Medium-density housing designed to conserve and regenerate native biodiversity in Auckland, Aotearoa New Zealand.

ROBYN KAY DU PREEZ





Figure 1. Native species

Medium-density housing designed to conserve and regenerate native biodiversity in Auckland, New Zealand Aotearoa.

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Maibritt Pedersen Zari (Supervisor)

2024

School of Future Environments,

A thesis submitted to Auckland University of Technology in partial fulfilment of the requirements for the degree of Master of Architecture (Professional) (March(Prof)).

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgements), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning.

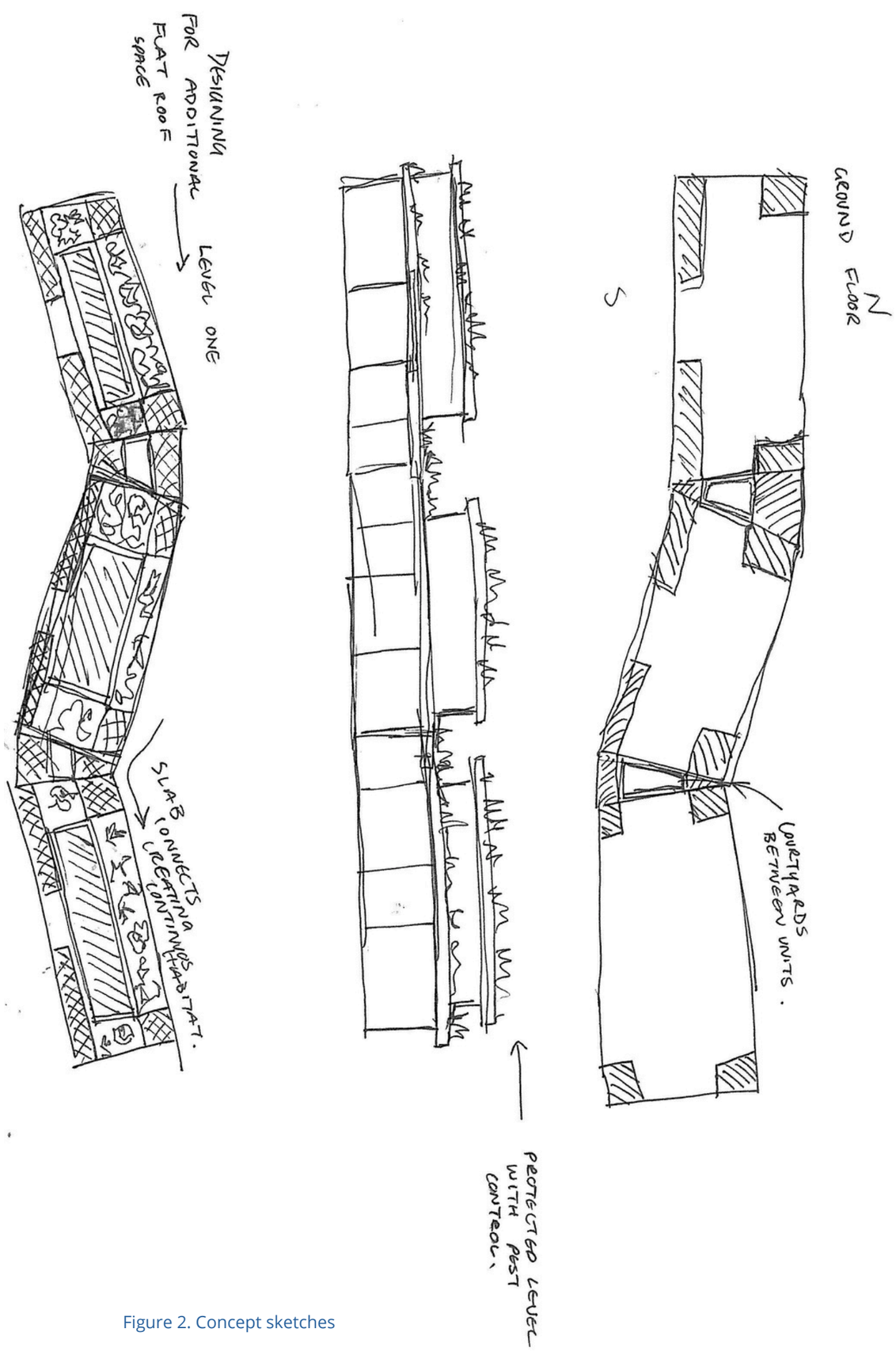

Figure 2. Concept sketches



Figure 3. Natives stranded in new builds

ABSTRACT

How homes are designed has changed through the centuries. Design drivers rotate through a hierarchy of form, function, and aesthetic. Houses are designed and built separately from the natural environment and in most cases create a physical divide between the two. Thus, houses are built in a way that disconnects us from the outdoors and encourages us to time spent inside.

New developments tend to be human-centric designs that push the non-human out, leaving biodiversity without habitat and ecosystems degraded. The humans in these developments suffer from a lack of exposure to nature and its biophilic benefits. The disconnect of humans from the natural environment means people can not see the damage they are doing to their ecosystems. There is a gap in knowledge on how to design residential housing that increases biodiversity.

To successfully design medium-density houses that regenerate and conserve biodiversity, the relationship between humans and nature needs to be examined and repaired. This places humans back into their ecosystems and removes the nature-human binary so they can see how their actions have repercussions on their ecosystems and thereby rejuvenating human's roles in conservation may be key. This thesis explores how houses can be designed to shift human’s connection to their ecosystems while tangibly supporting the capacity of biodiversity, specifically birds, to thrive in urban settings.

This knowledge pushes built environment designers to acknowledge their role in biodiversity loss and provides a framework for designing a biodiverse future more effectively, through the medium of architectural design.

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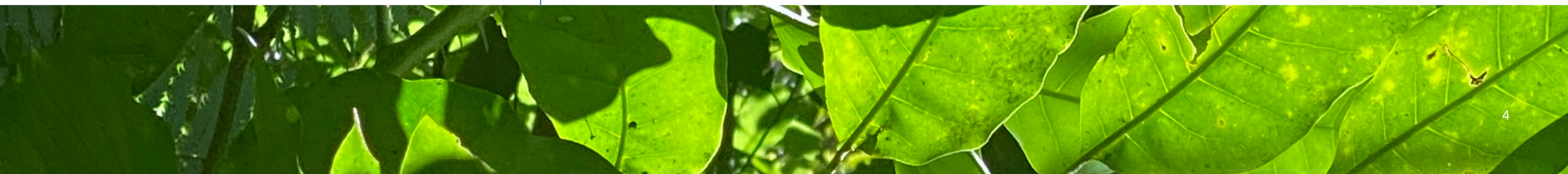


POSITIONALITY STATEMENT

I grew up in South Africa and spent much time in game reserves. I viewed and learned the value of the circle of life and how interconnected each species was. A strong sense of conservation was embedded in me as I watched extinction take place in real time.

I currently live in Aotearoa New Zealand in a new development that has been designed to be completely removed from nature. The development was previously home to native Aotearoa New Zealand species. Some species, such as the Pūkeko, are trying to survive in this new development. There is no habitat or food for them in this area anymore and I often find them digging through trash or as roadkill on the edges of the development.

Through past and present experiences, I have come to understand how important the natural environment is to our human survival, and how ultimately people are part of the natural world, but also how our ecosystems deserve to be cared for regardless of their use to humans. As a designer, I have a role to play in this conservation.

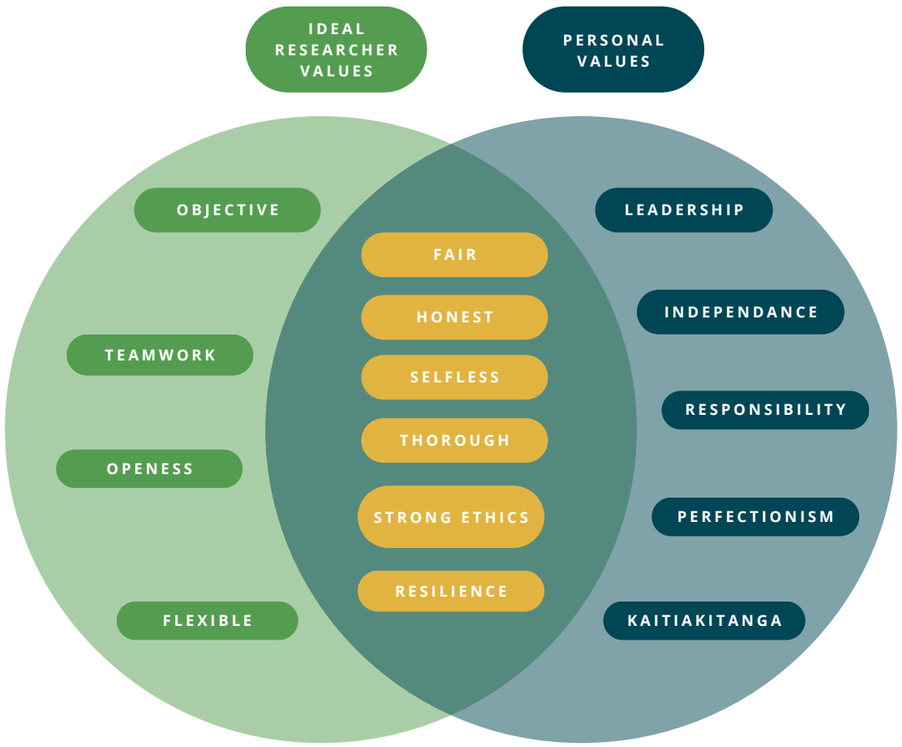


Figure 4. Values of a researcher

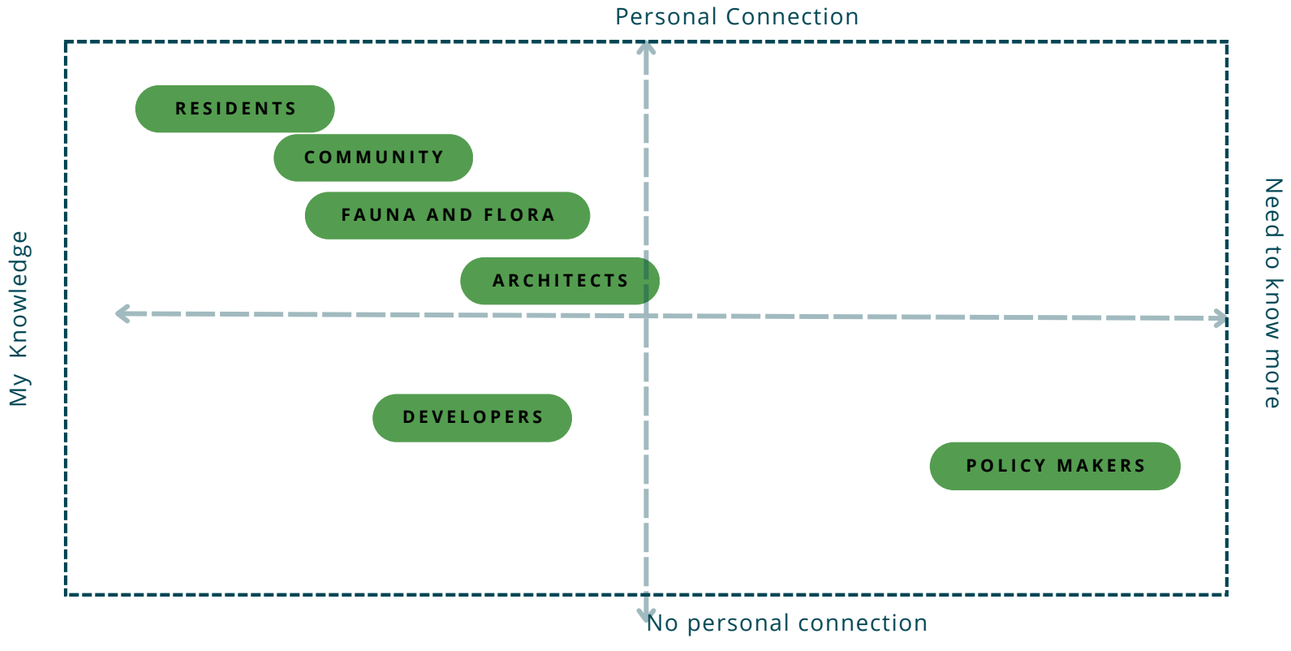


Figure 5. Existing knowledge

ACKNOWLEDGEMENTS

I would like to extend my deepest gratitude to my supervisor, Maibritt, for pushing me to be better every step of the way and for sharing your endless knowledge. Your guidance has been invaluable throughout this journey.

To People, Cities, Nature, thank you for giving me the opportunity to research this important topic. Your platform allowed me to explore and contribute to the future of ecological residential housing.

To my friends, thank you for keeping me happy, fed, and motivated through the ups and downs. Your support has meant the world to me.

To my fellow architecture students, we did it! I couldn't have asked for better companions on this journey.

To my family, I am endlessly grateful for getting me to this point. Thank you for giving me every opportunity and support that has shaped me into who I am today.

And finally, to Cam—thank you for your constant support, love, and patience. You have dealt with every challenge alongside me, and I couldn't have done this without you.



Figure 6. In Zealandia's cafe

BIODIVERCITY

This thesis was funded under a scholarship from People, Cities, Nature.

People, Cities, Nature has four research focuses: Residential Design for Biodiversity, Retain and Restore Wildlife, Restore Health-Promoting Soil Biodiversity, and Whanake rākau, whakatipu mātauranga, poipoia te tangata. The group this thesis is most closely connected to is Aotearoa BiodiverCITY (ABC) which is the Residential Design for Biodiversity team.

Aotearoa BiodiverCITY's goal is to increase native species in residential design. The four key methods are to review best practice, identify motivations and barriers, create biodiversity assessment tools, and outline biodiversity strategies.
The current study's goal to increase urban biodiversity in residential developments in Aotearoa aligns with all of these research focuses. However, it is directly involved with outlining strategies that can restore native species in residential design which is most closely related to the work of Aotearoa BiodiverCTIY.

This research builds on knowledge from Katie Jenkins' thesis BiodiverCity: *The integration of biodiversity within medium-density housing*, who was also People, Cities, Nature scholarship recipient.

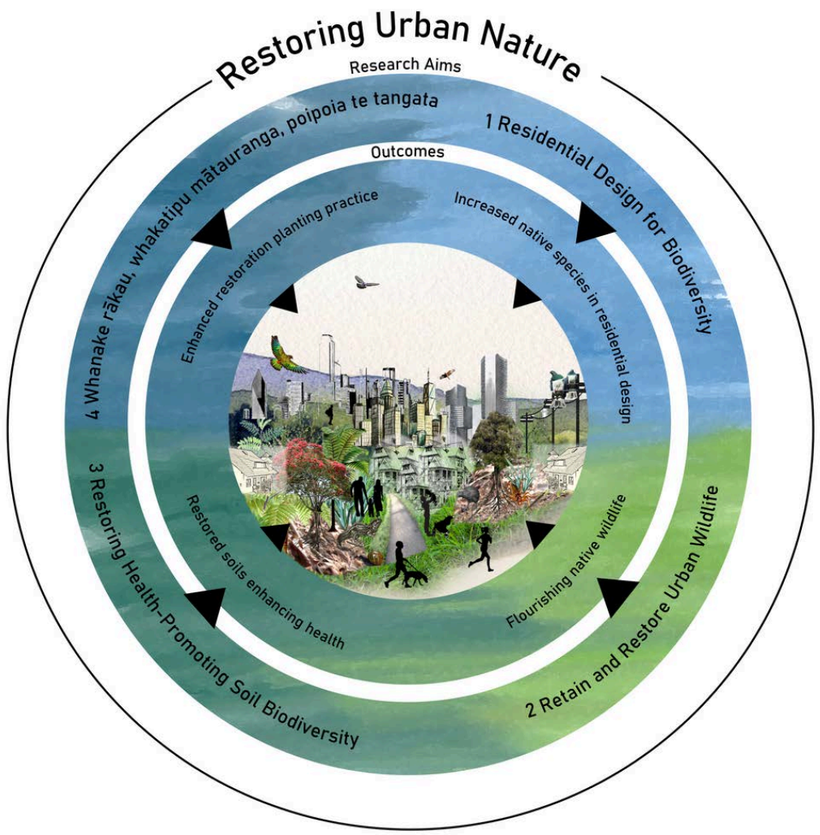


Figure 7. People, Cities, Nature - Restoring Urban Nature.

The research aims of the programme Restoring Urban Nature (MBIE grant UOW2102) which enhances work from the earlier programme, People, Cities and Nature (MBIE grant UOW1601).



Figure 8. People, Cities, Nature conference at Zealandia

People, Cities, Nature conference 2024



Figure 9. People, Cities, Nature conference at Zealandia

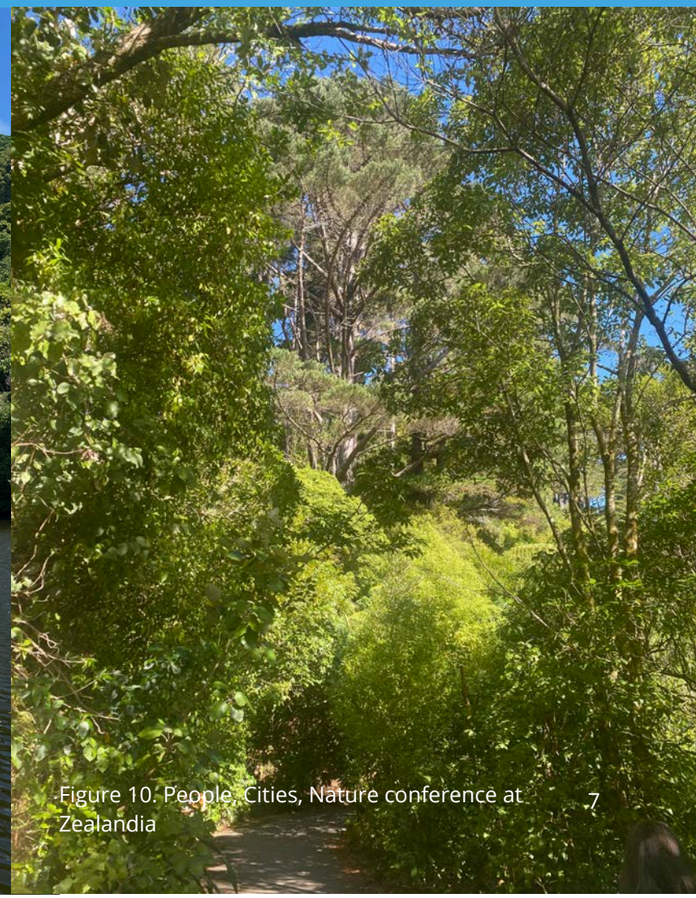


Figure 10. People, Cities, Nature conference at Zealandia

CHAPTER ONE

INTRODUCTION:

THE GLOBAL CRISIS OF BIODIVERSITY IN ARCHITECTURE

This chapter explores the thesis aims, the contents, case studies, and literature that underpins the research. The thesis theoretical framework is identified and discussed.

Figure 11. Native trees in Zealandia

INTRODUCTION

1.1 RESEARCH QUESTION

How can medium-density housing be designed to conserve and regenerate native biodiversity in Auckland, Aotearoa New Zealand?



Figure 12. Garden

1.2 RESEARCH AIM AND OBJECTIVES

AIMS

The research aims to identify strategies to design a development that enhances the area's biodiversity while building medium density housing.

- Analyse existing medium density development's design for biodiversity.
- Explore how to design for the wellbeing of both humans and non-humans.
- Experiment with strategies to enhance the community's sense of kaitiakitanga (stewardship) towards biodiversity.
- Identify strategies that guide design for biodiversity-focused housing that can be used in future developments.

OBJECTIVES

- Compare business-as-usual buildings with biodiversity-focused designs.
- Design to match and improve current development 's density standards.
- Distinguish what requirements NZ native species have to survive.
- Experiment with designing to meet species requirements.
- Investigate how architecture affects the connection between humans and the natural environment.
- Determine an effective design processes for increasing biodiversity wellbeing in medium-density development
- Determine strategies at urban, architecture, and detail scales to increase biodiversity wellbeing in medium-density development.

1.3 LITERATURE REVIEW

CLIMATE CHANGE

Climate change is a complex global problem of the Anthropocene. The Earth's climate has been affected and changed by human activity (Rafferty, 2010). This negatively affects biodiversity (Thomas et al., 2004) which in turn reinforces climate change, resulting in a vicious circle (McElwee, 2021). Native species have dropped by 20 percent in significant terrestrial biome (Brondizio et al., 2019). Within the next few decades, another 1 million species could be lost to extinction (Brondizio et al., 2019). In Aotearoa New Zealand (AoNZ), biodiversity loss is caused by multiple factors, but the largest drivers appear to be: habitat loss and fragmentation through the clearing of forests and wetlands for agriculture and to a lesser extent urban sprawl; competition and predation from invasive pests and species; the arrival of new diseases alongside the increase of homogenous species; and climate change (Clarkson, 2022). Coupled with weak regulations protecting fauna and flora (Brown et al., 2015), AoNZ stands to lose its unique biodiversity. This is a complex problem that impacts human survival. Besides the intrinsic value of biodiversity, humans rely on fauna and flora and the living systems they create (ecosystems) for human existence. Ecosystem services are the processes of ecosystems and their species that sustain human life (De Groot et al., 2002; Wallace, 2007). These processes include water regulation, soil formation, pollination, pest control, gas regulation, nutrient regulation and food provisioning, which are all processes that are detrimental to human life (Wallace, 2007). Human health is dependent on the health of the planet's biodiversity, ecosystems, and climate, which are all interdependently interconnected. Without a healthy planetary biosphere and climate system, humans are at risk of losing ecosystem services such as fresh air, clean water, nutrient-rich soil, and, because of the compounding impacts of climate change, are at risk from increased frequency and intensity of weather-related disasters, rising sea levels, and the impacts of increasing temperatures, all leading to the possible decline of functional human society (Atapattu, 2008).

URBAN IMPACT

The key cause of climate change is the emission of greenhouse gases (GHGs) into the atmosphere. Cities and those who dwell within them are currently responsible for a large proportion of GHGs released into the atmosphere. The proportion of global GHGs attributed to cities varies greatly depending on how it is calculated but could be as high as 80 percent of emissions (Spiegelhalter & Arch, 2010). Housing accounts for 30 to 40 percent of global energy use and the associated GHG emissions. These numbers were calculated based on data on all life cycle stages of buildings but mostly apply to the operational stages (i.e. the power used to run a building). Significant GHGs and energy use are associated with the construction and demolition stages of buildings. The construction industry is also responsible for using a large share of raw materials (UNEP, 2007) and producing over 70 million tons of waste each year (Keys et al., 2000). With over half of the world's population living in urban areas (UNEP, 2007), there is a direct need to create more sustainable urban developments. Due to growing populations, and in some parts of the world increasing urbanisation, cities are growing, impacting resource availability, environmental degradation, and pollution (Bhadouria et al., 2023), all of which further contribute to the vicious cycle of climate change and biodiversity loss.

Urbanisation's link to habitat loss means how cities are built must be adapted. New strategies are required (Pedersen Zari et al., 2022). Blue and green infrastructure are designs that incorporate water (blue) or land (green) systems that aid the creation of a resilient and ecologically beneficial site (Mell & Scott). Blue, green, and hybrid infrastructure as nature-based solutions are considered to be key in enabling cities to mitigate and adapt to the effects felt from climate change (Almaaitah et al., 2021) as opposed to the typical grey solutions currently being implemented. Nature-based solutions should be included in designs in order to increase habitat and therefore biodiversity, thereby enhancing the benefits of rich biodiversity in urban areas for humans (Taylor & Hochuli, 2014). Urban developments can be designed to utilise better sources of energy such as solar energy, utilise passive house design to reduce energy, eliminate waste through material choice, design for deconstruction, and ultimately be designed to help restore and regenerate ecosystems rather than be a source of damage (Pedersen Zari, 2018).

Instead of being a driver of climate change, architecture, and specifically medium-density developments, have the potential to aid in mitigating the causes of climate change, adapt to the impacts of climate change, and enhance biodiversity. This can be termed regenerative design (Cole, 2011). There are some examples of attempts at regenerative architecture globally (Attia, 2018), but there is often a lack of focus on weaving biodiversity health into such architecture. One example of a project that considers biodiversity health is the Fishermans Bend development in Melbourne, Australia, which uses a specific framework derived from Biodiversity Sensitive Urban Design (BSUD) developed by Georgia Garrad. This framework could be used in other developments to better plan for and include biodiversity in design (Kirk et al., 2021). People, Cities, Nature, a research group focusing on urban biodiversity, is currently developing a tool that indicates how biodiverse a design is. The research group is also developing a design guide that helps designers create more biodiverse plans. The aim of this tool is to enhance residential biodiversity.



Figure 13. View of landscape

PLANTINGS

Ecological biodiversity is influenced by plantings, particularly by the complexity of vegetation which is directly related to a diversification of habitats. Urbanisation decreases species richness through the structural simplification of vegetation and the planting of primarily non-native trees or shrubs, chosen for their aesthetic appeal and ease of maintenance (McKinney, 2008). An important aspect of complex plantings is culture and identity. In Aotearoa, there should be recognition of the cultural significance of plants and their importance to Māori cultural identity (Rodgers et al., 2023). Plantings that have historically been found on a site are likely better adapted and connected to the larger ecosystem of the region (Jump & Peñuelas, 2005). Consideration should be given to plantings both in terms of how these plants can adapt and mitigate the effects of climate change, for example through carbon sequestration, and in terms of the impacts of such plantings on the local biodiversity.

PARADIGMS

Current approaches to urban planning and building design are characterise by an anthropogenic worldview, which considers humans to be separate and disconnected from nature. Within this worldview, nature is merely a resource with monetary value that can be exploited by humans (Robbins, 2007). However, to be able to repair ecosystems and address climate change and biodiversity loss, there needs to be a paradigm shift or return to an eco-centric worldview (Brumfield, 2016). The eco-centric worldview views humans as connected to nature and responsible for the well-being of ecosystems and is often found in indigenous worldviews.

Architecture may be able to help facilitate such a shift in paradigms. Humans spend 60% of their time in their homes (Ortiz-Ospina et al., 2020) separated from nature. This shows that a change in residential design could have an influence on people's perceptions of the world. These new designs need to reconnect humans to nature both physically, through the introduction of habitat or stepping stones for biodiversity, but also mentally by allowing humans to see the impact their activities are having on nature and to become involved in protecting their environment. As noted by Hage and Rauckienė,

"Environmental education should be understood as a lifelong process, actively, critically, and creatively engaging children and the adult population in the daily decisions that affect the biosphere. It requires strengthening public participation in environmental policy and decision making through capacity development for strategic environmental action".

page 61

(Hage & Rauckienė, 2004).



Figure 14. Pathway next to harsh ground

1.4 BUILDING DESIGN FOR BIODIVERSITY

As climate change data and biodiversity loss news become more widespread and well known, some designers are adapting to how they design to try and adapt to climate change or mitigate its effects as well as avoid biodiversity loss. This consideration of environmental factors marks a transition away from a human-centric design paradigm to a more inclusive approach that seeks to generate designs for people as well as ecosystems and native species (Parris et al., 2018). Adopting such an inclusive approach can play a key role in regenerating ecosystems, which has a wide range of benefits for humans (Huelat, 2008). The impact of adopting such an inclusive approach is twofold: first of all, it contributes to the regeneration of ecosystems, and the resulting improvement of the natural living environment are also likely to have a range of benefits for humans.

Regenerative design is an approach that conceptualises a building site and its environment as an interconnected system. It incorporates human health and well-being with the ecosystem's health and considers how these can be interwoven through design to create spaces for the community that positively impact the natural world (Gibbons, 2020). Regenerative design can be used as a framework that helps guide designers through the different design phases (Attia, 2017), ensuring they are going beyond using new techniques and instead shifting how they design (Mang & Reed, 2011). Building design for biodiversity can be seen as an aspect of regenerative design.

Building design for biodiversity has a range of benefits to mitigate and adapt to climate change. It adapts to climate change through an increase of permeable spaces and biomass cover, reducing the effects of heavy rainfall by filtering stormwater. It reduces the effects of the urban heat island effect, with vegetation offering a natural cooling system to cities. This vegetation also purifies air, sequestrates carbon production, increases the opportunity for food production, and restores soil's richness to a certain extent (Hisano et al., 2017).

With a focus on societal and well-being benefits, building design for biodiversity is based on the idea that there is a direct correlation between biodiversity health and conservation, and the quality of human physical health and well-being through biophilic design. Exposure to nature has been shown to have cognitive and mental health benefits, such as increasing or regulating mood and stress levels, lowering anxiety, lessening depression, and improving executive functioning, which is responsible for concentration (Hung & Chang, 2021). There are also physiological benefits to being around nature (Pedersen Zari, 2018). The body can experience a reduction in cortisol, blood pressure, and heart rate, along with an increase in the body's parasympathetic response (Scott et al., 2021). Exposure to biodiversity and microbiomes also supports the immune system (Lo Templio et al., 2023). Design can enhance cultural well-being by considering plants of place (Rodgers et al., 2023) through the site. Plants of place is a concept that celebrates AoNZ's pre-colonial natural heritage and suggests planting to contribute to decolonisation and environmental and spatial justice.

Building design for biodiversity provides ecosystem services through biological control of weeds and pests, decomposition of natural materials, increased permeable surfaces and therefore hydrological cycle regulation, food production, genetic resource protection, habitat provisioning, nutrient cycling, pollination, and purification of water, soil, and air (Horwitz & Finlayson, 2011; Reid et al., 2005). These ecosystem services are responsible for creating the conditions in which humans need to survive (Jackson et al., 2013).

Building design for biodiversity is directly related to ecological health (Rafferty, 2010). Designing nature back into the buildings with a focus on this nature being a habitat for native species increases the number of habitats which species need to survive. Building design for biodiversity ensures that species (including those in the soil) are not removed from greenfields when developments are built, as well as species being re-introduced when brownfields are designed. Designs built for biodiversity act as habitats for specific species as well as stepping stones for habitats for other species. Ensuring they are designed to avoid biodiversity loss is paramount to the ecosystem's health (Green & Clarkson, 2005). Each species has a role in the larger working of the ecosystem; when a species is lost, the ecosystem has to change function to withstand the loss. The scale of this change depends on the role of the species (Lawton, 1994). The more species lost, the more the ecosystem has to change to function, gradually decreasing the ecosystem and its role on earth, which is fundamental to the human race's survival (Cardinale et al., 2012). In addition to these important factors as to why humans need nature to survive, there are also ethical considerations. There is an understanding that human processes are killing the natural world, and biodiversity restoration should be implemented regardless of the benefits to humans (Oksanen, 1997).

Building design for biodiversity has the ability to deliver key building performance benefits. Specific methods of building design for biodiversity have been shown to increase the quality of the house. The inclusion of green walls or living green walls, for instance, were found to support potentially increase internal wall U-values, acting as additional insulation (Fox et al., 2022). Strategic plantings with deciduous species in front of exposed areas can also be used for heating and cooling benefits (McPherson et al., 1988). Increasing the footprint of biodiversity through the design plan involves an increase of plantings and nature instead of man-made materials, reducing construction waste (Du Preez, 2024).



Figure 15. Green wall

Building design for biodiversity: Applications in architecture case study

Victorian Comprehensive Cancer Centre
Rush Wright Associates
Melbourne
2016

A goal for the project was to increase biodiversity at the hospital while reconnecting humans with nature. The design has a strong biophilic influence as it features central biodiversity rich spaces that can either be looked at from within the hospital or interacted with by hospital staff and able patients. The spaces were designed with a focus on the health benefits of biophilic design. On the outside of the first level, there is a rainforest niche of diverse plantings, with spaces to rest and meet. On the seventh and twelfth floors are large rooftop gardens. These spaces were designed to host social spaces that are surrounded by nature, designed for the use of patients and hospital staff with their well-being in mind. There is a range of plantings in the space, including edible fruit trees and gardens for users to access. Overall, the hospital has included these diverse park-like spaces that offer the opportunity to increase biodiversity in the city while also giving some of the community's most vulnerable people a space to find relief. This is also true for the hospital staff, giving them a space to relax and refresh from their workloads (Bull & Wright, 2019). This design shows that humans need to be reconnected to nature for their health and wellbeing. The design offers plenty of opportunities for people to reconnect with nature and ensured that those who are not able to go outside can enjoy views of nature from inside the hospital. The design has successfully shown that urban centres can be a host for biodiversity rich designs that benefit both the humans around it as well as nature.



Figure 16. Victorian Comprehensive Cancer Centre

1.5 PRINCIPLES

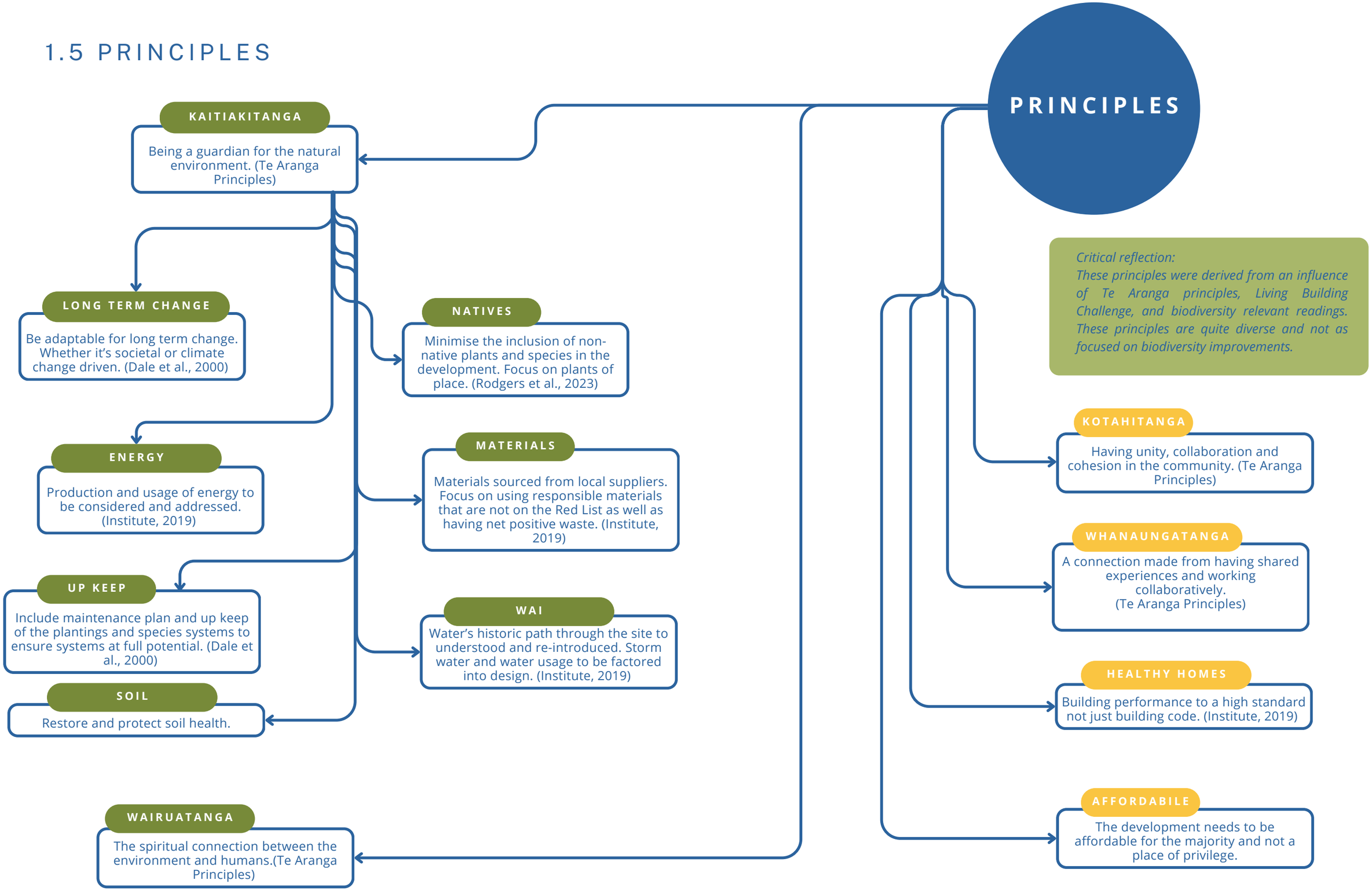


Figure. 17 Principles diagram

1.6 FRAMEWORK

The literature review presented above explored the principles that inform building design for biodiversity, which is focused on restoration of biodiversity in urban areas, and highlighted the strengths of the approach. The framework used in this thesis therefore is biodiversity sensitive urban design (BSUD). BSUD was created by Garrard et al. (2017) as a framework that can be used by architects, planners, developers, and councils to ensure urban developments are built in a way that enhances biodiversity. The framework to design a biodiverse development consist of five key steps. The first step is to “maintain and introduce”, which is concerned with avoiding habitat loss by maintaining existing habitats and introducing more habitat opportunities. The second step is to “facilitate dispersal”, which involves the addition of movement infrastructure for species and establishing connections to other habitats. Allowing for species to move freely through the site and wider city is essential for processes such as seed dispersal. The third step is to “minimise threats and anthropogenic disturbance” by incorporating pest control management, reducing stormwater run-offs, and minimising light and noise pollution. The fourth step is to “facilitate natural ecological processes”. This involves planning for adequate resources for target species, enhancing pollinator habitats, and planning for natural or climate change induced events such as fires and floods. The last step is to “improve the potential for positive human-nature interactions”, which relates to biophilic design principles and is key to community engagement with conservation. In the AoNZ context, this means to create, revive, or celebrate a sense of kaitiakitanga (guardianship) in the community. This step is key for ensuring that the project can move from being driven by conservationists or ecologists to having the community support, engagement, and backing, aiding an ontological shift that re-positions humanity as part of the ecosystem. These steps are used throughout the thesis to give direction to the design as well as to analyse the success of precedents and design experiments.



Figure 18. Zealandia scenery

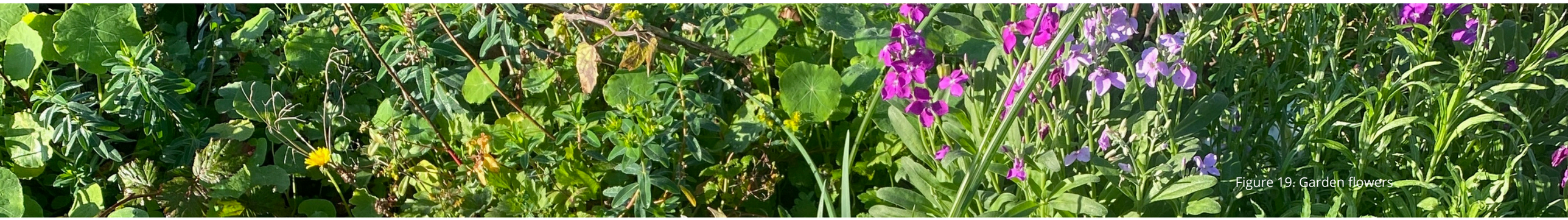


Figure 19. Garden flowers

MAINTAIN AND INTRODUCE

- Avoid habitat loss.
- Develop in low ecological value areas.
- Use native species.
- Create vegetative complexity.
- Design green infrastructure.
- Incorporate key resources for habitat analogues.

FACILITATE DISPERSAL

- Add animal movement infrastructure.
- Establish connectivity corridors through public and private lands.

MINIMISE THREATS & ANTHROPOGENIC DISTURBANCE

- Incorporate predator, weeds and exotic plant control and future managements.
- Reduce runoffs through blue/green infrastructure.
- Minimise light and noise pollution.

FACILITATE NATURAL ECOLOGICAL PROCESSES

- Provide adequate resources for target species.
- Protect and enhace pollinator habitats.
- Plant for natural events to safely occur, such as fire or flooding.

IMPROVE POTENTIAL FOR POSITIVE HUMAN-NATURE INTERACTIONS

- Create a sense of Kaitiakitanga and Wairuatanga within the community.

FRAMEWORK STRATEGIES

maintain and introduce

STRATEGY
• Plant native plants that feed nectivorous birds. • Provide refugee for lizards through habitat creation with shrubs and rock piles. • Create vegetative ground cover with leaf litter, rotting logs and bare ground for invertebrates. • Design spaces for low maintenance wild plantings for pollinators. • Design complex plantings with diverse species composition.

NATURE-BASED SOLUTIONS
• Green/living roofs • Green/ living walls • Urban forests • Constructed wetland

PRECEDENT

Green/living Roofs



Figure 20. Remuera Rooftop Garden

Year: 2023
Designer: Natural Habitats
Location: Remuera Auckland

On a residential renovation project more green space was required on the site. This was achieved by making the roof of the garage into a living roof that could have aesthetic appeal but also attract birds and bees.



Figure 21. Green wall diagram

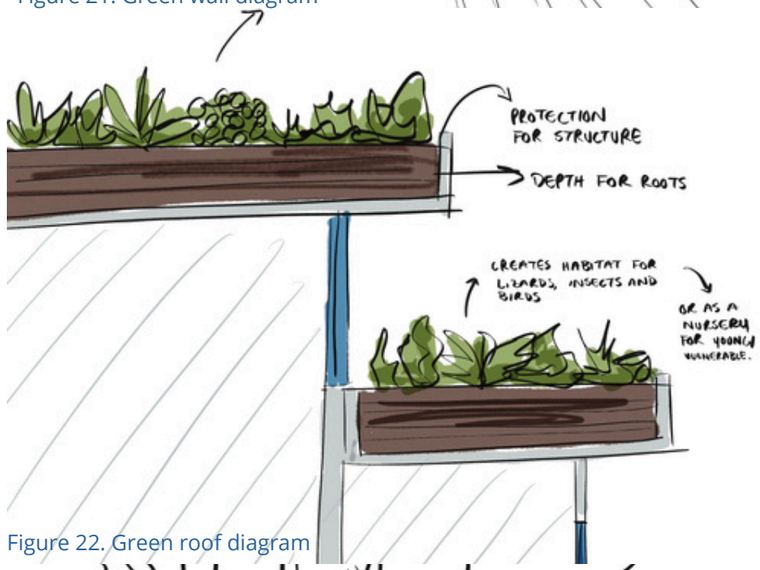


Figure 22. Green roof diagram



Figure 23. Urban forest diagram

FRAMEWORK STRATEGIES

Facilitate dispersal

STRATEGY

- Add animal movement infrastructure.
- Establish connectivity corridors through public and private lands.
- Cluster private gardens.

NATURE-BASED SOLUTIONS

- Green corridors.
- Habitat steeping stones.
- Tree canopy.

PRECEDENT

Green Corridors



Figure 24. Lisbon Street Trees

Year: 2012
Architect: Ribeiro Telles
Location: Lisbon, Portugal

Lisbon planned a local biodiversity action plan. As a part of the contribution to this plan there were nine green corridors created within the city. These green corridors were designed to connect important parts of the city.



Figure 25. Green corridor diagram



Figure 26. Stepping stone diagram

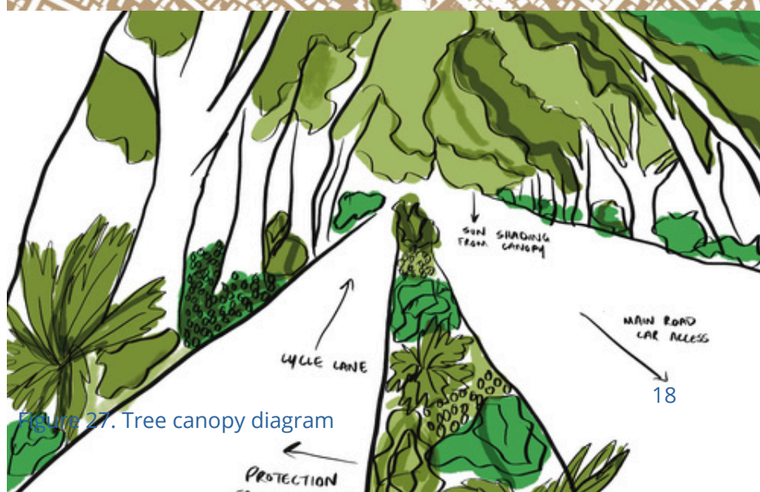


Figure 27. Tree canopy diagram

FRAMEWORK STRATEGIES

Minimise Threats & anthropogenic disturbance

STRATEGY

- Incorporate predator, weeds and exotic plant control and future managements.
- Reduce runoffs through blue/green infrastructure.
- Minimise light and noise pollution.

NATURE-BASED SOLUTIONS

- Rain gardens
- Bioswales
- Permaculture
- Xeriscaping
- car-free zones
- Bird safe facades
- Bioremediation - phytoremediation of soil.

PRECEDENT

Bioswales



Figure 28. Long Bay Masterplan

Year: 2022
Architect: Construkt Architects
Location: Long Bay, Auckland.

As a part of the masterplan of a suburb in Auckland, Long Bay, there is a bioswale designed into the site. This bioswale helps reduce impacts from heavy rainfall.

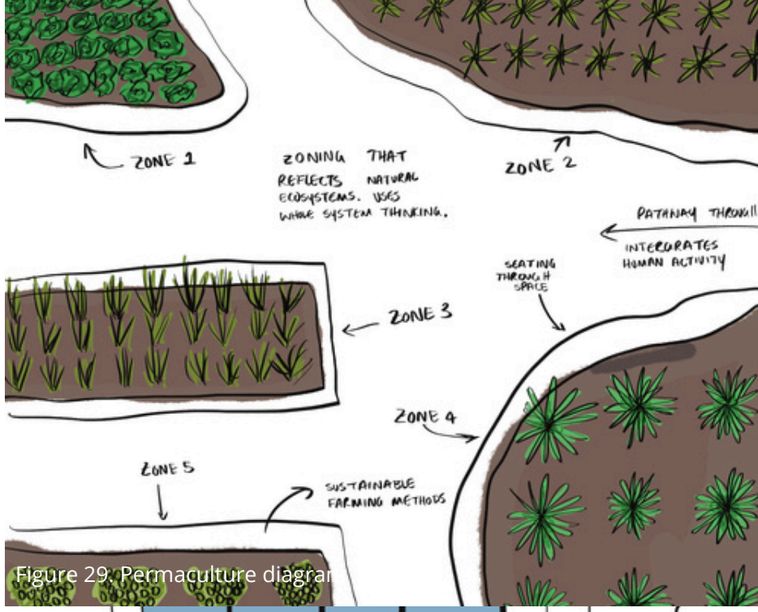


Figure 29. Permaculture diagram



Figure 30. Bird safe facade diagram

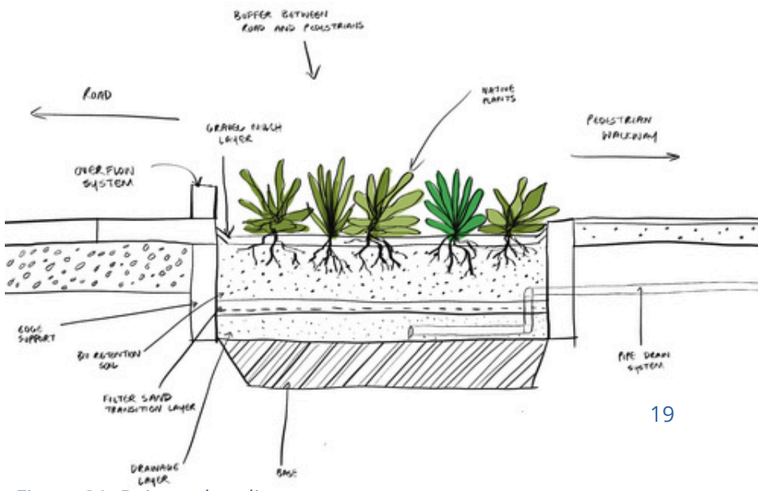


Figure 31. Raingarden diagram

FRAMEWORK STRATEGIES

Facilitate Natural Ecological Processes

STRATEGY

- Provide adequate resources for target species.
- Protect and enhance pollinator habitats.
- Plant for natural events to safely occur, such as fire or flooding.

NATURE-BASED SOLUTIONS

- Stormwater management.
- Stormwater permeability as not to affect the vegetation.
- River restoration and daylighting.
- Insect/bee hotels.
- Urban beehives.
- Urban composting.
- Pollinator gardens.

PRECEDENT

Insect Hotels



Figure 32. Hobsonville Feeders.

Year: 2018
Architect: Isthmus
Location: Hobsonville, Auckland

Through Hobsonville's coastal walk Isthmus, an architecture firm, and a collaborator Phillip Meier, created 'Homes for Creatures'. These wooden markers have carved holes through them that can host a mixed variety of wildlife.

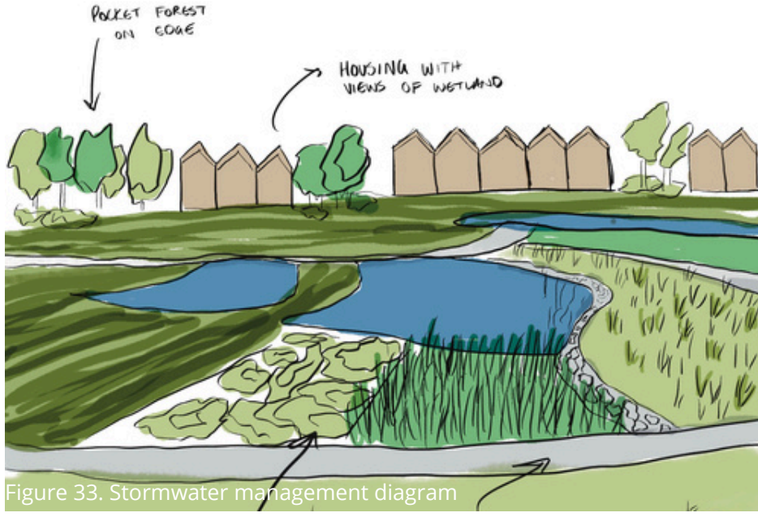


Figure 33. Stormwater management diagram

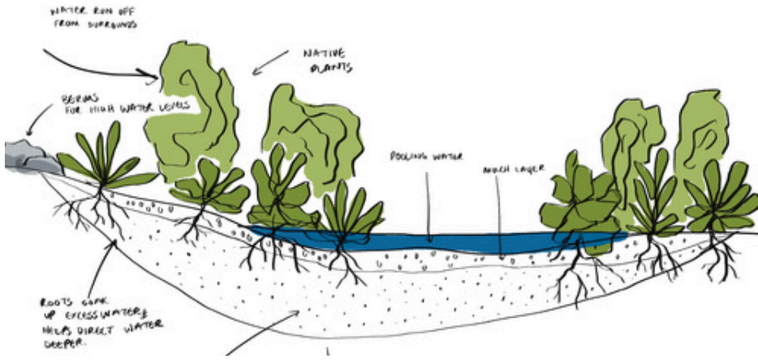


Figure 34. Stormwater permeability diagram

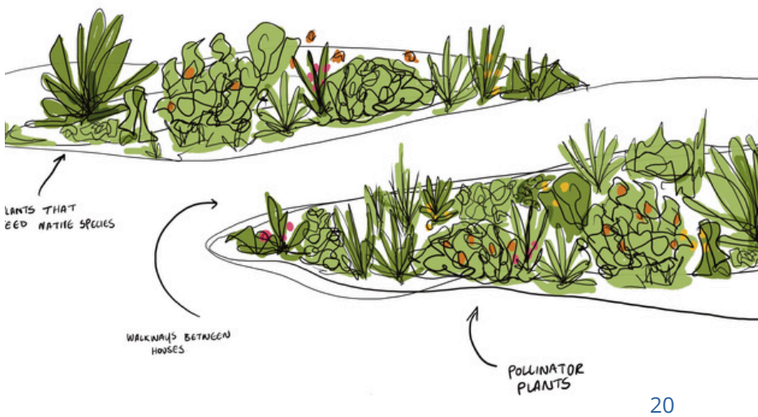


Figure 35. Pollinator garden diagrams

FRAMEWORK STRATEGIES

Improve potential for positive human-nature interactions.

STRATEGY

- Create a sense of Kaitiakitanga and Wairuatanga within the community.
- Design these ecological rich spaces around human centered activity, bring the humans in to interact.

NATURE-BASED SOLUTIONS

- Community gardens
- Urban forests

PRECEDENT

Community Gardens



Figure 36. Vegetables growing

Year: 2018
Architect: For The Love Of Bees
Location: Uptown, Auckland

For The Love of Bees is a not for profit team that have implemented a community garden in the middle of Uptown, central Auckland, This garden focuses on organic and sustainable planting.



Figure 37. Community garden diagram

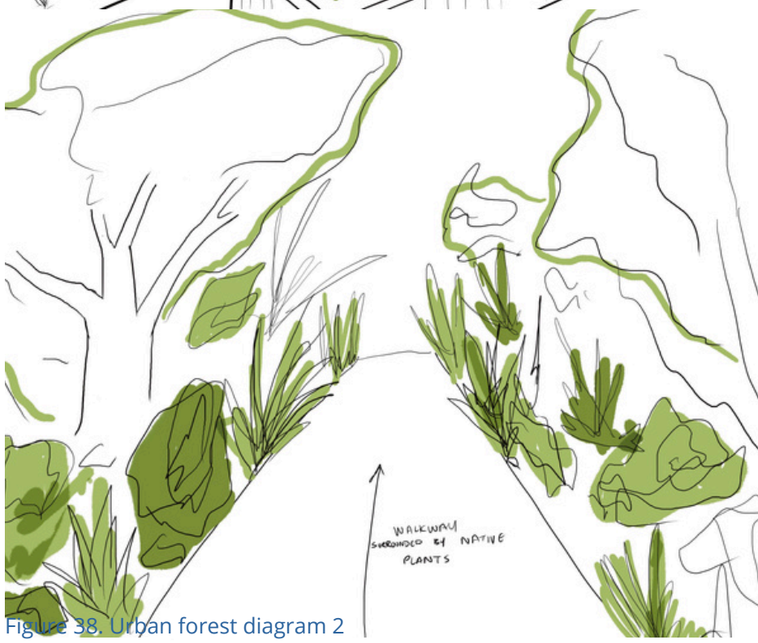


Figure 38. Urban forest diagram 2



Figure 39. Community garden diagram 2

1.7 POLICY

MEDIUM DENSITY STANDARDS

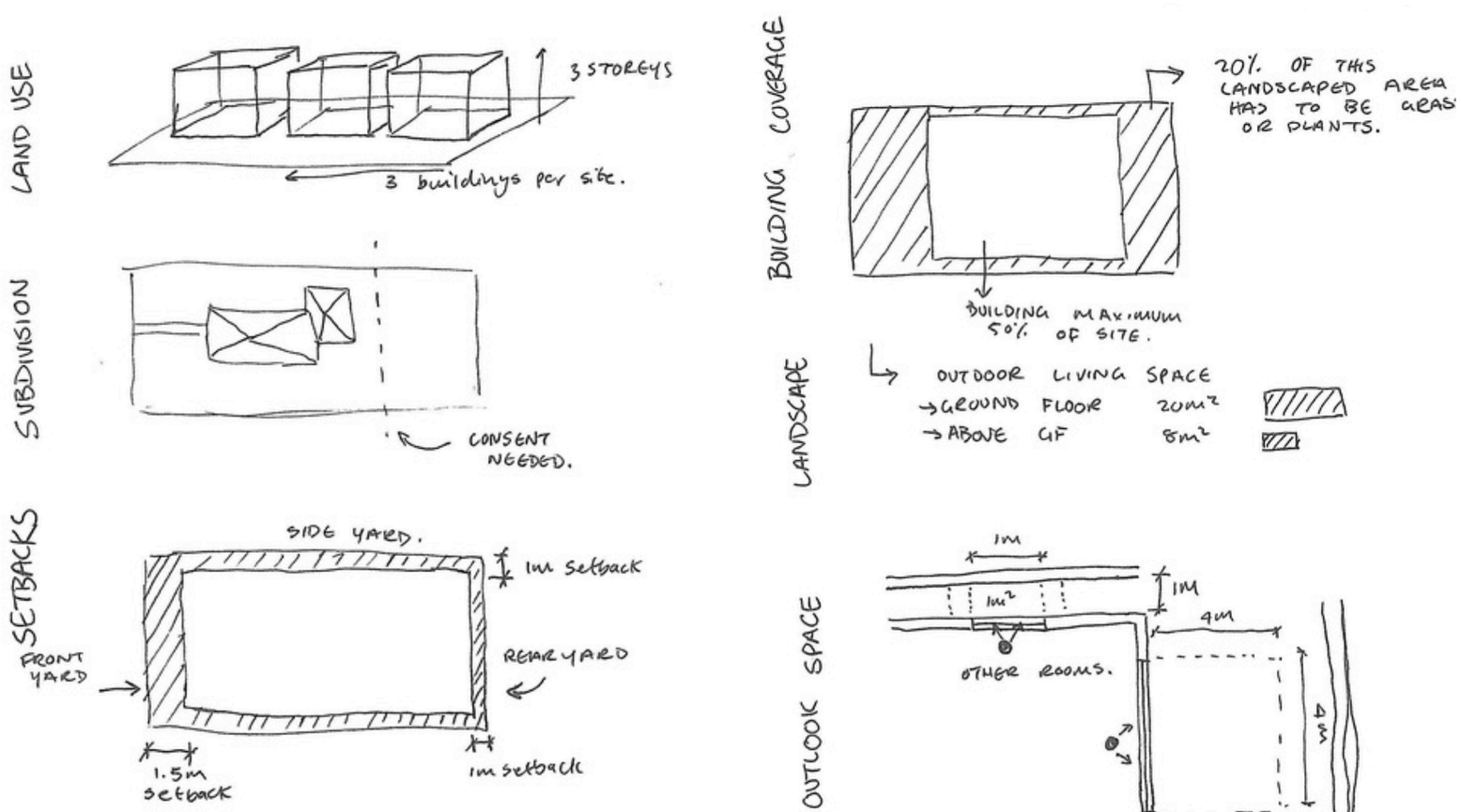


Figure 40. Medium density standards drawn

The medium density standards (Ministry for the Environment, 2022) leave very little space for vegetation that could be used for habitation from species. Moreover, the landscape area requirements that do exist can be met by planting grass, which is preferred by developers as it is relatively low maintenance but which has minimal benefit for ecosystems.
The minimum outlook space dictated by the standard does not consider human wellbeing (Parsaee et al., 2021) as all rooms except the living room can have an outlook of 1m wide and 1m deep. Pairing this with the setbacks condition and most rooms on the side of the house can legally look at their boundary fence 1m away from the window. This is a reality in many new developments, typically seen in the smaller, more affordable units.

The standard's focus on maximising building space instead of the wellbeing of occupants (Buckenberger, 2011) is the result of political interference. Each government that takes on the problem of housing reframes the standards to suit their interests (Murphy, 2015) and not focus on the well-being of occupants.

Mentioned in the standards document is the non-statutory national medium density design guide Ministry for the Environment, 2022). This design guide has a more holistic approach to residential design. It mentions key points to design to: be a part of the community, a welcoming address, a good neighbour, a well-configured building, an integrated landscape, a liveable home. The guide refers to planting native plants that contribute to ecological habitats, however, this idea is not fully developed. There is a lack of biodiversity health research used in this design guide. Overall, contrary to the standards, this design guide is more focused on human well-being instead of maximising building space.

District plans and residential design guidelines need stronger integration of biodiversity strategies. Current biodiversity policies in medium-density housing only focus on green spaces and not the buildings themselves; in other words, the guidelines restrict the urban environment's potential to increase biodiversity. Policy should encourage or require urban green infrastructure throughout the building, site, and development. There must be clear urban biodiversity goals that have been set and can be tracked after construction. To implement policy that enforces biodiversity promotion would reflect AoNZ's commitment to te tiriti, recognising the spiritual and cultural connection between people and nature (Varshney et al., 2024).

1.8 PRECEDENTS

Looking at a range of precedents in Auckland as well international examples, shows the tactics that made developments successful and others not successful in aiding ecological restoration. The developments all have their own positive factors, and combining the positive values from each precedent allows a more holistic approach to a design. The precedent's amenities, current site, historical site and success are investigated and compared.

There are two types of developments examined in this study:

Business as usual - These are what is predominately being built in Auckland. The main objectives are to get as much capital from a site, through maximising the building footprint and the number of sites on a lot. These developments leave very little space for vegetation in between.

Better developments - These developments have a focus on community living, and ecological welfare. They typically have shared facilities, central community hubs, or community gardens and they are designed for pedestrians as opposed to cars.



Figure 41. New build in Silverdale

PRECEDENTS

Business as usual



Figure 42. Stranded native in Milldale

PRECEDENTS

MILLDALE - STAGE 3D

SQM of site	11,500
No. Sites	23
SQM of individual lots	450
SQM of individual Building	220
SQM of individual gardens	150
SQM of shared Vegetation	1100
No. Bedrooms	4
No. Bathrooms	2
House types	Free hold house

Averages calculated from Google Earth, estimations and site plan.

(MILLDALE: MASTERPLAN)



Figure 43. Stage 3D.

Year Built: 2021
Designer: Milldale (Master plan), mixed property developers for individual sites.
Location: Milldale, New Zealand

Milldale is a large development of a greenfield in Auckland. This development mostly consists of housing with commercial amenities, a school and town centre that were included in the master planning of the site. The site is currently split into 20 stages, with the intention to double this number with further developments.

The master plan of the site shows a lush green underlay, which is an image of the farmlands that once occupied this land. However, in reality the site is extremely grey and filled with high amounts of non-permeable spaces and well as very little vegetation. The houses are built to the extent of their site boundaries and building regulations, featuring large non permeable driveways and decks, leaving very little space for vegetation to be planted. What space is left is used as private grass gardens. Therefore, none of the housing sites have any significant vegetation plantings. The next possible location for plantings would be in the parks and public areas of the site. These areas do have plantings of a mix of native and non-native plants; unfortunately, there is only one built park with these plantings, as well as planting along the river flowing through the site. The master plan reduces the vegetation to a single and a sliver along the river but the residential sites are not considered.

The site was previously used for agriculture as well as open vegetation. This space was home to many native species. The result of this new development spells the loss of habitat for many species. These species can still be seen trying to survive on this new site. Unfortunately, most of the species are unable to survive because of the loss of food, habitat, and increase in mortality as many have ended up as road kill.

What has been successful in Milldale's masterplan is the attention to storm water. Milldale lies within a flood plain. To combat this the designers have implemented rain gardens along almost all of the roads in the development, the impact of these was seen in floodings of 2023, when Milldale was left untouched by the floods, despite being in a flood plain. This aligns with step four "facilitate natural ecological processes" of the BSUD.

Designed stormwater systems that worked with the existing natural process of water movement.

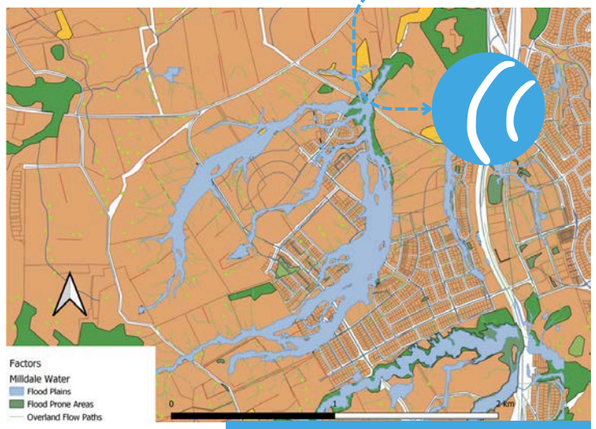


Figure 44. Stormwater map of Milldale

FACILITATE NATURAL ECOLOGICAL PROCESSES

These rain gardens have also aided the goal to create a safe neighbourhood by separating the pedestrians from the cars. The designers have also helped reduce the car speed in the area with multiple speed bumps and raised roundabouts. However, to better their road safety further, the planners could have reduced the number of roads through the site and left more space for pedestrians.

A new method was used to finance the development: housing charges. This was used to fund the bulk infrastructure (Squiresa et al., 2021). This allows housing developments to be built at a larger and faster rate than usual as it is paid for by private and government funding (Auckland Plan 2050 Three Yearly Progress Report, 2020).

Overall, Milldale has success in their design of stormwater systems, community safety around roads, and the speed and scale of producing the neighbourhood. However, from an ecological stand point, Milldale has destroyed the original habitat and evicted native species from the natural habitats. The full scale of the development involves 296 hectares of land that will be taken from native species, which would represent significant loss.

PRECEDENTS

HOBSONVILLE - HUDSON SECTION 9

SQM of site	40,000
No. Sites	90
SQM of individual lots	90
SQM of individual Building	70-190
SQM of individual gardens	15
SQM of shared Vegetation	1600
No. Bedrooms	2-4
No. Bathrooms	1-3
House types	Townhouse and apartments

Averages calculated from Google Earth, estimations and site plan.
(Precincts)

Hobsonville Point has been split into 35 precincts featuring a range of residential and commercial lots, including a primary school, secondary school, early learning centre, and a park. The masterplan of the site pays attention to the community environment of the site and strives to promote a strong sense of community between the residents. Other factors such as access to public transport and walking radius were also considered. From research, Hobsonville residents expressed a high level of satisfaction to having views of nature and green landscaping around their residence (Haarhoff et al., 2019). This is in line with the BSUD's step five "improve potential for positive human-nature interactions".

The focus of this review now shifts on to precinct 9, called Hudson on the masterplan, which is a medium to high density lot. There are 104 townhouses and 35 apartment units. The townhouses include gardens that are around 15m2 in size and have predominantly been planted with grass. As a result, these gardens act as a permeable surface that do nothing to help ecological restoration. The park is 4685m2 and includes well grown vegetation on 800m2 of the park. The rest of the park consists of grass, courts, and playgrounds. The site also includes parking spaces for the townhouses which have all been concreted and are non-permeable.

Hobsonville Point has been successful in the application of medium to high density housing and the site's wider transport connection. A strong sense of community has also been formed (Haarhoff et al., 2019). Despite the residents feeling satisfied by the view of nature, from an ecological restoration view point, Hobsonville point is not aiding ecological health as only a small amount of green space was included in the design, most of which consists of grass plantings.

Creating spaces for the community to engage with nature by having walkways along native bush.



Figure 45. Hobsonville Point Map

IMPROVE POTENTIAL FOR POSITIVE HUMAN-NATURE INTERACTIONS

PRECEDENTS

Better developments



Figure 46. Earthsong home exterior

PRECEDENTS

COHAUS

SQM of site	2500
No. Sites	20
SQM of individual lots	70
SQM of individual Building	70
SQM of individual gardens	0
SQM of shared Vegetation	1500
No. Bedrooms	2-4
No. Bathrooms	1-2
House types	Apartments

Averages calculated from Google Earth, estimations and site plan.

Year Built: 2021
Architect: Studio Nord
Location: Grey Lynn, Auckland

Cohaus was developed by a group of people who wanted to create housing that focused on community and resource use instead of profit. Motivated by the groups keen awareness of Auckland's housing crisis, they decided to design townhouses and apartments as opposed to stand alone houses as those would take up more space and leave less room for community areas.

In choosing the site, the developer's criteria were that it had to be close to public transport and local amenities. Historically, the site was a lodge, and the villa was able to be repurposed on the site (Cohaus).

The site was then developed into a 19-unit apartment and townhouse mix. These are angled around a shared garden courtyard , giving the residents a place to interact and become a community (Davis, 2022). The site also has shared amenities such as a guest bedroom, common room, storage, laundry, and bike parking. In a "business as usual" development model, these facilities would normally be included into each unit, taking up precious space. Turning these features into shared amenities saves space in the units and also creates shared spaces for the residents to engage with one another.

MAINTAIN AND INTRODUCE

FACILITATE DISPERSAL

FACILITATE NATURAL ECOLOGICAL PROCESSES

IMPROVE POTENTIAL FOR POSITIVE HUMAN-NATURE INTERACTIONS

Figure 47. Cohaus exterior



PRECEDENTS

MAINTAIN AND INTRODUCE

MINIMISE THREATS & ANTHROPOGENIC DISTURBANCE

FACILITATE NATURAL ECOLOGICAL PROCESSES

BRASSERHOUT

SQM of site	138,196.
No. Sites	295
SQM of individual lots	70
SQM of individual Building	70
SQM of individual gardens	80
SQM of shared Vegetation	30,000
No. Bedrooms	2-4
No. Bathrooms	1-3
House types	Mixed

Averages calculated from Google Earth, estimations and site plan.



Figure 48. Brasserhout

Year Built: 2003
Architect: DP6
Location: The Hague, The Netherlands

Brasserhout is a neighbourhood development that was built around a stream of waterways in the Netherlands. It is a medium to high density model, but through thoughtful design it has the feel of a low to medium density neighbourhood.
The designers strategically placed the units around the waterways, with pathways along and through the site. There is limited car access and car parks are hidden by green shrubs. The design boasts an increase in permeable surfaces and a decrease of concrete pavements (“Brasserhout, The Hague, The Netherlands”n.d.).

Water movement through the site was well thought out. Gutters and underground drain systems address the BSUDs “minimise threats & anthropogenic disturbance” as well as “facilitate natural ecological processes”. Biodiversity was also addressed by the use of banks along the river, which provide food and a place to live to local species. The banks around the water were designed as green riparian zones which purifies the water running through and allows further habitat for species (Xing, 2017), further working to the BSUD framework addressing the principle of “maintain and introduce”.

Although the figures seem low for the amount of vegetation, it is a strong example of an effective nature-based solution as opposed to developments featuring high volumes of grass gardens.

PRECEDENTS

EARTH SONG

SQM of site	16,000
No. Sites	32
SQM of individual lots	56-122
SQM of individual Building	56-122
SQM of individual gardens	0
SQM of shared Vegetation	12,000
No. Bedrooms	1-4
No. Bathrooms	1-2
House types	Mixed

Averages calculated from Google Earth, estimations and site plan.

Year Built: 1997
Architect: Bill Algie
Location: Ranui, Auckland

Earth Song is an eco-village located in Rānui, Auckland. The development is a co-housing structure that enables sustainable living. This development was funded and created by individuals who wanted change. The individuals had the shared belief in a healthier and more sustainable neighbourhood.

Location was vital for this village and a retired orchard village was the chosen lot. The area was chosen because the developers wanted a site that was close to shops, hospitals, and other amenities so that residents can choose to walk instead of drive. The masterplan of the site pushes cars to the edge of the village and centres the design around people. Pedestrian paths weave through grown vegetation instead of crossing roads, creating a safe space for children to play and neighbours to interact.

The buildings themselves were built to use passive solar climate control, north facing to be energy efficient, and materials were chosen for their low impact lifecycle and their environmental impact on the site.

The developers believed in a society that was reconnected and interdependent on those around them, leading them to design a space that encourages social interactions through shared gardens, community spaces, and social organisations (Allison, 2013).

FACILITATE DISPERSAL

MINIMISE THREATS & ANTHROPOGENIC DISTURBANCE

MAINTAIN AND INTRODUCE

FACILITATE NATURAL ECOLOGICAL PROCESSES

IMPROVE POTENTIAL FOR POSITIVE HUMAN-NATURE INTERACTIONS

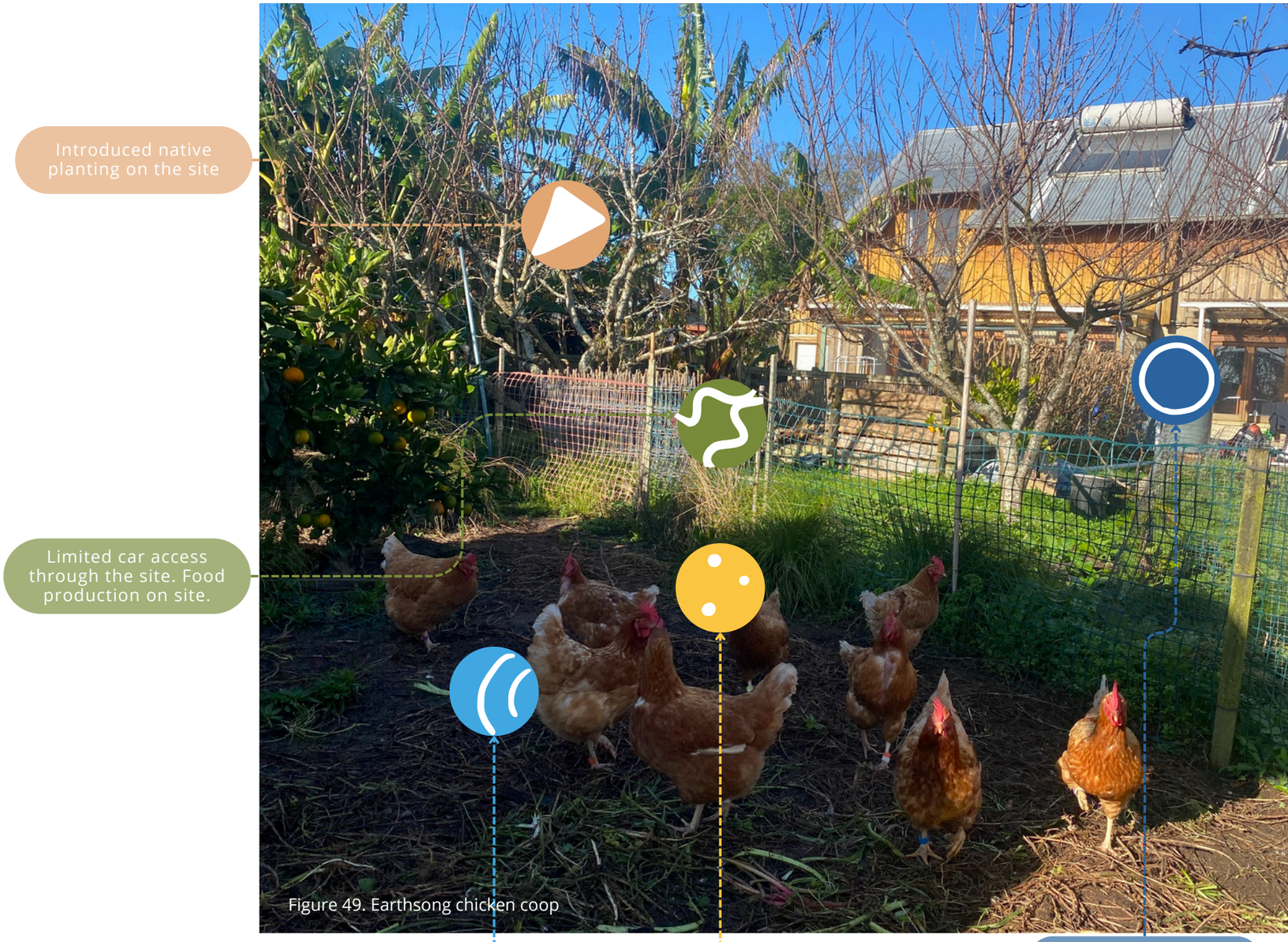


Figure 49. Earthsong chicken coop

PRECEDENTS

EARTH SONG SITE VISIT

In June, a site visit was conducted at Earth Song. The site has been carefully laid out on the land to create an oasis from the neighbouring suburbia.

The site was designed to create a strong sense of community with a central community house. The building has shared amenities including a laundry room, kitchen, dining, library, lounge, and mixed use spaces. All residents have roles in the maintenance and operation of the development. These roles are small enough to not cause undue stress but instead give residents a purpose and allow them to participate in the site's wellbeing, which creates a sense of being a part of a community.

The units are orientated and laid out to create nodes between units. These nodes are smaller shared spaces shared between two to four families, creating semi-private space. Having such smaller nodes is important in bigger developments as they encourage interaction between neighbours.

The buildings are made out of a mix of timber and rammed earth. The use of these natural materials further helps the developments' immersion into nature.

Most of the plantings on the site consist of edible plants but native plants are also featured. The abundance of edible plants has positive implications on the residents, but it has a less targeted impact on biodiversity. Edible plants increase biodiversity only as an after effect, while this can be considered to be a good strategy, biodiversity could have been increased more had a different approach been taken.

The site conditions has been considered through planning of the stormwater. There are swales along the walkways leading to the lower side of the site into a wetland.

Earth Song has been carefully crafted to encourage residents to engage with the surrounding nature as well as with each other, creating a happier community and thriving environment.



Figure 50. Earth song site visit - external buildings



Figure 51. Earth song site visit - Zoomed out buildings



Figure 52. Earth song site visit - View through nature



Figure 53 - Earth song site visit -Inside the common house



Figure 54. Earth song site visit - Plants on site



Figure 55. Earth song site visit - Stormwater management

PRECEDENTS

COMPARISON OF PRECIDENTS

	Milldale - 3D	Hobsonville Hudson	Cohaus	Brasserhout	Earth Song
SQM of site	11,500	40,000	2500	138,196	16,000
SQM of Footprint	5060	6300	1400	20,658	1920
• **Percentage**	44%	15%	56%	14%	16%
SQM of Garden	4550	2950	1500	53,600	12,000
• **Percentage**	39%	7%	60%	38%	75%
No. of lots	23	90	20	295	32
units/acre	8.21	9.18	32.78	8.67	8.20

Averages calculated from Google Earth, estimations and site plan.

Figure 56. Table of comparison of precedents

SQM OF SITE

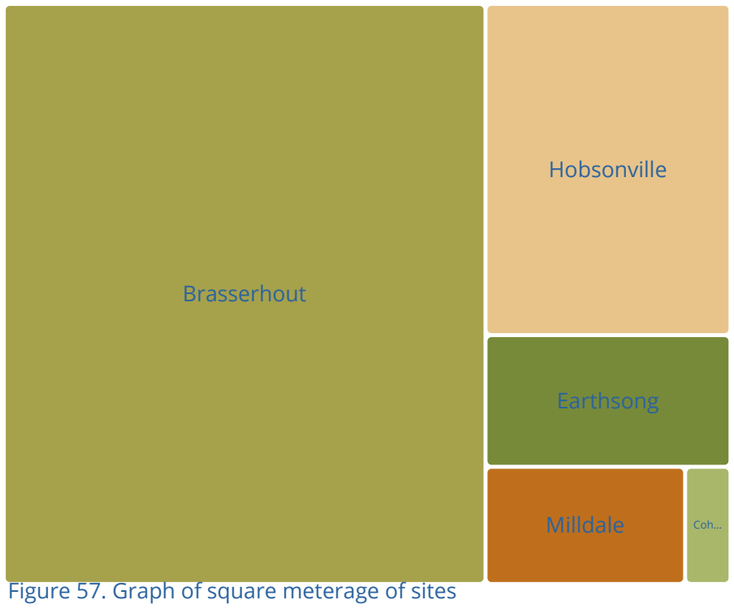


Figure 57. Graph of square meterage of sites

Brasserhout is a medium to high density development with apartments which therefore spreads across a larger section. Earthsong is larger than Milldale.

PERCENTAGE OF GARDEN

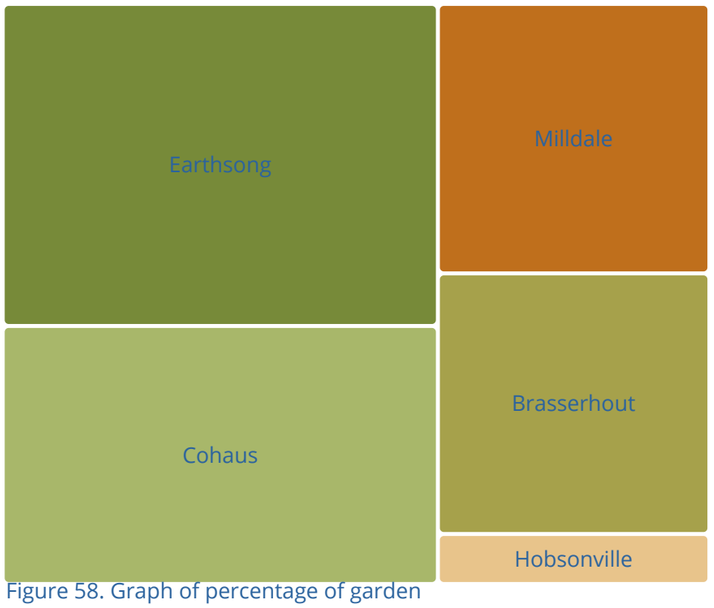


Figure 58. Graph of percentage of garden

Earthsong and Cohaus have the largest percentage of garden. This is interesting as Cohaus has the smallest site. Hobsonville is the second largest site but has the least amount of garden space. Brasserhout is showing a similar garden percentage to Milldale; however, Brasserhout has included complex native plantings whereas Milldale has grass verges and private gardens that mostly consist of grass. Therefore, Brasserhout has created habitat for biodiversity. A future potential path of study would be to look into the species and compare through this instead of overall garden.

UNITS PER ACRE

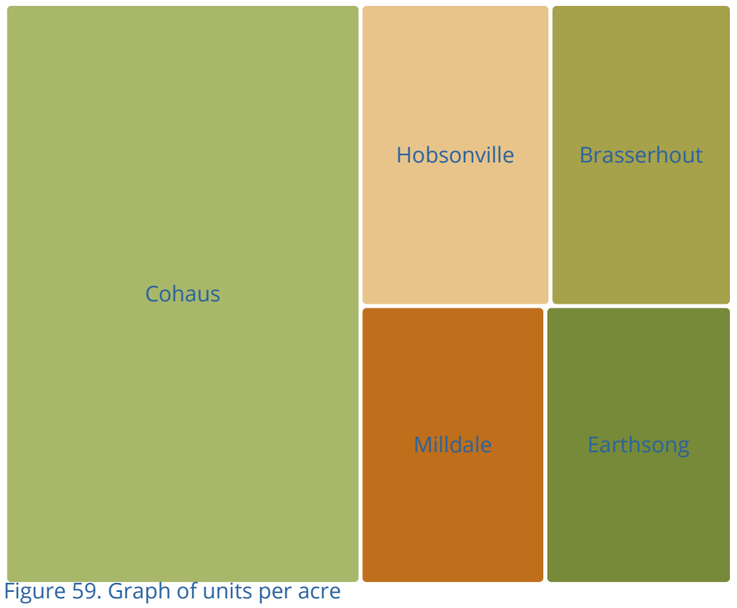


Figure 59. Graph of units per acre

Cohaus has the most units per acre while also having a large percentage of garden space. Earthsong has the same amount of units per acre as Milldale. These observations are important because they show that developments can implement more green space while keeping the same number of lots per square meter. This means that the implementation of building design for biodiversity does not mean that housing space has to sacrificed; instead, this approach can increase biodiversity and offer housing to the same number of people as conventional approaches at the same time.



1.9 METHODOLOGIES

The methodology used through this thesis will be Design Led Research. Design Led Research is the applied, tested, verified, and validated method of research through design as well as research for design (McRobert, 2018). Design-led research follows key stages of initiate, discover, interpret, ideate, refine, and implement. These stages run in a circular interconnected path, to ensure design and research are collaboratively intertwined. This research method allows the knowledge learnt to be outputted through design and contextualized with real-world constraints. (McRobert, 2018). This further verifies and validates the research .

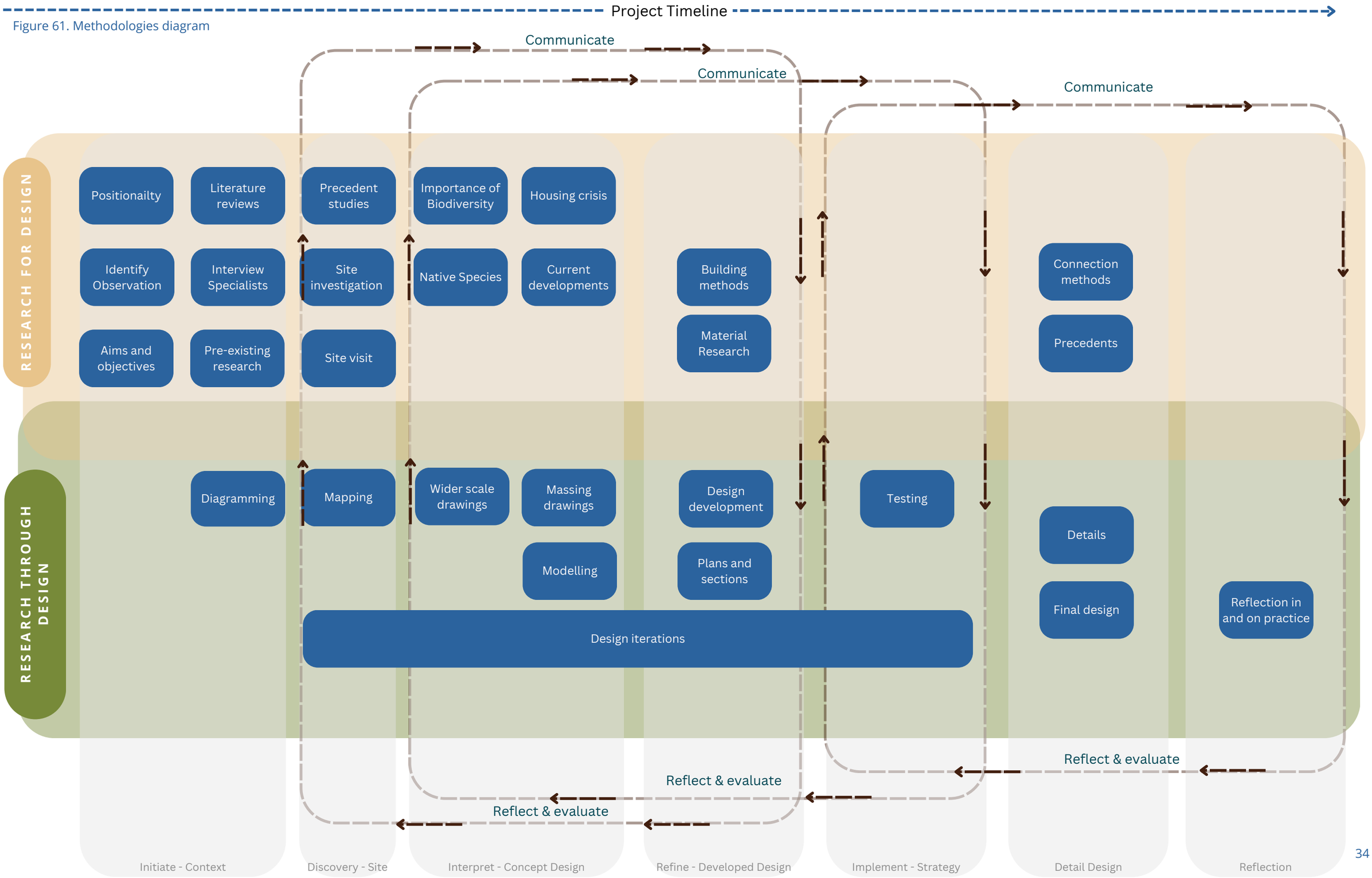
Design for research and design through research will be two main tactics that will run in parallel through the project, aiding the other in further development. The following diagram visualises the cross over and iteration between the stages, this is to ensure the decisions are being tested, justified, and rethought (Groat & Wang, 2002).

AIMS	OBJECTIVES	METHODOLOGY	THESIS SECTION
Analyse the existing building design for biodiversity	• Compare business as usual buildings with biodiversity focused designs. • Apply parameters from existing development quotas.	• Precedent Review • Policy Review	• Section 1.4 • Section 1.7 • Section 1.8
Demonstrate how to design for both human and non-human's wellbeing.	• Distinguish what requirements NZ native species need to survive. • Experiment with concept designs to species requirements.	• Discovery and research • Concept design • Discussion	• Section 2.1 • Section 3.2 • Section 4
Experiment with strategies to enhance the community's sense of kiatiakitanga (stewardship) to the ecosystems.	• investigate the disconnect between humans and the natural environment. • Explore architect that reconnects humans and the natural environment,	• Literature review • Concept design	• Section 1.3 • Section 3.2
Identify a design matrix for biodiversity focused housing that can be used in future developments.	• Analyse nature-based solutions used to increase biodiversity • Compile urban design strategies	• Context - framework • Design strategies • Discussion	• Section 1.6 • Section 3.1 • Section 4

Figure 60. Table of methodologies

METHODOLOGIES: DESIGN LED RESEARCH

Figure 61. Methodologies diagram



1.10 CRITICAL REFLECTION



Figure 62. Water on soil

The literature review presented in this chapter provided an overview of the complex relationship between humans and nature. It analysed the connection between biodiversity loss, climate change, and urbanisation. The issues discussed raise crucial questions about our business-as-usual model developments and the inadequacy of our policies. Developers are unlikely to change how they design unless they are required to by policy changes. The paradigm shift from anthropocentric to eco-centric thinking is key in biodiversity conservation and requires a deep societal change that architecture can support.

CHAPTER TWO

CONTEXT:

THE GROUND WORKS

Chapter two explores Aotearoa New Zealand’s biodiversity. This research aims to understand, through a thorough species investigation, species' requirements for survival.

A comparison of site types will lead to the mapping strategies to determine a relevant site. This strategy will be tested in the Auckland region to identify the location for a medium density development design exploration. This location will be further analysed to understand the site’s conditions.

Figure 63 Car hidden by nature

CONTEXT

2.1 BIODIVERSITY

Auckland's urban green space dropped 30 per cent per person between 1980 and 2016 (Upton, 2023), which is alarming. People in urban areas will have less and less exposure to nature if this trend continues. This is problematic for humans and has long-term implications for survival (Rafferty, 2010). For Aotearoa's fauna and flora, this decline in urban green space could result in a direct decline in species' habitat. According to the 2020 report from the Department of Conservation, vascular plants, lepidoptera, lichens, reptiles, coleoptera, macroalgae, powelliphanta, marine invertebrates, orthoptera, and freshwater invertebrates have seen a marked decline in populations. Birds and freshwater fishes have had declines and increases. The populations of bats and marine mammals have increased (Department of Conservation, 2020).

Threats to biodiversity are largely from land use change, human activity, animal pests, and weeds (Pedersen Zari, 2018a). To increase biodiversity in Aotearoa, there needs to be targeted recovery work for threatened species (Green & Clarkson, 2005) and ecosystem habitats need to be restored and maintained. Aotearoa New Zealand has seen success in restoration in urban areas. For example, Zealandia is a fenced urban ecosanctuary set across 44,000 hectares of now biodiversity rich land in Wellington. The sanctuary has been successful in increasing native species populations (*"The story of Zealandia is told by its founder",* 2019). The sanctuary has achieved this through strict pest control, community conservation, and strong biosecurity (Caballar, 2021). Zealandia's species fly over the fence and through the rest of Wellington. There is an opportunity to create stepping stones (habitat for species to move between) to and from this urban ecosanctuary to encourage wildlife through the city and urban developments (Thompson, 2020).

The current design objectives for medium-density developments tend to conform to a human-centric approach. To design a space that conserves and enhances native biodiversity there needs to be a multi-species stakeholder approach (Saroglou et al., 2024), where all species are designed for equally and where a collective solution for all species is found. This formulates a design approach that allows for the introduction of ecological knowledge into architecture.

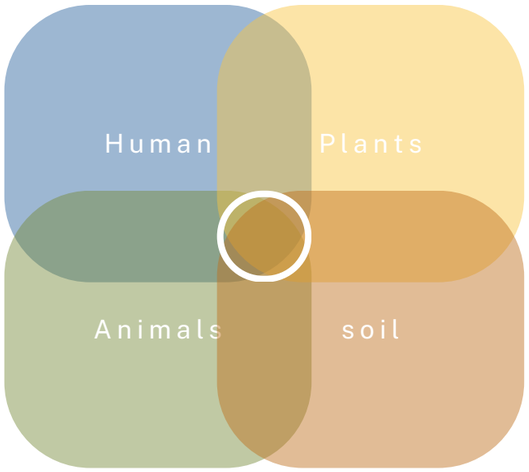


Figure 64. Multistakeholder diagram

Figure 65. Tuatara in bush

2.1.1 SPECIES STRATEGY

When looking at species selection for conservation, it is common for designers or conservationists to default to an “umbrella species” method. An umbrella species is a species whose conservation indirectly supports the protection of a variety of species within the same habitat (Roberge & Angelstam, 2004). By prioritising the conservation of an umbrella species, conservation efforts will also safeguard other parts of the ecosystem. However, this is not always the case, and if not correctly researched, the impacts on the non-targeted species can be detrimental (Carlise et al., 2018). Species chosen to be the umbrella species are often keystone species. Keystone species are vital parts of the structure and functioning of the ecosystem. The loss of a keystone species can cause detrimental effects on an ecosystem such as the collapse of ecological relationships which then affects other species’ survival. Often, the keystone species chosen to be the umbrella species are species charismatic to the human eye (Simberloff, 1998), which can mean that the wrong scientific choice is made. The umbrella species method can be applied effectively, it just requires more research and diligence (Conniff, 2018).

Instead, an alternative method can be taken to design for conservation in medium-density developments. Such an alternative method involves the Identification of species that survive in the site’s climate and conditions, species that have a population within reach of the site (unless alternative conservation efforts are made), and species that can survive in urban areas. From these identified species, a representative from the key groups is selected and further analysed to understand their habitat, threats, food source, and movements.

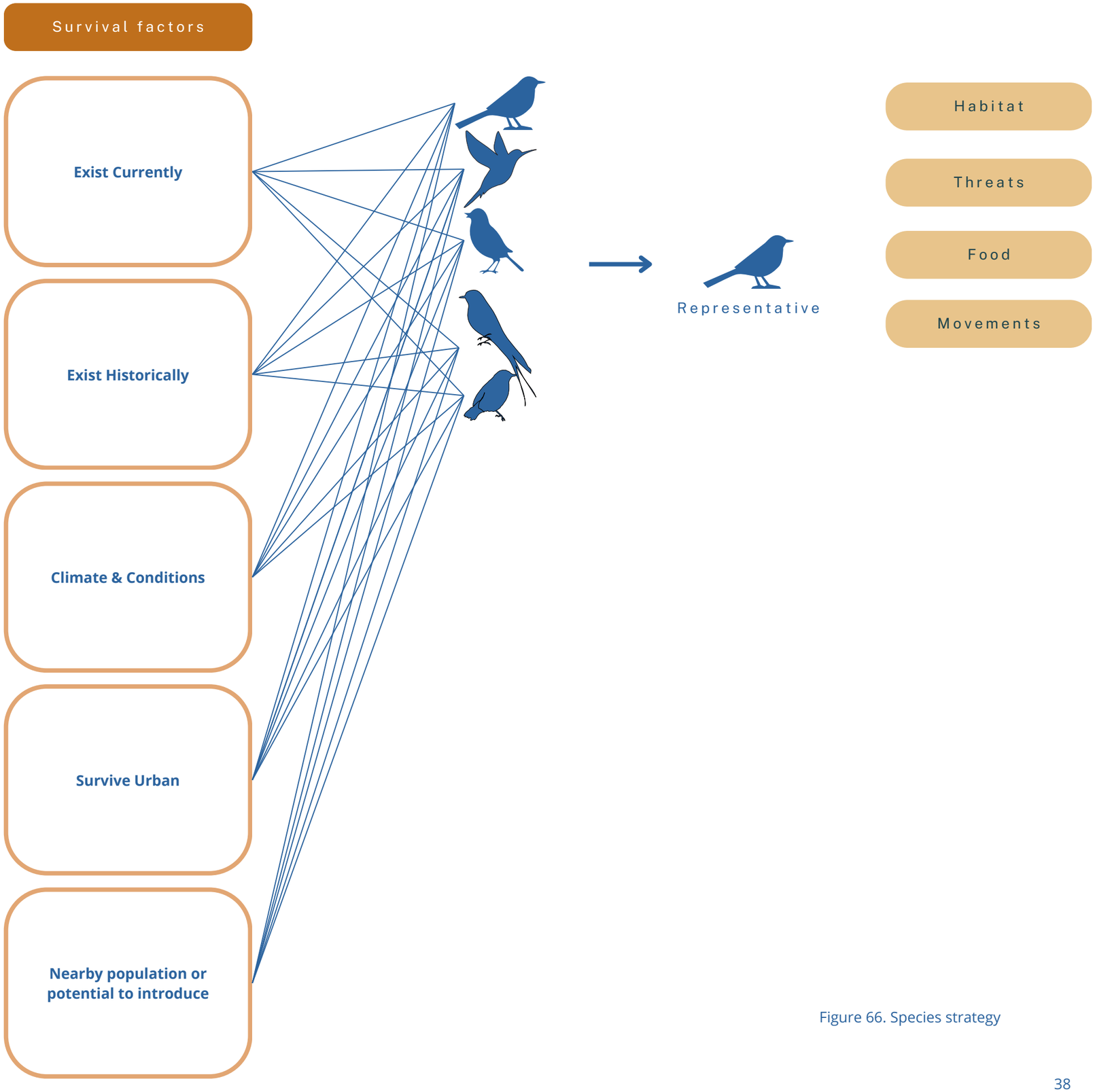


Figure 66. Species strategy

SPECIES INVESTIGATION
Birds

pīwakawaka/ Fantial

THREATS

- Humans (urbanisation)
- Cats
- Rats
- Stoats
- Myna

FLIGHT PATHS

- Intelligent - not likely to fly into high-rise window.
- Can not find research on how far they fly.
- For comparison Tui fly's a radius of 15km for feeding.



Figure 67. Fantail

HABITAT

- Has been successful in adapting from native forest habitat to range of urban areas, including gardens.
- Nests are constructed of mosses, wood fibres, dried grasses, fern scales and cob webs. The nets are protected by foliage from above. With an average of 10cm trail below the nest of excess material.
- Prolific breeding, helps increase the rate of survival.

FOOD

- Diet of a range of small insects, occasionally fruit.
- Hunting methods:
- Hawking - Long distance approach. In clear plantings.
- Flushing - used in denser plantings.
- Feeding associations: Follow other species to get any insects disturbed in their movements.

(Dawson, 2000) (New Zealand fantail | Pīwakawaka) (Fantail/pīwakawaka)

Kererū

THREATS

- Humans (urbanisation)
- Cats
- Rats
- Stoats
- Myna
- Possums
- Hunting (humans)

FLIGHT PATHS

- Can fly long distances over multiple days.
- Able to move between suburbia.



Figure 68. Kererū

HABITAT

- Has been successful in adapting from native forest habitat to range of urban areas.
- Sit on top of taller shrubs or trees.
- Raise a single chick at a time and three per season.

FOOD

- Kererū are vital for the ecosystem as they eat fruit from Taraire and Karaka native trees. The seeds from these fruits are then passed which helps establish new plantings.
- Kererū also eat leaves, twigs and shoots.

(Emeny et al., 2009) (Williams et al., 2004) (Gaskin & Rayner, 2013)

Critical reflection:
The Kaka was researched as an option but the closest established population was in Tawharanui which is too far a distance. There would need to be stepping stones designed in between first.

Tree wētā

THREATS

- Humans (urbanisation, habitat destruction)
- Cats
- Rats
- reptiles
- Birds
- Mustelids
- Hedgehogs
- Bats

MOVEMENTS

- Unknown migration patterns.
- Stay in groups.
- They run and jump.
- Can not fly.
- Hide during day and come out at night.

HABITAT

- Tree tunnels.
- Forest, gardens or shrubs.
- Create holes under stone or logs.

FOOD

- Leaves, fruit and occasionally small insects.

(Sherley, 1998)



Figure 69. Tree wētā



Figure 70. Copper & Ornate Skink

Copper & Ornate Skink

THREATS

- Humans (urbanisation, habitat destruction).
- Cats
- Rats
- Stoats
- Weasels
- Exotic skinks
- Hedgehogs
- Resource competition

MOVEMENTS

- Unknown migration patterns.

HABITAT

- Compost heaps.
- Rock gardens.
- Does not bask in the open or spend much time in open areas such as gardens and gravel.
- Thigmothermic.
- Annual mating and reproduction, not all females reproduce annually. The litter size is from one to four.

FOOD

- Diet of a range of spiders, slaters, sand-hoppers, harvestmen, beetles, crickets, mites, flies and rarely soft fruit.

(Bell et al., 2018) (Society)

Tecomanthe speciosa

THREATS

- Currently threatened species.

Shade from other plants growing over.

MOVEMENTS

- Pollinated by both native and exotic birds.

HABITAT

- Climbing plant.
- Tubular flowers bloom in winter.
- Needs a strong structure.
- Good sun exposure.
- Rich moist soil.
- Roots to be shaded.
- Can handle wind

FOOD

- Mulch annually.
- General purpose fertiliser in spring.
- May need restrictive pruning.

(Threatened Native Plants)



Figure 71. Tecomanthe speciosa



Figure 72. Hebe bishopiana

Hebe bishopiana

THREATS

- Vulnerable species.
- Threat from growth of mist-flower and the pampas grass (exotic plants).
- Damage from road works, urbanisation and tramping.
- Weeds.

MOVEMENTS

- Pollinated by both native and exotic birds.

HABITAT

- Grows to be around 1m tall.
- Typically found on the sides of the streams as well as the coastal cliffs in the Waitakere ranges.
- Narrow leaf with purple stem to mauve flowers.
- Abundant moisture.
- Semi-shaded.
- Need humidity and lack of air movement.
- Draws high insect activity.

FOOD

- Cluster plants.
- Water schedule.

(Threatened Native Plants) ("Hebe bishopiana and Hebe obtusata," 2012) (De Lange, 1996)

SPECIES INVESTIGATION

Plants - Trees

Tōtara

THREATS

- Loss of habitat

MOVEMENTS

- Pollinated by both native and exotic birds.
- Readily regenerates.

HABITAT

- Grows to be around 30m tall.
- Prefers well drained soil.

FOOD

- Water schedule.

(Totara (Podocarpus totara))



Figure 73. Tōtara



Figure 74. Kōwhai

Kōwhai

THREATS

- Loss of habitat.
- Exotic weeds and grasses.
- Pests while seedlings.

MOVEMENTS

- Pollinated by both native and exotic birds.

HABITAT

- Grows to be around 25m tall.
- Diverse habitat from flood plains to suburbia.
- Prefers dry slopes with sunshine.

FOOD

- Water schedule.
- Feeds Native birds.

(Kōwhai)

Critical reflection:
There is a lack of concrete research into these species in an urban area and what requirements are needed.

2.1.2 SOIL BIODIVERSITY

Soil is a complex habitat that accounts for a large percentage of biodiversity, housing a diverse range of organisms (Anthony et al., 2023; Thakur, 2020). It is therefore important to include it in any plans aimed at restoring and conserving biodiversity. To protect soil and its biodiversity it is crucial to understand how soil functions and why it is good for humans.

Soil biodiversity consists of the following main groups: microbes, microfauna, mesofauna, macrofauna, and megafauna. Each group has its function in the soil ecosystem (Wall et al., 2012). Soil biodiversity has been impacted by anthropic activities such as land-use change, urbanisation, agriculture, and extreme weather events resulting from climate change (Wagg et al., 2014). This has caused a degradation in soil biodiversity and loss of ecosystem functioning and provisioning (Nielson et al., 2015). The richness of soil affects human, plant, and animal health through a wide scope of functions (Wall et al., 2015). Biodiversity-rich soil is good for humans because it helps control disease, cleans the air, impacts food growth quality and quantity, filters water, removes some pathogens and heavy metals, and aids bioremediation. Soil biota are responsible for processes such as decomposition, mineralisation, and nutrient cycling along with other ecosystem services that are necessary for human health (Li, 2018). This importance indicates the need for a design that incorporates consideration of soil biodiversity health in urban settings, ensuring the conservation and restoration of healthy soil as well as exposure and access for plants, animals, and humans to this biodiversity-rich soil (Sun et al., 2023).

During excavation on site, diggers go through the site and scrape back all the topsoil to allow for a flat compacted building site as well as excavate for foundations. This biodiversity-rich topsoil, which has been developing on the land for many millennia perhaps, is either repurposed on other sites, disregarded and used as landfill cover, or sealed over with non-permeable materials (Magnusson et al., 2015). Post-construction, a thin layer of imported topsoil may be added back so vegetation can be planted (often grass). This soil may be made of a very different biome to that which was removed. Repairing this soil biodiversity in such scenarios is extremely difficult (Turbé et al., 2010). Instead, the practice of compacting and removing topsoil could be avoided, and/or soil taken during excavation could be stored and reused on the site later (Katsumi, 2014).



Figure 75. Planting in soil

2.1.3 SPECIES INVESTIGATION

Design response exploration

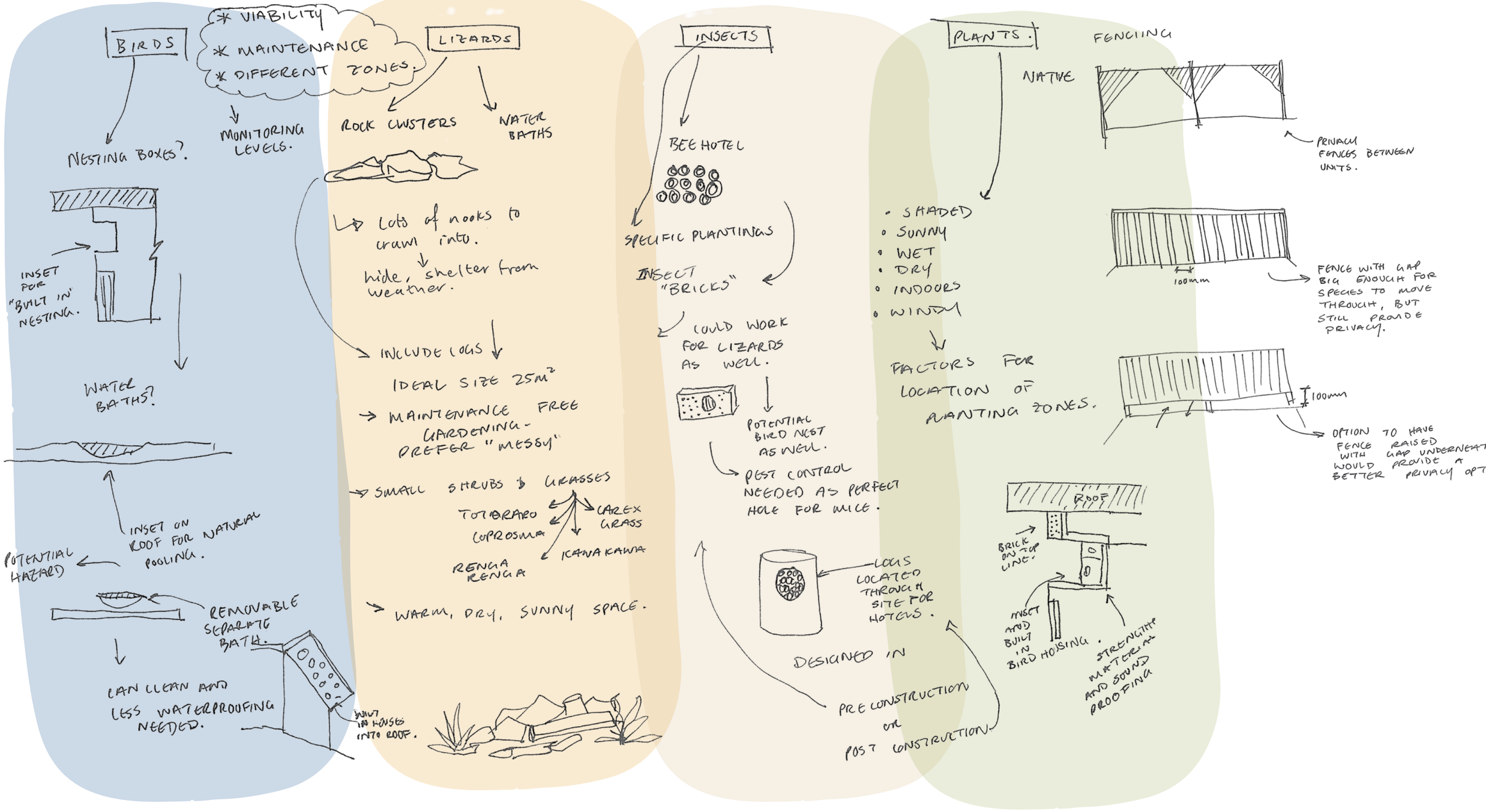


Figure 76. Design response diagram

SPECIES INVESTIGATION

2.1.3.1 Design response - birds

VEGETATION COMPLEXITY

To improve and encourage bird species through an urban site the complexity of vegetation is important. There should be a diverse range of plantings that create habitat, food, cover and nesting opportunity (Cerra & Crain, 2016). Within this vegetation there should be different scales of exposure to humans to allow birds their space if required.

WIDER ECOSYSTEM

It is important to think beyond the site to the wider ecosystem of the region. This shows the connections to and from the site for the species, allowing stepping stones. These stepping stones help the dispersal of seeds through the area (Saura et al., 2013).

NESTING BOXES

Previous research has shown that nest boxes may not always be the best solution for nesting success, in fact, predators can recognise these boxes over time as a resource. Therefore, nesting boxes are only more effective than natural nesting sites in predator-free zones (Miller, 2002).

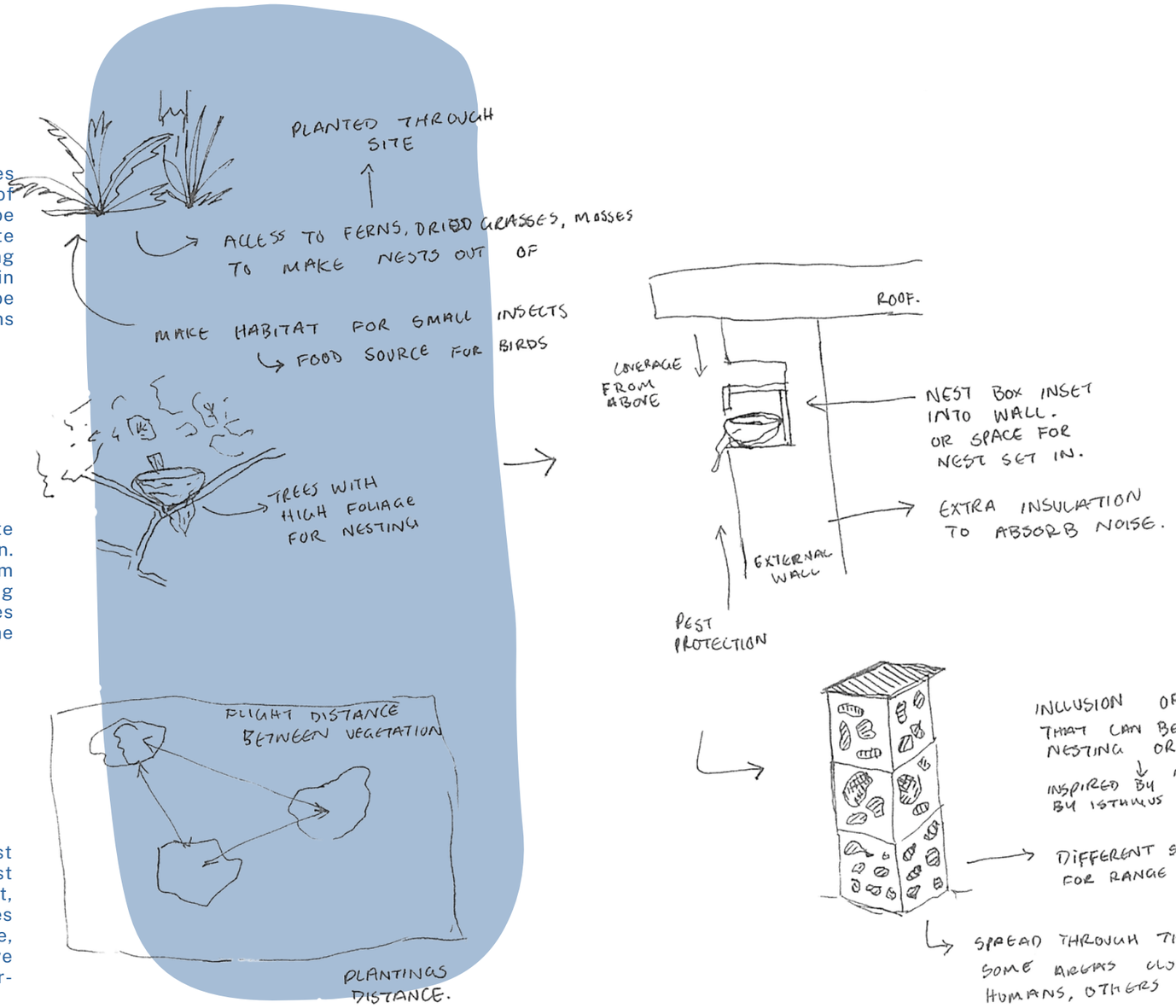
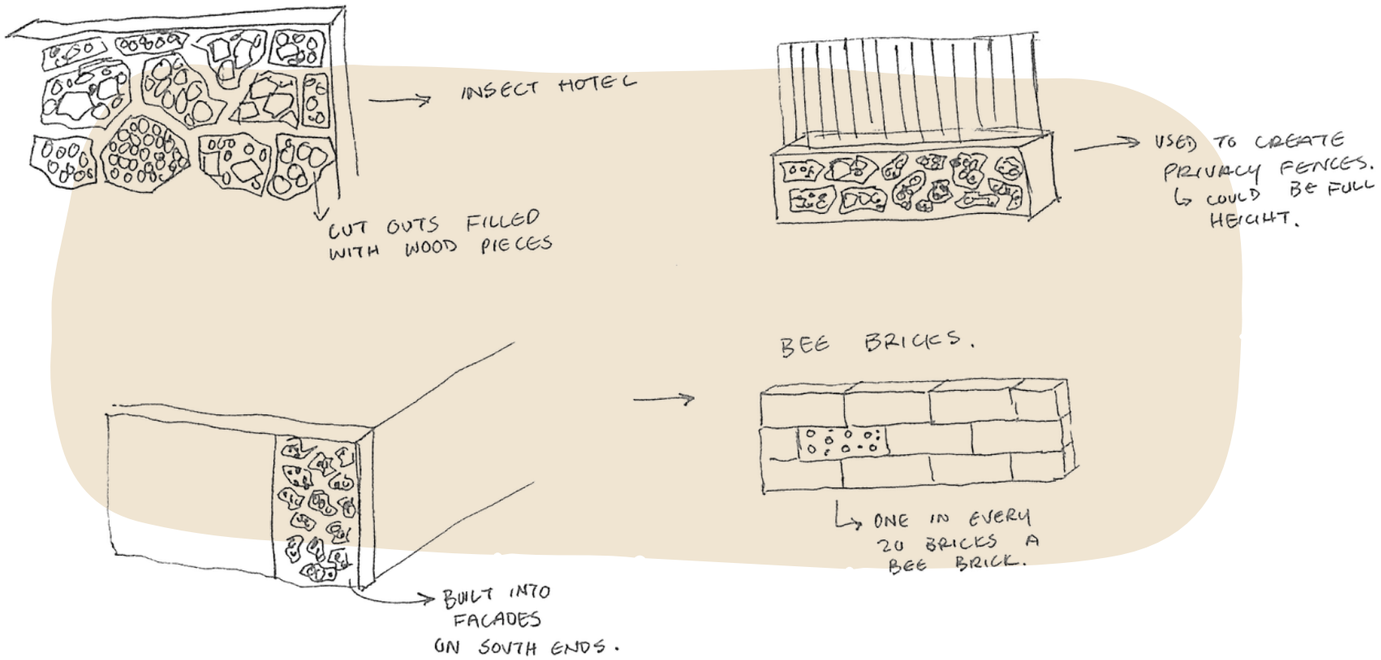


Figure 77. Bird design response diagram

SPECIES INVESTIGATION

2.1.3.2 Design response - insects



2.1.3.3 Design response - lizards

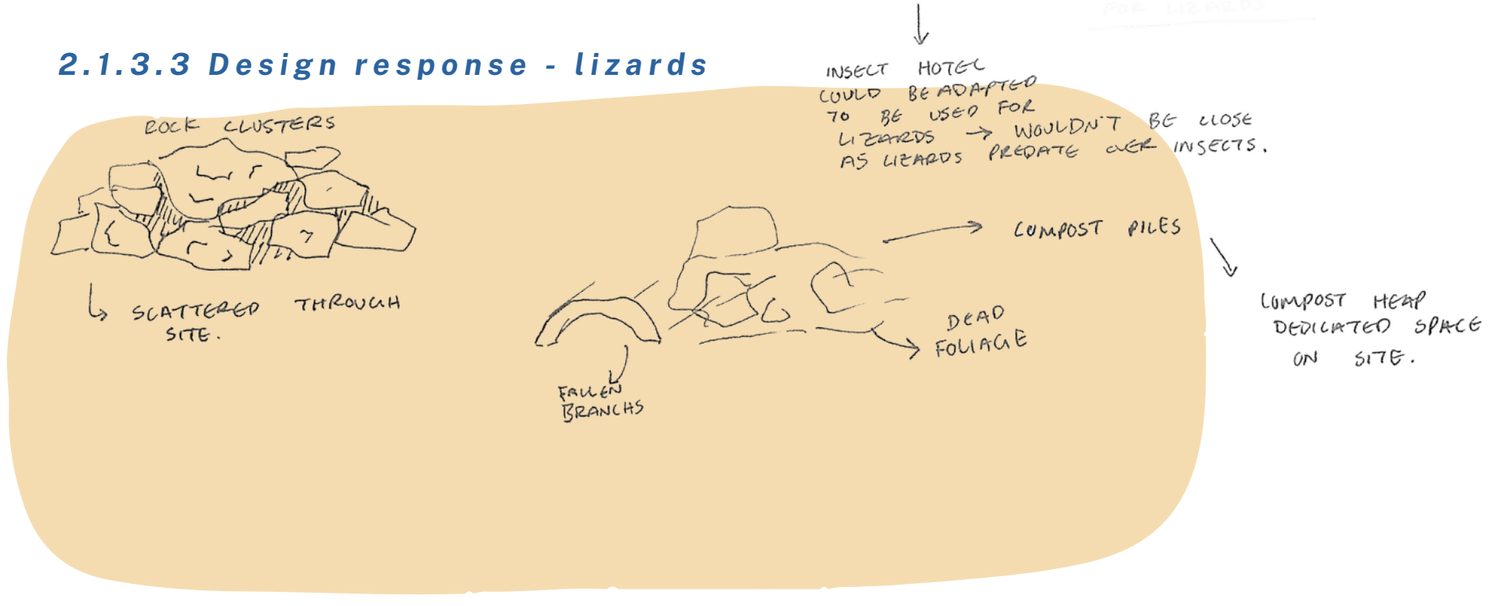
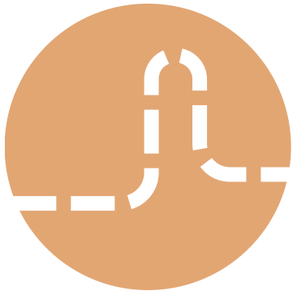


Figure 78. Insect and lizard design response diagram



VEGETATION COMPLEXITY

It is shown that insects tend to be more present in native plantings. These plantings should also be diverse in complexity (Schueller et al., 2023; Shrestha et al., 2021).



WIDER ECOSYSTEM

Designing habitat that connects to avoid fragmentation, allowing species movement through the site and beyond (Schueller et al., 2023).



ROCK PILES

To create habitat and safe spaces for lizards, rock piles are a viable option. They allow the lizards to get into the crevices and exclude predators (Herbert et al., 2023).



LIVING MULCH

Use plants that create leaf litter and create an active mulch. This can be used as habitat for different insect species.



INSECT BRICKS AND HOTELS

Creating habitat through bricks on the building as well as insect hotels through the site. The bricks can be used on external walls, boundary walls and through landscaping (Christman et al., 2023).

SPECIES INVESTIGATION

2.1.3.4 Design response - plants

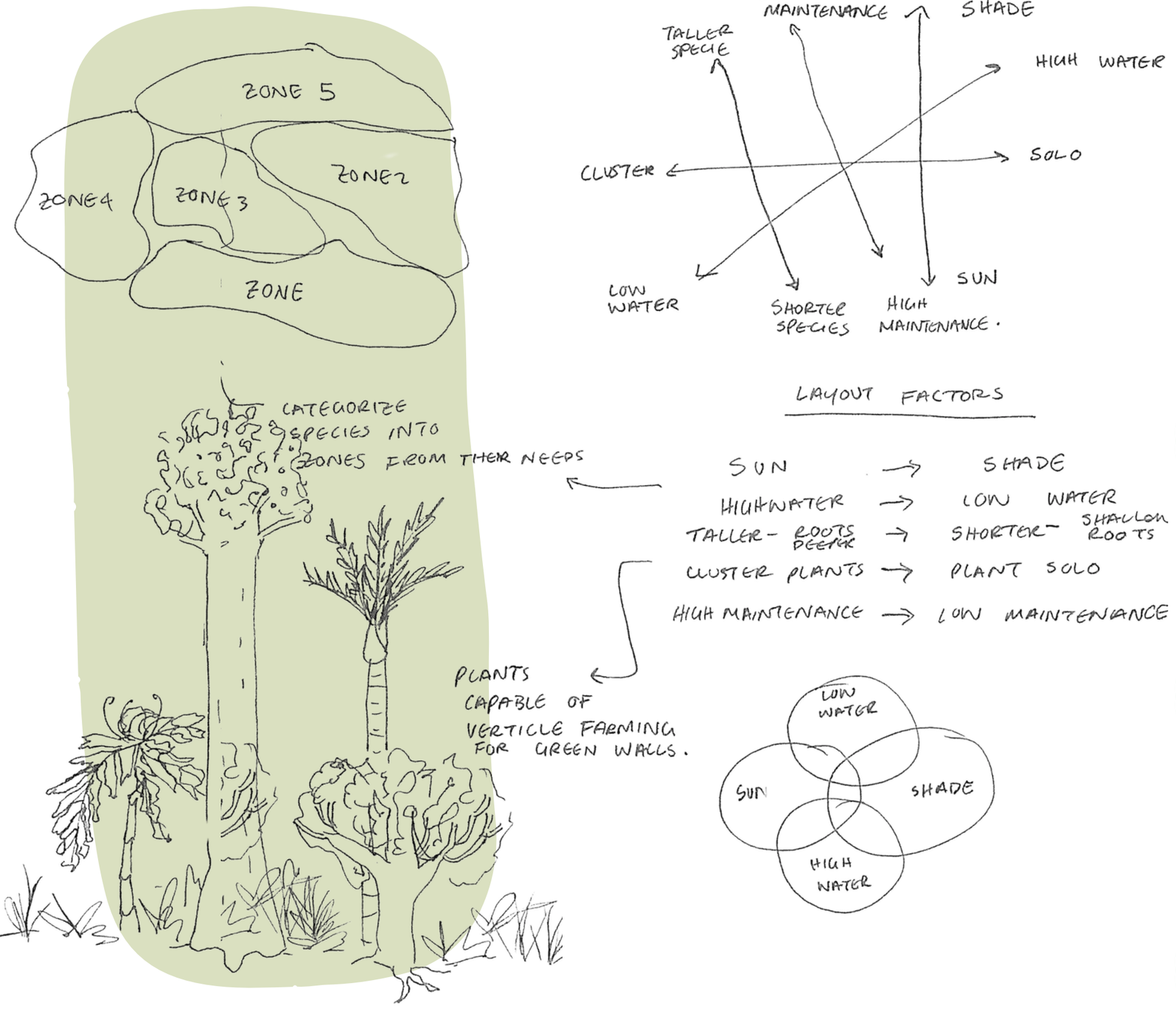
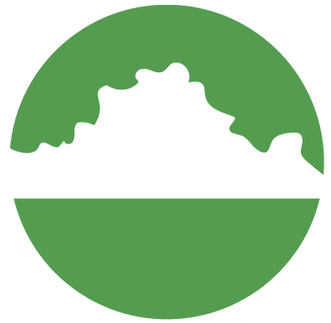
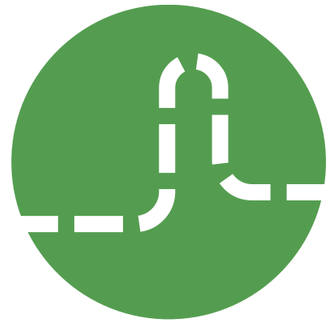


Figure 79. Plant design response diagram



HABITAT CREATION

Each plant species has different habitat requirements for survival and optimal growth. Factors to consider when choosing the layout of plants are climate, soil, pH, situation, light, water, nutrients and competition (Wöhrle & Wöhrle, 2017).



WIDER ECOSYSTEM

Vegetation is a part of a wider ecosystem that needs to be analysed when selecting plantings. Consideration should be taken into designing for plants that work in this existing ecosystem and can further develop and regenerate it.



NATIVES

The use of native species throughout the site is vital in the conservation and regeneration of biodiversity. Exotic species are native species in other countries, and therefore it is important to still consider their requirements and benefits to an ecosystem before removing them (Dunnet & Hitchmough, 2004). While there is still a place for exotic species in these designs, native plants will have similar habitat requirements as well as similar aesthetics, allowing a simpler design process.



HUMAN &NON-HUMAN CONNECTIONS

These plantings should connect to a wider ecosystem as well as the urban ecosystem they will be planted. Different species have a range of benefits and uses for both humans and non-humans. This could be in the form of the plant's edible, medicinal or cultural uses. It is key to acknowledge the connection of plantings to identity (Rodgers et al., 2023).



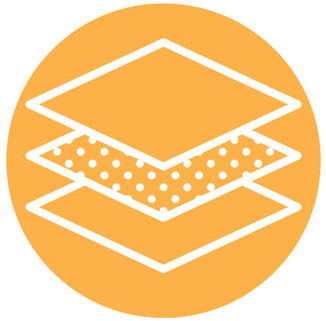
INTERIOR PLANTINGS

Plants have incredible benefits to humans. Plantings indoors extend and enhances exposure to humans that can help improve indoor air quality, human well-being, health and productivity (Lohr, 2010),
By planting indoors there is a physical and mental barrier broken between human and nature. This assists in the process of reconnecting humans to their ecosystems.

SPECIES INVESTIGATION

2.1.3.5 Design response - soil

Design responses that could be incorporated through the project to enhance soil health and biodiversity are strategies such as protection, enhancement and creation of space for soil. These strategies link with previously identified biodiversity enrichment strategies and can be used alongside them. Human exposure to soil would be designed through the larger site by designing walkways near planting and access to vegetation. On an internal scale, integrated indoor potting zones would be designed into the building floorplan, ensuring further exposure to soil and vegetation. Allowing humans, plants and animals to obtain the benefits from soil exposure that creates healthier communities and ecosystems.



RETAINING TOP SOIL

During construction, any excavated topsoil should be carefully stored for later reuse on the site.



AVOID COMPACTING

While building, efforts should be made to avoid any soil compaction on the site.



NATIVES

Complex plantings with a diversity of plant species can help create healthy soil (Salomon et al., 2020).



LIVING MULCH

Use plants that create leaf litter and create an active mulch. This supports a healthy soil biome.



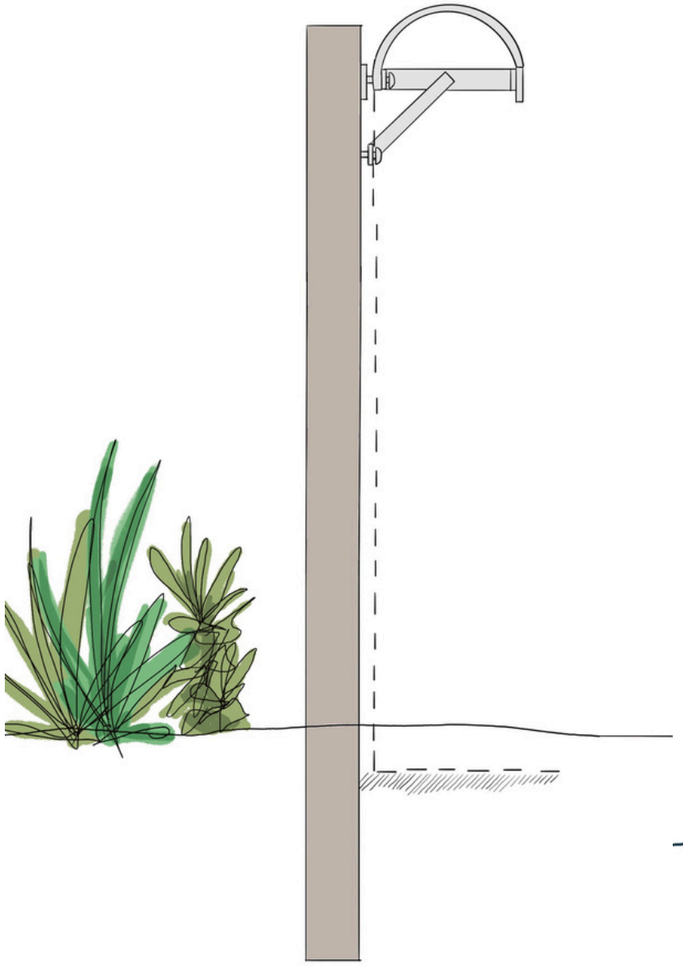
INTERIOR PLANTINGS

Implement indoor plantings to further expose humans to soil.



SPECIES INVESTIGATION

2.1.3.6 Design response - predator prevention



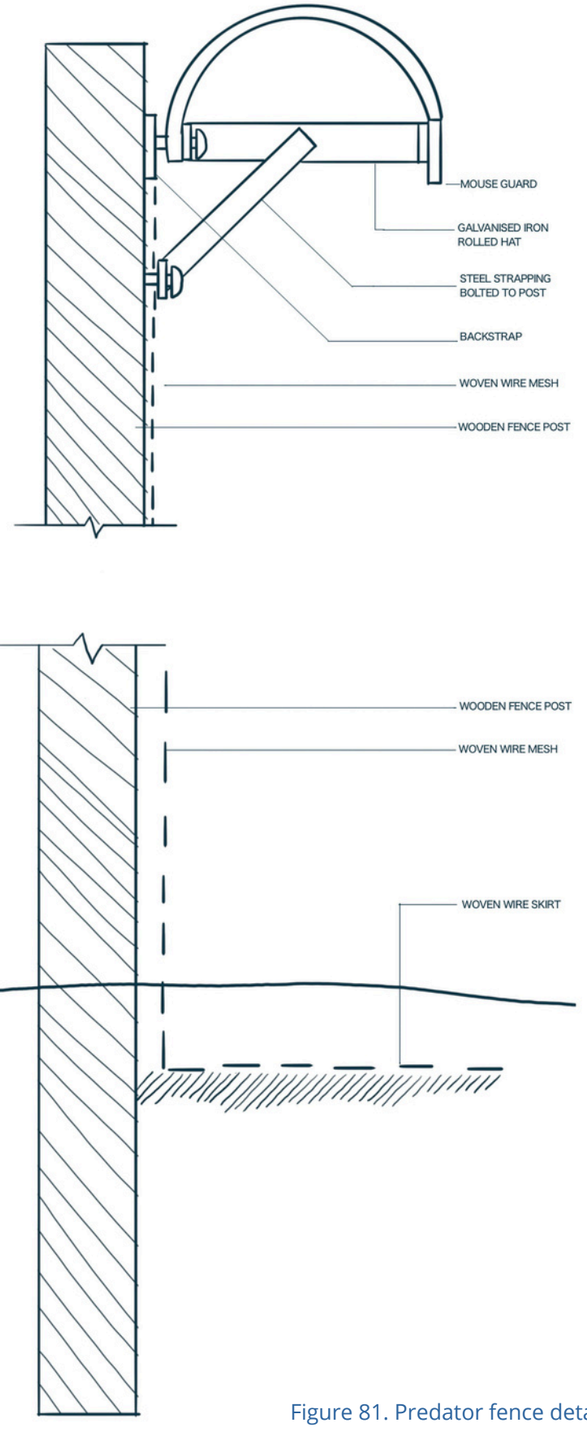
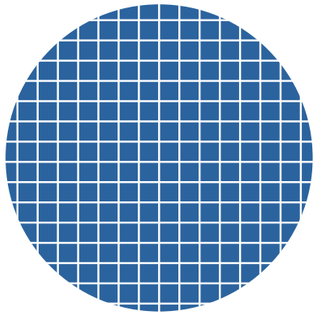
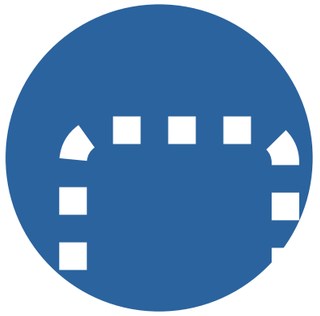


Figure 81. Predator fence detail



PREDATOR FENCE

The predator fence has two main systems, a hooded top and a skirt bottom. These systems combined are a thorough method of excluding pests, shown in use at Zealandia Eco Sanctuary (Burns et al., 2011).



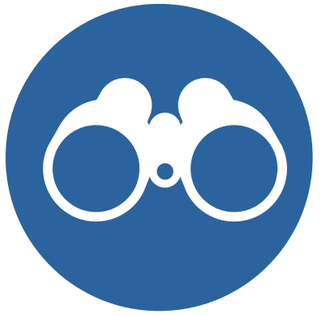
HOOD SYSTEM

The hood system is a zincalume half pipe that prevents climbing predators from getting over the hood (Zealandia, 2021).



GALVANIZED SLIP SHEETS

These slip sheets will be put on any posts that hold insect hotels, bird boxes or other safe zones for the native species.



MONITORING

A range of active and passive monitoring from the community can be encouraged and taught.



TRAPS

Predator traps placed through the site to capture any pests that move through the site.

2.2 MAPPING

Understanding the site location is a key step in the success of the project when there is a focus on biodiversity. This is because biodiversity occurs at a range of geographical scales (Poiani et al., 2000) and the larger ecosystem the site falls into should be understood. There are four main layers to consider and breakdown to find a site that will have the most effective ecological restoration potentials as well as desirable housing conditions: ecological, urban, wider connections and culture.



Figure 82. Dry ground

2.2.1 SITE

TYPES OF SITES

There are three main types of sites that residential developments would typically be built on; greenfields, brownfields, and greyfields.

A Greenfield site can be described as a low to medium density development that is to occur on an undeveloped urban or rural site that was previously natural land or agricultural land. These sites are typically found on the outskirts of current cities. As cities spread into surrounding farms and reserves, we are building homes that are further away from amenities, which creates a higher dependency on cars and petrol, impacting CO2 emissions. Any flora on the site is typically excavated to make room for the development, which results in a loss of habitat for any fauna on the site. When built on agricultural land, the farm that used to be on this site would now also have to find a new home, which would result in the deforestation of other uninhabited land (Newton, 2010).

Brownfield sites are the redevelopment of an under-utilised site within an urban area. These sites were built for outdated industry functions (Alker et al., 2010). There may be contamination to a certain extent (Newton, 2010) from previous uses. Brownfields can be used to combat the housing crisis by using this wasted space in urban areas and redeveloping it. These redevelopments can help bring investments back into these older parts of the city and encourage a more compact urban design (De Sousa, 2002). Brownfields also typically need less infrastructure to be built. Therefore, brownfields can have positive environmental, social, and economic benefits.

Greyfields are the extension of existing buildings, typically growing in height. This is usually more common in high density developments and, therefore, not applicable to this research.



Figure 83. Greenfield



Figure 84. Brownfield

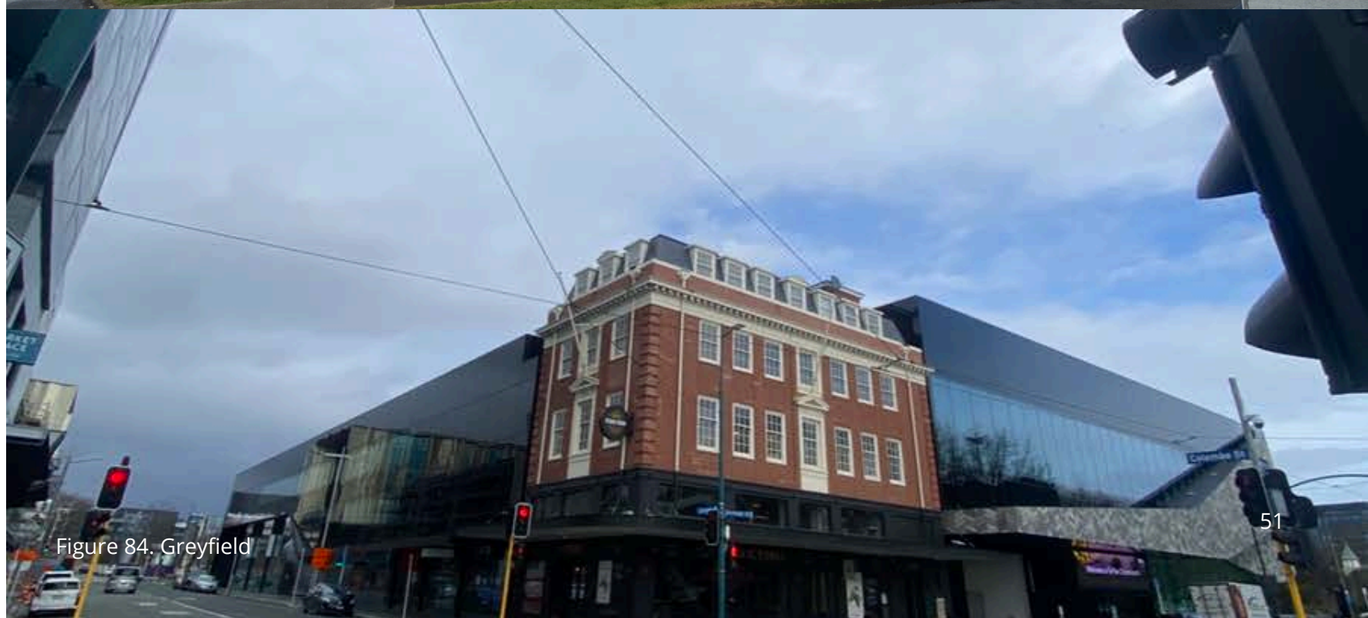


Figure 84. Greyfield

2.2.2 ECOLOGICAL MAPPING STRATEGY

Ecological mapping includes identifying and analysing existing vegetation in the wider region. From this, a stepping stone patch map can be identified. Stepping stones are areas of habitat that are within a distance from each other that a species can move between. Stepping stones are vital to reduce habitat fragmentation and to allow species dispersal and movement (Saura et al., 2013). It is important to understand the species of the area, as looked through in the species strategy, to understand the flight paths and movement capabilities of the local species. From this together with research into the existing plantings and species habitat in the wider region, a radius can be identified for a viable site location.

AIMS

- Identify large plantings in area.
- Existing forests and habitats.
- Location of native species.
- Climate of region.
- Plants of place.
- Species movement limitations (e.g. flight paths).

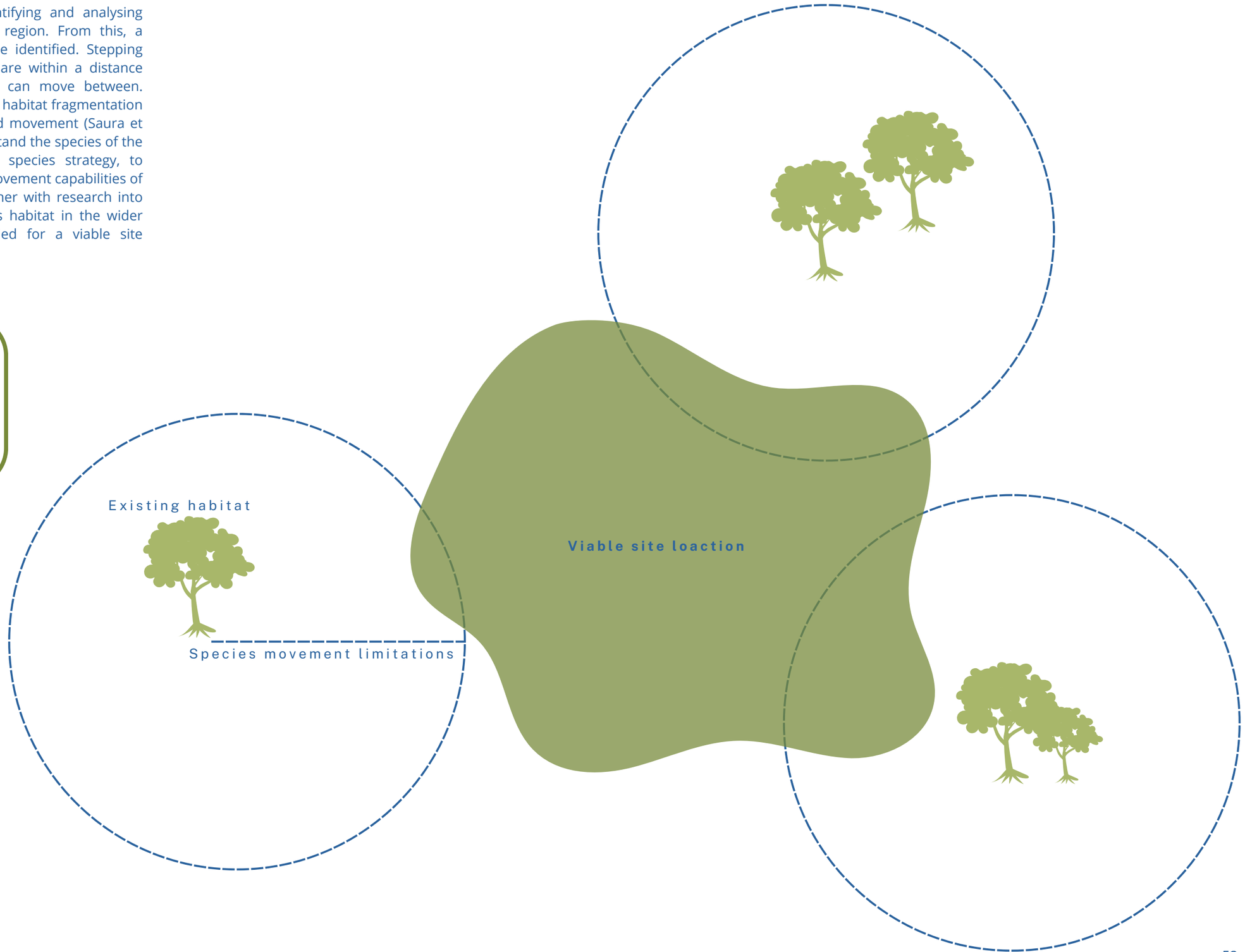


Figure 86. Ecological mapping diagram

2.2.3 URBAN ANALYSIS STRATEGY

Urban analysis is looking at the human connections of the site. Being a residential development, people are based at this site and move outwards. It is therefore important that they are close enough to amenities. Some facilities may need to be accessed quickly by car, such as hospitals, whereas for others, for instance supermarkets, should also have the option to walk, cycle, or use public transport to get to. Therefore, access to public transport stations, cycleways, pedestrian friendly zones need to be considered in selecting the site.

Hospital

Distance to drive or public transport to.

Shopping Centre

Distance to walk or cycle to.

Grocery Store

Distance to cycle or public transport to.

Transport Station

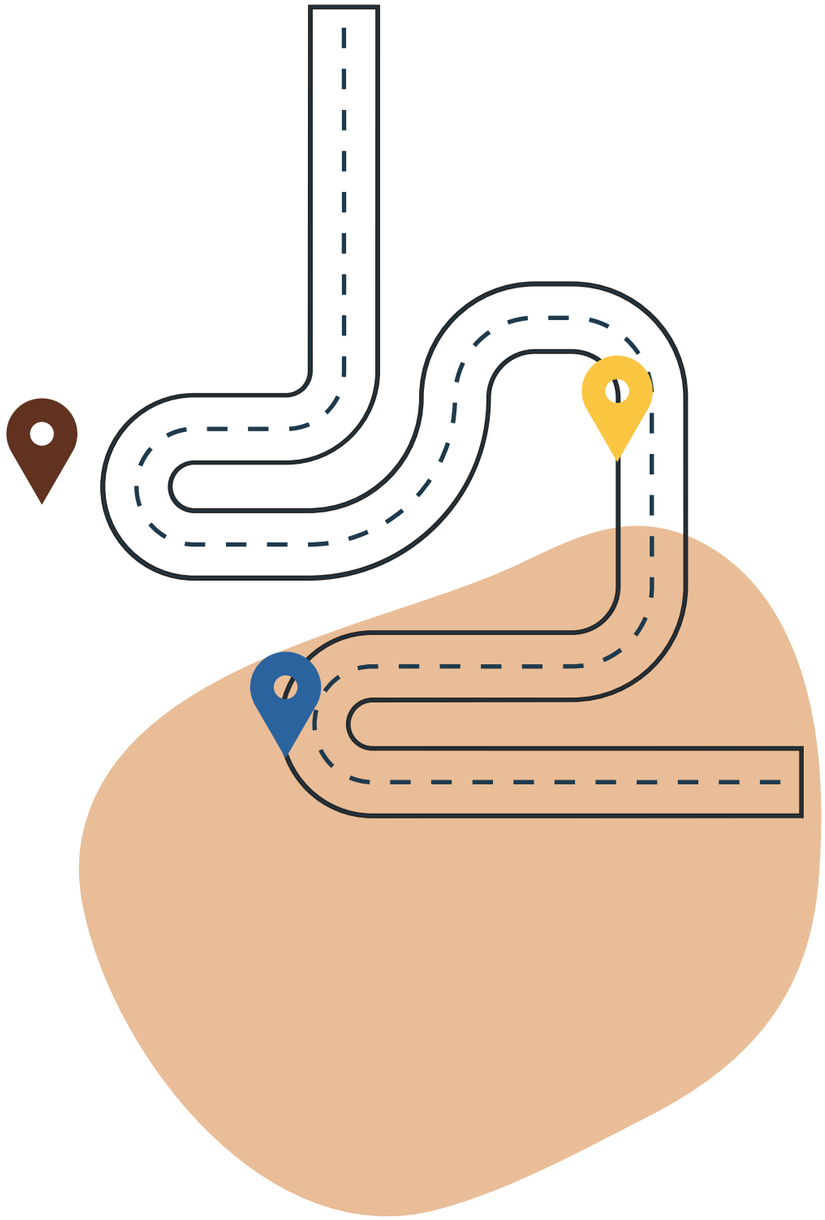
Distance to walk or cycle to.

Education

Distance to walk, cycle or public transport to.

CBD

Distance to cycle or public transport to.



AIMS

- Amenities in region.
- Public transport routes.
- Infill and edge-land locations.
- Current new developments.

Figure 87. Urban analysis diagram

WIDER CONNECTIONS STRATEGY

Ecological restoration involves many different groups that often work independently. Therefore, it is helpful to understand the areas these groups are working in and if these initiatives can work alongside the medium-density development's goals. It is also helpful to understand what past initiatives may have attempted in the region and understand why they were not successful in order to learn from their mistakes. Lastly, it is important to look at the region's development plan and relevant legislation to identify any legal blocks to the development plans (Gama et al., 2013).

AIMS

- Existing initiatives.
- Region planning.
- Past initiatives.

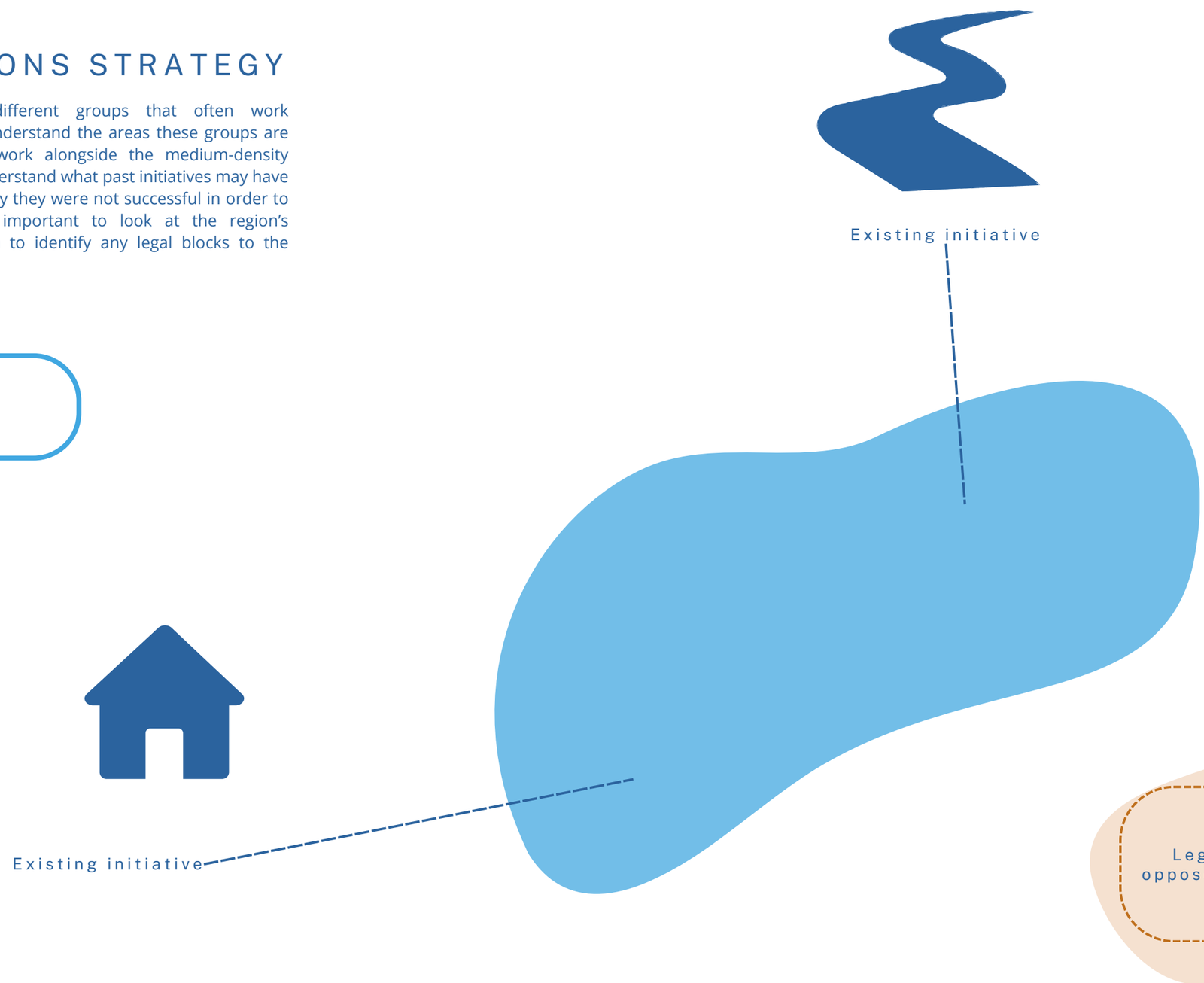


Figure 88. Wider connection diagram

2.2.5 CULTURAL LENS STRATEGY

A site can have a lot of history that can be understood differently between groups. It is important to gather this whakapapa (genealogy) of the land to respect and ensure that the site is treated with respect by learning about its history and incorporating this learnt knowledge into the design.

Mātauranga Māori (Indigenous knowledge) should be given the space to be heard and understood on the site. This should be done by collaborating with the local iwi (Māori tribal groups) and mana whenua (indigenous Māori people) of the site. Te Aranga Māori Design Principles are a set of guidelines that can be useful in aiding the collaboration of core Māori cultural values into the development (Kake & Paul, 2018).

AIMS

- History of site.
- Whakapapa (genealogy) of the land.
- Iwi associations.

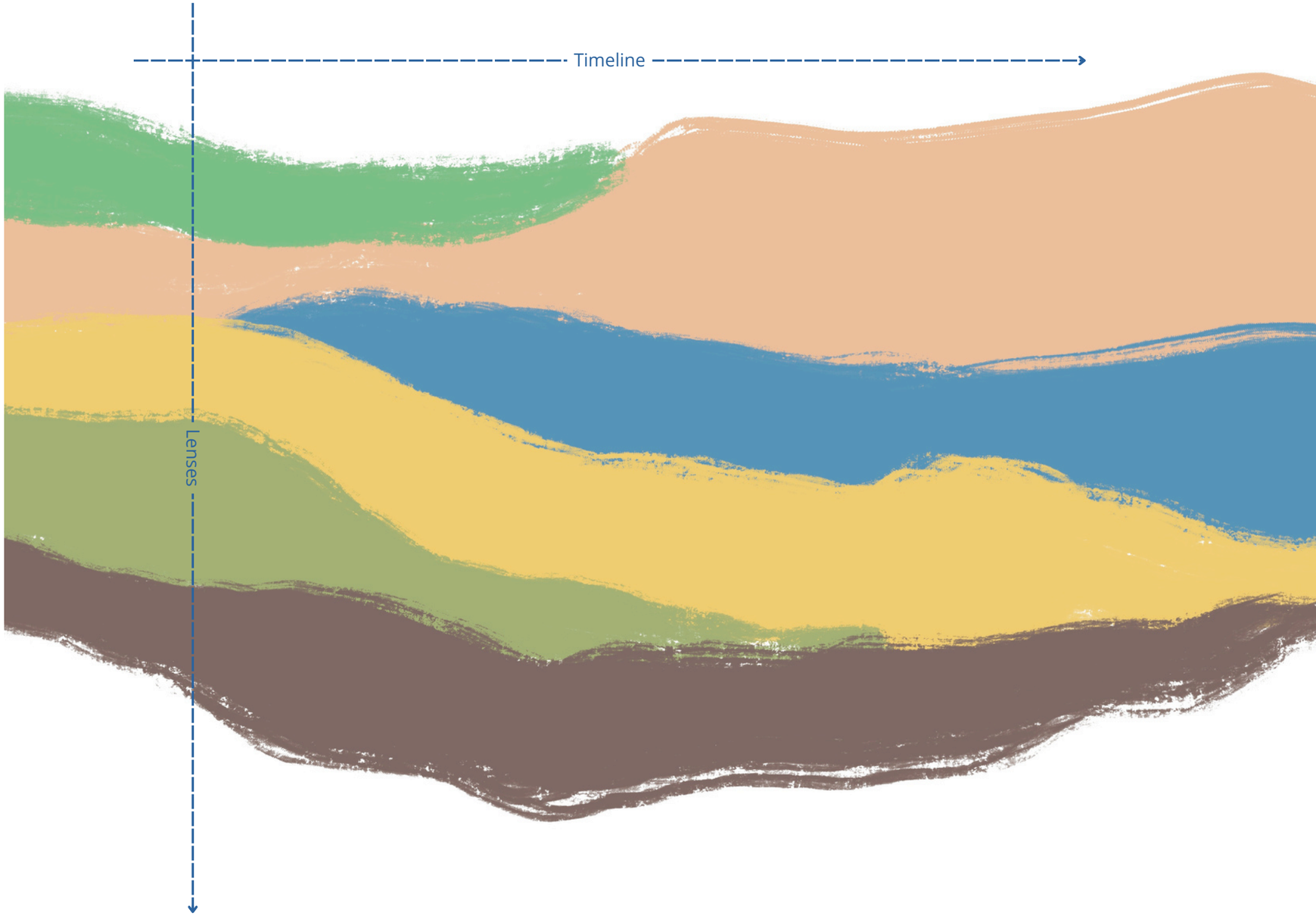
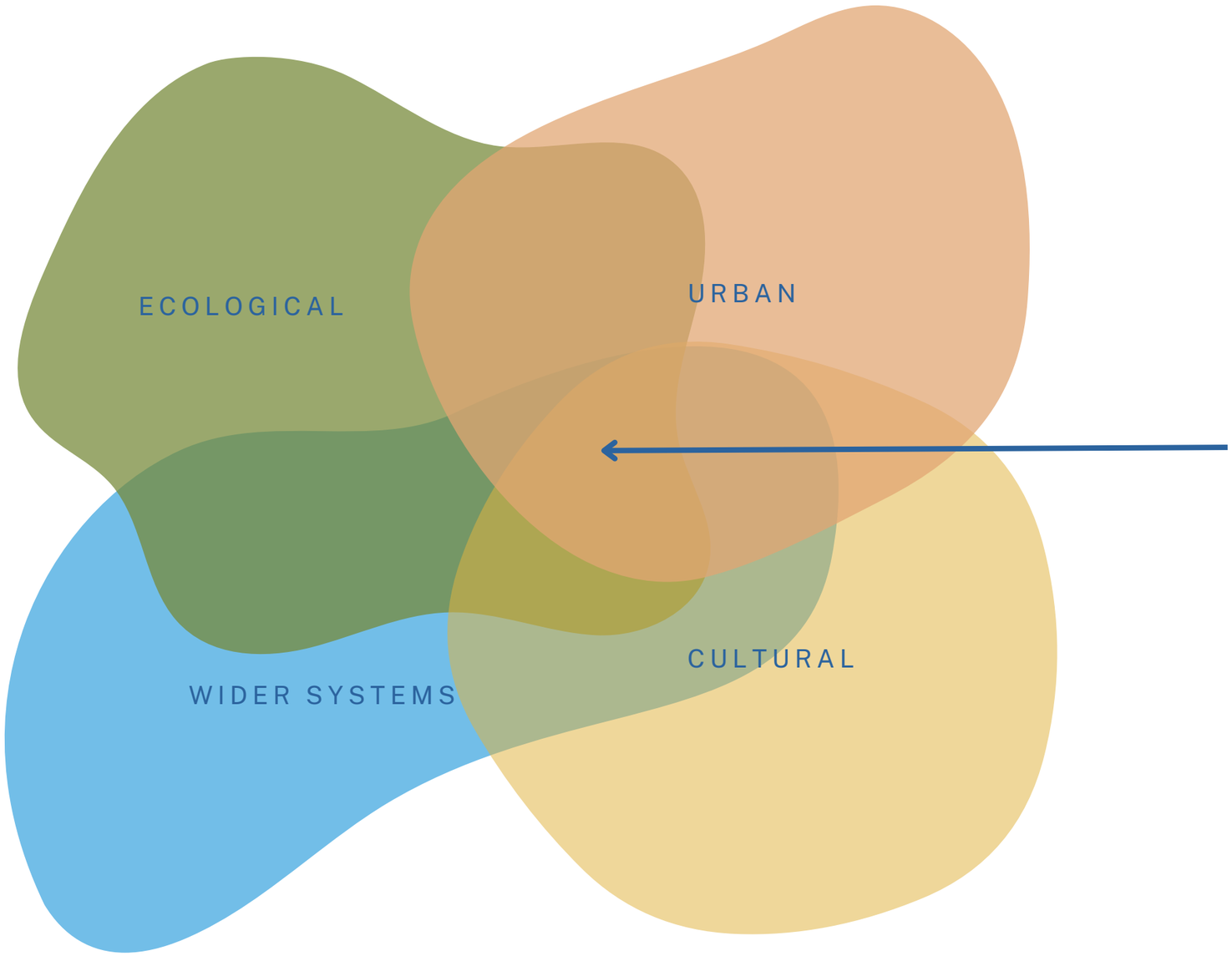


Figure 89. Cultural connections diagram

2.2.6 MAPPING STRATEGY

All these mapping categories are layered to find a site in the overlapping areas. The space in the overlapping areas represents a site that can address ecology, urban understanding, wider connections and cultural connections.



Ecological mapping

- Identify large plantings in area
- Existing forests and habitats
- Location of native species
- Climate of region
- Plants of place
- Species movement limitations (e.g flight paths)

Urban analysis

- Amenities in region
- Public transport routes
- Infill and edgeland locations
- Current new developments

Wider connections

- Existing initiatives
- Region planning
- Past initiatives

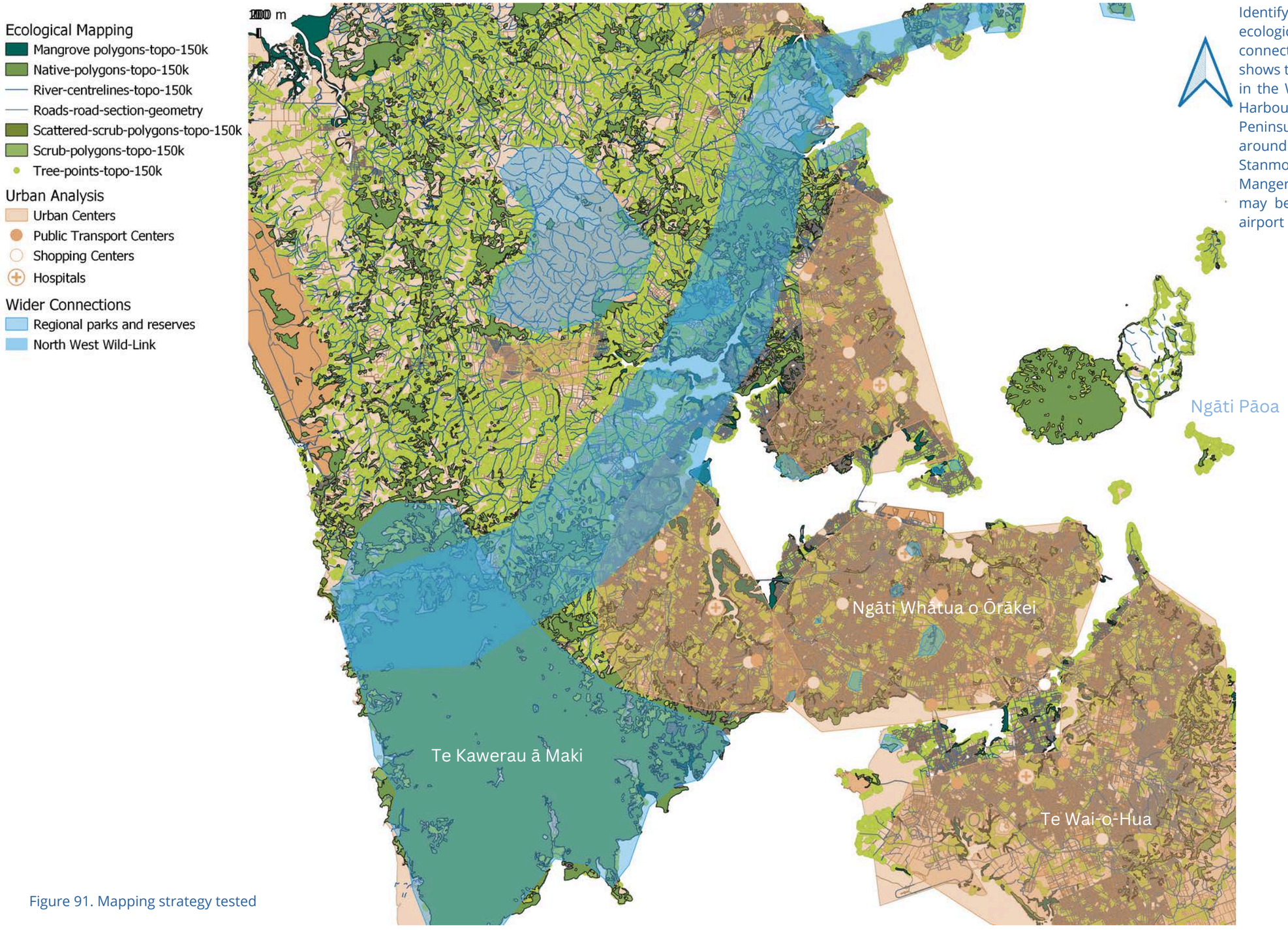
Cultural Lense

- History of site
- Whakapapa (genealogy) of the land
- Iwi associations

Figure 90. Mapping strategy diagram

MAPPING STRATEGY TESTED

SCALE 1:200 000 @A3



Identifying and layering all the ecological, urban and wider connections on Auckland's map shows there are spaces that overlap in the Western area; Massey, West Harbour, Whenuapai and Te Atatu Peninsula; the Northern area around Silverdale, Milldale and Stanmore Bay; lastly around Mangere, however, this location may be too disruptive due to the airport located within the region.

Figure 91. Mapping strategy tested

WIDER CONNECTIONS

Forrest & Bird have devised a plan for Auckland, The North-West Wildlink, to create ecological stepping stones for wildlife from the Waitākere ranges across to the Hauraki Gulf islands. The goal of the project is the conservation of native species by integrating a green corridor through the region.

This work started in 2006 and has seen implementation in the Hibiscus Coast on the Raroa reserve in Auckland, where 10,000 native trees and plants were planted and a start at pest control was made. Forest & Bird has started educating and helping Redvale landowners to implement pest control on their privately owned lands.

The residents of the Whangaparaoa Peninsula are advocating for a pest free peninsula and are providing monitoring of mammal pest control. Within the Whangaparaoa peninsula, there is the Shakespeare Reserve which is a sanctuary for birds flying from or to the mainland from Hauraki Gulf Island and Tiritiri Matangi Island in particular. Pest control monitoring and native plantings can also be seen in Paremoremo, State Highways 16 and 18, Tuff Crater, Project Twin Streams, and Ark in the Park buffer zone under the North-West Wildlink banner (North-West Wildlink, 2018).



Figure 92. Northwest Wildlink

STEPPING STONES

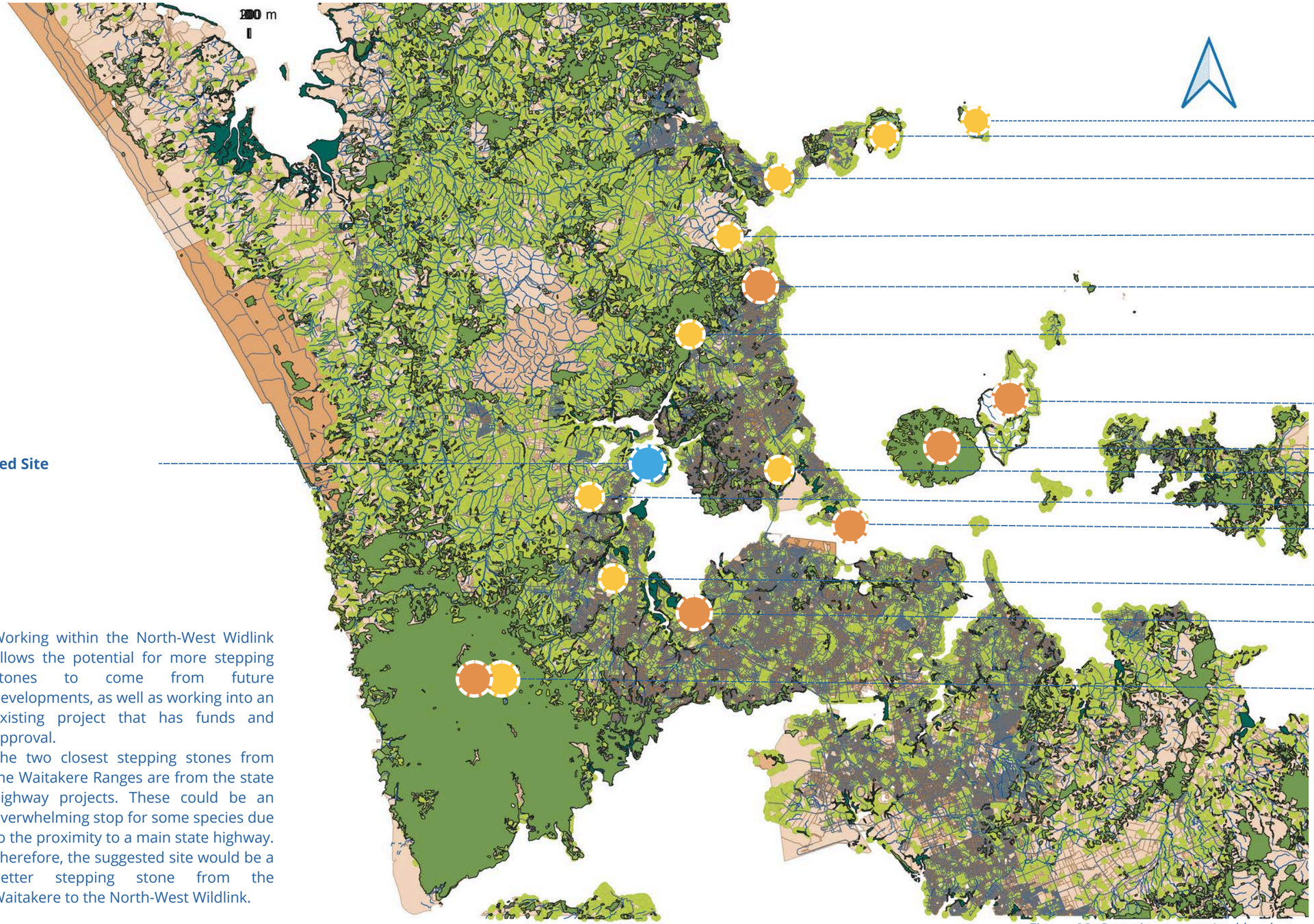


Figure 93. Steppingstones Auckland map

Working within the North-West Widlink allows the potential for more stepping stones to come from future developments, as well as working into an existing project that has funds and approval.

The two closest stepping stones from the Waitakere Ranges are from the state highway projects. These could be an overwhelming stop for some species due to the proximity to a main state highway. Therefore, the suggested site would be a better stepping stone from the Waitakere to the North-West Wildlink.

North-West Wildlink Current projects

Native reserves

SITE SELECTION



Figure 94. Hobsonville map

Zooming out on Tamaki Makaurau, most of the native flora can be found in the Waitakere ranges to the western coast. There are smaller polygons from there moving north and through to the Hibiscus Coast. This path is along the North-West Wildlink (North-West Wildlink, 2018), which has not yet been completed and therefore does not yet serve as stepping stones for species from the Waitakere ranges to the outer islands. However, this route is clearly more defined than the eastern route from the ranges.

Hobsonville Point is currently a growing new development. It has been successful in building a development with denser units; however, this densification has not left space for vegetation.

There are currently still empty brown sites available at the southern end of Hobsonville Point. In the current study, these empty sites are used to develop a complete mock design of a neighbourhood that both addresses the needs of developers to produce many distinct housing units and at the same enhances biodiversity.

2.2 7 SITE ANALYSIS
Strategy

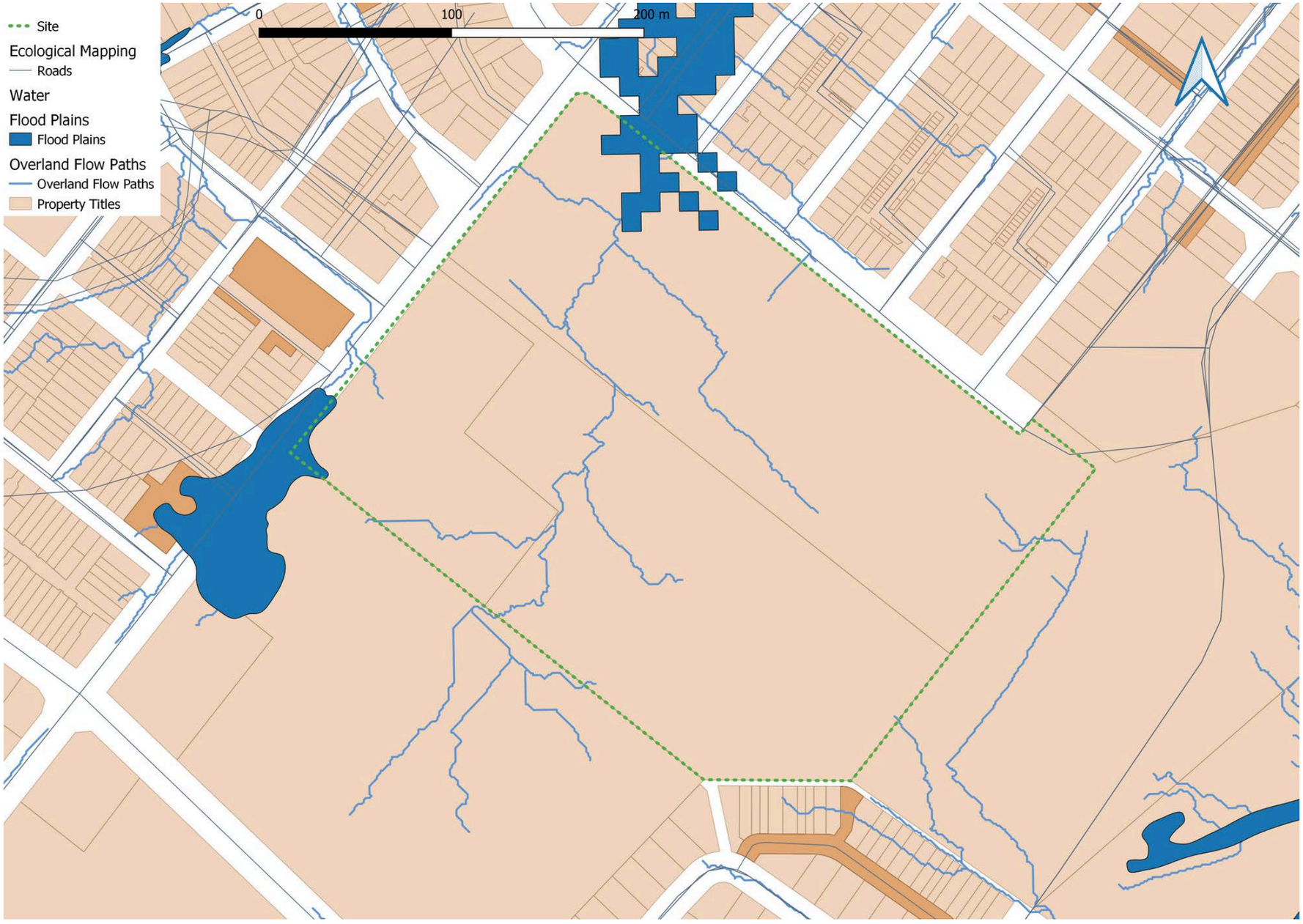


Figure 95. Site map analysed

Analysing the three streams to better understand the site: Ecology, climate and culture.

Ecology

- Soil conditions.
- Existing ecosystem.
- Potential ecosystem.

Climate

- Rainfall and stormwater.
- Temperature.
- Wind zone.
- Past, current and future climate.
- Climate adaptation.
- Natural disaster risks.

Culture

- Significant Views.
- Significant Events.
- Whakapapa of the land.
- Local Iwi.

SITE ANALYSIS
Tested



Figure 95. Site map tested

Rainfall:
Average 1231l per annum
(Chappel, 2013)

Temperature
15 degrees Celsius mean annual temperatures.
(Chappel, 2013)

Ecology

- Soil conditions - Impeded Allophanic Soils (*The New Zealand Soils MapViewer, 2023).*
- Currently Hobsonville does not have a classified ecosystem however, certain species are present in the area.
- The potential ecosystem of Hobsonville is a Pūriri forest or a Kauri forest *(Singers et al., 2017).*

Climate

- El Niño and La Niña can create up to 25% variance in our expected rainfall and temperatures. In summer New Zealand experiences stronger and a higher frequency of westerly winds. In winter there is a stronger southerly wind. La Niña creates rainy conditions and higher temperatures for the North Island *(El Niño and La Niña).*

Culture

- It was an airbase and bomb dump during WWII

(Royal New Zealand Air Force (RNZAF) Headquarters and Parade Ground (Former)).

- A place of gathering for seafood, timber, kauri gum and clay.
- Ngāti Whātua and Te Kawerau ā Maki mana whenua.
- Historic name: Onekiritea, named after clay soil found in area.
- After land 'bought' from the Ngati Whatua it was used for farming and then commercial production of clay.
- Range of historic buildings through larger site *(History).*
- Art trail around site.
- Planned marae from Te Kawerau ā Maki *(Mo Tatou).*

2.2.8 SITE REQUIREMENTS

	Site
SQM of site	80,000
Number of units	170
SQM of individual footprints	80
SQM of Footprint	12,800
• **Percentage**	16%
SQM of Garden	60,000
• **Percentage**	75%
Units per Acre	8.5
No. Bedrooms	1-4
No. Bathrooms	1-2
House Types	Terraces and apartments

Calculated from precedents examples

Figure 97. Table of site requirements

The precedents have offered examples of how a site can be used to effectively create housing with shared and private garden spaces. The precedents also show what current developers need to achieve from a site to ensure sales. It was identified that a better development could achieve the same amount of lots per square meter as the business as usual models. Therefore, this study aimed to have 0.002 lots per square meter. 75% of the site is to be dedicated to garden vegetation. Current developments are designed to include mixed housing types from terraces, apartments, and houses that range from 1-4 bedrooms as well as 1-2 bathrooms.



Figure 98. Greenhouse at Earthsong

2.2.9 SITE VISIT

Hobsonville Point is a growing area that has been designed with densely laid out units. The architecture throughout the site consists of modern-styled townhouses and some historic buildings. There is a lack of access to nature for residents. There is a walkway around the outskirts of Hobsonville Point along the water's edge. This walkway gives residents exposure to the natural environment; however, it is isolated to the edges of the sites and not pulled through the urban design.
The selected site is a flat piece of land covered in grass and a large parking lot. The site is zoned for sports and recreation. A baseball fence was built and the site is called Te Kori Baseball Diamond. The rest of the site is named the Te Kori Scott Point (Scott Point Sustainable Park). The site has not been designed to host sports and recreation and the site is also not been designed to be a sustainable park. Stranded pūkeko can be seen wandering through the site.

Hobsonville - surrounding site



Figure 99. Surrounding site

Selected site



Figure 100. Selected site

2.3 CRITICAL REFLECTION

Auckland's urban green space is declining, threatening both biodiversity and humans. This decline is concerning as it reflects a global trend of biodiversity loss and the severed relationship between humans and nature. There are urban restoration projects, such as Zealandia, that demonstrate that biodiversity can be regenerated and conserved in urban centers. These projects offer hope and demonstrate that with targeted recovery urban sites can support biodiversity.

Current designers continue to design human-centric developments that prioritise increased building footprints and car movement through the site. There are precedents of developments that show the potential of designing for both biodiversity and humans. These better developments can create the same amount of units as the business as usual models, but also create habitat for local biodiversity.

Designing on brownfield sites is a way to implement urban acupuncture, a small intervention into a city that promotes environmental regeneration. Mapping is an effective strategy for choosing a site that will be impactful to the region's biodiversity. Important mapping strategies go beyond looking at ecology factors and look at a site holistically.



Figure 101: Native tree

CHAPTER THREE

DESIGN RESPONSE

Chapter three explores the design process of the project. At the urban scale, this chapter outlines the different site conditions and layout options. The clustering of houses, nodes, is investigated to create ecological corridors around the nodes. The chapter will then assess architectural forms that create interconnected spaces that promote biodiversity. Finally the chapter will delve into the details of the design, focusing on how fauna and flora can be regenerated and conserved through architectural elements such as green walls and roofs.

The chapter will produce a final development that is designed for humans and nature, encouraging interactions between the two. This final design will shown an example of how the strategies created can be architeculised.

Figure 102. Wheelbarrows in garden

DESIGN RESPONSE

3. 1 DESIGN MATRIX - TECHNOLOGIES AND TECHNIQUES

AIM	STRATEGY	URBAN SCALE	ARCHITECTURE SCALE	DETAIL SCALE
Maintain and Introduce	• Avoid habitat loss • Develop in low ecological value areas. • Use native species. • Create vegetative complexity. • Design green infrastructure. • Incorporate key resources for habitat analogues.	• Urban Forest • Constructed wetlands	• Green roofs • Green walls • Clusters buildings to allow better areas for plantings.	• Provide refugee for lizards through habitat creation with **shrubs and rock piles.** • Create **vegetative ground cover** with leaf litter, rotting logs and bare ground for invertebrates. • **Plant native plants that feed** nectivorous birds. • Design complex plantings with **diverse species composition.** • Preserve existing soil and vegetation on site before groundworks.
Facilitate Dispersal	• Add animal movement infrastructure. • Establish connectivity corridors through public and private lands. • Cluster private gardens	• Green corridors • Habitat steeping stones • Tree canopy	• Green roofs • Green Walls	• Remove private garden fences. • Reduce private garden section, instead have connected gardens.
Minimise Threats & anthropogenic disturbance	• Incorporate predator, weeds and exotic plant control and future managements. • Reduce runoffs through blue/green infrastructure. • Minimise light and noise pollution.	• Pest free zones • Rain gardens • Bioswales • Car free zones	• Bird safe facades • composting toilets • Passive house design • Permeable spaces • Design protected areas for species to have minimum human interaction in.	• Permaculture planning • Xeriscaping plantings • Bioremediation - phytoremediation of soil. • Car parking on edge of development with few necessary roads in. • Cycle lanes through site.
Facilitate Natural Ecological Processes	• Provide adequate resources for target species. • Protect and enhace pollinator habitats. • Plant for natural events to safely occur, such as fire or flooding.	• Stormwater management • Stormwater permeability as not to affect the vegetation. • River restoration and daylighting.	• offset areas of plantings away from walkways - no pick gardens.	• Insect/bee hotels • Urban beehives • Urban composting • Design spaces for low maintenance wild plantings for pollinators. • Nesting boxes
Improve potential for positive human-nature interactions.	• Create a sense of Kaitiakitanga and Wairuatanga within the community. • Design these ecological rich spaces around human centered activity, bring the humans in to interact.	• Community gardens • Urban forests	• Spaces orientated around views of nature. • Walkways through native plantings. • Outdoor gathering spaces within plantings. • Include plantings within building • Community green spaces.	• Attract species that humans have better connotations to, closer to walkways and houses. • Have a show house that the surrounding community can walk through and have learnings within. • Have activities for the residents to take responsibility for.

Figure 103. Table of design matrix

3.2 CONCEPT, DEVELOPED AND DETAIL DESIGN

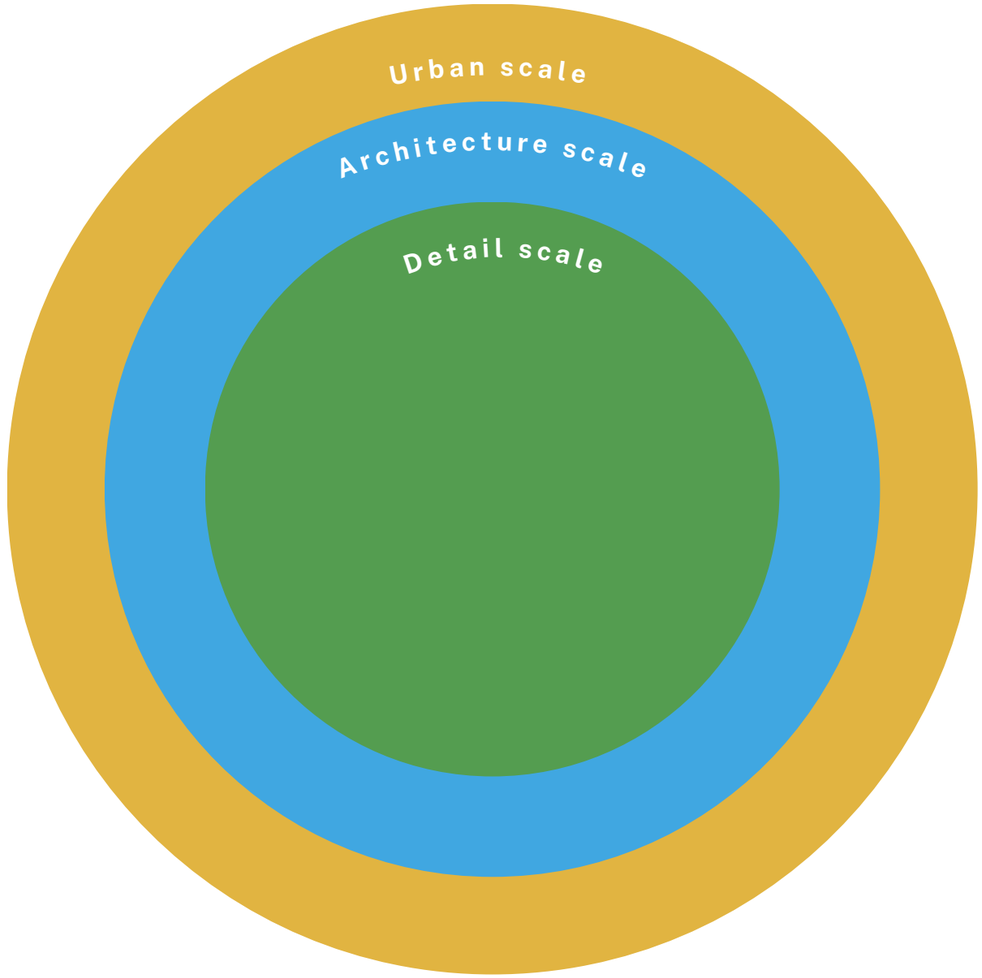
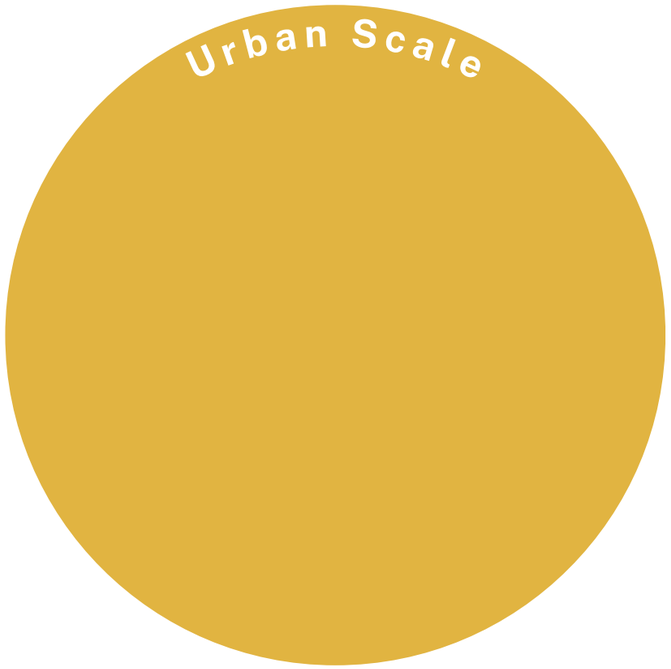


Figure 104. Design scales



Figure 105. Render of resident walking through site

CONCEPT DESIGN
3.2.1 Urban Scale Strategy



Plan



Create buffer of vegetation around site.



Restore natural movement of water on site through swales.



Plant vegetation around water systems.



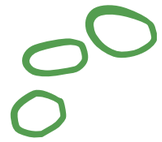
Focused habitat plantings.



Pedestrian orientated access.



Exploration trails and boardwalks.



Creates nodes with building orientation and dense plantings.

Various spaces for socialising through the space.

Design Matrix

Maintain and introduce

- Urban Forest
- Constructed wetlands

Facilitate dispersal

- Green corridors
- Habitat steeping stones
- Tree canopy

Minimise threats & anthropogenic disturbance

- Pest free zones
- Rain gardens
- Bioswales
- Car free zones

Facilitate natural ecological processes

- Stormwater management
- Stormwater permeability as not to affect the vegetation.
- River restoration and daylighting.

Improve potential for positive human-nature interactions.

- Community gardens
- Urban forests

Figure 106. Urban scale diagram

CONCEPT DESIGN
Urban Scale

Typical urban layout - focused around car access and private lots.



Figure 107. Typical urban design

The first step when developing an urban plan would be to identify where water moved through the site. Upon mapping the water flow direction, a plan developed. Thus, this path should be reestablished to facilitate movement through the site during heavy rainfalls and to function as a bioswale. Large-scale vegetation plantings should be organised around the water path. According to this plan, roads for cars are placed on the outer edges of the site, leaving space to be divided into nodes and terraces with apartments. The shape of the units was explored to determine the best layout for increasing biodiversity on the site.



Figure 108. Concept urban designs

CONCEPT DESIGN
Urban Scale



Figure 109. Concept urban plan



Figure 110. Urban design layout options

This design created nodes that felt natural on the site. However, the placement of the units did not maximise the use of the site and resulted in some units facing south or having limited sun exposure.

CONCEPT DESIGN
Urban Scale



This design required a better clustering method for the units to increase space for native plantings between rows and to create shared spaces for nodes. Additionally, the path of the water did not indicate termination points or its impact on the surrounding areas.

Figure 111. Urban scale concept developed

DEVELOPED DESIGN
Urban Scale



Figure 112. Developed urban design

The final urban design established a buffer of vegetation around the site creating a space that felt fully surrounded by nature. The access through the site is pedestrian-focused and has many access points from the surrounding suburb into the site, encouraging visitors. Stormwater management was addressed through the implementation of raingardens, bioswales and a wetland, which became a central point to the development. This wetland is surrounded by native plantings with a walkway around it.

The urban plan prioritised habitat creation for native species by strategically organising houses together. These nodes placements allowed green corridors to run through the site as well as pocket forests to be designed in larger openings.

Additionally, the urban plan ensures residents or visitors are interacting with nature as they move through the site, as well as introducing spaces that encourages them to be outside connecting with the native species.

DEVELOPED DESIGN
Urban Scale

Car access

Cars can move on the outskirts of the site on a one way road. This road follows the full site and has one entry point deeper into the site. Along the road there are parking spaces for residents. There are trolleys the residents can use to cart large loads to and from their cars. By restricting car access on the site, residents are encouraged to use alternative transport methods. This creates a site that allows kids and fauna to move freely through the site as well as maximise space for habitat creation.





Figure 113. Car access plan

DEVELOPED DESIGN
Urban Scale

Nodes

The site is divided into nine nodes, each containing a smaller number of housing units, named after extinct New Zealand native birds. This arrangement supports the development of micro-communities, making it easier for residents to connect with one another. By living in smaller groups, individuals can form more meaningful relationships and strengthen their sense of community. Naming the nodes after the extinct birds, Huia, Kaoriki, Mātuhituhi, Pouākai, Moa, Piopio, Wren, Adzebill and Whēkau pays respect to New Zealand's unique biodiversity and also serves as a reminder of the importance of conservation and the need to protect what remains.



Figure 114. Node urban plans

Nodes example

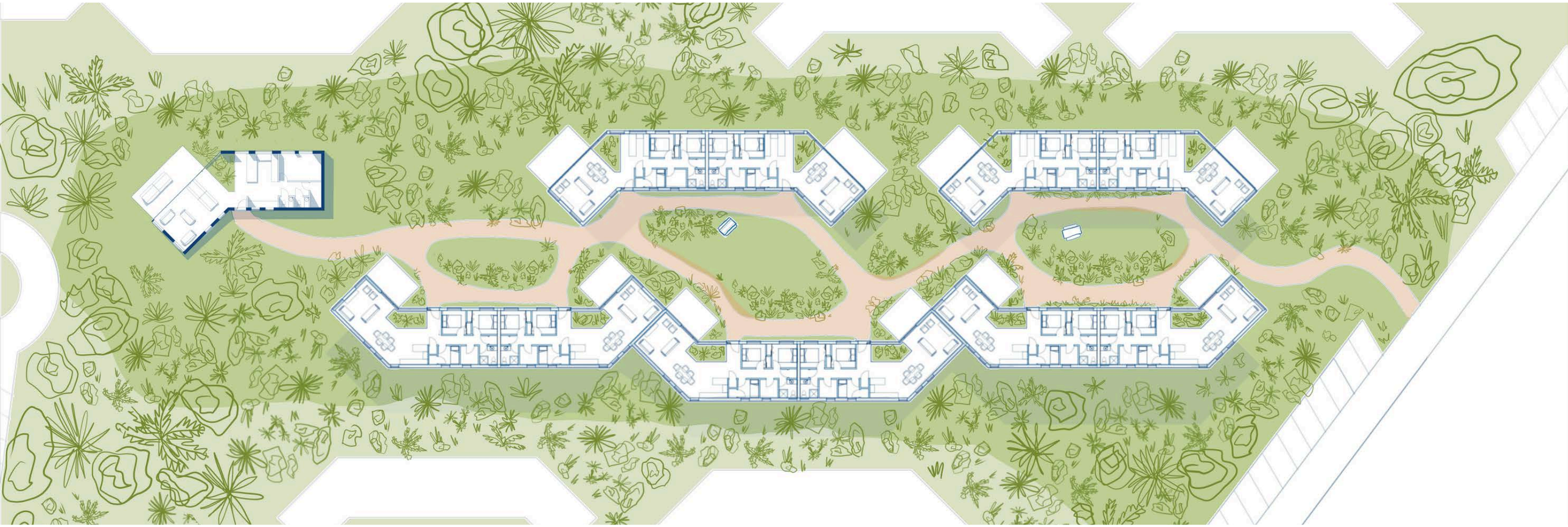
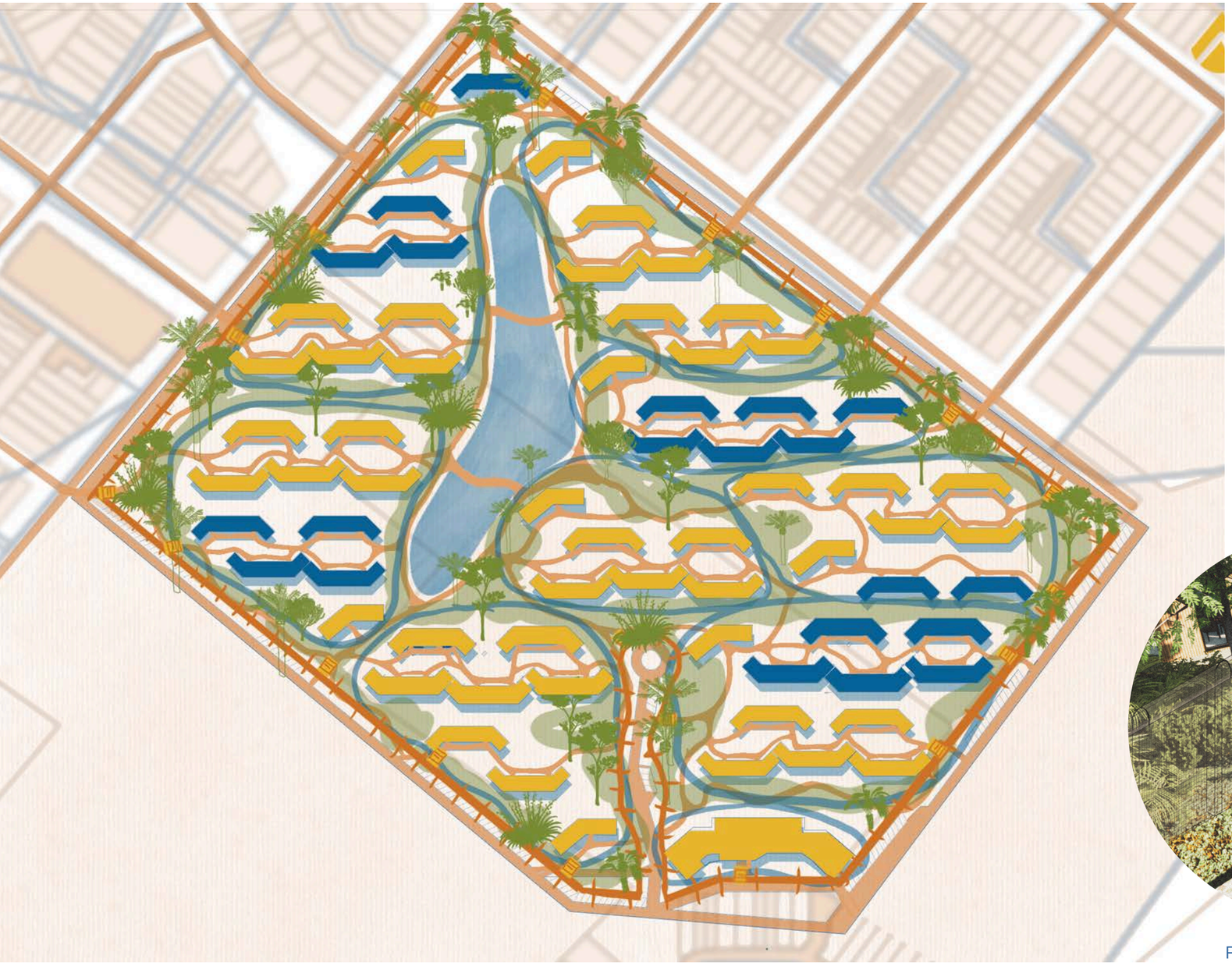


Figure 115. Node plans

Each node is thoughtfully designed to incorporate shared green spaces between the houses, promoting social interaction and providing areas for children to play. These communal spaces are strategically placed between the houses, facilitating easy interactions between neighbours. Within each node there is a common house, this features large areas for socialising and meetings, a shared kitchen, storage space, a mixed use room and laundry facilities. By removing these spaces from the individual houses, and instead making a shared space for them, this has allowed for more space within the houses for plantings. The common house has no green roof as it collects all rainwater to distribute to the houses. All organic waste from the units is collected and composted at the common house. This has a community garden for the residents.

DEVELOPED DESIGN
Urban Scale

Predator-free zoning

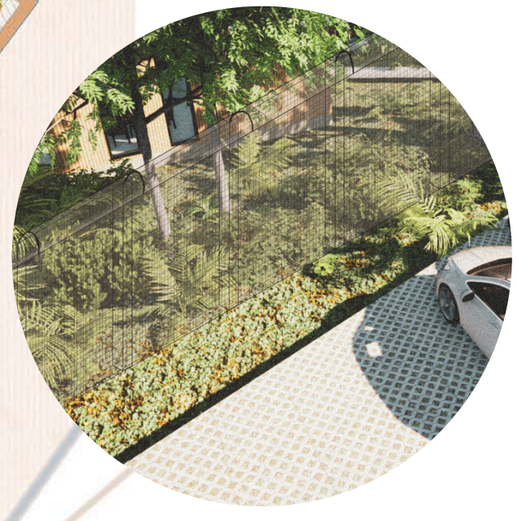


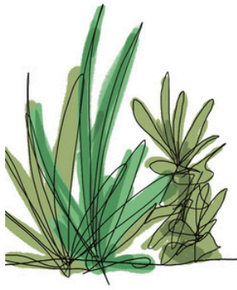
The full site is enclosed by a predator fence, modelled after Zealandia's fence, with gates placed at key entry points. While these gates would not be manned on a daily basis they would be manned on community events involving non-residents. Different levels of predator prevention will be established, through the site, recognising that breaches may occur as predator fencing is uncommon in urban residential areas.

The yellow-marked houses represent houses that are more beneficial to human-nature connections than to predator prevention. These houses are within the larger predator fence, but do not have any other physical barriers for predators.

The orange-marked houses are taller units or apartment blocks that incorporate the hooded system on their walls. The green walls on these units stop before the hooded system and do not connect to the roofs. This design allows the roofs to accommodate more vulnerable species as well as nurseries.

The development will implement guidelines required by residents to follow in order to live within the community, this would include pest-prevention measures.





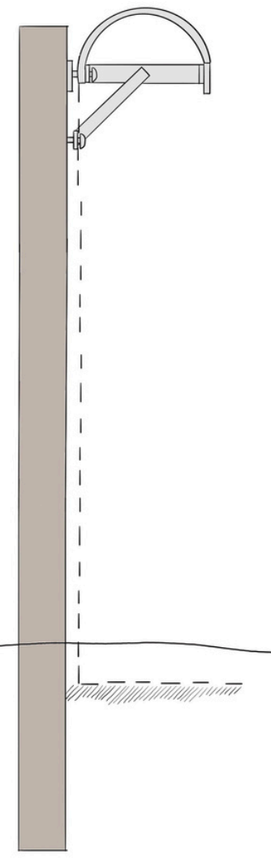


Figure 116. Predator-free zoning plan

DEVELOPED DESIGN
Urban Scale

Learning/visitor center

The visitor and learning center, situated at the entrance of the development, serves as a hub for meetings, conferences, and educational programs focused on biodiversity and conservation. Designed with the same building footprint as the residential units, the center allows visitors to gain a tangible sense of the housing design.

The center features a cafe and restaurant, inviting surrounding community members in and letting them extend their stay in nature. This promotes more community members to learn about biodiversity and conservation, broadening the network of knowledge.

On the outside of the building there is open space that can be used for markets, enabling community residents to sell their goods and engage in micro-enterprise activities.

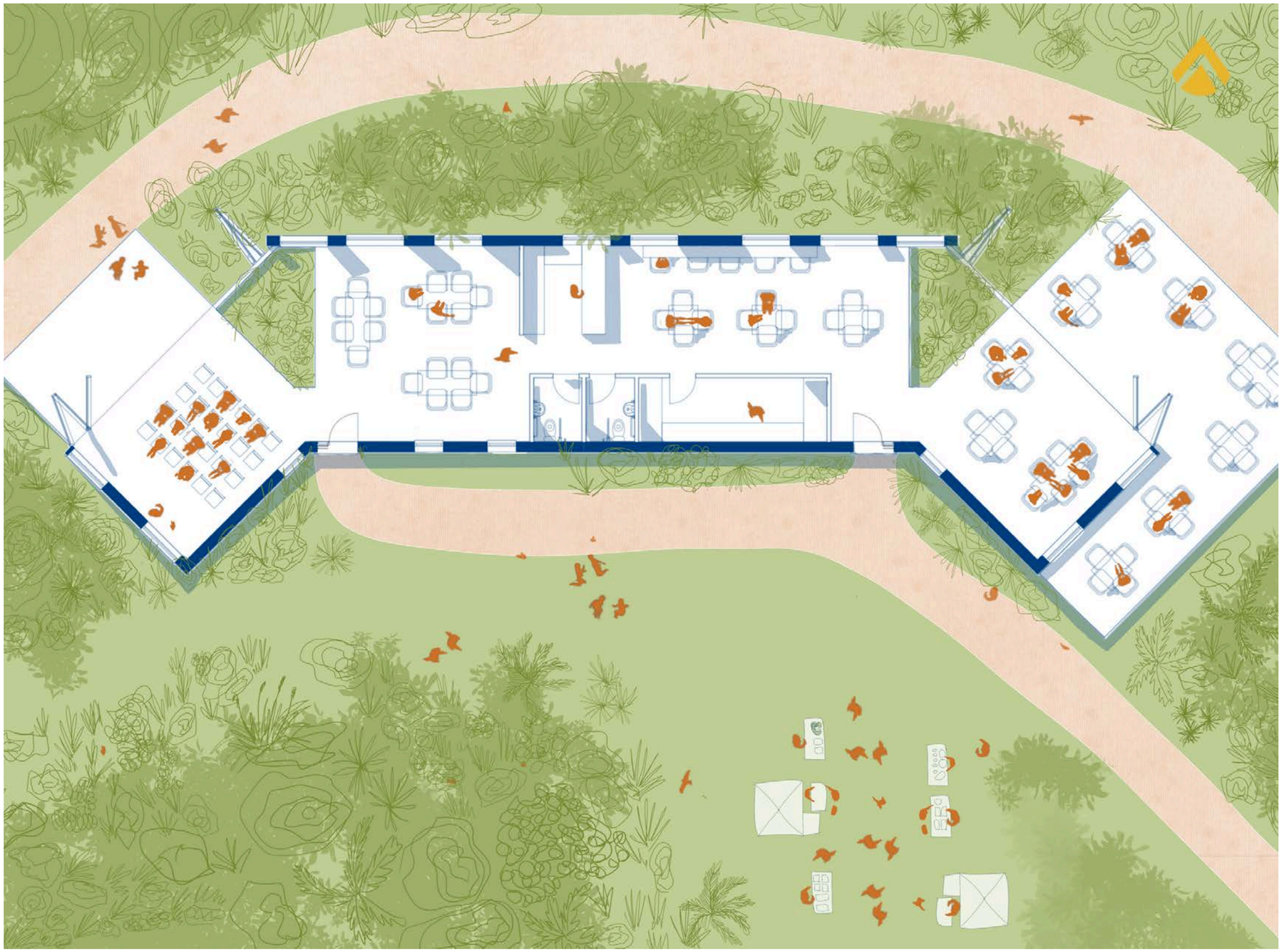
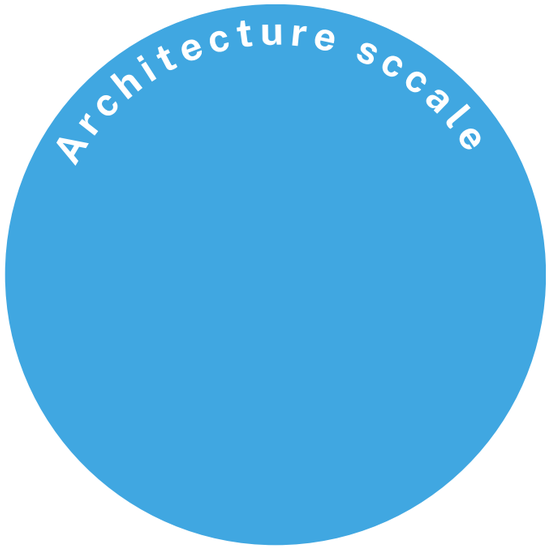


Figure 117. Learning/ visitor center floorplan

CONCEPT DESIGN
3.2.2 Architecture Scale Strategy



Plan

Cluster houses to create micro-communities.

Common house with shared ammenities.

Remove private fenced gardens.

Passive housing.

Green walls on southern facades and particular elevations.

Green roofs on majority buildings.

Internal plantings.

Design Matrix

Maintain and introduce

- Green roofs
- Green walls
- Clusters buildings to allow better areas for plantings.

Facilitate dispersal

- Green roofs
- Green Walls

Minimise threats & anthropogenic disturbance

- Bird safe facades
- composting toilets
- Passive house design
- Permeable spaces
- Design protected areas for species to have minimum human interaction in.

Facilitate natural ecological processes

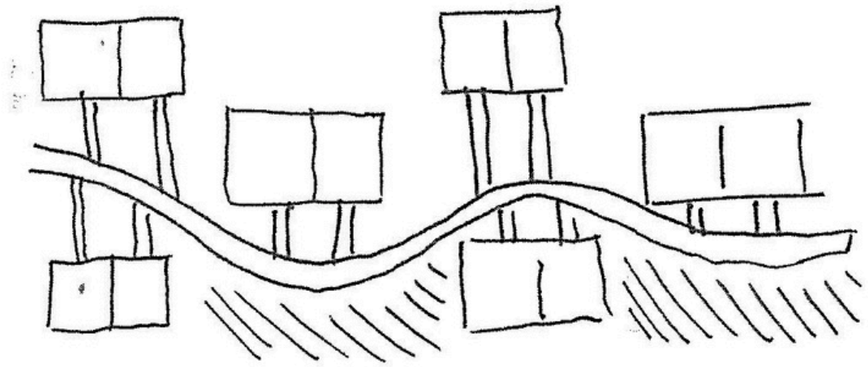
- Offset areas of plantings away from walkways - no pick gardens.

Improve potential for positive human-nature interactions.

- Spaces orientated around views of nature.
- Walkways through native plantings.
- Outdoor gathering spaces within plantings.
- Include plantings within building
- Community green spaces.

Figure 118. Architecture scale diagram

CONCEPT DESIGN
Nodes



The configuration of buildings with surrounding structures is designed to allow terraces to have a shared green space, cut out of the building shape, which creates a micro-community while also providing private areas both inside and outside the units. The orientation of the buildings to face north, and maximise exposure to sunlight.

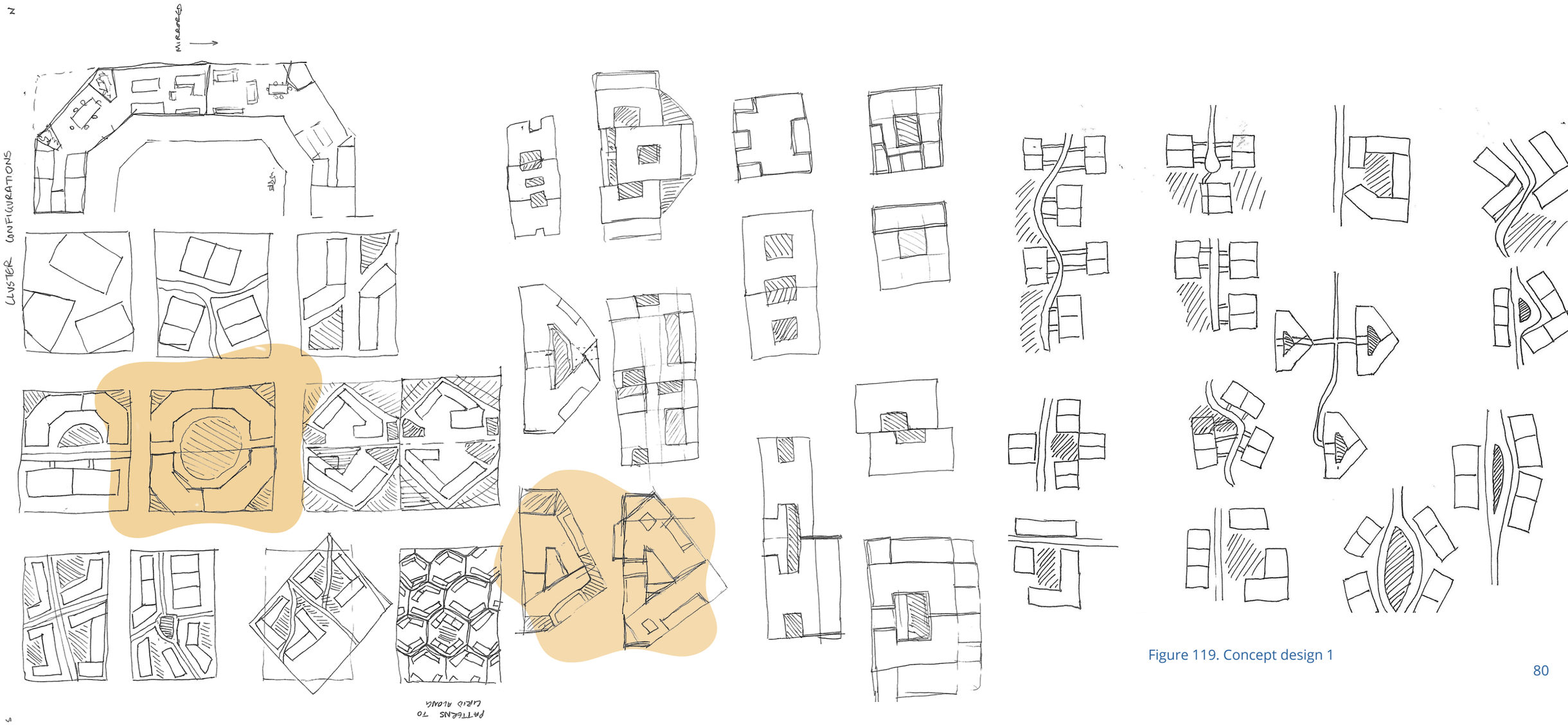


Figure 119. Concept design 1

CONCEPT DESIGN
Nodes

Units feature a sloped wall connecting the green wall to the green roof, encouraging species movement through the site and onto the roof. This sloped wall is located at the southern entrance and includes a corridor leading to the entrance of the units. Roofs are connected to surrounding terraces, allowing for an extended habitat.



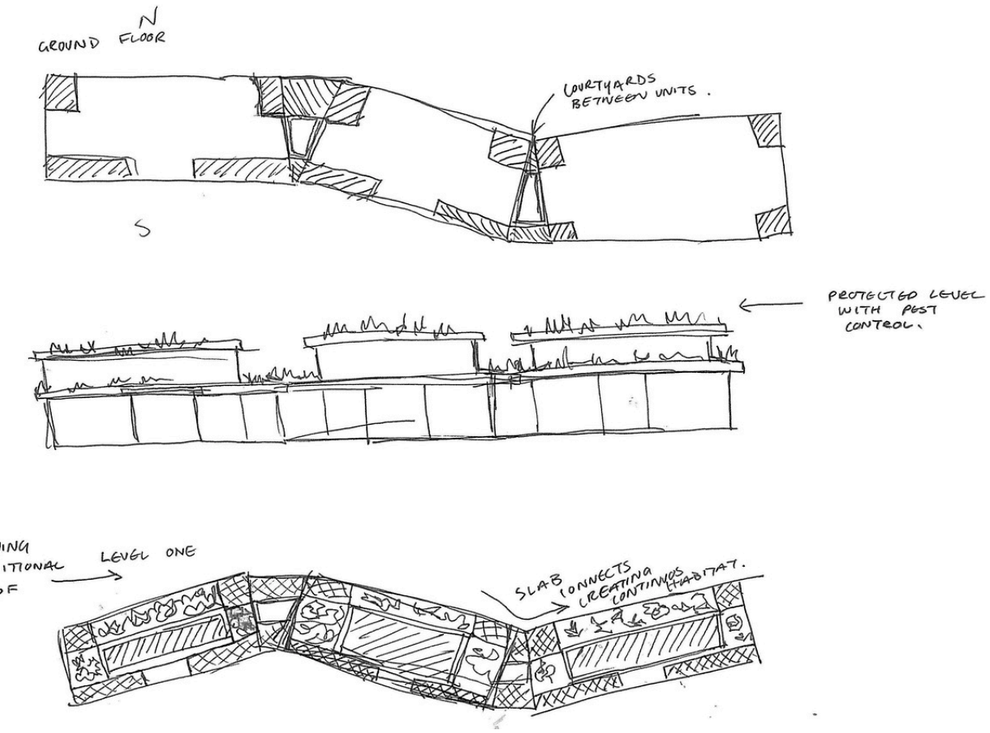


Figure 120. Concept design 2

CONCEPT DESIGN
Double storey terraces



More traditional styled terraces feature green walls that extend up to the green roofs. Pitched roofs, which are more common in modern architecture, may not be ideal for species habitats due to the risk of slipping and falling off the roof. A flat roof would provide a more comfortable option for the species.

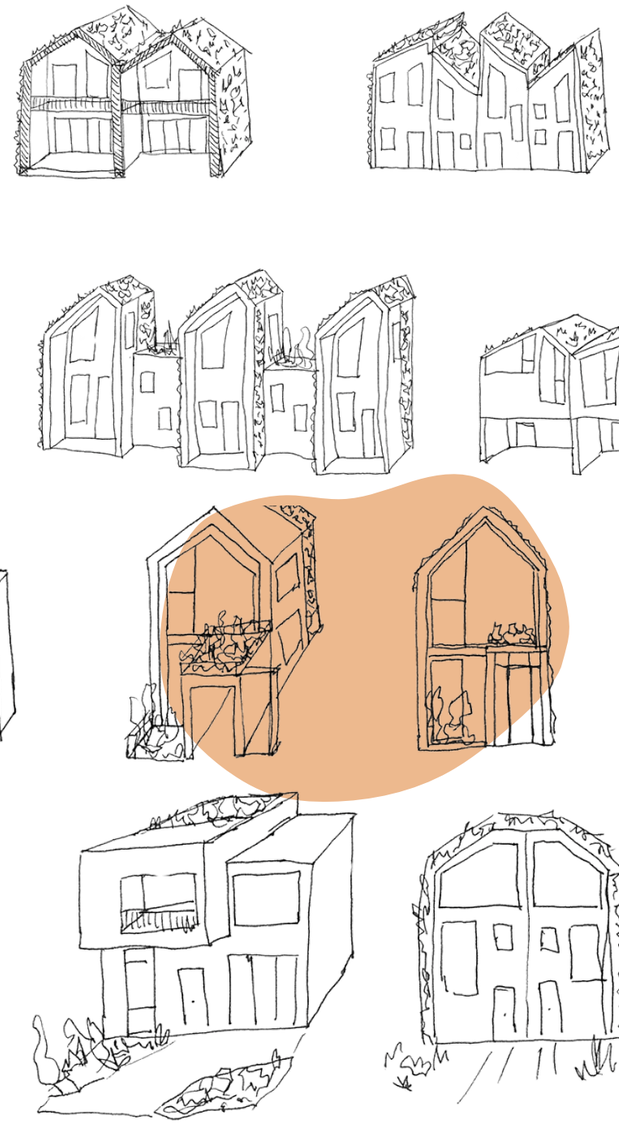
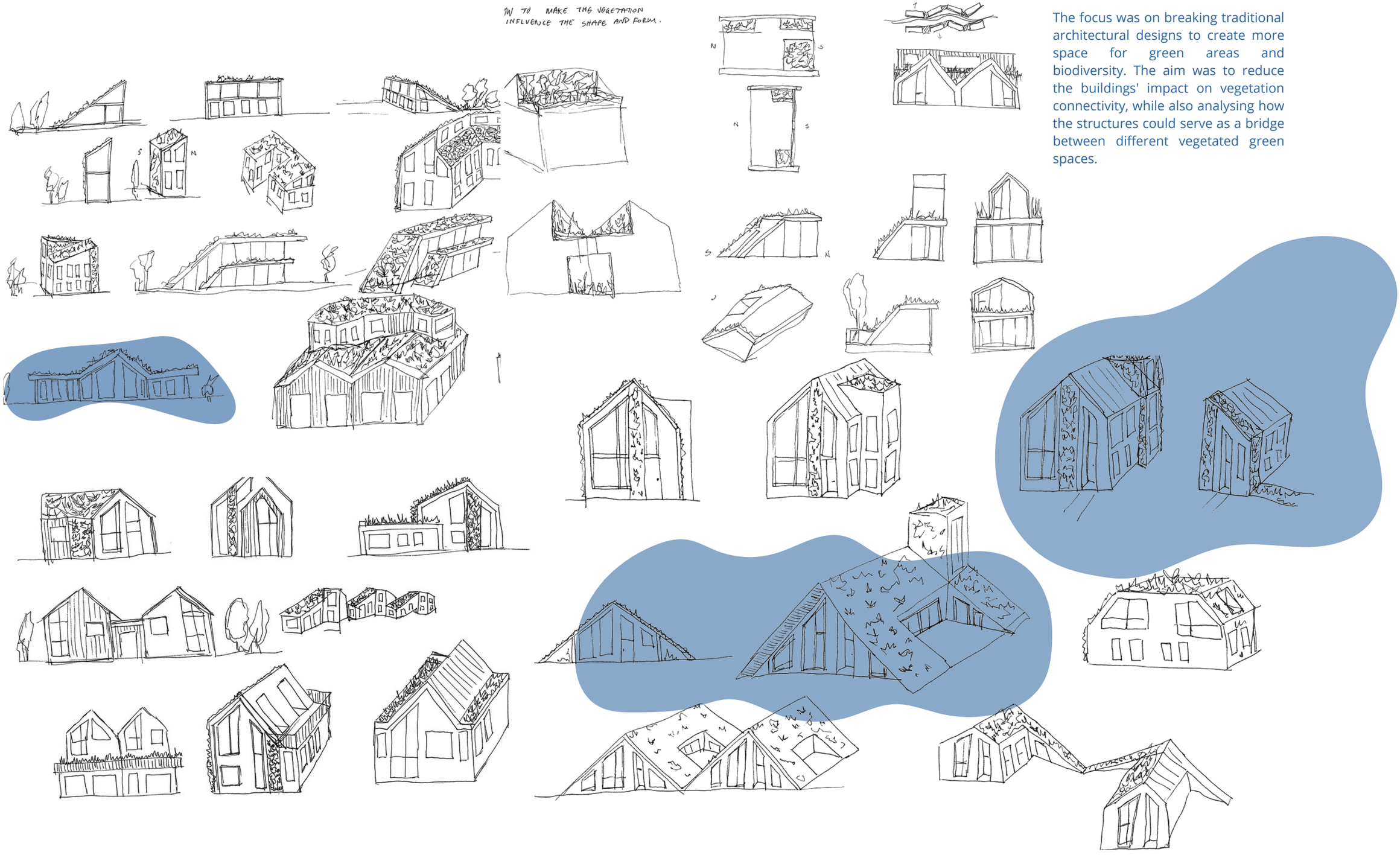


Figure 121. Concept design 3

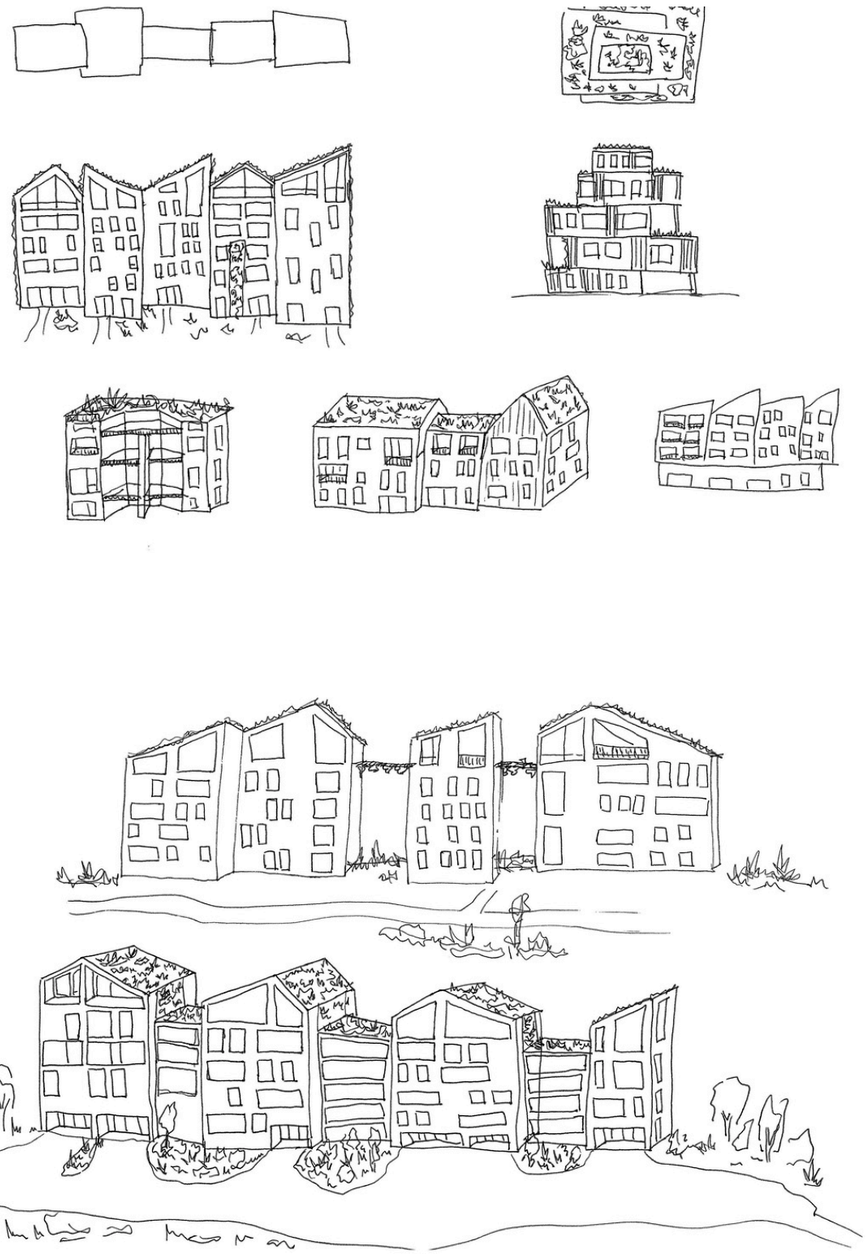
CONCEPT DESIGN
Double storey terraces



The focus was on breaking traditional architectural designs to create more space for green areas and biodiversity. The aim was to reduce the buildings' impact on vegetation connectivity, while also analysing how the structures could serve as a bridge between different vegetated green spaces.

Figure 122. Concept design 4

CONCEPT DESIGN
Apartments



A comparison was made between different stacking and elevations of units to assess how they could encourage biodiversity. Apartment units are taller than the terraces, providing more space for green walls. The higher roofs could be used as protected, pest-free islands.

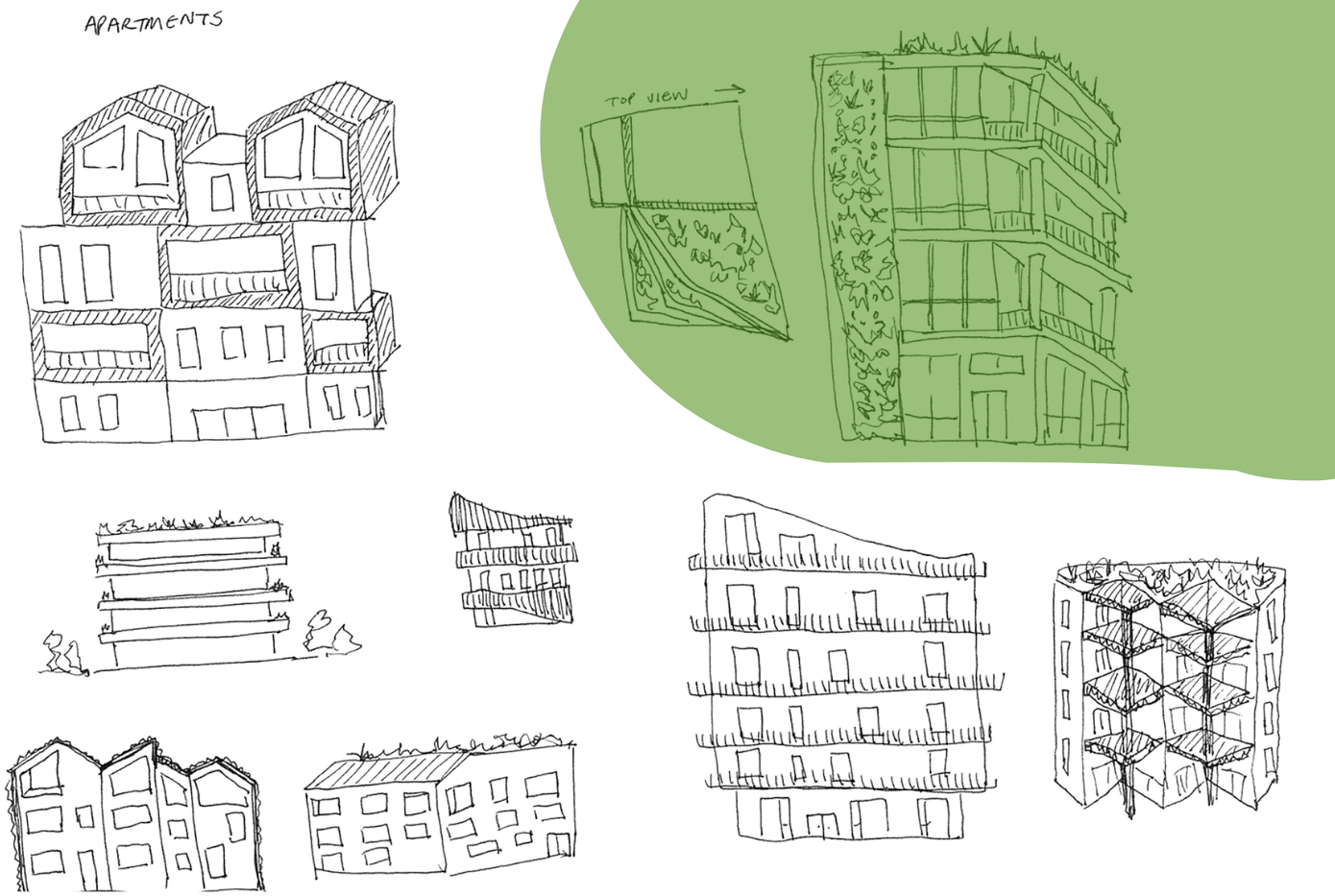


Figure 123. Concept design 5

CONCEPT DESIGN
Idea explored



Figure 124. Concept idea floorplan

This ideation explored the use of a slanted green wall connecting up to the green roof. This design has a simple floor plan that incorporates an open plan flow between the living spaces. The double storey units allow for an additional space for plantings that also act as sun shades during summer months.

After reflection, it was decided that the design did not encourage enough interaction between residents and nature while in their units. This interaction is crucial for fostering a paradigm shift of humans role in conservation.

Sloped roofs offer a unique opportunity to facilitate species movement to and from the roof. However, their implementation would require a complex construction method, potentially increasing building costs and leading to fewer designs incorporating them .



Figure 125. Collage of concept idea

CONCEPT DESIGN
Idea revisited

Upon reflecting on the previous design, the focus shifted to breaking the boundary between the outside natural world and the interior spaces where humans typically reside. With this shift, the design evolved to maximise outdoor views, bring nature indoors, and create opportunities for residents to spend more time outside.

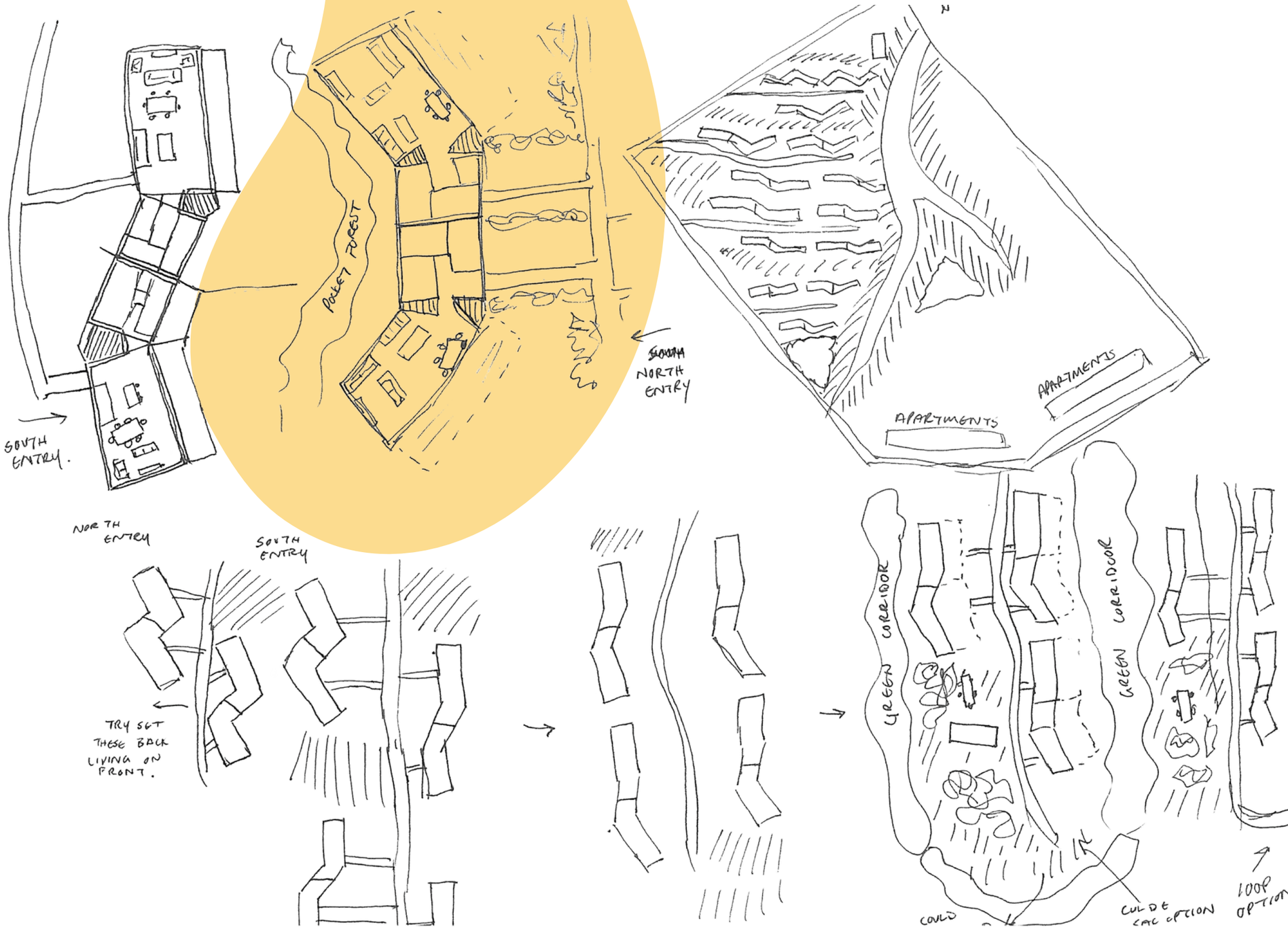


Figure 126 Concept revisited

CONCEPT DESIGN
Idea revisited

This design was further explored and refined to investigate the potential for increasing space for nature both inside and around the home.

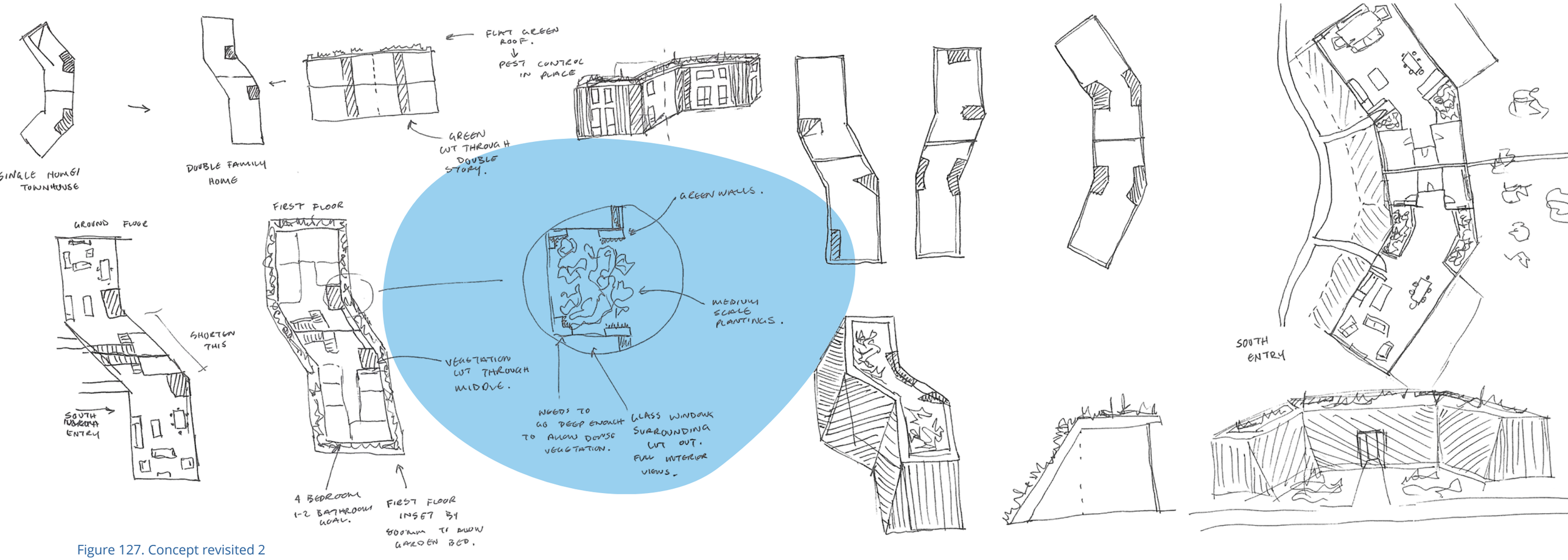


Figure 127. Concept revisited 2

CONCEPT DESIGN
Idea revisited

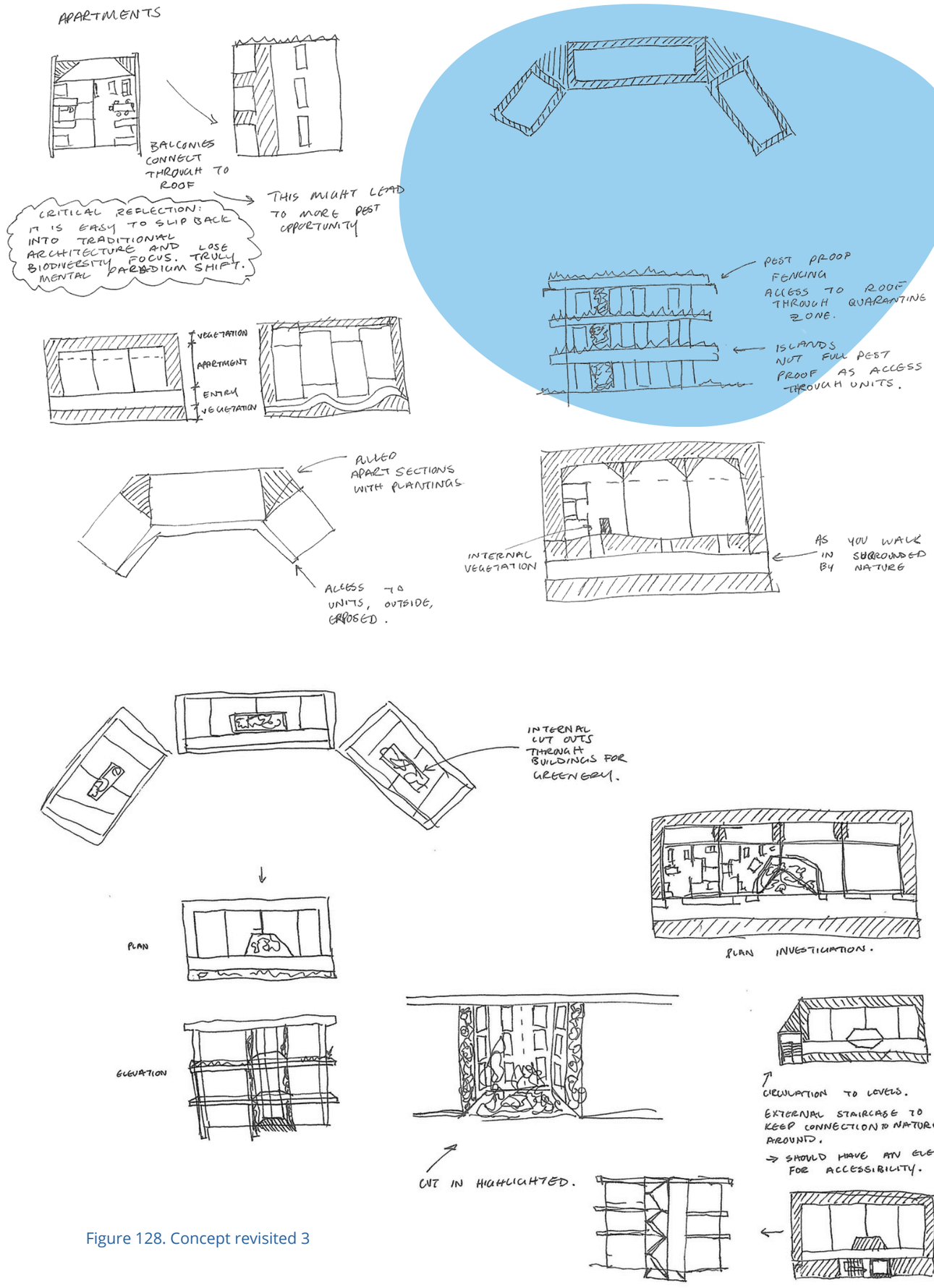


Figure 128. Concept revisited 3

DEVELOPED DESIGN
Terrace single storey

Ground Floor



Figure 129. Terrace single storey ground floor

DEVELOPED DESIGN
Terrace single storey

Section 1





Figure 130. Terrace single storey section 1

DEVELOPED DESIGN
Terrace single storey

Section 2



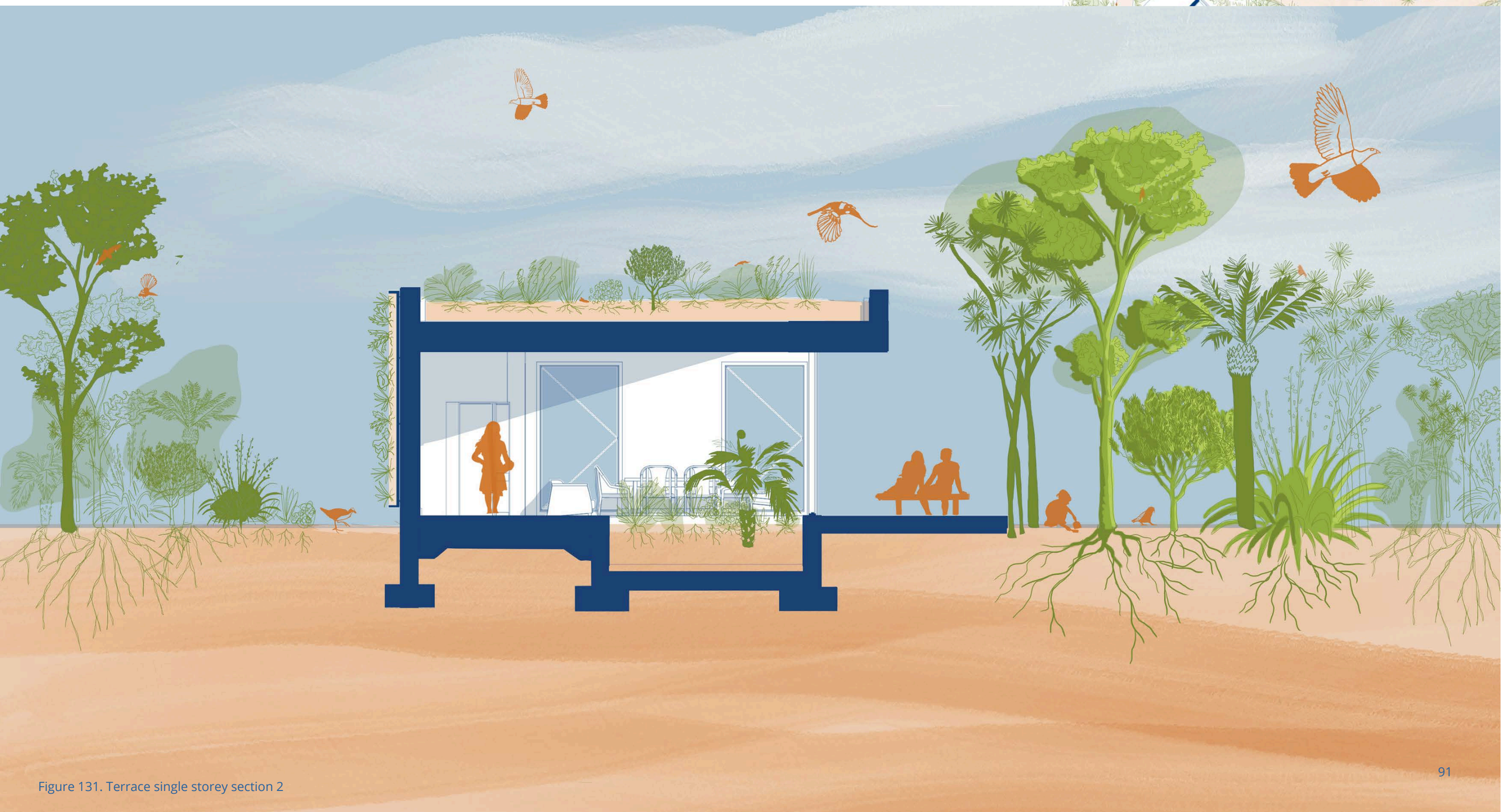


Figure 131. Terrace single storey section 2

DEVELOPED DESIGN
Terrace single storey

RESULTS

SQM of site	160
Number of units	2
SQM of individual units	80
No. Bedrooms	3-4
No. Bathrooms	1
House Types	Terraces

The single-storey terrace units feature two homes connected by a shared central wall. Each individual unit comprises three bedrooms, with the option for a fourth bedroom or a designated study or storage area. The design includes an open-plan living, dining, and kitchen space, seamlessly integrating native vegetation into the floor plan. The entire northern facade offers an expansive view of the surrounding native plantings, enhancing the connection to nature. Additionally, each unit has a spacious deck, providing an outdoor space for residents to relax and immerse themselves in their natural surroundings.

The homes are designed to strengthen the human-nature connection by offering residents continuous views of the surrounding natural environment. Native plantings are also integrated into the interior, allowing nature to be a constant presence within the living space



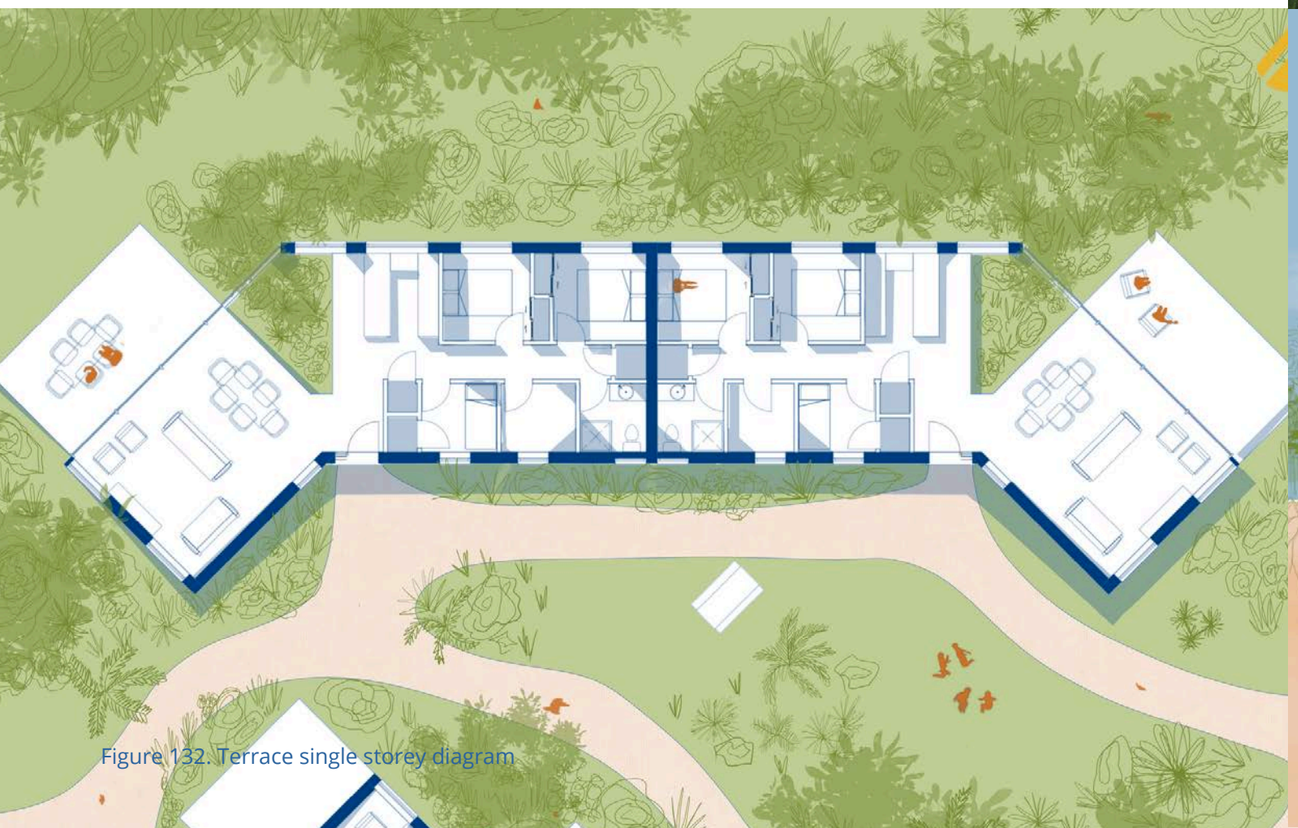


Figure 132. Terrace single storey diagram



DEVELOPED DESIGN
Terrace double storey

Ground Floor

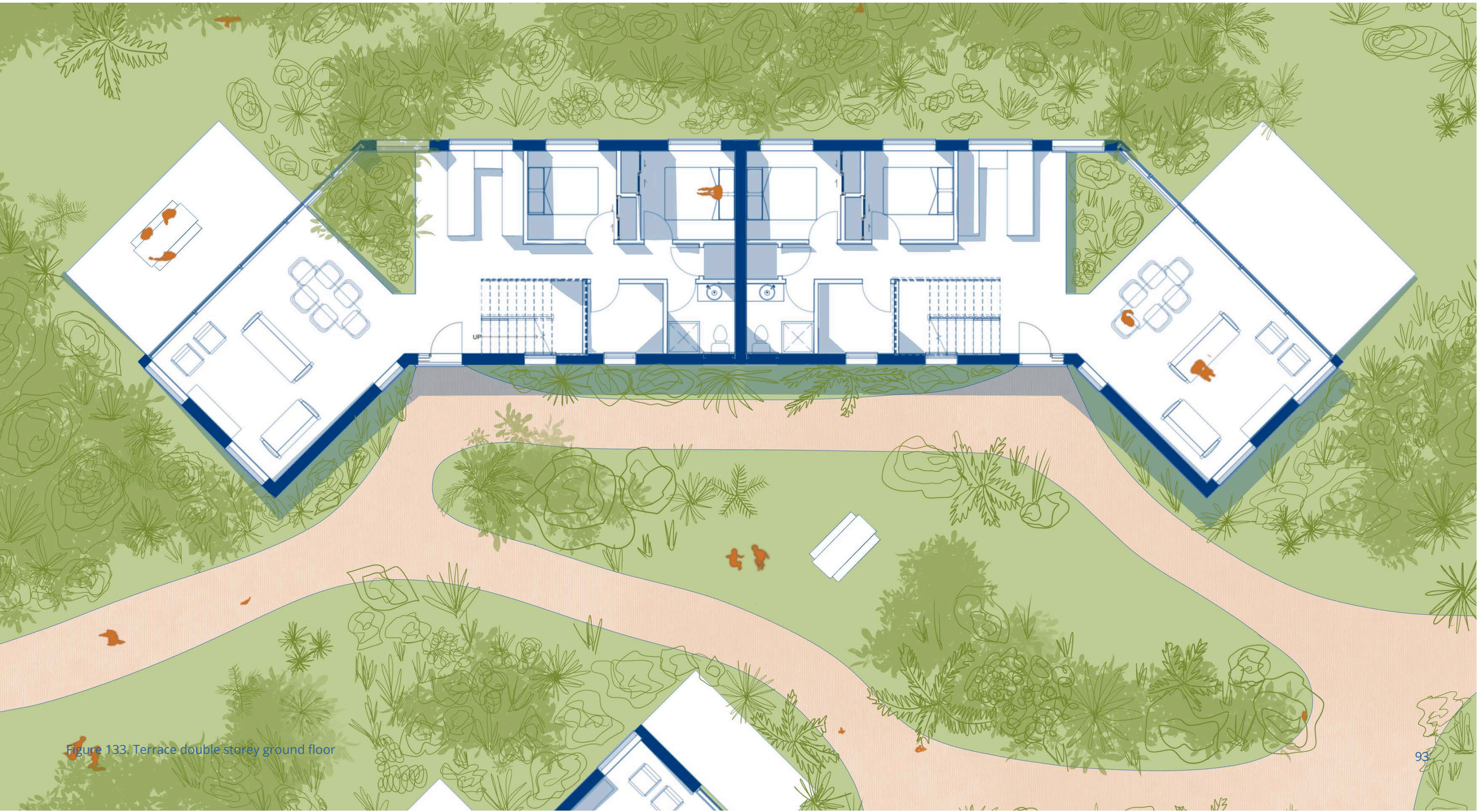


Figure 133. Terrace double storey ground floor

First Floor

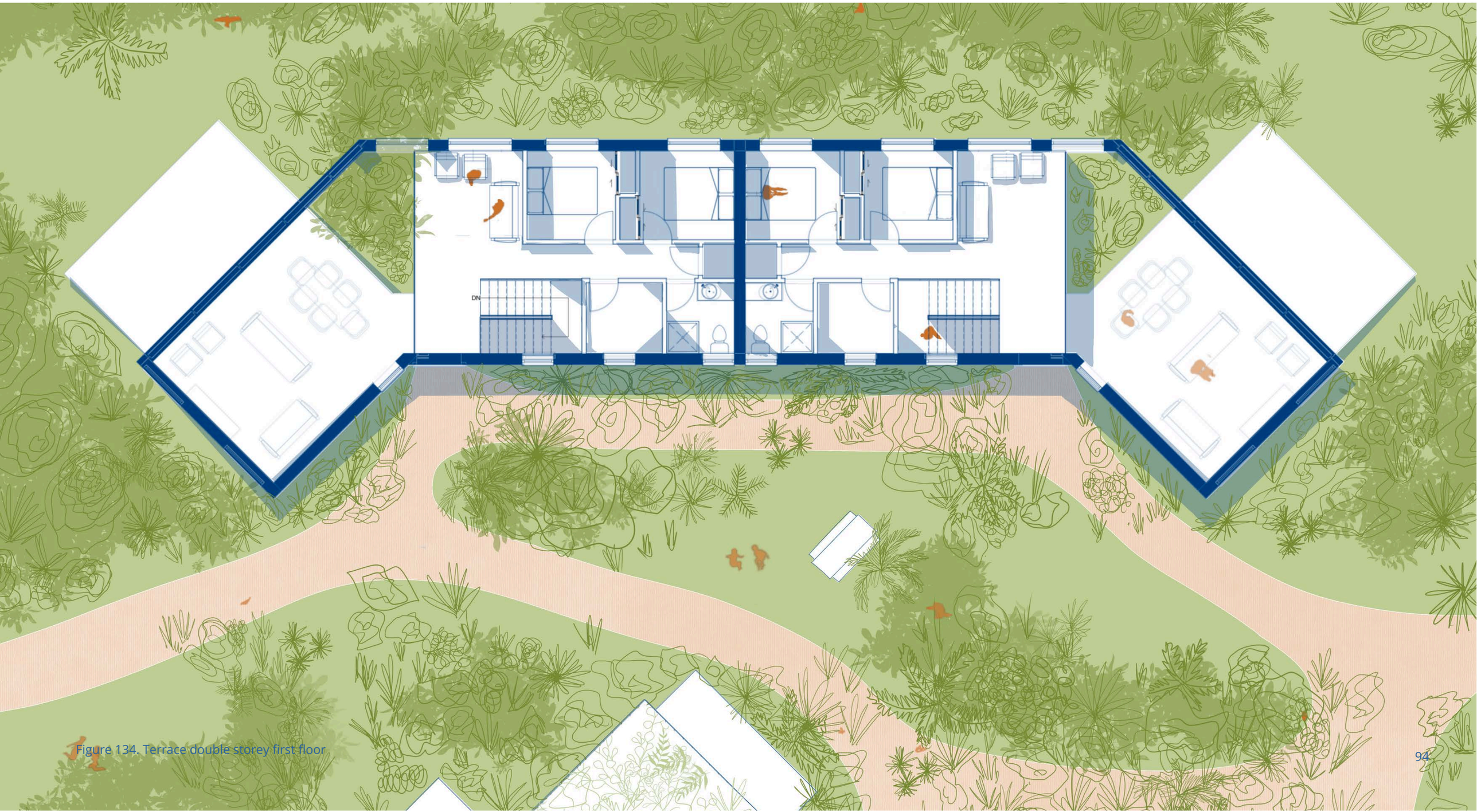


Figure 134. Terrace double storey first floor

DEVELOPED DESIGN
Terrace double storey

Section 1



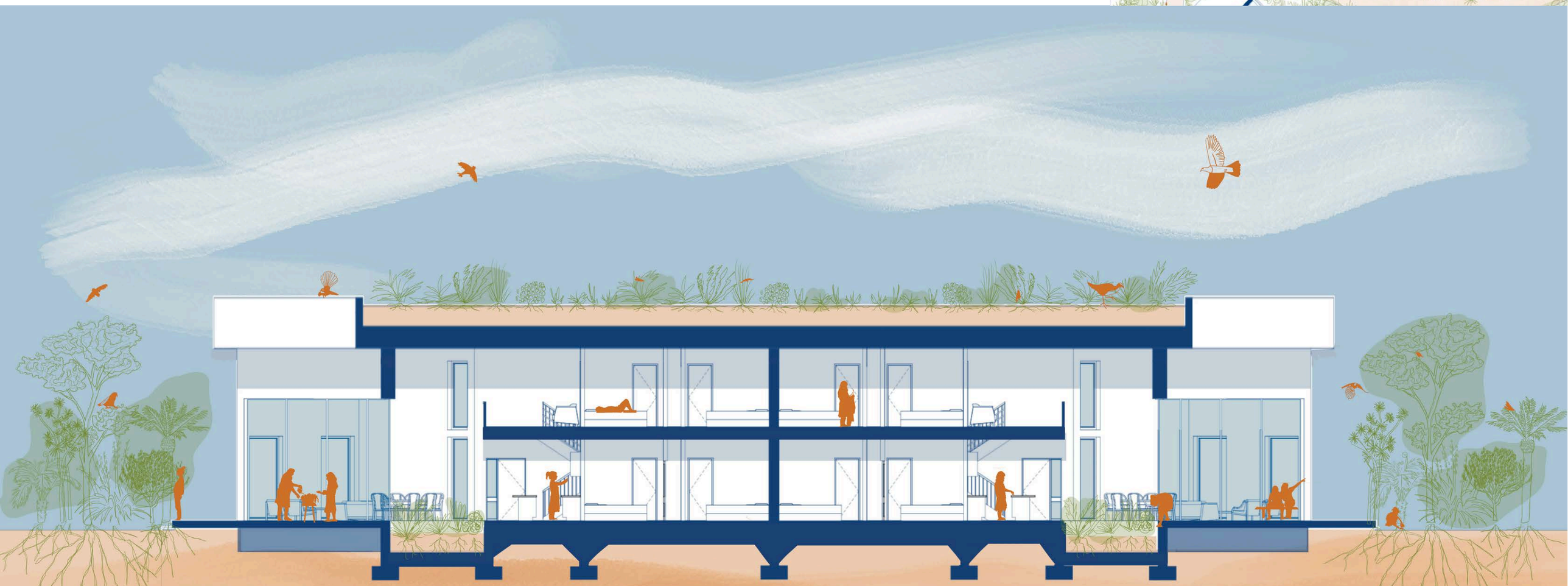


Figure 135. Terrace double storey section 1

DEVELOPED DESIGN
Terrace double storey

Section 2





Figure 136. Terrace double storey section 2

DEVELOPED DESIGN
Terrace double storey

RESULTS

SQM of site	160
Number of units	2
SQM of individual units	160
No. Bedrooms	4-6
No. Bathrooms	2
House Types	Terraces

The double-storey terrace units feature two homes connected by a shared central wall. Each individual unit comprises four bedrooms, with the option for a two more bedrooms or a designated study or storage area. The design includes an open-plan living, dining, and kitchen space, seamlessly integrating native vegetation into the floor plan. The entire northern facade offers an expansive view of the surrounding native plantings, enhancing the connection to nature. Additionally, each unit has a spacious deck, providing an outdoor space for residents to relax and immerse themselves in their natural surroundings.

The homes are designed to strengthen the human-nature connection by offering residents continuous views of the surrounding natural environment. Native plantings are also integrated into the interior, allowing nature to be a constant presence within the living space



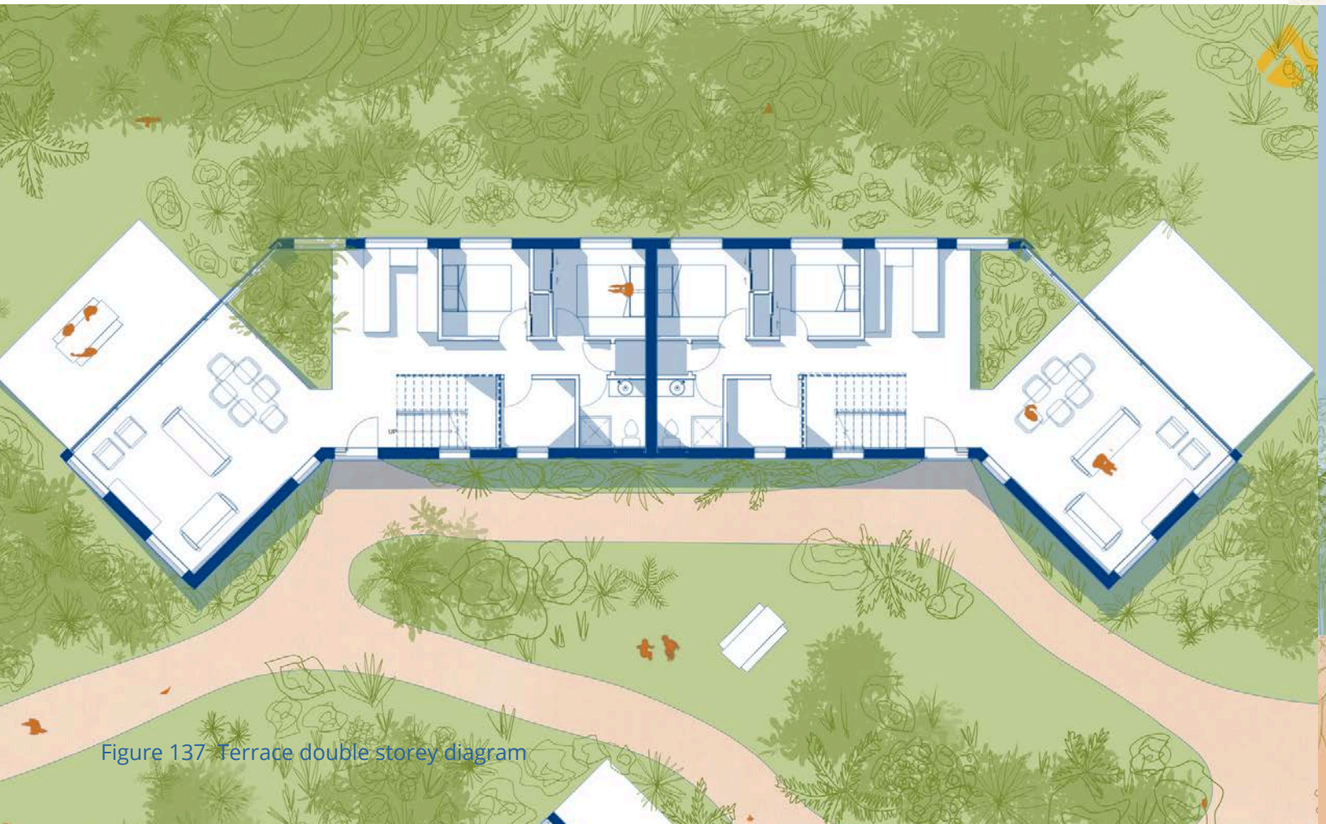




Figure 137 Terrace double storey diagram

DEVELOPED DESIGN
Terrace Apartment

Ground Floor

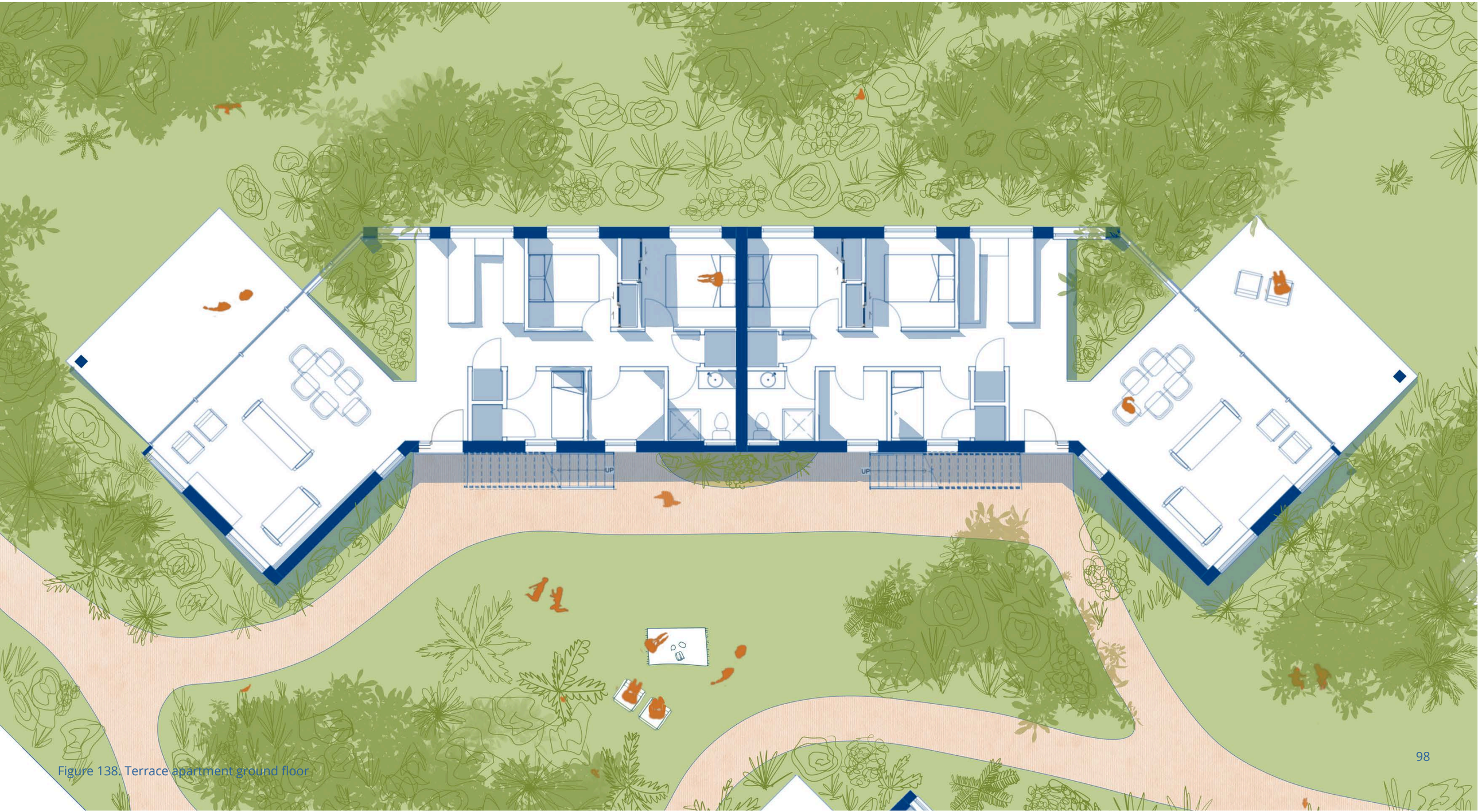


Figure 138. Terrace apartment ground floor

DEVELOPED DESIGN
Terrace Apartment

Level 1



Figure 139. Terrace apartment firstfloor

DEVELOPED DESIGN
Terrace Apartment

Section 1



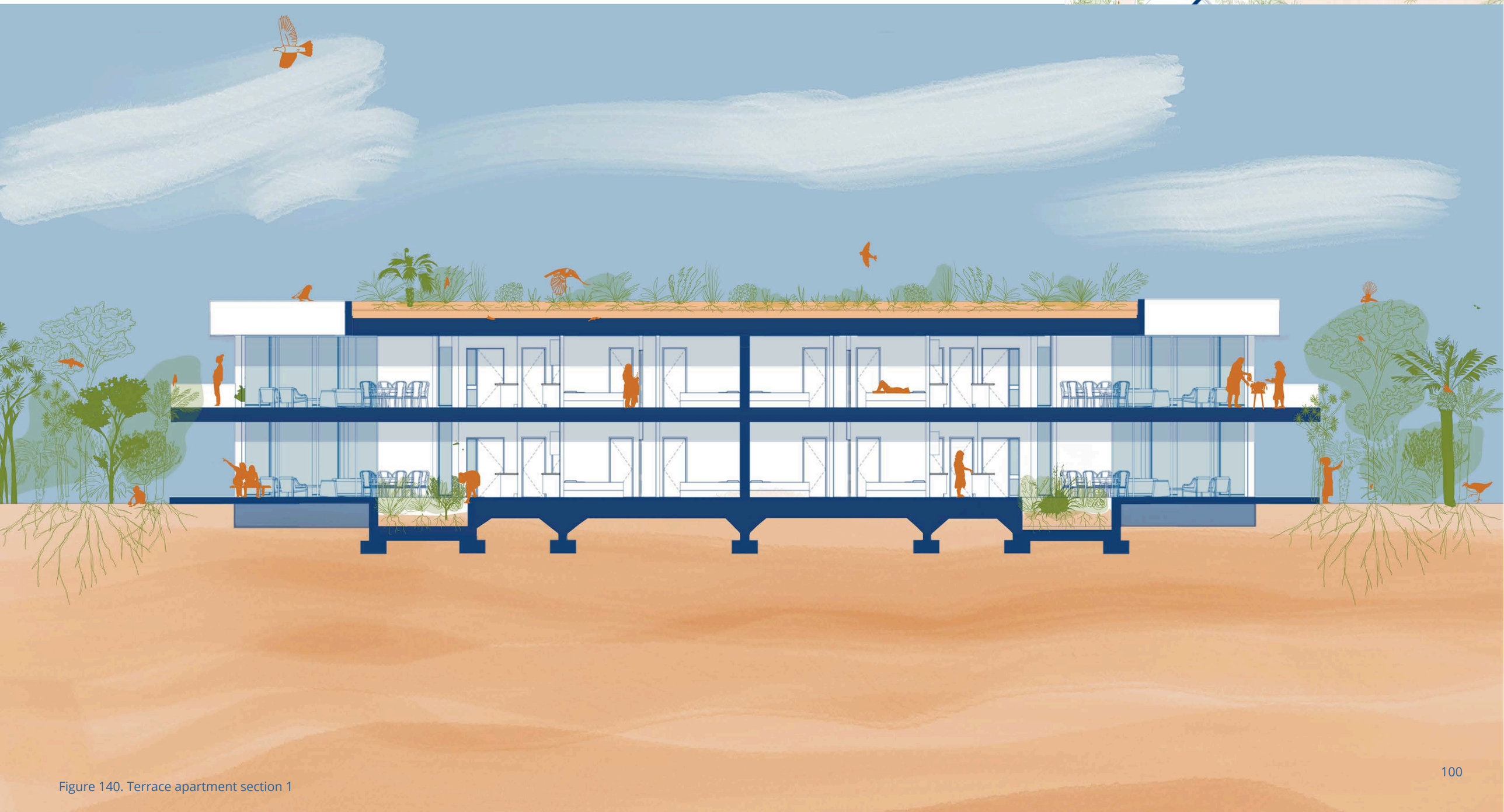


Figure 140. Terrace apartment section 1

DEVELOPED DESIGN
Terrace Apartment

Section 2





Figure 141. Terrace apartment section 2

DEVELOPED DESIGN
Terrace Apartments

RESULTS

SQM of site	160
Number of units	4
SQM of individual units	80
No. Bedrooms	3-4
No. Bathrooms	1
House Types	Apartments

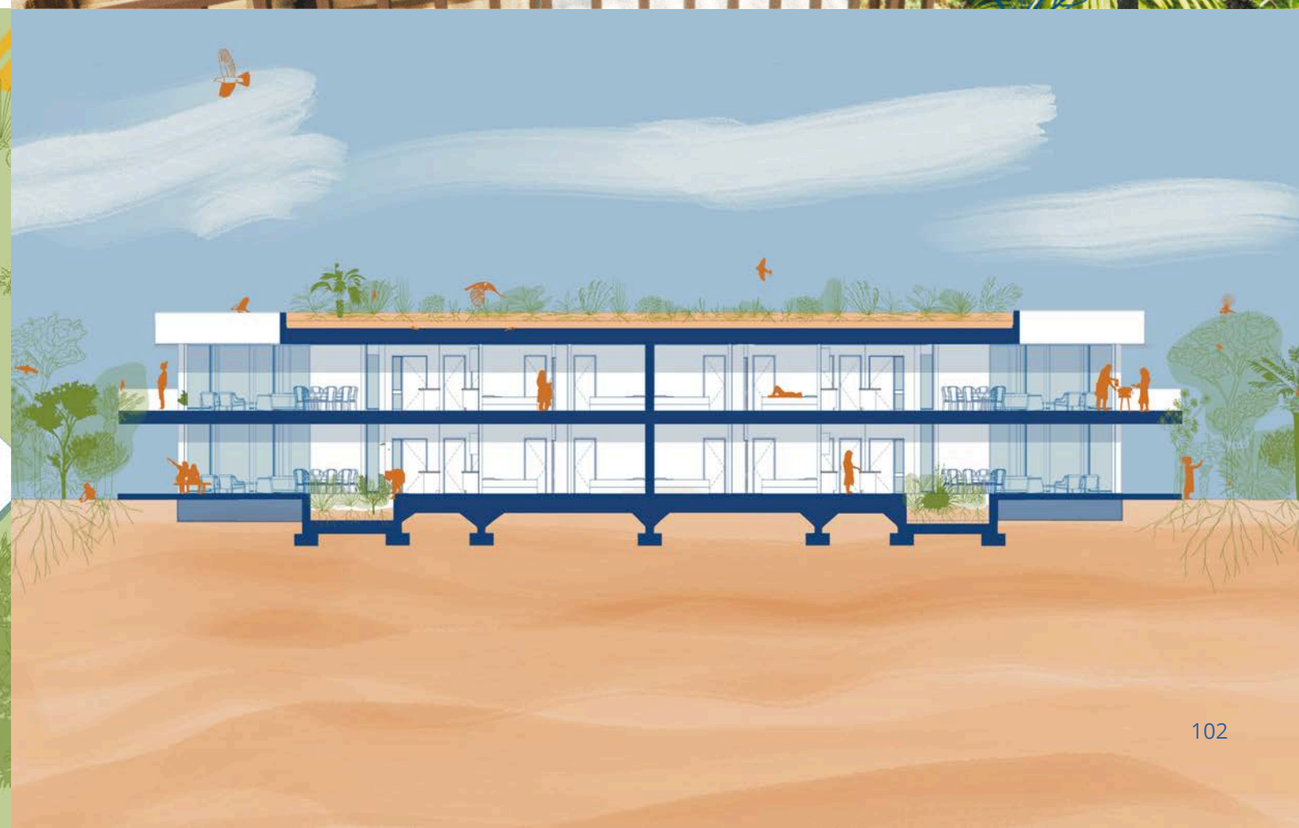
The double-storey terrace units feature four apartments. Each individual unit comprises three bedrooms, with the option for another bedrooms, study or storage area. The design includes an open-plan living, dining, and kitchen space, seamlessly integrating native vegetation into the floor plan. The entire northern facade offers an expansive view of the surrounding native plantings, enhancing the connection to nature. Additionally, each unit has a spacious deck or balcony, providing an outdoor space for residents to relax and immerse themselves in their natural surroundings.

The homes are designed to strengthen the human-nature connection by offering residents continuous views of the surrounding natural environment. Native plantings are also integrated into the interior, allowing nature to be a constant presence within the living space





Figure 142. Terrace apartment diagram



Ground Floor

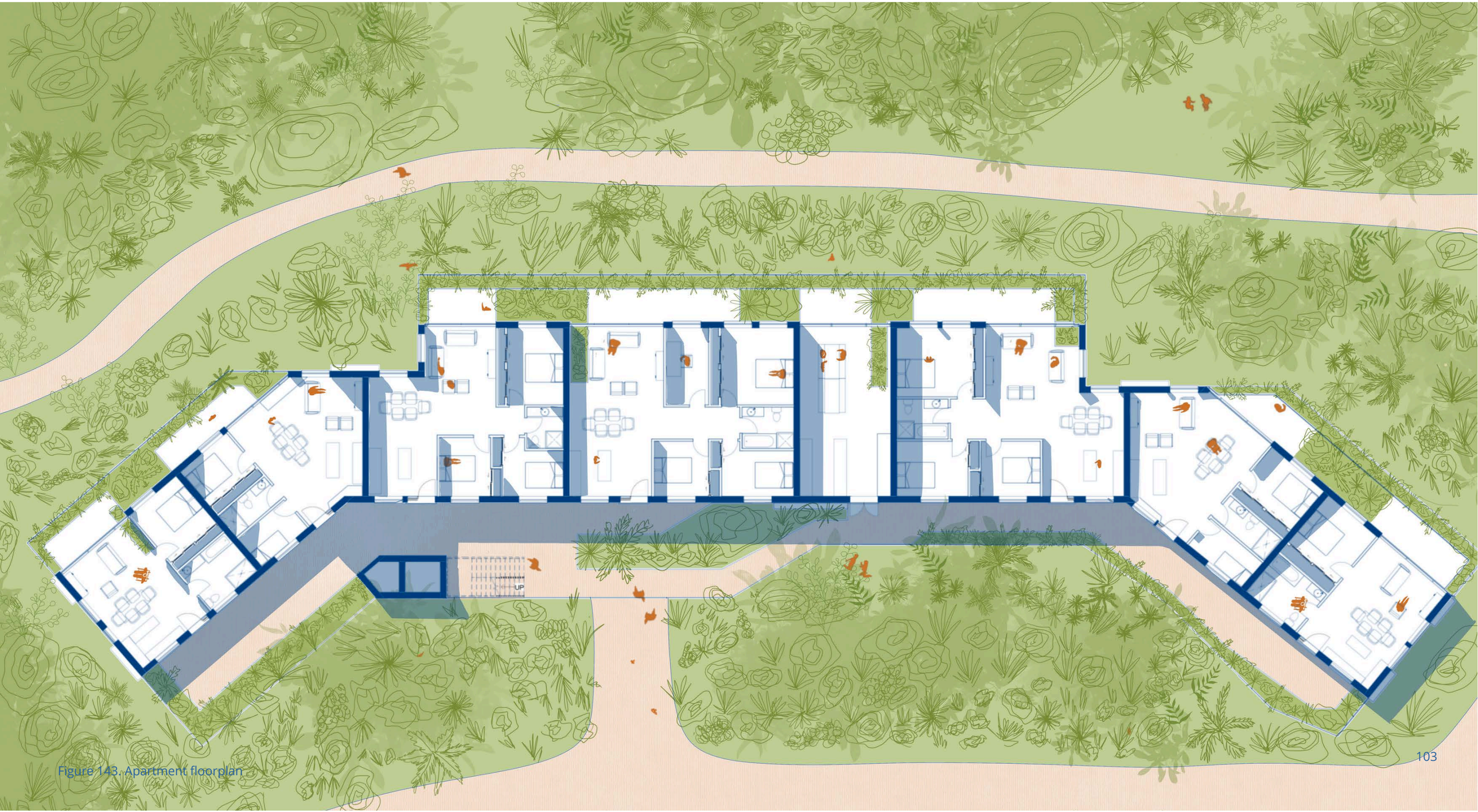


Figure 143. Apartment floorplan

Section 1



Figure 144. Apartment section 1

Section 2



Figure 145. Apartment section 2

DEVELOPED DESIGN
Apartment Building
RESULTS

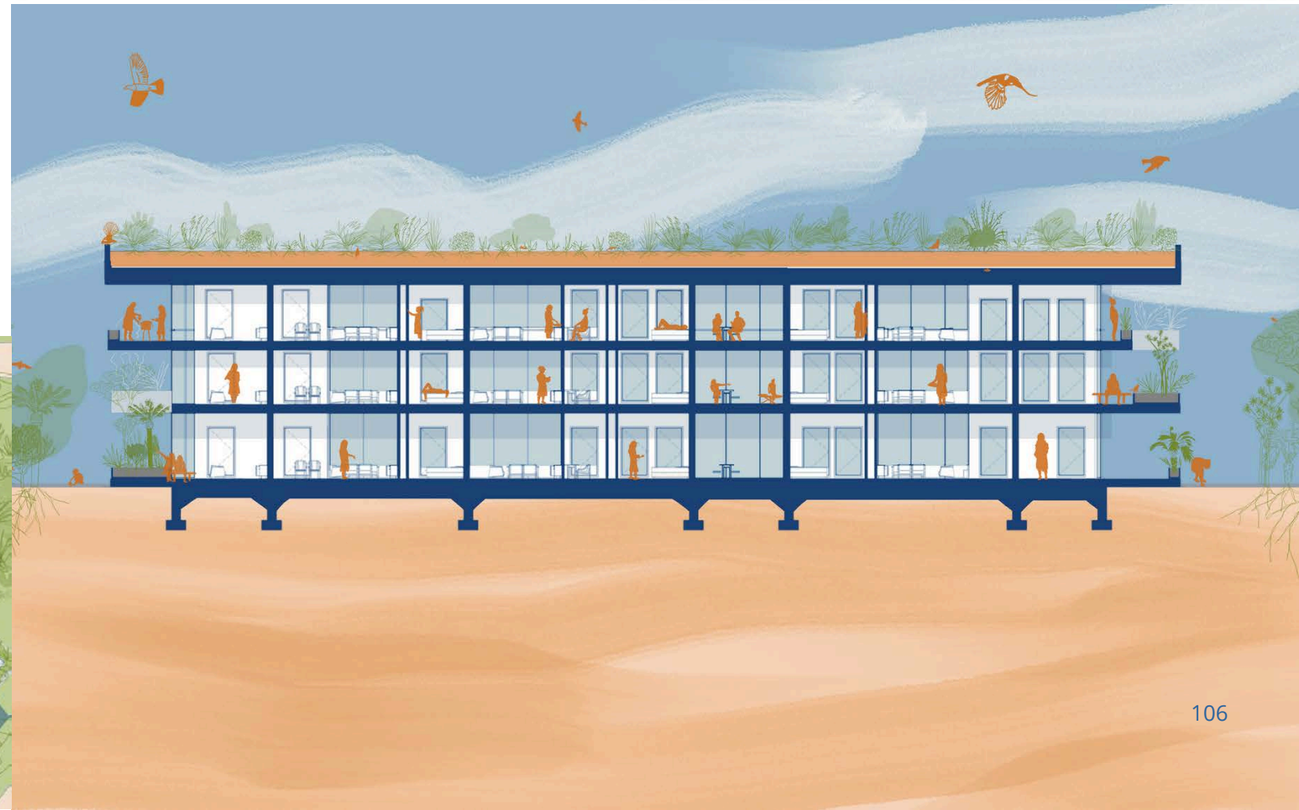
SQM of site		600
Number of units		21
SQM of individual footprints		60-100
Type 1	**No. Bedrooms**	1
	No. Bathrooms	1
Type 2	**No. Bedrooms**	2
	No. Bathrooms	1
Type 3	**No. Bedrooms**	3
	No. Bathrooms	1
Type 4	**No. Bedrooms**	3-4
	No. Bathrooms	1
House Types		Aparments

The three-storey apartment block includes seven diversely designed apartments on each level. Rather than a single common house, each floor includes a shared space with communal amenities. The apartments are oriented to provide views of the surrounding biodiverse landscape, fostering a strong connection with nature. A vertical forest is formed through staggered, planted balconies, with greenery extending into the living rooms. This design not only maximises planting opportunities but also prolongs residents' daily interaction with nature, enhancing both the living experience and the ecological impact of the site.



Figure 146. Apartment diagram





DEVELOPED DESIGN
Common house

Ground Floor

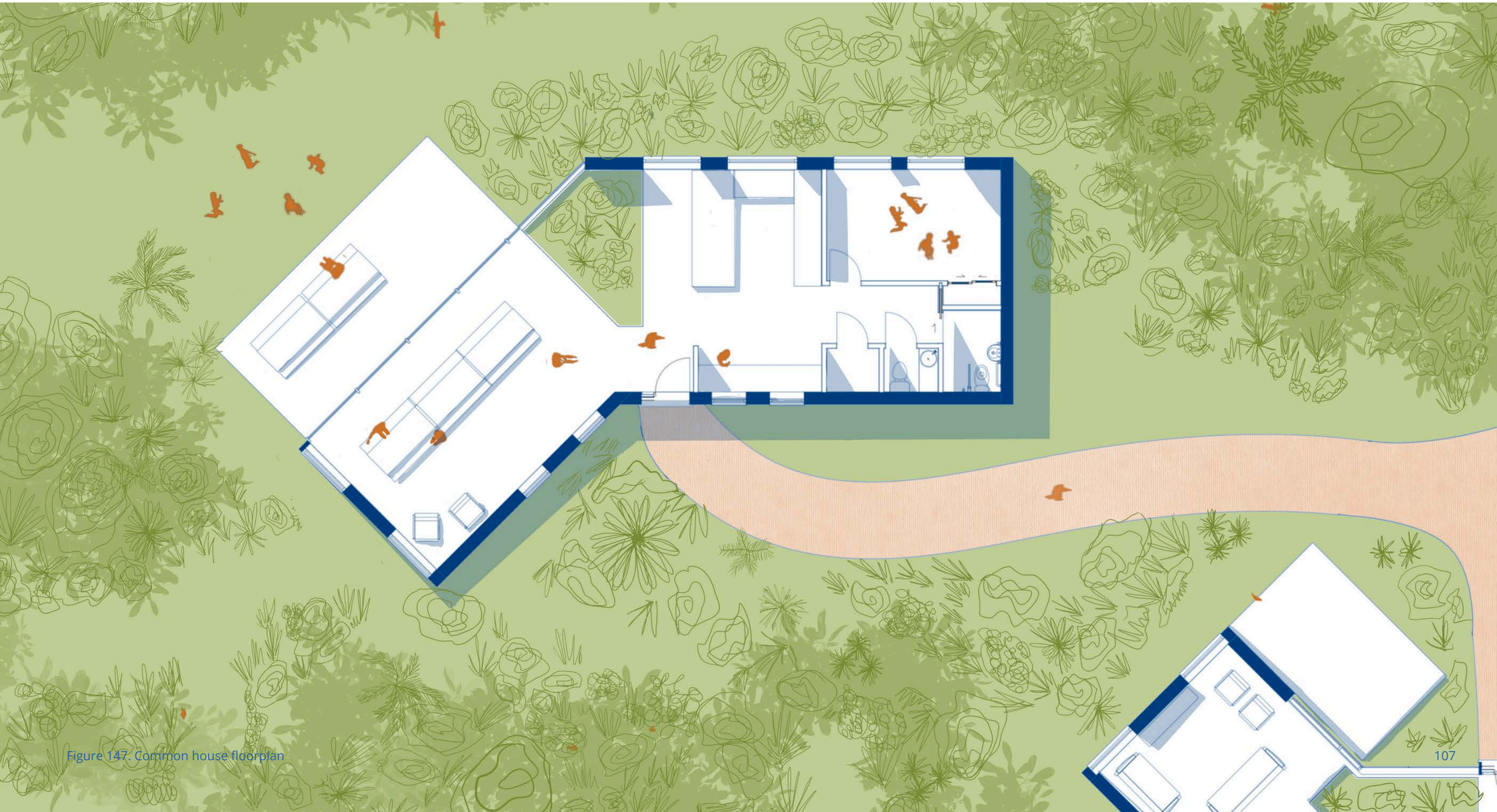


Figure 147. Common house floorplan

DEVELOPED DESIGN
Units

RESULTS

Unit		Amount
Terrace single storey		40
Terrace double storey		42
Terrace double apartment		72
Apartments		21

	Site
SQM of site	80,000
Number of units	175
SQM of individual footprints	80
SQM of Footprint	14,000
• **Percentage**	17.5%
SQM of Garden	60,000
• **Percentage**	75%
Units per Acre	8.75

These results demonstrate that the development successfully achieved a balance between sufficient unit density and native vegetation for habitat creation.

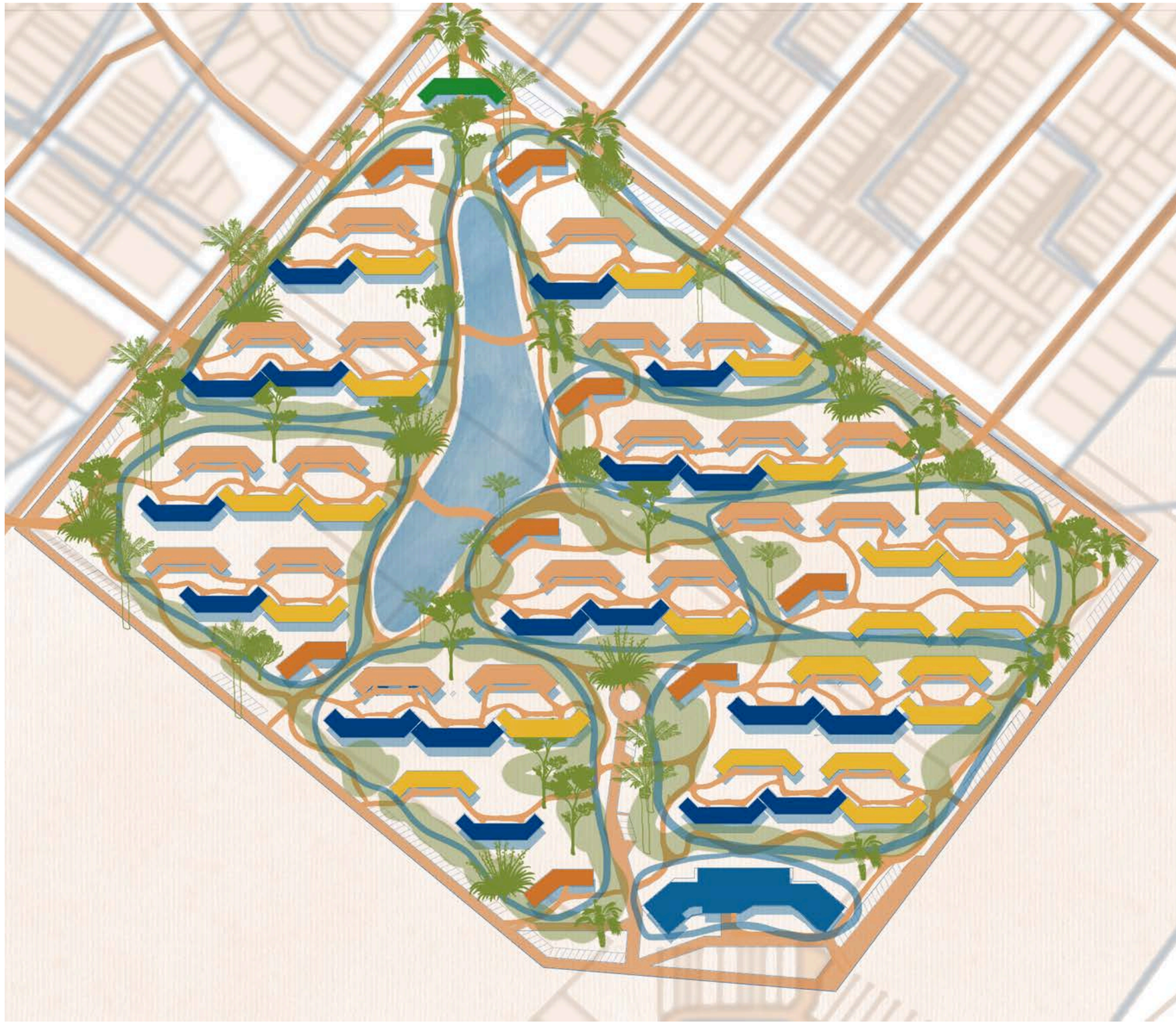


Figure 148. Units diagram

DEVELOPED DESIGN
Terrace Renders

Figure 149. Render of walkway through nodes

DEVELOPED DESIGN
Terrace Renders



Figure 150. Render of view from terrace apartment balcony

DEVELOPED DESIGN
Terrace Renders



Figure 151. Render of family spending time outside

DEVELOPED DESIGN
Terrace Renders

Figure 152: Render of view inside a double terrace house.

DEVELOPED DESIGN
Terrace Renders



Figure 153. Render of residents in their kitchen

DEVELOPED DESIGN
Terrace Renders



Figure 154. Render of residents hosting on their patio

DEVELOPED DESIGN
Terrace Renders



Figure 155. Render of house at night

DEVELOPED DESIGN
Terrace Renders



Figure 156. Render of units during the rain

DEVELOPED DESIGN
Terrace Renders



Figure 157. Render of terrace apartment external view



Figure 158. Render of terrace double storey external view

DEVELOPED DESIGN
Node renders



Figure 159. Render of common space between nodes

DEVELOPED DESIGN
Node renders



Figure 160. Render of common space between nodes 2

DEVELOPED DESIGN
Node renders



Figure 161. Render of top view of nodes and green roofs

DEVELOPED DESIGN
Apartment Renders



Figure 162. Render of apartment block from west side.



Figure 163. Render of apartment block from south side.

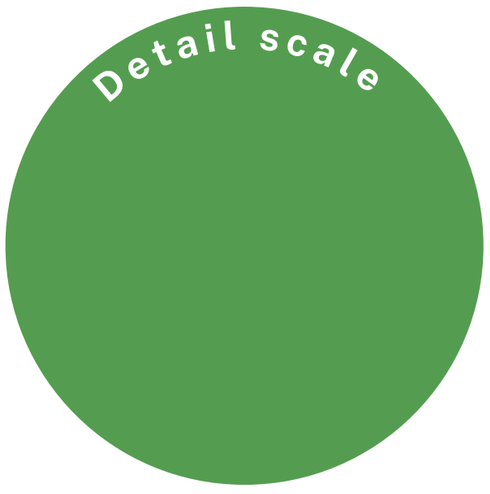
DEVELOPED DESIGN
Apartment Renders



Figure 164. Render of apartment block from north east side

DEVELOPED DESIGN
Apartment Renders

Figure 165: Render of apartment block from north.



Plan



Predator fences.



Predator monitoring through site.



Hidden traps.



Multiple levels of predator restrictions.



Building materials that are low waste and have minimal ecological impacts.



Green roofs as islands.



Species housing built into architecture.

Design Matrix

Maintain and introduce

- Provide refugee for lizards through habitat creation with shrubs and rock piles.
- Create vegetative ground cover with leaf litter, rotting logs and bare ground for invertebrates.
- Plant native plants that feed nectivorous birds.
- Design complex plantings with diverse species composition.
- Preserve existing soil and vegetation on site before groundworks.

Facilitate dispersal

- Remove private garden fences.
- Reduce private garden section, instead have connected gardens.

Minimise threats & anthropogenic disturbance

- Permaculture planning
- Xeriscaping plantings
- Bioremediation - phytoremediation of soil.
- Car parking on edge of development with few necessary roads in.
- Cycle lanes through site..

Facilitate natural ecological processes

- Insect/bee hotels
- Urban beehives
- Urban composting
- Design spaces for low maintenance wild plantings for pollinators.
- Nesting boxes

Improve potential for positive human-nature interactions.

- Attract species that humans have better connotations to, closer to walkways and houses.
- Have a show house that the surrounding community can walk through and have learnings within.
- Have activities for the residents to take responsibility for.

Figure 166. Detail scale diagram

DEVELOPED DESIGN
FRAMEWORK

MAINTAIN AND INTRODUCE

- Avoid habitat loss.
- Develop in low ecological value areas.
- Use native species.
- Create vegetative complexity.
- Design green infrastructure.
- Incorporate key resources for habitat analogues.



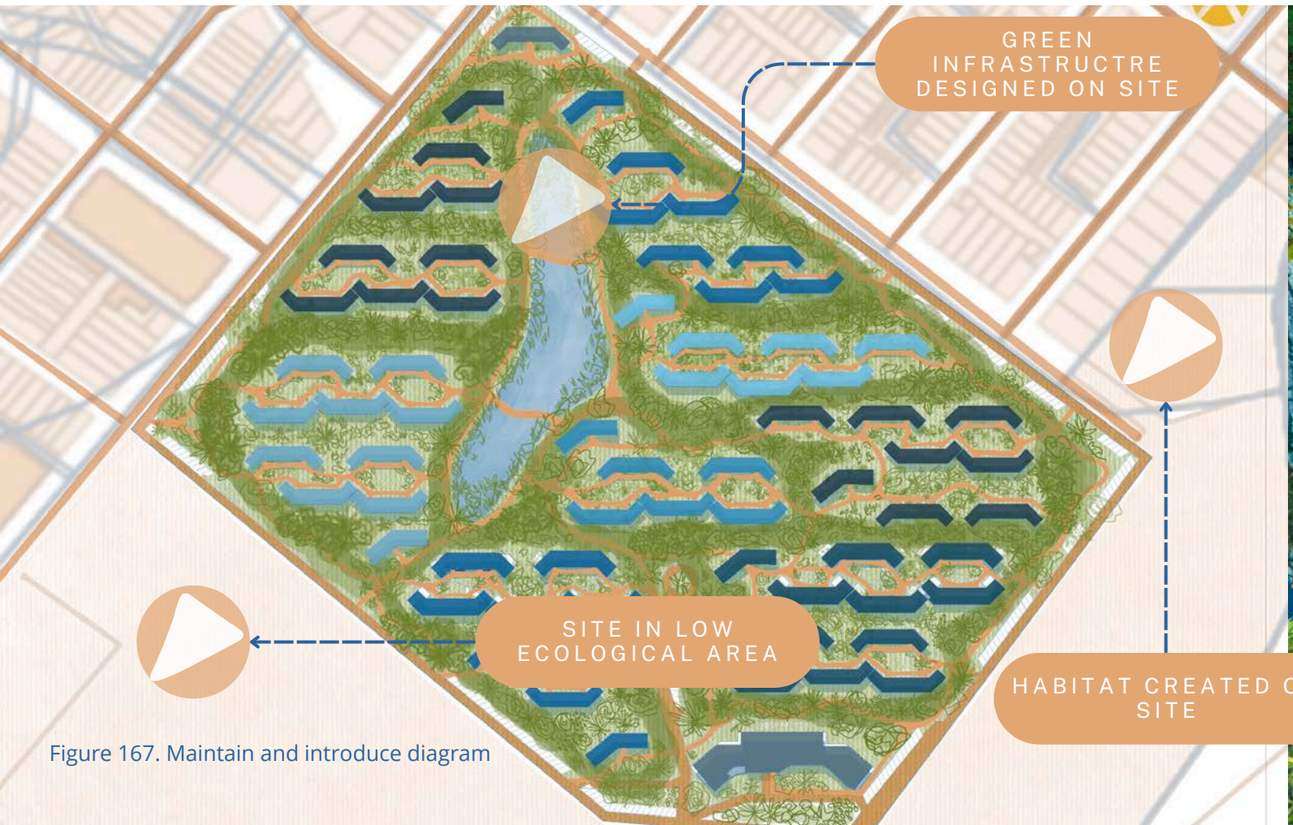


Figure 167. Maintain and introduce diagram



DEVELOPED DESIGN *FRAMEWORK*

FACILITATE DISPERSAL

- Add animal movement infrastructure.
- Establish connectivity corridors through public and private lands.





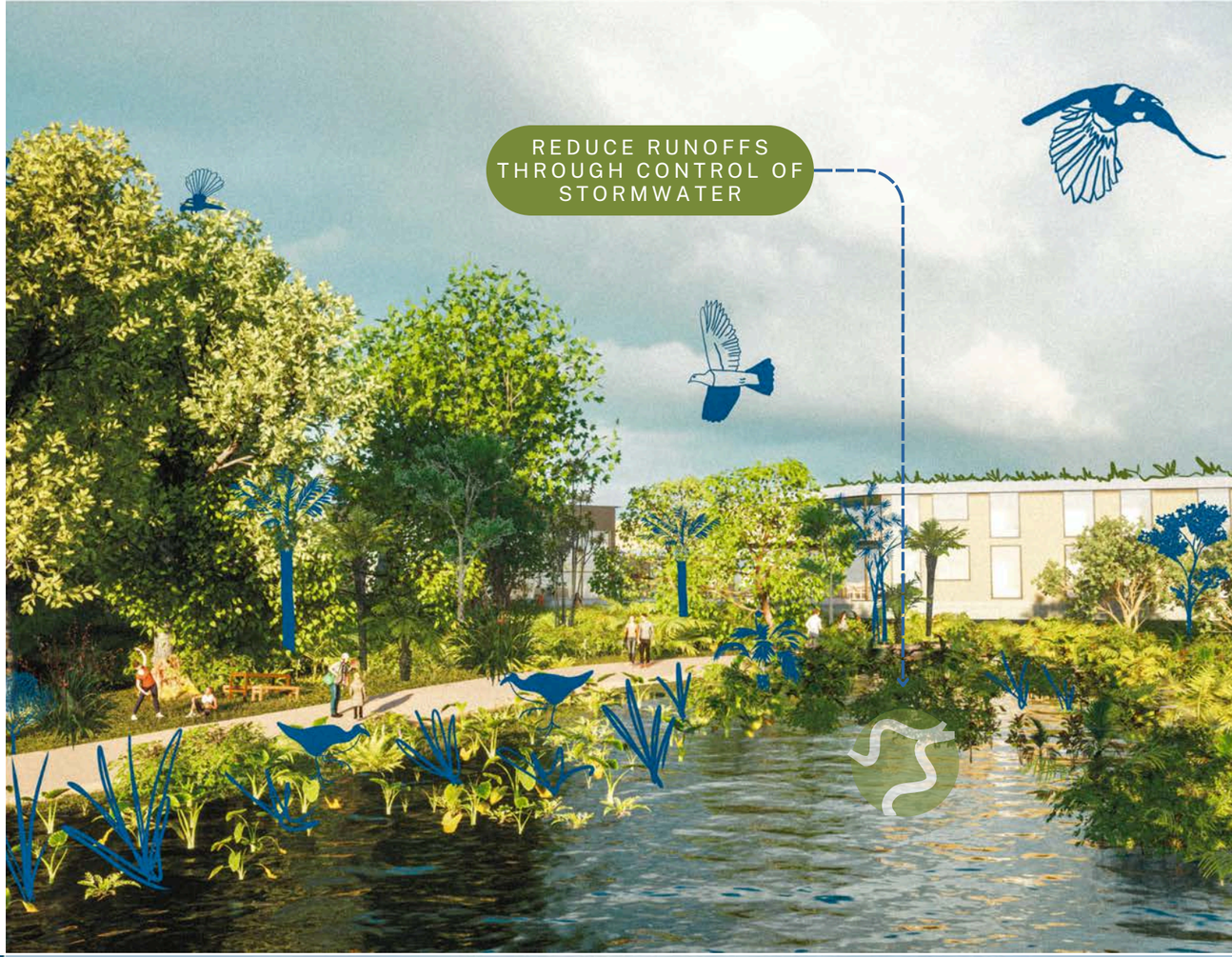


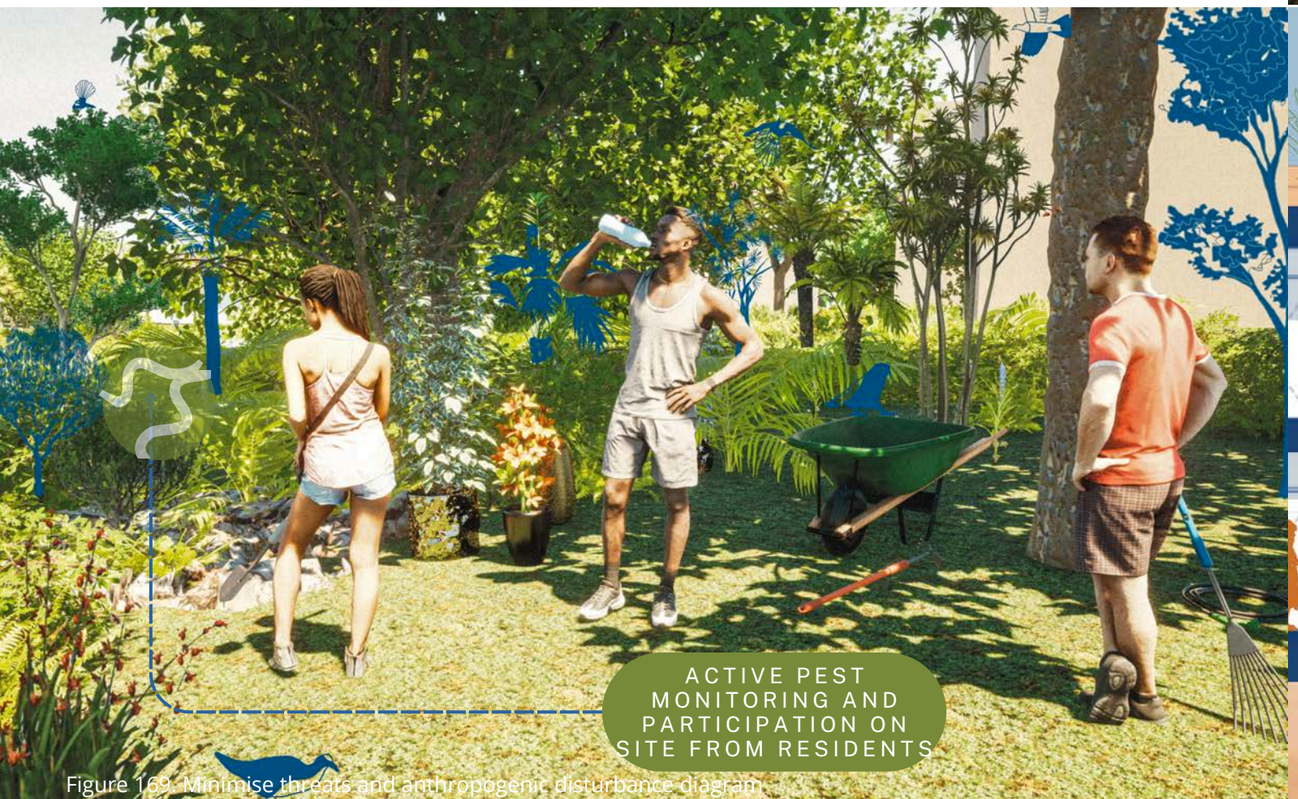
Figure 168. Facilitate dispersal diagram

DEVELOPED DESIGN
FRAMEWORK

MINIMISE THREATS & ANTHROPOGENIC DISTURBANCE

- Incorporate predator, weeds and exotic plant control and future managements.
- Reduce runoffs through blue/green infrastructure.
- Minimise light and noise pollution.





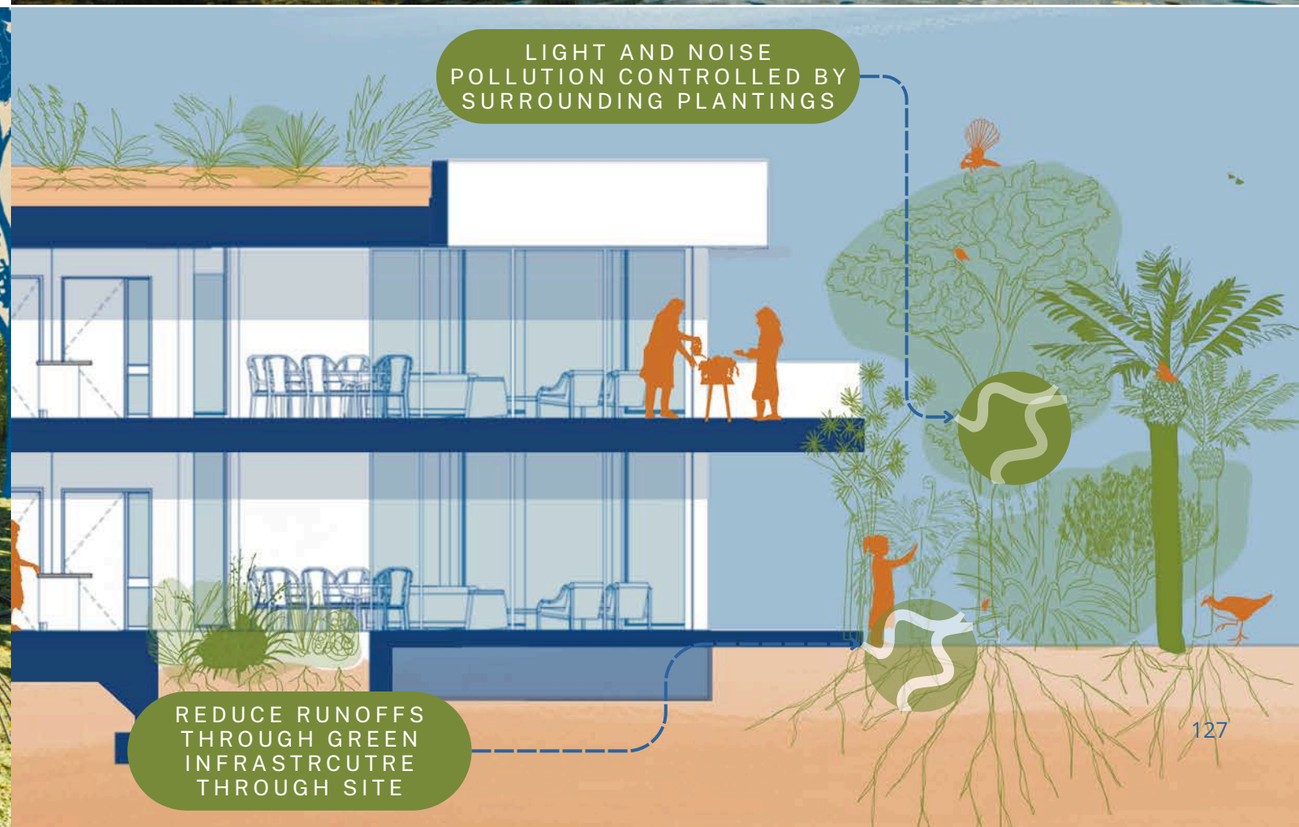


Figure 169. Minimise threats and anthropogenic disturbance diagram

DEVELOPED DESIGN
FRAMEWORK

FACILITATE NATURAL ECOLOGICAL PROCESSES

- Provide adequate resources for target species.
- Protect and enhace pollinator habitats.
- Plant for natural events to safely occur, such as fire or flooding.



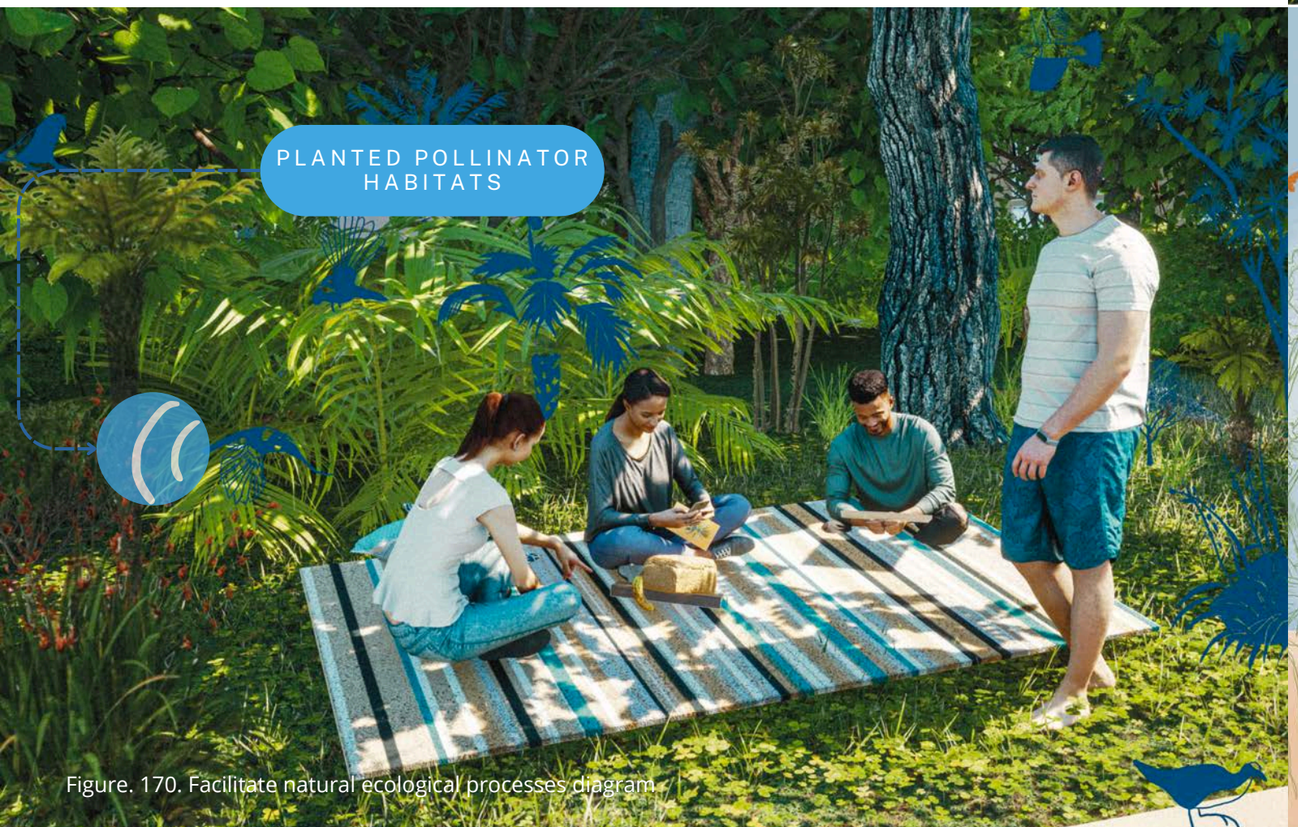




Figure. 170. Facilitate natural ecological processes diagram

DEVELOPED DESIGN *FRAMEWORK*

IMPROVE POTENTIAL FOR POSITIVE HUMAN-NATURE INTERACTIONS

- Create a sense of Kaitiakitanga and Wairuatanga within the community.

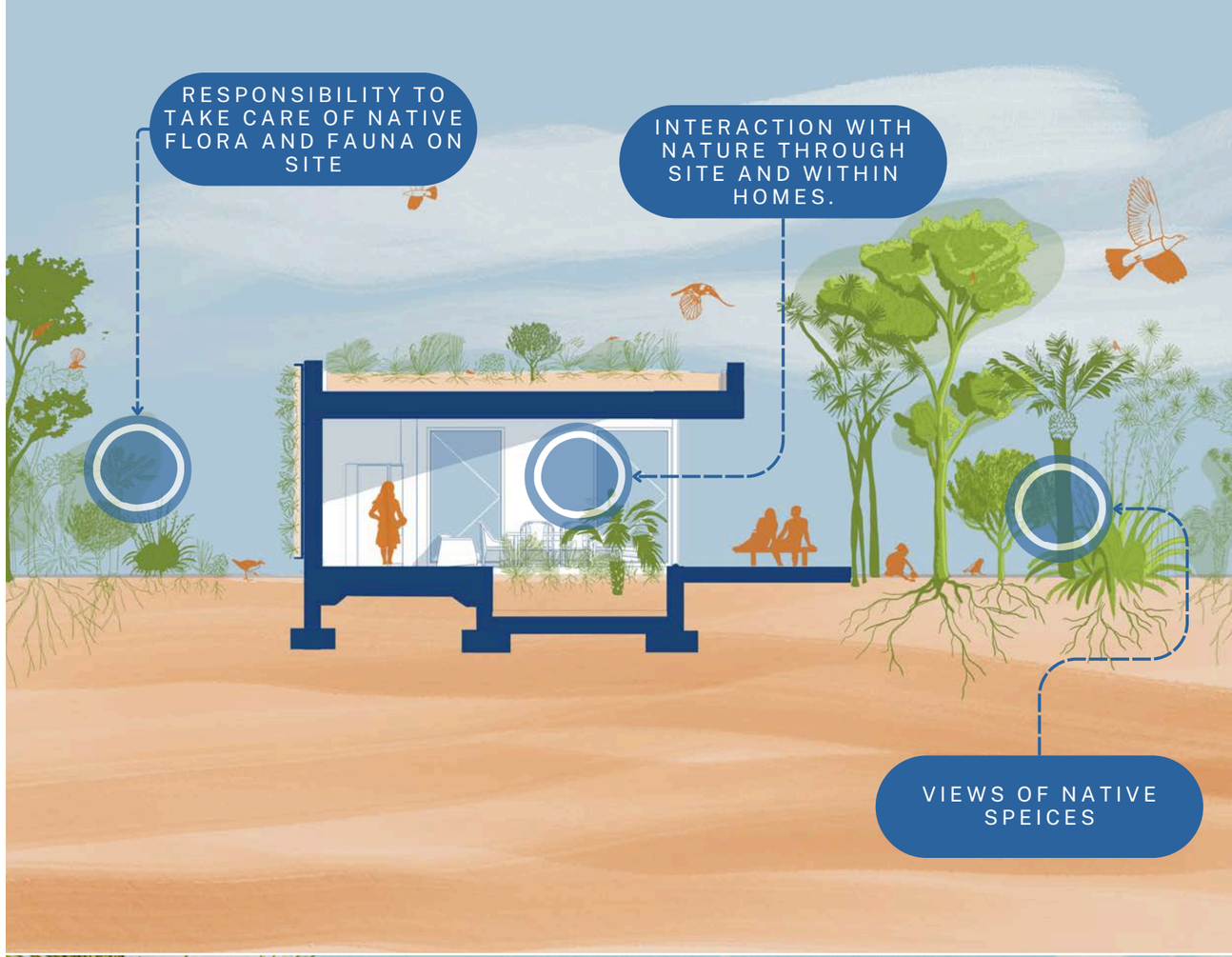




Figure 171. Improve potential for positive human-nature interactions diagram



DETAIL DESIGN
1:20 Detail

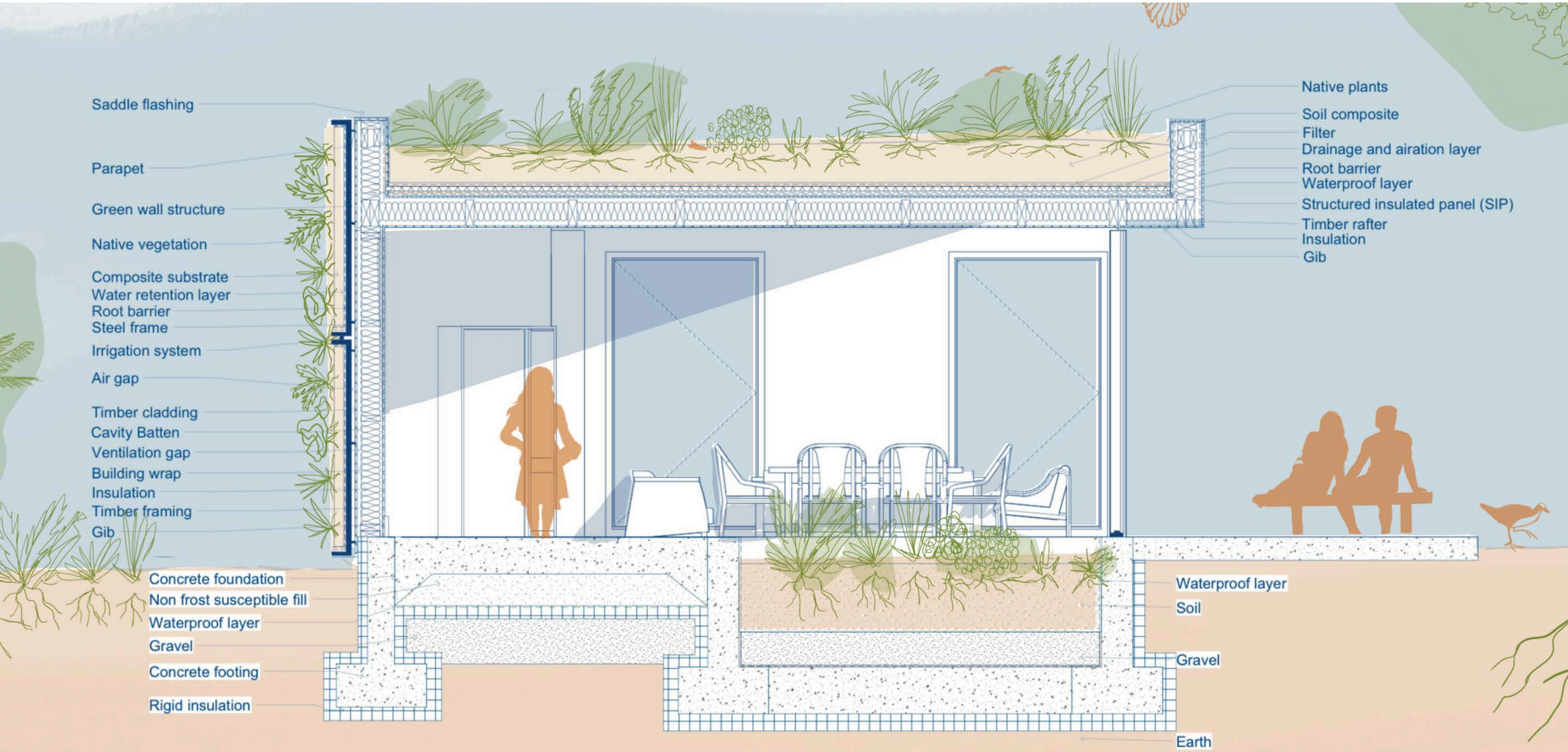


Figure 172.1:20 detail

DETAIL DESIGN
Green wall section

The use of green walls and green roofs helps improve biodiversity through a multi-species envelope (Saroglou et al., 2024). This method is vital in high density areas, allowing habitat creation in spaces that are underutilised.

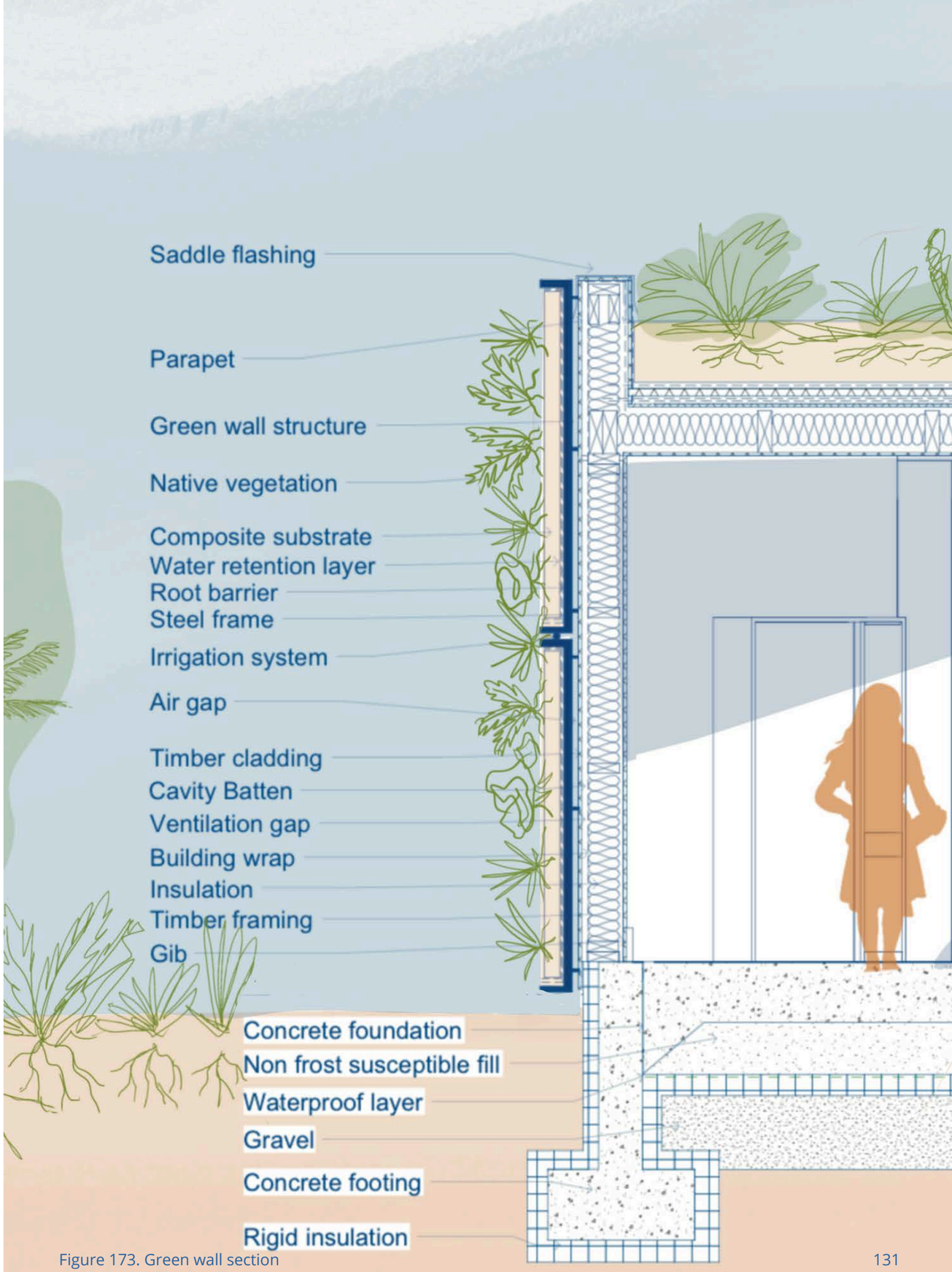


Figure 173. Green wall section

DETAIL DESIGN
Green roof section - protected roofs

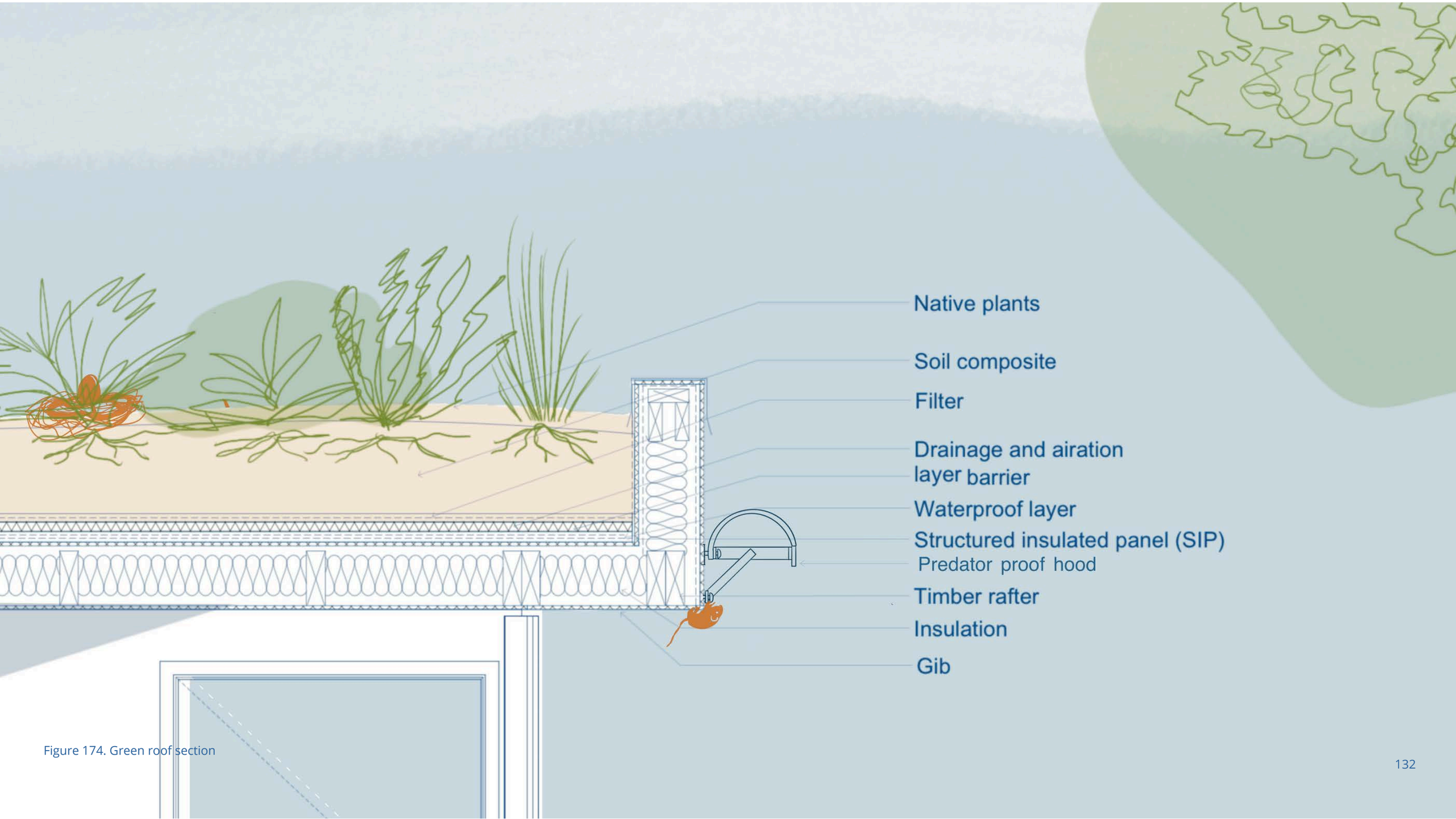


Figure 174. Green roof section

DETAIL DESIGN

Systems

Passive solar architecture

The design of the house incorporates passive house techniques. The house is orientated towards the north maximisng sun exposure to the unit. In winter the sun's rays heat the concrete slab, which retains the warmth and slowly releases it. During summer, the roof overhang blocks the suns angle, shading the slab and preventing overheating.

Cross ventilation is integrated into the design, with windows placed perpendicular to the prevailing winds, naturally colling the house. Additionally, the green roofs and walls provide extra insulation, completing a well insulated and weathertight building envelope.



Figure 175. Systems

DETAIL DESIGN

Systems diagram

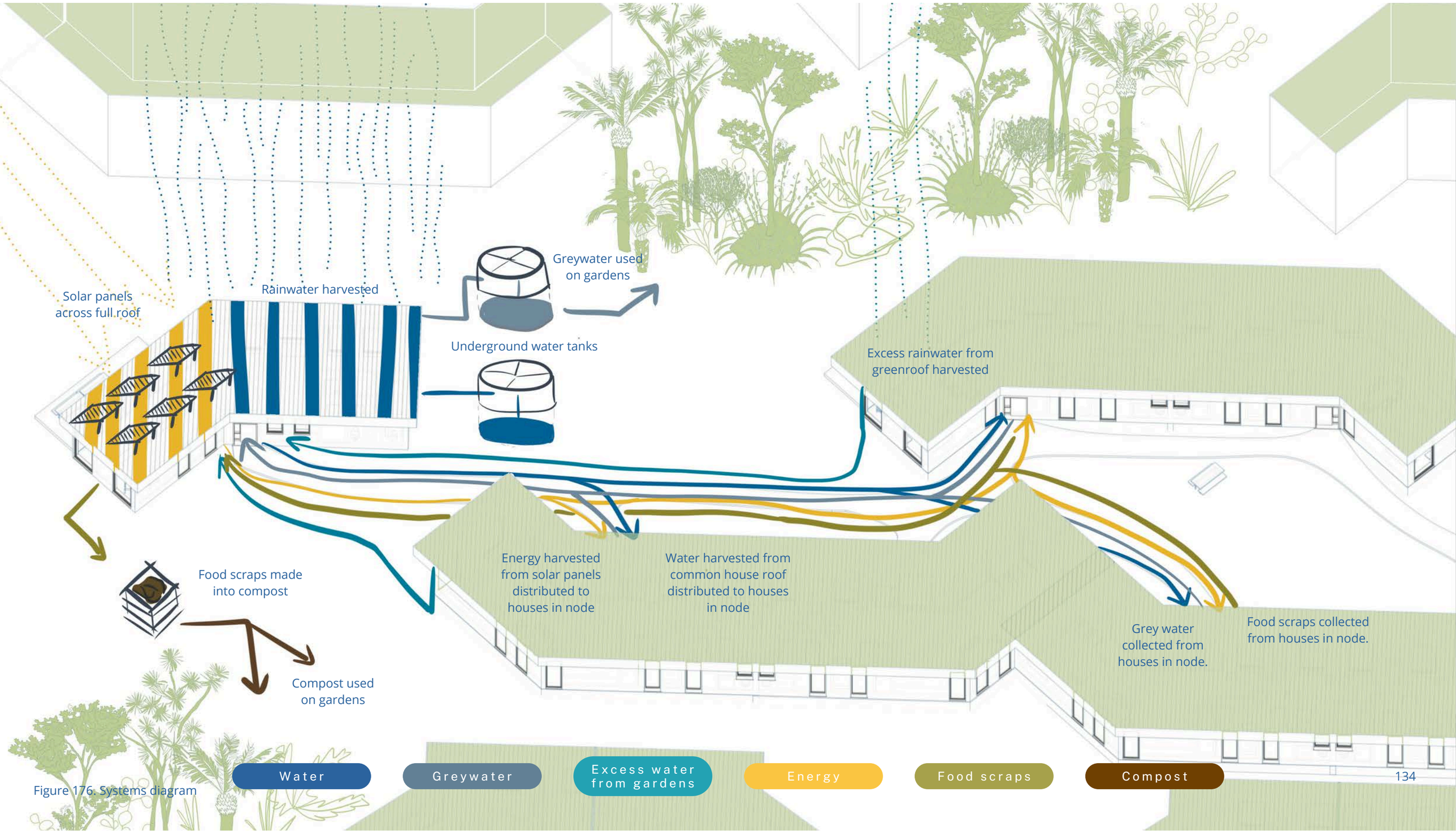
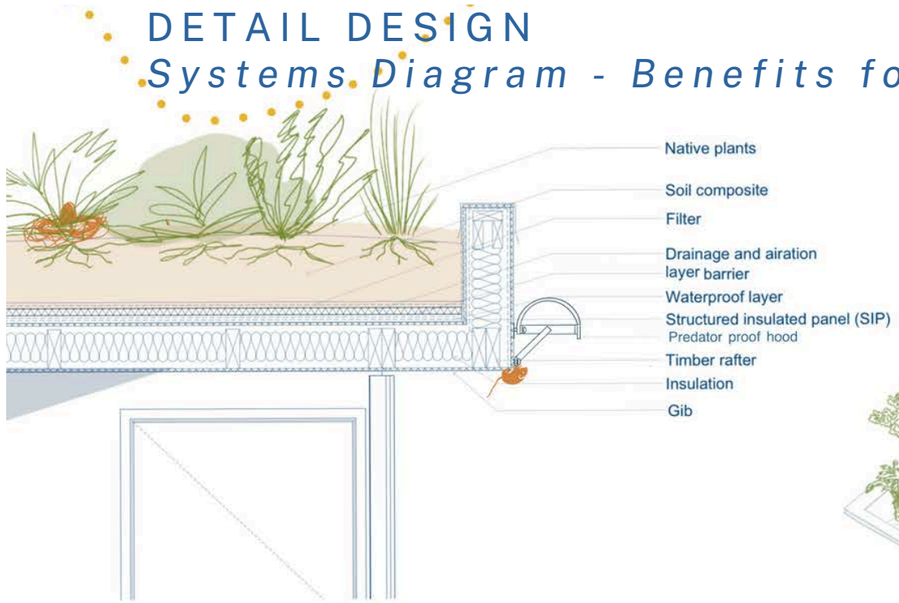


Figure 176. Systems diagram

DETAIL DESIGN

Systems Diagram - Benefits for birds



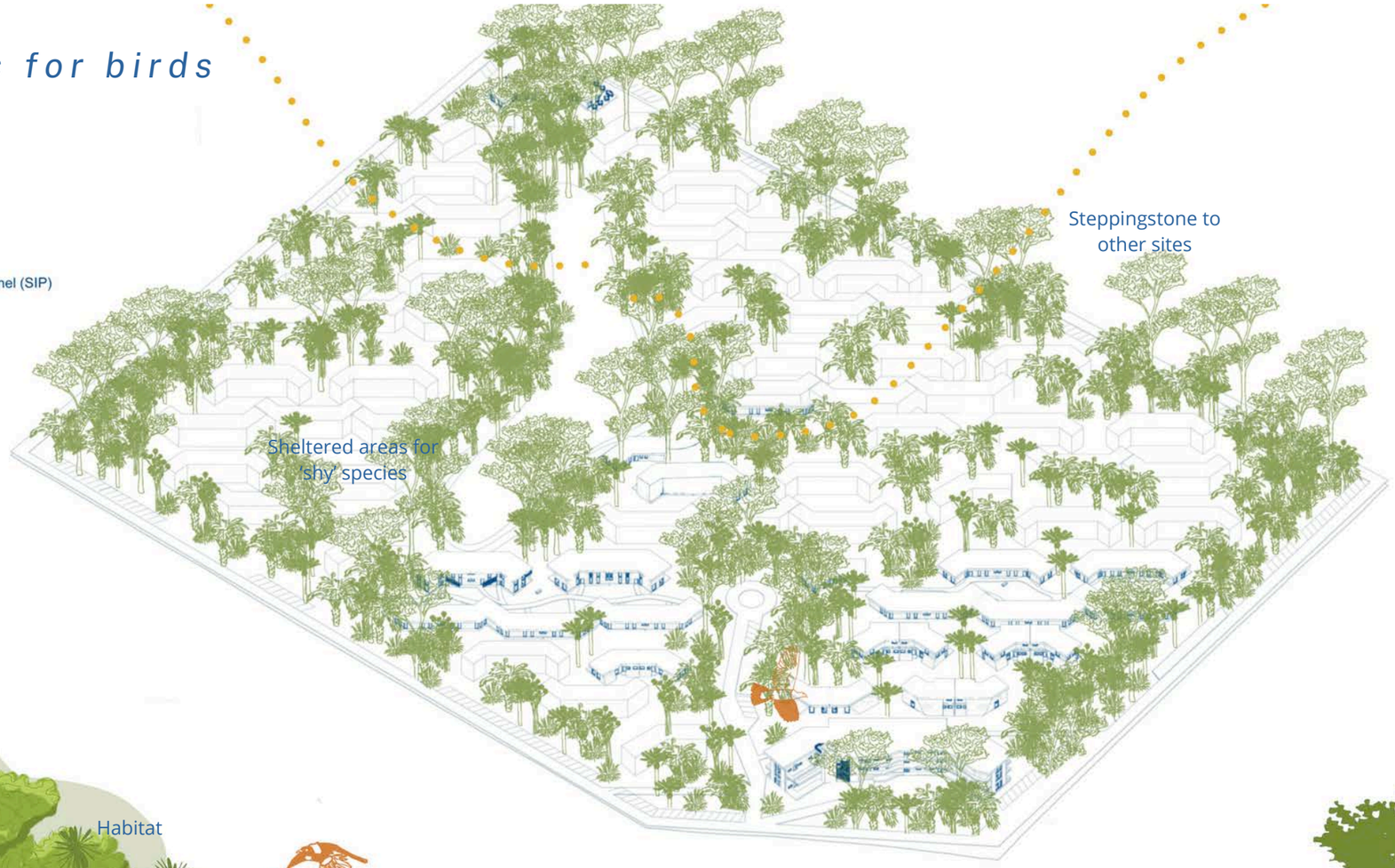
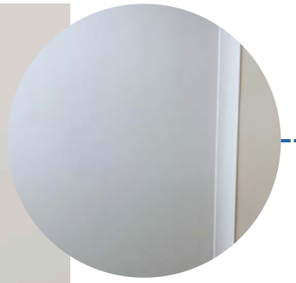




Figure 177. Systems diagram - benefits for birds

DETAIL DESIGN
Materiality

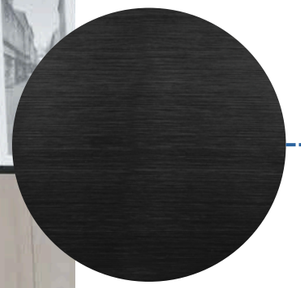




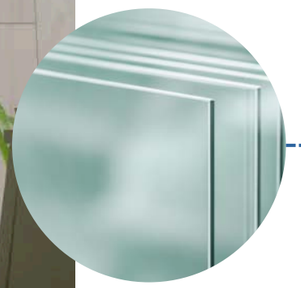
Plasterboard



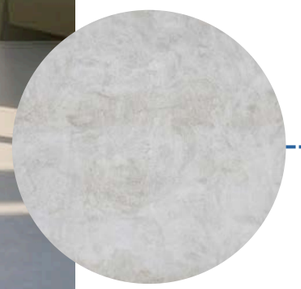
Timber paneling



Aluminum



double glazed glass



Polished concrete

Figure 178. Materiality diagram

DETAIL DESIGN
Construction detail

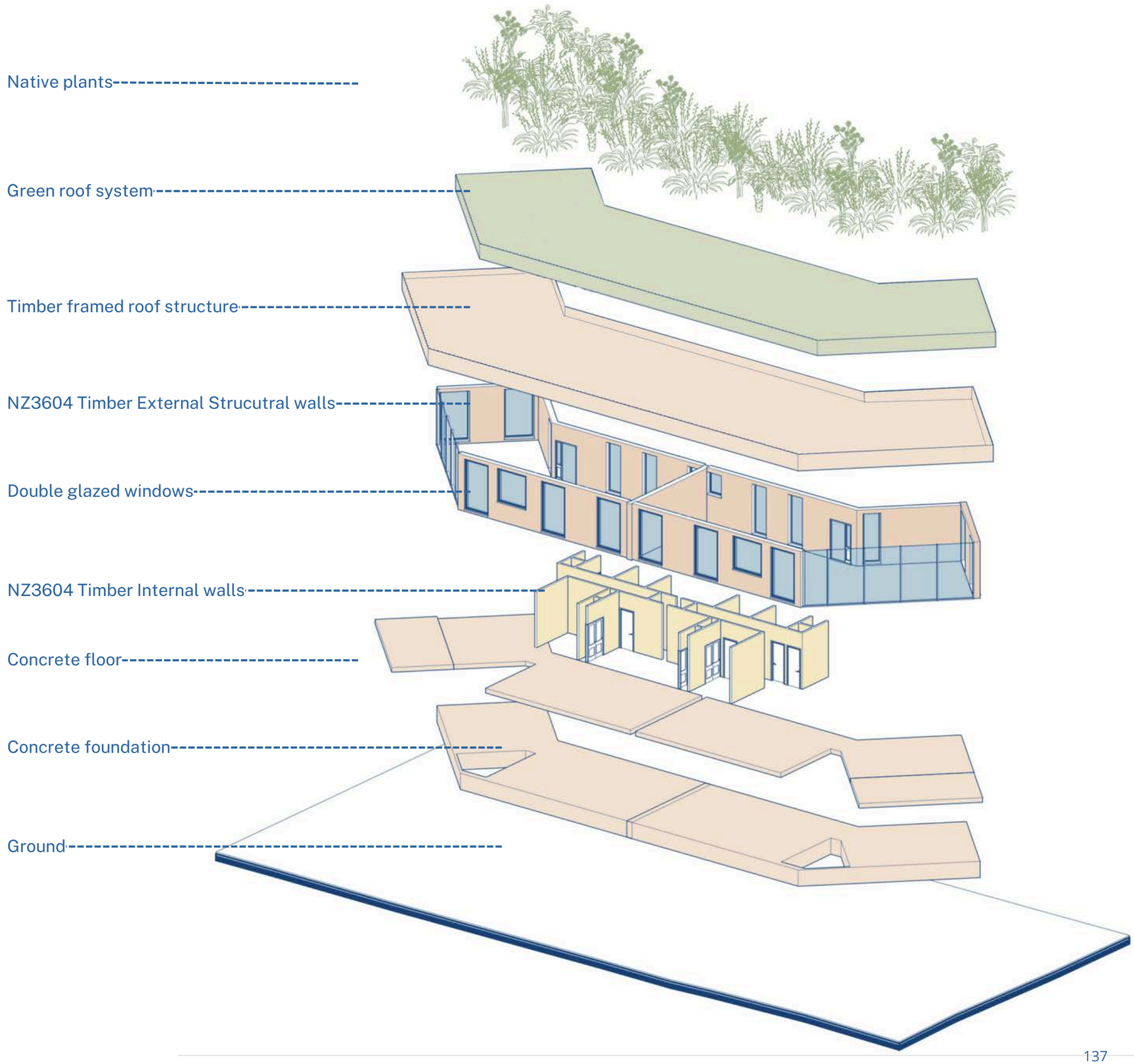
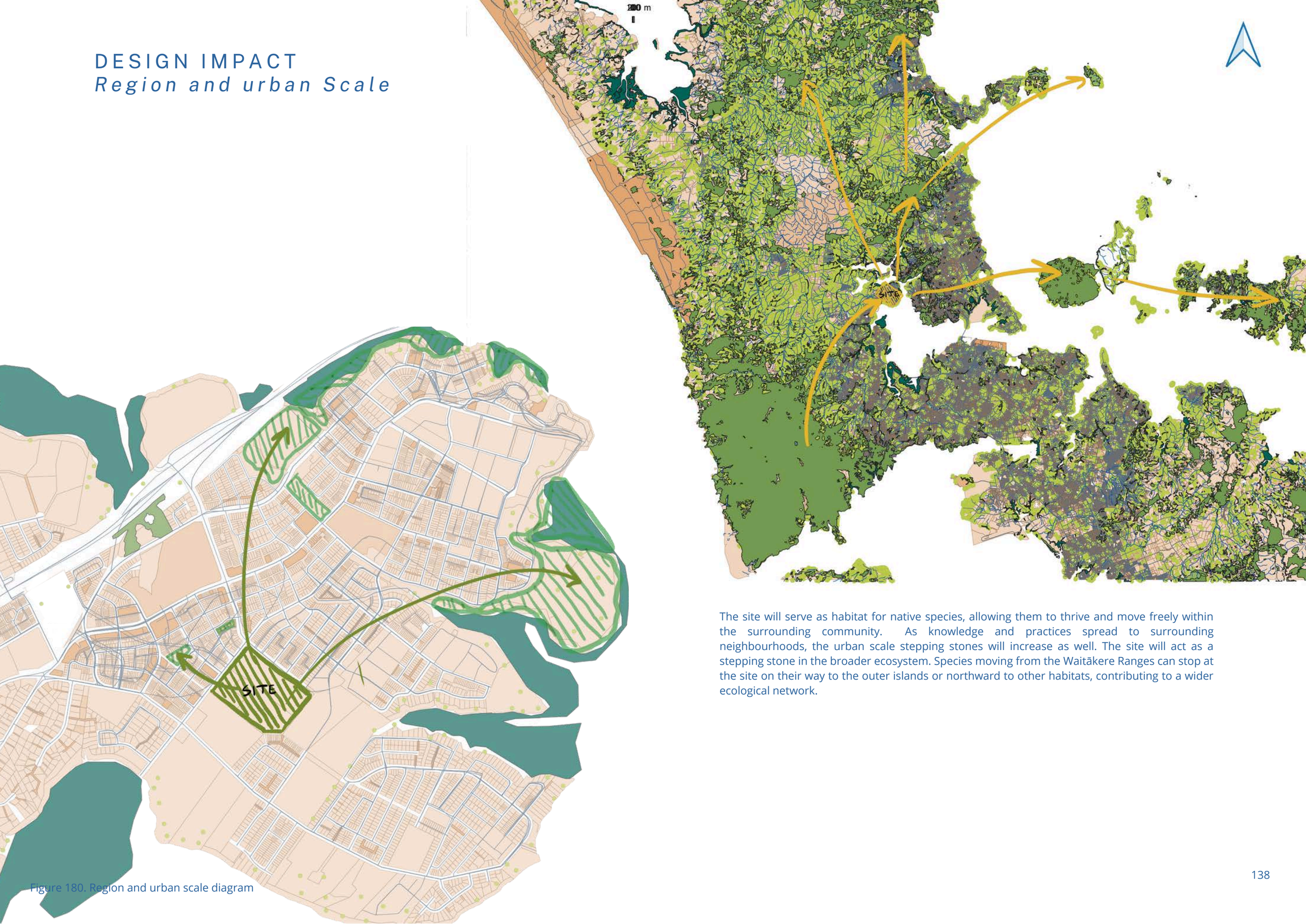


Figure 179. Exploded construction view

DESIGN IMPACT
Region and urban Scale



The site will serve as habitat for native species, allowing them to thrive and move freely within the surrounding community. As knowledge and practices spread to surrounding neighbourhoods, the urban scale stepping stones will increase as well. The site will act as a stepping stone in the broader ecosystem. Species moving from the Waitākere Ranges can stop at the site on their way to the outer islands or northward to other habitats, contributing to a wider ecological network.

Figure 180. Region and urban scale diagram

3.3 CRITICAL REFLECTION

To design a development that regenerates biodiversity there are challenges and opportunities presented at different scales of architecture. At the urban scale there are approaches to the layout of the houses on the site, that can create ecological corridors and habitat creation for species movement. The goal of medium density housing can be met by removing private gardens and allowing continuous native plantings through the site.

.At an architectural scale, the building footprint can be designed to increase exposure to nature, inside and outside the homes. The homes can also work with other systems, such as passive home techniques, to design holistically.

The detail scale of the design shows potential to include vegetation on typically wasted spaces of a house, such as southern walls and the roofs. This chapter reflects the design opportunities that occur when developments are designed with multi-species stakeholders.



Figure 181. Native tree with moss

CHAPTER FOUR

DISCUSSION

This chapter will discuss and evaluate the process of the research as well as critically reflect on the developed design. There will be an analysis of the key findings and strategies outlined through this thesis.

Figure 182. Native trees

DESIGN FLOW CHART

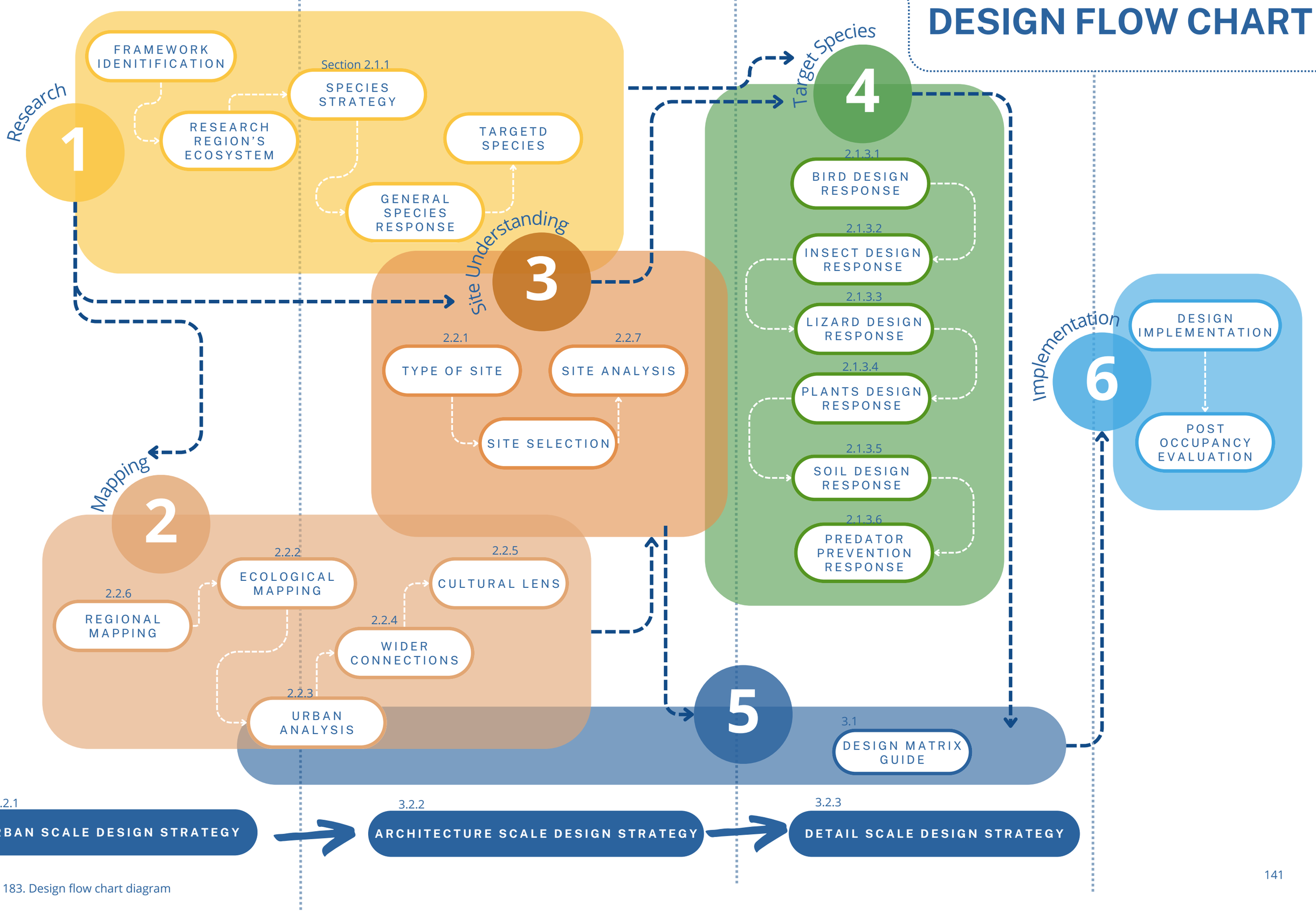


Figure 183. Design flow chart diagram

DISCUSSION

The proposed design for a medium density development increases biodiversity on the site and also acts as steppingstone habitat in the wider regional ecosystem. This helps conserve and regenerate the native plant and bird population by habitat creation and reduction of habitat fragmentation. The design implements the strategies outlined in the research and thereby justifies the theory by applying it into practice and testing it through design. A flow diagram was created that developers can use to guide them in designing a medium density development that regenerates and conserves native biodiversity.

The developed design demonstrates the key findings from the research through a range of architectural scales. On an urban scale, by removing private gardens, the design maximises the space available for plantings of native flora that could be home to native fauna. This could be viewed as a factor that would cause hesitation from developers or future residents as private gardens are sought after. Through removing the fences and privatisation of the land, a landscape design that allows more complex planting structures could be accomplished. By removing the private gardens, nodes are instead created to enhance opportunities to socialise with residents. These nodes are formed by the placement of the buildings themselves and surrounding vegetation which leaves pockets of shared space for the residents of that node. Each node contains an average of twenty units and has a common house with a communal kitchen, laundry, extra guest room, storage space, and space for socialising with larger groups. The removal of laundries, storage, and space for socialising from individual units reduces the building's footprints and allows more space for nature to be planted. The clustering of the nodes has the potential to be even further designed to create a more seamless layout that could have a singular centre point that the units are orientated around. This would require additional types of units to account for the change of orientation to the sun.

The architecture has been designed to break the physical wall and mental barrier between the inside of the home and nature. The units have cutouts in their floor plans that allow external plantings to continue into the home. Having this planted vegetation inside the home increases the resident's exposure to soil microbiomes, native flora and possibly some types of fauna, and benefits humans' physical and mental wellbeing. The design also allows for an extensive green roof along all units and provides multiple spaces along the southern elevation to include green walls connecting to the roof for a seamless connected area of vegetation. This exposure to nature aids the paradigm shift needed for humans to take responsibility and instill a sense of kaitiakitanga (guardianship) to protect biodiversity.

The orientation and shape of the buildings are formed to increase views of nature, maximise sun exposure onto the edge-insulated concrete slab for passive heating purposes, allow cross ventilation within the units, exploit seasonal sun shading, and minimise overshadowing from neighbouring units. These design choices ensure a more holistic approach to design that accounts for the resident's needs and wants within their homes. The complex shape of the buildings may cause an initial increase in building cost; this would be counterbalanced by only three home footprints being repeated throughout the development instead of different designs throughout the site. Detailed design to fit to standardised sheet and block sizes and some possible prefabrication of components offsite will also reduce construction costs and material waste.



Figure 184. Render of family



Figure 185. Render of pathway between nodes

The apartment block was able to increase density on the site and introduce multiple apartment sizes and layout options which cater to different physical abilities. The building being three stories high creates a taller protected predator-free ‘island’ on the carefully designed green roof, with its predator proof ‘fence’. The apartment residents are encouraged to interact with nature through the design of the site itself and the views from the apartments. The balconies have been staggered to give the plantings space to grow up as a vertical forest and include tree boxes. However, the apartment design could be further developed and researched to increase the benefit of physical plantings within the units themselves. An amount of air purification and possibly food growing benefit depending on resident’s species choices is expected. These internal gardens become the private garden space for residents.

Key findings from the research include the identification of the range of frameworks that work with biodiversity. Numerous building or urban design frameworks aim to increase biodiversity as an overarching approach but do not outline the specifics needed to achieve this typically. On the opposite spectrum, there are many frameworks from ecologists that are orientated around biodiversity health and regeneration, however, few frameworks address biodiversity in an urban context on a detailed level. One of the frameworks that analyses biodiversity design in urban areas discussed in the study is the Biodiversity Sensitive Urban Design (BSUD). This framework could still be further developed and reorganised into strategies for different architectural scales instead of the aims it is currently framed into. In this research, the BSUD framework acted as a guide and then was expanded further as part of the design process.

The importance of the site was highlighted through the research into mapping strategies. When choosing a site, a wide scope of mapping should be done with urban analysis, ecological mapping, wider connections, history and significance of the site, and an understanding of the region through a cultural lens. This mapping aids in choosing a site that is both a relevant development location and a suitable site for biodiversity regeneration and conservation efforts. The site was designed to connect to a wider project, the North-West Wildlink. This allows the work done on the site and in the North-West Wildlink to be further amplified and increases the chances of biodiversity regeneration and conservation in both the development and the stepping stones project. It illustrates the importance of siting design for biodiversity projects carefully.

An important finding from the research relative to designing for flora and fauna is the need to challenge previous design methods, such as the representative species over the targeted species, as different methods should be used in different situations. Over the course of the study, it became apparent that research into design responses for species needed to be localised to at least a national scale and likely a regional scale is most appropriate. This is due to the contrast in species themselves and responses to conserve them across countries. The significance of soil was outlined and understood as a key holder of diverse species. Strategies were identified to preserve the soil biodiversity on site, such as avoiding the excavation of topsoil. The creation of the species strategies for design led to discovery of the range of development aims to design for species; there is an approach to regenerating and conserving biodiversity that supports more species instead of a more targeted approach.

While designing, it is easy to slip back into a traditional type of architecture and not notice the biodiversity impact. It is also important to note the power of design to illicit a paradigm shift in thinking about the interaction between the built environment and biodiversity and therefore the relationship between people and nature. Architects can influence how humans think and behave.

This research applied a range of strategies that could be used by built environment designers to design medium density housing that conserves and regenerates biodiversity. The use of these strategies is demonstrated in the design flow chart.

CHAPTER FIVE

CONCLUSION

This chapter will conclude the findings from the thesis and give suggestions for future practice.



Figure 186. Render of wetland

CONCLUSION

The built environment has often been designed to separate humans from the natural environment. This is done by designing human-centric homes that cause habitat loss and fragmentation and therefore metaphorically remove humans from the ecosystems they are part of. The impact of such human-centric design is a fractured relationship between humans and the natural world that prevents people from seeing and caring about the destruction caused by their activities. Entering the Anthropocene and with it needing to address climate change and biodiversity loss globally means that there is little time to waste, and many changes to make. A change of consequences in this context would be to reimagine how the built environment is designed and lived in.

Homes are where people spend a substantial amount of their time and thus a change to the way these are designed is needed to repair the relationship between humans and the natural environment and to practically support biodiversity. Medium-density developments can conserve and regenerate native biodiversity by being designed to maximise space created for habitat for the fauna and flora, as well as by becoming steppingstone habitat through integrated green roofs and walls and maximising green and blue spaces for species to move through and connect to the wider ecological context of a region. The proposed design would expose humans to nature daily, inside and around their homes. This would enforce a sense of kaitiakitanga (guardianship) within the residents and encourage them to see the impact their actions have on the environment. This creates a paradigm shift where humans see themselves as a part of the rest of the ecosystem. Increased exposure to nature would also have physical and psychosocial benefits for residents as discussed in biophilic design theory.

Future research could include an examination and testing of the logistics of predator fencing in urban developments. Residents need a fence that is effective at keeping out pests but fast and simple for families to move through. This research could also include methods that make such fences aesthetically fit into an urban area more seamlessly, without becoming an exclusive gated community. Future research could also build upon this work to identify a framework for designing for biodiversity in Aotearoa New Zealand's urban context. This could build on frameworks created by biologists, planners, architects, and other existing frameworks such as BSUD. Lastly, research should be done on the requirements of New Zealand's native flora and fauna to thrive in urban settings.

This research shows that the built environment plays a large role in the degradation of ecosystems. Without a functioning ecosystem, humans will not survive. Built environment designers have the opportunity to increase ecological health through design. Designs have many complex impacts that can be understood by working with other disciplines, researching, understanding the ecosystem, and most importantly, caring about more-than-human species. When we grasp the widespread impact of our designs we may begin to design for better cities for people *and* all the creatures alongside us.



Figure 187: Tui in tree of residential garden



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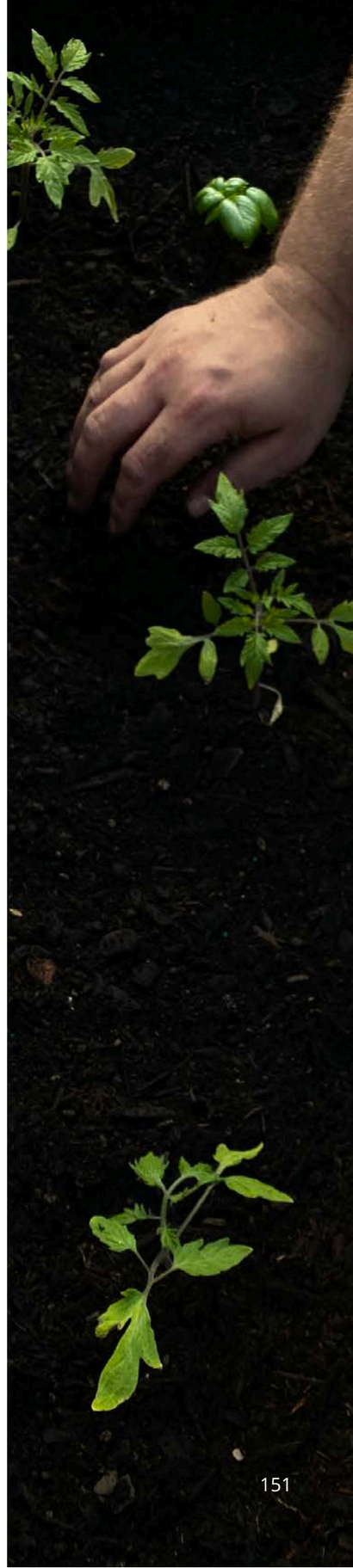

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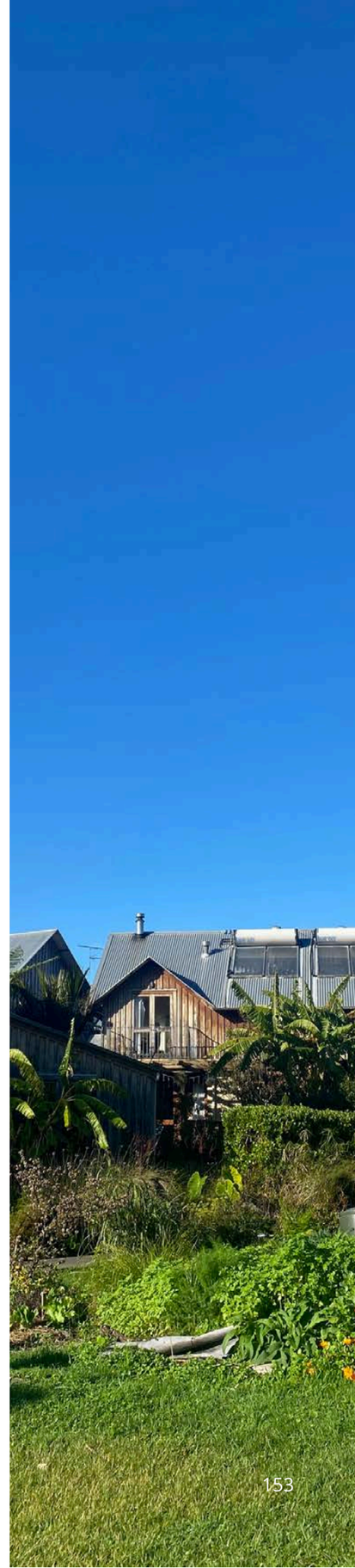

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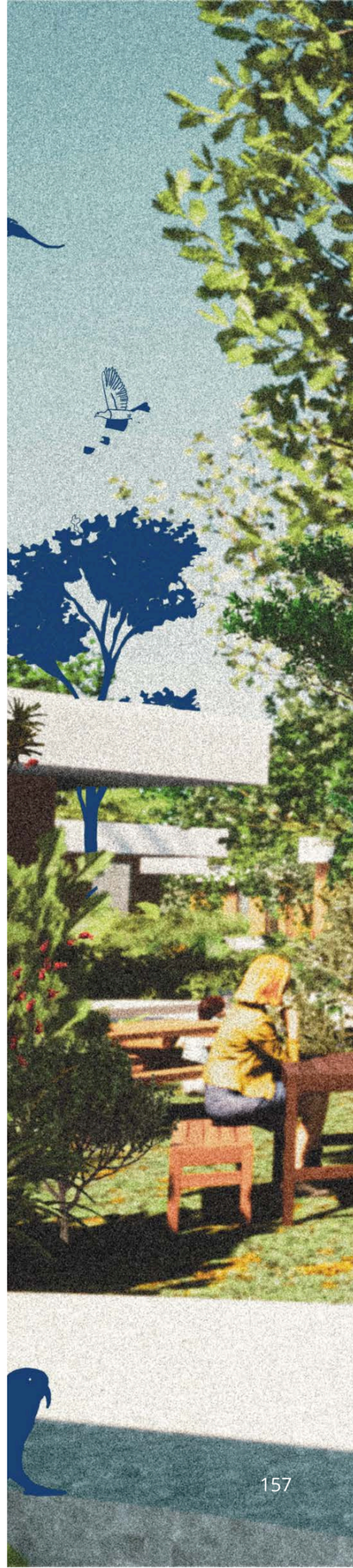

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APPENDIX



DEVELOPED DESIGN
Urban Scale



DEVELOPED DESIGN
Urban Scale



DEVELOPED DESIGN
Urban Scale



DEVELOPED DESIGN
Render



FINAL PRESENTATION











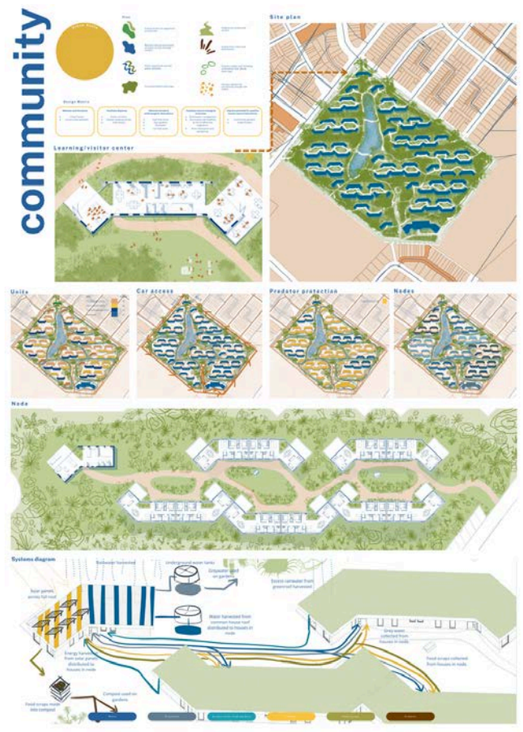

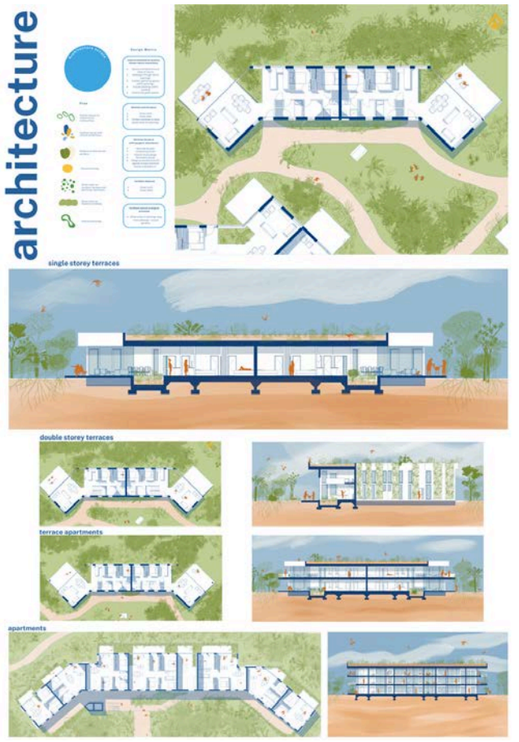











NZIA RESENE STUDENT AWARDS LAYOUT



