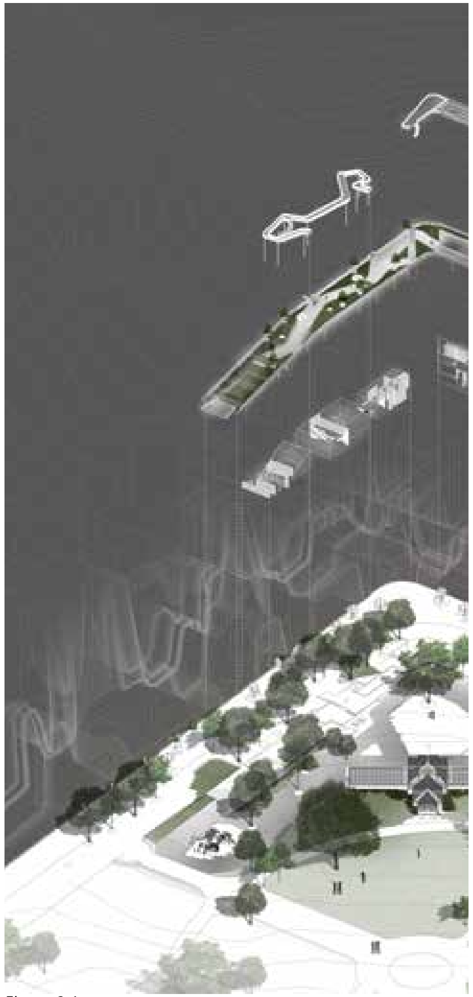


Figure 9.1
(Author, 2016)

CHAPTER 09

TECHNOLOGICAL INVESTIGATION

The dynamic between the heritage landscape and the contemporary contextual needs of Joubert Park and the Conservatory Complex have been explored on various levels: in a macro and micro analysis, theoretical considerations, programmatic proposals, and the subsequent design development to reach a final architectural solution. This chapter explores the assembly and construction resolution of the building on a conceptual and detailed level. The contextual approach taken throughout the dissertation and design informs the material selection, inspired by the existing heritage fabric.

9.1_ TECTONIC CONCEPT

9.1.1_INTRODUCTION_STEREOTOMIC & TECTONIC

Gottfried Semper (1851) explains the origins of architecture through the lens of anthropology in 'The Four Elements of Architecture' whereby architecture is divided into four categories: the hearth (stereotomic), the roof (tectonic), the enclosure (tectonic) and the mound (stereotomic) (Figure 9.2). Stereotomic construction uses compressive mass like stone work while tectonic employs lighter framework elements. Stereotomic is associated with permanence, and tectonic with transience (Wunder, 1998).

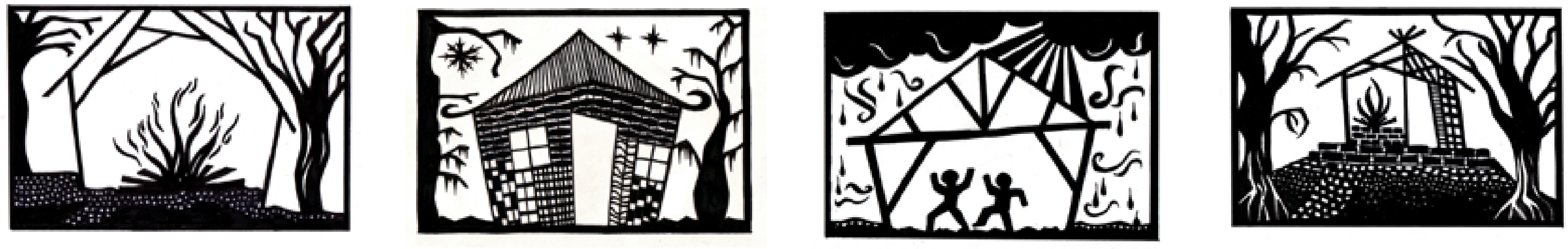


Figure 9.2
(Owen, 2012)

HEARTH
The fireplace, the heart of the structure, protected by the roof, enclosure, and mound

ROOF
The protective overhead shelter

ENCLOSURE
Walls, spatial dividers and screens of light fabric or weaving, with their materiality changing only if required to serve structural purpose

MOUND
The solid foundation on which the structure is built

9.1.2_TECTONIC CONCEPT

The century old Conservatory structure on the site drives design and technical conceptualisation. It is a lightweight timber, glass, and steel structure supported on a masonry base with an earthen floor, and the hearth is the stereotomic pond in its centre, reflecting the roof above. Therefore, the Conservatory has a tectonic roof and enclosure with a stereotomic mound and hearth. The programme of the CC as a conservatory of the arts opposed to a greenhouse conservatory turns the typology around and the technological approach mimics this. The tectonic concept turns this structure upside down, having a stereotomic roof rising from the earth, seemingly supported by a tectonic base (Figure 9.3). The hearth of the Creative Conservatory is a central courtyard that is framed by the CC building and the heritage Conservatory, becoming the heart of the Complex, connecting the old with the new. This tectonic concept is explored in junctions, materiality, and sustainability.

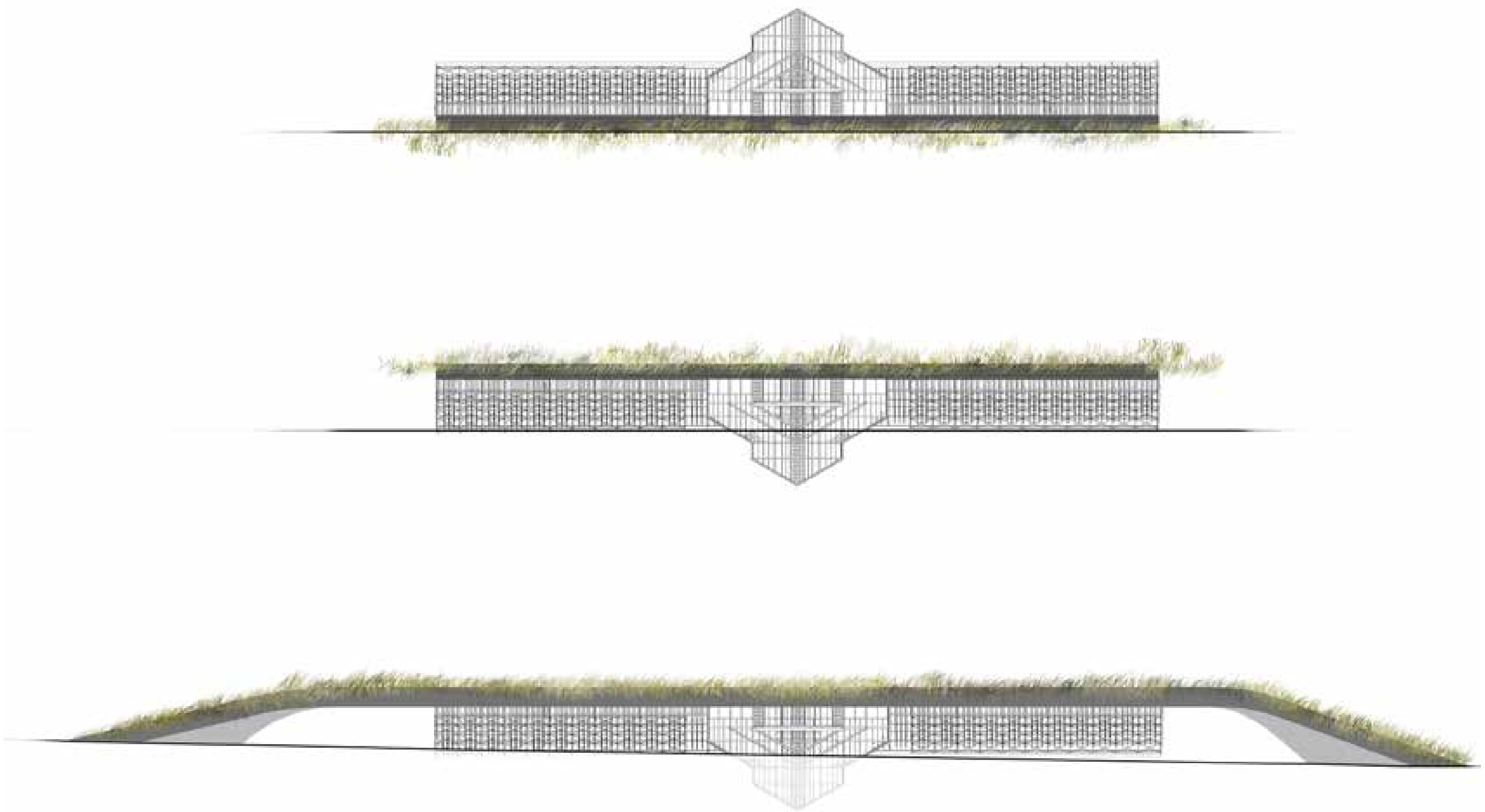


Figure 9.3
Tectonic Concept (Author, 2016)

9.1.3_PRECEDENT EXPLORATIONS OF STEREOTOMIC & TECTONIC

9.1.3.1_The Stereotomic

Landesgartenschau / Landscape Formation One
Weil am Rhein, Germany
Zaha Hadid
1996-1999
Structure: Concrete

DESCRIPTION
Landesgartenschau was built for a garden festival and rejects the concept of a building as an isolated object as it emerges from the paths of the park and dissolves back into the landscape. The building houses an exhibition hall, café and environmental centre (Zaha Hadid Architects, 2016). Landesgartenschau has a stereotomic, heavy nature as it draws inspiration from the landscape. The sculptural concrete structure fulfils the stereotomic concept of rising from the ground, rather than sitting on top of it in space (Figures 9.4 & 9.6).

RELEVANCE
Landesgartenschau is a relevant precedent, as the Creative Conservatory's concept also explores the building roof as an extension of the landscape (Figure 9.10). The stereotomic nature of Landesgartenschau dominates the architectural language and forms an accessible path on a secondary ground plane. The CC takes this further, as the planted landscape of the Park transitions onto the sloping roof, becoming an extension of the Park.

Figure 9.4
(Binet, nd)

Figure 9.5
(Hadid, 1996)

Figure 9.6
(Binet, nd)

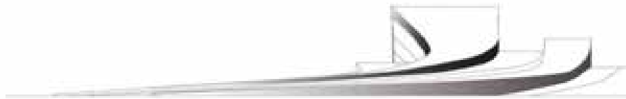


Figure 9.7
Elevation (Hadid, 1996)

Figure 9.8
Roof Plan (Hadid, 1996)

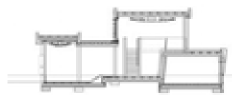


Figure 9.9
Cross Section (Hadid, 1996)

Figure 9.10
Longitudinal Section (Hadid, 1996)

9.1.3.2_The Tectonic

Kanagawa Institute of Technology (KAIT)
Kanagawa, Tokyo, Japan
Junya Ishigami + Associates
2008
Structure: Steel frame

DESCRIPTION
KAIT is a single storey, open plan workshop providing a flexible space for students to work on self-initiated projects, while also accessible for public use (ArchEyes, 2016). The structure consists of 305 scattered columns of varying shapes and sizes echoing the irregular position of trees in a forest (Figures 9.13 & 9.14). These columns ambiguously divide the space, blurring programmatic boundaries within the building. The transparent façade reflects surrounding Cherry Blossom trees, further blurring the interface between inside and outside (Figure 9.11).

RELEVANCE
KAIT successfully creates a space that is visibly accessible to the public and allows for flexible use. The building's glass skin and thin columns give the structure a tectonic character and the reflections of the trees connect the building to nature. KAIT is a relevant precedent as its simple glass box reflects its context and stimulates the curiosity of passers-by (Figure 9.12). The CC will mobilise the same concept with tectonic glass boxes inviting public interest and participation, as certain panels can be opened up to engage directly with the people on the street and within Joubert Park.

Figure 9.11
(Junya Ishigami + associates, 2008)

Figure 9.12
(Junya Ishigami + associates, 2008)

Figure 9.13
(Junya Ishigami + associates, 2008)

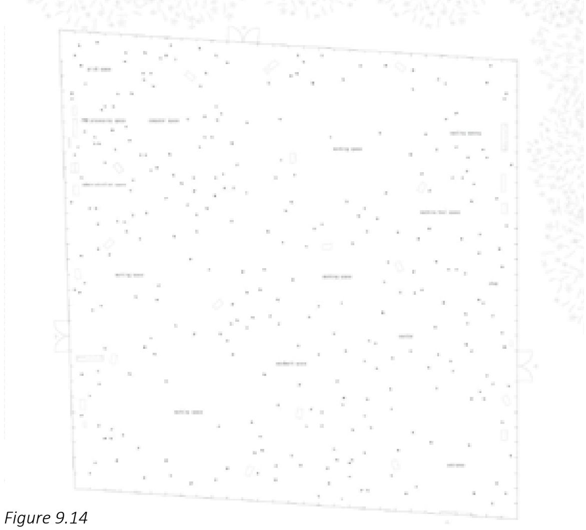


Figure 9.14
Plan (Junya Ishigami + associates, 2008)

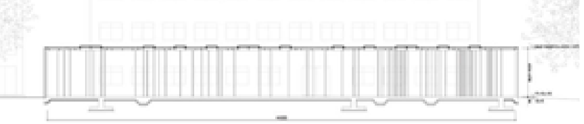


Figure 9.15
Section (Junya Ishigami + associates, 2008)

9.1.3.3_The Combination

Hearst Tower
New York City, New York, USA
Foster + Partners
2000-2006

DESCRIPTION
Hearst Tower is a 44 storey skyscraper rising above a 1920s heritage building (Figure 9.19). Foster established a creative dialogue between the stereotomic existing base and the tectonic new tower. The tower has a steel 'diagrid' frame, which efficiently uses 20% less steel than conventional framing, contributing to the Tower's sustainability (Foster + Partners, 2016). The faceted silhouette of Hearst Tower has become a landmark on the Manhattan skyline.

RELEVANCE
Hearst Tower is an example of an architectural language combining tectonic and stereotomic elements, which contrast one another to create a powerful whole (Figures 9.17 & 9.18). The Tower also uses a heritage building as inspiration for the footprint and massing of the new structure (Figure 9.16). Hearst Tower is relevant to this dissertation, which also aims to use both tectonic and stereotomic building forms and draw inspiration from the heritage Conservatory. The construction concept of the CC also considers the potential of contrasting the stereotomic and tectonic languages of architecture to generate beauty in contradiction.

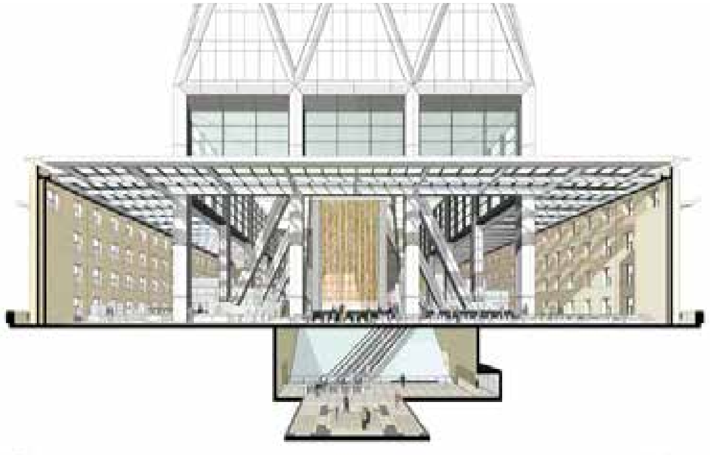


Figure 9.16
Sectional Perspective (Foster + Partners, 2006)

Figure 9.17
(Foster + Partners, 2006)

Figure 9.18
(Foster + Partners, 2006)

Figure 9.19
(Foster + Partners, 2006)

9.2_STRUCTURE

9.2.1_STRUCTURAL CONCEPT

The structural concept is a planted roof supported by a thick concrete slab and columns on a regular grid, with a tectonic glass skin enclosing various spaces with gaps between the boxes facilitating free pedestrian movement into the courtyard (Figure 9.20).

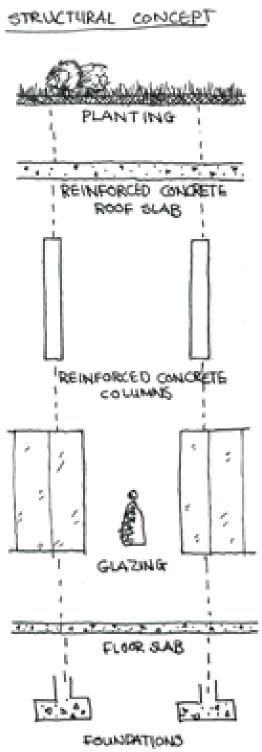


Figure 9.20
(Author, 2016)

9.2.2_STRUCTURAL INFORMANTS

The structural resolution is inspired by the different contexts, reinterpreting the materialistic characteristics of the Conservatory, Joubert Park, and the City (Figure 9.21).

Figure 9.21
(Author, 2016)

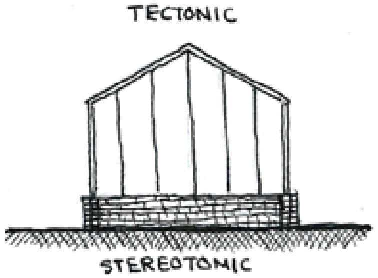


Figure 9.22
(Author, 2016)

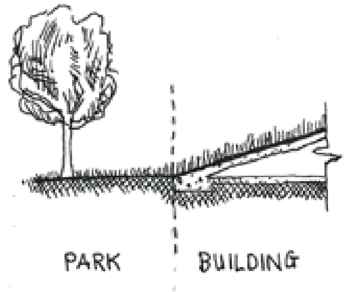


Figure 9.23
(Author, 2016)

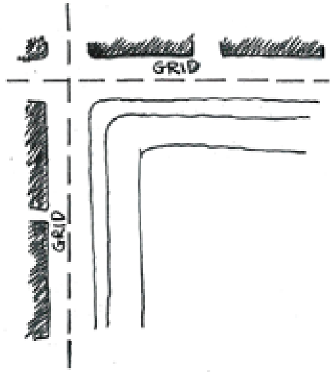


Figure 9.24
(Author, 2016)

9.2.2.1_ Conservatory

The Conservatory is the primary structural informant, with the relationship between its tectonic roof and walls, and stereotomic base and floor constituting the structural concept. The Conservatory's structure has a wood, glass and steel enclosure and roof with a masonry base and earthen floor. The CC considers the same language using different materials, with aluminium framed glass panelled walls with a concrete floor slab and roof slab, planted and supported by concrete columns.

9.2.2.2_ Park

Joubert Park's green landscape informed the decision for a green roof. The living roof will be planted with indigenous species rather than the exotics currently present in the Victorian Joubert Park, thus adding a new, local dimension to the Park's colonial landscape.

9.2.2.3_ City

The CC's column grid, slab and roof edges are informed by the City's grid, which encloses Joubert Park in a rectangular space (Figure 9.24). In doing so, the CC respects the boundary of the heritage Park, strengthening and framing the corner and the Conservatory. The surrounding high rise buildings are very stereotomic in nature, with thick masonry and concrete walls and columns, and relatively small apertures. The street edges formed by the buildings on the northern edge of the Park are solid, unresponsive walls, failing to activate the public realm. Contrasting this, the CC aims to have visually and directly accessible facades, using different qualities of glass that contribute to the public interface.

9.2.3_STRUCTURE & CONSTRUCTION

The primary structural system is a structural concrete roof slab, supported by concrete columns on a regular 9x9m grid that meet a floor slab and have footing foundations. The glass facade encloses space without structural significance (Figure 9.25).

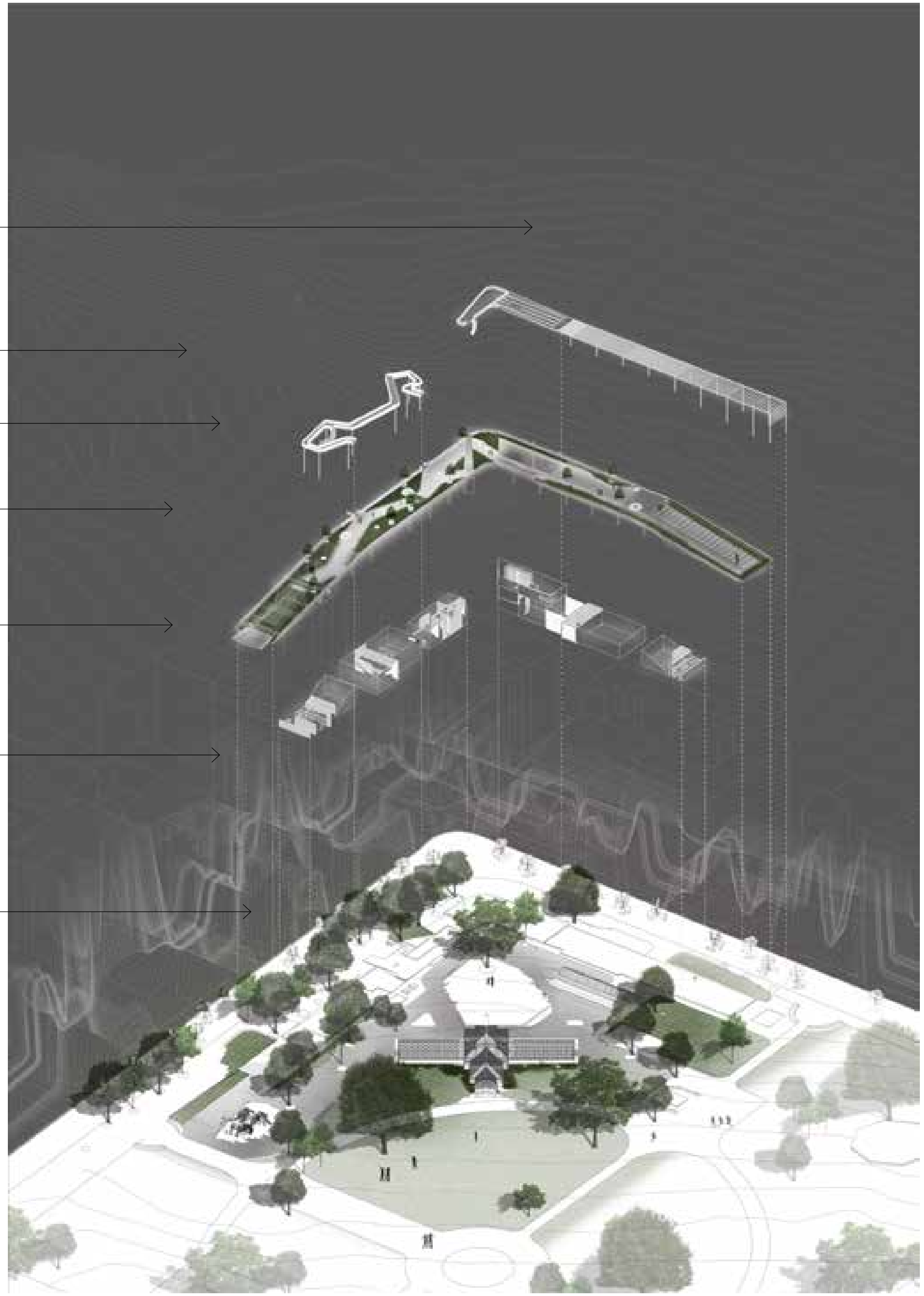


Figure 9.25
Exploded Axonometric (Author, 2016)

9.2.4_STRUCTURAL PRECEDENT

9.2.4.1_Local

The DBSA Welcome Centre
Midrand, Gauteng
Holm Jordaan Architects
2010

DESCRIPTION
The DBSA Welcome Centre is a concrete, masonry and timber building with columns on a 5 x 5m grid (Figures 9.27 & 9.28) and a green roof planted with indigenous grasses that is inaccessible to visitors. The building is designed to be completely off the grid, using photovoltaic energy for electricity, and solar water heaters to heat the floor in winter and provide hot water. Underground pipes provide fresh air supply into the building, preheating it in the winter, and precooling in the summer (Holm Jordaan Architects, 2010). The undulating planted roof harvests rainwater and provides thermal mass. Storm water is treated and stored in a retention dam, reducing the demand for council supply.

RELEVANCE
The DBSA Welcome Centre is an excellent precedent for this dissertation as it is also based in Gauteng, considers sustainable approaches, and successfully integrates a green roof planted with indigenous grass (Figure 9.26). The indigenous grasses on the roof match the grass on the site, and need to be burnt once a year to propagate. The CC's living roof is also planted with indigenous species, contrasting the exotics within the Park, but the grasses and shrubs chosen will not require burning, but rather need to be cut back to propagate.

Figure 9.26
(Holm Jordaan Architects, 2010)

Figure 9.27
(Holm Jordaan Architects, 2010)

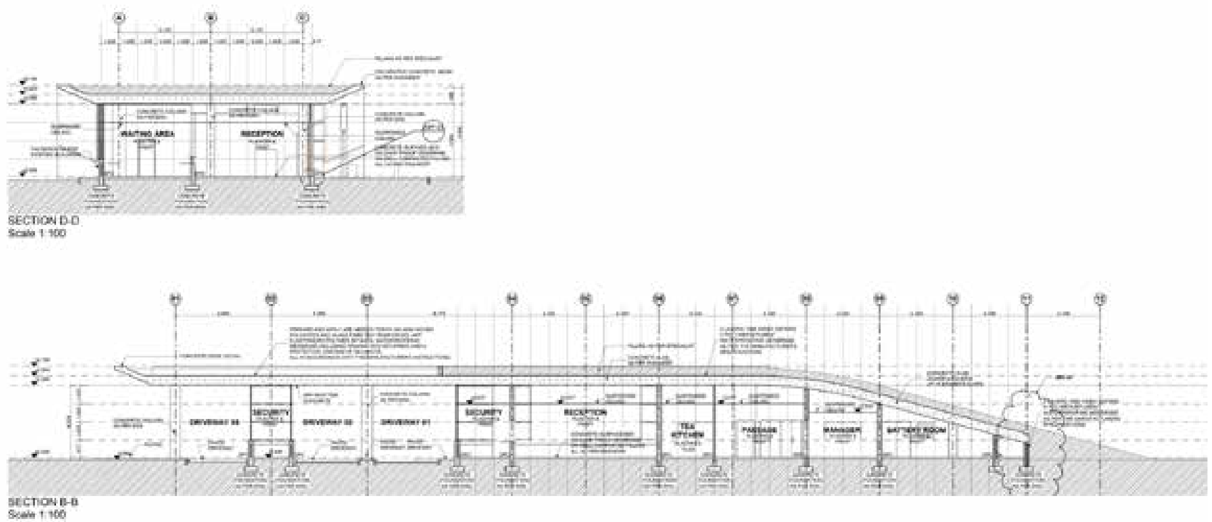


Figure 9.28
Sections (Holm Jordaan Architects, 2010)

9.2.4.2_International

Städel Museum
Frankfurt, Germany
Schneider + Schumacher
2008- 2012

DESCRIPTION
The Städel Museum extension is placed beneath the courtyard garden, almost doubling the exhibition space from 4000m2 to 7000m2 (Gaete, 2012). The planted roof is dotted with 195 circular skylights of varying diameter (1.5m-2.5m) designed to accommodate walking (Figures 9.29 & 9.30). Daylight entering the exhibition can be augmented by integrated LED lights or mitigated by shading elements (Figure 9.31). The roof slab is supported by 12 reinforced concrete columns (Figure 9.32) and the extension is anchored by 160 piles, 36 of which are geothermic, passively maintaining thermal comfort (Gaete, 2012).

RELEVANCE
The Städel Museum extension is relevant to this dissertation as it has a walkable green roof with well-designed skylights that make the interior pleasant and bright. The extension creates space whilst keeping the existing garden pavilion and is sensitive to the heritage building on site (Figure 9.33). The project is a relevant structural precedent as the CC also makes use of walkable skylights to brighten the interior spaces as well as a regular column grid enabling the flexible use of space.

Figure 9.29
(Bonke, 2012)

Figure 9.30
(Bucher, 2012)

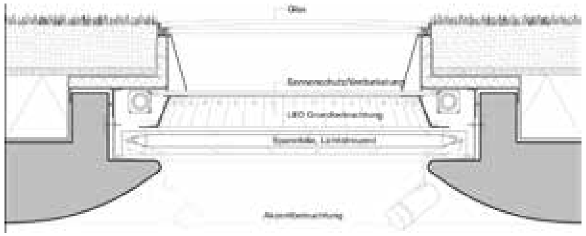
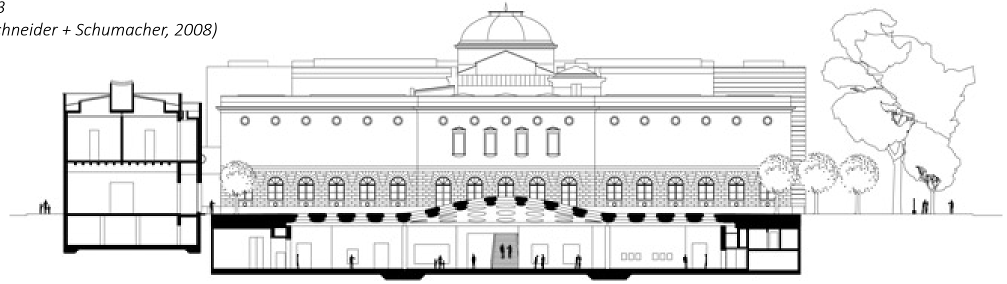


Figure 9.31
Skylight Detail (Schneider + Schumacher, 2008)

Figure 9.32
(Miguletz, 2010)

Figure 9.33
Section (Schneider + Schumacher, 2008)



9.3_MATERIALITY

The material palette is inspired by the Conservatory also intending to articulate the contrast between stereotomic and tectonic materials. The monolithic concrete roof is the fundamental stereotomic element, with a planted roofscape. The plant palette of indigenous South African species contrasts Joubert Park's historically exotic plants and is discussed in section 9.4. The tectonic palette is glass with a light aluminium framing, galvanised steel is used for the construction of the canopy walk and pergola.

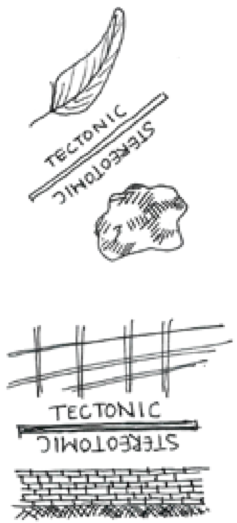


Figure 9.34
Materiality Concept (Author, 2016)

9.3.1_DEMOLISHED MATERIAL RE-USE & RECYCLING

Materials from the proposed building demolitions are recycled as far as possible and either used in the new building or taken by the local scrap material collectors. The timber doors, bricks, and steel fittings from the Greenhouse Project earth buildings are reused in the CC. The polycarbonate sheeting of the polytunnels, corrugated sheeting of the earth building, and roof tiles are collected and taken off site to be reused in other projects. The concrete demolished on site is crushed and recycled as dry aggregate for the new concrete used in the CC.

Figure 9.35
(Author, 2016)

9.3.2_MATERIAL PALETTE

The palette is informed by the contrasting relationship between stereotomic and tectonic materials and aims to use a restricted palette of simple materials.

9.3.2.1_Stereotomic

CONCRETE
(Figures 9.36 & 9.37)
The architectural language explores the sculptural quality of concrete, using it to extend the landscape over the building seamlessly. Off-shutter reinforced concrete is the primary structural material for construction of the CC. The roof is a structural slab which is designed to support the heavy load of the planted roof when it is saturated with water. The large reinforced concrete columns are arranged on a regular grid, evenly supporting the load of the roof. The floor slab is also polished concrete, taking advantage of its thermal mass abilities.

MASONRY
(Figure 9.38)
Reclaimed bricks from the demolished buildings on site are recycled and used in the landscaping, radio tower, and interior walls. The brickwork will not be plastered.

Figure 9.36
(Author, 2016)

Figure 9.37
(NAMELESS Architecture, 2014)

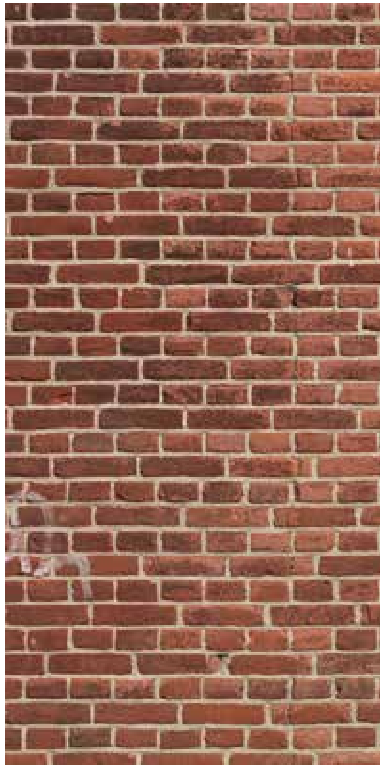


Figure 9.38
(Wallpaper, 2016)

9.3.2_MATERIAL PALETTE [CONTINUED]

9.3.2.2_Tectonic

GLASS PANELS IN ALUMINIUM FRAMES

Most of the façade is aluminium framed with glass panels of varying transparency depending on the function enclosed. Glass dictates the visual access into the building and the interface between the interior and exterior conditions. Tempered glass is used, which is manufactured using controlled heat treatment giving it four times the strength of annealed glass, as the outer surfaces are in compression and the inner surfaces in tension (Scientific American, 2016). Low E and double glazed glass is employed to reduce heat transfer and maintain thermal comfort¬ within the interior. The glass is treated to control the light entering the interior spaces below. Various skylights, some of which are walkable, bring light into the interior spaces.

STEEL

The steel pergola is a tectonic element providing shading on the roof. The structure consists of galvanised hot rolled mild steel C-channels and I-beams with bolted connections, enabling disassembly and thus adaptability. The canopy walk is also a galvanised steel structure.

Figure 9.39
(Lanoo, 2016)

Figure 9.40
(Lanoo, 2016)

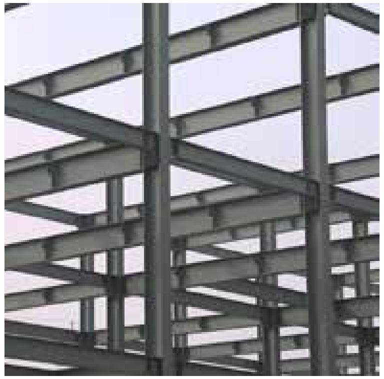


Figure 9.41
(National Prefab Systems, 2016)

Figure 9.42
(DZine Construction, 2016)

9.4 _LANDSCAPE OVER STRUCTURE: THE LIVING ROOF

9.4.1_INTRODUCTION

9.4.1.1_Green Roofs

Green roofs, also known as living roofs or landscapes over structure, are roofs constructed to accommodate planting. The concept of a living roof is to create a pervious surface and comfortable, accessible open space without taking up additional land. Living green roofs have ecological, aesthetic, and economic benefits. Green roofs are used as storm water retention systems, reduce heat gain, and stimulate biodiversity (Weiler & Scholz-Barth, 2009).

9.4.1.2_Extensive & Intensive Green Roofs

Green roofs can be described as either 'extensive' or 'intensive' depending on the depth of the growing medium and maintenance requirements (Weiler & Scholz-Barth, 2009). Extensive green roofs have a shallow growing medium, commonly for sedums, and are usually used for storm water management and insulation rather than as a garden or accessible open space. Intensive green roofs, on the other hand, have greater soil depth and thus larger diversity in size and vegetation type. These roofs are often accessible garden spaces and require a more intensive level of maintenance (Weiler & Scholz-Barth, 2009).

An intensive roof has been selected for the Creative Conservatory, becoming an extension of Joubert Park as landscape over structure. The soil depth of over 300mm will accommodate various plants and allow for human activity. An intensive roof requires more maintenance and detailed construction design to suit the unique building and site conditions.

EXTENSIVE

Figure 9.43
(Miller, 2016)

INTENSIVE

Figure 9.44
(AOSHI16, 2012)

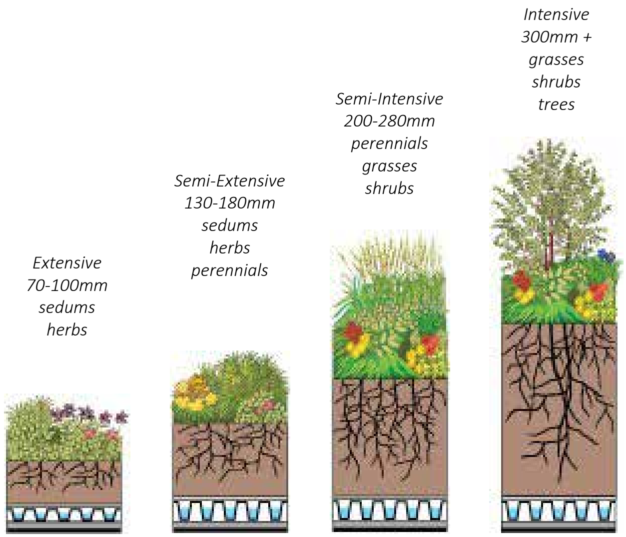


Figure 9.45
(Conservation Technology, 2008)

9.4.2_ PLANTING PALETTE

The landscape design for the living roof and CC Complex Park uses species native to the Gauteng region. This is in contrast with the exotic landscape of Victorian Joubert Park. The indigenous landscape will support biodiversity, attracting birds and insects. A landscape architect would need to be consulted for detailed development of the landscape, but certain plants have been identified by the author as aesthetically suitable.

The following species and information was sourced from the 'Wild Flower Nursery: Suppliers of indigenous plants to Landscape Architects and Developers (2016).'

9.4.2.1_Grasses

All grasses are native to Gauteng, very hardy, require sun, grow in loam soil, are approximately 50cm tall, and are water wise, unless otherwise stated.

Figure 9.46
(Wildflower Nursery, 2016)

Hairy Trident Grass (Tristachya leucothrix) is a perennial, tufted grass which flowers in summer. Its basal leaf sheaths are ornamentally covered by golden hairs.

Spear Grass (Heteropogon contortus) is a variable specie (in characteristics and height) flowering in early summer.

Wether Love Grass (Eragrostis nindensis) is drought resistant with a beautiful inflorescence flowering in summer.

Natal Buffalo Grass (Panicum natalense) has attractive blue-green leaves and flowers in early summer. Its relatively small size makes it an ideal choice for a grassland garden.

Natal Red Top (Melinis repens) is a hardy, perennial grass that flourishes in sun or semi-shade. Its beautiful pink plumes and white fluffy seeds attract seed eating birds. The grass flowers in spring and needs to be pruned down to 5cm above ground level every winter.

False Love Grass (Bewsia biflora) is a tufted grass with pink culms and flowers, and purple sheaths, flowering in the early summer.

Iron Grass (Aristida diffusa) flowers in summer and has a misty pink appearance when its inflorescences are open.

Red Dropseed (Sporobolus festivus) is a grass with a loose, pink inflorescence. The grass flowers in summer and must be cut back in autumn.

Narrow Heart Love Grass (Eragrostis racemosa) is a 300mm tall, densely tufted perennial grass that is a common groundcover of the Highveld landscape. The grass is adorned with attractive golden seeds year round and flowers in spring.

9.4.2.2_Shrubs

All shrubs are native to Gauteng, very hardy, require sun, grow in loam soil, and are water wise, unless otherwise stated.

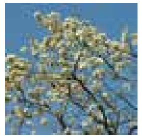
Wild Sweet Pea (Sphenostylis angustifolia) is a 1m tall perennial shrub of the Highveld with beautiful, faintly aromatic flowers which bloom in the early spring irrespective of rainfall.

Shell Flower (Orthosiphon labiatus) is a beautiful 1m flowering shrub needing sun or semi-shade that attracts insects and bird life to the garden. The shrub flowers in autumn and must be pruned and kept neat.

Rough-leaved Raisin (Grewia flavescens) is a semi-deciduous, hardy shrub that grows to 3m and has attractive rough leaves. The shrub flowers from October to March with beautiful star-shaped blossoms, followed by yellow seeds that attract birds, making the shrub an essential part of a wildlife garden.

Bush Violet (Barleria gueinzii) is a 1-2m tall, evergreen, scrambling shrub with olive-green leaves and mauve flowers flowering in Autumn. Bush Violet enjoys sun and can be planted on embankments to control erosion and must be trimmed back in winter.

9.4.2.3_Trees



Common Wild Pear (Dombeya rotundifolia) is a hardy, drought and fire resistant tree that grows quickly to reach 5m tall. Its beautiful, scented white flowers bloom in July and September before leaves appear. The Common Wild Pear is ideal for small garens and attracts birds, insects, and butterflies.

Lavender Tree (Heteropyxis natalensis) is a hardy, slender tree with glossy, waxy leaves that smell of lavender when crushed. In spring, yellow, scented flowers grow in clusters, attracting butterflies and other insects. The Tree's bark matures to a beautifully patched, creamy colour.

9.4.2.4_Climbers

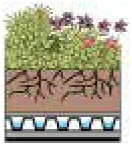
Starry Wild Jasmine (Jasminum multipartitum) is an evergreen, hardy creeper that grows fast up to 5m in sun or semi-shade. It has small, glossy foliage and blooms with beautiful, fragrant, star-shaped, white flowers from August to January. The creeper bears edible berries that attract birds and can also be used for herbal teas.

9.4.3_CONSTRUCTION

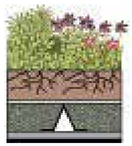
An extensive study of intensive green roof construction and consideration of various applications and methods drove the generation of the following appropriate technical resolution.

9.4.3.1_ Drainage Considerations

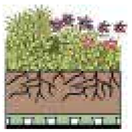
The drainage of green roofs is of huge importance and impacts its capabilities and appearance. Green roofs should be able to store water to sustain its plants through dry periods, but the hardy plants that thrive on living roofs require water to be rapidly drained from their root zones. Therefore, green roof construction needs to find a balance between water storage and drainage, which can be done in several ways. Three drainage methods were considered using information from Conservation Technology (2008). The CC's living roof will make use of drainage plates and drainage mats.



A] Drainage plates
Drainage plates are waffled plastic sheets able to store water above and drain water below. They are lightweight, easily installed, and can be specified to meet the water storage requirements of almost any green roof.



B] Granular Media
Lightweight, inorganic, porous granular media is used with triangular drainage conduits. This method is heavier and requires labour intensive installation.

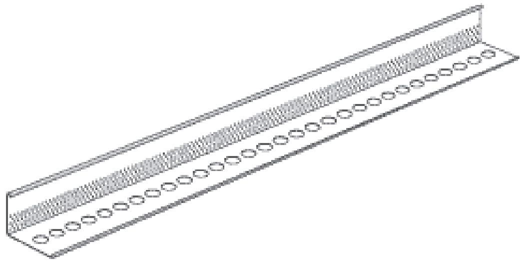


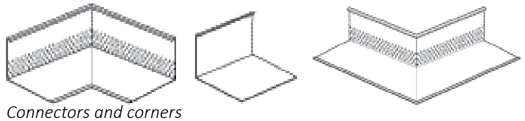
C] Drainage Mats
A drainage mat is a layered fabric fulfilling soil separation, drainage, and protection functions. Mats are fast to install and create the thinnest green roof, but have limited water storage and drainage capacity.

Figure 9.47
(Conservation Technology, 2008)

9.4.3.2_Soil Retention at Edges

Intensive green roofs have at least 300mm of soil that needs to be separated from gravel borders, paving, and retained at roof edges. The Optigreen Aluminium Edge (or similar) has small holes on the vertical leg to facilitate draining whilst retaining soil (Conservation Technology, 2008). The aluminium edges have connectors interlocking the edges with corners, and can be secured to waterproofing with cold-applied tape.





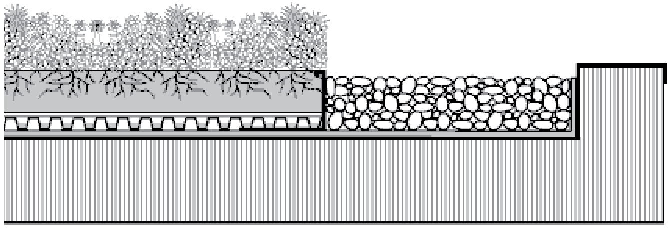
Connectors and corners

Connectors interlock edges and corners

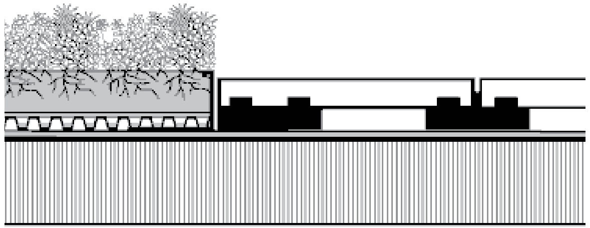
Taping an aluminium edge to an EPDM rubber membrane

Figure 9.48
(Conservation Technology, 2008)

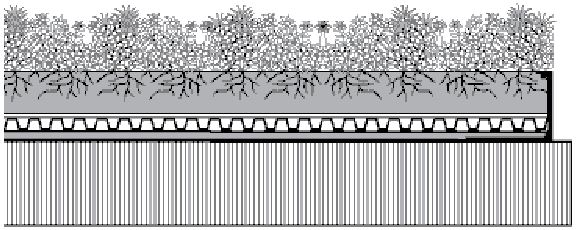
The Optigreen Aluminium Edge (or similar) provides the following functions:



- Separates soil and the gravel edge band



T- Separates soil from pavers and decks



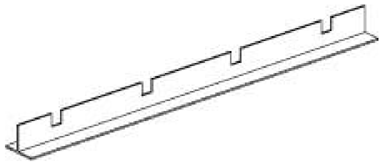
- Retains soil at the edge of a roof

Figure 9.49
(Conservation Technology, 2008)

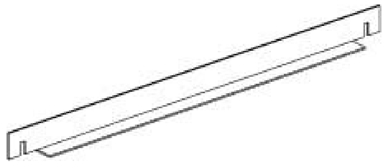
9.4.3.3_Soil Stabilisation on Slopes

Special precautions must be taken on the two sloping roofs of the CC to prevent soil from sliding down. The proposed method is Optigreen's Anti-slip Tees (or similar) which transfer the soil load down the roof to a structural parapet, or in the case of the CC, the ground. The system has two interlocking T-shaped plastic extrusions: the bottom extrusions follow the slope of the roof at 1m intervals and the top extrusion crosses the slope of the roof at 0.7m.

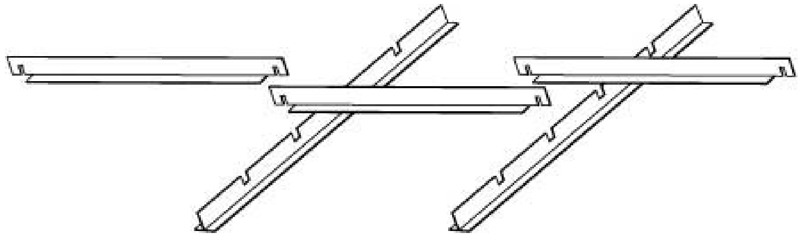
Figure 9.50
(Conservation Technology, 2008)



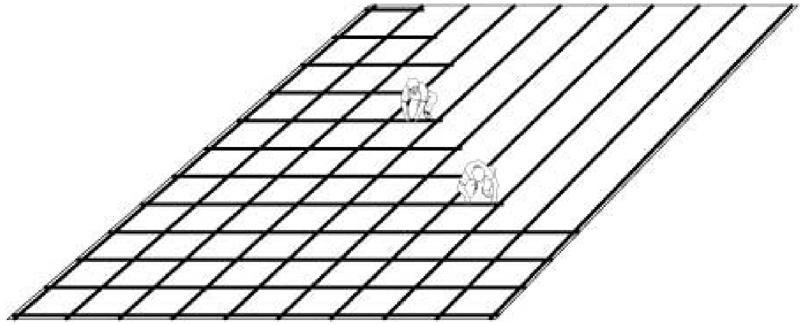
Lower tee follows slope



Upper tee crosses slope



Upper tees fit into slots in lower tees



Typical sloped roof

9.4.4_FINAL CONSTRUCTION METHOD

The final construction method of the green roof suggests primarily Optigreen products, a world leader in the green roof industry whose products are made from completely recycled materials.

9.4.4.1_Technical Specifications

The following information is supplied from Optigreen (2016)

Weight – 680 kg/m² (Saturated Condition, dry weight is 60-70% of saturated weight)
Layer Height – 260-470 mm
Roof Pitch – 0–5°
Water Retention – 70-95 %
Discharge Coefficient – C=0.2
Water Storage – ca. 110-160 l/m²

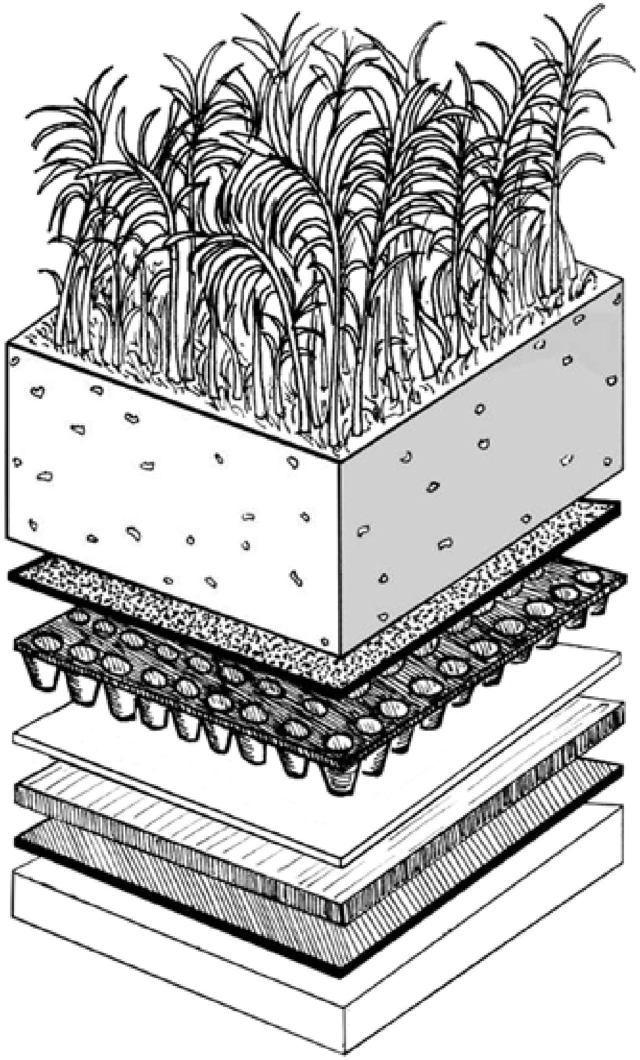


Figure 9.51
(Author, 2016, Adapted from Hilary, 2015)

9.4.4.2_Components

The following information is supplied from Optigreen (2016)

A] INDIGENOUS VEGETATION

The green roof environment is often hot and dry, so the selected native vegetation needs to be hardy and water wise (Section 9.4.2 illustrated the vegetation palette).

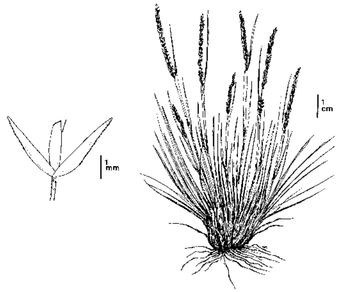


Figure 9.52
(State of California, 2016)

B] OPTIGREEN INTENSIVE SUBSTRATE, 300 mm (or similar)

Green roof soil is not ordinary soil: it must be lightweight and have a low organic content, varied particle sizes, and good water storage capacity. The Optigreen Intensive Substrate fulfils these needs and has good air porosity and water permeability.

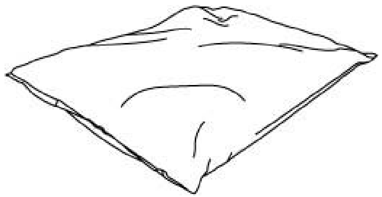


Figure 9.53
(Conservation Technology, 2008)

C] OPTIGREEN FILTER FLEECE TYPE 105 (or similar)

The filter fleece has a high water permeability but prevents soil particles from entering the drainage layer.

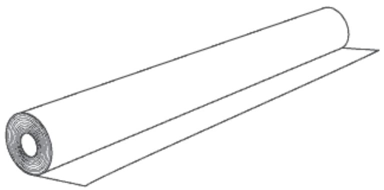


Figure 9.54
(Conservation Technology, 2008)

D] OPTIGREEN DRAINAGE BOARD TYPE FKD 60 BO (or similar)

The drainage plate's upper side stores 10.5l/m2 of water and the underside is a high volume drainage passage for surplus water. Water fills to the midpoint of the sheer, creating an air gap below the separation fabric.

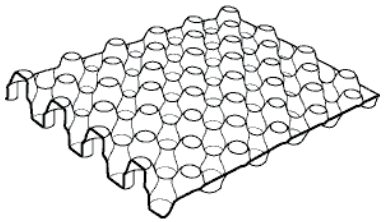


Figure 9.55
(Conservation Technology, 2008)

DRAIN BOX

A 200mm drain box is used to prevent soil from entering the drains while allowing for the free flow of water.

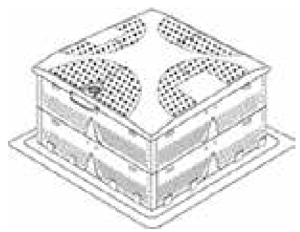


Figure 9.56
(Conservation Technology, 2008)

E] OPTIGREEN PROTECTION AND STORAGE FLEECE TYPE RMS 500

The fleece stores water and protects the roof membrane from damage.

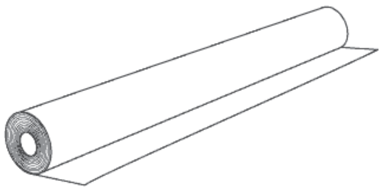


Figure 9.57
(Conservation Technology, 2008)

F] INSULATION

SANS 10400 requires insulation in Johannesburg to have an R-value of 3.7. The green roof components combined with the 600mm reinforced concrete roof slab meet this requirement, however, in certain areas of the roof where the slab is thinner, extruded polystyrene insulation will be added.

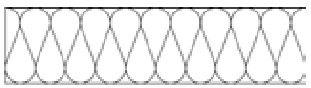


Figure 9.58
(Author, 2016)

G] WATERPROOFING

Waterproofing must withstand building movement, ponded water, and root penetration.
Specification from Derbigum (2016): One layer Derbigum CG4H (horticultural) on one layer Derbigum CG3 waterproofing membrane, laid staggered with side laps of 100mm and end laps of 150mm, sealed to bitumen primed surfaces by "torch-fusion" followed by 250 micron polyethene sheeting loose laid with 100mm laps sealed with pressure sensitive tape

H] SUBSTRUCTURE

Screed to fall on a structural concrete slab

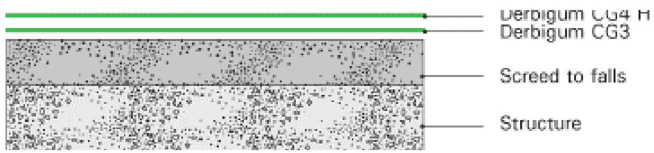


Figure 9.59
(Derbigum, 2016)

9.5_ SUSTAINABLE DESIGN STRATEGY

Johannesburg's climate is favourable for outdoor exposure, so the building enables spaces to open up to the Park and engage with the street on a beautiful day. The Creative Conservatory makes use of passive design strategies and hybrid systems, such as geothermal heat pumps, to reach a comfortable environment in a sustainable manner. The design is optimised for passive systems first, which downsizes the need for active systems. Ambient energy sources are used such as daylighting, natural ventilation, and solar energy.

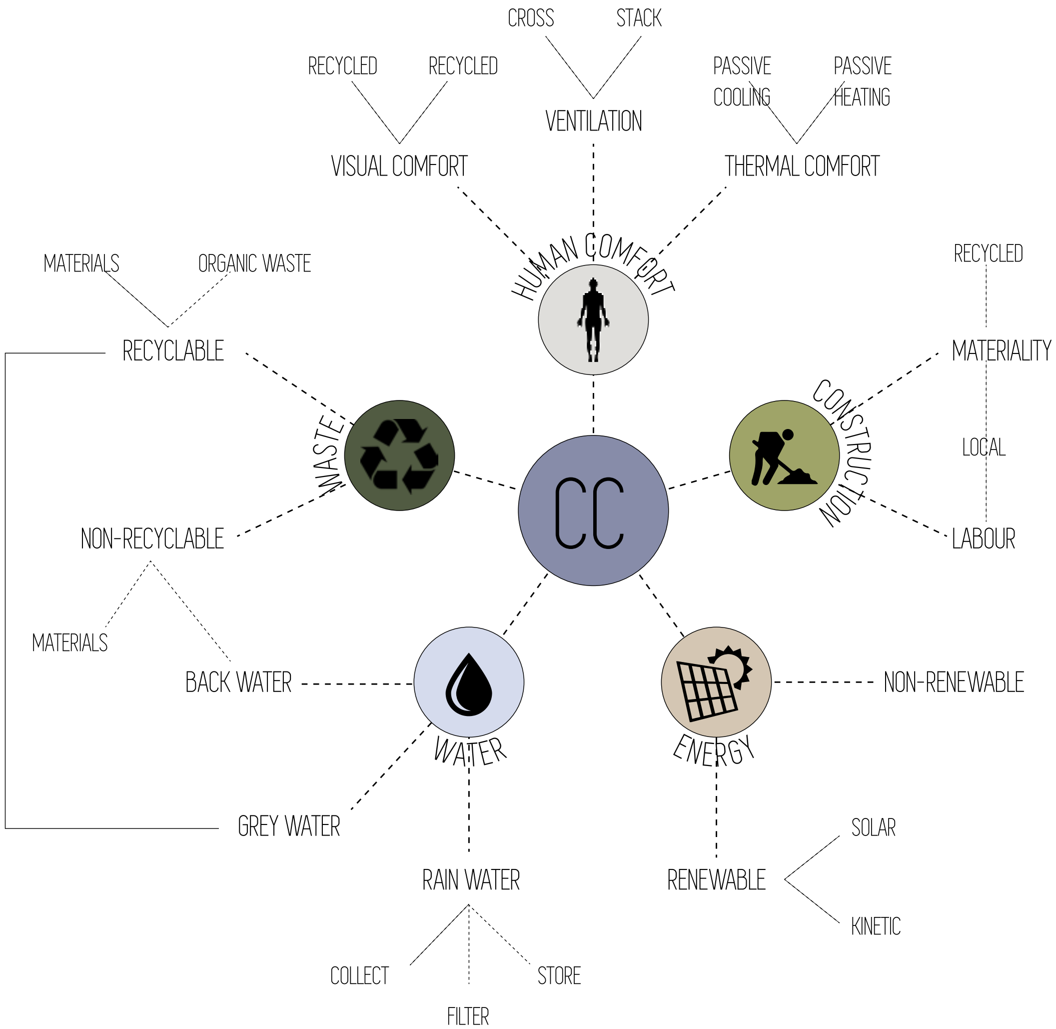


Figure 9.60
(Author, 2016)

9.5.1_ DESIGNING FOR NATURAL VENTILATION

9.5.1.1_ Johannesburg's Wind Conditions

The wind roses (Figure 9.61) illustrate Johannesburg's wind direction, strength, and frequency. As read, the annual wind rose average is split between NE winds and SW winds. On a monthly basis, from December to April, there is a primarily NE wind, from May to September, a SW wind, and October a NW and November SW. These winds are used to optimise natural ventilation within the CC building. Wind also assists with passive cooling in the warmer months where the breeze passes over water for evaporative cooling and is captured and brought through the building.

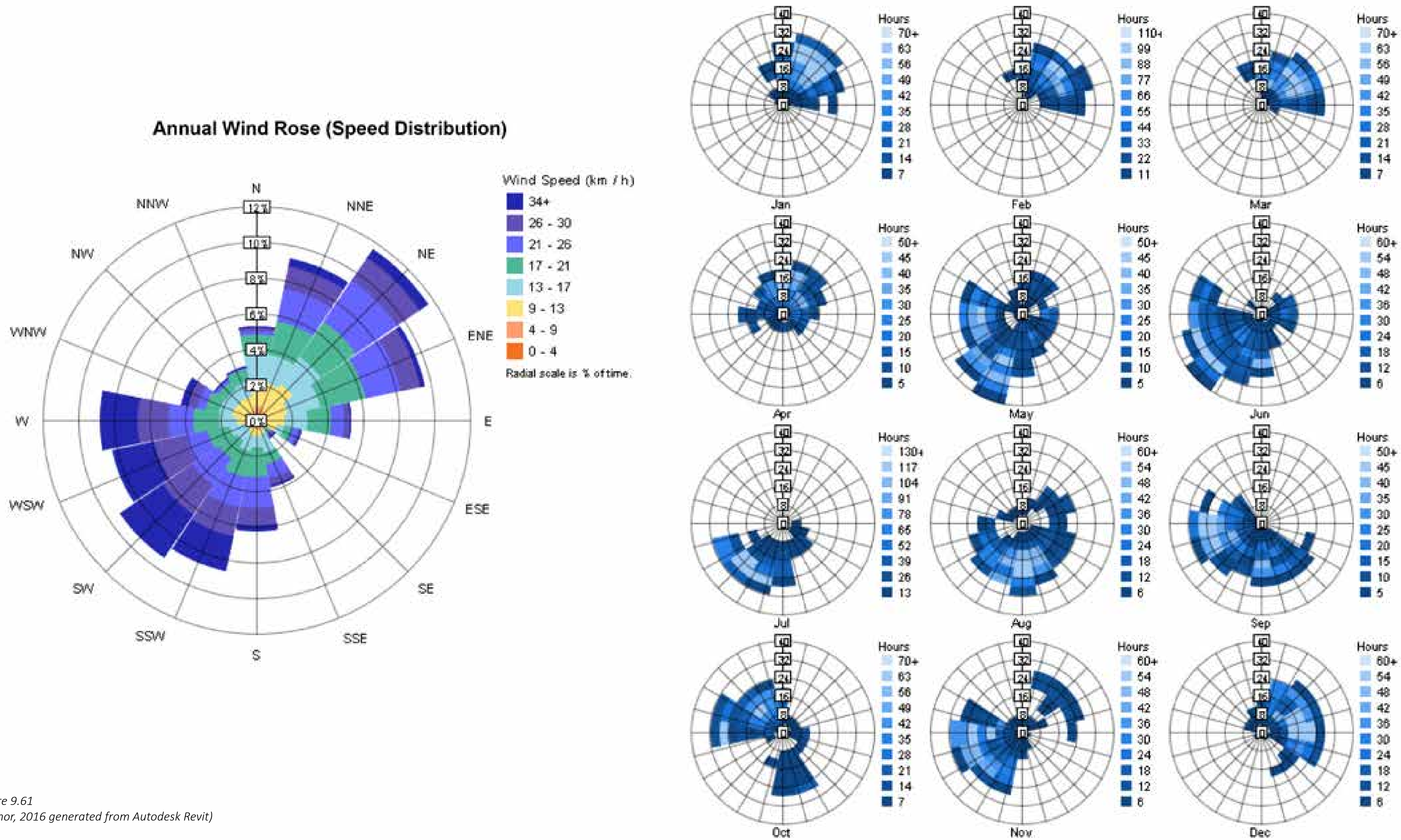


Figure 9.61
(Author, 2016 generated from Autodesk Revit)

9.5.1.2_Cross Ventilation

The 9m wide open plan spaces of the CC are optimal for cross ventilation.

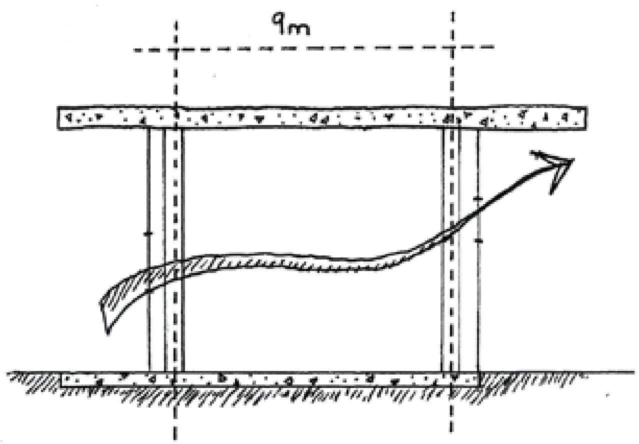


Figure 9.62
(Author, 2016)

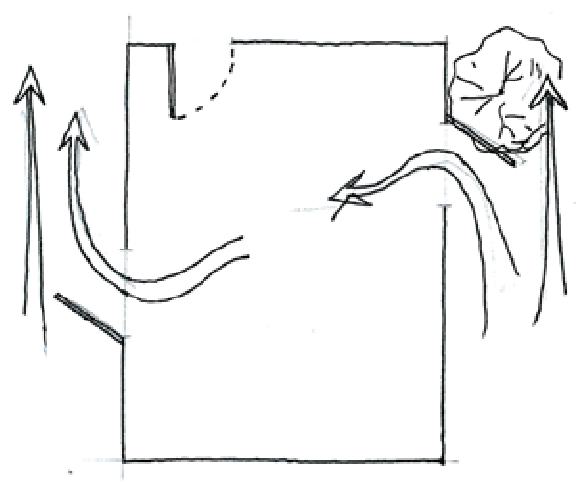


Figure 9.63
(Author, 2016)

Fresh air entering the interior is distributed and mixed by placing openings in the façades across from, but not directly opposite, each other.

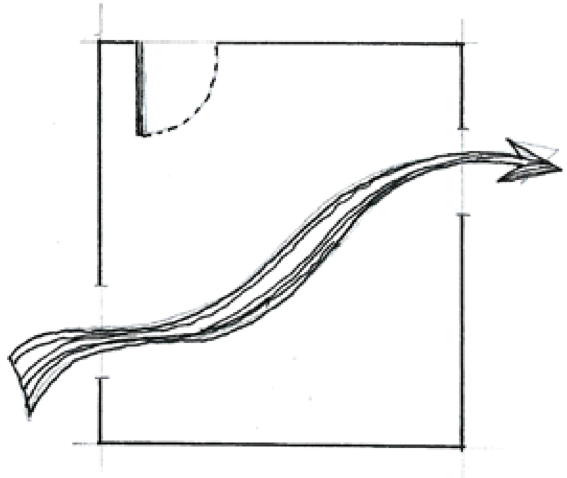


Figure 9.64
(Author, 2016)

Façades of the CC that are not well orientated for cross ventilation make us of architectural features to steer the wind into the building, such as wing walls and vegetation.

9.5.1.3_Stack Ventilation

Stack ventilation uses temperature differentials to mobilise air as hot air rises due to its lower pressure.

Stack ventilation is employed in the double volume of the CC Administration and Media Centre Block (Figure 9.66). Inlets are placed low in the room and outlets higher up to leverage natural air convention and cool the interior space.

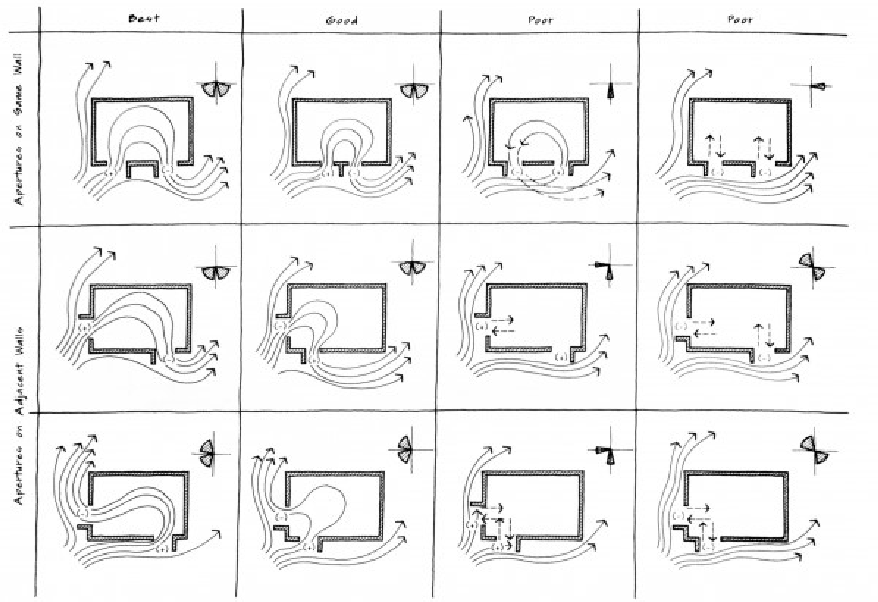


Figure 9.65
(DeKay, M. & Brown, G. Z., 2014)

Wing walls project beyond the aperture, creating high and low pressure zones with even a slight breeze, therefore air is drawn in the one window and out the adjacent opening. The diagram illustrates the effectiveness of different wing walls

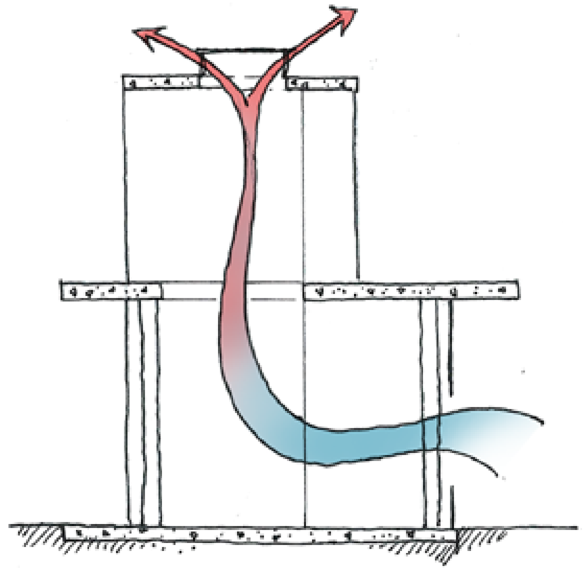


Figure 9.66
(Author, 2016)

Hot air rises and the resultant low pressure draws fresh air from the outside (Author, 2016)

9.5.2_ DESIGNING FOR THERMAL COMFORT

9.5.2.1_Thermal Comfort

Interior spaces of the CC will to be kept comfortable for human inhabitation using passive heating and cooling techniques as well as the geothermal heat pump hybrid system.

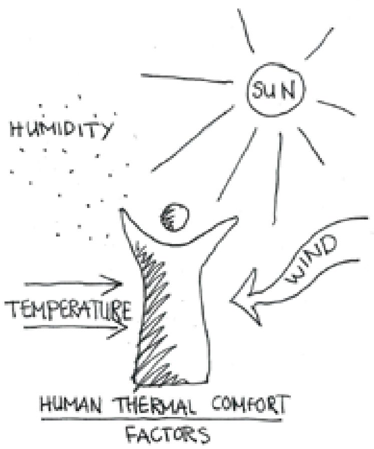


Figure 9.67
(Author, 2016)

9.5.2.2_Passive Heating & Cooling

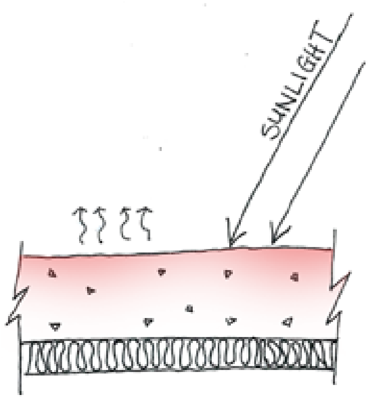


Figure 9.68
Thermal Mass of the Concrete Floor (Author, 2016)

Direct solar gain is achieved using the thermal mass of the concrete slab floors, extending the climate band in winter. Floor insulation prevents solar heat gain from radiating into the ground.

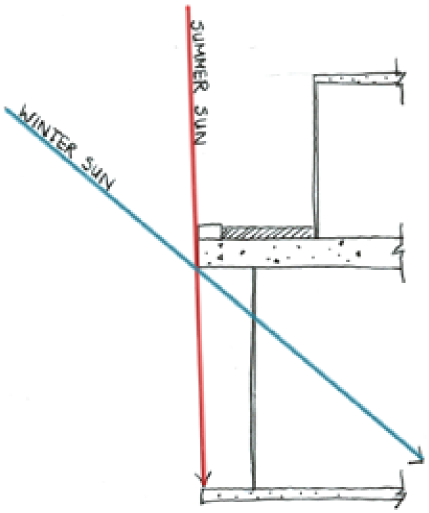


Figure 9.69
Overhangs & Shading (Author, 2016)

The roof overhangs are designed to allow winter sun to penetrate the interior, while direct summer sun is restricted by the overhang.

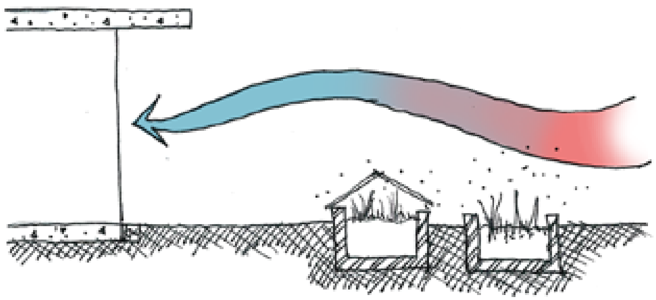


Figure 9.70
Evaporative Cooling (Author, 2016)

Evaporative cooling works well in Johannesburg's hot and dry climate. The placement of the wetland and fountains on the Southern and eastern elevations work with the natural prevalent wind directions (refer to Figure 9.61) to supply cool air into the active areas of the Black Box and the City Workshop.

9.5.2.2_Geothermal Pipes

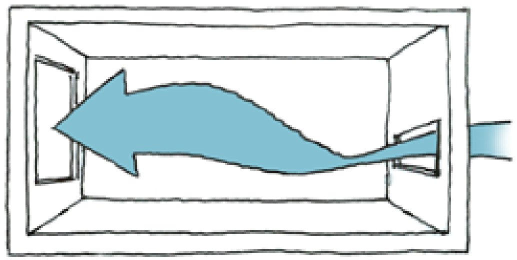


Figure 9.71
Aperture size for Cooling (Author, 2016)

Pairing a large outlet with a small inlet increases incoming wind speed.

A geothermal earth tube system regulates the building's internal environment. Johannesburg experiences seasonal temperature fluctuations, with averages of 16°C in winter and 25.6°C in summer, however, underground temperatures of 8-11°C are relatively consistent throughout the year. Earth tube systems exploit heat transfer to cool or heat the outdoor air drawn through the pipes, depending on the season, and pump thermally comfortable air into the building's interior.

Increasing the length of the earth tube increases the opportunity for heat transfer, but if the earth tube is too long, air cannot move through the system effectively. Therefore, earth tubes should not exceed 73m in length (Grondzik & Kwok, 2007). To reach an air change rate of 10 per hour for the Creative Conservatory's area of 1000m², an airflow rate of 10000m² per hour is needed. Therefore, 150m diameter earth tubes will run below the building in 70m lengths. The tubes need to be laid at least 600mm below the ground to regulate the internal condition at 25°C. Air intake occurs in a cool part of the site, next to the shaded trees by the vertical flow constructed wetland.

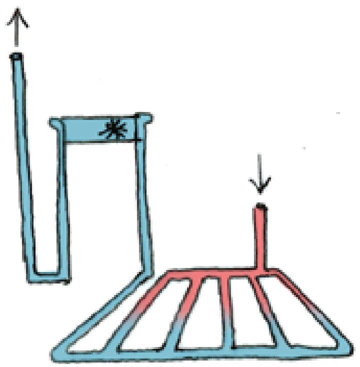


Figure 9.72
Diagram illustrating the workings of the geothermal system (Author, 2016)

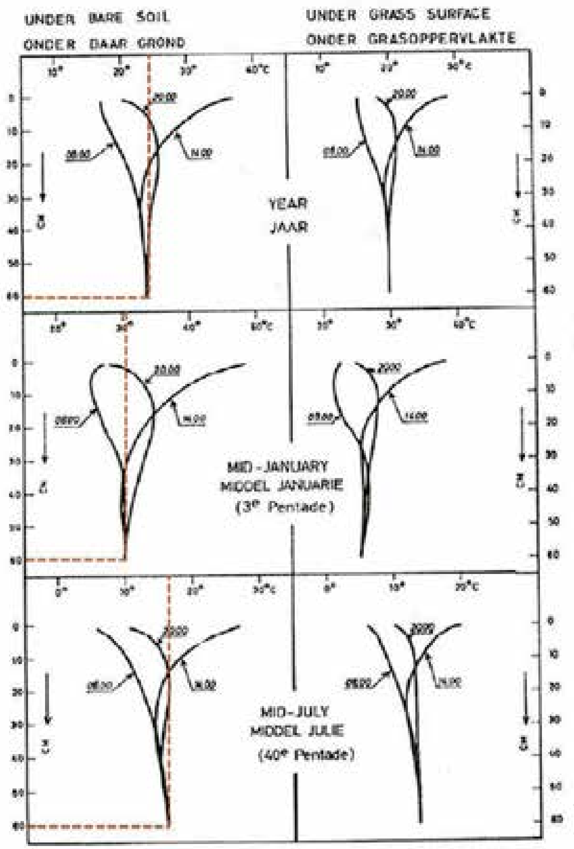


Figure 9.73
These graphs illustrate the change in earth temperature at different depths underground, indicating that 600mm is the minimum requirement (Holm, 1996)

9.5.3_DESIGNING FOR DAYLIGHTING

The L-shaped plan of the CC results in half the building having north and south facing façades, which is preferable, and the other half having west and east facing façades. The western façade is shaded by trees, but the eastern façade may result in unwanted glare. The building skin is primarily glazed, so different types of glass are used to adjust the quantity and quality of daylight entering the different spaces, depending on their individual requirements. Skylights provide light from above, as well as a visual connection between people walking on the living roof and the occupants below.

9.5.3.1_Skylights & Top Lighting

Higher apertures will need to be introduced to bring light into the west/east facing blocks of the CC. Top lights are much brighter than side lights per unit area, for example, the amount of light brought in from a roof light compared to a side window is: vertical monitor x2, angled monitor x3, and horizontal skylight x5 (Autodesk, 2016).

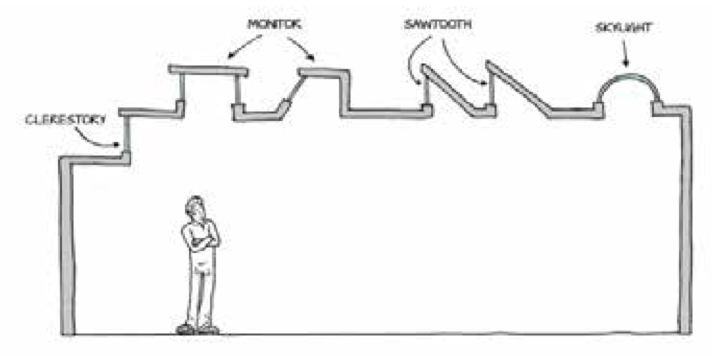


Figure 9.74
There are various types of top lighting that can be used in the CC (Autodesk, 2016)

9.5.3.2_Light Shelves

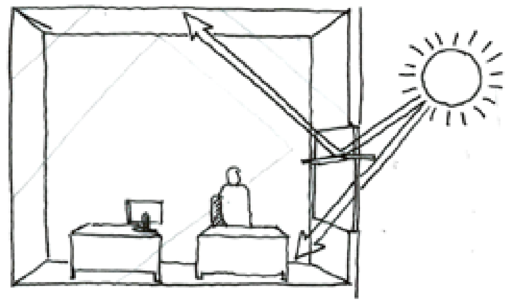


Figure 9.75
Light Shelves (Author, 2016)

Reflecting sunlight off surfaces, such as light shelves, helps evenly distribute interior lighting and reduce glare caused by direct sunlight. This strategy is employed on the eastern façade. Light shelves divide windows providing viewing area at the bottom and daylighting at the top. Light skelves on the east and west effectively reduce heat gain and glare.

Baffles are vertical light shelves used to direct and distribute daylight from above to reduce glare, and will be used with certain skylights in the CC.

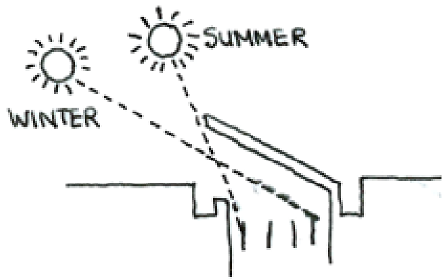


Figure 9.76
Baffles (Author, 2016)

9.5.4_ DESIGNING FOR VISUAL COMFORT

This section will consider the City Workshop space of the Creative Conservatory and iterate the design to improve visual comfort levels. Visual comfort is the light required for an occupant to successfully and comfortably complete certain activities in a space, and daylighting is preferable for sustainability, as well as visual reasons.

9.5.4.1_ Basic Principles of Light & Perception

Light is described and measured in multiple ways: the amount of light emitted by a source is luminous flux (lumens), the measure of light falling on a surface is illuminance (lux), and the quantity of light reflected off a surface perceived by the inhabitant is luminance (m^2) (Autodesk, 2016). These quantities change depending on the distance between the source, the surface, and the inhabitant.

Illuminance (lux or lumen/ m^2) is the common measurement for the optimisation of visual comfort and defines the light levels required for different activities and environments. Luminance values are more concerned with the quality of light in a space rather than quantity, making it a good method for interpreting distribution and glare, but a poor reflection of the capacity of a space to have enough light for its intended use (Autodesk, 2016).

SUNLIGHT VS. DAYLIGHT

The sun is a predictable light source perceived as sunlight or daylight. Sunlight is direct light from the sun entering a space and can produce glare and excessive heat gain. Daylight is diffused natural light from the sky and is desirable for interior space due to its even distribution. As the sun is predictable, daylight is a reliable light source.

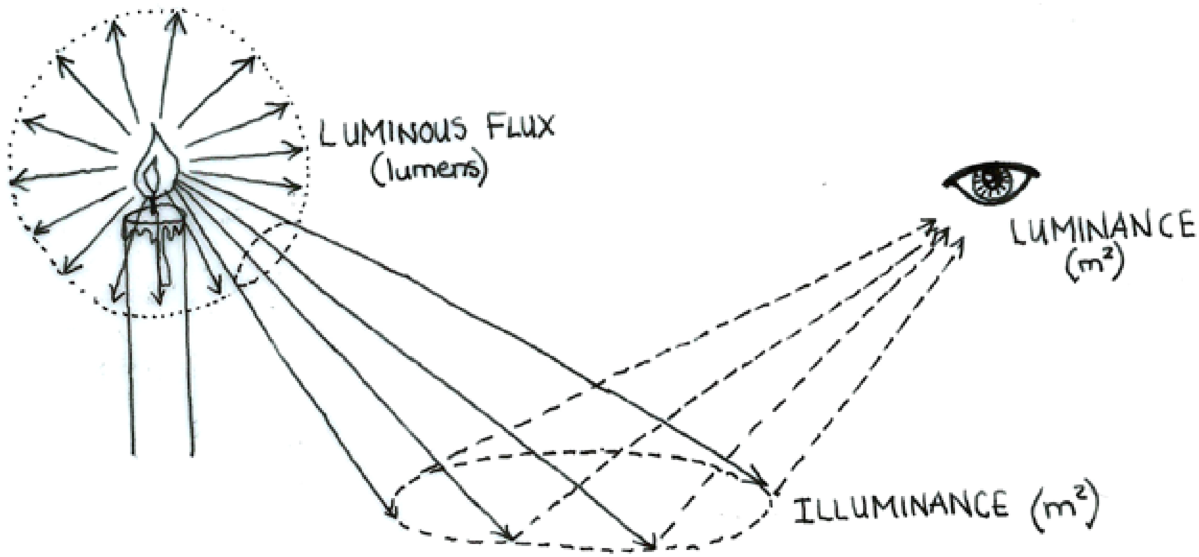


Figure 9.77
Light & Perception (Author, 2016)

9.5.4.2_ Illuminance Values

The Workshop falls under the category of 'interior with some/moderate demand for visual acuity', meaning the Standard Maintained Illuminance ought to be between 300-500 lux (Autodesk, 2016). The illuminance value of the sky's brightness during full daylight is 10,752 lux and 1,075 lux on an overcast day (Autodesk, 2016).

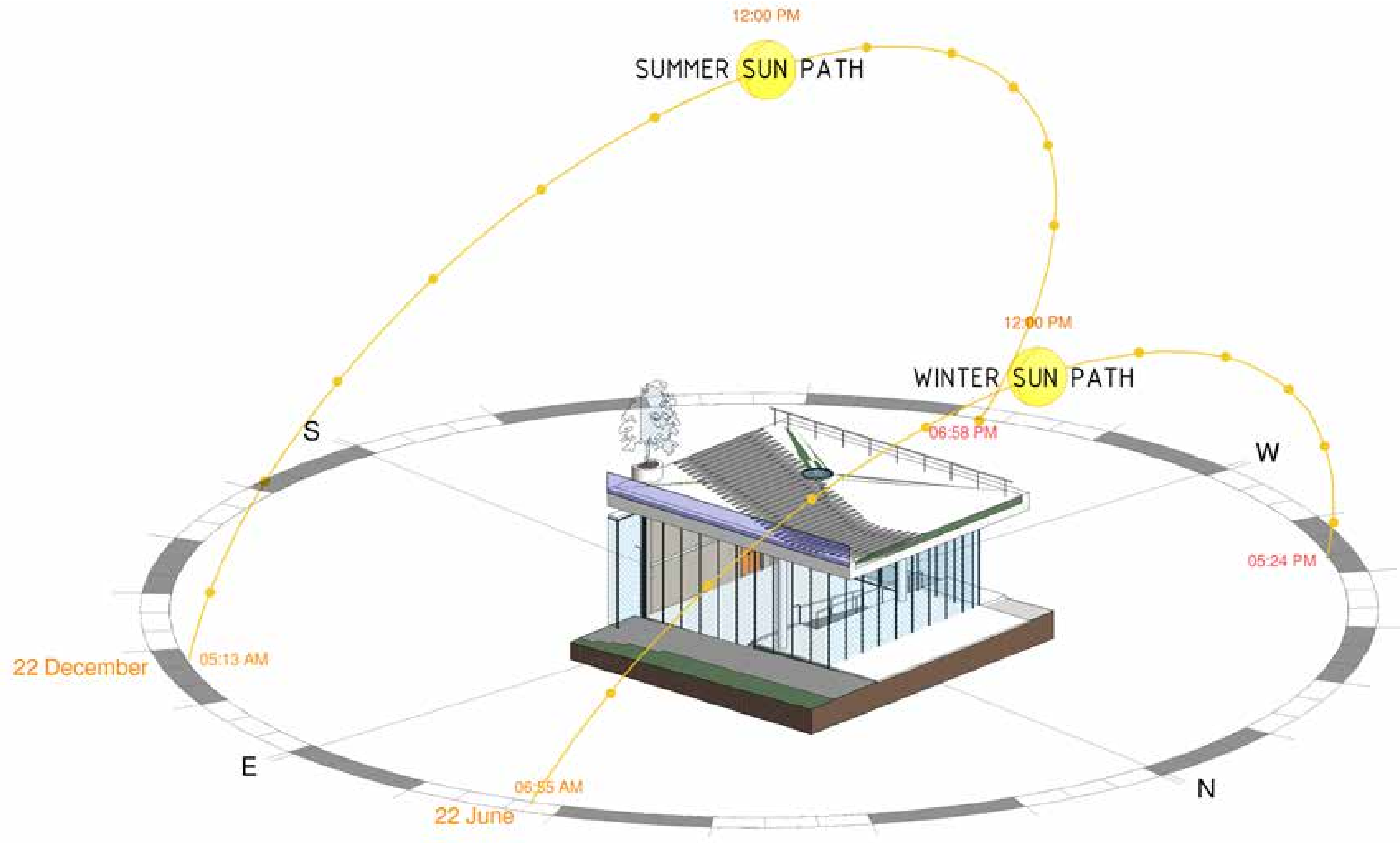


Figure 9.78
Diagram illustrating the summer & winter solstice paths (Author, 2016)

9.5.4.3_Iterating the Workshop for Visual Comfort

BASE CONDITION

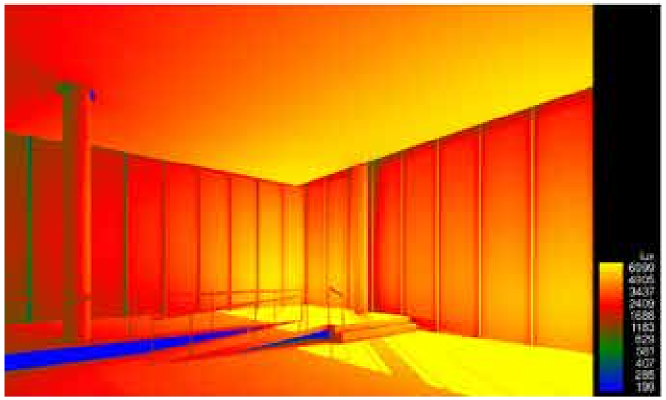


Figure 9.79
Base Study (Author, 2016)

The initial illuminance render of the Workshop highlights the problematic glare entering the interior from the eastern façade. The light quality in the interior is uneven, with the western side heavy shaded by adjacent buildings and trees while the east has little contextual shadowing.

VERTICAL SHADING LOUVERS

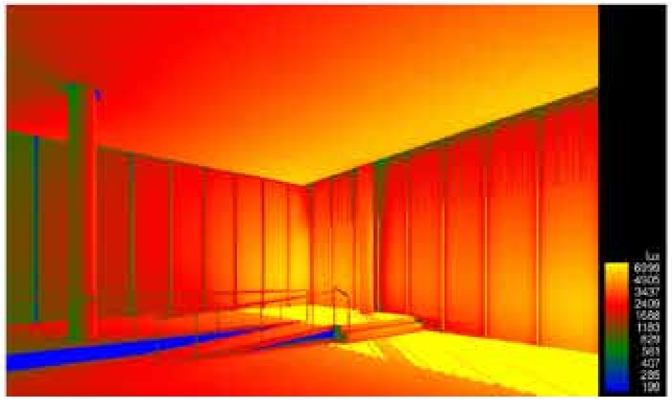


Figure 9.80
East Louvers (Author, 2016)

Vertical louvers were added on the eastern façade to mitigate the extreme glare. This was relatively successful, but glare was still problematic.

ADJUSTED SHADING & SKYLIGHT

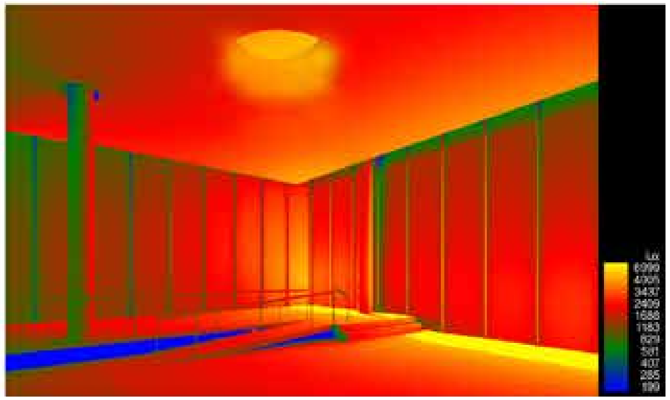


Figure 9.81
Skylight Addition (Author, 2016)

The vertical louvers were increased in length, successfully reducing glare. In order to generate a more uniform lighting condition, which is preferable for visual comfort, a skylight was introduced. During the day, the Workshop's lux requirements are met by daylighting, reducing the need for electronic light sources.

9.5.5_ENERGY STRATEGY

(Please refer to Appendix B for energy calculations)

The CC is connected to the city grid but also generates its own power using solar and kinetic energy. The building requires approximately 75,803 kWh per year. Solar panels generate an estimated 33,966 kWh, reducing the building's reliance on city power. The CC uses energy saver appliances and lighting to meet the demands of users.

9.5.5.1_Evacuated Tubes

Evacuated tubes are implemented to heat the water used by the Creative Culinary School and its restaurant facilities as well as the staff showers.

9.5.5.2_Solar Energy

34 solar panels, with a 300 W power gain per tile, are mounted on the roof and generate 33,966 kWh per year. The panels are installed facing north at a 26 degree tilt so as to optimise efficiency. The landscape lighting fixtures also have their own pvc panels which absorb solar energy in the day and light up in the evening.

9.5.5.3_Kinetic Energy

Kinetic playground equipment is installed in the existing playground. Each element is able to generate 31,55W/hr play, so assuming each of the 10 elements is in play for 2 hours per week day and 5 hours per weekend day, the playground generates approximately 6.31kW per week and 340.74 kW per year.

Figure 9.82
(Author, 2016)

9.5.6_WASTE STRATEGY

9.5.6.1_Recyclable Waste

Paper, plastic, and glass waste is recycled by the City's collectors and local artists who are able to use the resources to earn a living.

9.5.6.2_Non-recyclable Waste

Non-recyclable waste is traditionally disposed of in garbage bins collected weekly. Pickup locations on King George St and Wolmarans St serve this purpose.

9.5.6.3_Greywater

Greywater from the restaurants, kitchenettes, and sinks is filtered through a vertical flow constructed wetland and used in the irrigation of the Park or UV filtered for use within the building (refer to section 9.6.3 for more information).

9.5.6.4_Organic Waste

A biodigester is used to recycle the kitchen offcuts from the culinary school and restaurant into biogas used for cooking. Toilet flushing also enters the biodigester where it is safely recycled.

9.5.7_SBAT Rating

The SBAT rating system considers social, economic, and environmental factors to access the sustainability of a building.

Figure 9.83
(Author, 2016, generated from SBAT)

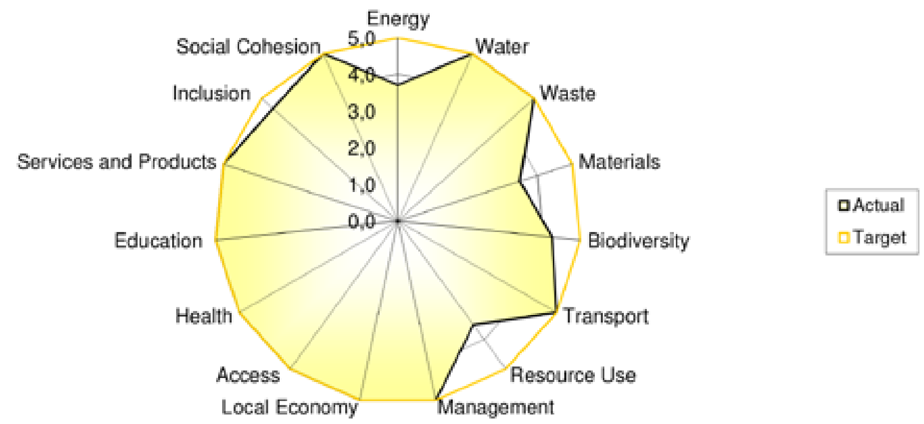
SUSTAINABLE BUILDING ASSESSMENT TOOL
1,04

		Achieved
SB	**SBAT REPORT**	**4,6**

SB1 Project
The Creative Conservatory

SB2 Address
Conservatory Complex, Joubert Park, Johannesburg

SB3 SBAT Graph



SB4 Environmental, Social and Economic Performance	Score
Environmental	4,3
Economic	4,7
Social	4,9
SBAT Rating	4,6

SB5 EF and HDI Factors	Score
EF Factor	4,3
HDI Factor	4,9

SB6 Targets	Percentage
Environmental	86
Economic	94
Social	98

9.6_WATER SYSTEM EXPLORATION & INTEGRATION

9.6.1_WATER STRATEGY

Johannesburg has a historically difficult relationship with water, being the only major city established without direct access to a substantial waterway. Joubert Park is literally an oasis, and a sustainable water strategy is paramount to upkeep Joubert Park and the proposed living roof of the CC.

The water strategy illustrates the importance of water by reusing and recycling grey water and rainwater in an accessible and educational manner. The building runs completely off rain and grey water, with Rand Water backup systems in place for the unlikely event that there isn't sufficient collected water.

Visual and haptic connections to water and the landscape it supports is explored in the CC Complex, using fountains, ponds, and wetlands. This connects to the Victorian heritage of fountains and the natural landscape of the Park.

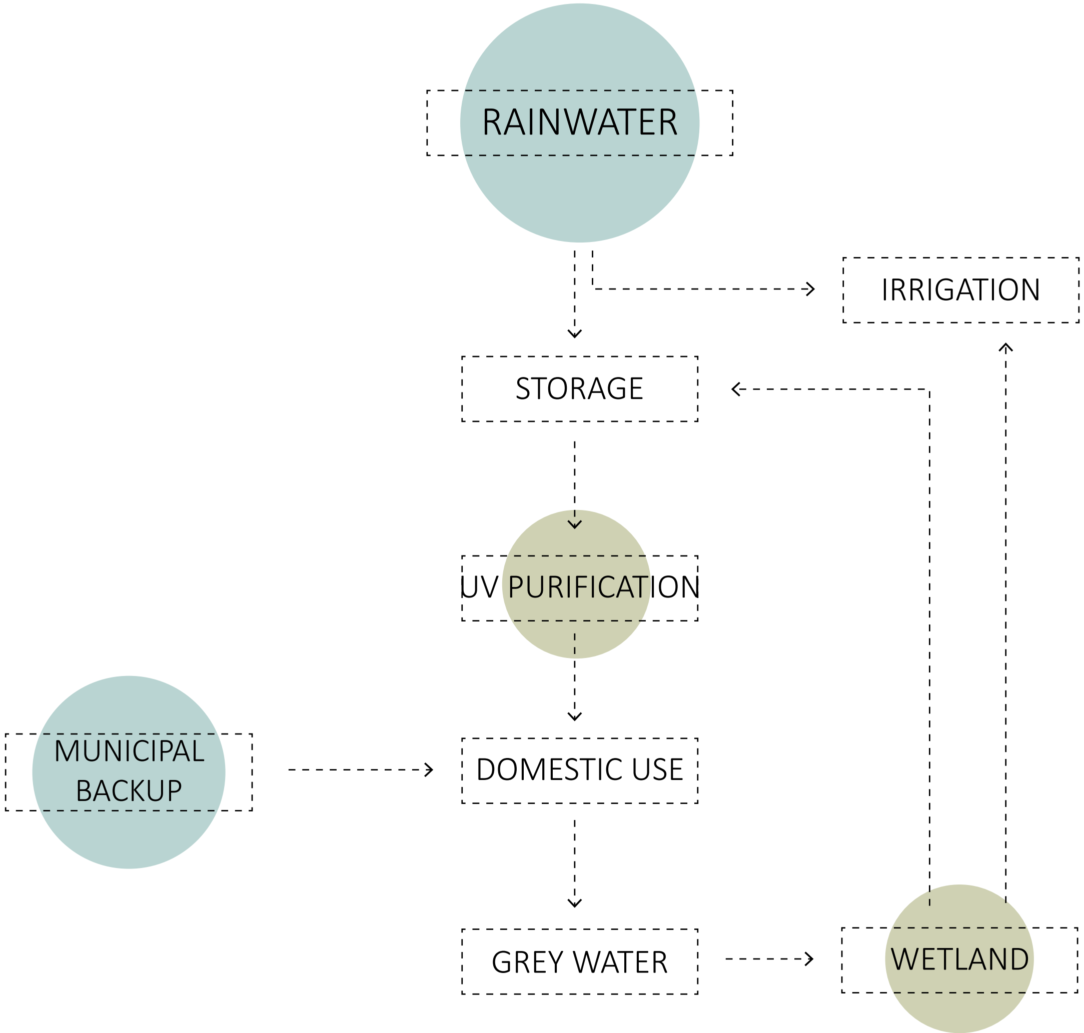


Figure 9.84
(Author, 2016)

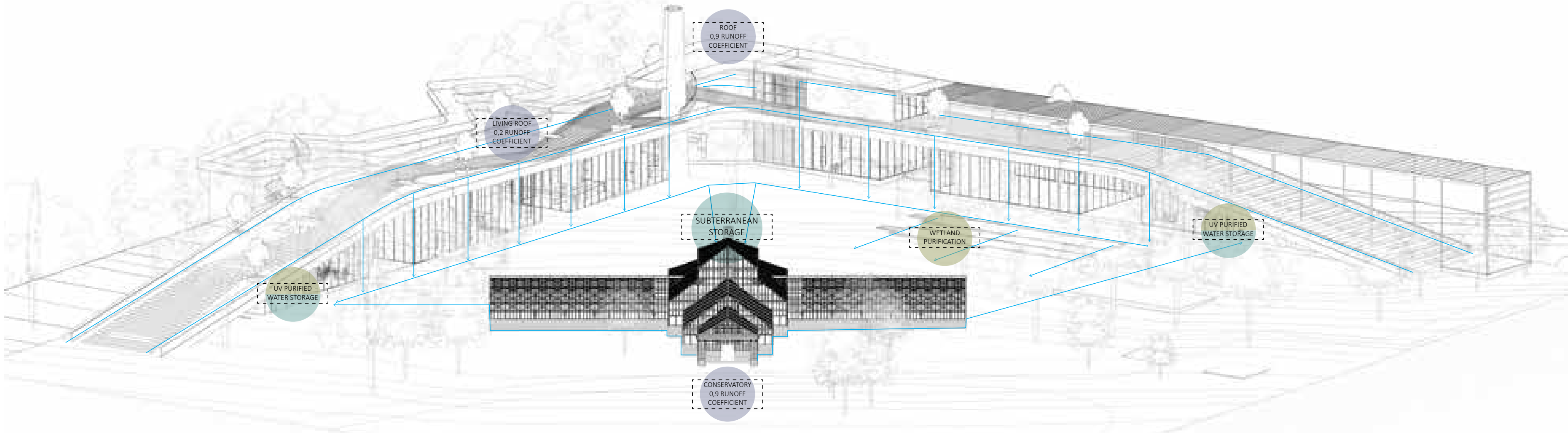


Figure 9.85
(Author, 2016)

Figure 9.86
(Author, 2016)

9.6.2_WATER COLLECTION & DEMAND

Please refer to Appendix A for detailed water calculations.

9.6.2.1_Collection

RAINWATER
Rainwater will be collected from the roofs of the Creative Conservatory as well as the heritage Conservatory. It is estimated to yield 646 m^3

GREYWATER
Greywater from showers, cooking, and sinks will be filtered via a vertical flow constructed wetland and stored in the primary subterranean tank (Refer to section 9.6.3 for more information). An estimated 8.82 m^3 of greywater is harvested per month.

9.6.2.2_Demand

DOMESTIC
The calculated monthly domestic demand for the Creative Conservatory Complex is 16,94m^3, while the yield is 148.87 m^3 in January. A safety factor of 2 is considered in the tank sizing to plan for droughts, necessitating a tank of at least 33.88 m^3. The water is stored in a central primary tank of 40m^3 and transferred to two smaller secondary tanks near the ablution services where it is treated further for domestic use (Refer to section 9.6.4 for more information). The Wolmarans Street tank is 12 m^3 and the King George Street Tank is 21 m^3, according to their monthly requirements.

IRRIGATION
The green roof is planted with indigenous species which will not require supplementary irrigation due to the water storage capacity of the drainage plate within the green roof's construction.

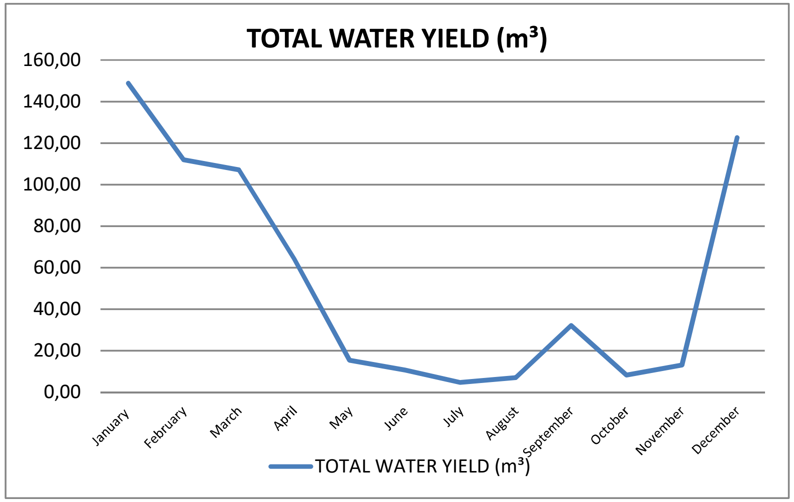


Figure 9.87
(Author, 2016)

9.6.3_GREY WATER FILTRATION_ VERTICAL FLOW CONSTRUCTED WETLAND

Constructed wetlands are planted filter beds used to treat greywater. There are three types of constructed wetlands: Free Surface Constructed Wetlands, Horizontal Flow Constructed Wetlands, and Vertical Flow Constructed Wetlands. Grey water produced by the CC will be recycled naturally by a Vertical Flow Constructed Wetland (VFCW). Grey water is treated to separate unwanted solids and oils and thereafter stored in a holding tank which seeps into the two tier VFCW located in two of the old propagation tunnels already present on site. The VFCW filters the water which is used for irrigation, the flushing of toilets, or passes through a UV ¬filter, enabling domestic usage. The wetland will not only filter grey water, but also complement the landscape's aesthetic and promote biodiversity.

9.6.3.1_VFCW Working Principle

Filtered greywater is intermittently applied (4-10 times a day) to a planted filter bed from above where it percolates vertically through the unsaturated filter substrate, allowing physical, biological, and chemical processes to purify the water (Morel & Diener, 2006). Treated water is collected at the bottom of the basin by a drainage pipe and stored.

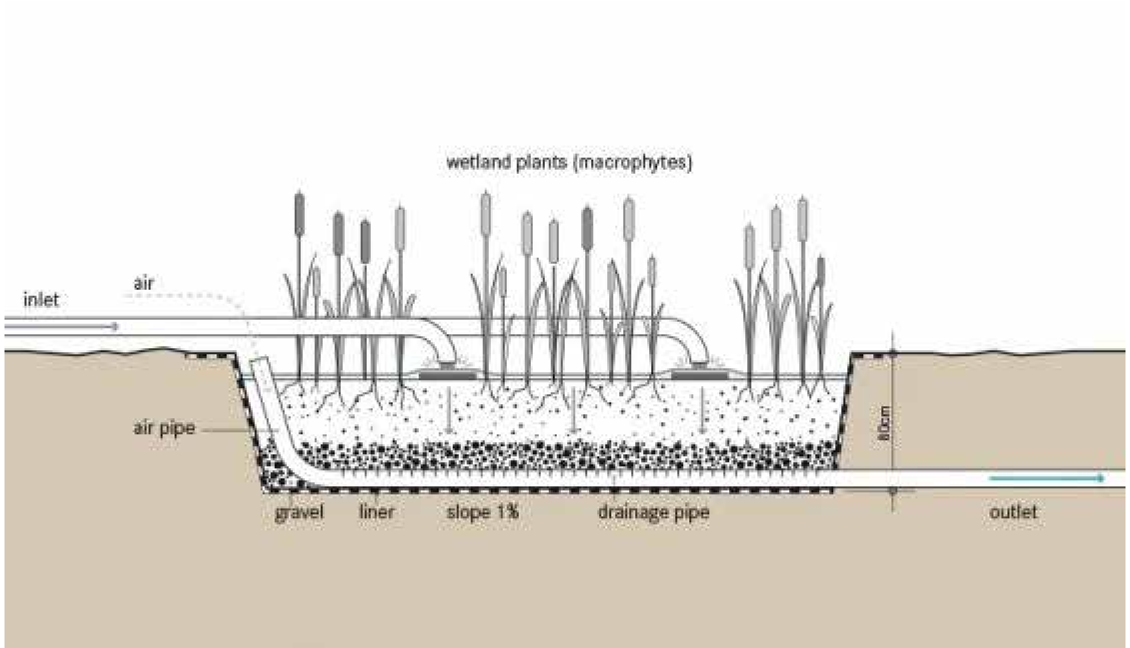


Figure 9.88
Schematic of the Vertical Flow Constructed Wetland (Tilley, et al., 2008)

9.6.3.2_Strengths

(Morel & Diener, 2006)

- Natural processes are used
- Suspended and dissolved organic matter, pathogens, and nutrients are removed efficiently
- No odour
- Mosquitos cannot breed, as they do in Free-Water Surface and Horizontal Wetlands
- Less space is required than for Free-Water Surface and Horizontal Wetlands
- Reduced clogging compared to a Horizontal Flow Constructed Wetland
- Planting becomes an ornamental landscaping feature
- Low operation and maintenance costs

9.6.3.3_Weaknesses

(Morel & Diener, 2006)

- Even wastewater distribution requires a pump system and thus electricity
- Pre-treatment of the wastewater is needed to prevent clogging

9.6.3.4_Plants

The following water based plants are used for the VFCW system:

Cyperus involucratus
(Figure 9.89)

Cyperus papyrus
(Figure 9.90)

Cyperus alternifolius
(Figure 9.91)

Cyperaceae cypeus
(Figure 9.92)

Ethiopia grass
(Figure 9.93)

Zantedeschia aethiopica
(Figure 9.94)

Figure 9.89 (Meerbrook Pond Plants, 2016)

Figure 9.90 (Yannsgob, 2016)

Figure 9.91 (Mullany, 2016)

Figure 9.92 (Prosperi, 2016)

Figure 9.93 (Creative Commons, 2008)

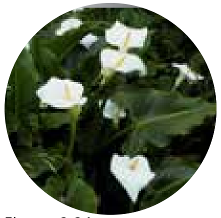


Figure 9.94 (Eurobodalla Shire Council, 2016)

9.6.4_WATER STORAGE

The rainwater storage system of the CC was extensively considered to arrive at the final construction resolution. Water from all the downspouts of the Creative Conservatory Precinct is piped to a central filter to remove solids. The filtered water is stored in a master underground tank. A pump draws the water to be disinfected and stored in secondary tanks by the ablution services.

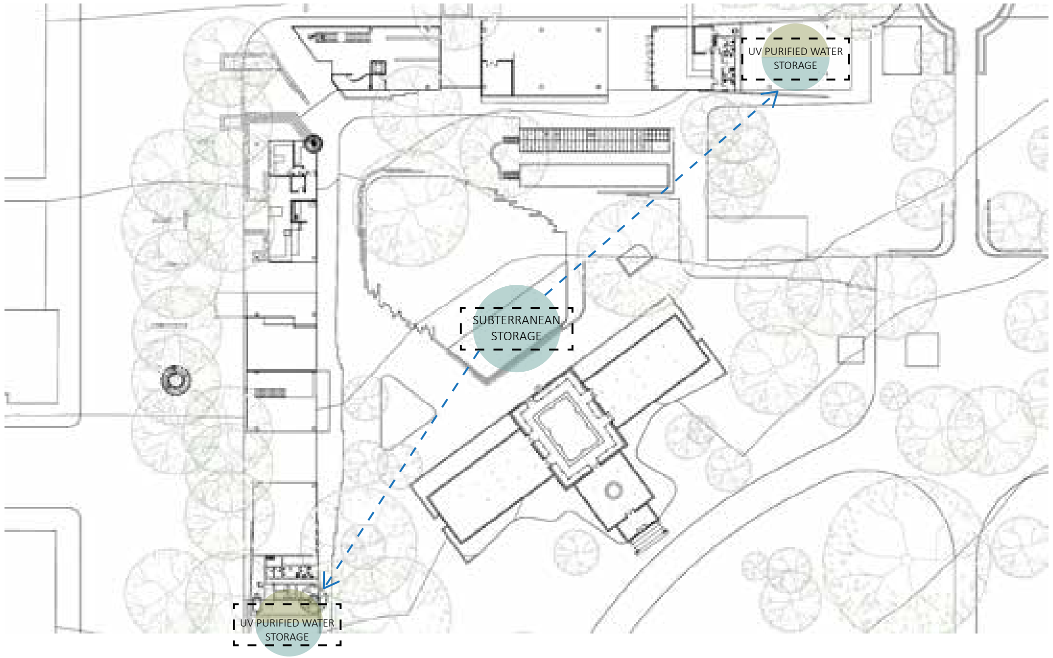


Figure 9.95
Water Storage Plan Diagram (Author, 2016)

Figure 9.96
Water Storage System (Author, 2016) with images from Conservation Technology (2008)

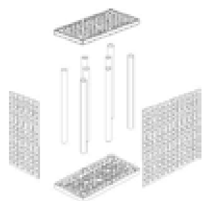
PREFILTRATION

LARGE BASKET FILTER

A large screened filter basket sits within a plastic body, and water flows through the inlet port and the basket and out the outlet port, filtering 100% of the rainwater. The filter is buried and accessible through a manhole cover.

+

STORAGE



RAINCAVERN

An underground storage system has been selected as it is unobtrusive and unaffected by freezing weather. The underground tank's cool, dark conditions prevent algae and microbial growth. The 'RainCavern' is an underground water chamber consisting of modular plastic elements wrapped in waterproofing and backfilled with earth. The modules are easy to assemble and can be manipulated to for any site size or depth. Each module creates a void space capable of storing 360l. The modules can withstand vehicular traffic and are easy to inspect and clean.

+

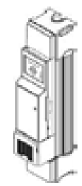
PUMPING

SURFACE PRESSURE PUMP

The pump serves as a complete water delivery system operating any irrigation as well as transferring water from the master to the slave storage tanks.

+

POST-TREATMENT



SEDIMENT FILTERS & UV STERILISATION

Rainwater that has been prefiltered can be used for landscape irrigation and exterior applications, but needs to be treated for use within the building. A sediment filter will remove any suspended solids and an ultraviolet steriliser disinfects the water.

+

BACKUP INTEGRATION

RAND WATER

DIRECT BACKUP

A motorised three-port valve connects the rainwater and municipal backup water supplies to the plumbing system. The valve is connected to the rainwater supply by default, but switches to the backup supply if the tank reaches a pre-set low.

9.7_SERVICE REQUIREMENTS & REGULATIONS

The design and construction of the Creative Conservatory has been conducted to meet the requirements of the South African National Building Regulations.

9.7.1_SANS 204_Energy Efficiency in Buildings

SANS 204 was consulted in the design and technical resolution of the CC to ensure the development of an energy efficient and sustainable building, evidence of which has been relayed in the preceding sections.

9.7.2_SANS 10400_The Application of the National Building Regulations

9.7.2.1_PART A: OCCUPANCY AND CLASSIFICATION

The Creative Conservatory's programmes fall under a combination of classifications (SABS, 2010, pp. 43-44), including:

A1 – Entertainment & Public Assembly
(Occupancy where persons gather to eat, drink, dance or participate in other recreation)
A2 – Theatrical & Indoor Sport
(Occupancy where persons gather for the viewing of theatrical, operatic, orchestral, choral, cinematographical or sports performances)
A3 – Places of Instruction
(Occupancy where school children, students or other persons assemble for the purpose of tuition or learning)
C1 – Exhibition Hall
(Occupancy where goods are displayed primarily for viewing by the public)
C2 – Museum
(Occupancy comprising a museum, art gallery or library)
G1 – Offices
(Occupancy comprising offices, banks, consulting rooms and other similar usage)

9.7.2.2_PART O: VENTILATION

Air requirements for different vacancies of the CC was considered according to SANS requirements (SABS, 2010, pp. 17-19).

Assembly halls = 10 Air changes per hour; 7,5l per person
Theatres =10 Air changes per hour; 7,5l per person
Classrooms =2 Air changes per hour; 7,5l per person
Library =2 Air changes per hour; 7,5l per person
Restaurant = 10 Air changes per hour; 7,5l per person
Kitchens = 20 Air changes per hour; 17,5l per person
Ballrooms = 10 Air changes per hour; 7,5l per person
Conference room = 10 Air changes per hour; 7,5l per person
Cleaners Rooms = 10 Air changes per hour; 1l per person
Office= 2 Air changes per hour; 7,5l per person
Ablutions= 20 Air changes per hour; 20l per person

9.7.2.3_PART P: DRAINAGE

The provision of sanitary fixtures for the CC was calculated using the requirements for the 'provision of sanitary fixtures for public, visitors, students and pupils subject to peak demand (SABS, 2010, p. 32)' for 100 (or less) people

Males:1 toilet pan, 2 urinals, 1 wash-hand basin
Females: 3 toilet pans, 2 wash-hand basins
2 unisex paraplegic ablution facilities are provided

9.8_SECTIONAL EXPLORATION

9.8.1_LONGITUDINAL SECTIONS

9.8.1.1_Section A-A

Section A-A cuts through the northern block, including the Creative Conservatory Knowledge Centre, Black Box, and the Coffee Concepts Café.

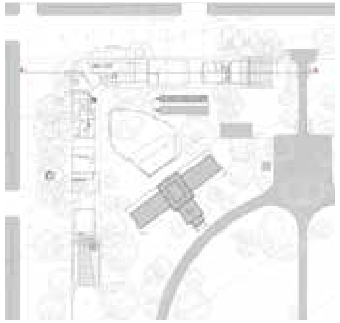


Figure 9.97
Section A-A Key (Author, 2016)

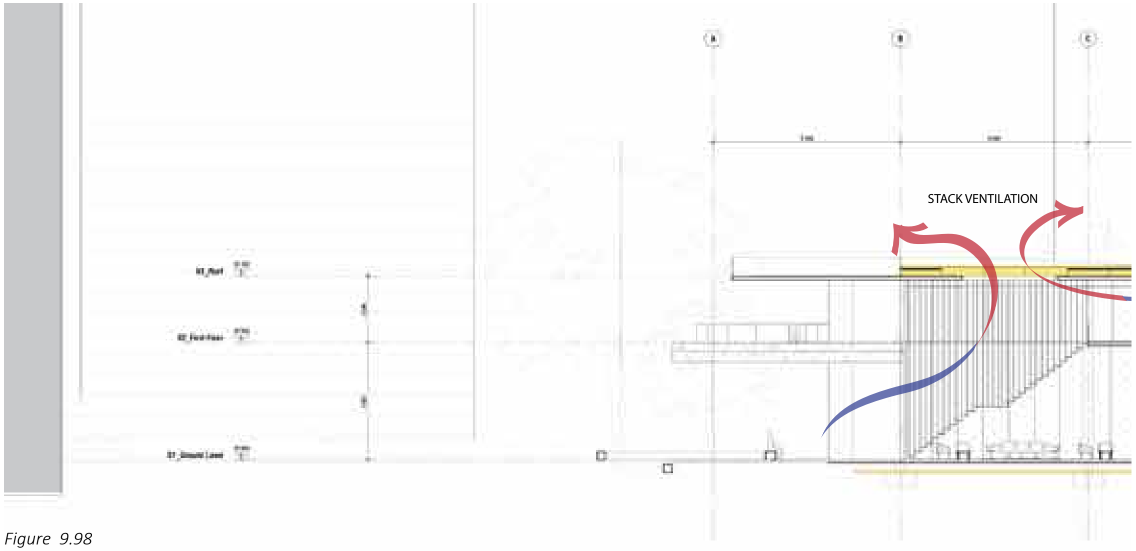


Figure 9.98
Section A-A (Author, 2016)

9.8.1.2_Section B-B

Section B-B cuts through the Black Box, vertical flow constructed wetlands and the Conservatory.

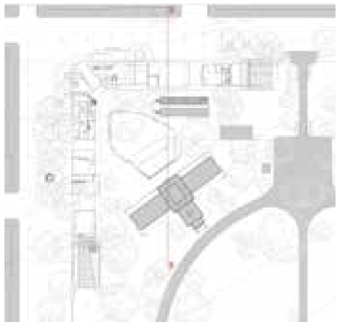


Figure 9.99
Section B-B Key (Author, 2016)

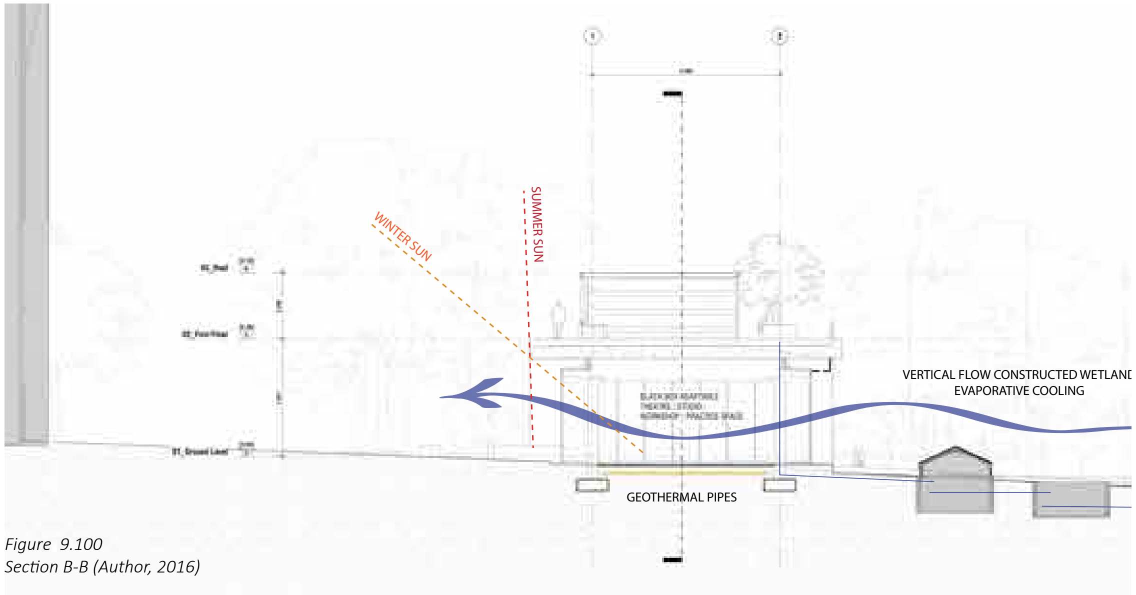
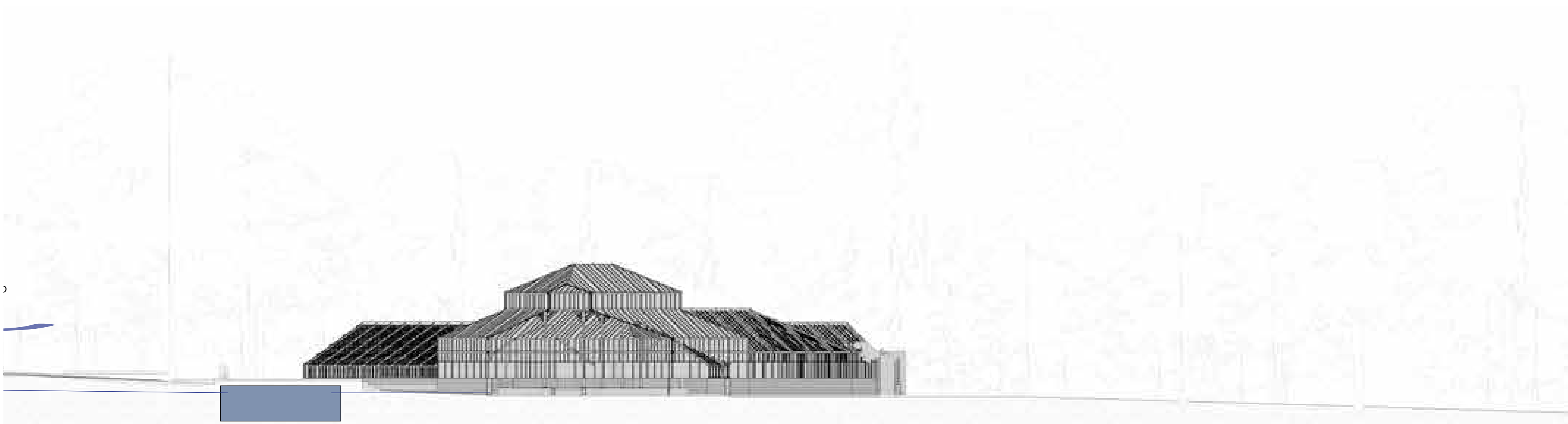


Figure 9.100
Section B-B (Author, 2016)


SOLAR PANELS
GEOTHERMAL PIPES
SECONDARY
WATER TANK


SUBTERRANEAN WATER TANK

9.8.2_ CROSS SECTION

The construction and detailing of a cross section through the CC was explored through iterations. The technology impacted the initial design that drove the construction methods, iterating the section to come to a final resolution.

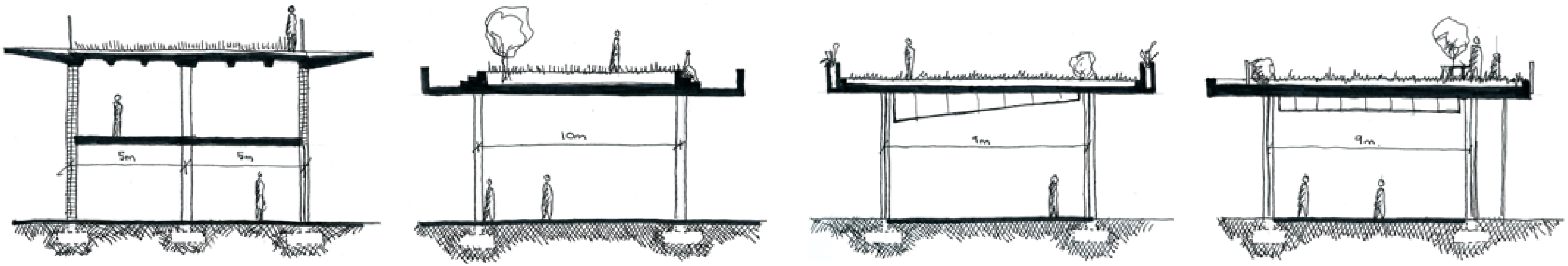


Figure 9.101
Cross section progression (Author, 2016)

9.8.2.1_Base Section

BASE SECTION

The first structural attempt was a double storey building with a 5mx5m grid and waffle slab. The overhangs tapered and glass balustrades were setback.

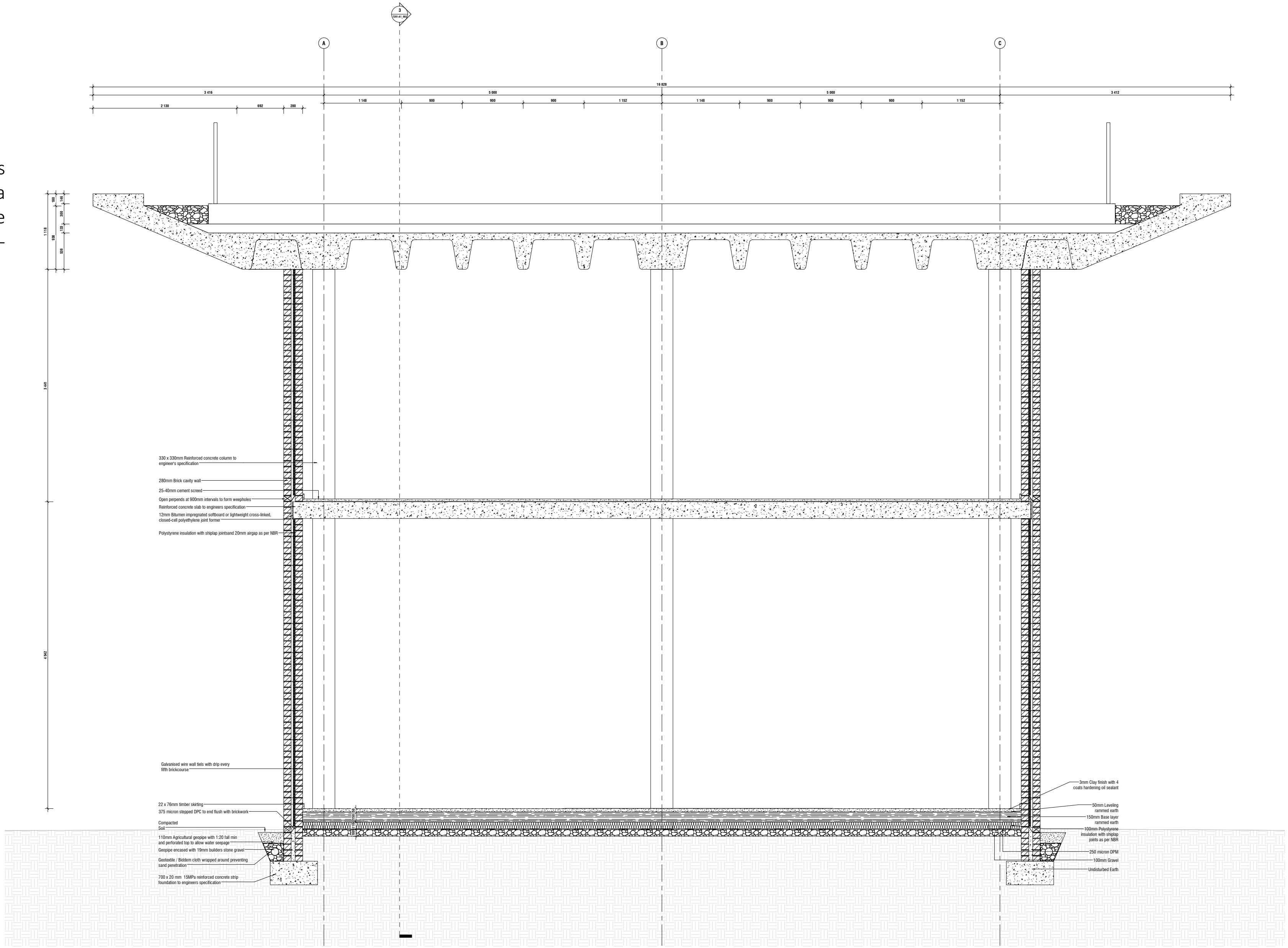


Figure 9.102
Base Section (Author, 2016)

9.8.2.2_Iteration 1

ITERATION 1

The waffle slab was replaced with upstand beams that also functioned as balustrades. Steps were introduced so that the majority of the planted roof was in line with the balustrade, allowing people to look straight over it whilst walking in the garden. The larger soil depth enabled the planting of shrubs and small trees. The column grid also changed to 10m, with the columns increasing in size to accommodate an open plan, adaptable space. The majority of the building was also reduced to a single storey in order to be more sensitive to the heritage Conservatory. The tapered slab edges of the base design were iterated to straight edges, aligning with the concept of the roof as a heavy element. The façades became primarily transparent glass to represent the tectonic element of the building and identify with the Conservatory.

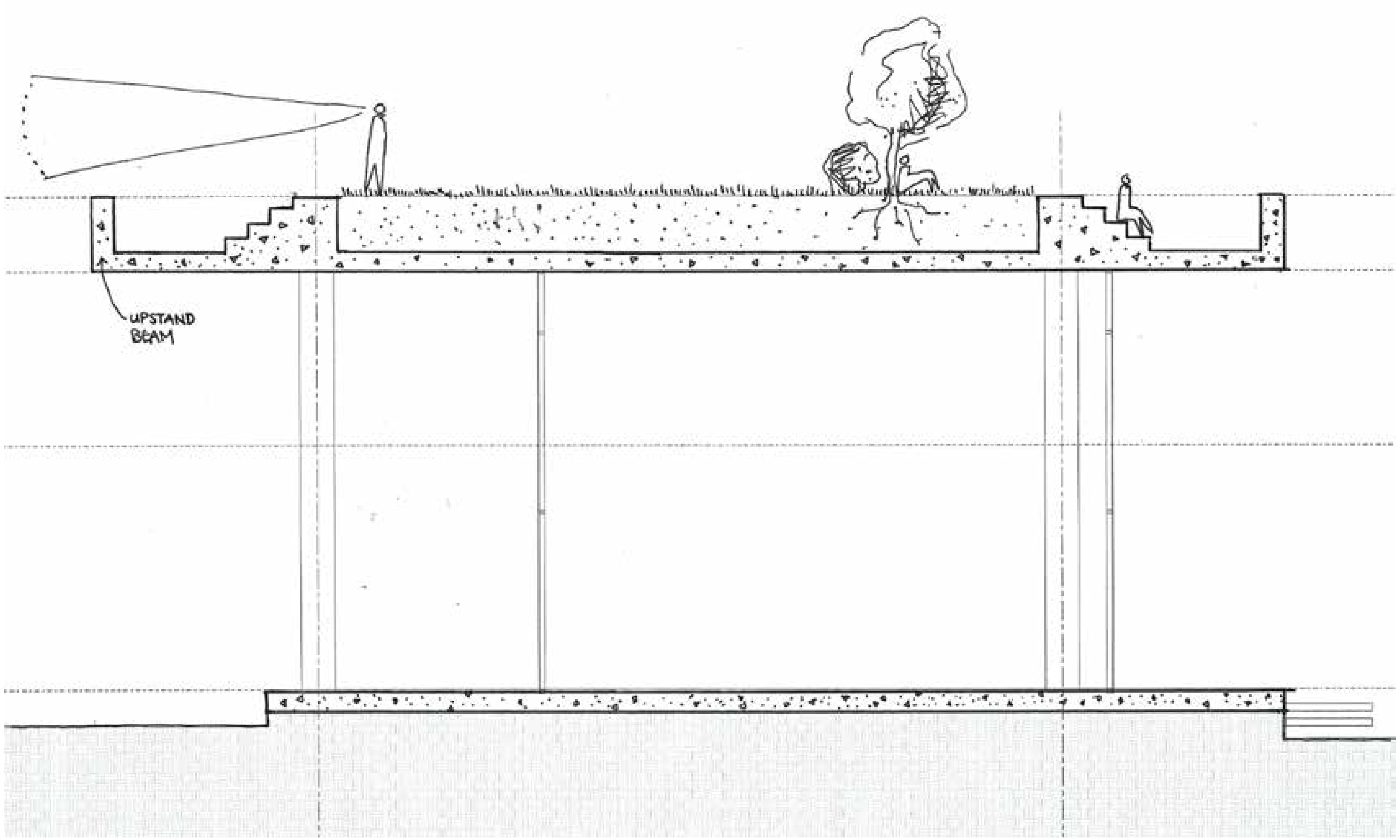


Figure 9.103
Iteration 1 (Author, 2016)

9.8.2.3_Iteration 2

ITERATION 2

The large upstand beams were replaced by a thick reinforced concrete structural slab, allowing the balustrade to become a planter with vegetation spilling over the edge. As the soil depth was reduced, planter boxes were placed on the column grid to accommodate small trees. Ceilings were also introduced to assist with services and acoustic insulation and also helped define space. The grid was adjusted to 9m x 9m to reflect the proportions of the Conservatory. Skylights were designed to bring light into the interior as well as form a visual connection between those within the building and the people walking on the living roof.

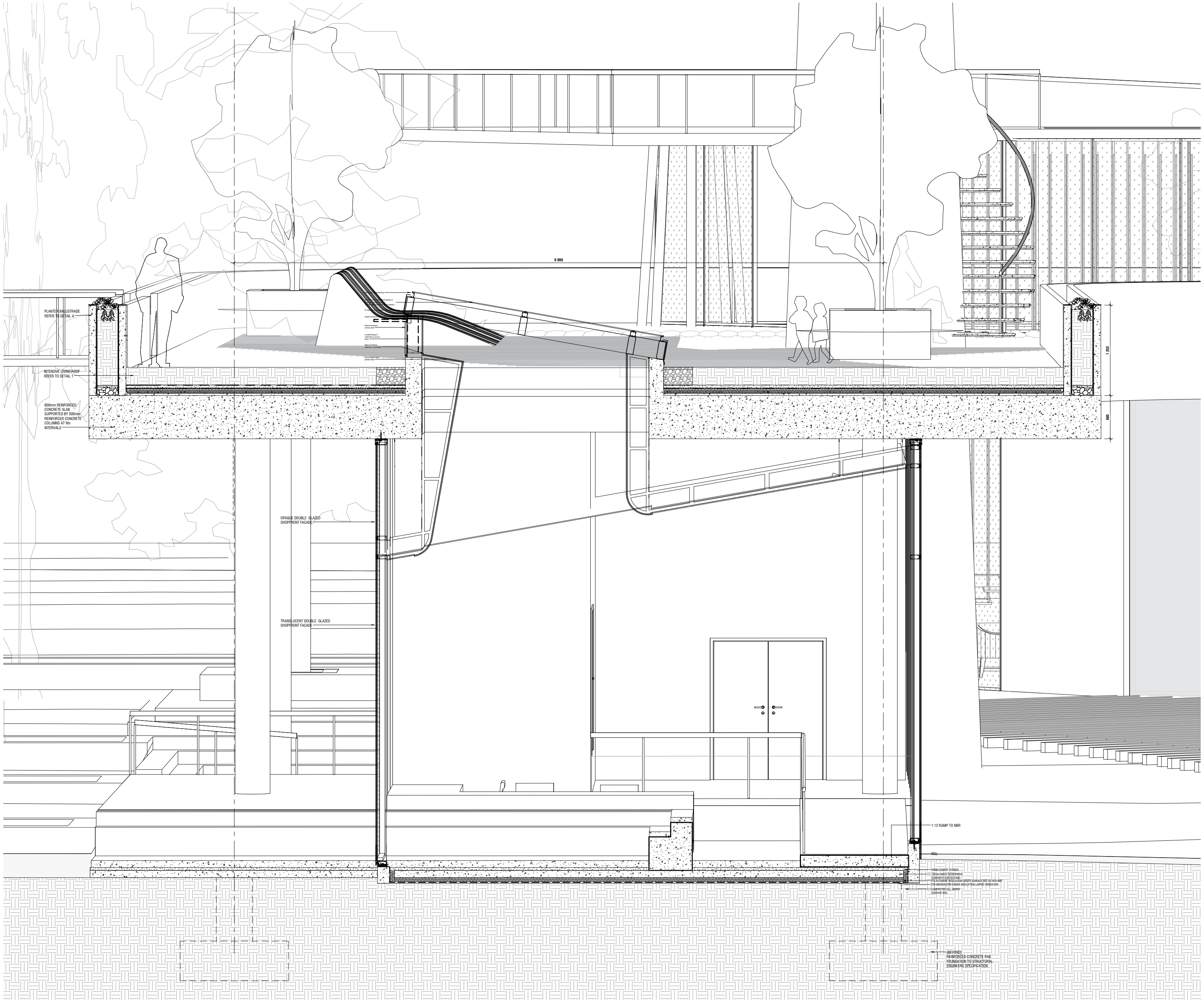


Figure 9.104
Iteration 2 (Author, 2016)

9.8.2.4_Final Sectional Perspective

FINAL SECTION

The slab edge planters restricted views for children and people sitting on the grass, as such, they were replaced by galvanised steel and glass balustrades. The skylight was reconfigured as a walkable roof light, becoming part of the living roof's landscape. The transparency of façade's curtain wall panels were adjusted according to the needs of the interior functions. The canopy walk was also developed further as the tectonic detail of the cross section.

Figure 9.106 indicates the three details developed, which illustrate the tectonic concept:

Detail 1_ Tectonic Component, the Canopy Walk

Detail 2_ Stereotomic Component, the living roof

Detail 3_ Stereotomic / Tectonic Component, the skylight

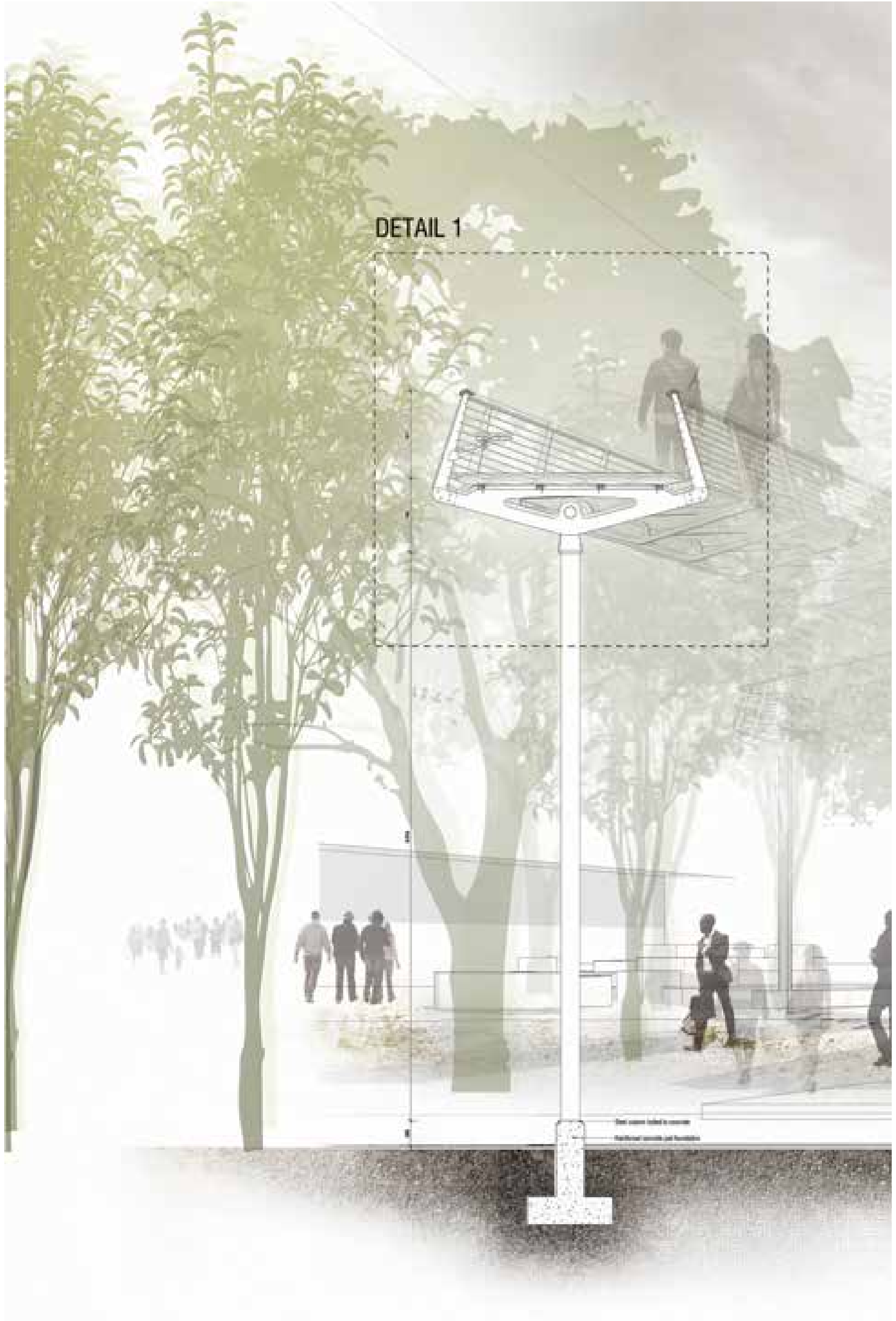
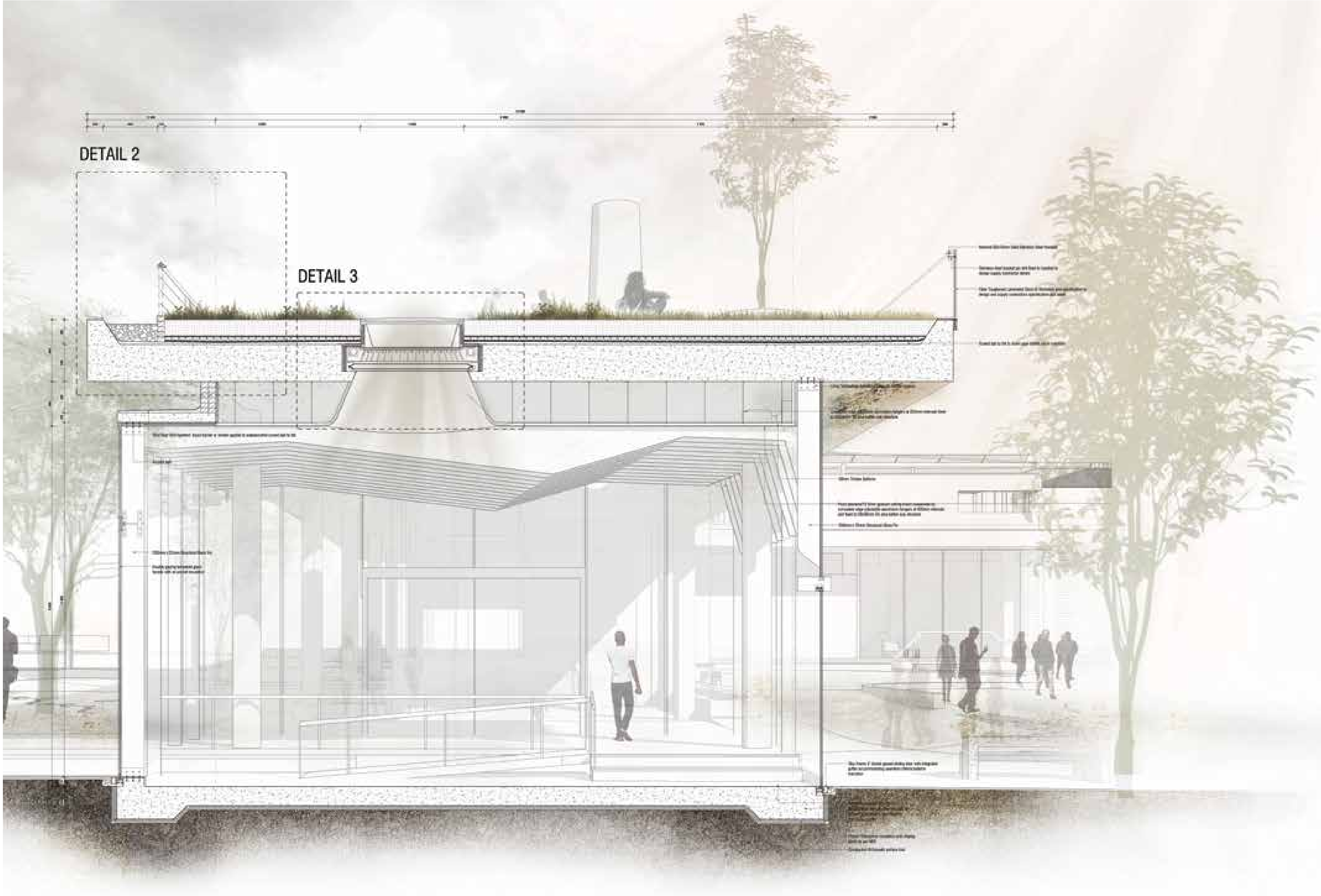


Figure 9.106
Sectional Perspective (Author, 2016)


DETAIL 2
DETAIL 3

9.9_DETAIL RESOLUTION

9.9.2_ DETAIL 1_ TECTONIC COMPONENT

9.9.1.1_Preliminary Detail for the Black Box's Façade

[DEVELOPED FOR ITERATION 2]

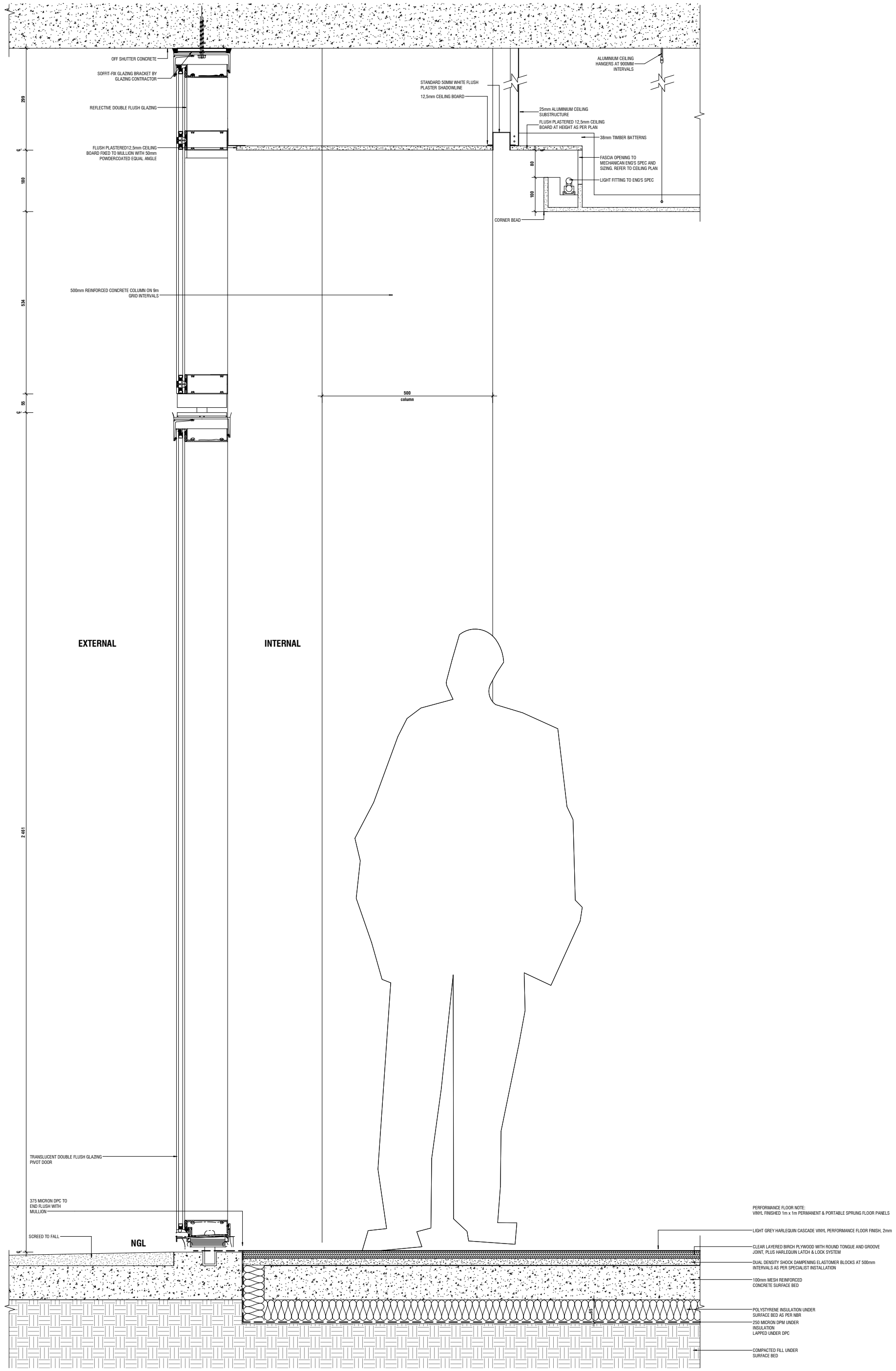


Figure 9.109
(Author, 2016)

9.9.1.2_Final Canopy Walk Detail

[DEVELOPED FOR FINAL SECTION]

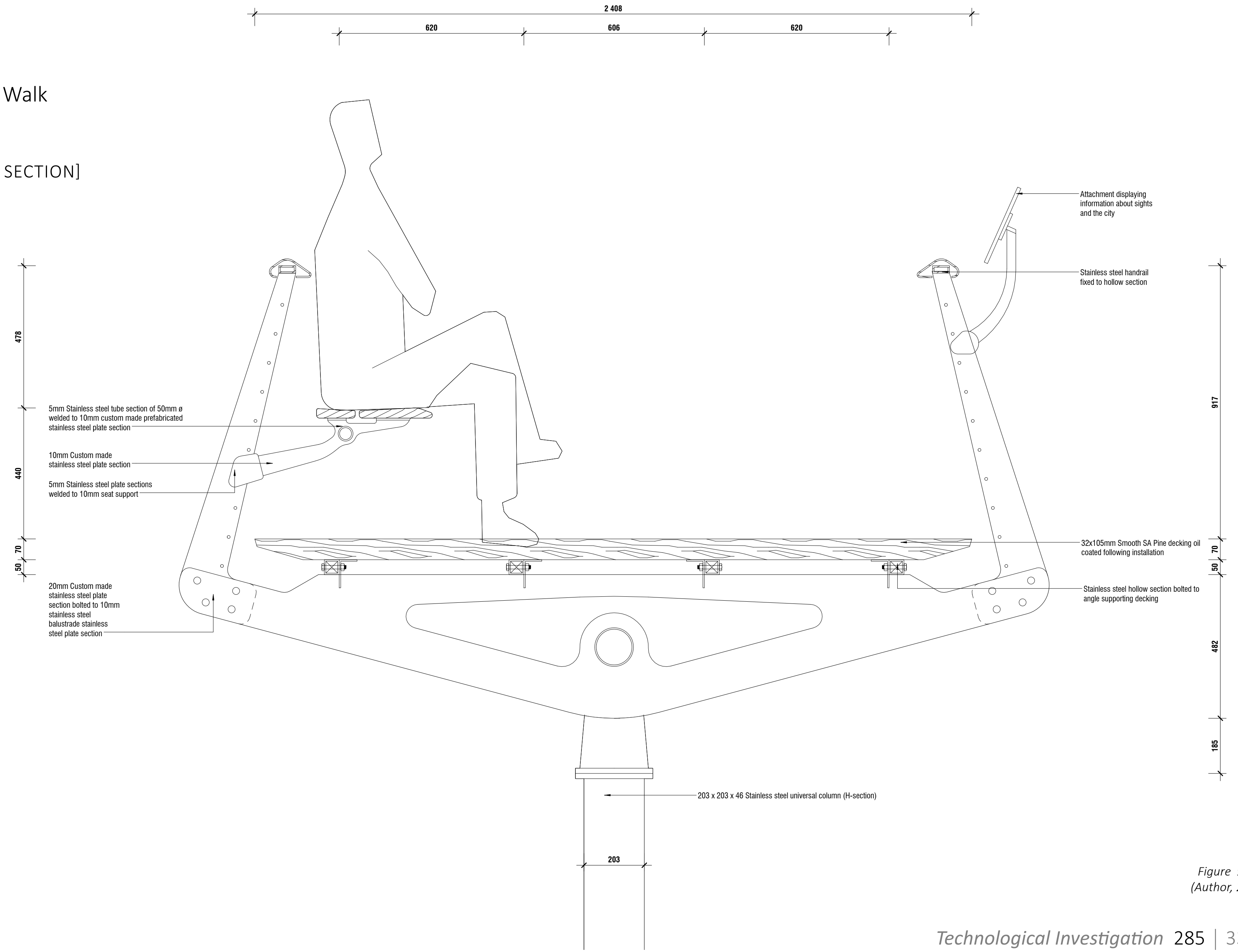


Figure 9.110
(Author, 2016)

9.9.1_ DETAIL 2 _ STEREOTOMIC COMPONENT
THE LIVING ROOF

9.9.2.1_Preliminary Intensive Green Roof Detail

[DEVELOPED FOR ITERATION 2]

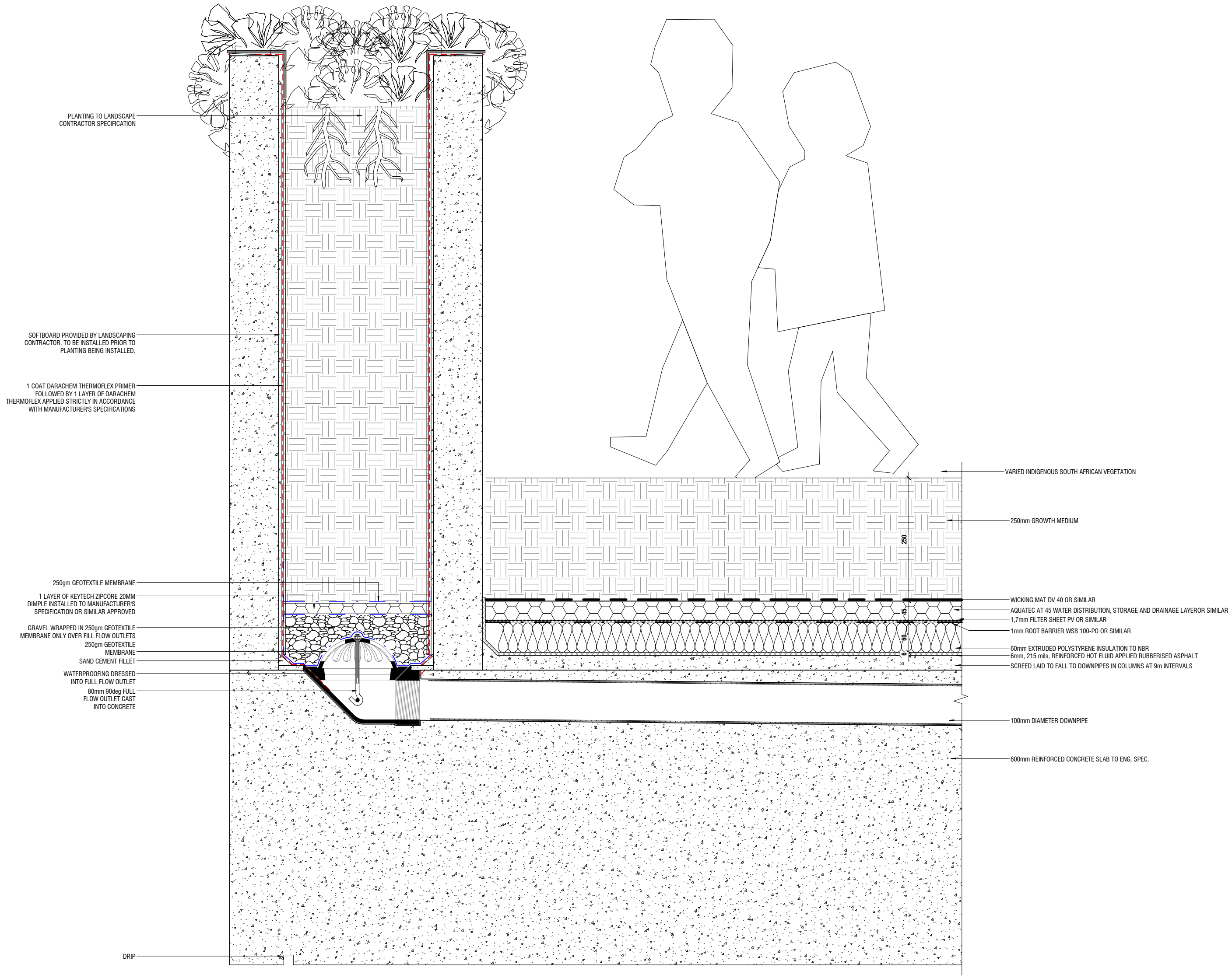


Figure 9.107
(Author, 2016)

9.9.2.2_Final Intensive Green Roof Detail

[DEVELOPED FOR FINAL SECTION]

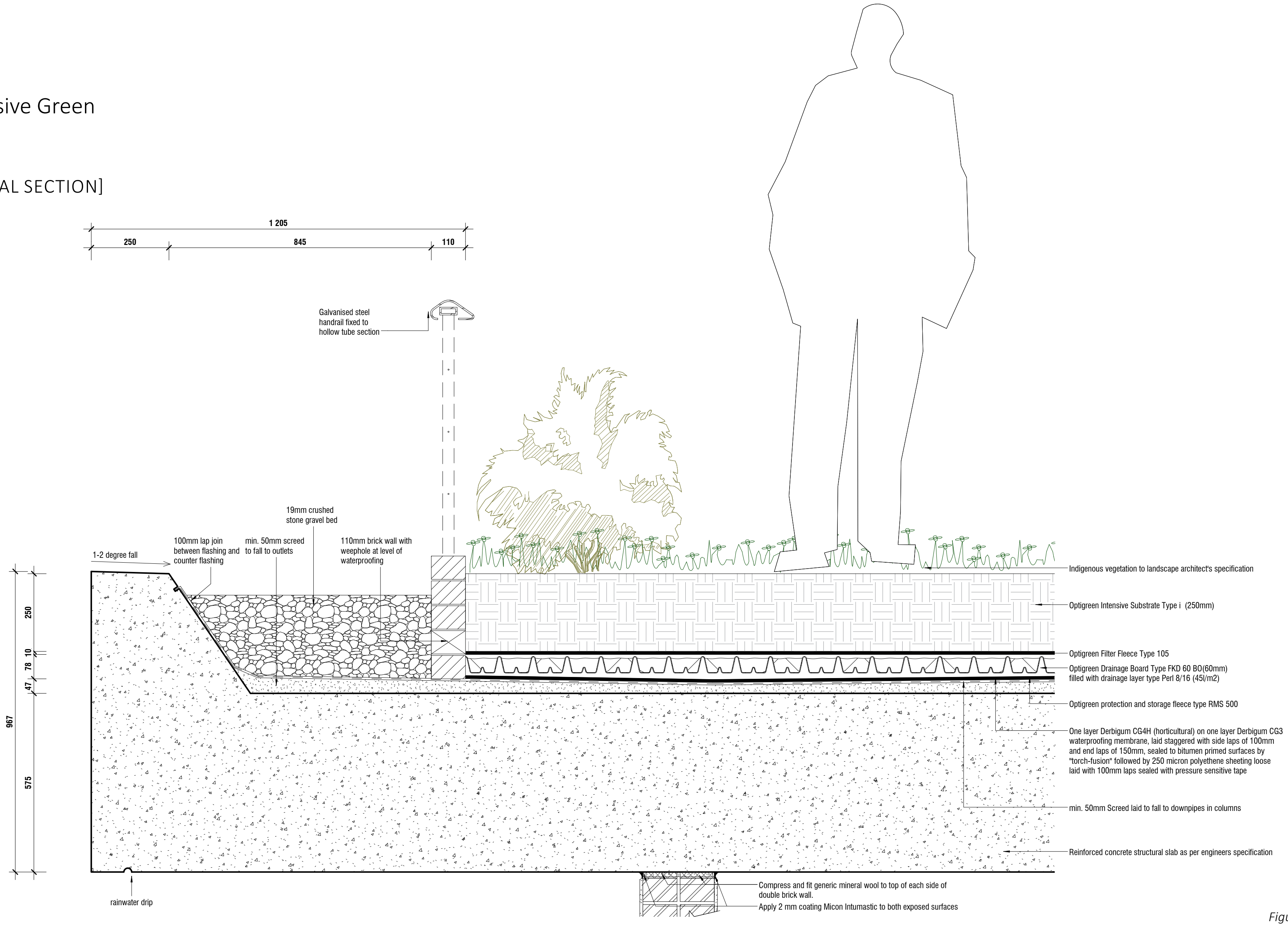


Figure 9.108
(Author, 2016)

9.9.3_ DETAIL 3 _ STEREOTOMIC / TECTONIC COMPONENT
THE SKYLIGHT

9.9.3.1_Preliminary Raised Skylight Detail

[DEVELOPED FOR ITERATION 2]

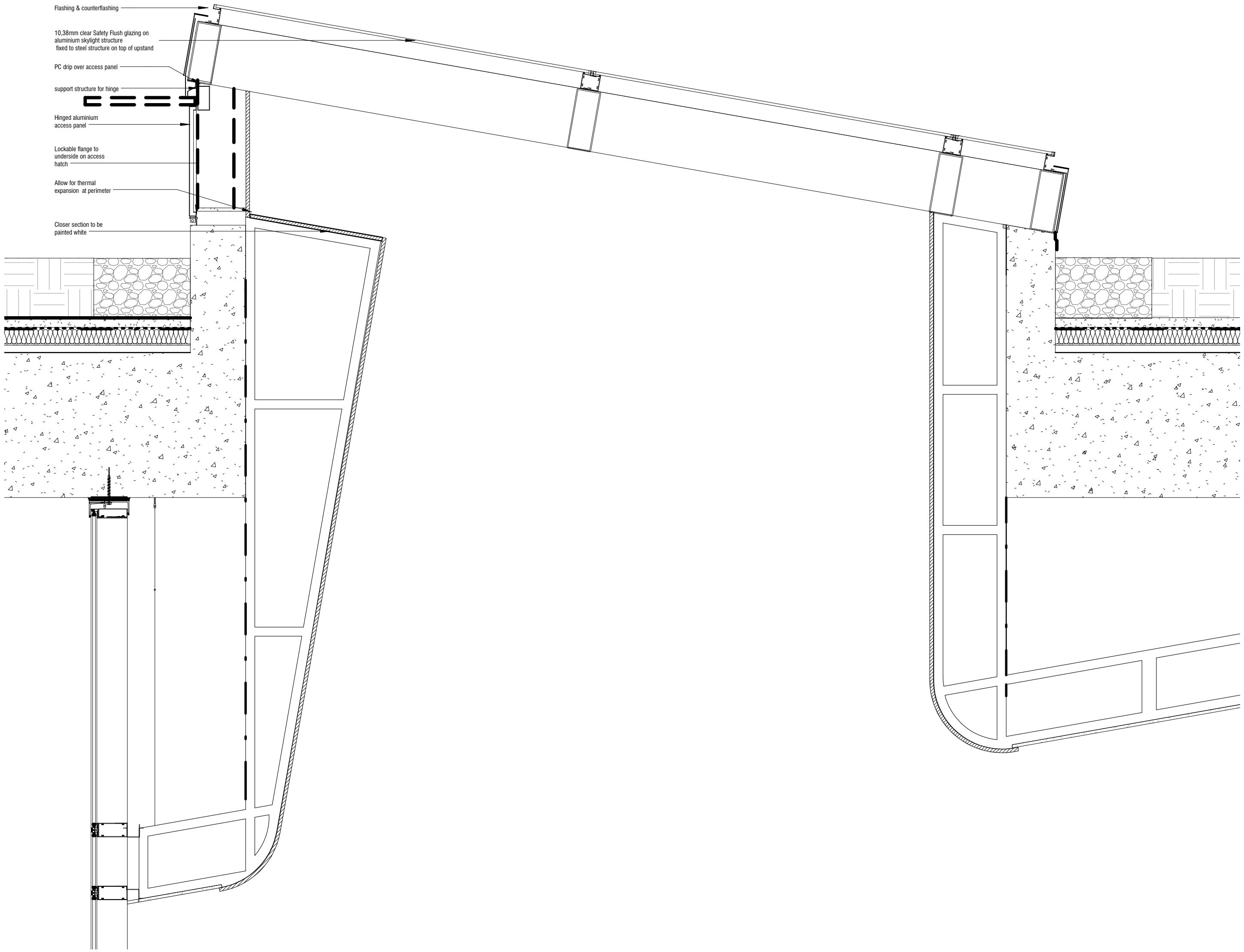


Figure 9.111
(Author, 2016)

9.9.3.2_Final Walkable Skylight Detail

[DEVELOPED FOR FINAL SECTION]

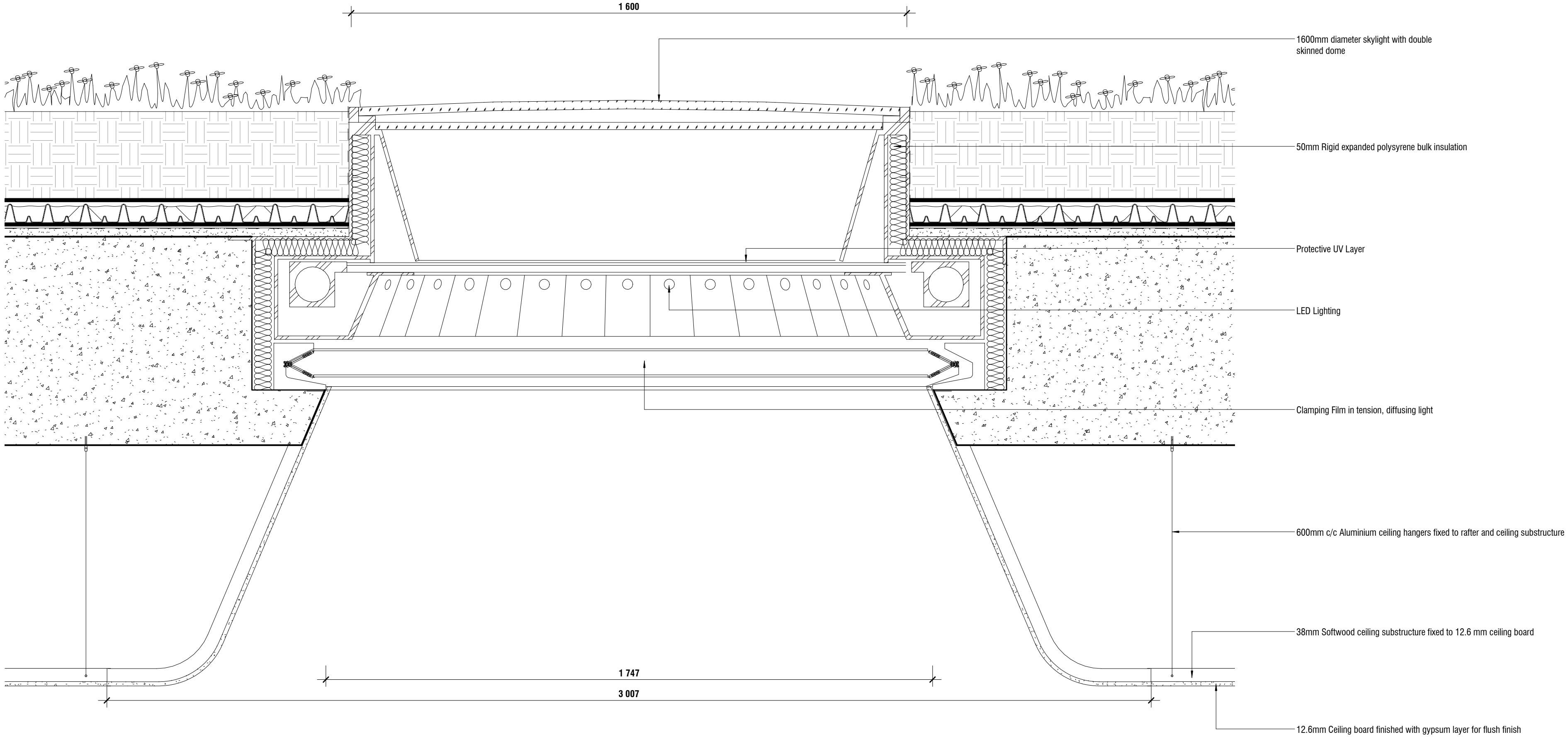


Figure 9.112
(Author, 2016)

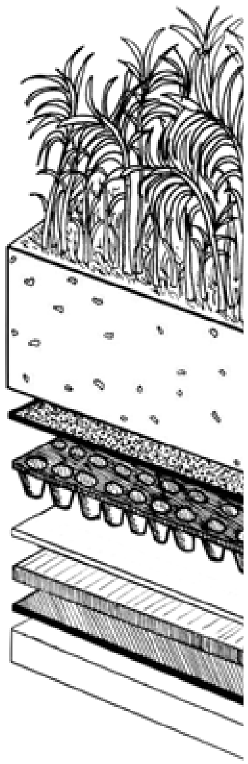


Figure 9.113
(Author, 2016)

9.10_SYNOPSIS

The technical resolution and sustainability investigation of the Creative Conservatory's architecture and systems enriched the project with detail and understanding, verifying the ability of the CC to confront the issues and intentions laid out in Chapter 1 and conclude with a holistic architectural intervention.