10
10.1 Introduction

Following the design intentions to connect the urban and natural realms, the technical and technological investigation aims to further develop and actualise the hybrid typology. The technical concept therefore stems from and perpetuates the idea that the building is an extension of the park and landscape, and the park is an extension of the building. The form, structure and materiality of the building consequently reinforces and expresses the notion of the building as a constructed landscape and connecting interface.

Tectonic, technical and technological considerations assist to refine the design concept and a reciprocate mode of expression comes to the foreground. The mode of expression is also combined with elements of merger to create a building that responds to its urban and “natural” context. As the technical resolution of the project is interlinked with the design process, the technical and technological development ultimately becomes another design iteration and layer that informs and develops the final building product.
The elevated and constructed landscape
Source: Author

Figure 10.1 ~ The elevated landscape.jpg
Sculptural concrete, expressed in form and texture. 
Source: Simona Rota for Menis Arquitectos

Sacred Museum of Adeje and the Plaza of Spain. A stereotomic mass embedded into the surrounding topography. Source: Simona Rota for Menis Arquitectos

The semi-buried spaces with their articulated openings are situated below the public plaza. Source: Simona Rota for Menis Arquitectos

The plaza and tower overlooking the surrounding landscape. Source: Simona Rota for Menis Arquitectos

The building and plaza is integrated in the context of town and landscape. Source: Simona Rota for Menis Arquitectos
10.2 Technical Precedents

10.2.1 Tectonic Precedent: Sacred Museum of Adeje

Project: Sacred Museum of Adeje and the Plaza of Spain
Architect: Fernando Menis, Menis Arquitectos
Location: Adeje, Spain
Programme: Flexible exhibition spaces and plaza
Client: Municipality of Adeje, Spain
Year: 2006

The project was awarded with the 2012 European prize for urban public space and included the new “museum” building and municipal facility, as well as an extension and remodelling of the existing Plaza of Spain. The Sacred Museum is selected as a tectonic precedent due to the project’s similarities with that of the Hybrid. It also provides a series of spaces that are able to accommodate a flexible public programme and as the building is situated at the edge of the town, it also required an aesthetic that would respond to the context of the town, existing buildings and the surrounding landscape.

The sculpted stereochromic mass of the Sacred Museum is integrated and imbedded into the “rugged” topography of Adeje, with building spaces suppressed and buried into the landscape (Lomholt, 2016). The semi-buried spaces that is indented for community activities, particularly events and exhibitions, flow out to an upper plaza and public platform, which is celebrated by a projecting concrete tower (Lomholt, 2016). The Plaza serves as public stage, cafeteria and lookout point over the picturesque landscape and surrounds of Adeje (Menis, [sa]).

A simplistic material palette consisting of a combination of concrete applications and textures was employed. It also allows the surrounding landscape to take centre stage, but also gives justice to the sculpted and carved structure that is embedded into the topography. Board finished off-shutter concrete highlights the sculptural lines of the monolithic structure and its articulated openings and polished concrete and basalt applications are used for secondary surfaces and floors. The robust nature of concrete is perfectly suited for the public nature of the building, but the poetic use of form and light allows this public infrastructure to present an aesthetic that is also elegant.
10.2.2 Green Roof Precedent, DBSA Welcome Centre

Project: Development Bank of Southern Africa Welcome Centre
Architect: Holm Jordaan Architects and Urban Designers
Landscape architects: Insite Group
Location: Midrand, Gauteng, South Africa
Programme: Welcome centre and gatehouse
Client: Development Bank of Southern Africa
Year: 2010

The Development Bank of Southern Africa's (DBSA) Welcome Centre at the entrance of its Midrand campus was designed as a completely off-grid pavilion to conform to the sustainable policies of the institution. As part of this strategy the architects designed a sloping planted roof (Matthews, 2011:50), which is the reason for the selection of this precedent. The building’s intensive green roof will be the focus of the following short discussion, as the incorporation of a vegetated and landscaped roof has been present since the early concept and development of the hybrid building.

The motivation for the implementation of a green roof was twofold. Firstly, the soil for the indigenous grasses would provide desirable thermal mass to assist with the control of the internal climate conditions and secondly, it could offer the opportunity to harvest and manage storm water (HolmJordaan, [sa]). In addition it can be reasoned that green roofs are a potential bio-diversity element as they have the ability to support and promote life in environments that may otherwise be sterile (Dunnet & Kingsbury, 2008:43).

The DBSA roof is classified as an intensive green roof, meaning that the roof is physically accessible, consists of deep soil layers exceeding 300mm (could accommodate a variety of plants) and requires a higher level of maintenance (Schmidt & Vollmer, 2013:295-296). In order to support the heavy loading of the soil, people accessing the roof, as well as the growing medium’s moisture content (wet load), reinforced concrete structures are typically used for intensive planted roofs in South Africa (Schmidt et al., 2013:298-300). At the DBSA Welcome Centre a reinforced concrete coffer slab supported by concrete columns was used. The top of the coffer slab was waterproofed, topped with a drainage layer, covered with geotextile and then filled with a suitable growing medium/soil for the selected vegetation. Refer to the detail supplied in Fig. 10.10.

The sloping, reinforced, off-shutter concrete roof and particularly its visible and defined edge is integral to the building’s aesthetic and architectural language. It creates a prominent secondary ground plane that connects to the surrounding grassland landscape. The slope also promotes a natural flow of water and presents a drainage solution for storm water runoff (HolmJordaan, [sa]).
DBSA Welcome Centre. Welcome centre building with its sloped planted roof. Source: HolmJordaan
Figure 10.7 ~ DBSA Welcome Centre a.jpg

DBSA Welcome Centre. Welcome centre building with its sloped planted roof. Source: HolmJordaan
Figure 10.8 ~ DBSA Welcome Centre b.jpg

DBSA Welcome Centre. Welcome centre building with its sloped planted roof. Source: HolmJordaan
Figure 10.10 ~ DBSA Welcome Centre roof edge detail.jpg

The roof structure, a reinforced concrete coffer slab. Source: HolmJordaan
Figure 10.9 ~ DBSA coffer slab.jpg
10.3 Structural & Tectonic Approach

A stereotomic approach was regarded as the most suitable based on the following considerations:

- the concept of the hybrid as an interface;
- the development of the roof as a public, accessible and circulation component that features intensive landscaping elements;
- the flexible public programme of the building;
- its horizontal scale; and
- the intention of creating a constructed landscape.

As such the development of a stereotomic aesthetic that fulfils the dual and hybrid role of structure and surface is implemented. It is believed that this, as in the case of the Sacred Museum, will aid to generate a tectonic language that will best articulate the notion of the building as a sculpted constructed landscape.

The building structure consists primarily of a grid of reinforced concrete columns that support a reinforced concrete waffle slab system that forms the roof and constructed landscape.
Elevated timber walkway fixed to lightweight steel structure

Reinforced concrete roof slab sloped at 4°, waterproofed and covered with soil/growing medium for roof vegetation

Reinforced Slanted off-shutter concrete columns with increased pad foundations

Reinforced concrete roof slab sloped at 3°, circulation route waterproofed and covered with soil/growing medium for roof vegetation

Pour strip detail (closure strip) to control shrinkage and elastic shortening filled 30 to 60 days after adjacent sections have been cast

Reinforced concrete facade walls support the waffle beam and roof structure were an increased span, to provide open space below is required in the events hall

Ramp from roof garden to the south entrance on Upper Ground floor

Cast in situ reinforced concrete waffle slab structure allows clear open space below, provides sufficient support for the intensive roof garden and openings permit options for natural light

Vertical circulation: alternative access from roof to the upper ground floor entrance provided by means of an elevator and staircase

Stereotomic structure and skin

The tectonic language articulates the notion of the building as a sculpted constructed landscape to form a new topography
landscape plane. The reinforced concrete waffle slab comprises a grid of rib beams to strengthen the roof, which will be utilised for roof vegetation, walkways and the social event space on the eastern edge of the building. There are however two exceptions, the central hinge point area with projecting vertical circulation that connects to the bridge and the event space above the restaurant kitchen area. The ground floor roof slabs in these two areas are handled differently, as these areas will not receive vegetation and therefore loads are reduced. Reinforced roof slabs without beams are proposed for these areas, as well as for their respective first floor roof slabs.

The main roof slopes in response to the site topography and in essence becomes an elevation and extension of the ground plane. In the western flank where the building cuts in below the natural ground level and an increased roof span is required, an external structural concrete skin provides additional support in the form of a perimeter beam of sorts and also acts as the basement retaining structure.

The use of the column grid, waffle beam and slab combination permits a clear and open, flexible internal space that can accommodate a variety of uses, while sufficient support is rendered for the external and intensive roof loads. The bridge on the northern side of the building and the ramp that connects to the ground plane on the southern side of the building both rely on their own independent structural systems comprising reinforced concrete columns.

The columns and waffle beams respond to the slope of the constructed landscape (roof slab). The majority of the columns and beams are therefore slanted, as the columns throughout the building are perpendicular to the roof slab in order to create an aligned geometry. This
alignment expresses the relationship between the internal building spaces and the roofscape and celebrates the constructed landscape condition in the building’s structural and tectonic aesthetic.

Rem Koolhaas/OMA applied a similar approach at Kunsthal in Rotterdam. Although the tectonic language of Kunsthal differs substantially from that of the Hybrid, Koolhaas used a series of slanted columns in the auditorium wing that responds to an access ramp and angled floor surface located above it. Refer to Figs. 10.14-10.16. The slanted columns and the ramped floor plane are expressed as an integrated geometry and structural aesthetic. Koolhaas further uses a glazed facade to display the structure to the surrounding museum park, hence it becomes part of the overall tectonic and architectural language of the building’s western facade (Kunsthal Rotterdam, 1995:16).
Materiality
patterns of Man & Nature
10.4 Material Palette and Application

The material palette, as with the tectonic and structural approach, aims to express the duality of the selected materials. The palette is therefore kept basic rather than to implement an extensive combination of materials. This implies that the functional, aesthetic and textural qualities of a limited selection of materials can be explored and the diversity of these materials are showcased.

In-situ cast 30 MPa, off-shutter, architectural finished concrete is selected as primary building material. This decision is informed by several factors. The use of concrete is primarily motivated by the material’s well-known robustness and structural load bearing qualities (van der Merwe, 2011:7). Due to the building’s public programme and the structural load bearing requirements resulting from the sloping and accessible intensive green roof, concrete is an obvious choice for the building structure. Additional potential benefits, such as the thermal mass and external noise reduction (Federal Highway Administration, 2011) provided by the mass of concrete are also desirable, but as the tectonic approach to the building combines structure and surface, the opportunity to incorporate concrete’s aesthetic and surface qualities comes to the foreground.

The use of concrete as a surface material is contextually fitting in terms of the surrounding urban environment. As presented in the Photographic Overview of the Node and Precinct Context in Chapter 4.2, the majority of the buildings in the area are constructed from a combination of brick and concrete with several prominent off-shutter concrete buildings either in close proximity to, or visible from the Hybrid site. Some of the prominent buildings and structures include amongst other Prestige Park, the Telkom tower and the Drie Lelies residential block.

Concrete buildings, as described in a recent article by Felix Salmon in the Guardian’s architectural feature (2016), are humble, unpretentious and often rooted in place due to the typical colour and characteristics obtained from the use of local aggregates. In response to the natural context and landscape, the use of concrete as a surface material is motivated by the same argument and it also relates to the strategy Menis used in the Sacred Museum (refer Chapter 10.2.1). The simplicity of a stereotomic off-shutter concrete building provides an ideal backdrop against which the natural character of the surrounding landscape can be emphasised, while concrete casting technology and the use of texture enables the building to shine in its own right as a sculpted building landscape.

A combination of off-shutter in-situ finishes and textures such as board-marked finishes, rope finishes, as well as unformed finishes like polished and rough exposed aggregate concrete textures, are utilised respectively on walls, column, beam and floor surfaces. This approach also eliminates the need for additional building products, because the core material (concrete) functions as structure, mass and finish. By creating a rich textural palette, patterns of biophilic design are also implemented. For example, the visible wood grain of board-marked finished concrete, achieved from using sand blasted timber boards in formwork (van der Merwe, 2011:62), is typical of the natural analogue strategy discussed in Chapter 5.4.

Syenite is a siliceous rock formation present on site (refer to Chapter 4.6) and
Architectural concrete finishes

[a] Board marked Finish.
   Source: Menis Arch.
   Off-shutter board finish concrete.
   Rough-sawn and sandblasted SA Pine timber boards in diagonal pattern to be use in lining
   of plywood formwork. Boards to be sealed with form oil prior to casting. Specified for column’s,
   beams and feature walls.
[b] Roped finish.
   Source: van der Merwe.
   Off-shutter rope finish concrete.
   40mm diameter damp hemp rope fixed in
   formwork with pins at 250mm centres. Rope
   can be removed 48 hours after casting. Rope
   finishes are ideal for exposed external surfaces
   as the texture reduces streaking and distributes
   water flow (van der Merwe 2011, 17) and will
   therefore be used for prominent external walls
   and the roof perimeter.
[c] Exposed aggregate, semi-polished concrete
   floor finish for external application.
   Source: Lafarge.
   A robust slip resistant floor finish ideally
   suited for the external walkways, ramp and
   bridge.
[d] Polished concrete floor finish for internal
   applications.
   Source: Geocrete.
   A smooth textured and uniform finished
   achieved by honing and polishing the concrete
   floor surface.

Figure 10.18 ~ Concrete finishes.jpg
due to its high strength and weather-resistant properties is suitable for use as an aggregate in concrete construction (Kogel, Trivedi, Barker and Krukowski, 2006:654). Selected rock from site excavations may therefore be crushed and used as an aggregate for the external exposed aggregate floors.

Local clay face brick is used for certain internal walls, external screen walls and exposed portions at ground level along the southern facade. The use of brick responds to the surrounding context and tradition to use brick in Pretoria. The earthy tones of the local clay face brick will complement the neutral tone of the off-shutter concrete and add another textural layer to the palette.

Juxtaposing the heavy stereotomic building mass, articulated openings with recessed glazing and aluminium framed, glazed facade components are used throughout the building along the northern, southern and eastern facades. The fenestrations establish a connection between inside and outside, permits natural light to penetrate the internal building spaces and the incorporation of operable windows in the multipurpose spaces and restaurant allows passive ventilation. Stack doors are used in the restaurant area along the eastern edge, closest to the wetland to allow the space to be completely opened during summer in order to emphasise the connection with the waterfront and “nature” edge. Clear low-E glass is specified to improve thermal performance by limiting potential solar heat-gain and where the northern facade consists of large portions of glazing, the glazing is also angled to reduce the area of solar penetration.

12 mm Danpalon multicell panels, a structural polycarbonate clear panel with ultraviolet (UV) coating, will be used as glazing element for a series of patented ventilated aluminium framed skylights in the multipurpose spaces. The panels are lightweight, durable, provide good and even light transmission, eliminates glare and its insulating properties ensure thermal comfort (Rainbowskylight, [sa]). The polycarbonate glazing has a Solar Heat Gain Coefficient (SHGC) of 0.61 and a U-value (thermal transmittance) of 1.84 W/m²·K, which is superior in comparison to low E glass in thermal break aluminium framing that has a total U-value of 2.41 (SANS 204:2011,14). Rhino wood, a thermally modified wood that is particularly suitable for external applications such as decking, cladding and sun screens and will be used for the elevated roof walkways, terraced decking, sun shades, bench seating slats and external tables. Rhino wood is a patented trade product that employs thermal treatment and pressure impregnation to increase the strength and durability of sustainably sourced South African pine (Rhinowood, [sa]). The process does not use chemicals or any toxic oils and delivers a durable product that has a reduced moisture absorption rate and is thus substantially less susceptible to swelling and shrinking caused by exposure to water. Rhino wood has class 1 durability rating and does not require any treatment through its life span, other than colour treatment if required (Rhinowood, [sa]). The natural greying and patina produced by leaving the timber untreated is however desired and will allow the timber to mature with its surroundings.
From top to bottom:
1. Earthy clay facebrick, Corobrick Redwood
2. Travertine from local Rosema factory
3. Glazing and fenestrations
4. Danpalon multilight structural polycarbonate panels with uv coating
5. Rhinowood

Figure 10.19 ~ Secondary material pallette.jpg
10.5 Environmental Strategies

10.5.1 General Considerations

Site conditions permit the building to be orientated north, with small portions of the building facing east and west. A basic sun study indicates that overshadowing in winter from tall buildings in close proximity to the site will not be a major concern, as only a small portion of the Hybrid (on the western flank) is affected late in the afternoon before the sun sets. Refer to Fig. 10.19.

Natural lighting and considerations to optimise natural lighting relevant to the uses of the internal spaces were considered and fenestrations and skylights are provided accordingly. Refer to Fig. 10.. ...

The low vertical scale of the building allows existing and new deciduous trees along the north, east and western facades of the building to shade the building envelope in summer, reducing solar exposure on the surface, while winter sun will penetrate the glazing along the northern facade during under-heated periods (Oberholzer, 2011:19). Evapo-transpiration, a process by which plants transforms heat into moisture, will also assist with creating a cooler environment in summer due to the roof vegetation and the surrounding landscape vegetation (Schmidt et al., 2013:297).

Thermal mass provided by the thick concrete walls, concrete floors and roof will allow the building envelope to absorb and retain heat during the day and release it at night time. The earth surrounding the semi-basement western flank of the building adds additional mass particularly around the western edge of the building. This is beneficial for thermal performance and will aid in reducing the penetration of unwanted noise from the surrounding urban environment into the events hall.

The intensive planted roof will promote bio-diversity and foster an improved ecology, as the proposed selection of local indigenous plant species will attract birds and insects such as bees and butterflies. The typical roof detail is depicted in Fig. ....... The green roof provides thermal mass and will help insulate the building, reducing the mechanical cooling and heating requirements. Other advantages include the management of water run-off and the increased roof lifespan obtained from a well maintained green roof (Schmidt et al., 2013:296-297).
Figure 10.20 ~ Sun study.jpg
Sun study, investigating the potential overshadowing from adjacent buildings in winter. Source: Author
10.5.2 Bulk Services

As the site is located in a serviced urban area, bulk services like water, sanitation, electrical and waste disposal is assumed to be supplied by the City of Tshwane municipality. The elected service of choice that will be resolved in more detail is Water.

10.5.3 Water

Water is a very valuable natural resource and as stressed in earlier chapters, South Africa’s freshwater sources are under severe strain to meet current water demands. The Hybrid’s water management strategy therefore includes the collection of rain water and runoff from the roof and other hard surfaces on site, as well as the re-use of grey-water. As the site is located in a serviced urban area, potable water will be obtained from municipal supply. Harvested rain water, runoff and recycled grey water feeds an on-site surface flow wetland and will eventually be used for irrigation purposes and the flushing of water closets after having been sufficiently processed.

Water will also be abstracted from the Apies River channel by means of constructing a small sump in the base of the concrete channel and directing water to a temporary underground storage tank at a lower level. The necessary trash trap, as well as oil and grit traps will be installed. The water will subsequently be pumped to the surface flow wetland. By law, as stipulated in the National Water Act, 1998 (Act No 36 of 1998) any abstraction of water from a river requires a water use licence. The outlined strategy and calculations to follow is based on the premise that a Water Use Licence Application (WULA) for the abstraction process has been successful and the relevant licence has been obtained from the Department: Water and Sanitation (DWS).

As the base flow in the river channel provides a year round supply of water, water abstracted from the channel is an ideal source for the proposed surface flow wetland, which flows via gravity from the South Block to the North Block. An overflow point at the end in the North Block releases the water back into the river channel. The wetland serves as a symbolic celebration of the Apies River and the water heritage of Pretoria. The new waterfront will enhance the ecological character of the area and serve as place making tool.

The water strategy is diagrammatically illustrated in the following figures and tables.
Figure 10.21 ~ Water strategy.jpg
Source: Author
**Marginal/ emergent species:** shallow waters 5-30cm deep

- From left to right:
  - *Typha capensis* (Hillrush)
  - *Cyperus papyrus* (Dwarf/ponty papyrus)
  - *Juncus effusus* (Flush)

**Pond Species, floating leaved**

- From left to right:
  - *Nymphaea capensis* (Blue water lily)
  - *Potamogeton dasyphyllus* (Waterlommetjie/ Cape pond weed)
  - *Nymphaoides thunbergii* (Floating heart/Small yellow water lily)

**Submerged species:** 0-150mm - 2 m/s deep

- From left to right:
  - *Potamogeton schweinfurthii* (Broodleaved pondweed)
  - *Vallisneria spiralis* (Hydrocharitaceae)
  - Repens

---

*Species selection based on:*

*Aquatic Plants, A guide to the identification of water plants in and around South African Impoundments 2004* and *Creative Gardening with Indigenous Plants, a South African guide, Second edition 2012*

---

**Figure 10.22 ~ Wetland species selection.jpg**

Source: author
Figure 10.23 ~ Water process diagram.jpg
Source: Author
Figure 10.24 ~ Water Management plan.jpg
Source: Author
APIES RIVER CHANNEL CROSS SECTION: WATER ABSTRACTION DETERMINATION

**ABSTRACTION CALCULATIONS:**

Flow depth = 0,05 m  
Trapezoidal area = 0,253 m²  
If assumed,  
Flow velocity (v) = 1,24 m/s  
Flow area (A) = 0,253 m²  
Flow = Q = vA = 0,313 m³/s  
Abstraction at 1,0% = 0,00313 m³/s  = 3,13 t/s  
Abstraction / day = 270,432 m³/d  = 270 432,0 t/d  
Abstraction / month = 8113 m³/mon.  = 8 112 960,0 t/mon.

**OPEN CHANNEL FLOW QUALCULATIONS:**

\[ Q = \frac{1}{2} \times A^{\frac{5}{3}} \times S^{\frac{1}{2}} \]

Area A = 0,253 m²  
Slope So = 0,019 m/m  = (1 : 51.875)  
Wetted perimeter P = 5,141 m  
Manning roughness coeff. n = 0,015  
Q = 0,313 m³/s  
v = 1,241 m/s

Figure 10.25 ~ Abstraction.pdf  
Source: Author
WATER MANAGEMENT MODEL

A WATER RESOURCE INFORMATION [YIELD (m³)]

A1 RAIN WATER HARVESTING DATA

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A2 RECYCLED / ALTERNATIVE WATER SOURCE

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<th>SOURCE 2 - Restaurant Prep. Sinks</th>
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<td>WEEKLY YIELD</td>
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<tr>
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<td>9.58</td>
<td>41.04</td>
</tr>
<tr>
<td>December</td>
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A3 WATER ABSTRACTED FROM APIES RIVER CHANNEL (m³)

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<th>m³/month</th>
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<td>Percentage abstracted from Apies River channel =</td>
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Abstraction Flow = 0.00313

A4 TOTAL WATER YIELD (PER MONTH)

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<th>GREY WATER SOURCE (m³)</th>
<th>WATER ABSTRACTED FROM APIES RIVER CHANNEL (m³)</th>
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<th>TOTAL WATER YIELD (m³/day)</th>
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<td>191.72</td>
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Figure 10.26 ~ Water yield.pdf

Source: Author
### B1. Landscape Irrigation Demand (m³)

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**ANNUAL TOTAL:** 82,286

Source: Author

### B2. Building / ALT Demand

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**ANNUAL TOTAL:** 3732.48

### B3. Evaporation Loss (For ‘open’ reservoirs)

- **35 mm - 45 mm/week in summer**

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**ANNUAL TOTAL:** 0.315 | 13.50 | 549.00

### B4. Total Water Loss & Demand

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**ANNUAL TOTAL:** 292.465 | 3732.480 | 540.000 | 4 564.95

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**Figure 10.27 ~ Water demand.pdf**

Source: Author
Figure 10.28 ~ Water demand.pdf:2

Source: Author
## POTABLE MUNICIPAL WATER REQUIREMENTS

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Source: Author

Figure 10.29 ~ Municipal water demand.pdf
C WATER BUDGET

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<th>VOLUME IN SUB-TERRANEAN STORAGE TANK (m³)</th>
<th>VOLUME IN ELEVATED STORAGE TANK (m³)</th>
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FILL UP OF WETLAND AND TANKS SIMULATION

C2 WATER BUDGET

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SEASONAL MONTHLY WATER BALANCE (m³)

Source: Author

Figure 10.30 ~ Water balance.pdf
10.5.4 Heating, Cooling and Ventilation

A hybrid system combining both active and passive systems is used due to the varied scale and diversity of internal spaces. As discussed earlier, the building’s green roof will assist with climate mitigation and reduce the energy requirements of the mechanical systems employed.

The excavations for the events hall in the western flank present the opportunity to use a geo-exchange heating and cooling system (geothermal pipes) throughout the building on the Upper and Lower Ground Levels. A geo-exchange system (earth tubes) cools air in summer and heats air in winter, since the earth is either used as a heat sink or a heat source (Sayed, 2012:189). The geo-exchange process conditions the temperature of the air by means of the temperature differential between the atmosphere and the constant temperature of subterranean soil (typically at 18°C).

Air enters the geo pipes from (fanned) intake air vents situated on the southern side of the building below the floor level. Subsequently the air is circulated in a looped system of buried horizontal pipes where the temperature exchange occurs due to the surface contact with the earth. Conditioned air, cooled or heated depending on the season, is then released into the internal building spaces via a series of integrated and strategically placed supply vents just above floor level along the building envelope.

The events hall, due to its size and capacity, will also be fitted with an active Heating Ventilation and Air Conditioning (HVAC) system. The geo-exchange system will regulate temperatures under moderate conditions and temperature sensors will ensure a switch to the active system under extreme conditions. Heat inside the events hall is collected by means of return air vents situated at the highest point of the space.

The other building spaces, such as the multipurpose spaces and the restaurant areas, have strategically placed operable windows and doors along the northern and southern facades, ideal for natural cross ventilation and passive control that the occupants can manage. The multipurpose rooms also have a series of ventilated skylights where hot air can escape at the higher levels of the space.
Deciduous trees will shade the building in summer and will permit winter sun.

Rising hot air escapes through ventilated skylights.

Cross ventilation through operable windows along northern and southern facades.

Fan assisted fresh air intake along southern facade.

Earth to air geo exchange supplies air via ducting at 18°C just above floor level.

Polyethylene earth tubes in horizontal closed loop configuration conditions air via the temperature differential between the earth and atmosphere.

Operable windows to allow passive cross ventilation.

Hot air will flow via the ceiling slope from east to west.

Return air vent with ducting to the outside is provided at the highest point of each of the multi purpose spaces.

Shading devices are incorporated at the highest part of the slanted glazing along the northern facade.
10.5.5 SBAT Performance

The Sustainable Building Assessment Tool (SBAT) was used to analyse the approach to sustainability and important influential factors required to achieve related goals. The tool measures, social, economic and environmental factors as a combined platform for sustainable performance. The results are depicted in Fig. 10.23.

**SUSTAINABLE BUILDING ASSESSMENT TOOL (SBAT- P) V1**

<table>
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<tr>
<th>Social</th>
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<td>Environmental</td>
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**Overall** 3,6

Source: Author
Figure 10.32 ~ SBAT- assessment.jpg
10.6 Drawings and details

Source: Author
Figure 10.33 ~ Site plan.pdf
Combined Upper & Lower Ground Floor Plans

Source: Author
Figure 10.34 ~ Combined Ground Floor Plans.pdf
Main Roof
Event and Beer Garden Plan

Source: Author
Figure 10.35 ~ Roof plan.pdf

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South Elevation

Berea Park edge

North Elevation

Urban elevation _ Justice Mahomed edge

Source: Author
Figure 10.36 ~ Elevations.pdf
ROOF IRRIGATION
WATER SUPPLY VIA STORAGE TANK
AND PRESSURED SYSTEM
PUMP POWERED BY SOLAR ENERGY

SELECTION OF HARDY REGIONAL
INDIGENOUS PLANT SPECIES
WITH LITTLE TO MODERATE WATER
REQUIREMENTS
FULL SUN EXPOSURE

400MM GROWING MEDIUM/ SOIL
30MM DELTA TERRAXX DRAINAGE SHEET
WITH FUSED ON GEOTEXTILE
TROWEL FINISH TO TOP OF
REINFORCED OFF SHUTTER CONCRETE BEAM
ROPE FINISH

DOUBLE WATER PROOFING LAYER
TOP: DERBIGUM CG4 H
BOTTOM: DERBIGUM CG3
PROVIDE 75MM SIDE LAPS AND
100MM END LAPS
SEALED TO PRIMED SURFACE BY TORCHFUSION
FALL AT 3° AS PER ROOF STRUCTURE

GEOTEXTILE & WATERPROOFING TAKEN
TO UNDERSIDE OF 20MM RECESS

DAY JOINT
40MM SCREED FILLETED ALONG BEAM

CAST INSITU 30MPA REINFORCED
OFF SHUTTER CONCRETE UPSTAND
TEXTURED ROPE FINISH TO EXTERNAL FACE

SHADING DEVICE TO NORTH FACING
WINDOWS TO DETAIL
3° FACETED/SLANTED FACADE GLAZING SYSTEM
LAMINATED 8MM LOW E SAFETY GLASS
IN POWDER COATED ALUMINIUM FRAME
VERTICAL PIVOT WINDOW FOR PASSIVE VENTILATION
LAFARGE ARTEVIA POLISHED INTERNAL
CONCRETE FLOOR SURFACE
GLAZING FRAME & MULLIONS FIXED TO MILD STEEL
FIXING CLEAT BOLTED TO CONCRETE FLOOR
SILICONE SEALED
TROWEL FINISH TO SLOPED REINFORCED
CONCRETE FLOOR SLAB

GRDED & COMPACTED GROUND FILL
IN LAYERS OF 150MM

HORIZONTAL DPM
0,25MM POLYETHYLENE
SHEETING WITH 200MM OVERLAPS

Section B
NTS
12mm Danpalon Multilight Multicell Structural Polycarbonate Panel with Clear UPVC Coating at 900 Centers

Patented Ventilated Aluminium Sky Light Bedded in Mastic Sealant

Sliding Aluminium Shutter with Insect Mesh

Waterproofing Dressed up onto Concrete Upstand & Taken Under Skylight Flashing and Aluminium Fixing Flange

Detail 03

Mild Steel Balustrade Posts Fixed @ 2250mm Centres

Elevated Rhino Wood Walkway Fixed to Galvanised Steel Framework

Cast in situ Reinforced Concrete Ramp at 1:20 Slope

Cast in situ Reinforced Concrete Upstand Rope Finished Applied to Internal and External Faces Trowel Finish Top

38mm x 38mm Mild Steel Balustrade Post and Top Rail Bolted Between Two 65mm x 100mm Mild Steel Angles and Bolted to Concrete with Chemical Bolts

100mm Wide Channel Filled with Gravel Stones

60mm x 60mm Mild Steel Angle Bolted to Reinforced Concrete Ramp

Lafarge Artevia Exposed Aggregate External Concrete Floor Finish

25mm Galvanised Steel Outlet Pipe

1000 x 400 x Extruded Aluminium External Weather Louvre Gill for Air Intake, Fan Assisted Earth to Air Geo Exchange Air Intake Ducting Earth to Air Geo Exchange Supply Air Ducting Air Supplied at 18"

160mm Ø Polyethylene Earth Tubes in Horizontal Loop Configuration Sloped to Drain Condensation
Detail 1
Shading device
Detail 2
Ventilated skylight

Source: Author
Figure 10.41 ~ detail 02.pdf
**Detail 3**

**Elevated walkway**

38MM x 38MM MILD STEEL HOLLOW SECTION TOP RAIL WELDED TO POST

20MM x 38MM MILD STEEL HOLLOW SECTIONS WELDED BETWEEN POSTS @ 100MM VERTICAL CENTERS

38MM x 38MM x 96MM MILD STEEL BALUSTRADE POST BOLTED TO 65MM x 100MM MILD STEEL UNEQUAL ANGLE SECTIONS ON EITHER SIDE OF POST POSTS @ 2250MM CENTERS SLANTED AT 3º TO FOLLOW ROOF GRADIENT

140MM x 1250MM x 20MM RHINO WOOD THERMALLY TREATED AND PRESSURE IMPREGNATED SA PINE DECKING BOARDS FIXED TO GALVANISED MILD STEEL FRAMEWORK WITH STAINLESS STEEL SPEED SCREWS

75MM x 75MM GALVANISED MILD STEEL SQUARE SECTION STRUCTURAL FRAME WITH 120MM x 1200MM x 6MM BASE PLATES FIXED TO CONCRETE SLAB WITH CONCRETE WEDGE ANCHORS

30MM DELTA "TERRAXX" DRAINAGE SHEET WITH FUSED ON GEOTEXTILE

DOUBLE WATER PROOFING LAYER TOP: DERBICUM C04 H & BOTTOM: DERBICUM C03 75MM SIDE LAPS WITH 100MM END LAPS APPLIED TO PRIMED SCREED WITH TORCH FUSION

40MM SCREED TO FOLLOW SLOPE OF ROOF STRUCTURE WATERPROOFING & GEOTEXTILE TAKEN TO UNDERSIDE OF 20MM RECESS

Source: Author
Figure 10.42 ~ detail 03.pdf

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10.7 Visualisations
The building spills out onto a terraced deck that...
In Edge

that connects to the wetland and green spine
Rooftop Evergreen

View towards the west and city
Tent Garden

Edge from the rooftop garden
o Berea Park
Street

View from Justice Mahomed

Source: Author
Figure 10.46 ~ Visualisation Street Edge.jpg
Edge

Street towards the west