Design development

Aim of design

Location: Buitenkant Street, Pretoria West Industrial Area, City of Tshwane.

Purpose: to advance the principles of sustainable living through production, research and urban integration.

Architectural goal: adaptive re-use of discarded industrial space

Aim: to design a bio-diesel plant that will demonstrate low energy architecture, energy production and sustainable community integration (fig: 73).

The design development process is divided into two main categories:

- Technical & practical exploration: exploring the functional design guidelines in the production process of bio-diesel.
- Spatial exploration: Integrating the functional design guidelines to appropriate spatial qualities between the production process (Bio-diesel plant) and the urban fabric that will demonstrate sustainable urban integration.

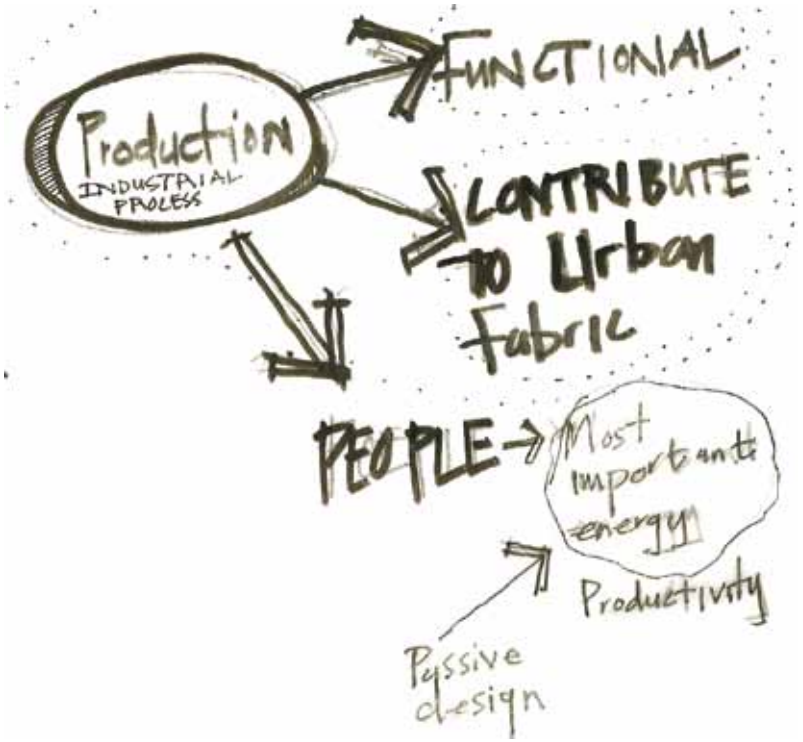

Figure 73. Diagram explaining the aim of the architectural design process for the Pretoria West Bio-diesel plant: Author 2010.

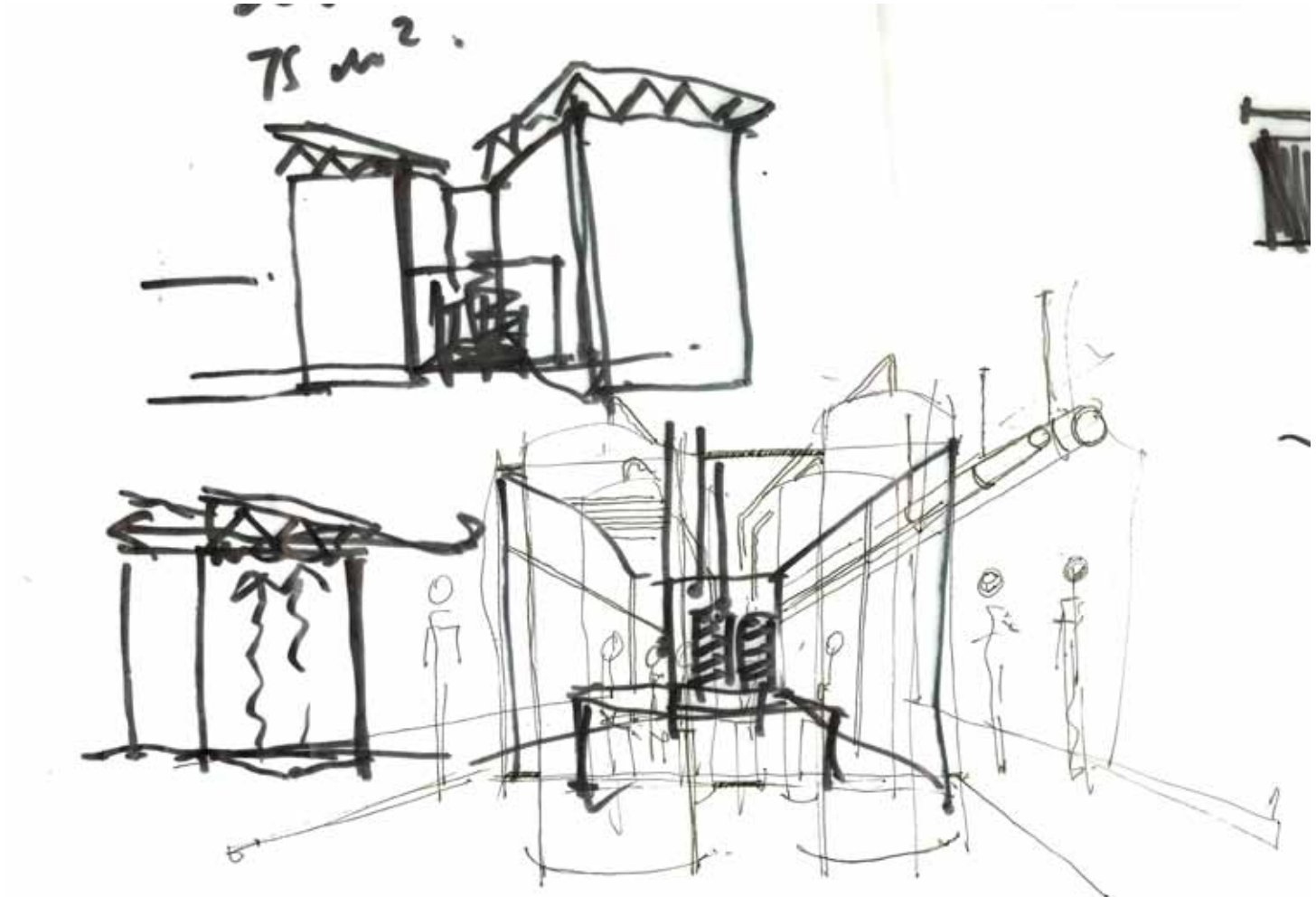

Figure 74. Conceptual exploration where the production process (functional and technical qualities) will be used to define the spatial qualities of the bio-diesel plant: Author 2010.

Technical design development

The industrial building works on an input and output base; the arriving resources and dispatched finished products strengthen the linear and closed nature of the operations. The aim is to maximise the possibilities of the industrial building to operate less as an isolated process, and more as an integrated ecosystem in the urban fabric; to address social needs by providing economic empowerment and skills development and for the building to contribute in a positive manner to the character and wellbeing of the urban fabric (as discussed in the design development chapter).

Bio-diesel production at the Pretoria West Bio-diesel Plant (quantity):

According to the South African White Paper, released four years ago, a 2% penetration level of biofuels in the national liquid fuel supply by 2012 was set as a goal. This target was decreased from the 4.5% target initially proposed in the draft strategy document. The 2% target of the national liquid fuel supply equals around 180 million litres per annum.

> *The country will need large scale biodiesel plants to achieve this target, and a lot has to change in the South African bio-fuels strategy to make this possible (Smith, 2010).*

The main reason commercial bio-diesel plants aren't currently viable in South Africa is due to the taxes that these commercial producers have to pay if they produce more than 300 000 litres per annum. Government policy has a negative effect on the bio-diesel industry making only small backyard bio-diesel production operations viable. One or two small commercial bio-diesel plants, with a capacity of around 500 000 litres each per month, in every major city producing SABS certified bio-diesel which could have further spawn other bio-fuel projects (Smith, 2010).

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Due to the Pretoria West Bio-diesel Plant's location, it could service both the City of Tshwane (road and rail freight) and Johannesburg (rail freight). With the figure of 500 000 litre per month per one major city suggested by Smith (2010), the production of 1120 000 litres bio-diesel per month could be justified when both these major cities are serviced.

The discarded cooking oil will primarily be collected from restaurants. Another form of harvesting is to place drum containers at dumping yards for household collection. With the target of 280 000 litres per week and 40 000 litres per day; 700 restaurants would be required to each contribute 400 litres of oil per week. According to the Uptown Oil plant in London the average restaurant can provide 400 litres of oil per week. There are 6552 food premises in the City of Tshwane (refer to addendum B). The plant will be serviced by both the City of Tshwane and Johannesburg, therefore the hypothesis of 700 participating restaurants could be considered realistic and justified.

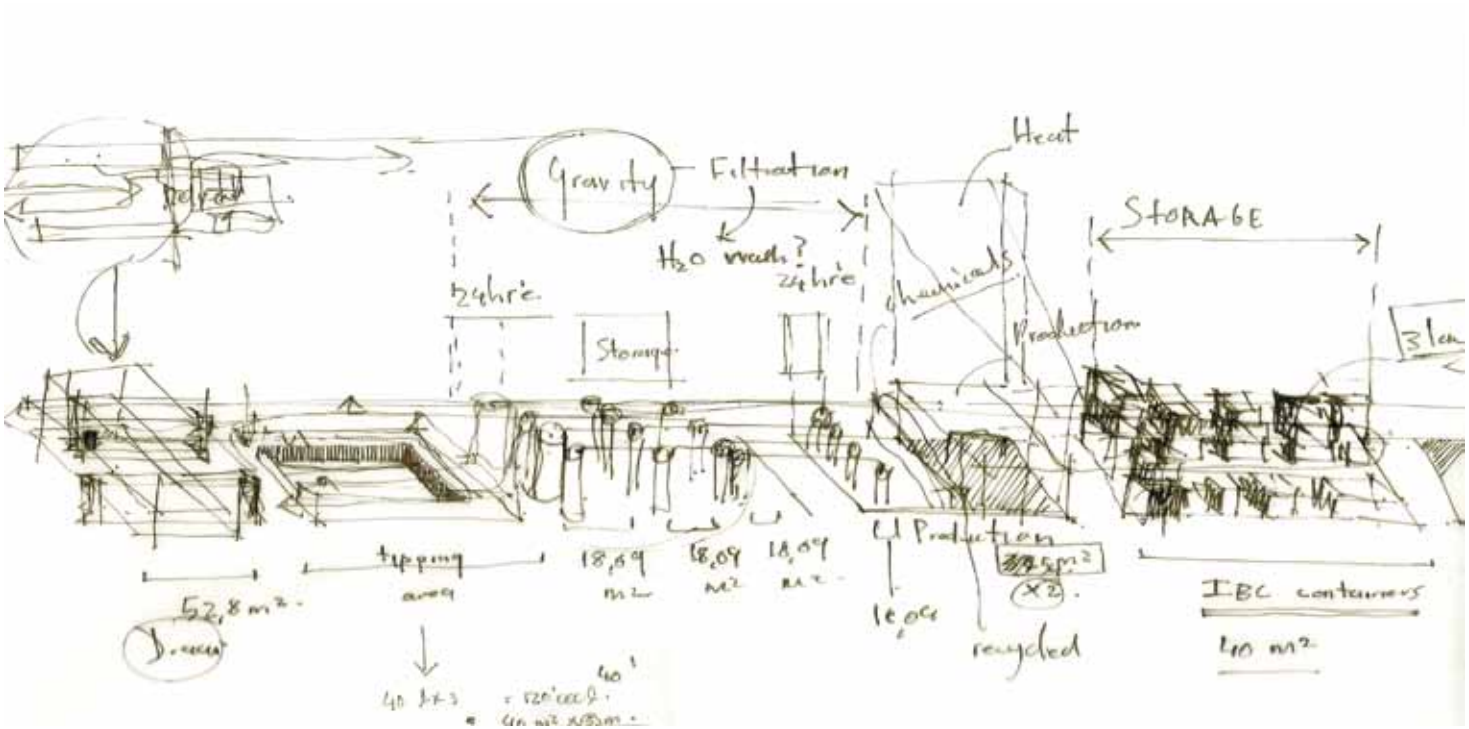


Figure 75. Exploration of the production process of bio-diesel to determine the area needed for the various functions of the building: Author 2010.

Defining area (production zoning):

Following a theoretical start it is critical to submit the proposed bio-diesel plant to the intelligence of matter.

Buildings have an interesting epic, a story that is embedded in the organisation of matter. . . (Ferre, 2002 :3)

The first step was to determine the area in square meters that is needed for the various functions of the building (fig: 75). The building mass is spread over the entire site to gain maximum floor space for the production, movement and storage of the bio-diesel.

Employment opportunities:

In the Uptown Oil case study it was stated that the plant employs 8 people and that 10 000 litres of bio-diesel is produced per day. Should the Pretoria West Bio-diesel Plant produce 40 000 litres of oil per day, the hypothesis is that 24 people could be employed at the plant with 20 working in the production area and 4 working in the office and laboratory. The employment figure of the Pretoria West Bio-diesel Plant is based on the concept of economy-of-scale; the production in relation to Uptown oil is increased with a factor of 4 (10 000l x 4) and therefore the workforce in relation to that of Uptown Oil can be increased with a factor of 3 (8 x 3).

Impact

With the production of 280 000 litres of bio-diesel per week, an average of 4 000 vehicle tanks can be filled (with the average vehicle tank having a capacity of 70 litres).

Accommodation schedule:

- Production area
- Movement area
- Services (energy generator, waste)
- Offices
- Laboratory
- Communal space
- Amenities

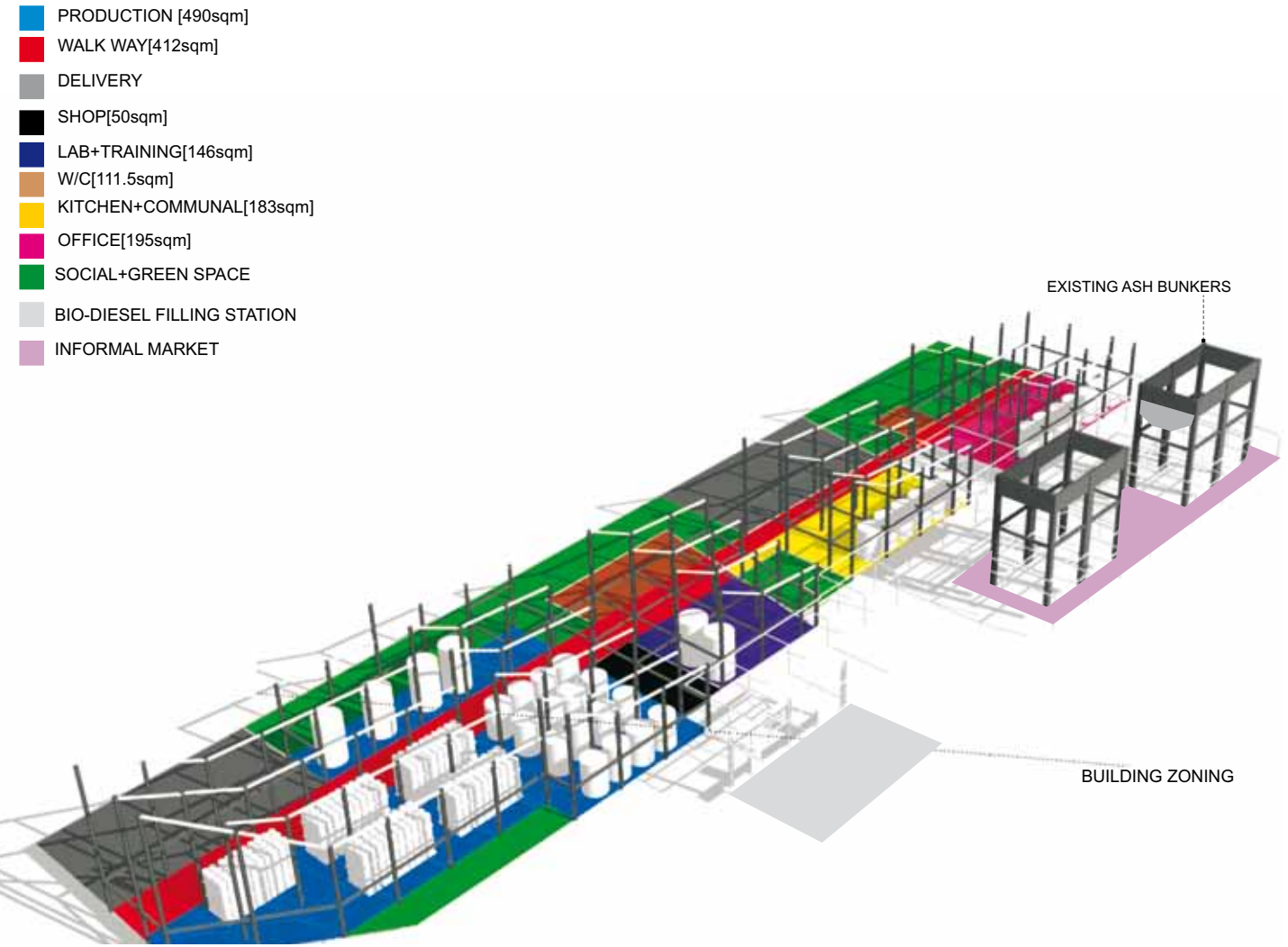


Figure 76. Diagram showing Pretoria West Bio-diesel Plant's spatial layout diagram; indicating social integration to the production process: Author 2010.

Pretoria West Power Station spatial layout (fig:76):

Production area - 490m^2:

Movement area - 412 m^2:

Working aisle - 1.650m
Transfer aisle - 4.300m

Offices and Boardroom - 195m^2:

Office occupation: 4 people
Boardroom occupation: 10 people

Communal space - 183m^2:

Indoor: kitchen and eating area
Outdoor: eating area

Lab and training room - 146m^2:

Amenities - 111,5m^2:

Office staff: Occupation : Male: 1 W/C, 1 urinal, 1 washbasin.
Female: 2 W/C, 1 washbasin

Production staff (w/c, changing rooms and lockers) occupation : Male 1W/C, 1 urinal, 1 Washbasin.
Female: 2W/C, 1 Washbasin.
Male: 3 showers.
Female: 2 shower.
20 lockers

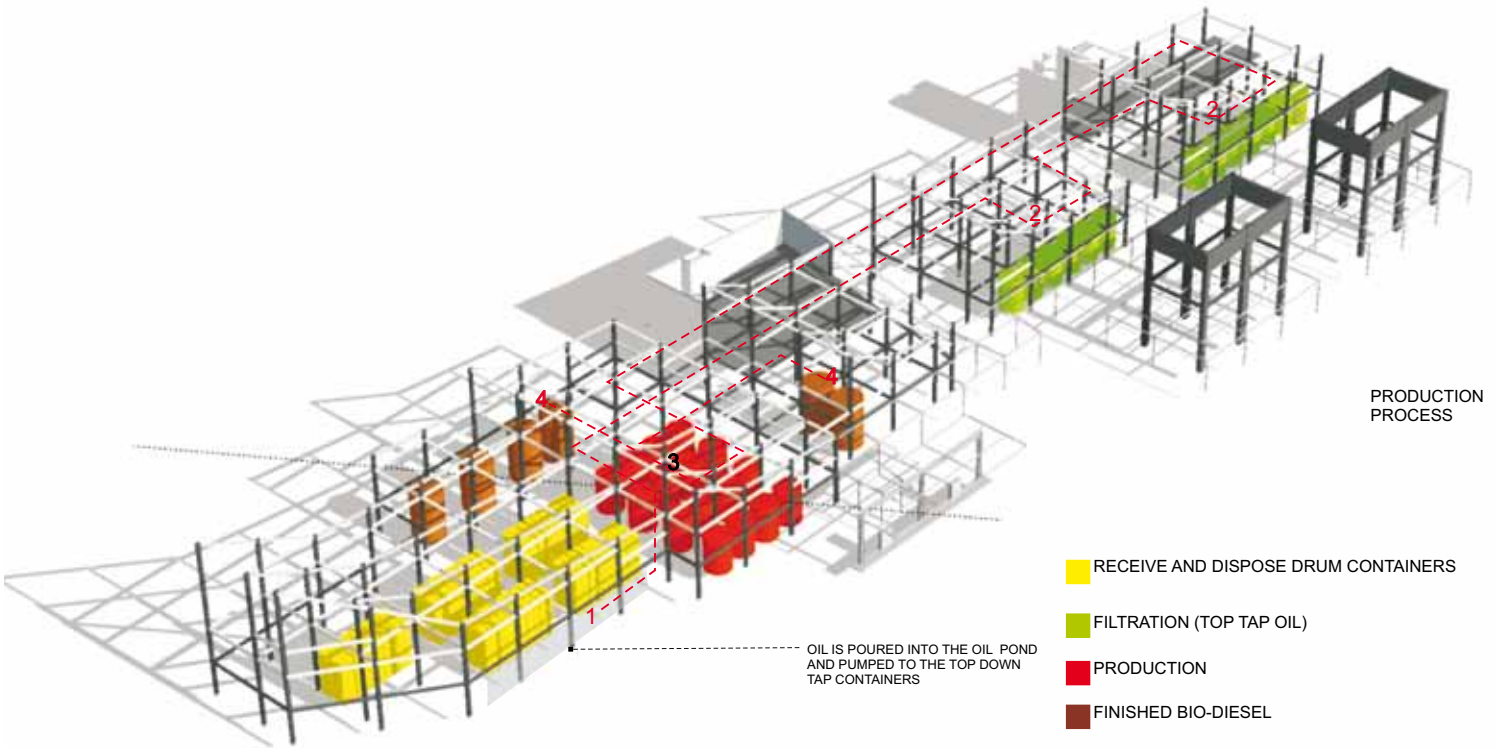


Figure 77. Diagram indicating Pretoria West Bio-diesel Plant spatial layout of the production process for bio-diesel. The current layout allows for maximum interaction between the production process and the surrounding urban fabric: Author 2010.

Production area (fig: 77) 490m² based on:

- A seven day working week,
- 700 restaurants (harvesting 400 litres of discarded cooking oil per week from one restaurant),
- producing 280 000 litres bio-diesel per week,
- producing 40 000 litres of bio-diesel per day,
- a holding period (storage) of three days (including the production day)

Drum containers (containers placed at restaurants and dumping sites to harvest discarded cooking oil):
Size: 94cm (h), 58,4cm (d), 208 litres capacity.
Area: A = πr²= 3,142 (0,292m²) = 0,264m²
Total: 0,264m² x 200 = 52,8m².
Holding period: 52,8m² x 3 days = 158,4m²

Tipping area:
40 000 litres per day.
Holding period: 40 000 x 3 days = 120 000 litres.

Filtration and storage (capacity):
10 000 litre tanks
Size: 2200cm (d), 3040cm (h)
Area: A = πr² = 3,142 x (1,2m²) = 4,52m².
Total: 4 x 4,42m² = 18,09m²

Chemical storage:
18,09m² (equal to one storage bay)

Production:
Working on a ratio of 1 : 3 (storage : production).
18,09m² x 3 = 54m².

Dispatch and storage:
15000 litre storage tanks
Size: 2 600 (d),3450 (h)
Area: A = πr² = 3,142 x (1,3m²) = 5,3m²
Total:8x 5,3m² = 42,4m²

Synopsis of bio-diesel production (fig: 77):

1. Used cooking oil is received and tipped into the oil ponds under the mentis grid floor where the oil is mixed with water and washed. Washing in this instance implies that the impurities in the oil will react with the water, during which the cleaning process of the used cooking oil begins (filtration process).

2. The oil is next pumped into the top tap containers, where the impurities move to the bottom of the container. This is a passive process whereby the impurities are separated from the oil through gravity. Filters are placed in the pipes, to purify the oil while it is pumped into the containers. The cleaner the oil, the less chemicals need to be added.

3. The oil then goes into the production process where methanol and a catalyst with the combination of heat are used to produce bio-diesel.

4. The bio-diesel is next pumped into the storage containers to be dispatched within two days, assuming one day is allocated to production.

Design generators: three concepts developed out of emergence for production

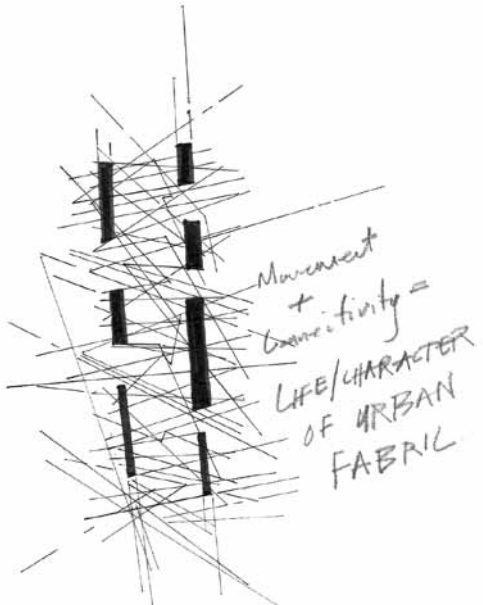


Figure 78. Connectivity: Author 2010.

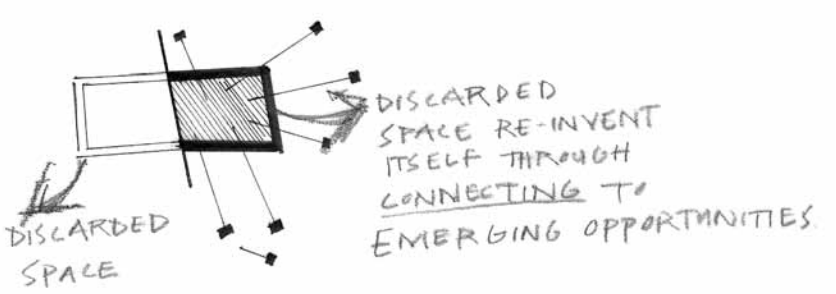


Figure 79. Discarded objects and space: Author 2010.

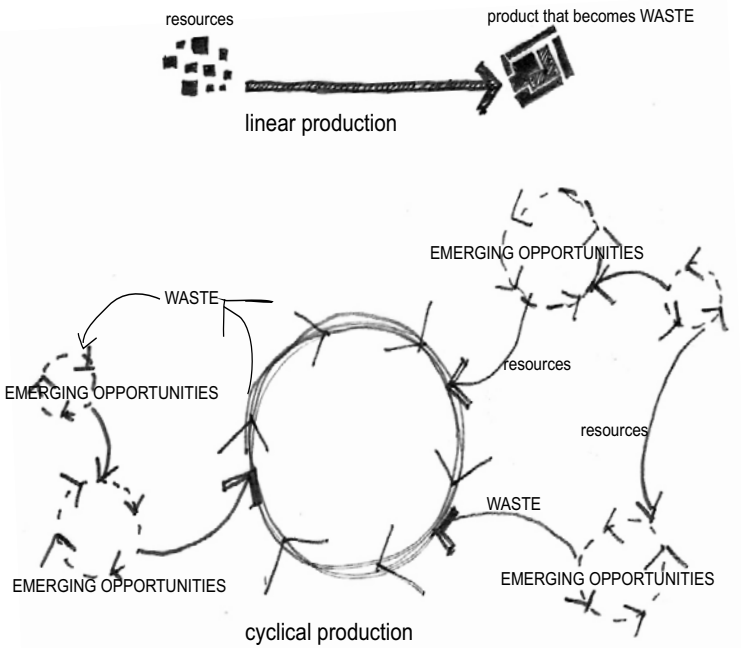


Figure 80. Production not linear, but cyclical: Author 2010.

Spatial design development

The spatial design process started with a theoretical investigation into the work of Hamdi (2004) and Capra (2002) (see page 11, chapter 1). Their analyses investigated emergence as a tool to redefine and regenerate the urban environment. Emergence can then be defined as; the integrated urban fabric that will sustain the growth and evolution of a community.

To bring this concept back to the proposed design intervention in the industrial context; the author next defines production in terms of emergence.

Definition of production in terms of emergence:

- Production that emphasises the community over the individual.
- Production that moves away from the concept of being a linear process only focused on the product to a cyclical process that respects the material and immaterial components. It is through the interaction of the material and the immaterial that emerging opportunities would arise.
- Production that uses existing energy.
- Production that establishes emerging opportunities through connectivity between the production process and the local urban fabric.

Three concepts developed out of this definition of production in terms of emergence:

- Connectivity/movement (fig: 78)
- Discarded objects and space (existing energies and activities) (fig: 79)
- Production moving away from a linear process to a cyclical process (fig: 80)

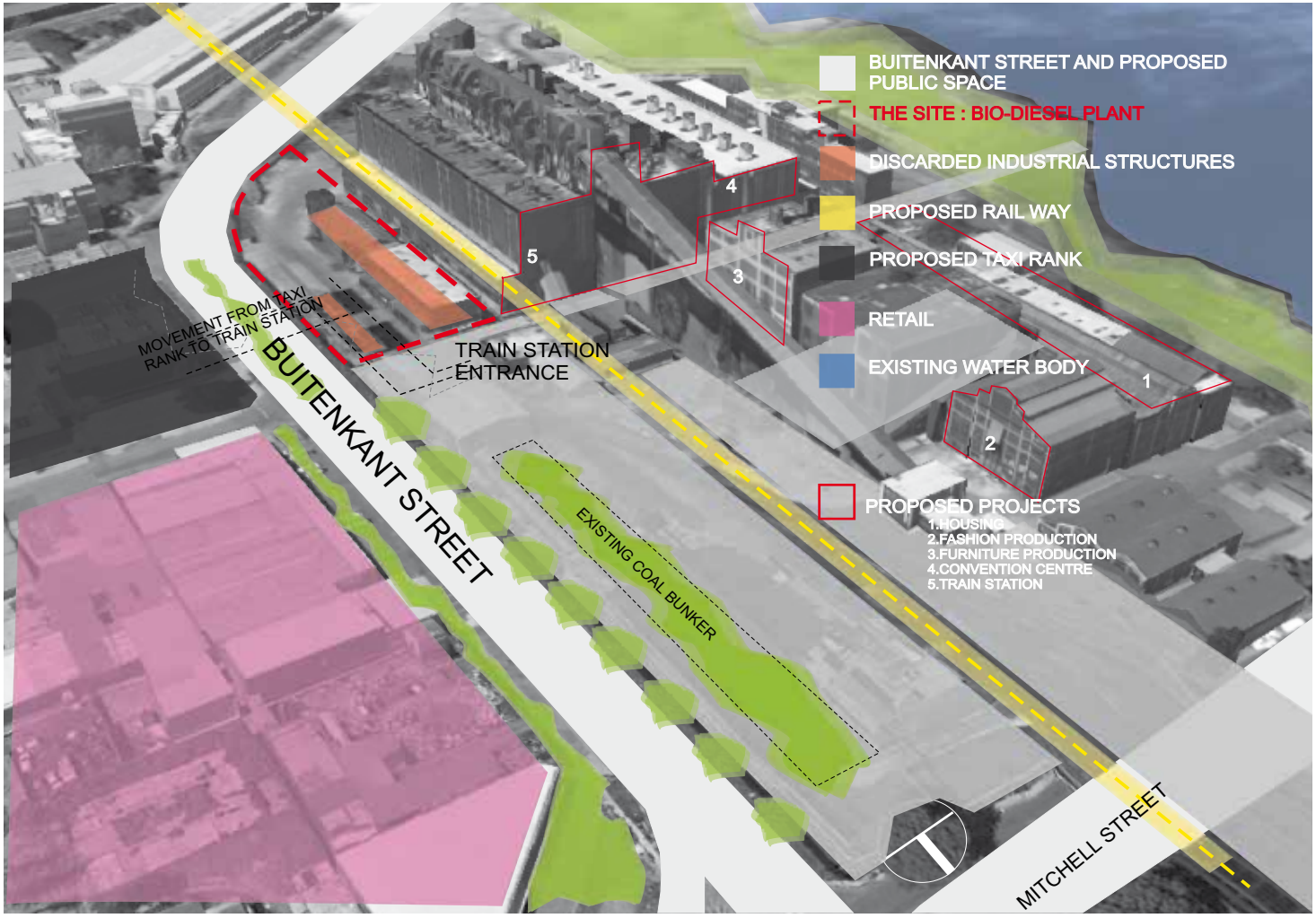


Figure 81. Factors that influence the site location: Google Earth, edited by Author 2010.

To strengthen the integrity and consistency of the design the three aforementioned concepts guided the decision-making processes; from choosing the site and determining the building programme to the design intervention itself.

The specific site was chosen for (see fig: 81):

- Its location next to Buitenkant Street and the proposed public square. This location will generate the opportunities for the industrial building to respond to the urban environment (connectivity and movement opportunities).
- The opportunity to utilise discarded industrial structures (workshop, boiler maintenance workshop and the ash bunkers).
- Its location next to the proposed train station, which will ease movement of resources in the industrial ecosystem (cyclical production).

Bio-diesel plant emerged as the building program due to :

- The industrial process being environmentally friendly and sustainable that will fit in well with the industrial ethos of the area. It will also address the social needs (addendum A, newspaper analysis, 2010) of job creation and economic empowerment.
- Discarded objects (used cooking oil) that will be used to produce energy (bio-diesel)
- The production process of bio-diesel being cyclical and its ability to create an industrial ecosystem, where, the waste (used cooking oil) of an industrial process is used to produce a resource (bio-diesel)

The European Union will require all transportation fuels to contain a 10% bio-fuel component by the beginning of 2011 and China indicated that it will add 15% bio-fuel into its diesel and petrol in the near future. The South African White Paper, released four years ago, set a goal of achieving a 2% penetration level of bio-fuels in the national liquid fuel supply by 2012. This target was decreased from the 4.5% target initially proposed in the draft strategy document. The 2% target of the national liquid fuel supply equals around 180-million litres per annum. The country will need large scale bio-diesel plants to achieve this target (Smith, 2010).

The design intervention:

Design intentions

What emerged from the first conceptual spatial exploration is that the building started to react to the surrounding urban activities (fig: 83) through a human scale, rather than an industrial scale. The non-linear façade (fig: 82) creates rhythm and the opportunity for visual and physical connection points between the industrial process and the surrounding urban fabric (fig: 84), and soft elements such as green and social spaces become the threshold between the industrial process and the adjacent urban environment (fig: 85).

The exploration of passive design strategies guided the form of the building (fig: 86 and 87). For example, in deriving the form of the roofs, natural light flowing into the building and the angle of the position of the solar panels guided much of this process. From a theoretical point of view, deriving the form of the roofs wasn't just a linear process followed to enclose and protect the building, but also cyclical in terms of accommodating processes such as rainwater harvesting and the use of solar panels.

Figure 82. First conceptual spatial exploration showing the non-linear facade to create social spaces that will form connection points between the production process and surrounding urban activities : Author August 2010.

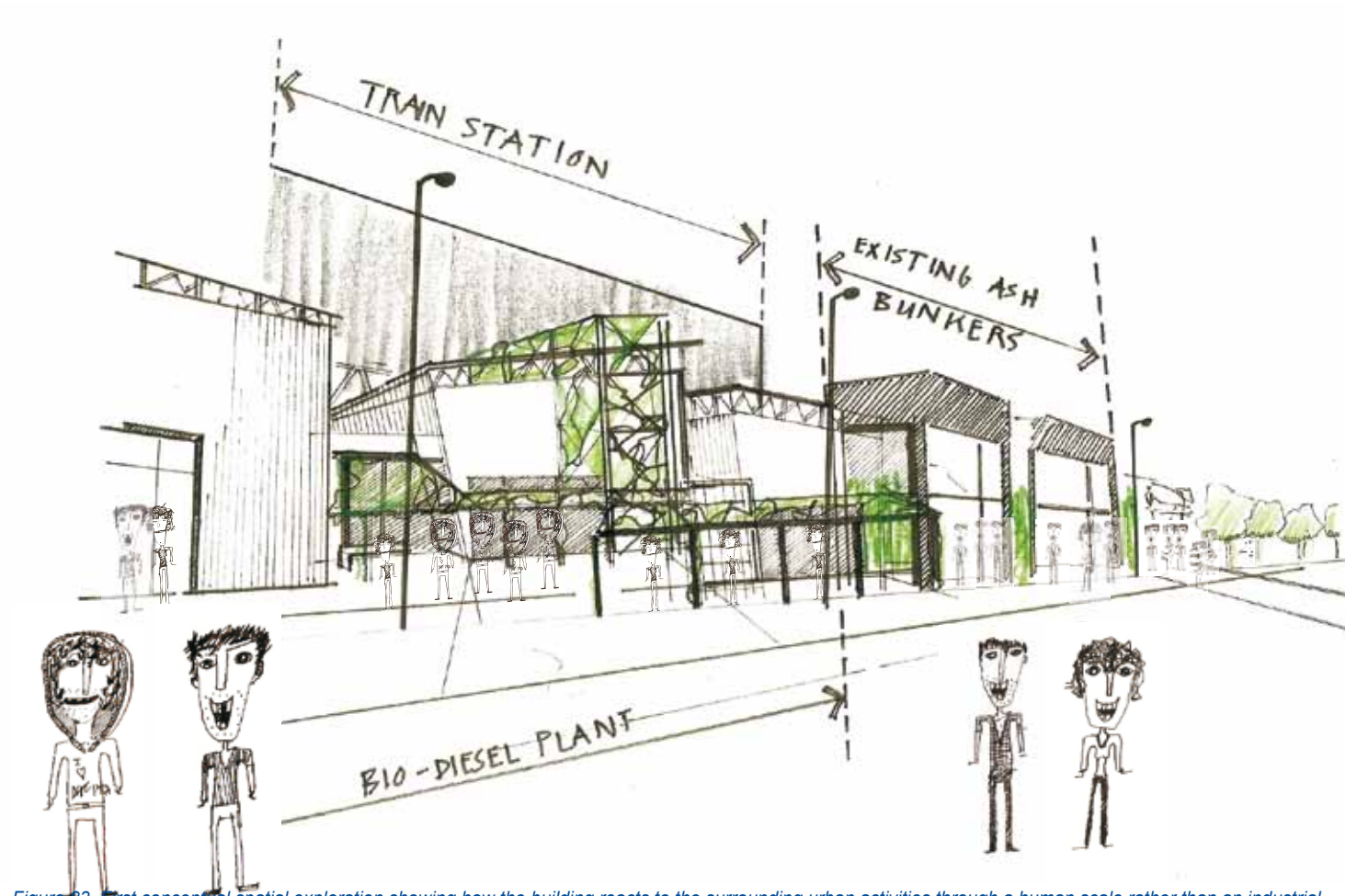


Figure 83. First conceptual spatial exploration showing how the building reacts to the surrounding urban activities through a human scale rather than an industrial scale: Author August, 2010

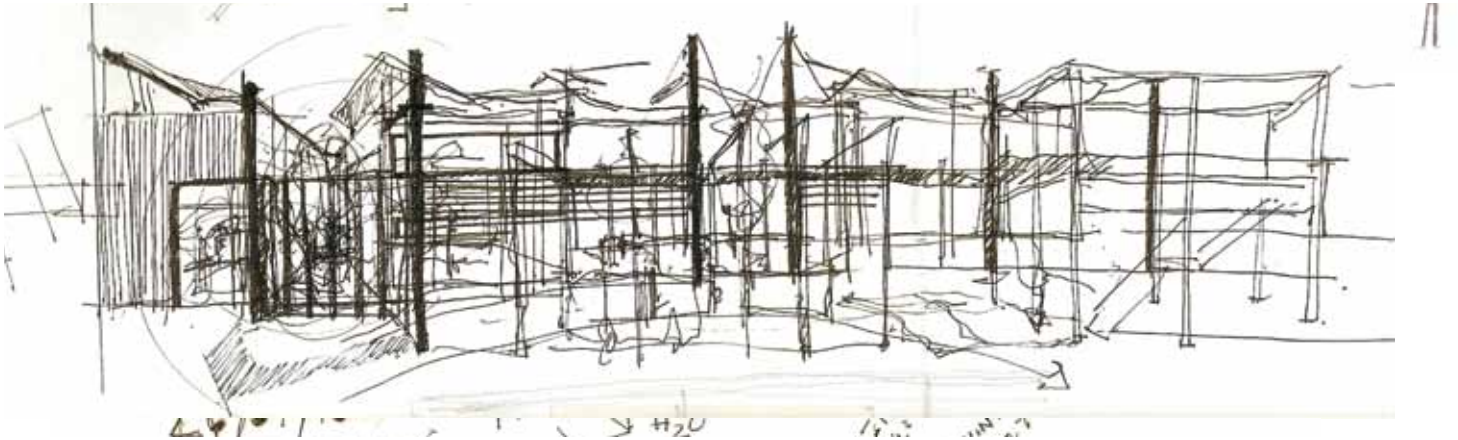


Figure 84. Conceptual exploration,the non-linear façade imitates non-linear processes and creates rhythm and opportunity for visual and physical connection points between the industrial process and the surrounding urban fabric. By breaking up the facade the building will relate to a more human scale: Author 2010

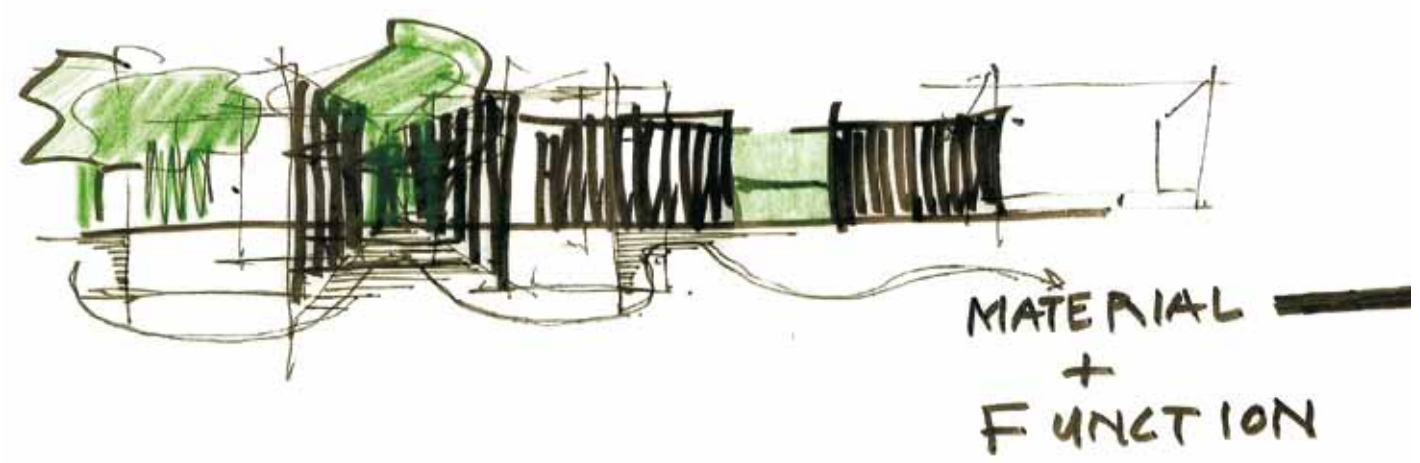


Figure 85. Conceptual exploration, soft and humane spaces become the threshold between the industrial process and the adjacent urban fabric: Author 2010

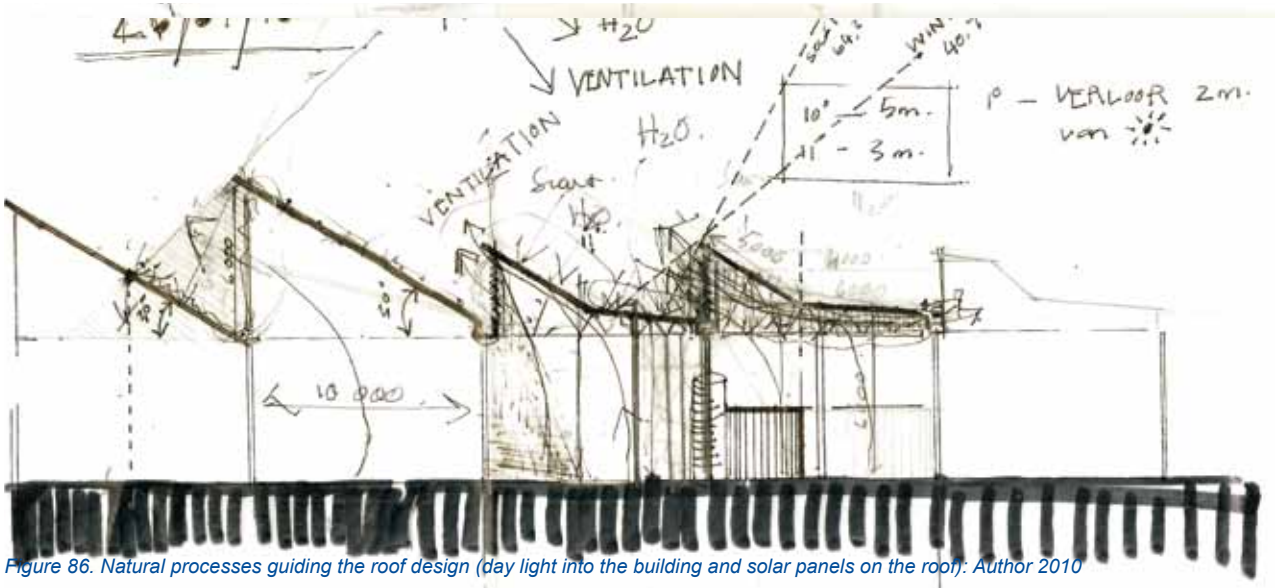


Figure 86. Natural processes guiding the roof design (day light into the building and solar panels on the roof): Author 2010

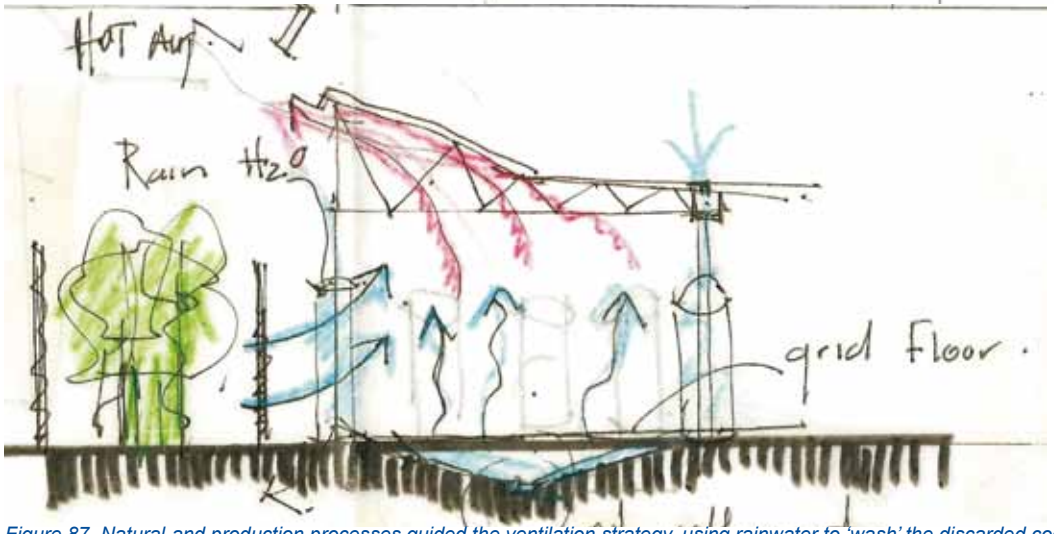


Figure 87. Natural-and production processes guided the ventilation strategy, using rainwater to 'wash' the discarded cooking oil will double up as the natural ventilation system for the production area: Author: 2010.

Natural ventilation will double up with the process to wash the discarded cooking oil. Washing the oil is a process whereby the harvested rainwater is mixed with the oils. Impurities in the oil react to the water. This process is intended to take place in a concrete funnel under the mentis grid floor. The cool air created by the water will be used to cool down the production plant and the clearstory louvers will allow hot air to escape (fig: 87).

Design response:

Contextually the Pretoria West Bio-diesel Plant must respond to the surrounding public space and to the street edge (Buitenkant Street) that will accommodate the proposed taxi rank and informal markets (fig: 89). This interaction will be programmed with thresholds, visual links and relating the industrial process to the urban environment with the appropriate human scale (fig: 88 + 89).

The integration of the production process into the urban fabric is deployed through a movement diagram (fig: 90) to organise the architecture and establish the connections between the urban fabric and the industrial building.

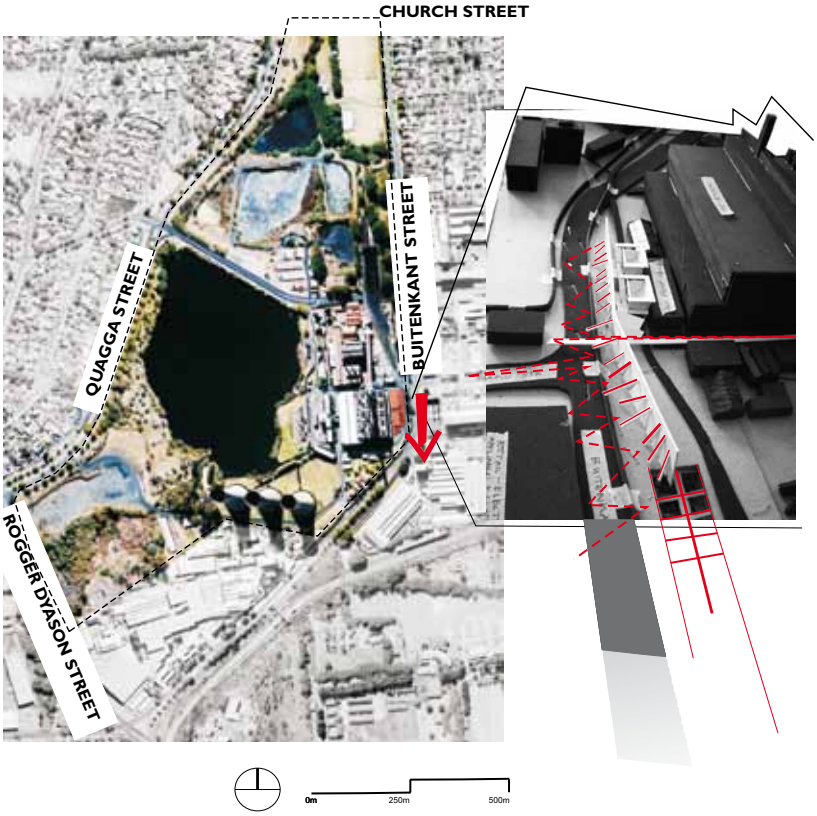


Figure 88. Integration with the public space and street edge will be programmed with thresholds, visual links and relating the industrial process to the urban environment with the appropriate human scale: Author 2010.

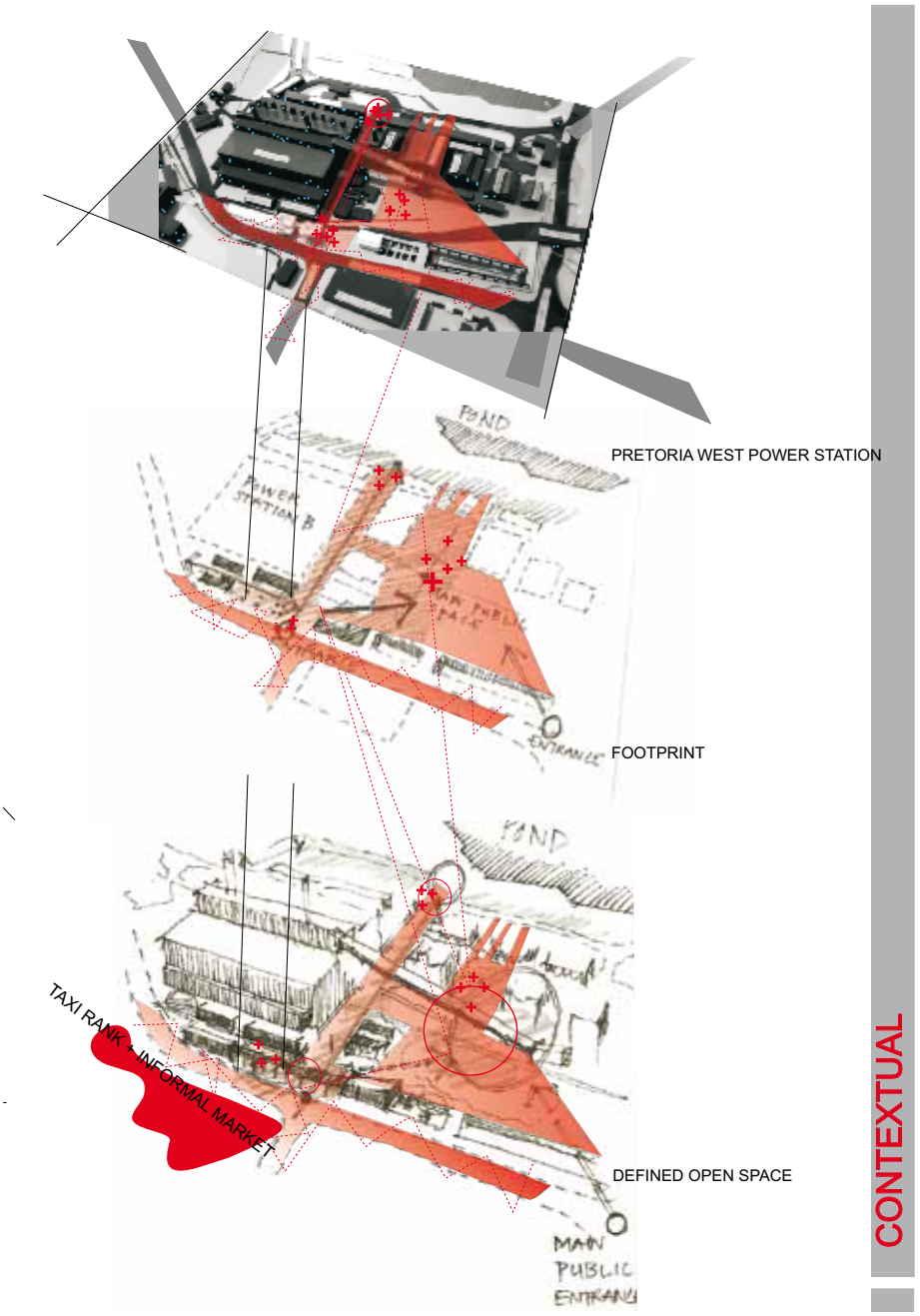


Figure 89. Contextual response based on spatial intentions; contextually the Pretoria West Bio-diesel Plant must respond to the surrounding public space and to the street edge (Buitenkant Street) that will accommodate the proposed taxi rank and informal markets: Author 2010.

Development of the movement diagram (fig: 90)

The purpose of the development of the movement diagram is to establish the connection between the building functions and the surrounding urban fabric (activities).

- The main movement corridor of the proposed bio-diesel plant is placed parallel to the street and at the back; this will allow for maximum interaction in the front with the production process from the street and yield an optimal logistical operation with rail and road freight.
- The production and related activities are placed closest to the street to establish visual connection and, by creating production annexes that will accommodate the production activities, a non-linear facade will be created that will enable a tacit connection between the production process and the local community through visual and social interaction.

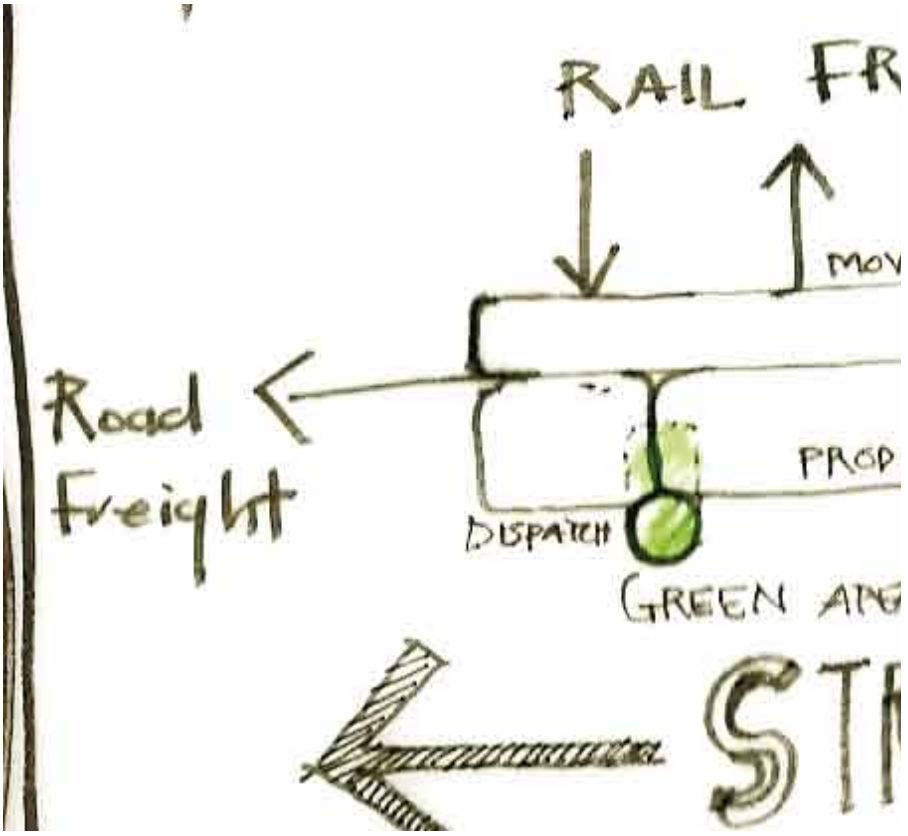
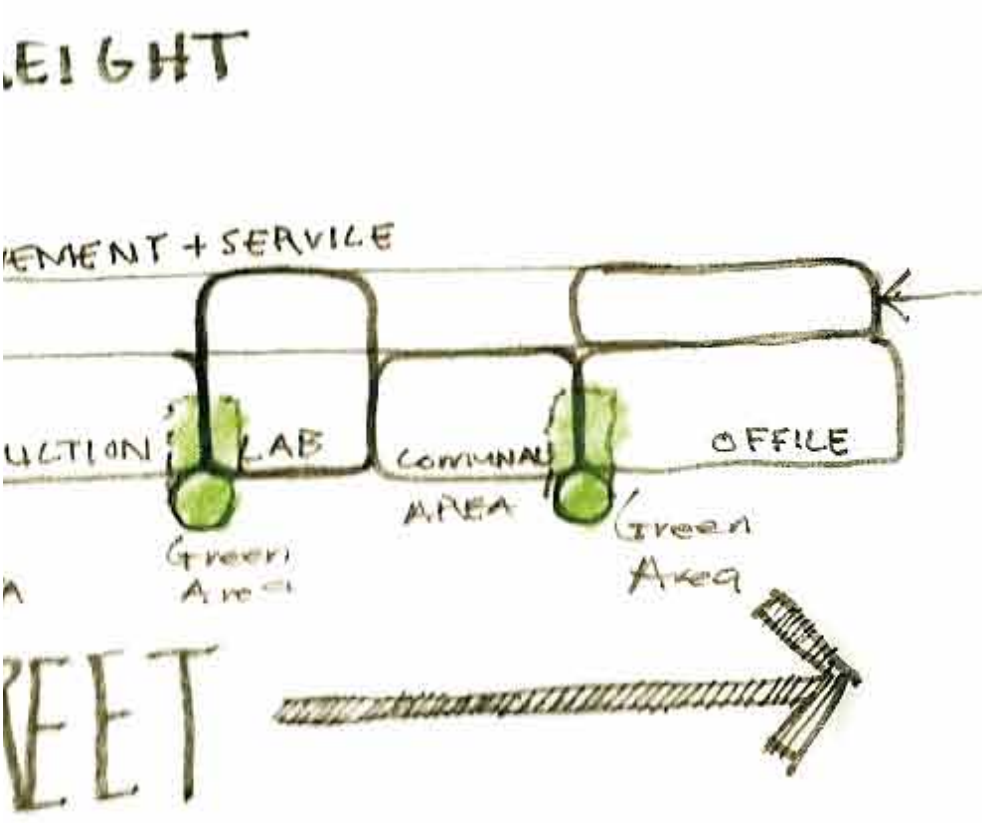


Figure 90. The movement diagram is the first response to provide the building with spatial performance: Author 2010.

The integration strategies of the production process (Bio-diesel plant) with the urban fabric (see fig: 91):

- Movement along the non-linear facade is used to establish visual links between the urban fabric and the production process; with large openings in the facade to expose the day to day activities in the Bio-diesel plant.
- The second strategy was to integrate the activities of the Bio-diesel plant to that of the surrounding urban fabric; threshold spaces are programmed to accommodate these physical interaction. These threshold spaces are spill out areas for the Bio-diesel plant and flows directly into the surrounding urban activities; in the case of the Pretoria West bio-diesel plant it is the informal market around the ash bunkers and the adjacent public space to the north that the design responded to.
- The third strategy to integrate the production process into the urban fabric was to bring down the industrial scale to a human scale. Timber pergola structures along the facade with trees are used to define these humane areas; that are closely stitch to the surrounding urban activities.



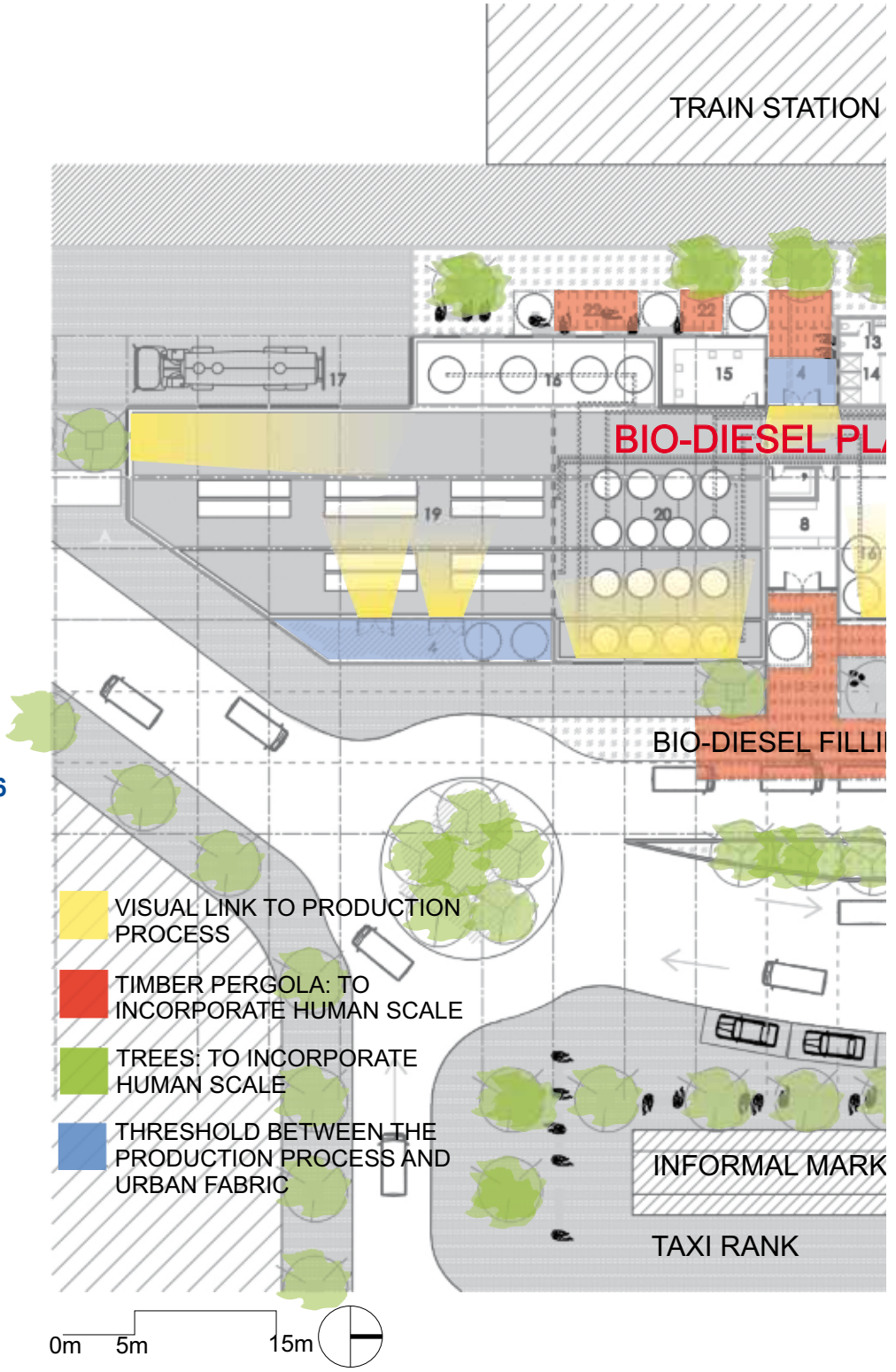
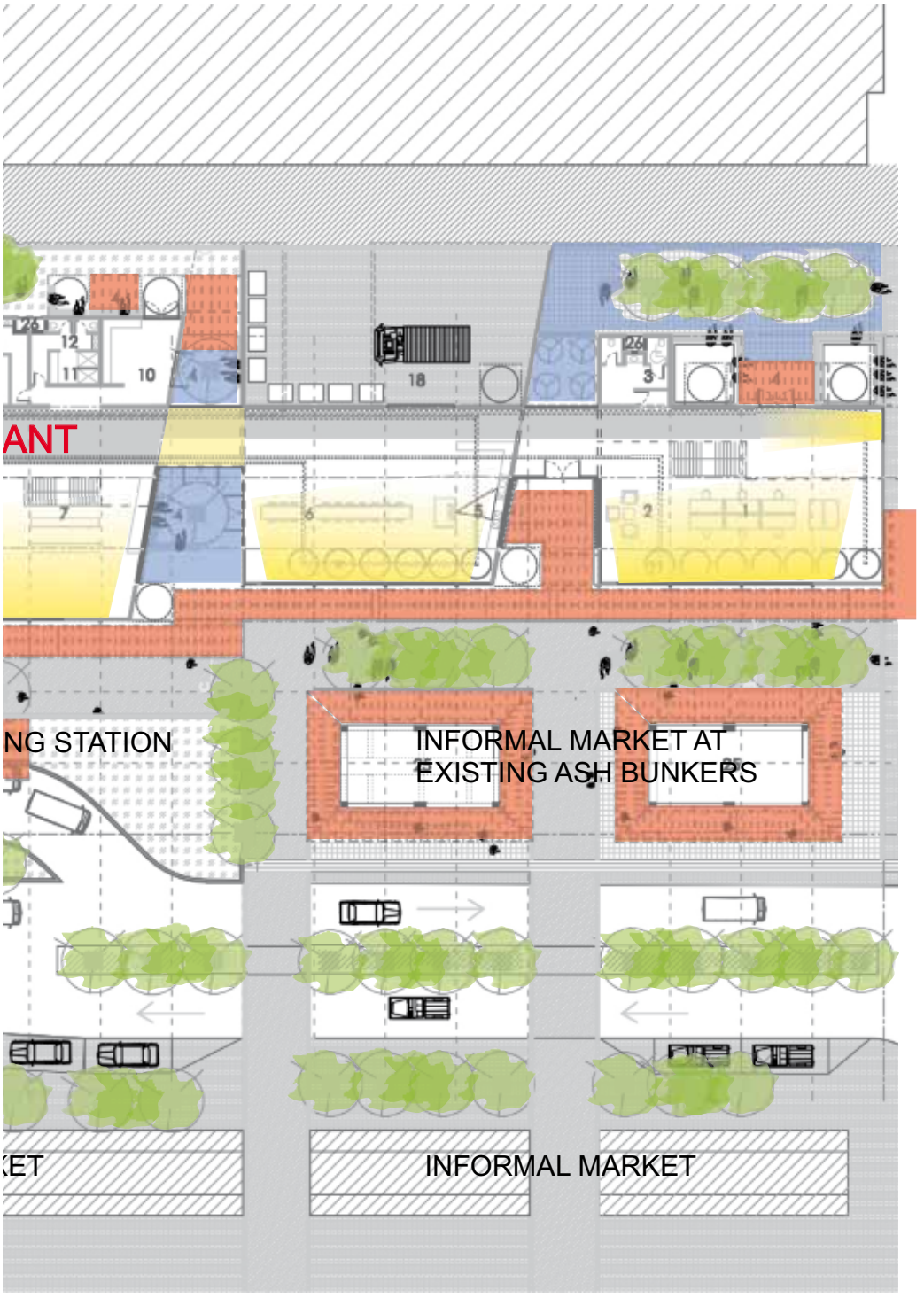


Figure 91. Pretoria west Bio-diesel Plant: showing integration with the urban fabric through the employment of visual links, threshold and incorporating human scale: Author 2010.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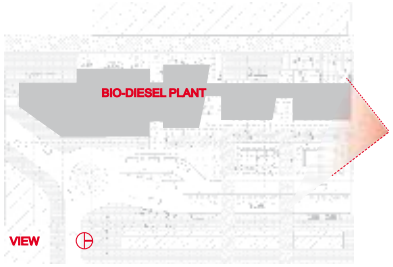


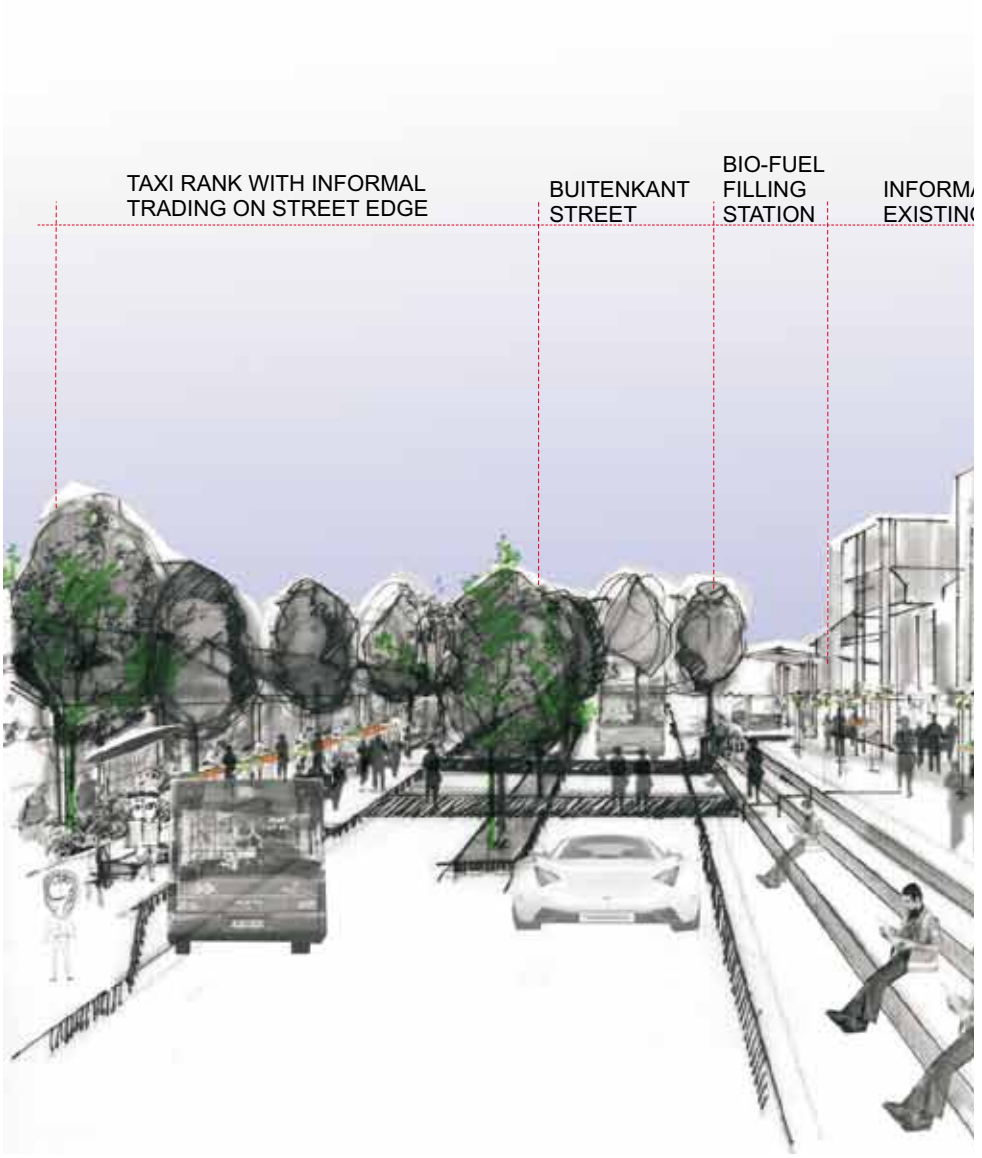
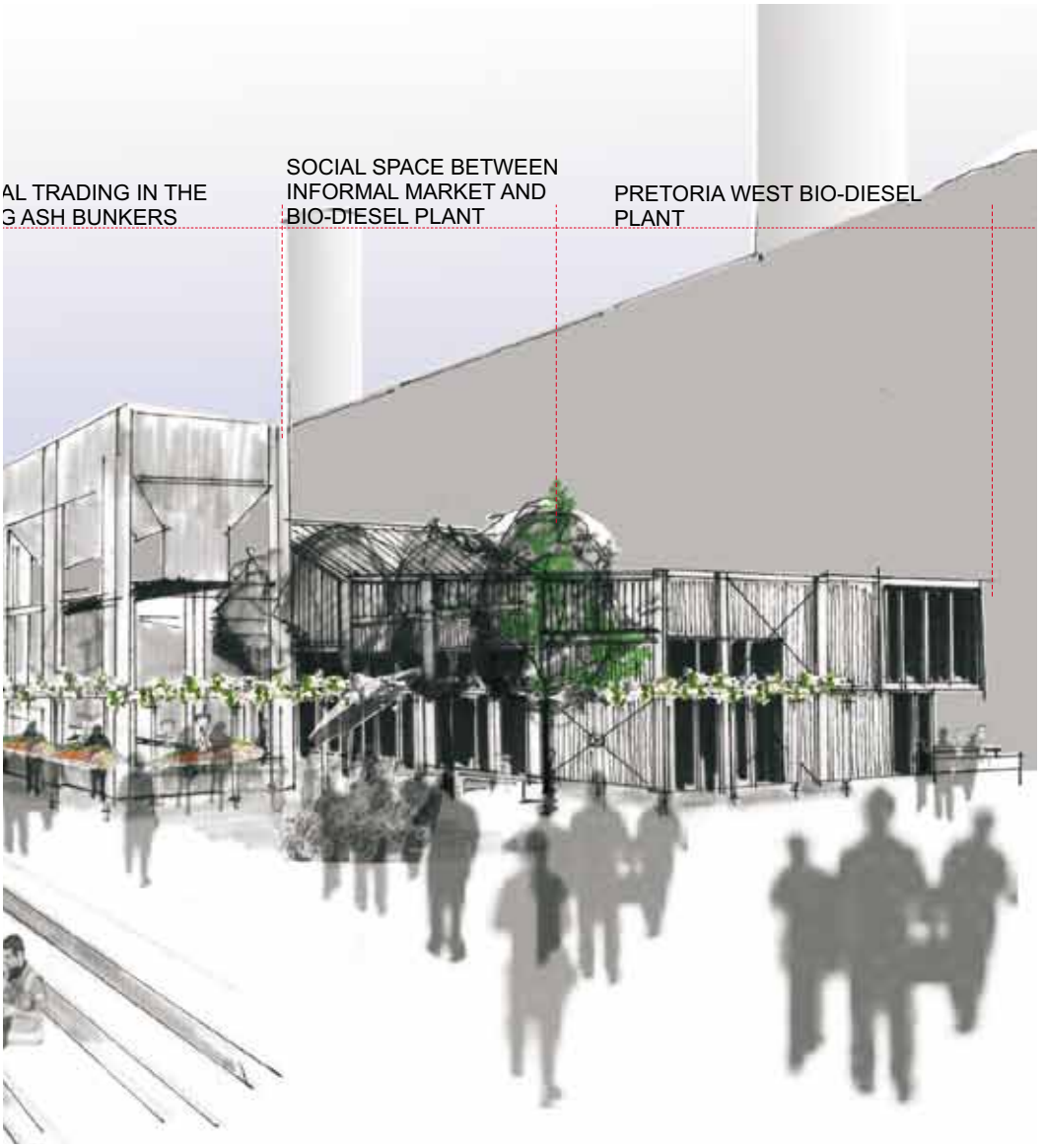


Figure 92. Pretoria west Bio-diesel Plant: showing Buitenkant Steet and how the Pretoria West Bio-diesel plant is integrated into the surrounding urban fabric: Author 2010.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