LIVING AND WORKING AT THE ROMAN CATHOLIC PRECINCT:

SUSTAINABLE STRATEGIES FOR DESIGNING A PRECINCT EXPANSION

LOURENS DU PLESSIS

NAMIBIA UNIVERSITY OF SCIENCE AND TECHNOLOGY - DEPARTMENT OF ARCHITECTURE, PLANNING AND CONSTRUCTION
MASTER OF ARCHITECTURE - THESIS 2023

Acknowledgments

I wish to extend my sincere gratitude and appreciation to all those who played a pivotal role in the successful completion of this master's thesis. First and foremost, my heartfelt thanks go to my thesis advisors for their unwavering guidance, invaluable support, and the wealth of knowledge they shared throughout this research journey. Their insights and feedback have left an indelible mark on the direction and quality of this work.

I am also indebted to the dedicated faculty and staff at the Namibia University of Science and Technology. Their commitment to providing a nurturing academic environment and essential resources has been indispensable to the progress of this research.

I'd like to express my gratitude to my mentor, Rowan McNamara, for the exceptional guidance and insights provided during my employment with Kerry McNamara Architects Inc. This experience allowed me to gain valuable skills in the fields of architecture and urban planning.

I owe a profound debt of gratitude to my wife Johané Engels du Plessis and family for their unwavering support, encouragement, and understanding, particularly during the demanding phases of this thesis. Their belief in my abilities served as an enduring source of motivation and inspiration.

Lastly, I extend my thanks to the study participants whose cooperation and willingness to share their experiences and insights were instrumental in making this research possible.

A Thesis Presented
By
LOURENS DU PLESSIS
Student number: - 214012492

Submitted to the Namibia University of Science and Technology in fulfillment of the requirements for the degree of

Master of Architecture
April 2024
Department of Architecture, Planning and Construction

Declaration

I,Lourens Andries Stephanus du Plessis hereby declare that the work contained in the thesis, entitled Living and working at the roman catholic precinct: Sustainable strategies for designing a precinct expansion is my own original work and that I have not previously in its entirety or in part submitted it at any university or other higher education institution for the award of a degree.

Signature:.................................. Date:.........................

Supervisor: Mr. Jens Wiedow
First Co-Supervisor: Prof. Jaco Wasserfall

The drawings in this document are not drawn to scale. Unless otherwise noted, all images and drawings have been created by the author.

NAMIBIA UNIVERSITY OF SCIENCE AND TECHNOLOGY | Faculty of Engineering and the Built Environment
DEPARTMENT OF ARCHITECTURE, PLANNING AND CONSTRUCTION

ABSTRACT

This study delves into the realm of sustainable design strategies for the expansion of the Roman Catholic Precinct in Windhoek, Namibia, specifically focusing on creating living and working spaces that adhere to sustainable principles. The objective is to propose design solutions that not only accommodate the spatial requirements but also prioritise sustainable practices throughout the precinct.

The research critically examines the existing spatial and sustainable shortcomings of the Roman Catholic Precinct, identifying areas where improvements are needed. By analysing the current state of the precinct, the study seeks to uncover opportunities for enhancing its livability, functionality, and environmental performance.

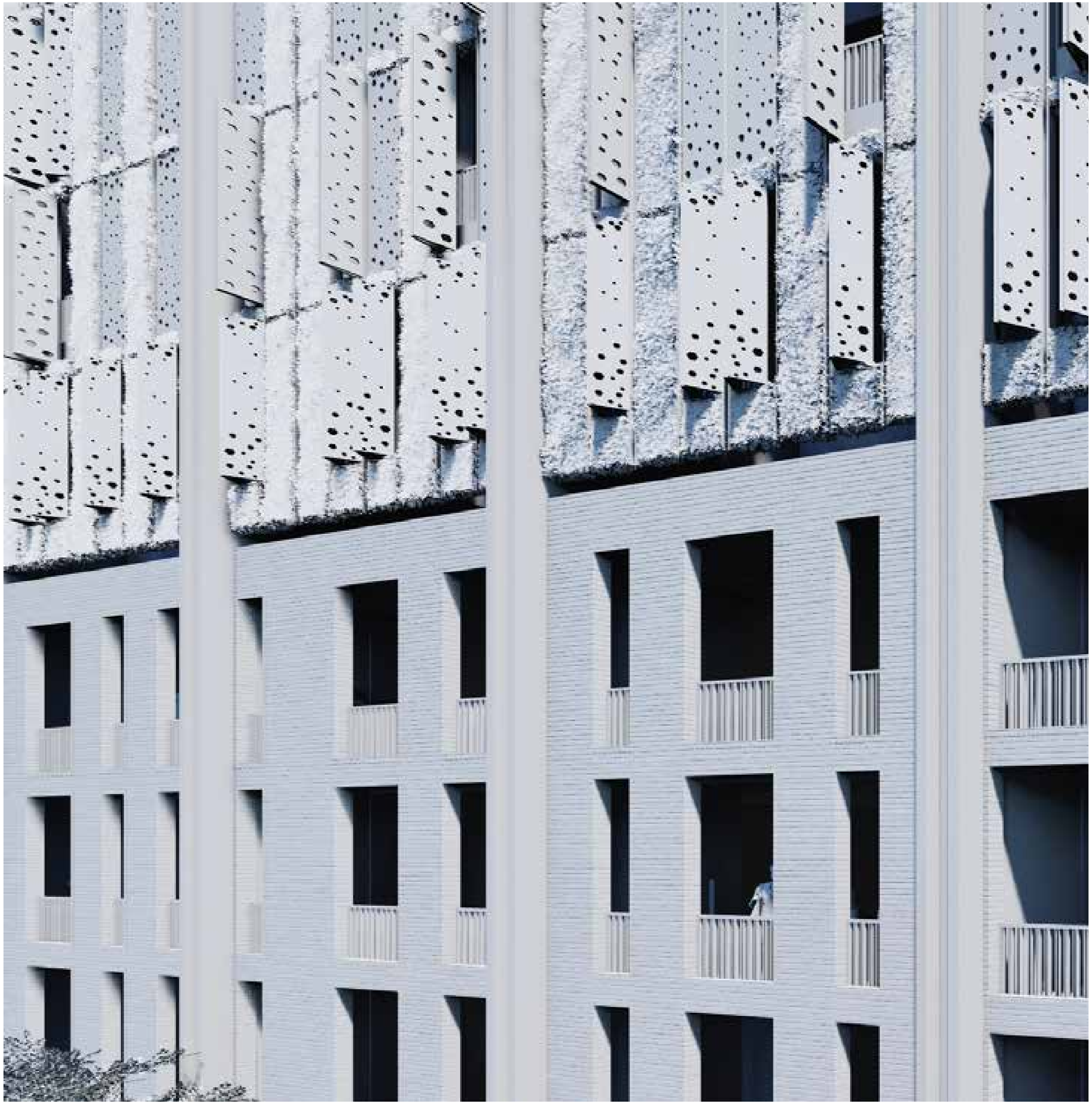
Furthermore, the study explores how an expansion within the precinct can positively impact its overall conditions. It investigates various approaches and strategies that can be employed to optimise the use of space, improve connectivity, and create a harmonious blend of living and working environments.

A significant aspect of this research is the exploration of passive design strategies beyond the building site. By harnessing the natural elements and climate of the region, the study aims to extend passive design principles to the entire precinct. It investigates how passive design can be integrated into the planning, architecture, and infrastructure of the expansion, with a focus on maximising energy efficiency, reducing environmental impact, and promoting occupant comfort and well-being.

To ensure the suitability of the proposed design solutions, the study identifies and evaluates passive design measures that are appropriate for the Namibian context. It considers factors such as climate, cultural considerations, and local resources, aiming to develop a design approach that is sensitive to the specific needs and conditions of the Roman Catholic Precinct.

Ultimately, this research contributes to the advancement of sustainable design strategies for precinct expansions, offering insights and recommendations that can guide future developments. By embracing sustainability and integrating passive design principles, the aim is to create a precinct that not only meets the functional requirements of its inhabitants but also minimises its environmental footprint and contributes positively to the overall well-being of the community.

CONTENTS



SECTION 1

INTRODUCTION

Global warming is a critical issue driven by unsustainable construction practices. Passive design, an eco-friendly approach that leverages natural resources for energy-efficient living spaces, presents a solution. However, conventional sustainable design often neglects precinct contexts, as seen in Windhoek's Green Star-rated buildings. Shifting from Northern-hemisphere-centric methods to region-specific, low-tech passive strategies is crucial.

The research will primarily involve precedent studies and design iterations to determine the most suitable design solutions tailored to the local climate.

This study aims to propose sustainable design solutions for the Roman Catholic Precinct expansion, addressing spatial and sustainability issues and serving as a model for wider passive design integration in Namibia. The research seeks to enhance Windhoek's CBD livability and promote sustainable architecture for a greener future.

1.1 BACKGROUND OF THE STUDY

INTRODUCTION

Global warming is a pressing issue caused by increased carbon dioxide emissions from unsustainable resource use in construction. The building industry must adopt sustainable practices to combat this. In Africa, raw material usage is projected to double by 2060, necessitating the adoption of sustainable design techniques. Passive design in architecture is a solution that leverages natural resources to create energy-efficient living spaces. It takes a holistic approach, considering factors like natural ventilation, energy reduction, water usage, and land use. Implementing passive design strategies ensures fresh air supply, regulates temperature through natural elements, promotes efficient water usage, and reduces the need for expanding land. These approaches contribute to mitigating global warming and developing sustainable cities.

GLOBAL PROBLEM

Global warming rise due to increase of carbon dioxide emissions

The world is currently experiencing global warming, characterised by rising temperatures resulting from increased carbon dioxide emissions. One of the contributing factors to this trend is the unsustainable use of resources during construction and building operations.

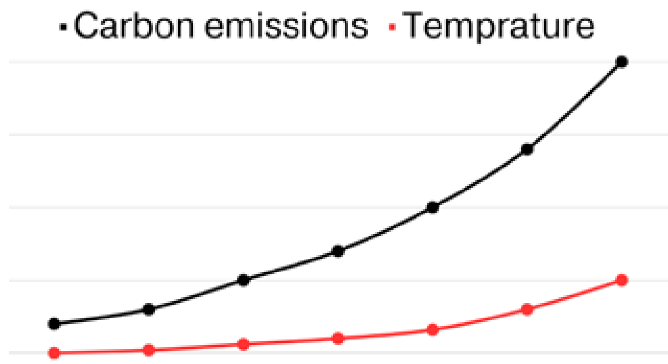


Figure 1.1.1 - Global warming rise due to increase of carbon dioxide emissions

Construction accountability for energy and process-related carbon emissions

According to the United Nations Environment Programme (2019), the construction sector is responsible for 40% of energy and process-related emissions. These carbon emissions result from material manufacturing, material transport and post-construction energy consumption. Therefore, the building industry must adopt more sustainable practices to contribute towards reducing the effects of global warming.

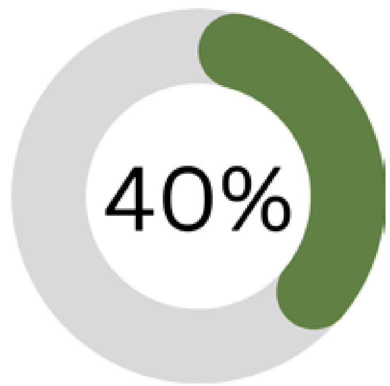


Figure 1.1.2 - Construction accountability for energy and process-related emissions

Note. Adapted from Global Status Report for Building and Construction, by United Nations Environment Programme, 2019, Publisher. Copyright 2019 by United States Environmental Protection Agency

LOCALISED PROBLEM

Africa’s raw material usage

Raw material usage in Africa will double by 2060 thus, Africa should look at sustainable design technics (El Sheikh, 2019). Passive design in architecture is a solution that can combat the effects of global warming and promote the development of sustainable cities by optimising building design to reduce the reliance on mechanical heating and cooling, resulting in lower energy consumption and reduced carbon emissions. Passive design strategies do not only consist of building design but include the urban context and human factor for sustainable design by taking advantage of the local climate (Altan et al., 2016).

Figure 1.1.3 - Africa’s raw material usage is expected to double by 2060

Note. Adapted from CO2 emissions from buildings and construction hit new high, by El Sheikh, S., 2019, Publisher. Copyright 2019 by United Nations Environment Programme

Utilising natural resources in passive design for energy-efficient living spaces

Passive design is an approach that uses natural resources like the sun, wind and light to create energy-efficient living spaces. It involves designing buildings that can optimise natural resources and minimise energy consumption, resulting in comfortable, sustainable, and healthy living spaces (DeKay and Brown, 2014)

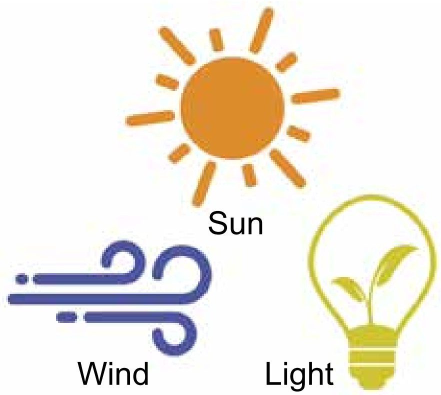


Figure 1.1.4 - Natural resources to utilise for passive design strategies

Note. Adapted from Sun, Wind and Light, by DeKay, M. and Brown, G., 2014, Publisher. Copyright 2014 by John Wiley and Sons, Inc

THE SOLUTION TO THE PROBLEM

Passive design strategies take a holistic approach by considering various interrelated aspects. Some aspects considered, according to the Green Building Council South Africa (GBCSA), are as follows (Reinink et al., 2017):

Natural ventilation:
Yang & Clements-croome, (2012) notes that natural ventilation is crucial in passive design because it allows buildings to harness natural airflows, reducing the need for mechanical cooling and improving indoor air quality. This not only enhances occupant comfort but also significantly reduces energy consumption, making buildings more sustainable and environmentally friendly.

Figure 1.1.5 - Natural ventilation

Reduction in the use of energy:
Passive design utilises the micro-climate to regulate the temperature in buildings by harnessing natural elements such as thermal mass to warm cooler spaces during winter and prevailing winds to cool and ventilate buildings. This reduces the use of mechanical means to achieve cooling and heating.

Figure 1.1.6 - Reduction in the use of energy

Water usage and sewerage:
Namibia is a drought-stricken country, "Identified as one of the driest countries south of the Sahara, Namibia has been experiencing persistent drought conditions for over 7 years" (International Federation of Red Cross and Red Crescent Societies, 2022, p. 5). Passive design strategies can promote efficient water usage by implementing practices such as water recycling and harvesting, thereby reducing the need for a constant supply of fresh water.

Figure 1.1.7 - Water usage and sewerage

Land use – Densification and inner city living:
From 2011 to 2021 Namibia has steadily become more urbanised from 42.64% in 2011 to 53.01% in 2021 (O'Neill, 2023). Densifying the inner city to create liveable spaces reduces the need for creating and servicing more land, resulting in a lower ecological impact of building activities. Densifying land use also lessens transportation emissions by reducing dependence on private vehicles and shortening commutes. This promotes cleaner, more eco-friendly urban environments.

Figure 1.1.8 - Land use – Densification and inner city living

1.2 STATEMENT OF THE PROBLEM

INTRODUCTION

The conventional approach to sustainable building design, as seen in the five Green Star-rated buildings in Windhoek, tends to focus primarily on individual site sustainability while overlooking the broader precinct context. This approach falls short of addressing the United Nations' sustainability goals and requires a substantial shift in mindset towards implementing passive design strategies on a larger scale. Architects often rely on mechanical methods borrowed from the Global North, neglecting the potential of locally suitable low-tech passive design strategies. To achieve a holistic, energy-efficient approach and mitigate the energy consumption issue, it is essential to develop sustainable design strategies tailored to the region's unique climate and context

The conventional approach often focuses on sustainable strategies within individual buildings, without extending considerations for the broader precinct context (The Fifth Estate, 2014). This is exemplified by Windhoek's five Green Star-rated buildings, which, certified by the Green Building Council of South Africa (GBCSA), primarily emphasise sustainability at the building level, neglecting broader integration. However, to align with the United Nations' sustainable goals, a paradigm shift is needed in Windhoek and Namibia, emphasising the integration of passive design strategies on a larger scale. While the GBCSA provides precinct design guidelines to help designers understand sustainable principles, current trends involve constructing individual sustainable buildings. Architects commonly achieve sustainability using mechanical methods borrowed from the Global North. Lighting consuming 42% of total energy in buildings and heating or cooling accounting for 28% of energy consumption (Oertzen, 2019). By implementing passive strategies, these figures can be significantly reduced. Therefore, the importance of exploring passive design strategies as a low-tech means of achieving sustainability is growing, especially given the high energy consumption associated with buildings.

Furthermore, El Sheikh (2019) appropriately noted that Africa should develop its unique sustainable design strategies tailored to the local climate. In this context, the Roman Catholic Precinct faces the challenge of effectively harnessing its distinctive attributes, including single ownership, available space for development, and the amalgamation of diverse functions within and around the area, to realise sustainable strategies. The quest for practical solutions that align with a unified vision, promote responsible expansion, and nurture a lively, interconnected community becomes pivotal in successfully embedding sustainability principles into the precinct's evolution and progress.

Gattupalli (2023) also argues that the current green star rating tools are primarily designed to cater to the needs and resource utilisation patterns of North American and European countries. However, this approach may not be suitable for countries in the global south, as their sustainability requirements and contextual factors differ significantly. Therefore, there is a need to develop alternative systems that can effectively address the unique challenges and priorities of the global south in achieving sustainable development.

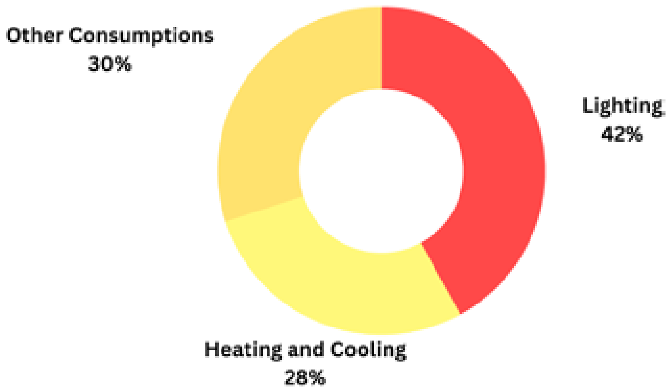


Figure 1.2.1 - Energy consumption of building in Namibia

Note. Adapted from State of the Namibian Electricity Sector , by Oertzen, D., 2019, Publisher. Copyright 2019 by Konrad Adenauer Stiftung

ISSUES WITH GBCSA

Energy dependent

The main aspect is that the buildings heavy reliance on electricity to power mechanical systems in buildings for comfort and functionality is a concern as the use of fossil fuels is necessary to provide cooling, heating, and lighting for interior spaces.

Many of these systems consume substantial amounts of energy, necessitating on-site energy production through the use of Photovoltaic (PV) panels to offset the high demand.

Mechanical systems reliance

The dependence on mechanical systems in existing green star rated buildings poses a problem as they tend to consume more energy than what is produced. To address this, a shift towards passive design strategies and reducing reliance on mechanical systems is crucial.

Integrating renewable energy technologies like Photovoltaic (PV) panels can help bridge the energy gap, while energy-efficient practices and advanced building management systems can optimise energy consumption. This holistic approach promotes sustainability and balances energy usage in green star rated buildings.

Lack of nature based solution

Despite the availability of nature-based solutions, there is a prevalent tendency in building design to prioritise high-tech solutions over simpler, nature-inspired approaches.

This inclination towards complex technological systems often leads to a disregard for the benefits that can be derived from incorporating nature into building functionality.

Financially unsustainable

Despite the potential advantages of green star systems in promoting sustainable building practices, there exists a notable barrier for many building owners due to the financial costs involved. The expenses associated with implementing these systems can often outweigh the perceived benefits, making them less attractive for building owners, especially those with limited resources.

As a result, the adoption of green star systems tends to be predominantly limited to large corporate companies that have the financial capacity to invest in sustainable initiatives.

PASSIVE STRATEGIES ON A PRECINCT LEVEL AS A SOLUTION

Passive design strategies at a precinct level involve applying sustainable and energy-efficient design principles to an entire area or neighbourhood, rather than just individual buildings. The aim is to create a sustainable, comfortable, and environmentally friendly urban environment while minimising the use of mechanical or active systems. These strategies focus on the broader context and interactions between buildings, open spaces, infrastructure, and the community. Here are some key passive design strategies at the precinct level:

Mixed land use: Promote a mix of residential, commercial, and recreational spaces within the precinct. This minimises the need for long commutes, reduces traffic congestion, and encourages walking or cycling.

Compact urban planning: Develop a compact urban layout with shorter distances between buildings and amenities. This not only fosters a sense of community but also reduces the need for vehicular travel.

Shade and green spaces: Incorporate shade trees, parks, and green spaces that provide cooling effects, recreational opportunities, and areas for community gatherings. Greenery can help reduce the urban heat island effect and improve air quality.

Energy Efficiency: Implement energy-efficient lighting and infrastructure throughout the precinct. Smart street lighting, LED technology, and efficient transportation systems contribute to lower energy consumption.

Water management: Develop rain gardens and permeable surfaces to manage stormwater on-site. Collecting and treating rainwater for non-potable uses can also reduce the strain on municipal water supplies.

Community engagement: Encourage participation in recycling programs, community gardens, and other environmentally conscious activities.

Solar access: Plan building heights and layouts to maximise solar access for passive heating and daylighting.

Public transportation: Well connected public transit can make it convenient for residents to use buses, trams, or subways.

Sustainable materials: Encourage the use of sustainable, locally sourced materials in construction and landscaping to reduce transportation-related emissions.

Urban agriculture: Promote urban agriculture and community gardens to provide locally grown produce and reduce the need for long-distance food transportation.

Passive design strategies at a precinct level aim to create communities that are self-sustaining, energy-efficient, and environmentally responsible. These strategies not only improve residents' quality of life but also contribute to the long-term sustainability of the entire area.

Full passive design as low-tech approach

Full passive design strategy harnesses natural elements and passive techniques to regulate environmental factors in a building, including temperature and lighting, without the need for human or mechanical intervention. By minimising reliance on mechanical systems and active interventions, it aims to achieve energy efficiency and enhance occupant comfort. However, attaining a fully passive design can be complex, necessitating the integration of both passive and active strategies to optimise performance.

Figure 1.2.2 - Full passive design as low-tech approach

Active passive design to assist systems

In today's modern world, achieving full passive design strategies can be challenging. However, there is a recognised need to enhance the efficiency of passive systems by combining human and mechanical means, leading to the concept of an active passive system. By integrating active elements with passive design strategies, such as the use of sensors, controls, and smart technologies, we can optimise the performance of passive systems and improve their overall effectiveness. This approach harnesses the benefits of both natural elements and technological advancements, creating a synergistic solution that maximises energy efficiency and comfort in buildings.

Figure 1.2.3 - Active passive design to assist systems

1.3 OBJECTIVE OF STUDY

INTRODUCTION

This study aims to propose sustainable design solutions for expanding the Roman Catholic Precinct while considering its spatial and sustainable shortcomings. It will explore how an expansion can enhance the precinct and integrate passive design beyond the building site. The study will identify suitable passive design solutions for Namibia and examine their integration into the building design and larger precinct context. Additionally, it will propose a design solution to improve the livability of Windhoek's CBD.

THE STUDY AIMS TO:

Explore sustainable expansion of the Roman Catholic Precinct using passive design strategies.

● How can passive design strategies address spatial and sustainable issues in the Roman Catholic Precinct?

● Propose sustainable design solutions for the Roman Catholic Precinct, including passive strategies.

● Extend passive design beyond the building site for the precinct's sustainability.

Integrate passive design solutions for Namibia in the Roman Catholic precinct expansion.

● What passive solutions work for Namibia and how to integrate them sustainably?

● Incorporate Namibian passive designs in the Roman Catholic precinct expansion.

● Combine diverse passive design measures for a harmonious expansion.

Create a sustainable solution to enhance Windhoek's CBD and address Roman Catholic Precinct expansion needs.

● How can a sustainable design improve CBD liveability and address Roman Catholic Precinct expansion needs?

● Enhance Windhoek's CBD livability through proposed building functions in the Roman Catholic Precinct expansion.

1.5 SECTION CONCLUSION

In conclusion, the narrative presented here vividly illustrates why passive design strategies are paramount in our pursuit of a more sustainable and resilient future, particularly in the context of precinct planning and urban development.

The conventional approach, often seen in various parts of the world, tends to focus narrowly on implementing sustainable measures within individual buildings while neglecting the broader precinct context. This fragmented approach, exemplified by Windhoek's Green Star-rated buildings, certified by the Green Building Council of South Africa, underscores the urgency of embracing a paradigm shift towards integrating passive design strategies on a larger scale.

The primary importance of passive design strategies lies in their potential to significantly reduce energy consumption. Buildings, which are major energy consumers, rely heavily on mechanical methods that are typically borrowed from developed regions. However, these high-energy consumption patterns can be curbed through passive design, particularly in lighting and heating or cooling systems, where substantial energy savings can be achieved.

In addition to reducing energy use and associated costs, passive design strategies hold the key to addressing climate change by minimising carbon emissions. They facilitate a more sustainable coexistence with the environment by optimising natural resources like sunlight and wind to create comfortable indoor spaces. These strategies, in essence, help us mitigate the environmental challenges of our time.

Furthermore, embracing passive design strategies means acknowledging the importance of developing sustainable design principles that are tailored to the local climate and context. Africa, as noted by El Sheikh (2019), must cultivate its unique sustainable design strategies that align with its climatic conditions, an imperative that extends to regions worldwide.

Gattupalli's (2023) argument underscores the necessity of designing for the specific needs and contextual factors of different regions. One-size-fits-all approaches, such as the Green Star rating tools, designed primarily for North American and European countries, may not suffice for the unique challenges and priorities of the global south. The call to develop alternative systems that are regionally relevant and effective is thus a clarion call for the adoption of passive design strategies.

In summary, passive design strategies are indispensable in our pursuit of sustainable development and urban planning. They are a low-tech, high-impact means to achieve not only energy efficiency but also broader environmental, economic, and societal benefits. They represent our commitment to a more sustainable and interconnected future, where the precincts and cities we build harmonise with nature and thrive as resilient communities.

SECTION 2

PRECEDENT PASSIVE DESIGN

The selected precedents are primarily chosen for their extensive use of passive strategies in design. Furthermore, these precedents are specifically chosen due to the similarity in climatic conditions to Windhoek. This selection enables us to gain insights into designing sustainable passive buildings in a warm arid climate. Crucially, the chosen precedents demonstrate inventive sustainability solutions, both at the building and precinct levels. They will be analysed based on their techniques and systems to determine their efficiency.

2.1 VODAFONE SITE SOLUTION INNOVATION CENTRE

INTRODUCTION

The Vodafone Site Solution Innovation Centre (SSIC) stands as a remarkably eco-friendly structure located in South Africa, having earned a prestigious 6 Star Green Star SA certification. This building serves as a prime example of inventive construction and design methodologies, encompassing effective cooling systems, ample infusion of natural illumination, generation of renewable energy, water reclamation, and the incorporation of reused materials. The SSIC has garnered a multitude of commendations and functions as a testament to the implementation of energy-efficient and sustainable building approaches.

BUILDING INFORMATION

Architects: GLH Architects
Construction Year: 2011
Building Location: Midrand, South Africa
Main Function: Office Building

Project Information:
The building achieved the highest 6-star rating in Office Design v1 certification from GBCSA, which is equivalent to the prestigious LEED Platinum status.

Figure Examination

Figure 2.1.1 depicts the boardroom, designed to establish a visual link with the natural surroundings and facilitate the entry of abundant daylight.

The expansive roof overhangs are seen designed to extend shading durations. Additionally, the exterior natural area is showcased, which serves the purpose of mitigating the heat island effect, thereby cooling the surrounding air and the site (figure 2.1.2).

Figure 2.1.3 showcases the implemented constructed wetlands positioned at the building’s core. This strategic placement aids in pre-cooling the incoming air and recycling water from basins and sinks.

Figure 2.1.1 - Vodafone Site solution innovation centre - Boardroom with maximum views to nature and ample daylighting

Image by GLH Architect (2011). https://www.glh.co.za/app/glh/index.html#/work/20/project-image-gallery

Figure 2.1.2 - Vodafone Site solution innovation centre - Exterior large overhangs for shading and nature surrounding the building

Image by GLH Architect (2011). https://www.glh.co.za/app/glh/index.html#/work/20/project-image-gallery

Figure 2.1.3 - Vodafone Site solution innovation centre - Internal court-yard with constructed wetland for cooling and water recycling

Image by GLH Architect (2011). https://www.glh.co.za/app/glh/index.html#/work/20/project-image-gallery

ANALYSES - BUILDING MODEL

Exterior analysis

The structure features a sloped roof that channels rainwater towards the courtyard for collection.

Essential utilities are smartly positioned on the building's western side, acting as a buffer against intense afternoon sunlight.

Surrounding vegetation reduces the heat island effect and cools incoming air before it enters the building.

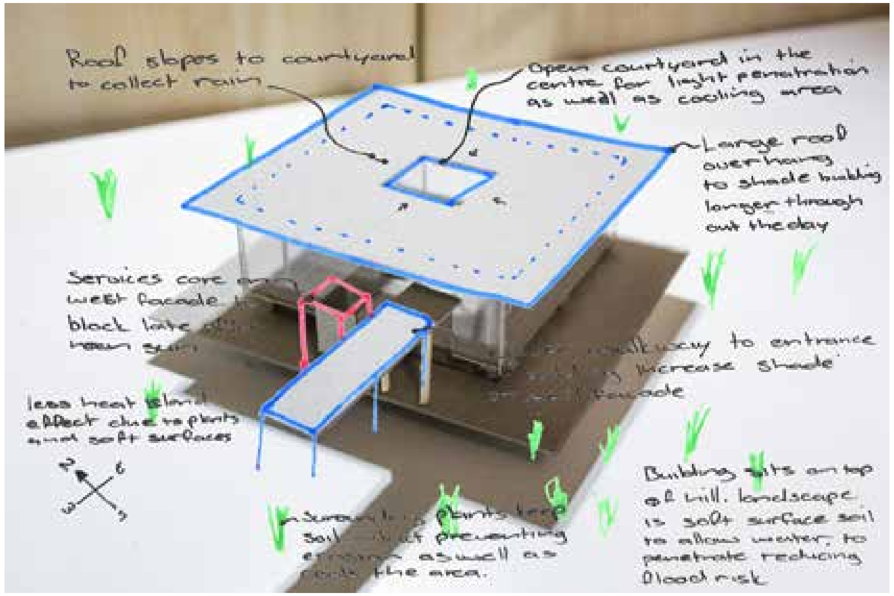


Figure 2.1.4 - Vodafone Site solution innovation centre - Model - Exterior analysis

Ground floor analysis

The building features large windows for ample natural light and a connection to nature.

In the central courtyard, a purpose-built constructed wetland recycles water from sinks and captures rainwater.

Openable windows around the courtyard allow cooled air from the wetland to enter the building.

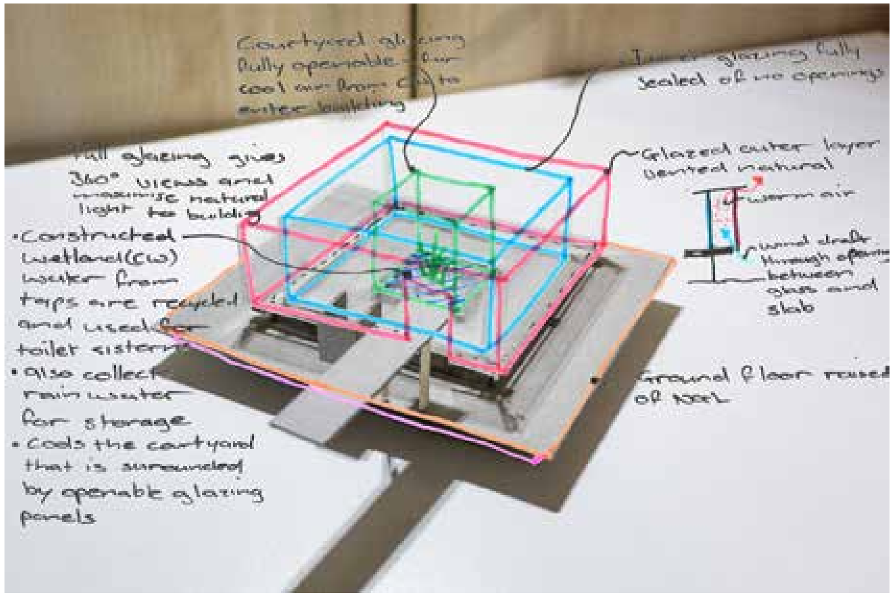


Figure 2.1.5 - Vodafone Site solution innovation centre - Model - Ground floor analysis

Basement cooling analysis

By using earth edge, the basement stays cool, with rock storage and water reservoirs located in the basement working together for enhanced building cooling.

Apertures in the basement walls draw in air, subsequently cooling it before it is channeled through the ventilation system and circulated into the interior spaces.

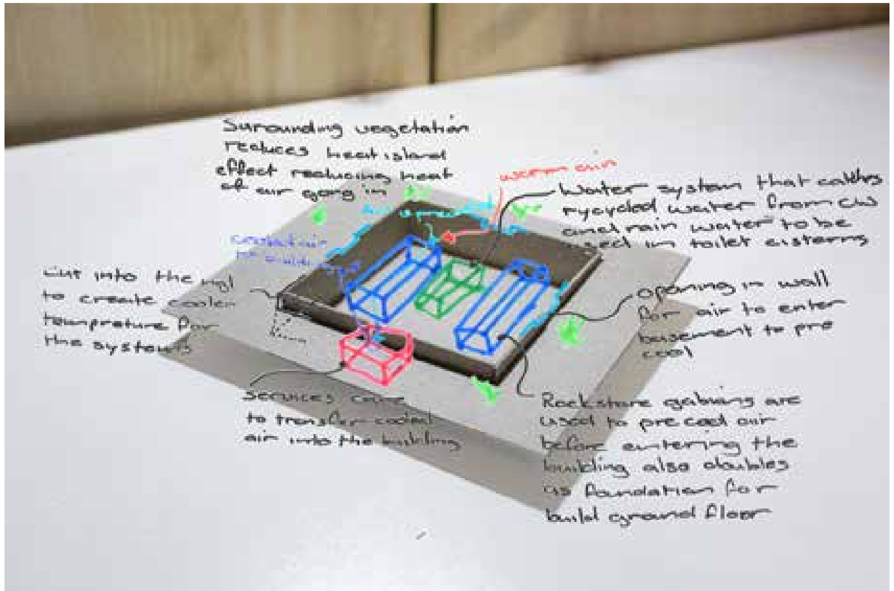


Figure 2.1.6 - Vodafone Site solution innovation centre - Model - Basement analysis

Exterior skin analysis

Incorporating a second skin design, the building effectively captures heat along its outer perimeter.

This ventilated second skin performs akin to a trombe wall, releasing trapped warm air through ventilation openings in the facade.

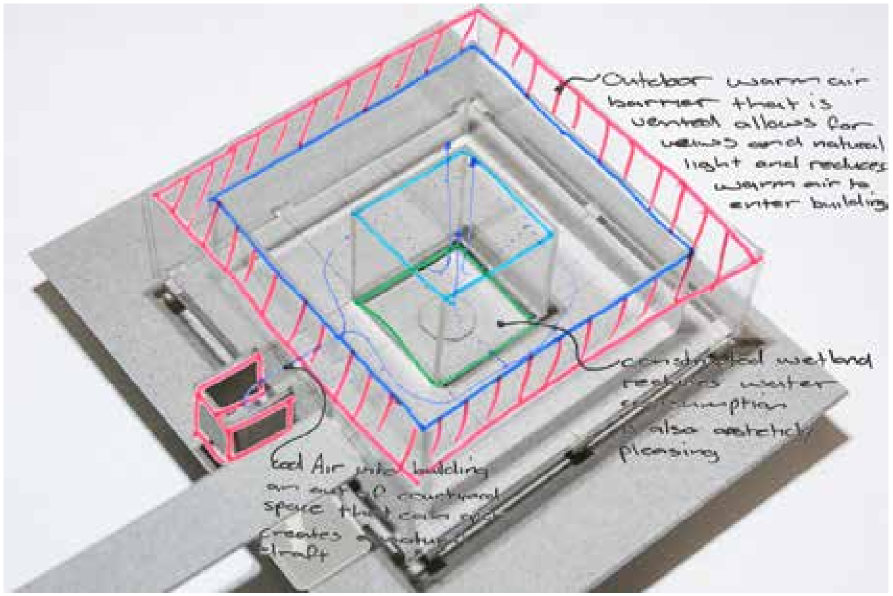


Figure 2.1.7 - Vodafone Site solution innovation centre - Model - Exterior skin analysis

Passive cooling analysis

Elevated from the natural ground level, the ground floor facilitates air entry into the basement rock stores, cooling it prior to entering the interior space. This approach is complemented by on-site vegetation and thermally activated floor slabs.

The roof, constructed from wood, effectively prevents the absorption and release of heat into the interior spaces.

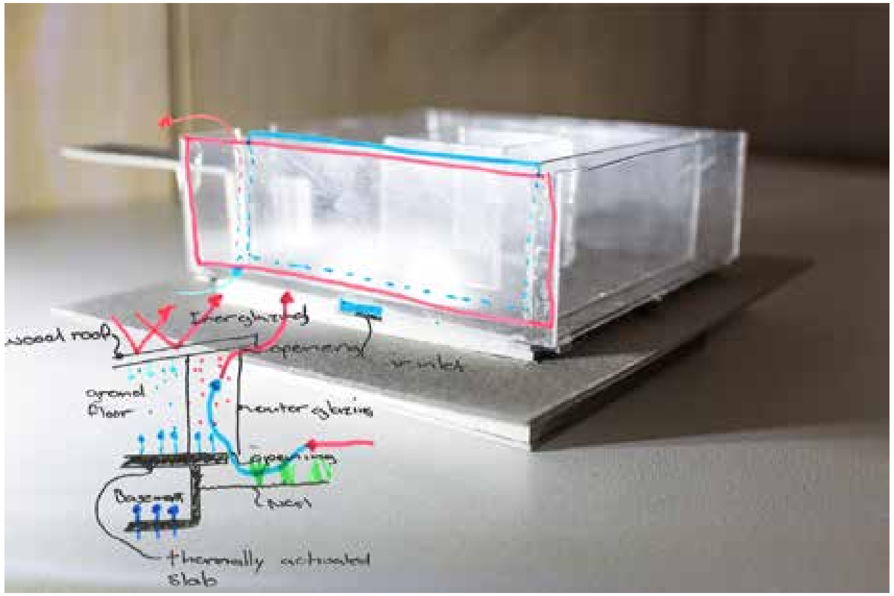


Figure 2.1.8 - Vodafone Site solution innovation centre - Model - Passive cooling analysis

Interior planning analysis

The central courtyard serves as a hub for various functions and allows cooling to all interior spaces.

Offices and showrooms are strategically positioned on the northern and southern sides, while service areas are situated along the eastern and western facades. This arrangement effectively shields against direct sunlight during the summer months.

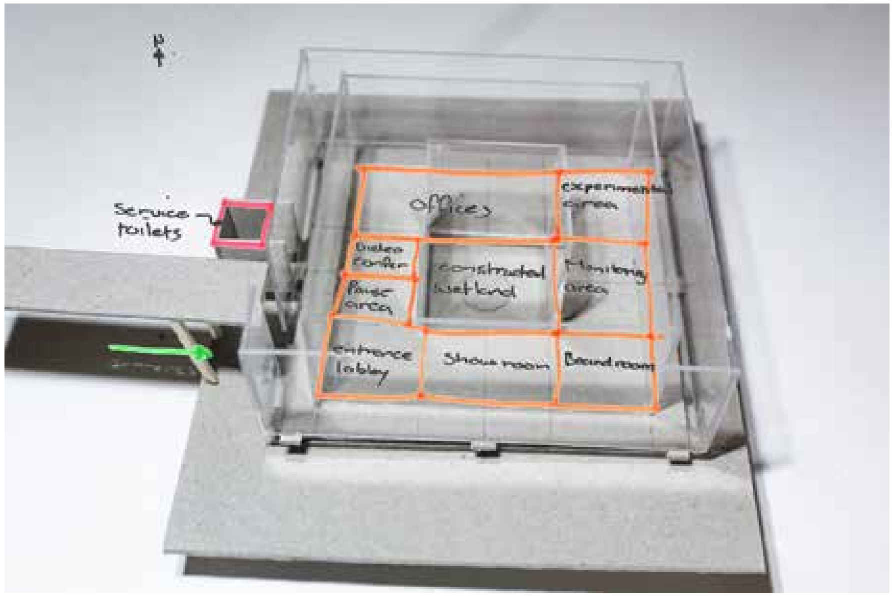


Figure 2.1.9 - Vodafone Site solution innovation centre - Model - Interior planning analysis

2.2 EASTGATE SHOPPING MALL

INTRODUCTION

Eastgate in Harare is a sustainable architectural expression that combines modern and traditional elements. The design incorporates regionalised features inspired by the ancient stone architecture of Great Zimbabwe and the local environment. The building utilises massive stone elements and small windows for sun protection, while precast concrete with exposed granite aggregate matches the natural landscape. Green vines supported by steel columns bring nature into the urban setting. The design is influenced by the concept of an ecosystem rather than a machine for living.

BUILDING INFORMATION

Architects: Mick Pearce collab Arup Engineers
Construction Year: 1991
Building Location: Harare, Zimbabwe
Main Function: Shopping Centre and Office blocks

Project Information:
The building takes inspiration from termite mounds and incorporates a self-cooling system, eliminating the need for air conditioning. With massive stone elements and strategic ventilation, it maintains a comfortable indoor environment. This innovative design showcases the potential of sustainable architecture.

Figure Examination

Figure 2.2.1 illustrates the south-facing facade, intentionally designed with minimal shading devices to facilitate the fullest possible influx of daylight. Additionally, the incorporation of substantial facade setbacks effectively diminishes direct sunlight exposure within interior spaces.

The east-facing facade presents fewer windows and a heightened emphasis on shading elements (figure 2.2.2). Notably, the enclosed atrium comes into view, serving a pivotal role in regulating the micro climate of the interior environment.

Figure 2.2.3 demonstrates the strategic integration of vegetation within the interior. This greenery plays a significant role in enhancing humidity levels and efficiently cooling the surrounding air.

Figure 2.2.1 - Eastgate shopping mall - South facade with minimum shading to maximise daylight

Image from Chayaamor-Heil & Vitalis, (2021) by Pierre Côté, Université Laval (nd). https://doi.org/10.1016/j.foar.2020.10.002

Figure 2.2.2 - Eastgate shopping mall - East facade with enclosed atrium space

Image by Ben Oduor (nd). https://issuu.com/constructiondigest/docs/cd_mag_final._/s/13819946

Figure 2.2.3 - Eastgate shopping mall - Internal space creating micro-climate

Image by gholamhossinarmin Pintrest (nd). https://www.pinterest.com/pin/378865387375876310/

ANALYSES - BUILDING MODEL

Program analysis

The building's functions are divided into two primary categories: a shopping mall occupies the ground and first floors, while office spaces span from the second to the eighth floors.

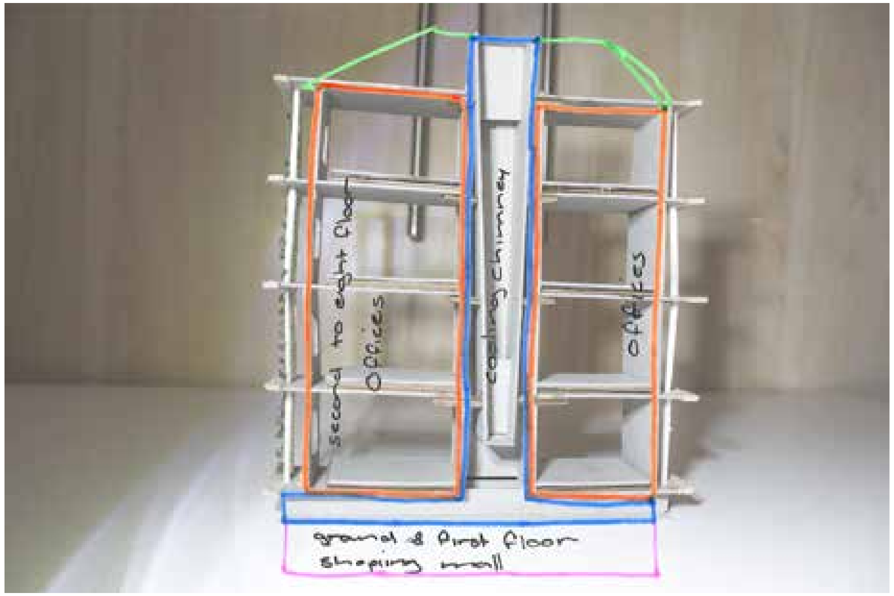


Figure 2.2.4 - Eastgate shopping mall - Model - Program analysis

Cooling chimney analysis

The chimney functions by pulling air through openings situated between the first and second floors. As the air passes through the thermal slabs, it undergoes cooling before entering the ventilation chimney. Subsequently, it is directed to the furthest extent of the room, situated below the floor slab on each level. This process effectively expels warm, stagnant air into the chimney, which is subsequently vented above the roof level.

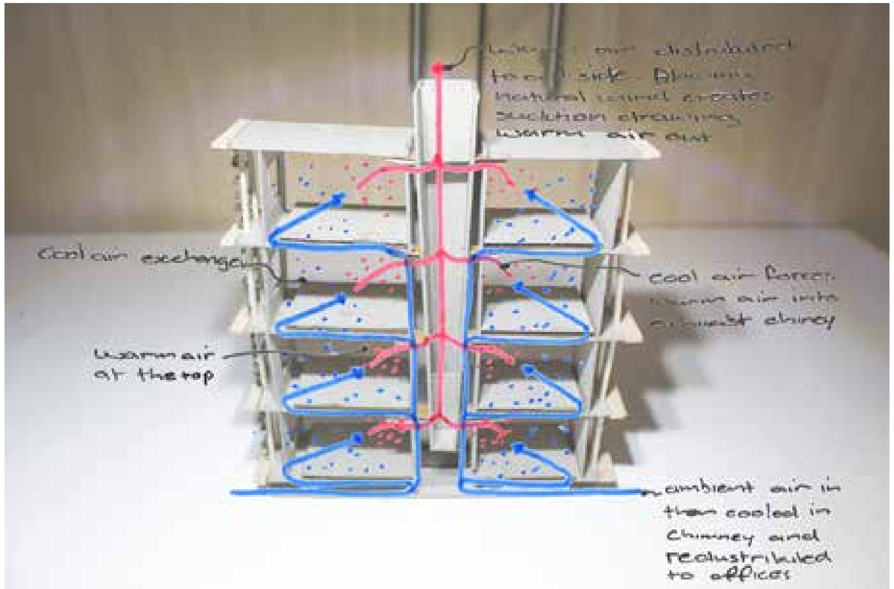


Figure 2.2.5 - Eastgate shopping mall - Model - Cooling chimney analysis

Exterior facade analysis

Vegetation is integrated into the facades to serve as a barrier and filter for low-angle sunlight, simultaneously contributing to the mitigation of direct sunlight exposure on the building's exterior.
To reduce the influx of direct sunlight, window openings are deliberately designed to be smaller. These openings are sealed in order to enhance the efficiency of the cooling system, facilitating a natural convection of airflow.

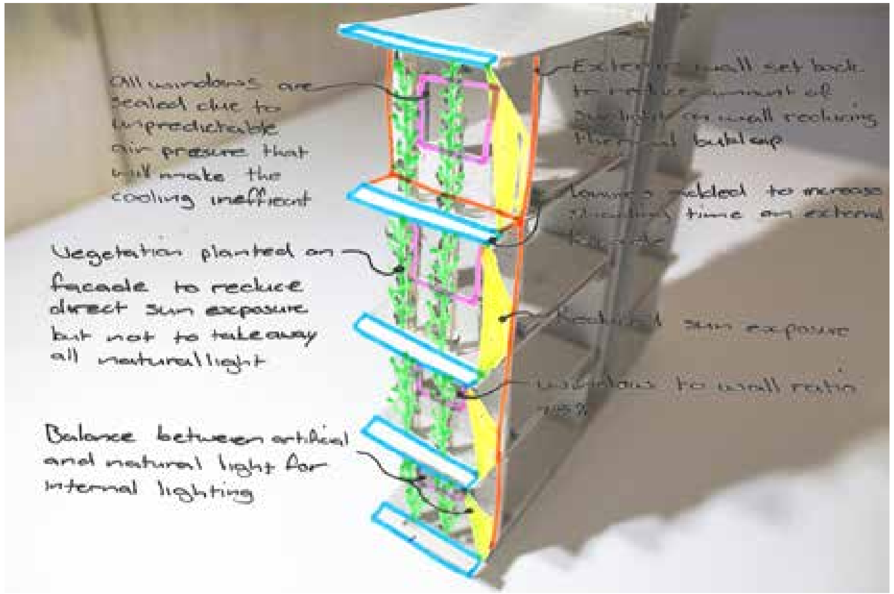


Figure 2.2.6 - Eastgate shopping mall - Model - Exterior facade analysis

Detail analysis of cooling chimney

Cold air is distributed through a floor void, extending to the farthest corner of the room, where the cooling effect of the slab comes into play.

Conversely, warm air is directed towards the exhaust shaft of the chimney positioned closest to the interior space, eventually finding its way to be vented above the roof.

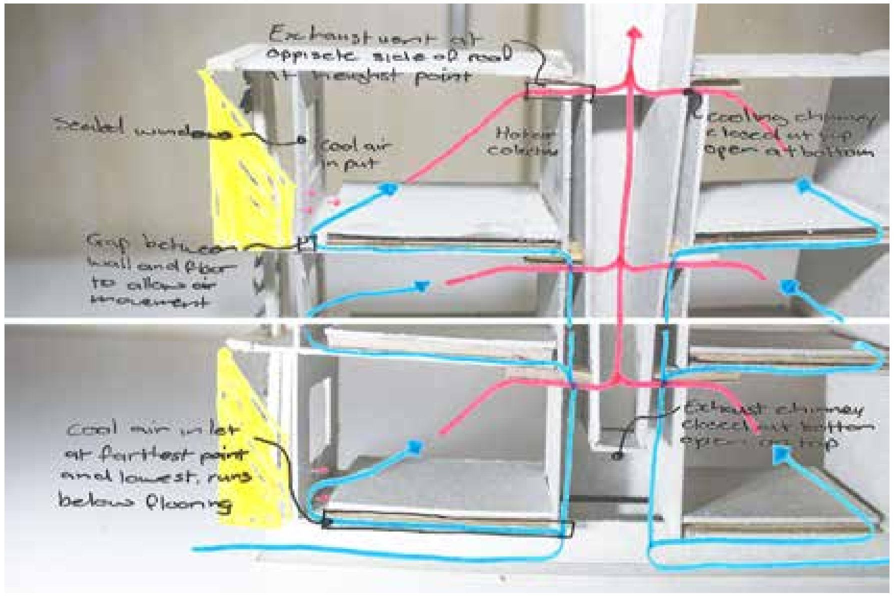


Figure 2.2.7 - Eastgate shopping mall - Model - Detail analysis of cooling chimney

Model - Atrium space analysis

The atrium area is covered with a translucent roof, which serves to filter and infuse light into the atrium space.

The roof also features apertures that facilitate the entry of cool air from above into the atrium, effectively ensuring the circulation of fresh air within the interior.

The heat accumulating in the atrium space is expelled through openings in the atrium's roof.

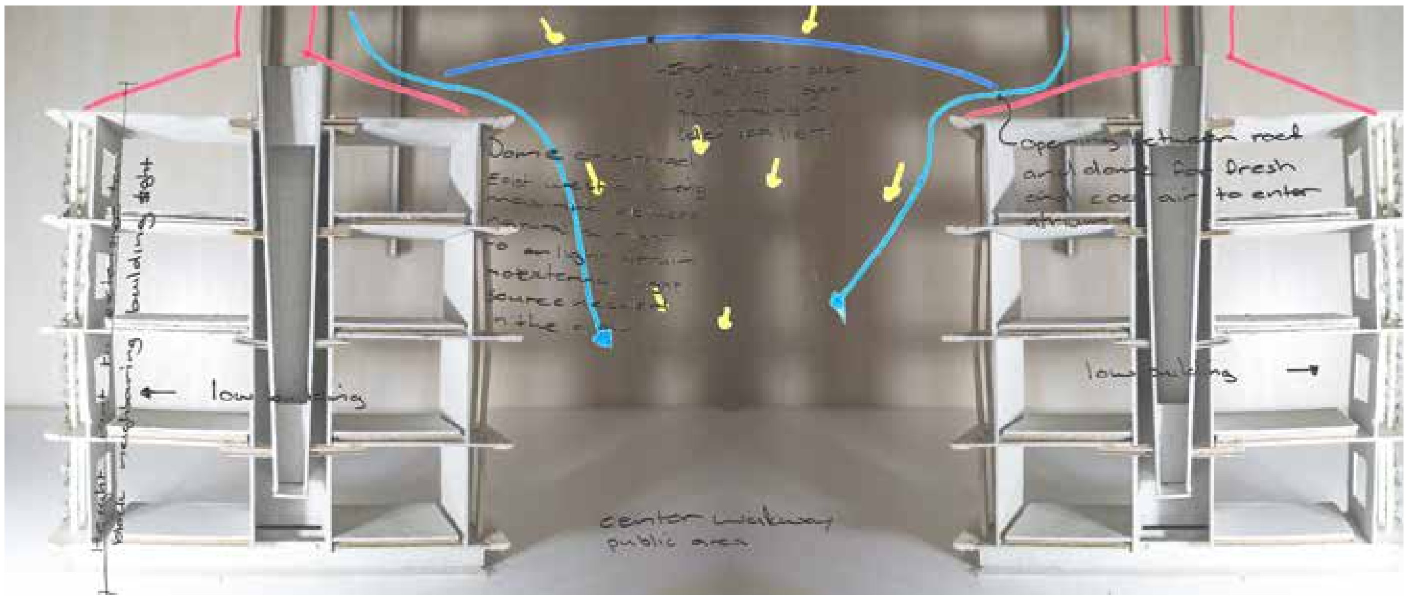


Figure 2.2.8 - Eastgate shopping mall - Model - Atrium space analysis

2.3 WITKLIPFONTEIN ECO LODGE

INTRODUCTION

Witklipfontein Lodge is a unique and sustainable home that seamlessly blends into its natural surroundings. It incorporates traditional vernacular building techniques with modern minimalistic design, creating a harmonious connection with nature. The lodge utilises thermal mass, such as thick stone walls and earth structures, to regulate temperatures without the need for mechanical air-conditioning. Various sustainable innovations, including recycled materials, renewable energy systems, and natural water treatment, contribute to its eco-friendly design. Witklipfontein Lodge serves as a showcase project for green building, embodying modern sustainability principles and reconnecting occupants with nature.

BUILDING INFORMATION

Architects: GLH Architects
Construction Year: 2018
Building Location: Vredefort, South Africa
Main Function: House

Project Information:
The building relies on the principles of thermal mass instead of mechanical air conditioning, utilising materials sourced on-site such as rock walls and rammed earth walls. This approach prioritises natural cooling methods and highlights the use of locally available resources in the construction process.

Figure Examination

In figure 2.3.1, the southern facades boast expansive openings strategically designed to facilitate the optimal infusion of daylight into the interior spaces.

Rammed earth walls are employed on the western and eastern facades (Figure 2.3.2). These walls serve to absorb heat gain while simultaneously minimising the radiation of heat into the interior spaces, leveraging their substantial thermal mass.

Figure 2.3.3 highlights the building's integration into the surrounding landscape, ensuring a harmonious fit within the natural surroundings. This positioning also capitalises on the inherent cooling properties of the natural earth edges.

Figure 2.3.1 - Witklipfontein Eco Lodge - South facade with views to each space and access to natural sunlight

Image by GLH Architect (2018). https://www.glh.co.za/app/glh/index.html#/work/15/project-info

Figure 2.3.2 - Witklipfontein Eco Lodge - Rammed earth walls to absorb heat reducing interior heat gain

Image by GLH Architect (2018). https://www.glh.co.za/app/glh/index.html#/work/15/project-info

Figure 2.3.3 - Witklipfontein Eco Lodge - Building set into landscape utilising earth edges to cool interior spaces

Image by GLH Architect (2018). https://www.glh.co.za/app/glh/index.html#/work/15/project-info

ANALYSES - BUILDING MODEL

Sizable roof overhangs provide coverage for the outdoor patio area. Furthermore, the entire building benefits from extensive roof overhangs, creating extended areas of shade.

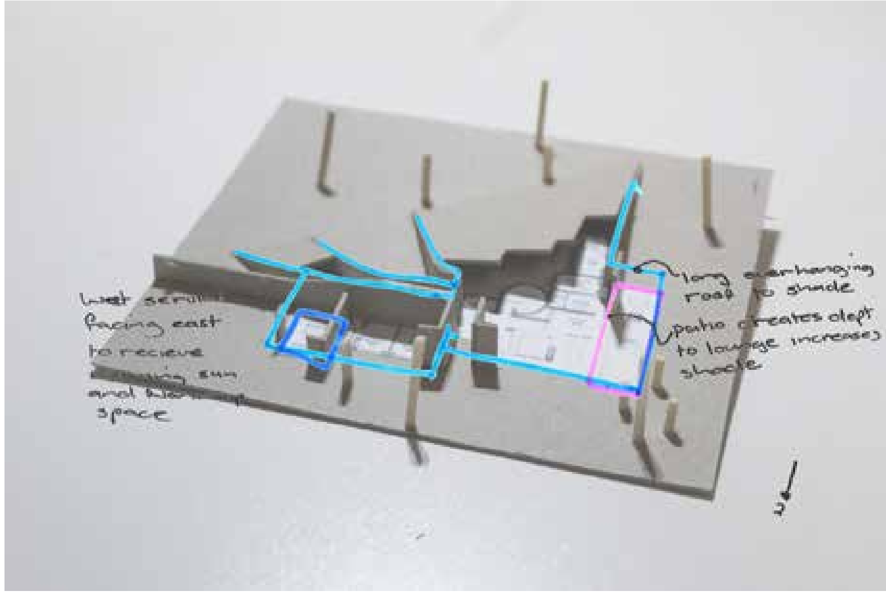


Figure 2.3.4 - Witklipfontein Eco Lodge - Model - Roof overhang analysis

The building is harmoniously integrated into the landscape, harnessing the cooling effects of the earth’s edges. Additionally, the roof is adorned with vegetation to mitigate heat absorption. Within the roof, light wells facilitate the penetration of daylight into the deeper interior spaces.

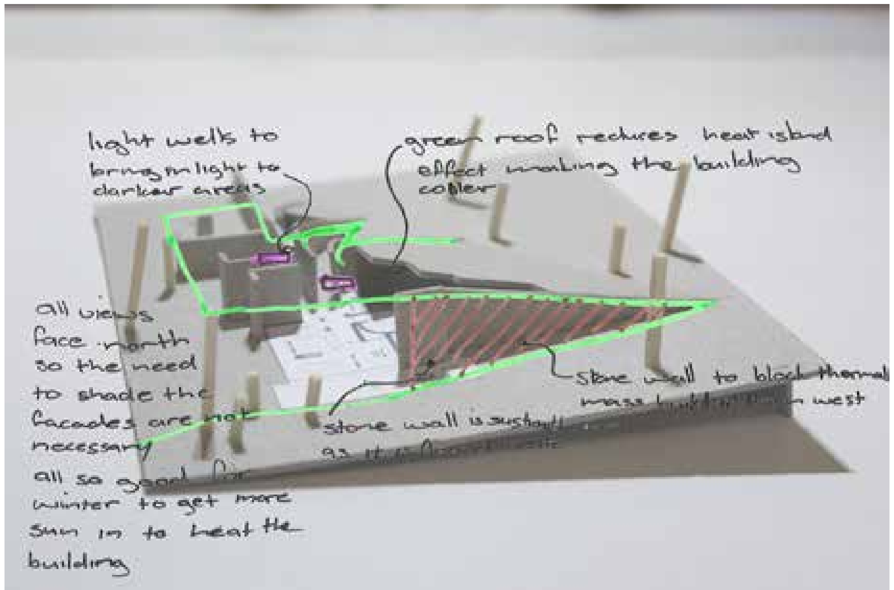


Figure 2.3.5 - Witklipfontein Eco Lodge - Model - Integration into landscape for cooling

Integration with nature to pre-cool winds

The site features a variety of vegetation strategically employed to enhance cooling and provide shading. This greenery also contributes to the preservation of the ecosystem, ensuring the natural water flow on the site remains intact without disruption.

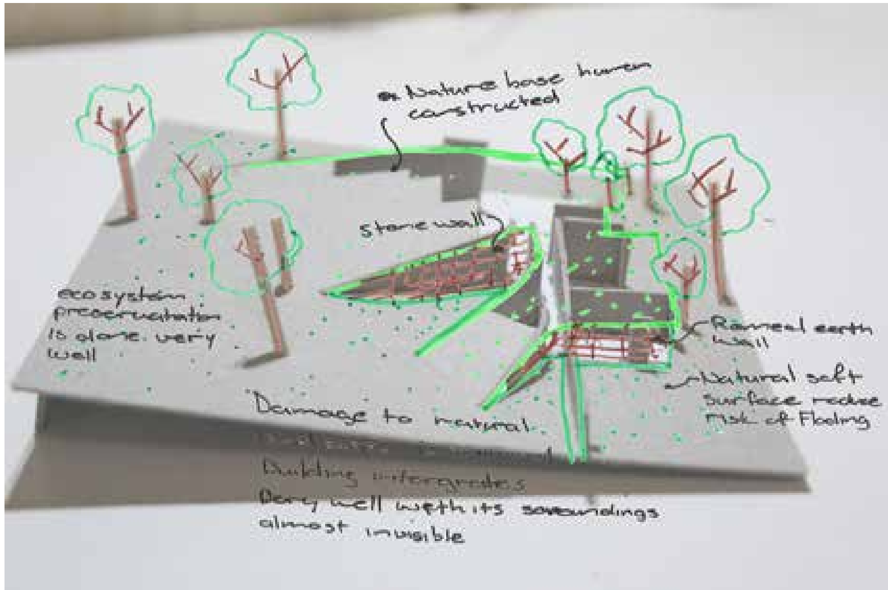


Figure 2.3.6 - Witklipfontein Eco Lodge - Model - Integration with nature to pre-cool winds

2.4 NEW BARIS VILLAGE

INTRODUCTION

Architect Hassan Fathy's New Baris village stands as a significant project, akin to his renowned New Gourna undertaking. Located in a remote wilderness in Egypt, New Baris aimed to be a self-sustainable agricultural community. Fathy faced the challenge of designing for an unknown population, relying on surveys for guidance. Inspired by local architecture and the region's climate, Fathy prioritised natural systems and passive design. The vibrant central souk, surrounded by purposeful buildings, became the heart of the community. Fathy ingeniously addressed cold storage needs with thermal mass materials and innovative airflow techniques. Residential quarters were organised along shaded streets, utilising orientation for heat relief. The village's design fostered continuous airflow and a convective system

BUILDING INFORMATION

Architects: Hassan Fathy
Construction Year: 1964 - Incomplete
Building Location: Baris, Egypt
Main Function: Village

Project Information:
The aim of the project was to establish a self-sustainable village that heavily relied on passive design strategies, considering the absence of power supply in the area. Unfortunately, the project was halted due to government regulations deeming earth bricks unsafe for construction purposes. Despite the setback, the project sought to create a community that could thrive without relying on external energy sources, emphasising the importance of sustainable and low-impact design approaches.

Figure Examination

In figure 2.4.1, compact exterior openings are depicted, serving the purpose of minimising direct sunlight exposure within interior spaces.

Figure 2.4.2 illustrates how interior spaces are intentionally situated at a greater depth, affording them a cooler environment.

Moving to figure 2.4.3, the facades are strategically recessed to mitigate the direct entry of sunlight into the interior spaces. Ventilation openings positioned at the upper sections of the facade serve a dual purpose: enabling the intake of cool air into the spaces and facilitating the exhaust of warm air from the interior.

Figure 2.4.1 - New Baris Village - Village exterior orientation unknown

Image by Senses Atlas (2020). https://www.sensesatlas.com/hassan-fathy-building-in-the-desert-in-new-baris/

Figure 2.4.2 - New Baris Village - Deep spaces to shade and cool interior

Image by Senses Atlas (2020). https://www.sensesatlas.com/hassan-fathy-building-in-the-desert-in-new-baris/

Figure 2.4.3 - New Baris Village - Facade setback with fenestration cool and vent heat interior

Image by Senses Atlas (2020). https://www.sensesatlas.com/hassan-fathy-building-in-the-desert-in-new-baris/

ANALYSES - URBAN SCALE

Village orientation

The Village is aligned along a north-south axis, a strategic orientation that facilitates future expansion.

This positioning enables the Village to effectively utilise building shadows, cooling the spaces between streets throughout the day, given that the predominant sun exposure comes from the south throughout the year.

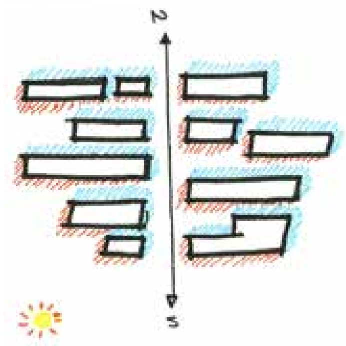


Figure 2.4.4 - New Baris Village - Village orientation

Wind channeling through village

Buildings and street dimensions align meticulously with prevailing winds for efficient cooling and ventilation.
Buildings are strategically oriented east-west to channel northwest winds evenly through the Village.
Narrower streets amplify wind speeds and enhance shading, both enhancing the cooling effect.

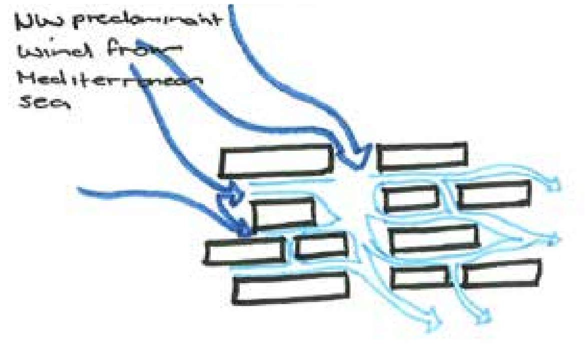


Figure 2.4.5 - New Baris Village - Wind channeling through village

Village inhabitants ratio

To enhance the village's resilience, it is composed of an equal distribution of 50 percent farmers and 50 percent personal service providers. This balanced composition ensures a continuous market for farmers to sell or trade their goods, while also offering essential services for repair and sale of necessary items. This self-sufficient arrangement eliminates the reliance on external aid, promoting the Village's autonomy.

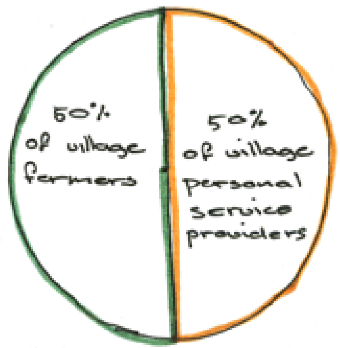


Figure 2.4.6 - New Baris Village - Village inhabitants ratio

Continuous ventilation

The architectural layout strategically harnesses the concept of continuous ventilation, operating in a manner that efficiently expels warm air from various spaces while simultaneously ensuring the maintenance of a consistently cool interior atmosphere. This ventilation strategy not only promotes effective thermal regulation but also contributes to the overall comfort and sustainability of the environment within.

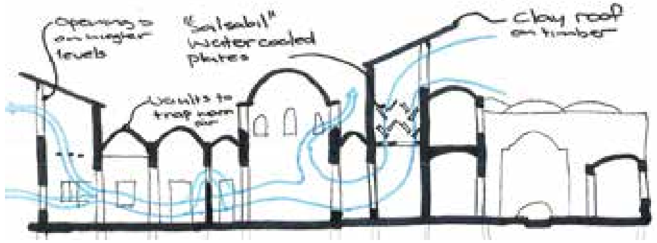


Figure 2.4.7 - New Baris Village - Continuous ventilation

Dwelling layouts to create cool spaces in between

Homes encircle courtyards, utilising compact layouts for efficient shading. Dwellings extend toward these courtyards for cooling benefits.

Exterior perimeters of connected residences adopt enclosed designs, reducing warm air entry.

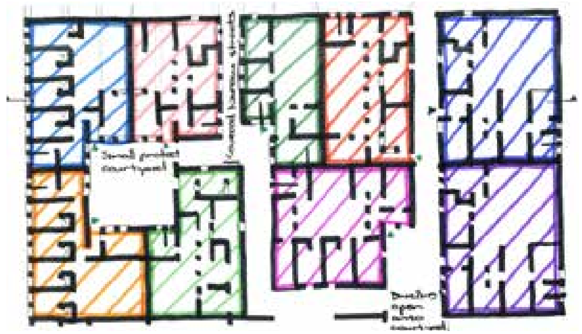


Figure 2.4.8 - New Baris Village - Dwelling layouts to create cool spaces in between

ANALYSES - DETAIL SCALE

Shuksheika - Fenestrated openings in dome of main hall

The Shuksheika functions as a means to expel warm air through its openings. These openings are predominantly open but have the flexibility to be shut if needed. As heat ascends, it reaches the upper regions of the vaulted roof, ultimately venting out at the top.

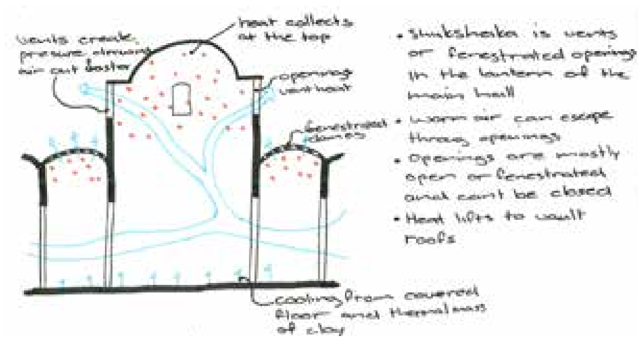


Figure 2.4.9 - New Baris Village - Shuksheika - Fenestrated openings in dome of main hall

Rasha / Taka - Opening in upper level of wall to exterior

The Rasha / Taka serves as a modest aperture situated at the upper section of the wall, enabling the release of warm air confined at the elevated ceiling. This mechanism generates a convection current that draws in cool air from the interior.

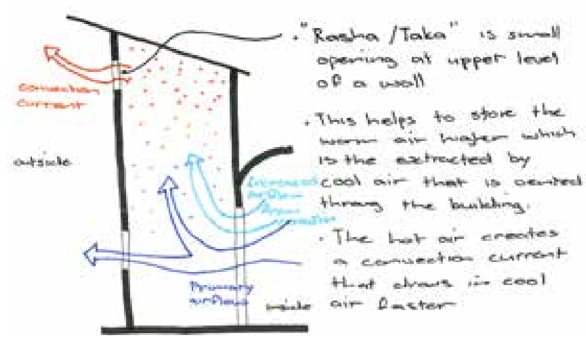


Figure 2.4.10 - New Baris Village - Rasha / Taka - Opening in upper level of wall to exterior

Taktaboosh - Covered outdoor niches

Taktaboosh refers to an outdoor sheltered alcove that forms shaded spaces amidst buildings.

This design harnesses the inherent outdoor cooling while establishing a human-scale connection between the structures.

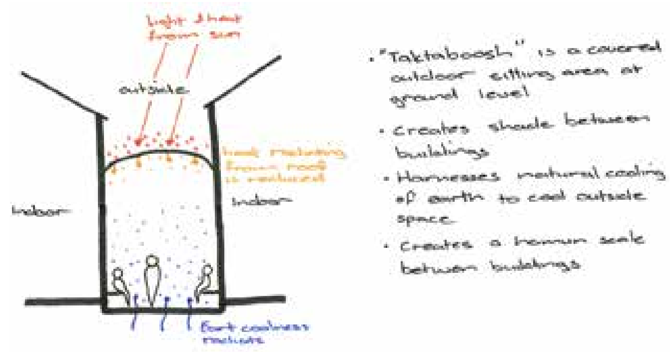


Figure 2.4.11 - New Baris Village - Taktaboosh - Covered outdoor niches

VISUAL ANALYSES - ELEMENTS

Shaded colonnades

The incorporation of deep colonnades serves a dual purpose: firstly, they offer substantial shaded areas for pedestrians to walk comfortably, shielding them from the sun's direct rays; secondly, these colonnades effectively curtail the extent of direct sunlight that enters interior spaces, contributing to a cooler and more comfortable indoor environment.

Figure 2.4.12 - New Baris Village - Shaded colonnades

Internal cool courtyard

Vegetation within internal courtyards plays a crucial role in generating shading effects. Additionally, this greenery aids in cultivating humidity levels, facilitating the cooling of air within these spaces.

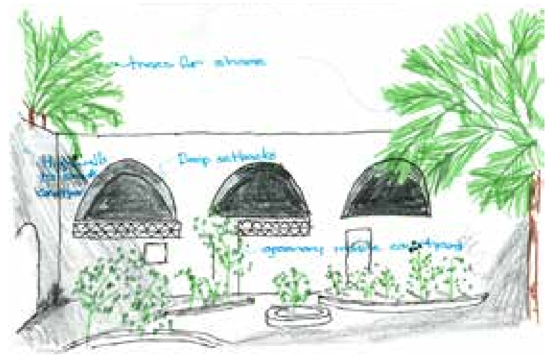


Figure 2.4.13 - New Baris Village - Internal cool courtyard

Internal vaults with fenestrations in walls

The deep interior spaces are equipped with fenestrations located in both the walls and the domed roof. These openings enable the penetration of daylight while simultaneously limiting the direct influx of sunlight into the interior areas. This design feature effectively contributes to maintaining cool temperatures within the interior spaces.

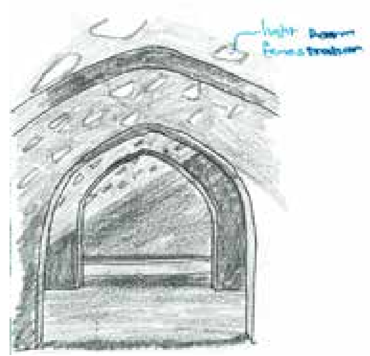


Figure 2.4.14 - New Baris Village - Internal vaults with fenestrations in walls

Narrow streets for cool outdoor spaces

The streets are characterised by their narrow width and tall walls, deliberately designed to maximise the shaded areas between them.

This intentional arrangement aids in mitigating the heat island effect, thereby fostering cooler and more comfortable street environments.

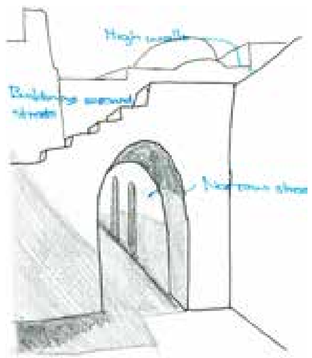


Figure 2.4.15 - New Baris Village - Narrow streets for cool outdoor spaces

2.5 SECTION CONCLUSION

INTRODUCTION

Passive design strategies encompass a bundle of techniques that work together synergistically for improved efficiency. Material selection is crucial for their success, as different materials possess distinct thermal properties and insulation capabilities. Integrating diverse materials with the right techniques, like using high thermal mass materials for heat absorption or insulating materials for temperature control, enhances energy efficiency. Material choices also affect factors such as solar reflectance and sustainability. Architects achieve optimal efficiency by combining materials and strategies, resulting in buildings that are functional, aesthetically pleasing, and environmentally conscious. This approach aligns with a sustainable future by minimising environmental impact and creating spaces that meet occupants' needs.

FINDINGS

Passive design strategies rely on various key aspects for their effectiveness:

Orientation:
Proper orientation of a building is crucial to maximise natural daylighting, minimise heat gain from the sun, and optimise natural ventilation. Designing openings and spaces in response to the sun's path can help control temperature and lighting levels.

Internal circulation:
Considerations should be given to the width and height of internal circulation spaces to promote shading and reduce the heat island effect within the building. Well-designed circulation areas can contribute to thermal comfort and energy efficiency.

Wind direction:
Understanding the prevailing wind direction allows for the strategic placement of openings and building configurations to facilitate natural ventilation. Ventilation pathways between buildings can be designed to promote air exchange and cooling.

Courtyards:
Placing courtyards at the center of dwellings can create cooler outdoor spaces that provide natural ventilation and a connection to the surrounding environment. Courtyards can act as thermal buffers, enhancing comfort within the building.

Continuous ventilation:
Utilising continuous ventilation systems takes advantage of the thermal mass of interior walls to cool incoming fresh air. This approach helps maintain comfortable indoor temperatures while reducing reliance on mechanical cooling systems.

Micro society:
Creating a sense of community and promoting a self-reliant environment within a building or development is essential for long-term sustainability. Encouraging social interaction, shared resources, and a sense of responsibility among occupants fosters a sustainable and resilient community.

Relationship among strategies "Bundling"
Strategies cannot operate in isolation and are best combined to form bundles.

Integrated strategies encompass a unified array of interconnected methods aimed at addressing common design challenges.

To enhance wind flow, light, and cooling, architects incorporate elements such as vaulted structures and strategically positioned openings, like lanterns. These components are intended to optimise air circulation, ensuring efficient ventilation, while also maximising the infusion of natural light. Simultaneously, this approach fosters effective cooling within the space, resulting in a harmonious synergy that elevates the overall environmental quality.

CLIMATE CONDITIONS OF THE SITE CONSIDERED ACCORDING TO DEKAY AND BROWN, (2014) SUN, WIND AND LIGHT

Upon thorough examination of the precedent studies, it became evident that the principles applied in those projects closely align with the concepts discussed in the literature review by Dekay and Brown (2014).

Temperature

Considering the site's climate conditions, such as temperature, is crucial. Temperature significantly affects comfort, energy efficiency, and building performance. By understanding local temperature patterns, architects can design with shading, insulation, and ventilation systems that optimise comfort and energy use. This knowledge, combined with insights into sun and wind patterns, enables architects to create holistic solutions for sustainable and comfortable spaces.

Relative humidity

Recognising climate conditions such as relative humidity is vital in architectural design. Relative humidity directly affects comfort, indoor air quality, and building performance. Architects must address it to design proper ventilation. This consideration ensures healthier, more comfortable, and efficient buildings, aligned with local climate realities.

Wind

Wind impacts ventilation, orientation, and material choice. Leveraging wind patterns allows architects to enhance natural ventilation, improve comfort, and reduce energy reliance. This consideration ensures effective and sustainable designs that align with the local environment.

Day light

Daylight affects well-being, energy use, and building performance. Incorporating natural light through strategic design enhances visual comfort, reduces energy consumption, and fosters a connection with the outdoors. Integrating daylight intelligently ensures sustainable designs aligned with the site's unique characteristics.

Solar radiation

Solar radiation impacts energy use, comfort, and sustainability. Properly managing solar exposure through design elements reduces energy consumption, enhances comfort, and ensures the longevity of materials. By considering solar radiation alongside other factors, architects are able to create designs that optimise energy efficiency and occupant well-being.

PRINCIPLES USED ACCORDING TO DEKAY AND BROWN, (2014) SUN, WIND AND LIGHT

Well-lighted primary spaces

Well-lighted primary spaces involve positioning key areas to receive ample natural daylight. This entails placing living, working, and communal spaces strategically with windows and openings to minimise artificial lighting use.

This approach enhances energy efficiency and occupant comfort, aligning with sustainable design principles.

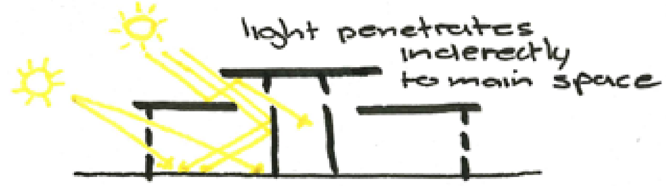


Figure 2.5.1 - New Baris Village - Well lighted primary spaces

Cooling neighbourhood

Cooling neighbourhood concept focuses on designing communities that utilise passive cooling methods.

By strategically positioning buildings, incorporating shading, promoting ventilation, and using materials with high thermal mass, this approach enhances comfort and reduces energy use in warm climates.

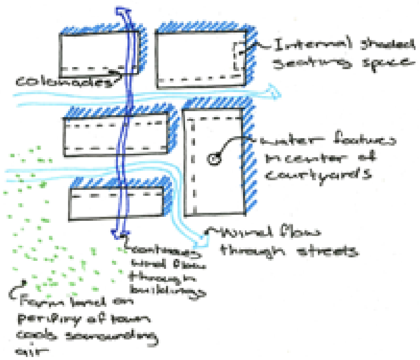


Figure 2.5.2 - New Baris Village - Cooling neighbourhood

Integrated urban patterns

This approach considers natural factors like sunlight, wind, and light to shape the layout of buildings and streets. By strategically positioning structures, green spaces, and pedestrian routes, integrated urban patterns enhance energy efficiency, human comfort, and overall sustainability. This aligns urban design with the local climate, fostering a harmonious balance between the built environment and nature.

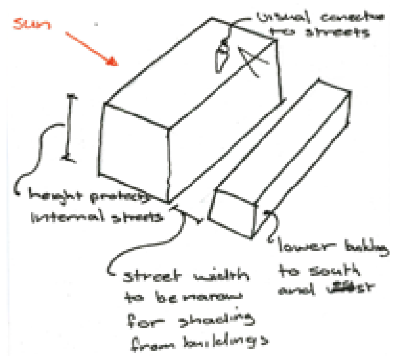


Figure 2.5.3 - New Baris Village - Integrated urban patterns

SECTION 2 PRECEDENT PASSIVE DESIGN - 2.5 SECTION CONCLUSION

Micro climate shaping

Micro climate shaping means designing to change local climate conditions. Through architecture, vegetation, and materials, this approach adjusts temperature, airflow, and light. Creating sheltered areas, optimising solar exposure, and promoting ventilation shapes micro climates for comfort and efficiency. This strategy tailors environments to human needs, fostering sustainable design that adapts to local conditions.

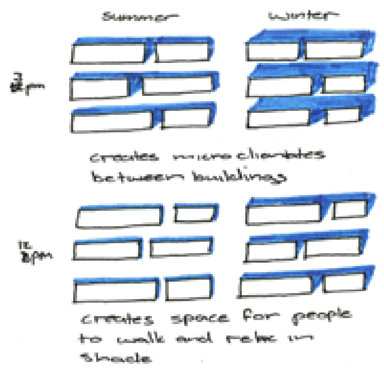


Figure 2.5.4 - New Baris Village - Micro climate shaping

Multivalent design - Combining functions in a single building

Multivalent design involves creating architectural solutions that serve multiple functions. By considering factors like sun, wind, and light, spaces are designed that balance energy efficiency, aesthetics, comfort, and sustainability. This approach aligns with a holistic perspective, aiming for adaptable and responsive designs that optimise resources and overall performance.

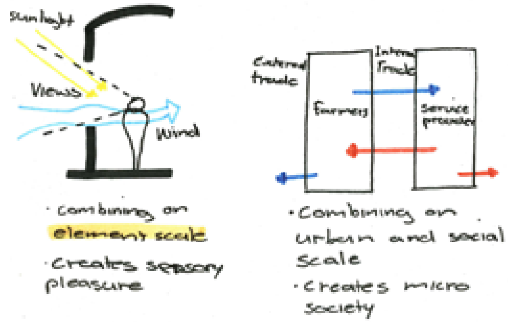


Figure 2.5.5 - New Baris Village - Multivalent design - Combining functions in a single building

Passively cooled buildings

Passively cooled buildings are designed to naturally regulate temperature using strategies like shading, ventilation, and thermal mass.

By harnessing local climate conditions, architects are able to create comfortable spaces while minimising energy use. This approach aligns with sustainability, prioritising harmony between the built environment and nature

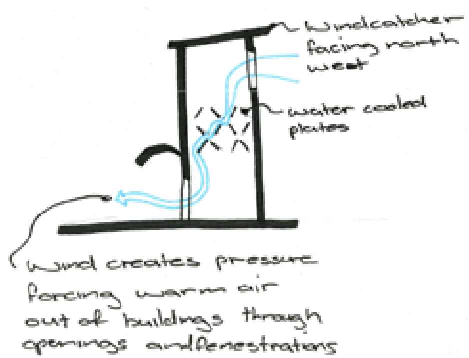


Figure 2.5.6 - New Baris Village - Passively cooled buildings

Spatial zoning - Provide access to light, sun and wind

Spatial zoning involves dividing spaces into functional zones to optimise factors like sunlight and wind.

This strategy creates efficient and comfortable environments that respond to local climate conditions, enhancing both usability and sensory experience.

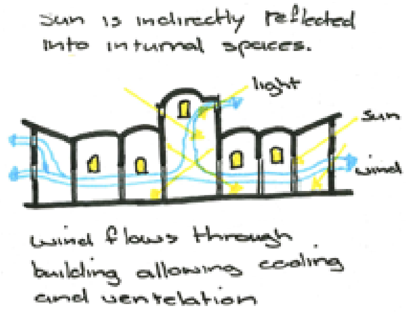


Figure 2.5.7 - New Baris Village - Spatial zoning - Provide access to light, sun and wind

Spatial zoning - Selection of best form and grouping of forms

Spatial zoning entails two aspects: selecting optimal forms and organising them into effective groups. This involves choosing architectural shapes that align with function and climate, then arranging them to maximise efficiency, comfort, and aesthetics. This approach ensures spaces are well-suited to factors like sunlight and wind, creating cohesive and responsive designs.

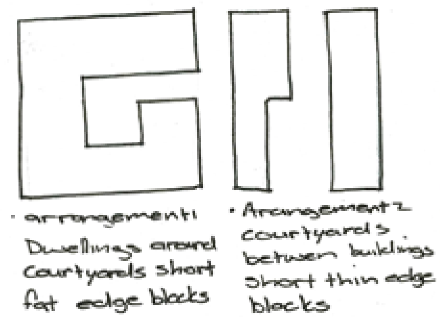


Figure 2.5.8 - New Baris Village - Spatial zoning - Selection of best form and grouping of forms

Thermal mass

Thermal mass refers to materials' ability to store and release heat gradually. Architects use materials like concrete or brick to stabilise indoor temperatures. These materials absorb heat during the day and release it at night, enhancing energy efficiency and maintaining comfort.

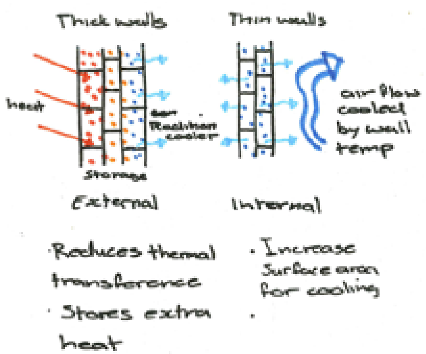
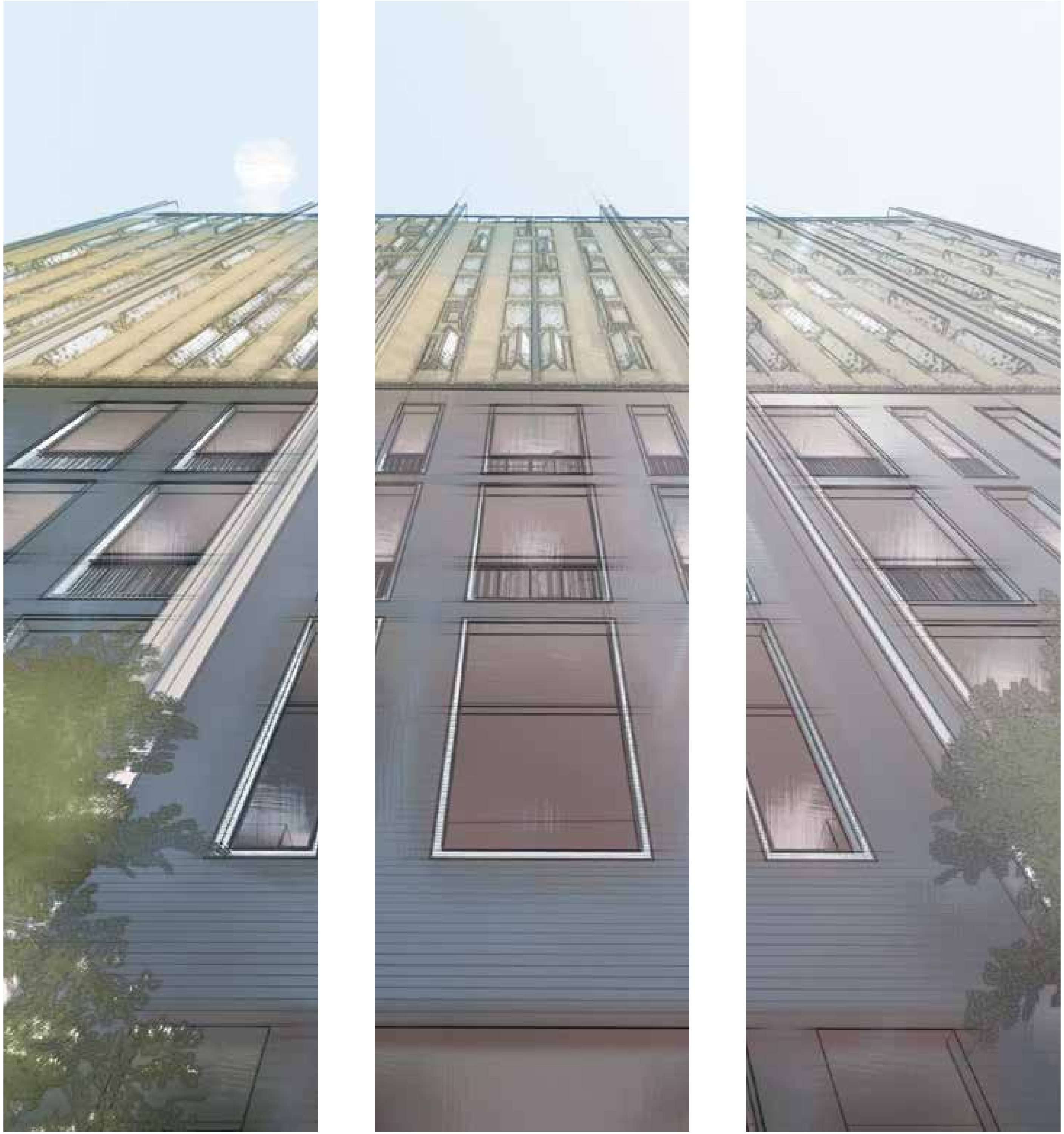


Figure 2.5.9 - New Baris Village - Thermal sailing



SECTION 3

MATERIALS AND COMPONENTS STUDY

Materials and building components are of paramount importance in passive design strategies for sustainable buildings. They influence thermal mass, insulation, natural ventilation, shading, roofing, daylighting, and more. The analysis of materials and components for passive sustainability encompasses factors such as thermal performance, solar gain, daylighting, ventilation, durability, sustainability, local availability, cost, health considerations, recyclability, compatibility, and adherence to regulatory requirements. This comprehensive assessment ensures that the chosen materials align with passive sustainability strategies in architectural design. Properly chosen materials and components enhance energy efficiency, comfort, and environmental sustainability.

3.1 FACADE ELEMENTS

INTRODUCTION

The integration of facade elements is a cornerstone of passive design, where architectural features are strategically employed to enhance a building's energy efficiency and occupant comfort. These elements go beyond mere aesthetics, serving as dynamic tools to harness natural resources such as sunlight, wind, and shade. By thoughtfully incorporating elements like shading devices, glazing orientation, and thermal insulation into a building's facade, architects create an environmentally responsive envelope that optimises indoor conditions while reducing energy consumption. This synergy between facade design and passive strategies underscores the potential for sustainable and harmonious architecture, where form and function converge to create spaces that are both visually striking and operationally efficient.

GREEN FACADE ELEMENTS

Aung et al., (2023) notes that green facades hold great importance in modern building design due to their numerous benefits such as:

Air quality enhancement: Green facades act as natural air filters, effectively removing pollutants and particulate matter from the atmosphere.

Thermal regulation: They provide insulation to buildings, thereby reducing the need for excessive heating or cooling, leading to lower energy consumption and associated cost savings.

Energy efficiency: By decreasing the energy required for temperature control, green facades contribute to improved overall energy efficiency in urban areas.

Noise reduction: Green facades absorb and deflect sound, mitigating noise pollution from traffic and other urban sources, creating a quieter and more pleasant environment.

Aesthetic improvement: Besides their functional advantages, green facades also enhance the visual appeal of buildings and soften the often harsh and monotonous urban landscapes.

Biodiversity promotion: They offer habitats for various forms of urban wildlife, promoting biodiversity within city limits.

Stormwater management: Green facades aid in rainwater absorption, reducing runoff and helping manage stormwater in cities, which can alleviate flooding concerns.

Well-being and mental health: The presence of greenery and a connection with nature positively influence mental health, offering residents and city dwellers a sense of well-being.

Carbon sequestration: Green facades play a role in mitigating climate change by absorbing carbon dioxide, aiding in emissions reduction.

Mitigating urban heat island effect: They contribute to cooling urban areas, providing shade and helping counteract the urban heat island effect, which is a significant concern in many cities.

While green facades do have their drawbacks, the advantages they offer far outweigh these limitations. Incorporating green facades harmonises architecture with nature, offering a holistic solution that benefits the environment, aesthetics, and occupants.

Full cover green facades

Green facades offer dual benefits by blocking direct sunlight and minimising thermal heat gain.

However, they demand high maintenance and water consumption, making them less viable in arid areas. Pest attraction is a concern, and their implementation might raise suspicions of green washing in some cases.

Careful evaluation is crucial before integrating green facades into designs.

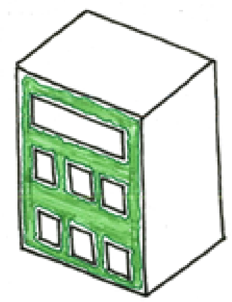


Figure 3.1.1 - Full cover green facades

Partial covered green facade

Reducing direct sunlight into buildings yields various benefits. While it minimises facade shading, it requires strategic planning to address parallel sun rays. However, improved air quality indoors and enhanced visibility of the natural environment are notable advantages. This approach often involves using vine-type plants to achieve these outcomes effectively, blending sustainability and functionality in design.

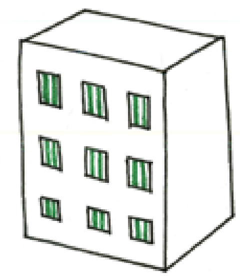


Figure 3.1.2 - Partial covered green facade

Planters on facade

Minimising direct sunlight in buildings offers multiple benefits. It lessens facade shading, particularly from low-angle sunlight, improving indoor comfort. This approach enhances air quality and provides occupants with clearer views of the outdoors. Incorporating personal gardens adds a distinctive aesthetic touch, blending nature seamlessly with functional design.

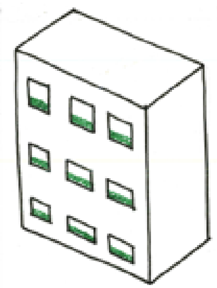


Figure 3.1.3 - Planters on facade

VIABLE PLANTS FOR GREEN FACADE ELEMENTS

Table 1 - Creepers / Vines for green facade elements

Creepers / Vines

Image	Scientific name	Common name	Facts
 Image by Lorna Krig (2022). https://gardenerspath.com/plants/flowers/grow-jasmine/	**Jasminum fluminense** **or** **Jasminum multipartitum**	Brazilian jasmine Starry wild jasmine	These woody creeper plants are well-suited for warm, arid climates. They are known for producing highly fragrant flowers with a strong, sweet aroma.
 Image by Gardenia Creating Gardens,(n.d.). https://www.gardenia.net/plants/genera/ipomoea-morning-glory	**Ipomoea adenioides**	Trumpet morning glory	These woody creeper plants come in multple colors.
 Image by Atlasing in Namibia, (n.d.). http://www.the-eis.com/atlas/?q=node/5390	**Solanum seaforthianum**	Brazilian nightshade	This creeper demonstrates exceptional heat resistance and produces berries as well.

Table 2 - Grasses for green facade elements

Grasses

Image	Scientific name	Common name	Facts
 Image by Random Harvest, (n.d). https://www.randomharvest.co.za/South-African-Indigenous-Plants/Show-Plant/PlantId/370/Plant/Aristida-junciformis?Filter=All	**Aristida Junciformis**	Gongoni grass	The seeds remain on the plant for an extended period, typically from November to May, and the stems retain their green color for a while into the winter, making it an ideal choice for landscaping.
 Image by SANBI, (n.d-a). https://pza.sanbi.org/cenchrus-ciliaris	**Cenchrus Ciliaris**	Foxtail buffalo grass	Cenchrus Ciliaris is highly regarded for its nutritional value and is an excellent choice for pastures in hot, arid regions. It is prized for its ability to produce tasty forage and support grazing during dry spells in tropical areas.
 Image by SANBI, (n.d-c). https://pza.sanbi.org/melinis-repens	**Melinus Repens**	Natal red top	Melinis repens is often an annual but can sometimes exhibit perennial traits. Natal Red Top is excellent for soil erosion control and horticultural use.

WALL ELEMENTS

Wall elements are pivotal in passive design, crucial for regulating temperature, providing insulation, controlling solar heat, and managing airflow. They also impact a building's aesthetics, indoor air quality, and sustainability through material selection. In essence, well-designed wall elements significantly enhance energy efficiency, comfort, and environmental impact. Saadatian et al., (n.d.) mentions focus to reduce energy is the emphasized, but lacks the use off elements like walls to reduce usage further

Solid brick wall

Solid walls exhibit high thermal mass, increasing the thermal lag within interior spaces (Li et al., 2015). Conversely, a drawback stems from their substantial thermal mass, resulting in heightened heat radiation during the night. On a positive note, their exceptional airtightness diminishes heat loss and gain. Additionally, their straightforward construction method contributes to afford ability and simplicity in design.

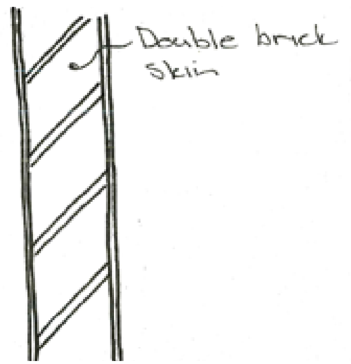


Figure 3.1.4 - Solid brick wall section

Cavity brick wall

Cavity walls offer high thermal mass, creating a higher thermal lag. The cavity extends this lag, reducing heat radiation to interiors (Construction Tuts, 2017). Their strong airtightness minimises heat gain or loss, and their effective insulation results from the air gap between brick layers. These features make cavity walls an energy-efficient choice in passive design, ensuring comfort indoors. They are ideal for east and west facades

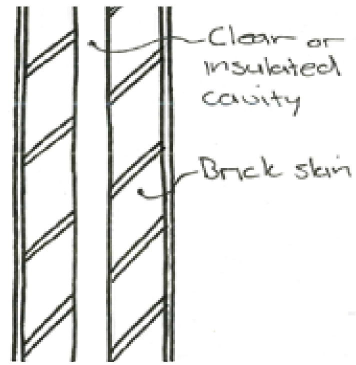


Figure 3.1.5 - Cavity brick wall section

Clay brick wall

With a high thermal mass, clay bricks exhibit a notably higher thermal lag. Their strong airtightness effectively reduces heat gain or loss. Additionally, these bricks are environmentally conscious, being derived from natural earth materials (Brick Development Association, 2022). Nonetheless, their cost can vary, influenced by the quality of the brick itself.

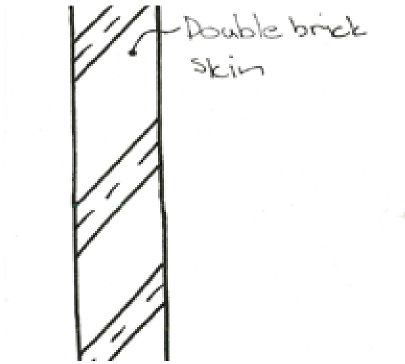


Figure 3.1.6 - Clay brick wall section

Concrete hollow block wall

Concrete hollow blocks, characterised by their thin exterior, possess a low thermal mass, resulting in a low thermal lag. The inclusion of an air gap further reduces this lag. The construction process is expedited due to the uniform and interlocking nature of these blocks. Additionally, they present a cost-effective choice among options. These walls are good for east and west facades.

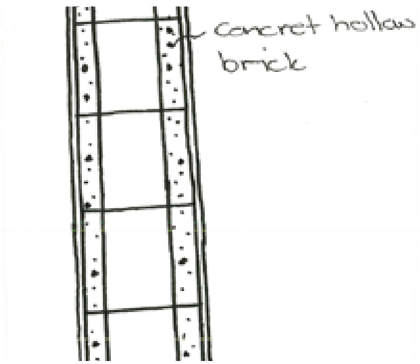


Figure 3.1.7 - Concrete hollow block wall section

Insulated concrete hollow block wall

With a low thermal mass, the walls exhibit a lower thermal lag. Enhancing insulation by filling the air gap bolsters its insulating properties. This option carries a slightly higher cost compared to concrete hollow block walls due to the incorporation of insulation.

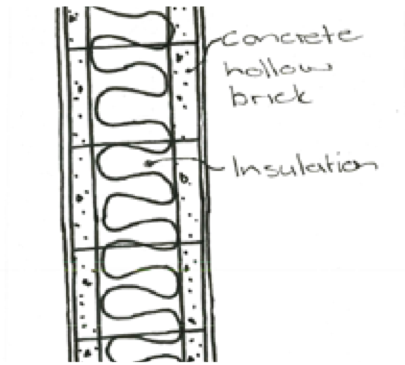


Figure 3.1.8 - Insulated concrete hollow block wall section

Wood framed wall

Wood boasts exceptional thermal insulation, effectively curbing heat radiation within interior spaces. Its rapid construction method involves off-site panel fabrication for convenient installation. Despite its sustainability, the expense arises from the challenge of sourcing the required quality of wood, often not locally available.

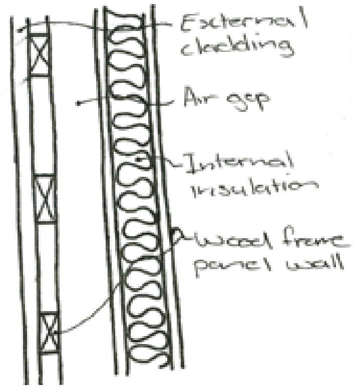


Figure 3.1.9 - Wood framed wall section

Steel framed wall

Steel-framed walls offer notable thermal insulation, effectively reducing heat transfer within spaces. Their swift construction process and lightweight materials contribute to their appeal. Importantly, they present a more budget-friendly option compared to walls framed with wood.

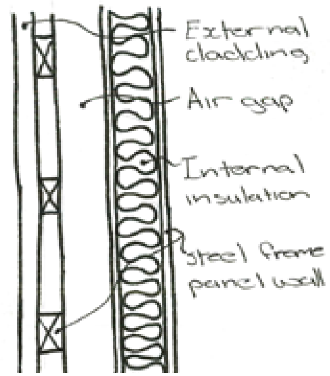


Figure 3.1.10 - Steel framed wall section

Rammed earth wall

Rammed earth walls exhibit an exceptional thermal mass, resulting in a reduced thermal lag. The affordability of construction is attributed to the utilisation of locally sourced materials. However, the construction process is notably gradual. These walls align with environmentally friendly practices and are well-suited for warmer climates. Their substantial weight can be a drawback, particularly for multi-storey structures.

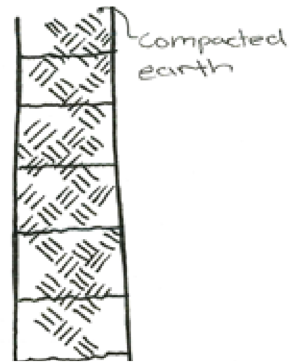


Figure 3.1.11 - Rammed earth wall section

WINDOW ELEMENTS - FRAME TYPE

Window frame materials play a crucial role in passive sustainable design by profoundly influencing a building's energy efficiency, thermal comfort, and environmental impact. Their thermal insulation, airtightness, and heat transfer properties significantly affect heat gain or loss, ensuring stable indoor temperatures (Asif et al., 2005). A wise material choice can reduce energy consumption and greenhouse gas emissions, promoting sustainability. Moreover, window frames contribute to a building's aesthetic appeal, making their selection pivotal in achieving both environmental and visual harmony.

Steel

Steel framed windows, unfortunately, lack airtightness, leading to significant heat loss and gain. Their propensity to transfer heat into interior spaces adds to their energy inefficiency. While they offer cost advantages, their production is confined to specific sizes, limiting customisation possibilities.

Wood

Wood frames, due to their airtight nature, effectively curb heat gain or loss. However, their suitability wanes in warm arid climates, as they tend to dry out. Notably, wood frames are the priciest choice in Namibia. While customisation is achievable, it entails additional costs due to the requirement for skilled labor.

Aluminium

Aluminium frames boast low maintenance, yet their airtightness is compromised, leading to heightened heat loss or gain. They offer lightweight properties and a relatively affordable price point. Tailoring windows to fit openings is feasible without incurring substantial costs. This is the best option as it is a standard material in Namibia.

WINDOW ELEMENTS - FRAME STYLE

Window opening methods impact frames, affecting airflow, indoor air quality, and thermal comfort. Full openings offer maximum ventilation, while adjustable options provide tailored airflow control. Selecting the right method enhances indoor comfort and well-being

Awning

Featuring an openability range of 20% to 30%, these windows are not only cost-effective in construction but also guarantee safety with their small openings. Crafted to fit designated openings precisely, they effortlessly harmonise with the architectural layout. Their adaptability extends to integration within larger glass facades, providing both aesthetic appeal and functional cohesion.

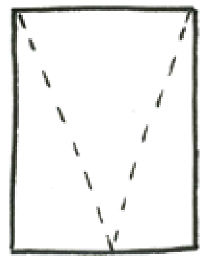


Figure 3.1.12 - Awning

Tilt and turn

By offering a dual functionality of opening with a 20% tilt and 90% turn, these windows grant superior control over airflow and ventilation. However, their elevated cost results from the intricate dual opening mechanics. Custom-made to precisely match specific openings, these windows seamlessly integrate into architectural designs. Moreover, they can be seamlessly incorporated into larger facades.

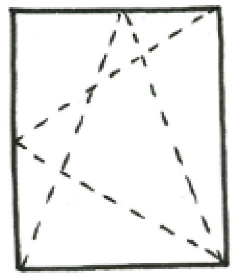


Figure 3.1.13 - Tilt and turn

Louvre frame

With a remarkable 90% openability, these windows excel in facilitating fresh air circulation. They possess the additional advantage of controlling direct sunlight entry into interior spaces; however, this feature can compromise exterior visibility when the windows are closed. This enhanced functionality, albeit beneficial, comes at a higher cost due to the added complexity integrated into the window frames.

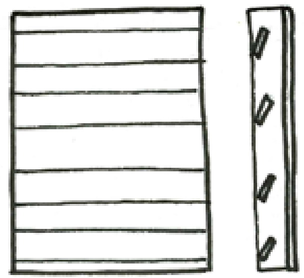


Figure 3.1.14 - Louvre frame

Conclusion

The selection of frames should be tailored to specific functions, as there is not a universal solution that caters to the diverse requirements of every space. Different spaces necessitate varying qualities from their frames to optimise energy efficiency, thermal performance, aesthetics, and functionality. Consequently, a thoughtful consideration of the unique demands of each area will ensure that the chosen frames align effectively with the overall design goals and contribute to creating a harmonious and sustainable built environment.

WINDOW ELEMENTS - GLASS TYPE

Window glass type is crucial in passive sustainable design due to its significant impact on energy efficiency, thermal comfort, and overall building performance. The right glass can reduce heat gain, heat loss, and glare while maximising natural light. High-performance glass with coatings and insulation minimises energy use, enhancing comfort and reducing environmental impact. Proper glass selection optimises daylight and contributes to a sustainable, comfortable indoor environment.

Single glazing

Single glazing contributes to heightened heat gain within interior spaces and is prone to substantial heat loss when cooled. While its capacity for abundant sunlight penetration enhances natural daylight within interiors, it also brings with it increased thermal penetration (Aiini et al., 2017). Notably, this option stands out as the most cost-effective among various glass types.

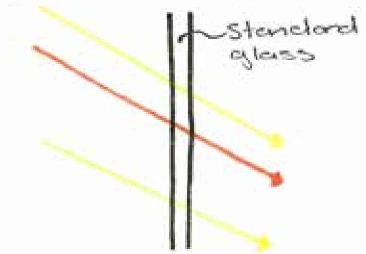


Figure 3.1.15 - Single glazing section

Double / triple glazing

Multi glazing effectively mitigates heat gain within interior spaces and exhibits minimal heat loss when cooled externally. This glass type offers substantial daylight penetration while maintaining low thermal penetration, resulting in reduced heat accumulation within interiors. However, it is worth noting that the advantages of multi glazing come with a higher price tag compared to other options (Aiini et al., 2017)..

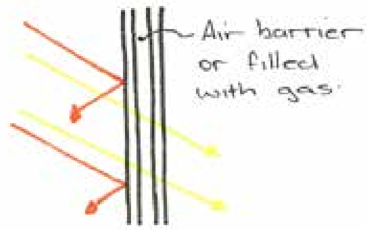


Figure 3.1.16 - Double / triple glazing section

Toned glass

The degree of daylight penetration hinges on the chosen glass color, but this choice does not influence thermal transmission reduction. This glass type is pricier compared to coated glass alternatives. However, it effectively diminishes glare within interior spaces.

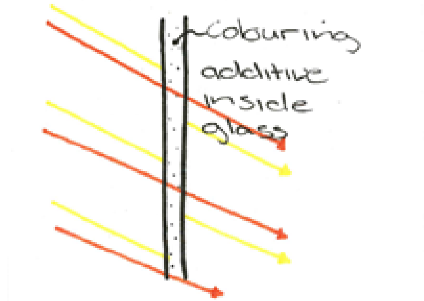


Figure 3.1.17 - Toned glass section

Laminated glass

Laminated glass does not reduce sunlight penetration nor does it contribute to thermal transmission reduction. Primarily employed for safety reasons due to its non-shattering properties upon breakage, this glass type comes at a higher cost.

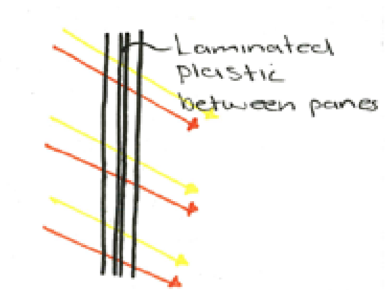


Figure 3.1.18 - Laminated glass section

Secondary glass

Secondary glass can be conveniently retrofitted onto existing windows, effectively curbing air infiltration within the air gap. This modestly contributes to minimising heat gain and loss. Nonetheless, its performance is comparatively less effective due to the absence of an airtight seal, setting it apart from other more efficient alternatives.

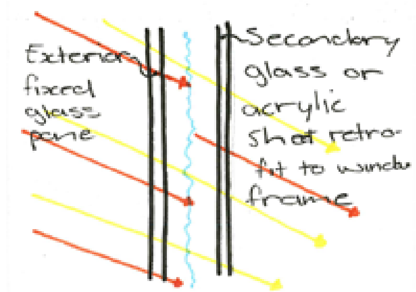


Figure 3.1.19 - Secondary glass section

Low emissivity glazing

Emissivity glazing is susceptible to damage if not cleaned in accordance with the manufacturer's recommended methods.

High transmission
High transmission glazing maximises sunlight penetration, consequently elevating both daylight and thermal gain within a space. It exhibits notable thermal penetration and releasing characteristics as well. This glass type is better suited for colder climates due to its properties.

Low transmission
Low transmission glass increases daylight penetration while diminishing thermal heat entry into interior spaces. This glass type is particularly suitable for warmer climates.

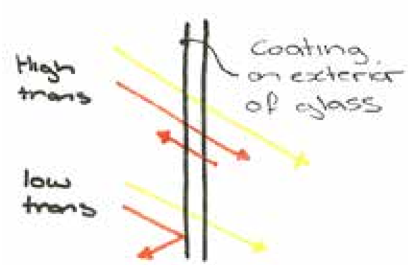


Figure 3.1.20 - Low emissivity glazing section

Conclusion

For exterior facades facing east and west, low emissivity glass emerges as the optimal choice, owing to its effective thermal reduction properties, even if it entails a slightly higher cost.

On the other hand, single glazing and secondary glass are well-suited for north and south facades, facilitating ample daylight introduction into the spaces.

3.2 HORIZONTAL ELEMENTS

INTRODUCTION

The choice of materials for horizontal elements like floors and roofs is vital for passive sustainable design. They impact thermal performance, energy efficiency, and overall environmental impact. High thermal mass materials regulate indoor temperatures, while insulation materials prevent heat transfer. Reflective surfaces reduce heat absorption, and durability affects maintenance. Sustainable, local materials minimise carbon footprint, and renewable's enhance eco-friendliness. Material selection for these elements is crucial for achieving a holistic and effective passive design.

FLOOR ELEMENTS

Choosing the right floor materials is crucial for passive sustainable design. They impact thermal comfort, energy efficiency, and indoor air quality. High thermal mass materials like concrete stabilise temperatures, while insulation prevents heat transfer. Reflective surfaces reduce heat absorption. Sustainable, local options minimise environmental impact. The right floor material ensures a comfortable, energy-efficient, and eco-friendly space (European Concrete Platform, 2007).

Standard concrete floor

Standard concrete floors absorb heat from the lower space, which is then cooled through the slab and subsequently released into the upper area. Moreover, these slabs emit a cooling influence within the interior environment (European Concrete Platform, 2007). This economical method is extensively utilised in Namibia, proving especially fitting for high-rise structures.

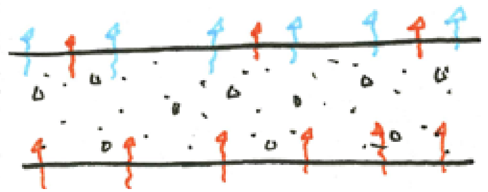


Figure 3.2.1 - Standard concrete floor section

Wood floor

Underfloor cooling and heating systems can be integrated into the flooring structure. Wood flooring offers a combination of high heat insulation and low thermal storage capacity. Moreover, it contributes to enhanced indoor air quality within interior spaces. However, this flooring option comes at a higher cost and is less suitable for high-rise buildings due to certain limitations like how maintenance and sound insulation.

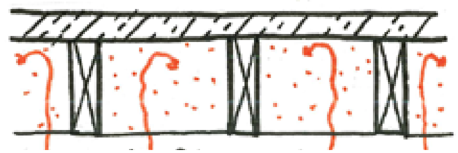


Figure 3.2.2 - Wood floor section

Thermally cooled concrete floor

Thermally cooled concrete floors effectively absorb internal heat, undergoing cooling before radiating it to upper levels. The void within the slab offers opportunities for cooling and heating applications. This design suits high-rise structures well. However, the implementation of these slabs tends to come at a higher cost.

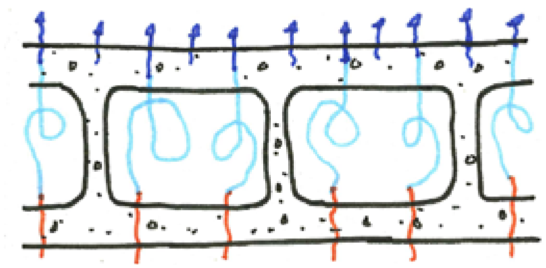


Figure 3.2.3 - Thermally cooled concrete floor section

Conclusion

While thermally cooled slabs offer advantages, they come with a higher cost. As a more cost-effective alternative, opting for standard concrete floors with complementary supporting elements can enhance efficiency (Bourne & Hoeschele, 2000).

ROOF ELEMENTS

Roof material selection is pivotal in passive sustainable design, influencing energy efficiency and comfort. Roofs manage solar heat gain, insulate against heat loss, and impact daylighting. The right choice reflects sunlight, regulates interior temperatures, and reduces lighting needs. Material durability, sustainability, and maintenance are key considerations (European Concrete Platform, 2007). In essence, roofs contribute significantly to creating a comfortable, energy-efficient, and eco-friendly building.

Conventional concrete roof

Concrete roof slabs contribute to a heightened heat island effect, resulting in excessive heat radiation to indoor areas (European Concrete Platform, 2007). Adequate waterproofing is imperative for this roofing type. It stands as a cost-effective solution, particularly suitable for tall structures.

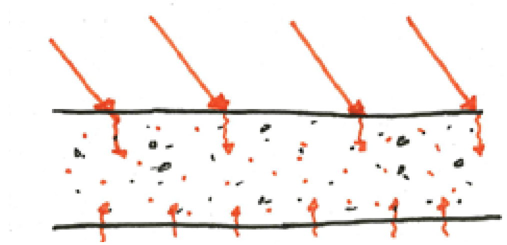


Figure 3.2.4 - Conventional concrete roof section

Green roof

Green roofs boast a substantial thermal mass within their soil layers, effectively absorbing solar heat (Asmat et al., 2008). The soil's cooling impact extends to the concrete structure as well. The presence of soil prolongs the heat radiation process (thermal lag), contributing to enhanced performance. However, green roofs are comparatively more costly than conventional roofing options.

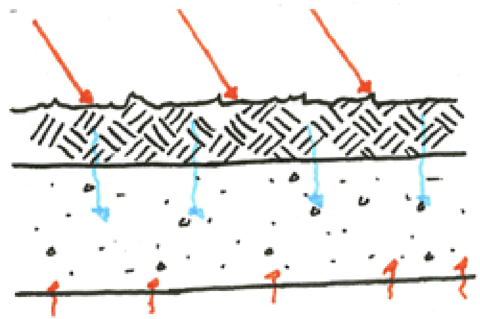


Figure 3.2.5 - Green roof section

Corrugated iron roofing

Corrugated iron sheeting exhibits significant heat reflection properties. However, its low thermal capacity results in heightened heat radiation into interior spaces. To counteract this, additional insulation is needed to mitigate heat transfer. This roofing option is particularly cost-effective for smaller projects and low-rise buildings.

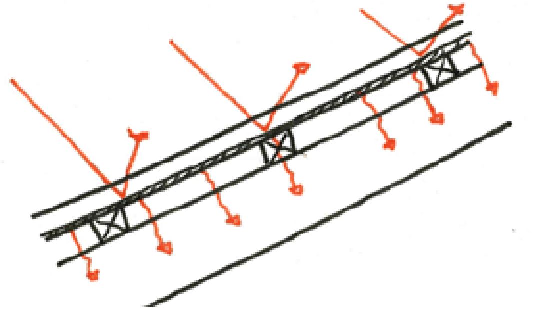


Figure 3.2.6 - Wood floor section

Aluminium coated roofing

Aluminium roof sheeting effectively reflects sunlight, minimising heat radiation. Its high thermal dissipation and low thermal storage properties further contribute to reduced heat transfer. Although more expensive than corrugated iron sheeting, aluminium requires less maintenance due to its pre-applied coating.

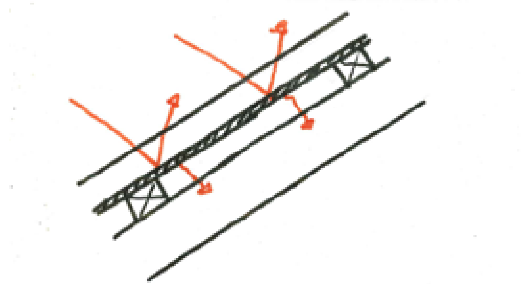


Figure 3.2.7 - Aluminium coated roofing section

Asphalt coated wood roofing

Asphalt coated wood roofing offers high heat insulation and minimal thermal storage due to its wooden composition. It effectively prevents heat radiation into interior spaces. However, it may not be suitable for warm arid climates. The asphalt layer provides waterproofing, adding to its functionality. Despite being more expensive than standard roof sheeting, its benefits are noteworthy.

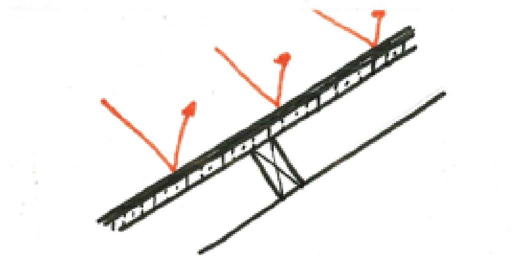


Figure 3.2.8 - Asphalt coated wood roofing section

Solar roofing

Solar shingles harness sunlight and convert it into energy, eliminating heat radiation into interior spaces as the absorbed heat is transformed into usable power. This sustainable approach generates energy for the building's needs. However, its adoption can be prohibitively expensive for larger-scale projects.

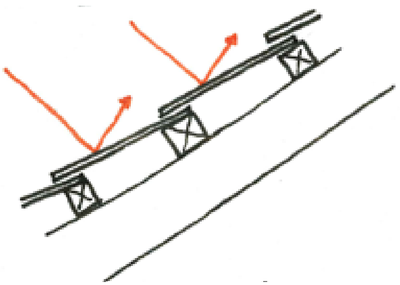


Figure 3.2.9 - Solar roofing section

Conclusion

Roofing solutions should be tailored to the specific area and intended function. A combination of conventional concrete, green roofs for environmental benefits, and solar roofing to generate energy emerges as the most effective approach (Athmani et al., 2023).

3.3 LANDSCAP-ING ELEMENTS

INTRODUCTION

Landscaping elements like ground cover, vegetation, and water are essential for passive sustainable design. They regulate temperature, manage water, enhance air quality, and foster a connection between the built environment and nature. Trees and plants provide shade, reducing heat absorption and improving air quality. Water features manage stormwater and contribute to cooling through evaporation. Water-efficient practices minimise consumption. Overall, these elements enhance aesthetics, energy efficiency, and occupant comfort in alignment with passive sustainable design principles.

GROUND COVER ELEMENTS

Ground cover elements like pavers, vegetation, stones, and water are essential for passive sustainable design. Pavers and stones provide shade to ground cover and reflect sunlight, reducing heat absorption (Munawaroh et al., 2022). Vegetation offers shade, cools through transpiration, and enhances air quality. Water features facilitate evaporative cooling. These elements collectively create a comfortable, sustainable, and attractive outdoor environment aligned with passive design principles.

Grass

Grass exhibits a minimal heat island effect, offering natural shading and aiding moisture retention in the ground layer. Its effective water infiltration qualities contribute to flood prevention. However, the upkeep demands substantial maintenance and water usage. Additionally, it preserves the topsoil layer, enhancing its ecological significance.

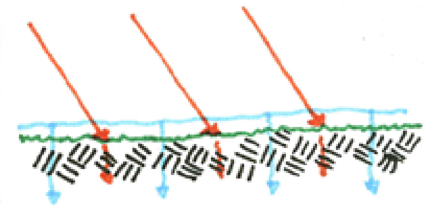


Figure 3.3.1 - Grass section

Paving

Paving contributes to a noticeable heat island effect and exhibits limited water infiltration capabilities. It demands low maintenance and presents a slightly higher installation cost compared to grass. During installation, the topsoil is removed and compacted. Paving offers a range of colors and patterns to choose from, adding aesthetic diversity to outdoor spaces.

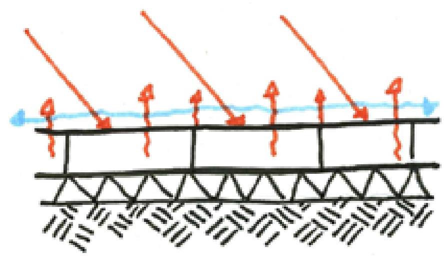


Figure 3.3.2 - Paving section

Stones

Stone features a moderate heat island effect and boasts excellent water infiltration properties, effectively mitigating flooding risks. It requires minimal maintenance and is budget-friendly. Importantly, stone installation leaves the topsoil undisturbed.

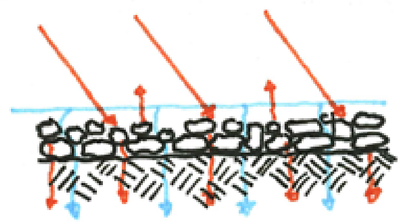


Figure 3.3.3 - Stones section

Concrete

Concrete exhibits an extremely high heat island effect and lacks any water infiltration properties. Despite being low maintenance, it comes with a significant cost. Concrete offers excellent durability but unfortunately requires the removal and compaction of topsoil during installation.

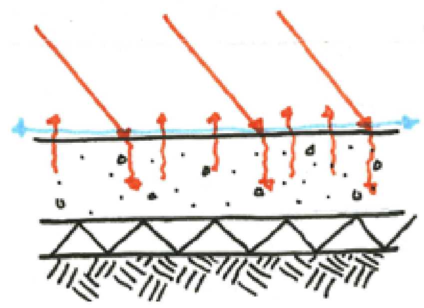


Figure 3.3.4 - Concrete section

Water

Water showcases no heat island effect as it effectively reflects all sunlight. Its remarkable heat capacity, alongside excellent water infiltration capabilities, proves valuable. The presence of water leads to increased humidity, contributing to air cooling, and also facilitates the reflection of daylight into interior spaces. It's important to note that water features require high water consumption due to evaporation.

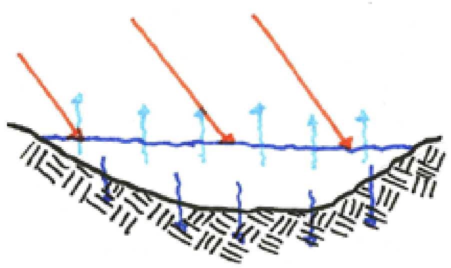


Figure 3.3.5 - Water section

Indigenous Namibian grass

Native Namibian grass boasts a minimal heat island effect, offering a beneficial quality. This grass type effectively shades the ground layer, fostering moisture retention, and exhibits impressive water infiltration properties that aid in flood reduction. The grass requires minimal maintenance, making it a practical choice. However, it is important to acknowledge that its aesthetic appeal might not match that of other options.

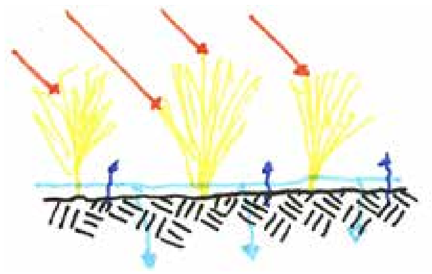


Figure 3.3.6 - Indigenous Namibian grass section

Conclusion

Ground cover materials must be selected carefully based on the specific conditions of each location (Munawaroh et al., 2022). Pavers and concrete are best suited for areas with limited shading and high traffic flow, while materials with high thermal capacity should be chosen for regions with intense sunlight to mitigate the heat island effect

LANDSCAPING ELEMENTS

Spirn et al. (1981) emphasis the valuable role of trees in passive sustainable design. Trees offer natural shading, reducing cooling requirements, and dropping leaves in winter to allow sunlight for warmth. They enhance aesthetics, create appealing outdoor spaces, and boost energy efficiency. Opting for native species conserves water in arid regions, contributing to thermal comfort, air quality, and sustainable design appeal.

Deciduous

Deciduous trees provide shading during the summer months and allow sunlight to enter the building when their leaves are shed in winter. The extent of shade depends on factors such as tree size, diameter, and form. These trees are generally low maintenance in nature.

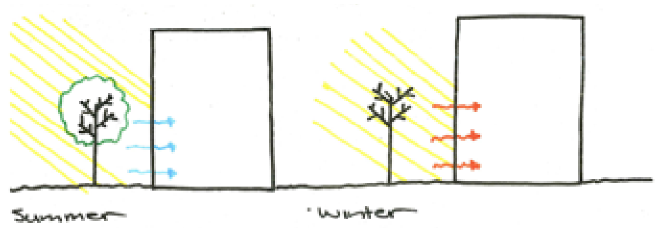


Figure 3.3.6 - Deciduous trees summer and winter

Evergreen

Evergreen trees offer year-round shading due to their continuous foliage. These trees are typically tall and narrow, providing effective shading with a smaller coverage area. However, their maintenance demands are relatively high, and they require substantial water resources.

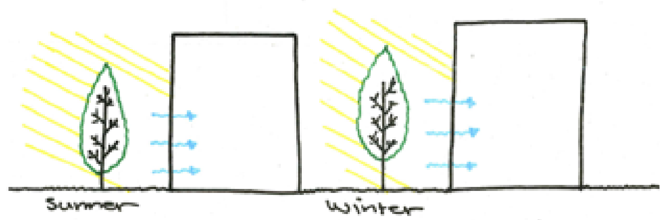


Figure 3.3.7 - Evergreen trees summer and winter

Positioning of trees

The positioning of trees plays a crucial role, especially when they are placed in close proximity to buildings to provide shading for interior spaces. Additionally, trees positioned near buildings can guide and channel the airflow beneath their canopy, directing it into the building.

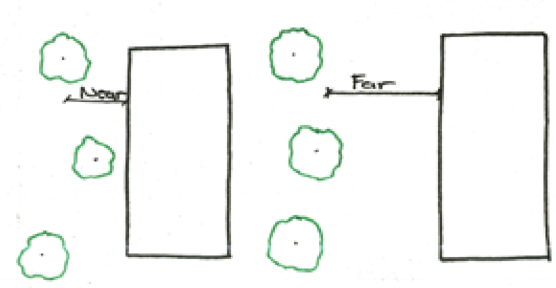


Figure 3.3.8 - Positioning of trees

Arrangement of trees

Arranging trees in clusters is essential to achieve broader areas of shading. Combining both clustered and spread-out arrangements further optimises the shading effectiveness.

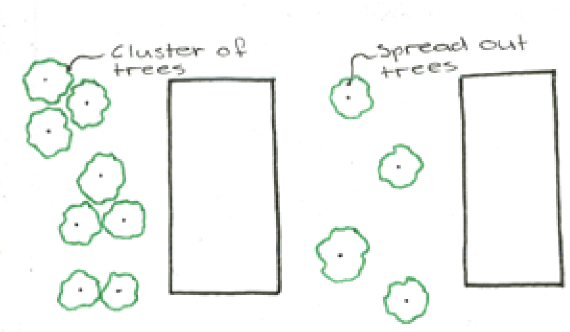


Figure 3.3.9 - Arrangement of trees

Conclusion

Ground cover materials must be selected carefully based on the specific conditions of each location. Pavers and concrete are best suited for areas with limited shading and high traffic flow, while materials with high thermal capacity should be chosen for regions with intense sunlight to mitigate the heat island effect

VIABLE PLANTS FOR LANDSCAPING ELEMENTS

Table 3 - Grasses for landscape elements

Grasses

Image	Scientific name	Common name	Facts
 Image by Random Harvest, (n.d). https://www.randomharvest.co.za/South-African-Indigenous-Plants/Show-Plant/PlantId/370/Plant/Aristida-junciformis?Filter=All	**Aristida Junciformis**	Gongoni grass	The seeds remain on the plant for an extended period, typically from November to May, and the stems retain their green color for a while into the winter, making it an ideal choice for landscaping.
 Image by SANBI, (n.d-a). https://pza.sanbi.org/cenchrus-ciliaris	**Cenchrus Ciliaris**	Foxtail buffalo grass	Cenchrus Ciliaris is highly regarded for its nutritional value and is an excellent choice for pastures in hot, arid regions. It is prized for its ability to produce tasty forage and support grazing during dry spells in tropical areas.
 Image by SANBI, (n.d-c). https://pza.sanbi.org/melinis-repens	**Melinus Repens**	Natal red top	Melinis repens is often an annual but can sometimes exhibit perennial traits. Natal Red Top is excellent for soil erosion control and horticultural use.

Table 4 - Succulents for landscape elements

Succulents

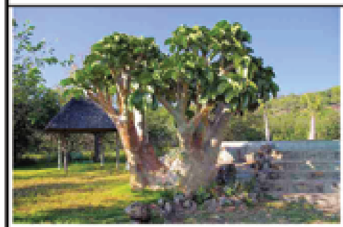
Image	Scientific name	Common name	Facts
 Image by Cactus Kingdom, (n.d). https://cactuskingdom.ca/product/adenium-boehmianum/	**Adenium Boehmianum**	Desert roses	It can thrive in tropical and sub-tropical arid climate, little humid conditions are acceptable.
 Image by Fourie, (n.d). https://www.gateway-africa.com/fuanaflora/Plants/aloe_asperifolia.html	**Aloe Asperifolia** **or** **Aloe Chabaudii** **or** **Aloe Littoralis**	Namib Aloe Dwala Aloe Uitenhage Aloe	Waterwise, adds colour in winter to garden and attracts wild life
 Image by Trees Planet, (2013). https://treesplanet.blogspot.com/2013/06/cyphostemma-currorii-cobas-tree-butter.html	**Cyphostemma Currorii** **or** **Aloe Chabaudii**	Butter-tree Namibian grape	It thrives when cultivated in dry tropical and warm temperate climates, but it's sensitive to even the mildest freezes. Additionally, it performs admirably when grown in pots.
 Image by World of Succulents, (n.d). https://worldofsucculents.com/tavaresia-barklyi-thimble-flower-devils-trumpet/	**Tavaresia barklyi**	Devil's Trumpet	Catches flies and other insects good to use as a lot of water is used on site

Table 5 - Shrubs for landscape elements

Shrubs

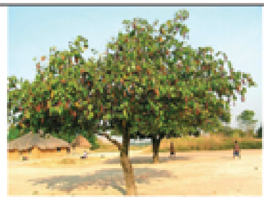
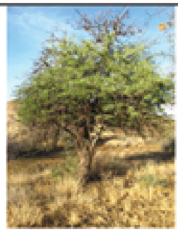
Image	Scientific name	Common name	Facts
 Image by Grow Wild, (n.d). https://growwild.co.za/product/melianthus-comosus/	**Melianthus Comosus**	Honey flower	The small, nectar rich bird pollinated flowers are borne in short clusters
 Image by Cures decoded, (n.d). https://www.curesdecoded.com/Products/Sutherlandia/3683	**Sutherlandia Frutescens**	Cancer bush	Shrub with bitter, aromatic leaves. Red-orange flowers appear in spring to mid-summer
 Image by SANBI, (n.d-b). https://pza.sanbi.org/flueggea-virosa	**Flueggea Virosa**	White berry-bush	It bears very small flowers which are creamy green. Fruit are white and fleshy and appear in December-March
 Image by WellsforZoe, (n.d). https://wellsforzoe.org/portfolio/piliostigma-thonningii-msekese/	**Piliostigma Thonningii**	Camel's foot tree	The shrub has a range of commodities for the local population

Table 6 - Trees for landscape elements

Trees

Image	Scientific name	Common name	Facts
 Image by SANBI, (n.d-d). https://pza.sanbi.org/senegalia-galpinii	**Acacia galpinii** **or** **Acacia erioloba** **or** **Acacia tortilis**	Monkey thorn Camelthorn Umbrella thorn	A fast growing, long-lived tree, with a maximum height of 30 m
 Image by Dreyer, (2006). https://www.kyffhauser.co.za/Plants1/Albizia_anthelmintica/Image4.htm	**Albizia anthelmintica**	Aru	Fairly fast-growing deciduous tree up to 8m high
 Image by Frost, (2018). https://calphotos.berkeley.edu/cgi/img_query?enlarge=0000+0000+0218+1517	**Kirkia acuminata**	White seringa	It grows from 6 to 18 m high with a trunk diameter of 0.8 m
 Image by Boething Treel Farms, (n.d). https://www.boethingtreeland.com/plants/rhus-lancea/	**Searsia lancea**	Silver terminalia	A medium height, deciduous shrub or small tree generally 5-6 m

3.4 SUPPORTING ELEMENTS

INTRODUCTION

Supporting elements are vital in enhancing the efficiency of existing passive sustainable design components. They work in harmony with the core elements to optimise energy savings and environmental impact. These additions, such as shading devices and natural ventilation strategies, enhance thermal comfort and reduce the need for mechanical systems. Incorporating thermal insulation materials and rainwater harvesting systems further bolster sustainability. The synergy between these elements and the core design features results in buildings that achieve superior performance in energy efficiency and overall environmental impact.

SUPPORTING ELEMENTS

Wall thickness

Increasing the thickness of a wall offers advantages like higher thermal storage and lag. This results in cooler daytime interiors and warmer nighttime interiors, enhancing overall comfort and reducing the need for artificial heating and cooling.

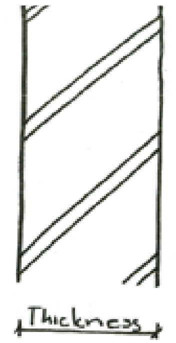


Figure 3.4.1 - Wall thickness

Window depth in walls

Utilising deeper windows in building design offers multiple advantages. These windows diminish direct sunlight penetration, enabling larger windows to be integrated while minimising heat gain. The result is a comfortable indoor environment with ample daylight and reduced risk of overheating.

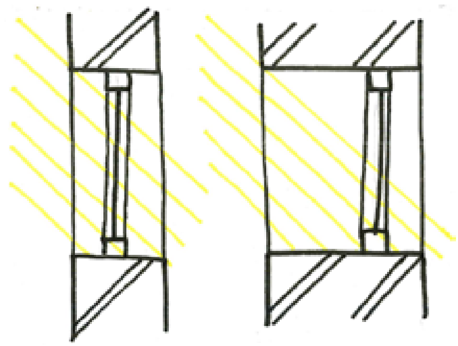


Figure 3.4.2 - Window depth in walls

Horizontal louvres

Horizontal louvres present a highly effective solution for managing direct sunlight on north and south facades. By strategically placing these louvres, the intensity of sunlight entering interior spaces is significantly reduced, contributing to a more comfortable indoor environment. One of the advantages of horizontal louvres is their adaptability—they can be retrofitted to existing structures where necessary.

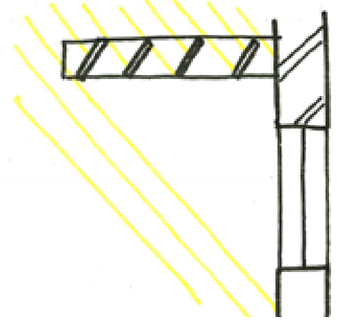


Figure 3.4.3 - Horizontal louvres

Vertical louvres

Vertical louvres are ideal for east and west facades, effectively reducing direct sunlight penetration into interiors. They can be retrofitted to existing structures, providing an efficient way to enhance energy efficiency and comfort. Strategically using vertical louvres allows for effective solar heat gain management while maintaining aesthetics and functionality.

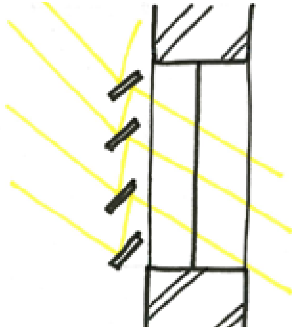


Figure 3.4.4 - Vertical louvres

Balconies

Expanding balcony depth yields multiple benefits. The increased overhang provides more shading and significantly reduces direct sunlight penetration, consequently lowering thermal gain within indoor spaces. This tactic aligns with passive sustainable design, enhancing comfort and energy efficiency while enhancing exterior aesthetics. Most effective for north / south facades, but can also assist on east / west facades

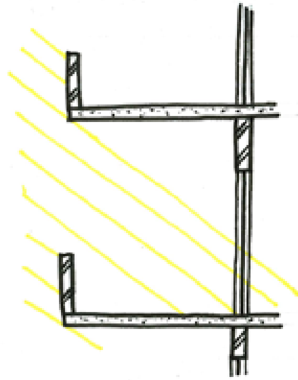


Figure 3.4.5 - Balconies

Large overhangs

Shading devices are key in reducing direct sunlight penetration indoors. They effectively cut down on thermal gain, proving cost-effective, especially for low-rise buildings. Most effective for north / south facades, but can also assist on east / west facades

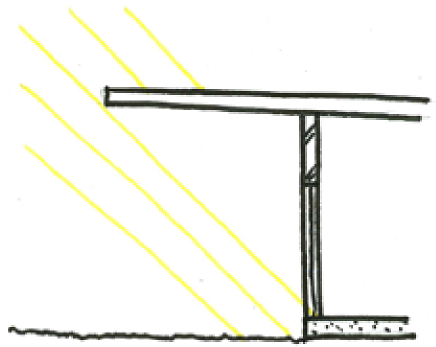


Figure 3.4.6 - Large overhangs

Second skin wall

Adding a second layer of cladding to the facade provides a dual benefit for passive sustainable design. This cladding acts as a heat reflector, deflecting external heat. This effectively reduces direct sunlight penetration, leading to lower thermal gain indoors. Moreover, the gap between the cladding and the building structure promotes the flow of cool air, displacing warmer air and improving ventilation.

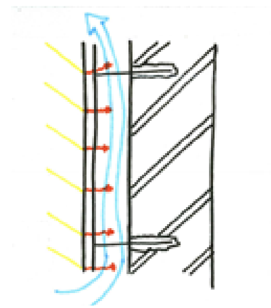


Figure 3.4.7 - Second skin wall section

Trombe wall

The Trombe wall employs a second layer to generate warm air during winter, serving as passive heating. Users can control this strategy for personalised comfort. This aligns with passive sustainable design, prioritising energy efficiency and individual well-being.

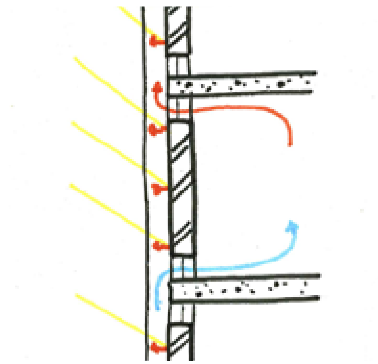


Figure 3.4.8 - Trombe wall

Stone store cooling

Rock stores, positioned below ground to evade sunlight, maintain a cool temperature. Air passing through them cools before entering indoors, lessening reliance on energy-intensive cooling methods and reducing water consumption. This embodies passive sustainable design by using natural elements for efficient and eco-friendly building solutions.

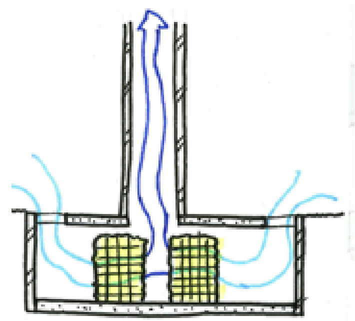


Figure 3.4.9 - Rock stores

3.6 SECTION CONCLUSION

In the realm of passive sustainable design, the importance of materials and components cannot be overstated. These fundamental building blocks are at the heart of creating environmentally responsible, energy-efficient, and resilient structures. The choice of materials with high thermal mass, efficient insulation, and low thermal conductivity is essential for maintaining a stable indoor temperature and reducing reliance on mechanical heating and cooling systems, which in turn decreases energy consumption and operational costs. Sustainable materials, such as low-impact concrete, play a pivotal role in reducing the environmental footprint of construction, conserving natural resources, and decreasing emissions.

Durability is another critical factor, as high-quality, long-lasting materials result in reduced replacements and repairs, ultimately minimising waste over the building's lifespan. Moreover, materials also affect indoor air quality, with low-VOC materials contributing to healthier indoor environments. Components that enable effective daylighting and adaptability to changing weather conditions further enhance energy efficiency and occupant comfort.

Lastly, resilient materials capable of withstanding extreme weather events are vital in an era of climate change, ensuring the safety and longevity of structures. In summary, materials and components are the foundation of passive sustainable design, influencing building performance, environmental impact, and the quality of life for occupants. Careful selection and integration of these elements are paramount in constructing a sustainable, resilient, and aesthetically pleasing built environment that aligns harmoniously with nature and contributes to a better future for all.

Plant selection involves a thoughtful process that prioritises low maintenance and water-wise varieties. This careful consideration ensures that the chosen plant species not only thrive in the specific environmental conditions but also demand minimal care and water resources. In essence, it contributes to the sustainability and efficiency of the landscape, aligning with the principles of responsible resource management and ecological balance. By opting for low-maintenance and water-wise plants, the site's greenery becomes not just an aesthetic feature but a functional and sustainable component of the overall design, requiring fewer resources to flourish while still enhancing the site's visual appeal and environmental compatibility.

SECTION 4

DESIGN INCEPTION AND VISION

In order to provide guidance for the design process, it was essential to formulate a design vision that would serve as the project's starting point. This vision not only offered direction but also played a crucial role in the selection of potential project sites, ensuring their viability. To determine the most suitable site at the precinct level, a set of criteria was established. Once a site was chosen, detailed technical assessments of the site's regulations were conducted to gain a comprehensive understanding of how to maximise its development potential. Additionally, the choice of building function was tailored to align with the specific requirements of the selected site and precinct. This approach ensured that the project was not limited to generic office space in an already saturated CBD market, but instead, it became a viable and purposeful addition to the urban landscape.

4.1 SITE VISION

INTRODUCTION

An urban environment that champions sustainability and the well-being of its residents places a strong emphasis on creating spaces that prioritise people. This includes features like pedestrian-friendly streets, green areas, inner courtyards, eco-friendly boundaries, and effective water management systems. By integrating these components, the environment not only enhances safety and community involvement but also fosters improved air quality, biodiversity, and spaces that encourage social interaction and relaxation. This cohesive approach contributes to the establishment of a vibrant and enduring urban landscape.

URBAN SCALE

Pedestrian-friendly streets

Pedestrian-friendly streets prioritise safety and comfort, creating vibrant urban environments. They feature wide sidewalks, crosswalks, and pedestrian amenities. These streets encourage walking, social interaction, and contribute to sustainable cities.

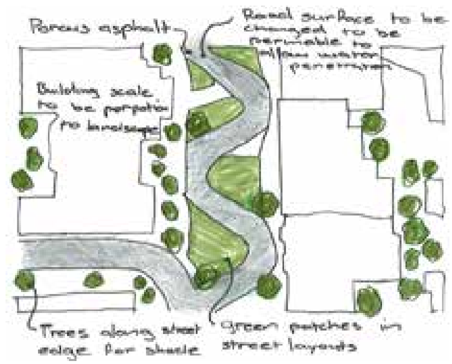


Figure 4.1.1 - Site vision urban scale - Pedestrian-friendly streets

Green spaces in urban developments

Green spaces in urban developments enhance livability and sustainability. These areas of vegetation, parks, and open spaces provide recreation, relaxation, and social interaction. They improve air quality, mitigate urban heat, and support biodiversity. Green spaces contribute to physical and mental well-being and create vibrant communities.

Figure 4.1.2 - Site vision urban scale - Green spaces in urban developments

Atrium or inner courtyard

Atriums or inner courtyards are essential architectural features that offer multiple benefits. They provide natural light, enhance ventilation, encourage social interaction, and create inviting and serene spaces within a building.

Figure 4.1.3 - Site vision urban scale - Atrium or inner courtyard

BUILDING SCALE

Eco borders

Eco borders are vital for ecological balance, biodiversity, and sustainable development in urban areas. They provide habitat for species, improve air and water quality, reduce noise, and enhance the visual appeal of cities. Eco borders play a crucial role in creating sustainable and harmonious urban environments.

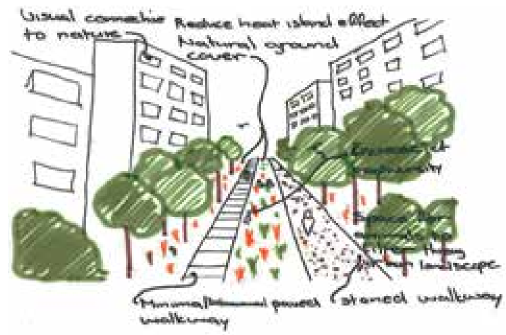


Figure 4.1.4 - Site vision building scale - Green spaces in urban developments

Public and private eco-spaces

Public and private green spaces are essential for enhancing urban living and promoting sustainability. Public green spaces, like parks and plazas, offer recreational opportunities, encourage social interaction, and improve air quality. Private green spaces, such as gardens and rooftop terraces, provide residents with a personal connection to nature, promoting relaxation and well-being. Together, these green spaces contribute to a livable and balanced urban environment that fosters community, biodiversity, and a healthier lifestyle.

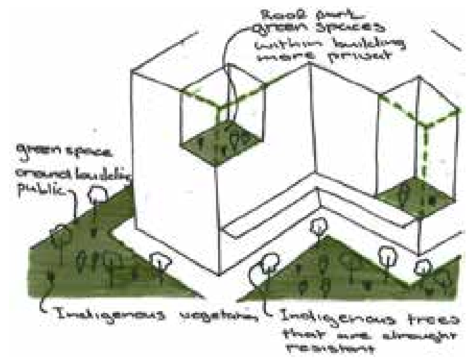


Figure 4.1.5 - Site vision building scale - Public and private eco-spaces

BUILDING SYSTEMS SCALE

Sustainable water management through constructed wetlands

Constructed wetlands efficiently treat and recycle wastewater through natural processes and vegetation, removing pollutants and producing high-quality treated water According to Vymazal, (2010). This sustainable approach reduces strain on freshwater sources and combats water pollution.

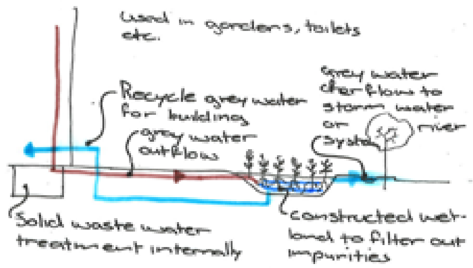


Figure 4.1.6 - Site vision systems scale - Sustainable water management through constructed wetlands

Water management: controlling floods and encouraging infiltration

Flood control and infiltration are essential for sustainable water management, preventing damage and conserving resources. Effective measures and infiltration ensure sustainable water use and support ecosystems. Water management safeguards against floods and secures long-term resources.

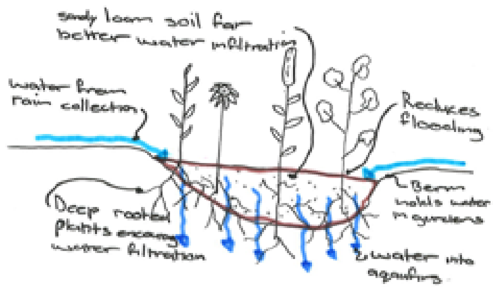


Figure 4.1.7 - Site vision systems scale - Water management: controlling floods and encouraging infiltration

Passive cooling techniques for ground level

Ground-level passive cooling techniques optimise natural elements and design strategies to reduce energy consumption. By utilising cool air, earth contact, and thermal gradients, these methods enhance comfort and sustainability.

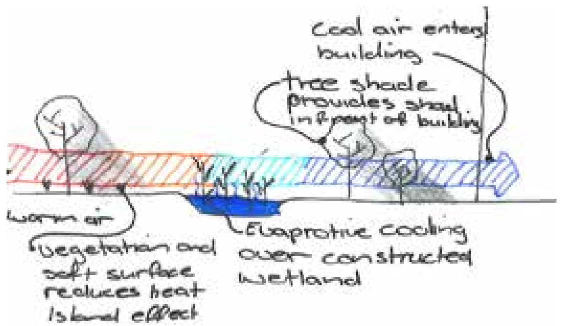


Figure 4.1.8 - Site vision systems scale - Passive cooling techniques for ground level

VISUAL SUMMATION OF VISION IN THE DESIGN

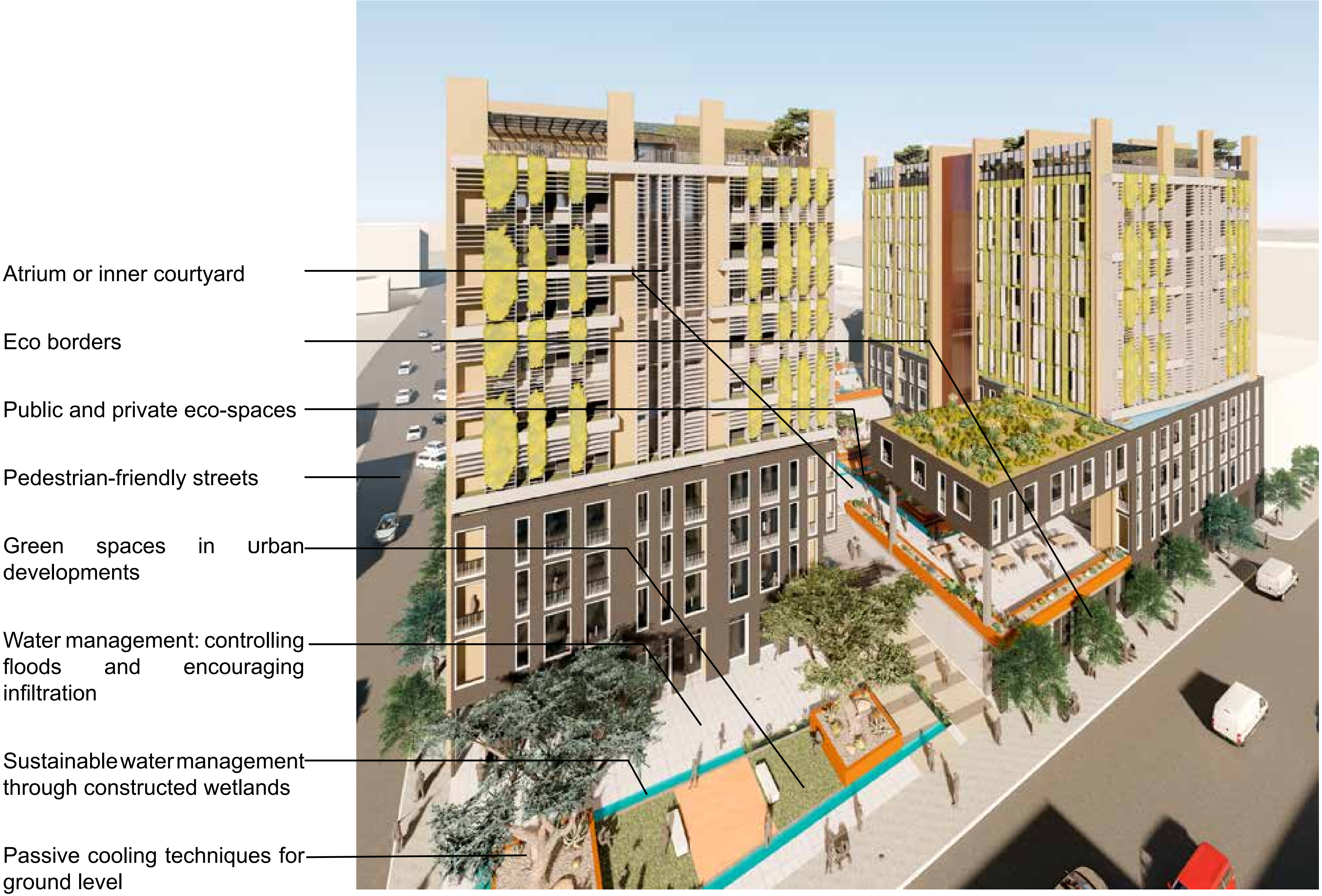


Figure 4.1.9 - Visual summation of vision in the design

4.2 SITE SPECIFIC CRITERIA

INTRODUCTION

In the process of choosing an urban development site, several pivotal considerations contribute to establishing a sustainable and community-oriented atmosphere. These encompass factors such as proximity to public amenities, an east-west alignment to maximise natural illumination, multiple access points for improved connectivity, unspoiled land to minimise ecological effects, and adaptability to cater to both high-rise and low-rise construction developments. By taking these elements into account, planners can craft a site that fosters sustainable urban expansion and cultivates a superior standard of living for inhabitants.

URBAN CRITERIA

Urban setting

Choosing an urban site is essential for sustainable precinct expansion, particularly in central business districts (CBDs). Urban locations leverage existing infrastructure, services, and amenities, minimising resource usage and environmental impact. Proximity to public transport, education, healthcare, and cultural facilities offers convenience and connectivity. This approach curbs urban sprawl, optimising land use and fostering vibrant communities while promoting resource efficiency and economic vitality.

Figure 4.2.1 - Urban criteria - Urban setting

Nearby public facilities

Selecting an ideal site for sustainable precinct expansion involves its strategic positioning near essential public facilities. These include shopping centers, public green spaces, schools, and healthcare institutions. This approach offers multiple benefits, such as convenient access to services and reduced travel requirements. The presence of recreational areas and educational institutions promotes well-being and development, while proximity to healthcare ensures prompt medical assistance. This thoughtful site selection enhances the overall quality of life for residents.

Figure 4.2.2 - Urban criteria - Nearby public facilities

SITE AND BUILDING CRITERIA

Orientation east-west axis positioning

An accurately oriented site provides the advantage of strategically positioning a building to effectively capitalise on the optimal opportunities presented by passive sustainable design principles.

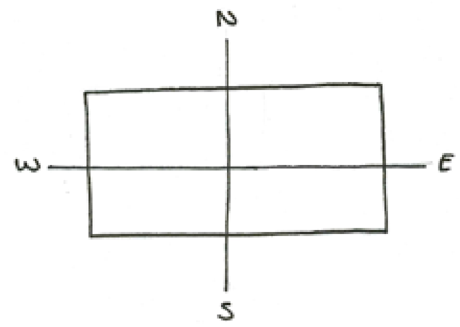


Figure 4.2.3 - Site criteria - Favorable east-west axis positioning

Multiple points of access

The site should feature multiple access points for both pedestrians and vehicles, enhancing overall accessibility by providing diverse entry options.

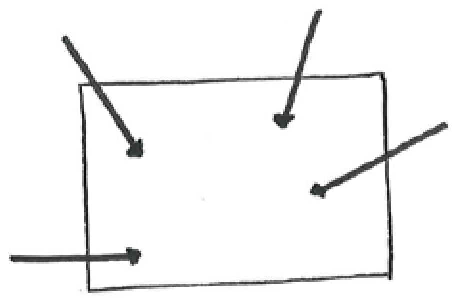


Figure 4.2.4 - Site criteria - Multiple points of access

Green field site

Ideally, the site should be a greenfield area devoid of existing construction or pollutants. Any existing natural elements on the site can be seamlessly integrated into the design.

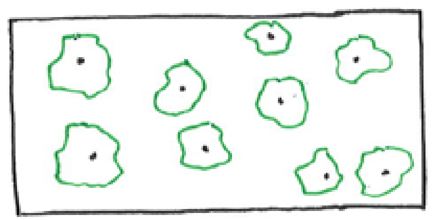


Figure 4.2.5 - Site criteria - Green field site

or Underdeveloped land (brown field site)

Alternatively, the site can be a brown field area, allowing for the re-purposing of existing land. This approach minimises the need for new land creation and reduces ecological impact, making it a more sustainable option.

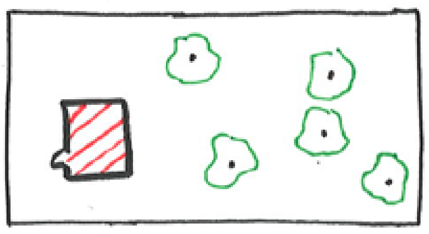


Figure 4.2.6 - Site criteria - Underdeveloped land (brown field site)

Site should facilitate hi-rise building

The site should be suitable for accommodating high-rise development, enabling a higher density of living and office spaces.

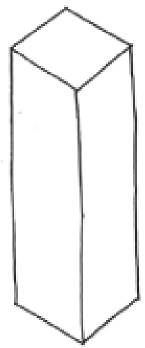


Figure 4.2.7 - Building criteria - Hi-rise building

or Low-rise large scale development

The site should be suitable for accommodating low-rise large scale development, enabling a higher density of living and office spaces.

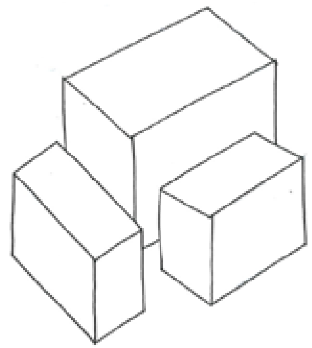


Figure 4.2.8 - Building criteria - Low-rise large scale development

SITE SPECIFIC CRITERIA WEIGHTING

The criteria weighting was informed by insights gained from the literature review conducted, specifically referencing the works of Dekay and Brown (2014) and Sefton Council (2014). These sources provided valuable guidance in selecting and aligning specific criteria weighting with the sites envisioned goals and objectives.

Urban setting (Medium weight):
Choosing an urban site in CBDs is essential for efficient resource use and connectivity.

Nearby public facilities (Medium weight):
Proximity to essential public facilities enhances residents' quality of life.

Orientation East-West axis (Medium weight):
Emphasising an east-west building orientation optimises energy efficiency.

Multiple points of access (Medium weight):
Several access points ensure efficient traffic flow and safety.

Green field site (Low weight):
New development potential with fewer constraints carries a low weight.

Brown field site (High weight):
Redevelopment potential is a primary focus, bearing a high weight.

Facilitate hi-rise building (Low weight):
Urban density and land use optimisation are considered, but not exclusively.

Facilitate low-rise large development (High weight):
Emphasising low-rise large development is of high importance alongside other criteria.

Table 7 - Site specific criteria weighting

Criteria	Weighting
Urban Setting	12.5%
Nearby public facilities	12.5%
Orientation east west axis	12.5%
Multiple points of access	12.5%
Green field site	6.25%
Brown field site	18.75%
Facilitate hi-rise building	6.25%
Facilitates low-rise large development	18.75%

4.3 POTENTIAL SITES ANALYSES AND SELECTION

INTRODUCTION

The site selection process was guided by a thorough evaluation of specific criteria to ensure the project's success as a sustainable and passive design precinct. These criteria were carefully defined to identify a site that would offer the most favourable conditions and opportunities for achieving the project's goals. By adhering to these criteria, the site adjacent to the Roman Catholic precinct presents the optimal foundation for creating a thriving and environmentally conscious development.

SITE LOCATION MAP

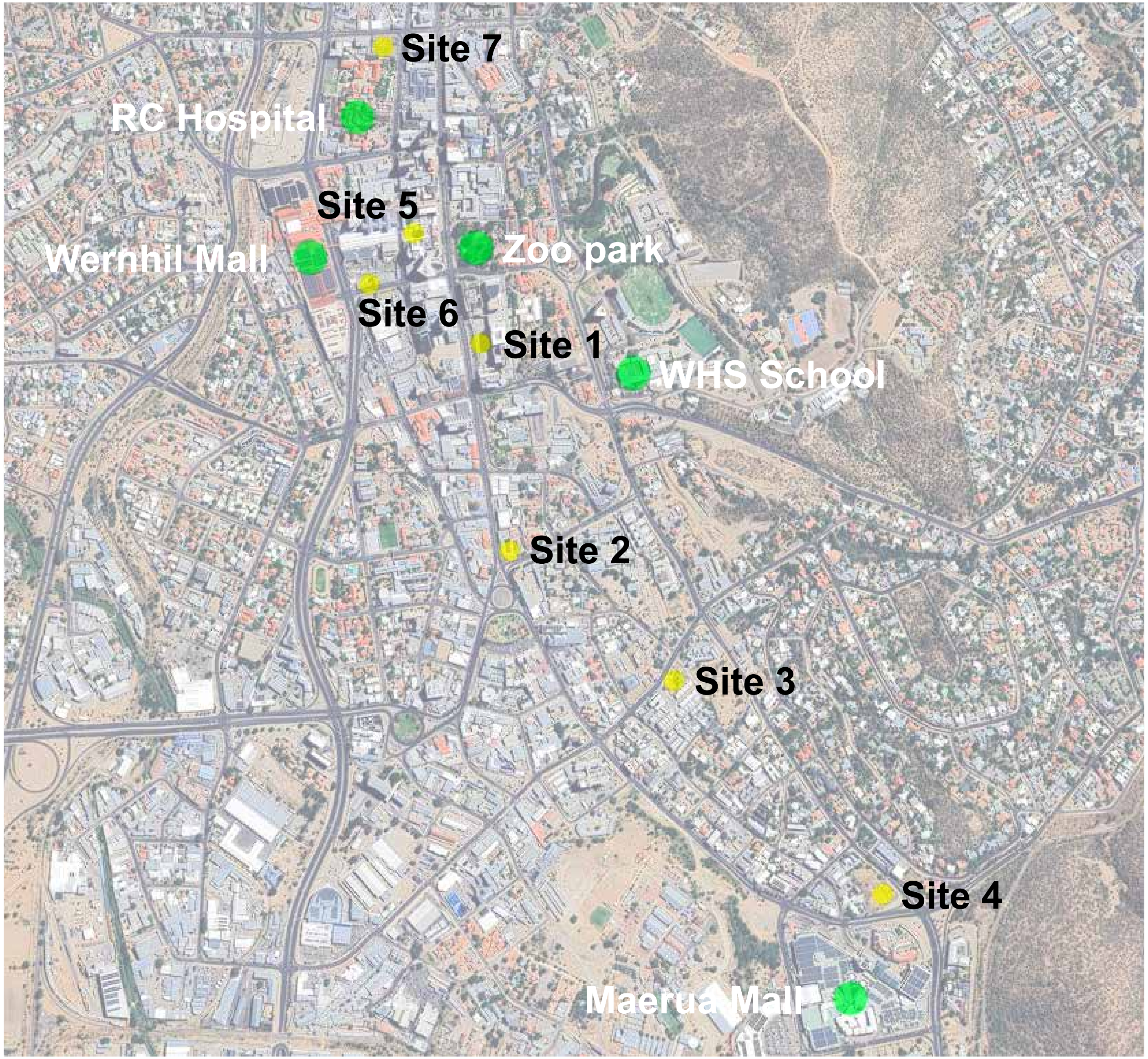


Figure 4.3.1 - Site location map

ANALYSES OF POTENTIAL SITES

Site 1 - CBD Centre (Independence Avenue, SSC plot on Freedom Plaza and plot opposite the street)

✓ - Urban setting
✓ - Nearby public facilities
× - Orientation east west axis
✓ - Multiple points of access
× - Raw land
✓ - Underdeveloped land
✓ - Facilitate hi-rise building
× - Facilitates low-rise large development

Overall score: 62.5%

Figure 4.3.2 - Potential site analysis - Site 1 - CBD Centre (Independence Avenue, SSC plot on Freedom Plaza and plot opposite the street)

Site 2 - CBD Periphery (Corner of Independence Avenue and Dr. A.B. May Street, Langerhans parking)

✓ - Urban setting
✓ - Nearby public facilities
✓ - Orientation east west axis
✓ - Multiple points of access
× - Raw land
✓ - Underdeveloped land
× - Facilitate hi-rise building
✓ - Facilitates low-rise large development

Overall score: 87.5%

Figure 4.3.3 - Potential site analysis - Site 2 - CBD Periphery (Corner of Independence Avenue and Dr. A.B. May Street, Langerhans parking)

Site 3 - Urban surroundings (Lazarett Street, NWR property next to Tenbergen Village)

× - Urban setting
× - Nearby public facilities
× - Orientation east west axis
✓ - Multiple points of access
× - Raw land
✓ - Underdeveloped land
× - Facilitate hi-rise building
✓ - Facilitates low-rise large development

Overall score: 50%

Figure 4.3.4 - Potential site analysis - Site 3 - Urban surroundings (Lazarett Street, NWR property next to Tenbergen Village)

Site 4 - Urban surroundings (Corner of Jan Jonker Street and Robert Mugabe Avenue, opposite Maerua Mall)

× - Urban setting
✓ - Nearby public facilities
× - Orientation east west axis
✓ - Multiple points of access
✓ - Raw land
× - Underdeveloped land
× - Facilitate hi-rise building
✓ - Facilitates low-rise large development

Overall score: 50%

Figure 4.3.5 - Potential site analysis - Site 4 - Site 4 - Urban surroundings (Corner of Jan Jonker Street and Robert Mugabe Avenue, opposite Maerua Mall)

Site 5 - CBD Centre (Between Werner List Street and Independence Avenue, behind Post Street Mall)

✓ - Urban setting
✓ - Nearby public facilities
✓ - Orientation east west axis
× - Multiple points of access
× - Raw land
✓ - Underdeveloped land
✓ - Facilitate hi-rise building
× - Facilitates low-rise large development

Overall score: 62.5%

Figure 4.3.6 - Potential site analysis - Site 5 - CBD Centre (Between Werner List Street and Independence Avenue, behind Post Street Mall)

Site 6 - CBD Centre (Corner of Ndemufayo Avenue and Fidel Castro Street, Near Wernhil Mall)

✓ - Urban setting
✓ - Nearby public facilities
✓ - Orientation east west axis
✓ - Multiple points of access
× - Raw land
✓ - Underdeveloped land
✓ - Facilitate hi-rise building
× - Facilitates low-rise large development

Overall score: 75%

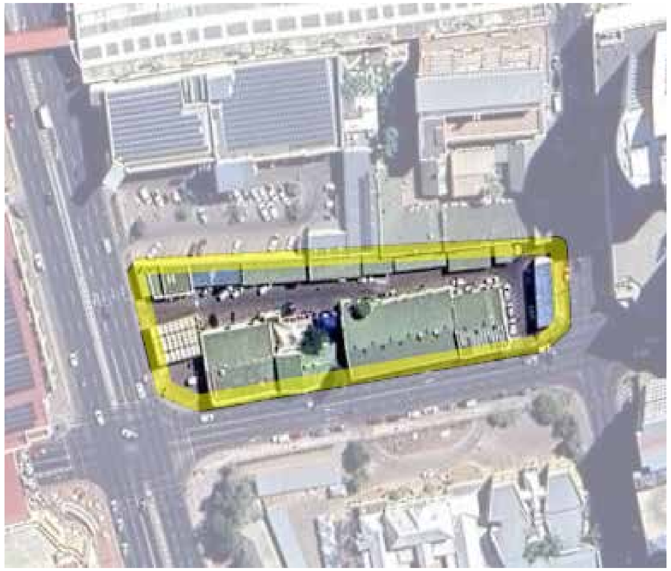


Figure 4.3.7 - Potential site analysis - Site 6 - CBD Centre (Corner of Ndemufayo Avenue and Fidel Castro Street, Near Wernhil Mall)

Site 7 - OLD CBD Centre (Corner of John Meinert Street and Werner List Street, adjacent Holy Cross Convent Primary School)

✓ - Urban setting
✓ - Nearby public facilities
✓ - Orientation east west axis
✓ - Multiple points of access
× - Raw land
✓ - Underdeveloped land
✓ - Facilitate hi-rise building
✓ - Facilitates low-rise large development

Overall score: 93.75%

Figure 4.3.8 - Potential site analysis - Site 7 - OLD CBD Centre (Corner of John Meinert Street and Werner List Street, adjacent Holy Cross Convent Primary School)

Conclusion

The site adjacent to the Roman Catholic precinct was selected for its strategic advantages. Currently underutilised as public parking and a taxi stop, its close proximity to the precinct allows for seamless integration of passive design strategies on a larger scale. The site presents an opportunity for the Roman Catholic institution to become the client, as their existing site is nearly fully developed. With ample space for a large-scale development, it serves as a testing ground for various passive strategies. By implementing innovative approaches to solar orientation, natural ventilation, and materials, the site can transform into a sustainable and vibrant urban area.

4.4 SITE INFORMATION AND CONSTRAINTS

INTRODUCTION

The property encompasses an area of 5,036m² and has a bulk factor of 4, granting the potential for a total floor area of 20,140m². The building can occupy up to 75% of the entire site, allowing for efficient utilisation of space. In terms of parking, the zoning regulations require one parking bay for every 50m² of floor area. Therefore, at the maximum bulk factor, a total of 403 parking bays would be required to meet the parking needs of the development.

SITE INFORMATION

See annexure D for Town Planning Certificate no 1 where information was collected

Erf No: 7203
Erf Size: 5 036m^2
Township: Windhoek / Windhoek blocks
Street: John Meinert Street

Zoned: Restricted business
Density: N/A
Parking: 1 per 50m^2
Bulk factor: 4
Maximum permissible bulk: 20 140m^2
Coverage: 75%

Site diagram

Figure 4.4.1 - Site information - Site diagram

Erf size

Figure 4.4.2 - Site information - Erf size

Bulk factor and maximum permissible bulk

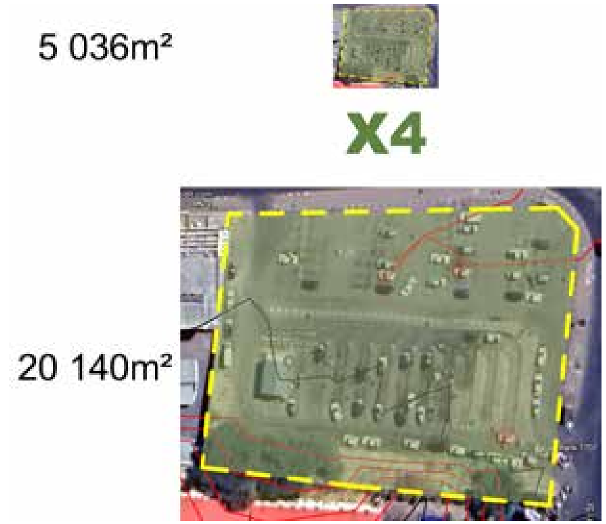


Figure 4.4.3 - Site information - Bulk factor

Coverage

Figure 4.4.4 - Site information - Coverage

Parking requirement

Figure 4.4.5 - Site information - Coverage

4.5 SPATIAL CRITERION

INTRODUCTION

The building design will accommodate a diverse range of functions, including retail, housing, and workspaces. Retail spaces should feature a mix of brand shops, boutique stores, and pop-up shop stalls, while residential areas should offer a variety of apartment sizes, from bachelor to three-bedroom units, with a focus on creating a sense of standalone living and private garden spaces. The office spaces should cater to both large corporate offices and smaller SMEs, with flexibility in layout and access to shared amenities. The overall goal is to create a dynamic and inclusive environment that appeals to a wide range of businesses and residents.

BUILDING USE AND SPATIAL REQUIREMENTS

The building design should accommodate a diverse range of functions, including retail, housing, and workspaces. The retail section should cater to both large and small shops, providing a platform for various businesses to thrive. The housing component should offer a range of options, from affordable housing to upper-market living, ensuring inclusivity and meeting the needs of different income groups. The office spaces should be designed with flexibility in mind, allowing for a variety of office sizes to attract both small and medium-sized enterprises (SMEs) as well as corporate offices. This approach aims to create a balanced mix of businesses and foster a dynamic and vibrant environment.

Retail

Retail spaces should encompass a diverse mix of brand shops, boutique stores, and dynamic pop-up shop stalls.

These spaces should be designed to incorporate the following essential elements:
- Access to ground floor and public areas
- Open plan layout with minimal structure in the interior space
- Storage space
- Communal bathroom facilities
- Delivery area

Figure 4.5.1 - Spatial criterion - Retail

Office

Office spaces should encompass a blend of expansive corporate offices, flexible workspaces for small to medium enterprises (SMEs), and collaborative shared workspaces. These spaces should be designed to incorporate the following essential elements:

- Flexible plan layouts
- Access to internal open space
- Views to the outside
- Access to ablutions depending on the size, it will either be communal ablutions facilities or dedicated bathrooms
- Dependant on the size of the office lobbies will be shared or dedicated

Figure 4.5.2 - Spatial criterion - Office

Residential

Residential units should offer a diverse range of options, including bachelor, single-bedroom, double-bedroom, and three-bedroom apartments. Each unit should provide a sense of a standalone house, featuring private garden spaces. This design aims to enhance inner-city living's appeal and attract individuals seeking an urban lifestyle. These spaces should include:

-Bedrooms with closets
-Private balcony gardens
-Full bathroom (additional shared bathroom)
-Views to the outside
-Passive cooling and heating
-Connection to recycled water for toilets and gardens.

Figure 4.5.3 - Spatial criterion - Residential

PRELIMINARY ACCOMMODATION SCHEDULE

Table 8 - Preliminary accommodation schedule

Retail

Unit Type	Dimension	Area	Kitchen	Bathroom	Staff area	Office	Storage	Unit QTY	Total Size
Pop-up shop	4.25m x 4m	17m²	×	×	×	0	✓	10	170m²
Boutique shop	8.5m x 12.1m	103m²	×	×	×	1	×	15	1545m²
Brand shop	8.5m x 24.3m	207m²	✓	✓	✓	3	✓	10	2070m²
				Total Retail Area					3785m²

Office

Unit Type	Dimension	Area	Kitchen	Bathroom	Balcony	Office	Open Plan	Unit QTY	Total Size
Collaborative office	8.5m x 16.2m	138m²	✓	×	✓	0	✓	2	960m²
Small office	8.5m x 8.1m	69m²	×	×	×	0	✓	25	1725m²
Medium office	8.5m x 12.1m	103m²	×	×	✓	1	✓	22	2266m²
Large office	8.5m x 24.3m	207m²	✓	✓	✓	5	✓	5	1035m²
				Total Office Area					5302m²

Residential

Unit Type	Dimension	Area	Kitchen	Bathroom	Balcony	Bedroom	Lounge	Unit QTY	Total Size
Bachelor unit	6m x 8m	48m²	✓	1	1	1	✓	20	960m²
Single bedroom unit	8.5m x 8.1m	69m²	✓	1	2	1	✓	25	1725m²
Double bedroom unit	8.5m x 12.1m	103m²	✓	1	3	2	✓	19	1957m²
Three bedroom unit	8.5m x 16.2m	138m²	✓	2	3	3	✓	15	2070m²
				Total Residential Area					6732m²
				Total Building Area					15799m²
				Total Bulk					3.1

4.6 SECTION CONCLUSION

The selection of the site was an intricate process driven by a set of well-defined criteria. Among the available options, Site 7, strategically positioned adjacent to the Roman Catholic Precinct, emerged as the most promising choice. This selection was based on a comprehensive evaluation of the site's attributes, which were meticulously assessed in line with the predetermined criteria. Site 7 garnered the highest score, indicating its potential to fulfil the desired objectives effectively.

To gain a thorough understanding of the site's characteristics and its associated building possibilities, a meticulous analysis of municipal property information was carried out. This data provided invaluable insights into the property's dimensions, regulations, and constraints, offering a realistic picture of what could be achieved within the established parameters.

To maximise the site's utility and potential, an accommodation schedule was developed. This schedule takes into account the estimated floor areas allocated to various functions and uses within the site. However, it is designed to remain adaptable, subject to refinements and adjustments as the design process progresses. This flexibility is essential to ensure that the site can cater to a wide range of activities and functions, including shops, restaurants, offices, and residential units. Such versatility enables the site to be consistently in use, serving as a dynamic and vibrant hub for the community.

SECTION 5

PRECINCT ANALYSES

Through a visual analysis of the precinct's surrounding area, one can gather crucial contextual insights that serve as guiding principles for the architectural theme of the new design. By comprehending factors such as the existing building heights and prevalent materials, the design can be seamlessly integrated into the surrounding context. Moreover, careful observation of key nodes and issues within the vicinity can inspire architectural responses aimed at resolving these challenges and establishing connections between various levels of these nodes. The result is an integrated and cohesive system that enhances the overall connectivity of the area.

5.1 NEIGHBOUR-HOODANALYSES

INTRODUCTION

The majority of buildings in the area cater for office space with a retail component on ground floor. There are some government institutions and private institutions within the area. The north west area portion caters to single to triple story small businesses.

There are multiple points of interest in the neighbourhood surrounding the site. Wernhil Mall and Post Street Mall is walking distance from the site. The area has three key transport nodes being two taxi parking one being not official that is located in the site and a long distance transport stop. The Holy Cross Convent School, Roman Catholic Church and hospital border the site

Due to high pedestrian use of area traffic is a problem in the area.

TYPOLOGICAL INVESTIGATION

Buildings in Independence Avenue are mainly office with a retail component on ground floor (see figure 5.1.2 and 5.1.3). Buildings along John Meinert Street consist mostly of single to triple story business spaces (see figure 5.1.4 and 5.1.5).

To the south of the site is a school and hospital. There are residential developments in the area as well, but not to an extent that it assist with the current need for housing in Windhoek. There are some major retail buildings like Wernhil Mall and Shoprite.

Due to the lack of residential buildings in the area the new development should incorporate an portion of this as the site have right to free residential bulk.

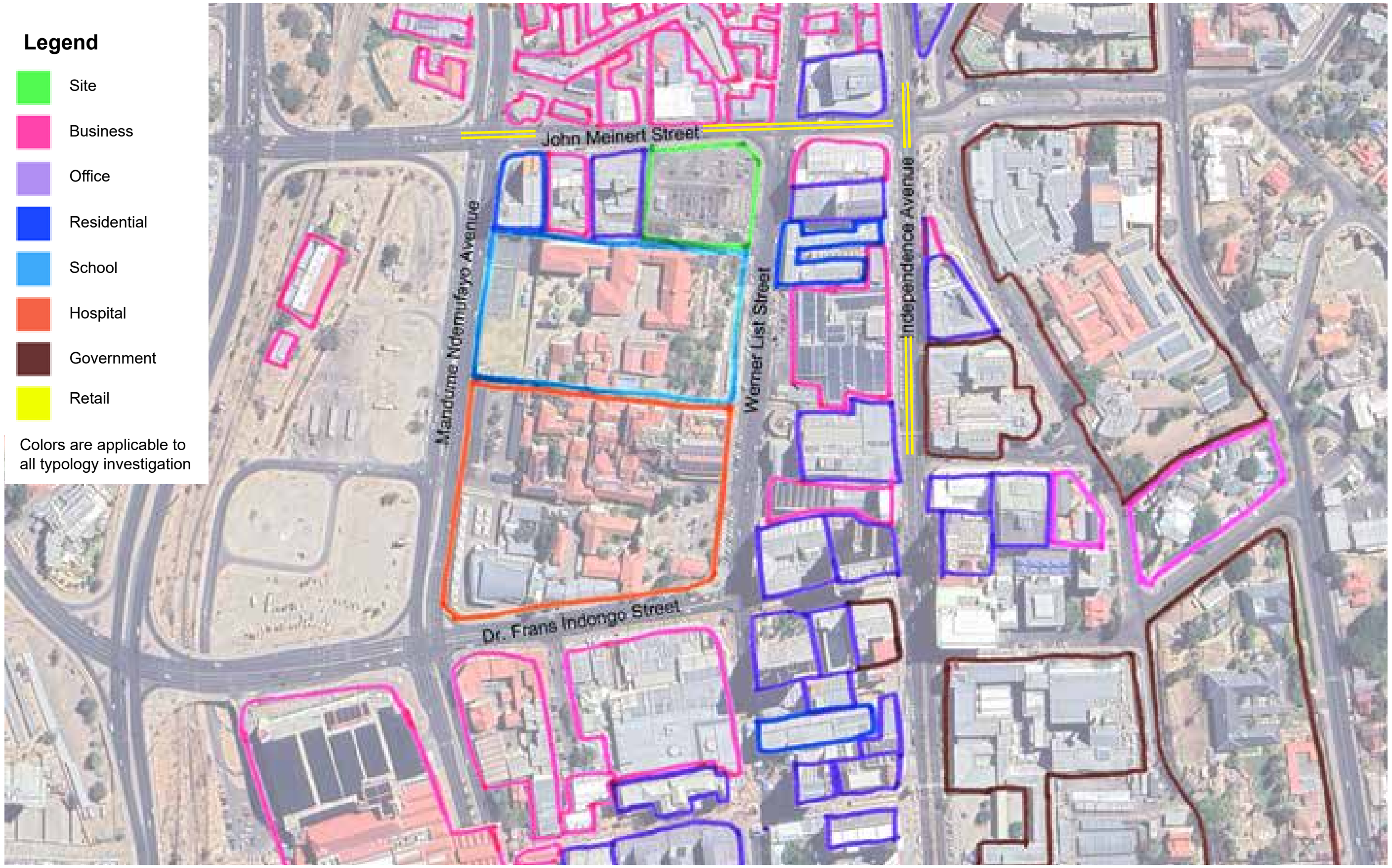


Figure 5.1.1 - Typology identification within the neighbourhood

Understanding the building typology of the surrounding areas informs the design of the new precinct development. This insight helps identify local architectural styles, spatial arrangements, and usage patterns.

By recognising these elements, designers can incorporate relevant functions and features that align with the community's needs and the urban context. This analysis ensures a cohesive and contextually appropriate approach to urban design.

Figure 5.1.2 - Independence Avenue looking west

Figure 5.1.3 - Independence Avenue looking east

Figure 5.1.4 - John Meinert Street looking south

Figure 5.1.5 - John Meinert Street looking south

NEIGHBOURHOOD AMENITIES AND KEY NODES

The strategic location of the site offers several key node points that make it an ideal opportunity for residential development. The presence of three major transport nodes for intercity and outer city travel (figure 5.1.8 and 5.1.9), along with nearby service stations, provides convenient access for residents and encourages after-hour shopping (figure 5.1.7 and 5.1.10). The surrounding area is enriched by the presence of schools, a hospital, and churches, creating a sense of a close-knit community that fosters self-sufficiency. Given the site's proximity to the Roman Catholic site, it would be advantageous to incorporate amenities that cater to the school and hospital, further enhancing the potential for the site to evolve into a vibrant and self-contained neighbourhood.

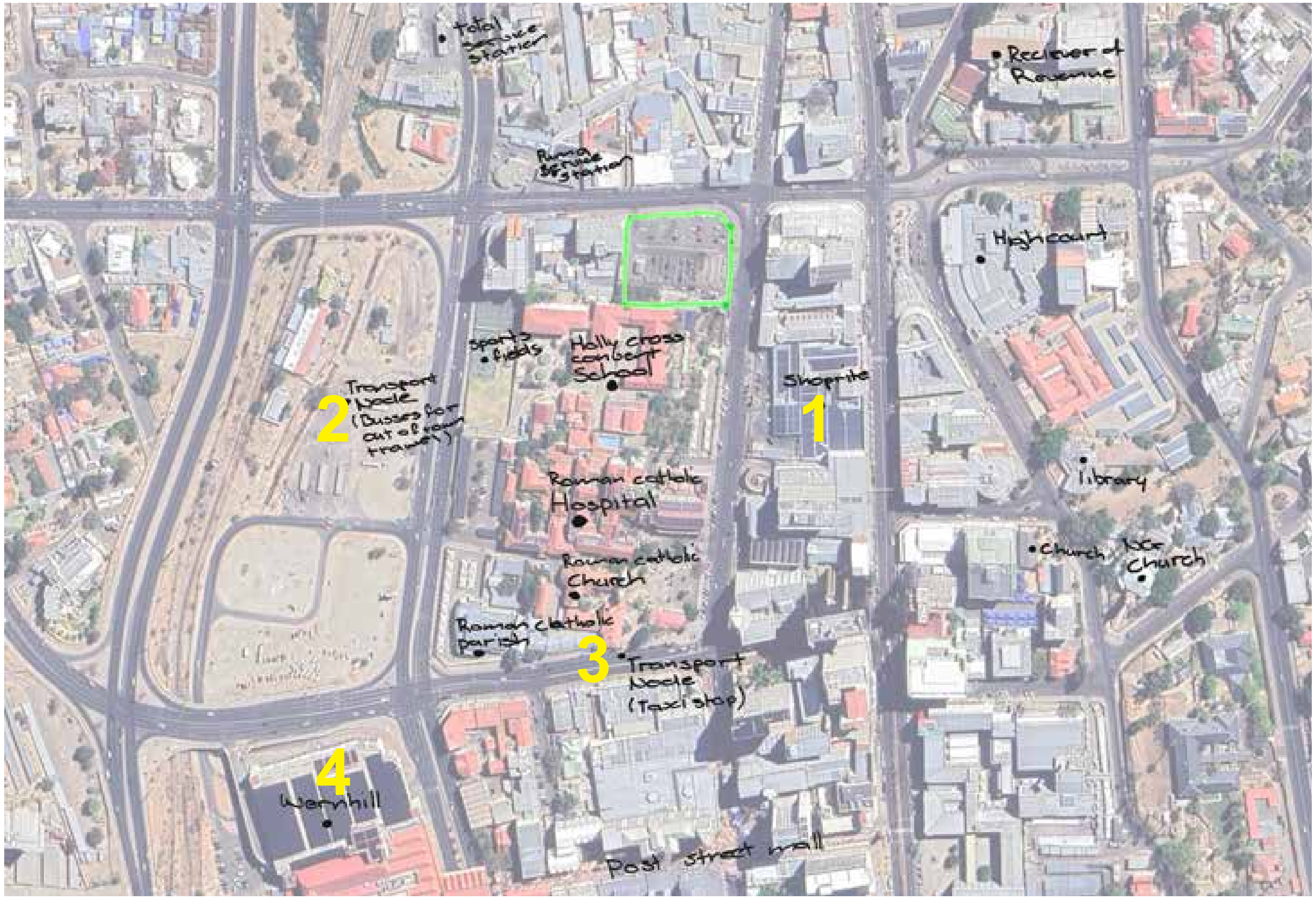


Figure 5.1.6 - Key amenities and nodes within the neighbourhood

1 - Grocery store

A nearby grocery store is within walking distance of the new development, providing convenient access to essential supplies (figure 5.1.6 for location).

Figure 5.1.7 - Amenities and key nodes - Grocery store

2 - Bus and taxi hub

A transport hub located down the road serves both long-distance and short-distance travel needs, offering potential for increased utilisation and improved connectivity (figure 5.1.6 for location).

Figure 5.1.8 - Amenities and key nodes - Bus and taxi hub

3 - Taxi drop off

A nearby taxi drop-off point provides convenient access for commuters, allowing them to be dropped off within a short walking distance of the inner CBD area (figure 5.1.6 for location).

Figure 5.1.9 - Amenities and key nodes - Taxi drop off

4 - Wernhil mall - Retail

The mall offers a wide range of retail amenities, fulfilling all the necessary shopping needs, and it is conveniently located within walking distance of the new development (figure 5.1.6 for location).

Figure 5.1.10 - Amenities and key nodes - Mall for retail

NEIGHBOURHOOD OBSERVATIONS

The site benefits from excellent connectivity to various thoroughfares, enhancing its accessibility to different parts of the city. The presence of a major thoroughfare directly across from the site (figure 5.1.15) offers the advantage of shorter travel times to inner city areas, thereby reducing the reliance on private vehicles. However, it is worth noting that the corner of Independence Avenue and John Meinert Street has experienced a challenge due to taxis stopping in front of the Namlex building (figure 5.1.12), where Independence Avenue is closed off for taxis. Furthermore, during rush hours, John Meinert Street experiences significant traffic congestion, as it serves as one of the primary routes to the west of Windhoek.

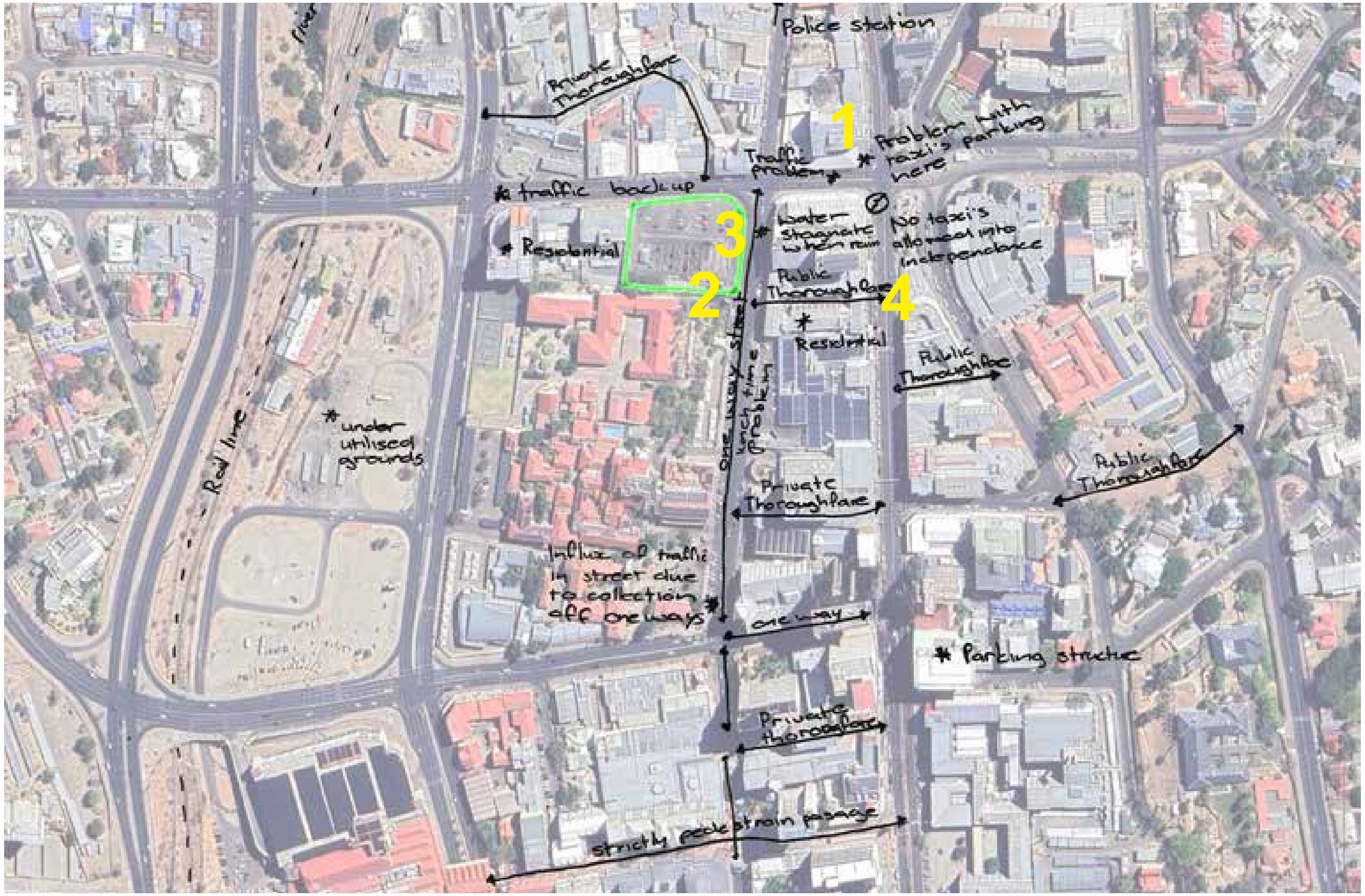


Figure 5.1.11 - Functionality observations within the neighbourhood

1 - Taxi congestion

Traffic congestion is a significant issue at the intersection near the Namlex building due to taxis stopping in the middle of the road. This situation arises because taxis are prohibited from making a southward turn into Independence Avenue (figure 5.1.11 for location).

Figure 5.1.12 - Taxi congestion

2 - Street vendors

The entrance of the site is crowded with street vendors, but unfortunately, they neglect to maintain cleanliness, resulting in an unpleasant walking environment (figure 5.1.11 for location).

Figure 5.1.13 - Street vendors

3 - Unattractive street edge

Despite the municipality's efforts to address the issue, the nearby skip bin intended for waste disposal often ends up overflowing or attracting illegal dumping, as the street vendors neglect to properly manage their waste (figure 5.1.11 for location).

Figure 5.1.14 - Unattractive street edges

4 - Thoroughfare from Werner List Street to Independence Ave

This thoroughfare, located on the opposite side of the street, offers pedestrians a convenient route to the inner city, eliminating the need to take a longer route around a city block (figure 5.1.11 for location).

Figure 5.1.15 - Thoroughfare / arcade between buildings

PRECINCT OBSERVATION

The site presents several key areas of focus that can be enhanced to create a more connected and vibrant precinct. However, there are also challenges that hinder the site's overall connectivity.

The urban fabric in and around the precinct consists of inner city buildings with protected walkways, retail street edges, and private spaces. While these elements contribute to the overall design, there is a need to prioritise the designing for people aspect to ensure a more human-centric environment.

Figure 5.1.16 - Functionality observations within the precinct

1 - Impermeable boundary

The neighbouring properties on the western edge have constructed boundary walls that extend up to the height of the adjacent school, effectively closing off any connection between the properties (figure 5.1.16 for location).

Figure 5.1.17 - Precinct observation - Impermeable boundary

2 - Impermeable boundary with opportunity

An impermeable boundary between the school and the properties on the northern side creates a corridor that can extend the thoroughfare and connect with the bus and taxi node, improving accessibility and urban mobility (figure 5.1.16 for location).

Figure 5.1.18 - Precinct observation - Impermeable boundary with opportunity

3 - School parking on street edge

The staff parking area, currently situated at the street edge, lacks activation potential, as it is enclosed and hinders the creation of a bustling pedestrian walkway (figure 5.1.16 for location).

Figure 5.1.19 - Precinct observation - School parking on street edge

4 - Access to school and hospital

The single entrance connecting the school and hospital can be extended to the new development, thereby creating a new public garden within the inner city (figure 5.1.16 for location).

Figure 5.1.20 - Precinct observation - Access to school and hospital

PRECINCT URBAN FABRIC

The area exhibits a consistent urban fabric characterised by common design elements. These include corner buildings, canopies along street edges for weather protection, closed-off void spaces resulting in inactive facades, and medium-rise buildings positioned towards the street edges. When designing a new building in this context, it is important to consider these existing elements and ensure harmonious integration with the urban fabric. The design should strive to blend with the surroundings while also incorporating unique features that make the building stand out in its own right. Balancing familiarity and distinctiveness will contribute to a cohesive yet individualistic architectural expression.

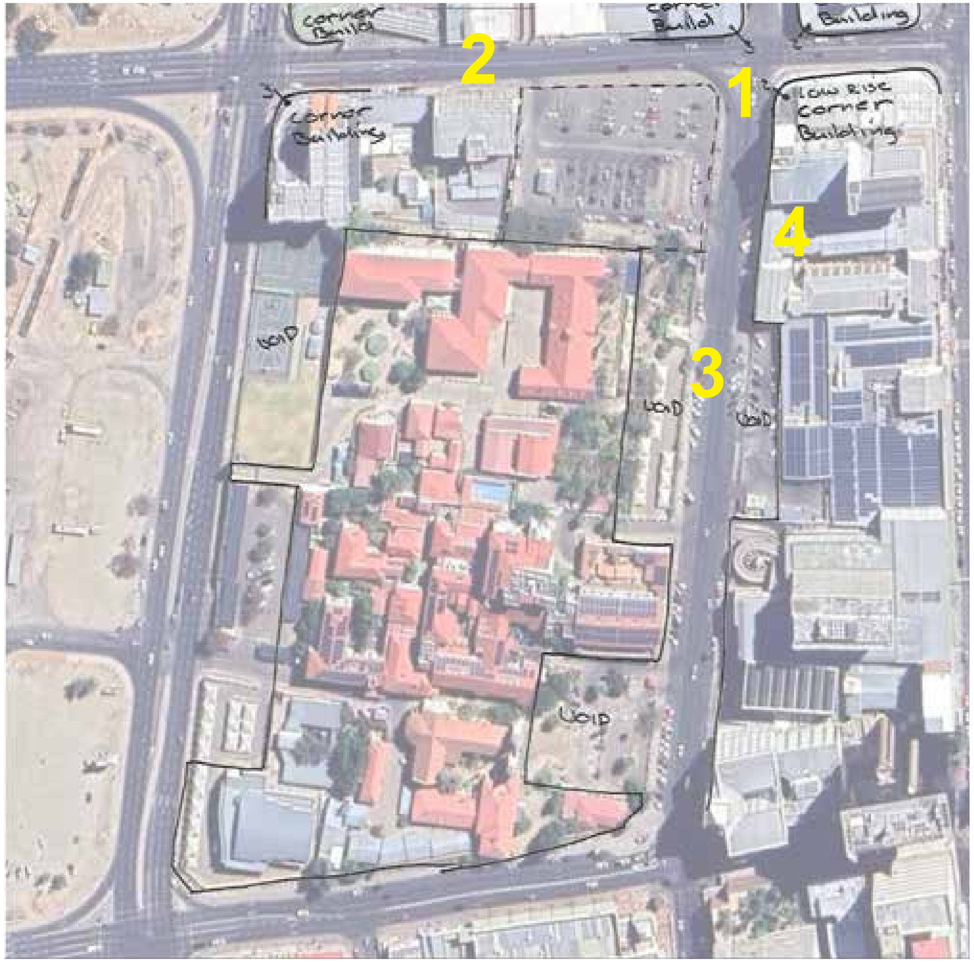


Figure 5.1.21 - Functionality observations within the neighbourhood

1 - Strong corner elements

Low-rise corner elements are strategically positioned at every corner surrounding the precinct and across from it, reinforcing the distinct corner edges of the urban fabric (figure 5.1.21 for location).

Figure 5.1.22 - Precinct urban fabric - Strong corner elements

2 - Street edge canopies

The buildings in the area feature shaded walkways that lack columnades, adding depth to the street facades and providing protected walking spaces (figure 5.1.21 for location).

Figure 5.1.23 - Precinct urban fabric -Street edge canopies

3 - Void spaces

The precinct has underutilised void spaces that can be activated to enhance public-private interaction (figure 5.1.21 for location).

Figure 5.1.24 - Precinct urban fabric - Void spaces

4 - Medium rise buildings

The area features medium-rise buildings set back from the street edges, providing a more human-scale environment (figure 5.1.21 for location).

Figure 5.1.25 - Precinct urban fabric - Medium rise buildings

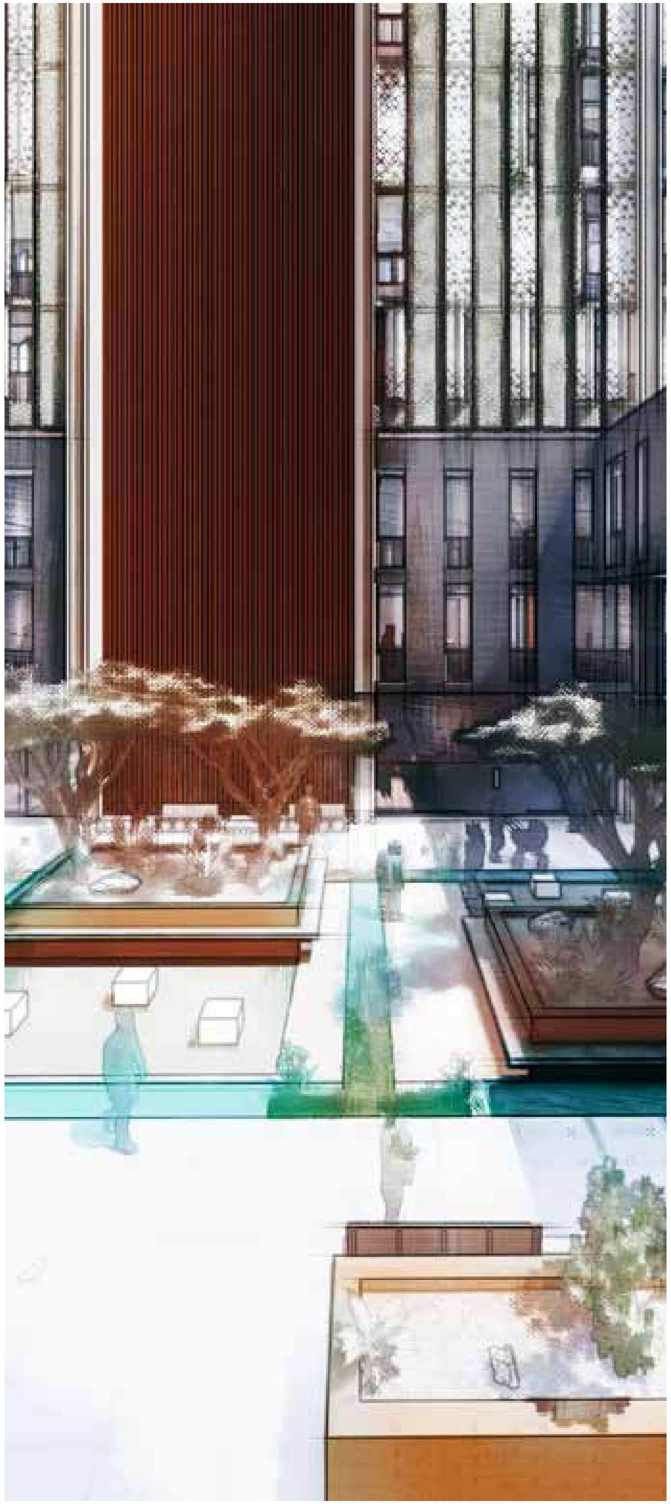
5.2 SECTION CONCLUSION

In conclusion, the comprehensive analysis of this neighbourhood has provided invaluable insights into the multifaceted world of urban design and planning. It is evident that neighbourhoods are complex ecosystems where various elements, from housing and transportation to green spaces and public facilities, must coexist harmoniously to create vibrant and sustainable communities.

The role of mixed land use, well-planned transportation networks, and accessible public amenities cannot be overstated. These factors are the bedrock of a thriving neighbourhood, enhancing the quality of life for its residents and contributing to the overall well-being of the community.

Moreover, the study has emphasised the pivotal importance of sustainability in modern urban planning. Sustainable neighbourhoods are not only environmentally responsible but also economically viable and socially inclusive. Lessons from this analysis underscore the need for a holistic approach that integrates passive design strategies, renewable energy sources, and sustainable materials to build resilient neighbourhoods that can withstand the challenges of the future.

In essence, this neighbourhood analysis reinforces the idea that urban planning and design are not static endeavours. They are dynamic processes that demand foresight, adaptability, and a commitment to creating neighbourhoods that are not just spaces to live but communities that thrive, grow, and enrich the lives of all who call them home.




SECTION 6

INITIAL DESIGN EXPLORATION

Drawing insights from the precinct analyses, the initial design form takes shape by harmonising with the existing context. This foundational design integrates the site vision, aligning it with the urban fabric and nodes that define the area. The exploration of building height serves to establish connections between various levels, bridging the gap between the street and the Roman Catholic Precinct. Given the crucial role of structure in building design, different basement structures are examined to optimise parking layouts efficiently. Furthermore, an exploration of the maximum permissible bulk assesses its feasibility for the development.

6.1 INITIAL SPATIAL DESIGN EXPLORATION

INTRODUCTION

Design considerations are initiated by a thorough analysis of the site's characteristics and its integration into the existing urban fabric. This process is guided by various factors, including the site's physical attributes, neighbouring structures, and overall urban context. A crucial objective is to establish a seamless connection between the site and the larger precinct, rectifying any previous disconnection. This entails re-imagining the layout to eliminate the sense of isolation, fostering a sense of unity and continuity across the precinct. By addressing these fundamental aspects, the design aims to create a harmonious transition between the site and its urban surroundings, while also enhancing the overall accessibility and integration of the Roman Catholic precinct within the broader neighbourhood.

SITE AND URBAN FABRIC INFORMANTS

Low-rise corner element

The prevailing architectural trend in the area involves incorporating low-rise corner elements in building designs. These elements serve various purposes, including improving aesthetics, creating unique entryways, and offering engaging public spaces. By recognising and emulating this trend, designers can seamlessly integrate the new precinct with the existing urban fabric. This approach not only respects the local context but also fosters a sense of connection and continuity between the new development and the surrounding neighbourhood.

Figure 6.1.1 - Site and urban fabric informants - Low-rise corner element

Public green space

While the area contains limited green spaces, mainly allocated for private use, there is potential to broaden their scope. Introducing communal green spaces, like public parks and landscaped plazas, within the new precinct can encourage social interaction and elevate the urban environment. This expansion of green spaces promotes a more sustainable and inclusive community while enhancing the overall living experience.

Figure 6.1.2 - Site and urban fabric informants - Public green space

Full street edge envelope

In the vicinity, ground-level street spaces are primarily designated for retail use. This configuration encourages a dynamic connection between the public and the built environment. Retail establishments at street level facilitate engagement, social interaction, and economic vitality, contributing to the energetic urban ambiance. By incorporating retail spaces, the pedestrian experience is enriched, foot traffic is promoted, and a bustling atmosphere is cultivated, benefiting both residents and visitors. This design approach reflects urban design principles centered on accessibility, community engagement, and vibrant public spaces.

Figure 6.1.3 - Site and urban fabric informants - Full street edge envelope

Connection to RC precinct

The Roman Catholic precinct currently faces isolation and disconnection from its surrounding neighbourhood. This spatial separation challenges integration and accessibility. Addressing this is essential for inclusivity, community engagement, and urban cohesion. By redesigning the layout, stronger linkages can be established, enhancing the precinct's role within the neighbourhood and creating a more vibrant urban experience.

Figure 6.1.4 - Site and urban fabric informants - Connection to RC precinct

FORM EXPLORATION INFORMED BY SITE AND URBAN FABRIC IN-FORMANTS

East West building axis

Multiple layout variations were considered during the design process, and the chosen option prioritised connectivity. However, this layout does have some drawbacks, including the separation of functions and the obstruction of the link to the Roman Catholic precinct. The orientation of the building is favorable, but it does present challenges in terms of providing adequate shading during summer and creating a cold space in between during winter.

Figure 6.1.5 - Exploration 1 - East West building axis

Street edge open space

Consideration was given to the possibility of creating a public green space along the street edge, in line with the existing voids within the precinct. However, this option presented drawbacks, particularly in terms of building orientation. With large east and west facades, the preferred orientation for optimal energy efficiency and comfort was not achievable.

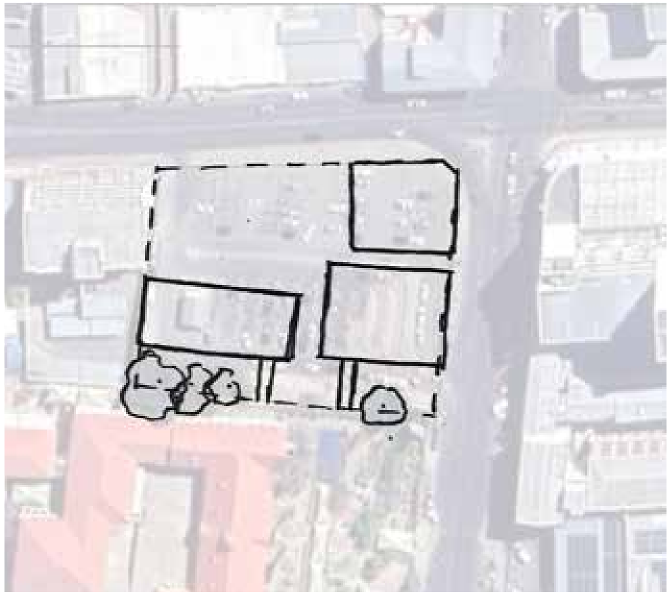


Figure 6.1.6 - Exploration 2 - Street edge open space

Green space expansion

The design took into consideration the preservation of the void space and the extension of the green space along Werner List street. This approach created an outdoor space that could be enjoyed during both summer and winter. However, there was a concern regarding the activation of the street edge, as it did not fully meet the desired level of engagement. Additionally, the building width posed challenges, as it would require a centralised corridor, limiting the potential for maximising natural daylight penetration into the interior spaces.

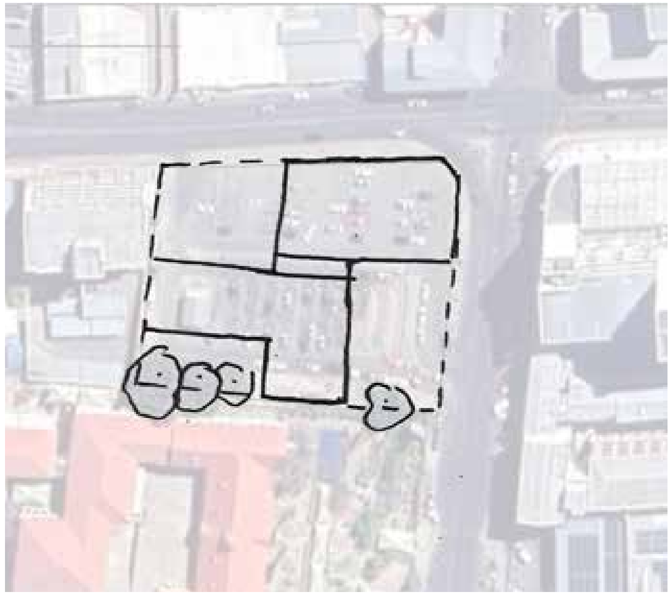


Figure 6.1.7 - Exploration 3 - Green space expansion

Centre courtyard

This design prioritised street edge activation and the creation of an internal public green space. It successfully established an interesting connection to the Roman Catholic precinct. However, one drawback was that the public green space ended up feeling more like a private green space, as it lacked visual connectivity from the public edge.

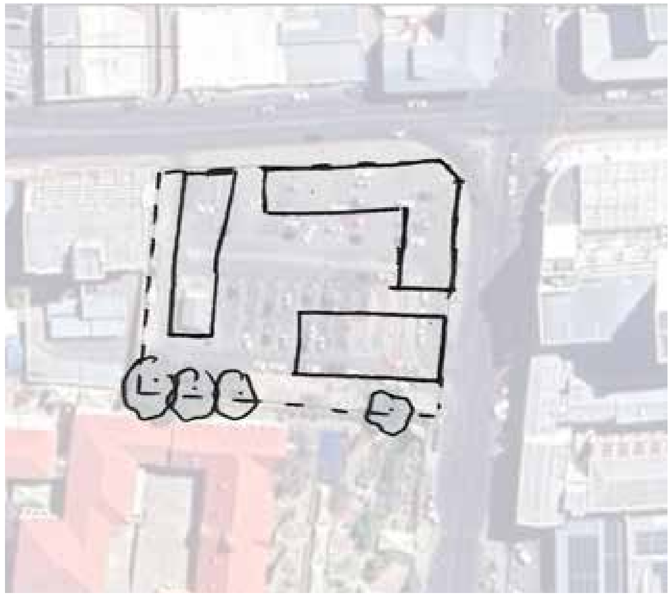


Figure 6.1.8 - Centre courtyard

FORM EXPLORATION BASED ON OUTDOOR SPACE CREATION

Step 1 - Critical elements on site

The primary objective was to maximise the available bulk while ensuring the preservation of the existing trees on site and maintaining a safe distance from the steep edge adjacent to the Holy Cross School.

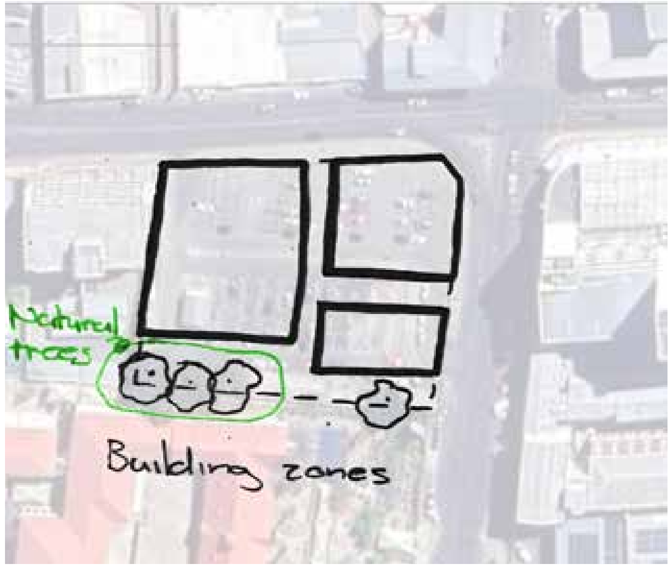


Figure 6.1.9 - Responding to space - Step 1 - Critical elements on site

Step 2 - Creating central courtyard

The central courtyard enhances the development with its versatile and purposeful design. It fosters community, offers a peaceful retreat, and promotes natural light and ventilation. With its greenery and visual appeal, the courtyard enriches the overall experience.

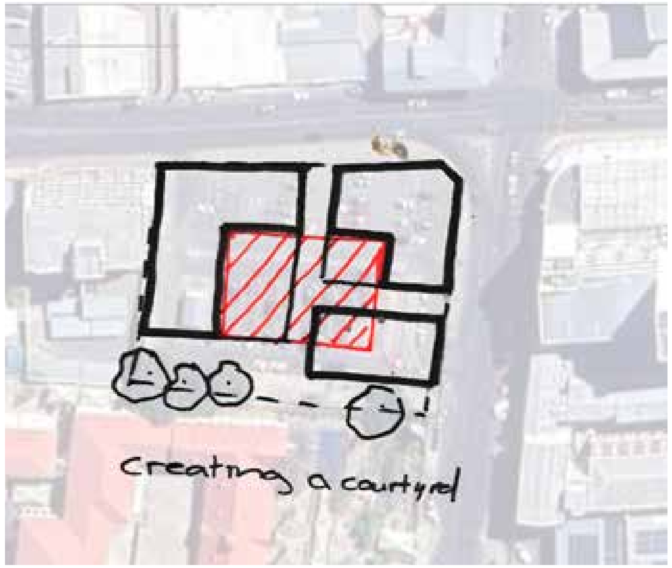


Figure 6.1.10 - Responding to space - Step 2 - Creating central courtyard

Step 3 - Linking green space to the public

To improve accessibility and increase the utilisation of the green space, additional access links were introduced. These new pathways and entrances provide greater connectivity between the street edge and the green space, inviting more people to enjoy and engage with the area.

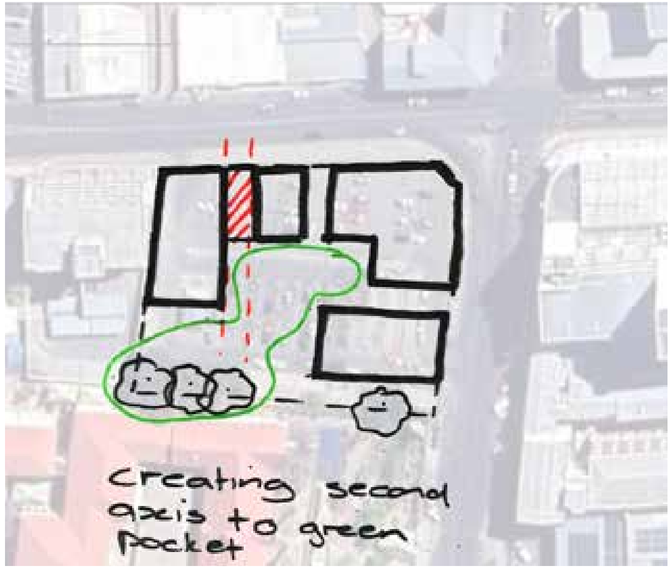


Figure 6.1.11 - Responding to space - Step 3 - Linking green space to the public

Step 4 - Multi layer access across the site

To enhance the connectivity and integration of the public green space, the design implemented a multi-layered approach to connect the freestanding buildings. This concept introduced various pathways, bridges, and walkways that traverse through the space, creating a network of interconnected routes. These connections facilitate easy movement between the buildings, promoting a sense of unity and shared experience within the precinct.

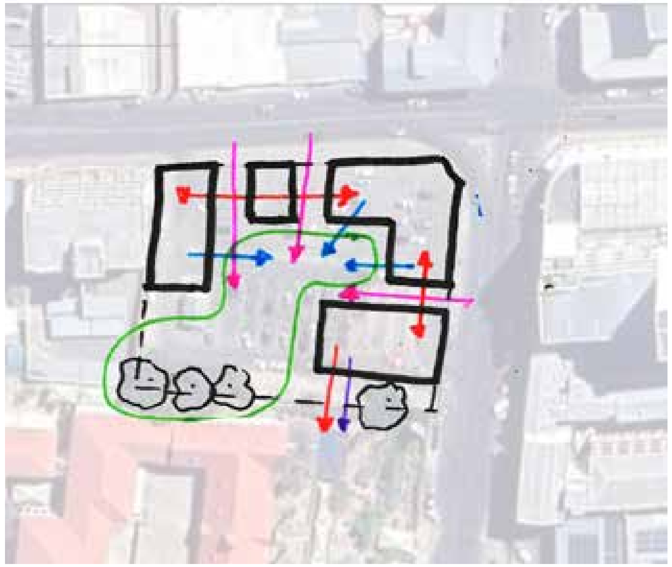


Figure 6.1.12 - Responding to space - Step 4 - Multi layer access across the site

VERTICAL EXPLORATION

Street edge - East / West facing north

In order to align the building with the surrounding context, a strategic setback from the street is proposed, accompanied by the integration of a public green space that seamlessly connects to the street edge.

This design approach aims to create a harmonious visual transition between the building and its urban environment, ensuring that the structure complements the existing street-scape while also providing an inviting communal area for residents and passersby.

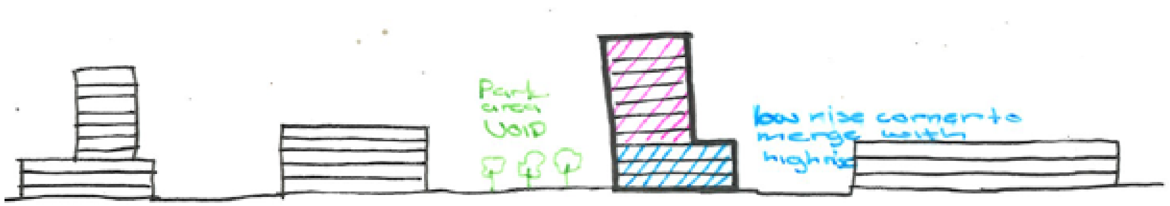


Figure 6.1.13 - Vertical exploration - Street edge - East / West facing north

Back of site - East / West facing north

The rear portion of the site is intentionally designed to have a denser construction, effectively maximising the site's volume. Moreover, a deliberate space is deliberately left between the buildings, serving as a pathway that facilitates a seamless connection towards the Roman Catholic precinct.

This thoughtful arrangement not only optimises the use of the available space but also enhances the overall urban flow, fostering a stronger integration between different areas of the urban fabric.

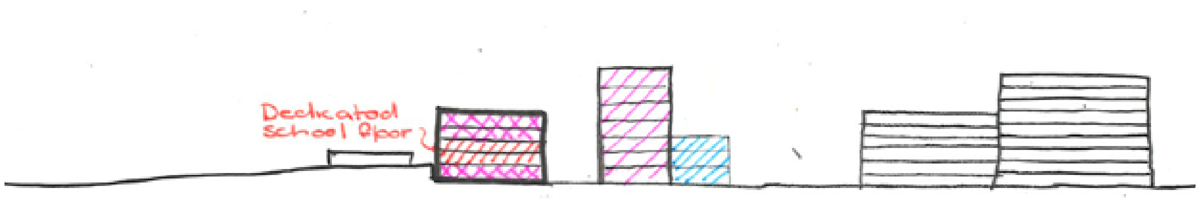


Figure 6.1.14 - Vertical exploration - Back of site - East / West facing north

Back of site - North / South facing east

Towards the rear section of the site, the residential components with unobstructed space are strategically positioned to establish a connection with the school level.

This arrangement is complemented by the inclusion of dedicated parking spaces intended for school staff and parents. This design not only maximises functional coherence within the precinct but also facilitates convenient access for those associated with the school.

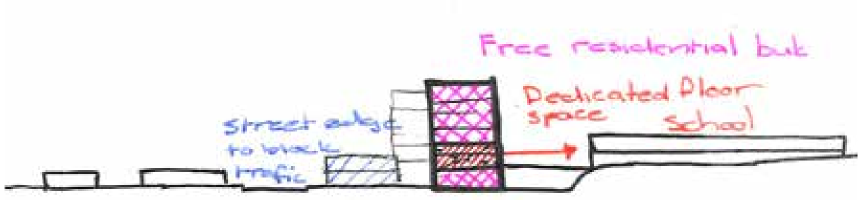


Figure 6.1.15 - Vertical exploration - Back of site - North / South facing east

Street edge - North / South facing east

The front corner of the building is designed to align with the height of the existing adjacent structure, while the building gradually increases in height towards the rear section.

This deliberate variation in height creates a harmonious transition with the surrounding built environment while allowing for optimal utilisation of available space.

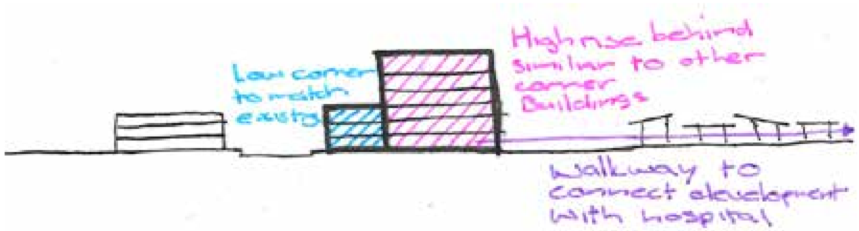


Figure 6.1.16 - Vertical exploration - Street edge - North / South facing east

6.2 PARKING STRUCTURE EXPLORATION

INTRODUCTION

When designing below-ground parking structures, the arrangement of parking columns and the grid layout are crucial. Proper column spacing ensures safe vehicle navigation, while an efficient grid layout maximises capacity and minimises congestion. A well-planned design also includes pedestrian pathways for safety. Balancing these elements creates accessible, functional, and integrated parking solutions.

PARKING STRUCTURE EXPLORATION

The choice of parking structure type significantly affects site sustainability and design. Various options, including surface, structured, or underground parking, have different implications for land use, aesthetics, and the environment. Sustainable choices like structured or underground parking can conserve land, improve looks, reduce the heat island effect, and create pedestrian-friendly areas. Thus, selecting the right parking type is crucial for sustainable and well-designed urban spaces.

Above ground parking structure

The design approach offers several benefits, including minimising the need for excavation, promoting natural ventilation, and utilising additional space on the site. However, it may not be aesthetically pleasing when analysed in the context of the surrounding area. On the positive side, it enhances connectivity to nearby buildings, fostering a sense of integration and interaction within the precinct.

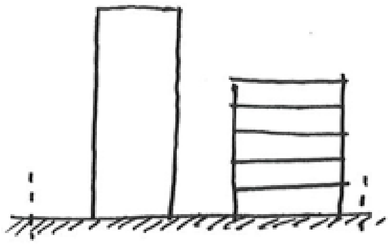


Figure 6.2.1 - Above ground parking structure

Below ground parking structure

The design features a larger podium space, which provides additional usable area. However, it requires extensive excavation, as well as the incorporation of vertical service cores. This design choice reduces the natural ground area available for water filtration and necessitates mechanical ventilation for extraction of toxic gases (NO2) from the vehicles in the basement.

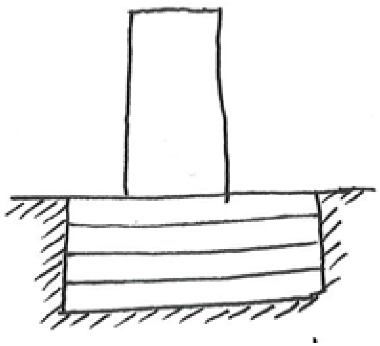


Figure 6.2.2 - Below ground parking structure

Hybrid parking structure

The design allows for connectivity to higher levels and offers the option to combine with other functions. It incorporates dual ventilation for improved airflow. However, vertical service cores are necessary, which may impact the overall layout. Additionally, the design reduces the amount of natural ground area available for water filtration.

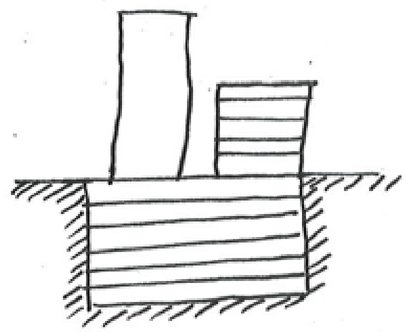


Figure 6.2.3 - Hybrid parking structure design

Preferred parking structure

The hybrid structure is deemed more suitable due to the school's parking needs and its elevated location compared to the site. It is also preferred because water from the water table is necessary for the implementation of passive cooling systems.

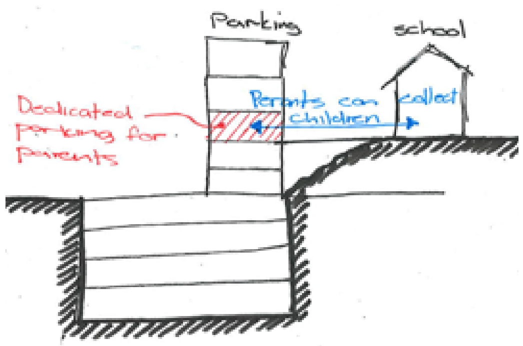


Figure 6.2.4 - Preferred parking structure design

PARKING STRUCTURE COLUMN PLACEMENT EXPLORATION

Strategically planning the placement of columns in parking areas is a critical factor in enhancing the ease of parking and ensuring safer traffic flow. When columns are correctly spaced, it results in accessible and usable parking spaces, eliminating the presence of tight corners and awkward angles that can otherwise complicate the parking process.

Moreover, well-arranged columns offer the advantage of improved line of sight, which means fewer blind spots and enhanced visibility for both drivers and pedestrians. This not only contributes to a more pleasant overall parking experience but also significantly bolsters safety by reducing the risk of collisions. Therefore, it becomes evident that giving careful consideration to column placement is a fundamental requirement in establishing a parking environment that is not only user-friendly but also inherently secure.

Edge of column on parking end

The design presents challenges in turning it into a bay, as well as the requirement for a wider driveway of 7.5m. The presence of columns that cannot be uniformly increased may result in the movement of the structural grid.

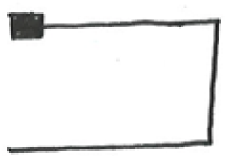


Figure 6.2.5 - Edge of column on parking end

Edge of column on offset to parking end

The design provides benefits such as improved parking bay access, a narrower 7m driveway requirement, and the flexibility to increase columns without affecting the structural grid.

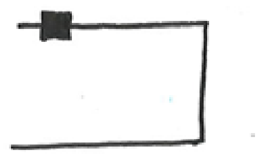


Figure 6.2.6 - Edge of column on offset to parking end

Center of column on parking line

The design results in a reduction of parking space near the column, restricts the ability to increase the column size, but minimises wasted space.

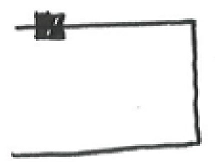


Figure 6.2.7 - Center of column on parking line

Center of column offset parking line

The design provides additional space in the parking bay closest to the column, allows for the expansion of the column without impacting the structural grid, but results in more wasted space.

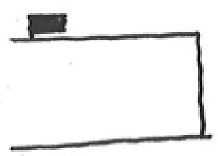


Figure 6.2.8 - Center of column offset parking line

PARKING STRUCTURE GRID SIZE EXPLORATION

A carefully planned parking grid layout plays a crucial role in optimising efficiency and functionality in a parking area. It organises parking spaces logically, reducing congestion, and making it easier for vehicles to move around. This efficiency leads to quicker parking spot searches, enhancing user satisfaction and reducing emissions, contributing to environmental sustainability. Therefore, a well-designed parking grid layout ensures a smooth, organised, and eco-friendly parking experience.

Percentage of people that feel parking is stressful

Understanding parking stress's impact on users is crucial. According to Tomkins (2022) stressful parking can lead to dissatisfaction, deterring visitors and affecting popularity. It also wastes time, increases emissions, and hinders sustainability goals. Addressing parking stress through improved signage, layouts, and technology enhances user experience, resource efficiency, and sustainability.

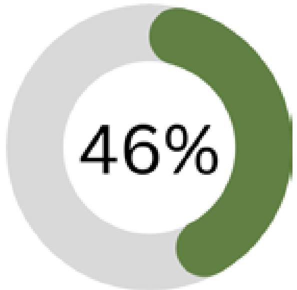


Figure 6.2.9 - Percentage of people that feel parking is stressful

Note. Adapted from Parking is the most stressful part of driving – say nearly half of drivers , by Tomkins, G., 2022, Publisher. Copyright 2022 by Appyway

Percentage of people that would give up a parking space which does not suit them

Knowing how many people are willing to forego parking spaces in unfavorable parking structures is vital. It informs design decisions, enhancing user satisfaction and optimising parking efficiency (Tomkins 2022) . This leads to sustainable, user-friendly urban spaces, reducing resource consumption.

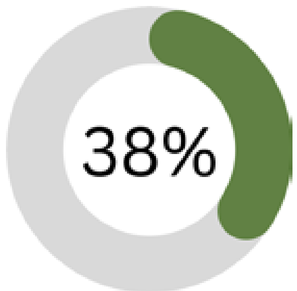


Figure 6.2.10 - Percentage of people that would give up a parking space which does not suit them

Note. Adapted from Parking is the most stressful part of driving – say nearly half of drivers , by Tomkins, G., 2022, Publisher. Copyright 2022 by Appyway

Standard parking layout

The typical parking layout includes a wall on the edge, a single parking bay, a driveway, and a dual parking bay. These parking areas are characterised by relatively tight and constrained spaces, making them less than ideal for parking due to the limited room available for maneuvering vehicles. This results in an overall unpleasant experience for drivers, who may find it challenging to park their cars comfortably and efficiently within such confined parking spaces.

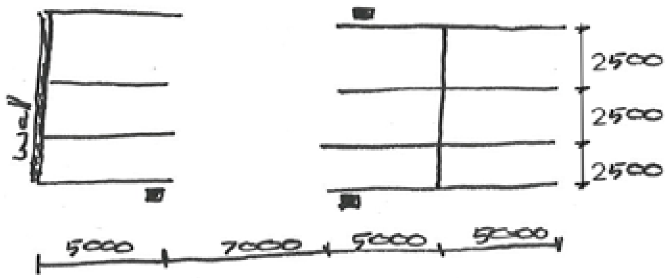


Figure 6.2.11 - Standard parking layout

Conclusion on parking layouts

Tomkin's (2022) research indicates that unpleasant parking design can lead to motorists giving up parking spaces more frequently. This finding suggests that optimising the parking design in the development can increase the likelihood of people wanting to use the parking facilities and improve their rentability. By reducing the time spent in parking, the overall user experience can be enhanced, contributing to higher utilisation and profitability of the parking spaces. Therefore, careful consideration of parking design elements is crucial to create an appealing and efficient parking environment.

Narrow grid layout

The design allows for a 450 x 600 column size and requires an additional column between dual bays to decrease the span. This reduces the width of two parking bays from 2500mm to 2275mm and creates an irregular structural grid. The design is adapted from Neufert & Neufert, (2012)

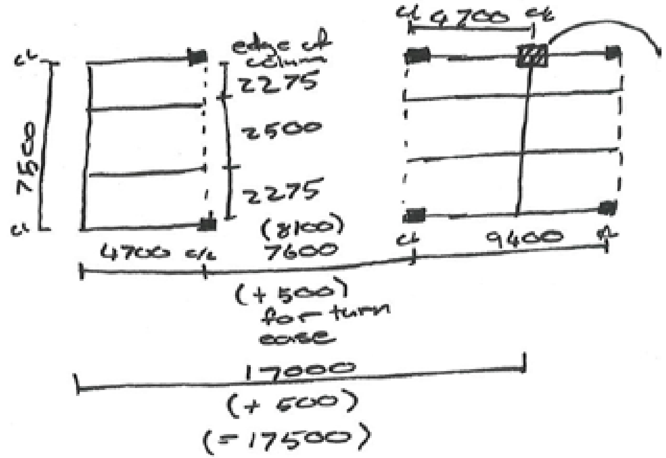


Figure 6.2.12 - Narrow grid layout

Note. Adapted from Neufert Architects' Data 4th Edition, by Neufert & Neufert, 2012, Publisher. Copyright 2012 by Wiley-Blackwell

Spacious grid layout (Preferred)

The design incorporates a column size of 450 x 600, resulting in a more conforming structural grid. This allows for better quality parking bays and facilitates the formation of a rounded number, creating a structural grid of 8500 x 8000. The grid presented here is adapted from a project completed by Kerry McNamara Architects Inc as part of Work Integrated Learning see Annexure F

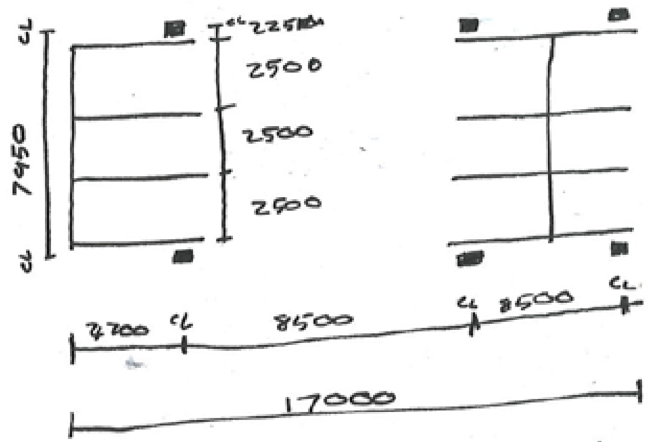


Figure 6.2.13 - Spacious grid layout

PARKING STRUCTURE GRID ORIENTATION EXPLORATION

Parking layout East / West (Preferred)

The design provides a total of 139 parking bays, excluding vertical circulation and services. This minimises wasted space and allows for efficient utilisation. There is also ample space available for service areas, ensuring smooth and convenient circulation within the parking facility. The layout promotes good circular movement, optimising accessibility and maneuverability for vehicles.

This parking layout is the preferred choice because it maximises the number of parking spaces available on each floor.

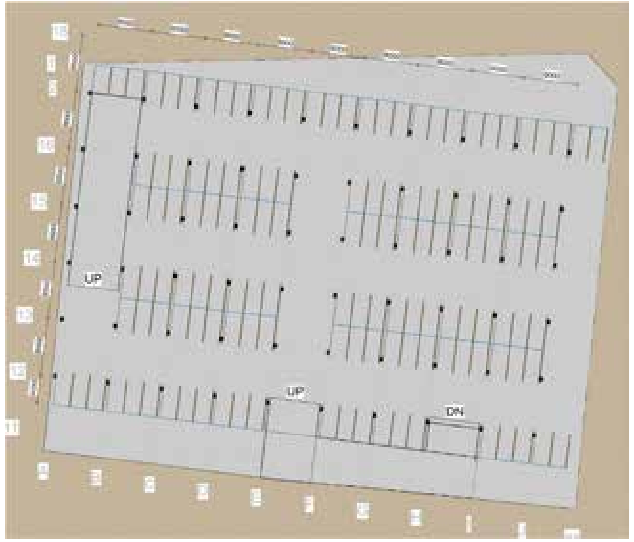


Figure 6.2.14 - Parking layout East / West

Parking layout North / South

The design features a total of 108 parking bays, excluding vertical circulation and services. Although there is more wasted space, the layout allows for excellent circular movement, ensuring smooth and efficient vehicle flow. However, there is limited available space for service areas, which may need to be considered for alternative placement.

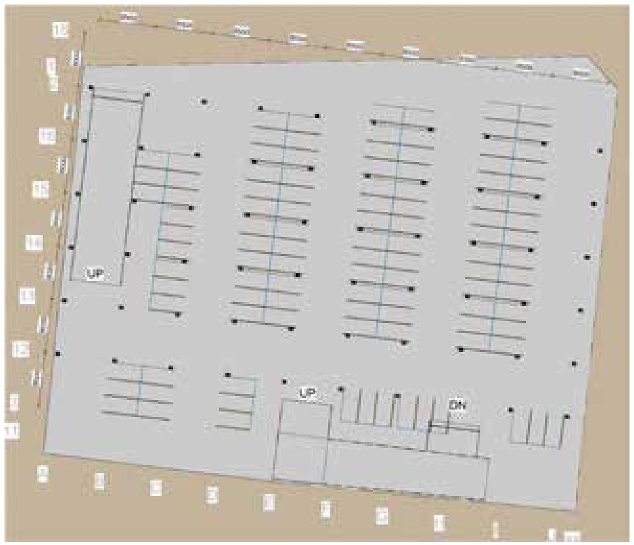


Figure 6.2.15 - Parking layout North / South

6.3 FULL SITE BULK EXPLORATION

INTRODUCTION

Maximising bulk is often a priority, but considering the existing neighbourhood dynamics and market demand within the CBD, it may not be the optimal approach. Instead, it is advisable to concentrate on developing a targeted program that addresses specific needs. The demand for office spaces in the CBD is decreasing while the demand for housing is increasing. By focusing on a smaller but higher-quality development, it is still possible to unlock its full potential and meet the desired outcomes. This approach ensures a more efficient use of space while catering to the evolving needs of the market.

BULK INFORMATION

Table 9 - Standard bulk and coverage

Standard bulk and coverage

Standard Bulk	
Property Size:	5036 sqm²
Bulk Factor:	4
Allowable Bulk:	20144 sqm²

Table 10 - Free residential bulk

Coverage:	
Coverage Percentage:	75 %
Allowable Coverage:	3777 sqm²
Min floors required @ 75% coverage:	5.33 Floors

Table 11 - Maximum bulk

Free residential bulk

Free Residential Bulk	
50% of approved bulk factor	10072 sqm²
Min floors required @ 75% coverage:	2.67 Floors

Table 12 - Parking based on maximum bulk

Maximum bulk

Full Bulk:	
Total Bulk	30216 sqm²
Min floors required @ 75% coverage:	8 Floors

Parking based on maximum bulk

Parking based on bulk	
Restricted Business 1 bay per 50 sqm²	604 Bays
Min floors required	4.35 Floors

Free residential bulk

See annexure E for Policy on free residential bulk where information was collected.

The policy for free residential was introduced to encourage urban densification and promote higher-density urban living. However, it's important to note that this policy applies to private entities exclusively and does not extend to government or financial institutions.

The allocation of free residential bulk is restricted to a maximum of 50% of the approved bulk of the site. Furthermore, this is contingent on the site's capacity to accommodate the necessary on-site parking spaces.

MAXIMUM BULK EXPLORATION

Step 1 - 4 Storey underground parking

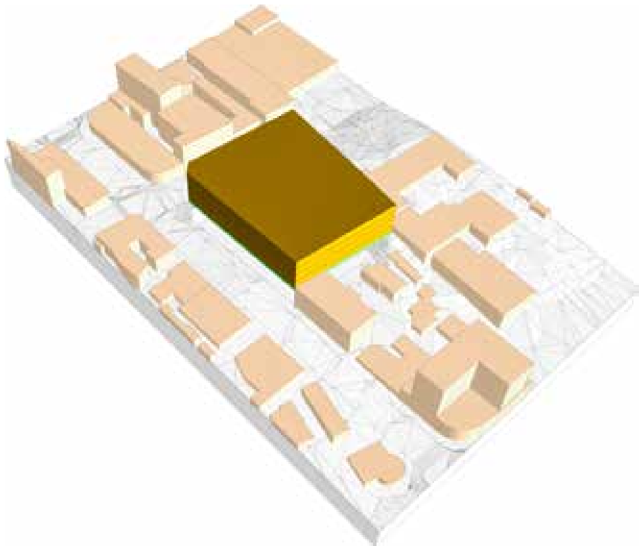


Figure 6.3.1 - 4 Storey underground parking

Step 2 - Parking entrances

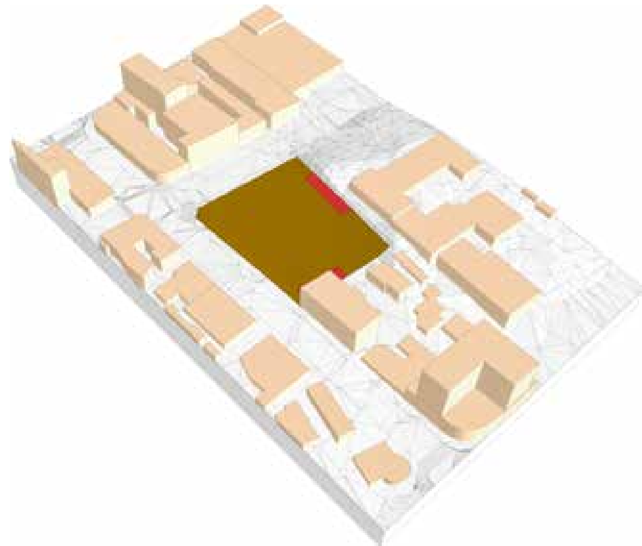


Figure 6.3.2 - Parking entrances

Step 3 - Full Bulk

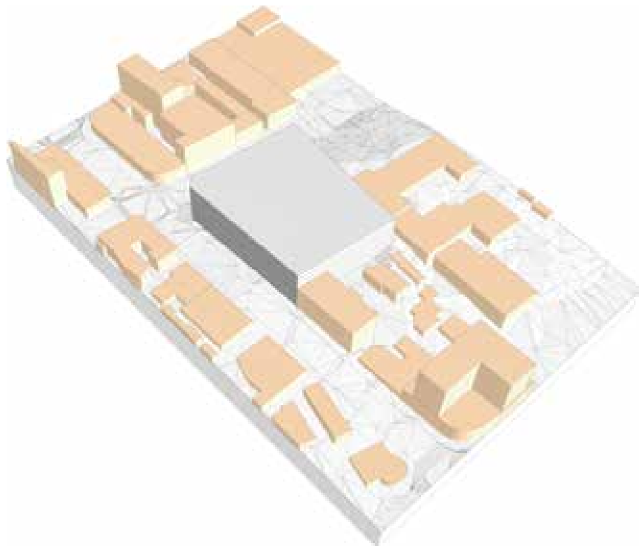


Figure 6.3.3 - Full Bulk

Step 4 - Internal micro climate

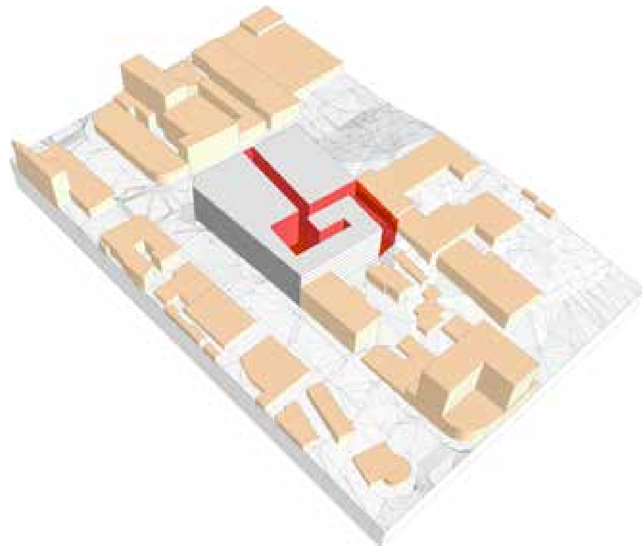


Figure 6.3.4 - Internal micro climate

Step 5 - Basement service cut away

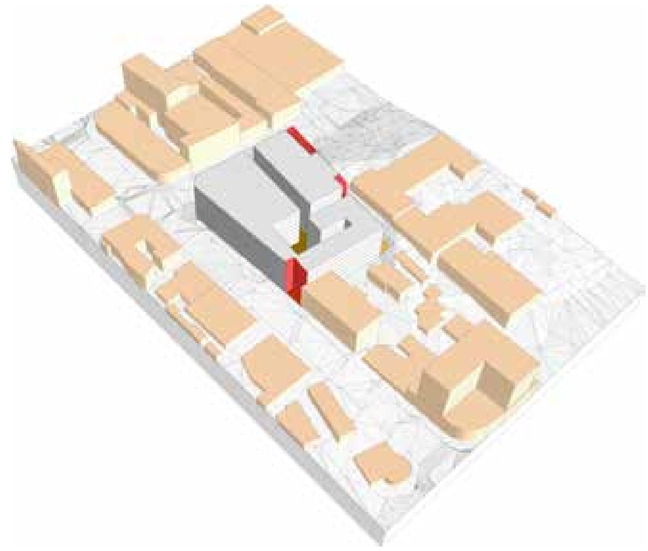


Figure 6.3.5 - Basement service cut away

Step 6 - Increase bulk by adding floors

Figure 6.3.6 - Increase bulk by adding floors

Step 7 - Sun penetration cut aways

Figure 6.3.7 - Sun penetration cut aways

MAXIMUM BULK AERIAL VIEWS

North west view

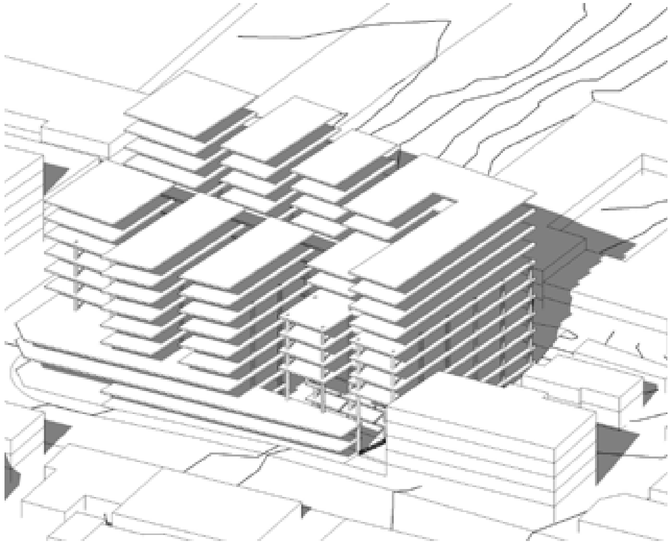


Figure 6.3.8 - Maximum bulk north west view

South east view

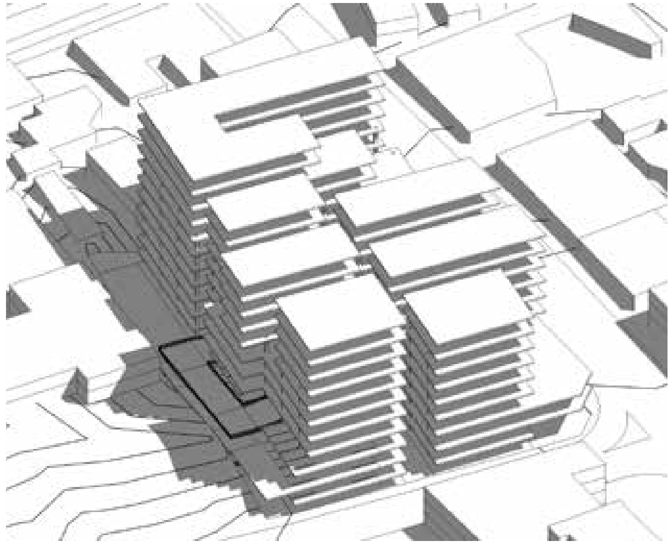


Figure 6.3.9 - Maximum bulk south east view

Conclusion on full bulk exploration

While maximising bulk may be a consideration for the development, it is important to strike a balance between building height and the surrounding building scale. Simply constructing a skyscraper may not necessarily meet the client's needs. It is crucial to assess the current requirements and market demand to avoid potential leasing challenges in filling the remaining space. By taking a measured approach and considering factors such as tenant preferences, market trends, and the overall urban context, a more appropriate and commercially viable building solution can be achieved.

6.4 FINAL DESIGN CONSIDERATION

INTRODUCTION

Taking into account the urban fabric and the surrounding built environment, a fundamental building massing is formulated on the site. This initial step helps comprehend the interplay between the constructed and natural surroundings, as well as the integration with the expansive Roman Catholic precinct.

PRELIMINARY DESIGN CONSIDERATIONS

Full design consideration

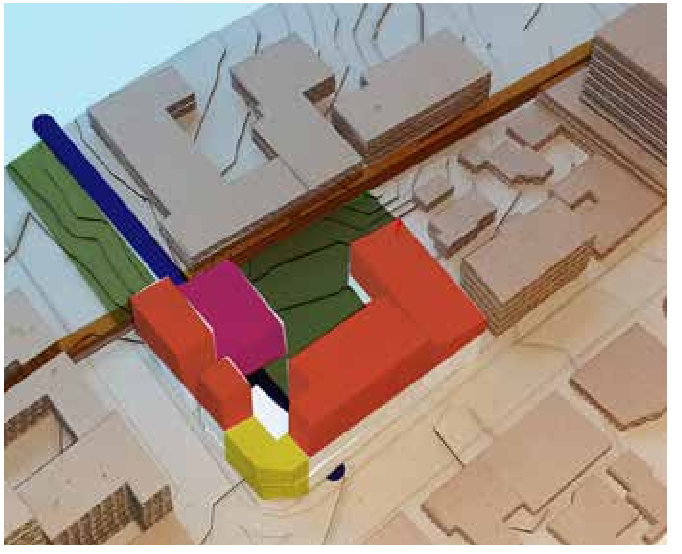


Figure 6.4.1 - Full design consideration

Enhance existing green space

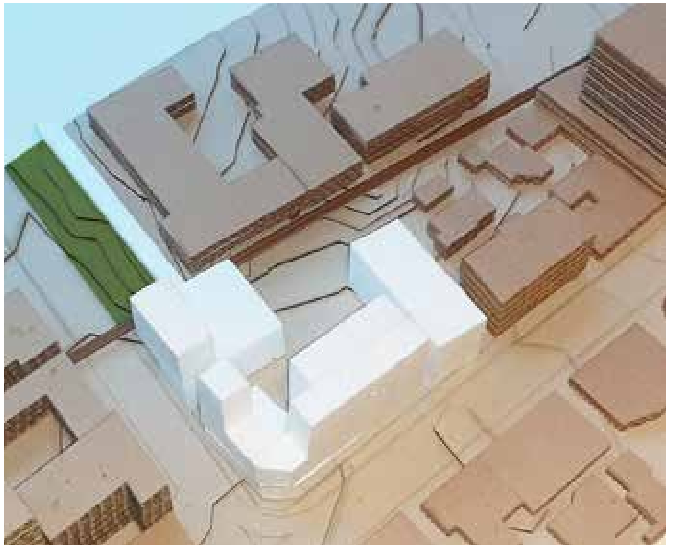


Figure 6.4.2 - Enhance existing green space

Link to Roman Catholic precinct

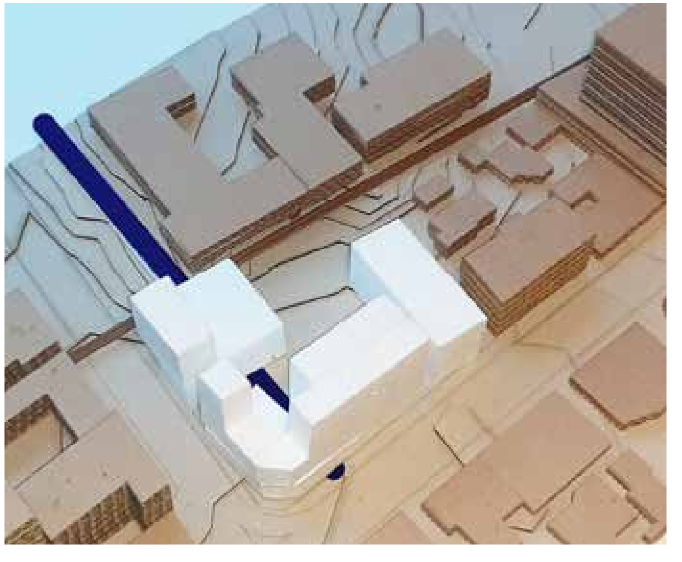


Figure 6.4.3 - Link to Roman Catholic precinct

Parking for school

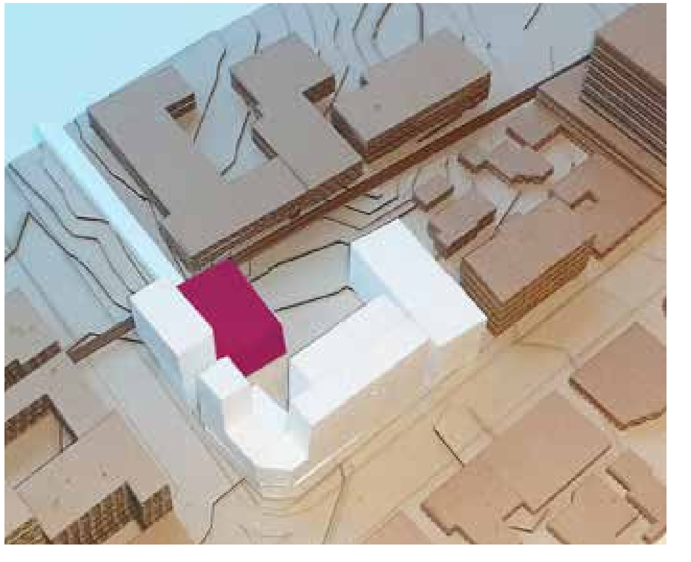


Figure 6.4.4 - Parking for school

Activated green space with constructed wetlands

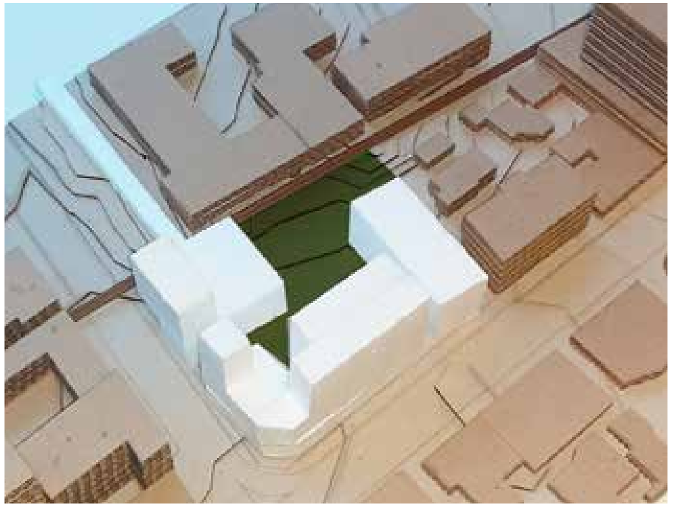


Figure 6.4.5 -Activated green space with constructed wetlands

Thoroughfare from CBD to establish transport node

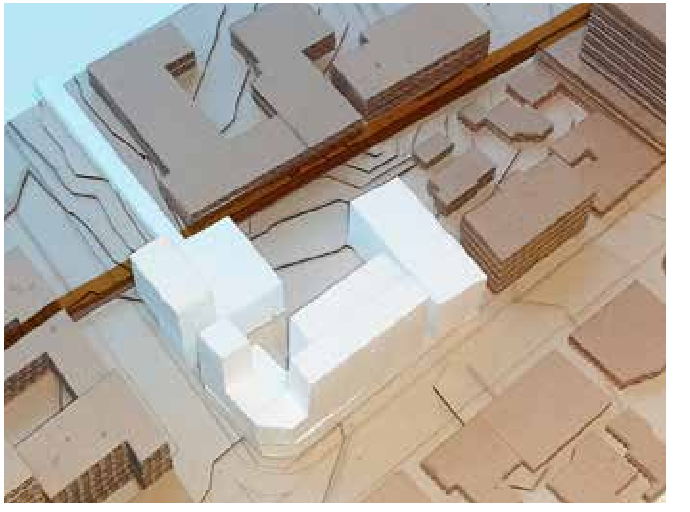


Figure 6.4.6 - Thoroughfare from CBD to establish transport node

High-rise street edge with retail

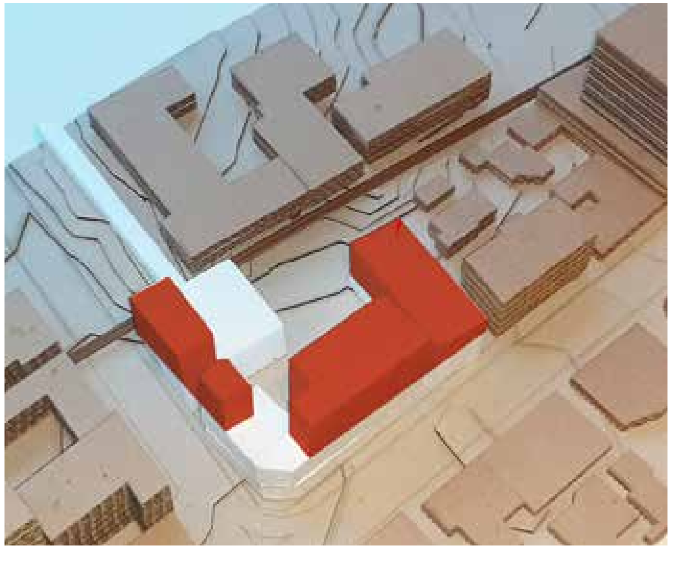


Figure 6.4.7 - High-rise street edge with retail

Low-rise corner building

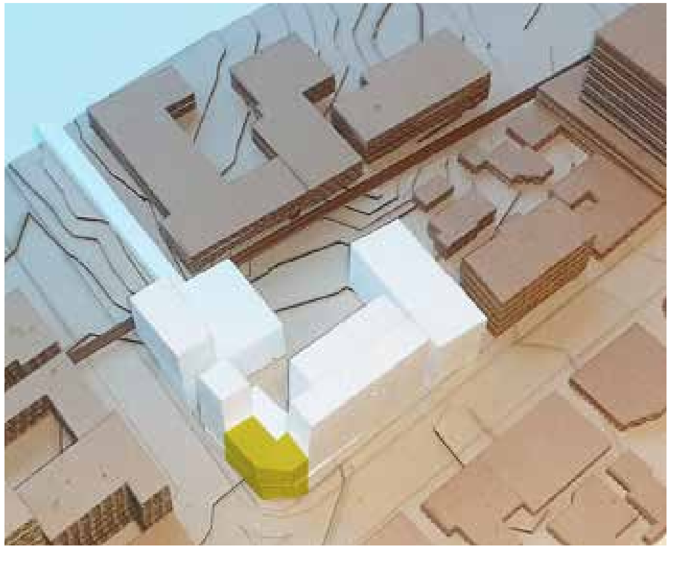


Figure 6.4.8 - Low-rise corner building

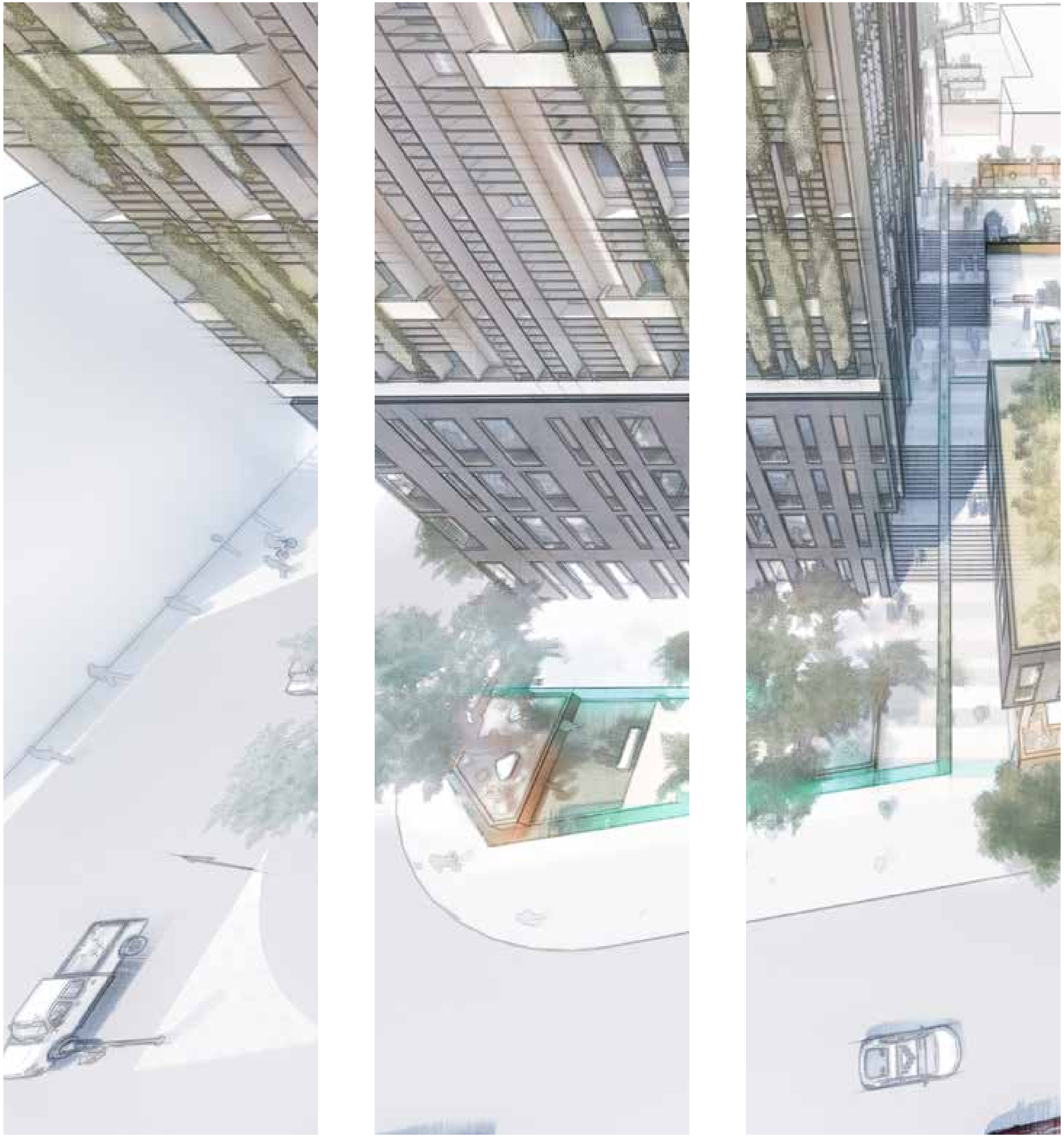
6.5 SECTION CONCLUSION

In conclusion, the analysis of the site fabric, encompassing the low-rise corner, public space, street edge, and their connection to the Roman Catholic Precinct, has been instrumental in shaping the design considerations. The intricate relationships between these elements have provided a strong foundation to guide the design process.

One critical aspect that has emerged from this analysis is the significance of the basement structure. It serves as a cornerstone for the development, providing the necessary structural support and functional capabilities from the very beginning. The basement structure sets the stage for a well-organised and efficient design that can effectively respond to the unique demands of the precinct.

It is essential to note that the quest for an ideal design does not equate to a full bulk approach. Such an approach is neither feasible nor realistic when considering the true needs and essence of the precinct. Instead, the focus must be on achieving a balance between design elements that respects the site fabric, supports functionality, and aligns with the precinct's practical requirements.

This analysis underscores the complexity and interconnectedness of various design components. It emphasises the importance of a nuanced and adaptive design process that is capable of delivering a precinct that not only addresses its current needs but is poised to evolve and thrive in the future. The site fabric, design considerations, and the pursuit of balance collectively contribute to the vision of a harmonious, functional, and sustainable precinct.



SECTION 7

DESIGN DEVELOPMENT EXPLORATION

In response to the building's sustainability being intricately tied to the specific climate conditions, the design development shifted towards a more analytical approach. This involved a comprehensive consideration of prevailing winds and the sun's path. To gain a deeper understanding of the site's micro-climate, a solar study was conducted to pinpoint heat-prone areas and develop strategies to address them. Multiple building forms, including atrium and courtyard plans, were explored to align with the site vision and precinct analyses. With a layout in place, attention turned to the vertical form, aiming for enhanced connectivity and systems integration. In this endeavour, the analysis of precedents played a vital role in creating a more cohesive and interconnected structure.

7.1 SITE MICRO CLIMATE INFORMANTS

INTRODUCTION

Navigating the intricacies of sunlight exposure and combatting the heat island effect, the site's design encounters a balance of challenges and possibilities. Approaches like strategic shading, heat-repelling materials, and natural ventilation emerge as allies in countering heat retention. A keen understanding of prevailing wind patterns shapes decisions to optimise air circulation. While the rear experiences shading, the sun's ample presence on the northern front paves the way for inviting, warm public spaces during the colder months. By expertly harnessing these dynamics, the design orchestrates a realm of comfort, energy efficiency, and social engagement, sculpting a sustainable and delightful environment for all to enjoy.

MICRO CLIMATE

N

Sun path and wind directions

Sunlight varies throughout the year, with the longest duration occurring during the summer solstice on December 21st and the shortest duration during the winter solstice on June 21st (Tukiainen, n.d.).

The prevailing wind in the area generally comes from the northeast, with occasional winds from the southwest. The northeast wind is known for its higher speeds (Meteoblue, n.d.). Understanding these climatic factors is essential for sustainable design and planning, enabling effective utilisation of natural resources and promoting energy efficiency.

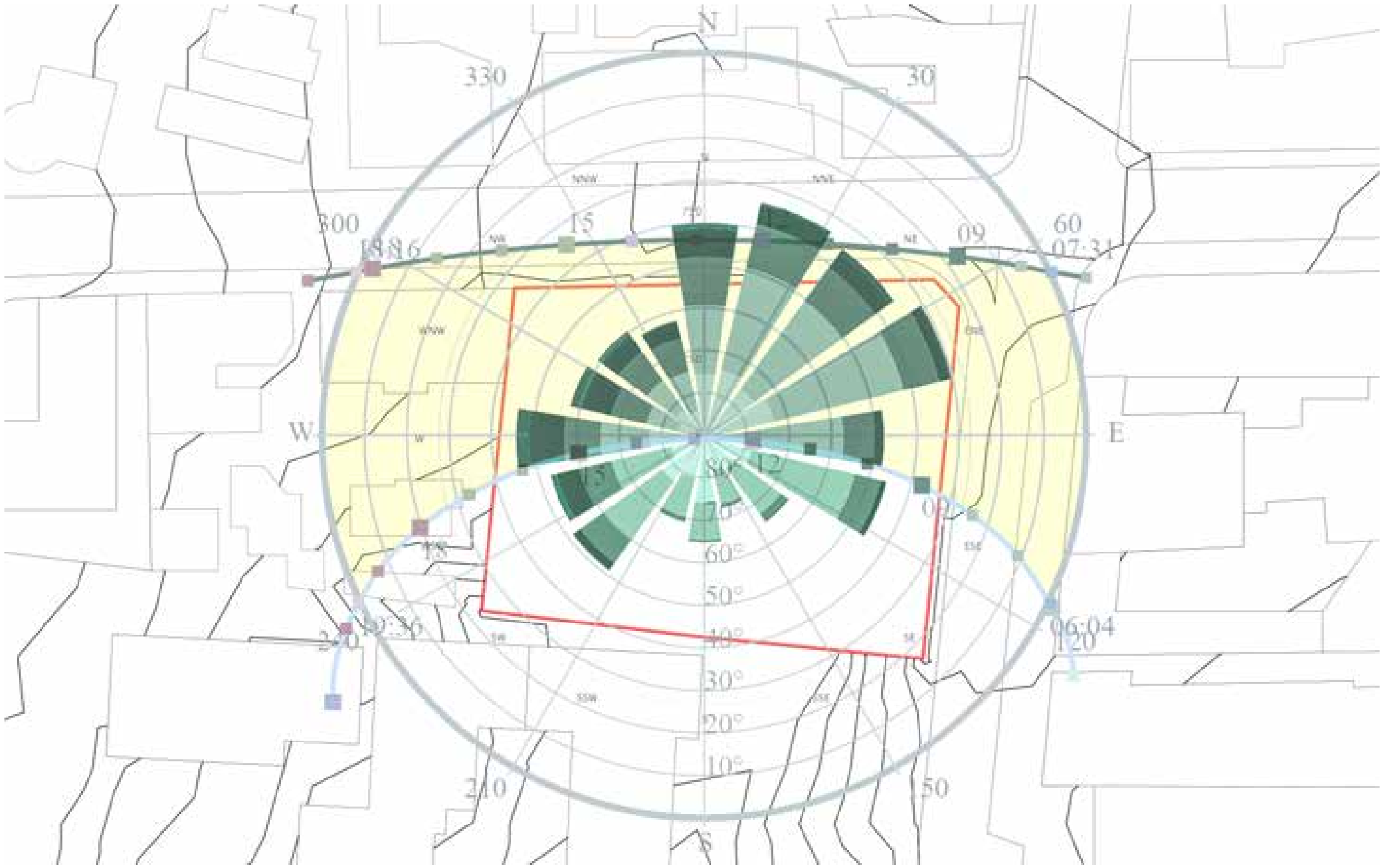


Figure 7.1.1 - Sun path and wind directions

Note. Adapted from Windhoek, Namibia - Sunrise, sunset, dawn and dusk times for the whole year , by Tukiainen, M n.d., Publisher. Copyright n.d by Gaisma and from Simulated historical climate & weather data for Windhoek , by Meteoblue, n.d., Publisher. Copyright n.d by Meteoblue

Shaded zones - Summer solstice full day solar micro climate

The site is highly exposed to solar radiation and experiences a pronounced heat island effect. This means that it receives intense sunlight and retains more heat compared to its surroundings.

These conditions pose challenges for maintaining a comfortable and energy-efficient environment. However, by implementing strategic design measures such as shading, insulation, and heat-reducing materials, it is possible to mitigate the impact of solar radiation and reduce the heat island effect. Sustainable design strategies, including green spaces and natural ventilation, can also contribute to a more comfortable and sustainable site.

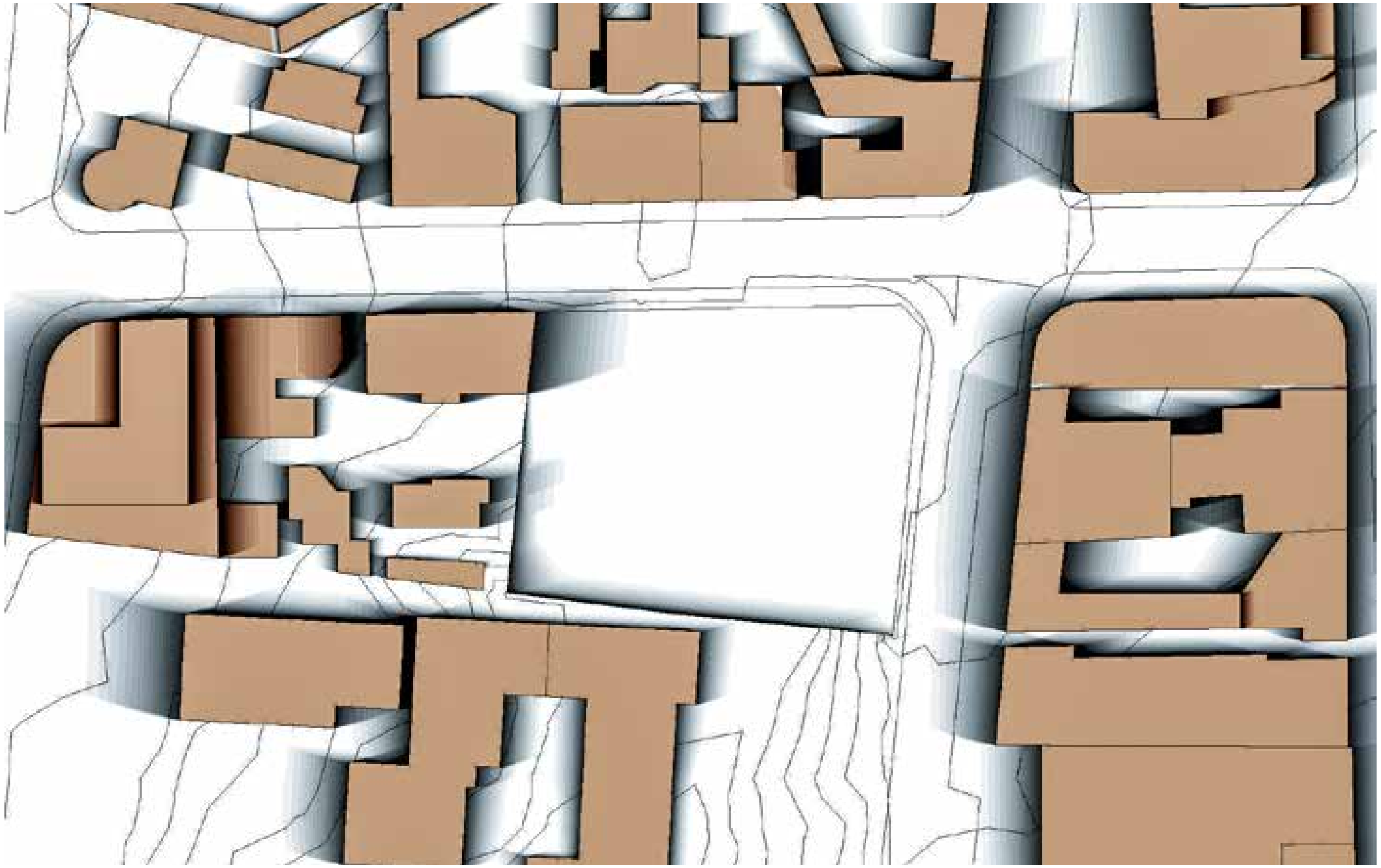


Figure 7.1.2 - Shaded zones - Summer solstice full day solar micro climate

Shaded zones - Winter solstice full day solar micro climate

Despite the unfortunate shading at the back of the site, there is ample sun radiation on the north side, presenting an opportunity to create public warm spaces during the winter.

This favourable solar exposure can be harnessed to design and activate outdoor areas that provide a comfortable and inviting environment for the public, even in colder months. By leveraging the site's solar potential, designers can enhance the usability and attractiveness of the space, promoting social interaction and maximising the benefits of natural light and warmth.

Figure 7.1.3 - Shaded zones - Winter solstice full day solar micro climate

CONCLUSION

In summary, the site's exposure to sunlight and the resulting heat island effect present both challenges and opportunities for the design process. The intense solar radiation can lead to increased heat retention, making it essential to implement strategies that mitigate the negative impacts and create a comfortable environment.

To address the heat island effect, designers can incorporate shading elements, such as overhangs, awnings, or vegetation, to reduce direct sunlight and minimise heat absorption by the building's surfaces. Additionally, the use of heat-reducing materials, such as reflective coatings or green roofs, can help to dissipate heat and lower the overall temperature of the site.

Furthermore, the prevailing wind patterns, with the dominant wind coming from the northeast, should be considered in the design to optimise natural ventilation and enhance thermal comfort. By strategically locating openings and designing airflow pathways, designers can promote air movement, allowing for effective cooling and reducing the reliance on mechanical ventilation systems.

While the site may be shaded at the back, the ample sun radiation on the north side presents a unique opportunity to create public warm spaces during the winter. By strategically positioning seating areas, outdoor gathering spaces, or even incorporating solar energy systems, designers can harness the sun's energy and create inviting environments that encourage social interaction and maximise the use of natural warmth.

In conclusion, by understanding the site's solar exposure, prevailing wind patterns, and the challenges associated with the heat island effect, designers can implement sustainable design strategies to mitigate adverse effects, enhance energy efficiency, and create comfortable and welcoming spaces. By integrating these considerations into the design process, the site can become a sustainable and enjoyable environment that benefits both its users and the surrounding community.

7.2 INITIAL PLAN DEVELOPMENT EXPLORATION

INTRODUCTION

Through an extensive exploration, a comprehensive examination encompassing diverse architectural forms and layout configurations was undertaken. This thorough investigation intricately considered the prevalent climatic conditions and the established urban fabric.

The overarching objective was to pinpoint the most fitting design strategy that seamlessly intertwines principles of sustainability while giving precedence to a layout that accommodates the human experience. This approach sought to forge a deep connection between the local community and the constructed environment, nurturing a harmonious coalescence and cultivating a profound sense of belonging.

INITIAL PLAN EXPLORATIONS

Atrium plan layout

The primary focus of the design revolves around an atrium building oriented in an east-west direction, aimed at mitigating direct sun exposure along the building's elongated sides.

Another key element of the design involves expanding the existing enclosed green area to connect with the new location. Additionally, the relocation of the taxi rank to the front of the site serves the purpose of minimising disruptions caused by incoming vehicles, contributing to a more pedestrian-centric environment.

However, a notable drawback of this design is the potential for the atrium space to become quite chilly during winter months, as the northern building block could obstruct direct sunlight from reaching the atrium. Furthermore, the design overlooks the surrounding architectural context, where the corners predominantly consist of robust built structures.

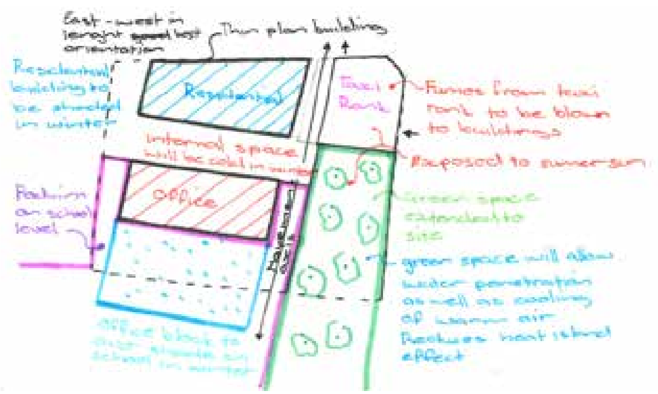


Figure 7.2.1 - Atrium plan layout

Multiple atrium plan layout

In this particular iteration, the design delves into the idea of incorporating multiple atrium's to achieve a more evenly spread layout for the building. However, while pursuing this approach, there is a trade-off: the extent of green space on the site, originally intended for the creation of constructed wetlands, ends up being diminished.

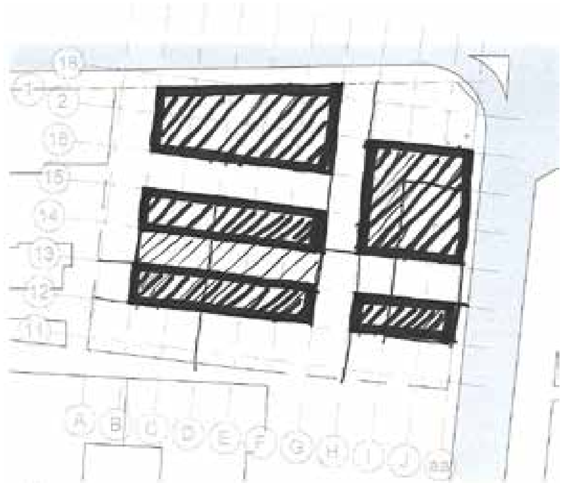


Figure 7.2.2 - Multiple atrium plan layout

Large courtyard plan layout

The primary objective was to maintain the same interplay between solid and void elements found within the existing precinct. To achieve this, the green space was relocated to the northern portion of the site. This new expansive green area serves as a versatile seasonal space, suitable for both summer and winter activities.

The building itself was shifted to the southern and western sides of the site. As a result, larger west and east-facing facades were established, increasing the potential for the building to capture heat from direct sunlight.

However, there are drawbacks to consider. The building on the southern side casts a shadow over the school during winter months, leading to colder conditions. Additionally, the exposed nature of the courtyard leads to heightened wind flow and turbulence within the enclosed space.

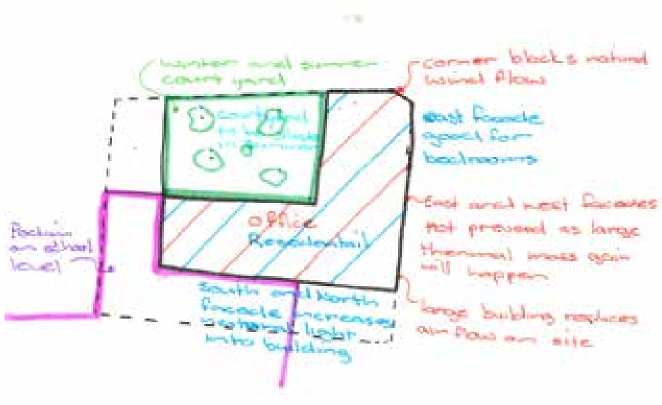


Figure 7.2.3 - Large courtyard plan

Multiple courtyard plan layout

The design transitioned from a singular courtyard to a configuration featuring multiple smaller courtyards. While this alteration resulted in an engaging and unique architectural form, it introduced challenges in addressing environmental considerations, as passive systems alone can already be intricate.

The presence of multiple courtyards, while interesting, brings about a sense of fragmentation. This division creates disconnected spaces, potentially conveying an impression that the site may not be universally welcoming, but rather more exclusive in nature.

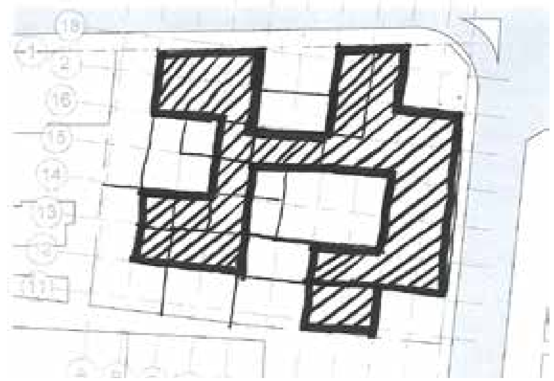


Figure 7.2.4 - Multiple courtyard plan

Thick building with atrium plan layout

The design amalgamates a substantial building layout with an atrium feature. The placement of green space on the northern side is deliberate, facilitating its year-round utilisation. The arrangement divides the building into office and residential units.

The courtyard at the site's forefront serves to temper the prevailing Northwest wind before it enters the building. Moreover, the design establishes pathways that link the neighbouring community to the existing precinct.

However, there are drawbacks to consider. The substantial layout leads to reduced natural light in interior spaces, and the functional division introduces privacy concerns, as office spaces could potentially overlook residential units.

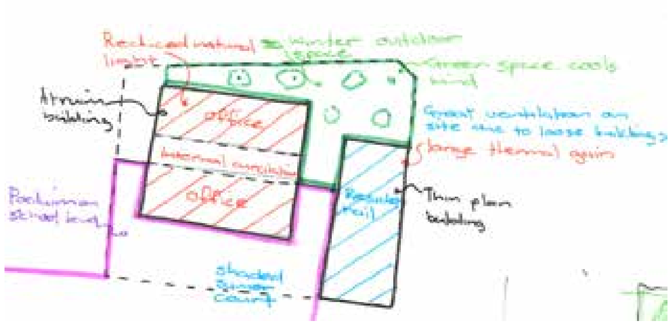


Figure 7.2.5 - Thick building with atrium plan layout

Thick building with courtyard plan layout

The design combines a substantial building structure with an internal courtyard area, offering significant advantages, particularly in the cooling of warm air before it enters the buildings.

The surrounding structures of the courtyard create shaded regions, enhancing its suitability as a cooler space during summer. Moreover, the design incorporates insights from the neighbouring urban landscape, establishing a robust street presence while maintaining accessibility to the site.

Regrettably, the buildings on the southern side cast shadows that diminish winter sunlight exposure to the school, resulting in colder conditions. Furthermore, the positioning of the courtyard at the centre could foster a perception of exclusivity rather than a publicly accessible area.

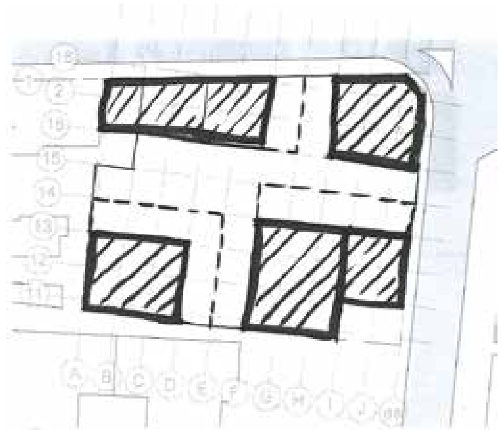


Figure 7.2.8 - Thick building with courtyard plan layout

INITIAL SITE EXPLORATION LAYOUT - COMBINATION OF ATRIUM AND COURTYARD PLAN

After thoroughly exploring various forms and layouts, the decision was reached to integrate these elements to achieve the desired design outcomes. This integration involves combining substantial office blocks with slender residential blocks. The office section occupies the lower levels, while the residential units are situated above. Incorporating an atrium within the residential units serves to cool the living spaces.

The central courtyard space serves as a primary public gathering area, offering an outdoor urban experience within the city. It's noteworthy that this courtyard area has a dual function as it also operates as constructed wetlands, contributing to water recycling and evaporative cooling.

The development is thoughtfully spread across multiple levels, establishing connections to nearby amenities like schools, hospitals, and taxi infrastructure. This design approach encourages interaction on various levels, fostering engagement among users.

To attract visitors and users, multiple entry points to the site have been strategically placed, inviting people to enter and enjoy the courtyard environment.

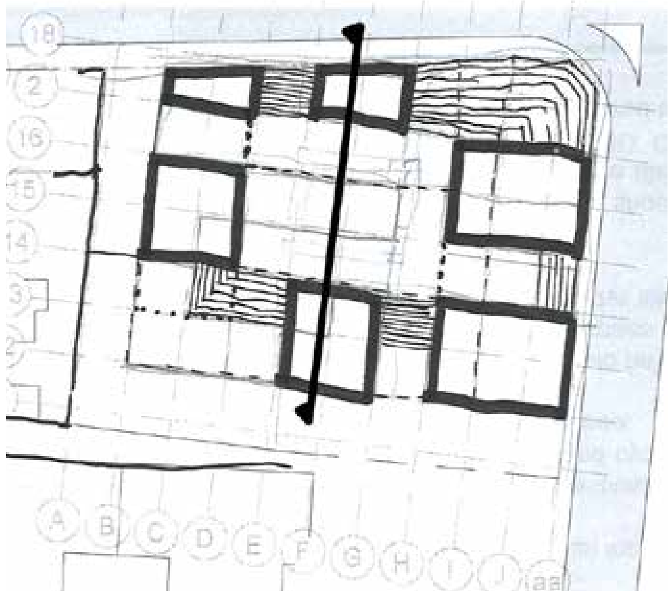


Figure 7.2.7 - Final combined plan layout

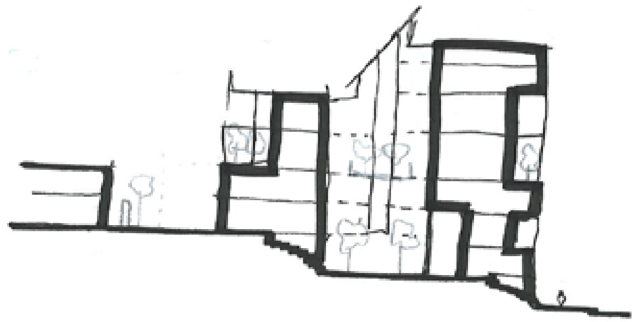


Figure 7.2.8 - Site section layout

7.3 INITIAL FORM DEVELOPMENT EXPLORATION

INTRODUCTION

From the chosen plan form, a vertical structure takes shape, carefully layering functions to ensure privacy on multiple levels and to compartmentalise various functions. Different architectural forms, such as thick and thin building structures, are considered. To further refine the design, an interlocking system is explored, creating an atrium space that serves to establish a controlled micro-climate within the building. This design approach optimises both functionality and environmental considerations.

INITIAL BUILDING FORM EXPLORATION

Thick building form

The northern building employs a substantial design to optimise the intake of both northern and southern light into the interior. This design choice results in spacious areas that extend deeper within, facilitating the penetration of light towards the centre.

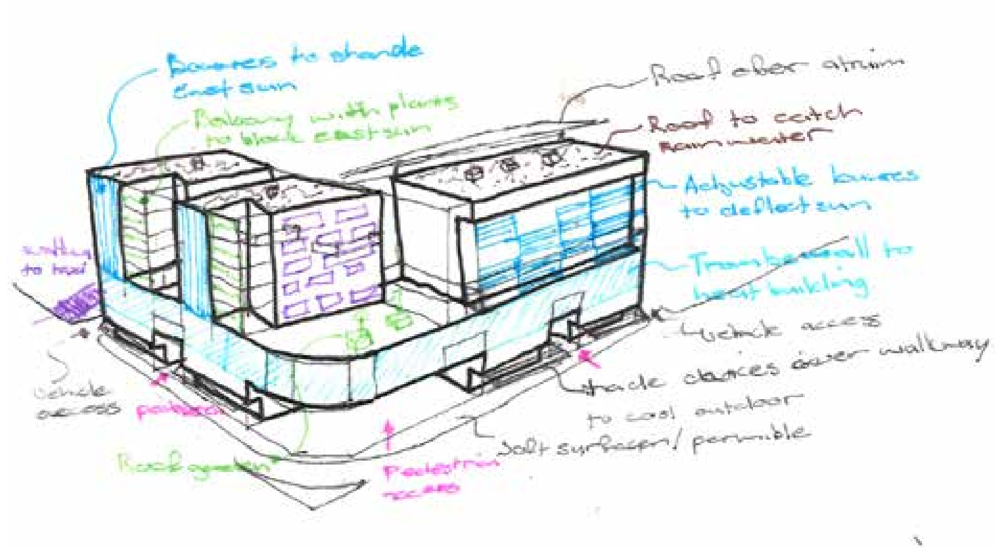


Figure 7.3.1 - Thick building form

Thin building form

The high-rise structures are divided into several smaller sections, thereby establishing atrium spaces between the units. These atriums serve as spaces where micro-climates can be cultivated between the individual structures.

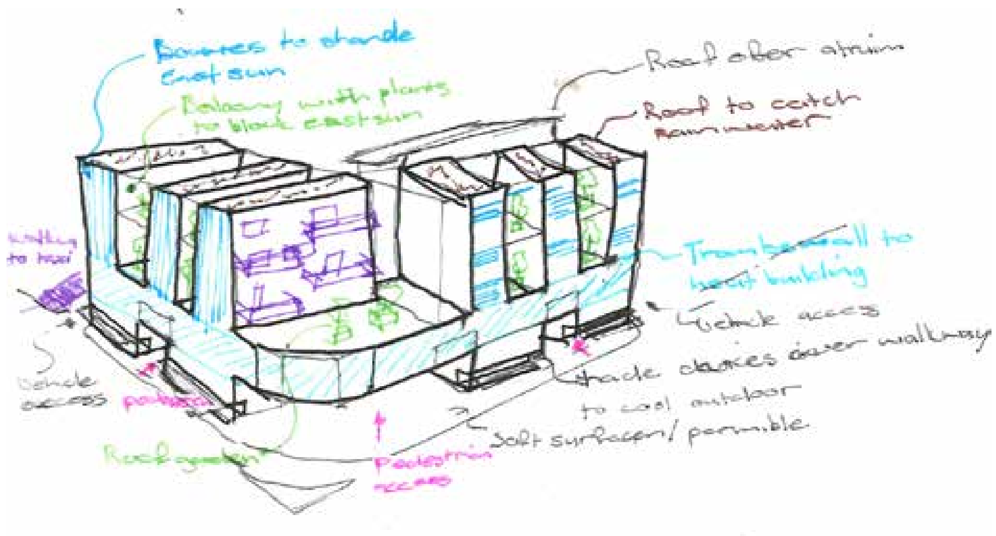


Figure 7.3.2 - Thin building form

INITIAL RESIDENTIAL UNITS FORM PRECEDENT

Evolution Precedent - Ziel

Architects: MVRDV Architects
Construction Year: 2022
Building Location: Montevideo, Uraguay
Main Function: Residential and retail

Project overview:
According to de Witte (2022), the project's main aim was to showcase the possibility of bringing nature and spacious countryside living to the tenth floor.

The project achieves this by using villa-style residences, incorporating multiple sky gardens, and featuring an interior courtyard.

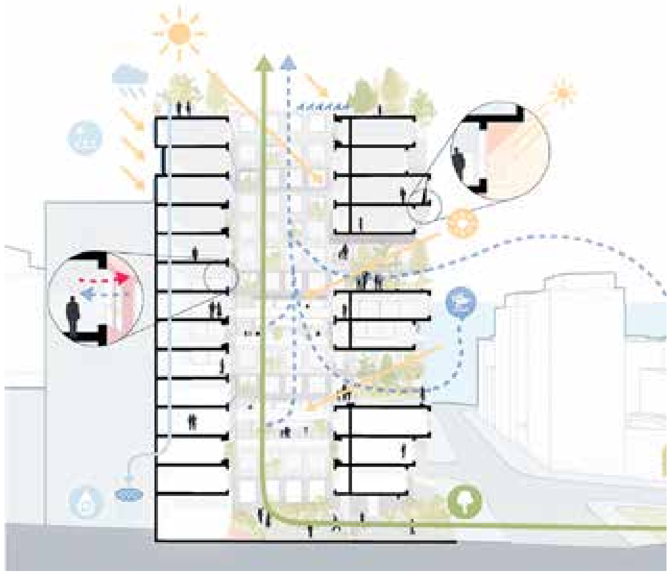


Figure 7.3.3 - Ziel building analysis

Image by MVRDV (2022) https://www.mvrdv.com/projects/829/ziel

Figure 7.3.4 - Ziel exterior render

Image by MVRDV (2022) https://www.mvrdv.com/projects/829/ziel

Figure 7.3.5 - Ziel courtyard render

Image by MVRDV (2022) https://www.mvrdv.com/projects/829/ziel

INITIAL RESIDENTIAL INTERLOCKING UNITS FORM EXPLORATION BASED ON MVRDV ZIEL PRECEDENT

Interlocking layout with green balconies

The core concept of the residential units is to offer a standalone-home living experience within high-density buildings, achieved through the villa-style design featuring sizable exterior gardens for each unit.

The interlocking layout creates stepped balconies that establish an internal ecosystem, contributing to improved air quality and occupants' mental well-being.

Additionally, the design minimises the size of the west and east facades.

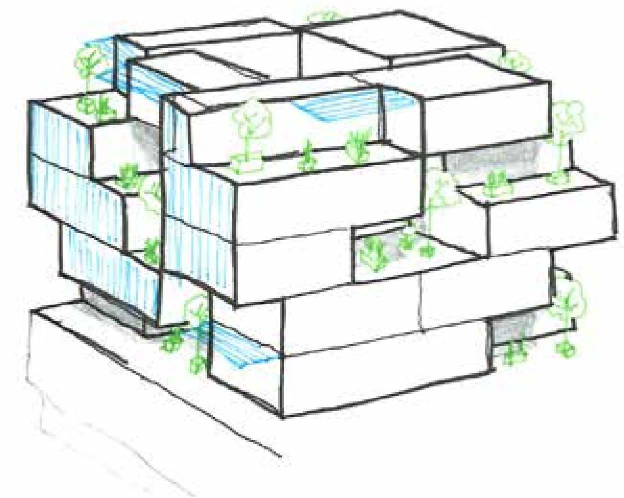


Figure 7.3.6 - Interlocking layout with green balconies and centre courtyard

Thin plan stacked with green balconies

This design opted for a thin layout to achieve a more organised arrangement, while still integrating residential balconies.

Interior atrium spaces were introduced to facilitate the cooling of warm air between the structures. However, a drawback lies in the uneven and uncontrolled nature of this cooling process, leading to a reduction in the effectiveness of passive cooling.

Moreover, the design capitalises on north and south lighting to illuminate the units, consequently decreasing the reliance on excessive indoor lighting.

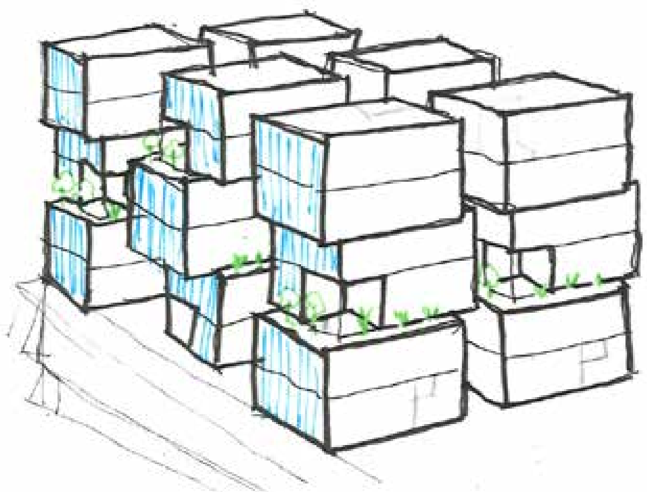


Figure 7.3.7 - Thin plan stacked with green balconies and atrium

EXPLORATION OF UNIT OFFSETS TO CREATE BALCONIES

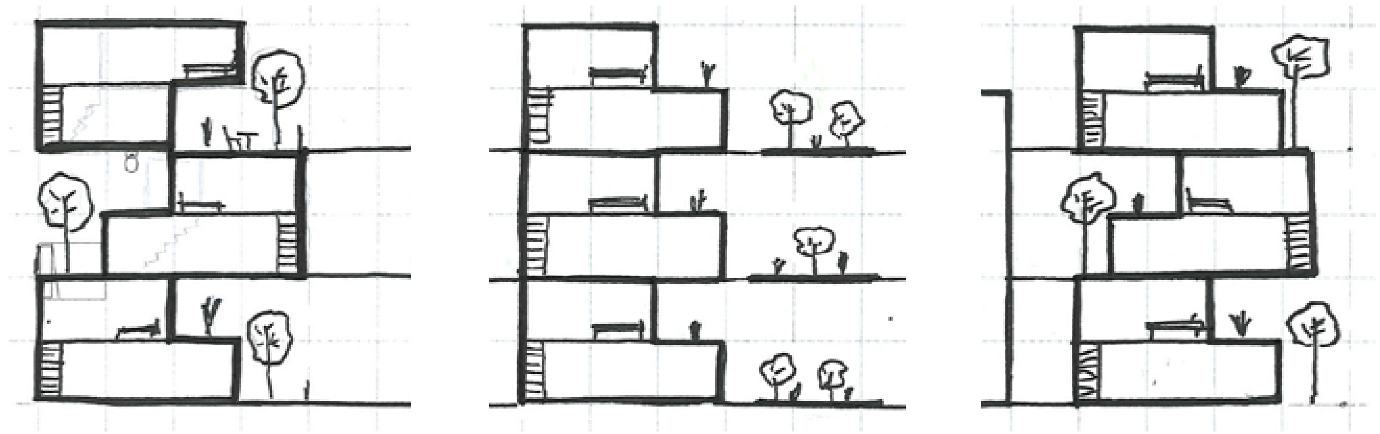


Figure 7.3.8 - Unit offset exploration section

Half-offset units

The unit arrangement's offsetting created large ground floor double-volume balconies and smaller ones on the bedroom level. This approach works exclusively for double-story units, adding staircases and reducing floor space.

Generous overhangs effectively shade facades, reducing heat accumulation from direct sunlight. Additionally, balconies with trees provide shading during early and late sun hours.

Units aligned with shared green spaces

Aligning the units resulted in balconies on the bedroom level. However, this deviates from the idea of expansive outdoor balconies. To address this, the design introduced centralised gardens on various levels for residents' use.

This approach simplifies the structure, resulting in a less intricate system. The challenge with this is that due to the absence of depth, the units receive more direct sunlight.

1.5m Offset units

The units are intentionally shifted by 1.5 meters, creating double-volume balconies in the living areas.

The possibility of setting back the structure adds to the illusion of the units being suspended above each other.

The benefits previously mentioned regarding the half-unit offset also apply here, making it a more advantageous and preferred choice to adopt.

INTERLOCKING FORM ITERATION

Building upon the valuable insights gained through the initial exploration, a more in-depth investigation was carried out. This phase of exploration focused on delving further into the intricacies of site massing, considering how the different architectural elements come together harmoniously. Additionally, a thorough examination was undertaken to understand the interconnections and relationships between various spaces within the design.

This iterative process aimed to refine and optimise the overall layout while ensuring that every element contributed cohesively to the project's overarching vision.

Legend - Building occupancy type

Figure 7.3.9 - Building occupancy type legend

Note: This legend is applicable to interlocking form exploration and initial plan exploration.

Plan exploration - Typical pancake layered building

This design embraces the conventional method of vertically stacking floors in a hierarchical manner. However, this arrangement brings about a particular challenge in the form of facades that directly align with the east and west directions.

Consequently, these orientations expose the building to the intense heat gain caused by direct sunlight. This consideration highlights the need for strategic solutions to mitigate the potential adverse effects of solar exposure on the building's energy performance and occupants' comfort.

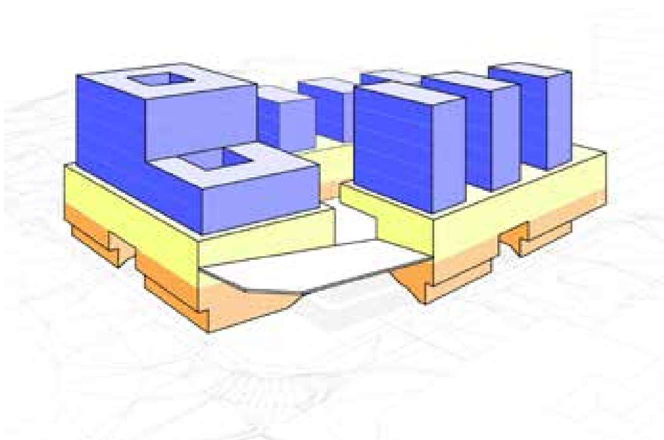


Figure 7.3.10 - Typical pancake layered building layout

Plan exploration - Units arranged around a centre cores single level units

Advantages to the design :
The second core is exempt from requiring a fireman's lift since it adheres to the height limit specified by this regulation.

Disadvantages to the design:
The core's tight configuration restricts circulation within the central area.
Additionally, the expansive east and west facades lack sufficient setbacks, resulting in heightened heat absorption within the units.

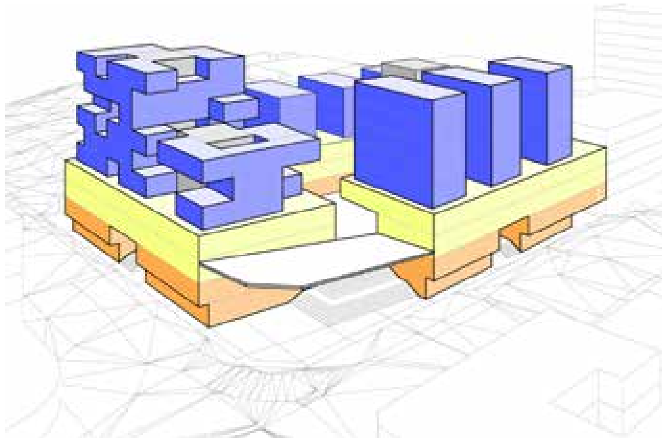


Figure 7.3.11 - Units arrange around a centre core building layout

Plan exploration - Units arranged around a edge core single level units

Advantages to the design :
A single vertical circulation core suffices, with circulation occurring within the unit interiors.
Substantial setbacks effectively aid in minimising direct solar heat gain.

Disadvantages to the design:
The complex arrangement of units and the need for structural considerations result in some units becoming too compact in size.

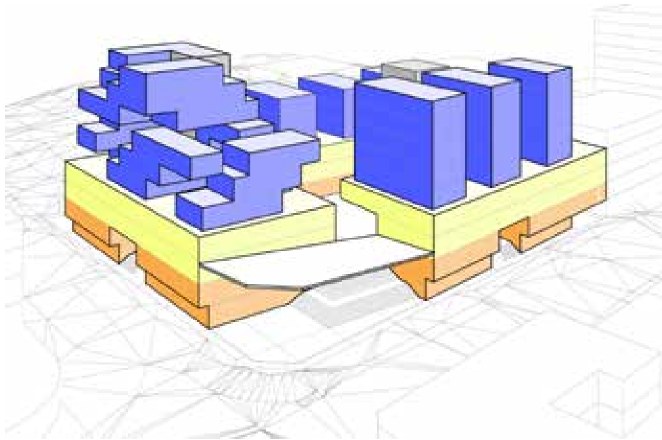


Figure 7.3.12 - Units arrange around a edge core building layout

Plan exploration - Units arranged around edge cores on side single level units

Advantages to the design :
The second core is exempt from requiring a fireman's lift since it adheres to the height limit specified by this regulation.
Substantial setbacks effectively aid in minimising direct solar heat gain.

Disadvantages to the design:
Due to the intricate layout of the complex, individualised unit designs are necessary, as uniform units cannot be accommodated.

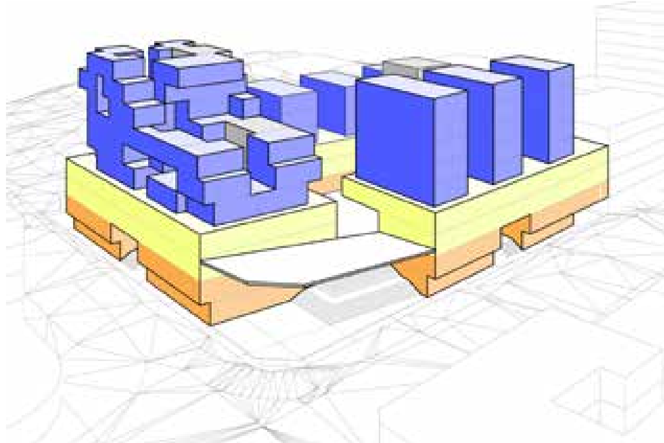


Figure 7.3.13 - Units arrange around edge cores on one side building layout

Plan exploration - Units arranged around edge cores on opposite side single level units

Advantages to the design :
The second core is exempt from requiring a fireman's lift since it adheres to the height limit specified by this regulation.
Residential units can possess their distinct entrance, independent from the office spaces.

Disadvantages to the design:
The absence of double-volume courtyards limits the use of only small bushes, failing to effectively provide shading for interior spaces.

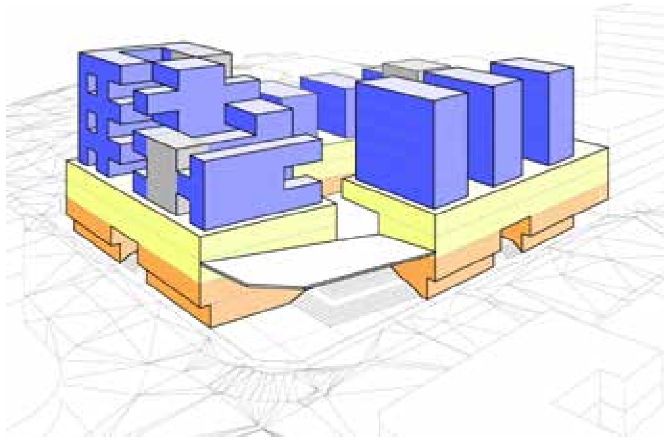


Figure 7.3.14 - Units arrange around edge cores on opposite sides building layout

Plan exploration - Units arranged around edge cores on side double level units

Advantages to the design :
The second core is exempt from requiring a fireman's lift since it adheres to the height limit specified by this regulation
Central atrium allows light into the deep offices below.
Substantial setbacks effectively aid in minimising direct solar heat gain.

Disadvantages to the design:
Create a barrier to prevent the morning sun from directly entering the public atrium space.

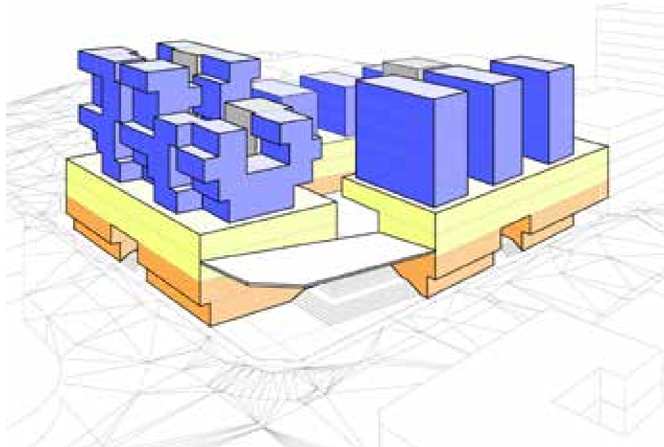


Figure 7.3.15 - Units arrange around edge cores on one side building layout

Conclusion on massing exploration

Although the interlocking units offer the advantage of incorporating numerous green balconies and an intriguing architectural form, the complexity introduced by this design approach poses challenges to the effective implementation of passive sustainability strategies.

The intricate interplay of interlocking units, while visually appealing, can hinder the seamless integration of passive sustainable features. This complexity might lead to difficulties in optimising energy efficiency, natural ventilation, and daylighting, which are fundamental aspects of sustainable design. Therefore, it's important to strike a balance between aesthetics and functionality to ensure that the chosen design aligns effectively with the project's sustainable objectives.

The interlocking exploration did not align with the passive sustainability elements but did provide valuable insights for further refining the mass depicted in figure 244.

INITIAL MASS REFINEMENT DESIGN

Facade design exploration based on plan layout

The units maintain a cohesive architectural appearance. Some units across multiple levels are removed to create space for communal sky gardens. To introduce shading depth, specific units extend forward, resulting in more substantial west and east facades. The office and residential segments are designed uniquely, clearly distinguishing their respective functions.

Figure 7.3.16 - North east view facade design exploration based on plan layout

7.4 PLAN DEVELOPMENT

INTRODUCTION

The initial plan form underwent refinement to introduce a courtyard between the buildings and incorporate atrium spaces among the residential units, connecting spaces across multiple levels. However, it became evident that the design, in its current state, was unable to meet the essential passive sustainability goals and site vision. Consequently, further refinements were pursued to align the design with these objectives.

INITIAL PLAN PROGRESSION

Initial plan exploration - Ground floor

Street-facing retail activates the area. Internal parking enhances convenience. Corner steps connect to upper green space

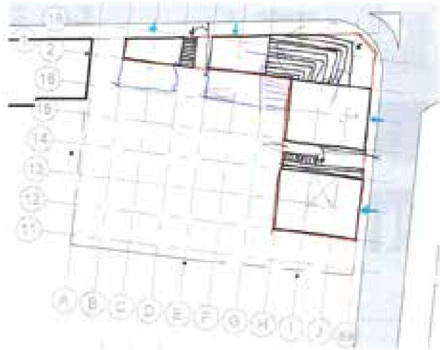


Figure 7.4.1 - Initial plan exploration ground floor

Revised plan exploration - Ground floor

Modifications to the northern retail section optimise retail space. A plaza is introduced at the corner entrance for added appeal.

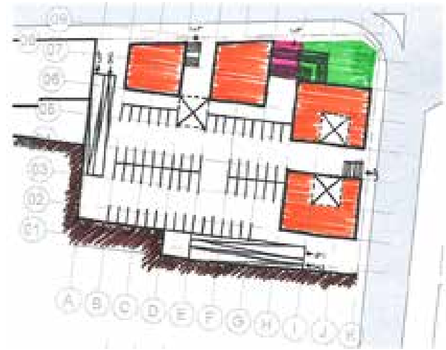


Figure 7.4.2 - Revised plan exploration ground floor

Initial plan exploration - First floor

First-floor retail activates the internal courtyard, functioning as a main public space and constructed wetland. School parking at back.

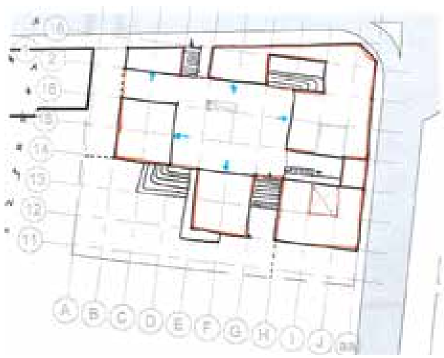


Figure 7.4.3 - Initial plan exploration first floor

Revised plan exploration - First floor

Adjustments to the east retail section maximise retail area. Corner element removal forms an open-air plaza.

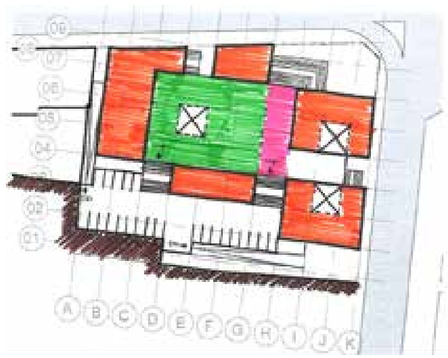


Figure 7.4.4 - Revised plan exploration first floor

Initial plan exploration - Second floor

Private green space at the rear, designated for use by second-level offices and adjacent to the school.

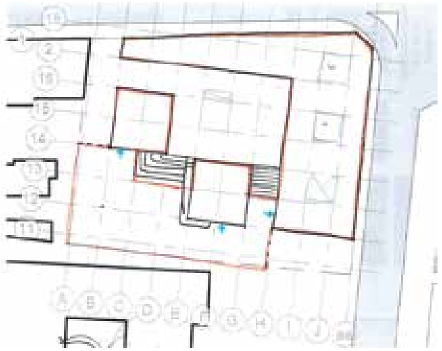


Figure 7.4.5 - Initial plan exploration second floor

Revised plan exploration - Second floor

Building layout adjusted to expand rent-able office space and establish a more robust link with the precinct.

Figure 7.4.6 - Revised plan exploration second floor

Initial plan exploration - Third floor

Exterior pathways within the building's interior are designed for offices, framing the courtyard area.

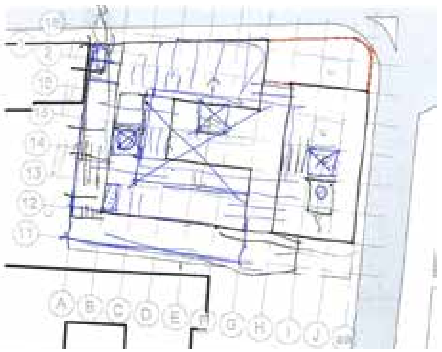


Figure 7.4.7 - Initial plan exploration third floor

Revised plan exploration - Third floor

Voids were incorporated into the western building to introduce light into the expansive office areas.

Figure 7.4.8 - Revised plan exploration third floor

Initial plan exploration - Fourth to fifth floor

Residential units situated atop office spaces with openings between them, facilitating the entry of northern light into the internal courtyard.

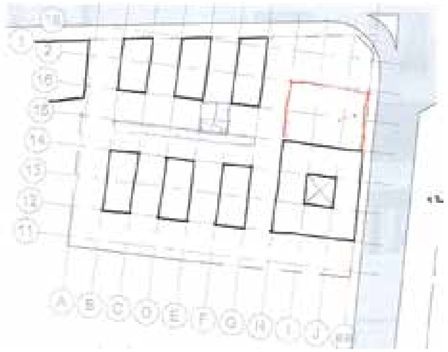


Figure 7.4.9 - Initial plan exploration fourth to fifth floor

Revised plan exploration - Fourth floor

External core enables residential access. Units are set back to create depth on the facade.

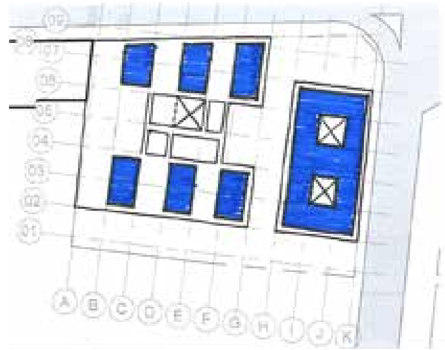


Figure 7.4.10 - Revised plan exploration fourth floor

Revised plan exploration - Fifth floor

Like the fourth floor, but with relocated walkways for a varied pattern to increase light penetration towards the centre.

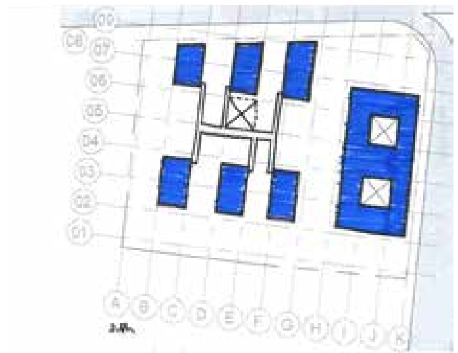


Figure 7.4.11 - Revised plan exploration fifth floor

Initial plan exploration - Sixth to seventh floor

Units on the southern side are designed to slope or fall away, ensuring that the school is not overly shaded during the winter months.

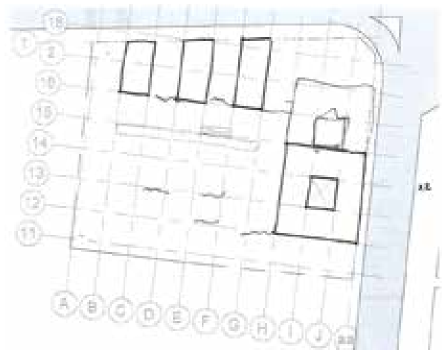


Figure 7.4.12 - Initial plan exploration sixth to seventh floor

Revised plan exploration - Sixth floor

The north-western building is reduced to align with the adjacent low-rise corner structures in the urban fabric.

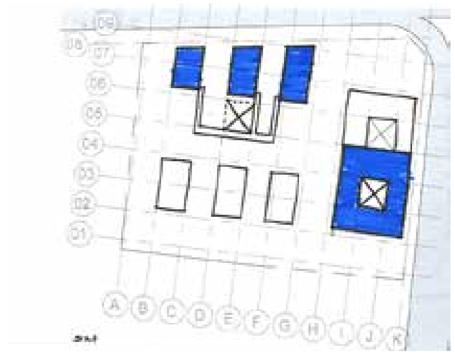


Figure 7.4.13 - Revised plan exploration sixth floor

Revised plan exploration - Seventh floor

Like the sixth floor, but with relocated walkways for a varied pattern to increase light penetration towards the centre.

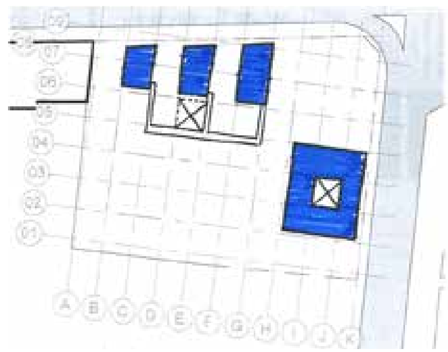


Figure 7.4.14 - Revised plan exploration seventh floor

7.5 CORE AND RESIDENTIAL UNIT ITERATION

INTRODUCTION

Multiple iterations were undertaken to determine the most efficient core layout that would best align with the structural grid. Concurrently, explorations were conducted on residential unit layouts to gain insights into unit spatial quality and movement within these units. These iterative processes were vital for optimising the overall design.

CORE LAYOUT ITERATIONS

The core assumes a crucial role, connecting levels and facilitating the vertical movement of services and passive strategies.

This central element harmonises the building's functionality, ensuring efficient distribution of utilities and sustainable features for enhanced comfort and sustainability.

The core layout is constrained by structural grid dimensions of 8500 x 8000, ensuring efficient placement that doesn't obstruct parking movement lanes.

Legend - Core functions

Figure 7.5.1 - Core functions legend

Full height core 1

- The fireman's elevator is independent of the main core.
- The core is accessible through a single corridor.
- The core is well-suited for the residential building on the northern side.

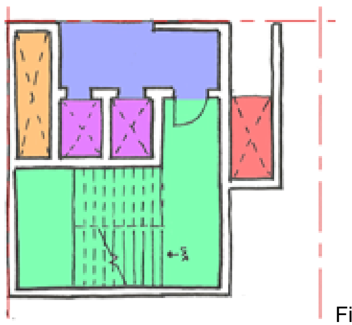


Figure 7.5.2 - Core layout 1

Full height core 2

- The fireman's elevator is independent of the main core.
- The core is accessible through a single corridor.
- The core is becomes to deep and thin making the movement space limited.

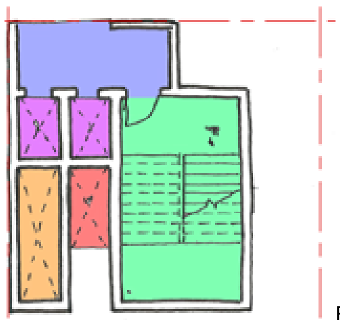


Figure 7.5.3 - Core layout 2

Full height core 3

- The fireman's elevator is independent of the main core.
- The core is accessible through a single corridor.
- The core is well-suited for the residential building on the northern side.

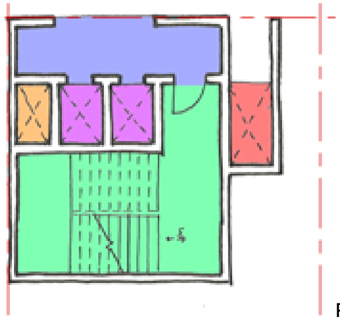


Figure 7.5.4 - Core layout 3

Full height core 4

- The fireman's elevator is independent of the main core.
- The core is accessible through a single corridor.
- The core is becomes to deep and thin making the movement space limited.

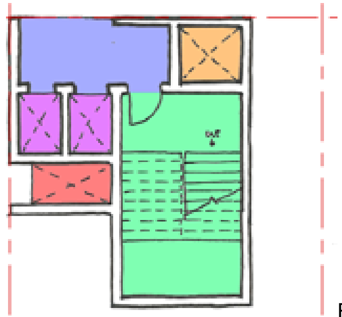


Figure 7.5.5 - Core layout 4

Full height core 5

- The fireman's elevator is independent of the main core.
- No duct in the core design requiring separate service ducting.
- The core is well-suited for the residential building on the eastern side.

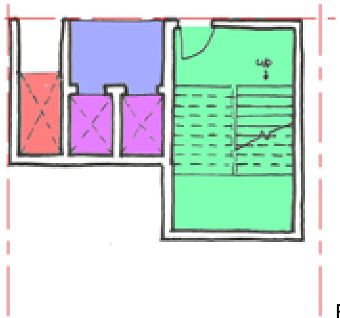


Figure 7.5.6 - Core layout 5

Full height core 6

- The fireman's elevator is independent of the main core.
- No duct in the core design requiring separate service ducting.
- The core is well-suited for the residential building on the eastern side.

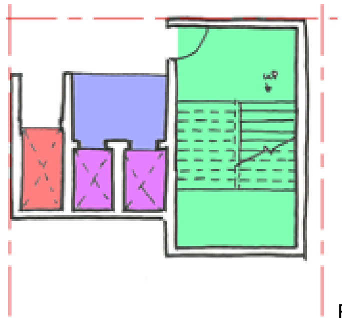


Figure 7.5.7 - Core layout 6

Maximum 30m height core 1

- Due to not exceeding the 30m height a fireman's lift is not required. Fire escape stairs has its own entrance
- The core has a compacted design reducing the needed space on the site.
- Well suited for low-rise units

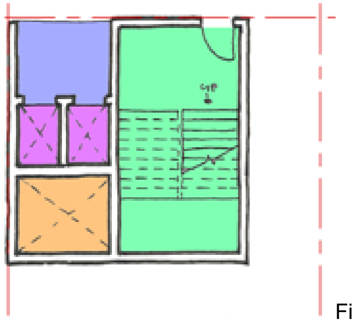


Figure 7.5.8 - Core layout 7

Maximum 30m height core 2

- Due to not exceeding the 30m height a fireman's lift is not required. Fire escape stairs entrance from lobby
- The core has a compacted design reducing the needed space on the site.
- Well suited for low-rise units

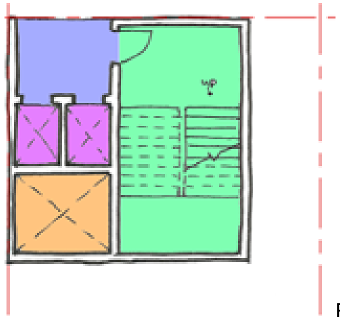


Figure 7.5.9 - Core layout 8

Maximum 30m height core 3

- Due to not exceeding the 30m height a fireman's lift is not required. Fire escape stairs has its own entrance
- The core has a compacted design reducing the needed space on the site, but has no duct for vertical circulation of services.

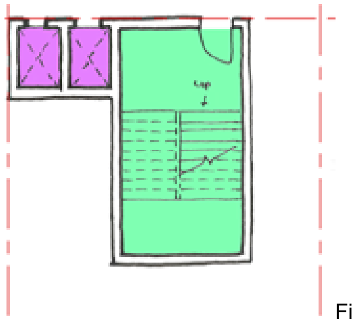


Figure 7.5.10 - Core layout 9

Conclusion on core exploration

Designing the core cannot be approached in isolation; it necessitates a comprehensive consideration of various factors inherent to the final plan layout. Elements such as exit directions and lift capacities must be meticulously analysed to ensure optimal functionality for users.

Through the process of exploration, key insights have been gained. These lessons have enriched the understanding of how to intricately tailor the final core layout design for heightened efficiency. These insights provide a solid foundation for making informed decisions that align with both practical requirements.

DOUBLE STOREY RESIDENTIAL UNIT LAYOUT DEVELOPMENT

Ground floor layout

Strategically placing living spaces on the lower level, along with large balconies and ample window openings, enhances natural ventilation throughout the units.

This design approach fosters comfortable indoor environments while reducing the need for mechanical cooling systems.

Figure 7.5.11 - Residential ground floor - Living area

First floor layout

Sleeping areas are allocated to the second floor, yet the room sizes within this layout for a three-bedroom unit are constrained. However, the units are equipped with sufficient openings to facilitate sunlight penetration and ventilation.

The complexity of the design escalates when multiple units are stacked atop one another. This is evident in the inconsistency of overhangs and balcony spaces, which can pose challenges in achieving a cohesive and harmonious aesthetic. Thus double storey units are not preferred for the design.

Figure 7.5.12 - Residential first floor - Sleeping area

7.6 PASSIVE SUSTAINABILITY DEVELOPMENT

INTRODUCTION

Extensive iterations were carried out to address key considerations related to sun management, heat regulation, ventilation, and cooling strategies within the building design. By thoroughly exploring multiple options and analysing their advantages, the most effective methods were singled out for further development. These selected strategies, when combined with carefully chosen materials, lay the foundation for the building to operate at the highest levels of efficiency. This approach ensures that the building not only responds effectively to environmental challenges but also remains in harmony with its surrounding context, contributing to sustainability and overall performance.

SOLAR CONTROL - ADAPTED FROM DEKAY AND BROWN, (2014)

Facade on edge, small openings

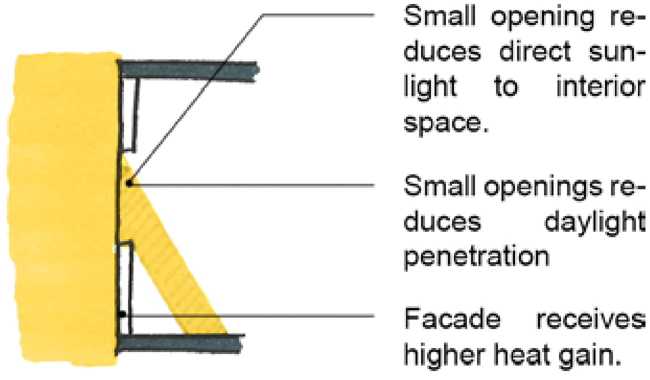


Figure 7.6.1 - Facade on edge, small openings

Facade setback, small openings

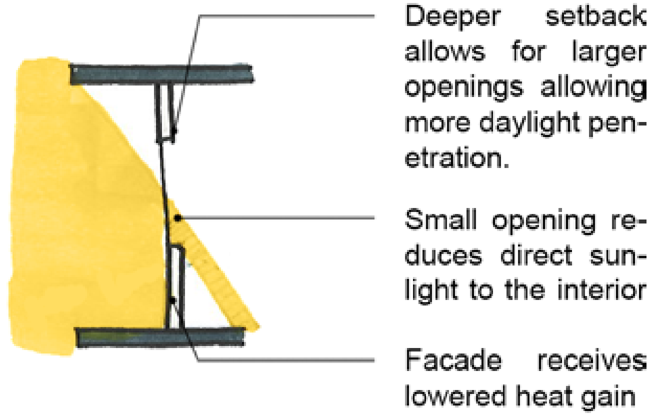


Figure 7.6.2 - Facade setback, small openings

Facade on edge, large openings

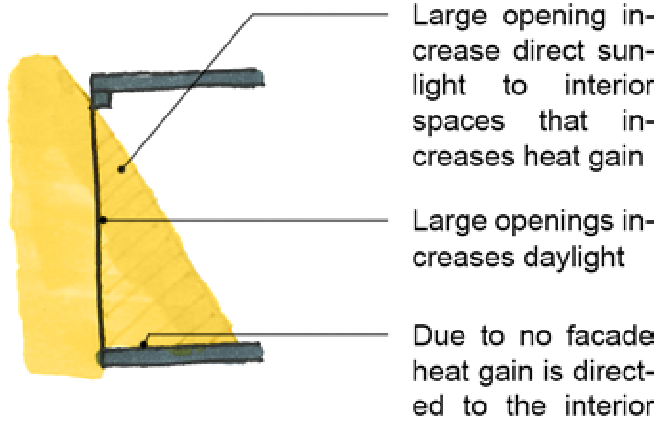


Figure 7.6.3 - Facade on edge, large openings

Facade setback, large openings

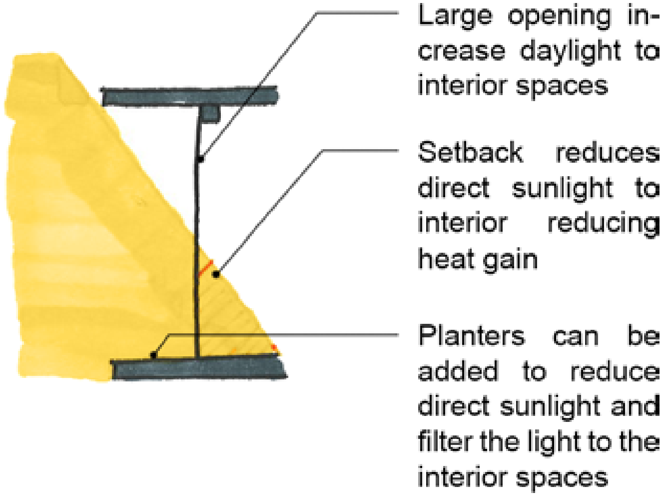


Figure 7.6.4 - Facade setback, large openings

Facade on edge, openings with louvres

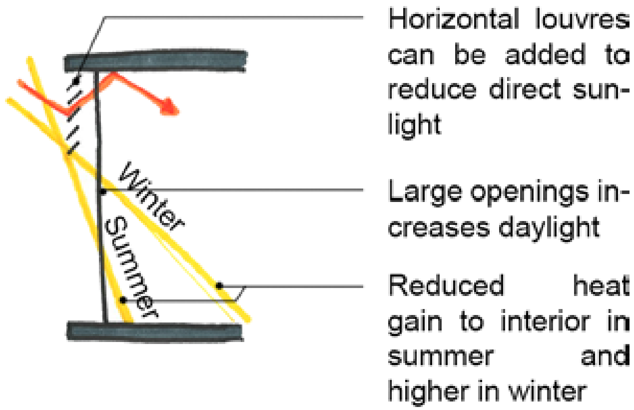


Figure 7.6.5 - Facade on edge, openings with louvres

Facade setback, openings with louvres

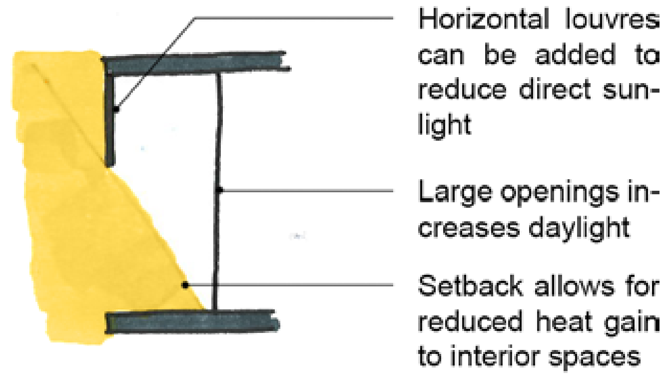


Figure 7.6.6 - Facade setback, openings with louvres

Facade on edge, with light shelves

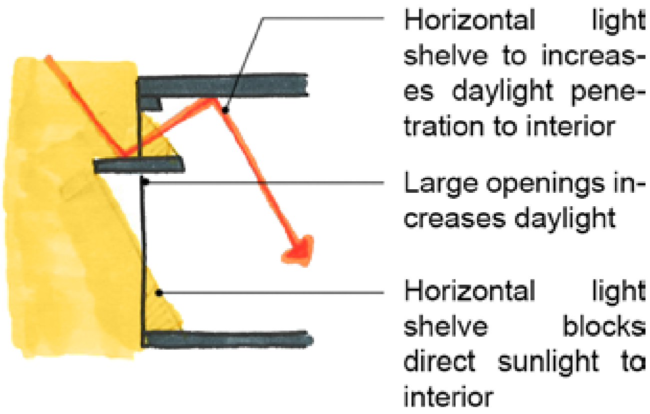


Figure 7.6.7 - Facade on edge, with light shelves

Facade setback, with light shelves

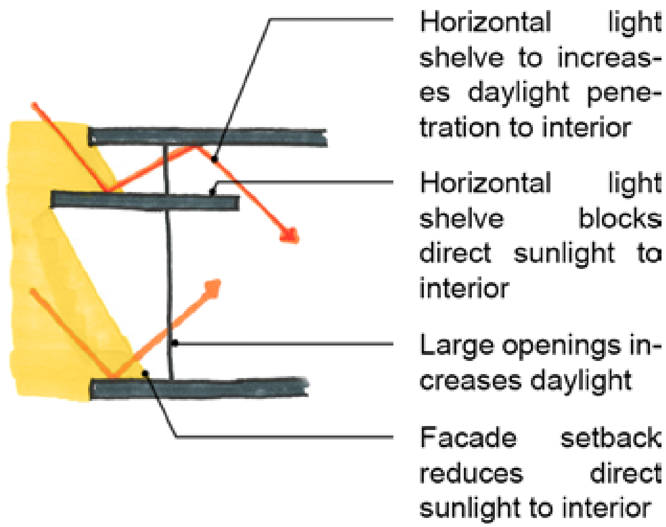


Figure 7.6.8 - Facade setback, with light shelves

HEATING - ADAPTED FROM DEKAY AND BROWN, (2014)

Trombe wall operations

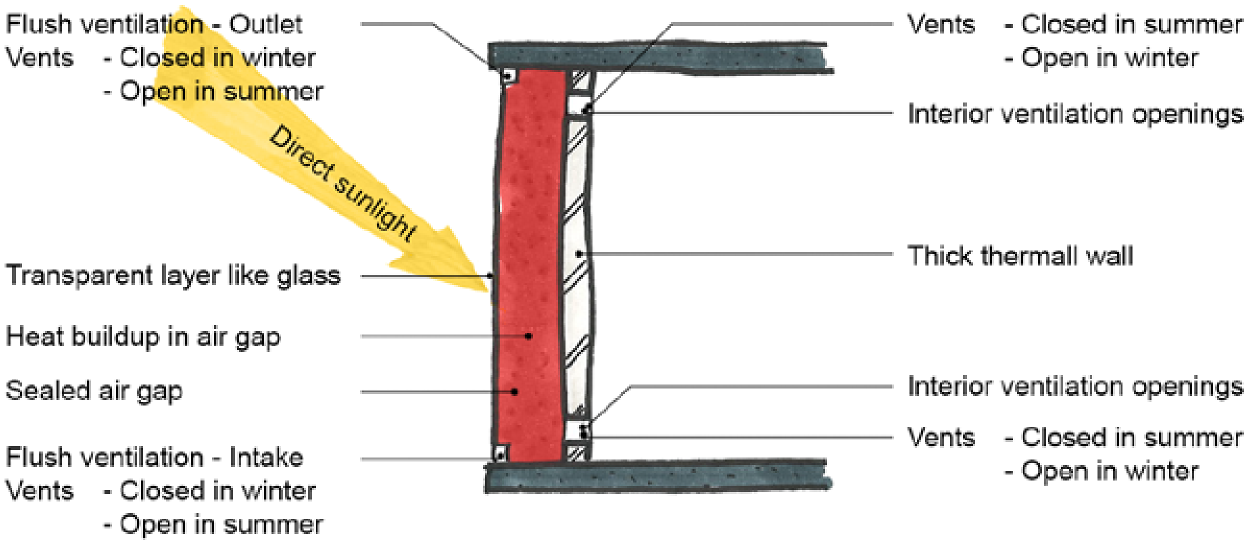


Figure 7.6.9 - Trombe wall operations

Trombe wall - Summer operations

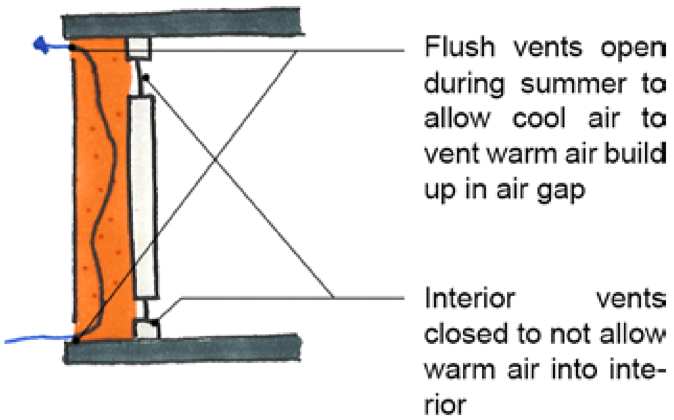


Figure 7.6.10 - Trombe wall - Summer operations

Trombe wall - Winter operations

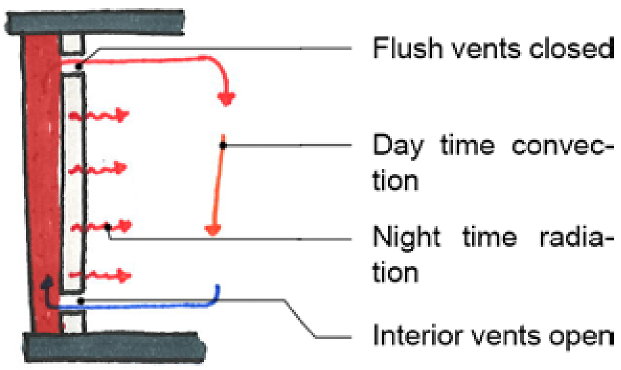


Figure 7.6.11 - Trombe wall - Winter operations

HEAT EXCHANGE - ADAPTED FROM DEKAY AND BROWN, (2014)

Heat exchange for overall building

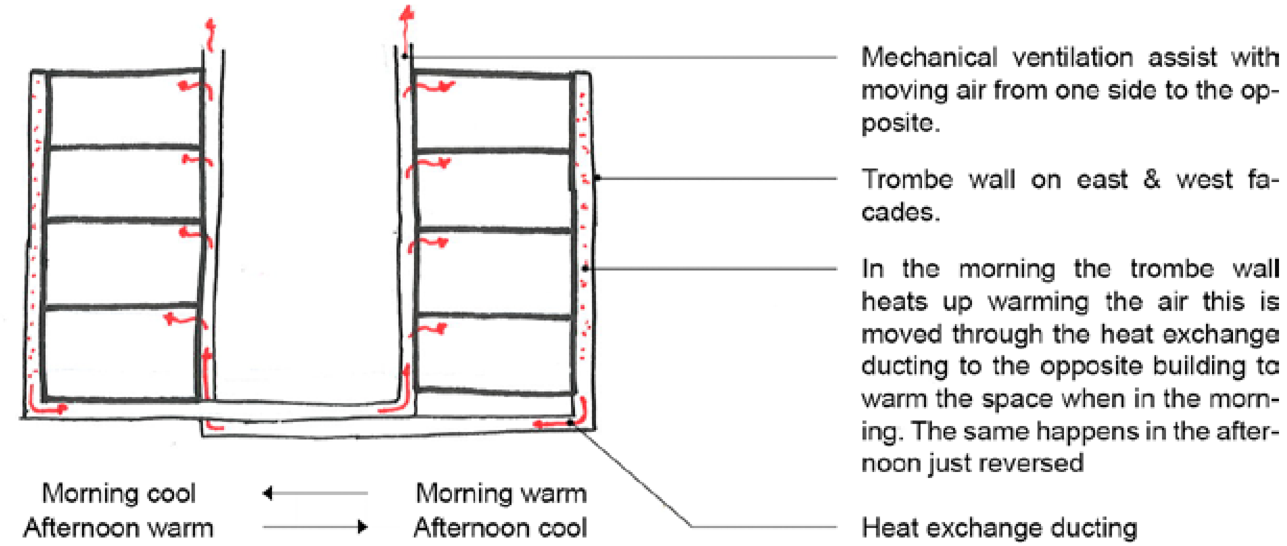


Figure 7.6.12 - Heat exchange for overall building

Heat exchange for units and interior spaces

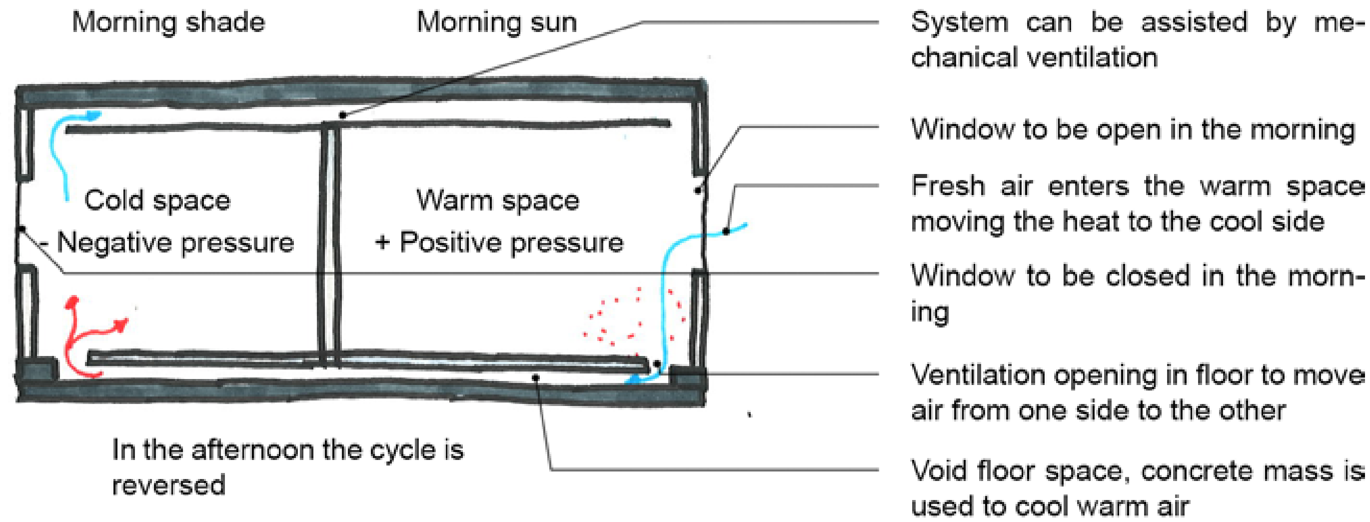


Figure 7.6.13 - Heat exchange for units and interior spaces

VENTILATION AND COOLING - ADAPTED FROM DEKAY AND BROWN, (2014)

Cross ventilation

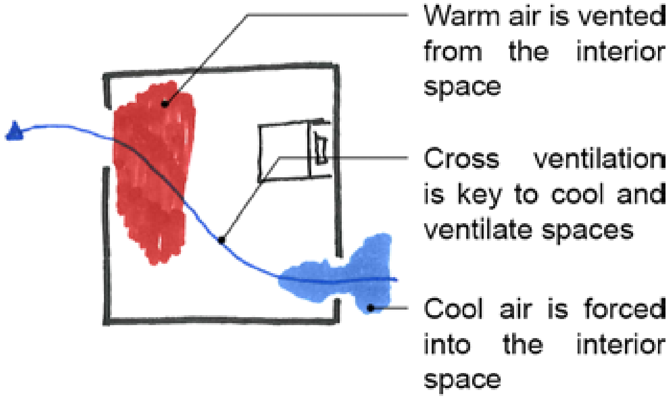


Figure 7.6.14 - Cross ventilation

Cross ventilation cooling and directing

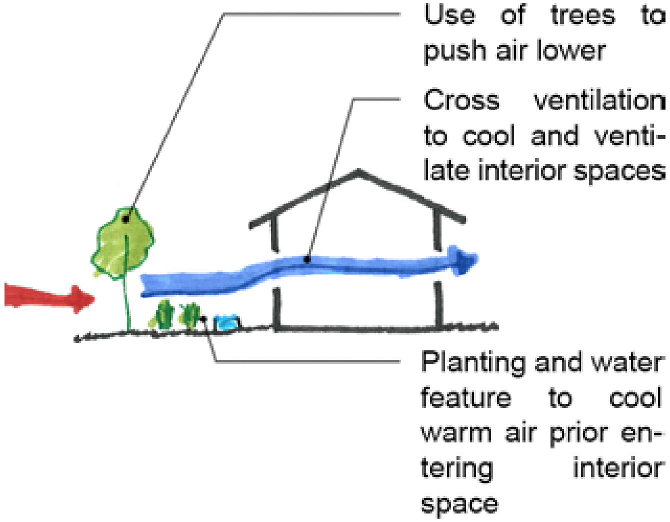


Figure 7.6.15 - Cross ventilation cooling and directing

Evaporative cooling towers

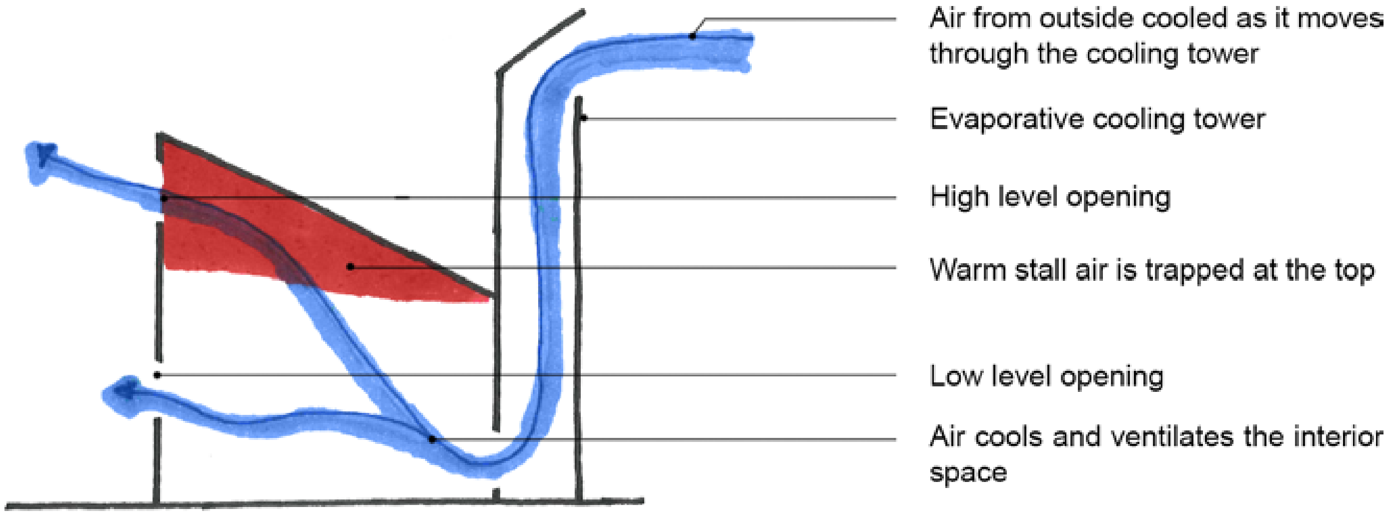


Figure 7.6.16 - Evaporative cooling towers

Earth - air heat exchange

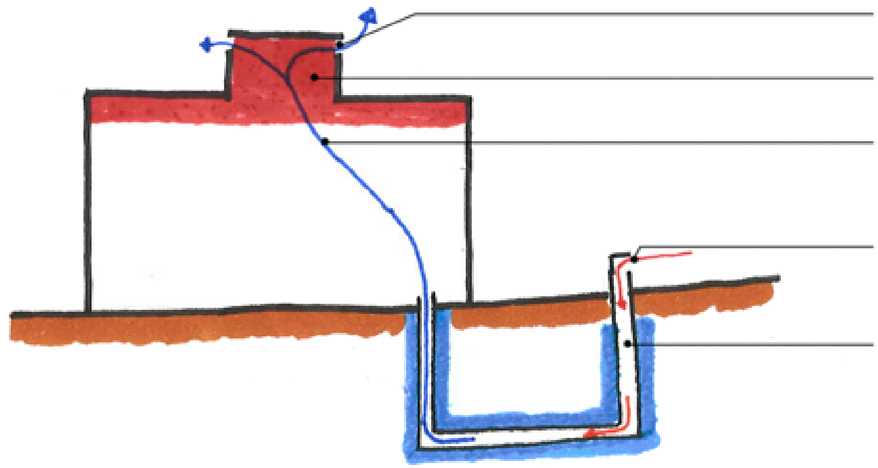


Figure 7.6.17 - Earth - air heat exchange

Combination of wind tower, rock stores and stacked ventilation

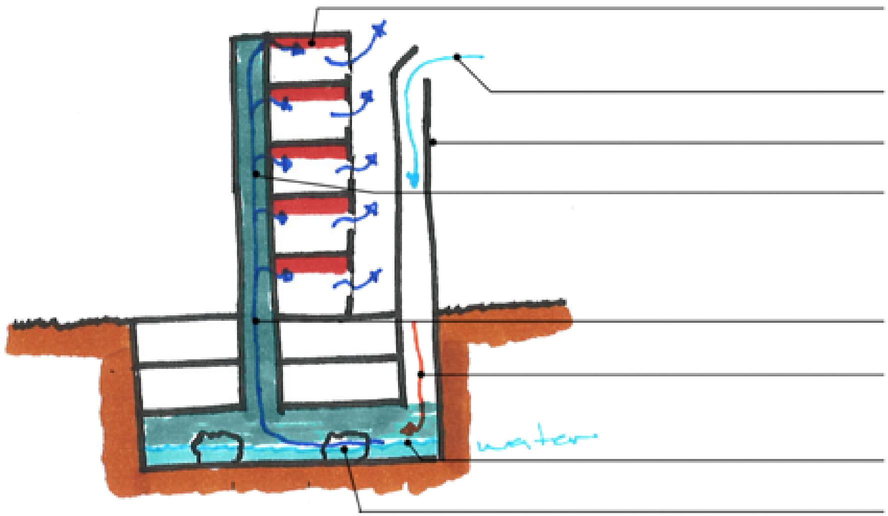


Figure 7.6.18 - Combination of wind tower, rock stores and stacked ventilation

Interior constructed wetland with wind channeling fins

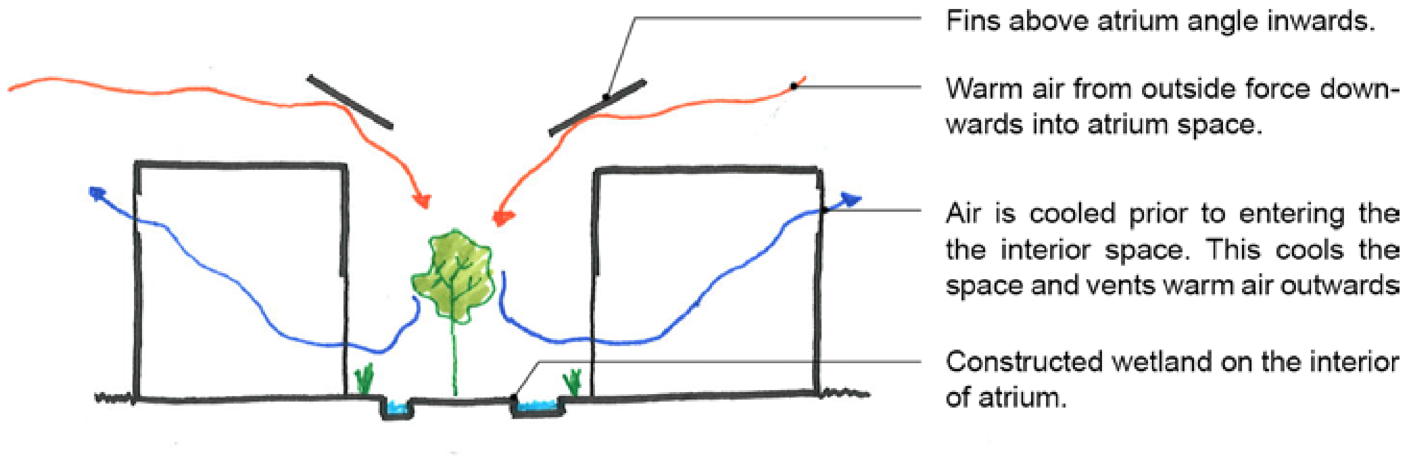


Figure 7.6.19 - Ventilation and cooling - Interior constructed wetland

Interior constructed wetland with evaporative pond

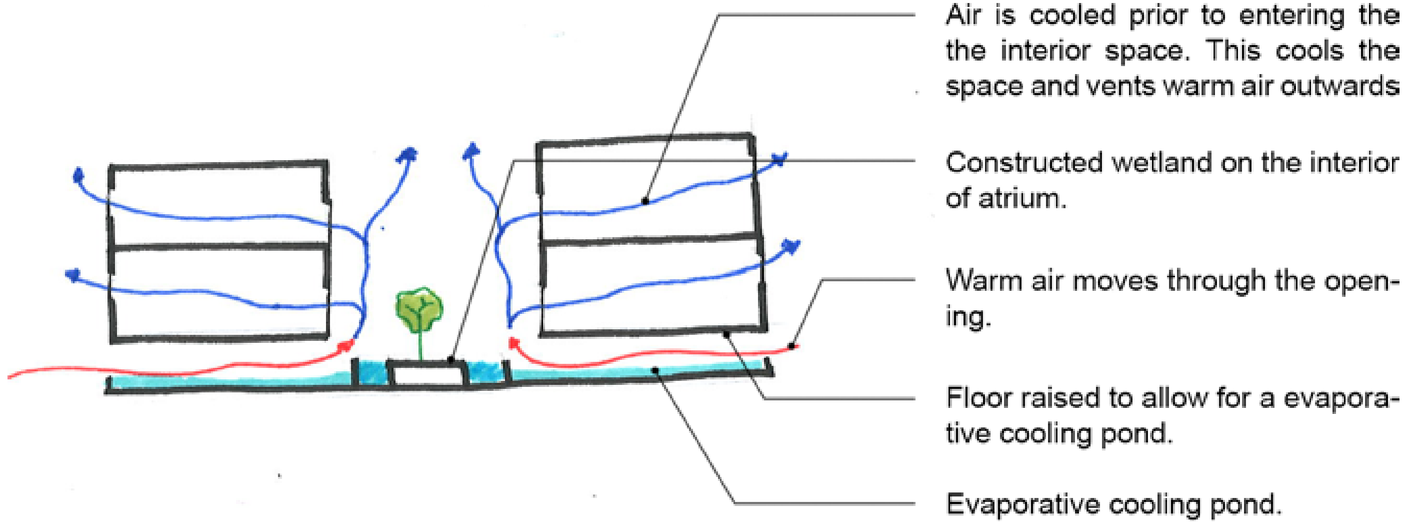


Figure 7.6.20 - Interior constructed wetland with evaporative pond

INTEGRATION OF SYSTEMS

Integration of systems in a structure

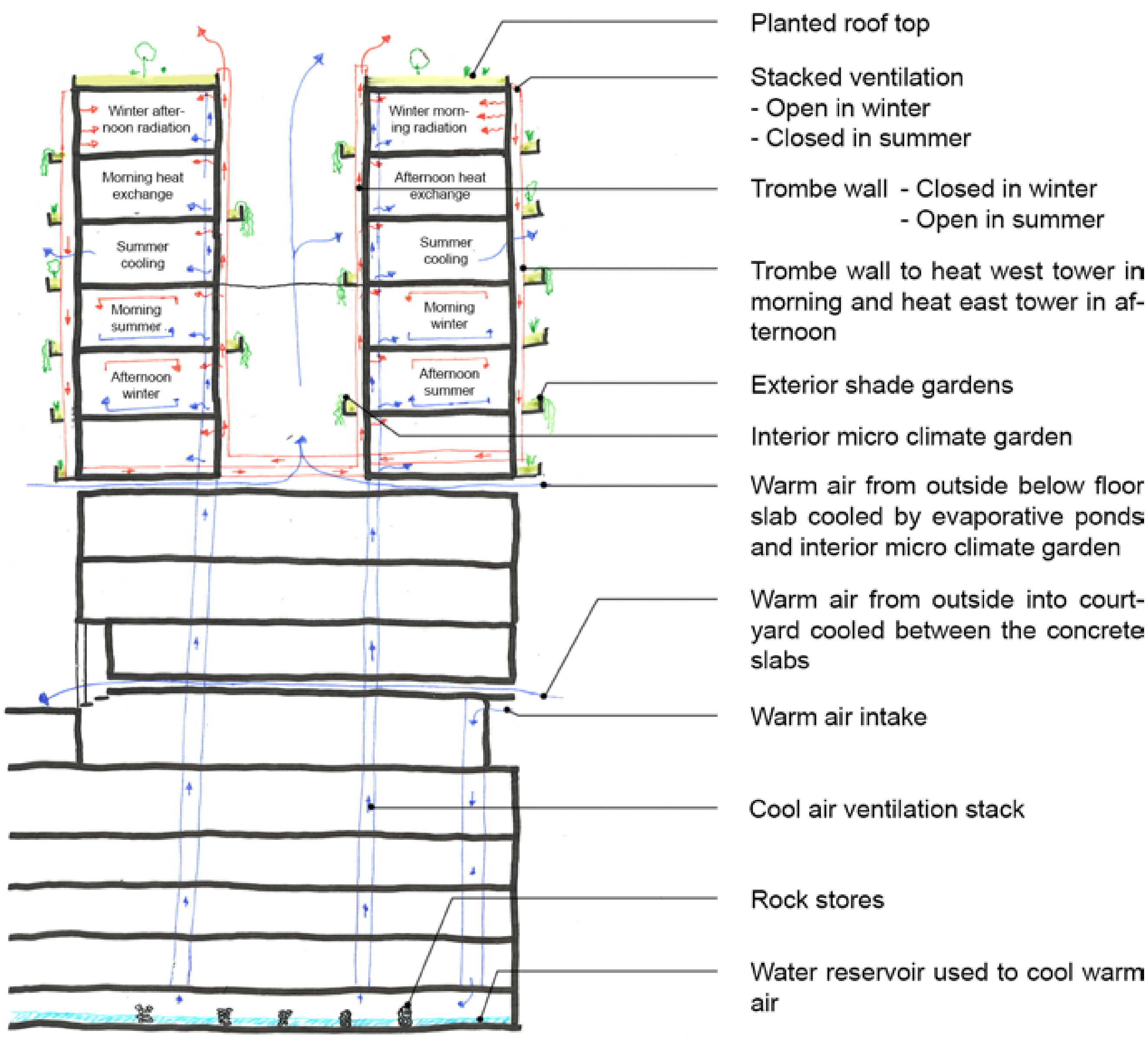


Figure 7.6.21 - Integration of systems in a structure

Conclusion on passive sustainability exploration

Achieving optimal passive sustainability and efficiency within a building necessitates the harmonious integration of multiple strategies that beneficially supports one another. As a result, the overarching systems evolve into a sophisticated network of interrelated components.

It's imperative to acknowledge that the treatment of west and east facades differs significantly from that of north and south facades. Each orientation presents unique climactic challenges and opportunities that must be addressed with tailored solutions.

In this pursuit, it's essential to place a strong emphasis on aligning the building's objectives with those of the surrounding precinct. By doing so, a holistic approach can be developed, ensuring that the built environment seamlessly interacts with its context to achieve sustainable and efficient outcomes.

Key aspects that is considered for this project are:

Natural ventilation
Natural ventilation is the sustainable practice of using wind and temperature differences to naturally regulate indoor air quality and temperature by strategically placing openings such as windows and vents.

Building cooling
Passive building cooling is the art of naturally maintaining comfortable indoor temperatures without active mechanical systems, often through architectural design and ventilation strategies.

Effective daylight
Passive effective daylight refers to utilising natural sunlight efficiently within a space through architectural design and layout, without the need for excessive artificial lighting.

Rich outdoor spaces
Rich outdoor spaces encompass creatively designed and inviting exterior areas that offer diverse experiences and interactions with nature, enhancing the overall environment.

Water saving
Sustainable water saving involves employing efficient practices and technologies to conserve water resources over time while minimising waste and promoting environmental responsibility.

Energy renewable
Energy renewal pertains to harnessing naturally replenished sources of power, such as solar and wind energy, to ensure continuous and eco-friendly energy generation.

7.7 INITIAL DESIGN CONCEPT DEVELOPMENT

INTRODUCTION

Developing a set of guiding principles for the building's desired outcomes serves as a foundational framework, allowing for the creation of a basic architectural form. This initial configuration can then be closely examined and analysed to assess its interaction and integration with the specific micro-climate conditions of the site. This strategic approach ensures that the building's design aligns effectively with the surrounding environment, harnessing its natural elements to enhance sustainability and functionality.

DESIGN CONCLUSION

After conducting a comprehensive exploration of architectural precedents and absorbing the insights garnered during the research phase, the decision crystallised to revisit a precedent that draws inspiration from Hassan Fathy's New Baris Village and is guided by the wisdom shared in DeKay and Brown's (2014) "Sun, Wind and Light - Architectural Design Strategies" book. This approach places a profound emphasis on the adoption of passive design strategies, strategically implemented across various scales.

Hassan Fathy's New Baris Village emerges as a beacon of sustainability in architectural history, seamlessly integrating sustainable design principles at both macro and micro levels. By revisiting this precedent, the design process seeks to tap into the wealth of knowledge from the past, adapting it thoughtfully to the demands and context of the contemporary world. This deliberate choice underscores the critical role played by passive design strategies in achieving a harmonious balance between functionality, environmental consciousness, and cultural resonance.

In this context, several pivotal aspects warrant consideration. Firstly, the incorporation of passive design strategies at multiple levels will be a defining feature. These strategies will harness the inherent qualities of materials and building components, facilitating optimum natural light and ventilation. Additionally, the choice of building orientation will be leveraged to its fullest sustainable potential. This approach epitomises the design's commitment to creating architectural harmony that pays homage to tradition, responds adeptly to modern needs, and embraces an eco-conscious ethos. It is an approach that endeavors to bridge the past and the present while looking toward a more sustainable and harmonious future in architectural design.

For aspects to consider see figure 294 to 301.

Building orientation

While the ideal building orientation is East-West, a minor rotation of approximately 15° from the true East-West axis can also be effective (McLeod, n.d.).

Due to the building's predominant north-south orientation, a 7° rotation from true north has been introduced to align with the east street while reducing the area of the east and west facades by 1%. Although this reduction may seem minimal, it significantly contributes to energy conservation, lowering cooling demands in summer and heating requirements in winter. Additionally, this orientation allows the courtyard to harness the benefits of low-angle winter sunlight for heating.

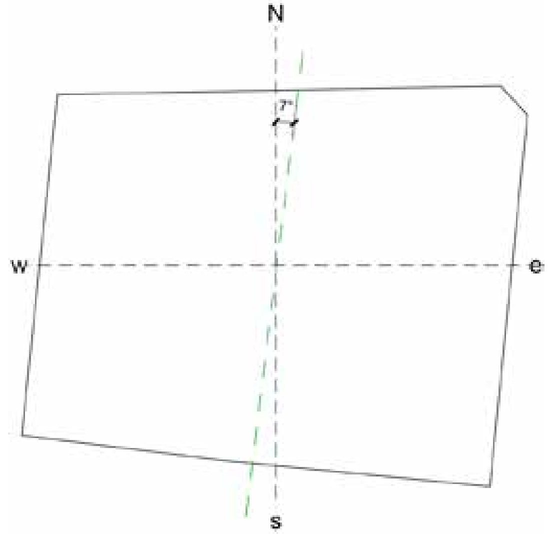


Figure 7.7.1 - Rotation of grid by 7° North East

Shared shaded summer courtyard

Placing buildings on the east and west sides of the site, although not the ideal orientation, creates an opportunity to establish a micro climate between them that offers a comfortable outdoor space.

This arrangement aims to achieve a balance where the area remains cool during winter and warm during summer, enhancing the comfort of the users.

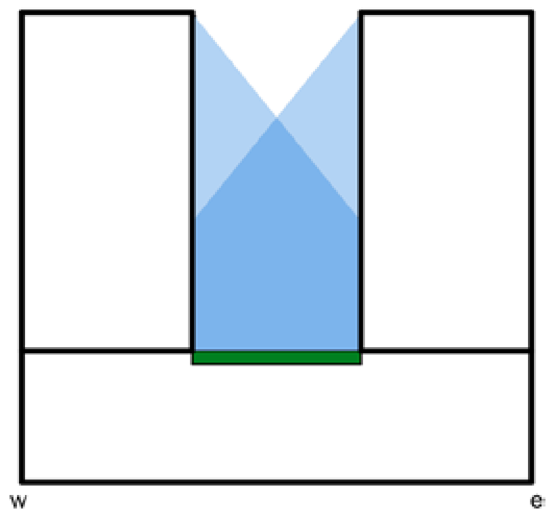


Figure 7.7.2 - Shared shaded summer courtyard

Thin building plan layout with atrium

In order to optimise sunlight exposure throughout the day, the blocks are divided into atrium spaces, resulting in narrower floor plans. This design approach enables cross ventilation as openings can be strategically placed on both sides of the units.

By creating these atrium spaces, the aim is to extend natural light to the lower floors as daylight is reduced on lower floors and facilitate efficient airflow within the buildings.

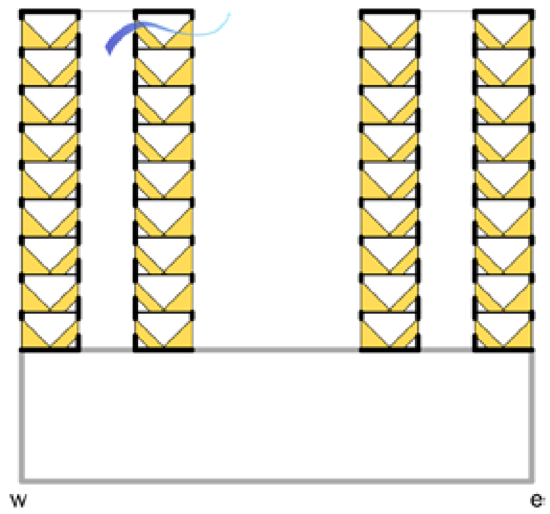


Figure 7.7.3 - Thin building plan layout with atrium

Internal micro climate control

In order to facilitate cooling within the units, the atrium spaces are enhanced with plants, which serve to increase humidity and effectively cool the surrounding area.

This cooled air is then ventilated into the buildings, providing a natural and refreshing indoor environment.

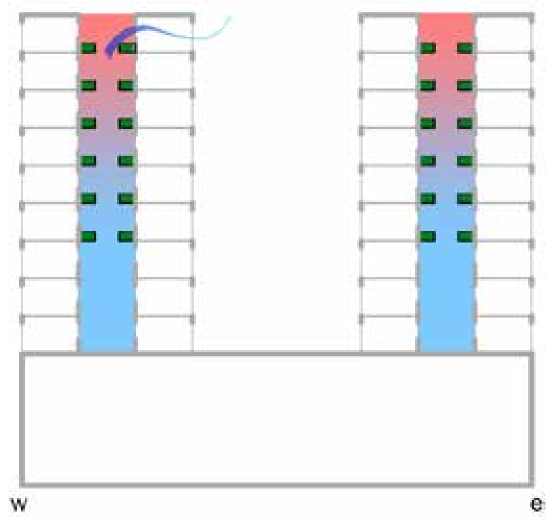


Figure 7.7.4 - Internal micro climate control

Natural ventilation to atrium space

Raising the floor level between the office and residential units creates space for an evaporative cooling pond, which cools natural airflow before it enters the atrium. Enclosing the top of the atrium directs the air through the units, significantly improving the cooling process in each unit.

This design strategy promotes the circulation of fresh air and maximises the cooling potential within the building.

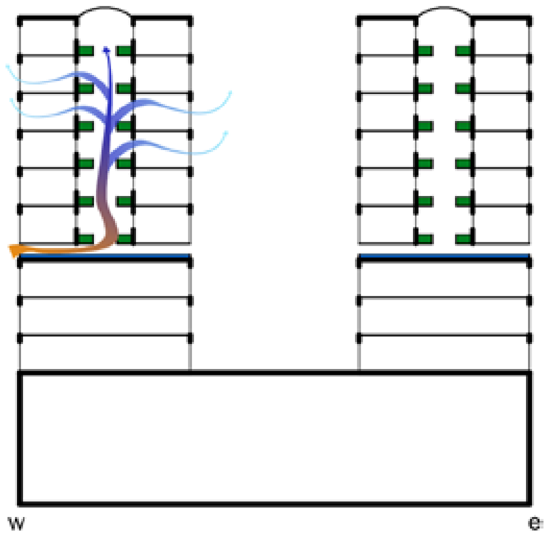


Figure 7.7.5 - Natural ventilation to atrium space

Building placement for wind channeling

Blocks are shifted to align with the prevailing NE and SW winds. The eastern block is moved towards the boundary while the western block is shifted up to the boundary.

This design allows the winds to be directed into the courtyard, enhancing natural ventilation and cooling.

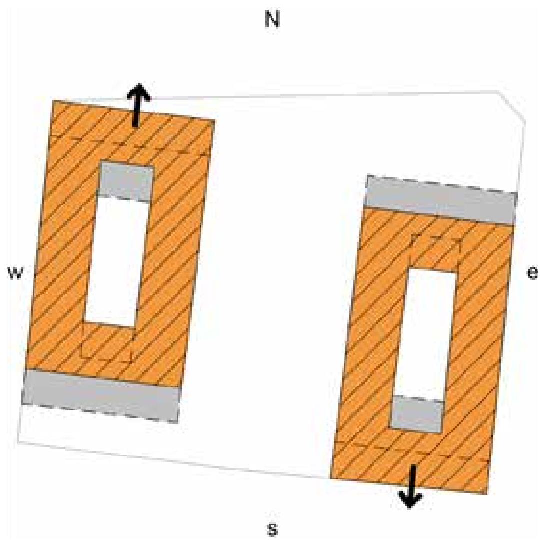


Figure 7.7.6 - Building placement for wind channeling

Connection to precinct and CBD

A direct connection is established between the Roman Catholic precinct, located at a higher level, and the surrounding area.

Additionally, a link is created from the existing thoroughfare to the existing bus and taxi rank, reducing the reliance on vehicle transportation.

These connections make it easier to navigate through the neighbourhood blocks, promoting pedestrian movement and reducing the need for vehicular travel.

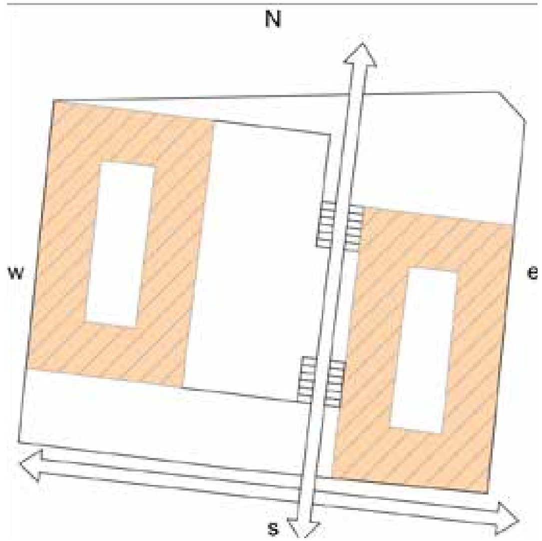


Figure 7.7.7 - Connection to precinct and CBD

Public spaces along connections

By creating these connections, a multi-level public space can be designed, offering various functions and amenities to the community.

This approach allows for the utilisation of different levels to accommodate a range of activities and enhance the overall liveability of the area.

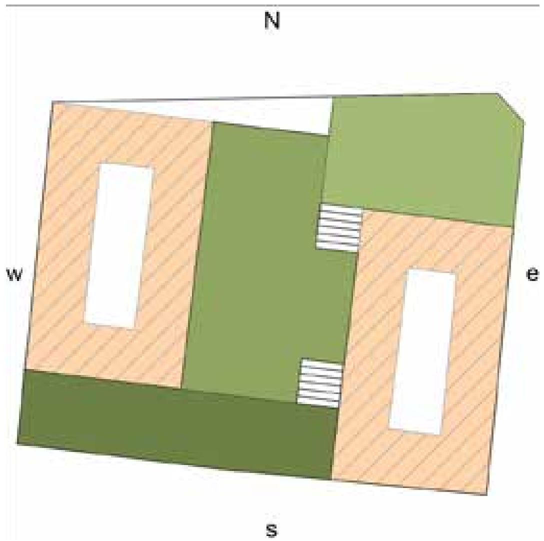


Figure 7.7.8 - Public spaces along connections

7.8 FORM DICTATED BY SOLAR STUDIES

INTRODUCTION

Through a careful and deliberate design process, the building's form was thoughtfully shaped in collaboration with the sun's influence. This synergy between design and the natural environment facilitated the refinement of the building's form, ensuring that it harmonised seamlessly with the unique micro-climate of the site. The design journey thus led to a more nuanced and purposeful architectural configuration, providing a solid platform for in-depth exploration and further development. This approach not only enhances the building's performance but also enables it to engage more effectively with its surroundings, achieving a sustainable and contextually responsive outcome.

ENHANCED MASSING DEVELOPMENT BASED ON DESIGN ASPECTS - STEP 1 - BUILDING ROTATION 7°

Summer Conditions

The rotation of the floor plans results in shading along the interior courtyard west and east facades, effectively decreasing direct heat gain.

1 - Morning solar study

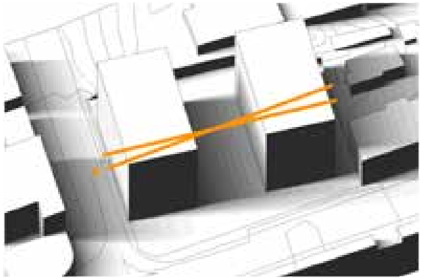


Figure 7.8.1 - Step 1 - Summer morning solar study 7:00 - 12:00

2 - Afternoon solar study

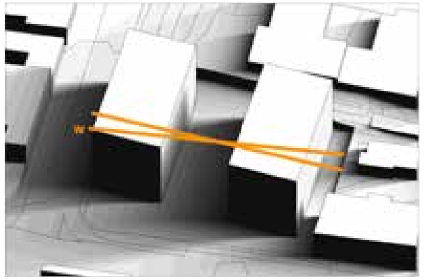


Figure 7.8.2 - Step 1 - Summer afternoon solar study 11:45 - 18:00

Winter Conditions

During winter, this rotation enables the interior courtyard's west and east facades to receive increased direct sunlight, effectively harnessing winter heat gain.

1 - Morning solar study

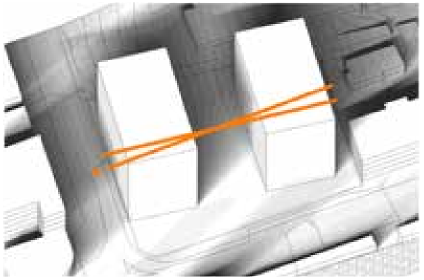


Figure 7.8.3 - Step 1 - Winter morning solar study 7:00 - 12:00

2 - Afternoon solar study

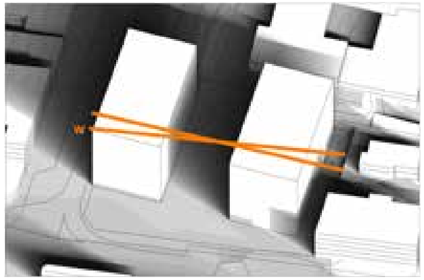


Figure 7.8.4 - Step 1 - Winter afternoon solar study 11:45 - 18:00

STEP 2 - CREATING AN ATRIUM SPACE

Summer Conditions

By designing the atrium space, natural light is able to penetrate the core of the residential unit.

1 - Morning solar study

Figure 7.8.5 - Step 2 - Summer morning solar study 7:00 - 12:00

2 - Afternoon solar study

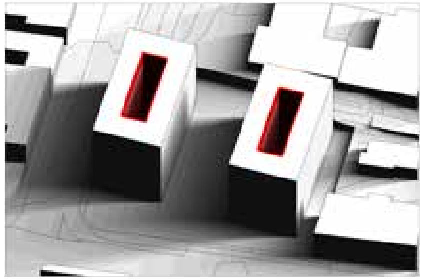


Figure 7.8.6 - Step 2 - Summer afternoon solar study 11:45 - 18:00

Winter Conditions

The atrium space permits greater penetration of winter light, thereby transforming what would have been a dim interior atrium space.

1 - Morning solar study

Figure 7.8.7 - Step 2 - Winter morning solar study 7:00 - 12:00

2 - Afternoon solar study

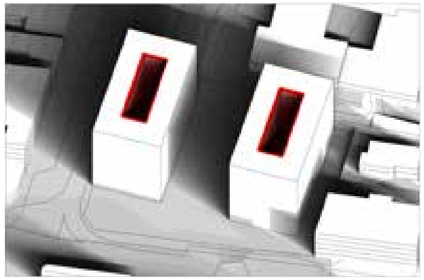


Figure 7.8.8 - Step 2 - Winter afternoon solar study 11:45 - 18:00

STEP 3 - SHIFTING BUILDING TO CHANNEL PREVAILING WINDS

Summer Conditions

For optimal natural ventilation, the west building is set back, and the east building is placed towards the front. This layout utilises the interior courtyard to guide the prevailing wind into the space.
Yet, this configuration does increase direct sunlight exposure on the interior courtyard's west and east facades.

1 - Morning solar study

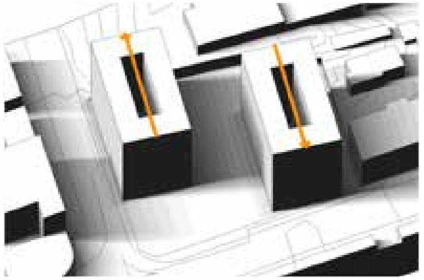


Figure 7.8.9 - Step 3 - Summer morning solar study 7:00 - 12:00

2 - Afternoon solar study

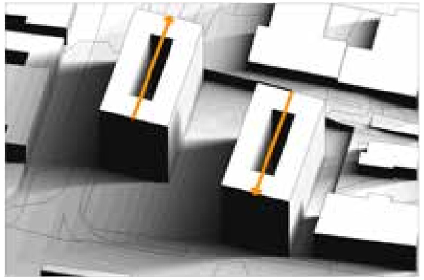


Figure 7.8.10 - Step 3 - Summer afternoon solar study 11:45 - 18:00

Winter Conditions

The heightened exposure to direct sunlight also holds true during the winter months, providing an advantageous means of warming the interior spaces.

1 - Morning solar study

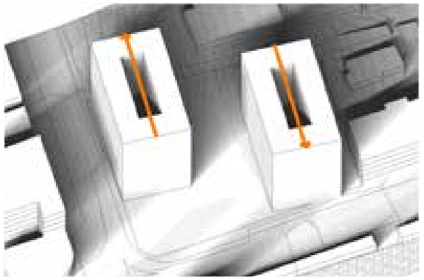


Figure 7.8.11 - Step 3 - Winter morning solar study 7:00 - 12:00

2 - Afternoon solar study

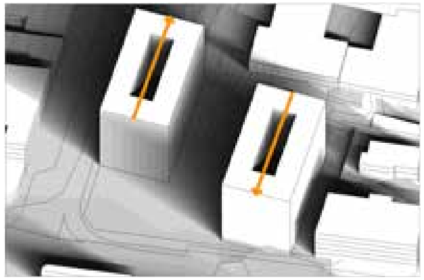


Figure 7.8.12 - Step 3 - Winter afternoon solar study 11:45 - 18:00

STEP 4 - REDUCING BUILDING HEIGHT ON THE NORTH SIDE

Summer Conditions

Reducing the northern building sides enhances the atrium's natural light intake, elevating its overall brightness and appeal.

1 - Morning solar study

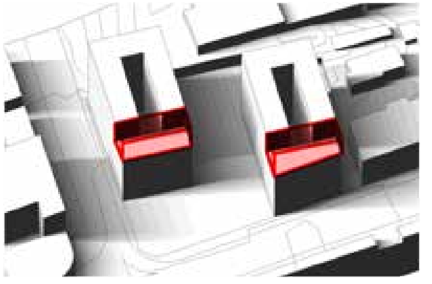


Figure 7.8.13 - Step 4 - Summer morning solar study 7:00 - 12:00

2 - Afternoon solar study

Figure 7.8.14 - Step 4 - Summer afternoon solar study 11:45 - 18:00

Winter Conditions

This design fosters a migratory space, enabling residents to utilise outdoor areas during the colder winter months.

1 - Morning solar study

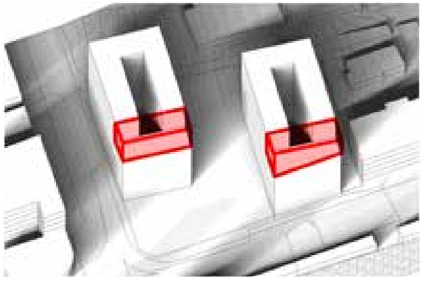


Figure 7.8.15 - Step 4 - Winter morning solar study 7:00 - 12:00

2 - Afternoon solar study

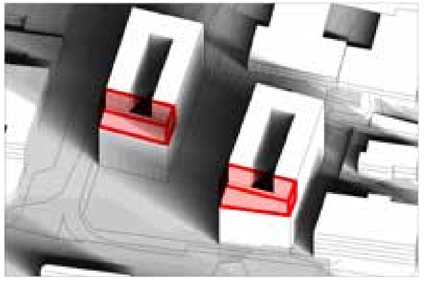


Figure 7.8.16 - Step 4 - Winter afternoon solar study 11:45 - 18:00

STEP 5 - INCREASING BULK OF THE BUILDING

Summer Conditions

The increase bulk helps to shade the courtyard interior space in summer to make the space more comfortable.

1 - Morning solar study

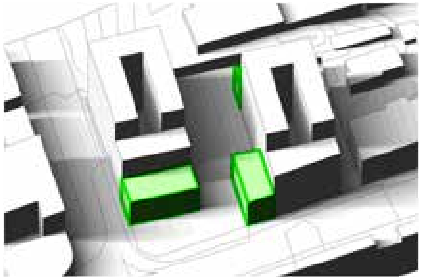


Figure 7.8.17 - Step 5 - Summer morning solar study 7:00 - 12:00

2 - Afternoon solar study

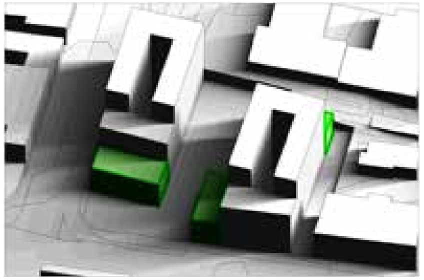


Figure 7.8.18 - Step 5 - Summer afternoon solar study 11:45 - 18:00

Winter Conditions

These additions open up fresh opportunities along the street edge, simultaneously reducing the potential obstruction of winter sun.

1 - Morning solar study

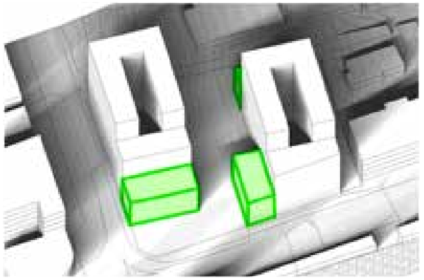


Figure 7.8.19 - Step 5 - Winter morning solar study 7:00 - 12:00

2 - Afternoon solar study

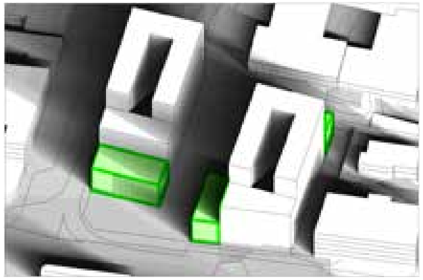


Figure 7.8.20 - Step 5 - Winter afternoon solar study 11:45 - 18:00

STEP 6 - REDUCING BUILDING HEIGHT ON THE SOUTH SIDE

Summer Conditions

Reducing the southern side building height allows greater natural light to filter into the atrium space.

1 - Morning solar study

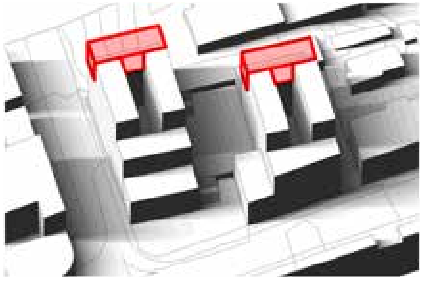


Figure 7.8.21 - Step 6 - Summer morning solar study 7:00 - 12:00

2 - Afternoon solar study

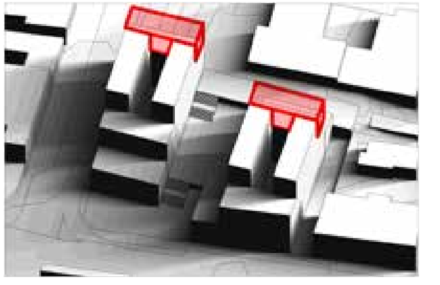


Figure 7.8.22 - Step 6 - Summer afternoon solar study 11:45 - 18:00

Winter Conditions

The diminished height permits sunlight to reach the school during winter while establishing a more human-scale ambiance along the pathway leading to the taxi rank.

1 - Morning solar study

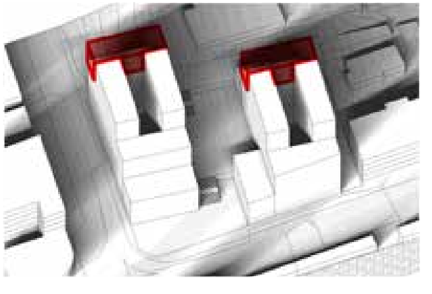


Figure 7.8.23 - Step 6 - Winter morning solar study 7:00 - 12:00

2 - Afternoon solar study

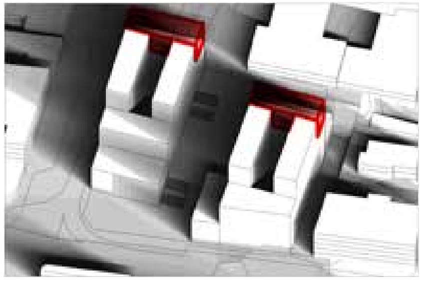


Figure 7.8.24 - Step 6 - Winter afternoon solar study 11:45 - 18:00

STEP 7 - CUT BACK ON STREET EDGE

Summer Conditions

The setback provides shading for the retail edge during the summer season.

1 - Morning solar study

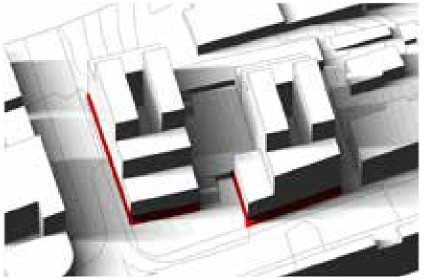


Figure 7.8.25 - Step 7 - Summer morning solar study 7:00 - 12:00

2 - Afternoon solar study

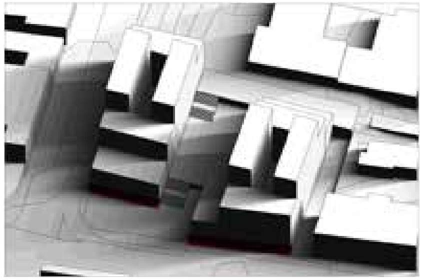


Figure 7.8.26 - Step 7 - Summer afternoon solar study 11:45 - 18:00

Winter Conditions

The winter sun angle is sufficiently low to permeate the retail edge, contributing to a warmer ambiance in the space.

1 - Morning solar study

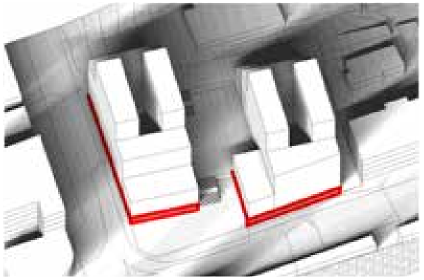


Figure 7.8.27 - Step 7 - Winter morning solar study 7:00 - 12:00

2 -Afternoon solar study

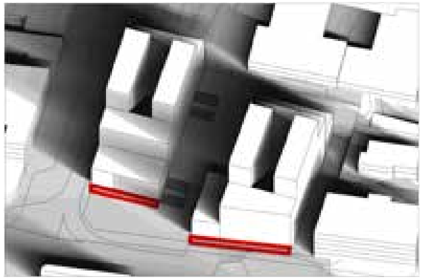


Figure 7.8.28 - Step 7 - Winter afternoon solar study 11:45 - 18:00

SOLAR RADIATION ANALYSES

Summer

During the summer days, all east and west facades experience significant heat gain due to direct sunlight exposure.

However, the courtyard nestled between the buildings remains predominantly shaded throughout the day, maximising its usability potential.

This design aspect lessens the reliance on shading devices, although it’s important to shade areas directly affected by afternoon sun.

Due to the rotation angle, all northern facades are shaded, resulting in reduced heat gain on this side of the building.
Roofs receive the highest solar exposure, offering an ideal setting for the installation of solar panels to generate electricity.

This also presents an opportunity to implement green roofs, effectively mitigating the heat island effect in the built environment.

Morning solar study 7:00 - 12:00

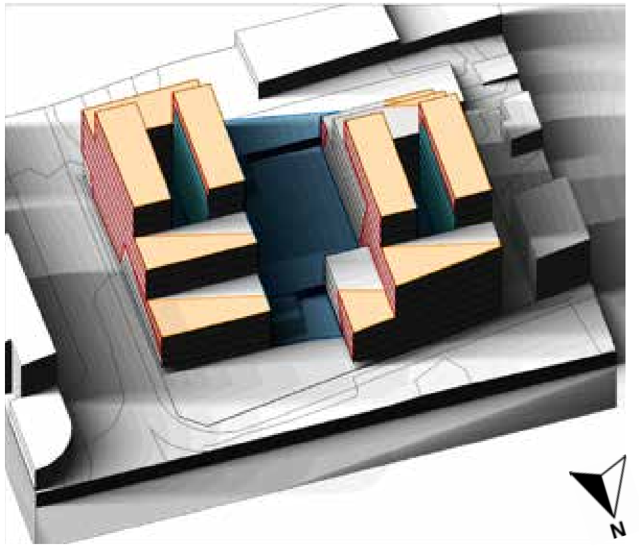


Figure 7.8.29 - Summer morning solar analyses 7:00 - 12:00

Afternoon solar study 11:45 - 18:00

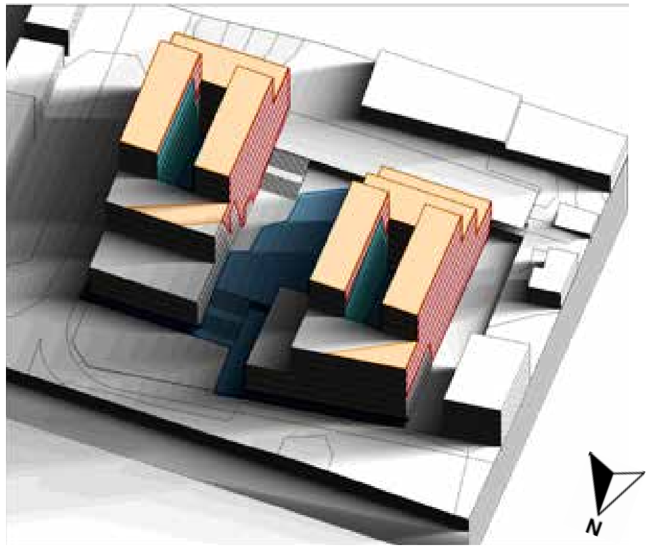


Figure 7.8.30 - Summer afternoon solar analyses 11:45 - 18:00

Winter

In winter, direct sunlight exposure leads to notable heat gain on both the east and west facades.

The central courtyard situated between the buildings benefits from less shading throughout the day, optimising its functionality.

With the rotation angle taken into account, all northern facades receive sunlight, which consequently increases heat gain on this side of the building.

Roofs, being subject to the greatest solar exposure, offer a prime location for the installation of solar panels to generate electricity. By strategically incorporating these factors, the site experiences heightened warmth during winter, consequently optimising the usability of space throughout this period.

Morning solar study 7:00 - 12:00

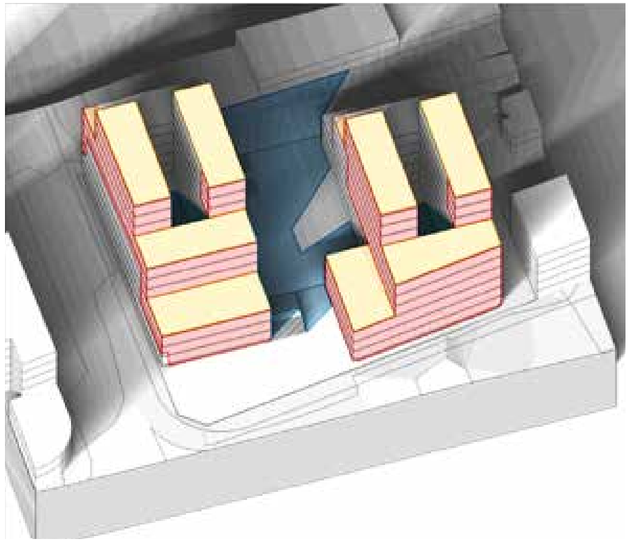


Figure 7.8.31 - Winter morning solar analyses 7:00 - 12:00

Afternoon solar study 11:45 - 18:00

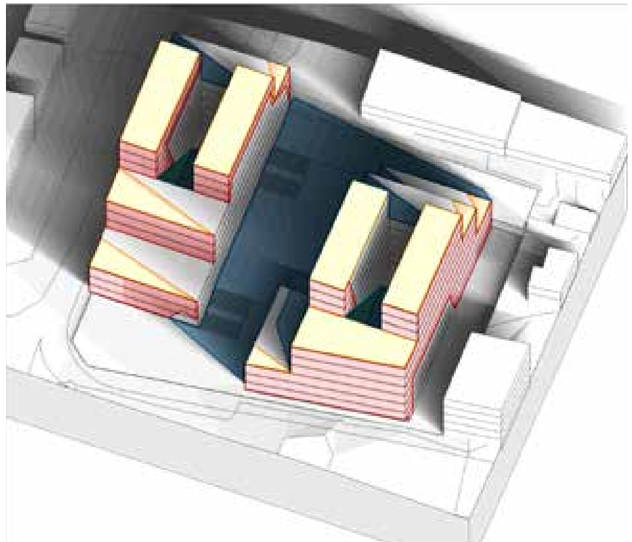


Figure 7.8.32 - Winter afternoon solar analyses 11:45 - 18:00

STRUCTURE SOLAR EXPLORATION

While establishing the initial design framework, it became apparent that direct sunlight affecting the west and east facades posed a significant challenge, leading to increased heat gain. In response, an extensive exploration of various floor plan configurations was initiated, focusing on achieving a balance between maximising natural light penetration into interior spaces and mitigating direct solar gain. This exploration aimed to identify an optimal design solution that leveraged the advantages of natural light while effectively managing its potential downsides. By examining diverse layouts, the design process aimed to create a cohesive and sustainable approach that emphasised both functionality and sustainability.

Stacked slabs low ceiling height

Sunlight has the capacity to infiltrate the interior space during both winter and summer. Regrettably, this also results in heightened heat gain, as an increased amount of sunlight enters the interior.

Summer

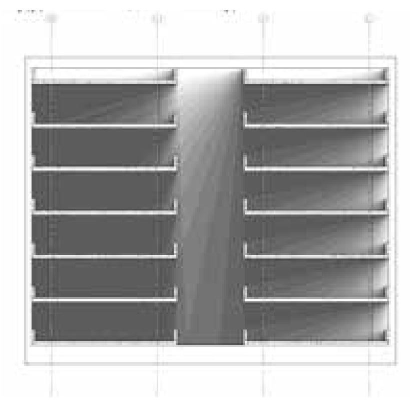


Figure 7.8.33 - Stacked slabs low ceiling height - Summer

Winter

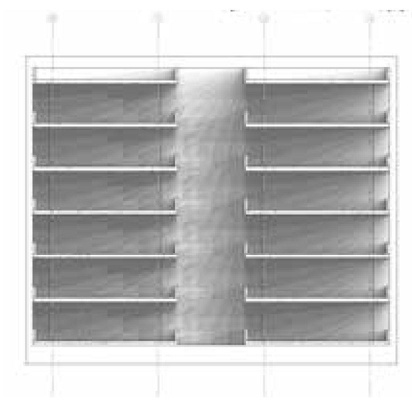


Figure 7.8.34 - Stacked slabs low ceiling height - Winter

Stacked slabs high ceiling height

Elevating the interior space height exacerbates the issue stemming from low ceiling height, making the problem more pronounced and persistent. Therefore, this approach is not a viable solution to pursue.

Summer

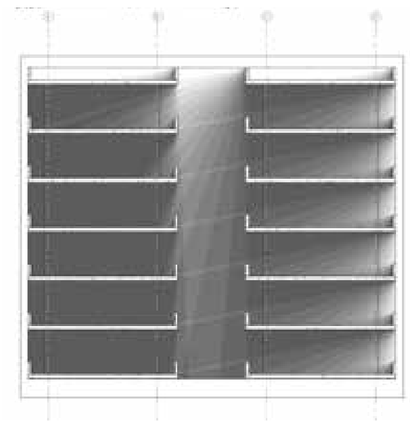


Figure 7.8.35 - Stacked slabs high ceiling height - Summer

Winter

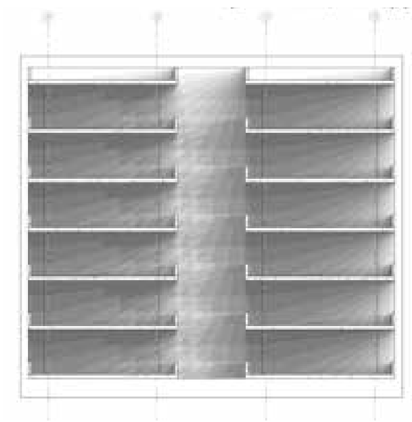


Figure 7.8.36 - Stacked slabs high ceiling height - Winter

Floors set back mirrored

Implementing a setback on every alternate floor introduces depth to the facade, effectively decreasing heat gain while enabling abundant natural light penetration. This is achieved through an elevation in the interior height.

However, the drawback to this approach is that the interior atrium space becomes notably enclosed.

Summer

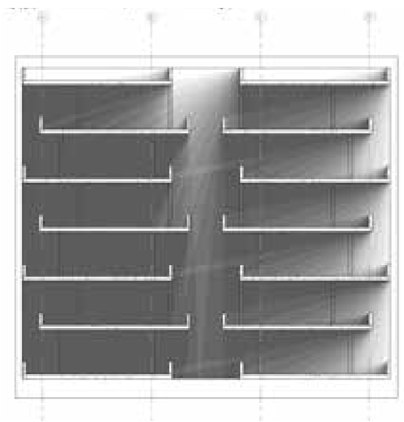


Figure 7.8.37 - Floors set back mirrored - Summer

Winter

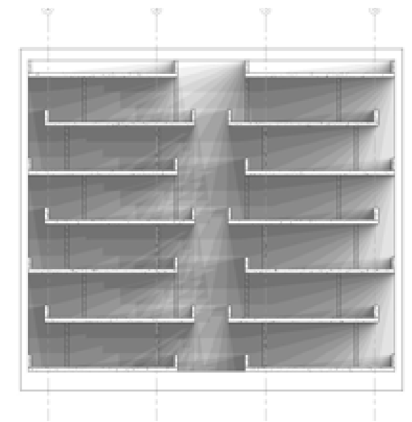


Figure 7.8.38 - Floors set back mirrored - Winter

Floors set back staggered

Staggering the floor layout expands the atrium space for improved light penetration and indirect interior illumination.

However, outer floors receive more direct sunlight, which could be countered with plants, yet limited balcony depth poses a challenge.

Summer

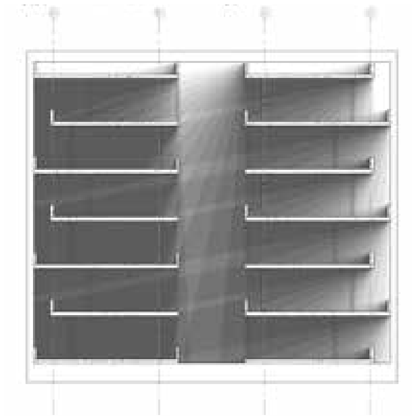


Figure 7.8.39 - Floors set back staggered - Summer

Winter

Figure 7.8.40 - Floors set back staggered - Winter

Balconies dropped staggered

The design features elevated interior spaces and a staggered floor plan. Lowered balconies provide room for larger plants that filter direct sunlight. External shading is still essential for areas with significant sun exposure.

Summer

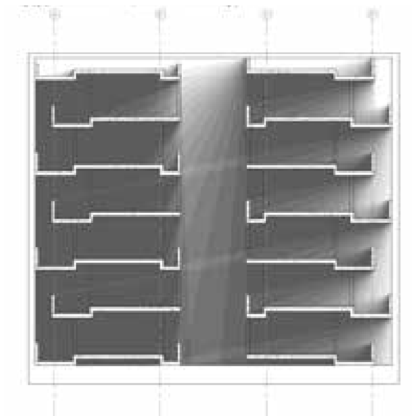


Figure 7.8.41 - Floors set back mirrored - Summer

Winter

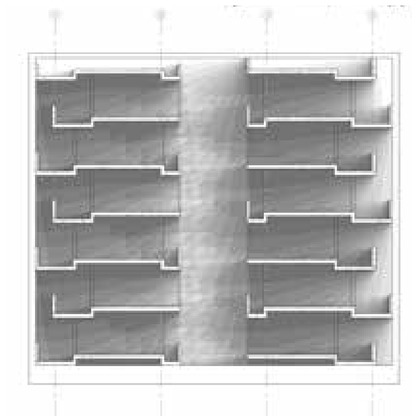


Figure 7.8.42 - Floors set back mirrored - Winter

7.9 INITIAL PLAN EVOLUTION

INTRODUCTION

After determining that the staggered dropped balcony design was the most suitable option for passive design strategies, the focus shifted to accommodating residential units within this space. Various layouts for typical residential units were thoroughly investigated before progressing to the exploration of a villa-style unit. This unique unit design presented the advantage of larger outdoor green spaces. The spacious balconies were strategically positioned to extend deeper into the floor, providing effective shading and optimising the unit's overall functionality.

RESIDENTIAL UNIT LAYOUT INITIAL DESIGN EXPLORATION

N

Residential typical unit layout design 1

In this unit plan exploration, the living space is positioned between the sleeping areas, with a separation between the main and secondary bedrooms. Secondary bedrooms have individual bathroom with a guest bathroom. High windows are placed on the atrium side to allow sunlight into the interior space.

The main bedroom has an en-suite bathroom overlooking a private garden to visually connect nature to the indoor space. The living space balcony can be landscaped to reduce heat island effect and introduce cool air towards the interior.

Figure 7.9.1 - Residential typical unit layout design 1

Residential typical floor layout 1

The placement of units is carefully orchestrated to minimise the extent of direct sunlight entering the interior spaces, while ensuring sufficient light penetration.

The units encompass a variety of sizes, including three-bedroom, two-bedroom, and one-bedroom units, positioned along the building's perimeter.

Leveraging the staggered configuration of the units, the shear walls are used as service cores as well as passive cooling cores.

Figure 7.9.2 - Residential typical floor layout 1

Residential typical unit layout design 2

Within this design exploration, wet services are strategically positioned towards the interior, adjacent to the atrium space.

Additionally, all sleeping spaces are concentrated within one structural bay, located towards the exterior of the building. This arrangement facilitates access to a garden space for each bedroom, albeit at the expense of bedroom size.

Meanwhile, the living space embraces an open-plan layout, seamlessly connecting to an exterior balcony, which can accommodate expansive openings.

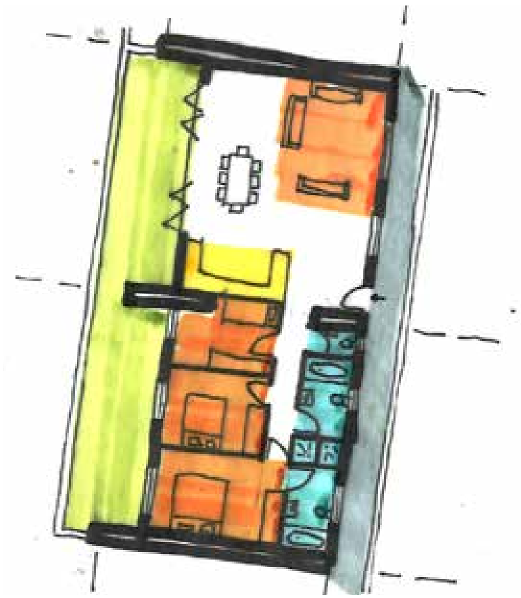


Figure 7.9.3 - Residential typical unit layout design 2

Residential typical floor layout 2

The arrangement of units facilitates the integration of wraparound garden spaces, contributing to effective cooling and generating deeper units that minimise direct sunlight exposure while enhancing sunlight penetration.

However, a drawback emerges concerning the wet services, as the misalignment hinders the use of ducts for service installation.

Figure 7.9.4 - Residential typical floor layout 2

Residential typical unit layout design 3

This design amalgamates the strengths of layouts 2 and 3, effectively segregating living spaces from sleeping quarters.

The main bedroom integrates a private garden adjacent to the bathroom, fostering a connection to nature. The living area is designed to accommodate expansive openings leading to exterior balconies.

Interior atrium gardens function as dividers between the walkway and residential units, presenting an opportunity to establish larger windows within the atrium's interior.

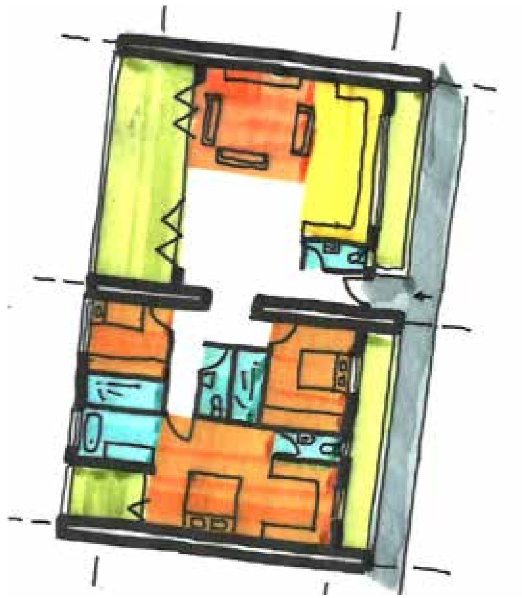


Figure 7.9.5 - Residential typical unit layout design 3

Residential typical floor layout 3

The layout is meticulously organised to capitalise on the creation of garden balconies, effectively establishing substantial setbacks that serve to mitigate direct sunlight exposure and aid in the cooling of external air. This arrangement further enables interior gardens to foster a micro climate within the atrium, thereby contributing to the cooling of the units.

This design is the favoured choice as it successfully captures the essence of standalone home living within a higher density context, while also seamlessly integrating nature into the urban environment.

Figure 7.9.6 - Residential typical floor layout 3

PLAN INITIAL DESIGN EVOLUTION

N

Basement services level plan

Located in the basement service level, the water reservoir serves as a central storage for recycled water, primarily utilised for gray water applications such as toilet flushing, garden irrigation, and supplying water to the evaporative cooling ponds serving the residential units. Within these reservoirs, rock stores are integrated, functioning to cool air for the office and retail levels.

Furthermore, this service level accommodates a water pretreatment facility aimed at purifying brown water sourced from basins and showers across the entire precinct to be reused. The reservoir can hold approximately 4780m^3 water.

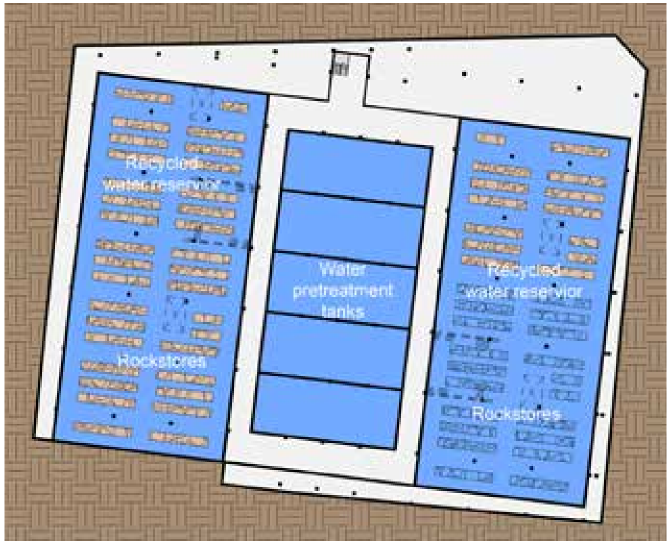


Figure 7.9.7 - Basement services level plan

Basement parking levels B1 to B3 plan

Each basement level offers 100 regular parking bays and 8 designated for disabled use. Some areas can be assigned to electric cars and carpooling, reducing private transport needs.

Residents and office users are the main parkers, with the potential for rentals to generate extra income and reduce street parking demand.

There's also sufficient space for essential building services like generator storage.

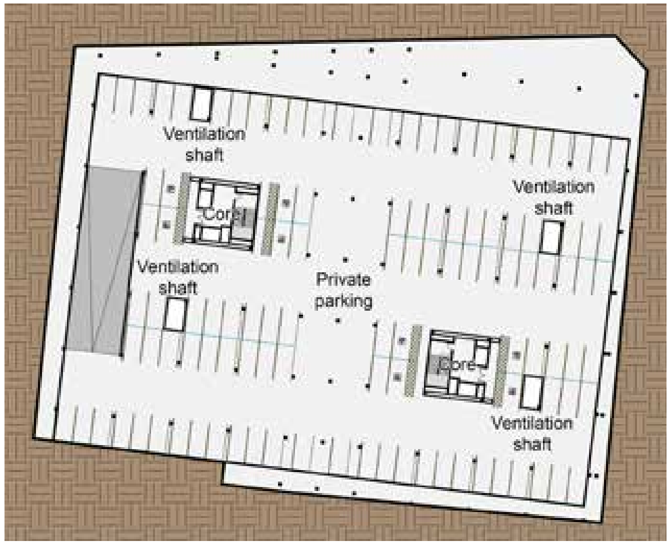


Figure 7.9.8 - Basement parking levels B1 to B3 plan

Ground floor plan - Retail

The street-level retail shops will enliven the street edge, providing a dynamic space for the public.

A public plaza is located at the corner, offering a gathering spot. The street pavement will utilise a soft surface to manage rainwater runoff.

Public parking will be discreetly situated behind the retail area, out of sight.

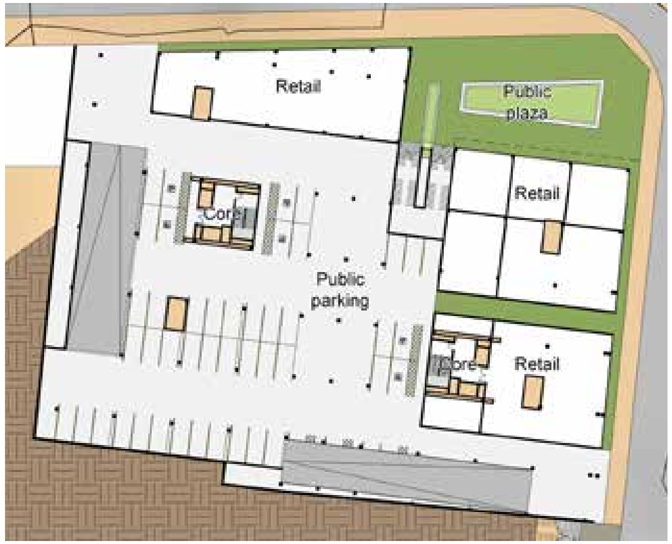


Figure 7.9.9 - Ground floor plan - Retail

First floor plan - Retail and office

On the first floor, there's a central public courtyard activated by a commercial edge.

This floor also features the primary constructed wetland, serving dual roles of water purification and evaporative cooling for the courtyard. The constructed wetland will operate as a subsurface flow system.

At the site's rear, a designated space will accommodate school drop-off and pick-up parking, ensuring a safer environment for children. This area can connect to neighbouring properties' parking for smooth in-and-out traffic flow.

Figure 7.9.10 - First floor plan - Retail and office

Second floor plan - Office

On this level, office spaces offer views of the courtyard, enhancing the connection to nature.

A constructed wetland here serves dual purposes of water purification and courtyard cooling.

Adjacent to the school and the development, an existing walkway can be revitalised to link with the nearby taxi and bus stop across Mandume Ndemufayo Avenue.

Figure 7.9.11 - Second floor plan - Office

Third floor plan - Office

The third level accommodates the largest portion of the office space. Similar to the Vodacom Site Solution precedent, this floor integrates internal constructed wetlands. Notably, these wetlands are designed in an open-air configuration, contributing to the cooling of the office areas and infusing the interior with natural elements.

This approach not only enhances the overall workspace environment but also permits sunlight from the atrium space above to permeate through, illuminating the central regions of the office floors.

Figure 7.9.12 - Third floor plan - Office

Fourth, sixth and eight floor plan - Residential

Beneath the fourth floor, an evaporative cooling pond is strategically positioned to provide cooling to the atrium space within the residential units. These ponds receive a supply of water from the basement water reservoir. The cooling process begins within the atrium, extending to the interior of the units and ultimately being expelled through ventilation stacks, along with venting through the balcony openings.

The vertical circulation of the residential units is efficiently managed by centralised cores.

The floors are copied across levels six and eight creating a consistent design.

Figure 7.9.13 - Fourth, sixth and eight floor plan - Residential

Fifth, seventh and ninth floor plan - Residential

The floor layouts are replicated on levels seven and nine, ensuring a uniform design approach. This replication also results in substantial setbacks that effectively mitigate the impact of direct sunlight on the units.

Figure 7.9.14 - Fifth, seventh and ninth floor plan - Residential

Tenth floor / roof plan - Green space

Due to the heightened solar radiation exposure at the roof level, it presents an ideal platform for implementing green roofing strategies to counteract the heat island effect.

This offers the potential for rooftop gardens or hydroponic systems that contribute to self-sustained living, and these could be marketed within the development.

Additionally, a rooftop walkway could be integrated, providing an outdoor recreational area for residents.

Figure 7.9.15 - Tenth floor / roof plan - Green space

Roof plan - Sustainability systems

To provide shade for the rooftop space and the plants beneath it from direct afternoon sunlight, a roof structure can be implemented.

This structure can also serve as a platform for solar panels to generate electricity and solar water heaters to pre-heat the building's water supply. This pre-heated water can then contribute to reducing night-time energy consumption for water heating.

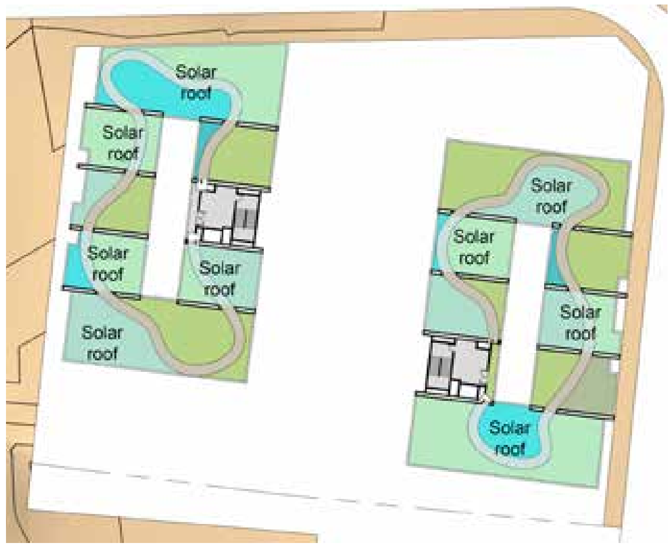


Figure 7.9.16 - Roof plan - Sustainability systems

Overall site layout

The site is thoughtfully integrated with the Roman Catholic precinct, forming a cohesive and interconnected space that fosters a sustainable and harmonious environment. This linkage not only promotes a sense of unity but also allows for the sharing of resources and amenities, contributing to the overall well-being of the community and the responsible use of resources.

The school's current street frontage, primarily used for teacher parking, presently lacks an inviting atmosphere due to its enclosed green space and parking function. However, it is slated for transformation into a novel public green area, addressing the scarcity of such spaces in the CBD, and aims to foster a more welcoming environment.

The new site will serve as a hub for both recycling water and generating energy to power the precinct, exemplifying a comprehensive approach to sustainability.

Figure 7.9.17 - Overall site layout

7.10 ELEVATION AND SECTION DEVELOPMENT

INTRODUCTION

Passive design strategies encompass a multifaceted system that extends across various aspects of the building's design. These strategies are meticulously integrated, not only on the building's exterior but also within its interior spaces. This integrated system operates in a symbiotic manner, where each component complements and supports the others, ultimately leading to a heightened level of efficiency and functionality. By harmonising elements such as natural lighting, ventilation, shading, and thermal mass, passive design strategies work together to create a well-balanced and energy-efficient building environment. This intricate interplay between these strategies results in a holistic approach to sustainable design.

ELEVATION INITIAL DESIGN DEVELOPMENT

West and East facade elevation

Figure 7.10.1 - West and East facade elevation

North and South facade elevation

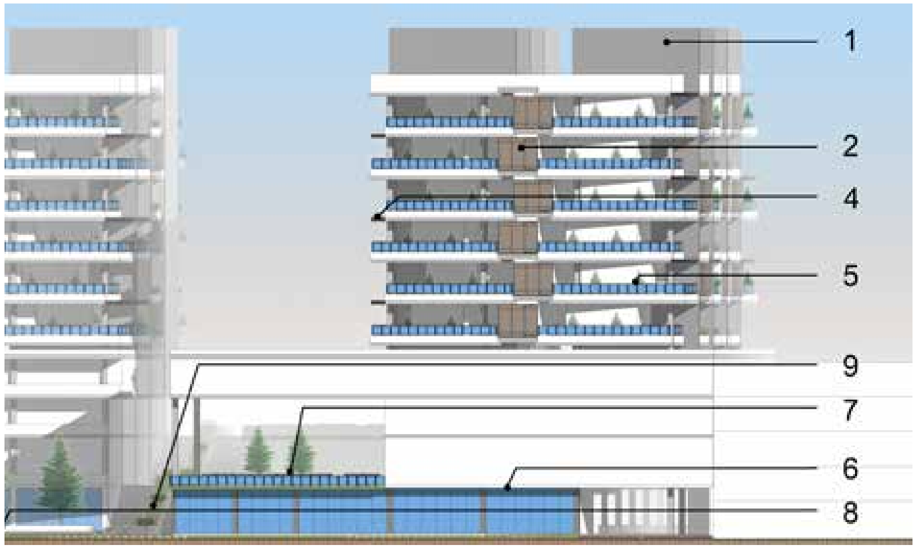


Figure 7.10.2 - North and South facade elevation

Table 13 - Elevation descriptions

Elevation descriptions

1 - Shear wall and stacked ventilation
2 - Trombe wall
3 - Light filtering garden
4 - Shade structure
5 - Balcony gardens
6 - Shaded retail edge
7 - Covered public outdoor courtyard
8 - Street level public plaza
9 - Constructed wetland (water purification garden)

West East building section

Figure 7.10.3 - West East building section

South North courtyard section

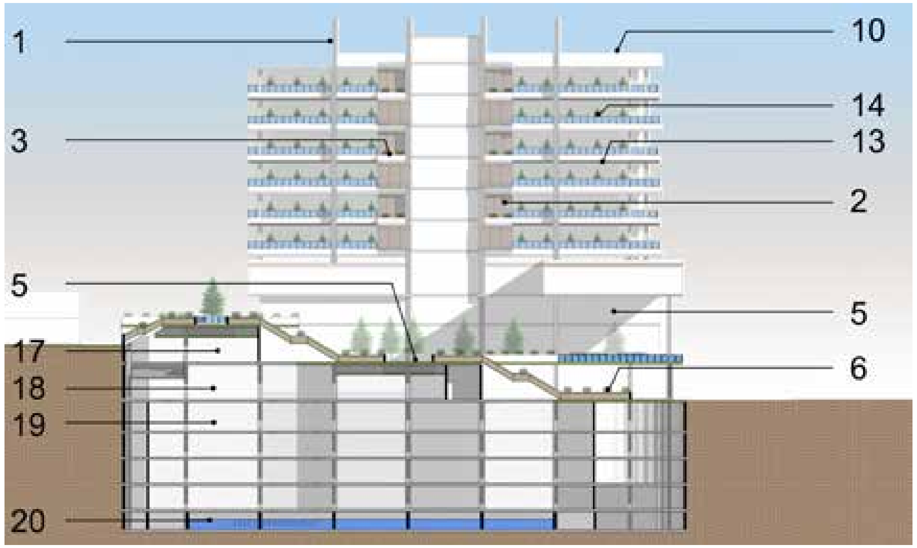


Figure 7.10.4 - South North courtyard section

Table 14 - Section descriptions

Section descriptions

1 - Shear wall and stacked ventilation
2 - Trombe wall
3 - Light filtering garden
4 - Evaporative cooling pond
5 - Covered public outdoor courtyard
6 - Constructed wetland (water purification garden)
7 - Open air void
8 - Water pre-treatment plant
9 - Gray water reservoir
10 - Roof garden / Hydroponics
11 - Rain water collection
12 - Micro climate gardens
13 - Shade structure
14 - Balcony gardens
15 - Shared shaded courtyard
16 - Interior constructed wetland
17 - School parking
18 - Public parking
19 - Residential and office parking
20 - Service floor

INITIAL PASSIVE SYSTEMS DESIGN DEVELOPMENT

South North stacked ventilation section

Figure 7.10.5 - South North stacked ventilation section

South North atrium section

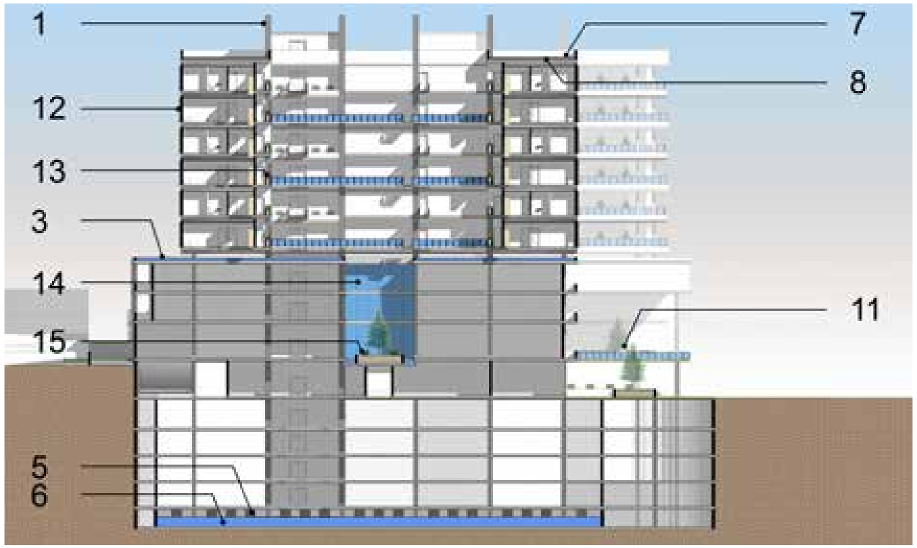


Figure 7.10.6 - South North atrium section

Table 15 - Passive systems descriptions

Passive systems descriptions

1 - Shear wall and stacked ventilation
2 - Ventilation opening
3 - Evaporative cooling pond
4 - Vertical services core
5 - Rock store
6 - Gray water reservoir
7 - Roof garden / Hydroponics
8 - Rain water collection
9 - Ceiling void for heat capture
10 - Balcony gardens
11 - Covered public outdoor courtyard
12 - Trombe wall
13 - Micro climate gardens
14 - Open air void
15 - Interior constructed wetland

East West residential detail section

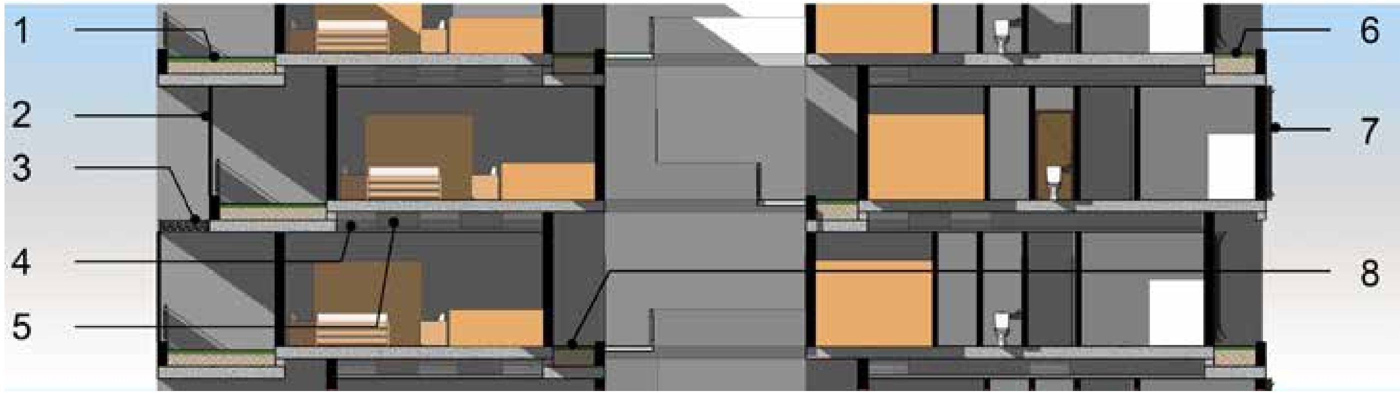


Figure 7.10.7 - East West residential detail section

Table 16 - Detail passive systems descriptions

Detail passive systems descriptions

1 - Balcony gardens
2 - Movable shade devices
3 - Shade structure
4 - Ventilation opening
5 - Ceiling void for heat capture
6 - Light filtering garden
7 - Trombe wall
8 - Micro climate gardens

INITIAL BUILDING DESIGN ENVELOPE

Aerial perspective - South West

Figure 7.10.8 - Aerial perspective - South West

Aerial perspective - North West

Figure 7.10.9 - Aerial perspective - North West

Perspective view - North West

Figure 7.10.10 - Perspective view - North West

BUILDING PASSIVE COOLING SYSTEMS PROGRESSION

Cooling and ventilation systems combined

To optimise cooling and ventilation, the building employs an integrated approach. By combining systems like water reservoirs and rock stores, cooling efficiency is heightened. Micro-climate atrium, featuring carefully selected vegetation, contribute to cooler spaces. Evaporative ponds, filled with recycled water, further enhance the system's effectiveness. This synchronised strategy ensures effective cooling and ventilation while highlighting the commitment to sustainability.

Cooling split system (figure 7.10.12)

Stacked ventilation (figure 7.10.13)

Internal evaporative cooling pond (figure 7.10.14)

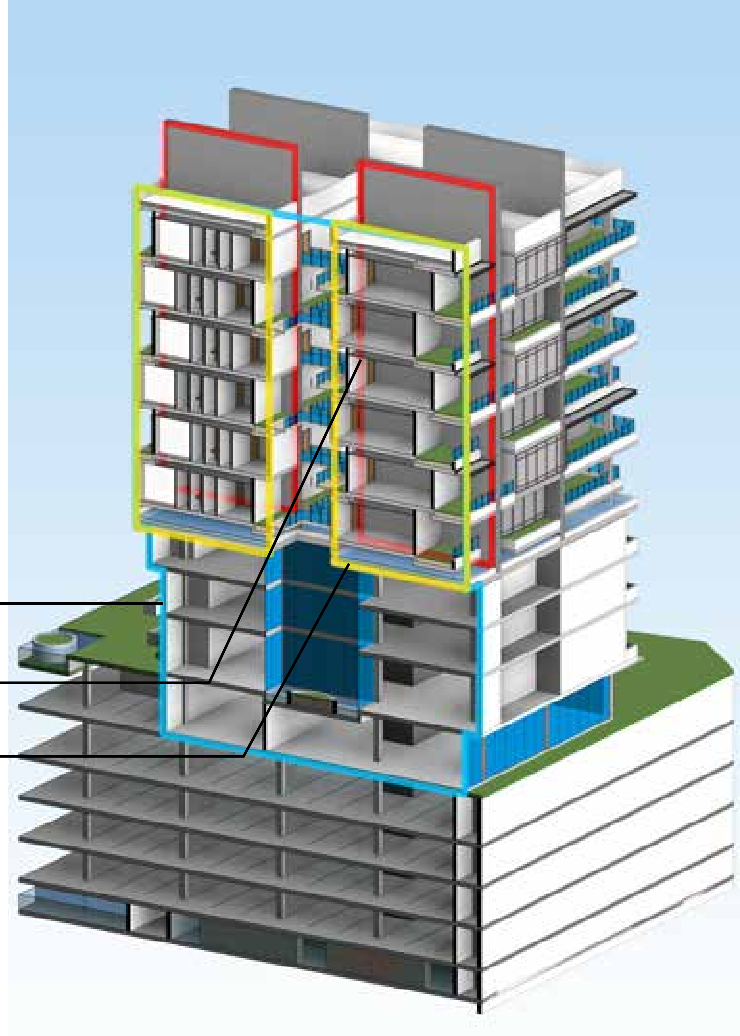


Figure 7.10.11 - Cooling and ventilation systems combined

Cooling split system

Given the diverse functions within the building, a uniform cooling solution is not applicable to both the residential and office units due to their distinct requirements. Consequently, separate cooling systems have been devised for the two sections.

The office spaces utilise wind-catchers that draw in warm air, channeling it to the basement where rock stores and a water reservoir are situated. Here, the air is efficiently cooled before being redistributed throughout the office areas.

On the other hand, residential cooling employs an evaporative cooling pond positioned between the office and residential units. Air is guided into the void space and cooled prior to entering the residential atrium. Within this space, another layer of cooling ensues, facilitated by the surrounding vegetation, fostering a refreshing micro-climate. Subsequently, the cooled air is directed into the residential units upon opening window openings. To eliminate warm air accumulation within the ceiling void, a ventilation system expels it through ventilation stacks, effectively venting it out of the building.

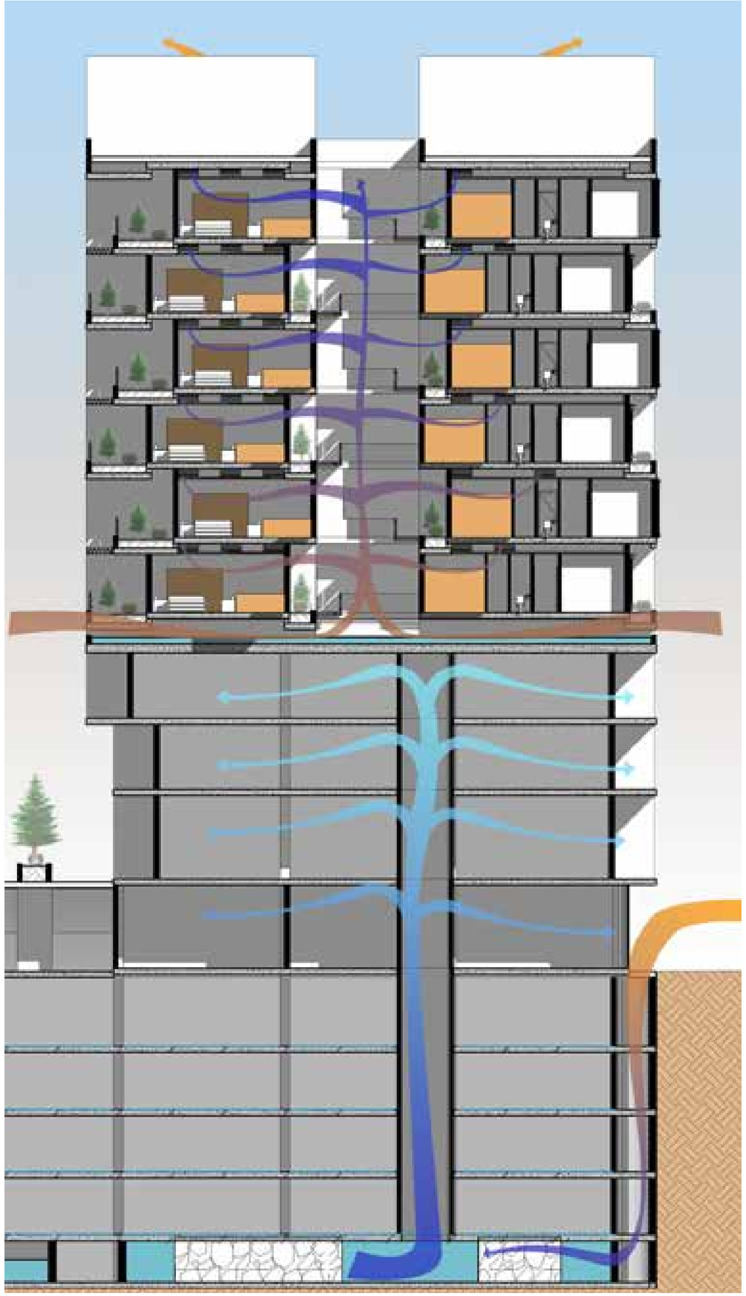


Figure 7.10.12 - Cooling split system

Stacked ventilation

Cool air is adeptly drawn through the ventilation stacks, effectively serving a dual purpose. Primarily, this action facilitates the ventilation of the stacks themselves, ensuring proper air circulation within the building. Moreover, this ventilation process contributes to the extraction of warm air from the residential units, consequently aiding in maintaining a comfortable indoor environment.

Furthermore, this ingenious system goes beyond simple ventilation. As the cool air passes through the ventilation stacks, it interacts with the surrounding wall materials. This interaction leads to a cooling effect on the materials themselves. Subsequently, these cooled materials act as natural radiators, disseminating a refreshing coolness to the adjoining residential units.

In essence, this innovative approach not only ensures effective ventilation but also harnesses the cooling potential of the ventilation stacks to enhance the overall thermal comfort and energy efficiency of the building.

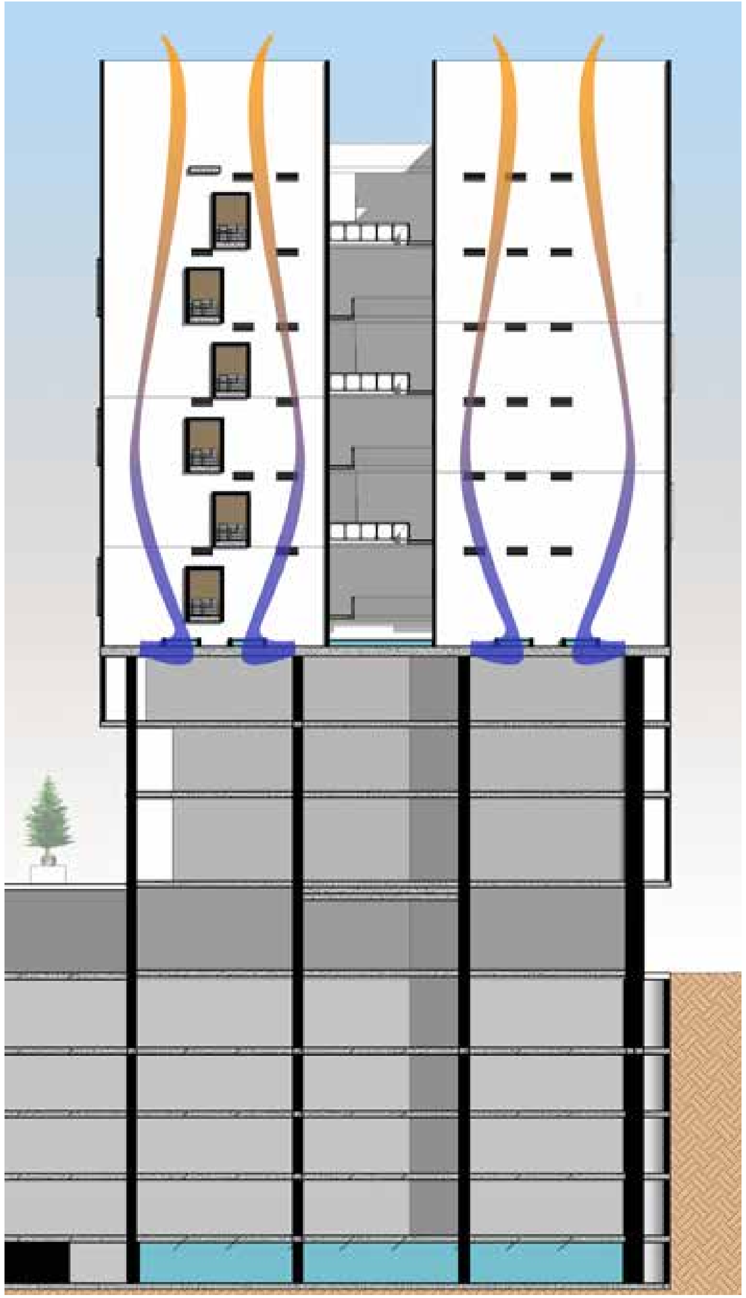


Figure 7.10.13 - Stacked ventilation

Internal evaporative cooling pond

The innovative cooling system orchestrates a seamless circulation of air for optimal comfort within the residential units. Initially, cool air infiltrates the units through the atrium, creating a refreshingly pleasant atmosphere. As time progresses, a portion of warm air accumulates in the ceiling void. To address this, the system ingeniously repurposes the cool air.

Redirected into the ceiling void, the cool air counteracts the warm air, ensuring a balanced temperature. This process, driven by natural air movements, propels warm air towards designated ventilation stacks. These stacks act as conduits, expelling warm air from the building through strategically positioned vent openings.

What sets this system apart is its adaptability. Vent openings in the stacks can be adjusted to meet residents' comfort preferences. This personalised control allows occupants to tailor indoor conditions to their liking, achieving a bespoke environment.

In essence, this advanced system not only regulates temperatures effectively but also harnesses nature's airflow dynamics to cultivate a harmonious living space for residents.

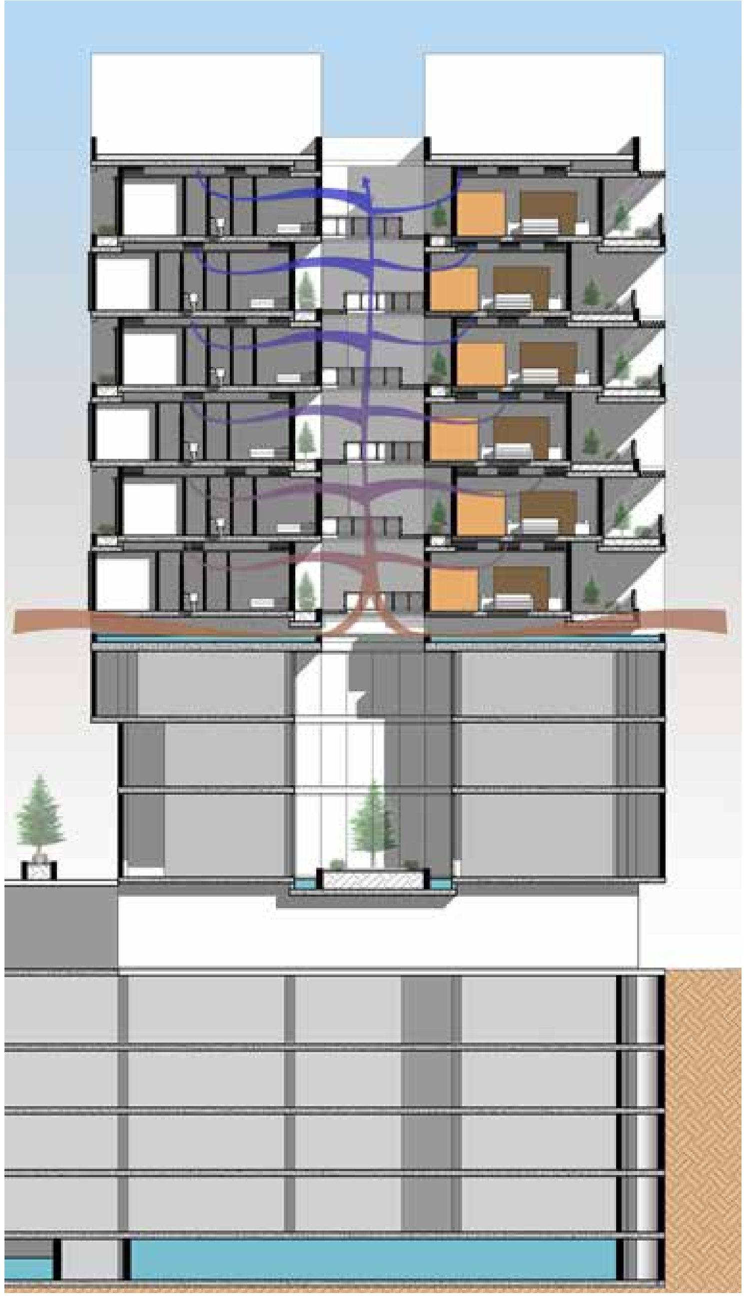


Figure 7.10.14 - Internal evaporative cooling pond

CONCLUSION ON INITIAL BUILDING DESIGN ENVELOPE

Integrating multiple passive systems into the building design proved to be a complex endeavor, but it was far from an insurmountable challenge. However, the process of integrating these systems led to an interesting evolution in the building's design. One of the primary issues encountered was the risk of the design becoming overly analytical, potentially overshadowing its architectural aesthetics. This was a crucial concern, as the goal was to strike a harmonious balance between functionality and form.

Additionally, it became apparent that some of the initially envisioned passive systems were not compatible with one another. This incompatibility necessitated a reevaluation of the design, prompting several significant adjustments. Among these modifications, the decision was made to relocate the interior constructed wetland. Originally positioned at the center of the office spaces, it was shifted to the northern and southern sides of the building. This strategic relocation served a dual purpose: enhancing the penetration of natural light into the building's interior and creating a closed atrium space within the structure.

Moreover, the adjustments included extending the ventilation stacks to the basement service level. This served multiple functions. Not only did it allow the ventilation stacks to be utilised as vertical circulation shafts, but it also contributed to forming a central structural element within the building's design.

These modifications were carefully considered to ensure that the building retained its architectural appeal while maximising its functionality and energy efficiency. In essence, the integration of passive systems became an exercise in balancing aesthetics and sustainability.

7.11 SECTION CONCLUSION

In conclusion, the design evolution that began with an interlocking approach, forming a fundamental mass structure, exemplifies the dynamic nature of architectural creation. As the design journey progressed, it absorbed valuable insights and lessons from past experiences.

The core of the design, while originating from an interlocking concept, underwent further refinements guided by the principles and knowledge gained from previous endeavours. This process of continuous improvement, driven by a commitment to better design practices, enriched the design's depth and complexity.

A pivotal juncture in the development focused on solar considerations, signifying a shift from the traditional context-driven approach. This shift was instigated by the recognition that the context alone was not sufficient to meet the project's goals effectively. Consequently, the design adaptation prioritised solar needs, aligning it with contemporary sustainability imperatives.

In essence, this design journey encapsulates the iterative and responsive nature of architecture. It highlights the importance of drawing inspiration from past experiences, remaining open to evolving design concepts, and embracing new priorities such as sustainable solar design. This holistic approach serves as a testament to the dynamic and adaptable nature of architectural creation and its continuous quest for innovative solutions.


SECTION 8

PASSIVE SYSTEMS INTEGRATION

To attain sustainability on a precinct level, the integration of passive systems must transcend the boundaries of individual buildings. Crucial elements for achieving sustainability encompass water management, energy efficiency, self-sufficiency, and comprehensive network planning. By merging and harmonising these management plans, sustainability can be extended beyond the building itself and into the broader precinct. This holistic approach paves the way for the potential retrofitting of sustainable practices throughout the entire neighbourhood, fostering a more extensive and enduring impact on the environment.

8.1 PRECINCT PASSIVE SUSTAINABLE DESIGN STRATEGIES

INTRODUCTION

The site embraces multiple sustainability systems, ensuring the precinct expansion's overall sustainability. These systems encompass water management, energy management, self-sufficiency strategies, and network management. Together, they enhance the site's ability to function sustainably and contribute to a greener and more efficient urban environment.

WATER MANAGEMENT

Water supply for the development is sourced from three primary sources:

1. Graywater collected from the building itself, as well as from the hospital and school. This graywater undergoes pre-treatment at the basement services level to eliminate pathogens and bacteria.

2. Rainwater runoff gathered on-site and within the precinct is directed to a pre-treatment plant to remove heavy oils.

3. Subterranean water from the aquifer beneath the CBD area seeps into the water reservoirs directly.

The recycled and stored water serves various purposes:

1. Initially, it's used for flushing toilets in the hospital, school, and the building.

2. It's employed for irrigating all gardens across the precinct, including the roof garden, public garden, micro-climate control gardens within the atrium, and the exterior balconies.

3. Furthermore, it undergoes a secondary treatment stage in the constructed wetlands.

4. Lastly, it fills the evaporative ponds to facilitate residential cooling. This multi-faceted approach ensures efficient water use and contributes to the development's sustainability.

Sustainable water management diagram

Legend - Water classifications

- Gray water (Basins and shower water)
- Recycled waste water supply
- Rain water runoff
- Blue water (Water from natural sources)

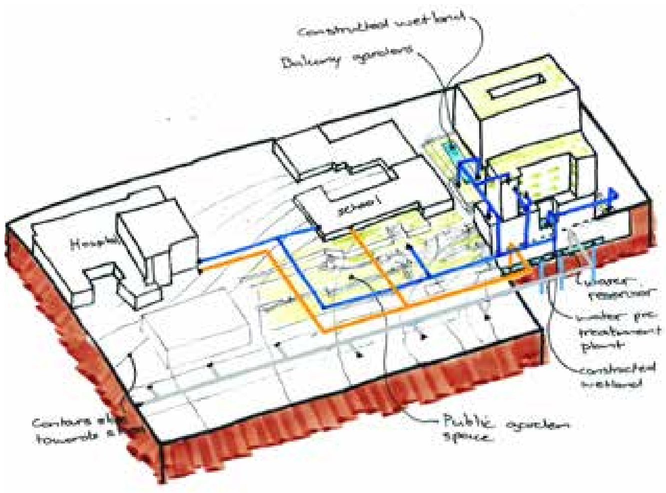


Figure 8.1.1 - Sustainable water management diagram

ENERGY MANAGEMENT

The development integrates a range of energy-saving and renewable strategies.

Efforts to enhance energy efficiency include using solar water heaters during the day to preheat water, thereby reducing night time energy consumption for water heating.

The architectural design prioritises natural lighting, passive cooling, and effective natural ventilation to minimise daytime energy demand, and it incorporates efficient heating solutions for colder nights.

The hospital uses air-conditioning, to mitigate the significant energy consumption associated with cooling, the air is pre-cooled through earth-air heat exchangers before being introduced into the air-conditioning system. This approach reduces energy consumption by minimising the need for mechanical cooling of warm air.

To offset energy usage within the building and precinct, solar panels are installed to generate daytime energy, with any surplus energy stored in batteries for night time usage.

Sustainable energy management diagram

Legend - Energy management

- Excess solar generation
- Energy supply at night
- Air - earth pre-cooling
- Solar panel

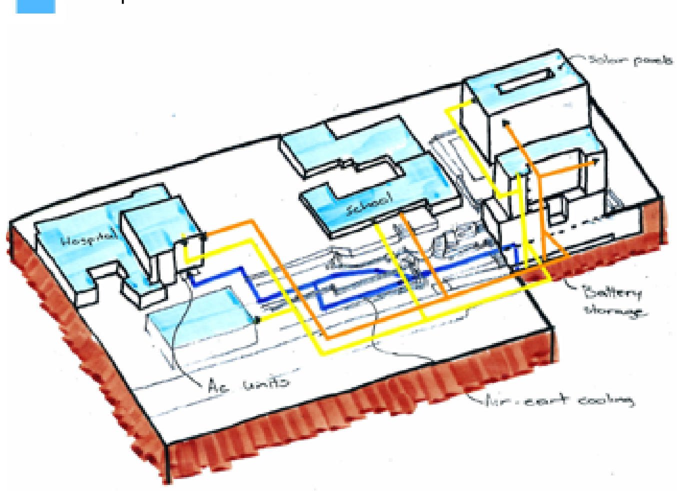


Figure 8.1.2 - Sustainable energy management diagram

SELF SUFFICIENCY MANAGEMENT

The building will adopt a partially self-sufficiency strategy, similar to the approach in New Barris Village.

Rooftops of the building will be transformed into productive spaces for cultivating vegetables, which will be supplied to the Roman Catholic Hospital. Any surplus vegetables will find their way to the formal market situated on the premises. This initiative aims to generate additional income that can help offset rental costs.

Moreover, residents will have the opportunity to cultivate their own produce on their balconies, contributing to the self-sufficiency plan. The value of these homegrown contributions will be subtracted from their monthly rental fees, serving as an incentive for residents to adopt sustainable and self-sufficient practices.

Sustainable self sufficiency management diagram

Legend - Self sufficiency management

- Vegetable supply
- Vegetable growing

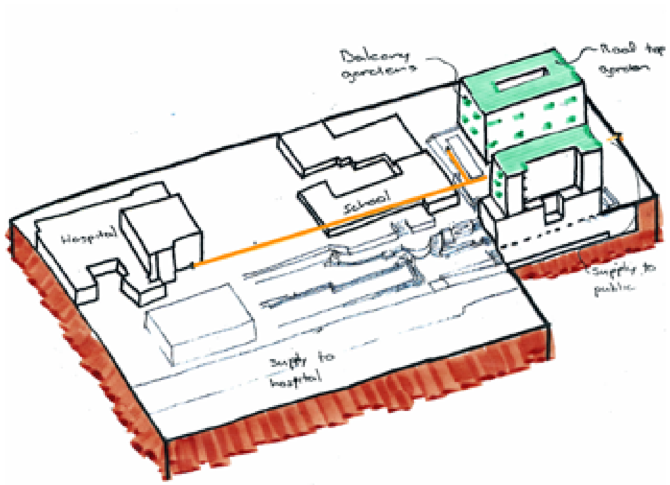


Figure 8.1.3 - Sustainable self sufficiency management diagram

NETWORKS MANAGEMENT

To enhance the sustainability of the site and precinct, the development of a pedestrian network is essential. Encouraging people to choose walking over driving necessitates the creation of key nodes for interaction and various functions.

The site will feature a connectivity route from the eastern CBD to the western taxi and bus stop.

Additionally, a connection from the northern area to the Roman Catholic Hospital in the south will be established to promote collective connectivity within the site. Along this pedestrian walkway, strategically positioned nodes will include shops, green spaces, and visual connections to the building's functions, fostering a vibrant and sustainable urban environment.

Sustainable networks management diagram

Legend - Network management

- CBD - Taxi and bus link
- Site - Hospital link
- Green space
- Public plaza

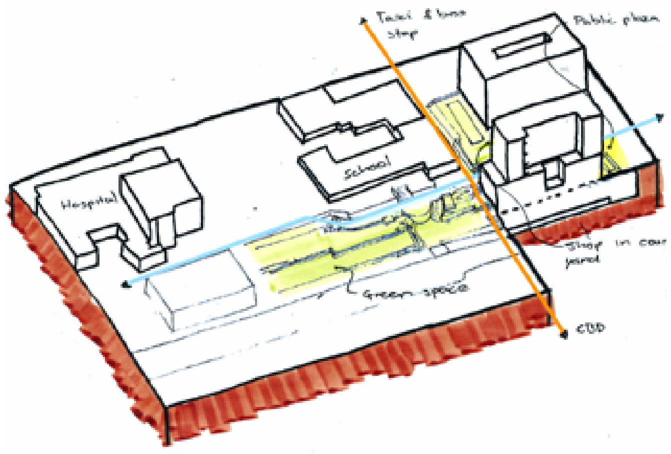


Figure 8.1.4 - Sustainable networks management diagram

8.2 SECTION CONCLUSION

CONCLUSION

In a comprehensive overview, the integrated sustainability systems within the precinct expansion are not merely individual components; they represent the very essence of a sustainable, passive design-oriented urban environment. These systems have been meticulously woven into the fabric of the site to address crucial aspects of environmental management. The emphasis on water management ensures the responsible use and conservation of this precious resource, contributing to both local and regional water sustainability. Energy management strategies reduce the precinct's carbon footprint while optimising energy efficiency, fostering a healthier atmosphere. The pursuit of self-sufficiency practices, especially in the context of Namibia's unique conditions, serves as a model for creating resilient and self-reliant urban spaces.

Moreover, the network management principles have interconnected various aspects of the precinct, facilitating smooth and efficient operations that conserve resources and reduce waste. The seamless integration of these sustainability systems not only secures the precinct's sustainable functionality but also positions it as a trailblazer for promoting eco-friendliness and resource-conscious urban development. By adhering to these sustainable management principles, the precinct champions a holistic and responsible approach to passive design. This approach creates a blueprint for a more sustainable, energy-efficient, and ecologically aware urban landscape, embodying the future of urban living in harmony with its environment. Ultimately, sustainable management serves as the cornerstone for the vision for a sustainable, passive design-driven precinct that inspires change beyond its boundaries.

SECTION 9

DESIGN PROGRESSION

As the architectural form and layout underwent further development, a particular focus was placed on the design of the building's facade, with sustainability as a central concern. This emphasis on the facade development was essential in addressing the specific challenges posed by the high solar radiation on the east and west-facing side of the building. By meticulously crafting the facade, the design aimed to not only enhance the building's aesthetic appeal but also to optimise its thermal performance and solar exposure management. This proactive approach to facade design plays a pivotal role in ensuring the overall sustainability of the structure and spaces.

9.1 PLAN ITERATION

INTRODUCTION

After finalising the initial design, a closer examination of the facade design was carried out. It became evident that a challenge with the initial plan, which involved duplicating floor plans vertically, was that it resulted in a somewhat flat facade design. To infuse more creativity into the design, adjustments were made to create a more distinctive facade while retaining the simplicity of employing similar units across multiple floors.

RESIDENTIAL UNIT FLOOR PLAN ITERATION

Reflecting on the precedents set by the Ziel building by MVRDV architects and the East-gate shopping mall by Mick Pearce, both of which integrated atrium or courtyard spaces for cooling, micro-climate management, and daylight penetration, an important decision was made.

Initially, residential units occupied the north and south sides of the atrium space, hindering daylight entry. To address this, these residential units were removed, allowing natural light to flood the atrium.

The sides of the atrium were then enclosed with translucent or transparent materials, enabling precise control of the micro-climate within the atrium. This setup facilitates the directed flow of cooling and ventilation through the residential units. Additionally, a translucent or transparent roof was added to the atrium to further aid in micro-climate control and to shield against the intense summer afternoon sunlight.

Furthermore, adjustments were made to the arrangement of units to accommodate the new open-ended atrium design. This configuration also presented an opportunity to incorporate a secondary fire escape staircase, ensuring compliance with fire safety regulations, which was lacking in the previous design. The units on the floor above were strategically shifted, creating a staggered effect in the facade's mass, which was then replicated every second floor.

Residential atrium iteration

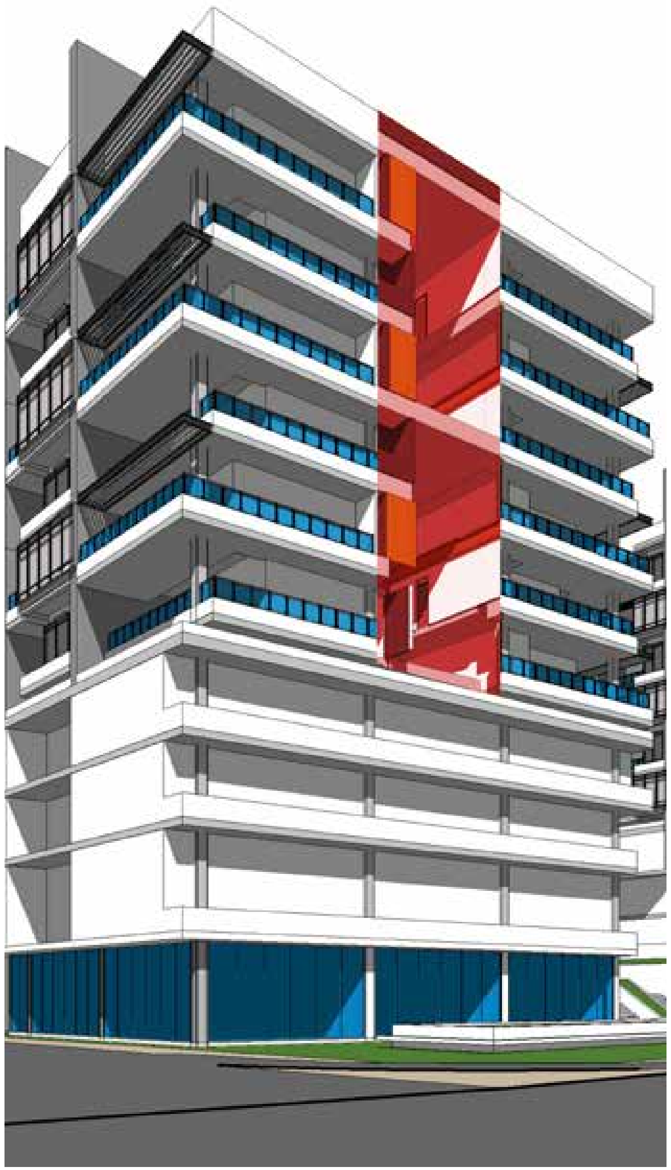


Figure 9.1.1 - Residential atrium iteration

Fourth, sixth and eight floor plan iteration

The fourth floor features shared green courtyard spaces on both the northern and southern sides of the atrium. This level comprises five single-bedroom units and two three-bedroom units.

Fifth, seventh and ninth floor plan iteration

The seventh floor also features a shared green courtyard spaces on both the northern and southern sides of the atrium. This level comprises three single-bedroom units and three three-bedroom units.

Figure 9.1.2 - Residential fourth plan iteration

Figure 9.1.3 - Residential fifth floor plan iteration

9.2 FACADE DESIGN PROGRESSION

INTRODUCTION

After establishing the fundamental form and systems, the next crucial step in the design process was to craft the exterior facades. This facet of the design was of paramount importance, especially considering that the main facades faced east and west, receiving the highest solar radiation throughout the day. The design of these solar facades was pivotal in ensuring effective cooling and shading for the entire building, making it a critical aspect of the overall sustainable design.

FACADE DESIGN 1 DEVELOPMENT - EAST WEST

Design 1 - Development - West facade

The design process took a creative leap regarding the facade. Passive sustainable design typically follows a parametric approach, but here, creativity was a priority.

The idea was to establish a vertical connection running through the building, incorporating various vertical elements. Initially, it was envisioned as a second skin, but its purpose extended beyond aesthetics. This innovative approach aimed to merge aesthetics with functionality for a holistic sustainable design.

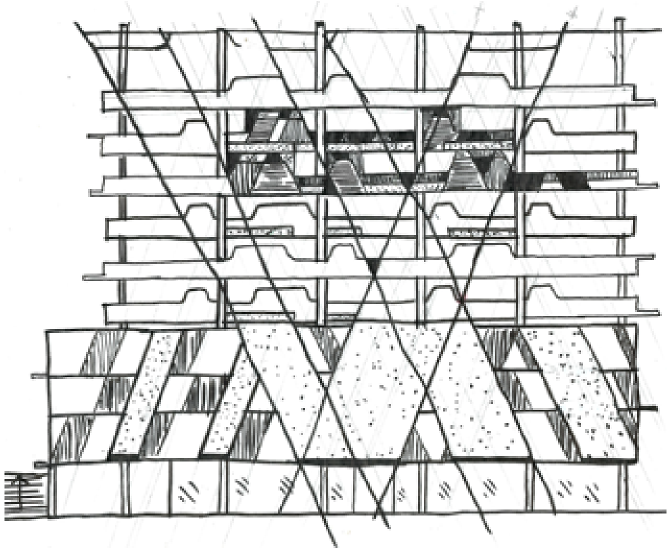


Figure 9.2.1 - Design 1 - Development - West facade

Design 1 - Evolution - West facade

The evolution of the facade design emphasised simplification as the initial concept began to appear overly intricate. The goal was to consolidate functionalities into larger units within the facade.

The green sections were incorporated as green facades to provide shading to the exterior walls, effectively reducing heat gain. Meanwhile, the yellow-gold sections were integrated as water preheating panels, contributing to the warming of water before it enters the system, ultimately reducing energy consumption for water heating.

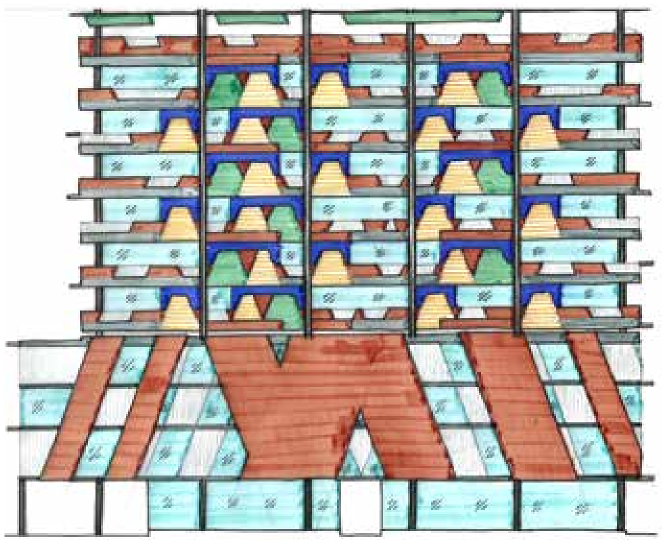


Figure 9.2.2 - Design 1 - Evolution - West facade

FACADE DESIGN 1 EAST WEST DETAIL SECTION

Detail section 1

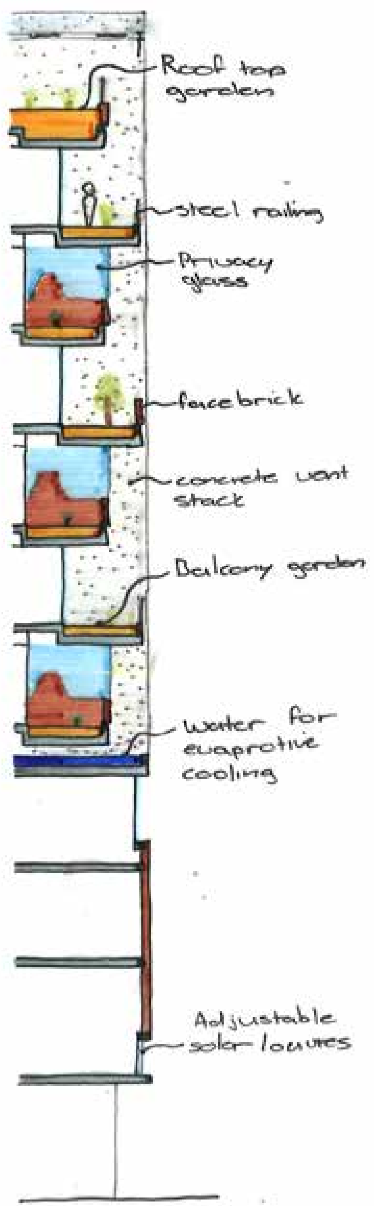


Figure 9.2.3 - Design 1 - Evolution - Detail section 1

Detail section 2

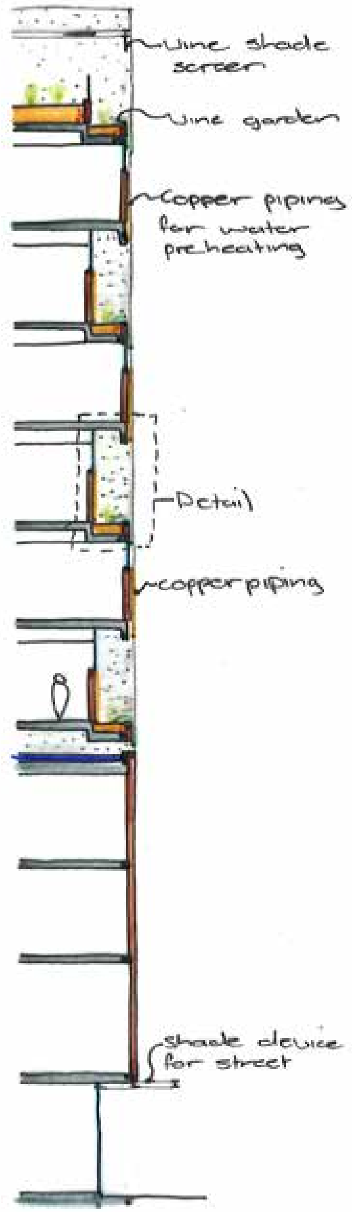


Figure 9.2.4 - Design 1 - Evolution - Detail section 2

Detail section 3

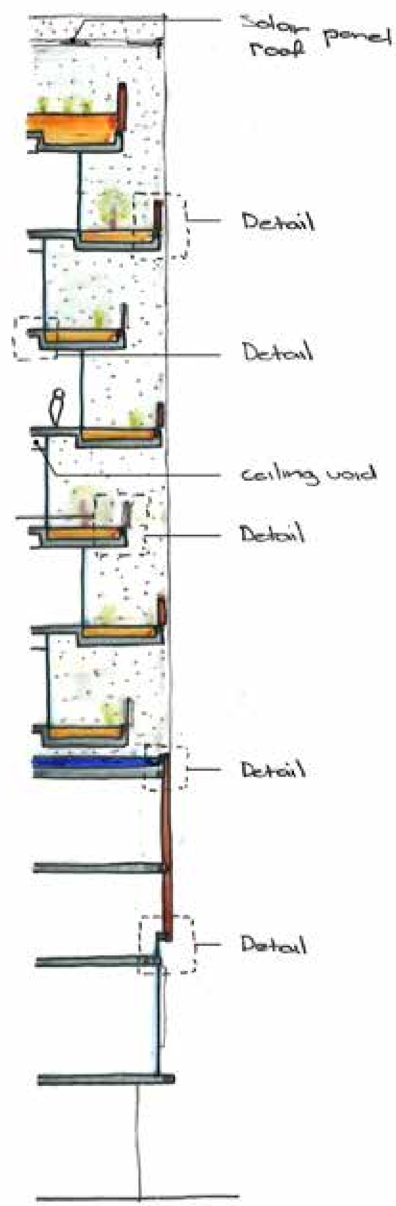


Figure 9.2.5 - Design 1 - Evolution - Detail section 3

FACADE DESIGN 1 DEVELOPMENT - NORTH SOUTH

Design 1 - Development - North facade elevation

The north and south facades are essential for managing sunlight and daylight penetration. Staggered vertical louvres on the sunny sides (east in the morning and west in the afternoon) block intense sunlight at low angles. Conversely, the opposite sides feature more open louvres due to a 7° angle adjustment in the initial design.

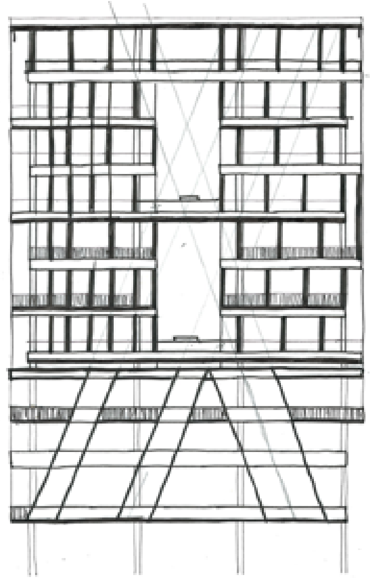


Figure 9.2.6 - Design 1 - Development - North facade elevation

Design 1 - Evolution - North facade elevation

As the facade design evolved, it became more uniform in its main vertical louvres. Additionally, secondary movable louvres were introduced on the sunny sides, giving residents the ability to adjust sunlight levels in their units according to their preferences.

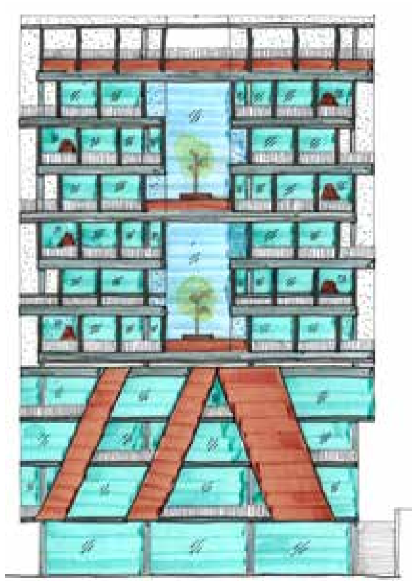


Figure 9.2.7 - Design 1 - Evolution - North facade elevation

9.3 FACADE DESIGN ITERATION BY PRECEDENT

INTRODUCTION

Within the context of the neighbourhood, the exploration seeks to refine the architectural expression of second skin solar facades. These facades are crucial for passive sustainable design, offering opportunities to optimise natural light, control heat gain, and enhance energy efficiency. By examining various design options, the goal is to discover a harmonious and unified solution that seamlessly integrates with the neighbourhood's character and material palette. This exploration not only prioritises sustainable principles but also aims to contribute to the aesthetic and functional harmony of the built environment.

FACADE DESIGN ITERATION 2

Designer: Hager Magdy
Construction Year: N/A
Building Location: New Cairo, Egypt
Main Function: House

Hager Magdy employed folding facades to boost building efficiency by reducing direct sunlight penetration. These facades provide user-controlled comfort and optimise energy use.

Initial design exploration 2 - Precedent

Figure 9.3.1 - Initial design exploration 2 - Precedent

Image by Abdullatif (2022). https://scenehome.com/Architecture/How-a-Folding-Facade-Helps-Make-This-New-Cairo-Design-Sustainable

Initial design exploration 2 - West facade elevation

Figure 9.3.2 - Initial design exploration 2 - West facade elevation

Initial design exploration 2 - West facade Plan

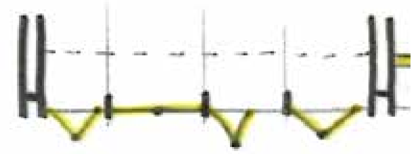


Figure 9.3.3 - Initial design exploration 2 - West facade Plan

Initial design exploration 2 - West facade Section

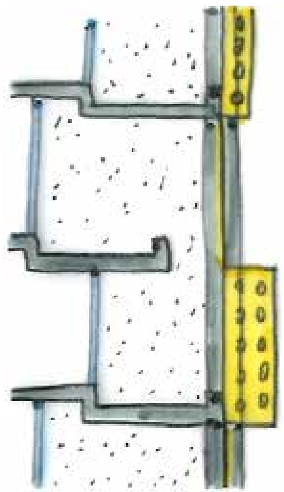


Figure 9.3.4 - Initial design exploration 2 - West facade Section

FACADE DESIGN ITERATION 3

Architect: HGA Architects and Engineers
Construction Year: 2012
Building Location: Saint Paul, Minnesota, USA
Main Function: Fine arts education centre

The design initially featured a vertical louvre steel facade primarily for aesthetic purposes. In my iteration, I aimed to transform the vertical louvre steel facade from a purely aesthetic element into a functional and practical feature.

Initial design exploration 3 - Precedent

Figure 9.3.5 - Initial design exploration 3 - Precedent

Image by Merrick (2022). https://continuingeducation.bnpmedia.com/article_print.php?C=2482&L=377

Initial design exploration 3 - West facade elevation

Figure 9.3.6 - Initial design exploration 3 - West facade elevation

Initial design exploration 3 - West facade Plan

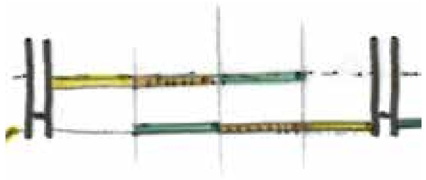


Figure 9.3.7 - Initial design exploration 3 - West facade Plan

Initial design exploration 3 - West facade Section

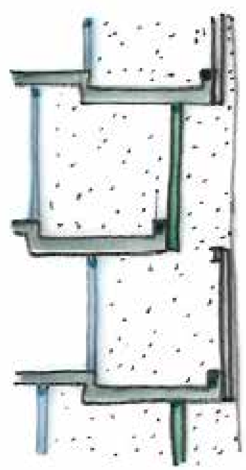


Figure 9.3.8 - Initial design exploration 3 - West facade Section

FACADE DESIGN ITERATION 4

Architects: Shma + Sansiri PCL + SdA
Construction Year: 2011
Building Location: Bangkok, Thailand
Main Function: Office

The building employs a modular green wall system with integrated irrigation, providing both shading and cooling benefits. Additionally, it incorporates a vertical louvre module designed to block direct sunlight while directing daylight into interior spaces.

Initial design exploration 4 - Precedent

Figure 9.3.9 - Initial design exploration 4 - Precedent

Image by Laylin (2011) https://inhabitat.com/sansiri-vertical-living-gallery-is-an-alluring-bangkok-office-wrapped-in-green/sansiri-vertical-living-gallery-8/

Initial design exploration 4 - West facade elevation

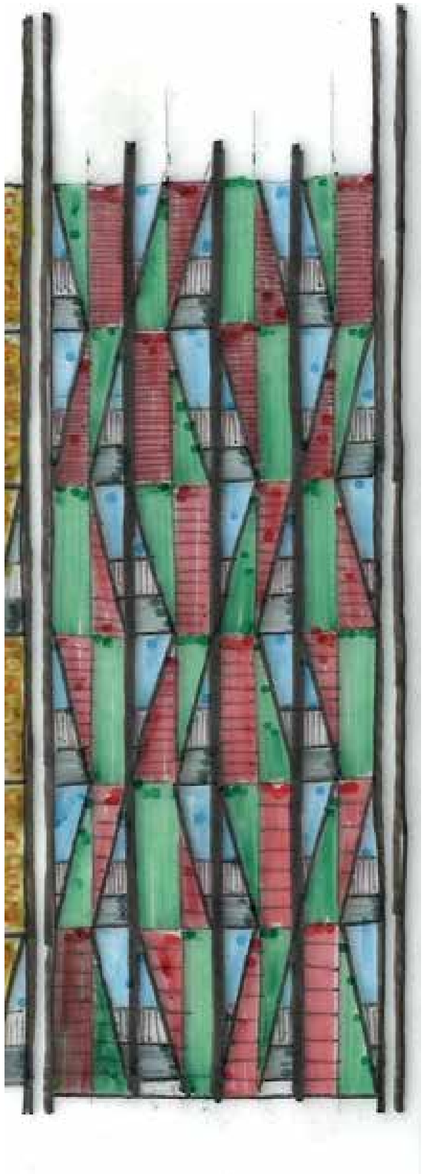


Figure 9.3.10 - Initial design exploration 4 - West facade elevation

Initial design exploration 4 - West facade Plan

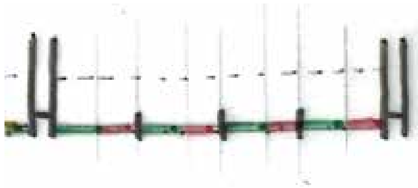


Figure 9.3.11 - Initial design exploration 4 - West facade Plan

Initial design exploration 4 - West facade Section

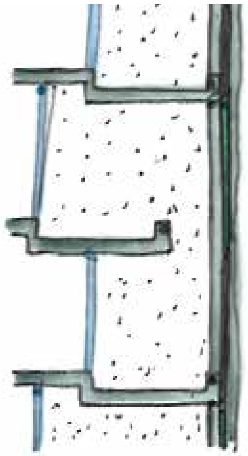


Figure 9.3.12 - Initial design exploration 4 - West facade Section

FACADE DESIGN ITERATION 5

This iteration represents a successful fusion of elements derived from both iteration 3 and 4. It harmoniously marries aesthetics with functionality, resulting in an environmentally sustainable design.

The facade is multifaceted, serving a range of purposes such as pre-heating water, providing shade to balconies and facades, and establishing a striking vertical green facade. This integrated approach enhances the building's overall sustainability while creating an aesthetically pleasing and functional architectural feature.

Initial design exploration 5 - West facade elevation

Figure 9.3.13 - Initial design exploration 5 - West facade elevation

Initial design exploration 5 - West facade Plan

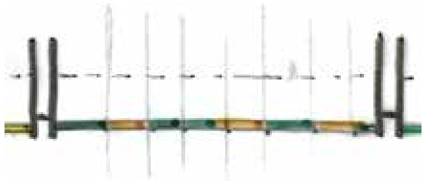


Figure 9.3.14 - Initial design exploration 5 - West facade Plan

Initial design exploration 5 - West facade Section

Figure 9.3.15 - Initial design exploration 5 - West facade Section

9.4 FACADE SETUP EXPLORATION

INTRODUCTION

Facades offer various design possibilities that balance aesthetics with functionality. The primary facade types are heavy mass facades and skeleton facades. These can be creatively combined to achieve an elegant architectural expression. One approach is to have a solid, massed lower section with a more skeletal upper section, while the reverse involves a skeletal lower section and a massed upper section. Each option has its unique advantages, and selecting the most suitable one should be a thoughtful decision in the project's design process.

FACADE TYPICAL SETUP

Facade design 1 - Massed facade

The facade functions as a secondary protective layer, absorbing and deflecting heat away from the interior spaces. It features multiple openings strategically positioned to introduce natural daylight into the interior while offering picturesque views to the surrounding environment.

Figure 9.4.1 - Facade design 1 - Massed facade

Facade design 2 - Skeleton facade

The vertical lightweight facade primarily aims to provide shade to the interior, with added benefits such as the incorporation of sun control elements. These elements can effectively reflect or block sunlight, giving users control over their environment. Additionally, the design allows for the integration of green modules to enhance cooling and sustainability.

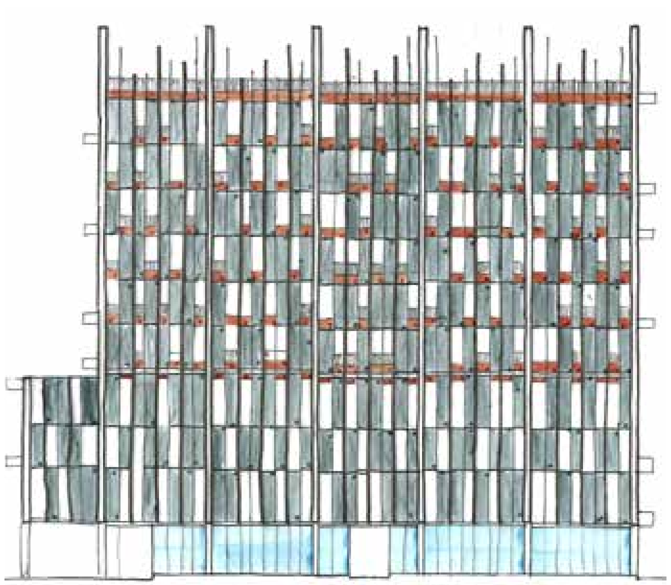


Figure 9.4.2 - Facade design 2 - Skeleton facade

Facade design 3 - Combination skeleton base, massed top

A skeleton base provides an open and airy ambiance at street level, affording offices the ability to regulate the amount of daylight entering the space. Meanwhile, a massed top serves as an effective heat absorber, particularly during direct sunlight exposure, when shade is limited, thereby reducing heat buildup within interior spaces.

Figure 9.4.3 - Facade design 3 - Combination skeleton base, massed top

Facade design 4 - Combination massed base, skeleton top (Preferred design)

A mass-based design approach harmonises with the surroundings, ensuring the building complements its environment and maintains a human-scale aesthetic. This blend contributes to a pleasing street-scape. Meanwhile, a skeleton structure at the top of the building offers occupants greater control over interior lighting, adding depth and visual interest to the facade. This facade design is favored for its seamless integration with the neighbourhood context.

Figure 9.4.4 - Facade design 4 - Combination massed base, skeleton top

9.5 FOLDING FACADE EXPLORATION

INTRODUCTION

Selecting a facade design that integrates both a massed base and a skeleton top was a pivotal decision in the design process. However, this choice also came with the challenge of determining the most suitable louvres configurations. Louvres play a dual role in such a design – they contribute to the building's overall aesthetics and influence its functionality. Therefore, delving into various louvre set-ups was a crucial step to strike the right balance between form and function, ensuring that the final design not only looked appealing but also performed optimally in terms of shading, daylight control, and heat reduction.

VERTICAL FOLDING FACADE

Orientation:
Vertical panels are positioned vertically, typically perpendicular to the ground. They are primarily used to block low-angle sunlight, especially during mornings and evenings. Vertical panels are effective in controlling glare and reducing heat gain from the sun when it is closer to the horizon.

Sunlight control:
Vertical panels excel in blocking sunlight from the sides. They are effective in reducing glare and preventing low-angle sunlight from penetrating deep into a building, which is particularly useful on north and south-facing facades.

Aesthetics and design:
Vertical panels can introduce a sense of verticality to a building's design. They can also be used creatively to enhance the building's appearance.

Ventilation:
Vertical panels can facilitate natural ventilation more effectively, especially when placed on the sides of buildings to capture prevailing winds.

Seasonal considerations:
Vertical panels are effective year-round but are particularly useful in the mornings and evenings when the sun is lower in the sky.

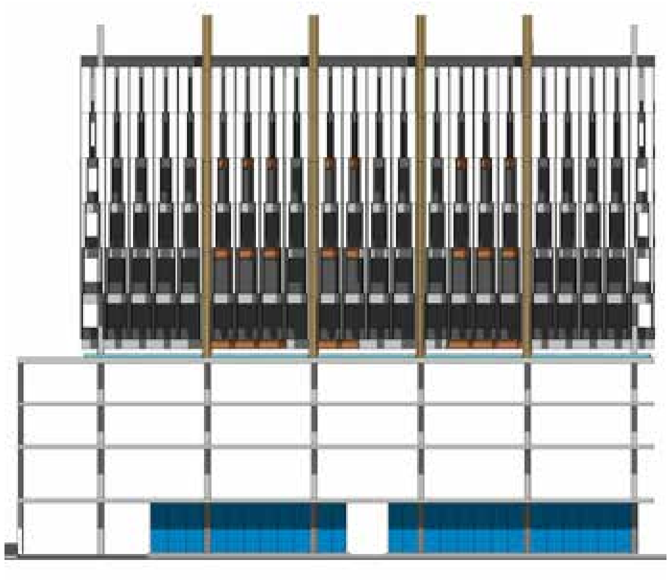


Figure 9.5.1 - Vertical folding facade exploration elevation

Figure 9.5.2 - Vertical folding facade exploration perspective

HORIZONTAL FOLDING FACADE

Orientation:
Horizontal panels are positioned horizontally, parallel to the ground. They are often used to block direct sunlight from entering a building's interior while still allowing natural light and ventilation. Horizontal panels are effective in shading windows from the high-angle sun, such as during the summer months.

Sunlight control:
Horizontal panels are well-suited for controlling overhead sunlight. They can provide shade to spaces directly beneath them, making them suitable for east and west-facing facades.

Aesthetics and design:
Horizontal panels can create a visually pleasing horizontal line, and their design can contribute to the building's architectural aesthetics.

Ventilation:
Horizontal panels while they are primarily used for shading, horizontal panels can still allow for natural ventilation when designed with adjustable or operable features.

Seasonal considerations:
Horizontal panels are better suited for summer conditions when the sun is higher in the sky and directly overhead.

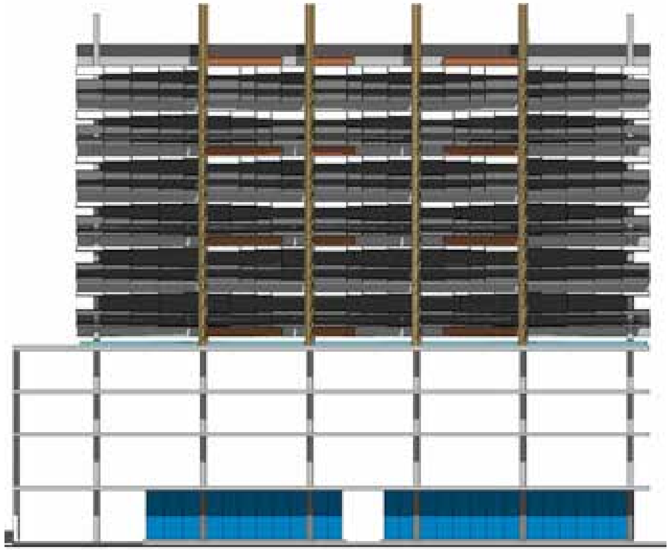


Figure 9.5.3 - Horizontal folding facade exploration elevation

Figure 9.5.4 - Horizontal folding facade exploration perspective

CONCLUSION FACADE

Combining both vertical and horizontal panels within a facade design can capitalise on the strengths of each. Vertical panels strategically placed in front of balcony spaces effectively block low-angle sunlight, reducing heat gain during mornings and evenings. On the other hand, horizontal panels in front of bedrooms and bathrooms provide privacy, glare control, and prevent direct sunlight from entering these spaces, enhancing overall comfort.

However, it is essential to note that combining these two systems introduces a challenge in terms of visual complexity. The facade can become intricate and busy due to the varying orientation of panels. Balancing these elements to maintain a cohesive and aesthetically pleasing design requires careful consideration. Despite this challenge, the approach allows for a nuanced control of light and heat, contributing to a more comfortable and energy-efficient building.

Figure 9.5.5 - Combined folding facade exploration elevation

Figure 9.5.6 - Combined folding facade exploration perspective

9.6 PLAN DESIGN CONCLUSION

INTRODUCTION

Following an extensive exploration of various design iterations and combinations, a definitive design iteration has been formulated. In this design, a solid facade is employed for the retail and office spaces, transitioning into a more skeletal design for the residential portion. This architectural plan incorporates adaptable sun control facades and cooling facade panels. Deliberate consideration has been given to the utilisation of different louvre systems on the facades, strategically optimising sun control throughout the year.

FLOOR PLAN ITERATION

Basement level 5 - Services floor

This floor is designated to accommodate various sustainability services. The primary sustainability features include a water storage reservoir for the collection of gray water, intended for purposes such as plant irrigation, filling evaporative ponds, and supplying water for toilet cisterns. Additionally, this level houses the water purification system responsible for treating water collected from basins and showers before it is stored in the reservoir. Ventilation ducts are integrated with this floor to facilitate the vertical distribution of these essential services.

Figure 9.6.1 - Basement level 5 - Services floor

Basement level 4-1 - Parking floors

This floor is designated for parking, primarily intended for building occupants and offering additional lease-able parking spaces to the public. Conveniently located near the cores are multiple disabled parking spots to ensure user-friendly access. On the lower level, the storage area for the batteries used in solar generation is situated. To maintain air quality, the stacked ventilation, which also double as service ducts for power and other water utilities, will exhaust any gases produced within the parking area.

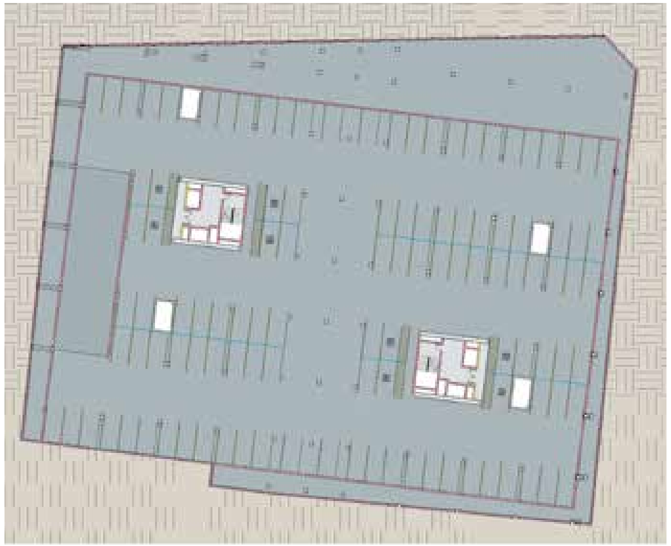


Figure 9.6.2 - Basement level 4-1 - Parking floors

Ground floor plan

On this particular level, you'll find retail spaces strategically positioned along the street edge to create a vibrant and engaging atmosphere. Towards the rear, there is a designated area for public parking, catering to visitors of the site. At the front, in the northeast corner, there is a public plaza thoughtfully designed to harness the cooling effect of the prevailing wind from the northeast. The inclusion of vegetation is also integral; it serves a dual purpose of directing the wind into the public space and interior areas while enhancing the overall aesthetic appeal.

Figure 9.6.3 - Ground floor plan

First floor plan

This level seamlessly integrates both retail and office spaces. Retail outlets are strategically positioned in the central courtyard area to infuse vibrancy into the space. The east building is oriented more toward retail functions, given its proximity to the pathway, while the west building is designed to house functions such as restaurants, capitalising on the courtyard as an outdoor dining area. The courtyard itself serves a dual purpose: it accommodates a constructed wetland for water purification while also functioning as a cooling feature for the courtyard space.

Figure 9.6.4 - First floor plan

Second floor plan

This level is dedicated to office spaces that provide scenic views overlooking the courtyard and offer access to exterior vistas of both the cityscape and natural surroundings. Additionally, it incorporates the infrastructure for the constructed wetlands, serving the dual purpose of water purification and cooling.

Figure 9.6.5 - Second floor plan

Third floor plan

This entire floor is exclusively designed for office use, featuring outdoor balconies and indoor green spaces along its northern and southern facades. This thoughtful layout maximises the penetration of natural sunlight into the interior areas.

Figure 9.6.6 - Third floor plan

Fourth, sixth and eight floor plan

The entire floor is designated for residential units, primarily comprising one and three-bedroom units. These units are intelligently designed to minimise exposure to the summer direct sun during the morning and afternoon hours. This is achieved by setting them back and extending the bathrooms outward. The fourth floor features evaporative ponds positioned beneath the residential units to facilitate cooling of the atrium space. Additionally, this floor incorporates gardens within the atrium, providing a green and recreational area for the residents.

Figure 9.6.7 - Fourth, sixth and eight floor plan

Fifth and ninth floor plan

The entire floor is designated for residential units, primarily comprising one and three-bedroom units. These units are intelligently designed to minimise exposure to the summer direct sun during the morning and afternoon hours. This is achieved by setting them back and extending the bathrooms outward.

Figure 9.6.8 - Fifth and ninth floor plan

Seventh floor plan

On the seventh floor, you'll find gardens within the atrium, creating a lush and recreational space for residents. These gardens serve a dual purpose by contributing to cooling within the area.

Figure 9.6.9 - Seventh floor plan

Roof plan

The rooftop serves a multifaceted purpose, featuring a blend of raised garden beds and hydroponic systems for gardening. Furthermore, rainwater is harvested from the roof and directed to the water reservoir for future use. In addition to these functions, the rooftop offers recreational spaces that can be enjoyed by the residents.

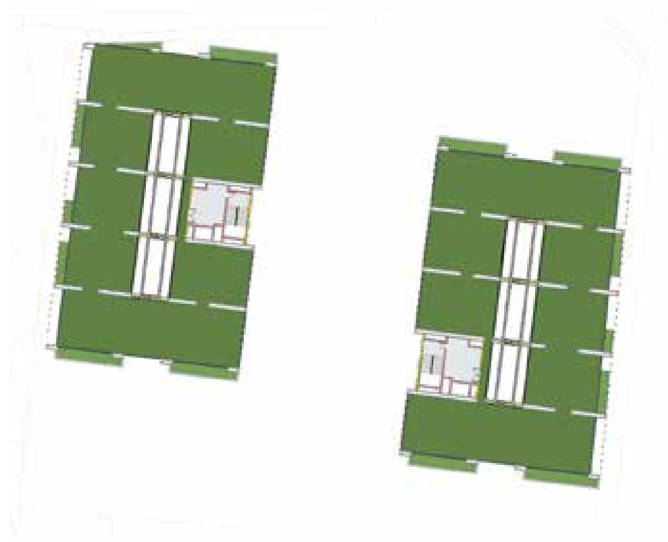


Figure 9.6.10 - Roof plan

9.7 PASSIVE SYSTEMS EVOLUTION INTEGRATION

INTRODUCTION

The evolution of passive systems has resulted in a more unified and efficient integration. This refinement has enhanced the effectiveness of passive strategies on both the building and unit scales, addressing the initial challenge of harmonising these systems. These improvements benefit individual units by providing tailored passive solutions for improved thermal comfort and energy efficiency, ultimately enhancing the quality of life for residents. The evolution of passive systems underscores the commitment to sustainability and its positive impact on the precinct's residents.

BUILDING PASSIVE SYSTEMS INTERGRATION

Passive integration - Courtyard

The primary role of the courtyard is to introduce a natural element within the development, offering users access to nature within the bustling CBD. It incorporates constructed wetlands that play a pivotal role in water purification and contribute to cooling by elevating humidity levels in the area.

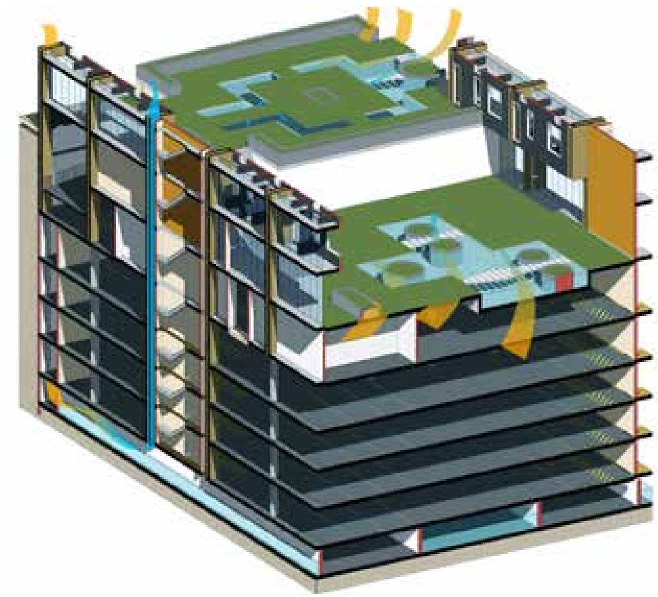


Figure 9.7.1 - Passive integration - Courtyard

Passive integration - Residential atrium

The micro climate within the residential units is carefully managed by the atrium space. This atrium incorporates elements such as vegetation and an evaporative pond to provide cooling for the area. The cool air generated is then directed into the residential units for temperature control. Conversely, warm air from the units is expelled through ventilation stacks. At the apex of the atrium, a skylight with light-deflection properties is employed to optimise the penetration of natural sunlight while mitigating the direct sunlight's impact, thereby effectively reducing heat buildup in the interior spaces.

Figure 9.7.2 - Passive integration - Residential atrium

Passive integration - Residential Units

The residential units utilise a range of systems to enhance cooling and optimise natural light penetration. The building's facade incorporates vegetation to facilitate the cooling of exterior air. Additionally, the facade features adaptable folding panels that effectively control the penetration of direct sunlight. Furthermore, a stacked ventilation system connects the atrium to the residential units, facilitating air circulation and maintaining a comfortable indoor environment.

Figure 9.7.3 - Passive integration - Residential Units

Passive integration - Residential slab layout

The units are arranged in a staggered manner across the different levels, creating deeper and shaded spaces for each unit. This strategic arrangement effectively minimises direct sunlight exposure within the interior spaces. Additionally, the unit on the lower level is designed to incorporate grass and soft surfaces, while the one above features a larger deck area for added versatility and outdoor space.

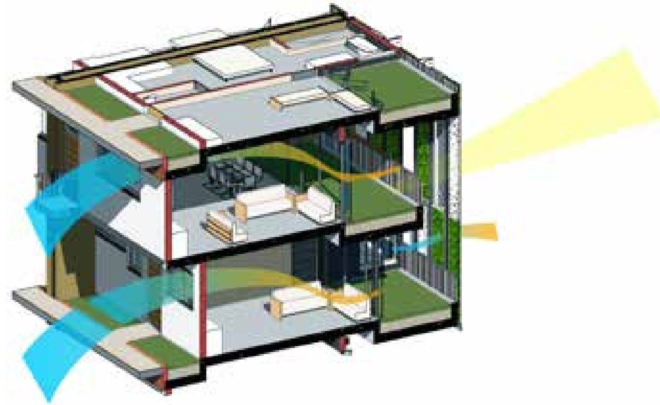


Figure 9.7.4 - Passive integration - Residential slab layout

Passive integration - Residential exterior facade

The facade is ingeniously divided into two primary panels, each serving distinct functions. The first panel, known as the vegetation panel, employs a design akin to a green wall, where water trickles down to cool the air from the exterior before it enters the balcony and interior spaces. The second panel is a foldable shading system that effectively blocks direct sunlight from various angles. Residents have the flexibility to manually adjust these panels to achieve their desired level of light penetration, providing a personalised and adaptable lighting solution for each user.

Figure 9.7.5 - Passive integration - Residential exterior facade

Passive integration - Office facade

The office building's east and west facades employ a dual-layered approach. The exterior layer comprises a solid face brick wall designed to provide shading for the fully glazed interior space. This system effectively reduces heat gain within the interior while maximising the penetration of natural sunlight, striking a balance between thermal comfort and ample daylight.

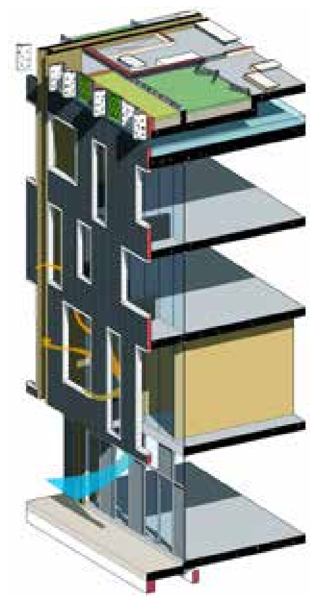


Figure 9.7.6 - Passive integration - Office facade

DESIGN EVOLUTION RENDERS

Figure 9.7.7 - Design conclusion renders - North East elevation

Figure 9.7.8 - Design conclusion renders - North elevation

Figure 9.7.9 - Design conclusion renders - East elevation

Figure 9.7.10 - Design conclusion renders - South elevation

Figure 9.7.11 - Design conclusion renders - Courtyard

9.8 FINAL DESIGN REFINEMENT

INTRODUCTION

The design has reached an advanced stage where the seamless integration of most passive systems into the building is realised. The next phase focuses on refining the architectural design to ensure a cohesive alignment with these passive systems, while the landscaping aspect plays an equally pivotal role in achieving the desired sustainable passive design objectives.

FACADE REFINEMENT

East / West facade - Refinement 1

The facade was simplified to establish a more structured and vertical pattern. Uniformity was achieved by maintaining consistent opening sizes. Additionally, the brick facade was extended to ground level, forming a shaded walkway. Solar openings were strategically positioned in alignment with the functions behind like balconies and windows.

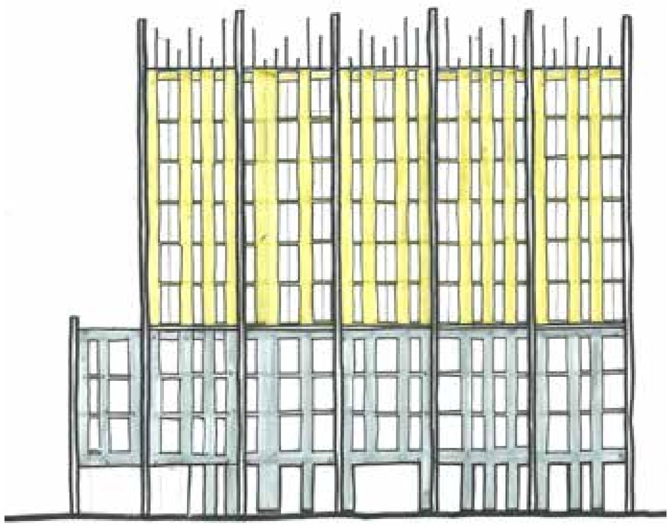


Figure 9.8.1 - East / West facade - Refinement 1

North / South facade - Refinement 1

The brick facade was extended to encompass both the north and south facades similar to the east and west facade, providing a substantial and cohesive base. This brick wall is also continued across the atrium opening, fostering a connection between the two towers while emphasising the significance of the atrium and maximising daylight penetration.

Figure 9.8.2 - North / South facade - Refinement 1

North / South facade - Refinement 2

The refinement of the facade involved the thoughtful addition of horizontal louvers to the north and south-facing facades. These horizontal louvres were integrated to work in harmony with the existing vertical louvres, effectively offering shading from low-angle sunlight.

Figure 9.8.3 - North / South facade - Refinement 2

COURTYARD REFINEMENT

Courtyard - Refinement 1

To create a cohesive visual theme that links the buildings with the courtyard, we utilised the geometric pattern derived from the vertical structure.

This pattern incorporates a diverse range of materials, including pavers, indigenous planters, indigenous tree and shrub planters, and water ponds. This thoughtful integration of materials and design elements unifies the architectural elements with the open courtyard space.

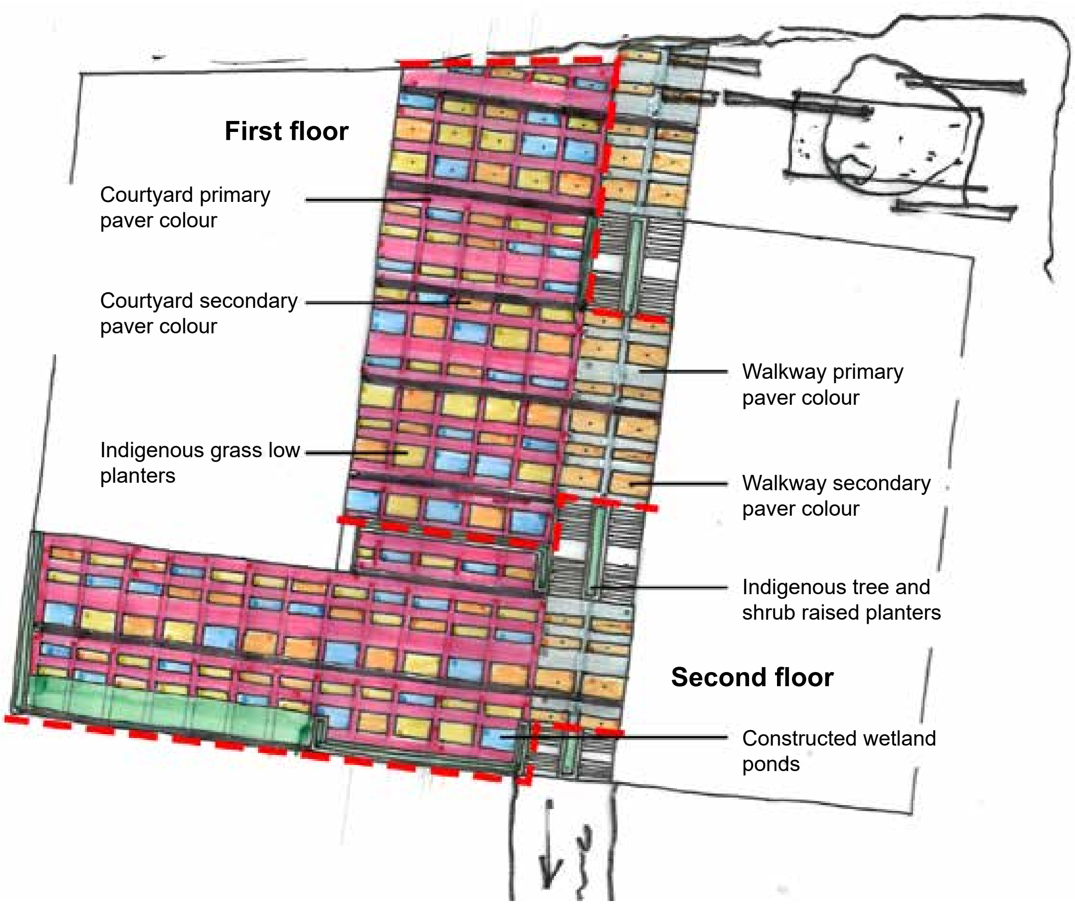


Figure 9.8.4 - Courtyard - Refinement 1

Courtyard - Refinement 2

The courtyard was refined as refinement 1 was a to complex pattern which creates confusion. It was further refined to keep the same geometry but at a less intense pattern layout.

The refinement also opted for larger concrete paver . The design allows for a much smoother movement between planters and water channel.

A constructed water channel is added as a tying element to link the multiple levels and foster the effect of movement.

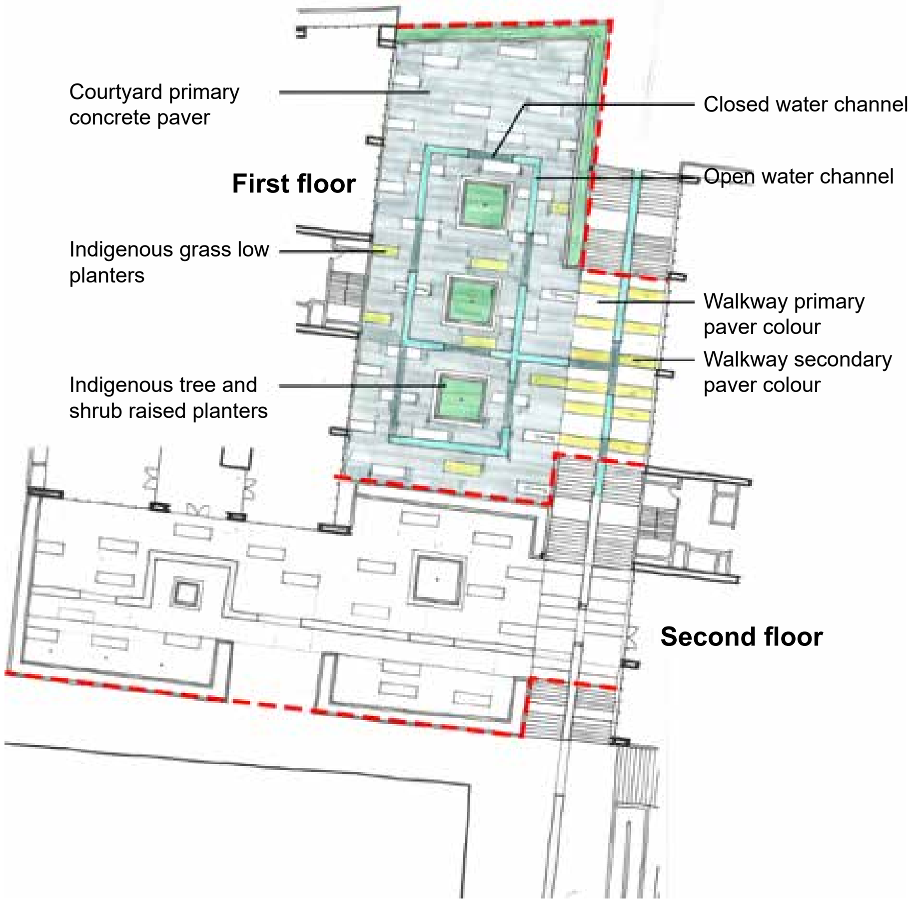


Figure 9.8.5 - Courtyard - Refinement 2

Courtyard - Refinement 3

The design underwent refinement to establish a consistent outer pattern in areas with high foot traffic. A spacious zone beneath the north office was intentionally left open for hosting larger events. The central part of the courtyard was transformed into a dedicated breakout area featuring landscaped gardens. These gardens incorporate raised beds for trees and shrubs, as well as a ground-level rain garden designed to manage floodwater. Additionally, the water channel functions as a flood control system by collecting rainwater from the courtyards. Furthermore, the primary walkway connecting the RC Precinct was extended to enhance the precinct's connectivity.

Figure 9.8.6 - Courtyard - Refinement 3

ROOF GARDEN REFINEMENT

Roof garden - Refinement 1

The rooftop garden underwent refinement, introducing a walkway that encircles the entire rooftop space. This rooftop integrates a variety of materials and elements.

Sections covered with photovoltaic panels feature a combination of artificial turf and fish ponds, which supply water to the aquaponics systems.

Areas shaded by netting incorporate a combination of lawns and raised planters filled with indigenous trees, shrubs, and grasses, functioning as rain gardens.

Additionally, aquaponic systems are set up to cultivate produce. The area can be enclosed to create a greenhouse that supports year-round cultivation, even during the winter months.

Figure 9.8.7 - Roof garden - Refinement 1

ROOF GARDEN REFINEMENT

Ground floor plan - Refinement 1

This floor features retail shops that face the street. It comprises four smaller shops, suitable for local businesses, and three larger shops designed to accommodate well-known brands.

Storage spaces are positioned at the rear of the shops for convenient deliveries from the parking area.

Public restrooms are also conveniently located near the entrance for use by tenants.

Additionally, the design incorporates a bicycle storage area to promote the use of non-motorised transportation.

Figure 9.8.8 - Ground floor plan - Refinement 1

First floor plan - Refinement 1

This floor includes two smaller retail spaces ideal for courtyard-serving restaurants, a larger area for local vendors to create an informal market, and a large shop perfect for a grocery store selling on site aquaponic grown produce.

It also houses two collaborative office units that share reception, core facilities, and restrooms, with large lounges adjacent to indoor gardens.

These spaces are equipped with boardroom areas connected to the indoor gardens.

Figure 9.8.9 - First floor plan - Refinement 1

9.9 SECTION CONCLUSION

In conclusion, the progression of the design in crafting a sustainable façade marks a significant journey in architectural innovation. The deliberate exploration of various façade designs and layouts, alongside the strategic placement of louvres on different sides of the building, showcases the multifaceted nature of passive sustainable design.

This journey underscores the intricate complexity of integrating sustainable elements into architectural design. It reveals the meticulous planning and detailing necessary to make various sustainable components work seamlessly together, striving for greater energy efficiency and environmental responsibility. The continuous refinement of the design to create a simplified yet aesthetically pleasing look highlights the importance of achieving both visual harmony and ecological sustainability in contemporary architecture.

Through this process, the project sets an inspiring example for modern architecture, emphasising that sustainability and aesthetics can go hand in hand. It demonstrates that buildings can be visually striking while also contributing to a more environmentally conscious and energy-efficient future. This journey reinforces the idea that architectural innovation plays a pivotal role in the quest for a sustainable and beautiful world.


SECTION 10

FINAL DESIGN AND TECHNICAL DOCU-MENTATION

Global warming is a pressing issue caused by increased carbon dioxide emissions from unsustainable resource use in construction. The building industry must adopt sustainable practices to combat this. In Africa, raw material usage is projected to double by 2060, necessitating the adoption of sustainable design techniques. Passive design in architecture is a solution that leverages natural resources to create energy-efficient living spac

10.1 ANALYTIC INFORMATION

INTRODUCTION

With the design now in its final form, the next step involves an assessment to ensure compliance with municipal regulations. This includes a comprehensive review of the accommodation schedule and parking requirements to confirm that the design aligns with standard regulations.

ACCOMMODATION SCHEDULE

Table 17 - Final accommodation schedule

Retail

Unit Type	Dimension	Area	Kitchen	Bathroom	Staff area	Office	Storage	Unit QTY	Total Size
Boutique shop	5m x 4m	20m²	×	×	×	0	✓	8	160m²
Brand shop	8.1m x 12.3m	100m²	×	×	×	1	×	6	600m²
Restaurant	16.2m x 13m	211m²	✓	✓	✓	3	✓	4	844m²
				Total Retail Area					1604m²

Office

Unit Type	Dimension	Area	Kitchen	Bathroom	Balcony	Office	Open Plan	Unit QTY	Total Size
Collaborative office	24.3m x 21.1m	513m²	✓	×	✓	0	✓	1	513m²
Small office	8.1m x 8.6m	70m²	×	×	×	0	✓	25	1750m²
Medium office	16.2m x 7.4m	120m²	×	×	✓	1	✓	15	1800m²
Large office	16.2m x 12.7m	207m²	✓	✓	✓	4	✓	4	828m²
				Total Office Area					4891m²

Residential

Unit Type	Approximate Dimension	Floor area excluding balcony	Kitchen	Bathroom	Balcony	Bedroom	Lounge	Unit QTY	Total Size
Single bedroom unit	9.5m x 7.8m	57.6m²	✓	1	1	1	✓	48	2764.8m²
Three bedroom unit	9.5m x 16.3m	115.8m²	✓	2	2	3	✓	30	3474m²
				Total Residential Area					6238.8m²

After school care

Unit Type	Approximate Dimension	Floor area excluding balcony	Kitchen	Bathroom	Balcony	Bedroom	Lounge	Unit QTY	Total Size
Class	16.2m x 19.3m	313m²	✓	1	0	0	×	1	313m²
				Total School Area					313m²

Total Building Area 7431.8m²

Total Bulk 1.48

Note:
Bulk my seem low, but is based on the actual bulk which excludes core, balconies and parking structures. Where as the coverage calculation would be higher.

PARKING REQUIREMENT

Table 18 - Parking requirement calculations

Fuction to SQM or Units

Function	Ground floor	First floor	Second floor	Third floor	Total SQM or Units
Retail	1101m²	503m²			1604m²
Office		965m²	1858m²	2068m²	4891m²
After school care		313m²			313m²
Single bedroom unit					48 Units
Three bedroom unit					30 Units

Parking calculations

Function	Municiple minimum	Total req.
Retail	5 bays per 100m²	80
Office	1 bay per 25m²	196
After school care	1 bay per 10 children + 1 bay per class	10
Single bedroom unit	1 bay per unit less than 3 bedroom	48
Three bedroom unit	1 bay per unit less than 3 bedroom	30
	Total parking required	364

Development allowed	Total req.
5 bays per 100m²	80
1 bay per 25m²	196
1 bay per 10 children + 1 bay per class	10
1.5 bays per single bedroom unit	72
2.5 bays per single bedroom unit	75
Total parking allocated	433

Required levels to achieve minimum

Level	Standard parking	Disabled parking	Total parking	Runing total	Notes
First floor	21	2	23	23	Not enought parking
Ground floor	39	9	48	71	Not enought parking
Basement -1	102	12	114	185	Not enought parking
Basement - 2	100	12	112	297	Not enought parking
Basement - 3	100	12	112	**409**	**Enought parking**
Basement - 4	104	11	115	524	Level not required but included in design

Note:
Basement -4 is left in the design to be able to be leased as there is a shortage of parking. Should ground conditions be difficult the option to stop at basement -3 is sufficient for municipal requirements

10.2 PLAN LAYOUTS

LEGEND

1. Recycled water reservoir
2. Grey water treatment plant
3. Plant room

PLAN LAYOUT DESIGN

Basement level 5 - Service floor

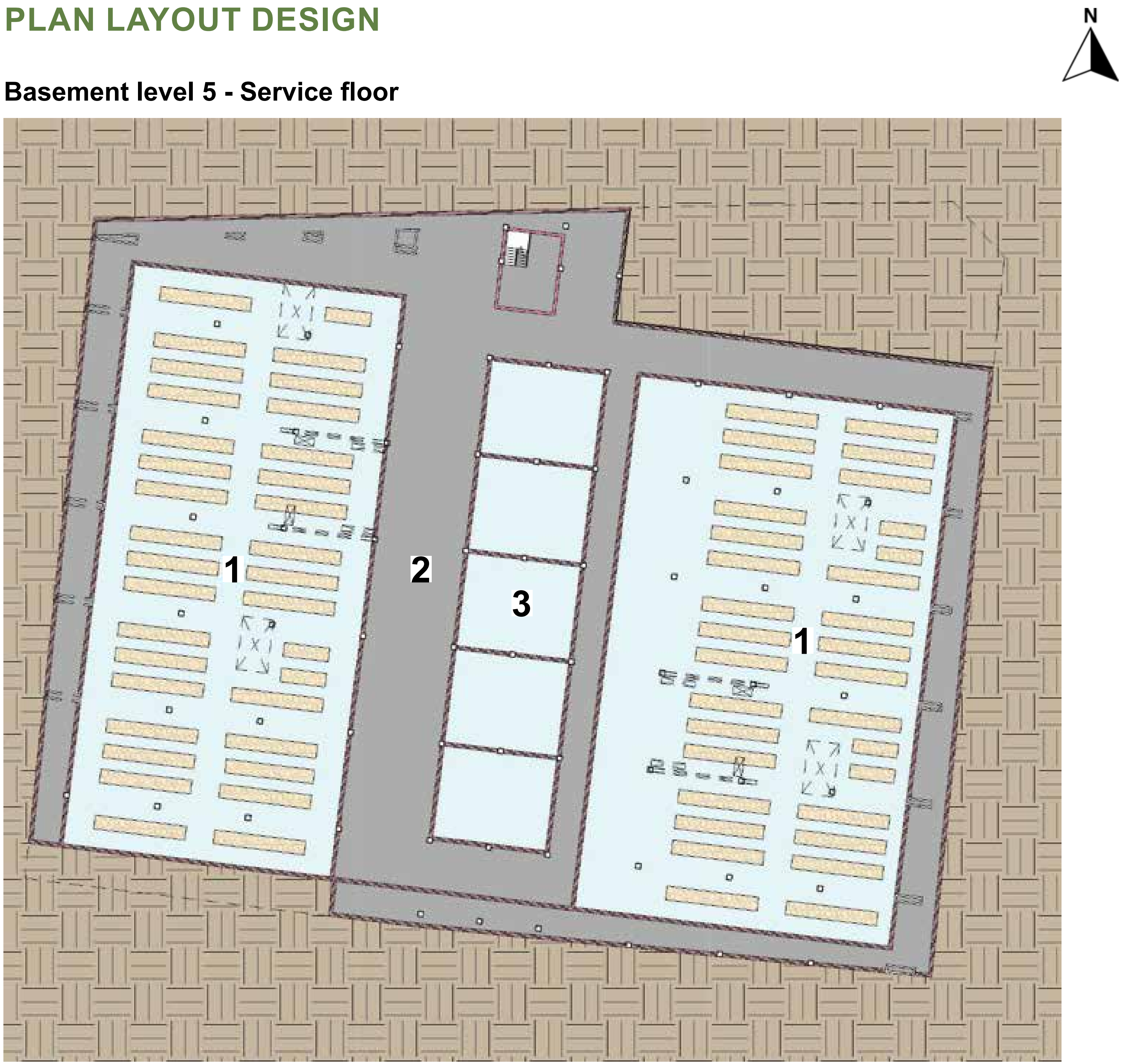


Figure 10.2.1 - Basement level 5 - Service floor

Basement level 4-1 - Parking floors

LEGEND

1. Core
2. Private and rentable parking
3. Plant room

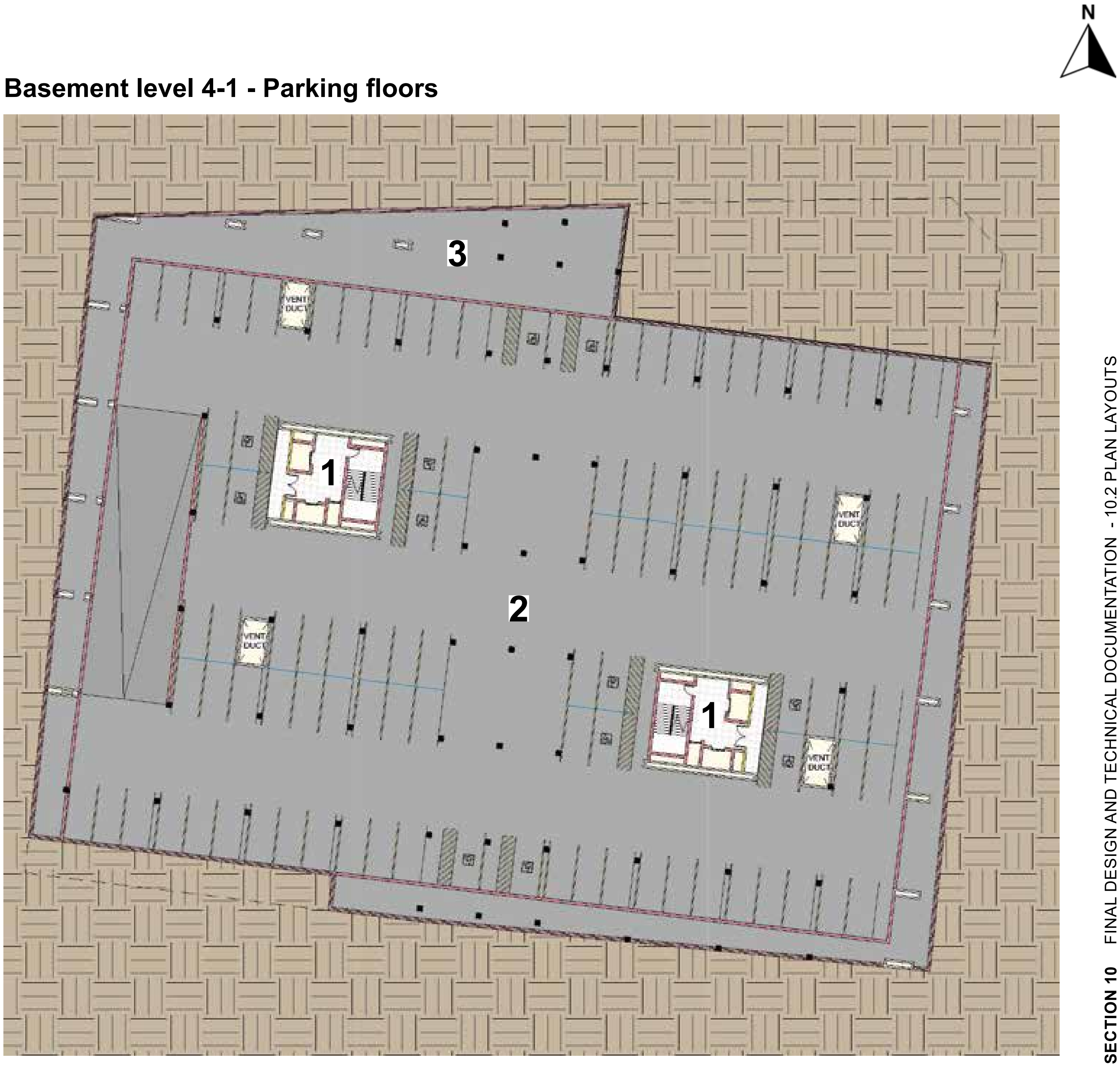


Figure 10.2.2 - Basement level 4-1 - Parking floors

Ground floor plan

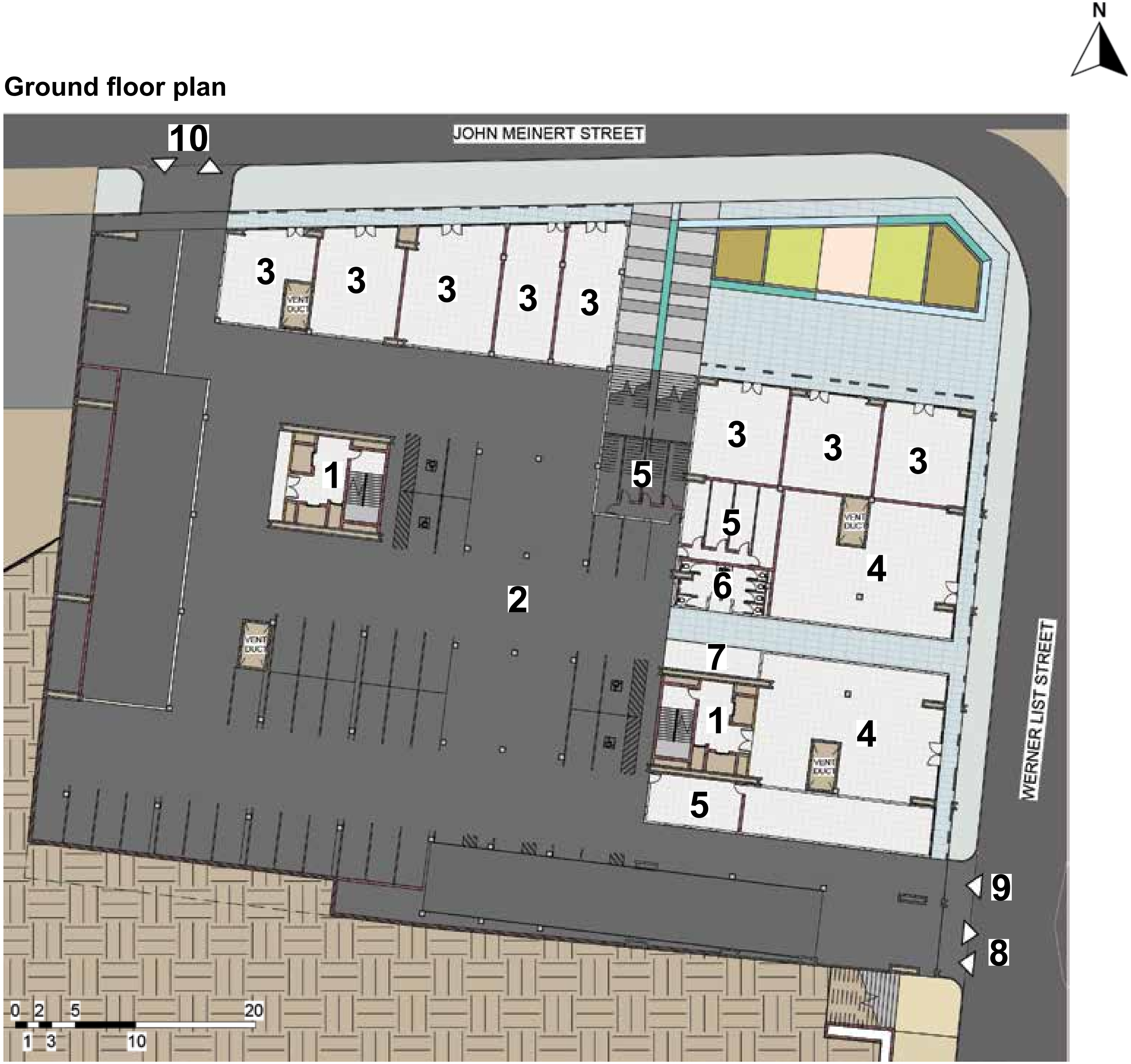


Figure 10.2.3 - Ground floor plan

LEGEND

1. Core
2. Public parking
3. Retail shop small
4. Retail shop large
5. Storage
6. Ablutions
7. Bicycle storage
8. Entrance and exit to first floor parking
9. Entrance to public parking
10. Entrance basement parking

First floor plan

LEGEND

1. Core
2. School parking
3. Shared lobby
4. Informal traders shop area
5. Restaurant
6. Small grocery store
7. Ablutions
8. Boardroom
9. Shared lounge
10. Shared offices
11. After school daycare
12. Internal garden

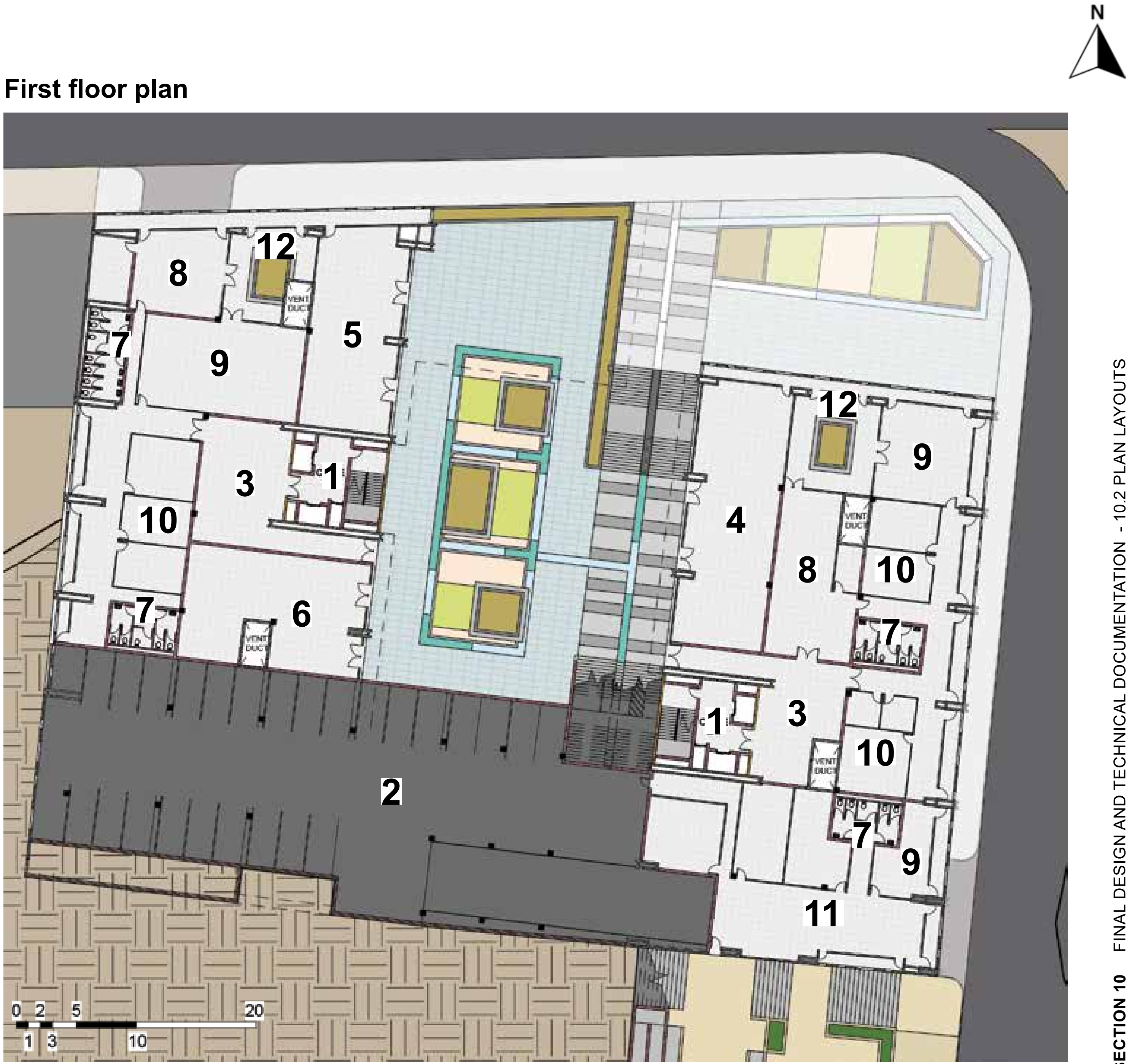


Figure 10.2.4 - First floor plan

Second floor plan

LEGEND

1. Recycled water reservoir
2. Shared lobby
3. Office
4. Internal garden

Figure 10.2.5 - Second floor plan

Third floor plan

LEGEND

1. Core
2. Office

Figure 10.2.6 - Third floor plan

Fourth floor plan

LEGEND

1. Core
2. Single bedroom unit
3. Three bedroom unit
4. Interior green space
5. Evaporative cooling pond
6. Soft roof / green roof

Figure 10.2.7 - Fourth floor plan

Fifth and ninth floor plan

LEGEND

1. Core
2. Single bedroom unit
3. Three bedroom unit

Figure 10.2.8 - Fifth and ninth floor plan

Sixth and eight floor plan

LEGEND

1. Core
2. Single bedroom unit
3. Three bedroom unit

Figure 10.2.9 - Sixth and eight floor plan

Seventh floor plan

LEGEND

1. Core
2. Single bedroom unit
3. Three bedroom unit
4. Interior green space

Figure 10.2.10 - Seventh floor plan

Roof garden plan

LEGEND

1. Core
2. Fish pond
3. Aquaponic deck
4. Astro turf
5. Daisy lawn
6. Swimming pool

Figure 10.2.11 - Roof garden plan

Roof plan

LEGEND

1. Solar roofing
2. Shaded roofing
3. Skylight roof

Figure 10.2.12 - Roof plan

Site plan

Figure 10.2.13 - Site plan

10.3 ELEVATIONS

INTRODUCTION

The northern and southern facades are equipped with broad horizontal louvres to provide shade at low angles, while the sections without louvres feature climbing plants that grow on trellises to cover these areas. During winter, the leaves of these plants fall off, permitting more sunlight to enter the interior.

ELEVATION DESIGN

North elevation - Exterior

Figure 10.3.1 - North elevation - Exterior

East elevation - Exterior

Figure 10.3.2 - East elevation - Exterior

South elevation - Exterior

Figure 10.3.3 - South elevation - Exterior

West elevation - Exterior

Figure 10.3.4 - West elevation - Exterior

East elevation - Interior

Figure 10.3.5 - East elevation - Interior

West elevation - Interior

Figure 10.3.6 - West elevation - Interior

10.4 SECTIONS

INTRODUCTION

The spacing between the buildings is thoughtfully planned to enable year-round use of the courtyard. The buildings are constructed on pilings with several sump pumps in place to transfer groundwater into the site's water reservoir for future use.

SECTION DESIGN

West - East section - Courtyard

Figure 10.4.1 - West - East section - Courtyard

South - North section - Courtyard

Figure 10.4.2 - South - North section - Courtyard

10.7 RENDERS

Perspective - North East

Figure 10.7.1 - Perspective - North East

Perspective - East Facade

Figure 10.7.2 - Perspective - East Facade

Elevation - East Facade

Figure 10.7.3 - Elevation - East Facade

Elevation - North facade

Figure 10.7.4 - Elevation - North facade

Perspective - North East

Figure 10.7.5 - Perspective - North East

Elevation - Courtyard

Figure 10.7.6 - Elevation - Courtyard

Elevation - South facade

Figure 10.7.7 - Elevation - South facade

Perspective - Public plaza

Figure 10.7.8 - Perspective - Public plaza

Perspective - Main walkway

Figure 10.7.9 - Perspective - Main walkway

Perspective - Courtyard interior

Figure 10.7.10 - Perspective - Courtyard interior

Perspective - Roof garden

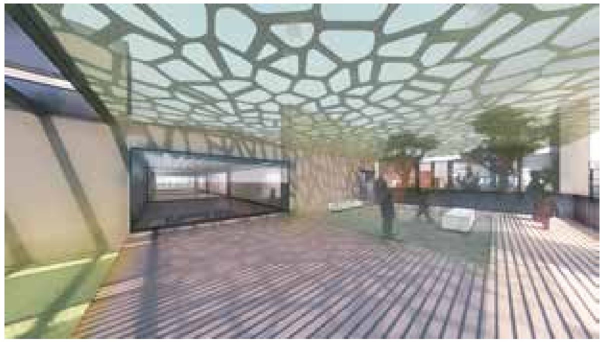


Figure 10.7.11 - Perspective - Roof garden

Perspective - Atrium interior skylight

Figure 10.7.12 - Perspective - Atrium interior skylight

10.8 PROJECT CONCLUSION

This research project represents a pivotal achievement in the ongoing journey towards sustainable precinct expansion in Namibia. Its significance extends beyond the boundaries of the study itself, offering a blueprint for future designers and urban planners seeking to navigate the complexities of urban development.

Central to the study's findings is the emphasis on holistic precinct-level sustainable design. This strategic approach shines a light on the transformative potential of urban environments, which can be simultaneously highly efficient and environmentally responsible. It underscores the capacity to breathe new life into existing precincts, morphing them into epicenters of sustainability and innovation. In doing so, this research encourages a more symbiotic relationship between humanity and the spaces they inhabit.

The implications of this research ripple far beyond Namibia's borders, as it stands as a best-practice model for urban development on a global scale. It effectively demonstrates the multifaceted advantages of integrating sustainable passive design strategies within precinct expansion efforts. This evidence-based approach is poised to inspire urban planners, architects, and policymakers worldwide to champion sustainability as the linchpin of precinct design.

As we peer into the future, this study's legacy is destined to shape urban development by influencing the core principles of design. Its lessons are enduring, and they will drive the metamorphosis of urban landscapes, resulting in cities that are not only greener and more sustainable but also more inviting and livable for all.

SECTION 11

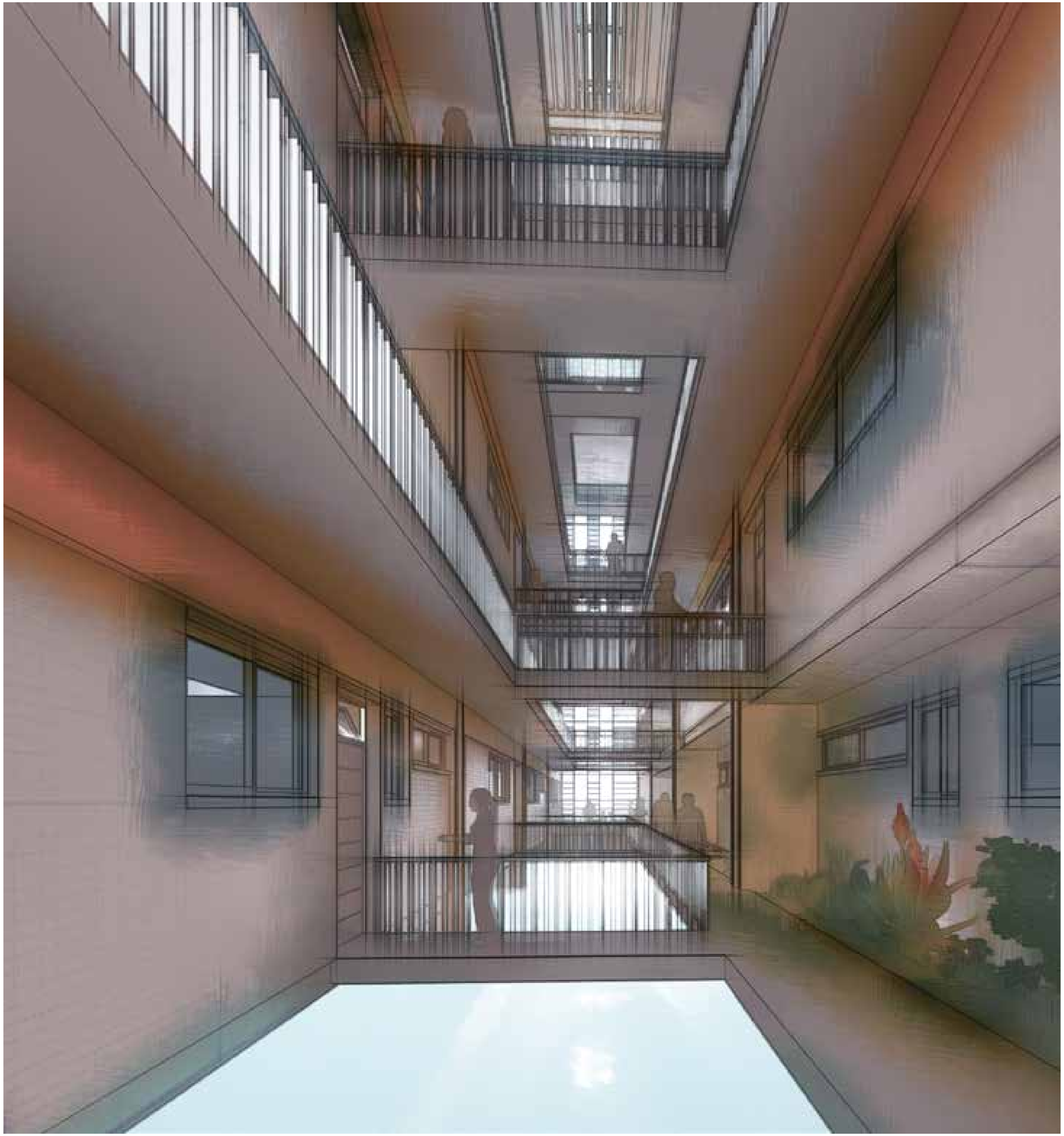
LIST OF TABLES

LIST OF TABLES


SECTION 12

LIST OF FIGURES

LIST OF FIGURES



SECTION 13

REFERENCES

REFERENCES

Abdullatif, K. (2022). How a Folding Facade Helps Make This New Cairo Design Sustainable. Scene Home. https://scenehome.com/Architecture/How-a-Folding-Facade-Helps-Make-This-New-Cairo-Design-Sustainable

Aiini, T. S., Culture, H., Expenses, E., Forughian, S., Taheri, M., & Aiini, S. (2017). Comparative Study of Single-glazed and Double-glazed Windows in Terms of Energy Efficiency and Economic Expenses. History Culture and Art Research, 6(3), 879–893. https://doi.org/10.7596/taksad.v6i3.884

Altan, H., Hajibandeh, M., Tabet Aoul, K., & Deep, A. (2016). Passive Design. ZEMCH: Toward the Delivery of Zero Energy Mass Custom Homes, 209–236.

Asif, M., Muneer, T., & Kubie, J. (2005). Sustainability analysis of window frames. Building Services Engineering Research and Technology, 26(1), 71–87. https://doi.org/10.1191/0143624405bt118tn

Asmat, I., Muna Hanim, A. S., & Abdul Malek, A. R. (2008). Using Green Roof Concept As a Passive Design Technology To Minimise the Impact of Global Warming. 2nd INTERNATIONAL CONFERENCE ON BUILT ENVIRONMENT IN DEVELOPING COUNTRIES (ICBEDC 2008), Icbedc, 588–598. http://eprints.usm.my/25136/1/BUILDING_ENGINEERING_AND_CONSTRUCTION_7.pdf

Athmani, W., Sriti, L., Dabaieh, M., & Younsi, Z. (2023). The Potential of Using Passive Cooling Roof Techniques to Improve Thermal Performance and Energy Efficiency of Residential Buildings in Hot Arid Regions. 1–24.

Atlasing in Namibia. (n.d.). Potato creeper. Retrieved November 7, 2023, from http://www.the-eis.com/atlas/?q=node/5390

Aung, T., Liana, S. R., Htet, A., & Bhaumik, A. (2023). Implementing green facades : A step towards sustainable smart buildings. 2, 41–51. https://doi.org/10.3233/SCS-230014

Ben, O. (n.d.). Eastgate Centre, Zimbabwe's green building construction through biomimicry. Retrieved March 25, 2023, from https://issuu.com/constructiondigest/docs/cd_mag_final._/s/13819946

Boething Treel Farms. (n.d.). Rhus lancea. Retrieved November 7, 2023, from https://www.boethingtreeland.com/plants/rhus-lancea/

Bourne, R. C., & Hoeschele, M. A. (2000). Applying natural cooling to slab floors. Proceedings ACEEE Summer Study on Energy Efficiency in Buildings, 3, 333–345.

Brick Development Association. (2022). Clay brick-v-Concrete brick; A comparative guide. November. www.brick.org.uk

Cactus Kingdom. (n.d.). Adenium Boehmianum. Retrieved November 7, 2023, from https://cactuskingdom.ca/product/adenium-boehmianum/

Chayaamor-Heil, N., & Vitalis, L. (2021). Biology and architecture: An ongoing hybridization of scientific knowledge and design practice by six architectural offices in France. Frontiers of Architectural Research, 10(2), 240–262. https://doi.org/10.1016/j.foar.2020.10.002

Construction Tuts. (2017). Advantages of Cavity Wall – What are Disadvantages of Cavity Wall Construction. https://www.constructiontuts.com/cavity-wall-advantages-disadvantages/

Cures decoded. (n.d.). Sutherlandia Health Benefits, Properties, and Uses. Retrieved November 7, 2023, from https://www.curesdecoded.com/Products/Sutherlandia/3683

de Witte, F. (2022). ZIEL. MVRDV Architects. https://www.mvrdv.com/projects/829/ziel

DeKay, M., & Brown, G. . (2014). Sun Wind and Light: architectural design strategies (S. Bennett (ed.); 3rd ed.). John Wiley & Sons Inc.

Dreyer, A. A. (2006). Plants photographed on Kyffhäuser. Kyffhauser. https://www.kyffhauser.co.za/Plants1/Albizia_anthelmintica/Image4.htm

El Sheikh, S. (2019). CO2 emissions from buildings and construction hit new high, leaving sector off track to decarbonize by 2050: UN. United Nations Environment Programme. https://www.unep.org/news-and-stories/press-release/co2-emissions-buildings-and-construction-hit-new-high-leaving-sector#:~:text=Materials used in the construction,overall energy-related CO2 emissions.

European Concrete Platform. (2007). Concrete for energy- efficient buildings The benefits of thermal mass.

Fourie, C. (n.d.). Namib Aloe (Aloe asperifolia). Gateway Africa. Retrieved November 7, 2023, from https://www.gateway-africa.com/fuanaflora/Plants/aloe_asperifolia.html

Frost, W. (2018). Kirkia acuminata; White Seringa. CalPhotos. https://calphotos.berkeley.edu/cgi/img_query?enlarge=0000+0000+0218+1517

Gardenia Creating Gardens. (n.d.). Ipomoea adenioides. Retrieved November 7, 2023, from https://www.gardenia.net/plants/genera/ipomoea-morning-glory

Gattupalli, A. (2023). Why the Global South Needs Different Sustainability Benchmarks. ArchDaily. https://www.archdaily.com/997062/why-the-global-south-needs-different-sustainability-benchmarks

gholamhossinarmin Pintrest. (n.d.). Zimbabwe History. Retrieved March 25, 2023, from https://www.pinterest.com/pin/378865387375876310/

GLH Architects. (2011). Vodafone SSIC. https://www.glh.co.za/app/glh/index.html#/work/22/project-info

GLH Architects. (2018). Witklipfontein Eco Lodge. https://www.glh.co.za/app/glh/index.html#/work/15/project-info

Grow Wild. (n.d.). Melianthus comosus. Retrieved November 7, 2023, from https://growwild.co.za/product/melianthus-comosus/

International Federation of Red Cross and Red Crescent Societies. (2022). Namibia Drought Assessment Report | 2022 1. 1–16. https://www.ifrc.org/sites/default/files/2022-08/Namibia-drought-assessment-report-2022.pdf

Kring, L. (2022). HOW TO PLANT AND GROW JASMINE. https://gardenerspath.com/plants/flowers/grow-jasmine/

Laylin, T. (2011). Sansiri Vertical Living Gallery is an Alluring Bangkok Office Wrapped in Green. Inhabitat. https://inhabitat.com/sansiri-vertical-living-gallery-is-an-alluring-bangkok-office-wrapped-in-green/sansiri-vertical-living-gallery-8/

Li, F. G. N., Smith, A. Z. P., Biddulph, P., Hamilton, I. G., Lowe, R., Mavrogianni, A., Oikonomou, E., Raslan, R., Stamp, S., Stone, A., Summerfield, A. J., Veitch, D., Gori, V., & Oreszczyn, T. (2015). Solid-wall U -values: Heat flux measurements compared with standard assumptions. Building Research and Information, 43(2), 238–252. https://doi.org/10.1080/09613218.2014.967977

McLeod, L. (n.d.). Top 5 Strategies for a Net Zero Ready Building Design: In Hot and Humid Climates. LS3P. Retrieved July 8, 2023, from https://www.ls3p.com/portfolio/top-5-strategies-for-a-net-zero-ready-building-design/

Merrick, N. (2022). Mitigating Glare and Solar Heat Gain with Exterior Shading Systems. Continuing Education Center. https://continuingeducation.bnpmedia.com/article_print.php?C=2482&L=377

Meteoblue. (n.d.). Simulated historical climate & weather data for Windhoek. Retrieved May 16, 2023, from https://www.meteoblue.com/en/weather/historyclimate/climatemodelled/windhoek_namibia_3352136

Munawaroh, A. S., Angkasa, A., Persada, B., Negeri, P., Laut, T., Andiyan, A., Faletehan, U., & Cardiah, T. (2022). Application of Passive Cooling Design Concept as an Effort to Reduce Climate change. October. https://doi.org/10.1063/5.0121256

Neufert, E., & Neufert, P. (2012). Neufert Architects' Data Fourth Edition. In J. Kister (Ed.), Journal of Chemical Information and Modeling (4th ed., Vol. 53, Issue 9). Wiley-Blackwell.

O'Neill, A. (2023). Namibia: Urbanization from 2011 to 2021. Statista. https://www.statista.com/statistics/455894/urbanization-in-namibia/

Oertzen, D. von. (2019). State of the Namibian Electricity Sector - 2019 (1st ed., Vol. 3, Issue 12). Konrad Adenauer Stiftung.

Random Harvest. (n.d.). Aristida Junciformis. Retrieved November 7, 2023, from https://www.randomharvest.co.za/South-African-Indigenous-Plants/Show-Plant/PlantId/370/Plant/Aristida-junciformis?Filter=All

Reinink, M., Moeng, B., Fourie, A., & Compion, C. (2017). Green Star Sustainable Precincts - Local Context Report for RSA. https://gbcsa.org.za/wp-content/uploads/2017/12/Sustainable-Precincts_Local-Context-Report_Final_05092017.pdf

Saadatian, O., Haw, L. I. M. C., Sopian, K., Salleh, E., & Ludin, N. A. (n.d.). Solar Walls : The Neglected Components of Passive Designs. 120–126.

SANBI. (n.d.-a). Cenchrus Ciliaris. Retrieved July 11, 2023, from https://pza.sanbi.org/cenchrus-ciliaris

SANBI. (n.d.-b). Flueggea virosa. Retrieved November 7, 2023, from https://pza.sanbi.org/flueggea-virosa

SANBI. (n.d.-c). Melinis repens. Retrieved November 7, 2023, from https://pza.sanbi.org/melinis-repens

SANBI. (n.d.-d). Senegalia galpinii. Retrieved November 7, 2023, from https://pza.sanbi.org/senegalia-galpinii

Sefton Council. (2014). Sustainability Appraisal and Site Selection Methodology (Issue November).

Senses Atles. (2020). Hassan Fathy, Building in the Desert in New Baris. https://www.sensesatlas.com/hassan-fathy-building-in-the-desert-in-new-baris/

Spirn, A. W., Santos, A. N., Johnson, D. A., Harder, L. B., & Rios, M. W. (1981). Plants for passive cooling.

The Fifth Estate. (2014). Creating sustainable precincts. www.thefifthestate.com.au/wp-content/uploads/2014/12/Precincts_ebook_final-double-page.pdf

Tomkins, G. (2022). Parking is the most stressful part of driving – say nearly half of drivers. Appyway. https://appyway.com/blog/press/parking-is-the-most-stressful-part-of-driving/

Trees Planet. (2013). Cyphostemma currorii - Cobas Tree - Butter Tree. https://treesplanet.blogspot.com/2013/06/cyphostemma-currorii-cobas-tree-butter.html

Tukiainen, M. T. (n.d.). Windhoek, Namibia - Sunrise, sunset, dawn and dusk times for the whole year. Gaisma. Retrieved May 16, 2023, from https://www.gaisma.com/en/location/windhoek.html

United Nations Environment Programme. (2019). 2019 Global Status Report for Building and Construction - Towards a zero-emissions, efficient and resilient buildings and construction sector. In Global Alliance for Buildings and Construction.

Vymazal, J. (2010). Constructed wetlands for wastewater treatment. Water (Switzerland), 2(3), 530–549. https://doi.org/10.3390/w2030530

WellsforZoe. (n.d.). Piliostigma thonningii. Retrieved November 7, 2023, from https://wellsforzoe.org/portfolio/piliostigma-thonningii-msekese/

World of Succulents. (n.d.). Tavaresia barklyi (Thimble Flower). Retrieved November 7, 2023, from https://worldofsucculents.com/tavaresia-barklyi-thimble-flower-devils-trumpet/

Yang, T., & Clements-croome, D. J. (2012). Encyclopedia of Sustainability Science and Technology. In Encyclopedia of Sustainability Science and Technology (Issue September). https://doi.org/10.1007/978-1-4419-0851-3

SECTION 14

APPENDICES

ANNEXURES

ANNEXURE A - REQUEST FOR PERMISSION LETTER

NAMIBIA UNIVERSITY OF SCIENCE AND TECHNOLOGY

Faculty of Engineering and the Built Environment

Department of Architecture, Planning and Construction

13 Jackson Kaujeua Street
Private Bag 13388
Windhoek
NAMIBIA

T: [illegible]
F: [illegible]
E: dapc@nust.na
W: www.nust.na

3 March 2023

Request for permission to access information and site for study purposes

To whom it may concern

Herewith is a request to allow students from the Department of Architecture, Planning and Constructionl from the Namibia University of Science and Technology (NUST) to access the site or information as required. The students are currently working on their individual thesis projects, toward the Master of Architecture degree qualification. This is only a proposed project with no direct impact on the site or environment.

The students registered for the Master of Architecture programme are listed below:

	STUDENT SURNAME & INITIAL	STUDENT NUMBER
1.	Denzel Awaseb	214039722
2.	Nagene Barnes	216065666
3.	Lourens Du Plessis	214012492
4.	Maria Iyambo	218032374
5.	Willie Junius	211002879
6.	Takudzwa Mukesi	218029802
8.	Jonathan Muller	216063485
9.	Rakel Nangolo	213091593
10.	Christoph Nakuumba	211079367
11.	Michelle-Denise Ndjoba	213102137
12.	Chantelle Neves	214001067
13.	Christian Strohbach	217023096

Please contact the Department of Architecture, Planning and Construction for additional information.

Regards

Dr Madelein Stoffberg
Postgraduate coordinator
Department of Architecture, Planning and Construction
061 207 2328

NAMIBIA UNIVERSITY OF SCIENCE AND TECHNOLOGY
P/Bag 13388
[illegible]
NAMIBIA
2023 -03- 03
DEPARTMENT OF ARCHITECTURE AND SPATIAL PLANNING

Client Name	Sr. Giselinde Shiwolo
Date of interview	20 March 2023
	Roman catholic ~~[illegible]~~ Hospital
What do you currently need	Need more space for patient
	rooms
	More consultation rooms as
	wait list is long
	Staff accomidation
What does the client want for the site	Parking is limited
What are the future for the client	Want to move pathcare out of
	main hospital
Other questions	

Client Name	Holy Cross Convent ~~P~~rimary school
Date of interview	15 March 2023
Interviewee	Principle Clair Kolberg
What do you currently need	• Parking for parents to
	drop children
	• Currently it is choas as parents
	have to stop and go
~~What does the client want for the site~~	• Street vendors make a mess
Issues	and they have complianed to
	Authorities
	• Taxis block entrence to parking
	and have requested Authorities
~~What are the future for the client~~	to move taxi rank further
	and public parking closer
Other qeustions	• ILMA has done a proposal that
	was liked, but CoW Rejected
	proposed design
	• Willing to offer up space if they
	can get parkin for parents
	• looked at increasing existing
	parking area by going up

ANNEXURE D - TOWN PLANNING CERTIFICATE

Town Planning Certificate No. 1:
Town Planning Scheme Information

Ref :
Enq :
Tel :
Applicants Address

Telephone Number :

Sir / Madam

Erf No: 7203
Township : WINDHOEK/WINDHOEK BLOCKS
Street : JOHN MEINERT STR

In terms of the Windhoek Town Planning Scheme the following conditions apply to the above mentioned erf.

1. Use Zone : RESTRICTED BUSINESS — Refer to Table B.
2. Density : — Refer to Table E.
3. Bulk Factor : 4 / 4.0 — Refer to Table F.
4. Coverage : 75 % — Refer to Table G.
5. Erf Size : 5,036 m²
6. Parking :

(The parking ratio should be confirmed with the Transportation Department for erven in the business zone, and for restaurants, grouped housing schemes, hotels, bed & breakfasts, resident occupations, places of amusement, social halls and churches)

7. Street Build Lines
8. Position Of Buildings :
9. Street Address : 39-43 JOHN MEINERT STR
10. Flood Line :
11. Height Restriction : — Refer to Table J.
12. Street Reservation :
13. Other :

The TOWN PLANNING SCHEME and MAP are open for inspection on the passage wall of the 7th floor of the town house. The information provided herein must be verified by the applicant by inspection of the Scheme and Map.

Your attention is further directed to any condition which may be registered against your property in the title deeds. You may be required to furnish a certified copy of the title deeds conditions before any building plans are approved.

ANNEXURE E - POLICY ON FREE RESIDENTIAL BULK

[Municipal Council Minutes: 2011-06-29]

HRD.2 [PLA] POLICY ON FREE RESIDENTIAL BULK
(L/3490/W)

On proposal by Councillor Ms AM Kafula, it was

RESOLVED

1 That the free Residential Bulk Policy continue to be implemented as an effective means to promote urban densification.

2 That free residential bulk consent be granted, subject to the following conditions:

2.1 That free residential bulk consent not apply to rezoning applications of corporations (e.g. financial institutions), Government buildings and parastatal buildings.

2.2 That free residential bulk be limited in the office areas to only 50 % of the approved bulk factor for office use. [In the Central Business District (CBD) the free residential bulk consent shall be limited to a floor area equal to the approved office bulk factor.]

2.3 That free residential bulk only be granted where all the required parking bays can be provided for on-site and no on-street parking be considered for the free residential bulk or the office component of the development in applications where free residential bulk is requested.

2.4 That the Strategic Executive: Planning, Urbanisation and Environment specify the approved floor area in square metre in cases where free residential bulk is applied for in the building plan files.

2.5 That the Strategic Executive: Transportation specify the amount of units that are approved for residential use on the building plan by ensuring that the required number of parking bays are provided on-site.

3 That the Strategic Executive: Planning, Urbanisation and Environment be delegated the power in terms of section 31(1) of the Local Authority Act, 1992 (Act 23 of 1992), which had been put on hold between January 2011 to the date of this Council Resolution as set out in paragraph 2 above, and subject thereto that the rezoning to office had been positively approved by a relevant Council Resolution and the provisions of the Windhoek Town Planning Scheme, to approve the free residential bulk applications.

RESOLUTION 167/06/2011

ANNEXURE F - WORK INTEGRATED LEARNING GRID LAYOUT