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Nº 10

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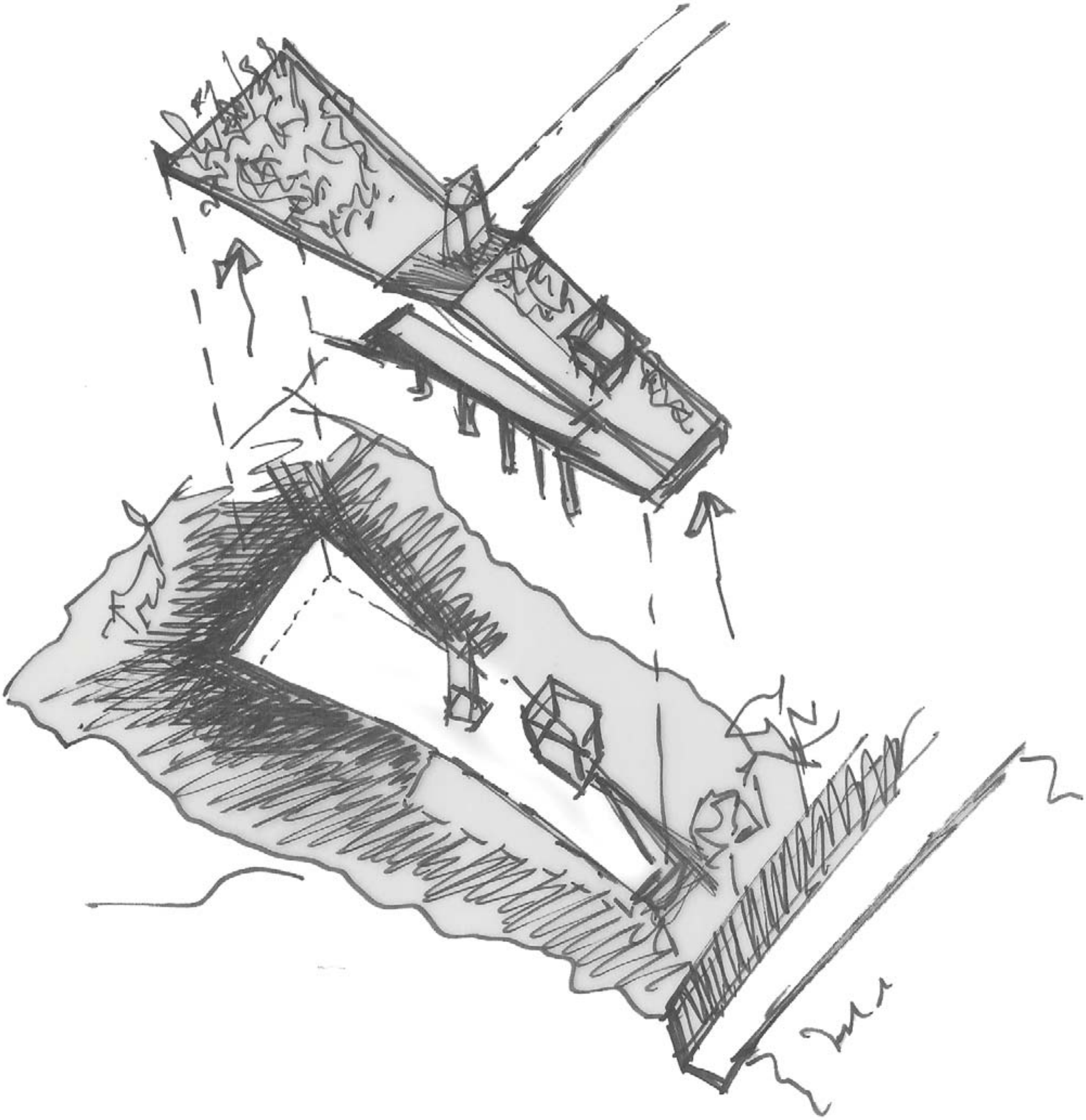
Techné & Technology

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

Figure 10.2 ~ Concrete expression.jpg
Sculptural concrete, expressed in form and texture.
Source: Simona Rota for Menis Arquitectos

Figure 10.3 ~ Semi buried spaces.jpg
The semi-buried spaces with their articulated openings are situated below the public plaza. Source: Simona Rota for Menis Arquitectos

Figure 10.6 ~ Stereotomic mass.jpg
Sacred Museum of Adeje and the Plaza of Spain. A stereotomic mass embedded into the surrounding topography. Source: Simona Rota for Menis Arquitectos

Figure 10.4 ~ Plaza & tower.jpg
The plaza and tower overlooking the surrounding landscape
Source: Simona Rota for Menis Arquitectos

Figure 10.5 ~ Between landscape and town.jpg
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 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

Figure 10.9 ~ DBSA coffer slab.jpg
The roof structure, a reinforced concrete coffer slab. Source: HolmJordaan

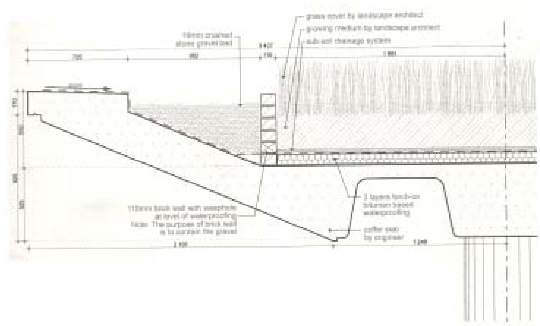


Figure 10.10 ~ DBSA roof edge detail.jpg
Detail of DBSA welcome centre roof edge. Source: Architective

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

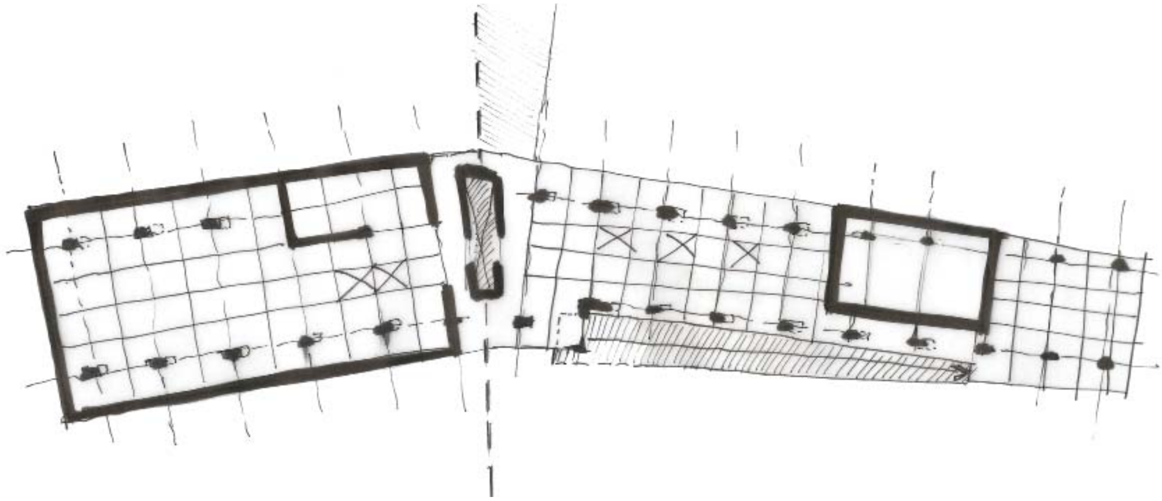


Figure 10.11 ~ Structure concept plan.jpg
Conceptual diagramme of structural approach on plan. Source: Author

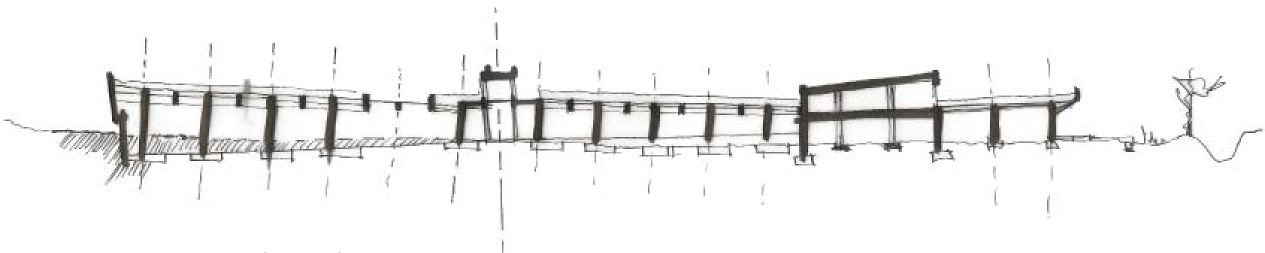


Figure 10.12 ~ Column alignment.jpg
Concept sketch, alignment of columns and beams with the constructed landscape plane. Source: Author

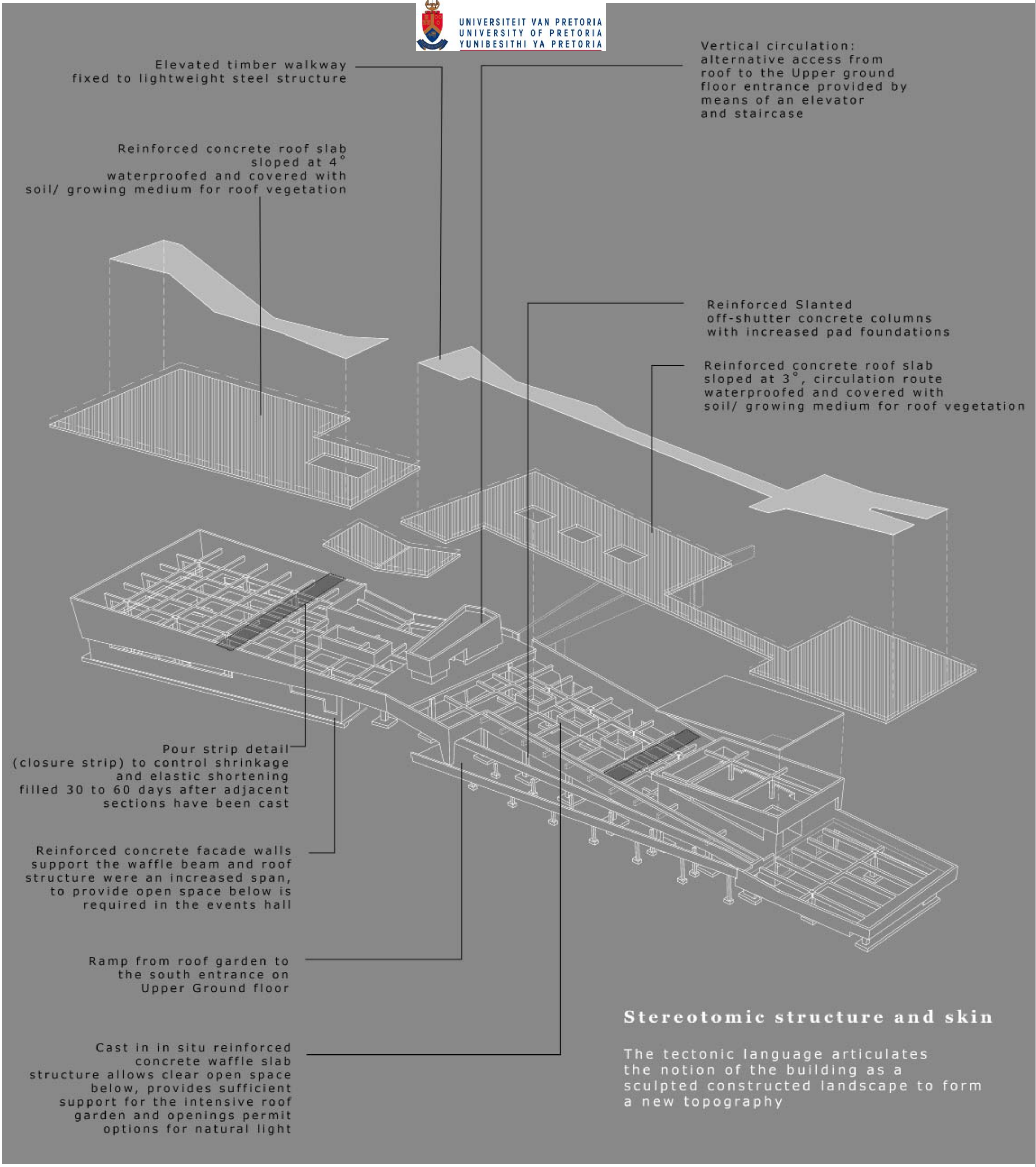


Figure 10.13 ~ Hybrid Structure & Skin.jpg
3D diagramme of structural and tectonic approach. Source: Author

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 Kunstahal 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).

Figure 10.14 ~ Kunsthal slanted columns auditorium.jpg
Kunsthal Rotterdam. Photo indicating the slanted columns in response to the ramped floor above. Source: OMA

Figure 10.15 ~ Kunsthal slanted columns.jpg
Kunsthal Rotterdam. Photo indicating the slanted columns in response to the ramped floor above. Source: OMA

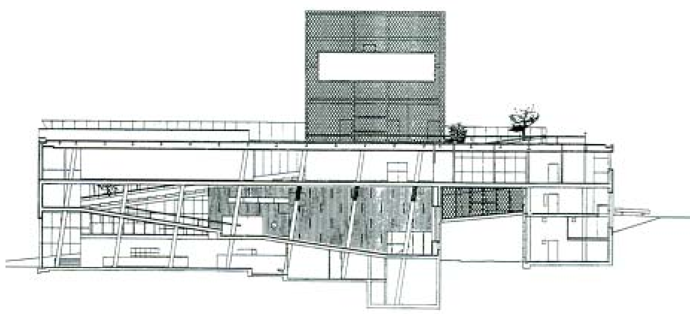


Figure 10.16 ~ Kunsthal section.jpg
Kunsthal Rotterdam. Section indicating slanted columns and aligned geometry. Source: OMA

Materiality
patterns of Man & Nature

Figure 10.17 ~ Materiality.jpg
Collage. Source: Author

10.4 Material Palette and Application

The material pallet, 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.

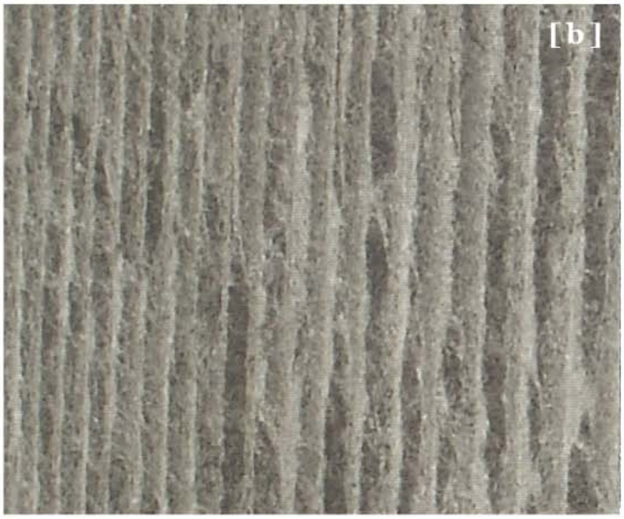
In-situ cast 30 MPa, off-shutter, architectural finished concrete is selected as primary building material. This decision is informed by several factors. The use of concrete is primarily motivated by the material's well-known robustness and structural load bearing qualities (van der Merwe, 2011:7). Due 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.

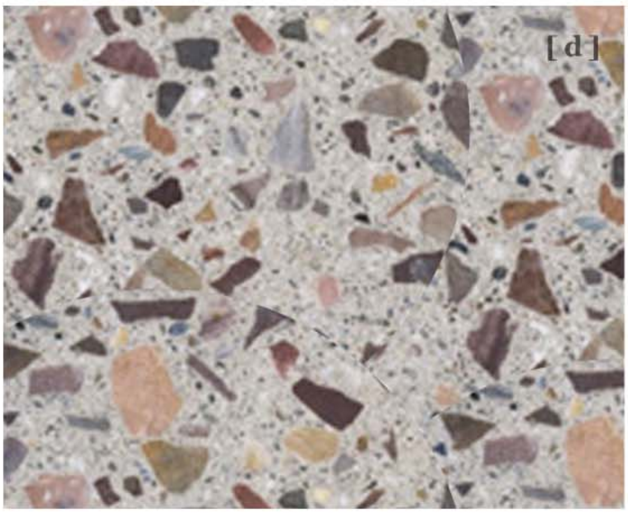
The use of concrete as a surface material is contextually fitting in terms of the surrounding urban environment. As presented in the Photographic Overview of the Node and Precinct Context in Chapter 4.2, the majority of the buildings in the area are constructed from a combination of brick and concrete 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 $W/m^2 \cdot K$, 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).

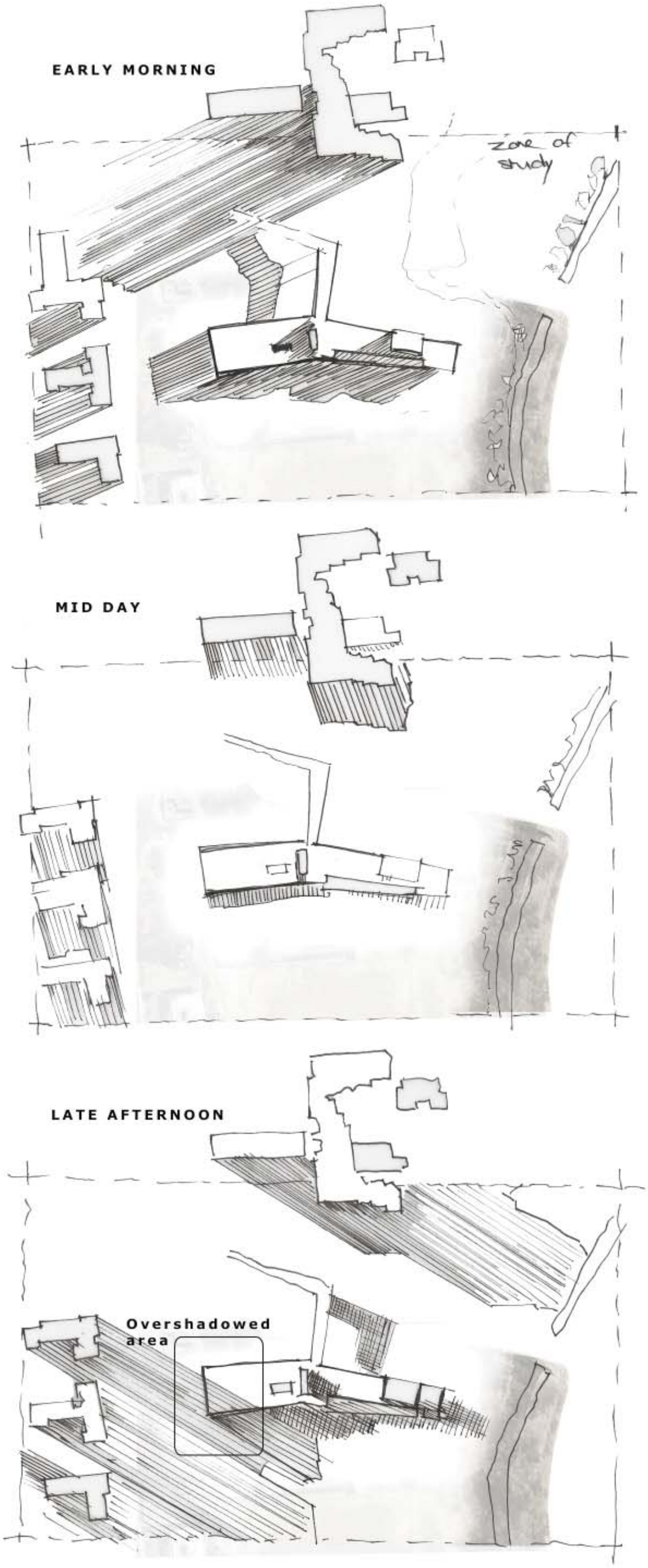


Figure 10.20 ~ Sun study.jpg
Sun study, investigating the potential overshadowing from adjacent buildings in winter. Source: Author

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.

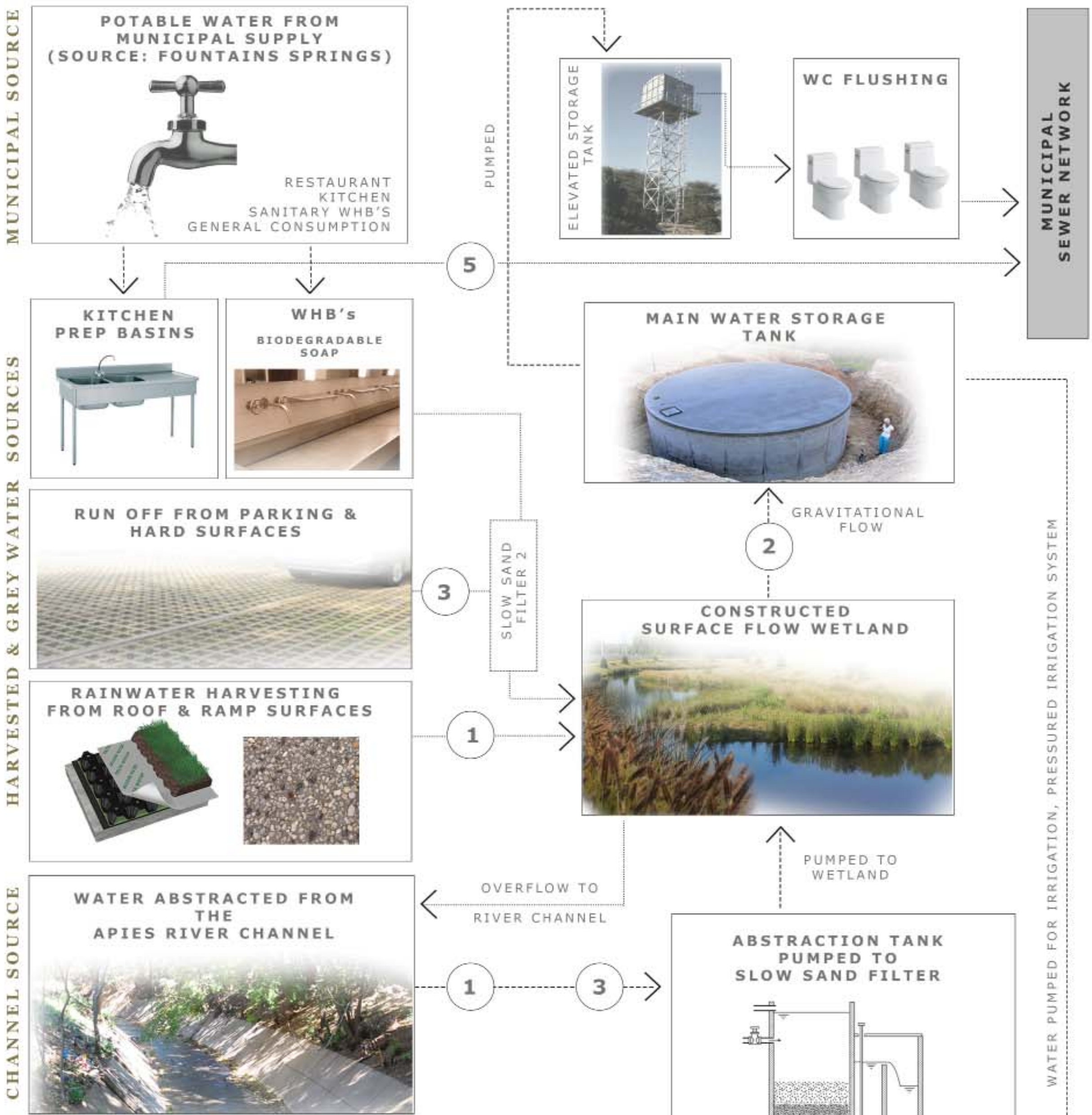
10.5.3 Water

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.



CONTAMINANTS & FILTERS & TRAPS:

1 Floating debris and trash,
Trash trap, grid at sump inlet

2 Contaminants heavier than water, such as sediments and solids,
Sand filter, or settlement to allow sediment to separate from water

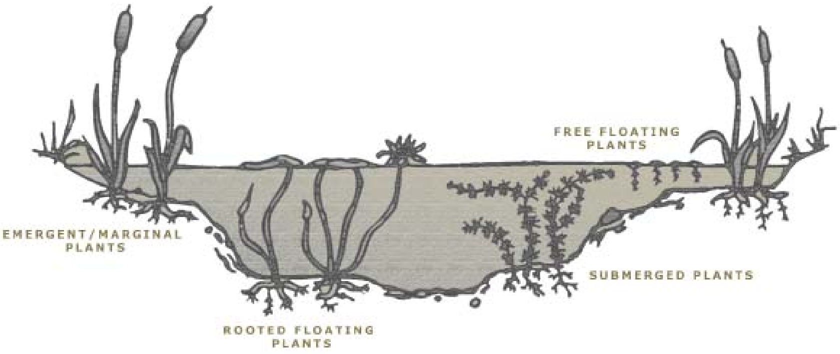
3 Pollutants lighter than water such as oil and hydrocarbons,
Oil trap, or combined oil and grit trap

4 Dissolved pollutants, such as metals or solutes consisting of nitrates, sulphates and phosphates (desirable for plants but not for human consumption).
Nutrient uptake by wetland and roof vegetation(water not intended for consumption or direct contact)

5 Food particles and dish washing water, will lead to unwanted odours in the wetland. Detergents and soap can also be harmful to plants
Grease/fat trap

Figure 10.21 ~ Water strategy.jpg
Source: Author

A placemaking tool and ecological element to enhance biodiversity and naturaly treat water as part of the water strategy



Marginal/ emergent species: shallow waters 5-30cm deep

From left to right:
Typha capensis (Bullrush)
Cyperus prolifer (Dwarf/miniature papyrus)
Juncus effusus (Rush)

Pond Species, floating leaved

From left to right:
Nymphae capensis (Blue water lily)
Aponigeton dystachios (Waterblommetjie/ Cape pond weed)
Nymphoides thunbergia (Floating hart/Small yellow water lily)

Submerged species: 500mm -2 m's deep

From left to right:
Potamogeton schweinfurthii (Broadleaved pondweed)
Valisneria 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

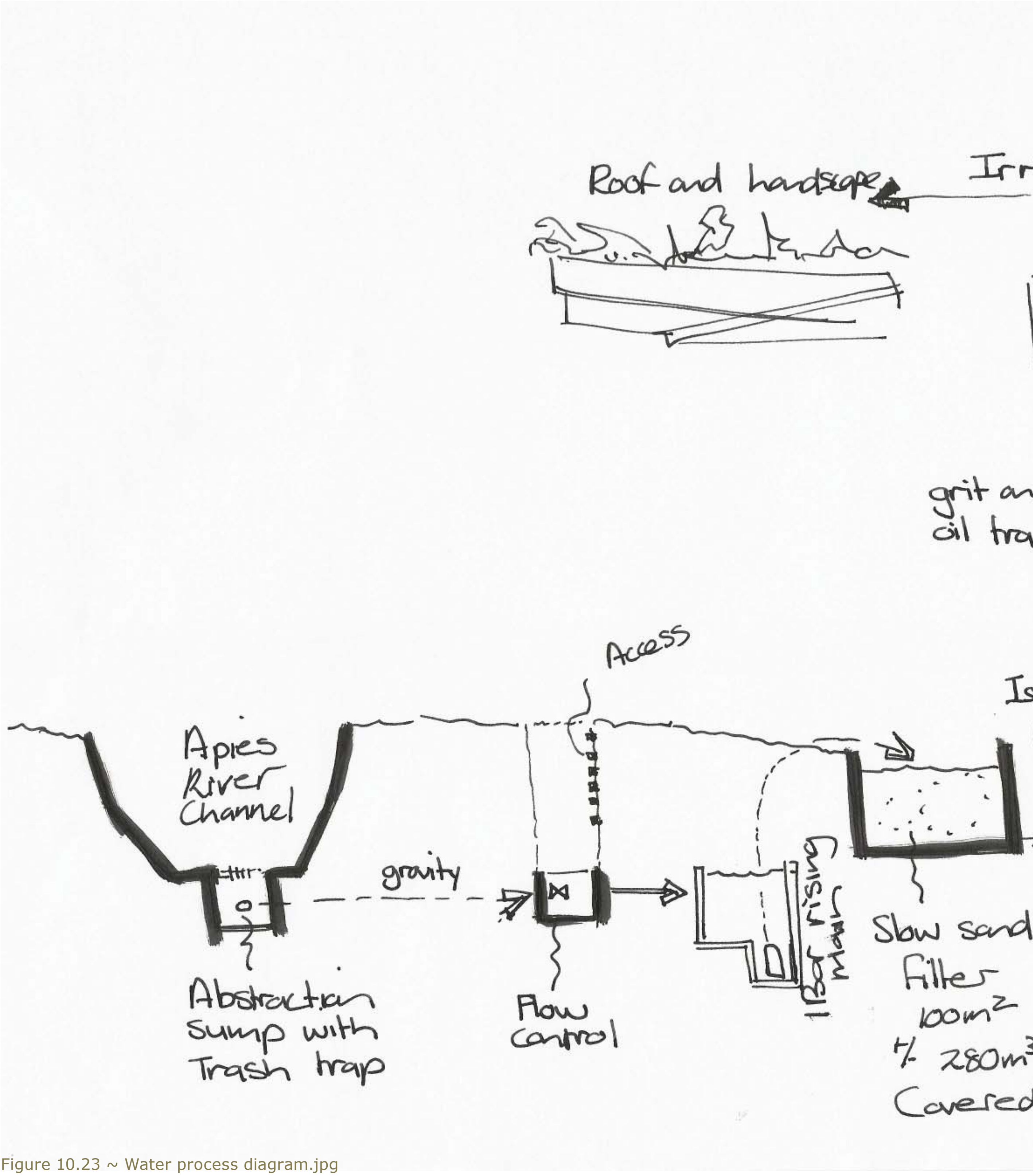
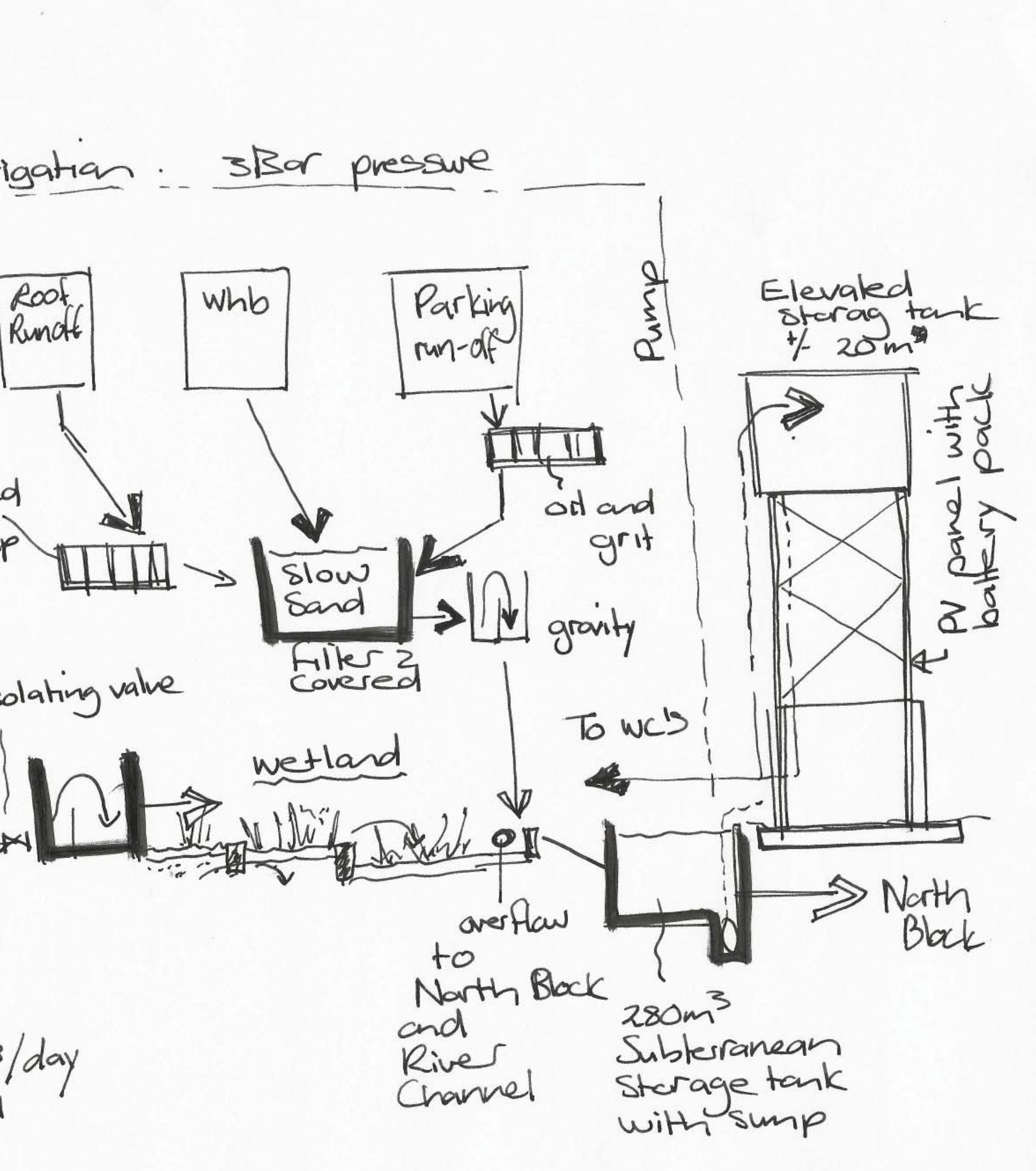


Figure 10.23 ~ Water process diagram.jpg

Source: Author


igation : 3Bar pressure
Roof Runoff
Whb
Parking run-off
Pump
Elevated storag tank +/- 20m³
oil and grit
Slow Sand
Filter 2 covered
gravity
PV panel with battery pack
olating valve
To wc's
wetland
overflow to North Block and River Channel
North Block
280m³ Subterranean Storage tank with sump
/day

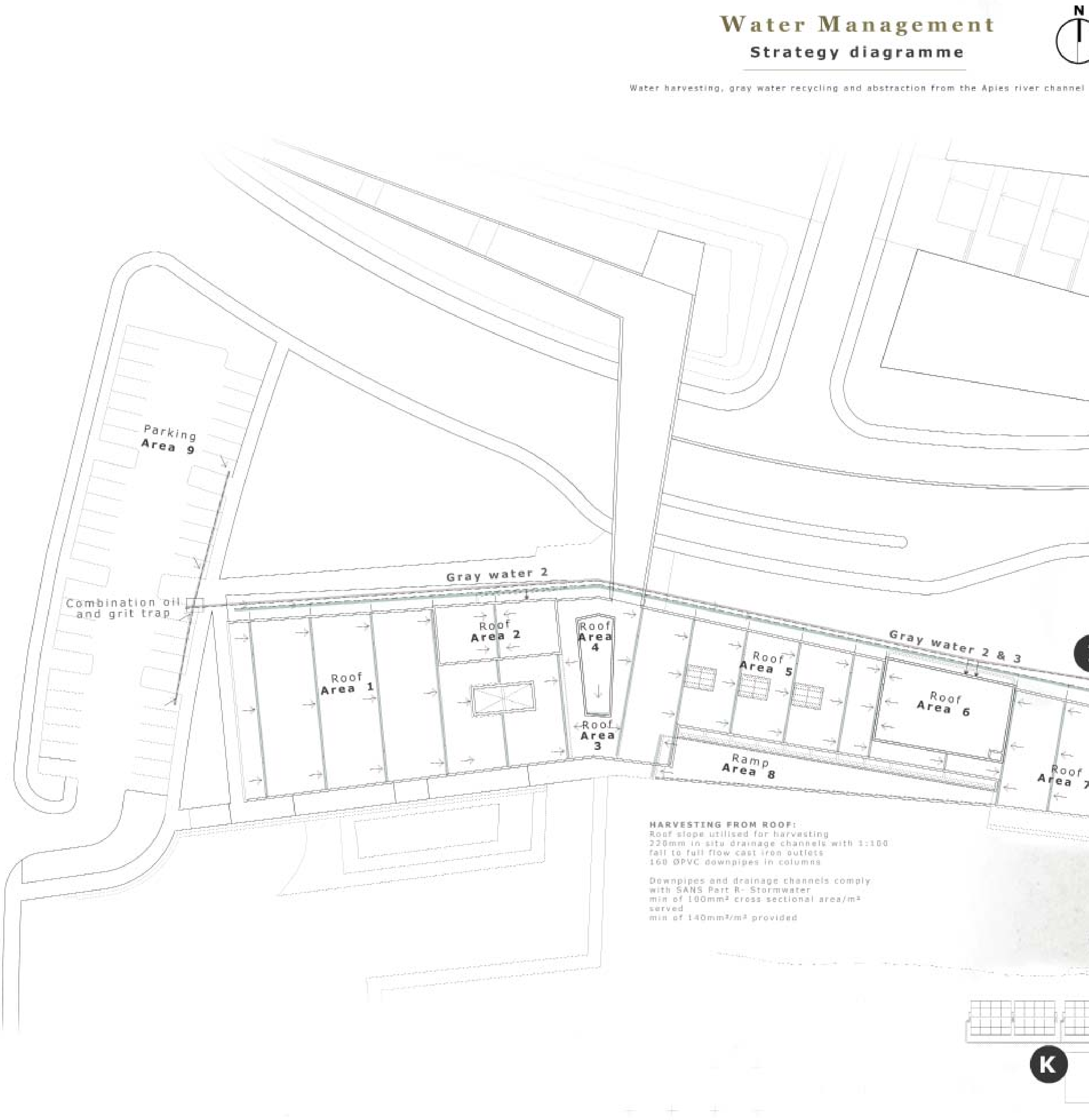


Figure 10.24 ~ Water Management plan.jpg
Source: Author

A — ABSTRACTION SUMP
Abstraction from Apies river channel via 300mm x 2000mm sump with trash trap
Abstraction at 1.0% =3.13 ℓ/s
Flow control valve to control abstraction volume
water flow to abstraction tank via gravity in HDPE pipe at 1;100 slope

B — FLOW CONTROL
Flow control and isolating valve (access via manhole)
Combination oil and grit trap

C — ABSTRACTION TANK
10,8m³ Subterranean Abstraction tank
2000w x 2000l x 3000h
tank equipped with sump and submersible pump
level control to switch pump for operation, water pumped to slow sand filter(D)
9.38ℓ/s at 30min every hour
Pump: 5kW power requirement

D — SLOW SAND FILTER
100m³ Slow sand filter
+/- 280m³ of water filtered per day
purification via biofilm to reduce bacteria content
(no chemical or mechanical operation required)

E — WETLAND
Water from Slow sand filter released into surface flow wetland
+/- 200m³ of water per day
gravitational flow and cascades to airate water
Selected indigenous water plant species planted
nutrient uptake by plants: solutes consisting of nitrates, sulphates and phosphates

F — SUMP
Sump and isolating valve
Water to subterranean storage tank
weir to control water released to North Block wetland

G — MAIN STORAGE TANK
280m³ Subterranean concrete storage tank
11m diameter
UV filter at entry point
Tank equipped with sump and submersible pump
water pump to elevated storage tank for wc flushing: 1Kw for 2hrs/day
water pumped to roof and landscape for irrigation: 1Kw for 10min to 1hrs/day depending on season
emergency overflow to Apies river channel

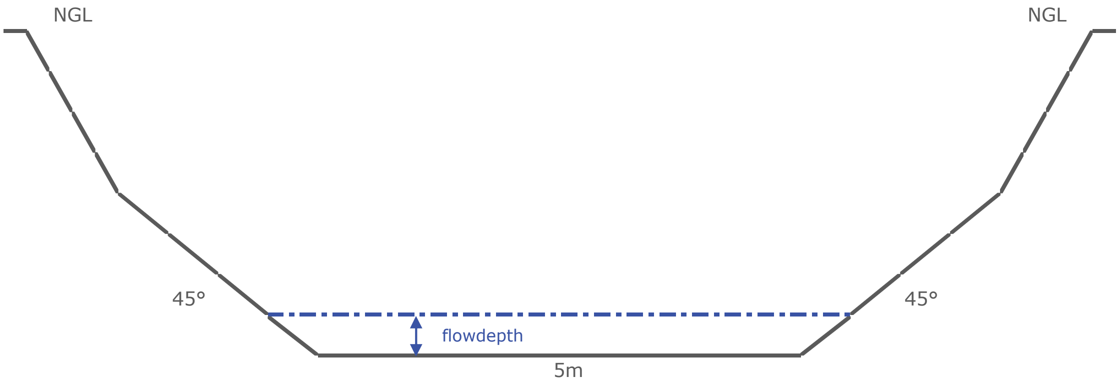
H — ELEVATED STORAGE TANK
Water pumped from main storage tank to elevated water storage tank
20m³ volume
water used for wc flushing
Emergency overflow to river channel

I — SLOW SAND FILTER 2
4m³ volume
parking run-off and gray water from building filtered before release into wetland

J — OVERFLOW TO CHANNEL
Water from wetland released back to Apies river channel
via gravity overflow

K — PARABOLIC SOLAR COLLECTOR
Alternative energy to power all pumps (additional/remaining power utilised for building operations)
2 x 12 000mm x 5000mm Parabolic Solar collector units
28kw thermal power delivered per unit
Thermal energy converted to electricity via Stirling engine and generator
delivers 14kw electricity/unit
Battery room provided for power storage and back up

APIES RIVER CHANNEL CROSS SECTION: WATER ABSTRACTION DETERMINATION



ABSTRACTION CALCULATIONS:

Flow depth =	0,05 m		
Trapesoidal 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 ℓ/s	
Abstraction / day	270,432 m³/d	270 432,0 ℓ/d	
Abstraction / month	8 113 m³/mon.	8 112 960,0 ℓ/mon.	

OPEN CHANNEL FLOW QUALCULATIONS:

$$Q = \frac{\frac{1}{n} * A^{\frac{5}{3}} * S_0^{\frac{1}{2}}}{P^{\frac{2}{3}}}$$

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 (m^3)]

A1 RAIN WATER HARVESTING DATA

ID No.	DESCRIPTION	SURFACE TYPE	AREA [A] (m^2)	RUNOFF COEFF. [C]
1	ROOF	Vegetated	1048	0,30
2	ROOF	Vegetated	135	0,30
3	ROOF	Concrete	162	0,90
4	ROOF	Gravel	65	0,60
5	ROOF	Vegetated	712	0,30
6	ROOF	Vegetated	208	0,30
7	ROOF	Vegetated	295	0,30
8	RAMP	Concrete	216	0,90
9	PARKING	Paving	1200	0,90
	TOTAL AREA (A)		**4041**	
	WEIGHTED C			**0,539**

A2 RECYCLED / ALTERNATIVE WATER SOURCE

	SOURCE 1 - Basins		SOURCE 2 - Restaurant Prep. Sinks		
MONTH	**WEEKLY YIELD (m^3)**	**MONTHLY YIELD (m^3)**	**WEEKLY YIELD (m^3)**	**MONTHLY YIELD (m^3)**	**TOTAL / MONTH (m^3)**
January	9,58	41,04	1,68	7,2	**48,24**
February	9,58	41,04	1,68	7,2	**48,24**
March	9,58	41,04	1,68	7,2	**48,24**
April	9,58	41,04	1,68	7,2	**48,24**
May	9,58	41,04	1,68	7,2	**48,24**
June	9,58	41,04	1,68	7,2	**48,24**
July	9,58	41,04	1,68	7,2	**48,24**
August	9,58	41,04	1,68	7,2	**48,24**
September	9,58	41,04	1,68	7,2	**48,24**
October	9,58	41,04	1,68	7,2	**48,24**
November	9,58	41,04	1,68	7,2	**48,24**
December	9,58	41,04	1,68	7,2	**48,24**
ANNUAL AVE.		**492,48**		**86,4**	**578,88**

A3 WATER ABSTRACTED FROM APIES RIVER CHANNEL (m^3)

	m^3/s	m^3/day	m^3/month	ℓ/s
Flow in cubic metre in Apies River channel at site =	0,31300	27 043,20	811 296,00	313,00
Percentage abstracted from Apies River channel =	1,0%			
Abstraction Flow =	0,00313	270,43	8 112,96	3,13

A4 TOTAL WATER YIELD (PER MONTH)

		A1	A2	A3	A1 + A2 + A3	
MONTH	**AVE RAINFALL [P] (m)**	**CATCHMENT YIELD (m^3) (Yield = PxAxC)**	**GREY WATER SOURCE (m^3)**	**WATER ABSTRACTED FROM APIES RIVER CHANNEL (m^3)**	**TOTAL WATER YIELD (m^3/month)**	**TOTAL WATER YIELD (m^3/day)**
January	0,133	289,75	48,24	8 112,96	**8 450,95**	**281,70**
February	0,085	185,18	48,24	8 112,96	**8 346,38**	**278,21**
March	0,088	191,72	48,24	8 112,96	**8 352,92**	**278,43**
April	0,052	113,29	48,24	8 112,96	**8 274,49**	**275,82**
May	0,012	26,14	48,24	8 112,96	**8 187,34**	**272,91**
June	0,008	17,43	48,24	8 112,96	**8 178,63**	**272,62**
July	0,004	8,71	48,24	8 112,96	**8 169,91**	**272,33**
August	0,006	13,07	48,24	8 112,96	**8 174,27**	**272,48**
September	0,025	54,47	48,24	8 112,96	**8 215,67**	**273,86**
October	0,073	159,04	48,24	8 112,96	**8 320,24**	**277,34**
November	0,104	226,57	48,24	8 112,96	**8 387,77**	**279,59**
December	0,108	235,29	48,24	8 112,96	**8 396,49**	**279,88**
ANNUAL AVE.	**0,698**	**1 520,66**	**578,88**	**97 355,52**	**99 455,06**	

Figure 10.26 ~ Water yield.pdf

Source: Author

B WATER DEMAND

B1 LANDSCAPE IRRIGATION DEMAND (m^3)

DESCRIPTION:	LAWN (m^2):	1600	VEGETATION A (m^2):		2190	VEGETATION B (m^2):		800

MONTH	WEEKLY IRR. (m)	MONTHLY DEMAND (m^3)	WEEKLY IRR. (m)	MONTHLY DEMAND (m^3)	WEEKLY IRR. (m)	MONTHLY DEMAND (m^3)	TOTAL MONTHLY IRR. DEMAND (m^3)	TOTAL DAILY IRR. DEMAND (m^3)
January	0,001	6,857	0,00043	4,036	0,001	3,429	**14,322**	0,477
February	0,001	6,857	0,00043	4,036	0,001	3,429	**14,322**	0,477
March	0,001	6,857	0,00043	4,036	0,001	3,429	**14,322**	0,477
April	0,001	6,857	0,00043	4,036	0,001	3,429	**14,322**	0,477
May	0,001	6,857	0,00300	28,157	0,001	3,429	**38,443**	1,281
June	0,001	6,857	0,00300	28,157	0,001	3,429	**38,443**	1,281
July	0,001	6,857	0,00300	28,157	0,001	3,429	**38,443**	1,281
August	0,001	6,857	0,00300	28,157	0,001	3,429	**38,443**	1,281
September	0,001	6,857	0,00300	28,157	0,001	3,429	**38,443**	1,281
October	0,001	6,857	0,00043	4,036	0,001	3,429	**14,322**	0,477
November	0,001	6,857	0,00043	4,036	0,001	3,429	**14,322**	0,477
December	0,001	6,857	0,00043	4,036	0,001	3,429	**14,322**	0,477
ANNUAL TOTAL		**82,286**		**169,037**		**41,143**	**292,465**	

B2 BUILDING / ALT DEMAND

MONTH	Water Closets (m^3/month)	Waterless Urinals (m^3/month)	Hand Basins (m^3/month)	Restaurant (m^3/month)	BUILDING DEMAND (m^3/month)	BUILDING DEMAND (m^3/day)
January	311,04	0	potable municipal water		**311,04**	10,37
February	311,04	0	potable municipal water		**311,04**	10,37
March	311,04	0	potable municipal water		**311,04**	10,37
April	311,04	0	potable municipal water		**311,04**	10,37
May	311,04	0	potable municipal water		**311,04**	10,37
June	311,04	0	potable municipal water		**311,04**	10,37
July	311,04	0	potable municipal water		**311,04**	10,37
August	311,04	0	potable municipal water		**311,04**	10,37
September	311,04	0	potable municipal water		**311,04**	10,37
October	311,04	0	potable municipal water		**311,04**	10,37
November	311,04	0	potable municipal water		**311,04**	10,37
December	311,04	0	potable municipal water		**311,04**	10,37
ANNUAL TOTAL					**3 732,48**	

B3 EVAPORATION LOSS (For 'open' reservoirs) 35mm - 45mm/week in summer

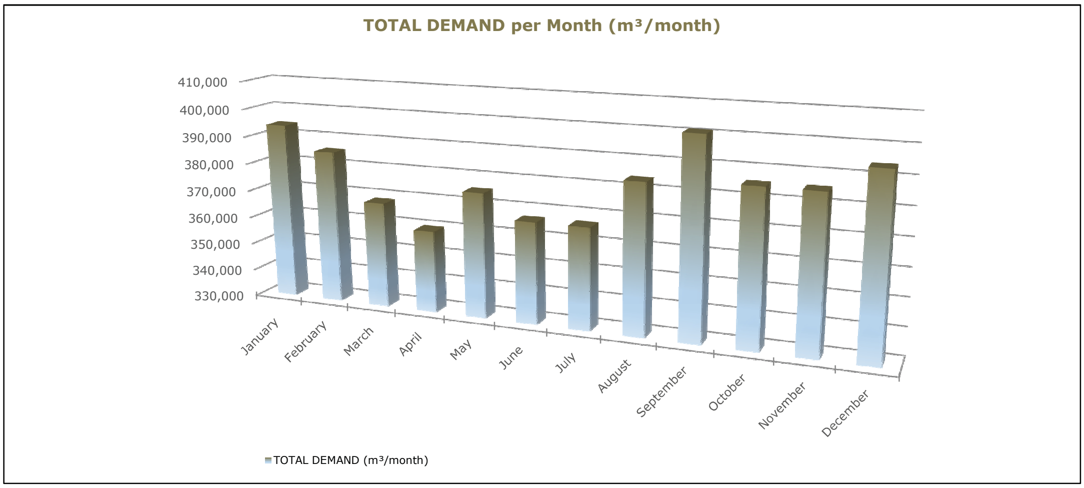
AREA OF RESERVOIR (m^2): 400

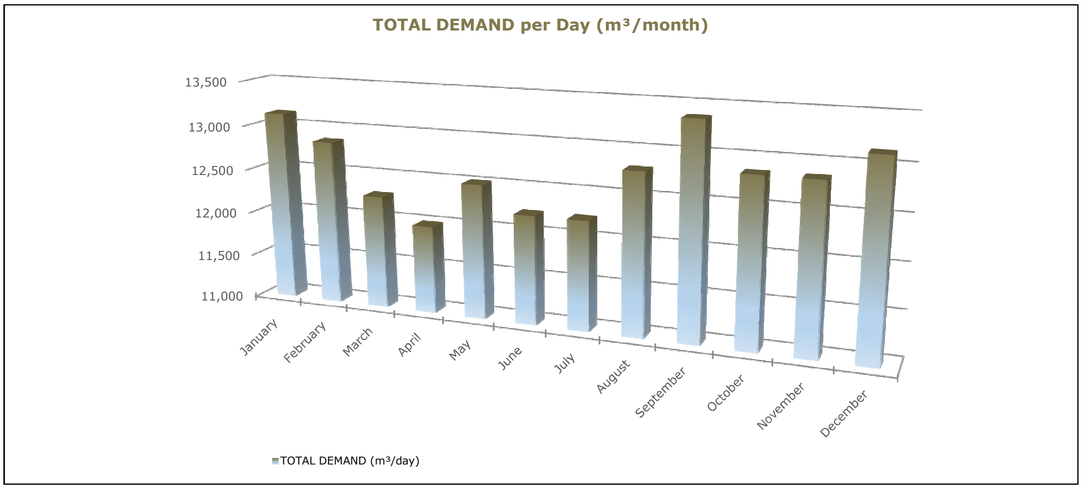
MONTH	EVAPORATION RATE (m/week)	EVAPORATION RATE (m/month)	TOTAL LOSS (m^3/month)	TOTAL LOSS (m^3/day)
January	0,040	0,171	68,571	2,286
February	0,035	0,150	60,000	2,000
March	0,025	0,107	42,857	1,429
April	0,020	0,086	34,286	1,143
May	0,015	0,064	25,714	0,857
June	0,010	0,043	17,143	0,571
July	0,010	0,043	17,143	0,571
August	0,020	0,086	34,286	1,143
September	0,030	0,129	51,429	1,714
October	0,035	0,150	60,000	2,000
November	0,035	0,150	60,000	2,000
December	0,040	0,171	68,571	2,286
ANNUAL TOTAL	**0,315**	**1,350**	**540,00**	

B4 TOTAL WATER LOSS & DEMAND

	B1	B2	B3	B1 + B2 + B3	
MONTH	TOTAL MONTHLY IRR. DEMAND (m^3)	BUILDING DEMAND (m^3/month)	EVAPORATION LOSS (m^3/month)	TOTAL DEMAND (m^3/month)	TOTAL DEMAND (m^3/day)
January	14,322	311,040	68,571	393,933	13,131
February	14,322	311,040	60,000	385,362	12,845
March	14,322	311,040	42,857	368,219	12,274
April	14,322	311,040	34,286	359,647	11,988
May	38,443	311,040	25,714	375,197	12,507
June	38,443	311,040	17,143	366,626	12,221
July	38,443	311,040	17,143	366,626	12,221
August	38,443	311,040	34,286	383,769	12,792
September	38,443	311,040	51,429	400,911	13,364
October	14,322	311,040	60,000	385,362	12,845
November	14,322	311,040	60,000	385,362	12,845
December	14,322	311,040	68,571	393,933	13,131
ANNUAL TOTAL	**292,465**	**3732,480**	**540,000**	**4 564,95**	

Figure 10.27 ~ Water demand.pdf
Source: Author





WATER DEMAND SPLIT

DESCRIPTION	TOTAL ANNUAL DEMAND (m³)	% OF ANNUAL TOTAL DEMAND
LANDSCAPE IRRIGATION DEMAND (m³)	292,47	6%
BUILDING / ALT DEMAND	3 732,48	82%
EVAPORATION LOSS (For 'open' reservoirs)	540,00	12%

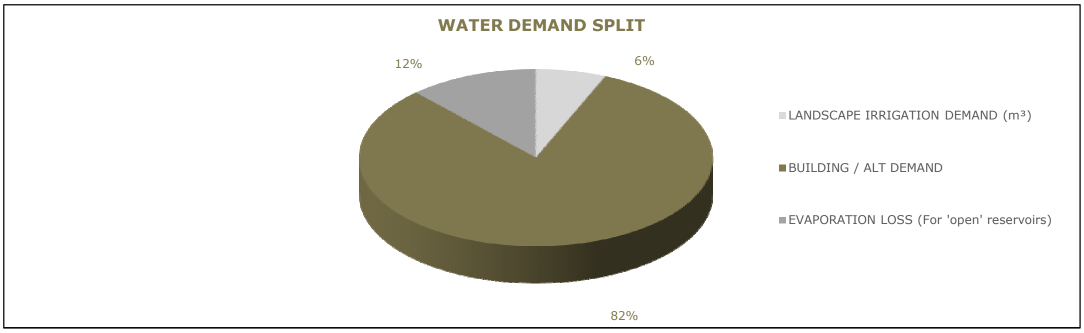


Figure 10.28 ~ Water demand.pdf:2

Source: Author

POTABLE MUNICIPAL WATER REQUIREMENTS

MONTH	Hand Basins (m³/month)	Restaurant (m³/month)	BUILDING DEMAND (m³/month)	BUILDING DEMAND (m³/day)
January	41,04	180	**221,04**	7,37
February	41,04	180	**221,04**	7,37
March	41,04	180	**221,04**	7,37
April	41,04	180	**221,04**	7,37
May	41,04	180	**221,04**	7,37
June	41,04	180	**221,04**	7,37
July	41,04	180	**221,04**	7,37
August	41,04	180	**221,04**	7,37
September	41,04	180	**221,04**	7,37
October	41,04	180	**221,04**	7,37
November	41,04	180	**221,04**	7,37
December	41,04	180	**221,04**	7,37
ANNUAL TOTAL			**2 652,48**	

Source: Author

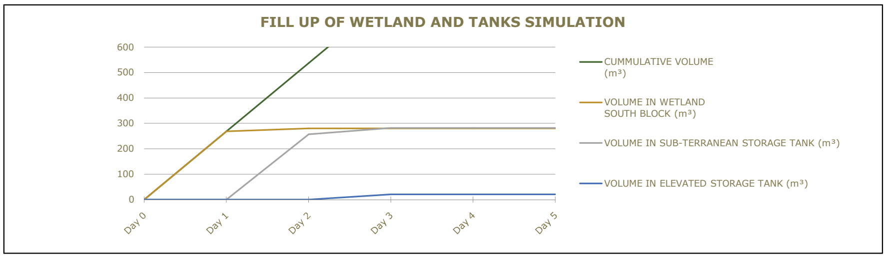
Figure 10.29 ~ Municipal water demand.pdf

C WATER BUDGET

WETLAND (m^3):	**280**	**TANK CAPACITY (m^3):**	**281,8**	**ELEVATED STORAGE (m^3):**	**20,9**

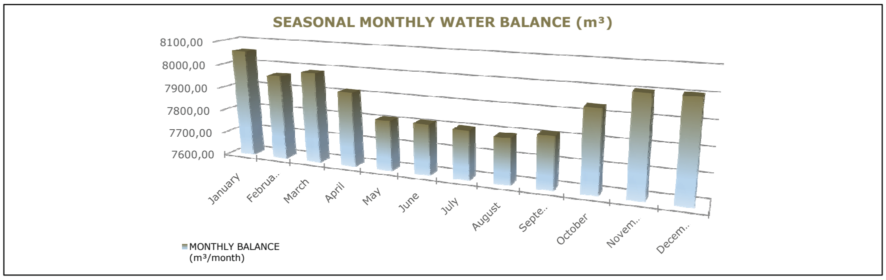
C1 WATER BUDGET **FILL UP OF WETLAND, SUB-TERRANEAN WATER STORAGE TANK AND ELEVATED STORAGE TANK SIMULATION**

DAY	YIELD (m^3/day)	DEMAND (m^3/day)	DAILY BALANCE (m^3/day)	CUMMULATIVE VOLUME (m^3)	VOLUME IN WETLAND SOUTH BLOCK (m^3)	VOLUME IN SUB-TERRANEAN STORAGE TANK (m^3)	VOLUME IN ELEVATED STORAGE TANK (m^3)	TO NORTH BLOCK WETLAND (m^3)
Day 0	-	-	-	-	-	-	-	-
Day 1	281,70	13,13	268,57	268,57	268,57	-	-	-
Day 2	281,70	13,13	268,57	537,13	280,00	257,13	-	-
Day 3	281,70	13,13	268,57	805,70	280,00	281,79	20,90	223,02
Day 4	281,70	13,13	268,57	1 074,27	280,00	281,79	20,90	491,59
Day 5	281,70	13,13	268,57	1 342,84	280,00	281,79	20,90	760,15
Day 6	281,70	13,13	268,57	1 611,40	280,00	281,79	20,90	1 028,72
	1 126,79	**52,52**	**1 074,27**					



C2 WATER BUDGET **SEASONAL MONTHLY WATER BALANCE**

MONTH	YIELD (m^3/month)	DEMAND (m^3/month)	MONTHLY BALANCE (m^3/month)	CUMMULATIVE VOLUME (m^3)	VOLUME IN WETLAND SOUTH BLOCK (m^3)	VOLUME IN SUB-TERRANEAN STORAGE TANK (m^3)	VOLUME IN ELEVATED STORAGE TANK (m^3)	TO NORTH BLOCK WETLAND (m^3)
Month 0	-	-	-	-	-	-	-	-
January	8450,95	393,93	8057,02	8 057,02	280,00	281,79	20,90	7 474,34
February	8346,38	385,36	7961,02	16 018,04	280,00	281,79	20,90	15 435,36
March	8352,92	368,22	7984,70	24 002,74	280,00	281,79	20,90	23 420,05
April	8274,49	359,65	7914,84	31 917,58	280,00	281,79	20,90	31 334,89
May	8187,34	375,20	7812,15	39 729,72	280,00	281,79	20,90	39 147,04
June	8178,63	366,63	7812,00	47 541,73	280,00	281,79	20,90	46 959,04
July	8169,91	366,63	7803,29	55 345,02	280,00	281,79	20,90	54 762,33
August	8174,27	383,77	7790,50	63 135,52	280,00	281,79	20,90	62 552,84
September	8215,67	400,91	7814,75	70 950,27	280,00	281,79	20,90	70 367,59
October	8320,24	385,36	7934,88	78 885,15	280,00	281,79	20,90	78 302,47
November	8387,77	385,36	8002,41	86 887,56	280,00	281,79	20,90	86 304,88
December	8396,49	393,93	8002,56	94 890,12	280,00	281,79	20,90	94 307,43
ANNUAL AVE.	**99 455,06**	**4 564,95**	**94 890,12**					



Source: Author
Figure 10.30 ~ Water balance.pdf

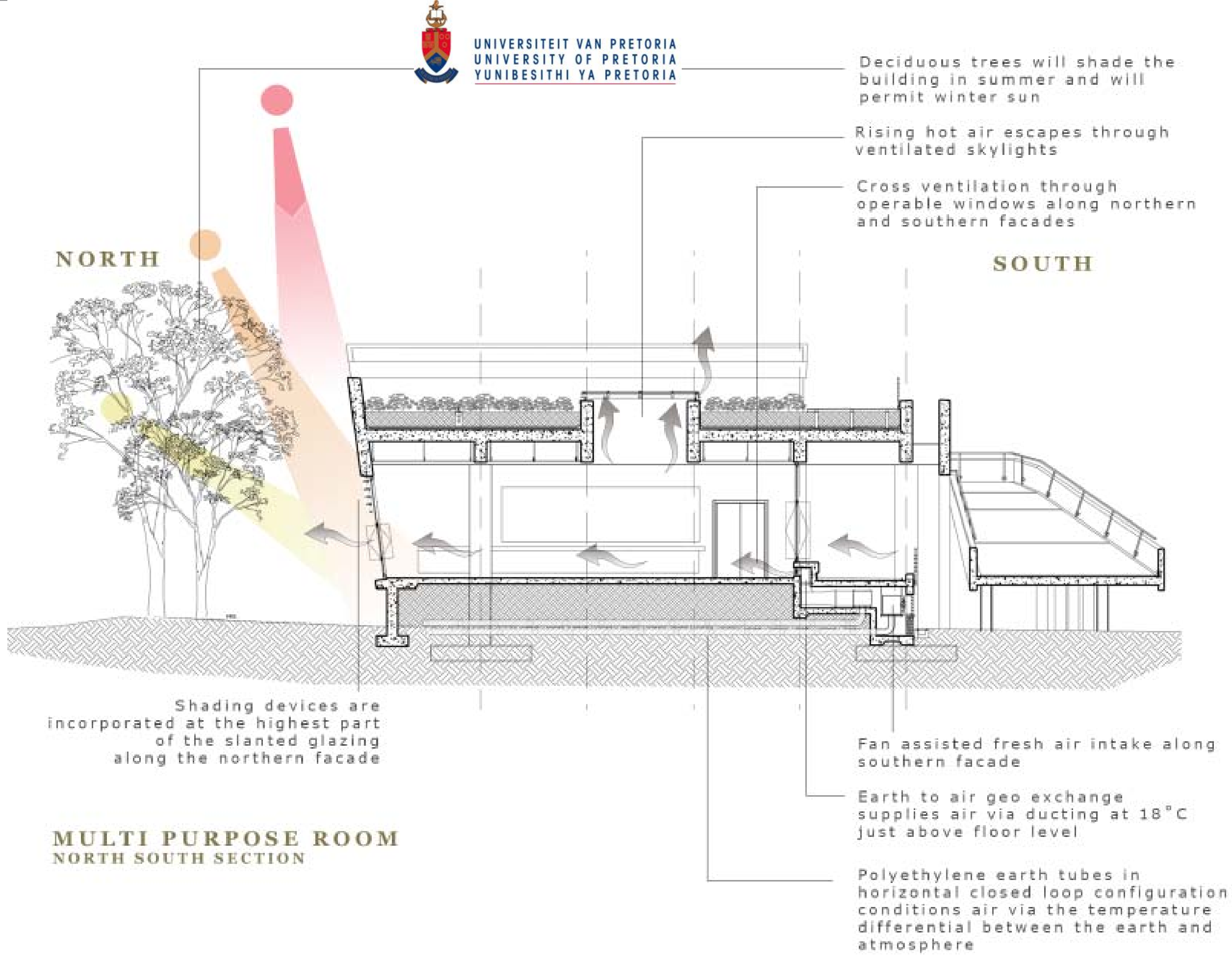
10.5.4 Heating, Cooling and Ventilation

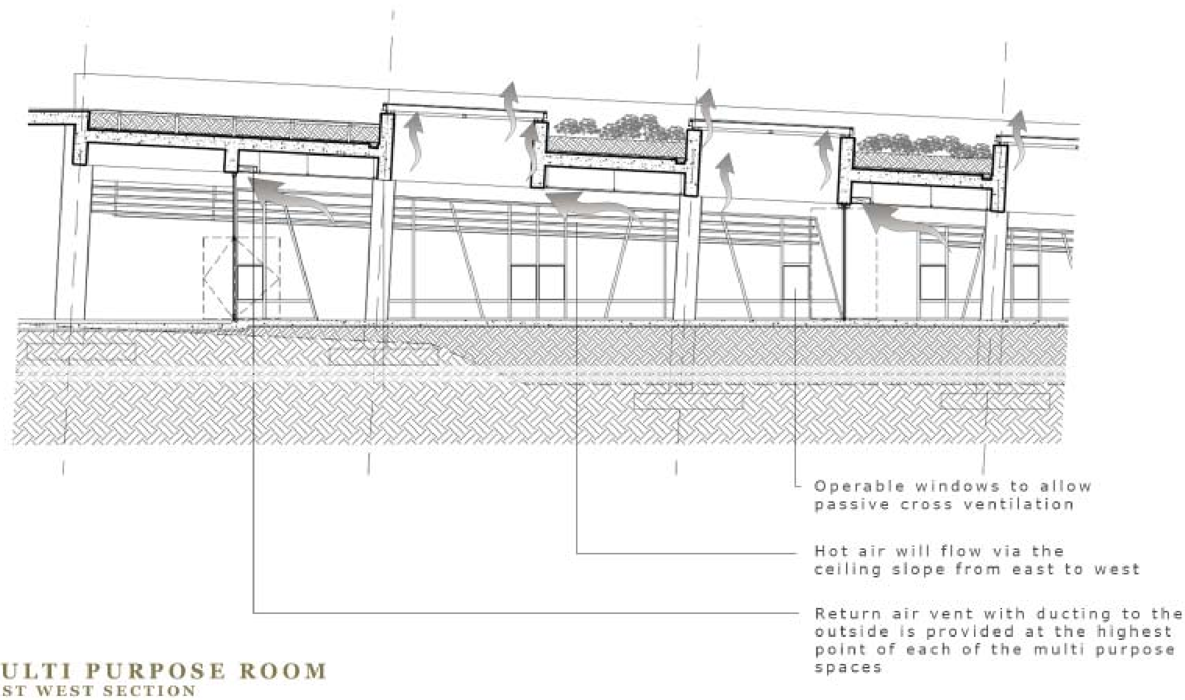
A hybrid system combining both active and passive systems is used due to the varied scale and diversity of internal spaces. As discussed earlier, the building's green roof will assist with climate mitigation and reduce the energy requirements of the mechanical systems employed.

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.



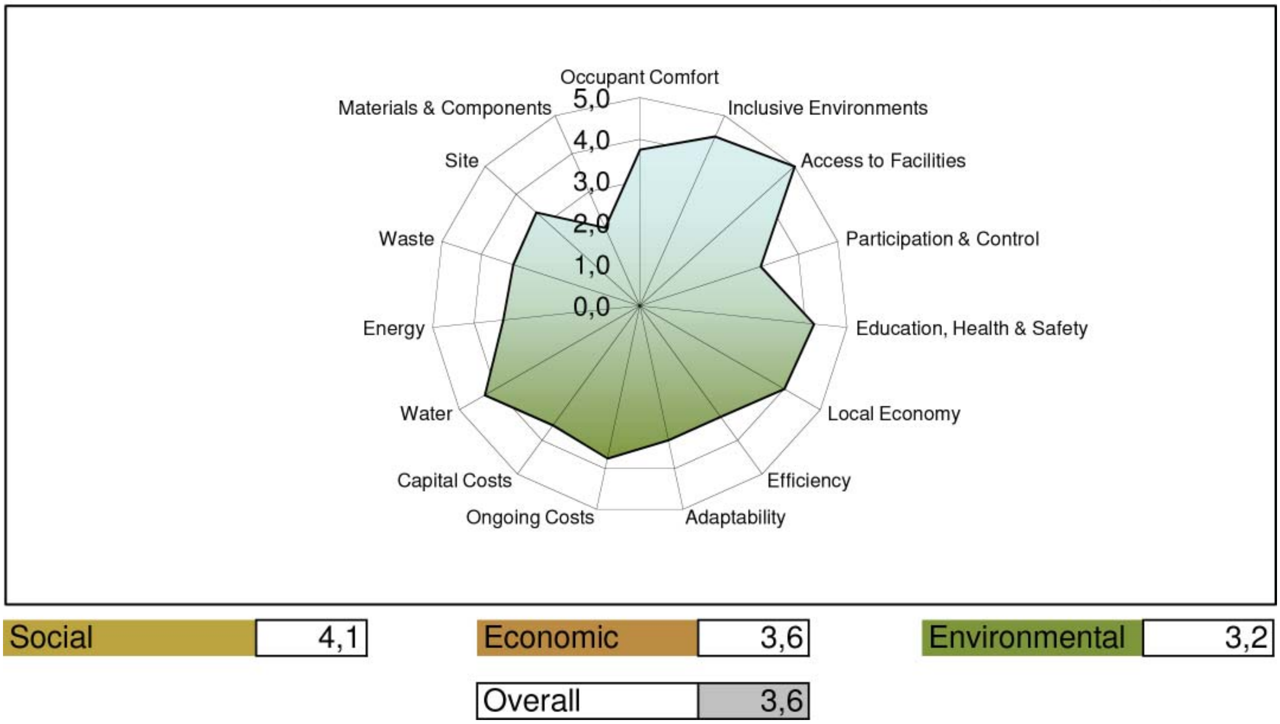


Source: Author
Figure 10.31 ~ Heating, cooling and ventilation strategy.jpg

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.

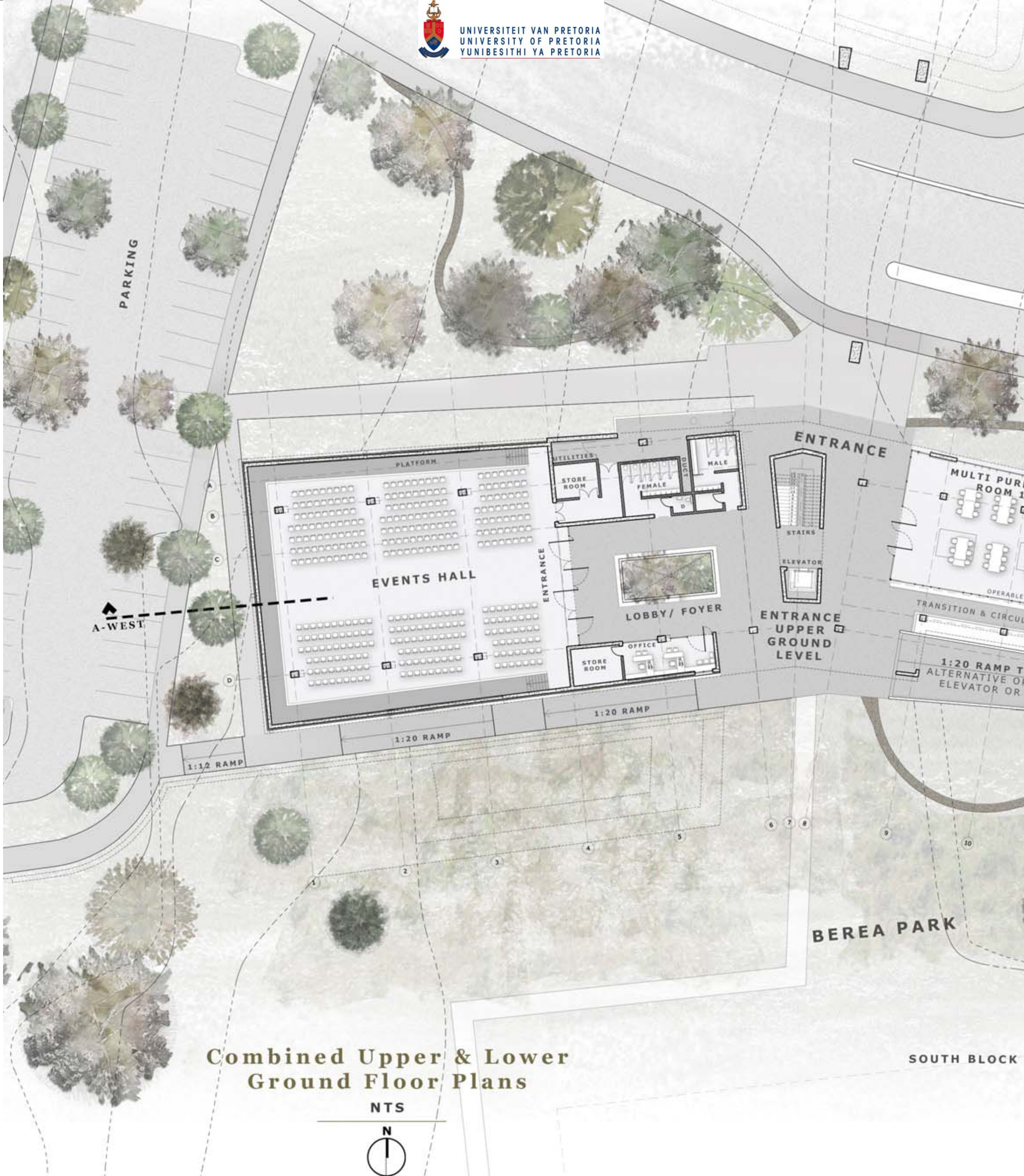
SUSTAINABLE BUILDING ASSESSMENT TOOL (SBAT- P) V1



Source: Author
Figure 10.32 ~ SBAT- assessment.jpg

10.6 Drawings and details

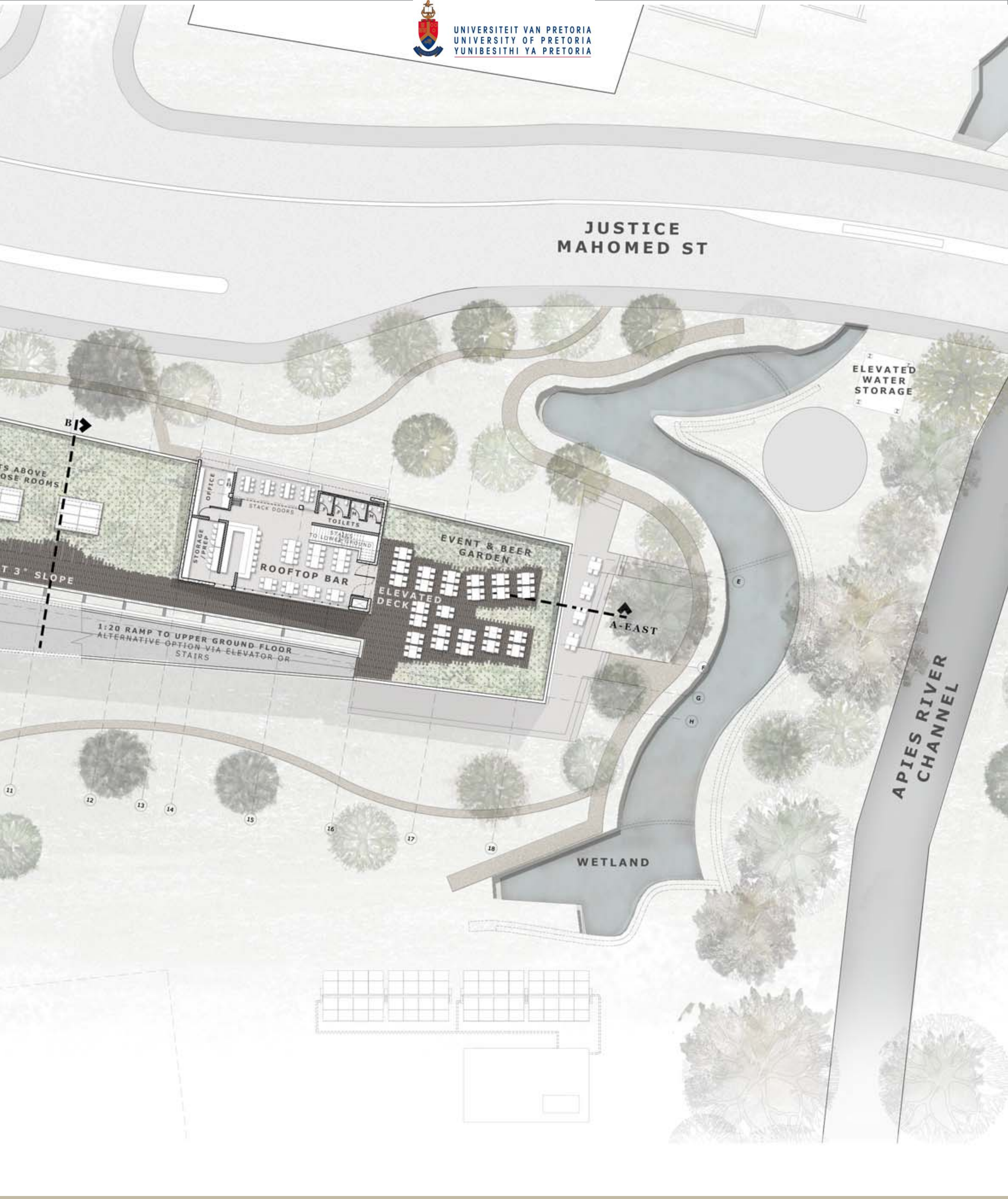
Source: Author
Figure 10.33 ~ Site plan.pdf



Source: Author
Figure 10.34 ~ Combined Ground Floor Plans.pdf


JUSTICE
MAHOMED ST
DROP OFF ZONE
MULTI PURPOSE
ROOM 2
YARD
COLD ROOM
FREEZER
PREP
DUCT
TOILETS
SCULLERY
KITCHEN
BAR
RESTAURANT
STAFF
DRY STORE
GRILL LINE
1:12 RAMP
1:12 RAMP
1:12 RAMP
LOWER GROUND
A-EAST
B
Utilities
room
280m³
Subterranean
water storage
tank
APIES RIVER
CHANNEL
WETLAND
RECREATIONAL
GARDEN
PARABOLIC SOLAR COLLECTORS
100m²
280m³/day
Slow sand
filter
BATTERY RM
ENGINE &
GENERATOR
ROOM

Source: Author
Figure 10.35 ~ Roof plan.pdf


JUSTICE
MAHOMED ST
ELEVATED
WATER
STORAGE
OFFICE
STACK DOORS
TOILETS
STAIRS
TO LOWER GROUND
STORAGE
/PREP
ROOFTOP BAR
EVENT & BEER
GARDEN
ELEVATED
DECK
A-EAST
1:20 RAMP TO UPPER GROUND FLOOR
ALTERNATIVE OPTION VIA ELEVATOR OR
STAIRS
WETLAND
APIES RIVER
CHANNEL

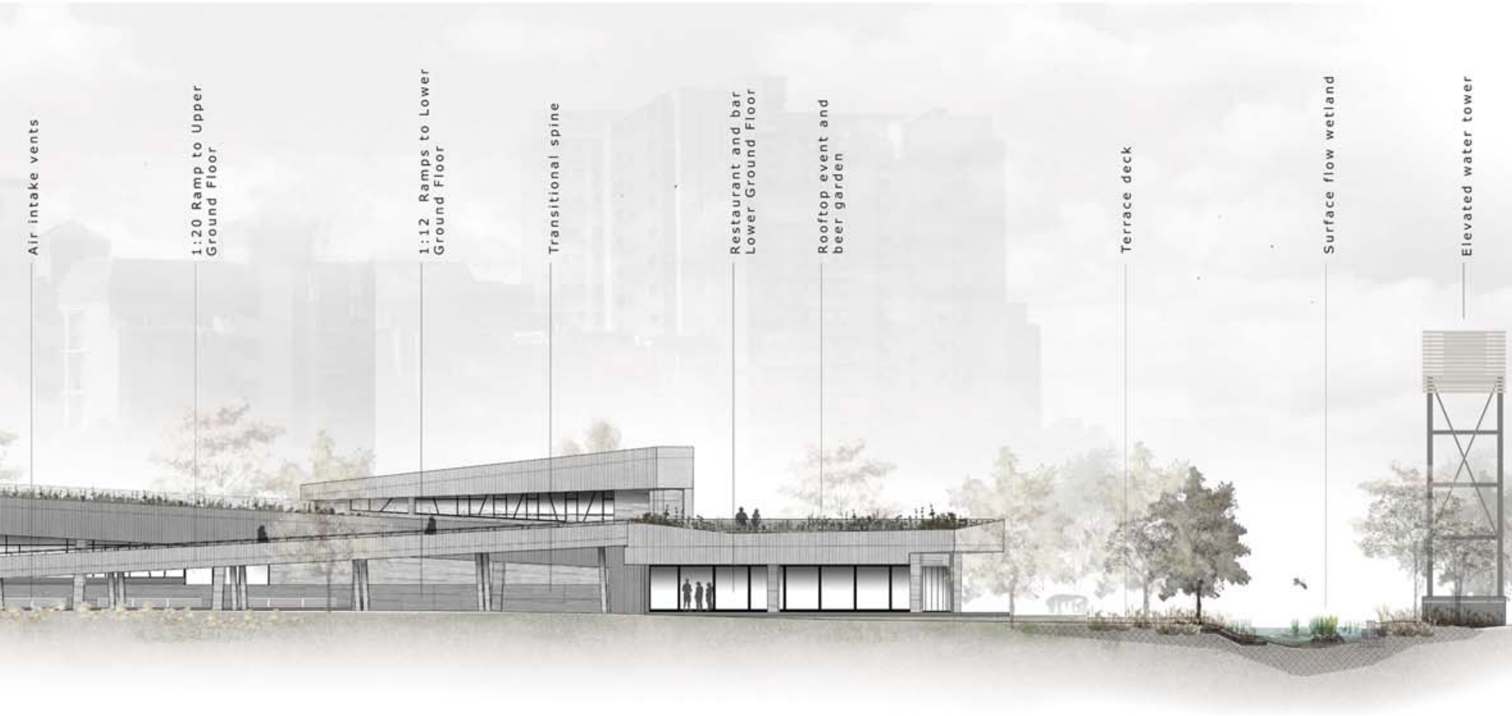
South Elevation
NTS

Berea Park edge

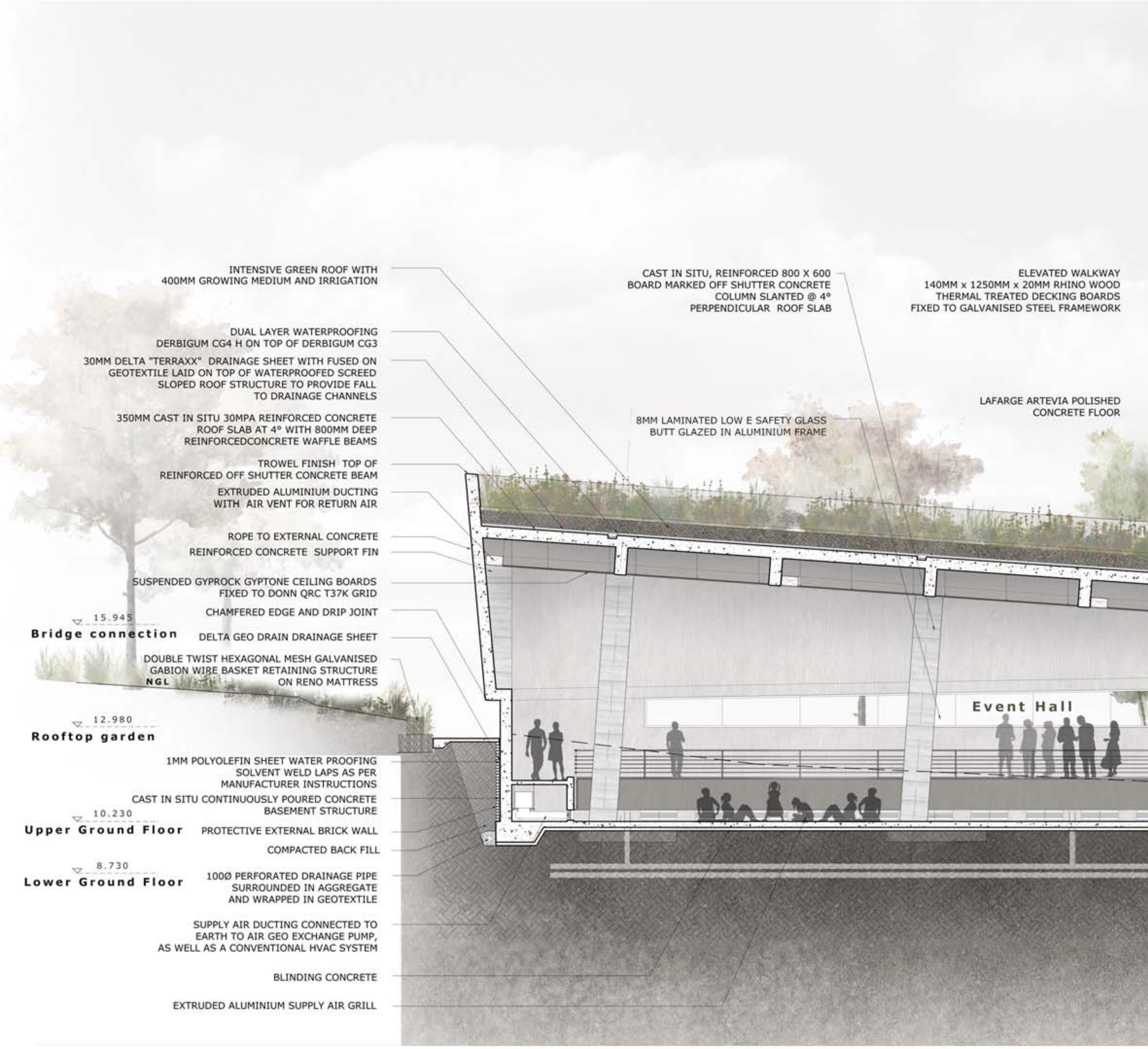
North Elevation
NTS

Urban elevation _ Justice Mahomed edge

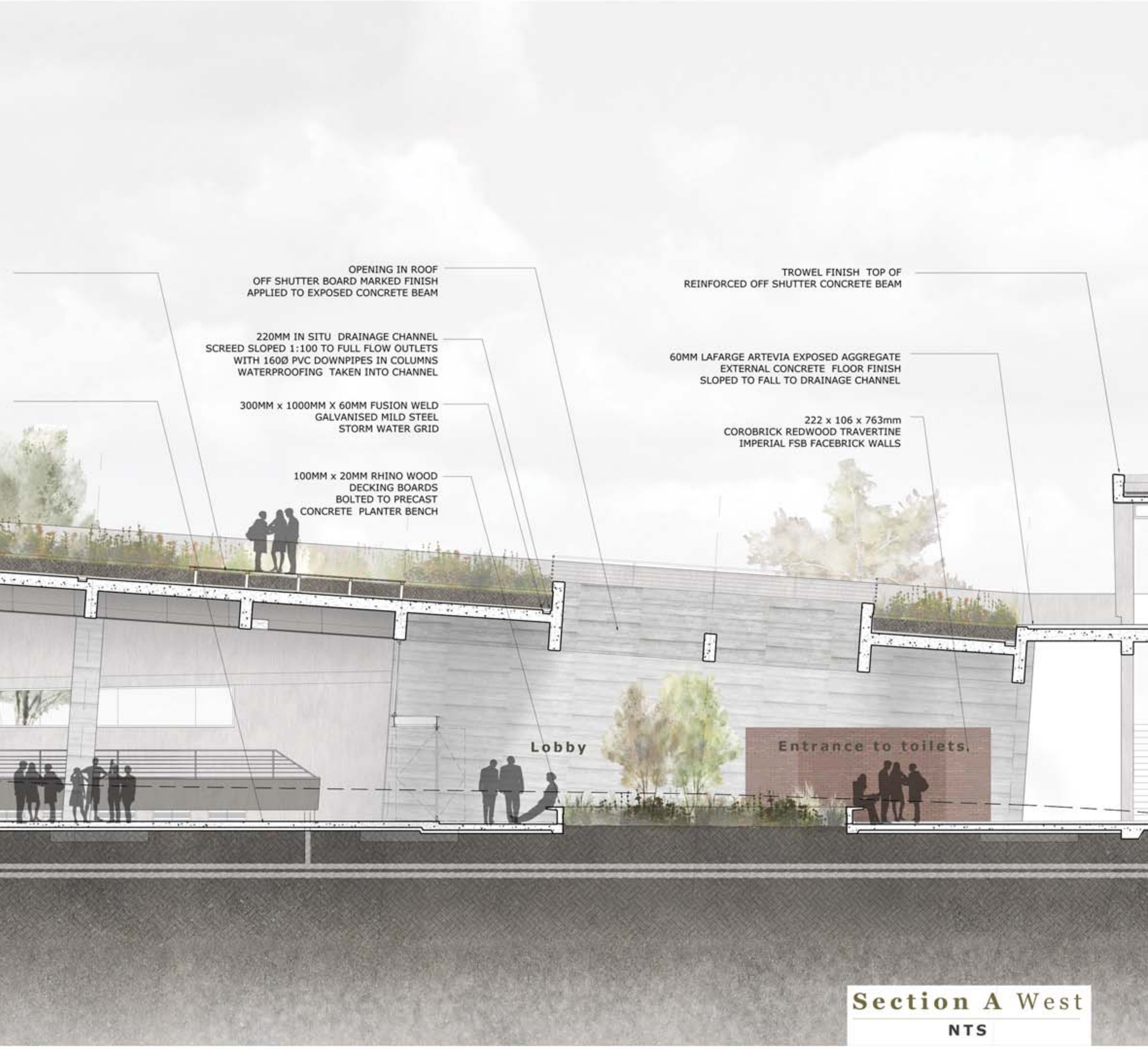
Source: Author
Figure 10.36 ~ Elevations.pdf

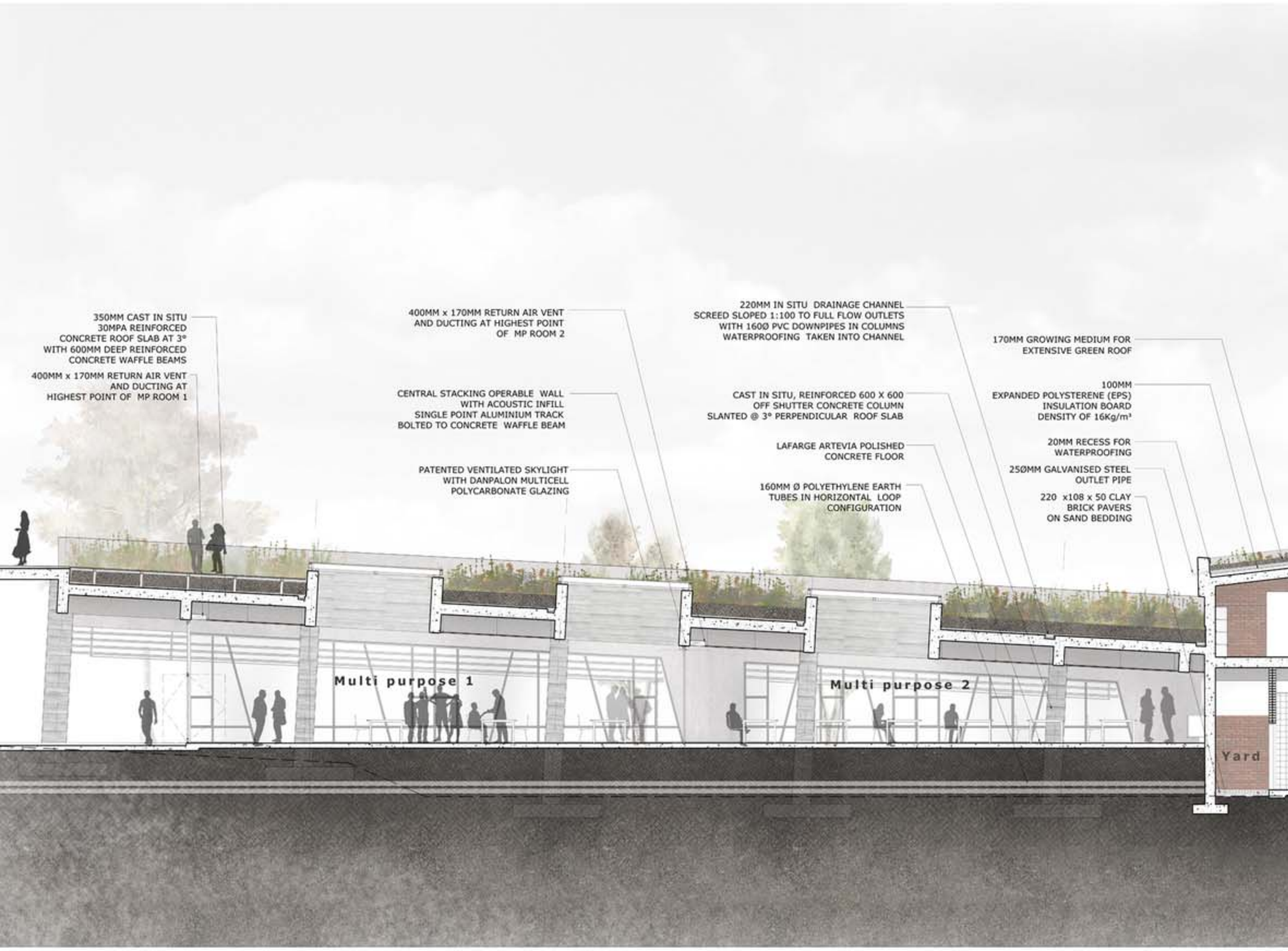

Air intake vents
1:20 Ramp to Upper Ground Floor
1:12 Ramps to Lower Ground Floor
Transitional spine
Restaurant and bar Lower Ground Floor
Rooftop event and beer garden
Terrace deck
Surface flow wetland
Elevated water tower


Bridge connection
Vertical circulation
External aces to Event hall

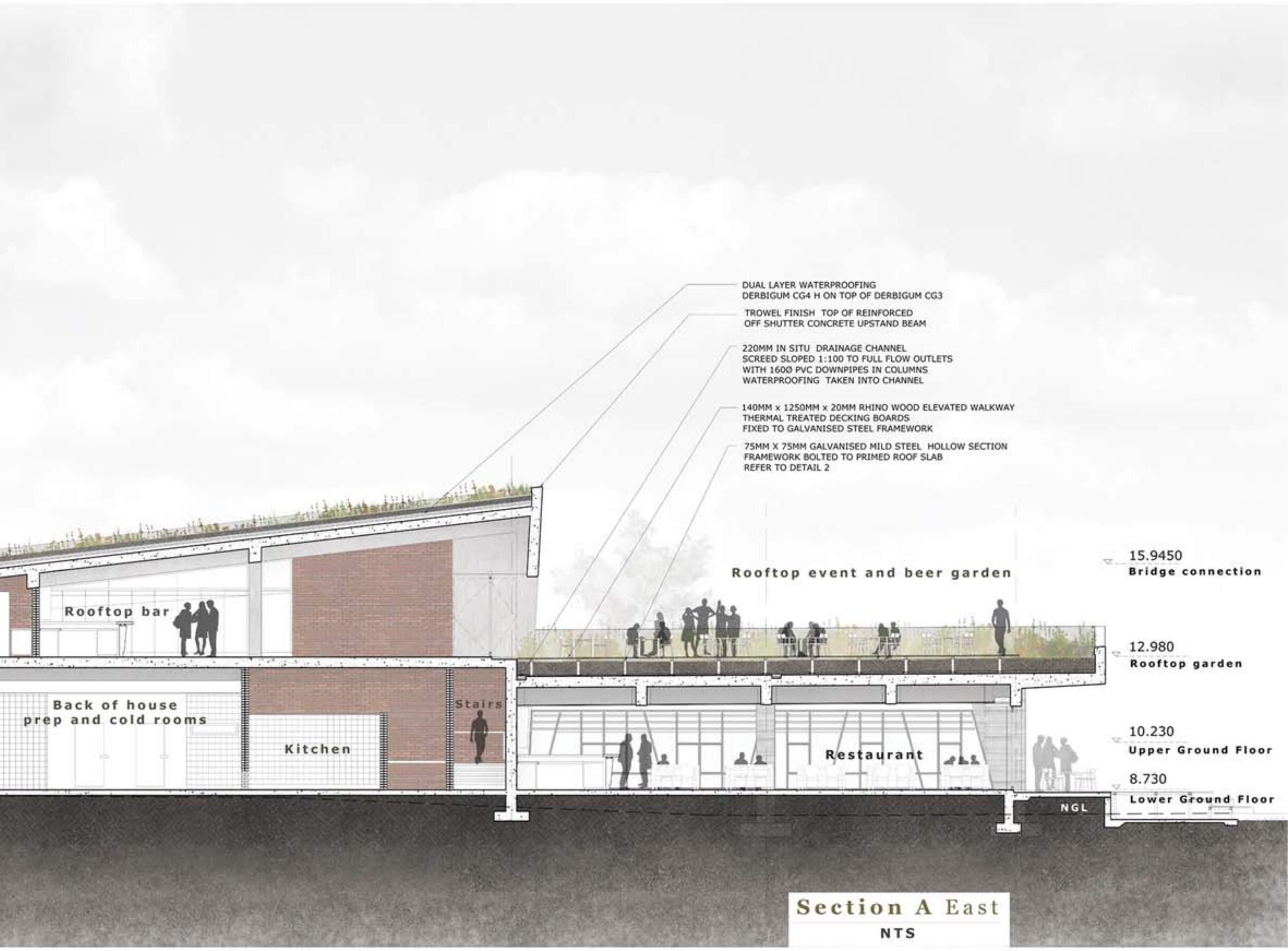


Source: Author
Figure 10.37 ~ Section A_west.pdf

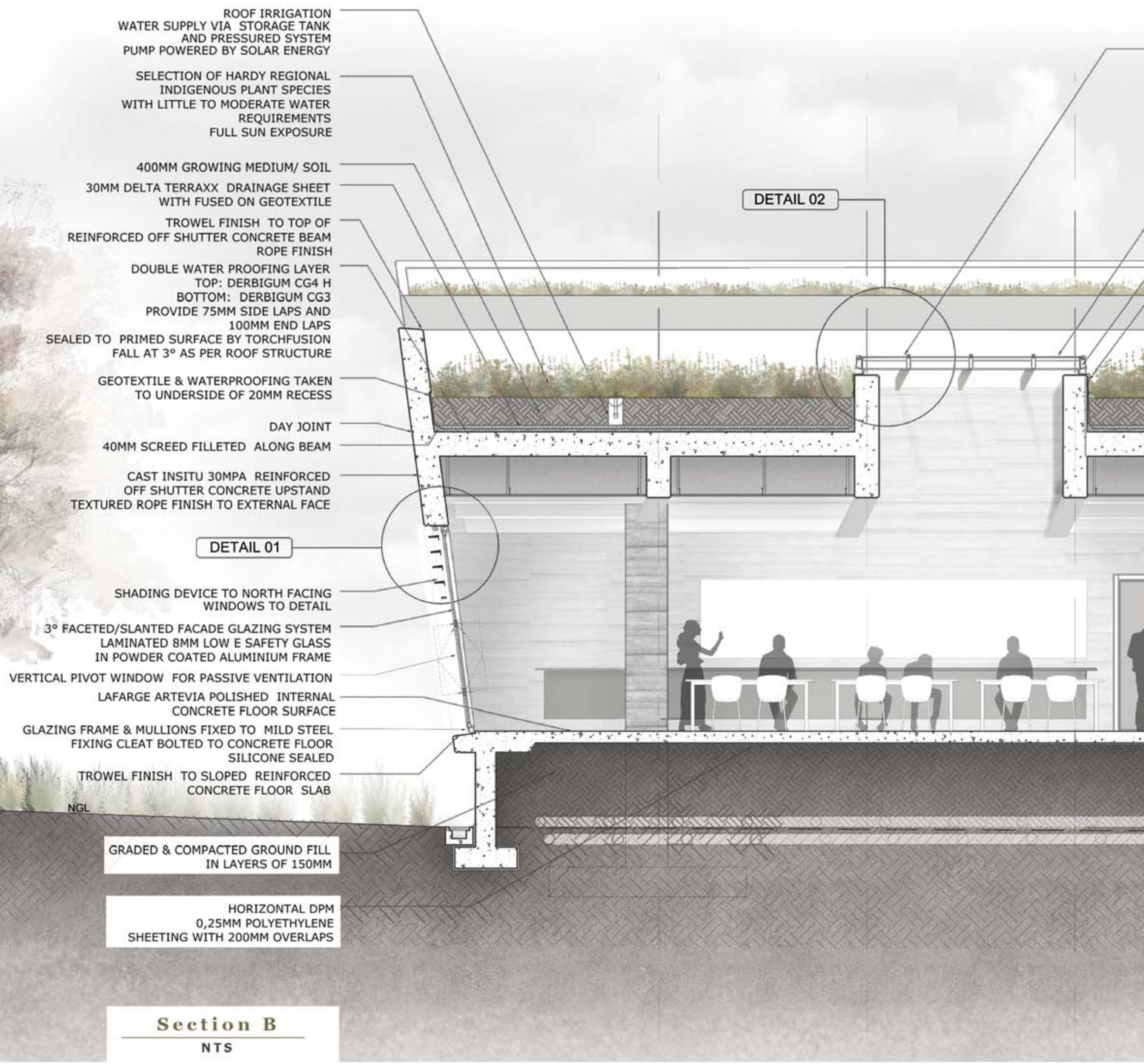

OPENING IN ROOF
OFF SHUTTER BOARD MARKED FINISH
APPLIED TO EXPOSED CONCRETE BEAM
220MM IN SITU DRAINAGE CHANNEL
SCREED SLOPED 1:100 TO FULL FLOW OUTLETS
WITH 160Ø PVC DOWNPIPES IN COLUMNS
WATERPROOFING TAKEN INTO CHANNEL
300MM x 1000MM X 60MM FUSION WELD
GALVANISED MILD STEEL
STORM WATER GRID
100MM x 20MM RHINO WOOD
DECKING BOARDS
BOLTED TO PRECAST
CONCRETE PLANTER BENCH
TROWEL FINISH TOP OF
REINFORCED OFF SHUTTER CONCRETE BEAM
60MM LAFARGE ARTEVIA EXPOSED AGGREGATE
EXTERNAL CONCRETE FLOOR FINISH
SLOPED TO FALL TO DRAINAGE CHANNEL
222 x 106 x 763mm
COROBRICK REDWOOD TRAVERTINE
IMPERIAL FSB FACEBRICK WALLS
Lobby
Entrance to toilets.
Section A West
NTS



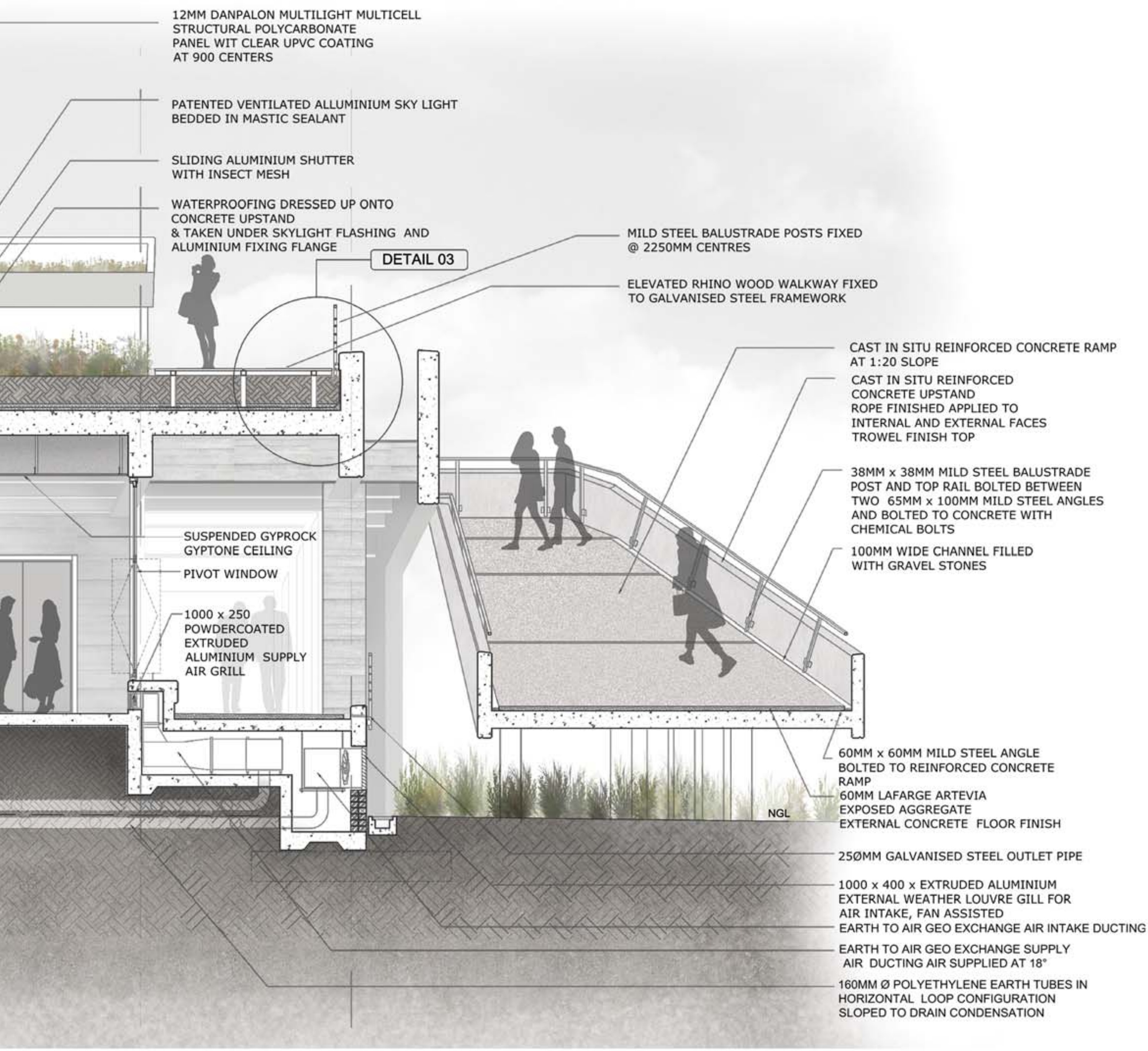
Source: Author
Figure 10.38 ~ Section A_east.pdf

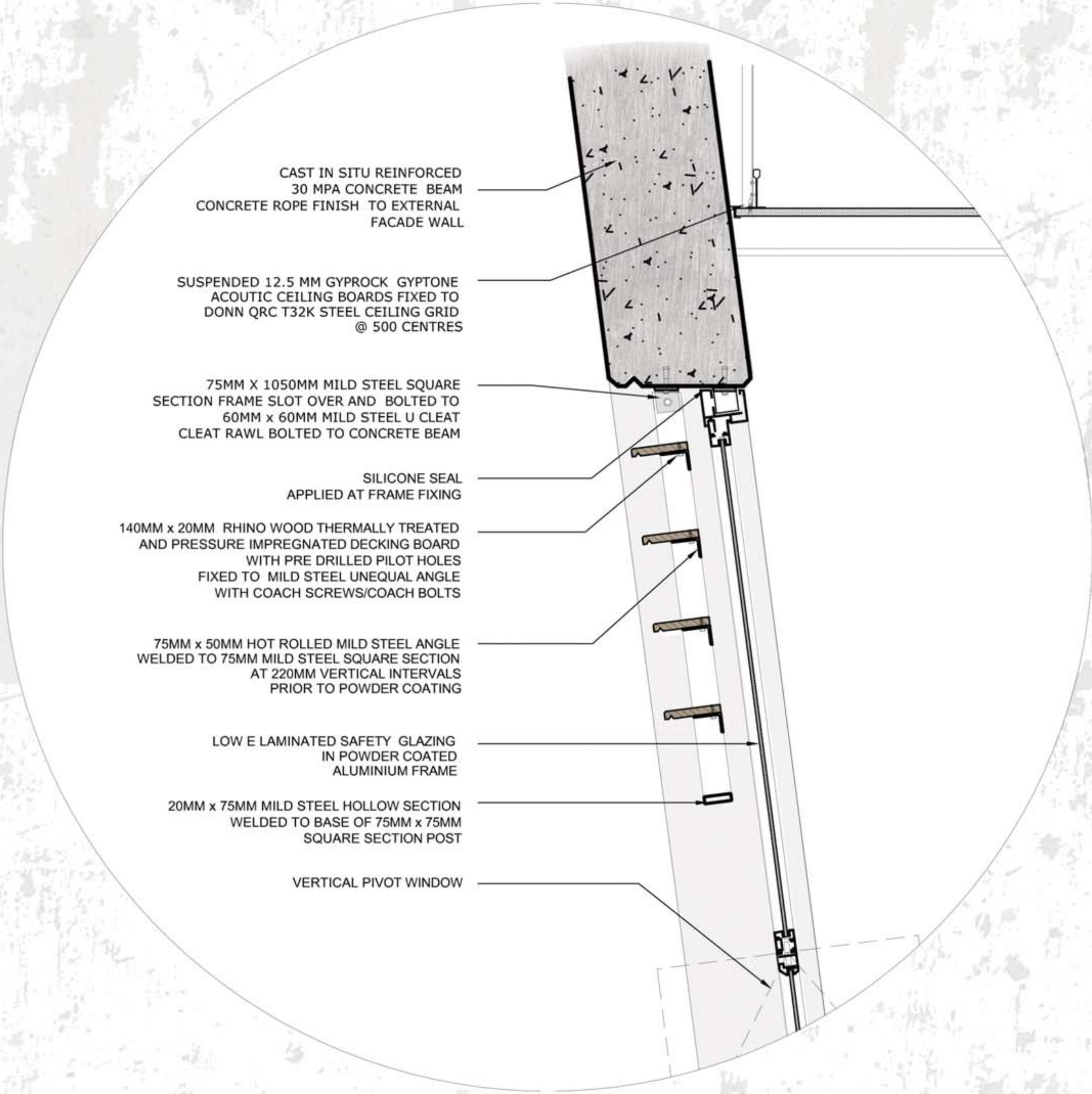


Section A East
NTS



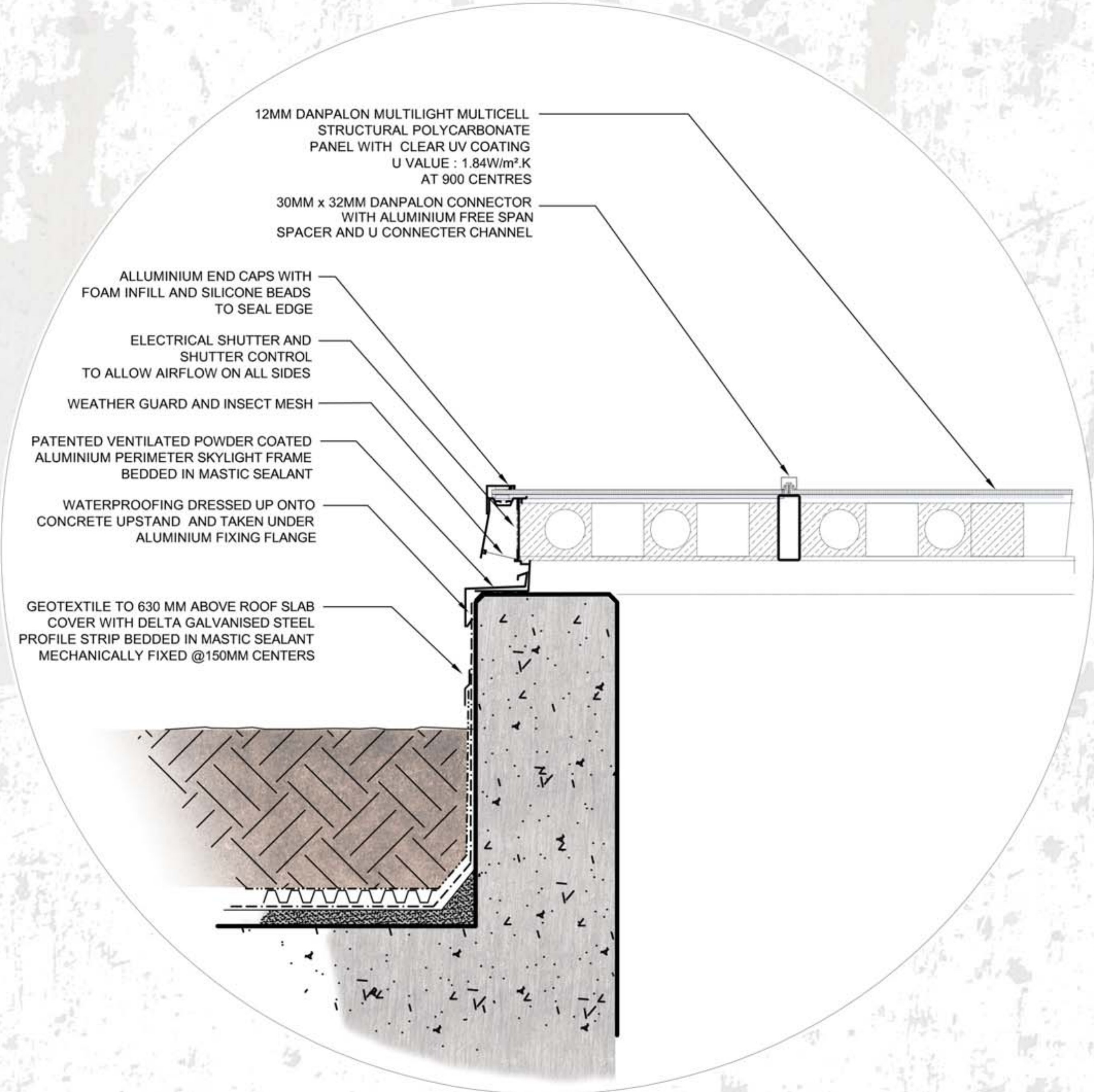
Source: Author
Figure 10.39 ~ Section B.pdf


12MM DANPALON MULTILIGHT MULTICELL STRUCTURAL POLYCARBONATE PANEL WIT CLEAR UPVC COATING AT 900 CENTERS
PATENTED VENTILATED ALLUMINIUM 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
SUSPENDED GYPROCK GYPTONE CEILING
PIVOT WINDOW
1000 x 250 POWDERCOATED EXTRUDED ALUMINIUM SUPPLY AIR GRILL
60MM x 60MM MILD STEEL ANGLE BOLTED TO REINFORCED CONCRETE RAMP
60MM LAFARGE ARTEVIA EXPOSED AGGREGATE EXTERNAL CONCRETE FLOOR FINISH
NGL
25ØMM 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



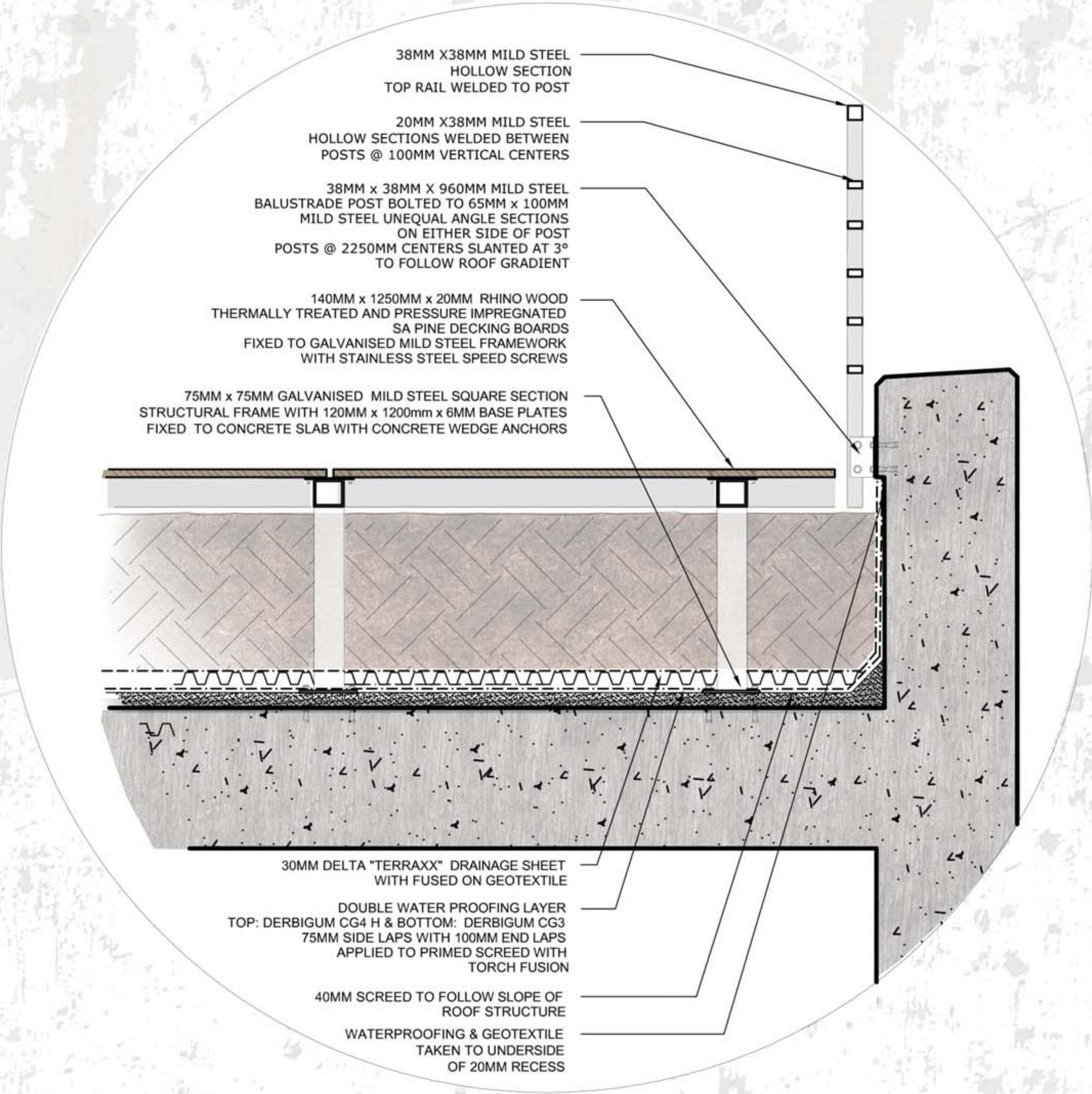
Source: Author
Figure 10.40 ~ detail 01.pdf

Detail 1
Shading device



Detail 2
Ventilated skylight

Source: Author
Figure 10.41 ~ detail 02.pdf



Detail 3
Elevated walkway

Source: Author
Figure 10.42 ~ detail 03.pdf

10.7 Visualisations

Eastern

The building spills out on to a terraced deck th

Source: Author
Figure 10.43 ~ Visualisation Eastern Edge.jpg

n Edge

hat connects to the wetland and green spine

Rooftop Eve

View towards the west and city

Source: Author
Figure 10.44 ~ Visualisation Rooftop Garden.jpg

ent Garden

edge from the rooftop garden

Source: Author
Figure 10.45 ~ Visualisation Southern link.jpg

o Berea Park

edge

Street

View from Justice Mahomed

Source: Author
Figure 10.46 ~ Visualisation Street Edge.jpg

Edge

Street towards the west