





09

technology



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REALISED DIFFERENCE



The physical expression of the Vulnerable Asylum is further defined through its technical resolution. As already discussed, the intervention is viewed as a culmination of cultural and historical expression. The contradictory facets of fossil, fetish, wish image and ruin are considered for how their tectonic delivery can create an architecture of shelter within a highly mobile and diverse context.

This shelter of contradiction is viewed as an extension of the environment and the primary means of negotiating the extremes between internal and external. It not only provides physiological protection but also reduces the vulnerability of the inhabitants and the architecture itself. An investigation into the structure, services, systems and materials aims to explore the possibilities of creating this sheltered environment.

Figure 9.1: Photograph of the lean-to roof typology that defines the edges of Boom Street in Marabastad (Source: Mentz 2015).

Tectonic Concept

intersections of difference

Making architecture is viewed as the combination of separate and different parts to create a useful assembly. Historically this process of amalgamation has been tested since the earliest expressions of shelter (Groák 1992:3). Before becoming distracted by the delightful intricacies of the connections between component assemblies, it becomes important to define the overall character of those primary elements that enclose the human habitat. The roof, the walls and the floor all serve in providing architectural qualities to those enclosed spaces and as such it becomes important to define a concept of selecting and expressing their tectonics.

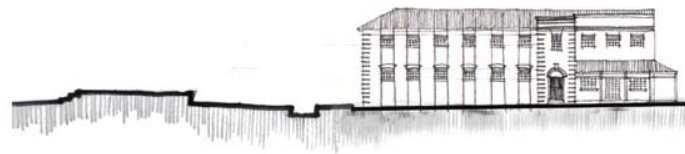
In achieving the theoretical outset of the investigation these elements, as negotiators, must consider and convey differences between the following:

- Old and new,
- Local and international,
- Internal and external,
- Tectonic and stereotomic.

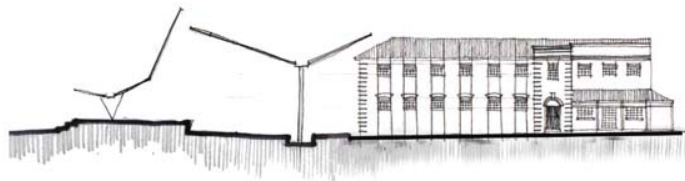
Thus the overall tectonic concept becomes defined by that of intersections of difference. Here, the connection between the roof, the walls, and the floor are exposed and celebrated in their ability to delimit space.

Drawing from contextual informants within Marabastad offers insights into the qualities of

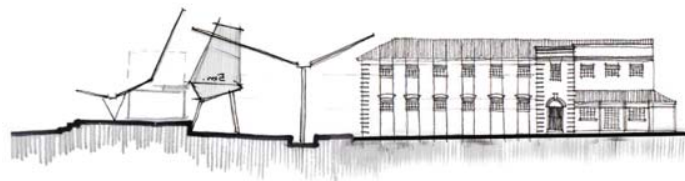
the makeup of these elements. Specific attention is given to the lean-to roof structures that define the edges along Boom Street. In this instance the manipulation of the floor controls and diverts movement between various horizontal planes through kerbs, sidewalks and steps. The colonnade, robust and highly adaptable in use, is covered by a roof, supported on both ends by stereotomic structures. These same principles are applied in a similar fashion to the tectonic concept of the investigation. The primary roof element, lightweight and distinct from its supports on either end, frames a flexible space below it where the morphing of the ground plane directs movement and interactions with the building. A steel structure, contained between stereotomic forms and delicately supported by the ground, becomes a flexible framework that accommodates the specific spaces between the two horizontal planes.



ground



roof



specific space

Figure 9.2: Diagrammatic illustration of the tectonic concept indicating the intersections of difference.

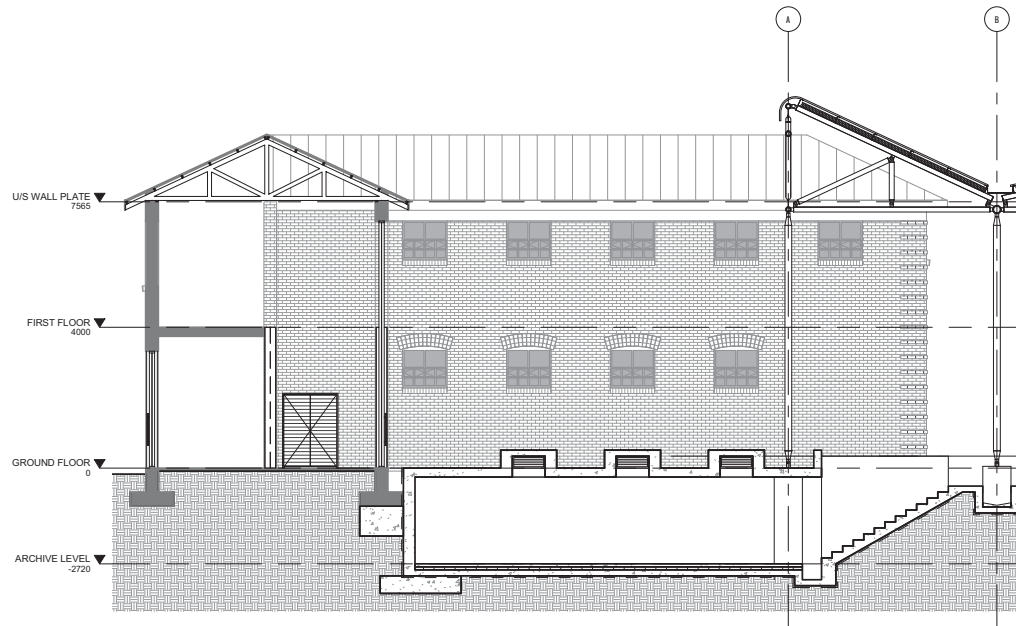
Structural System

susceptibility

In accordance with the Burra Charter, the new structural system is required to be easily distinguishable from that of the heritage. As such, a new lightweight steel structure that is open, connectible and detachable will be investigated. The aim is that this susceptibility to modification will allow for the necessary conditions to include the unintended and unforeseeable as sources of new interpretation.

Substructure

In keeping with the tectonic concept, the substructure of the building is seen as a manipulation of the ground plane. An excavated basement level utilises the well-insulated qualities of earth to house a digital archive where the radiant heat generated from the machinery is tempered by the lower temperatures below the surface. The earth excavated during this construction will be used as supplementary filling to create the new elevated ground plane areas, thus minimising the quantity of imported material required.



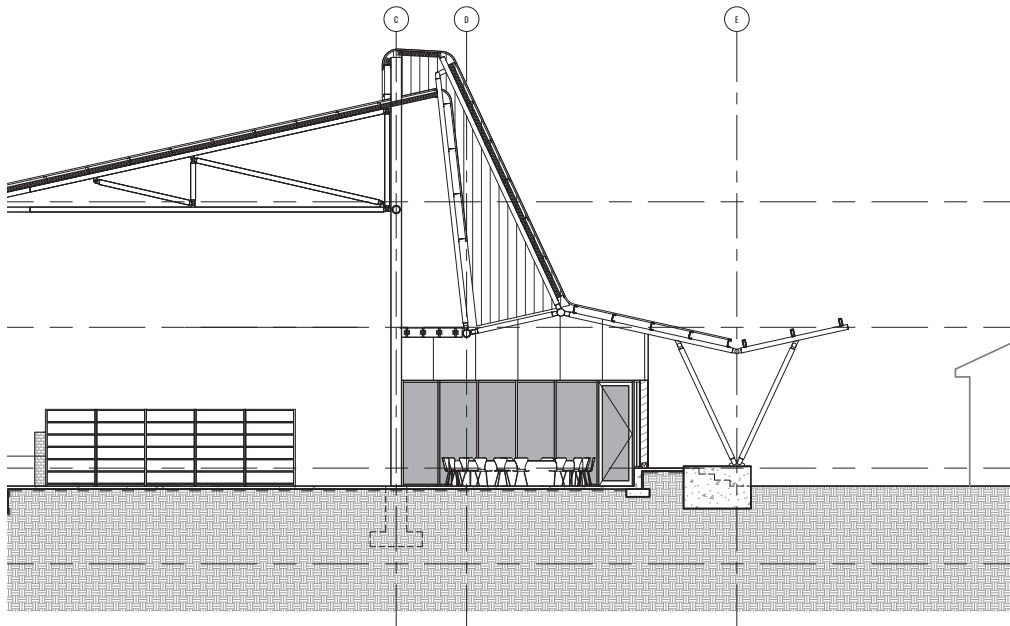
Primary Structure

The primary structure that supports the building is comprised of a steel frame. Painted steel I-profile sections define the main horizontal and vertical load-bearing elements. In contrast to the introverted masonry structure of the existing, this inertly open structure becomes the framework that allows access to the opportunities housed within the building and supports the skin that negotiates the differences between inside and outside.

Additionally, an open web steel truss comprised of hot-rolled steel angles spans between columns to carry the main roof.

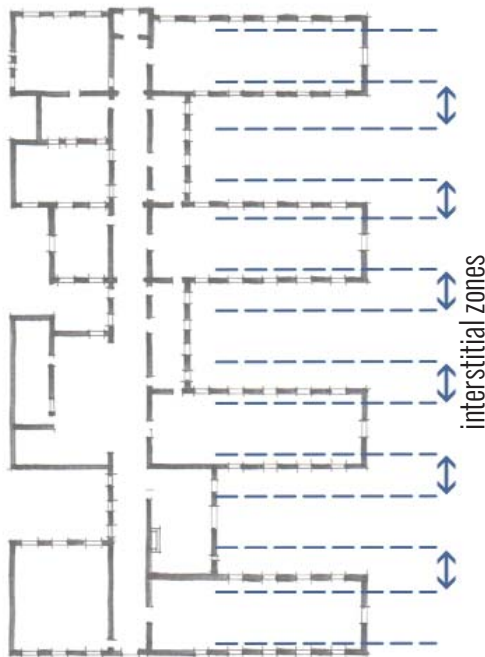
Secondary Structure

More permanent in nature, the secondary structure is made up of load-bearing masonry towers along the Eastern edge of the building. Constructed from unfinished face-brick, these structures house those programmatic elements that are least likely to change with the future use of the new building. As such, they contain services, circulation and support spaces necessary for the operation of the building. Their permanence allows these stereotomic elements to direct movement flows in and around the building while their material density provides much-needed thermal mass to the otherwise tectonic structure.



Interstitial Grid

In order to negotiate the connection between new and old structures, an interstitial grid helps to order the arrangement of the new steel structure. Any discrepancies in measurement between drawing and on-site construction are facilitated by intermediary grid lines.



Tertiary Structure

The tertiary structure is defined by that of the elevated 'pods' within the main volume. Seen as outlets for the community, these structures make use of local carpenters from the neighbouring craft centre in their construction. Organic in form, these structures required a material that could be easily formed to create the required profile while still being able to carry the applicable loads. As such, glue laminated timber beams were selected to fulfil these requirements while providing local labour the opportunity to hone their developing knowledge and skills.

Floors

Overhead floor levels supported by the steel structure were required to be lightweight in nature in order to reduce the section size and weight of load bearing elements. As such, two different flooring systems were selected. Firstly, pre-stressed, precast, hollow-core concrete slabs are used in areas where high dead loads are expected. The advantage of this system lies in its controlled, prefabricated nature which allows further spans with less material depth. The second flooring system investigated includes composite timber decking on timber joists and forms the main elevated walkway on first floor. Besides its lightweight nature, this flooring system presents added benefits to the scheme. The first, is that it offers another outlet

for skills development for those enrolled at the neighbouring craft centre. Secondly, positioned parallel to the existing structure, the Western walkway may need to have the ability to negotiate any tolerance discrepancies when joining the new with the old. These inaccuracies can easily be accommodated by on-site alterations to the supporting sub-structure of this flooring system.

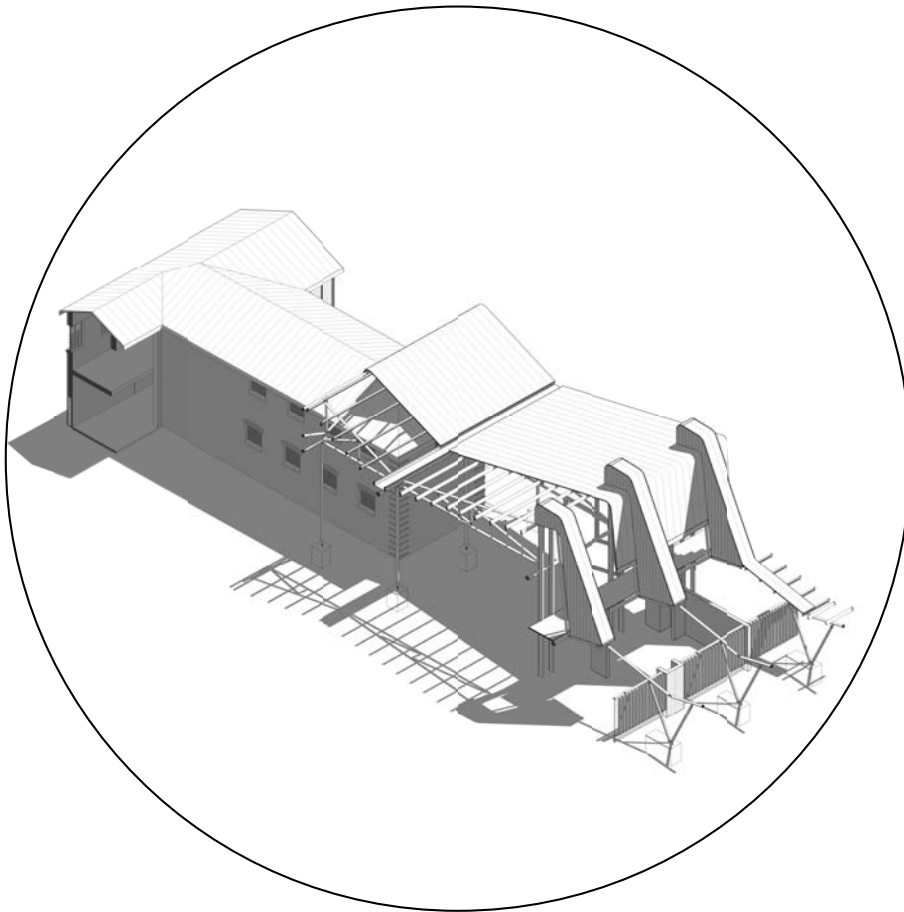


Figure 9.5: Isometric view of structural exploration.

Materiality

a scale of absoluteness

A material palette for implementation was developed through an investigation of the immediate context of Marabastad, neighbouring buildings and the historic memory of the site.

Much of Marabastad is characterised by a rich and textured materiality. Stereotomic façades constructed from plastered and painted clay bricks are punctuated by mixed colonnades of heavy concrete and light steel columns. Driven by the necessity of cost efficiency and future adaptability, recent alterations to the material nature include steel cladding and prefabricated concrete elements.

Similarly, many of the typologically industrial buildings neighbouring the Old Native Reception Depot have employed a modest use of technology and material that is both economical and functional. Considering the lightweight and utilitarian material nature of Tin Town, that once occupied the area, further entrenches this notion.

Thus the final material quality of the intervention is expressed along a scale of absoluteness where the passage of time is conveyed by varied levels of material permanence. Those elements most resistant to change are assigned heavier and hard-wearing materials such as face brick. Spaces more susceptible to change articulate this through their lightness and minimised density.



fibre cement boards

anechoic foam

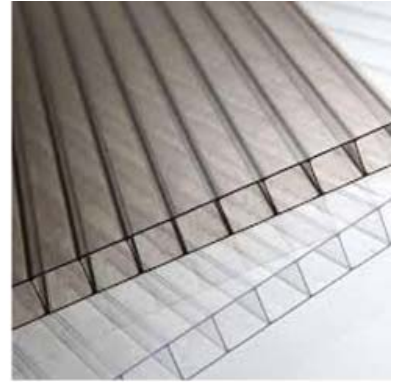
permeable paving



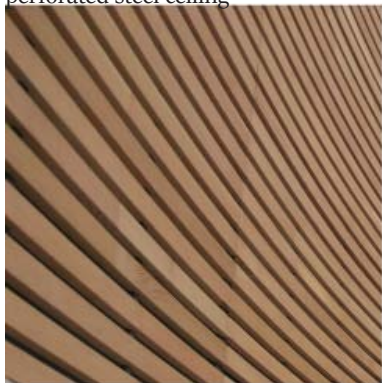
perforated steel ceiling



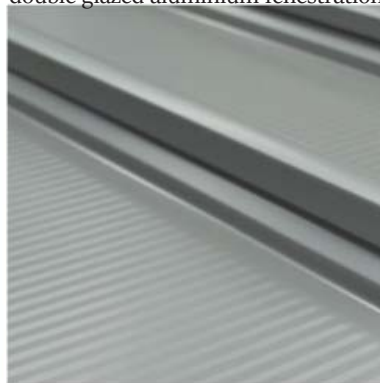
double glazed aluminium fenestration



polycarbonate sheeting



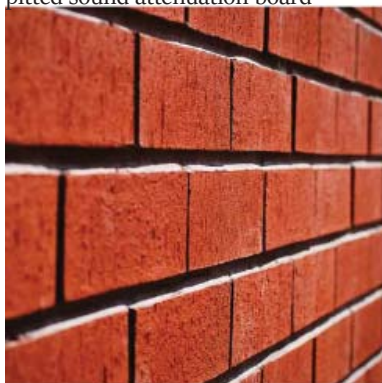
pitted sound attenuation board



concealed fix roof sheeting



composite timber flooring



clay face-brick

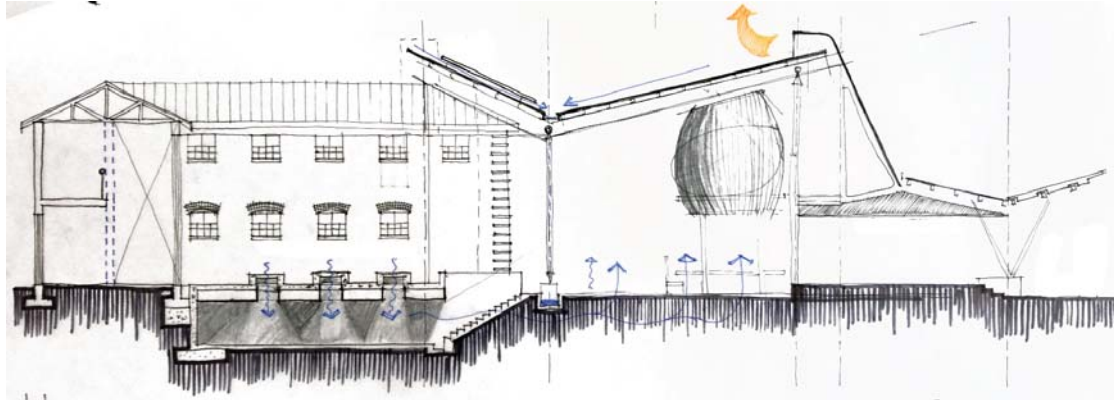


polished concrete floor



laminated timber

Figure 9.6: Palette of materials used within the scheme indicating their position on a scale of absoluteness.



The Comfort of Shelter

internal quality

The main challenges in controlling the indoor quality of spaces within the building arise due to its overall length and its mostly East-West orientation. In order to reduce the extent of active systems needed to maintain a comfortable internal environment, the investigation explores the use of a number of passive strategies.

Passive Ventilation

The ventilation of the main volume of the building harnesses the natural buoyancy of air to encourage cross ventilation through the main volume of the new structure. Cool air, drawn in at a low level from the primarily shaded existing courtyards gains heat from the activities occurring within the volume causing the air to displace upwards towards the high level ceiling. Clerestory ventilators along the eastern roof

apex allow the warm air to escape to the warmer exterior. The introduction of solar chimneys along the same roof line were considered to enhance this process and serve the spaces along the eastern facade, however in order for stack ventilators to be effective they are required to be twice the height of the served space. This height would not be achievable without the overall building height becoming excessive.

Daylight Control

The overall length of the roof structure combined with double glazing enclosing the Western and Eastern edges leads to poorly lit spaces below the main roof. Punctuating the otherwise solid roof and ceiling with translucent polycarbonate sheeting allows enhanced exposure to daylight thus reducing the need for artificial lighting.

Solar Exposed Thermal Mass

Maintaining human thermal comfort within the large volume space during cooler winter months is addressed through increasing the thermal mass of floors at ground plane level. Offset from the openings in the roof, thickened concrete surface beds harness incident solar radiation and through the thermal flywheel effect re-radiate this stored heat energy to the surrounding cooler spaces. During summer months shading devices at ceiling level prevent this incident radiation from reaching the floor.

Harnessed Potential

sustainability

The intervention makes use of three main sustainable systems in order to mitigate its impact on the environment. In line with the tectonic concept, these systems become extensions of the ground and roof planes.

Ground Exchange

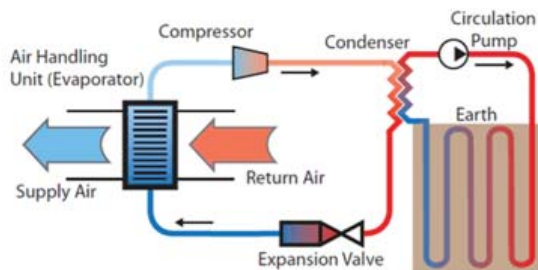
In order to maintain comfortable internal ambient air temperature, the project investigates the use of a ground source heat pump system in conjunction with the previously mentioned passive systems. If properly integrated, designed and applied, ground source heat pumps can provide significant energy and carbon savings (CIBSE 2013:1).

Often achieving co-efficient of performance (COP) factors of four, the system combines three units of thermal energy and a single unit of electrical energy to provide four units space heating or cooling.

Through conduction these heat exchange systems utilise the latent low temperature of the earth to either lower or increase the ambient air temperature within the building. In order to heat the earth energy is extracted from the ground, while for cooling exhaust energy is rejected to the ground (ibid.). As an added benefit, the excess energy extracted from cooling can be utilised by the heat exchanger to supplement hot water heating requirements.

Based on the aforementioned energy efficiency and benefits in conjunction with the tectonic concept, the investigation proposes the implementation of a horizontal closed loop system. As such, thirty-two millimetre diameter high density polyethylene (HDPE) pipe coils are buried in trenches, spaced eight hundred millimetres apart, that extend two metres below the surface.

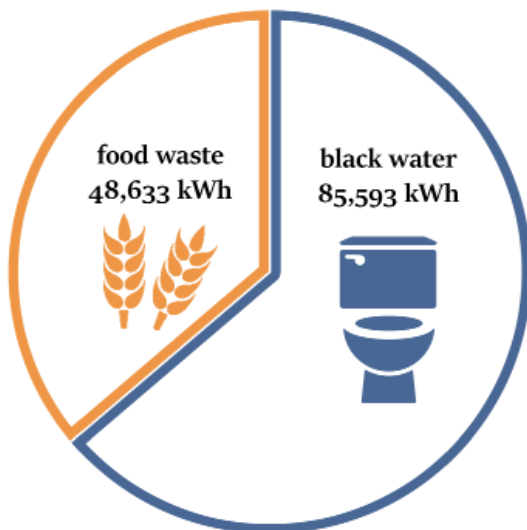
Alternate Energy



Considering the excessive energy demand and consumption associated with the high-volume use of electronic equipment within the programmatic elements of the building, the investigation seeks to implement an alternative energy source to offset these requirements.

Contemplating the extensive use and production of organic material within the growing areas, kitchen and ablution facilities of the building led to investigating anaerobic biodigesters as an alternate method of sustainable energy generation.

Anaerobic biodigesters make use of a natural process to break down organic material, in the absence of oxygen, to produce methane (60%) and carbon dioxide (40%) gas as by-products. The methane produced is a combustible gas that can be employed in the same way as LPG as a fuel for lighting, cooking, water heating and space heating. Furthermore, this chemical breakdown of the material removes pathogens from the matter, producing a high quality fertilizer that can be utilised for crop cultivation (Fox 2011:48). The implementation of this system to handle the food waste sourced from the kitchen as well as the black water from the ablutions within the building offers considerable potential alternative energy generation for the scheme. According to estimates obtained from preliminary calculations, the utilisation of a biodigester system allows for the yield of 134,226 kilowatt hours per annum



in alternative energy, requiring a twenty-four cubic metre tank to do so (Biowatts.org, n.d).

Rainwater Harvesting

With a combined catchment area of 2,700 square metres, the new and existing roof structures offer the opportunity to harvest and store rainwater for use in and around the intervention.

Even though highly efficient sanitary appliances, including aerated taps and shower heads, dual-flush water closets and waterless urinals are specified, the resultant water demand for the intervention is in excess of three-hundred-and-forty kilolitres per month. Unfortunately, the rainwater harvested each month would be

insufficient to sustain these appliances purely on rainwater, even during the wettest times of the year. As a result, the harvested water will be employed to supply the vegetable growing areas. In remembrance of the history of Marabastad, that once made use of subterranean wells as a water source, the reticulation and storage of rainwater occurs as an element of the manipulated ground plain. Storm water channels collect the harvested water and direct it towards underground storage tanks within the newly created basement.

Overflow and storm water are captured through the use of permeable precast concrete paving blocks and bio-swales.

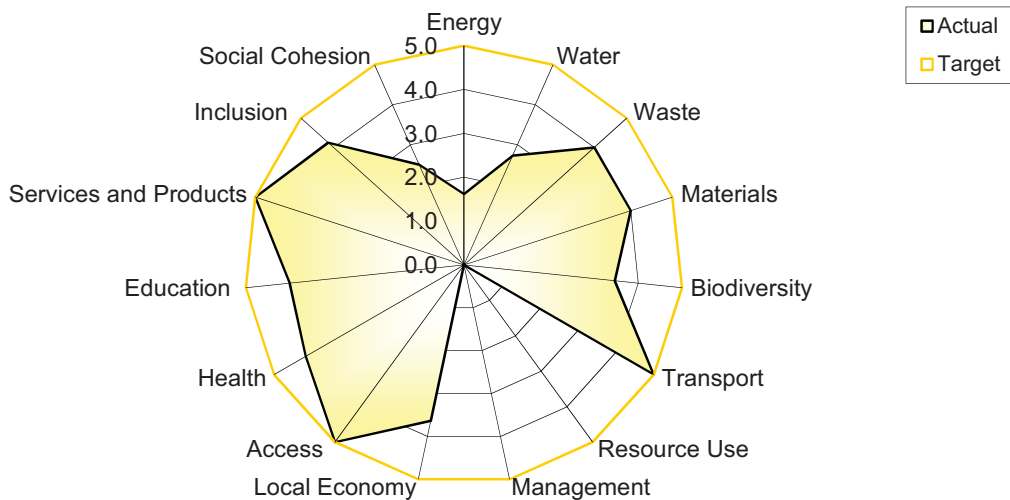


Figure 9.10: Results from an analysis on the building using the Sustainable Building Assessment Tool.

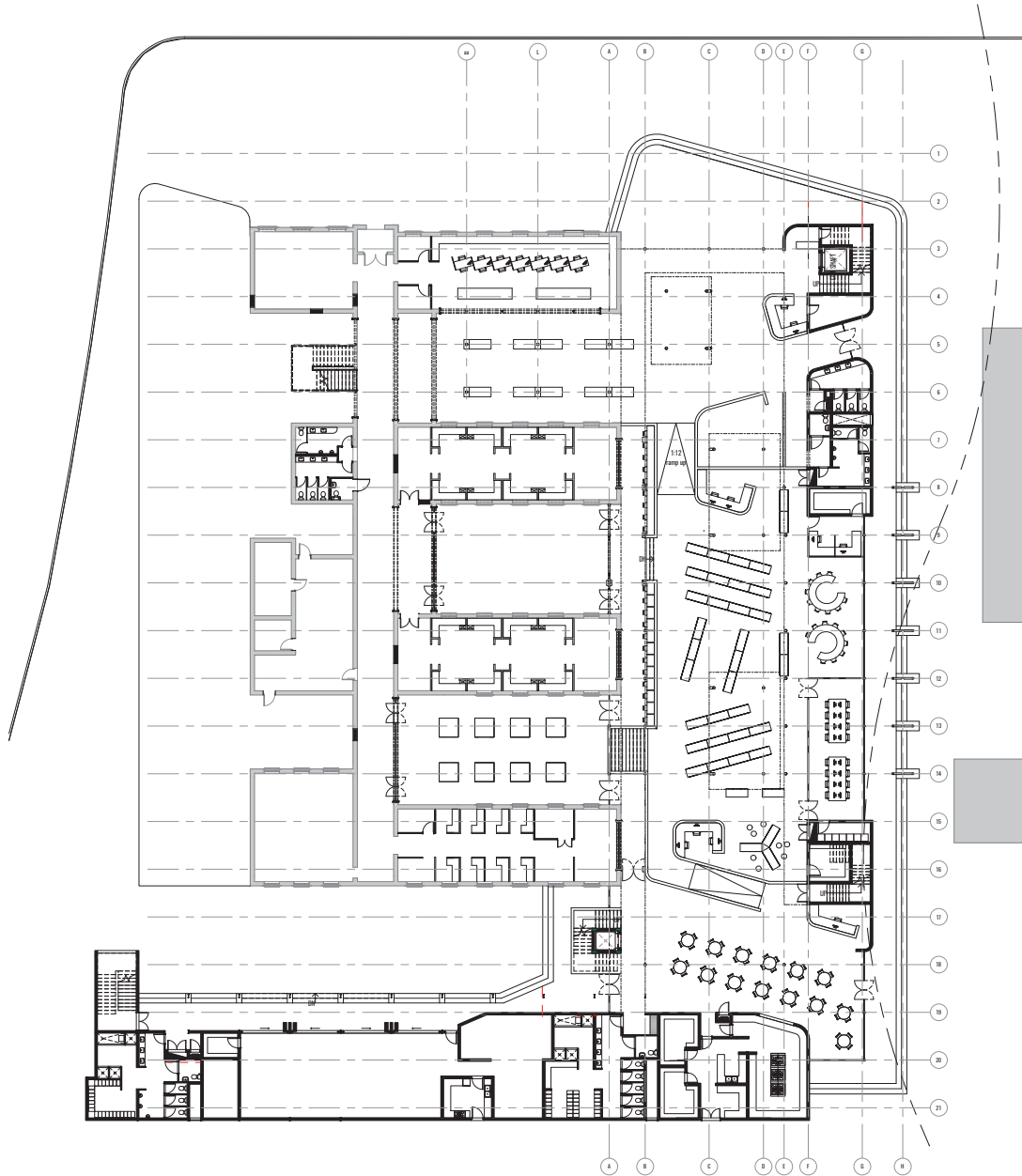


Figure 9.11: Ground floor plan layout of the Vulnerable Asylum (not to scale).

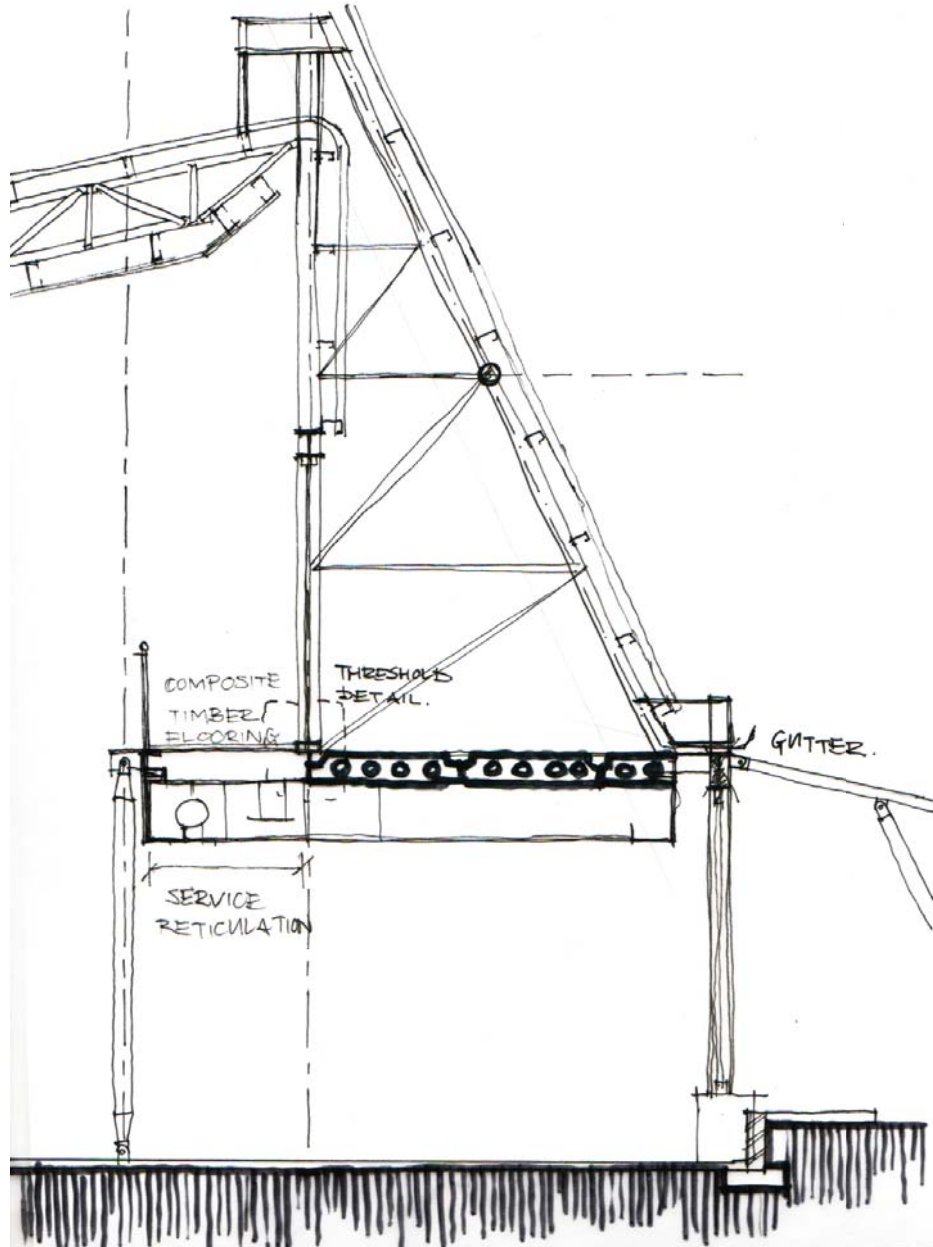


Figure 9.12: Detailed perimeter section of Eastern facade.

