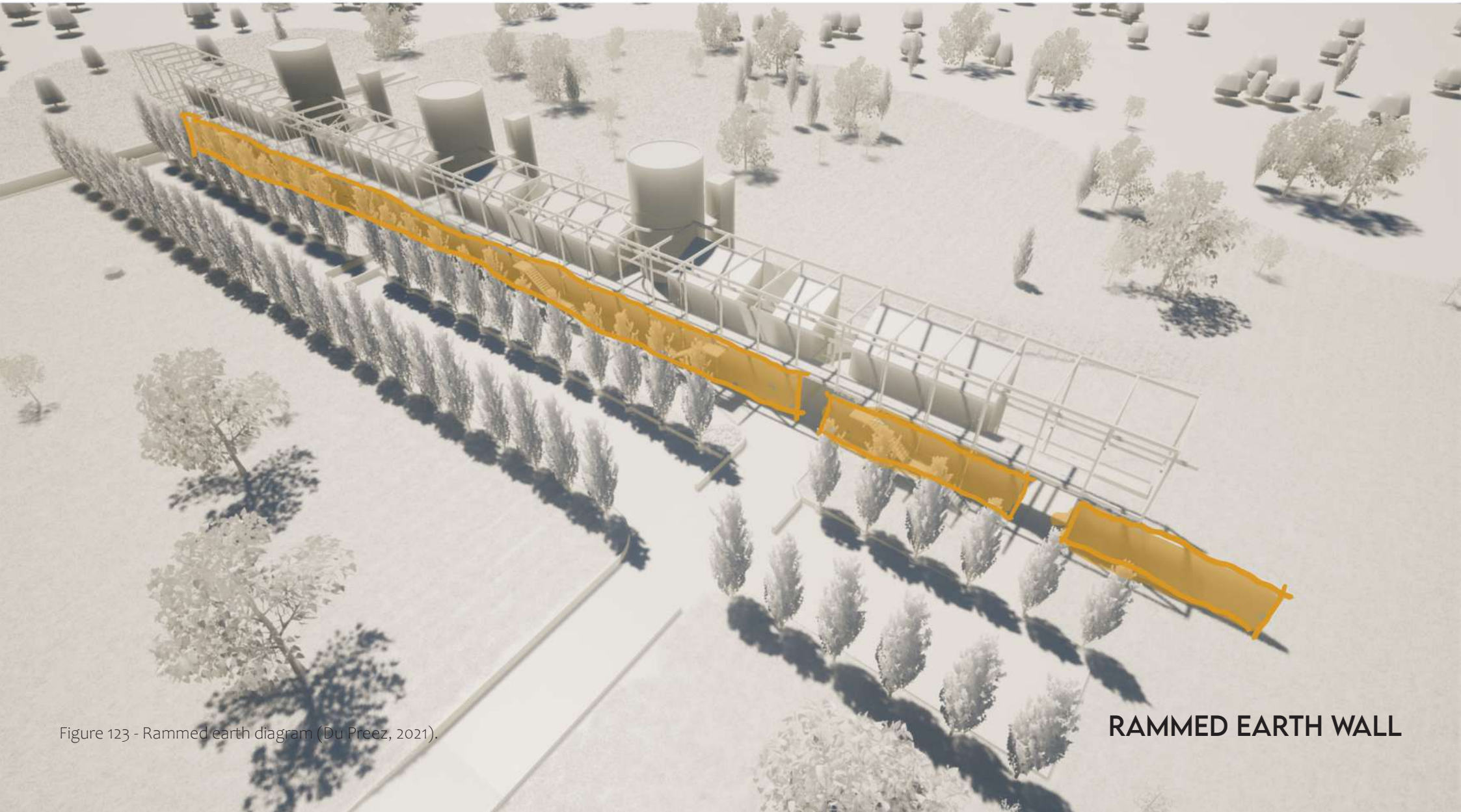


Figure 123 - Rammed earth diagram (Du Preez, 2021).

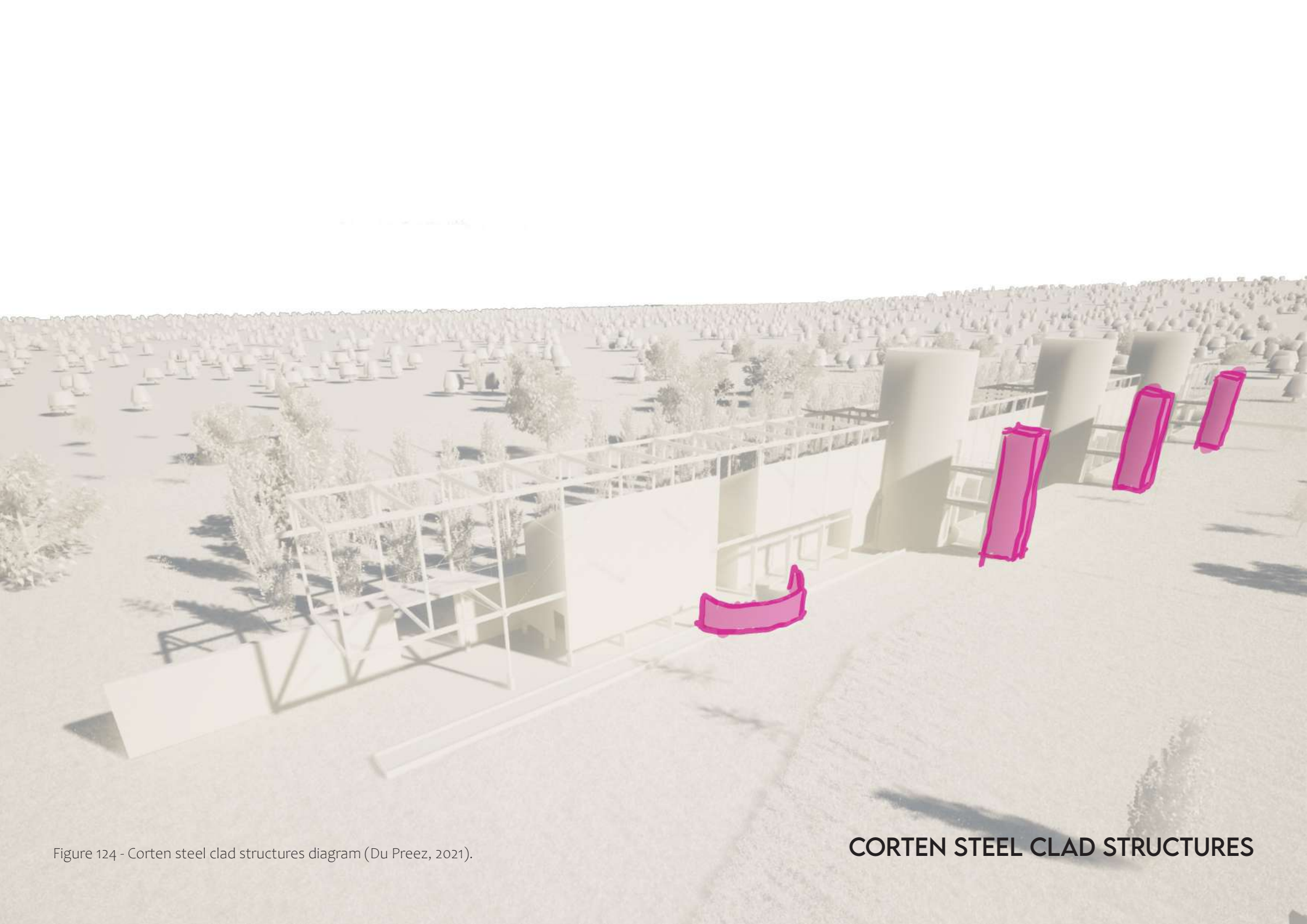


Figure 124 - Corten steel clad structures diagram (Du Preez, 2021).

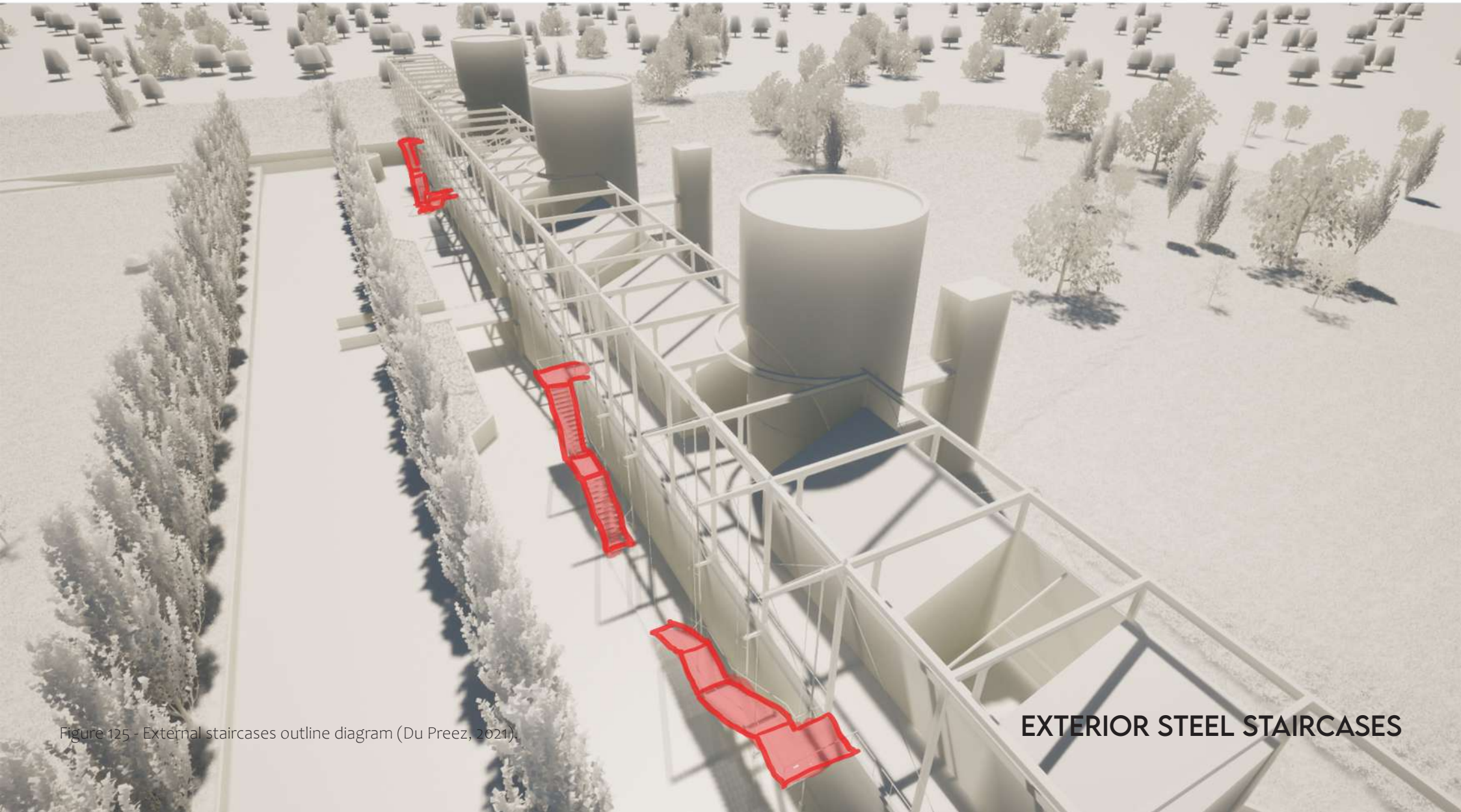


Figure 125 - External staircases outline diagram (Du Preez, 2021).

Figure 126 - Perspective render 1 (Du Preez, 2021).

Figure 127 - Perspective render 2 (Du Preez, 2021).

Figure 128 - Perspective render 3 (Du Preez, 2021).

Figure 129 - Perspective render 4 (Du Preez, 2021).

Figure 130 - Perspective render 5 (Du Preez, 2021).

Figure 131 - Perspective render 6 (Du Preez, 2021).

Figure 132 - Perspective render 7 (Du Preez, 2021).

Figure 133 - Perspective render 8 (Du Preez, 2021).

Part 05

REFLECTION & CONCLUSION

CONCLUSION

In conclusion it has become evident that by thoroughly analysing the intricate processes of how a seed bank functions greatly assists in it design. A comprehensive understanding of critical regionalism with specificity placed on defamiliarization and poetics of space makes it possible to facilitate the prolonging of natural life cycles and the preservation of our biodiversity for future generations.

For this dissertation it was important to merge the engineer's aesthetic with the poetic notions of reading the landscape. Through interpreting the concepts of *agoraphobia* and *claustrophobia* the design's structural approach evolved into a poetic intervention that truly belongs within the Free State landscape.

Throughout the year this dissertation continuously managed to challenge me. I chose a typology that I would not normally work with and utilising a very clean cut functionalist program was difficult. As a designer I tend to look for the poetic side of things and an open landscape challenged this way of working even more. Ultimately I am happy I saw it through to the end no matter the result.

Some observations made during this process were that self-doubt sabotaged quite a few promising developments and that this project had the potential to evolve into much more. Nonetheless I am content in the end result and proud of the perseverance that drove it there. In future quicker decision making pertaining to function will go a long way in finding the artistic details that we all long to create.

REFLECTION

Part 06

REFERENCES

Agri SA. 2021. Agri SA. [online] Available at: <https://agrisa.co.za/overview> [Accessed 19 September 2021].

ArchDaily. 2017. Zeitz Museum of Contemporary Art Africa / Heatherwick Studio [online]. Available at: <https://www.archdaily.com/879763/zeitz-museum-of-contemporary-art-africa-heatherwick-studio> [Accessed 10 Oct 2021].

Bachelard, G. 1969. The Poetics of Space. Boston: Beacon Press Publishers.

Bethany, L., 2017. Seed Banking and its Benefits. [online] Permaculture News. Available at: <https://www.permaculturenews.org/2017/02/28/seed-banking-benefits/> [Accessed 12 February 2021].

Csg.dla.gov.za. 2021. Chief Surveyor General - Spatial Data. [online] Available at: <http://csg.dla.gov.za/spatial.htm> [Accessed 14 October 2021].

Climate-Data.org. 2021. Bloemfontein Climate [online]. Available at: <https://en.climate-data.org/africa/south-africa/free-state/bloemfontein-394/> [Accessed 24 February 2021].

Crook, L. 2019. Centre Pompidou: high-tech architecture's inside-out landmark [online]. Dezeen. Available at: <https://www.dezeen.com/2019/11/05/centre-pompidou-piano-rogers-high-tech-architecture/> [Accessed 10 October 2021].

Cromarty, A. S., Ellis, R. H., Roberts, E. H. 1982. Design of Seed Storage Facilities for Genetic Conservation. Revised 1985 and 1990. International Board for Plant Genetic Resources, Rome.

Duggan, J., 2021. The 'Doomsday' Vault Where the World's Seeds Are Kept Safe. [online] TIME.com. Available at: <https://time.com/doomsday-vault/> [Accessed 9 February 2021].

Etsy.com. 2021. Dried Acacia Seed Pods Long Seed Pods Craft Supply Rustic | Etsy. [online] Available at: <https://www.etsy.com/listing/981207510/dried-acacia-seed-pods-long-seed-pods> [Accessed 15 October 2021].

Google Maps. 2021. [online]. Distance from Bram Fischer International airport to Tafelkop farm, Bloemfontein. Available at https://www.google.co.za/maps/dir/Bram+Fischer+International+Airport/-29.0314967,26.2843915/@-29.0437406,26.2998487,12.92z/data=!4m9!4m8!1m5!1m1!1s0x1e8fce1605bbc93b:0xcc6b26568ba59856!2m2!1d26.2987666!2d-29.0927358!1m0!3e0

Greyling, J. C., 2012. The Role of the Agricultural Sector in the South African Economy. Thesis (Masters). Stellenbosch: University of Stellenbosch.

Hall, A. J., 2006. The seed pod of a Baobab tree broken open to reveal the flesh within. [online] iStock. Available at: <https://www.istockphoto.com/photo/broken-baobab-seed-gm136650774-1513825> [Accessed 15 October 2021].

Humphreys, A., Govaerts, R., Ficinski, S., Lughadha, E. and Vorontsova, M., 2019. Global dataset shows geography and life form predict modern plant extinction and rediscovery. [online] envirobites. Available at: <https://envirobites.org/2019/06/25/finally-a-global-documentation-of-plant-extinction-in-the-anthropocene/> [Accessed 23 September 2021].
International Trade Administration, 2021. South Africa - Agricultural Sector [online]. Available at: <https://www.trade.gov/knowledge-product/south-africa-agricultural-sector> [Accessed 16 February 2021].

Keller, H. 2017. Thomas Heatherwick Gives AD a Tour of the Zeitz MOCAA. [online] Architectural Digest. Available at: <https://www.architecturaldigest.com/story/thomas-heatherwick-cape-town-zeitz-mocaa-south-africa> [Accessed 10 October 2021].

Kimbrough, L., 2020. Through war, wildfire and pandemic, the world's seed vaults hold strong. [online] Mongabay Environmental News. Available at: <https://news.mongabay.com/2020/12/through-war-wildfire-and-pandemic-the-worlds-seed-vaults-hold-strong/> [Accessed 12 February 2021].

Laurent, A., 2014. The Sorcery of Seedpods. [online] Harvard Magazine. Available at: <https://www.harvardmagazine.com/2014/01/the-sorcery-of-seedpods#article-images> [Accessed 15 October 2021].

Morelle, R., 2016. Kew report makes new tally for number of world's plants. [online] BBC News. Available at: <https://www.bbc.com/news/science-environment-36230858> [Accessed 3 September 2021].

Najafi, M., Shariff, K.M.B. 2011. The Concept of Place and Sense of Place in Architectural Studies. World Academy of Science, Engineering and Technology International Journal of Humanities and Social Sciences, 5 (8), pp. 1054-1056.

Ngcamu, S. B., Chari, F. 2020. Drought Influences on Food Insecurity in Africa: A Systematic Literature Review. International Journal of Environmental Research and Public Health, 17 (5897), pp 2-17.

Norberg-Schulz, C. 1979. Genius Loci: Towards a Phenomenology of Architecture. New York: Rizzoli, pp. 5-50.

NordGen. 2021. Frequently Asked Questions - NordGen. [online] Available at: <https://www.nordgen.org/en/our-work/svalbard-global-seed-vault/faq/> [Accessed 10 February 2021].

Pallasmaa, J. 2011. The Embodied Image. Imagination and Imagery in Architecture. John Wiley & Sons Ltd, pp. 118-129.

Pallasmaa, J. 2012. Eyes of the Skin. Architecture and the Senses. John Wiley & Sons Ltd. 3rd Edition, pp. 35-44.

Perez, A. 2010. AD Classics: Centre Georges Pompidou / Renzo Piano Building Workshop + Richard Rogers. ArchDaily [online]. Available at: <https://www.archdaily.com/64028/ad-classics-centre-georges-pompidou-renzo-piano-richard-rogers> [Accessed 11 Oct 2021].

Piesse, M. 2016. South Africa: Drought Threatens Food, Energy and Water [online]. Available at: https://www.futuredirections.org.au/publication/south-africa-drought-threatens-food-energy-water-security/ [Accessed 15 October 2021].

R B Construction Group. 2021. Millennium Seed Bank - R B Construction Group. [online] Available at: <http://www.rbconstructiongroup.com/millenium-seedbank/> [Accessed 31 May 2021].

Rees, V., 2021. A Taurus in Pictures. [online] TRENDLAND. Available at: <https://trendland.com/a-taurus-in-pictures/> [Accessed 15 October 2021].

Sakho-Jimbira, S., Hathie, I. 2020. The future of agriculture in Sub-Saharan Africa [online]. Southern Voice. Available at: http://southernvoice.org/the-future-of-agriculture-in-sub-saharan-africa/ [Accessed 10 August 2021].

SANBI. 2021. Millennium Seed Bank | SANBI. [online] Available at: <https://www.sanbi.org/biodiversity/foundations/biosystematics-collections/millennium-seed-bank/> [Accessed 19 September 2021].

SANBI. 2021. SANBI. [online] Available at: <https://www.sanbi.org/> [Accessed 19 September 2021].
SourceTrace Systems. 2021. What are seed banks and why should seeds be preserved? - SourceTrace Systems. [online] Available at: <https://www.sourcetrace.com/blog/seed-banks-seeds-preserved/> [Accessed 12 February 2021].

Stantonwilliams.com. 2021. Millennium Seed Bank • Projects • Stanton Williams Architects. [online] Available at: <https://www.stantonwilliams.com/projects/millennium-seed-bank/> [Accessed 12 February 2021].

Tzonis, A. & Lefaivre, L. 1990. Why Critical Regionalism Today? In: Nesbitt, K (ed.).
1996. Theorizing a new agenda for architecture: an anthology of architectural theory.
1965-1995. New York: Princeton Architectural Press, pp. 484-491.

Tzonis, A. & Lefaivre, L. 2003. Critical Regionalism: Architecture and Identity in a Globalized World. New York: Prestel, pp. 82-87.

Van Ittersum, K. M., Van Bussel., L. G. J, Wolf., J. et al., 2016. Can sub-Saharan Africa feed itself? [online] PNAS, 113 (52). Available at: <https://www.pnas.org/content/113/52/14964> [Accessed 1 September 2021]. Edited by Robert John Scholes, University of the Witwatersrand, Wits, South Africa, and approved November 3, 2016 (received for review June 28, 2016)

Waldner, F., Hansen, M.C., Potapov, P.V., Low, F., Newby, T., Ferreira, S., et al. 2017. National-scale cropland mapping based on spectral- temporal features and outdated land cover information [online]. PLoS ONE 12(8): e0181911. Available at: <https://doi.org/10.1371/journal.pone.0181911>

Weather Atlas, 2021. Bloemfontein, South Africa - Detailed climate information and monthly weather forecast [online]. Available at: <https://www.weather-atlas.com/en/south-africa/bloemfontein-climate#temperature> [Accessed 24 February 2021].

Windfinder.com. 2021. Wind and weather statistic Bloemfontein [online]. Available at: <https://www.windfinder.com/windstatistics/bloemfontein> [Accessed 24 February 2021].

THANK YOU