URBAN HARVEST

An Urban Agriculture Research and Innovation Centre for the University of the Witwatersrand.

FEBRUARY 2021

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This document is submitted in partial fulfilment for the degree: Master of Architecture (Professional) at the University of the Witwatersrand, Johannesburg, South Africa, 2020.

Declaration

I, **Nicholas Coghlan, 743043** am a student registered for the course Master of Architecture (Professional) in the year 2020.

I hereby declare the following:

I am aware that plagiarism [the use of someone else's work without permission and/or without acknowledging the original sources] is wrong.

I confirm that the work submitted for assessment for the above course is my own unaided work except where I have stated explicitly otherwise.

I have followed the required conventions in referencing thoughts, ideas, and visual materials of others. For this purpose, I have referred to the Graduate School of Engineering and the Built Environment style guide.

I understand that the University of the Witwatersrand may take disciplinary action against me if there is a belief that this is not my unaided work or that I have failed to acknowledge the source of the ideas or words in my own work.

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24 February 2021

To my mother Holly.
Thank you for all the hard work, and everything you have done to get me to this point, you are a rock. I hope I can make you proud.

To my brother Brendon
Thank you for your support and motivation all the way from the UK, it truly means alot.

To my supervisor Garret
Thank you for your patience, guidance and useful crtitcism throughout the year.

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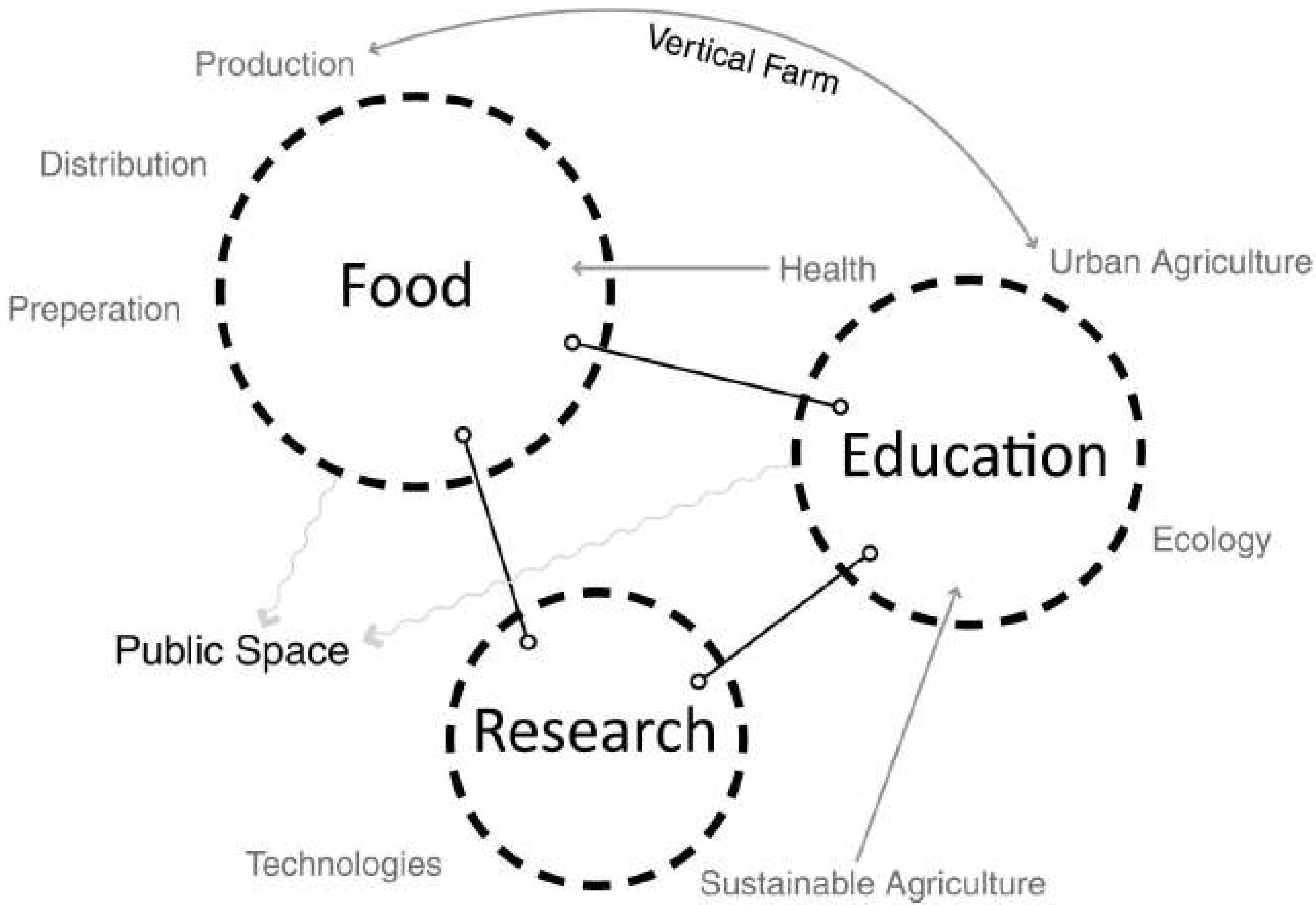
00

INTRODUCTION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Abstract

Historically people have had a close relationship with food, with food being grown in near proximity to where people lived. However, through the industrialization of farming processes, people in cities have become isolated from the food networks they were once connected to, now only seeing the final product in the isles of a supermarket or informal trade spaces. Due to this disconnect, we have lost our appreciation for food, which results in huge amounts of waste. At the same time, industrialization means that food is controlled by large corporate companies, which has caused food to become too expensive for many households. This along with rising populations has meant that food insecurity has become a problem for many South Africans. And with the populations in urban areas steadily rising, many believe that inner-city urban farms might be the solution to food insecurity. With the recent focus toward sustainability, current agricultural systems have been questioned, creating a push for the use of less harmful growing methods and more efficient technologies. As a result, efficient organic farming is now a possibility in the inner-city, and Johannesburg has seen an increasing number of farms being set up on rooftops all over the city. This provides opportunities for connection and integration between this community of urban farms.

The thesis explores how people in urban areas can be reconnected with the food production systems that they rely on. Through principles of organic farming, building integrated agriculture and urban farming, this thesis aims to find what the role of architecture is in this equation.

fig. 02. Backyard Mielie crops, Kwa-Thema, Springs. (Kwa-Thema Studio, 2019)

Research Themes

Aims and Objectives:

By looking at the University as an analogue for the city and studying methods of urban agriculture, this research report aims to find ways of restoring our connection to food systems, through the research, education, and implementation of agroecological farming interventions in existing urban contexts.

The research also aims to find the social benefits of urban food production and its position in relation to larger issues around health and food security. This could be done by viewing food production as a social upliftment mechanism and urban regenerator and integrating with intimate social activities in the urban public realm.

The design aims to develop an architectural model for vertical farming and the education and advancement of modern urban farming methodologies in the city, in the hope of establishing a link between the University of the Witwatersrand and the city of Johannesburg.

The project aims to invest in urban agricultural science & technology, education, and innovation to ensure [self]sustainable agricultural practices.

Hypothesis:

Architecture can generate and facilitate a change in the current perception and culture of urban agricultural production through the education and creation of sustainable, resource-friendly production opportunities in the urban context.

Sub-Questions:

- How can architecture return agricultural production processes into existing urban environments?
- Can food production be used as a social upliftment mechanism and urban regenerator?

Methods of Inquiry

Beginning with an in-depth **analysis** of site and context, I looked at various layers including (but not limited to) history, urban conditions, and environment. This included looking at The Spatial Development Framework of the university campus, historical data and municipal records.

Desktop research of the abovementioned themes was conducted. This was done by looking at relevant precedents, and literary sources. By looking at case studies and precedent examples of urban agriculture and vertical farming, I was able to adapt precedent models and develop a context specific program on my proposed site. Literary sources provided me with a theoretical and technical background and assisted me in the application of knowledge in the development of a resolved architectural expression.

I conducted a study of the agricultural opportunities within urban environments, by using the University campus as an analogue for the city. This study was a look at campus infrastructure (under-utilized open spaces, blank facades, rooftops, etc.) to assess their feasibility as opportunities for urban agriculture interventions. This study was done through the **identification** of possible opportunities and **observation** of these spaces. This enabled me to establish use patterns and critique spaces based on technical/spatial/ecological requirements of agriculture. **Photographs** of the campus were taken as part the observation process. These photographs were a way of documenting the spaces. Due to the closure of the University as a result of the Corona Virus pandemic I was unable to study and analyse the use patterns of spaces, therefore assumptions were made.

fig. 03. Leafy green crops grown under the protection of tall trees (Ana Cotrin, n.d)

01

R E S E A R C H

A Real-world Food Issue

It is estimated that more than 690 million around the world go hungry, despite the fact that more than enough food is produced (AAH, 2018). The United Nations has highlighted combatting hunger as one of its Sustainable Development Goals, and are aiming to achieve Zero Hunger (by ensuring access to food for all) by 2030. According to the Food and Agriculture Organization, the number of people affected by hunger will reach and likely pass 840 million by the year 2030 (FAO, 2020). These figures and efforts into addressing them are further burdened by factors like increasing levels of poverty, conflict, climate change, and more recently the Covid-19 Pandemic. In South Africa, the latest statistics show that in 2017, 6.8 million people experience hunger, and nearly 20% of households severely lacked adequate access to food (StatsSA, 2019).

Rapid population growth also puts further strain on food supplies. The global population is estimated to rise by roughly 3 billion people in the next 30 years. This figure is alarming given when we consider what each person's daily food requirements are – at least 1500 calories from safe food sources and 2.3 liters. Another factor to consider is urbanization. Many cities around the world have seen a population spike, as people move away from rural areas. The UN estimates that by 2050, 80% of the world's population will be living in urban centers (compared to the current 60%) (UN, 2018). In Sub-saharan Africa this figure is expected to be around 60%.

According to Dickson Despommier, 38% of the earth's land surface is being used for food production, this amounts to a total of 80% of the earth arable land currently being farmed (Despommier and Ellingson, 2008). As populations grow, so will the requirements for food, thus more and more land will need to be farmed. Most of the cultivated lands are done so in a harmful and destructive manner. Damaging soil, ecosystems, and water sources, which if possible could take decades to repair (Despommier and Ellingson, 2008).

Food Security vs Food Sovereignty

According to the UN FAO, "Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (FAO, 1996). Food insecurity occurs when there isn't a reliable and consistent quantity of healthy and safe food, or when people are unable to gain access to said food. These supplies of food usually come from domestic production or imports, or in many cases - where neither of these is possible – from humanitarian aid packages. And thus, the UN refers to four aspects of food security:

Food access: Do all individuals have access to enough food for a healthy and nutritious diet.

Food Availability: Is there sufficient quantities of quality food?
Utilization: The manner in which food is utilized to meet all physiological needs.
Stability: Do households and individuals have access to food at all times, even in times of crisis and seasonal events.

(FAO, 1996)

While the concept of security addresses the issue of hunger and malnutrition, it does not define where the food originates, nor "the conditions under which it is produced and distributed" (CFC, n.d.). Often addressing food security is a matter of meeting demands, and often does not address concerns around livelihoods.

Food sovereignty, on the other hand, refers to the people's right to healthy, nutritious, and culturally appropriate food accessed through ecologically appropriate production and local food systems. Food Secure Canada refers to food security as a goal, and food sovereignty as the means to achieve it (Food Secure Canada, 2013). The concept of food sovereignty puts people and their need for food at the center of all policy decisions. This is not only in terms of food supply but also in terms of supporting livelihoods in sustainable and beneficial ways. In Food Sovereignty, food production, distribution, and supply is localized and places the control of in the hands of local food suppliers thus reducing the reliance of private entities (Food Secure Canada, 2013; Gordillo and Mendez Jeronimo, n.d.).

Two important factors of food sovereignty are the emphasis on 'working with nature' and secondly the importance of building local skills and knowledge. The first will ensure that, by rejecting destructive production methods, food production and cultivation does not come at the cost of local ecosystems and the environment as a whole. The second ensures that people are educated and given the skills (as well as taking traditional knowledge into account) and that these skills are passed on to others to ensure their food security and that of the future generations.

Response

When we take rising populations, increased urbanization, land shortages, poverty, and climate change into consideration it becomes apparent that agriculture production practices need to change. One option for change is to locate more agriculture operations in urban areas. By pursuing urban agriculture we would have the ability to address local and hyper-local food shortages and provide for more job opportunities in cities. This comes with the responsibility to educate people about farming and provide for support to urban farmers in the push for food sovereignty in our society. A second is to invest in vertical agriculture, the benefits of which are many (and will be discussed later in this report), but perhaps most importantly is a way of addressing the shortage of arable land for farming. According to Despommier, depending on the type of crop 4-200 hectare in a traditional soil-based farm can be the equivalent of half a hectare in vertical agriculture (Despommier, 2015).

The response of this thesis and subsequent building is two-fold. Firstly, to question current farming practices and encourage urban farming practices through education and training. Secondly to invest in the research and development of vertical farming in urban environments.
The building design aims to respond to the relationship between the city of Johannesburg and the University of the Witwatersrand, by create an open and accessible educational facility centered around urban agriculture.

fig. 04. Community engagement at Bertrams innercity Farm (Unknown)

fig. 05. Backyard Mielie crops, Kwa-Thema, Springs. (Kwa-Thema Studio, 2019)

THE ‘PROGRESSION’ OF FARMING

A History of Agriculture

Around 10,000 years ago our ancestors began to try their hand at farming. They realized that by saving some of the seed that they ate, they could plant it in the soil and watch it grow. Thus, bringing the harvest right to them. This was the moment when our hunter-gatherer ancestor began to settle, giving up the nomadic lifestyle. They began to farm wild varieties of barley, lentils, chickpeas, and wheat (Chatterjee, 2016; Zimmer, 2016), and domesticate goats and wild oxen. This provided them with safety from the dangers and uncertainty of hunting and gathering, and they began to form the kind of societies we know today. As these societies grew so did the demand for food, and thus more land was needed to feed people. Farming operations spread out further into the landscape, into unsuitable terrain, so we began to alter the topography to make it suitable for farming. This led to farmers disregarding traditional ways and guided them towards the mechanized farm - The Green Revolution (Benyus, 1997).

Modern 'best practice' agriculture methods have been developed in the pursuit of two goals, the highest possible yields, and the highest possible profit. To achieve these goals, agriculture systems rely on several basic practices each chosen for their ability to aid in the overall productivity of the farm. These practices include monoculture crops, the use of chemical pesticides, extensive tillage, irrigation systems, genetically modified crops, and inorganic fertilizers (Gomiero et al., 2011). While these practices do assist the farm in producing higher yields, they have changed the way people see agriculture, turning it into an industrialized process. These processes have also come to contribute to the environmental concerns and unsustainability of commercial agriculture.

fig. 06. The Zagros Mountain Range, Iran (JTB Photo, n.d)

fig. 07. The Zagros Mountain Range where wild goats were domesticated (Fereidoun Biglari, n.d)

fig. 08. Chisel Plough Tilling field (Aaron Daigh, n.d)

fig. 09. Chisel Plough Tilling field (Aaron Daigh, n.d)

Tillage

Tillage is the process of preparing land for the planting of crops, this usually involves clearing the land of previous crops or plants followed by mechanical tillage which breaks up the top layer of soil. Tillage is used to aerate the soil, help incorporate fertilizers deeper into the soil, suppress weed growth, and assist in the activation of pesticides (Al-Kaisi, 2004; Gliessman, 2020). Tillage helps farmers in many ways; however, it has slowly been degrading the quality of important topsoil. Every time a field is ploughed the structure of the soil is destroyed, "we break apart its intricate architecture" (Benyus, 1997), and this removes some of its capacity for plant growth. Tillage increases the rate at which soil is eroded, further increased by the overall lack of crop residue (the leftover plant materials; leaves, stalks, and seed pods). Because tillage mixes crop residue into the soil, it no longer has the ability to dampen the force of raindrops falling on the soil, as it would if it were left as a cover for the soil (Al-Kaisi, 2004). This results in soil particles being dislodged by raindrops and blocking the soil 'pores' responsible for draining the water down towards the roots systems. This creates hard-packed topsoil which rain simply runs off – the soil left behind is slightly deader and a little thinner (Benyus, 1997).

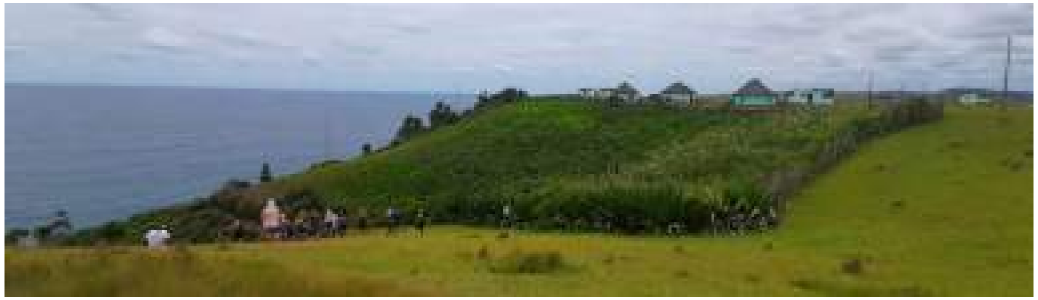
fig. 10. Manual Tilling, Horse drawn Plough (The Impatient Farmer, n.d)

Monocultures

A Monoculture is when a single crop is grown alone in a field, often chosen for the reduced cost implications. By cultivating a single crop, a farmer only has to use one method of harvesting and focus on a single set of crop requirements. Farmers used to grow a variety of products in case one of their crops fail in a particular cycle, however, "Industrial farmers abandoned traditional ways managing their lands, such as rotating crops" (Benyus, 1997) they have instead now focused on a single crop grown in constant rotation. This continuous monoculture cropping is effectively "continuous robbing" of soil nutrients. The lack of diversity limits the natural healthy processes that benefit other crops and most importantly the soil. Large monocultures farms are prone to pest outbreaks, due to the uniformity of crop species, as they lack the natural ability to manage pests, thus increasing the dependence on chemical treatments.

fig. 11. Monoculture Corn Field (Unknown, n.d)

fig. 12. Cliffside Cornfield, Coffee Bay (Author, 2019)



Chemicals

The modern agriculture system makes use of a number of chemical products to protect crops and encourage growth. This extensive use of agrochemicals (pesticides, fungicides, and chemical fertilizers) is the result of many crop species becoming more and more susceptible to weakness, further intensified by a monoculture's inability to protect itself against disease and pests. Herbicides are used to control weeds, pesticides were used to prevent disease and pest outbreaks, and chemical fertilizers were the answer to the decreasing soil fertility and quality. The problem became evident that pests develop an immunity to the chemicals, and once this happens, they come back stronger the next year requiring a larger chemical dose (Benyus, 1997). The excessive use of these chemicals results in the contamination of water sources. Chemicals easily leached into underground water supplies, and rivers and streams, (assisted in some instances by rain runoff) negatively impacting neighboring ecosystems. Traces of these chemicals remain of the crops after harvest, even after cleaning. Fertilizers cause a rise in nitrate levels in the water supplies, a huge concern for the country's drinking water.

Hey Farmer, Farmer,
Put away the DDT,
I dont care about spots on my Apples,
Leave me the birds and the bees,
Please!

- The Counting Crows, Big Yellow Taxi (2002)

While the current food production system has largely been effective in providing for the increasing food demands of the past, it is painfully obvious that it is beginning to fail us. These food systems have done great damage to the natural environment, and is the largest contributor to losses in biodiversity, land desertification, deforestation, and soil degradation (von Bormann, 2019). Along with soil degradation, water scarcity (and overall reductions of water quality) due to agriculture is perhaps the biggest failure. The food system in its current form needs to change. The question now becomes, How? The answer, according to the WWF, is a "resilient and regenerative future for food systems" (von Bormann, 2019) food system. But to achieve this we must start with efficient water management and irrigation, regenerative agricultural practices, reductions in food waste, and responsible sourcing of products. The need for alternative agricultural practices has become greatly important.

fig. 13. Glyphosate Herbicide sprayed onto crops, Ireland (2016)

Alternative Methods of Farming

Today, agriculture bears no resemblance to the natural ecosystems they are derived from. These natural ecosystems "ran on sunlight, sponsored by their own fertility" (Benyus, 1997) "energies of the natural world" (Todd Henaut, 1974). These ecosystems fought their own battles with pests and disease and protected (and even built) the soil. These are the system we need to return to, producing hardy crops that are not dependent on a farmer's intervention, a system that understands and utilizes the natural strengths of plants. The realization that there is a great need for alternative farming methodologies has led to the increased use of terms like 'organic farming' and 'permaculture'. These terms define one of the many methods of farming that take soil preservation, natural ecosystems, diversity, and overall human health into consideration - and can be placed under the umbrella of 'Sustainable Agriculture'. The goal of sustainable agriculture, and sustainable development as a whole, is to meet the requirements of societies without "compromising the ability of future generations to meet their own needs" (Brundtland, 1987; Doval, 2018). This is not a new concept and there are a number of methods and movements that can be studied and drawn from.

fig. 16. Native regenerative agricultural prairie (Lynn Betts, 2019)

The New Alchemists

Founded in 1969, by John and Nancy Todd, the New Alchemy Institute (NAI) was on a mission to design a sustainable way of life. A way of living top to bottom: food, energy, and shelter (Rose, 2019). The New Alchemists' approach to farming was: Low impact, no chemicals/pesticides, no waste, no fossil-fuels, no pollution, an approach we are, only now, realizing is important for the future of farming, the climate, and our health. Energy-efficient farming was at the heart of their beliefs. The aim was to emulate nature's way, within farming and our living spaces (Benyus, 1997). Their farming method made use of water systems and livestock as well as, tree canopies that fertilized the soil while they shaded/protected ground covers. The system ensured that every element had more than one task. "Wherever possible, the work of machines is replaced by the work of biological organisms or systems" (Benyus, 1997). Meaning that within the system the formation of local ecosystems helps to stabilize the environment which both, benefitted various species and aided in the growth of landscape.

fig. 15. Bio-dome fish pond on the New Alchemy Farm, Cape Cod (NAI, n.d)

fig. 14. The New Alchemy farm, Cape Cod, showing the bio-dome and the windmill used to pump water (NAI, n.d)

The aim of New Alchemy was to try and duplicate the productive and restorative processes of nature. And to do this they tried to link everything with everything else in the farm. The wind pumps the water, that waters the garden, that feeds the rabbits, that fertilize the soil, that feeds the worm, that feed the fish, all of which then feed people. And by doing this they proved that each time a connection is made, as in nature itself, the system as a whole becomes more stable, strong and healthier (Todd, 1974). This knowledge is something we can and should consider when thinking about agricultural processes.

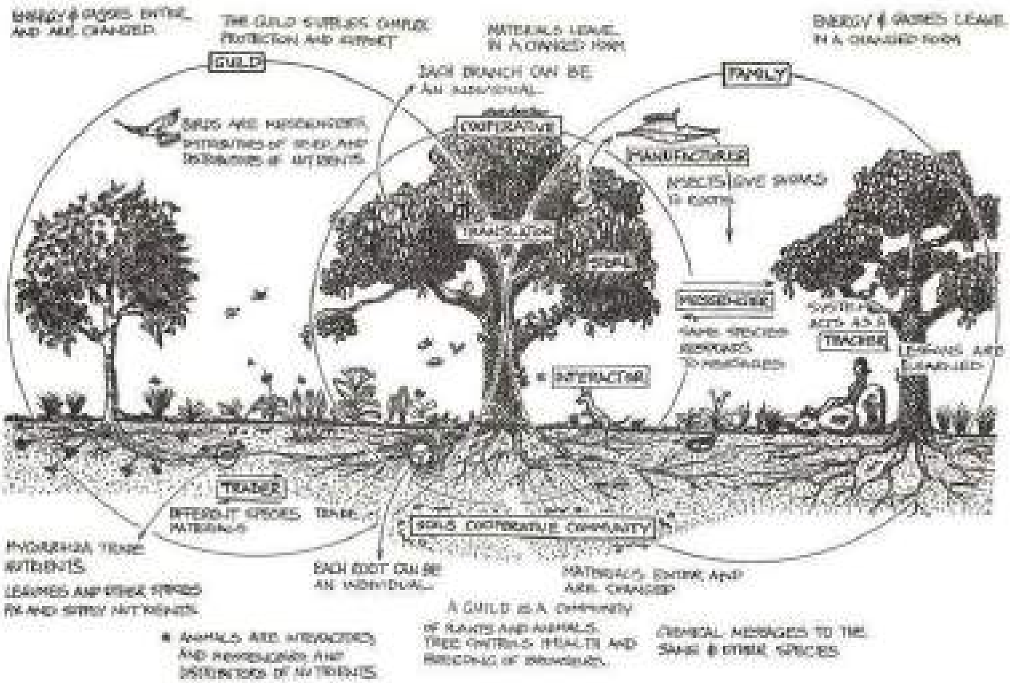


fig. 17. Permaculture Ecosystems Diagram Sketch (Bill Mollison, 1988)

Permaculture

Permaculture (for permanent agriculture), first developed by Bill Mollison and David Holmgren, is an approach to planning resilient agricultural systems that imitate the relationships found in natural ecosystems. Permaculture is the arrangement of the right elements in systems known as guilds. These groups naturally support and sustain each other in the long term. Permaculture demonstrates that instead of planting orchards or fields, we should build guilds.

The focus is placed on designing the system layout before planting. Benyus refers to "canopy schemes" which (like New Alchemy) allows for taller plants to protect and shade smaller plants. The excavation of troughs to aid in water collection, and the natural irrigation of the beds. The soil is minimally worked, mulches are layered on top which protects and nourishes the soil. The design of landscaping helps with maintenance and is also planned to take advantage of natural conditions: for instance, by planting along contours the system takes advantage of the natural slope of the land to naturally irrigate crops. "Designing with nature's wisdom is at the core of this farming philosophy", Bill Morrison focused on small-scale farms that would prepare "low-maintenance gardens", contributing to a sustainable lifestyle (Benyus, 1997). This farming philosophy teaches us about the functions of elements within a larger system, rather than specific elements. Apart from agriculture, permaculture also looks at other aspects such as, the design of living spaces, energy usage, and production and waste (which in permaculture is considered a resource) to name a few (Never Ending Food, n.d.).

fig. 18. Walkway through Permaculture Farm (Tyrant Farms, 2013)

fig. 20. Rice farmers carrying straw bales over rice fields, Chiang Mai Province (Unknown)

Polyculture

Polyculture refers to the mixing of crops, by simultaneous planting two or more different crops in the same area. The main issue with this method is that the work is doubled when compared to monoculture farming. This is due to the variety of species, the relationships between species need to be examined and designed. Along with the relationships, climate flexibility, water requirements, pest, and disease resilience also need to be considered (Benyus, 1997). Polyculture helps farmers to use less or almost no chemicals and pesticides, due to the natural capacity of a polyculture system to repel insects. This ability is a result of the variety of species making it harder, for insects that 'specialize' in a certain plant species. "That's why,… you don't see the runaway decimation that you see in monocultures" (Benyus, 1997). When deciding the component species of a polyculture, the "genius loci" should be consulted – climate, soil conditions, etc. Although the extra work is a small negative, the minimal pesticide requirement is often a major selling point for this farming method.

"Do Nothing"

"Do Nothing" farming is a term used to describe the system of farming conceived by Masanobu Fukuoka in Japan. So-called because it requires almost no labor on the part of the farmer. This method only requires that the farmer builds up layers of soil which "mimics nature's trick of succession and soil covering" (Benyus, 1997). Once rice crops are ready to harvest, Fukuoka removes the grain and throws the straw over the field. Fukuoka avoids ploughing the fields and relies on the "self-fertilizing and self-cultivating" (Benyus, 1997) processes of the crops. This ensures that soil fertility does not get diminished and that crops can be grown in the same filed for many more years. Less water is also required, a small dousing of water is needed initially to prevent weed germination. After this, the field is left alone. This method of natural farming does not require any mechanical equipment, and the need for fertilizers and chemicals is nil. The simplicity of this method is what has drawn many more farms in Japan and China to adopt the method.

fig. 19. Farmer harvesting crops on polyculture farm (Josh Noland, n.d)

Hardwood Forest

Sir Alfred Howard, who was often accredited with the invention of organic farming, spoke about farming to fit the land (Benyus, 1997). J. Russel Smith looked at the diversity and stability of the eastern deciduous forest as a model for tree canopy farming. This method considers the advantages of planting tree crops on hillsides. It was noted that tree crops suited the hillsides best, and reduced soil erosion on the hillside when compared to row crops (Benyus, 1997). Smith details the three levels – the canopy, shrubbery, and herbaceous understories – that created niches that help bolster diversity. Through this diversity, birds and animals benefit from the ecosystem, and in turn help with grazing the crops. Roots of trees and smaller understory crops, work together to hold the soil, and retain nutrients (Benyus, 1997). An added benefit of the canopy is that fallen leaves and debris nourish the soil and encourages the growth of mycorrhiza, a fungus that helps roots absorb water. Native American nomadic tribes made use of this farming method. They rotated crops, which allowed the soil to replenish itself after harvest. This also allowed for small plots to revert to their original forest state (Benyus, 1997).

Conclusion

When looking at agricultural systems there are essentially two types, destructive and regenerative. Commercial farming as we know it today is an example of destructive agriculture, they do not rebuild soil biology or reinstate the natural mineral cycles of the system. The abovementioned methods are all examples of agriculture that works with nature - regenerative agriculture. They help maintain and build ecosystems. These methods reaffirm our connection to the wind, the sun, the soil and the plants themselves. By following the simple principles mentioned above – no tilling, natural energy, polyculture, companion planting, etc – we essentially prioritize methods that benefit nature and our health over methods that make profit. And thus we can begin to produce healthy, chemical-free, nutrient-rich food that nourishes rather than just feeds us, as well as the. If we use these methods in place of current methods, we can begin to regenerate soil and heal the environment.

fig. 21. Leafy green crops grown under the protection of tall trees (Ana Cotrin, n.d)

URBAN AGRICULTURE

Urban Farming

With farming operations becoming less feasible, both economically and environmentally. Many are looking for alternative systems of providing food for the growing populations. The concept of Urban Agriculture (UA) refers to the practices of crop farming, livestock farming, and aquaculture that take place within urban or city environments (Warnes, 2019), and thus localizing food production. For this research, my focus will be on growing healthy crops in urban centers to help bridge the gap in the availability of healthy and nutritious food options. This definition of UA encompasses activities that turn the city into a productive landscape, which includes community gardens, backyard home gardens, school gardens, and urban farms (Nogeire-McRae et al., 2018). While the common perception of farming is that these methods require a piece of open ground, it is important to recognize the potentials of the city as a three-dimensional landscape. Urban environments have plenty of opportunities for Building-Integrated Agriculture (BIA). BIA is the strategic placement of high-performance farming systems on or within buildings, this includes indoor farming, edible green walls, hydroponics, rooftop gardens, and vertical farming (vertical farming and hydroponic systems will be explored later in this report). Incorporating farming practices into the built environment has the potential to improve the lives of people living in urban areas (Gould and Caplow, 2012).

fig. 22. Cuban farmer manually tilling his soil (Andy Cook, 2014)

Social Impact

Most urban farm projects require some level of social organization, whether by gathering a group of like-minded people to join the cause or in the planning/management of the farm. UA builds social engagement and increases social involvement (Nogeire-McRae et al., 2018), and in turn, builds social bonds between those who participate. One factor to note is that it is important that "the residents of the communities being affected by the urban agriculture projects are not just consulted but fully empowered in leadership and decision making to the greatest extent possible" (Santo et al., 2016). Another valuable benefit of AU is that it reconnects people with food and teaches them how to grow their food for themselves. Through growing food, people build a better understanding of what is required to grow food, and thus a bigger appreciation for food (Santo et al., 2016). Through AU programs we can increase the education of adults and children around topics of sustainability, health and in doing so increase the health of the food systems that feed us.

fig. 23. Oranjezicht City Farm & Market (Janina Mohr, 2017)

Health Impact

UA benefits individuals and entire communities, depending on the nature and extent of the project. Direct health benefits would likely apply to those who participate in the farming activities. Gardening provides those who participate with physical exercise, without it feeling like exercise (Bellows et al., 2008), and improves mental health and well-being by reducing stress (Santo et al., 2016).

AU projects also contribute to food security in communities, providing them with access to an affordable, healthy food source. The proximity to these food sources, whether it is sold through a market or directly from the farm, means that the produce will be fresh and nutritious (given that the transport time of the produce is cut down significantly or cut out completely). This access to food will help reduce levels of malnutrition and a variety of diet-related issues, as well as, reduces the risk of obesity, diabetes, and heart disease (Bellows et al., 2008; Santo et al., 2016).

fig. 24. Cuban farmer sowing seed (Andy Cook, 2014)

Cuba's Special Period

In the 1990s, years after the fall of the soviet union, the United States of America place an embargo on Cuba. The goal was to prevent food imports, among other things, from entering Cuba. The embargo was ultimately a success in propelling the country into economic trouble, an economy already in turmoil after losing the Soviet Union as their economic and political ally (Olomari, 2019). This was the beginning of a severe food crisis in Cuba having lost access to up to a third of their daily food requirements (Clouse, 2014). Cuba, however, was able to overcome this, and is now not only one of the most stable countries in the region, but is also regarded as a model for sustainable urban agriculture.

In Havana, citizens took matters into their own hands, planting crops anywhere and everywhere they could, on open plots of land, balconies, terraces, and backyards. Farm and gardens of varying scales opened up all over the city, and outskirts. Food production started to be woven into the existing built fabric of the city, in every neighborhood in Havana (Clouse, 2014; Quirk, 2012). These ground-up efforts by the citizens were incredibly important, however the government actions that followed were equally important. In 1994, the Cuban government formed the Urban Agriculture Department, with several key goals in mind. Perhaps the most important of those were, (1) adapting laws and policies to make it legal and free to transform disused public land into productive urban farms, (2) creating agricultural centers which provided resources, information, and technical support to farmers and (3) provided training to a number of community agents who monitored farms, educated community members and encouraged new gardeners within the community (Murphy et al., 2000; Quirk, 2012). By 1998, urban farms produced roughly 50% of Cuba's vegetables, and Havana alone boasted over 8000 organic farms and gardens (state-run and individual farms).

Cuba provides incredibly useful proof of the possibilities and benefits of urban agriculture. While Cuba was forced to adapt and overcome a food crisis, governments, policy-makers, architects and planners have the opportunity to use this model to help transform the food systems and food infrastructure from one reliant on large-scale chemical and resource-heavy commercial farms, to one of sustainability and self-sufficiency, as Cuba has demonstrated for almost 30 years.

fig. 25. Peri-urban farm in Alamar, Cuba (Melanie Reed,

fig. 26. Cuban farmer uses roof tiles to construct raised beds (Andy Cook, 2014)

fig. 27. Lush Green Urban farm, Havana, Cuba (Noah Friedman-Rudovsky, 2012)

Urban Farming in Johannesburg

We see from looking at Cuba as a precedent, the possibilities and benefits are of adopting urban agriculture strategies as a means of addressing food shortages, and food crisis. We also see how communities can bring about change by taking matters into their own hands. Perhaps most importantly we see how significant it is that governments adjust or even rewrite policies in ways that benefit urban agriculture practices and enable them to thrive. While Cuba was forced to adopt these practices it would be beneficial for governments and policy-makers to implement policies, strategies, and to proactively encourage urban agriculture practices to help alleviate the current food issues.

Currently, the City of Johannesburg (CoJ) does not have any particular strategies directly related to urban agriculture, although the CoJ highlights a prioritization of food insecurity in the city. In 2012 the CoJ developed the Food Resilience Framework (related to the Integrated Food Security Strategy for South Africa), with the goal of providing food parcels and vouchers, and to assist with backyard gardens in order to tackle individual hunger in the country.
The Johannesburg Food Resilience Policy also mentions agricultural development strategies and Agri-resource centers. These Agri-resource centers are places where general supplies (seeds, soil, equipment, etc.) can be acquired, as well as advice about access to land, training, and general information about food cultivation (Malan, 2015). The aim of these centers is to support communal and home farming operations, and provide access and support to farmers growing a surplus of food who wish to supply food to the Johannesburg Fresh Food Market.

While there are no official policies supporting urban farmers there are several farming operations in Johannesburg. Many of these farms are community-based operations, and some are the result of private organizations and initiatives (like The Urban Agriculture Initiative) supporting the concept of urban agriculture and providing would-be farmers with training and support. A good sign however is that the CoJ is currently in the process of compiling an urban agriculture policy, that will follow an approach centered around multi-stakeholder engagement (MSE) (Malan, 2015). According to Malan, MSE's are useful because they are usually built upon local needs and have "strong roots in participatory development" (Malan, 2015). MSE's will thus bring change and growth brought on by the support of stakeholders without taking farming control away from farmers themselves. Without these policies, however, it will be difficult to encourage farmers to engage in the urban agriculture idea, without providing them clear methods, support, and policies to do so.

fig. 28. Community participating in crop planting for Mandela Day 2014 (Unknown)

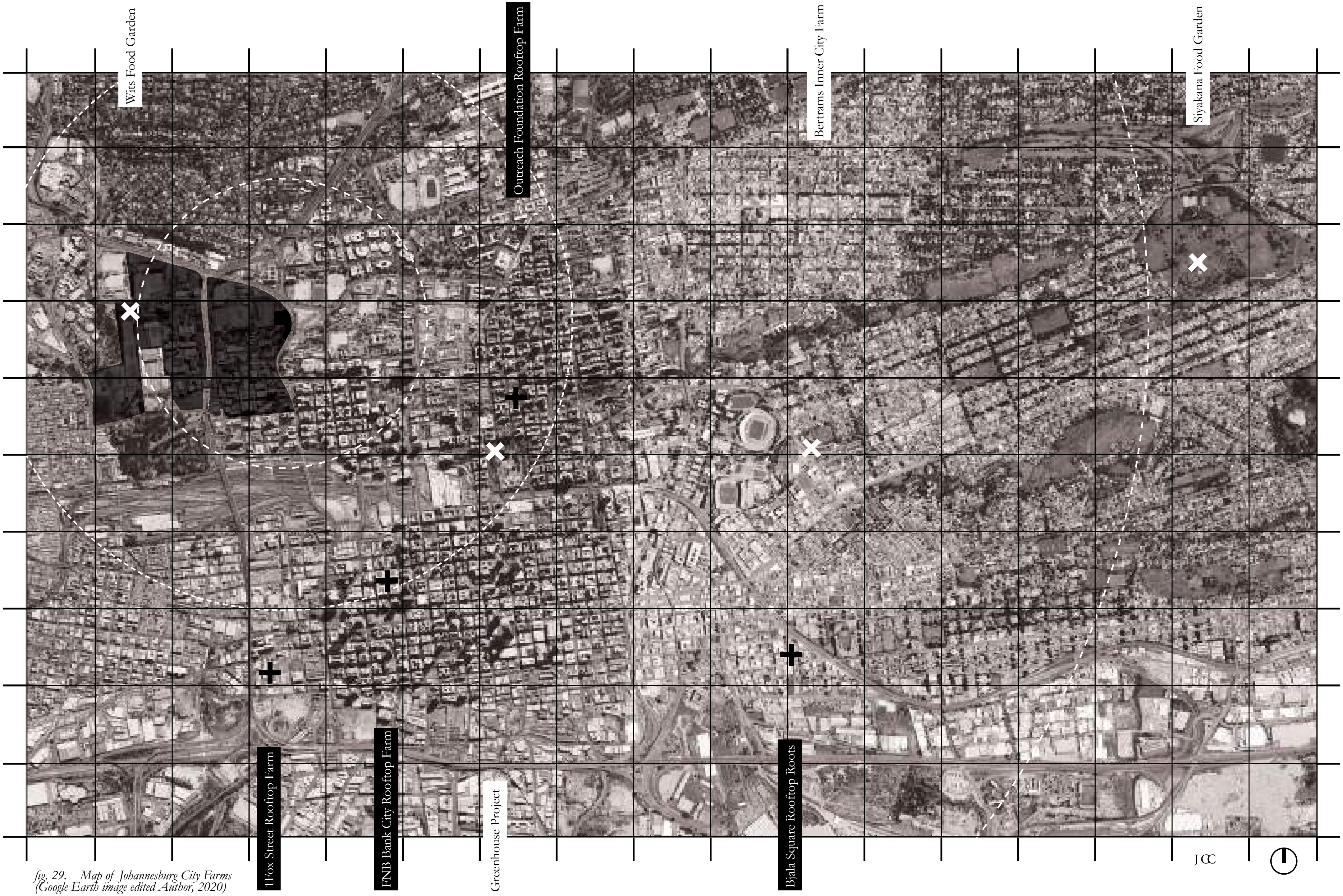


fig. 29. Map of Johannesburg City Farms (Google Earth image edited Author, 2020)

The Greenhouse Project

The Greenhouse Project (GHP) is located in the northwest corner of Joubert Park, Johannesburg CBD's largest open green space, in the center of the Johannesburg CBD. The project was initiated in 2002, by Dorah Lebelo (the former director) to address the food needs of communities and educate urban communities about recycling and organic farming by promoting "a holistic approach to integrating green building and design, efficient and renewable energy" (Paul, 2008) and exploring innovative methods of self-sufficiency.

The GHP began with the upcycle and re-use of the Old Parks Agency Maintenance Depot, to be used as their starting office space (Phase 1). This first phase also included the planting of a demonstration garden and a living willow boundary wall. This is what allowed them to achieve their goal of sharing and educating through "learn and build workshops". As they expanded, they were able to build a wellness clinic (through their recycling and earth building process) by restoring the old conservatory. A small recycling center was also built, this featured large compost and potting sheds ("A Green Corner in Inner City," 2011). Unfortunately, due to financial issues, they were unable to continue the expansion and were unable to reach their final vision, although they still host workshops and courses in the facilities.

The focus of the GHP lies in three main areas:
Share information that will empower individuals to improve the quality of life, for themselves and their community, in a sustainable way.
Providing support for organizations, particularly community-based organizations, who work to improve the urban environment.
Educating local communities, through working demonstrations of sustainable methods of planning, landscaping, and building, as well as ways of managing water, energy, and material resources.

("A Green Corner in Inner City," 2011)

fig. 30. Children working in the garden at the GHP (Elias Koch, 2008)

The underlying philosophy of The Greenhouse Project is the education of all members of the community (individuals, schools and organizations, etc), by imparting practical knowledge through working examples of sustainable farming. This is a concept I will bring into my project, teaching people about methods of organic farming that they can apply to their specific circumstances, whether it be in a household, corporate or school setting, enabling them to live a healthier, more self-reliant life.

fig. 31. GHP: Recycling (The Global Oneness Project, 2008)

fig. 32. GHP Observatory (The Global Oneness Project, 2008)

fig. 33. GHP: Spinach (Google Earth Image Edited by Author 2020)

The Urban Agriculture Initiative

The Urban Agriculture Initiative (UAI) was founded in 2017, by Wouldn't It Be Cool (WIBC) – a mentorship organization that helps young entrepreneurs start their business venture - in partnership with the Johannesburg Inner City Partnership (JICP).

The goal of the UAI is to provide business opportunities "through the creation of an urban agricultural entrepreneurial ecosystem supporting young black, urban farmers" (WIBC, 2017). The first UAI project was a 66m2 basil farm run by Nhlanhla Mpati, a graduate of WIBC, on the roof of the Chamber of Mines building on Main street Johannesburg. Mpati's farm has the capacity to grow 110kg of fresh basil every 21 days, and he supplies his produce to various restaurants and coffee shops nearby, as well as the Chamber of Mines canteen itself. Following the success of this first farm, the UAI secured funding from the Department of Small Business Development to set up 100 more inner-city rooftop farms. Several farms have been established since, there are also farms in Maboneng, Berea and Hillbrow. The long term goal of the UAI sees agri-processing operations opening up alongside farms, and the initiative spreading to other South African cities like Tshwane, Durban, and Mbombela (Cox, 2012).

The cost of setting up these farms is R200k, which includes everything the farm requires (frames, shade cloth, planting mediums, pumps, etc.), all supplied by Cape Town-based company Future Farm SA. Upon graduating from WIBC business and a week-long hydroponics course, participants are given a R200k loan to start their business, interest-free, and payable over three years. Farmers are also provided with an expert to assist and teach them the ins and outs of starting a Hydroponic farm (Davie, 2018).

The success of the UAI can be attributed to them identifying an ever-present problem – the lack of jobs for young people, and their desire to address a real-world food problem. The model they use to do so is one that should be studied, not only do they provide the education but they also provide the means to start a business and the support to sustain it. This is where the initiative truly succeeds.

fig. 34. Farm on FNB bank city rooftop (Lucille Davie, 2012)

fig. 35. Hydroponic spinach farm on 1Fox sreet rooftop (Lucille Davie, 2012)

Food Sovereignty at Wits

The University of the Witwatersrand, like many other Universities and countries as a whole, sees many of its students go hungry and struggle to feed themselves on a regular basis. Over recent years a number of initiatives have been developed by staff and students to help address food insecurity issues within the university, whether it be through the student-run vegetable garden or food schemes.

The Food Sovereignty Centre is a project that aims to fight food insecurity and encompasses several food security related initiatives on campus – namely the Inala Forum, The Wits Siyakhana Food Project and the Wits Food Programme. The Food Sovereignty Centre provides spaces for students to grow, cook, and eat food. With food gardens and communal kitchen their aim is to provide a space of dignity for food insecure students. The Wits Inala Forum is a student society that aims to empower students when it comes to matters of food insecurity, this is done by providing students with fresh healthy vegetables, but also teaching students the skills, knowledge, and facilities to grow their own food. The Inala forum is based on the crucial idea of advancing towards an "eco-centric university based on zero hunger, zero waste, and zero carbon emissions" (Satgar, 2018). And idea stemmed from the realization that despite the university recognizing the hunger challenges of students, not enough is done to address food issues in a manner "that affirms the dignity of students, solidarity and a food sovereignty pathway for all" (Satgar, 2018). The Wits Food Garden is located on the Braamfontein West Campus and is managed by the Inala Forum and the Wits Siyakhana Food Project. Students are assisted by university ground staff, who also have a garden next to the student garden, and the vegetables grown are harvest and packaged in food parcels for students. The Wits Food Programme is a combination of two meal provides daily lunch-time meals, as well as food parcels three days a week.

The Food Programme assists roughly 1500 students daily, however, this number does not reflect the number of students in need, only what the Wits Food Programme can provide for. And although the various food gardens are able to provide some food for the various entities that fall within the Food Sovereignty Centre, the scheme still relies heavily on donations. Through my proposed scheme I am hoping to fill in this gap, seeing the food that is grown in both the vertical farm (vegetables and fish) and the food gardens going to the Wits Sovereignty Centre. At the same time, my scheme will provide additional support, growing space, and opportunities for knowledge exchange.

fig. 36. The Sanctuary Building, the home of the Food Sovereignty Centre, Wits East Campus (Author, 2020)

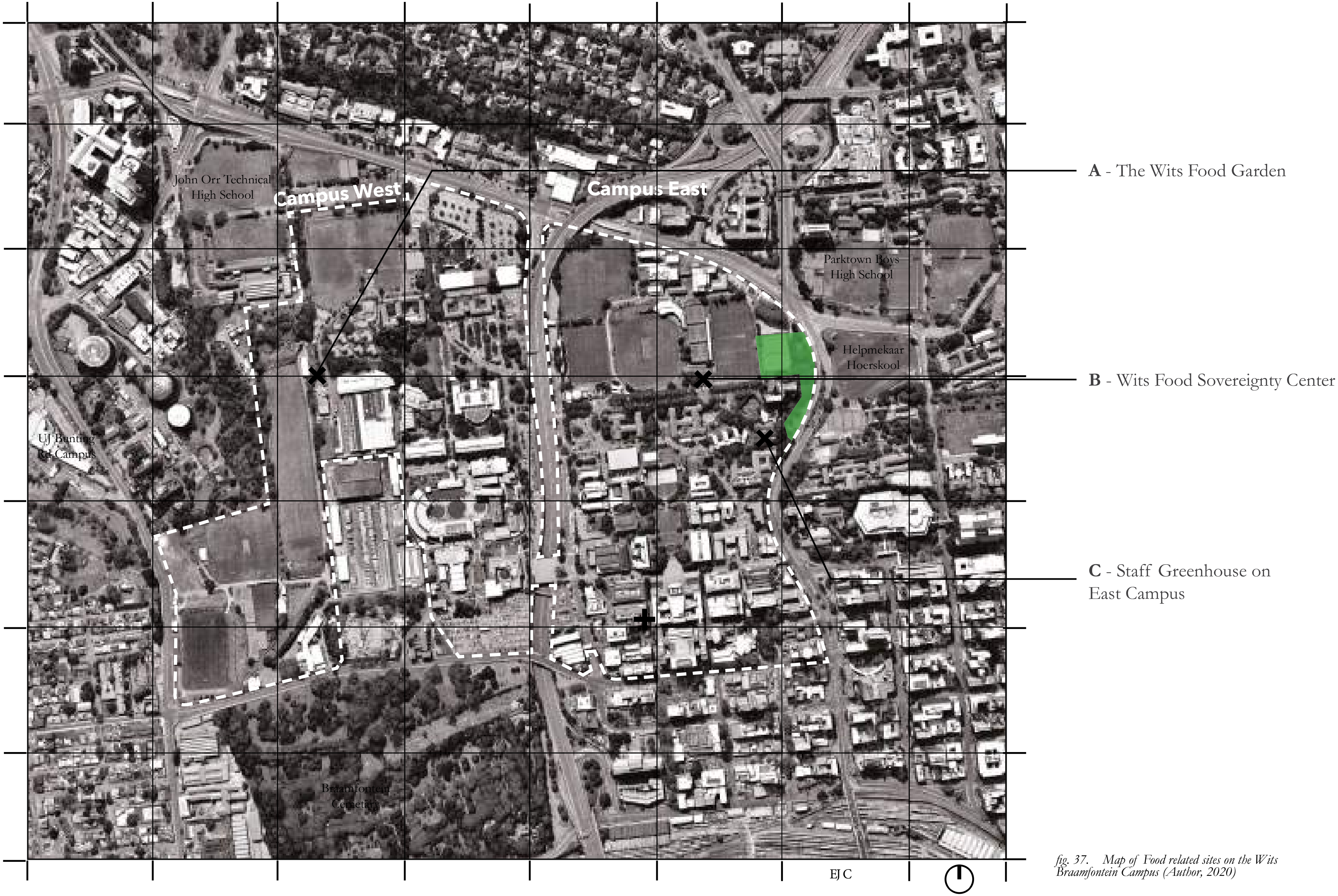


fig. 37. Map of Food related sites on the Wits Braamfontein Campus (Author, 2020)

The map on the left indictates the location of various food gardens and food related spaces on the Wits University Braamfontein Campus. My chosen building site is also indicated, highlighted in green.

Please note that these photographs were taken on an initial information gathering walk around campus before the country and university went into lockdown. When I went back to the University once it had opened up post lockdown, the gardens had mostly died and been overrun with weeds. I apologise for the lack of clarity in images A and C.

fig. 38. Greenhouse on East Campus (Author, 2020)

fig. 39. Wits Food garden, student and staff farm (Author, 2020)

fig. 40. Kale name card in gardens at The Sanctuary Building (Author, 2020)

SOILLESS FARMING

fig. 44. Farmer harvests produce from chinampas in Xochimilco, Mexico city (Leila Ashtari, 2019)

fig. 41. Artist impression of chinampas of the Aztecs (Unknown, n.d)

fig. 42. Floating Gardens of Lake Inhle, Myanmar (Thomas Schoch, 2010)

A History of Soilless Farming

While it is easy to think of Hydroponics as being a new age technology, it has been the belief, for over 70 years, that hydroponic systems would change the farming landscape. Before that people have been growing hydroponically, and perfecting the method, for thousands of years. The first known use of hydroponic principles is believed to be The Hanging Gardens of Babylon (Hershey, 1994; Folds, 2018), one of the seven wonders of the ancient world. Built around 600 B.C., on the banks of the Euphrates River, in Babylonia (near present-day Baghdad). The gardens used an elaborate watering system that provided a steady stream of water rich in nutrients and oxygen. The river water was carried up, using a chain pull system, and allowed to trickle down the steps of the gardens (Turner, 2008). Many discredit this comparison saying that there is no evidence of hydroponics and that the written descriptions of the gardens mentioned gardens that "were similar to multilevel roof gardens with plants growing in deep layers of soil" (Hershey, 1994). The Hanging Gardens are, however, an example of a nutrient solution (unknown at the time) being used to assist in the growth of plants.

fig. 43. Artist impression of Hanging Gardens of Babylon (Ferdinand Knab, 1886)

The Aztecs of Central America During developed a method of growing maize, beans, tomatoes, squash, chilies, and flowers on floating gardens called chinampas (Quillen, 2015), during the 10th and 11th centuries. Chinampas were rafts made from tying stalks and tough roots together, these rafts were loaded up with soil (rich in organic compounds and nutrients) from the bottom of the lake, in which the crops would grow. The roots of the plants reached down through the bottom of the raft and into the water below, allowing for constant watering and oxygenation (Folds, 2018; Turner, 2008). Similar floating systems are still being used today on Lake Inle, Myanmar (Anon., 2013), and writings by Marco Polo on his travels to China mention him witnessing floating gardens in the late 13th century (Folds, 2018). Climate change has also forced farmers in the Bay of Bengal, Bangladesh, to revive this ancient practice in order to survive, making similar rafts (from the invasive water hyacinth) to farm and live on (Pasotti, 2019).

Formal research and testing into hydroponics began in the early 1600s. In 1600 Jan Baptista Van Helmont (a Belgian scientist) conducted an experiment and deduced that plants obtain growth substances from water (Folds, 2018). Van Helmont's experiment consisted of him planting a 2.2kg willow in a clay pot filled with 90kg of dry soil. Over five years he added nothing but distilled water or rainwater to the pot. After the five-year period was over, he found that the soil had lost 57 grams and when he weighed the willow, he found that it weighed roughly 77kg. At the time photosynthesis had not yet been discovered, so he concluded that his experiment proved that plant obtained growth nutrients from the water (Chastain, n.d.).

Later, in 1620, British scientist Sir Francis Bacon began research on soilless gardening, his work sparked a wave of hydroponic research (Turner, 2008). It was another English scientist, John Woodward who is remembered as the first person to grow plants

fig. 45. Vegitation growing in beds on Ascension Island hydroponic garden (Unknown, 1945)

in water culture. Woodward conducted tests of various water solutions – rainwater, spring water, Thames River water, and water from the Hyde Park conduit – using spearmint, concluding that plants grow better in water that contains dissolved substances (Hershey, 1994). This led to German scientists, Julius von Sachs and Wilhelm Knop, developing recipes for nutrient solutions in the 1960s. Further refinement has left us with a list of seven elements and micronutrients that plants require - Iron, Copper, Chlorine, Manganese, Zinc, Boron, and Molybdenum, and macronutrients - Nitrogen, Sulfur, Potassium, Phosphorus, Calcium, Magnesium, Hydrogen, Oxygen and Carbon (Folds, 2018; Hershey, 1994).

It was only in 1929 when hydroponics was linked to agriculture. William Frederick Gericke suggested a method of using solution culture (nutrient solutions) to grow crops, he called this technique 'aquiculture' which he later changed to 'hydroponics', meaning water working (Hydro meaning water, Ponos meaning labour in Greek) (Gericke, 1940). Gericke believed that previous scientific inquiries failed to see the potential of the principles they were researching, saying that their research was aimed at one objective, "making better use of the soil" (Gericke, 1940). But Gericke's hydroponics suggested that crop production is not dependent on soil and that certain commercial crops can be grown in large quantities in a basin of a nutrient-rich solution. Despite his many successful tests with tomato plants and his belief that it would change the way food would be grown worldwide, Gericke was unable to convince the masses of the applications and viability of hydroponics. His main hindrances involved cost and expertise. A prospective grower would face a substantial initial investment cost, having to purchase pumps, troughs, piping, lighting systems, air filters, fans, and nutrient solutions. The cost of electricity was also a bit concern, lights had to do the work that the sun would naturally do outside. Hydroponics also required extensive knowledge of farming, plumbing, botany, and chemistry (Siegel, 2013), this along with the cost meant people were drawn to the traditional soil-based farming methods.

Although largely rejected as an agricultural method, there was a group of farmers that found Gericke's hydroponics useful, and profitable. Marijuana farmers were forced to grow crops indoors, as it was too risky to grow outside. This is where Gericke's inventions showed its true potential. This negative connotation with hydroponics still permeates today. When interest in the technology slowed down, these 'pot farmers' were left to progress the development of the technology through the 1970s (Siegel, 2013).

fig. 46. Dr Gericke standing beside Hydroponically grown corn crops (Unknown)

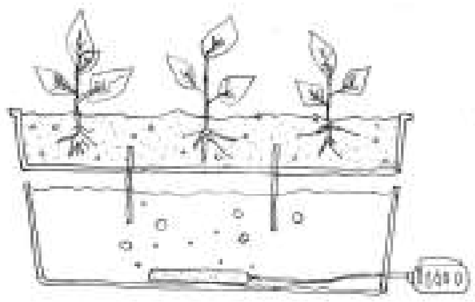
Hydroponics

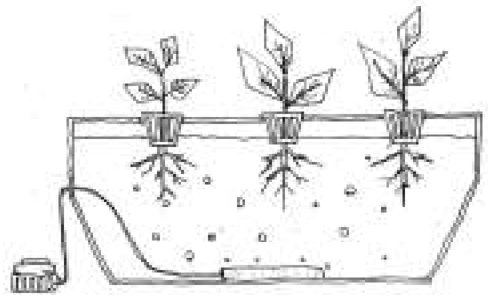
Within modern hydroponics, there are many techniques for optimizing the growth process. Growth techniques can be adapted to many situations, whether looking to start a backyard farm as a hobby or a larger commercial farm. The following are the most commonly used hydroponic systems:

Wick System: Wicking systems are the most basic system. Plant containers sit above the reservoir and the solution is delivered to the growing medium through capillary action via several wicks. Although the system in its most basic form does not require any moving parts, one can add an air pump to the system to reduce the frequency of cleaning the reservoir. (French and Roth, 2019; Quillen, 2015)

Deep Water Culture: Plants sit in 'floating' containers (often on Styrofoam boards), where roots extend into 150-450mm (depending on the crop) of a well-oxygenated nutrient solution. The solution is oxygenated using an air pump. This simple-to-make system is perfect for leafy greens, herbs, and plants that do not require much root support. (French and Roth, 2019; Quillen, 2015)

Drip: Perhaps the most popular method, drip systems use a pump on a timer that pumps the nutrient solution from the reservoir and allows in to slowly drip onto the growing medium (coco coir, peat moss, or rockwool) and the roots of each plant individually. Excess water is collected and returned to the reservoir. Although this system provides a high output, the pipes and drip lines can become clogged resulting in dry plants. (French and Roth, 2019; Quillen, 2015)





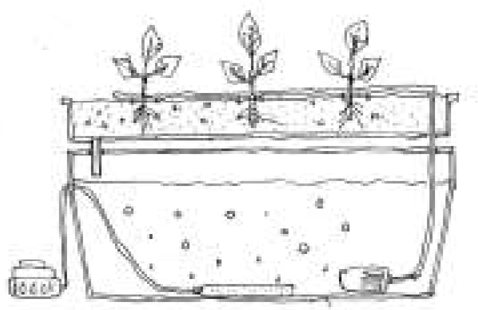
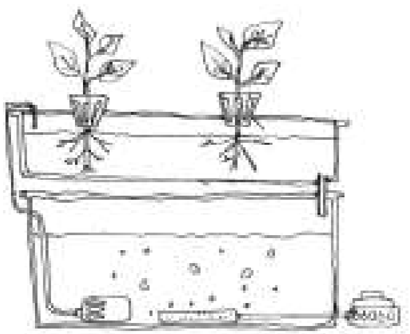


fig. 47. Wick Hydroponic System Diagram Sketch (Author 2020)
fig. 48. Deep Water Culture Hydroponic System Diagram Sketch (Author 2020)
fig. 49. Drip Hydroponic System Diagram Sketch (Author 2020)

Nutrient Film Technique: In this versatile system, channels are mounted at a slight angle. The angle aids in the drainage of the solution from the channel. The nutrient solution is pumped, on a timer or continuously, from a reservoir into the channels. The solution saturates the roots and then flows back into the reservoir, where it is oxygenated. NFT systems are easily stackable making them easier to customize to your growing space. (French and Roth, 2019; Quillen, 2015)



Aeroponics

Aeroponics is a newer innovation (circa 1983), whereby roots are suspended in the air and a nutrient solution is sprayed in a mist. The solution is then cycled back into the reservoir. These are very precise systems when it comes to water usage and nutrient delivery, and roots receive plenty of oxygen resulting in faster growth. This growing method requires less growing medium and significantly less water, however, this is a more expensive method and sprinkler heads are prone to clogging. (French and Roth, 2019; Quillen, 2015)

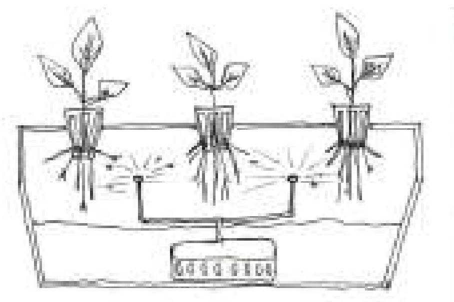


fig. 50. Nutrient Film Technique Hydroponic System Diagram Sketch (Author 2020)
fig. 51. Aeroponic System Diagram Sketch (Author 2020)

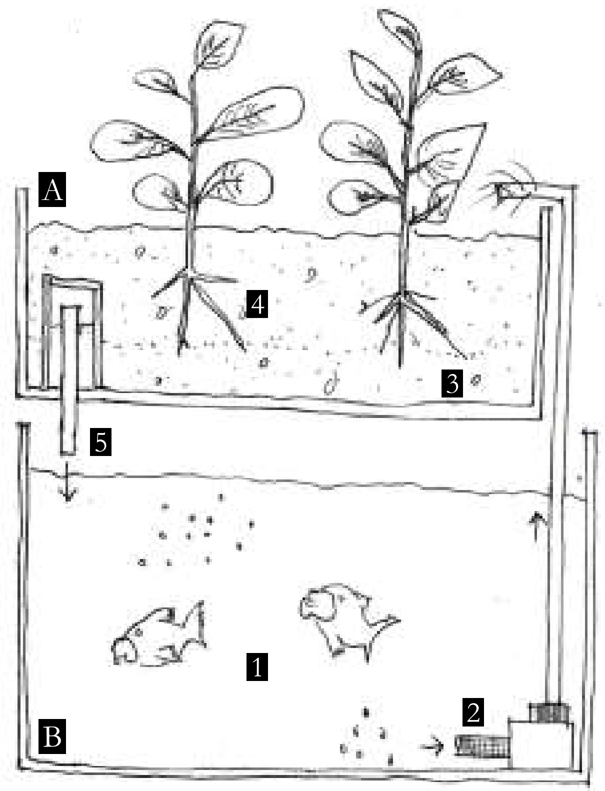
In the past, the hydroponic movement never managed to get a decent footing. Concerns around cost, energy requirements, and knowledge, although valid, prevented hydroponics from reaching the larger populous. Today, however, our climate crisis and increasing water scarcity has brought our collective attention back to soilless farming, and for obvious reasons. Water conservation is the most important one. On average, a hydroponic farm uses ten times less water when compared to soil agriculture, because water is reticulated more directly to the roots lowering waste significantly (Quillen, 2015). Most modern systems also recycle the nutrient solution/ water, further lowering water waste. While there are also valid concerns around modern hydroponics, along the same thread as those experience by Dr. Gericke; initial investment costs, energy requirements, and technical know-how, the difference is that today the benefits seem to outweigh the disadvantages of the system. That is not to say that will always disadvantages, as we have already seen electricity costs being cut with the use of renewable energy sources such as solar panels. Inexpensive, Do-it-yourself systems have become popular with hobbyists and home growers. And information on hydroponic farming is becoming more and more accessible, making it easier for people to make the transition. Climate change and rapidly increasing populations, along with the increased popularity of soilless farming, has changed the way industries and scientist look at agriculture giving rise to the Vertical Farming trend.

Aquaponics

Aquaponics is the oldest soilless farming technique; it has been discovered that ancient civilizations like the Aztecs used this technique. Aquaponics is a hybrid system of hydroponics (soilless method of growing plants) and aquaculture (raising fish and other aquatic animals), where fish and plants are raised in the same water source. Nutrient-rich water from raising fish is circulated to plant roots providing natural fertilizers for the plants, the plants in turn help purify the water for the fish, completing a closed cycle (French and Roth, 2019). Since hydroponics and aquaponics work on very similar principles, a standard hydroponic system (Drip, NFT, DWC, etc) can easily be fitted with a fish tank to benefit from the collaboration between plants and fish, with the additional benefit of edible fish being grown for harvest - depending on the farmers' requirement's and size of the system.

Fish are chosen based on a few simple criteria, growing speed, hardiness, and whether they will be eaten or not. The most common fish used in aquaponic are Tilapia because they are able to adapt well to a wide range of temperatures, but many types of fish can be used including perch, trout, even shrimp & prawns. For an ornamental system, Koi ponds can be converted to function as part of an aquaponic system.

The following page indicates the fish chosen for my scheme, they are chosen for their hardiness and ability to adapt to various water conditions. Two of the chosen, Tilapia and Perch, are edible the provides the scheme with either an additional source of income or and additional food source for the food scheme.



A. Growing Bed
B. Fish Tank

1. Clean water is contaminated by fish food and waste containing ammonia.
2. Pump removes waste and circulates water to growing bed.
3. Bacteria converts Ammonia and Nitrites to Nitrates.
4. Plants absorb Nitrates as plant food form the water.
5. Cleaned water drain back into fish tank. The Cycle is repeated.

fig. 52. Aquaponic System Diagram Sketch (Author 2020)

Nile Tilapia
(Oreochromis Niloticus)

Good for eating
Hardy Fish that can adapt to its environment.
Fast grow rate (± 9 months).
Omnivorous diet.
Reproduce quickly, this must be monitored to prevent overcrowding.
Requires water above 12°C.

Perch
(Perca)

Good for eating
Can flourish in a wide range of environments, thus can support a wide range of plants.
Slower grow rate (± 14 months).
Omnivorous diet, can be carnivorous if small fish are in the same tank as larger ones.
Optimal water temp between 20°C - 25°C.

Koi
(Cyprinus Rubrofuscus)

Attractive ornamental fish.
Not good for eating
Can survive in a wide range of temperatures 0°C - 30°C.
Long lifespan.
Large fish, recquires larger tank.

fig. 55. Nile Tilapia (Oreochromis Niloticus) (Mexican-fish.com)

fig. 54. Perch (Perca) (Mexican-fish.com)

fig. 53. Koi fish (Cyprinus Rubrofuscus) (Mexican-fish.com)

Photo Essay:
Farm District Eastgate










V E R T I C A L
F A R M I N G

The term "vertical farming" is a relatively new one. Dr. Dickson D. Despommier, a professor of parasitology and environmental science at Columbia University, seems to hold the credit for coining the term. In an interview with The New Yorker, he explains that the initial idea came from a lecture he was teaching in 2000. When he posed two questions to his students "What will the world be like in 2050?", and "What would you like the world to be like in 2050?", they immediately turned to the food problem. They wanted a New York City that is able to feed its population with crops grown within its city limits (Frazier, 2017). "So they turned to the idea of rooftop gardening. They measured every square foot of rooftop space in the city—I admired how they went to the map room of the public library on Forty-second Street and found aerial surveys and got their rulers out—and then they calculated what the city's population will be in 2050, and the number of calories that many people will need, and what kind of crops can best provide those calories, and how much space will be necessary to grow those crops. Finally, they determined that by farming every square foot of rooftop space in the city you could provide enough calories to feed only about two percent of the 2050 population of New York. They were terribly disappointed by this result" (Despommier, 2017). As part of his teaching he, along with his students, developed a number of conceptual models of vertical farms.

fig. 56. The Living Skyscraper: Farming the Urban Skyline (Blake Kurasek, 2009)

fig. 57. Leafy greens grown in vertical hydroponic systems (Bold Business, n.d)

Despommier's vision of vertical farms took the principles of soilless farming and stacked the crops (whether it be hydroponic beds or aeroponic towers), and then stacked multiple floors of these vertical crop system creating a highly intensive productive building, that maximizes the productive area by multiplying the usable floor space. The concept of indoor farming is not a new one, greenhouse agriculture has existed for some time. Vertical farming proposes to radically change the scale of these indoor farming practices. The intention is for commercial amounts of crops to be grown in significantly less ground area, and closer to/within urban areas (Despommier, 2015). According to Despommier, if cities and countries were to widely adopt vertical farming practices the following advantages would likely be realized:

Advantages of the vertical farm:

1. Year-round crop production.
2. No weather-related crop failures - In a vertical farm temperature, water and lighting can be optimized to remove climatic risk.
3. No agricultural runoff.
4. Allowance for ecosystem restoration.
5. No use of pesticides, herbicides, or fertilizers - The use of controlled environments means that the risk of bugs and birds harming crops is removed, thus also removing the need for harmful pesticides.
6. Use of 70-95 percent less water.
7. Greatly reduced food miles - Locating vertical farm closer to consumers means haulage is reduced significantly, as crops are not transported from rural farms on the outskirts of cities, or other cities entirely.
8. More control of food safety and security.
9. New employment opportunities.
10. Purification of greywater to drinking water.
11. Animal feed from post-harvest plant material.

(Despommier and Ellingson, 2008)

fig. 58. Sky Farm, Toronto (Gordon Graff, 2008)

fig. 59. Cactus, Paris (SOA, 2012)

In his book, The Vertical Farm: Feeding the World in the 21st century, Despommier identified principles for the design to ensure a successful Vertical Farm. He also believes that a "high-rise food-producing", must mimic natural ecological processes in order to succeed, by recycling organic materials, and recycling "used" water, and returning to drinking water (Despommier and Ellingson, 2008). The vertical should safe and easy to operate and be durable and ideally be cheap to construct.

Vertical farm Design principles:

1. Capture sunlight and disperse it evenly among the crops.
2. Capture passive energy for supplying a reliable source of electricity.
3. Employ good barrier design for plant protection.
4. Maximize the amount of space devoted to growing crops.

(Despommier, 2010)

fig. 61. Euroméditerranée Skyscraper (Stéphanie Durniak, Baptiste Franceschi, Anthony Frutoso, Caroline Mangin, 2010)

fig. 62. EDITT Tower, Signapore (TR Hamzah & Yeang, 2008)

fig. 65. Locavore Fantasia (WORKac, 2009)

fig. 60. Living Tower, Rennes (SOA, 2005)

fig. 63. The 'First Vertical Farm' Proposal (Chris Jacobs,)

fig. 64. Harvest Green Project (Romses Architects, 2009)

Pasona Urban Farm

Project: Pasona Tokyo Headquarters

Architects: Kono Designs

Location: Tokyo, Japan

Programme: Office Building

fig. 66. Planted Double skin facade (KONODESIGNS, 2010)

fig. 67. Vertical Farm Space (KONODESIGNS, 2010)

fig. 68. Tomato plants suspended above conference room table (KONODESIGNS, 2010)

fig. 69. Crops growing in the lobby (KONODESIGNS, 2010)

fig. 70. Planted fruit trees and vines used as dividers between meeting spaces (KONODESIGNS, 2010)

The Pasona Tokyo Headquarters was completed in 2010. The nine-storey office building is a refurbishment of a 50-year-old building and was intended to serve the clients' greater vision of helping to "create new farmers in urban areas of japan" (Andrews, 2013). The building is the manifestation of the philosophy that to encourage interest in farming one must actively engage with plants whether it be visually or through educational activities. The building consists of office areas, auditorium, roof garden, cafeterias, and urban agriculture facilities. Employees are encouraged to engage with the crops, participating in the maintenance and harvest of the crops, supported by agricultural specialists (Andrews, 2013).

Of the total 19.974 square meters of building space, 3995 square meters are dedicated to green space. Over 200 species of plants, vegetables, fruits, and rice are grown inside the building and all food that is harvested, is prepared on-site in the various cafeterias. The farming facilities are integrated into the everyday functions of the building, fruit trees are used to create partitions between meeting spaces and tomato vines are hung above conference room tables. Plants are grown all over the inside and orange trees and flowers are grown on the double skin louvered façade of the building (Andrews, 2013). The farm makes use of both soil and hydroponics systems throughout the building, and an intelligent climate control system controls temperature, airflow, and humidity, optimizing crops and providing a comfortable work environment (Plaskoff Horton, 2018).

By weaving the agricultural components throughout the building and integrating them with the everyday functional spaces of an office building, the Pasona Urban Farm has created constant physical and visual interactions between plants/farming and the building user. This concept makes use of the utility of farming, and employees benefit from the biophilic connection with nature, creating for a healthier and more peaceful working environment. Connections that would not be there if the farming occurred in isolation and was limited to a dedicated portion of the building. This is an idea that I intend to bring into my project, creating constant links between farming, education, and the everyday functions of the building, by using smartly designed systems.

fig. 71. CAU North Facade Rendered 3D View (Mithun, 2007)

fig. 72. CAU South Facade Rendered 3D View (Mithun, 2007)

Centre for Urban Agriculture

Project: Centre for Urban Agriculture

Architect: Mithun

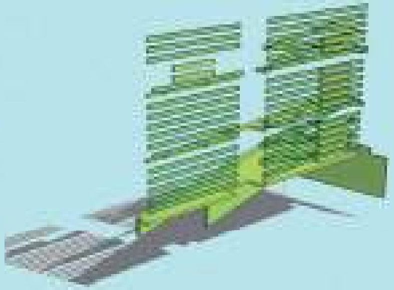
Location: Seattle, USA

Programme: Mixed-use housing concept

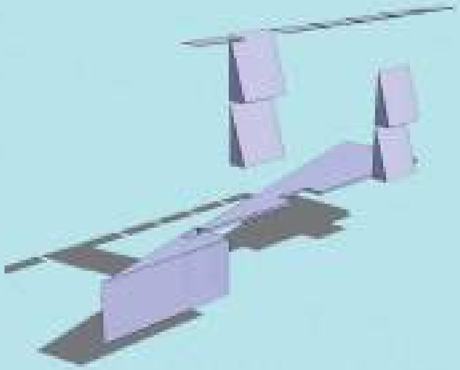
The Centre for Urban Agriculture (CAU) was designed with a focus on food, water, and energy, with the main of being a self-sufficient mixed-use building that produces enough food, energy, and water to fulfill the needs of the residents and benefit the community. The proposal is a 23-storey, 318 unit apartment building that responds to the rapidly growing urban populations, environmental change, and food security issues, resulting in a "living building" model for urban life that draws resources from the surrounding environment (Mithun, n.d.). The building transforms an awkward, disused triangular 0.72-acre site into a productive vertical ecological landscape that "reveals the ecological process" (Felstead, 2012) allowing for visual connection and understanding of the green structure and elements of the proposal.

The vertical proposal enables the CAU to reintroduce more than an acre of natural habitat into the small site footprint. Energy is collected by roughly 34,000 square feet of photovoltaic cells on the south façade of the building. The CAU features grey and rainwater collection systems. Grey and rainwater, which is collected by its rooftop and façade, is recycled and treated on site. The agricultural components of the building include greenhouses, rooftop gardens, fields for growing grains and vegetables, and a chicken farm. To future reduce the embodied carbon of the proposal, the concept makes use of recycled shipping containers as the module for the apartments. (Kim, 2007)

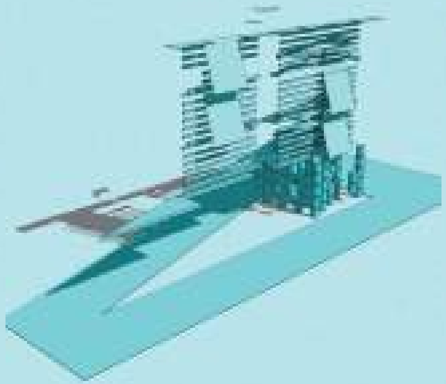
The use of under-utilized land for food production is an idea that I plan to push through my project proposal, this is a way of adding value and activating a location in a broader urban fabric while creating awareness of urban food production. This could be small left-over pieces of land, brown sites, or open public space that may need rejuvenation. Another aspect of the CUA that is relevant, is the use of systems to extract resources from the environment to create a self-sustainable proposal. Techniques for grey and rainwater harvesting, purifying, and reuse is of great importance in a hydroponic farm proposal. Additionally, the use of the façade as a means of collecting energy, for use by the functions of the building, is also relevant to my project (and for all modern buildings).



Areas of Habitat Reintroduction



Areas of Food Production



Areas of Water Collection

fig. 73. Areas of habitat reintroduction (Mithun, 2007)

fig. 74. Areas for food production (Mithun, 2007)

fig. 75. Areas of water collection (Mithun, 2007)

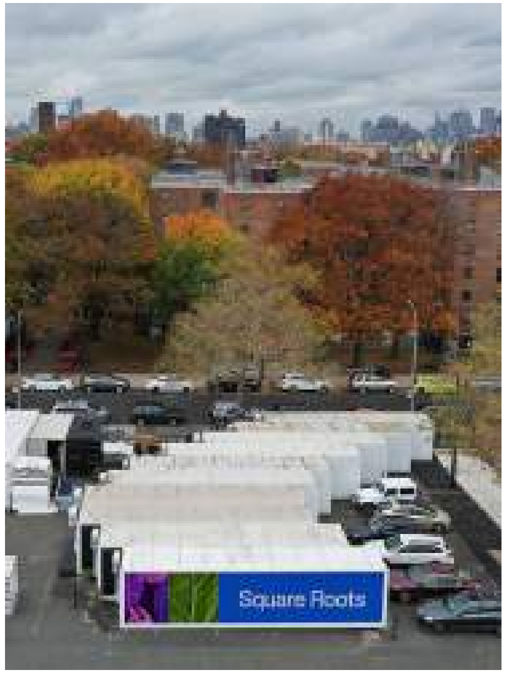
fig. 77. The Factory-like environement inside of Aerofarms Headquarters, Newark, New Jersey (Aerofarms, n.d)

While there has been a very large number of architectural design proposals being dreamt up in recent years, the majority of the effort is being directed to the farming aspect. Today, it seems that the term vertical farm simply refers to the method of using soilless farming systems inside of a controlled environment, to produce crops. Vertical farming is an intensive and highly productive method of crop production, whether it be stacked hydroponic beds or cylindrical aeroponics towers, companies are putting great time and effort into finding the best vertical farming solution.

One of the biggest names in vertical farming is AeroFarms, a company that has several farms throughout New Jersey. When looking at the production of leafy vegetables (lettuce, kale, watercress) and herbs, AeroFarms (like most vertical farms) are able to grow crops much faster and more efficiently than field/soil base farms, going from seed to harvest in roughly 15 days, whereas in traditional farms this would take 30 to 45 days. The stacking of their farm and their implementation of aeroponic systems also allows them to grow more than 390 times more crops per square meter than traditional farms (The B1M, 2019). Another reason why vertical farms, like AeroFarms, are able to grow more crops is that they require much less time between harvests. On a traditional farm, tractors need to re-cultivate the land wait for it to dry, fertilize it and then replant the crops. All this could take about a week. While in a vertical farm you can harvest the crops and you're ready to plant again (Venture City, 2019).

While companies like AeroFarms are looking to maximize the scale of vertical farms, there are companies like Square Roots and Neofarms providing small scale urban vertical farming options. Square Roots builds vertical farms inside of shipping containers, each with 250 growing towers (the equivalent to 2 acres of farmland) with the capacity to grow fifty pounds of leafy greens weekly. Neofarms, a German start-up, on the other hand, has developed a prototype farm for your kitchen, roughly the size of the average household fridge. (Baraniuk, 2017)

fig. 76. Contaner farms at Square Roots Brooklyn Campus (Square Roots, n.d)



Interestingly, vertical farming has largely been realized in contrast to Despommier's vision of purpose-made "high-rise food-producing" buildings. Many companies like Aerofarms have opted to repurpose existing buildings like disused factories, former warehouses, and shipping containers, resulting in factory-like settings (often referred to as plant factories). One company, Growing Underground, has transformed a World War 2 bomb shelter into a hydroponic farm 30 meters under the streets of London. This is a way companies are trying to avoid the extremely high real estate costs within cities opting to rent spaces instead of building entirely new structures, at the same time giving vacant buildings and plots some much needed financial and social upliftment.

One important component in crop production is sunlight, plants grow better and quicker in the sun. In vertical farms where crop beds are stacked on top of one another, it is difficult to ensure an even distribution of sunlight to all the levels. For this reason, vertical farms need to use artificial light in place of natural light. These alternative light sources consist mainly of LED (Light Emitting Diodes) or fluorescent bulbs. This along with the relatively complex HVAC and ventilation systems, is the main reason critics are against the idea. However, these energy requirements can be substantially reduced by using renewable energy sources. Solar panels/ wind power can offer some independence from the municipal power grid, LED lights are substantially less power-hungry and the combination of blue and red lights (that most indoor farms are using) are even more so. These farms also recycle the water used to feed the crops, purifying it before circulating back into the system.

fig. 78. MIT Open Agriculture Initiative Food Computer (Katie Medlock, 2013)

The technologies in these farms allow for clever modifications to the systems and when considering crop-specific environmental requirements, farmers can create crop-specific control strategies. This means that light quality and intensity, CO_2 levels, air temperature, velocity, and flow patterns can all be adjusted to A. Use resources more efficiently and B. Ensure an optimal growth environment for specific crops (Kozai, 2013; Luuk et al., 2017). Many farms are data-driven and the environmental levels are monitored by sensors and adjusted by computer programs. This allows farms to constantly improve crop production and quality. The Open Agriculture Initiative (MIT) is an open source digital library that allows indoor farmers to download specific climate recipes for each type of plant. Allowing farmers to grow plants from all over the world, plants that would normally have different humidity levels, temperatures, and water requirements that couldn't be offered in certain countries.

fig. 79. Purple glow of LED grow lights, MIT Open Agriculture Initiative Food Computer (Katie Medlock, 2013)

fig. 80. 25 Green by Luciano Pia (Beppe Giardino, n.d)

02

THEORY


NATURE
IN
SPACE

Architectural pieces, unlike nature, are static. Buildings do not interact with outside environments. Modern technologies have created barriers between people and nature, for example, HVAC systems. HVAC systems have allowed us to control our indoor micro-climates, thus we close our windows in order to maintain this indoor climate, blocking out the sounds, smells, and the natural breeze from outside. The popularity of gaming and the ease of access to digital content (movies and series) means that people spend less time outside. A survey (The National Human Activity Pattern Survey) was conducted by a team of members from various university departments showed that people in the United States, on average, spend up to 90% of their time indoors (Klepeis et al., 2001) and 92% in the UK. At the time of conducting this research similar statistics were not available for South Africa. An Australian study, completed in 2009, showed that only 25% of the participants actually spent time in their day doing sport or other outdoor activities, and on average did so for 1hr 28mins (5%) (ABS, 2009). These figures, coupled with rising urban populations, up to 7 billion people could live in cities by the year 2050 (Rhodan, 2013), shows the need to establish ways of connecting to natural elements in built environments.

Marc Antoine Laugier famously theorized that all man wants from a building, the primitive hut, was shade from the sun and shelter from the storms. Natural elements provided for basic needs, "pieces of wood raised perpendicularly, give us the idea of columns.", branches laid at an incline were covered with leaves and moss, "so that neither the sun nor the rain can penetrate therein" (Laugier, 1977). While the requirements mentioned by Laugier may have been the requirements of a more primitive human and considering that modern buildings have to fulfill more complex requirements, the argument can still be made that due to technological advancements we have lost our connections with nature whereas we should have been looking for ways to maintain them all along. Biophilic design is a way in which these connections, between natural elements and humans, can be re-established in the modern built environment.

Biophilia

Biophilia is the theory during the long line of human evolution, people have developed an inherent affinity for nature. It is our "innately emotional affiliation" (Wilson, 1995) to other living organisms. This psychological need to associate with nature is why we are drawn to outdoor settings - seashores, gardens, and wilderness areas (Kellert et al., 2008). It is also a way of interpreting why we are so captivated by the sight of fire and the sound of rain, and why animal companionship has a certain healing effect on us (Walker, 2015).

Biophilia and Health Relationships

Studies (looking into how health and well-being are impacted by their environment) have shown that sensory contact with nature can improve your overall well-being and mental health. Biophilia has been shown to affect our psychological state, which includes our concentration, attention, emotions, and moods. For example, we produce vitamin D when we are in the sun, this raises our brains serotonin levels (our happy hormones). The outdoors stimulates our six senses – the smell of plants, the feel of the sun on your skin, the sound of birds - which has profound effects on our ability to manage stress, anxiety, lowering heart rate and blood pressure. "Natural environments provide greater emotional restoration" (Browning et al., 2014), and when compared to urban environments with little elements of nature, have fewer instances of anxiety, anger, fatigue, and total mood disturbances.

With deeper looks into principles of biophilia, we are learning more every day about the benefits of designing elements of nature into built environments like schools, hospitals, offices and dense urban settings (Heerwagen and Gregory, 2008), by bringing the outside in. Carey J. Fitzgerald and Kimberly M. Danner, Oakland University researchers, after reviewing various experimental case studies concluded that there is plenty of evidence that supports the biophilia hypothesis in workplace environments (Fitzgerald and Danner, 2012). The Mismatch Hypothesis

fig. 81. Elevation of Atlas Hotel Hoian by VTN Architects, Greenery incorporated into facade desing to reconnect man with nature (Hiroyuki Oki, 2016)

states that humans have, over the last century, begun to live in environments that are vastly different to ones we have evolved from (the savannah). Due to this 'evolutionary mismatch', key aspects of our psychological mechanisms are no longer linked to the environment in the same way (Li et al., 2017). This mismatch may also account for the decreases in employee health and productivity in the workplace. The same can be said for schools.

Biophilia and Learning

As research has shown, spending time in nature has positive psychological and physiological effects, and that biophilic design can increase productivity in workplaces. These benefits are especially important for students. The ability of biophilia to actively engage a child in learning and increase the mental capacity to complete a task is beneficial for both the child and the teachers, creating for more engaging and productive teaching environments. This increase in productivity comes with the added benefit that children become more aware of environmental issues, which is good for the environmental conscience of our next generation.

Biophilic Design

Biophilic design seeks to form this connection, between humans and nature, by inserting elements of nature or natural arrangements into the urban environment or architectural interventions (Bernett, 2017). In terms of biophilic design, nature is defined as "living organisms and non-living components of an ecosystem" (Browning et al., 2014), this could be in the form of planted gardens, fish habitats and even, simply, the sun entering a space. In order to investigate how biophilia can be expressed in the design of buildings, we must understand what it is about nature that creates "a sense of pleasure, well-being, and engagement with place" (Heerwagen and Gregory, 2008). Biophilic design is more than just adding plants to a space, this is only one strategy for connecting to nature (Browning, 2018).

Judith Heerwagen and Gordon Orlens hypothesized that since we as humans originated on the African savannahs (according to the best scientific evidence), we have a strong preference for spaces that resemble those conditions. Characteristics of the savannah have now been implemented in modern landscape design - in parks, campuses, and suburban gardens – we see groups of shade trees and low growing grasses and understory plants (Browning, 2018). The main purpose of biophilic design principles is to re-establish our connection to nature and to continue this relationship between people, nature, and space.

fig. 82. Interior view of Haman Retreat Pure Spa by MIA Design Studio (Hiroyuki Oki, 2015)

Principles and Ideas

Biophilic design principles have a wide range of application opportunities for both interior and exterior settings, and can be broken down into the following three categories:

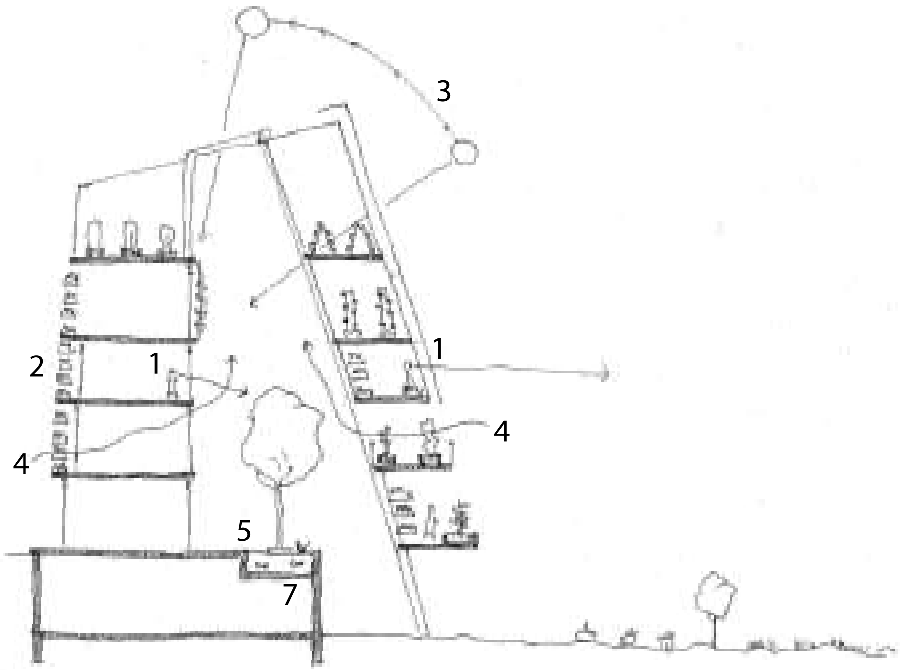
Nature in Space: The presence of nature in nature in space
Nature Analogues: Materiality and tactile recreations of nature in space
Nature of the Space: Experiences attained by creating intriguing spatial arrangements.

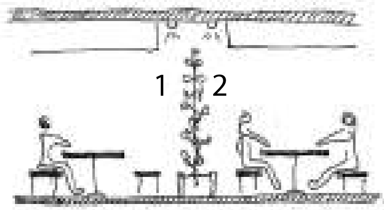
Nature in Space

Nature in space is described as “the direct, physical and ephemeral presence of nature in a space or place” (Browning et al., 2014). The experienced are best achieved by creating direct connections with natural elements, such as water, animal and plant life, sun, breezes, and any other such elements.

Nature in Space encompasses the following biophilic design patterns:

1. Visual Connection with Nature – A view of natural elements or processes and living systems.
2. Non-Visual Connection with Nature - Non-visual references to natural elements or processes and living systems. This could be tactile, auditory, oral, or olfactory stimuli.
3. Non-Rhythmic Sensory Stimuli – Vague and momentary connections with natural elements that may be statistically analyzed, but not precisely predicted.
4. Thermal & Airflow Variability – References to natural environments through changes in humidity, subtle changes in temperature, or airflow across one’s skin.
5. Presence of water – Hearing, seeing, or touching water.
6. Dynamic & Diffused Light – Recreating conditions by manipulating shadows and intensities of light over time.
7. Connection with Natural Systems – Awareness of temporal and seasonal changes in natural processes and healthy ecosystems.





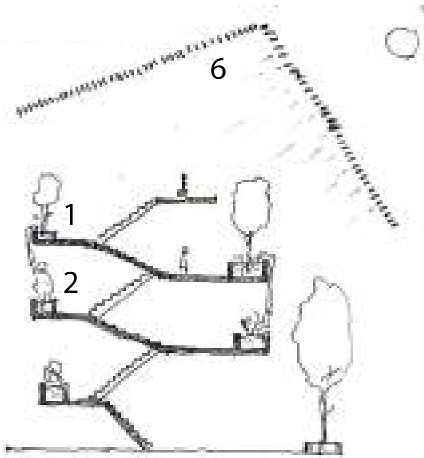


fig. 83. Various conceptual sketches identifying how principles and ideas of Biophilia will be implemented in the final design proposal (Author, 2020)

Nature Analogues

Nature in analogues describes indirect connections with nature, this includes organic, non-living, and indirect references to nature. This type of connection can be expressed through the use of colors and materials that mimic nature or by mimicking shapes and patterns that appear in nature. (Browning et al., 2014)

Natural Analogues encompasses the following biophilic design patterns:

1. Biomorphic Forms & Patterns – Symbolic references to natural textures, contours, patterns, or numerical arrangements.
2. Material Connection with Nature – Materials and elements from nature that create a sense of place and reflect local geology or ecology.
3. Complexing & Order – Vivid sensual clues that adhere to a spatial hierarchy related to those found in natural environments.

1

2

2

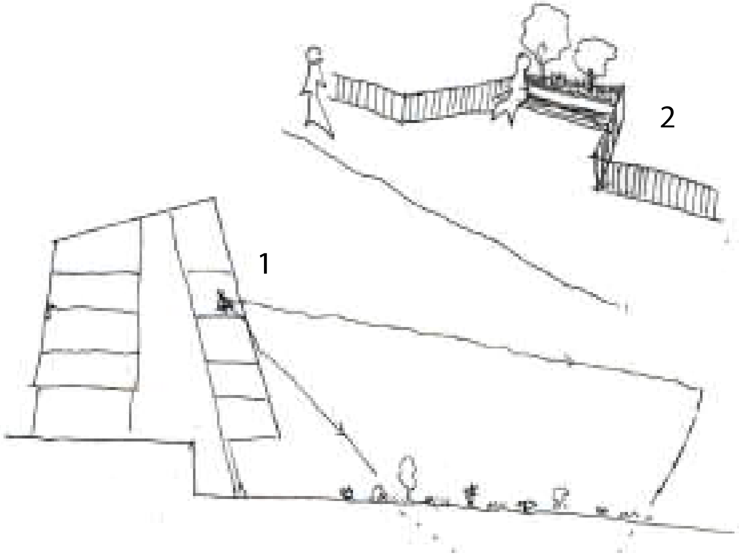
3

Nature of the Space

Nature of the Space focusses on spatial compositions found in nature. These compositions should activate our natural desire and attraction to mystery, and fascination with the unknown – our innate desire to explore beyond our immediate surroundings (Browning et al., 2014).

Nature of the Space encompasses the following biophilic design patterns:

1. Prospect – An unobstructed view over a distance, for planning and surveillance.
2. Refuge – A place for withdrawal from activity or environmental conditions; sun, rain, or wind. A refuge usually provides protection from behind and overhead.
3. Mystery – Partially obscured views that provide the promise of more information or other sensory devices that encourage a person to explore further into an environment.
4. Risk/Peril – An identifiable danger coupled with reliable protection.



Conclusion

Given that my proposed building is a vertical farm and agriculture research center, there is an inherent presence of nature in certain spaces. What becomes important is managing the connections between the rest of the building spaces and designing element of biophilia in spaces that dont have this inherent presence of nature and where the user could benefit form connections with nature.

> "The best biophilic design - design that effectively eliminates stress and anxiety from the built environment - is achieved by maintaining thoughtful connections with nature" (Salingaros, 2015).

It is evident that elements of biophilic design in spaces of learning and work, have many benefits, from mental health to creating a comfortable working space. The design aims to create meaningful connections between nature, space and function to create a effective and enjoyable experience in the building.

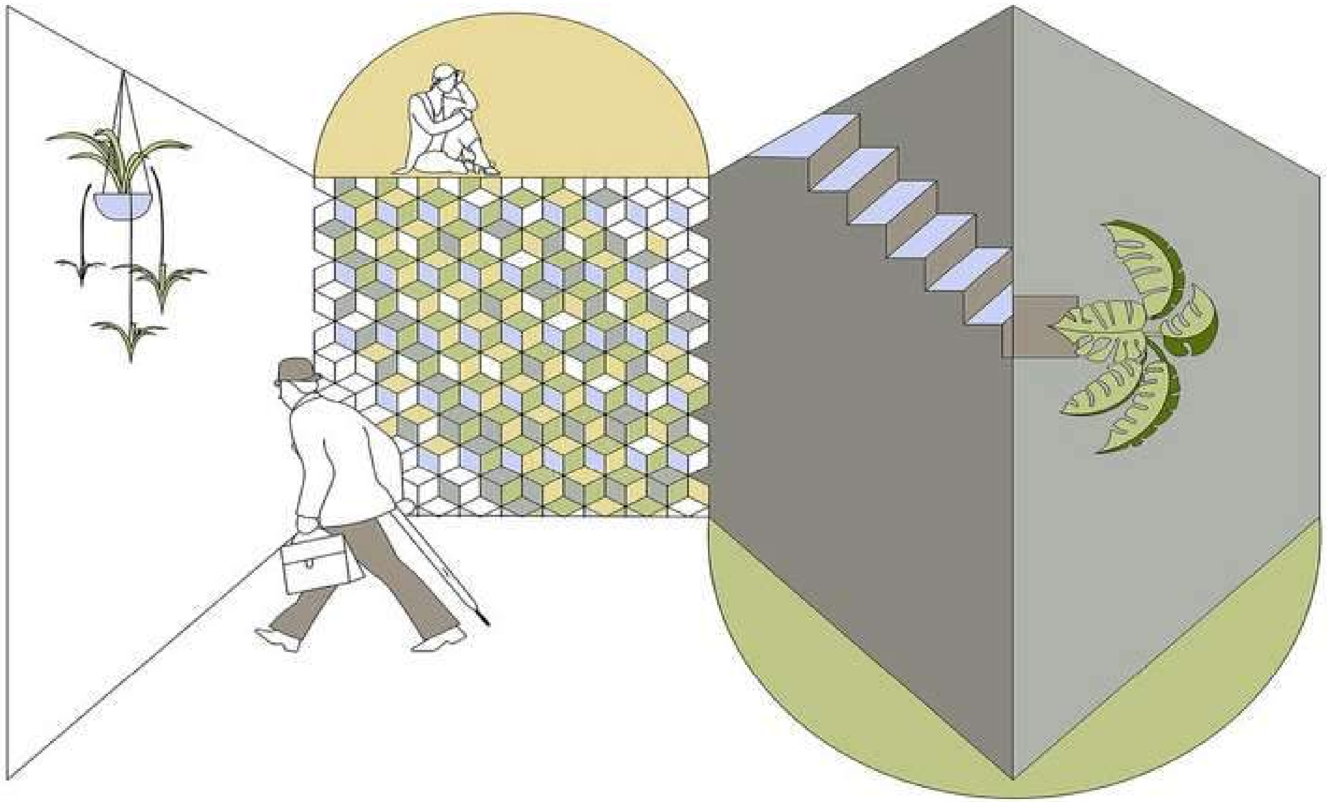


fig. 84. Biophilia Illustration (Amos Beech, 2017)

U R B A N A C U P U N C T U R E

Urban acupuncture is a socio-environmental theory devised by Finnish architecture professor Marco Casagrande. The concept has since been adopted by many urban planners, architects and artist (Gordon Matta-Clark, Jaime Lerner, Nicholas de Monchaux and Manuel de Solà-Morales to name a few), all of whom agree that this may provide a reliable answer to the problem of urban decay, stating that large-scale urban regeneration projects are becoming less feasible. These projects often fail to provide meaningful involvement to the communities, during their development and planning (Miller, 2011). The theory of urban acupuncture combines urban design with the principles of traditional Chinese acupuncture, to provide targeted relief to the larger context.

Cities are one of the most complex organizational entities we know of (Müller, 2009), with their ever-changing cultural, social, and economic systems. Often these systems are multilayered and dynamic. And each city has its own unique characteristics that are different from the next. Acupuncture is the technique whereby fine needles are inserted at specific points of the body and manipulated to relieve pain or for therapeutic purposes (Müller, 2009). Urban Acupuncture makes use of small-scale urban interventions to revamp the larger urban context, much like placing a needle into a specific part of the body that needs remedy.

Ruin Reclaimed

Casagrande's theory, brought on by time spent in Taiwan, was that urban acupuncture aimed "to establish contact between the urban collective conscious and the life-giving systems of nature" (Casagrande, n.d.). His focus was on the illegal farming community called Treasure Hill, inside the modern city of Taipei. He believed these farms to be fine examples of urban acupuncture, stating that "these gardens are the urban acupuncture needles that manipulate and manifest the collective underlying organic chi of the industrial city" (Casagrande, n.d.). The small elements or interventions that were introduced needed to align with, or in some cases manipulate the overall energy flows of the community.

fig. 85. The escalators in the Comuna 13 act as the spine of the intervention. while smaller, scale appropriate interventions created micro-activations with the urban fabric, Medellín. (Ingrid Truemper)

fig. 86. Treasure hill, Taipei (Chiang Pei-ying, n.d)

Urban Rejuvenation

The projects of Manuel de Solà-Morales are often thought of as urban architecture, he works at the intersection of urban planning and architecture. De Solà-Morales influences changes in the city beyond the physical or spatial characteristics of the intervention, driven by the concept of stimulating urbanism - this is done through minimal interventions that achieve a maximum possible effect. Much like Casagrande, de Solà-Morales 'works on the skin of cities', inserting needles in areas with very little or no energy (Ibelings, 2008). The architecture that exists on the skin, is valuable and should be viewed as raw material, as with his urban projects. As such, according to de Solà-Morales, the art of urban acupuncture is in the conscious manipulation of the energies and flows that exist in the urban skin. (Solà-Morales et al., 2008)

fig. 87. Render of Time Square revitalization. Busy traffic intersection tramsformed into permanent pedestrian plaza. (Snohetta, circa 2014)

fig. 88. Jaime Lerners first project, Rua XV de Novembro, Curitiba (Gazeta do povo, n.d)

Mobility

Jamie Lerner's theory of urban acupuncture revolves around two prominent features, mobility, and education. He believes that through educating children they develop stronger understandings of sustainability, thus strengthening their influence and ability to affect meaning change in the future. Lerner has created characters to aid in the education of children. The turtle is the "best example of living and working together" (Lerner, 2007), a comment on the dislocated modern city. Otto the automobile, another character, use to bring awareness to how cities are exhausting our natural resources and raise interest in public transport that improves sustainability (which transports many people around with minimal input of energy). Lerner believes that the city can be improved in three years or less, stating that each of the city's problems must have its own design and core responsibility, regardless of scale and financial resources. "Creativity starts when you remove a zero from your budget" (Lerner, 2007). Lerner led the movement, as mayor and architecture, led the movement that transformed his native city of Curitiba into "the gold standard in sustainable urban planning" (Adler, 2016) now boasting upwards of 50 sq meters of green space per person. This was achieved through initiatives that clean the city, green the city, and initiatives (like the BRT bus system) that encouraged people to use the car less. An important factor in Lerner's philosophy is time, stating that "we had to move fast to avoid our own bureaucracy" (Adler, 2016). One such example is Lerner's first project, 1972, in which a vehicular thoroughfare into a pedestrian mall over a weekend – partly to prevent shop owners from filing injunctions against the project as courts were closed over weekends. Although there was initial pushback from shop owners, who feared that removing the car from the street would mean a loss in business when monday night came around and the project was complete members of the public (including shop owners) wanted more of the sector pedestrianized. An albeit fortunate result of his philosophy - act now, adjust later.

Urban Art

In an unfinished project done by artist Gordon Matta-Clark, entitled Reality Properties: Fake Landscapes, he spent months (between 1971 and 1974) looking through New York City records to identify and purchase fifteen vacant and decaying land parcels. The criteria of these chosen sites were to be small leftover sites often inaccessible parcel that for some or other reason is of no interest to land and property buyers – Spaces between Places. Although Matta-Clark was unable to create any interventions on these sites (it is unclear whether he even had intentions to do so), he mapped and documented the sites, revealing the impracticalities of the city. This collection of photographs and maps became an important urban artwork wherein he questioned the value of property. (Fabrizi, 2014)

fig. 89. Fake Estates Little Alley, Block 2497, Lot 42, Queens. (Gordon Matta-Clark ,1973)

Locating the Needles

The process of urban acupuncture requires one to first identify the locations requiring stimulation. To do so one must approach the sites with caution and vigilance, "the skin of the city has to be observed with the attention of a detective" (Solà-Morales, 2008) in order to unearth their richness. It is important to take note of the potentials of a site as well as, the richness of the existing. Only once in-depth investigation has occurred can one begin to consider removing, adding, modifying, or restructuring urban elements on the skin - considering coherence and understanding context.

In a time where new technologies are being developed at a rapid rate what, if any, is the role of technology in urban acupuncture. Can we use technology to help broaden the reach of urban acupuncture? Local Code: Real Estates, by Nicholas de Monchaux, is a project that set out to test this. Setting out from Matta-Clark's work, Local Code "seeks to identify and engage legally and socially abandoned urban sites, transforming undocumented, and marginal conditions through emergent, digitally mediated methods into a social, and ecological resource" (de Monchaux, 2009). Using a Geographic Information System (GIS) a search (alike the one Matta-Clark conducted) that locates thousands of vacant, marginal city-owned lots throughout New York can be completed in minutes. When tested on the city of San Francisco the system revealed over 1500 remnant lots, seemingly clustered around industrial sites and highways, and in some cases outlined entire neighborhoods. With this list of land parcels the team was able to cross-reference and overlay public data such as crime and public health (respiratory hazards, carcinogen quotients) statistics, revealing that, worryingly, the located abandoned sites were most in need of healthy and safe environments (de Monchaux et al., 2010). Similarly, these areas were also found to have issues around energy inefficiency, airborne contaminants, and poor water management. The sites formed a distributed surface throughout the city, the size of roughly 2 sq kilometers, all with the potential to help alleviate the problems that seem to accompany these types of sites. Along with the documentation, parametrically generated designs were proposed for each site. Using GIS models of sun and wind movement, as well as water flows the parametric technology was able to govern the amount of hard and soft surfaces, mediating air quality, energy loads and drainage, thus increasing the resilience of the city's essential infrastructure (de Monchaux et al., 2010) important for the survival of 21st-century cities (Newman et al.,2009).

fig. 90. Local Code proposal focused on adressing issues of flooding (Local Code, 2010)

Verdict

While it is easy for people to meet concepts like urban acupuncture with apprehension and doubt, one cannot disregard the logic behind its goals and methodology. As we see in examples like Curitiba, Brazil, and Medellin, Columbia (where thoughtful planning connected slums to the city) the concept is actually relatively successful. In an interview with Design Indaba, Alfredo Brillembourg (Urban-Think Tank), speaking of the changes they noticed around their Vertical Gym, Dry Toilet, and various metro cable car stations, said "once you placed a powerful building within the slum context, you created a kind of urban acupuncture, which actually resonates and creates a lot of change around it" (Brillembourg, 2011).

By prioritizing small-scale changes/ interventions (pocket parks, pedestrian friendly routes etc) , that truly address community needs, over larger infrastructural changes some promising results have been achieved.

My question is, by using the principles of urban acupuncture can we create better connections to food – from growth to the distribution? What if we began mapping the city's "remnant parcels" (like Local Code: Real Estates), using food as the metric? Looking at which areas most need agricultural intervention – communities that are most affected by hunger, where there is a lack of nutritional education or high rates of obesity. By letting food be our guide, we could bring agriculture to the foreground of urban design and planning, encouraging community participation in the production of affordable healthy food. It is not foolish to suggest that we could use architecture and design to inspire a healthier relationship with food.

fig. 91. A Pocket park. Paley Park, NYC by Zion & Breene Associates (Sampo Sikio, 2006)

fig. 92. Urban Acupuncture Graphic Illustration (Unknown Author, n/a)

Experiment

Upon completing my research of Urban Acupuncture, the benefits and possibilities of this approach have become evident and some promising results can be seen. I decided to conduct a study of spaces around Wits campus with the hopes of adapting an approach to creating a productive campus based on the principles of Urban Acupuncture - revitalizing disused spaces or infrastructure to bring about change to the larger context. By doing this I am hoping to combine the idea of the urban acupuncture 'needles' with concept of urban agriculture. Types of spaces that I looked at where underutilized green spaces, building rooftops, disused infrastructure and building facades. Although the opportunities for farming the campus are abundant I have identified four locations that have potential, both in terms of productivity and awareness for the project.

A - Disused spectator grandstands.
B - Blank Facade of John Moffat building.
C - Portico roof over public walkway.
D - Tower of Light.

The intention of this approach is to identify locations in need of revitalisation. Once identified, these inteventions will be developed from the 'Urban Harvest' facilities and implemented across campus. These interventions will hopefully provide useful insight of the practicalities of farming in urban environements.

fig. 93. Aerial photograph of Wits Main Campus (Google Earth image edited by Author, 2020)

fig. 94. Photocollage of Disused spectator grandstand (Author, 2020)

A Disused spectator grandstands

This site is located on Braamfontein east campus, adjacent to the rugby fields and to my chosen building site. The location of this intervention is the existing spectator seating. These seats are rarely used and grass and weeds are often allowed to grow untamed. The seating on this embankment was built as a series of short retaining walls, filled with soil and grass was allowed to grow. This means that it easy to turn these retaining structure into raised beds for farming crops, and the open area allows plenty of sun making it an ideal location to grow food while providing a new life to an underutilized piece of university infrastructure.

fig. 95. Photocollage of John Moffat Blank Facade (Author, 2020)

fig. 96. Koi pond in front of John Moffat building (Author, 2020)

fig. 97. View of the approach to the blank facade (Author, 2020)

B John Moffat building blank facade

This site is located on the Braamfontein east campus. This blank facade offers the opportunity for a vertical intervention. Neighboring the John Moffat building is the Old Mutual sports hall, which hosts sporting events. Combining a vertical farm with a point of sale component on ground floor, could provide a business opportunity, perhaps a stall making fresh smoothies. This accompanied by the fact that the site is located along a relatively busy pedestrian route, could make for an attractive space for students to gather. There is a Koi pond (picture above) in front of the John Moffat building, this is an opportunity to incorporate an ornamental aquaponic system into this intervention.

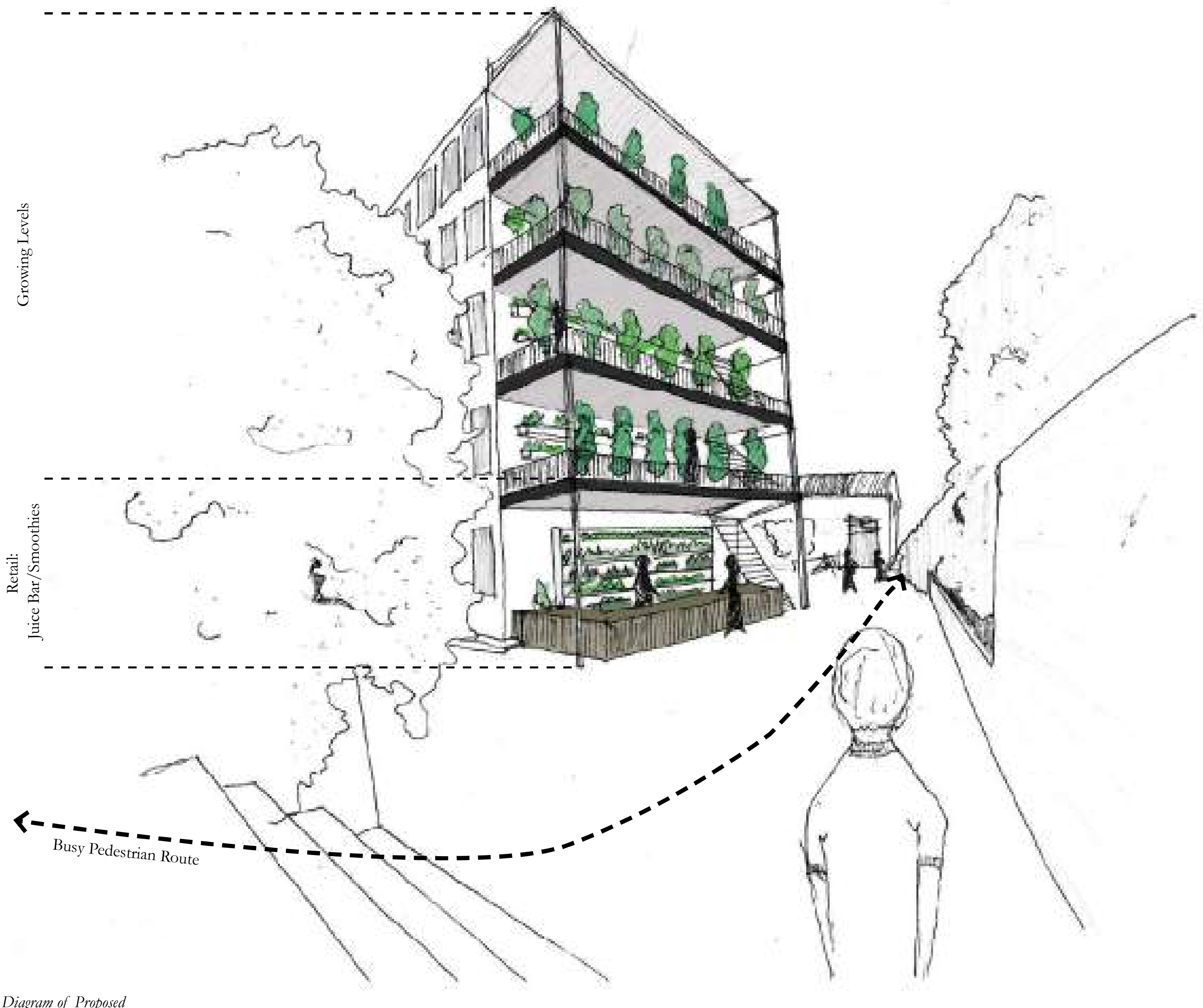


fig. 98. Conceptual Sketch Diagram of Proposed Urban Acupuncture intervention B (Author, 2020)

fig. 100. View of portico roof from inside John Moffat building (Author, 2020)

fig. 101. Eye level view of portico roof from pedestrian walkway (Author, 2020)

C Portico roof covering pedestrian walkway

This site is located on Braamfontein east campus, between the John Moffat building and the John Moffat extension. The courtyard that is formed between these buildings and the Construction building is quite a harsh and unattractive place. The roof is treated with silver reflective waterproofing, and is blinding at times when the sun is shining on it. Given its low level this roof can be seen from various angles on levels above. Although this courtyard has a small patch of grass and a number of trees, this area is in need some greenery. This roof provides a good opportunity to grow crops as there are varying levels of sun that enter this space during the day.

fig. 99. Photocollage of Portico roof above pedestrian walkway. (Author, 2020)

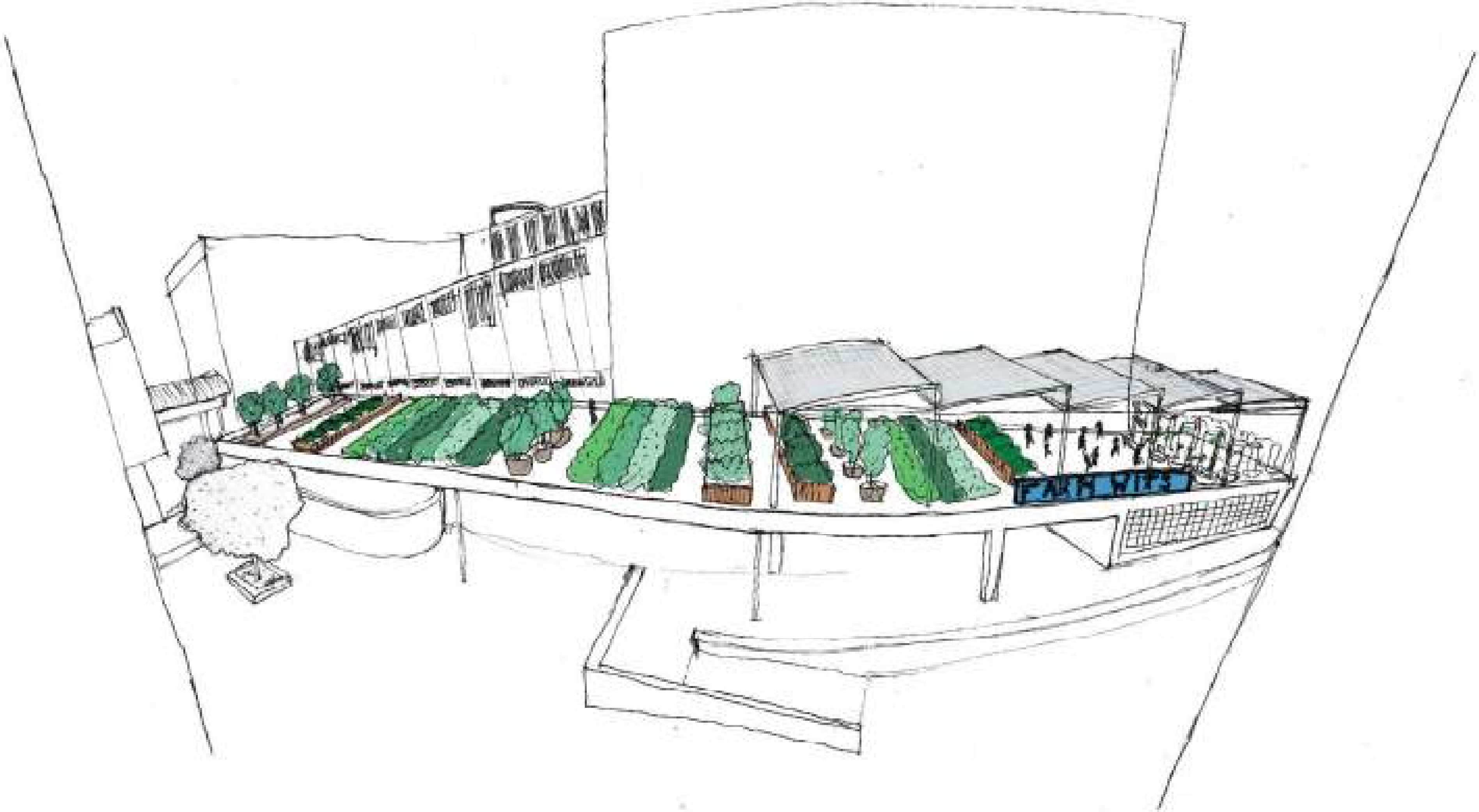


fig. 102. Conceptual Sketch Diagram of Proposed Urban Acupuncture intervention C (Author, 2020)

D Tower Of Light

The Tower of Light was built on, what was then, the Milner Park showgrounds. It was erected as a symbol of light and electricity for the Empire Exhibition in 1936. Today, this landmark is located in the rough centre of the Braamfontein west campus, on the main north-south pedestrian route. The majesty of this tower is still appreciated today however, is its significance relevant today. Transforming the Tower of Light into a landmark that champions healthy, organic urban farming practices could plant this building in the issues of today, rather than merely being a dear Johannesburg landmark and reminder of Rand Shows past.

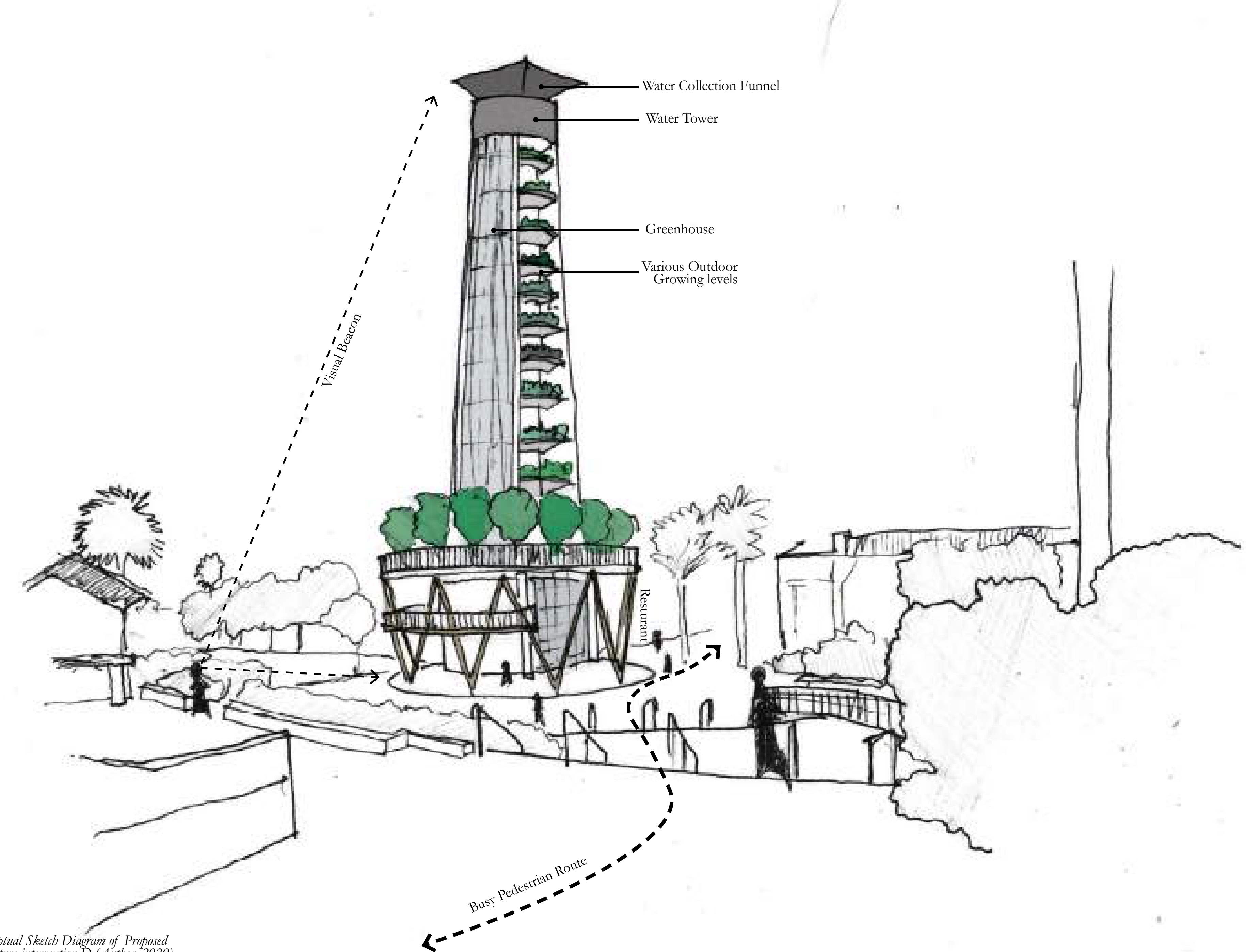
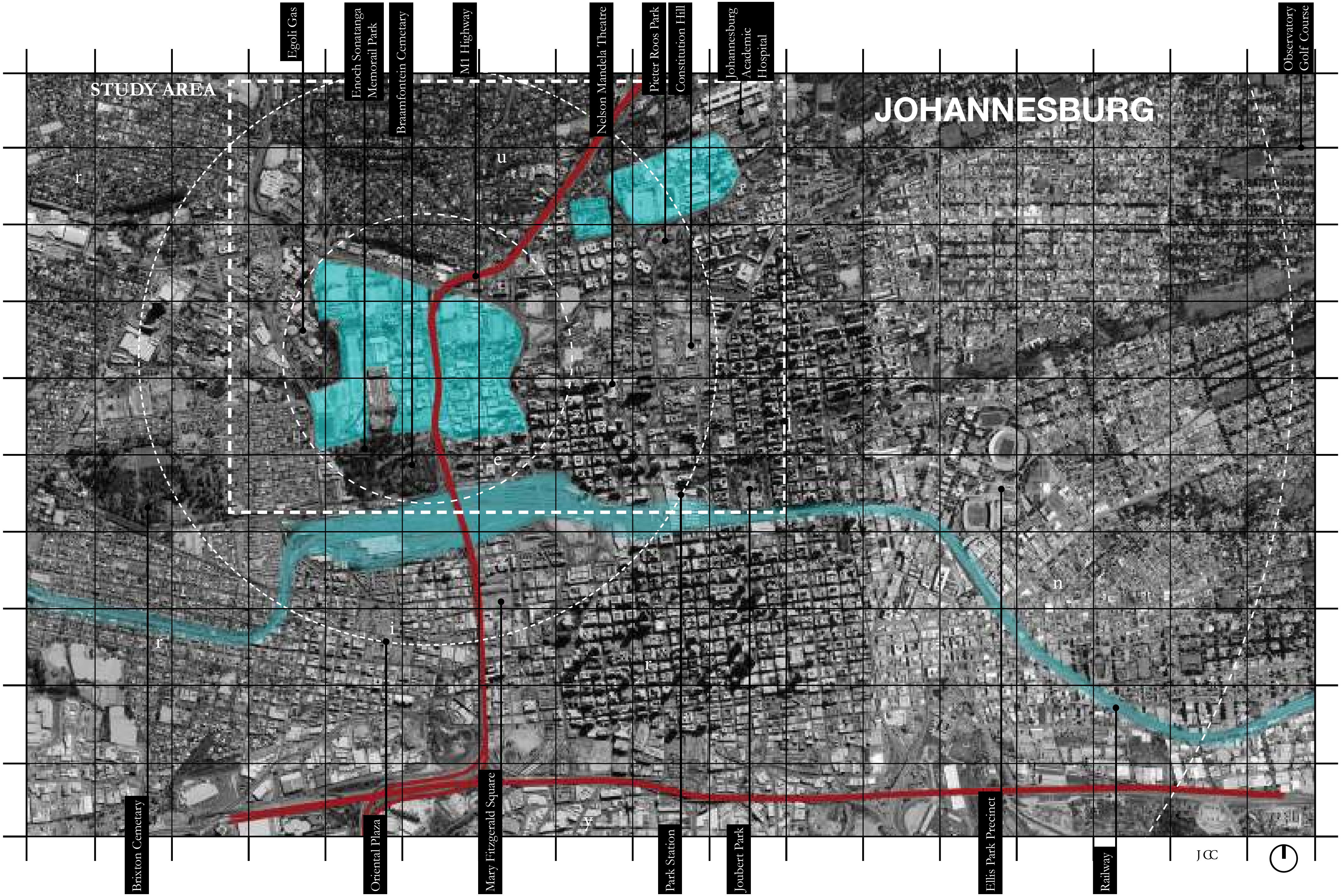


fig. 103. Conceptual Sketch Diagram of Proposed Urban Acupuncture intervention D (Author, 2020)

fig. 104. Johannesburg Aerial image (Google Earth, 2020)

03

C O N T E X T
&
S I T E

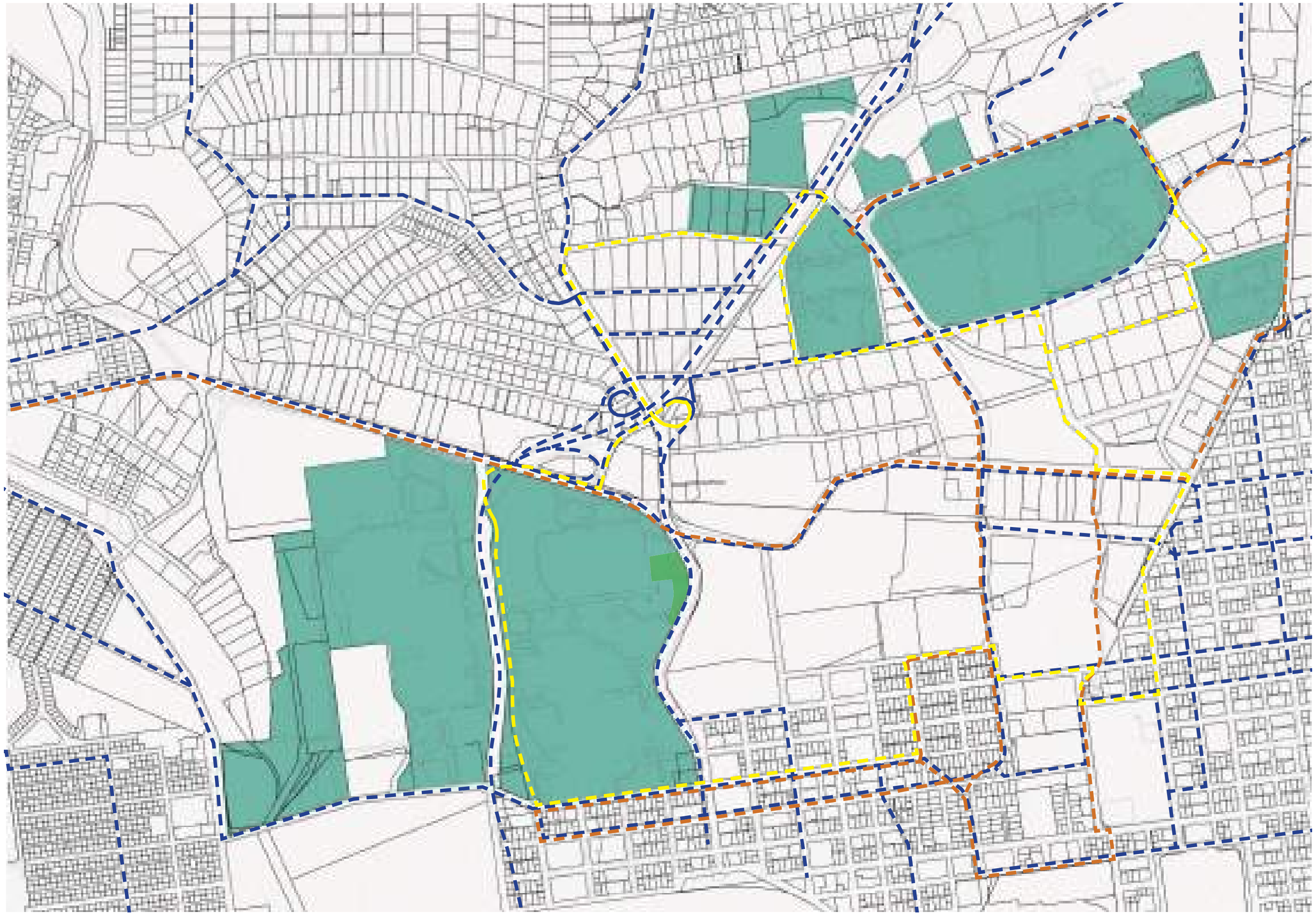

STUDY AREA
JOHANNESBURG
Egoli Gas
Enoch Sonatanga Memorail Park
Braamfontein Cemetary
M1 Highway
Nelson Mandela Theatre
Pieter Roos Park
Constitution Hill
Johannesburg Academic Hospital
Observatory Golf Course
Brixton Cemetary
Oriental Plaza
Mary Fitzgerald Square
Park Station
Joubert Park
Ellis Park Precinct
Railway
JCC

Land-Use

Indicated in this map is the broad land use of the immediate area around the Wits campuses. By looking at this you can see that Wits is situated at the border between the commercial business centre of the city and the beginning of the residential northern suburbs. Wits also forms part of an 'Educational Axis' as a number of schools and University campuses are nearby. This indicates a variety of sectors nearby that Wits can attempt integrating into, perhaps through this projects proposed agriculture community. For instance, nearby schools could start a garden on their premises teaching students how to farm at home in a self-sufficient and eco-friendly way, corporate building could likewise start rooftop gardens with the aim of providing healthy meal alternatives for their employees, and homeowners could come to the centre and learn about healthy and self-sufficient gardening methods for their homes.

- University of The Witwatersrand
- Education / Schools
- Residential
- Public Institutions
- Public Parks
- Cemetaries
- Commercial / Offices
- Mixed Use Areas
- Public Transport

fig. 105. Land-Use Analysis (Author 2020)



Movement Network

This map shows the larger movement network. This shows how Wits is how well situated Wits is in relation to the city's transport network. This along with the general road network shows how one might arrive at Wits, whether by private car or public transport. This shows the ease with which a visitor might find their way to the proposed project location.

The Wits service runs between all campuses and residences. The BRT connects Wits to an area of 30km in diameter (Diepkloof to the North) and the Metrobus route network runs between nearly all parts of Johannesburg.

This map indicates the location of the proposed site on the Wits east campus. Being on the edge of the campus adjacent to the busy Jan Smuts ave, means that the site is visible from the street. This portion of the campus boundary also has relatively visually permeable edge, enhancing the visibility. This visual connection is important in attracting the interest of the public and encouraging the participation in the functions within.

University of the Witwatersrand
Site
Metrobus
Rea-Vaya (BRT)
Wits Bus

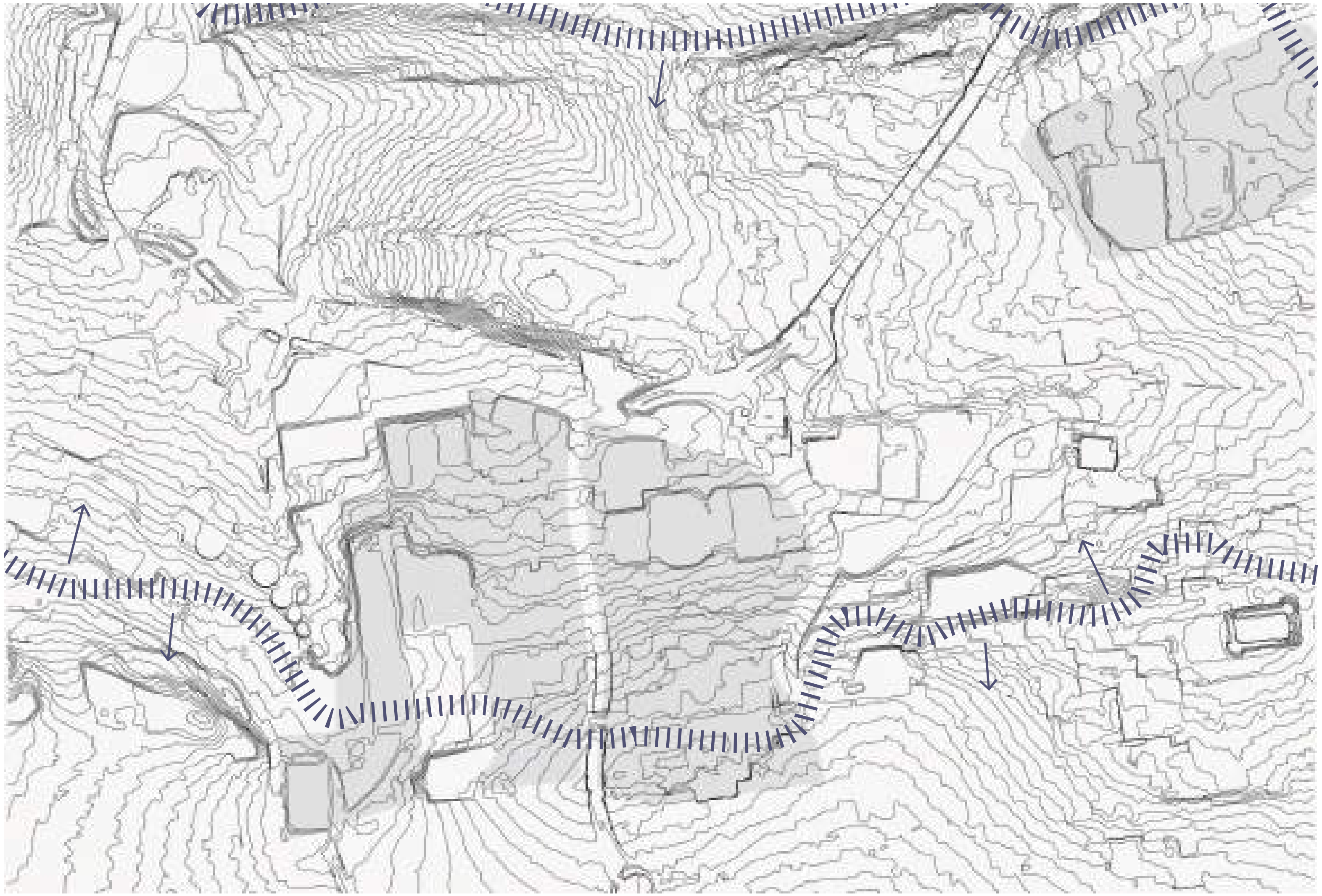
fig. 106. Movement Network Analysis (Author 2020)

Green Network

The broad green network indicated in this forms part of the larger green system of Johannesburg north. The spaces indicated include Melville Koppie, Various school feilds, cemetaries and Pieter Roos Park and connect to various green space within the Wits Campuses.

University of The Witwatersrand
Cemetaries
Public Parks
Wits Open Green Space
Sports Fields
School Fields
Open Green Space

fig. 107. Green Network Analysis (Author 2020)



Topography

Both campuses are located on ridge lines. in the case of the braamfontein campus, it is located on one of South Africa's most significant, as it defines the watershed splitting water flows to the north and south. The topography of the Braamfontein Campus has also created significant views to north

fig. 108. Topography Analysis (Author 2020)

University of the Witwatersrand

A Brief History

Also known as Wits, The University of the Witwatersrand is located in the culturally diverse and vibrant city of Johannesburg, north of the CBD. The origins of Wits are linked to the mining roots of South Africa.

The South African School of Mines was established in 1896 in Kimberley and later transferred to Johannesburg in 1904, the name changed to the Transvaal Technical Institute. After many name changes (Transvaal University College, 1906, the South African School of Mines and Technology, 1910 and the University College Johannesburg), and as Johannesburg grew several departments were added. In 1922, the College received full university status, which would take effect from March 1st, and would now be known as The University of the Witwatersrand. The Johannesburg municipality donated on a Milner Park site and building began later in 1922. (SARUA, n.d.)

The university began to vacate its Eloff Street premises, moving to the first building on the Milner Park campus. At the time the university had roughly 1000 students and 73 academic staff members from 6 faculties (Arts, Science, Medicine, Engineering, Law, and Commerce). The university saw considerable growth between 1947 and the 1980s, this meant that it became greatly important for the university to begin expansion. The Medical faculty moved into Hillbrow, Esselen Street 1964 (which moved again to Parktown, and the medical complex was opened in August 1982) and The Graduate School of Business was founded in 1968 in Parktown. The university acquired the Milner Park showgrounds in 1984, which became west campus, and the Chamber of Mines building was opened in 1989. The Amic Deck was built over the M1 highway to connect the east and west campuses. (SARUA, n.d.)

Braamfontein Campus

Today, Wits offers roughly 3400 courses to over 40 000 students (over a third of whom are postgraduate students) in five faculties (33 schools) over 4 campuses. The focus on the following study will be the Braamfontein campus, consisting of the east and west campuses. This campus forms part of the inner-city suburb of Braamfontein, Jorrisen Str and Jan Smuts Ave define the edge between the university and Braamfontein. The Northern edge is defined by Empire Rd, a main east-west route between Berea and Auckland Park. The Braamfontein campus is essentially 'boxed' in the by the city (LHA+UD, 2015) and separated from the urban fabric that surrounds it.

fig. 109. (Top) View of Wits Central Block from the library lawns (Author, 2020)
fig. 110. Aerial view of University of the Witwatersrand Milner Park campus Central Block under construction (Unknown, Circa 1925)

Access & Movement

This figure shows the main movement systems, pedestrian and vehicular. The main vehicular entrances are on the north and south ends of Yale Rd which connects Empire Rd and Jorissen Str. Vehicles are also able to access east campus from Yale Rd, below the M1 highway, and from a secondary entrance from Enoch Sontonga Rd. The vehicular movement route on east campus is difficult to decipher, and features a 'loop' route, the west part of this route acts as the main north-south route and the east side is mainly used for service and emergency vehicles.

There appears to be no structure to the pedestrian movement routes. Connections between east and west campus occur via the Amic deck and a smaller tunnel near the planetarium that runs below the M1 highway. The Predomination pedestrian routes run across the front of central block from the Jan Smuts entrance to the Chamber of Mines building, as well the north-south route between the Science Stadium and The Law Lawns on west campus are

This figure also highlights locations for possible integration and connection between the university and city, one such example is the Wits Art Museum.

The Pedestrian entrance marked with an 'A' is rarely used and this area rarely utilized by students. This entrance will be re-invented through this project.

Main Pedestrian Entrances
Rarely used Pedestrian Entrances
Main Vehicular Entrances
Secondary Vehicular Entrances
Possible Locations For City Engagement
Vehicular Movement
Pedestrian Movement

fig. 111. Access and Movement Analysis of The University of The Witwatersrand (Google Earth Image Edited by Author, 2020)

fig. 112. Green Network (Google Earth Image Edited by Author 2020)

Green Space Network

This figure indicates the various green spaces on the Wits Braamfontein Campus. By looking at this map wee see that Sports An recreation related green space have been located towards the edges of the campus, these are mainly sports fields. One of the main East-West routes has been heavily planted. Trees line both sides of the route, creating a comfortable boulevard for pedestrians to walk between campuses and to gather.

The main green space where students gather appear to be located along the main North-south axes of both campuses, these are relatively central to the various lecture venues on each campus.

There are a number of green spaces that basically are left-over spaces between buildings, I have called these passive green spaces. These spaces are relatively large, and are often under-utilized and offer opportunities to formalized them as active green spaces, or even transform them into productive areas for farming.

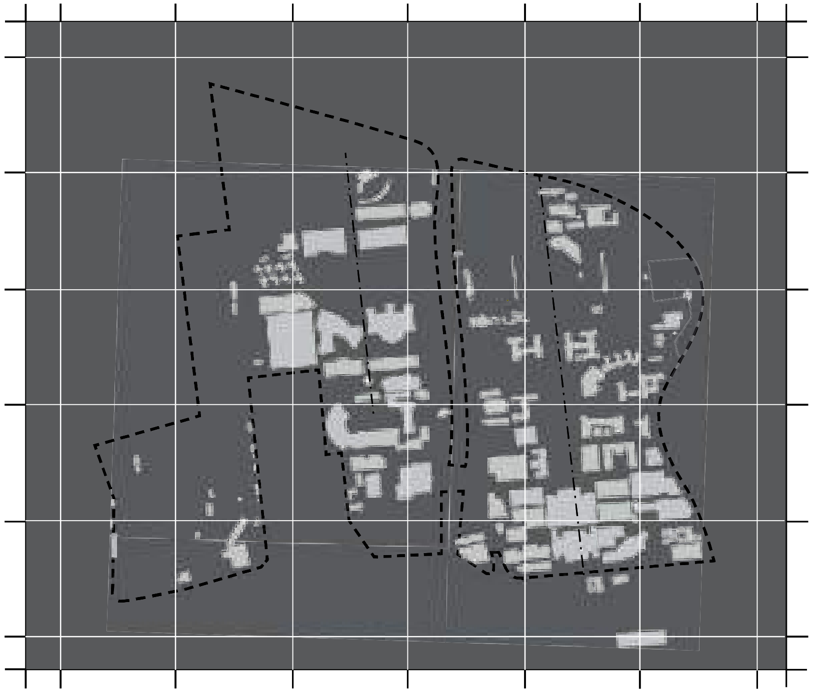


fig. 113. Left: Built Form (Author 2020)

fig. 114. Right: Open Space (Author 2020)

Built Form

Looking at the built structure of the campus, it is evident that that the design of the campus fid not follow any kind of real structure. this had led to a lack of structural and spatial clarity. West campus has almost no structure as this campus has been built on the existing structure of the old show grounds.

Open Space

Looking at the open space on campus, shows that the campus has plenty of open space, the problem is that because of the lack of structure the open public space is often awkward and has a poorer quality in certain areas - no defined public space.

Social/Gathering

On east campus the dominant collective spaces centre around the defined 'T' (the library lawns and the plaza in front of the great hall)(**A**). Buildings on campus have not been designed with social/public space in mind and are often treated as isolated objects. West campus does not have a defined social centre, however there are several smaller centres of gathering (**B**).

Heritage

This figure indicates the significant heritage buildings. The buildings shown in the diagram, are older than 60 years, and would require a indepth heritage study if and intervention is desired.

fig. 115. Left: Gathering Areas (Google Earth Image Edited by Author 2020)

fig. 116. Right: Heritage (Author 2020)

Building Site

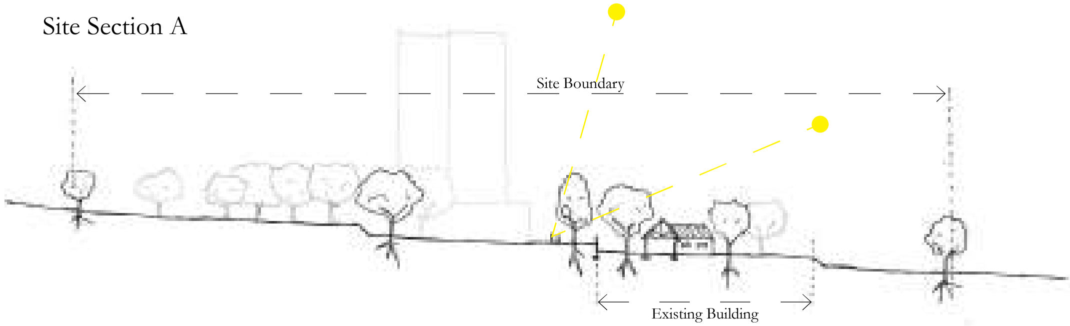
My intended site is located on the eastern edge of the University's east campus, adjacent to the Jubilee Hall residence. The site offers up opportunities for the campus to 'open up' to the surrounding city environment. This allows for the building to be the interface between the campus and the city, which speaks to the desired connection to the larger agriculture community in Johannesburg. I will also be looking at various spaces across the entire campus as part of my research into the opportunities for urban agriculture on the campus.

fig. 117. Analysis of aerial photograph of proposed site (Aerial Photograph from Google earth, Photographs and Editing by Author, 2020)

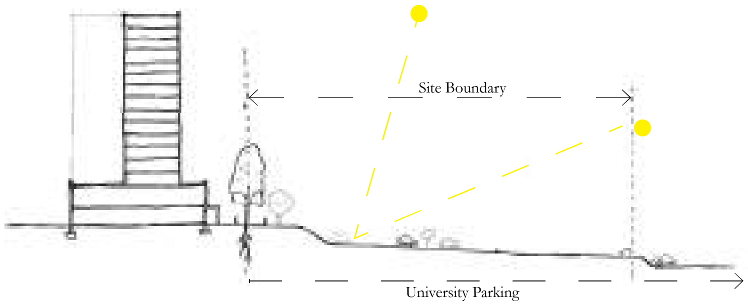
fig. 118. View from pedestrian entrance on my chosen building site (Photographs and Collage by Author, 2020)

fig. 119. View of my chosen building site from inside Wits East Campus, Jubilee Hall shown on the left of the image (Photographs and Collage by Author, 2020)

Site Section A



Site Section B



The diagram on the left represents the conditions on my chosen site. One important factor that is evident from the analysis is that there is quite a significant slope north to south across the site (south being approximately 18m higher). When looking at the site in section shows that the site is not a continuous slope but has been leveled and terraced at certain points across the site, resulting in relatively flat areas and significantly steep drops in level.

There are a number of trees currently on site, and while my intention is to maintain as many of those trees as possible. However I have itentified trees that are significant on site. These are sometimes older trees or trees that have some importnance, either to the campus or to the site. There is a line of trees that announces a kind of procession into the campus, that will be maintained as part of the entrance axis from Jan Smuts Ave.

- Sun Movement
- Pedestrian Entrances
- Pedestrian Movement routes
- Significant Trees
- Predominant Wind Directions

fig. 120. Aerial photograph of proposed site (Aerial Photograph from Google earth, Editing by Author, 2020)
fig. 121. Aerial photograph of proposed site (Aerial Photograph from Google earth, Editing by Author, 2020)

fig. 122. View from pedestrian entrance on my chosen building site (Photographs and Collage by Author, 2020)

04

FEASIBILITY STUDY

Client & Brief

Client

The University of the Witwatersrand

Partners:

- The Department of Higher Education and Training
- The Department of Agriculture, Forestry and Fisheries
- African Association for Vertical Farming (AAVF)

End Users

Primary:
Faculty of Science
The faculty of science consists of nine schools under four groupings (Mathematical Sciences, Physical Sciences, Earth Sciences, and the Biological Sciences) several which focusing on issues related to nature and environmental studies, namely the School of Animal, Plant & Environmental Sciences, and the School of Geography, Archaeology & Environmental Studies.

Secondary:
African Association for Vertical Farming.
The African Association for Vertical Farming (AAVF) is a non-profit organization who is working toward a future of sustainable farming on the African continent. Their goal is to provide a platform that connects stakeholders and value chains, and forms partnerships necessary for innovation in the urban agriculture sector.

Tertiary:
Wits Food Sovereignty Centre
The Wits Food Sovereignty Centre is and initiative that aims to address widespread issues of hunger at the University of the Witwatersrand and the broader Johannesburg inner-city, by providing a space of dignity for students to grow, prepare and eat their food.

Project Brief

This project brief is for an Urban Agriculture Research and Innovation Centre for the University of the Witwatersrand. The centre will be focused on the research and education of agricultural practices appropriate for dense urban contexts, as a way of providing alternatives for the failing food systems that we rely on and addressing food security and health issues in cities.

The design should be one that attracts the interest of people through the use of materials, green facades, landscaping and views through to internal spaces. The building should respond to the current need for environmentally conscious and sustainable design, both in the chosen farming methods and the operation of the building. The building and landscaping should provide for opportunities for the exhibition of the innovation and research that occurs within the building, and spaces of learning (both formal and informal).

The centre's program will focus on three objectives:

Research and Development:
The research focuses on the improvement of sustainable urban agriculture, including biotechnologies, growing conditions/environment, nutrients and planting mediums, vertical farming structures. This research will be used to develop new technologies and methods that could benefit farmers from commercial scale to balcony farms.

Public Education:
This objective will focus on the sharing of knowledge of agricultural methods, to educate the public, individuals, organizations or households about skills that can be used to grow and prepare healthy organic food in whatever context they find themselves in (balcony farming, indoor farming, backyard farming, micro farms or rooftop farming). This transfer of skills and knowledge will be done through easy-to-follow workshops, classes, hands-on experiments, and public talks. The centre is intended to provide education through working examples of the practices and principles it is teaching.

Support for urban farmers:
The centre will provide support for household and community farms, by providing training on the management aspects of an urban agriculture project, legal aid, funding, provide policy training and assist with acquiring resources and materials. This will be done to help strengthen the role of household and community farms in the city's food system and help develop and formalize the urban agriculture sector.

The program must include the following:

Staff/Administration
- Office spaces (Open plan and private)
- Meeting rooms
- Canteen

Educational spaces
- Lecture hall – 150 persons
- Seminar rooms
- Cooking Classroom
- Workshop
- Greenhouse

Research
- Laboratories
- Growing laboratory

Public
- Ablutions
- Reception

Farming
- Vertical Farm facilities
- Permaculture garden
- Greenhouse

Support
- Services
- Delivery area
- Miscellaneous storage spaces.

Accomodation Schedule				Building Cost	
Program	Area (m2)	Quantity	Total (m2)	Cost per m2	Cost (Rands)
General					
Entrance Foyer	200	1	200	4,000.00	800,000.00
Reception	50	1	50	5,000.00	250,000.00
Public Toilets	80	1	80	10,000.00	800,000.00
			330		1,850,000.00
Staff					
Admin Offices	150	1	150	9,800.00	1,470,000.00
Staff Toilets	50	1	50	10,000.00	500,000.00
Meeting room Small	30	2	60	8,000.00	480,000.00
Meeting room Large	70	1	70	8,000.00	560,000.00
Kitchen	10	1	10	10,000.00	100,000.00
Canteen	60	1	60	8,000.00	480,000.00
			400		3,590,000.00
Learning / Teaching					
Leacture Theatre	300	1	300	9,000.00	2,700,000.00
Lecture Hall Foyer	200	1	200	4,000.00	800,000.00
Teaching Class	60	2	120	7,000.00	840,000.00
Teaching Kitchen	60	2	120	10,000.00	1,200,000.00
Teaching Lab	100	1	100	11,000.00	1,100,000.00
Library	200	1	200	6,000.00	1,200,000.00
Teaching Greenhouse	100	1	100	5,000.00	500,000.00
			1140		8,340,000.00
Research					
Laboratory	100	3	300	12,000.00	3,600,000.00
Growing Area	100	1	100	10,000.00	1,000,000.00
			400		4,600,000.00
Growing/ Farming					
Greenhouse	300	1	300	5,000.00	1,500,000.00
Vertical Farm spaces	300	3	900	10,000.00	9,000,000.00
Germination Area	20	3	60	4,000.00	240,000.00
Wash	10	3	30	4,000.00	120,000.00
Pack	10	3	30	4,000.00	120,000.00
Mushroom Spawning	50	1	50	5,000.00	250,000.00
Mushroom Growing	150	1	150	8,000.00	1,200,000.00
Garden Store	70	1	70	3,000.00	210,000.00
Outdoor Farming	5000		5000	600.00	3,000,000.00
			1590		15,640,000.00
Technical					
HT/LT	50	1	50	11,000.00	550,000.00
Solar Battery room	20	1	20	10,000.00	200,000.00
HVAC plant	50	1	50	11,000.00	550,000.00
Refuse	50	1	50	11,000.00	550,000.00
Composting	100	1	100	2,000.00	200,000.00
Water Storage and treatment	150	1	150	11,000.00	1,650,000.00
			420		3,700,000.00
Program Total			4280	* Estimated Building cost based on Aecom Property & Construction cost guide '19-'20	
Circulation (15% Efficiency)			642		
Total Building Area			4922	Total Building Cost	37,720,000.00

	No. Of Floors	Area (m2)
Floor Area (per floor)	3	1641
Floor Area (per floor)	4	1231

fig. 123. Accomodation Schedule and Building Cost Estimate. Building cost estimates based on AECOM property & Construction cost guide 2019-2020 (Author, 2020)

Site

Site selection

The site was chosen based on the following factors

- Site on Wits Campus (proximity to educational function)
- Area that would have some level of public visibility.
- Good location for interaction between the University and the city.
- Area with disused or underutilized open space.
- Area marked (according to the Wits SDF) for future development.

The site

In 2004, a spatial development framework (SDF) for the University of the Witwatersrand was submitted by GAPP Architects and Urban Designers. A group of Architects and Urban Designers reviewed this framework in 2008 with the intention that this re-interpretation would help future decision making. In 2013, Ludwig Hansen Architects and Urban Designers was commissioned to review the previous framework, with new design informants in mind. These informants included the BRT system that had been implemented. This SDF covers both Campuses (Parktown and Braamfontein), my site falls under this framework. The University of the Witwatersrand Braamfontein campus is located on the Braamfontein farm (Braamfontein 53 IR), parcel number 53. The Braamfontein campus consist of numerous portions of Braamfontein township as well as a number of parcels of the Johannesburg 91 IR farm.

My chosen site does not have a defined SG diagram but is located on the north-east edge of Erf no. 401/53, one the largest portions that make up the greater Braamfontein campus.

My site is approximately 10 000m2 , and the building site boundaries must be defined (see annexure for SG Diagram)
The site has a significant slope, from south to north, with a height difference of roughly 18m (lowest point is the north edge). A competent Land Surveyor will be appointed to accurately survey the site, measure and define the site boundary, and accurately measure the topography. This surveyed information will be given to the Architect and Landscape Architect to begin with the design process.
A large portion of the proposed site is currently being used for on grade university parking, this parking will be removed, and a central parking location will be proposed on the campus.
The Project requires a delivery lane, I am proposing to construct a delivery lane along the west edge of the site

Schedule of Rights

The site is zoned for educational use. Given that the primary use of my building is for agricultural education my building complies. I intend to use certain portions of my site for agricultural gardens, because these areas will be used as part of an education initiative, rezoning is not necessary.

The height zone stipulates that a building can only be 3 Storeys, because I am proposing a 4-storey building, the project will need to apply for leniancy for the additional storeys. Given the fact that there are a number of buildings on campus (under the same height zone) that are more than 3 storeys, this appears to be something that Wits has received for past projects.

There is currently a building on site that I intend to adapt to the new functions of the project (offices), as it is older than 60 years, this building will require a detailed heritage study and a consultation with SAHRA (under the National Heritage Resources Act (No. 25 of 1999)) to determine the Heritage value of the building. According to the NHRA regulations, if the building it found to have any cultural and/or heritage significance, a permit will be required to intervene with the building in any way (Sections 27(18), 29(10) and 34(1)). Section 34 (1) is relevant to this project, as the building is older than 60 years, but does not appear to have any cultural/provincial significance, however, a heritage study will still be required.

Bulk services on site (according to the Wits SDF) include sewer and waters systems, gas, Telkom lines and high voltage electric services. These are all located along the south edge of my proposed site.
The proposed site contains around 2000m2 of relatively unused green space, this will be incorporated into the project.

ERF 401/53-IR		
Area (m2)	FAR	Coverage (%)
340963	0.01	0.36
Proposed Site		
Area (m2)	FAR	Coverage (%)
10000	0.49	12.3

*Calculations based on a 4 storey building

	Permitted	Proposed	Complies
FAR	2.1	0.01	Yes
Coverage	70%	12%	Yes
Height Zone	0 (3 Storeys)	4 Storeys	No
Building Line	none	n/a	n/a
Parking Requirements	0.5 per 100m2	n/a	n/a
Use Zone	Education	Education	Yes

FAR and coverage Calculations were done comparing the proposed building area to ERF 401/53-IR as well as, my proposed site. Because the propose site is not proclaimed and falls within ERF 401/53-IR, I have used the Schedule of Rights relating to ERF 401/53-IR to check wether or not the project complies

fig. 124. Aerial photograph of proposed site (Aerial Photograph from Google earth, Editing by Author, 2020)

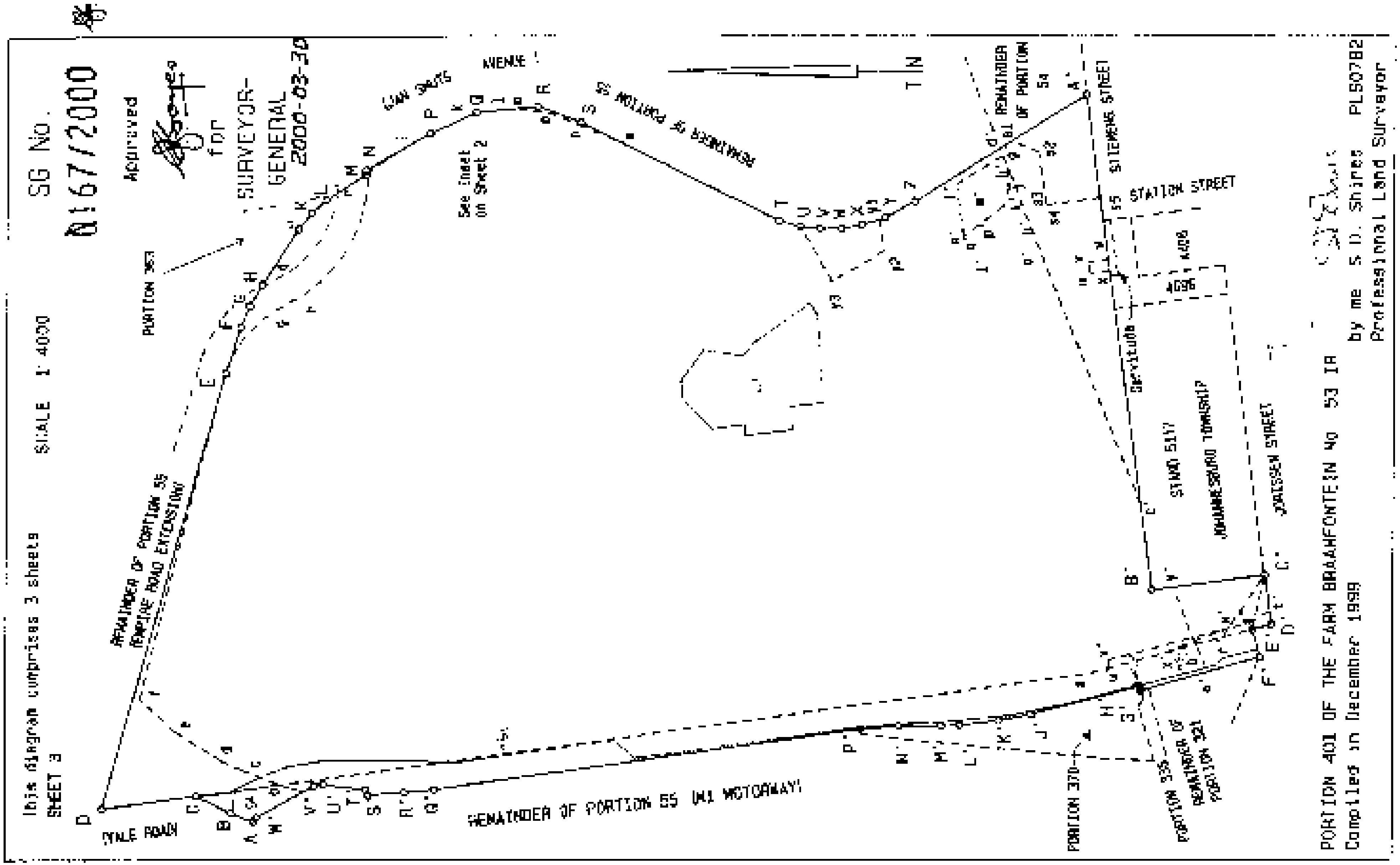


fig. 125. SG Diagram Portion 401 of Braamfontein Farm 53 , 401/53-IR (Supplied by SGData Gauteng)

Financial Matters

Funding

National Research Foundation
The mandate of the National Research Foundation, under National Research Foundation Act (Act No 23 of 1998), is to promote, support and advance research and human capacity development through funding and the provision of the necessary research infrastructure. This is to facilitate the formation of knowledge, innovation, and development in the fields of technology and science. (NRF, 2020)

Department of Higher Education and Training
The National Development Plan envisages that South African should have greater access to post-school education and training by the year 2030. Supported by the governments 2019-2024 medium-term strategic framework (which has prioritized education, skills, and health), this project will form part of the plan by Department of Higher Education and Training to transform universities and provide increasing student financial aid.
This includes a value of R8.8 billion in University subsidies directed towards spending on university infrastructure.
Roughly R2.5 billion has been allocated to Community Education and Training, which includes institutional development and support.

Department of Agriculture, Forestry and Fisheries
The Department of Agriculture, Forestry and Fisheries are funders due to their focus on the agriculture industry. The department has a main focus (along with a number of other aspects) on increasing food security and creating employment in the agricultural sector, improving the agricultural vale chain and agricultural production.
R278.3 million from the comprehensive agricultural support programme grant has been allocated to be used for the revitalization of provincial agricultural colleges.
In addition, R4.8 billion from comprehensive agricultural support programme has been allocated to initiatives focused on Food Security.

Department of Science and Innovation
The Department of Science and Innovation is a funder because of their commitment to the research and development of new technologies. The department has a R1.5 billion allocated toward technology innovation, R201 million of which is directed towards bio-innovation.

Old Mutual Masizane Fund
The Masizane fund provides funding to non-profit organizations. The fund has recently switched their focus to the agro-processing sector.

Operation

Income sources
Veg sales
Classes
Rentals
Research funding

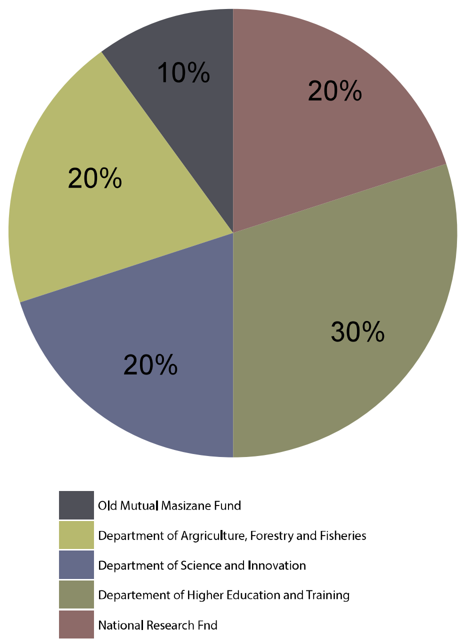


fig. 126. Graph indicating division of funding (Author, 2020)

Implementa-tion

Contract Type

The proposed contract type will be a Lump Sum Contract based on a provisional Bill of Quantities. A competent Quantity Surveyor will be appointed to generate a BOQ based on the quantities measured from most recent (thus most accurate at the time) set of architect's sketch plans, and value will be adjusted once the final construction drawings are completed. Although the bill of quantities will not be will not be 100 percent accurate at the time of tendering, this allows for the tender process to begin much earlier in the project timeline. After the tender process has been concluded and a contractor has been selected, the Client and the Contract will sign the JBCC Principal Building Agreement.
The choice of this contract was based on the sizable amount time saved, this then equates to money saved. For this project, the shortened project timeline means that the disruptions to the Universities education and residential function are kept to the minimum time possible.

A competent Attorney will be appointed by the client to oversee and manage the legal, contracting and tender aspects of the project.

Tender Process

Selection of a contractor will be done through a Selective tender process, which will be managed by the Wits Procurement Department. This will mitigate corruption and ensure a fair non-biased selection process. A list will be drawn up of contractors that work in the area or have work with the client or Architect on any previous project. This will help keep the evaluation process more streamlined and avoid having to review any irrelevant offers. For the sake of fairness, the tender period will take place over a period of 6 weeks, 4 weeks (from the date of invitation) to submit proposals and additional 2 weeks for evaluation and decisions at which point the winning proposal will be contracted.

Tender evaluations will be done by the Client, the Architect, Attorneys and the Quantity Surveyor.

The tender will be evaluated based on the following criteria:

- Cost
  - Subcontractors
  - Labor
- Previous experience
  - Quality of prior work
  - Relevance of prior work
- Construction methodologies
- Available resources
- Financial Stability

Professional Team

The professional team will be led by the architect. This team will be assembled by the architect and approved by the client.
The client will appoint an attorney to address any legal issues that come up during the course of the entire project timeline.
The Client will enter separate agreements with the Architect, Project Manager, and the appointed Contractor. Consultants will be appointed by the relevant member of the professional team where necessary, and fees will be arranged though the Project Manager.

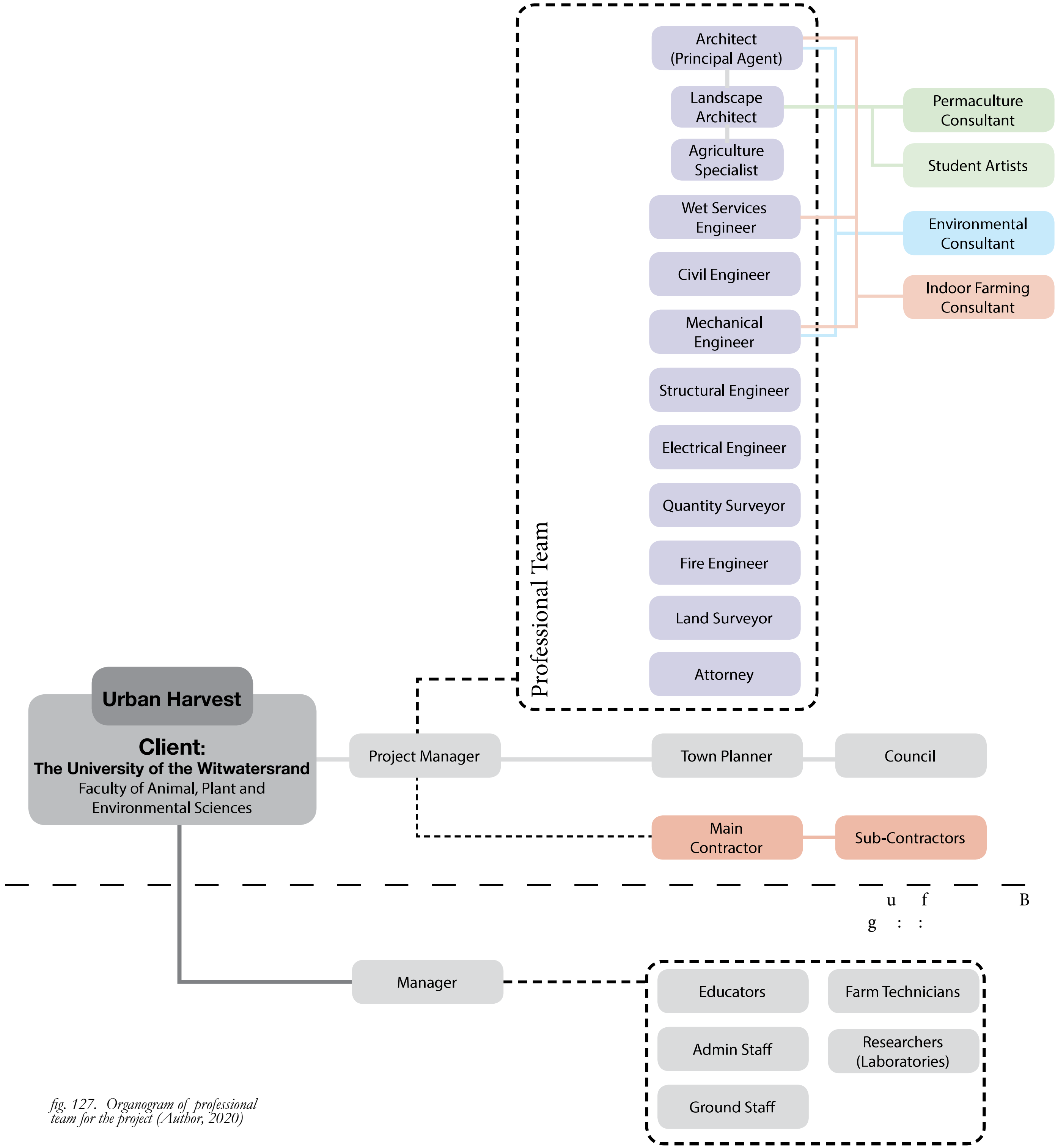


fig. 127. Organogram of professional team for the project (Author, 2020)

Professional Fees

Professional Fees				
Professional	Base fee (Rands)	Fee Percentage	Percentage amount	Total
Architect	1,346,249.00	9%	3,394,800.00	4,741,049.00
Landscape Architect		9.92% of R5,000,000.00	496,000.00	496,000.00
Structural Engineer	2,653,125.00	7%	2,640,400.00	5,293,525.00
Civil Engineer	2,653,125.00	7%	2,640,400.00	5,293,525.00
Mechanical Engineer	3,170,625.00	9%	3,394,800.00	6,565,425.00
Wet Services Engineer	3,170,625.00	9%	3,394,800.00	6,565,425.00
Electrical Engineer	2,408,125.00	6%	2,263,200.00	4,671,325.00
Quantity Surveyor	1,592,000.00	4%	1,508,800.00	3,100,800.00
Time based Professional fees				
Professional	Rate (Rands)	Hours		
Land Surveyor	8,000.00			8,000.00
Attorney	3,000.00	8		24,000.00
Environmental consultant	2,000.00	10		20,000.00
Fire Engineer	1,000.00	50		50,000.00
Total Professional Fees				36,829,074.00
Office Fitout	R 13 200 x 150m^2			1,980,000.00
Total Building Cost				37,720,000.00
Development Cost Total				76,529,074.00

fig. 128. Table of professional Fees for the project (Author, 2020)

Phasing

The project will be proposed as two phases/ Components to allow for funding strategies to be split. Implementing two phases will assist with project clarity and ease of management. Both phases will be conceived as part of Stage 1 (Inception), but stages 2 to 6 of each phase will be run independently of the other, in sequence. This will help stagger the design workloads of The Architects and the rest of the design team. The phasing of the construction project means that the construction will take longer, however, this will allow for a less concentrated presence of construction on campus.

This project consists of two parts.
Wits Urban Agriculture Center
Campus integration

Phase 1:

- Vertical Farm
- Research facility
- Urban Farm
- Greenhouse

Phase 2:

- Farming exhibitions
- Campus farm spaces

Site Management

The appointed contractor is to appoint a representative or team (foreman, safety officer) to oversee and ensure the site is constantly managed properly. A safety officer should enforce safety protocols at all times to ensure the safety off the on-site employees, consultants that may visit the site, and the general public around the site.

General

The project places huge importance on maintain green spaces on and around the site. The site contains a number of important trees, these identified trees are to be protected during the construction process.
Building supplies and materials to be stored within the border of the construction site.
Toilet and changeroom facilities to be provided on-site for construction workers.
Materials to be recycled, to lower the environmental impact of the project, where possible.

- Material packaging
- Timber pallets
- Etc.

Some materials from the demolition phase, can and should be recycled or reused for the construction of phase 1 and 2 These materials include:
Brick Pavers from the existing parking lot.
Concrete slab remain, can be used as aggregate for new concrete elements.

Safety

Because the site is part of a University Campus, extra precautions need to be in place to ensure the safety of students, faculty, and University staff.
Site to be adequately demarcated and blocked off.
Areas below cranes to be demarcated and blocked off during operation.
Toxic materials to be stored (and disposed of) securely and safely. (Hazardous waste disposal plan to be implemented)

Traffic

Given the proximity to the busy Jan Smuts Ave, some measures will need to be put in place relating to the road, sidewalk and traffic.
Traffic, going North, along Jan Smuts may need to be controlled.
A portion of the sidewalk and outer lane (Jan Smuts) to be blocked off.
Construction vehicles entry and deliveries from Jan Smuts.

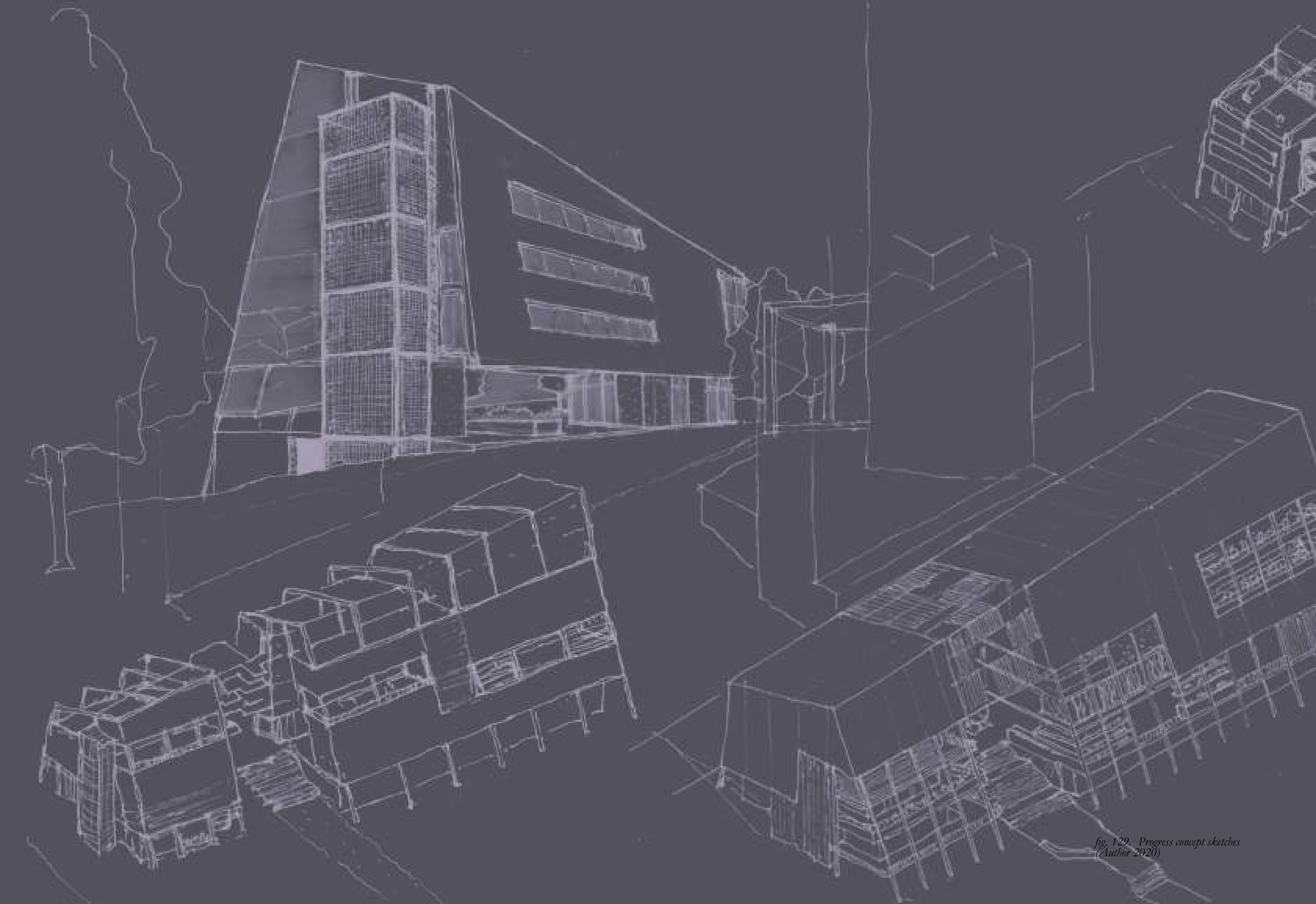
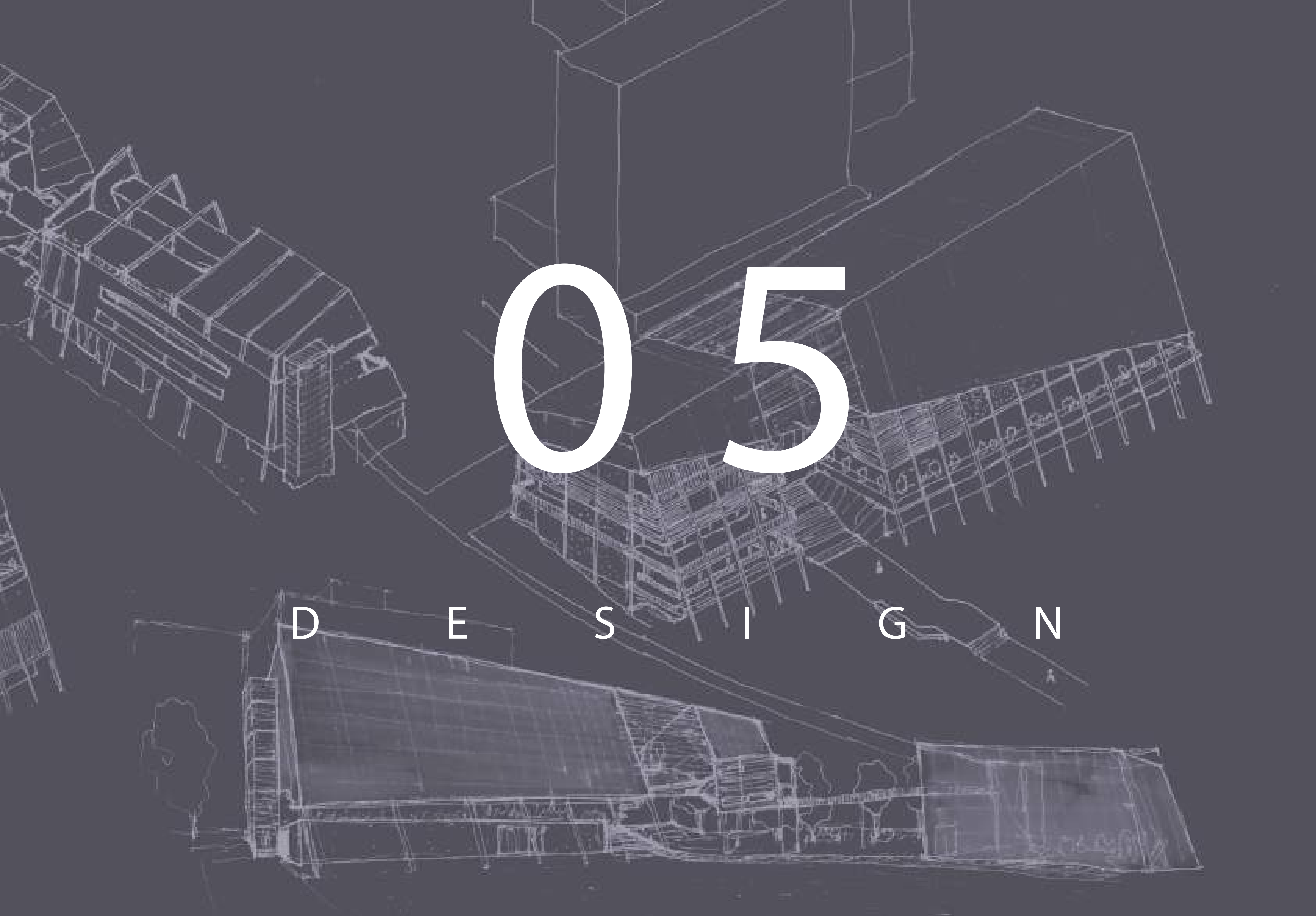


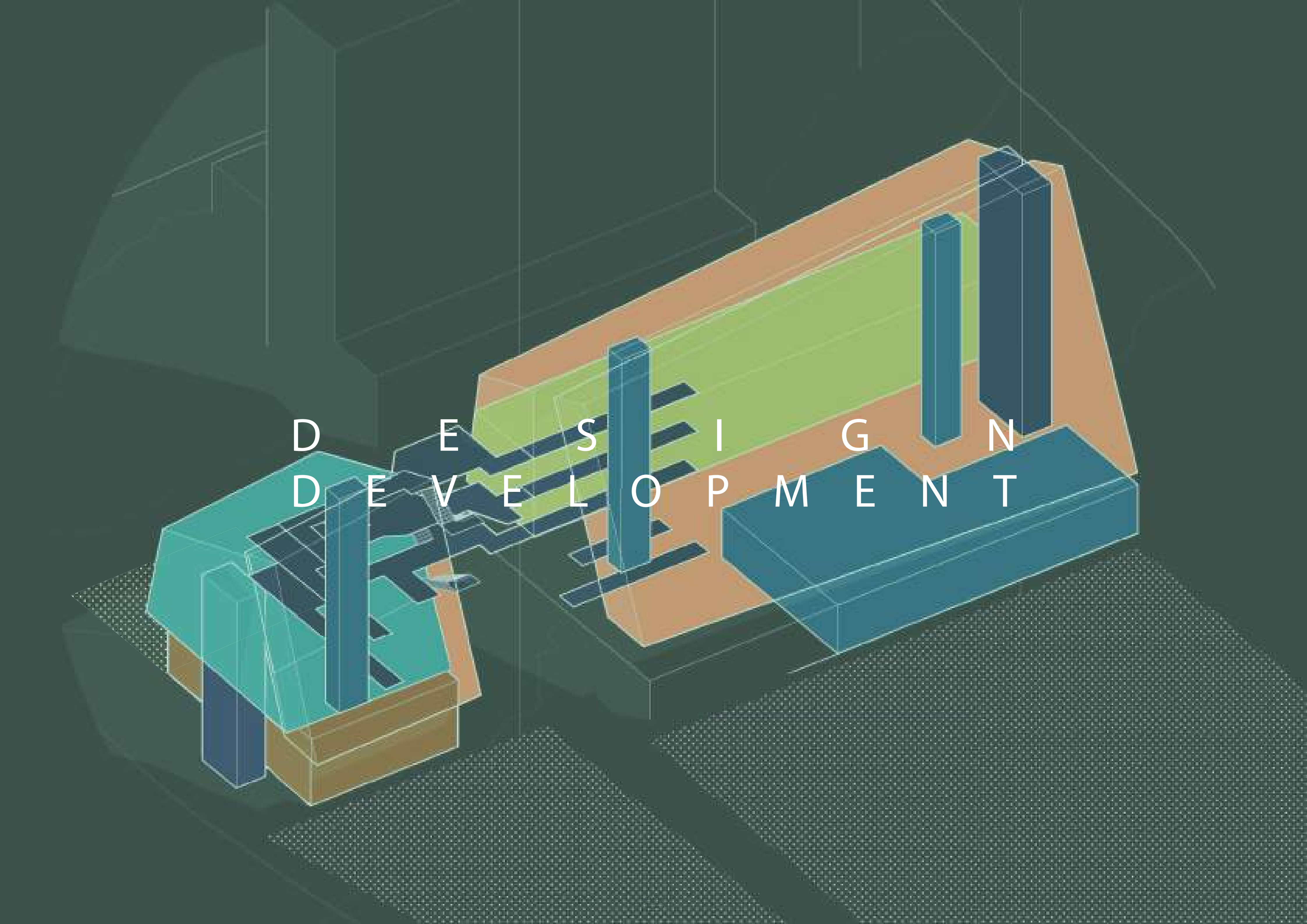
fig. 129. Progress concept sketches (Author 2020)

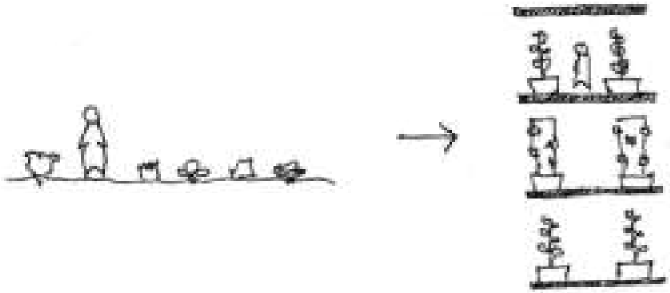
05

D E S I G N

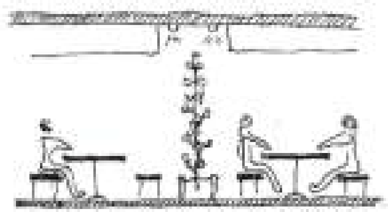


DESIGN DEVELOPMENT

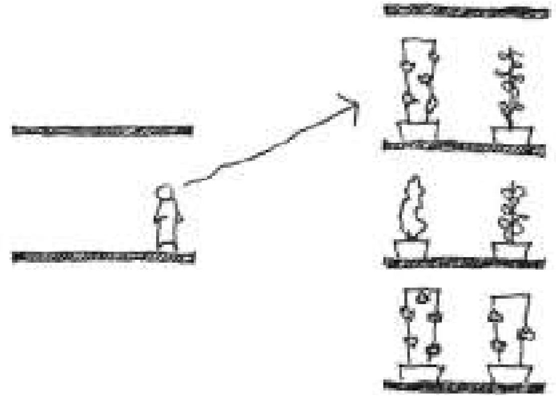




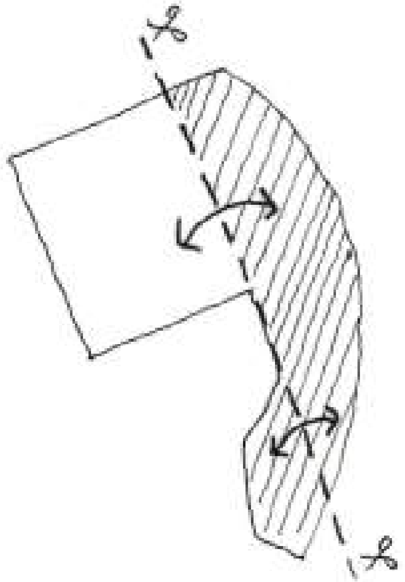
Vertical Farming



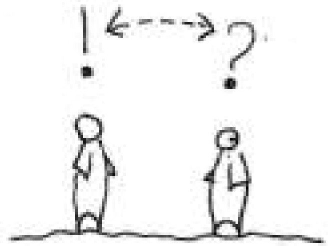
Building Integrated Agriculture



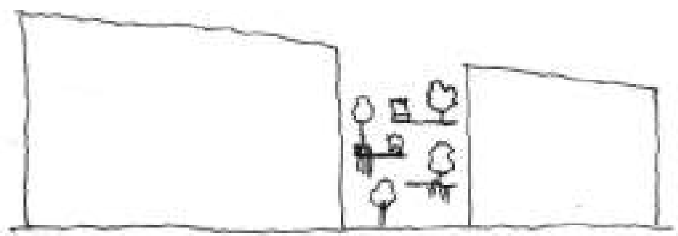
Visual Connections to Agricultural proccesses



Public-University Interface



Knowledge Exchange



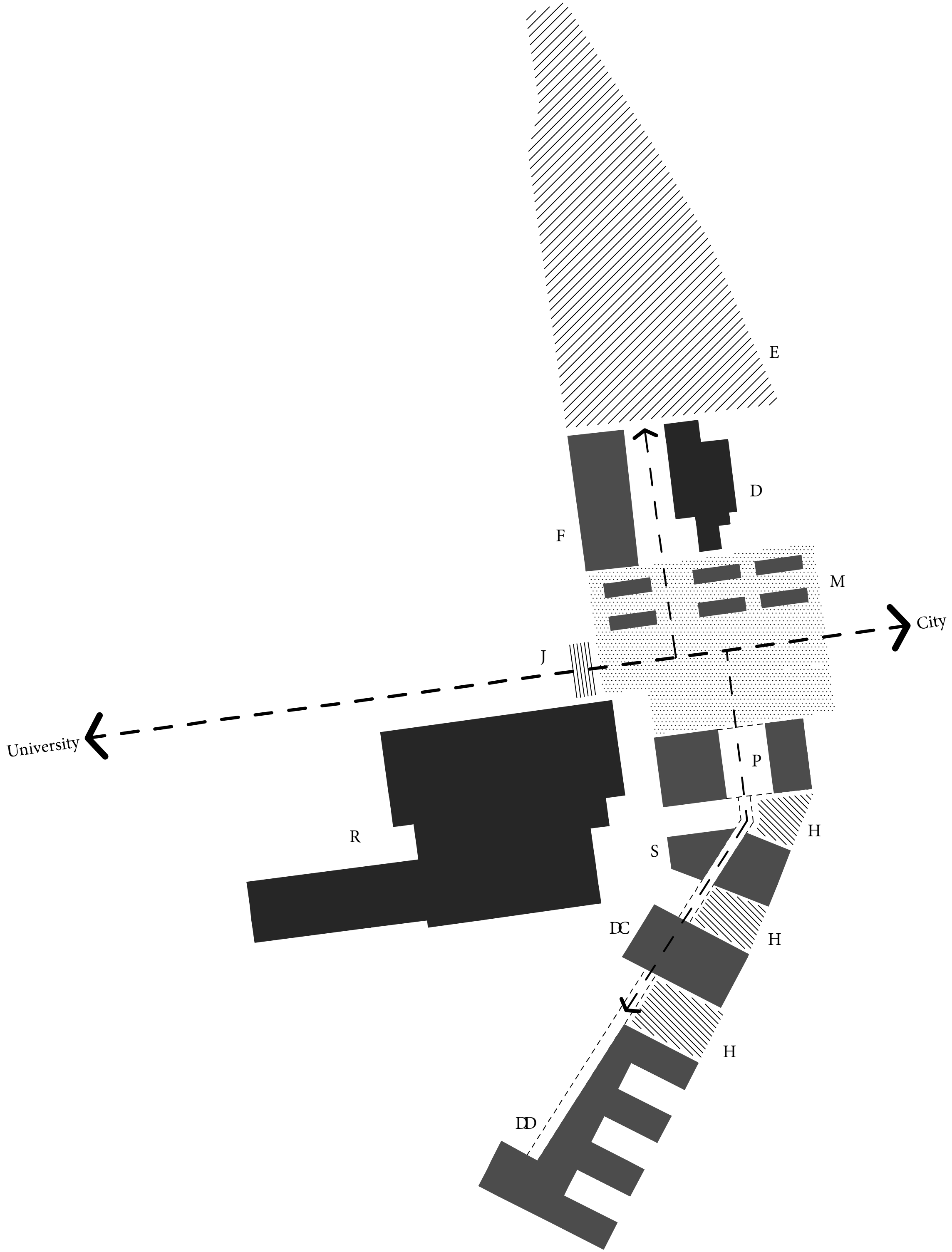
'Green' Building

Design Principles

Site Layout

Concept 01

This diagram looks at the basic arrangement of building functions. North and south portions of the site split by the main entrance axis. Each function being located in individual buildings placed on the south portion of the site - on the edge of the Wits campus. Between the main volumes are garden spaces creating a rhythm of buildings when driving or walking past along Jan Smuts Ave. The North portion of the site houses the community garden and greenhouse, to be used for teaching as well as being a functional farm, providing food for Wits students. The existing building will be used for staff facilities and garden/ equipment storage.



1 Garden Shed/ Equipment Store
2 Community Farm/ Market Garden
3 Greenhouse
4 Public Garden
5 University Entrance
6 Farmers Market
7 Entrance Foyer/ Reception
8 Jubilee Hall Residence
9 Teaching Kitchens
10 Public Lecture Room
11 Vertcal Farm

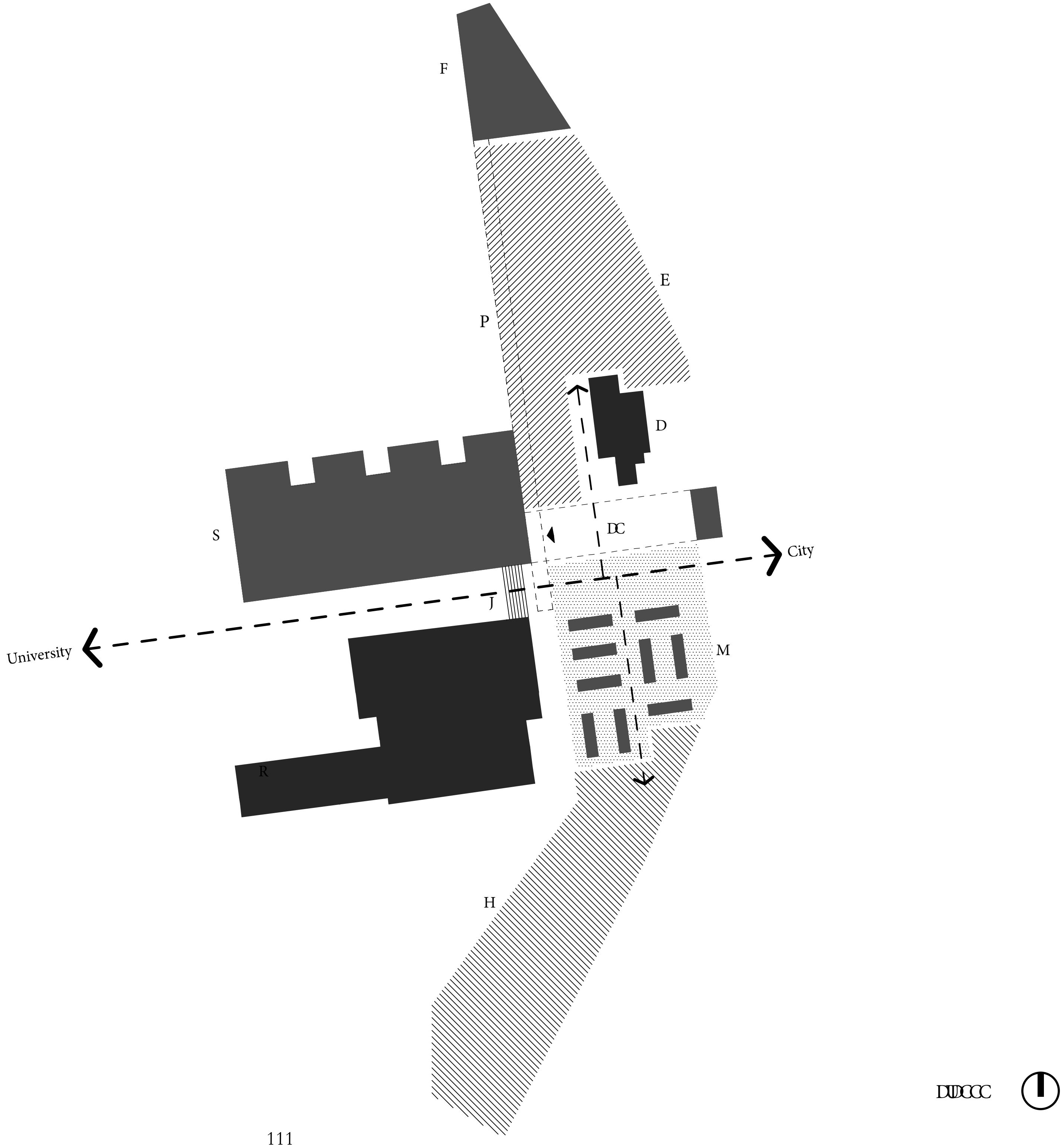
Existing Buildings
Proposed New Buildings
Public Gardens
Public Plaza
Market Garden

Concept 02

This arrangement looks at placing the main function into a single building. This building is located further into the campus, on the current Wits parking lot. By doing this the existing green is maintained as much as possible. Again, the main pedestrian entrance axis. In this case the north portion becomes part of the university and the south portion is essentially public green space. A greenhouse is placed on the northern end of the site, thus announcing the site and holding the community garden simultaneously. This garden will be used for teaching and will help feed Wits student in need. A raised (first floor) walkway link the main building to the greenhouse. The existing building will be used for staff facilities and garden/equipment storage.

1 Garden Shed/ Equipment Store
2 Community Farm/ Market Garden
3 Greenhouse
4 Public Garden
5 University Entrance
6 Farmers Market
7 Raised Walkway
8 Jubilee Hall Residence
9 Vertical Farm
10 Covered Foyer

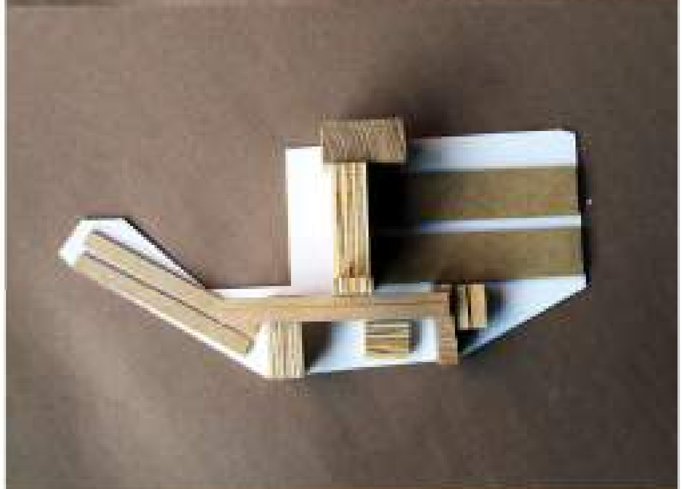
Existing Buildings
Proposed New Buildings
Public Gardens
Public Plaza
Market Garden

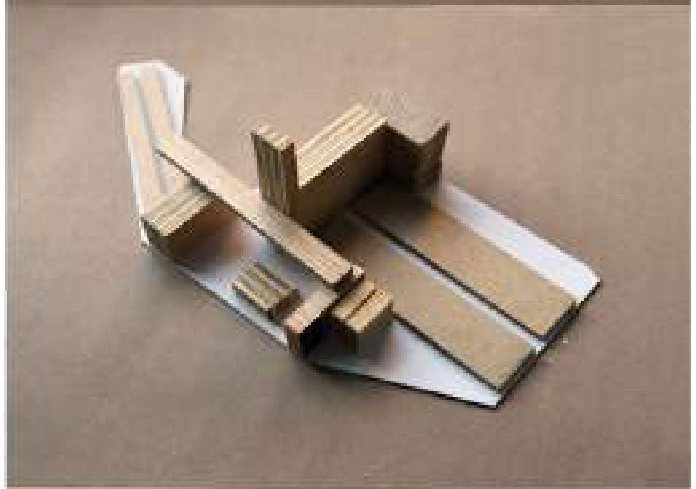


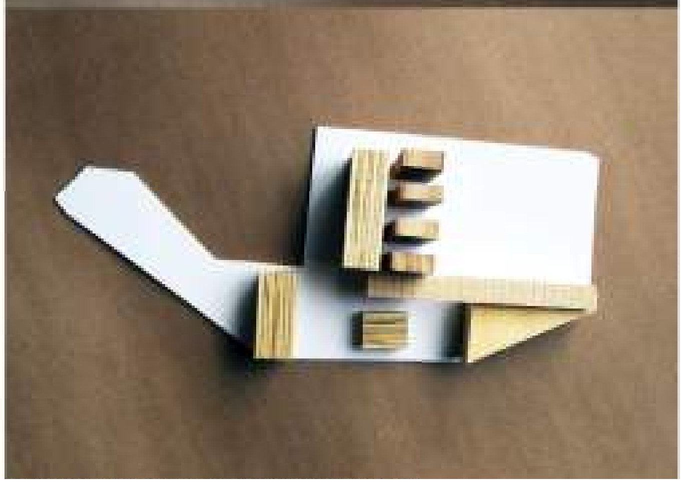
Model Charrete

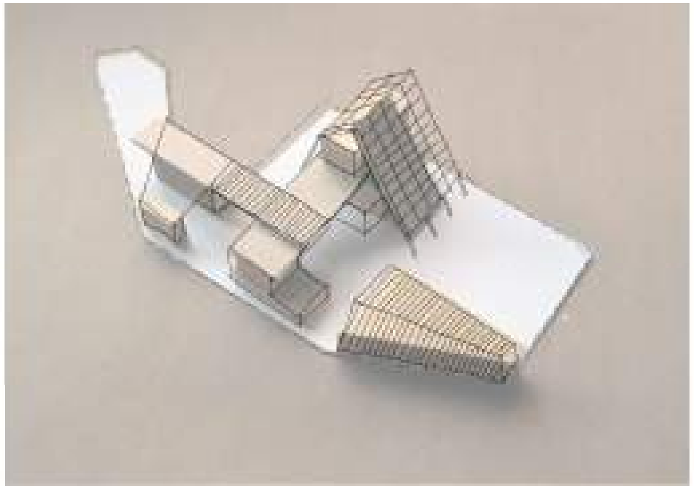
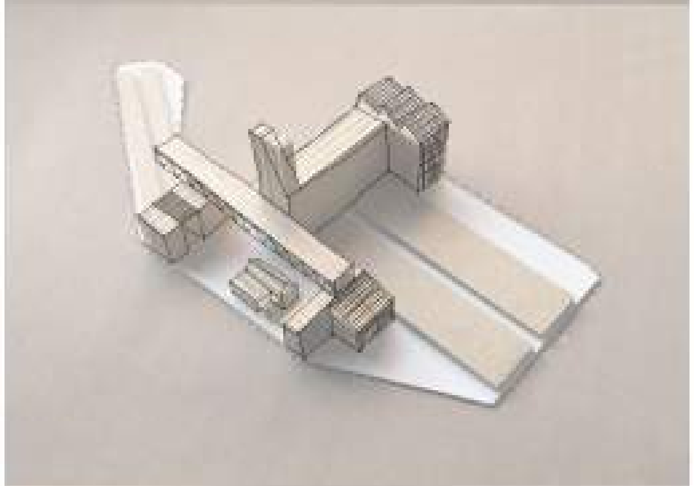
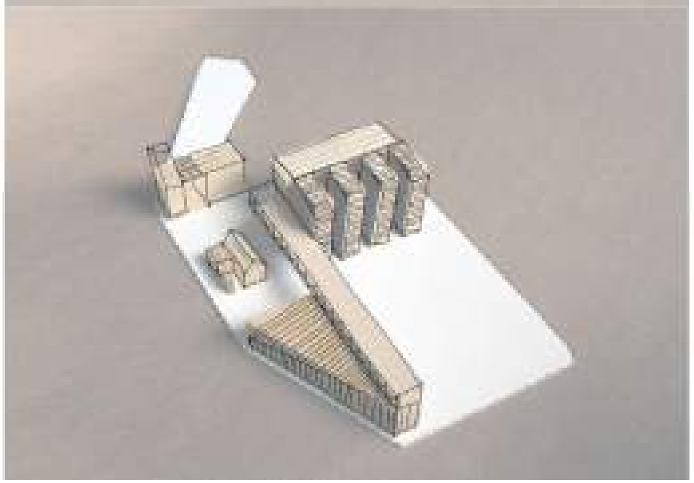
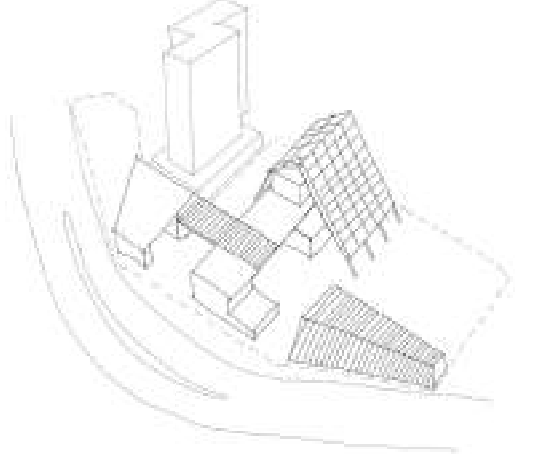
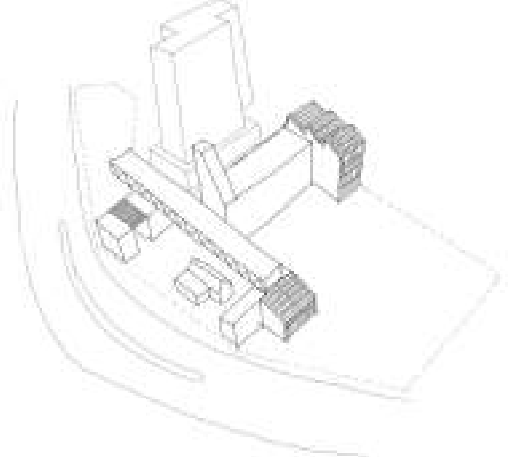
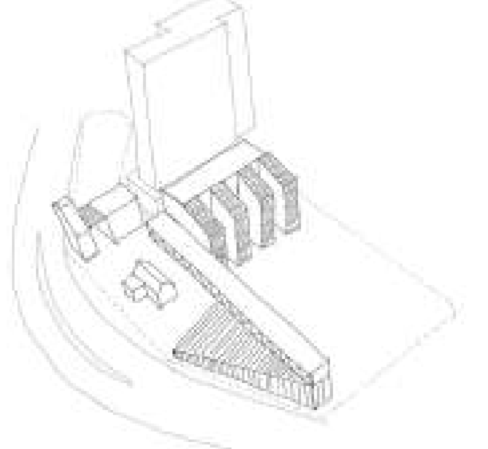
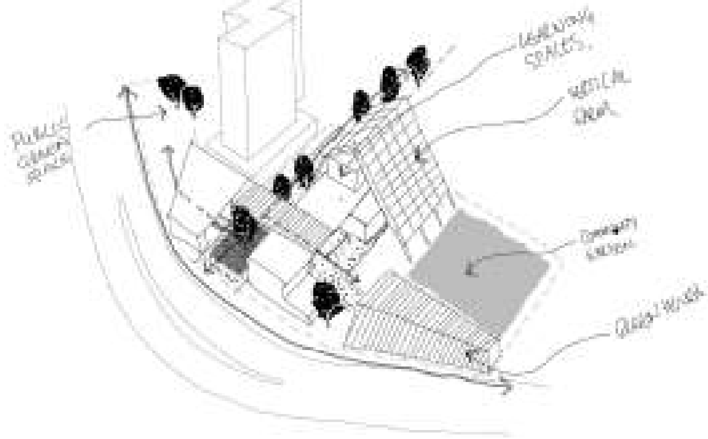
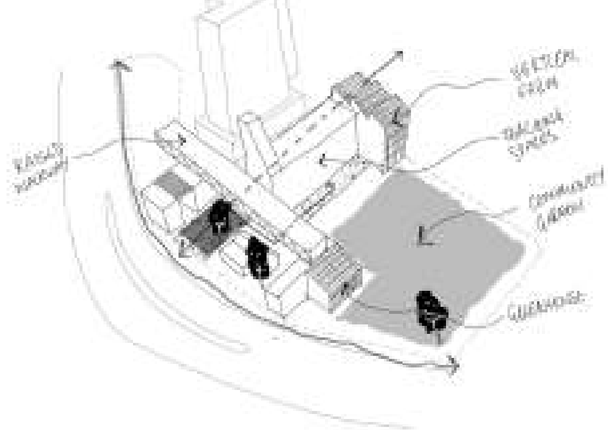
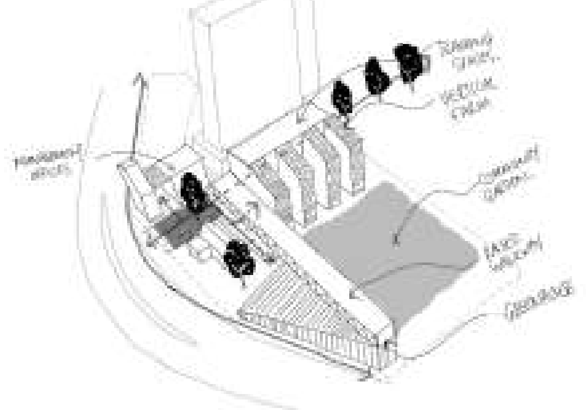
The following models were developed based on the above conceptual site layouts. These model are part of an initial design charette looking at building on the site. The models take basic mass blocks and attempt to locate how main volumes and masses could be situated on the site, and the connections between these proposed masses. After these models were built and photographed, I sketched over the photographs as a conceptual exercise, in an attempt to extract a building idea from the basic massing models.

When analyzing the models and sketches I came to the realization that I am proposing too much building on the site where I should be placing some additional focus in providing sufficient space for farming. I feel that this proposal should limit the amount of damage done to site, and try and heal parts that have already been damaged, for instance the large parking lot. This would mean that I should locate the proposed functions into fewer building masses - perhaps two. It might be rational to split function between public orientated functions and research/growing functions and then dedicate sufficient open ground space for the sustainable cultivation of crops.















VERTICAL FARM
COMMUNITY GARDEN
GREENHOUSE


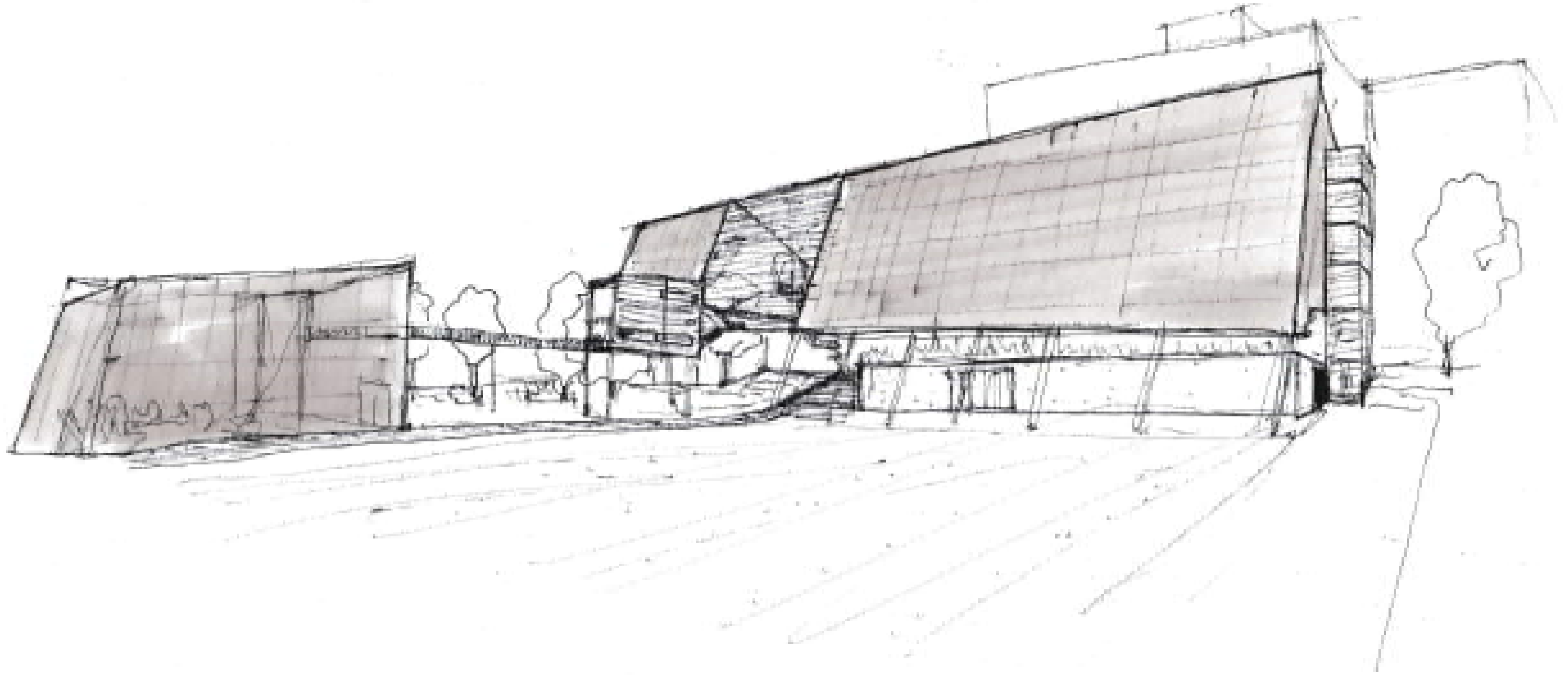


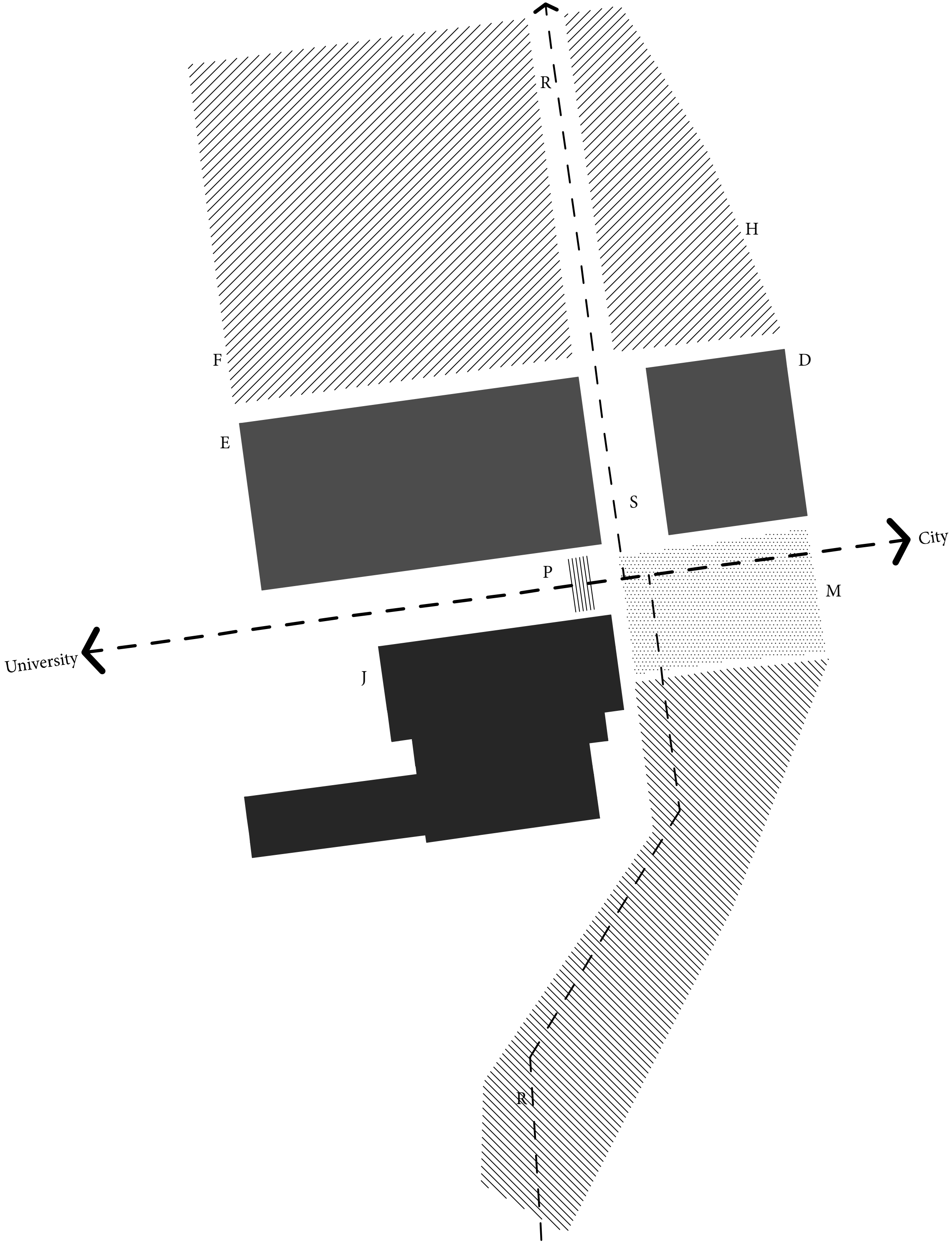
fig. 130. Conceptual sketch of proposed building after design charette (Author, 2020)

Concept 03

This third conceptual site layout diagram follows on from the above model charrete. In this iteration functions are split between public and research functions building forms. Public functions including teaching laboratories, cooking classrooms and public lecture hall, are located towards the east edge of the site, and research function toward the interior. A north-south pedestrian route is proposed. This routes will essentially split the site and the building forms This is to create a blurred boundary of this edge of the university campus, and create an interface between the university and the city. The pedestrian rout will divert pedestrians away from the street and guide them past various gardens, and through the building foyer where, if desired, they can enter either building. The lecture hall will be located so that the foyer can spill out onto the public plaza.

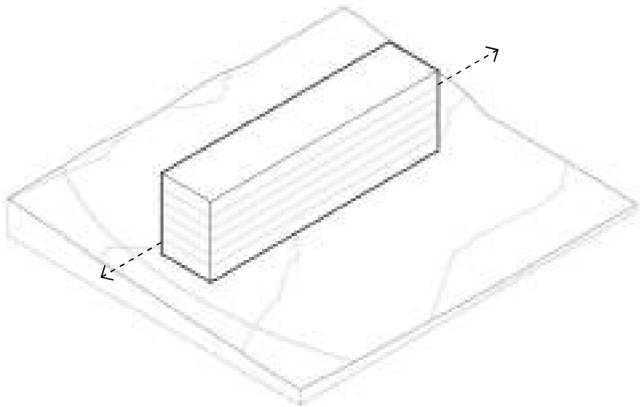
1 Public Education Building
2 Research Facility and Vertical Farm
3 Facility Polyculture Garden
4 Facility Permaculture Garden
5 Jubilee Hall
6 Public Plaza
7 University Entrance
8 Pedestrian Route Through Site
9 Covered Entrance Foyer

- Existing Buildings
- Proposed New Buildings
- Public Gardens
- Public Plaza
- Facility Gardens

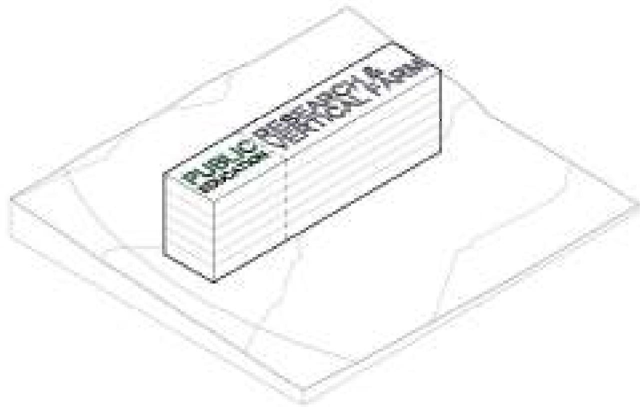


DUDCCC

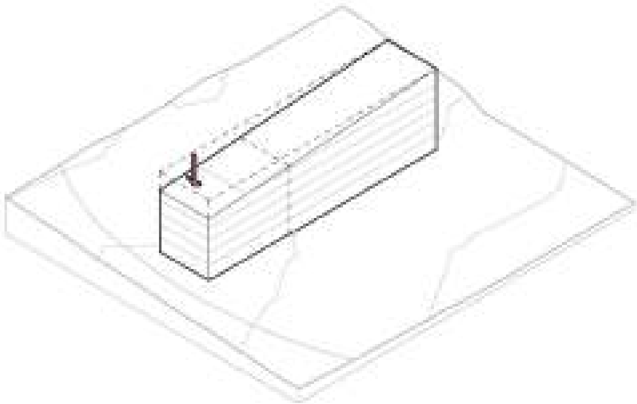
Form Development



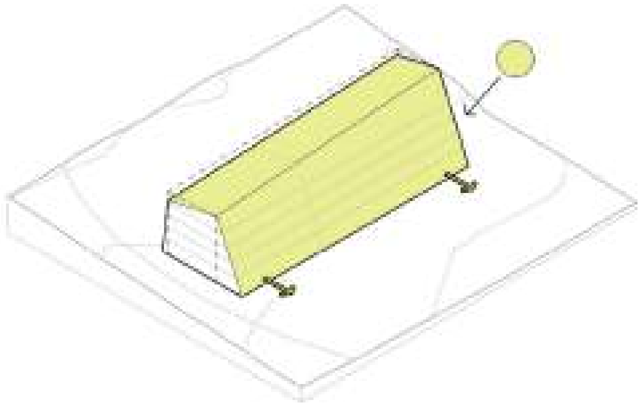
Building mass with required area sits on a portion of the site. Mass laid in line with the axis created by the existing pedestrian entrance.



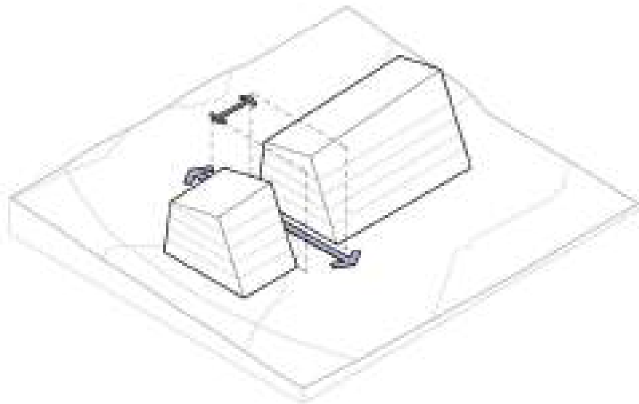
Building mass is divided into two. All functions related to the public (cooking classrooms, Lecture hall, etc.) are located towards the campus edge. This is suggestive of the building reaching out to the public.



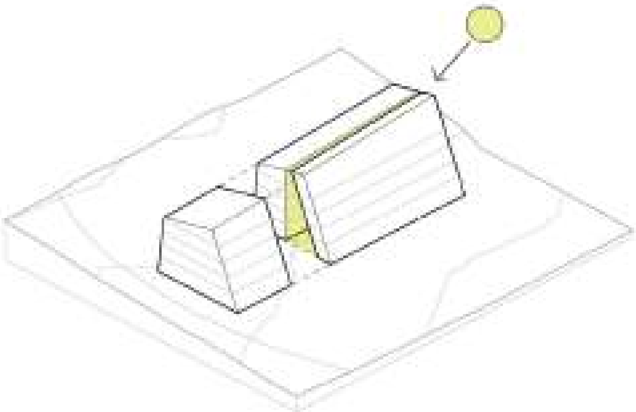
Building mass is compressed on the public portion. This is because the public functions require less storeys. By compressing the side of the building, a gradual east-west slope is created in the building form.



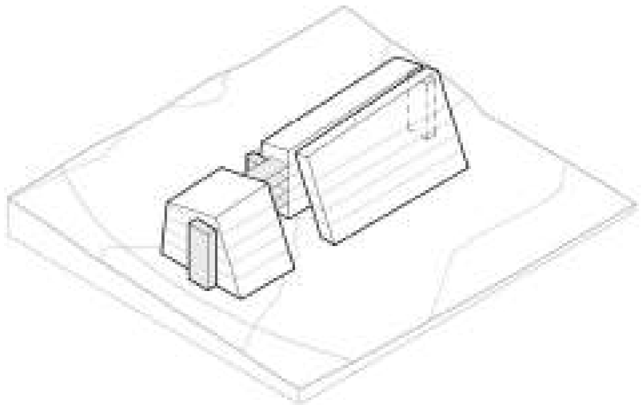
The base of the north facade is pulled outward. This is to ensure the maximum amount of sun is able to penetrate deeper into the floorplates where growing spaces will be located.



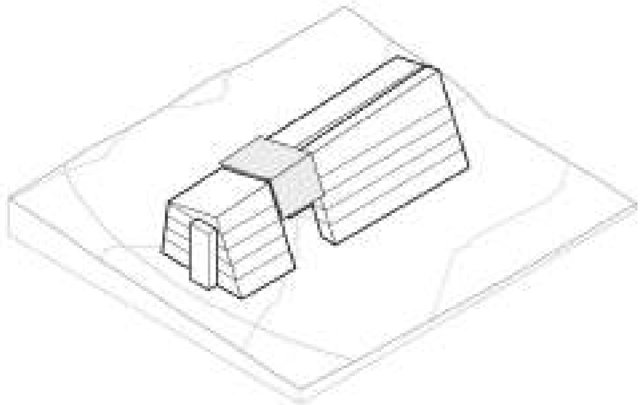
The mass is broken into two portions by creating a public foyer in between the two functional masses. The north-south pedestrian route runs through this foyer, where people can either enter the building or continue through the site.



The west portion of the building houses the various laboratories and growing spaces. These functions are split by an atrium. This atrium allows natural light to penetrate to the lower levels. The atrium will also create visual links between laboratories, growing spaces and offices.



The main circulation core is located cores are located in between the two masses. The core will allow for vertical circulation between floors, and horizontal circulation between building masses. A fire-escape is located on each side of building, allowing for adequate amount of escape routes.



A large pergola spans between the two masses to cover the pedestrian foyer and protect visitors from the rain and the high summer sun.

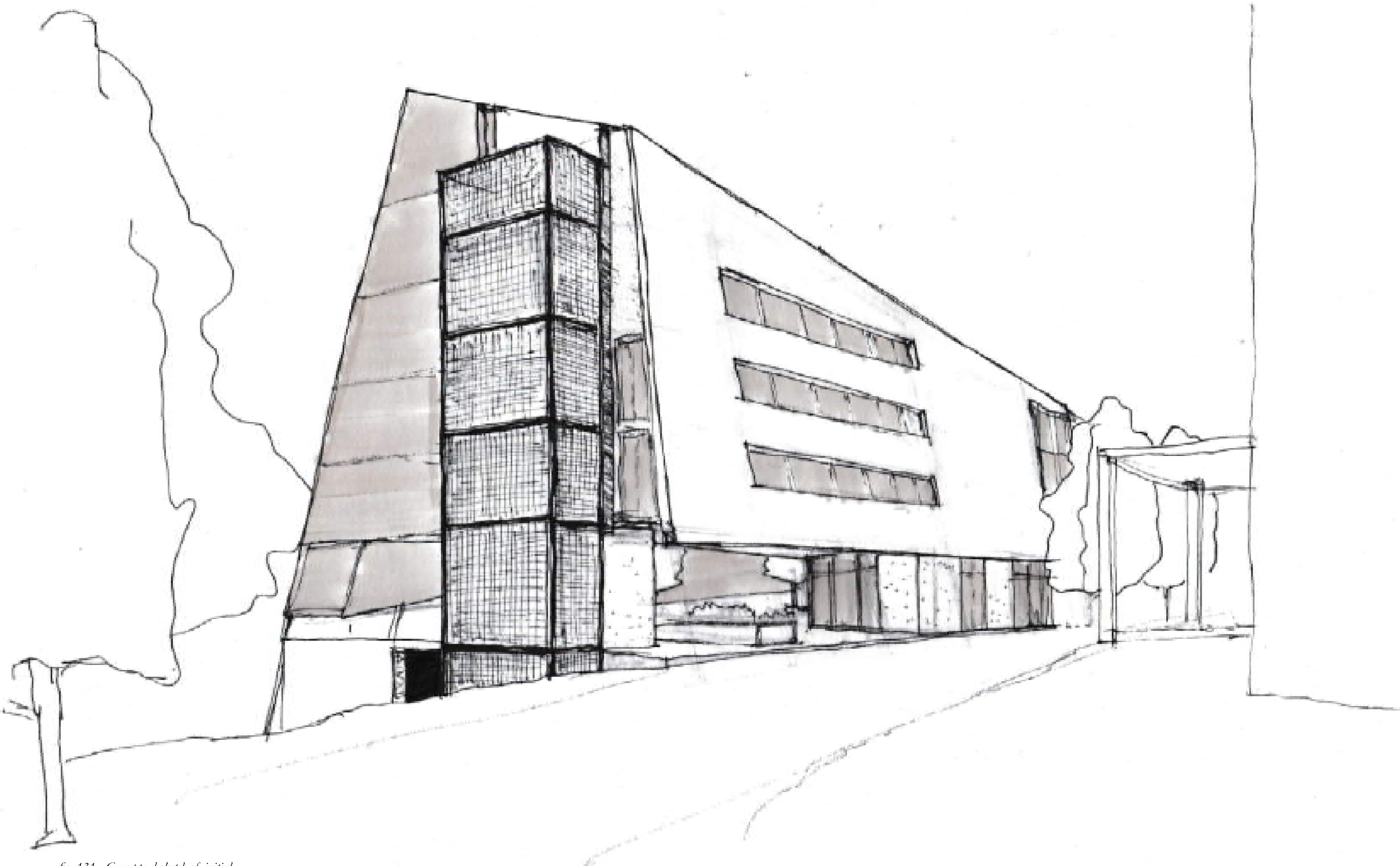
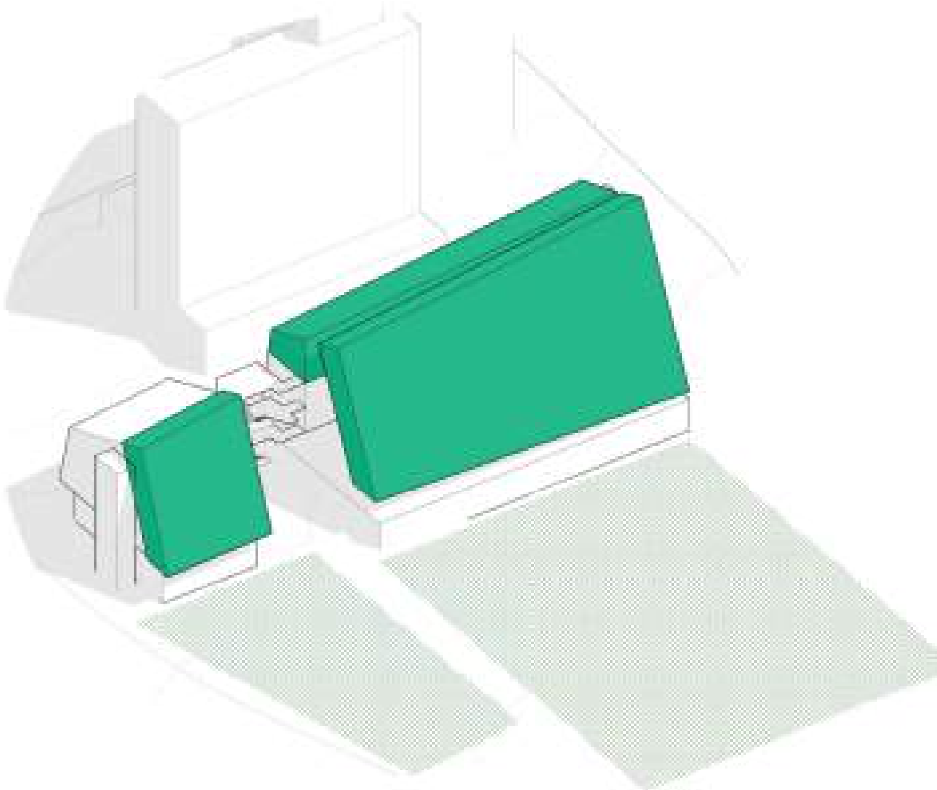


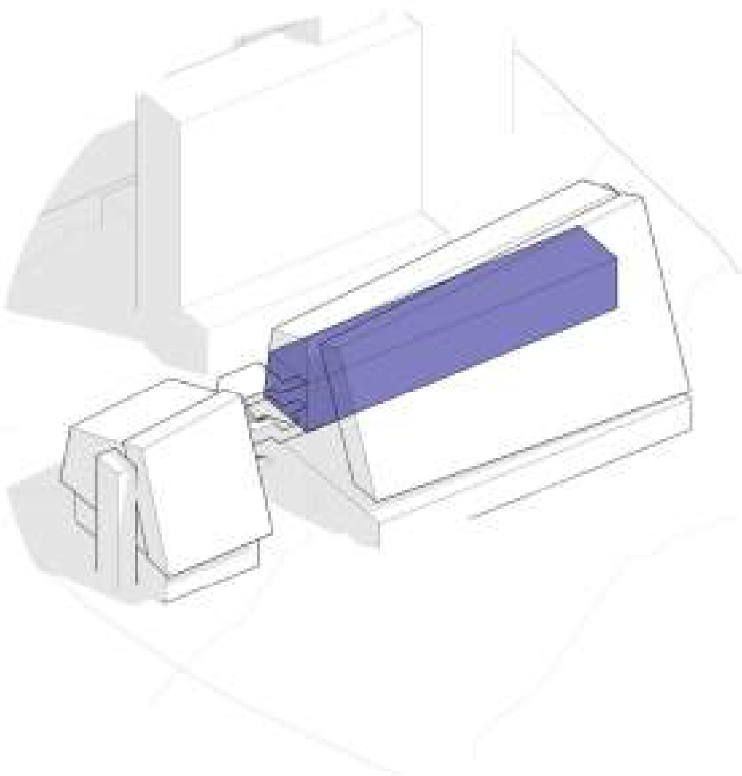
fig. 131. Conceptual sketch of initial building design (Author, 2020)

Programme



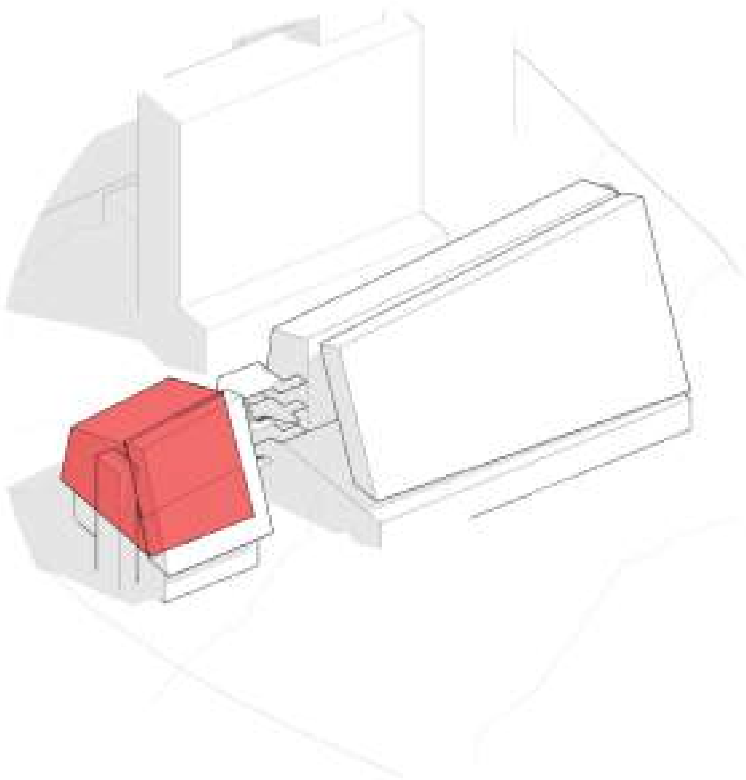
Growing Spaces

Greenhouse
Vertical Farm
Polyculture Gardens



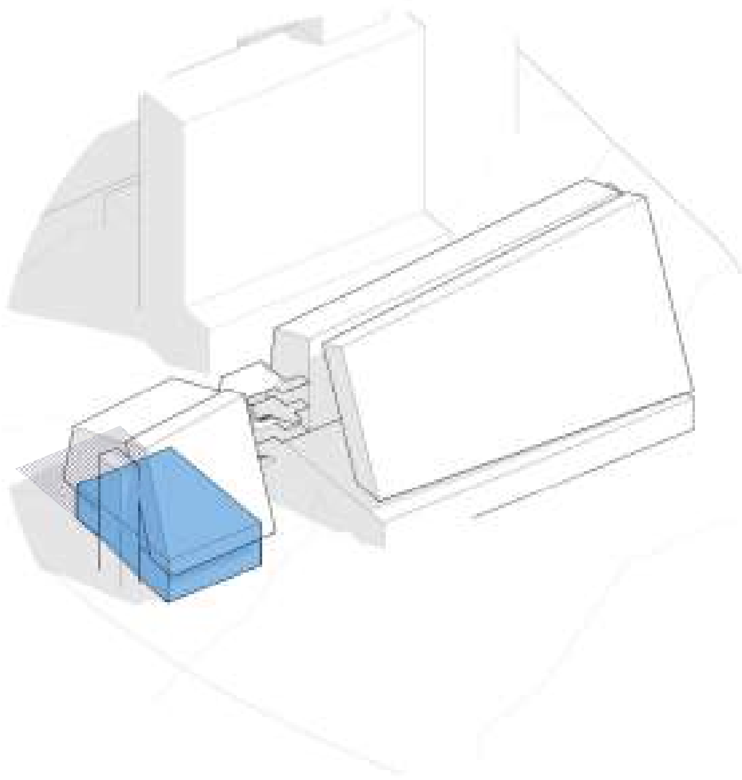
Research

Research Laboratories
Offices



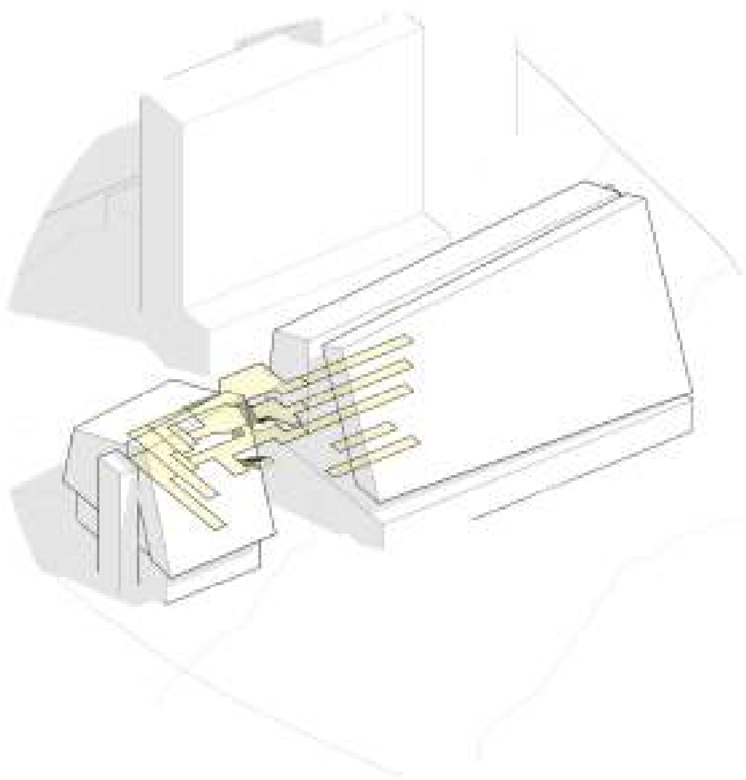
Education

Cooking Classes
Teaching Laboratories
Seminar Rooms



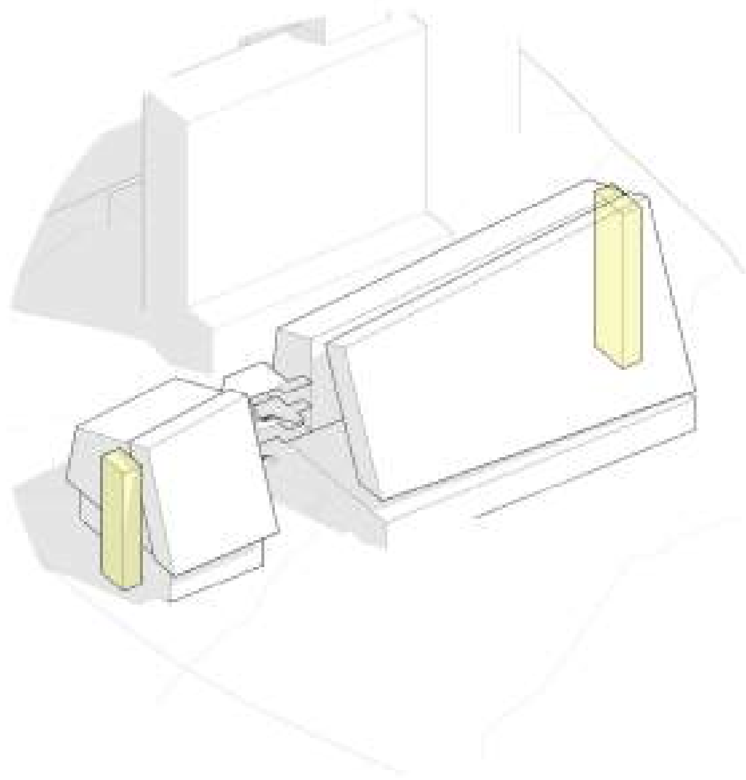
Lecture Hall

Foyer
Lecture Hall
Public Plaza Breakout

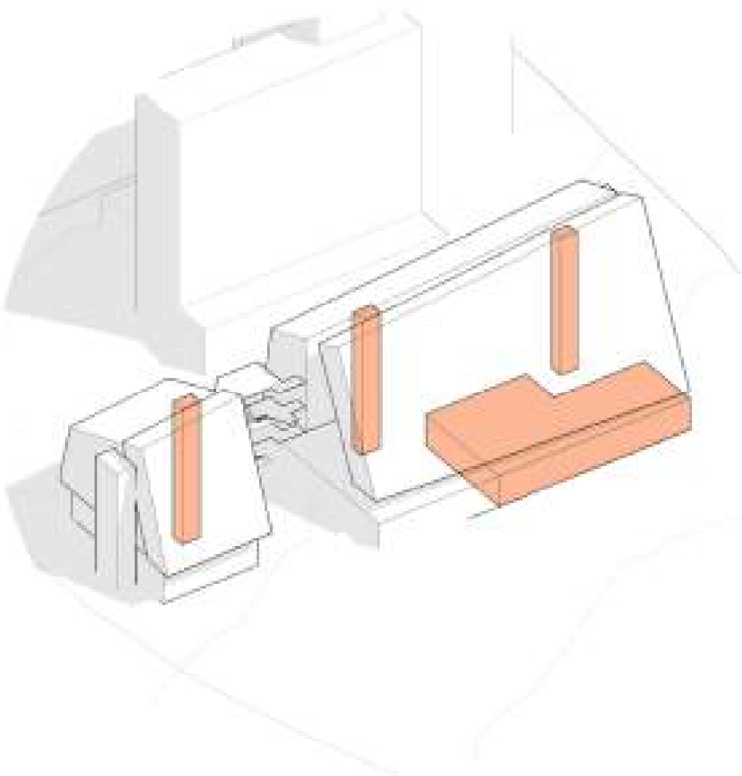


Circulation

Open Circulation Core

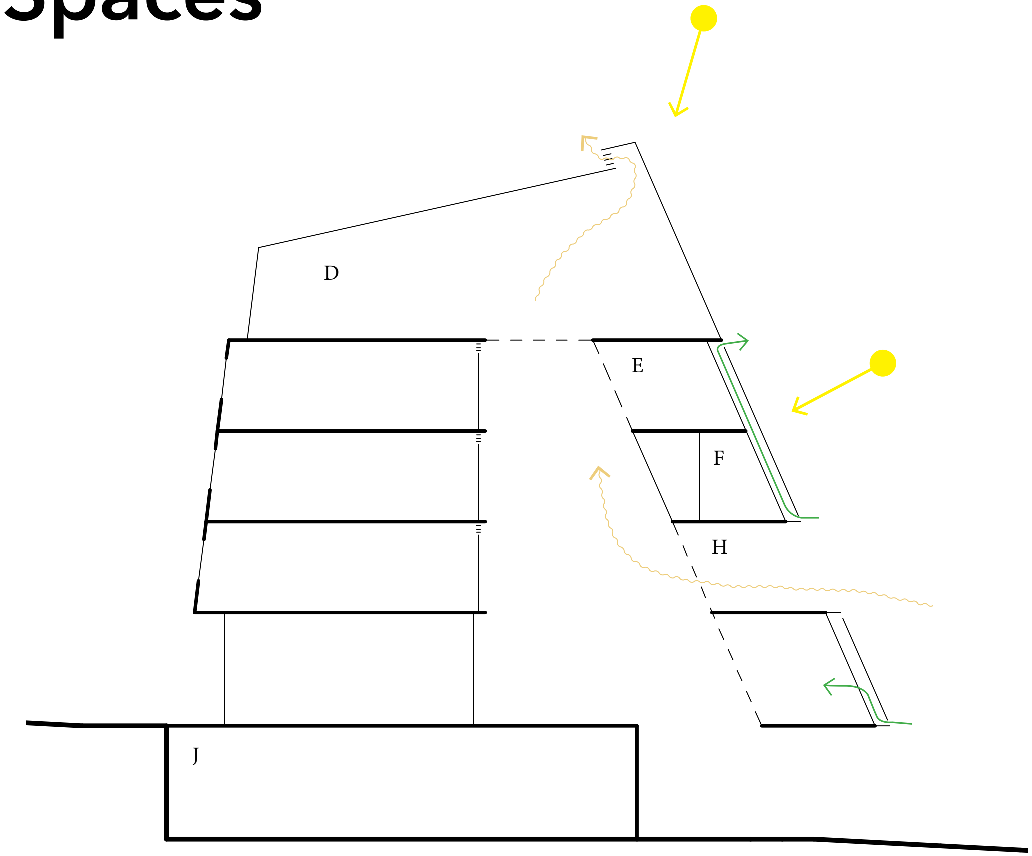


Fire Escape



Services

Types Of Growing Spaces



1 Greenhouse

The Hydroponic Greenhouse is located on the top floor of the building. It is naturally ventilated and naturally heated by the sun.

2 Enclosed Growing

These growing spaces are meant to be used for hydroponics system or traditional soil planting boxes, the intention is to test various methods and systems for growing. These spaces feature a double-skin facade system providing an additional level of temperature control, because they are smaller spaces and thus likely to heat up quickly, The 'inner wall' toward the atrium will be operable, allowing for cross ventilation and creating a flow between spaces.

3 Controlled Research Spaces

These spaces are intended to be used for very research or PHD research related to horticulture and vertical farming. These spaces need a high level of control in terms of temperature, light and humidity, thus need to be completely controlled. These spaces will feature working spaces as well as laboratory/growing spaces.

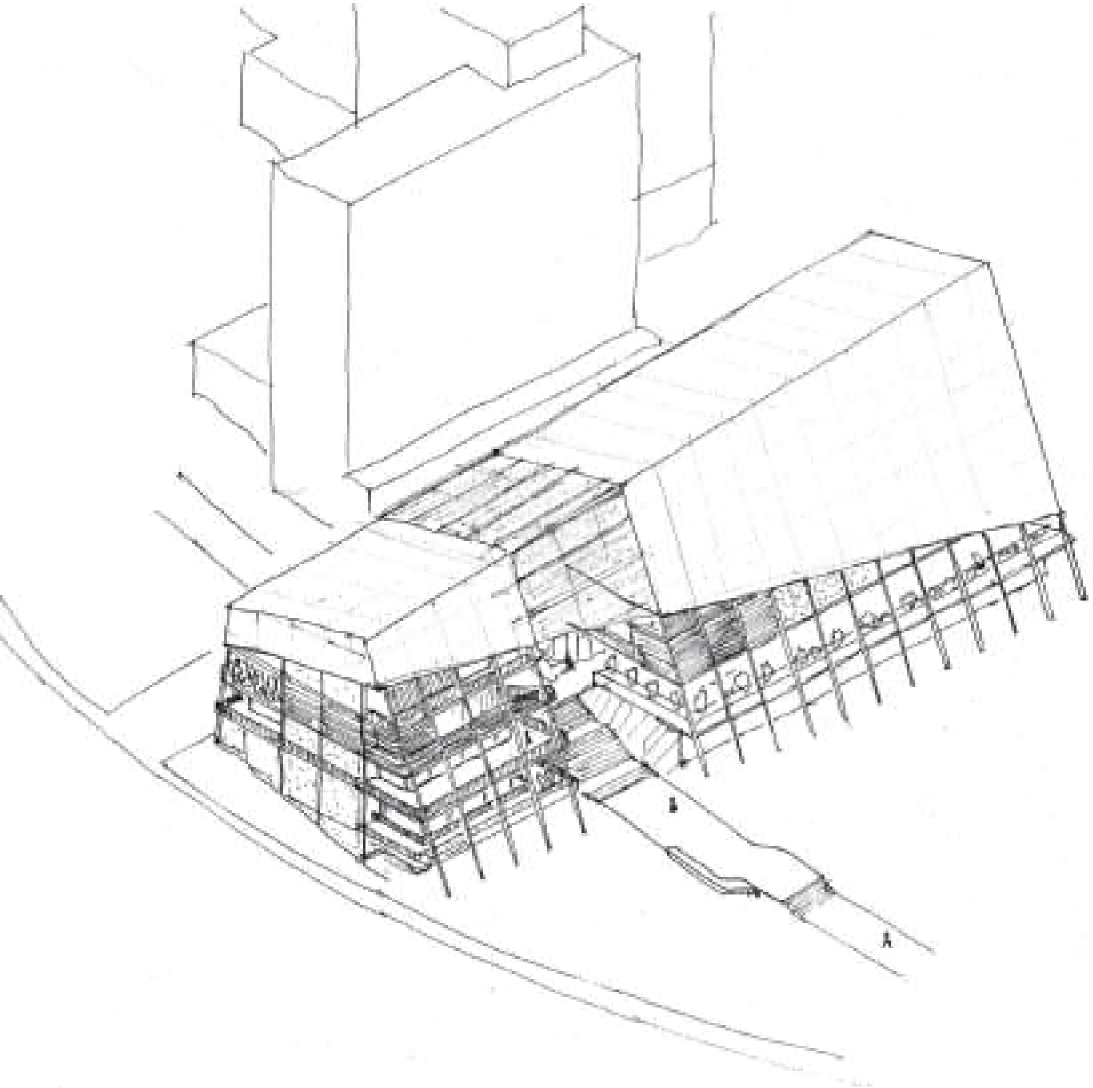
4 Open Growing spaces

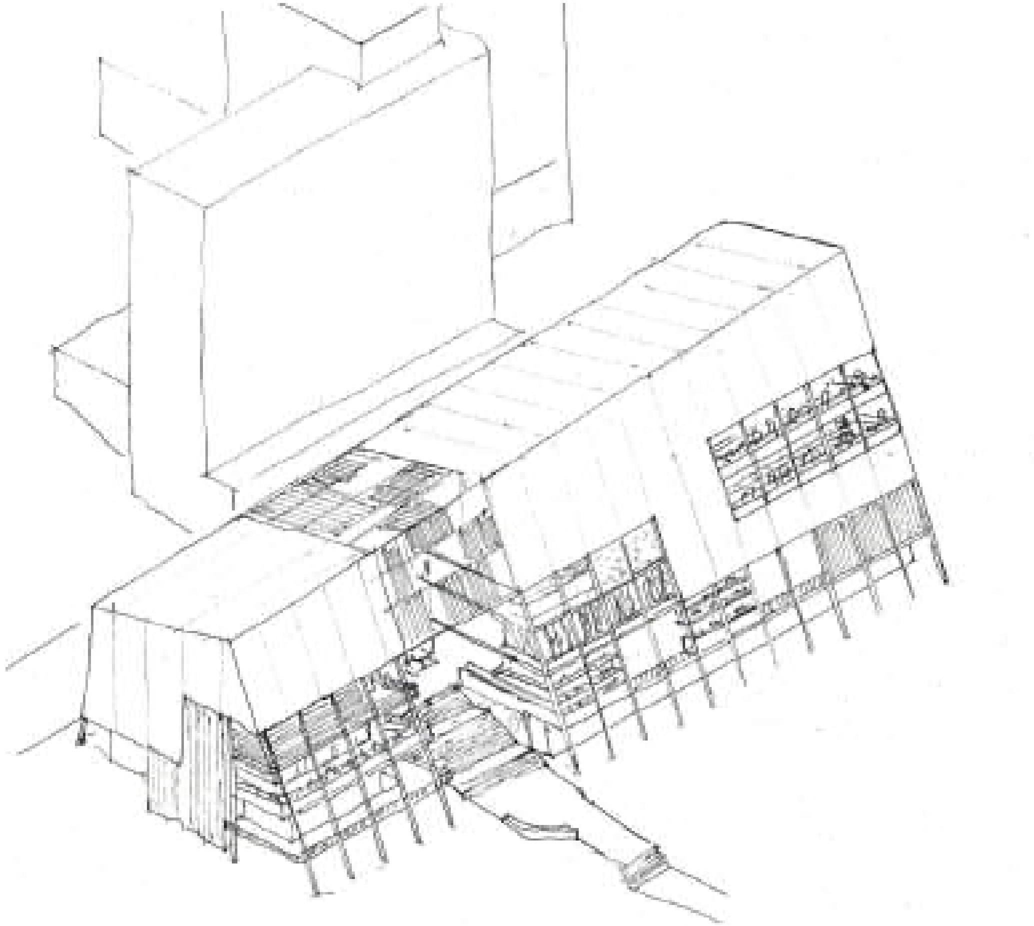
These spaces are meant to mimic outdoor spaces or balconies, and will not be enclosed by a facade. The 'inner wall' will be operable, to create a blurred definition between inside and outside. To protect against winter frost, a covering will be drawn to protect the plants.

5 Mushroom Level

Mushroom growing space will be located in the basement to better controlled temperature and levels of light in these spaces.

The following page features two sketches testing out how the various spaces will relate to the design and character of facade elevation in two instances.





TECHNICAL STUDY

	Growing Requirements							Space Requirements							
	Crop	Grow Method	Space Between Plants (mm)	Temperature (°C)	Sun/Light Hours	Germination (Days)	Time to Harvest (Days)	Weeky Requirement	Ave Yield per Plant	Growth Cycle (Weeks)	Plants Required	Space Requirement per Plant (m^2)	Area Required (m^2)	10% for Failure	Total Area (m^2)
Vegitables	Lettuce	NFT	200	7 - 21	3 - 4	7 - 10	45 - 55	1000 heads	-	5	5000	0.048	240	24	264
	Spinach	NFT	100 - 130	7 - 18	3 - 4	7 - 14	37 -45	1000 heads	-	4	5000	0.048	240	24	264
	Tomato	Dutch Bucket	400 - 450	12 - 18	6 - 8	5 - 12	60 - 90	340kg	5kg per month	4	600	0.3	180	18	198
	Beans	NFT	100 - 150	21 - 26	4 - 5	7 - 14	60 - 90	1000 pods	20	10	500	0.1	50	5	55
	Peas	NFT	100 - 150	12 - 18	4 - 5	7 - 14	60- 70	100 kg	0.05kg	8	6000	0.048	288	28.8	317
	Cucumber	NFT	900	21 - 29	10 - 12	7 - 10	50 - 70	100 kg	2.2 kg	6	545	0.25	136	14	150
	Bell Peppers	Dutch Bucket	450 - 600	18 - 23	14 - 18	7 - 14	50 - 80	400	8	7	350	0.3	105	11	116
													Total Area:		1363

In order to begin designing the building in greater detail I need to gauge how many space is required for growing crops. The above tables calculates an estimated area required based on the growing requirement of a number staple vegetables. The spatial calculation are aimed at supplying enough vegetables for 1000 students per week. While most of the crops are expected to be growing in the traditional vegetable gardens, I feel it is important to have the ability to grow a good quantity of crops indoors, to cover lower yields in the winter season. The above calculation dictates that I should aim for 1400m^2 of vertical farming space, spread between the greenhouse and other growing spaces.

1.5 Acres feeds 800 people per week

7300m2 of farming space

1300m^2 of Vertical Farm + Roughly 6000m^2 of site allocated to crops

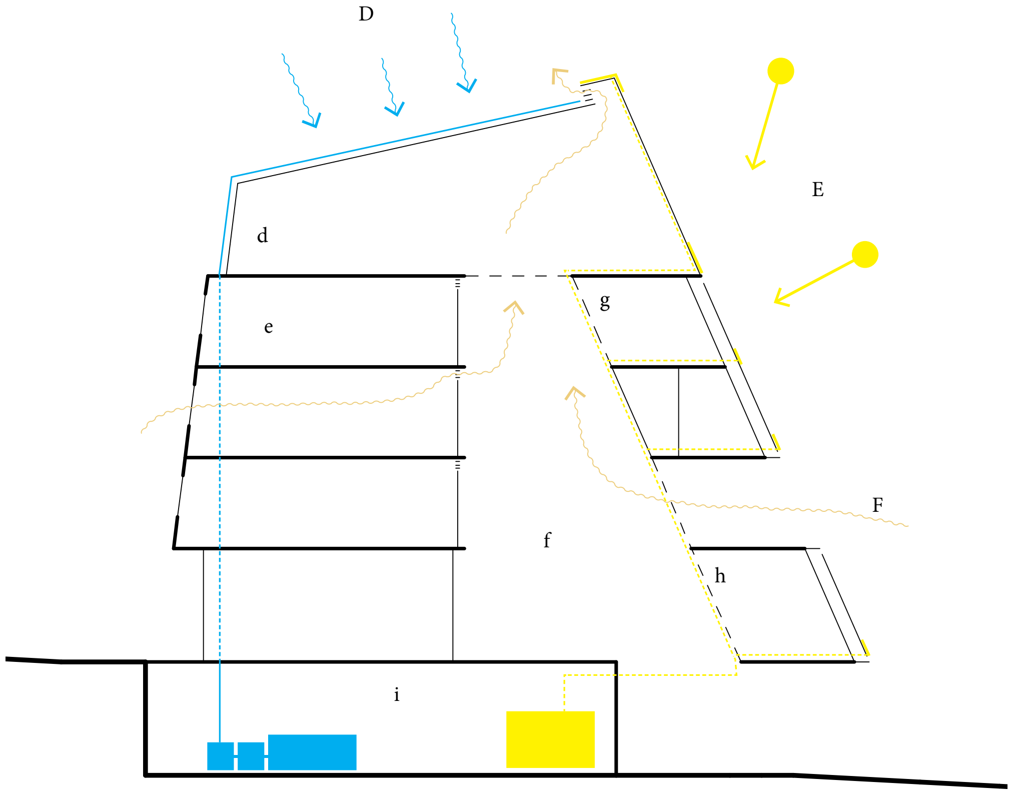
7300m2 = 1.7 acres

The Urban Harvest Facility will have the capacity to feed roughly

963 Students per week

fig. 132. Hydroponics system at Farm District, Eastgate (Author, 2020)

Sustainability



A Naturally Ventilated Greenhouse
B Laboratories and Office spaces
C Central Atrium
D Growing Spaces
E Operable window walls
F Basement Services

1 Rainwater Harvesting

Rainwater be diverted from the greenhouse roof, where it will be collected on the on the south side of building and taken down to the basement. In the basement it will be filtered, and disinfected through the use of an activated charcoal filter system. Water will then be stored, for irrigation purposes.

2 Photovoltaics

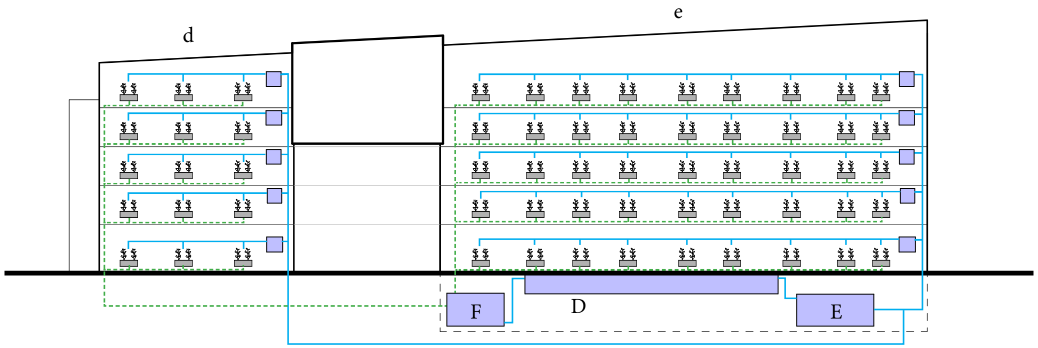
Given the large surface area of the north facade, this is an ideal place to harvest energy from the sun. However, the space within the north facade of the building are growing spaces and require as much sun to penetrate the spaces as possible. For this reason traditional solid PV panels cannot be used as they would block the sun. The building will make use of Building Integrated Photovoltaics (BIPV), these semi-transparent PV panels will replace the glazing modules in strategically chosen places in the facade. This will ensure that as much sun is penetrates where it is most needed.

3 Natural Ventilation

The top floor will house a naturally heated and ventilated greenhouse, this ensure that the temperature can be controlled without the use of energy draining cooling and heating systems. The growing spaces located on lower floors are smaller and thus likely to heat up quickly, the spaces will feature a double-skin facade system providing an additional level of temperature control. The teaching and laboratory spaces will be naturally ventilated. Air will be allowed to penetrate these spaces, and through to the atrium where heated air will escape through operable vents in the roof.

fig. 133. Building Integrated Photovoltaic panel used in skylight design (Unknown, n.d)

Aquaponics



Aquaponic System

The supply of nutrient solution (water from fish ponds) works on a closed loop system. This is ensure a maximum efficiency of water use.

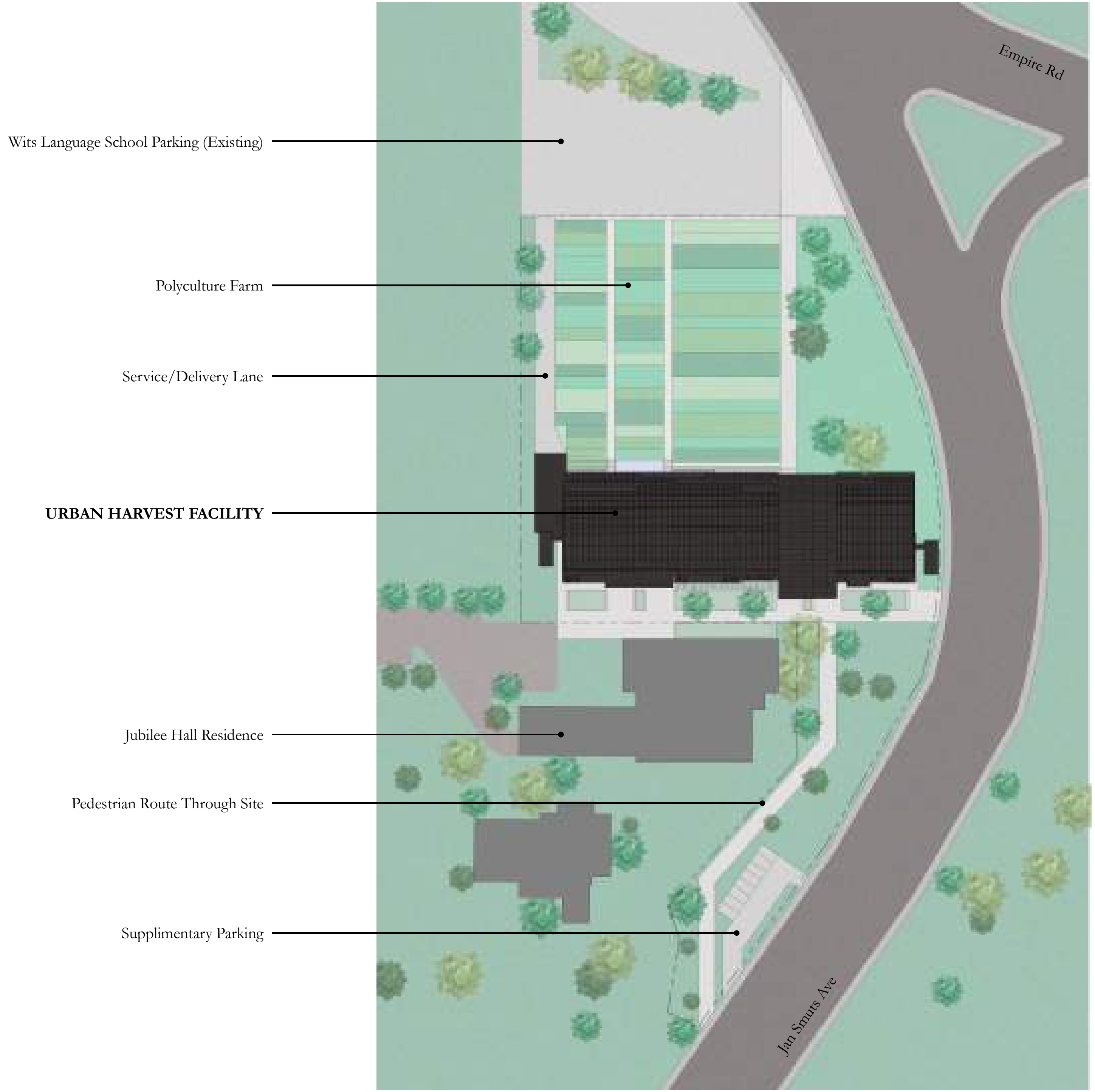
Fish ponds are chosen in place of fish tanks, and located in the central atrium. By do this the raising of fish becomes an ornamental feature of the building rather than being just a farming process. The fish ponds will also assist in cooling the central atrium.

Supply Water
Return Water

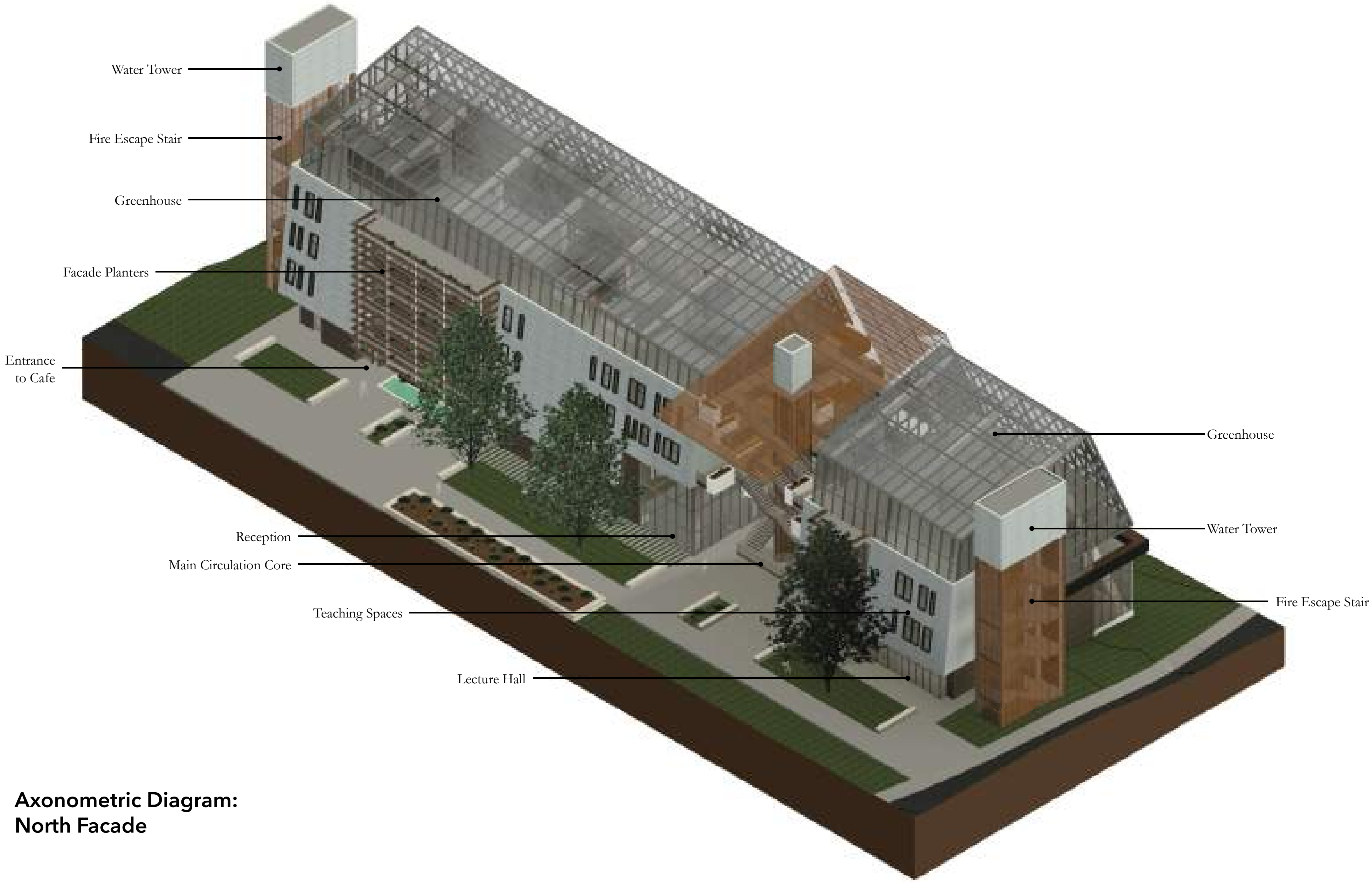
A Public Education Growing Spaces
B Vertical Farm / Research Growing Spaces

1 Central Atrium Fish Ponds
2 Storage Tanks
3 Return Storage Tanks

DESIGN DRAWINGS

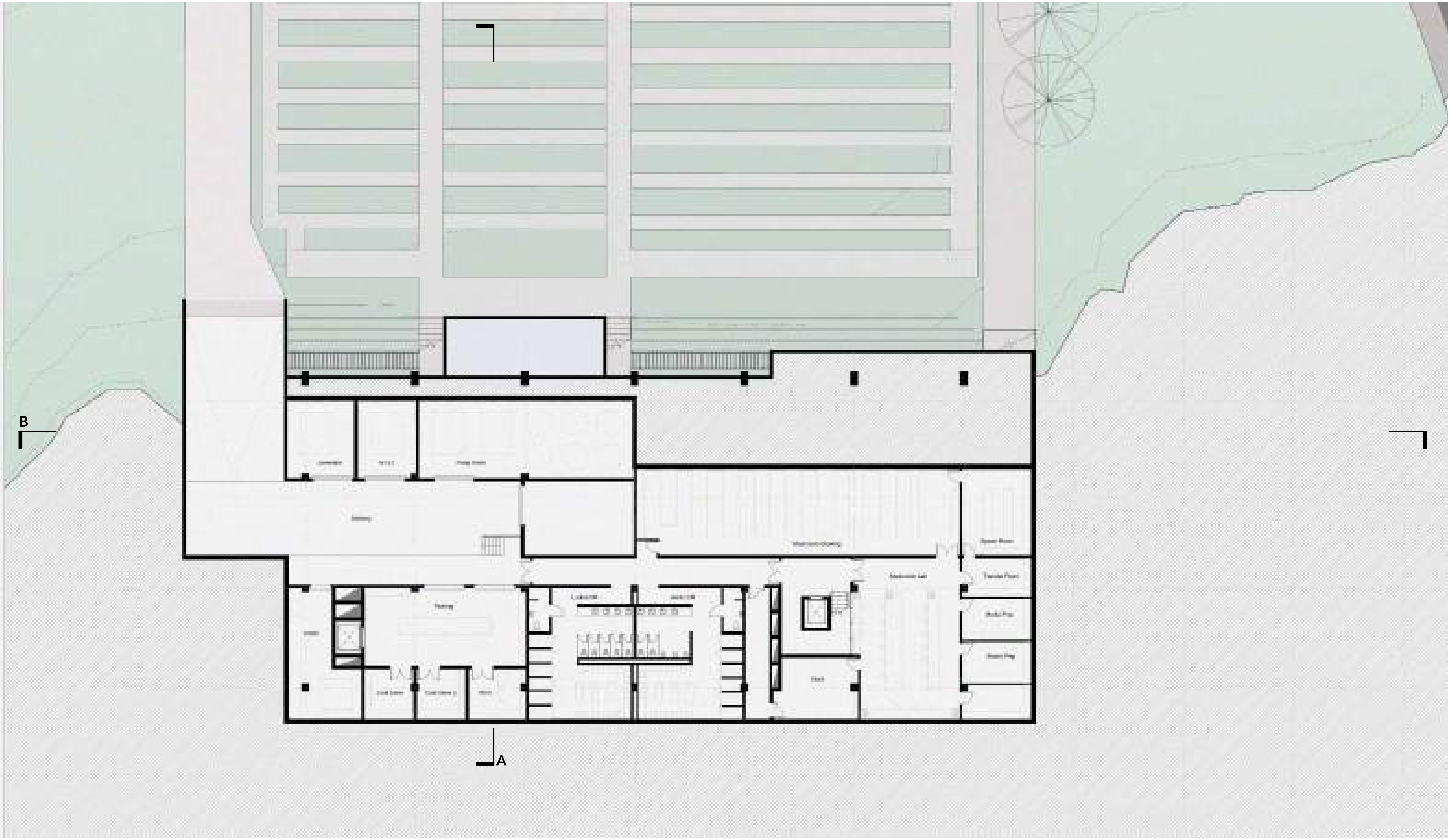

Wits Language School Parking (Existing)
Polyculture Farm
Service/Delivery Lane
URBAN HARVEST FACILITY
Jubilee Hall Residence
Pedestrian Route Through Site
Supplimentary Parking
Empire Rd
Jan Smuts Ave

Site Plan



Axonometric Diagram:
North Facade

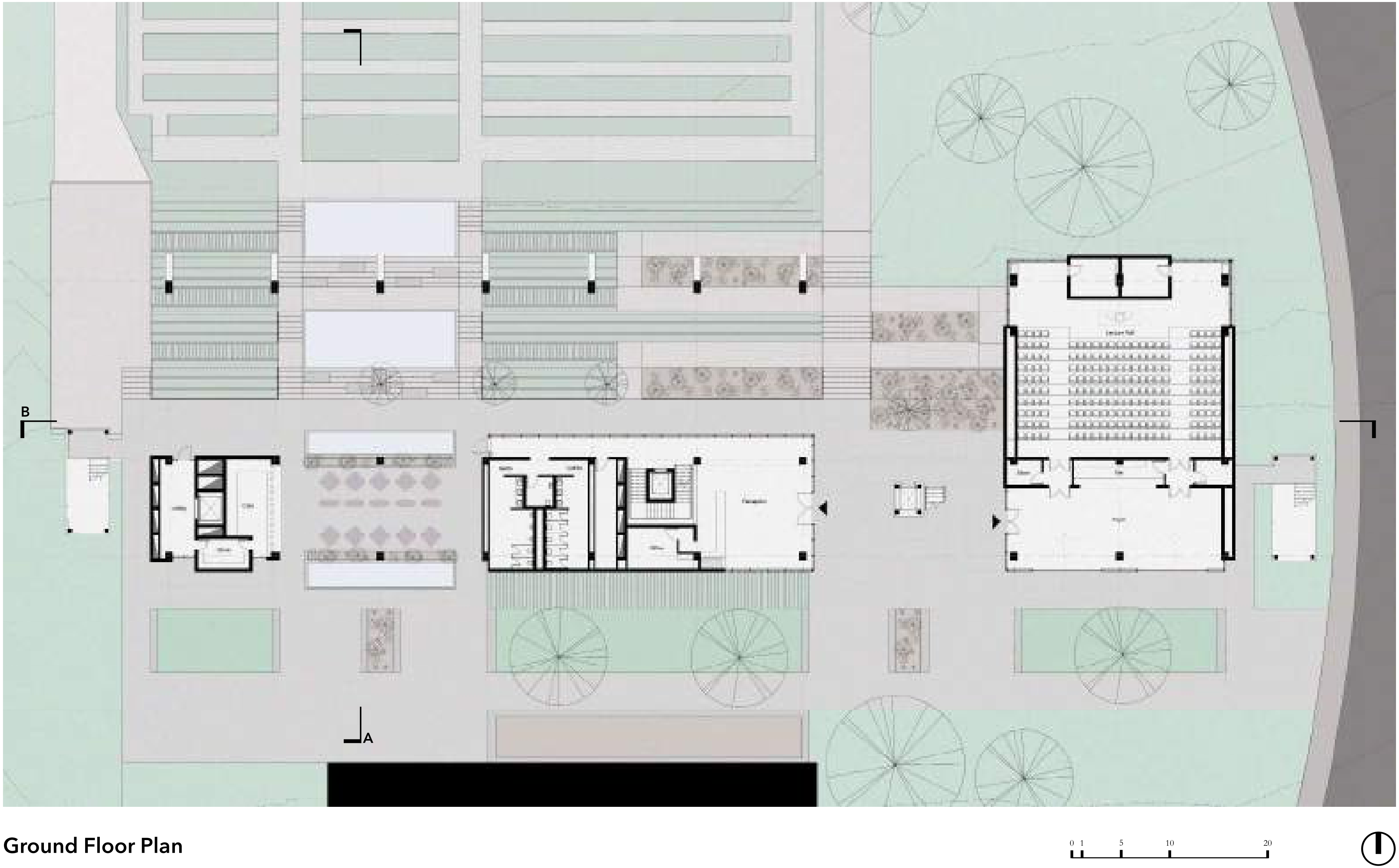
Axonometric Diagram: South Facade



Basement Floor Plan

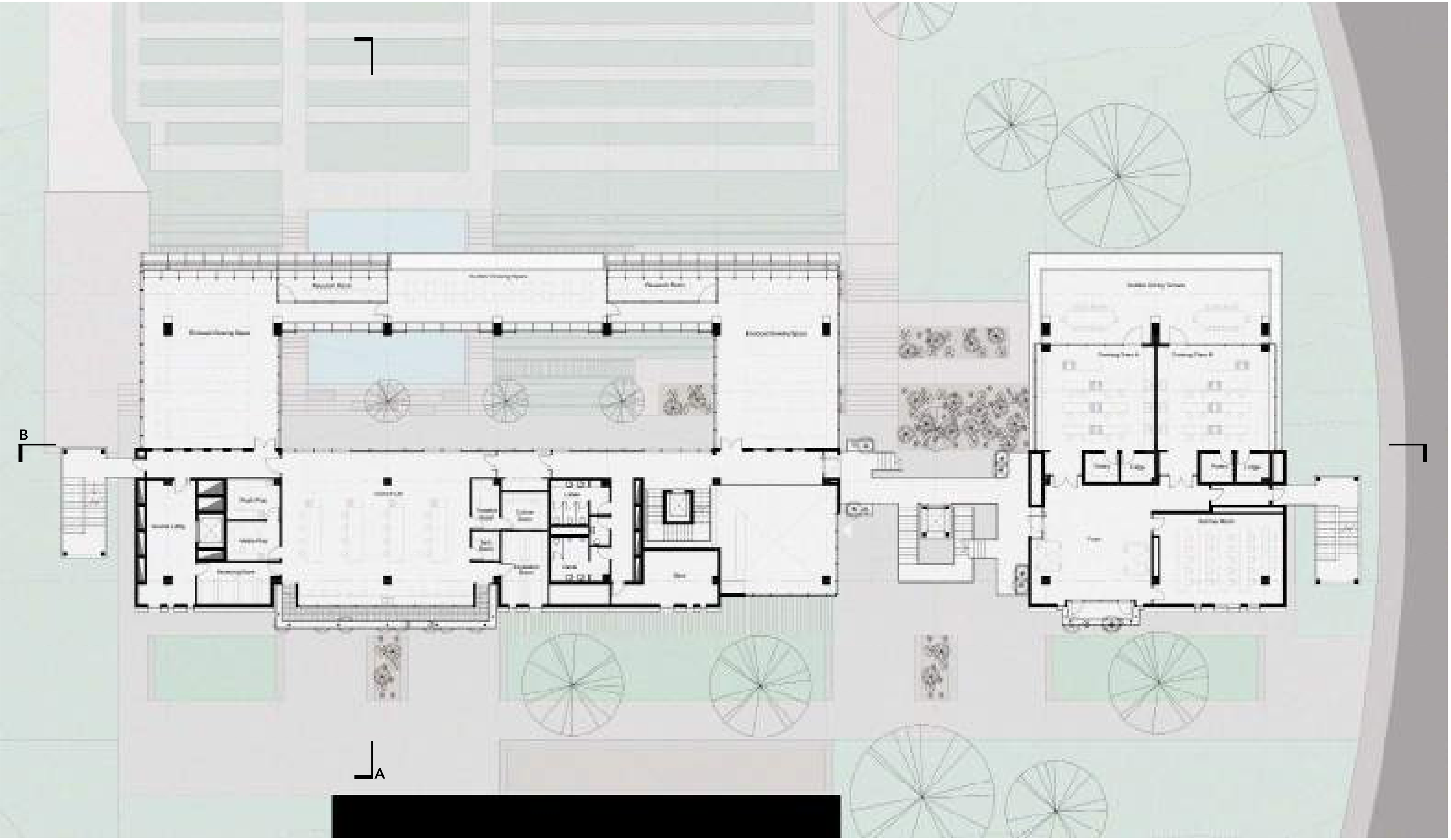
0 1 5 10 20

fig. 134. View of Urban Harvest facility looking north from polyculture gardens (Author, 2020)



Ground Floor Plan

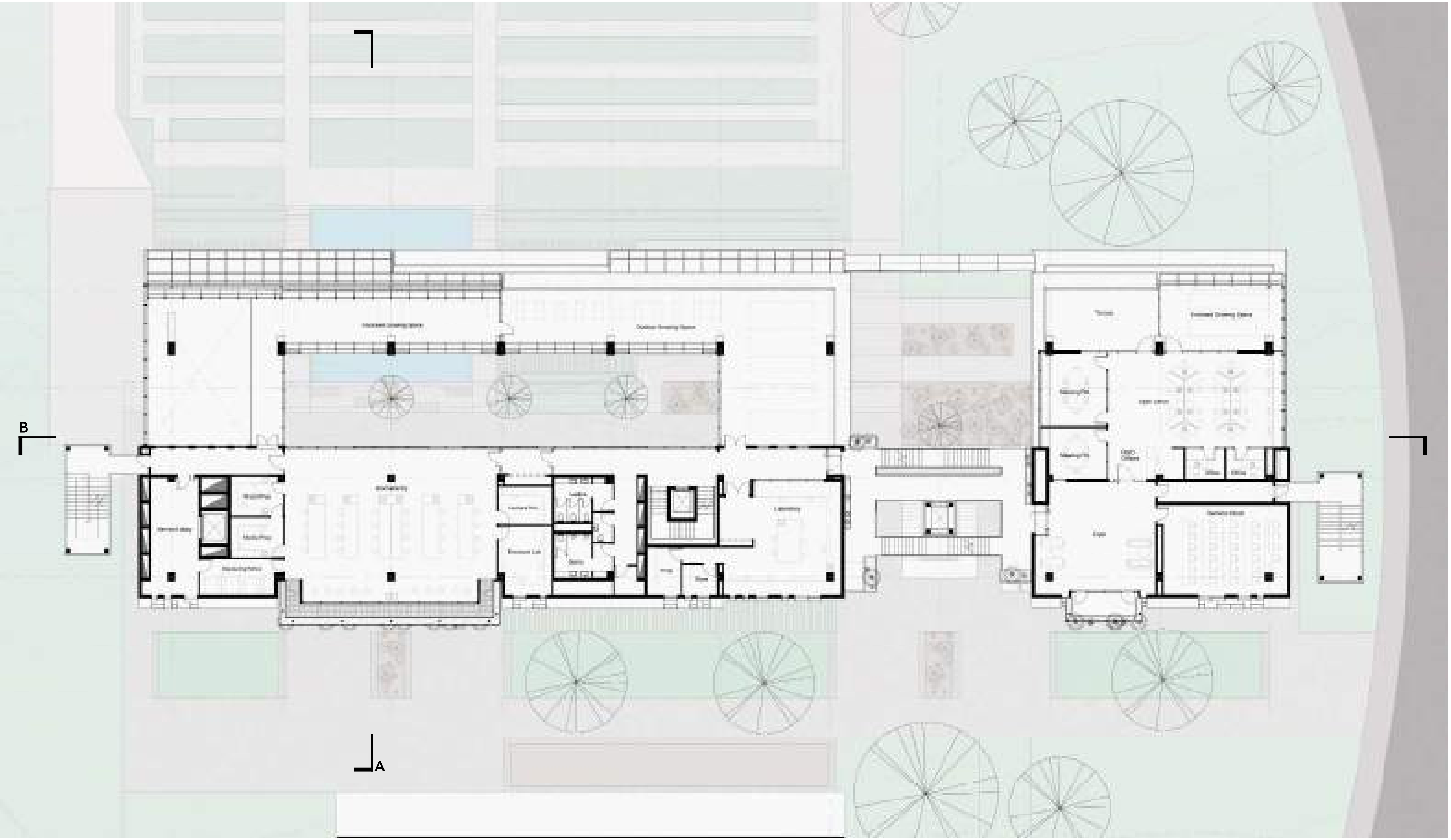
fig. 135. View looking south towards Cafe seating and central atrium space (Author, 2020)



First Floor Plan

0 1 5 10 20

fig. 136. View looking south towards main circulation core (Author, 2020)



Second Floor Plan

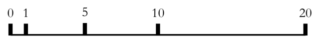
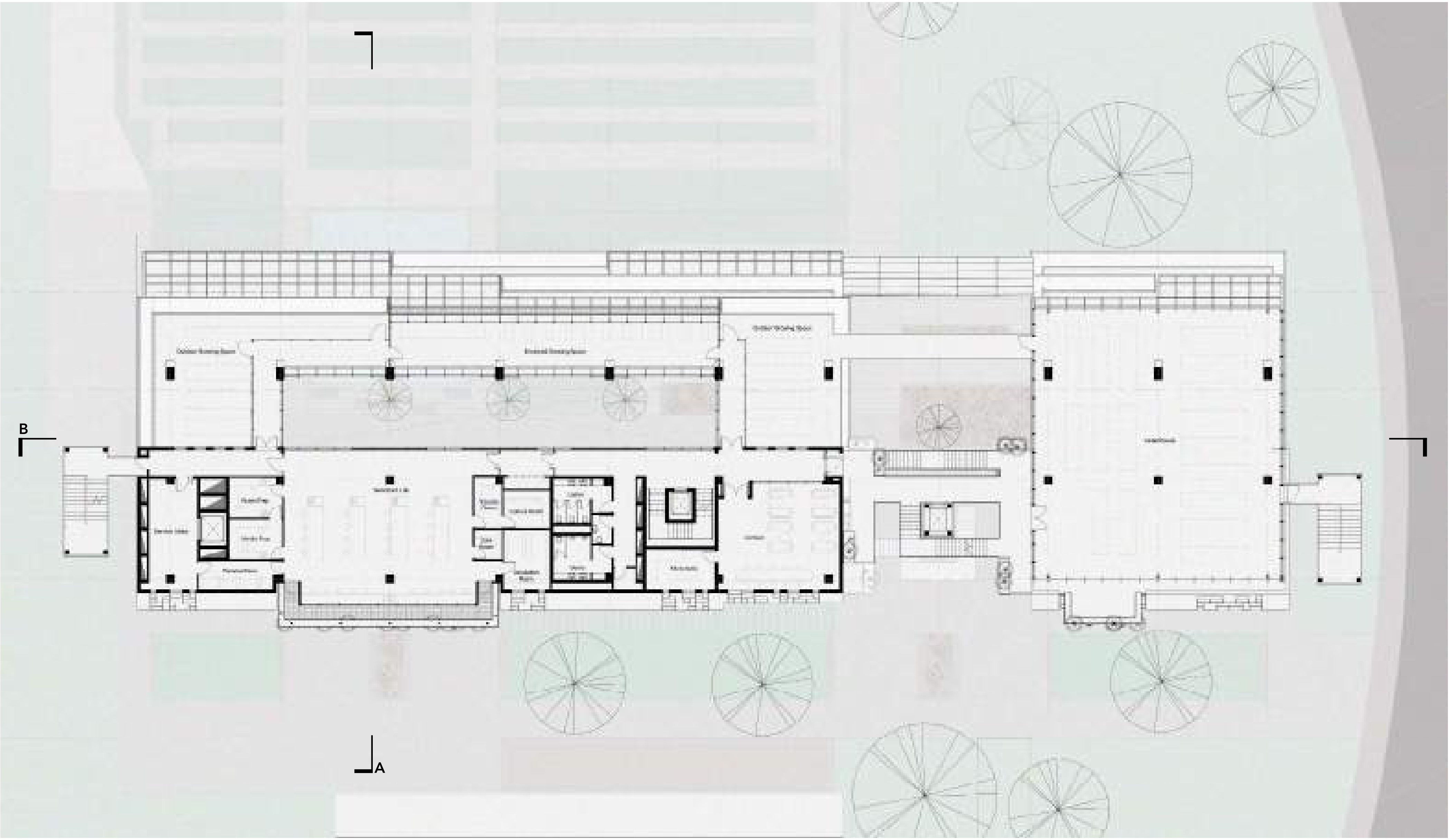
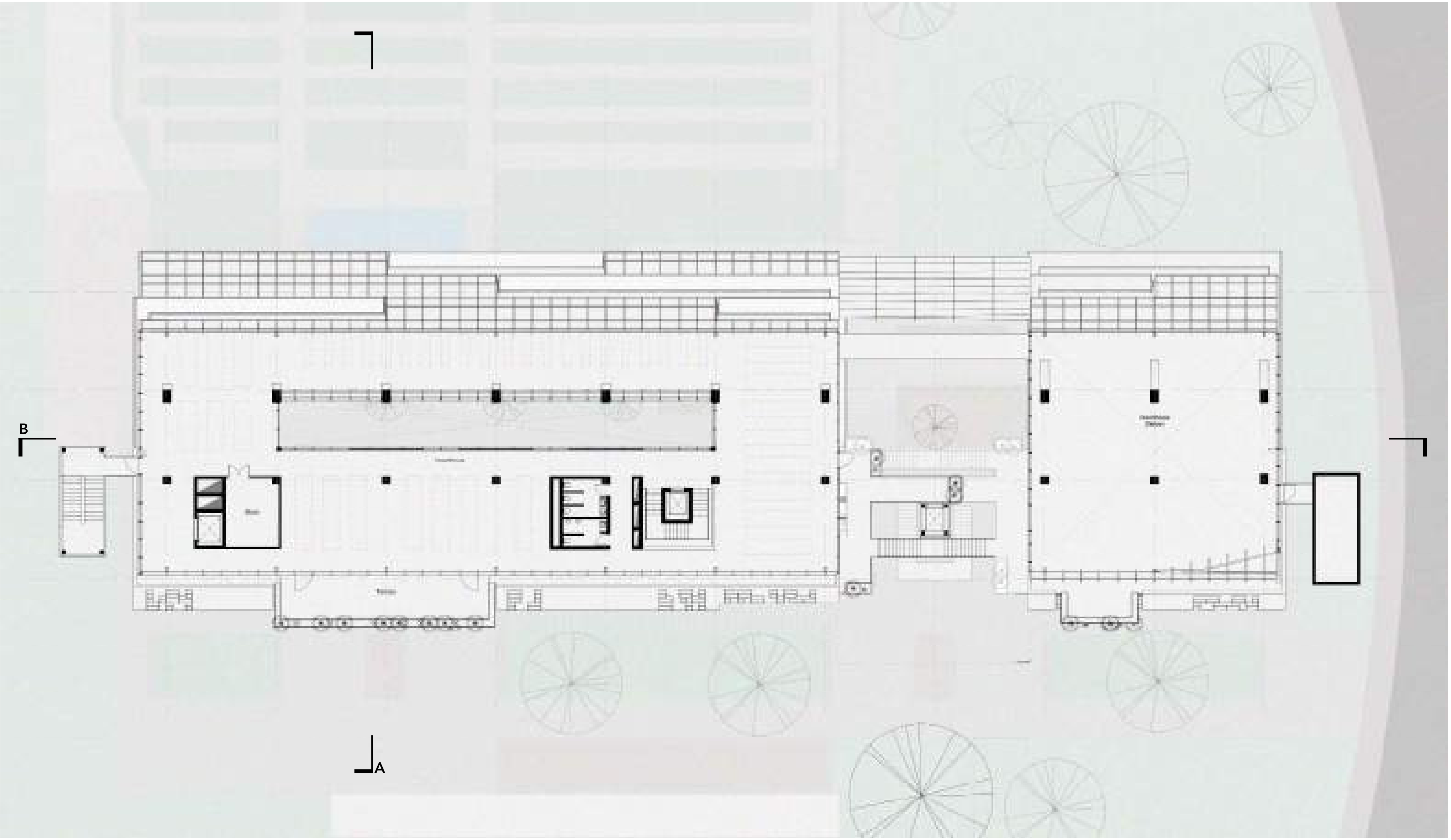


fig. 137. View inside one of the indoor 'controlled' growing spaces (Author, 2020)

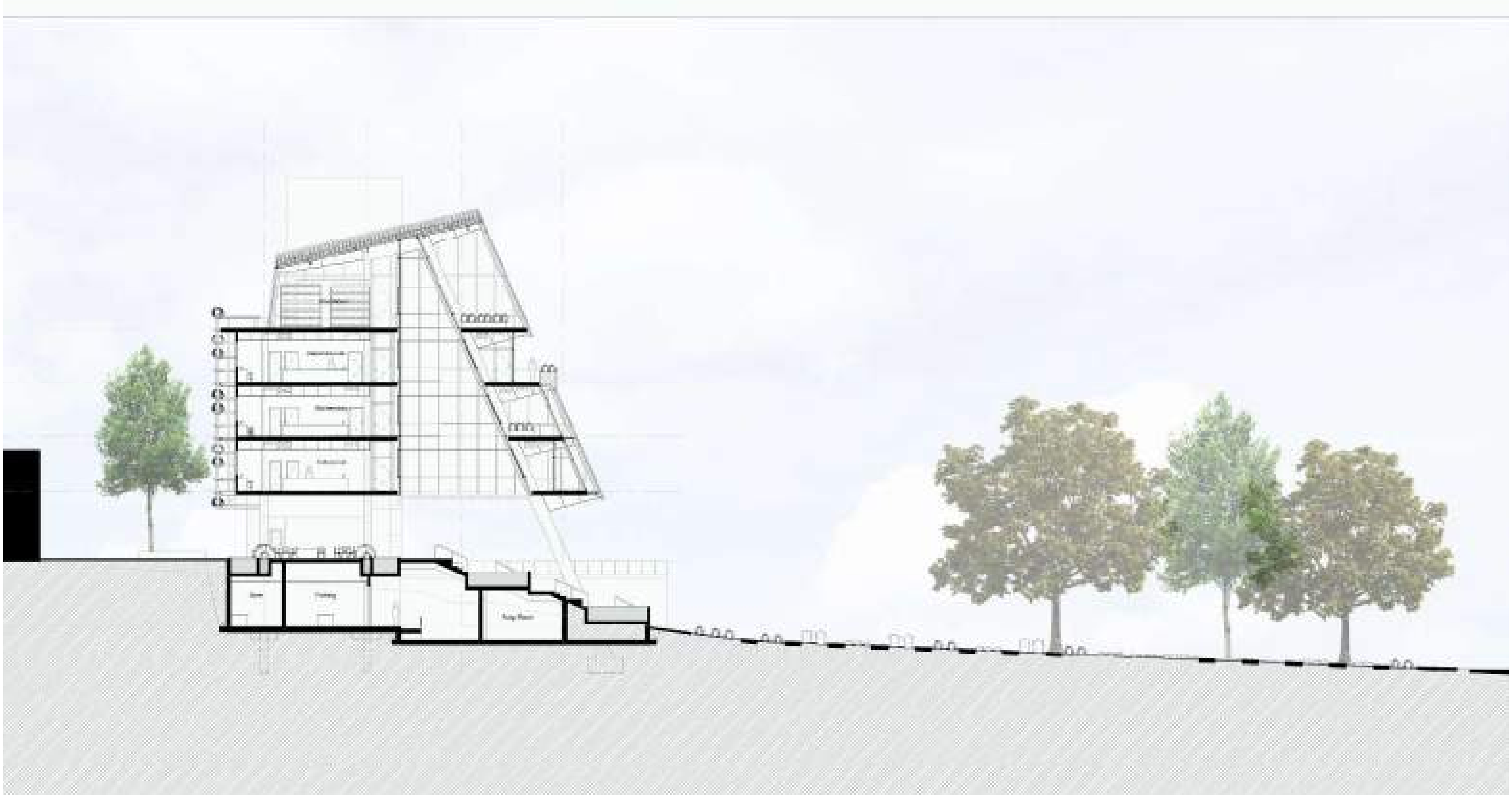


Third Floor Plan

0 1 5 10 20



Fourth Floor Plan

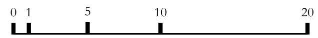


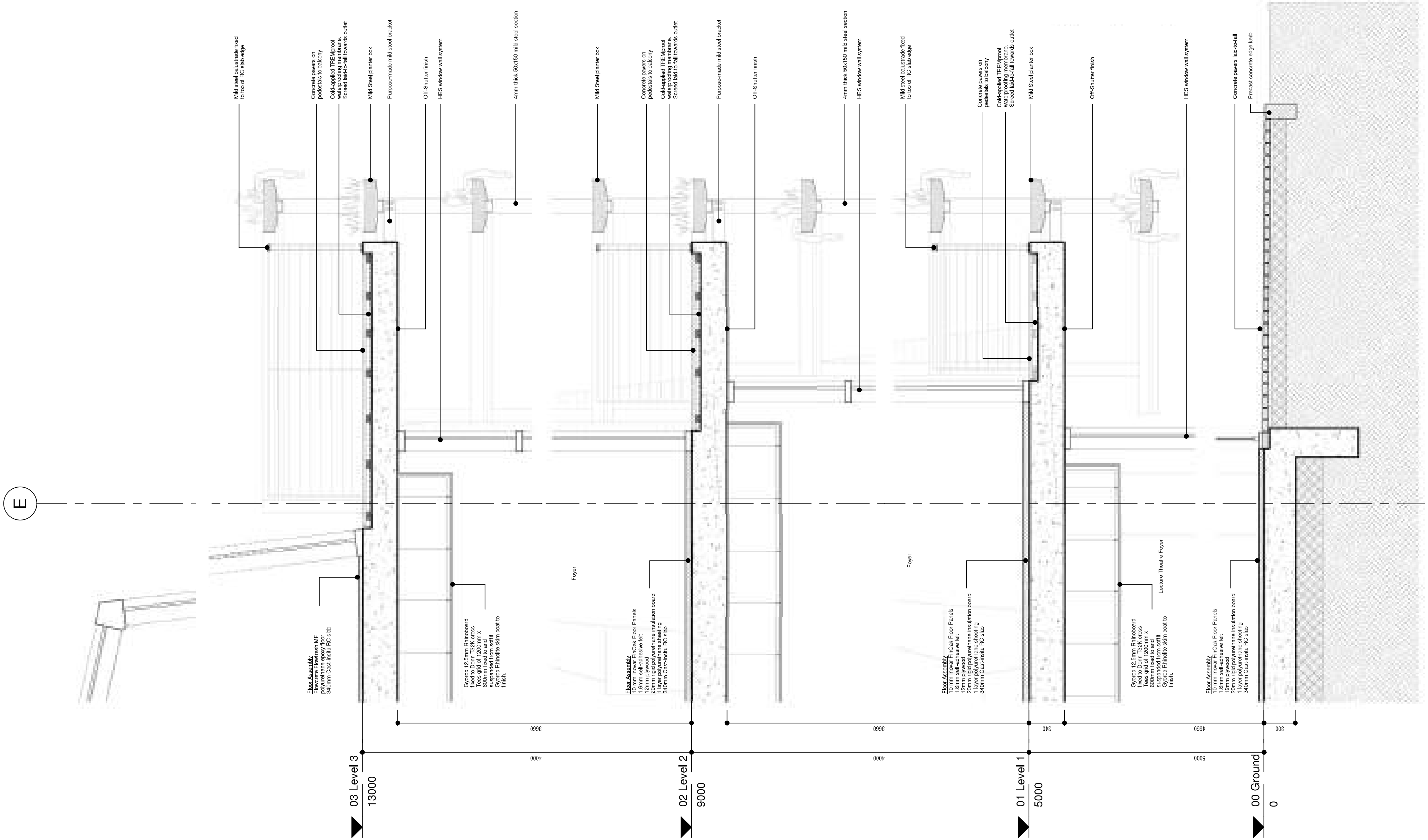
Section A-A

0 1 5 10 20

fig. 138. View inside the central atrium space (Author, 2020)

Section B-B

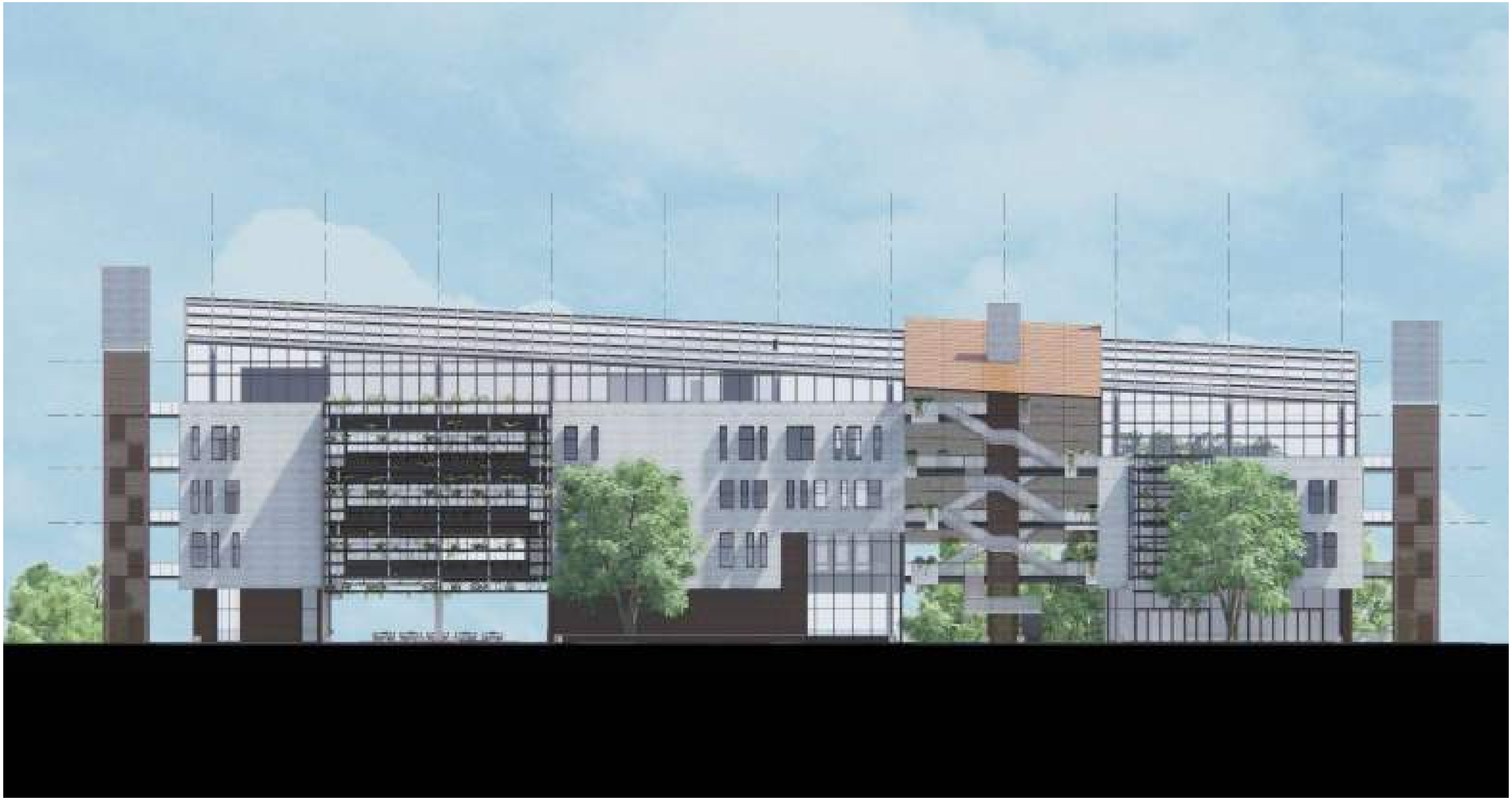




Perimeter Section C

South Elevation

0 1 5 10 20



North Elevation

0 1 5 10 20

06

APPENDICES

References

A Green Corner in Inner City [WWW Document], 2011. URL https://www.joburg.org.za/media_/Newsroom/Pages/2013%20articles/2011%20&%202012%20%20Articles/A-green-corner-in-inner-city-.aspx (accessed 5.25.20).
AAH, 2018. World Hunger: Key Facts and Statistics 2020 [WWW Document]. Action Against Hunger. URL https://www.actionagainsthunger.org/world-hunger-facts-statistics (accessed 9.17.20).
ABS, 2009. Sports and Physical Recreation: A Statistical Overview, Australia, 2009 [WWW Document]. URL https://www.abs.gov.au/ausstats/abs@.nsf/Latestproducts/B5D299DFC7E472BECA2576570015CD19?opendocument (accessed 8.9.20).
Adler, D., 2016. Story of cities #37: how radical ideas turned Curitiba into Brazil's "green capital." The Guardian.
Al-Kaisi, M., 2004. Frequent tillage and its impact on soil quality. A Technical Assessment of Non-point Pollution in Iowa.
Andrews, 2013. Pasona Urban Farm by Kono Designs [WWW Document]. Dezeen. URL https://www.dezeen.com/2013/09/12/pasona-urban-farm-by-kono-designs/ (accessed 5.25.20).
Anon., 2013. Myanmar's Inle Lake Shows Bridge to Ancient Hydroponic Farming Systems. URL https://inhabitat.com/myanmars-inle-lake-shows-bridge-to-ancient-hydroponic-farming-systems/ (accessed 4.8.20).
Baraniuk, C., 2017. How vertical farming reinvents agriculture [WWW Document]. BBC Future. URL https://www.bbc.com/future/article/20170405-how-vertical-farming-reinvents-agriculture (accessed 4.15.20).
Bellows, A., Brown, K., Smit, J., 2008. Health Benefits of Urban Agriculture.
Benyus, J.M., 1997. Biomimicry: Innovation Inspired by Nature. Perennial, New York.
Bernett, A., 2017. Biomimicry vs. biophilia: A primer [WWW Document]. GreenBiz. URL https://www.greenbiz.com/article/biomimicry-vs-biophilia-primer (accessed 2.29.20).
Birth of Farming, 2012. . Mankind: The Story of All of Us.
Brillembourg, A., 2011. Urban acupuncture.
Browning, B., 2018. Biophilic Design, More Than Just Plants! Terrapin Bright Green. URL https://www.terrapinbrightgreen.com/blog/2018/09/biophilic-design-just-plants/ (accessed 3.19.20).
Browning, W., Ryan, C., Clancy, J., 2014. 14 Patterns of Biophilic Design.
Brundtland, G.H., 1987. Our Common Future: Report of the World Commission on Environment and Development. (United Nations General Assembly document A/42/427).
Casagrande, M., n.d. Paracity: Urban Acupuncture.
CFC, n.d. Food Security vs Food Sovereignty [WWW Document]. URL https://changeforchildren.org/wp-content/uploads/2016/06/Food-Security-vs-Food-Sovereignty.pdf (accessed 9.18.20).
Chastain, B.B., n.d. Jan Baptista van Helmont | Belgian scientist. Encyclopedia Britannica.
Chatterjee, R., 2016. Where Did Agriculture Begin? Oh Boy, It's Complicated [WWW Document]. NPR.org. URL https://www.npr.org/sections/thesalt/2016/07/15/485722228/where-did-agriculture-begin-oh-boy-its-complicated (accessed 6.7.20).
Clouse, C., 2014. Cuba's Urban Farming Revolution: How to Create Self-Sufficient Cities. Architectural Review. URL https://www.architectural-review.com/essays/cubas-urban-farming-revolution-how-to-create-self-sufficient-cities (accessed 8.31.20).
Cox, A., 2012. Joburg launches first rooftop farm plan [WWW Document]. URL https://www.iol.co.za/the-star/joburg-launches-first-rooftop-farm-plan-11558958 (accessed 9.1.20).
Davie, L., 2018. Urban Agriculture Initiative. The Johannesburg Inner City Partnership. URL https://www.jicp.org.za/urban-agriculture-initiative/ (accessed 9.1.20).
de Monchaux, N., 2009. Local Code : San Francisco - Nicholas de Monchaux [WWW Document]. URL http://demonchaux.com/Local-Code-San-Francisco (accessed 4.2.20).
de Monchaux, N., Patwa, S., Golder, B., Jensen, S., Lung, D., 2010. Local Code: the Critical Use of Geographic Information Systems in Parametric Urban Design, in: ACADIA, ACADIA. Cooper Union, Pratt Institute, New York, pp. 234–242.
Despommier, D.D., 2017. The Vertical Farm: Interview with The New Yorker.
Despommier, D.D., 2015. Rationale for Vertical Farms. The Vertical Farm. URL http://www.verticalfarm.com/?page_id=36 (accessed 4.15.20).
Despommier, D.D., Ellingson, E., 2008. The Vertical Farm: The sky-scraper as vehicle for a sustainable urban agriculture. Presented at the CTBUH 8th World Congress, Dubai.
Doval, C., 2018. What is sustainable agriculture [WWW Document]. Agricultural Sustainability Institute. URL https://asi.ucdavis.edu/programs/ucsarep/about/what-is-sustainable-agriculture (accessed 6.7.20).
Fabrizi, M., 2014. Gordon Matta-Clark's "Reality Properties: Fake Estates" (1973) [WWW Document]. SOCKS. URL http://socks-studio.com/2014/10/22/gordon-matta-clarks-reality-properties-fake-estates-1973/ (accessed 4.2.20).

FAO, 2020. THE STATE OF FOOD SECURITY AND NUTRITION IN THE WORLD 2020 [WWW Document]. https://doi.org/10.4060/CA9692EN
Felstead, A., 2012. Mithun Center for Urban Agriculture. URL https://www.foodurbanism.org/mithun-center-for-urban-agriculture/ (accessed 5.26.20).
Fitzgerald, C.J., Danner, K.M., 2012. Evolution in the Office: How Evolutionary Psychology Can Increase Employee Health, Happiness, and Productivity. Evol Psychol 10, 147470491201000500. https://doi.org/10.1177/147470491201000502
Folds, E., 2018. The History of Hydroponics [WWW Document]. Medium. URL https://medium.com/@evanfolds/the-history-of-hydroponics-99eb6628d205 (accessed 4.8.20).
Food Secure Canada, 2013. What is Food Sovereignty [WWW Document]. Food Secure Canada. URL https://foodsecurecanada.org/who-we-are/what-food-sovereignty (accessed 9.18.20).
Frazier, I., 2017. The Vertical Farm. The New Yorker.
French, A., Roth, E., 2019. Soilless Agriculture: An In-depth Overview [WWW Document]. AGRITECTURE. URL https://www.agritecture.com/blog/2019/3/7/soilless-agriculture-an-in-depth-overview (accessed 4.8.20).
Gericke, W.F., 1940. The complete guide to soilless gardening. Prentice-Hall, Inc., New York.
Gliessman, S.R., 2020. Agriculture, Modern | Encyclopedia.com. Encyclopedia.
Gomiero, T., Pimentel, D., Paoletti, M., 2011. Environmental Impact of Different Agricultural Management Practices: Conventional vs. Organic Agriculture. Critical Reviews in Plant Sciences 30, 95–124. https://doi.org/10.1080/07352689.2011.554355
Gordillo, G., Mendez Jeronimo, O., n.d. Food Security and Sovereignty.
Gould, D., Caplow, T., 2012. 8 - Building-integrated agriculture: a new approach to food production, in: Zeman, F. (Ed.), Metropolitan Sustainability, Woodhead Publishing Series in Energy. Woodhead Publishing, pp. 147–170. https://doi.org/10.1533/9780857096463.2.147
Heerwagen, J., H., Gregory, B., 2008. Biophillia and Sensory Aesthetics, in: Biophilic Design : The Theory, Science, and Practice of Bringing Buildings to Life. Wiley, Hoboken, N.J., pp. 227–254.
Hershey, D.R., 1994. Solution Culture Hydroponics: History & Inexpensive Equipment. The American Biology Teacher 56, 111. https://doi.org/10.2307/4449764
Ibelings, H., 2008. Urbanity, in: A Matter of Things. NAi Publishers, Rotterdam, pp. 10–17.
Kellert, S.R., Heerwagen, J., Mador, M., 2008. Biophilic design: The theory, science, and practice of bringing buildings to life. Wiley, Hoboken, N.J.
Kim, J., 2007. Enter Yuffies - Center for Urban Agriculture - [WWW Document]. World-Architects. URL https://www.world-architects.com/en/architecture-news/reviews/enter-yuffies-center-for-urban-agriculture (accessed 5.26.20).
Klepeis, N.E., Nelson, W.C., Ott, W.R., Robinson, J.P., Tsang, A.M., Switzer, P., Behar, J.V., Hern, S.C., Engelmann, W.H., 2001. The National Human Activity Pattern Survey (NHAPS): a resource for assessing exposure to environmental pollutants. J Expo Sci Environ Epidemiol 11, 231–252. https://doi.org/10.1038/sj.jea.7500165
Kozai, T., 2013. Resource use efficiency of closed plant production system with artificial light: Concept, estimation and application to plant factory., in: Proceedings of the Japan Academy, Series B, Physical and Biological Sciences. Presented at the Japan Academy Series B, Physical and Biological Sciences., pp. 447–461.
Laugier, M.-A., 1977. An essay on architecture. Henneessey & Ingalls, Los Angeles.
Lerner, J., 2007. A song of the city. Monterey, California.
Li, N.P., Vugt, M. van, Colarelli, S.M., 2017. The Evolutionary Mismatch Hypothesis: Implications for Psychological Science: Current Directions in Psychological Science. https://doi.org/10.1177/0963721417731378
Luuk, G., Beaza, E., van Den Dobbelsteen, A., Tsafaras, I., Stanghellin, C., 2017. Plant factories versus greenhouses: Comparison of resource use efficiency. Agricultural Systems 160, 31–41.
Macnab, M., 2011. Design By Nature: Using Universal Forms and Principles in Design. New Riders Publishing, Berkeley.
Malan, N., 2015. Urban farmers and urban agriculture in Johannesburg: Responding to the food resilience strategy. Agrekon 54, 51–75.
Miller, K., 2011. Urban Acupuncture: Revivifying Our Cities Through Targeted Renewal. Kyle Miller MSIS. URL https://kylemillermsis.wordpress.com/2011/09/25/urban-acupuncture-revivifying-our-cities-through-targeted-renewal/ (accessed 4.1.20).
Mithun, n.d. Center for Urban Agriculture [WWW Document]. Mithun. URL https://mithun.com/project/center-for-urban-agriculture/ (accessed 5.26.20).
Müller, B., 2009. Narrating Urban Acupuncture[s] 10.
Murphy, C., Pinderhughes, R., Gonzalez, M., 2000. Urban Agriculture in Havana, Cuba.
Never Ending Food, N.E.F., n.d. Permaculture. Never Ending Food. URL http://www.neverendingfood.org/b-what-is-permaculture/ (accessed 2.22.20).

Nogeire-McRae, T., Ryan, E.P., Jablonski, B.B.R., Carolan, M., Arathi, H.S., Brown, C.S., Saki, H.H., McKeen, S., Lapansky, E., Schipanski, M.E., 2018. The Role of Urban Agriculture in a Secure, Healthy, and Sustainable Food System. BioScience 68, 748. https://doi.org/10.1093/biosci/biy071
Olomari, T., 2019. Cuba's Agricultural Lessons to Haiti [WWW Document]. Medium. URL https://medium.com/@TensaiAkagari/cubas-agricultural-lessons-to-haiti-2a2f2dc8a4a4 (accessed 8.31.20).
Pasotti, J., 2019. Hard-hit by climate change, Bangladesh finds solution in floating gardens [WWW Document]. Deutsche Welle - DW.COM. URL https://www.dw.com/en/hard-hit-by-climate-change-bangladesh-finds-solution-in-floating-gardens/a-47304742 (accessed 4.8.20).
Paul, R., 2008. The GreenHouse Project: Sustainable Living in Johannesburg. URL https://inhabitat.com/the-greenhouse-project-sustainable-living-in-johannesburg/ (accessed 5.25.20).
Plaskoff Horton, R., 2018. These Six Urban Farms Creatively Transform Disused Spaces [WWW Document]. Urban Gardens. URL https://www.urbangardensweb.com/2018/02/02/five-urban-farms-creatively-transform-disused-spaces/ (accessed 5.25.20).
Quillen, A., 2015. Growing Soilless. Made by CustomMade. URL https://www.custommade.com/blog/introduction-to-hydroponics/ (accessed 4.8.20).
Quirk, V., 2012. Urban Agriculture Part II: Designing Out the Distance. ArchDaily. URL http://www.archdaily.com/238382/urban-agriculture-part-ii-designing-out-the-distance/ (accessed 6.8.20).
Rose, S., 2019. The Circle of Life - The New Alchemists: could the past hold the key to sustainable living? URL https://www.theguardian.com/lifeandstyle/ng-interactive/2019/sep/29/the-new-alchemists-could-the-past-hold-the-key-to-sustainable-living (accessed 2.21.20).
Salingaros, N.A., 2015. BIOPHILIA & HEALING ENVIRONMENTS 44.
Santo, R., Palmer, A., Kim, B., 2016. Vacant Lots to Vibrant Plots: A Review of the Benefits and Limitations of Urban Agriculture. Johns Hopkins Center for A Livable Future.
Satgar, V., 2018. Students promote gardening on campus.
Siegel, E., 2013. Dirt-Free Farming: Will Hydroponics (Finally) Take Off? Modern Farmer. URL https://modernfarmer.com/2013/06/dirt-free-farming-will-hydroponics-finally-take-off/ (accessed 4.8.20).
Solà-Morales, M. de, 2008. A Matter of Things, in: A Matter of Things. NAi Publishers, Rotterdam, pp. 17–30.
Solà-Morales, M. de, Frampton, K., Ibelings, H., 2008. A matter of things. NAi Publishers, Rotterdam.
StatsSA, S.S.A., 2019. The Extent of Food Security in South Africa | Statistics South Africa. URL http://www.statssa.gov.za/?p=12135 (accessed 9.17.20).
The B1M, 2019. Growing Up: How Vertical Farming Works. The B1M Limited.
Todd Henaut, D., 1974. The New Alchemists. National Film Board of Canada.
Todd, J., 1974. The New Alchemists. National Film Board of Canada.
Turner, B., 2008. How Hydroponics Works [WWW Document]. HowStuffWorks. URL https://home.howstuffworks.com/lawn-garden/professional-landscaping/hydroponics.htm (accessed 4.8.20).
Venture City, 2019. Why the Future of Farming is in Cities - The Big Money in Vertical Farming. Venture City.
von Bormann, T., 2019. Agri-food Systems: Facts and Futures: How South Africa can produce 50% more by 2050. WWF South Africa, Cape Town.
Wahl, D.C., 2017. The New Alchemy Institute: pioneers of ecological design. Medium. URL https://medium.com/age-of-awareness/the-new-alchemy-institute-d0992ce33a68 (accessed 2.22.20).
Walker, J., 2015. Biophilic Urban Acupuncture: The Importance of Biophilia in Urban Places. Terrapin Bright Green. URL https://www.terrapinbrightgreen.com/blog/2015/10/biophilic-urban-acupuncture-biophilia-in-urban-places/ (accessed 3.1.20).
Warnes, K., PhD, 2019. Urban agriculture. Salem Press Encyclopedia.
Wilson, E.O., 1995. Biophillia and the Conservation Ethic, in: Kellert, S.R., Wilson, E.O. (Eds.), The Biophillia Hypothesis. Island Press, pp. 31–41.
Zimmer, C., 2016. How the First Farmers Changed History. The New York Times.

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