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chapter four

culture and industry

From the background study, urban framework and site investigation, research was conducted to meet the project aims of creating an architecture that helps generate productive urban landscapes and societies.

The investigation first led to an understanding of what such a society would be and on what scales the building can facilitate this.

Next, the potential and feasibility of the program was investigated and a model for vertical agriculture (in the form of a hydroponic factory) was developed for the old coal bunker. Suitable clients are proposed to approach with the project.

Lastly, the heritage status of the site together with the project aims and the heritage position, the design demanded that an adaptive re-use strategy be taken.

The knowledge collected on vertical agriculture, methods, requirements and energy systems together with heritage position and the greater project aims directed the design development further.

productive landscape

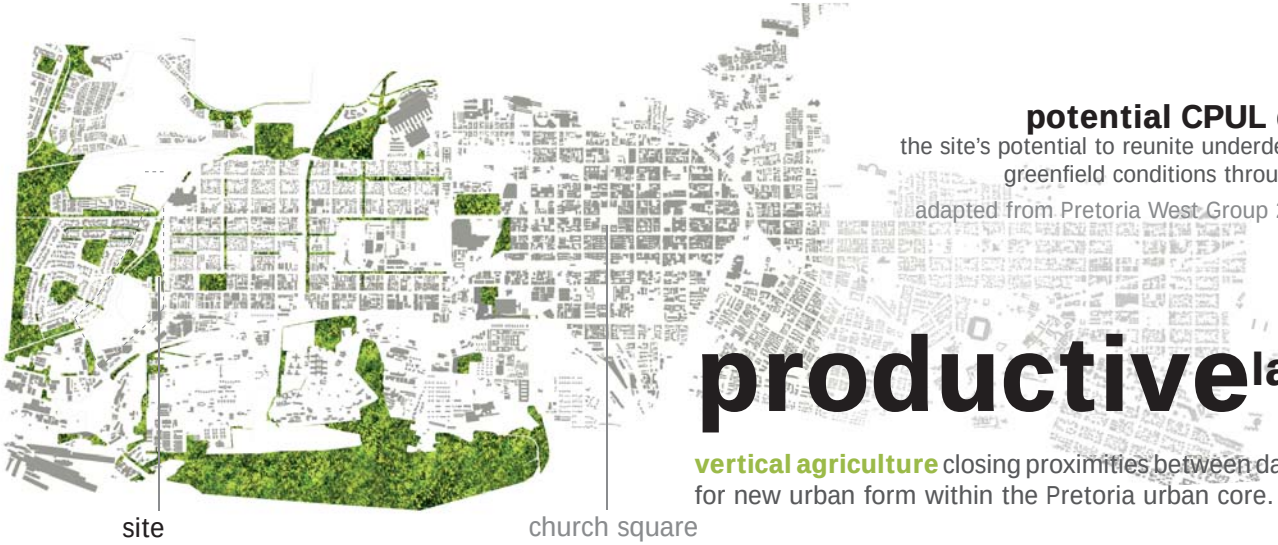
key concept: CPUL city

The vertical agriculture project is a catalyst for a greater Continuous Productive Urban Landscape (CPUL). This involves a network of urban landscapes and open spaces that are environmentally and also economically productive. According to architect and author Andre Viljoen in *CPULs: Continuous Productive Urban Landscape*, CPULs do not require the complete rebuilding or demolition of cities, instead they suggest reconfiguring the city so that it can operate within the envelope of its own environmental capacity and as far as possible make its own ecological footprint a constructive one [Bohn et al, 2005:266]. In Pretoria, the current green landscape is limited, scattered and unconnected. The project will be an important link in closing the loop within the city and uniting this landscape into a CPUL. It becomes the platform for further development on an urban agriculture CPUL for the Pretoria cityscape.

Figure 69 (right): Forming part of the greater landscape system and closing resource loops [author, 2010].
Figure 70 (below): Reconfiguring into an agriculture CPUL and becoming major linkage in the connecting the green landscapes of Pretoria [author, 2010].

existing highly disturbed areas
brownfield sites - areas disturbed and damaged from industrial processes
adapted from Pretoria West Group 2010 [author, 2010].

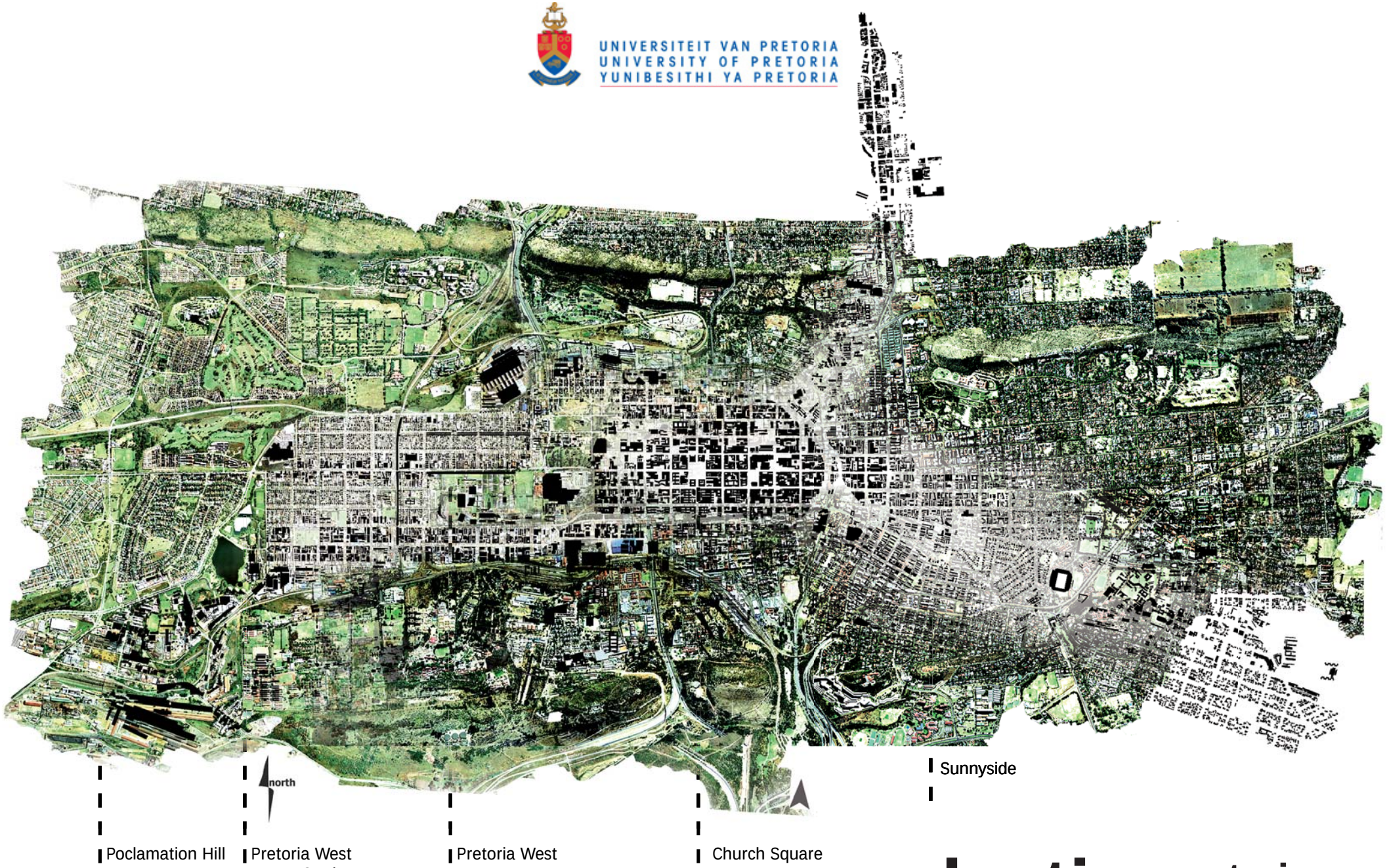
existing medium disturbed areas
brownfield sites - indication that proper intervention can bring together the separated industrial and urban proximities
adapted from Pretoria West Group 2010 [author, 2010].



potential CPUL development
the site's potential to reunite underdeveloped and hidden greenfield conditions through urban agriculture
adapted from Pretoria West Group 2010 [author, 2010].

productive landscape

vertical agriculture closing proximities between damaged landscapes for new urban form within the Pretoria urban core.



productive pretoria

Figure 71 (top): Potential and vision [author, 2010]. Local green and urban agricultural potential that the Old Pretoria West Power Station agriculture cell can catalyse.

productive community society

productive landscape society

With the birth and growth of a global industrial era over two centuries ago, urbanisation intensified dramatically [Byrne, 2002:261]. Industry became a system that acted beyond its initial economic goals and moulded entire industrial cities and cultures. Currently, most cities today are in the process of deindustrialisation and negative reputation of production and reproduction processes of industrial culture is perceived to be working against the goals of contemporary society and innovation, especially on issues of sustainability and resource-efficiency. When industry is completely removed from an area, large communities (mostly skilled workers) are left behind [Byrne, 2002:280]. These communities usually have multiple generations of experience and in an industrial lifestyle and cannot blindly follow the exodus of industry. The area of Proclamation Hill, Danville and Pretoria West is such an industrial community. When large industries move out (Iscor and the power station), there is a risk that sector will not only lose its identity, but also its livelihood.

It is therefore important to cultivate a new sustainable industrial culture for Pretoria West as it is not only its inherent legacy, but also its unique future. This implies that the new sustainable industrial society must have sense of ownership of this new industry. The aim of the design is to create this sense of belonging and sense of place for a greater urban community within this new industry to aid in the creation of sustainable industrial culture. This belonging, according the British urban historian David Byrne, is achieved by creating a greater feeling and experience of the industry as a culture, cultivating sentiments which guide and form ways of life for a community. Sociologist Inger Birkeland agrees and goes on to say that this cultural energy and vitality is as important for sustainable development within communities as other issues of social equity, economic viability and environmental responsibilities [Birkeland, 2008:283].

The project aim is to close the proximity between an urban environment and a productive environment and create a culture of a productive society. A healthy urban interface is required.

According to urbanist Jan Gehl, merely grouping functions or buildings of various programs together is not enough to stimulate the growth of a healthy urban space. The important factor is whether and how the people who work and live in an urban area use the same public space to connect on a daily basis [Gehl, 2006:101]. The French landscape designer Gilles Clement names this space where free and informal public activities or events occur a *Third Landscape* [Clement, 2006:90]. Since the aim of the project is to have an architecture that aids in the development of a productive urban society, it is essential for this quality of space to exist within the design project.

Gehl further explains that public activities are either necessary, optional or social [Gehl, 2006]. The interplay between them are not just created by the physicality of buildings and architecture, but also by the activities and interpretation of the spaces linking buildings.

A human being is sensitive to physical and metaphysical proximities. Physical proximities include the liberty of movement, scale of spaces or structures, materiality, and the practicality in the use of places. Metaphysical proximities include the level of spontaneous social stimulation, freedom of public activity, ownership, sense of place and sense of security. The *Third Landscape* is created where there is a close proximity between physical and metaphysical environments.

The hydroponic factory must form part of a *Third Landscape* in order to meet the project aims of creating of a productive society.

productive culture

vertical agriculture closing proximities between industry and urban living

productive society

A *Third Landscape* space is a virtual space - a place that connects physical and metaphysical proximities for a human experience. This virtuality of the *Third Landscape* implies that the physical boundaries of a building or space does not limit the experience of the building or space as a *place.*

In order to maximise a human experience of *place*, the building must extend its presence beyond its own physical built fabric. The following strategies were developed to do this:

[1] Layered and crossing interactions

Layering the public interactions with the production program narrows the proximity between an urban inhabitant and the productive process. Layering happens both horizontally (on plan) and vertically (in section). The experience of change in scale is also part of the layering strategy.

[2] Extensions

The building physically extends beyond its formal boundaries and into a streetscape and landscape. Simultaneously, street activities are pulled into the building, closing the proximity between a informal street experience and a formal industrial experience.

[3] Centrepoint

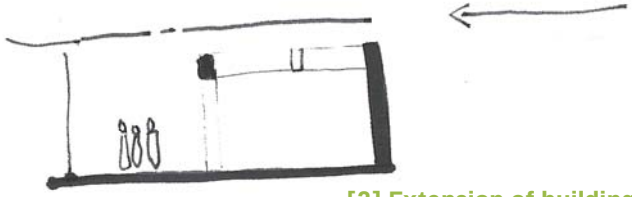
To generate a healthy public space, the interplay between the necessary, optional or social public activities should be encouraged. Considering this, the public program is developed to give gravity and a purpose to the public space. Considering the urban framework in the regards that new buildings and programs must provide ample employment [Pretoria West Group, 2010], it was decided to introduce a public food and farmers' market as the primary public program. This does not only meet the aims of the urban framework, but it also encourages entrepreneurship and matches the inherit spirit of the vertical farm in local food growth and distribution.

[4] Magnetism (below and next page)

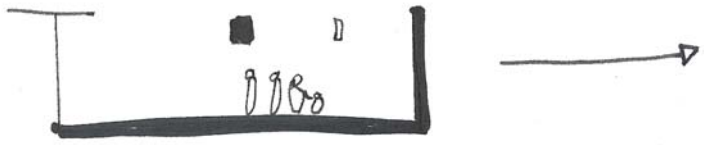
The building seduces and lures public curiosity by having different interests and activities aimed at different users within its public space. This is done through cross-programming the public space with both formal production activities and informal urban activities. This draws closer the proximity between formal users and informal users.

With this specific, active public program - a public market - a balance can be formed between the necessary, optional and social activities of the public space. Through the program of a public market, the proximity of point of production and point of consumption is illustrated literally and proximities are drawn closer.

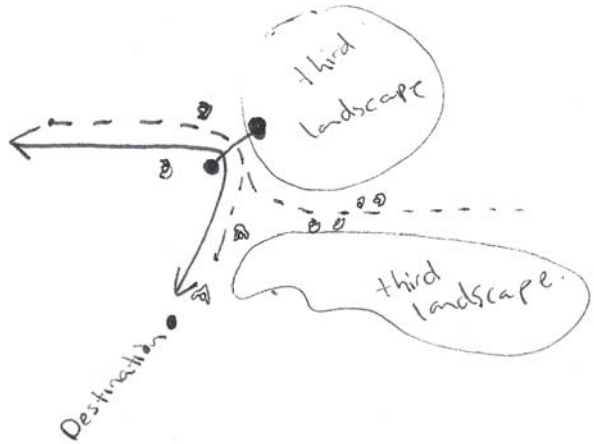
[1] Layered and crossing interactions



[2] Extension of building onto street



[3] Extension of street into building



[3 + 4] Centre point and magnetism

Figure 72: Diagrams and strategies to create a third landscape [author, 2010].

productive society

The design encourages movement through and across the bunker and onto the landscape by ensuring that the production process is either part of a public process or en route to an important transport node.

- **transport**

The introduction of Metro Bus and BRT stops as well as the new proposed passenger rail links.

- **education**

Public and staff hydroponic training and education.

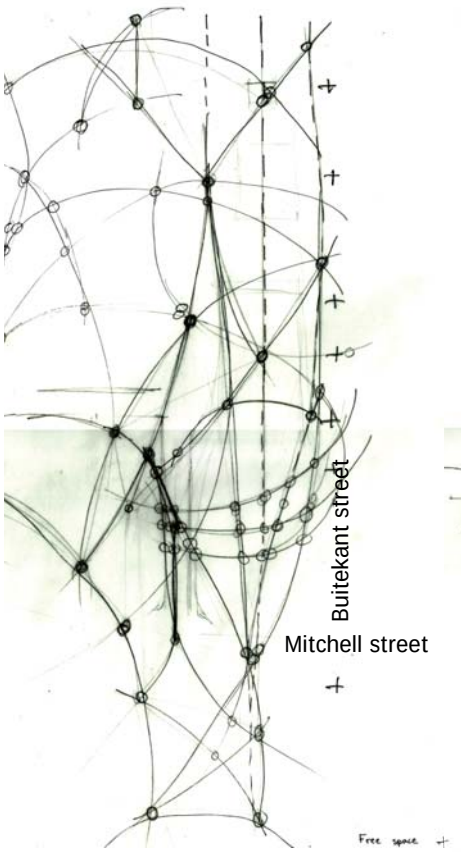
- **industry**

The hydroponic food factory.

- **commercial**

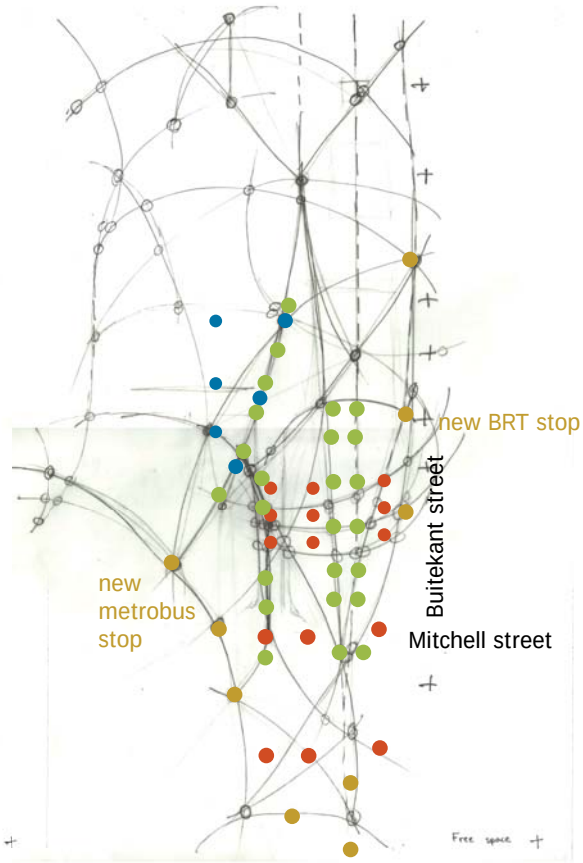
The farrmers' market public space and informal trade along Buitekant street.

In this way, the programmatic heritage of the streetscape (mixed-use) and the character of the light industrial environment will still be maintained. Through cross-programming the site becomes more permeable and accessible for the public and aids in closing proximities between the surrounding landscape, the production program and urban activities.



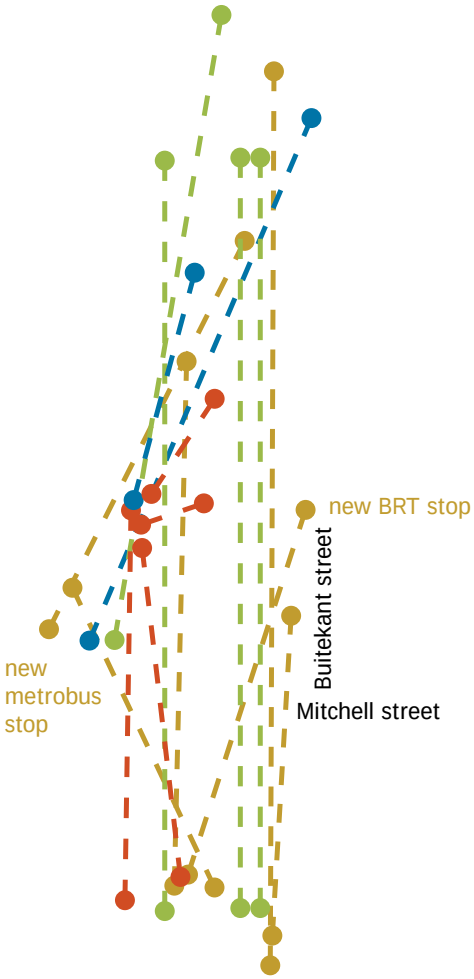
towards new train station

new movement flows and routes on site determined by current and historic site conditions and routes



towards new train station

programming to encourage more flow across the bunker and movement across the site



towards new train station

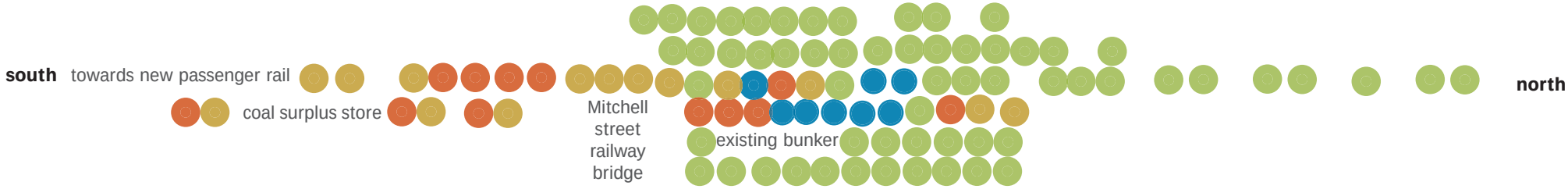
induced flow of various participants across the bunker onto and through the building and the landscape

Figure 73 (right): Cross-programming on plan [author, 2010].
Figure 74 (opposite): Cross-programming on section [author, 2010].

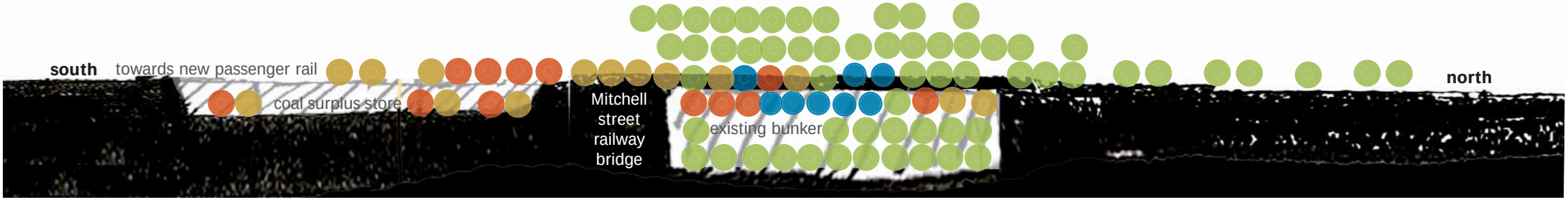
proximtiy programming

plan drawings creating movement by closing proximities between urban programs with an industrial /production program

section north-south



section north-south



section north-south

proximtiy programming

section drawings creating movement by closing proximities between urban programs with an industrial /production program.

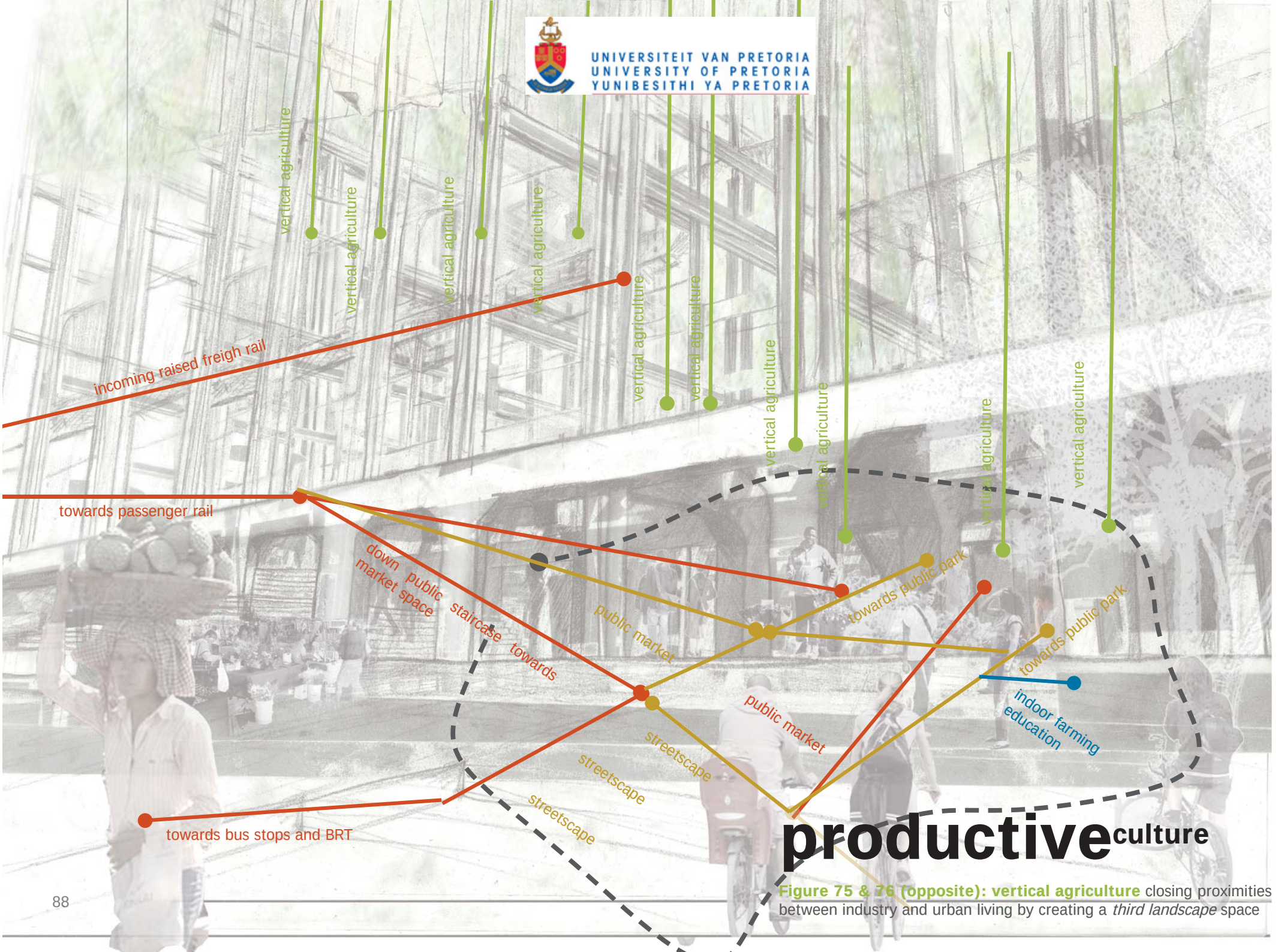
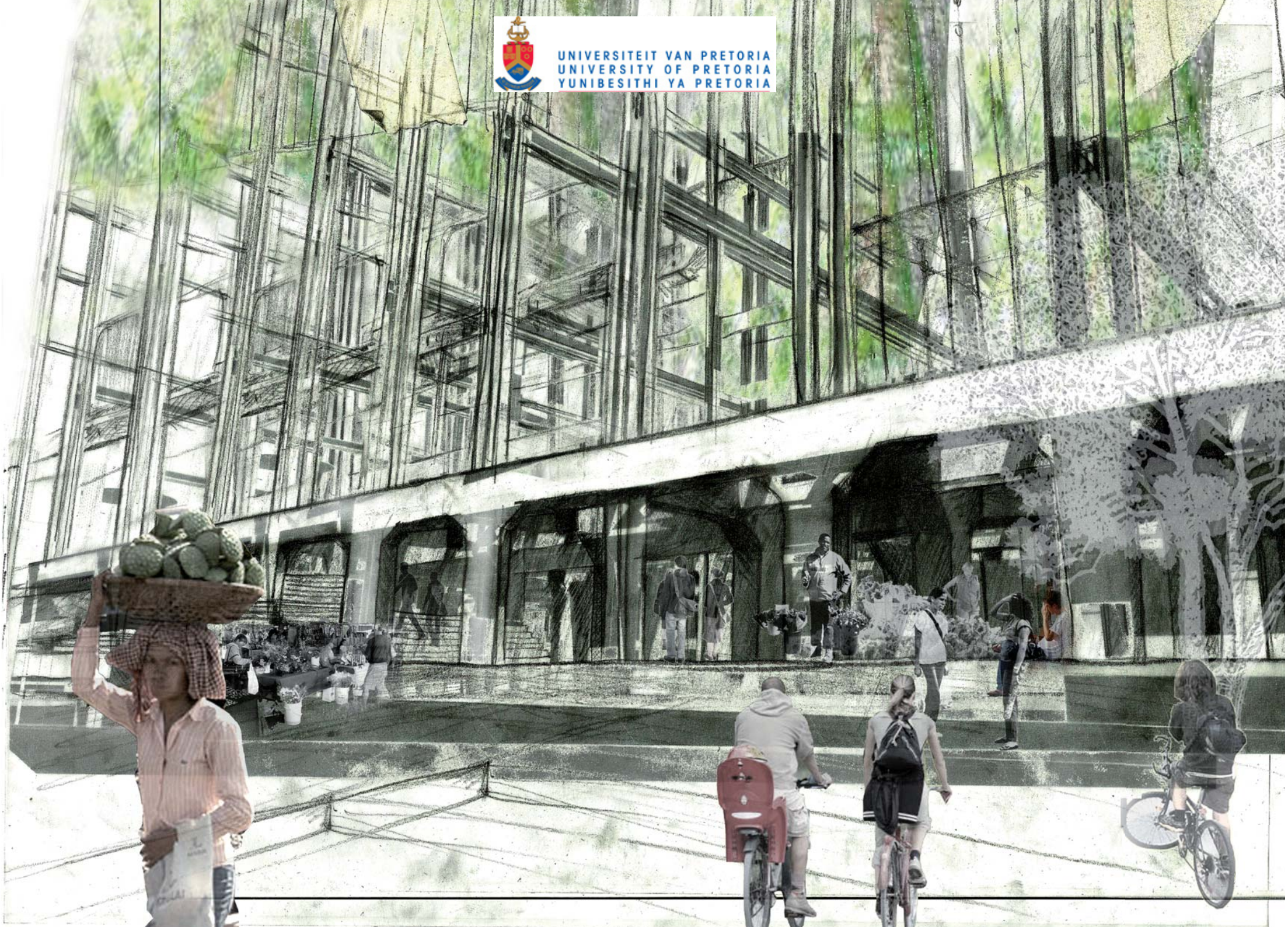


Figure 75 & 76 (opposite): vertical agriculture closing proximities between industry and urban living by creating a *third landscape* space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productive building

key concept:
integrated design approach

The vertical agriculture is modelled for the old coal bunker at the Old Pretoria West Power Station. Bearing in mind that the project aims to develop a sustainable urban landscape and society, a similar strategy for a productive building was adopted for the design. Vertical agriculture is ecosystemic in principle - as illustrated with the *Vertical Farm* project by Despommier and his students [Fitzpatric et al:2006:4]. Such an ecosystemic approach requires that the site must be understood as both a consumer of resources and as a producer of resources. The building closes the proximities between industry and the urban landscape on both a greater urban scale and an immediate building scale. The design actively participates with greater systems and on-site materials and resources. These resources are often overlooked through poor understanding of the potential of the site and as result go to waste. However, these resources form part of the hidden heritage of the site, especially in the case of the Power Station. For instance, there lies great potential in reconfiguring the existing nutrient-rich water resource from the Daspoort Sewerage Treatment Plant for the use on plants or the re-use of abundant coal fly ash from the existing ash ponds in new building materials.

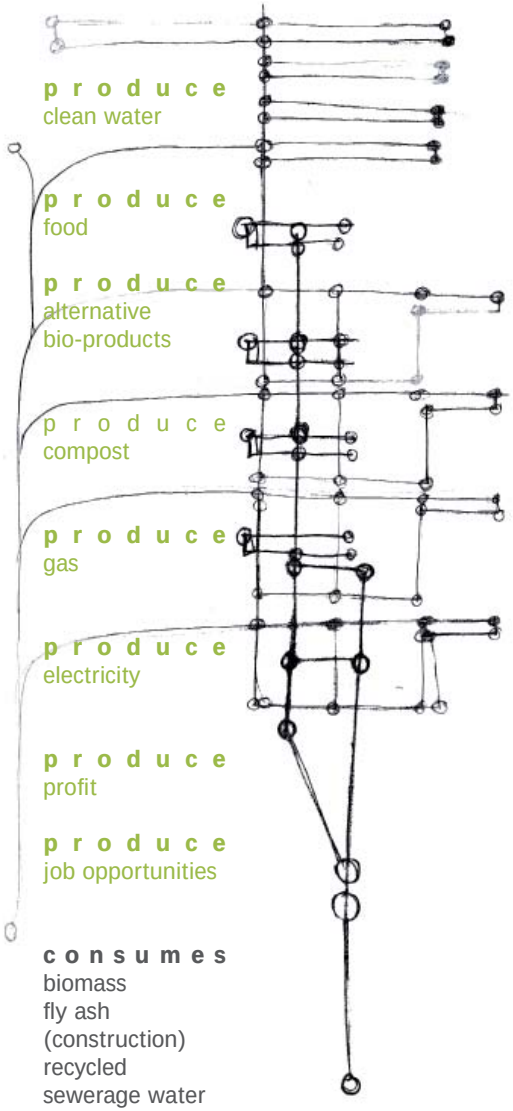


Figure 77 (top) : Catalytic potential of the vertical farm to aid in the development of CPUL cities in sustainable, resource-efficient urban cells [author, 2010]
Figure 78 (right) : Closing resource loops within the building as part of whole building design strategy [author, 2010].

productive building

vertical agriculture urban agriculture as resource efficient solution for urban planning and development for the Pretoria historic centre

hydroponic food factory

key concept:
inputs and outputs

The building aims to be part of a Whole Building Design strategy [Prowler, 2008]. Internally, the new hydroponic food factory building has a closed-loop strategy in regards to its own resource use, especially with water, electric energy and biomass.

The building has some biomass consumption through composting requirements (most crops are hydroponic and soil-less and will be explained shortly), and leaves a surplus of biomass and other organic crop by-products. Other consumptions of the building include recycled sewerage water (Daspoort); rainwater; fly-ash from the on-site ash ponds (provide ash as aggregate in concrete and masonry); and electricity. The building, however, also produces clean, potable water; food crops; alternative bio-produce and materials; excessive amounts of compost; gas; electricity; profits and job opportunities.

An investigation into indoor farming techniques and systems was carried out. The requirements for vertical agriculture later informs not only building organisation, but also a building form.

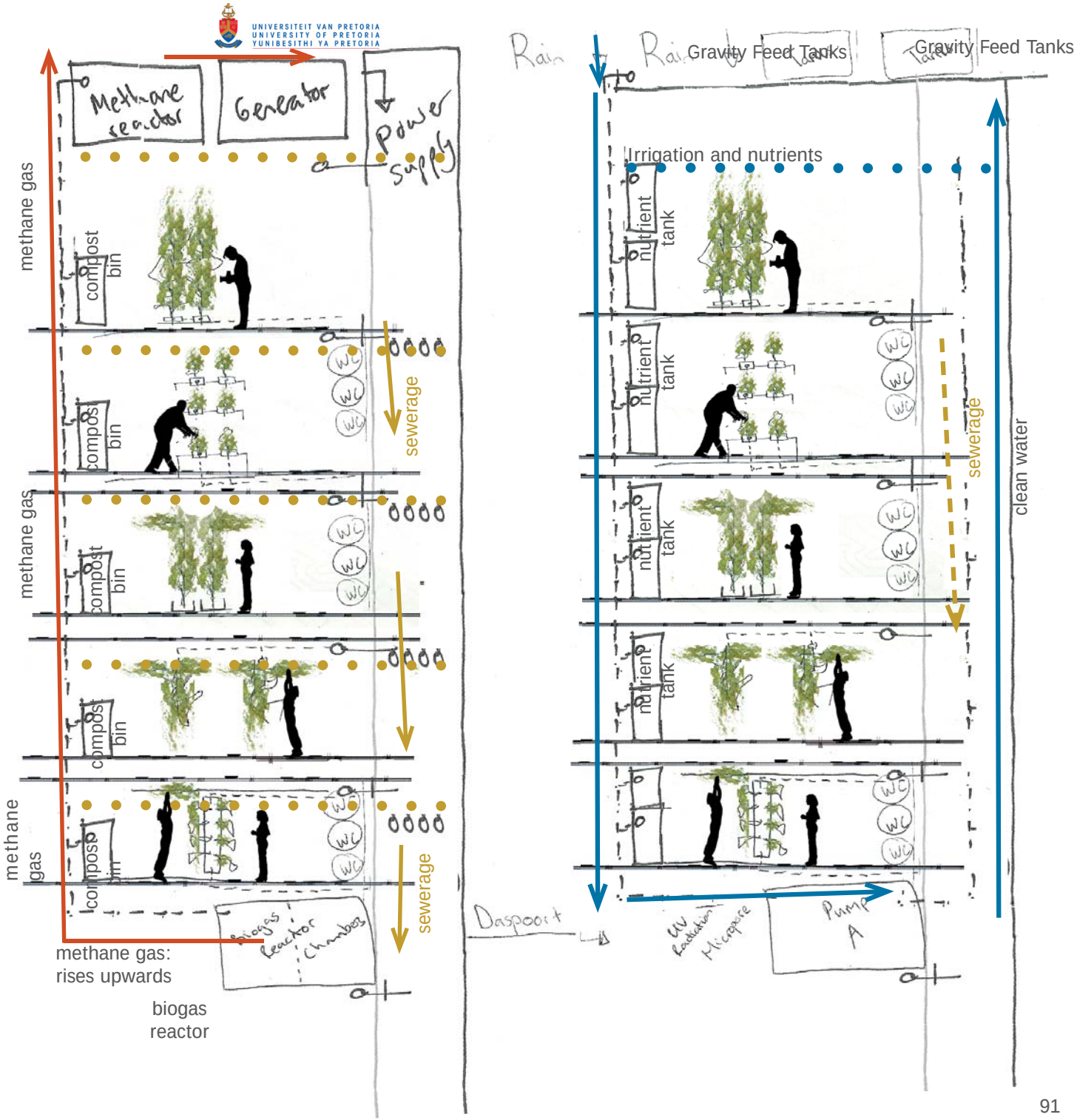


Figure 79 (right) : Building system illustrating the bio-gas created from the excess bio-wastes, converted into electricity [author, 2010].
Figure 80 (far right) : Building rainwater system [author, 2010].

hydroponic food factory

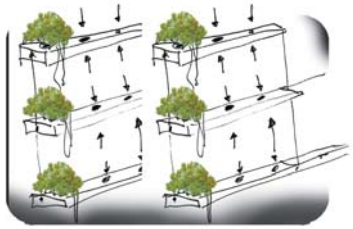
key concept:
hydroponic production

Indoor commercial or private food production relies primarily on a soil-less agriculture called hydroponics or aeroponics (see examples on the right). Hydroponics is a technology to grow crops with their roots suspended or hanging in nutrient-rich water. Today, the term is colloquial for growing plants without the need of soil whatsoever. The hydroponic system has its beginnings in many cultures, (Aztec culture, Hanging Gardens of Babylon), where crops have been grown on rafts or frames, suspended in shallow pools of water. Europe generally started experimenting with the soilless crops circa 1699 and the official term, “hydroponics”, was given by the Americans’ in the 1930’s. Today, it is a practical application in thousands of greenhouses worldwide and a large commercial industry [Turner, 2008].

Hydroponics is a successful, viable solution to the food crisis, especially in destitute nations and the application can vary from a small, poorer village in Africa to food-production for space-travel [Martin, 2006:92-110]. Because of the many advantages that soilless crop production can bring (verticality and optimization of space, year-round production and optimum yields and crop quality control), it is essential that South Africa take a leading role in this technology. A sister technique is aeroponics, where the plant is grown without any need for a substrate and is totally suspended. This technology is in development still for large scale commercial production [Clark, 2008] but commercial greenhouses can be found in New Zealand, United States and Japan [Cox, 2010].

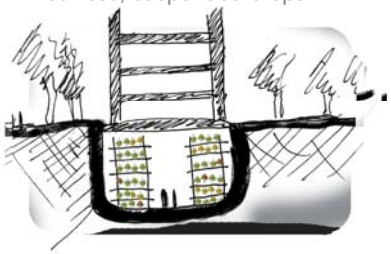
1. Figure 81: Diagrams of hydroponic methods [author, 2010]
2. Figure 82: Chicago [Blake Kurasek, 2009]
3. Figure 83: Pasona, Japan [www.treehugger.com]
4. Figure 84: South America [www.verticalfarm.com]
5. Figure 85: Pasona, Japan [www.treehugger.com]
6. Figure 86: Frasers, Sydney [www.sydneyarchitecture.com]
7. Figure 87: Private Window Farms, New York [www.windowfarms.com]

These technologies are not at all high-tech solutions only, and there are numerous products available to the home-gardener and for application in smaller, localised settings, especially in water-scarce environments [Martin, 2006:92-110]. The hydroponic food factory will provide a platform for commercial crop production, education and experimentation in alternative crop production strategies. The greater scheme will also facilitate education for Small Plot Developments.

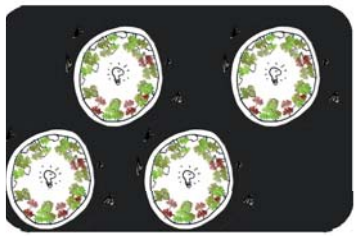


1. soilless, suspended crops

1. residential crops



1. underground farming



1. rotating carousels

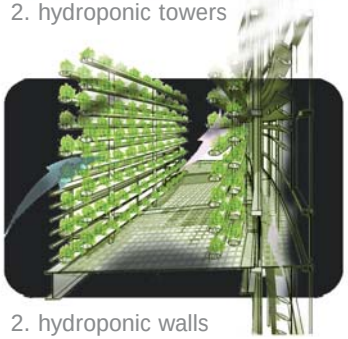
2. hydroponic towers

3. underground crops

4. hydroponic greenhouses

5. indoor hydroponic trellis crops

5. indoor aeroponic trellis crops



2. hydroponic walls

4. underground crops

6. mixed-used buildings

7. window farming

hydroponic food factory

Nutrient-film technique (NTF) is a hydroponic method where nutrients are dissolved in a shallow stream and fed to plants through channels. Aeroponic methods grow plants from a frame and suspended in an nutrient rich air-mist.

Vine crops (tomatoes, cucumbers et cetera) can be trained on frames or wires to grow in virtually any direction.

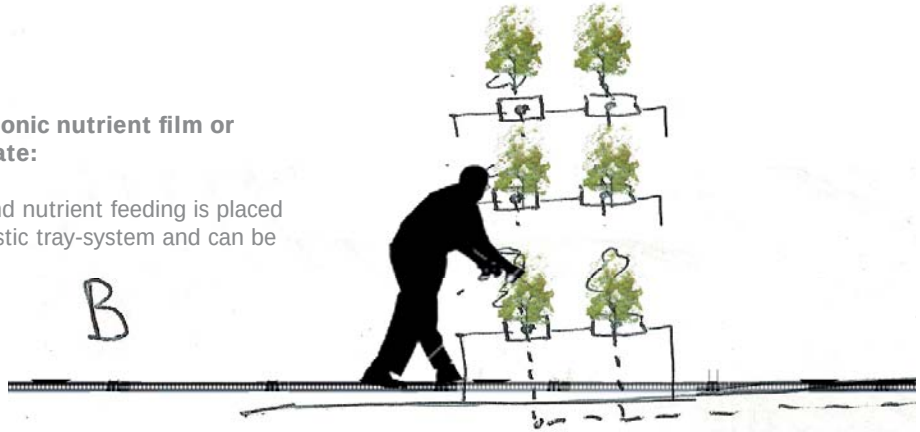
Figure 88: Hydroponic methods explained [author, 2010].

hydroponic nutrient film:

plant and nutrient feeding is placed in a plastic tray-system or container on ground plane, aluminium or timber framework.

hydroponic nutrient film or substrate:

plant and nutrient feeding is placed in a plastic tray-system and can be stacked

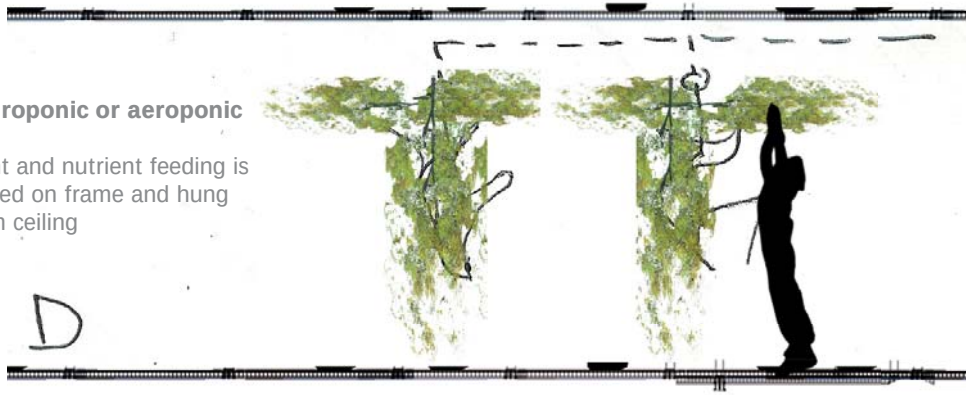


hydroponic dutch bucket

plant and nutrient feeding is placed in a bucket (like a pot-plant) and vine crops are trained to grow around the pot/bucket and onto frame (ceiling)

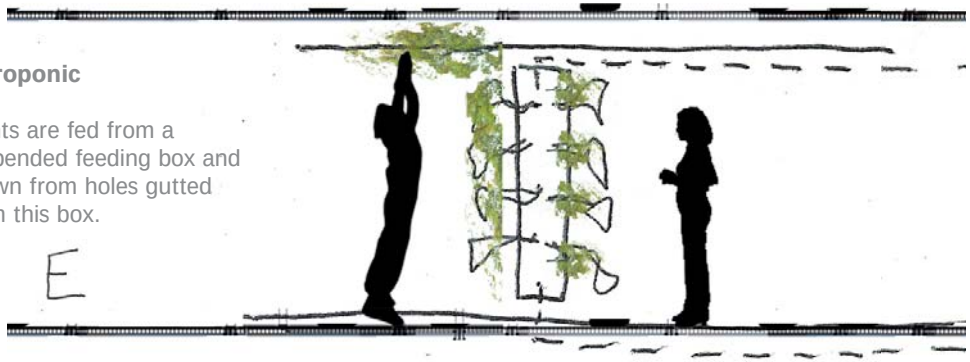
hydroponic or aeroponic

plant and nutrient feeding is placed on frame and hung from ceiling



aeroponic

plants are fed from a suspended feeding box and grown from holes gutted from this box.



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hydroponic food factory

key concept: crops and production types

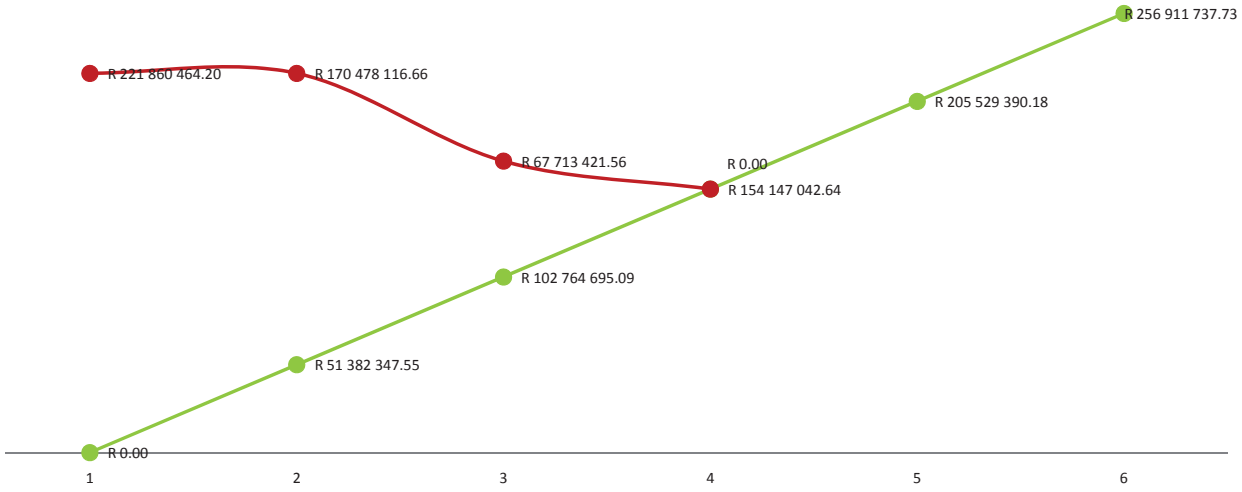
Considering the condition of the old coal bunker, it was decided that the environment within the bunker would be best suited for crops that required less sunlight. Underground production of typical hydroponic crops is possible and just as productive, but require much more artificial simulation. The bunker environment is best suited for plants that do not flourish on natural daylight. Most suited crops are typically mushrooms, sprouts, other fungi crops, potatoes et cetera [Combrink, 2010]. This will imply a more controlled and closed environment for the crop production as disease spreads about easily within these crops. Above ground, hydroponic and aeroponic production will be located. To determine the size of the new building, the tomato crop was used as a parameter since the plant is on the higher scale of most of the requirements concerning water, horizontal space, vertical trellising height, weight and sunlight [Combrink, 2010]. If the building can accommodate a tomato crop, then almost any other crop can be grown within it.

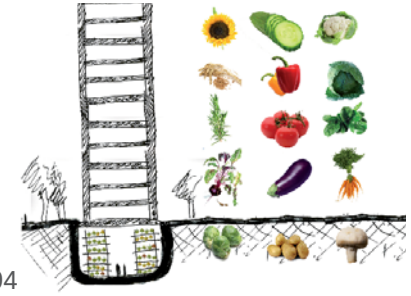
key concept: business

The design is conceived for ownership by a private company or as joint initiative with the municipality - the program aims to deliver a product for profit. It must be possible for an person or company to start the project and build it up to a factory that produces food (and the by-products of food production) for commercial profit within an urban setting. This is a parameter for design and determines the size and scope of the project.

key concept: business

A typical private client is Richard Branson, owner of Virgin Enterprises. He is reputed for controversial developments and such a project could open up a new dimension for his company. Other clients can also include local food chains (Woolworths, Fruit & Veg, or Spar.) The aim is to incorporate local food making not only into the urban landscape, but also to integrate vertical agriculture and urban agriculture as part of our general knowledge base as social urban dwellers. By building on this specific historic site with this contemporary program, the architecture can illustrate the proximities between the global and the local, history and future, industry and living. The site is ready for a goal-orientated, future-driven architecture.





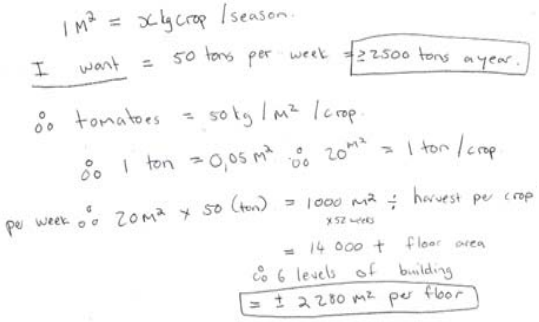


Figure 89 (above): Return on investment - building for production and profit [author, 2010]
Figure 90 (far left): Ordering crop production to suit conditions of the old coal bunker [author, 2010]
Figure 91 (left): Estimating building footprint [author, 2010]

profit return on investment

business urban agriculture is a great investment opportunity

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hydroponic food factory

key concept:
biomass and electric energy production

In the case of the *Vertical Farm Project* by Despommier and his students, it was possible to produce a great amount of **surplus** electric energy from the vertical farm, and feed this energy back into the city grid [Alam et al, 2004]. This is due to the fact that the entire vertical farm is designed on the principle to supply 50,000 people of all their food annually. The aim of the new Pretoria West hydroponic food factory, however, is to make the process of resource-efficient, commercial, vertical, urban food production possible as a norm: it must be possible and viable for an person to make a profitable living from vertical and urban agriculture as a real business opportunity. This reduces the scale for the project considerably in comparison with *Vertical Farm*, yet the ratio's of the various building systems and its processes still give sustainable results.

Hydroponic growing is method of growing, but like human beings, plants need fresh air, clean water, wake up and go to sleep. Since the building is a large, stacked indoor greenhouse, it is impossible to give natural daylight to every corner. However, daylight can be simulated for growing plants and many agriculture industries use OEM Light Emitting Diode (LED) to grow large scale commercial crops. This was also factored into the calculation for how much electric energy the building requires (for example: tomatoes use 10.7 W/m², for minimum of 7 hours to a maximum of 12 hours a day) [Alam et al, 2004].

In the case of the new hydroponic factory, the internal composting process and biomass has the potential to supply surplus electric energy through bio-gas production. It is proposed that the building be able to collect and process additional biomass from the city (restaurants, schools, shopping centres, schools) in order to produce an even greater amount of electric energy since it would already facilitate this process internally.

The building is a pilot development for similar projects across the city. When one person can succeed in this venture, smaller and similar projects will develop within a city, and so aid in the development of local, resource-efficient urban cells and the agriculture CPUL for Pretoria.

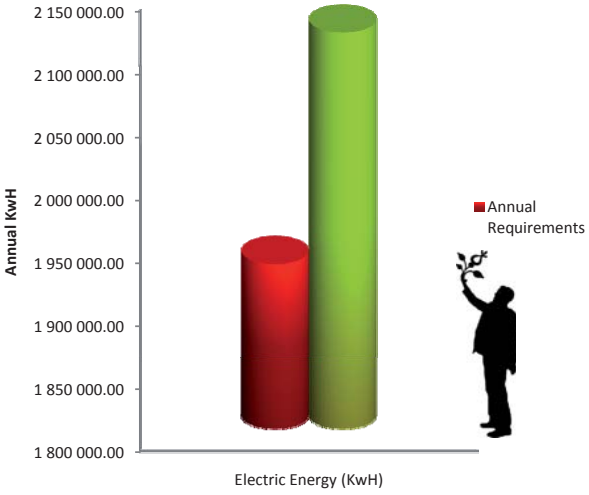

Figure 92 (top): Electric potential of the building [author, 2010].
Figure 93 (right): A comparison of the new hydroponic building in footprint and heights to the footprints and heights proposed by *Vertical Farm* [author, 2010].