Evolving the Quarter Acre

Explanatory Document

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“Nice to be home. Back in my shed...”

- Burt Munro

(The World’s Fastest Indian)
Like egg whites to a pavlova, New Zealand would not be the same without the quarter acre. The phenomenon of the quarter acre represents the iconic Kiwi housing pattern, although its extinction in our largest city is looming.

Auckland is currently experiencing a major transformation of its urban form, to accommodate the anticipated influx of new residents by 2040. The primary solution being put forward to solve this problem is the concentration of new dwellings (in the form of terraced housing and apartments), which sacrifice the quality of the environment for a higher density. This completely counters the culture of the quarter acre, which is the most significant housing pattern of New Zealand’s history. This research project explores different patterns of development to find how the legacy of the quarter acre can respond to the requirements for intensification.

An ‘evolutionary analogy’ is adopted to help guide this exploration. Formulation of an artificial evolution explains the generation, testing and application of housing patterns from different development approaches and how they relate to an Auckland context, regarding density, infrastructural demands and quality of the environment. Also as part of the methodology, the observation of the urban environment utilises concepts of pattern language to assist with the classification of and relationships between housing patterns.

There are two significant conclusions from this research project. Firstly, housing patterns should be considered for their cultural significance, rather than simply their geometric properties. Focusing on the latter can result in the forcing of foreign patterns and consequently undesirable environments to live in. Secondly, the housing patterns that best represent the qualities of the quarter acre in New Zealand need to offer a reasonable density, infrastructural independence, as well as geniality. The ideal balance of these three attributes should be the urban form that Auckland strives for, respecting both the past and the future of the city.
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1. Introduction
1.1. Establishing the Project

1.1.1. Project Outline

Auckland’s current policies\(^1\) aimed at intensifying housing are changing the patterns of our urban environment and encouraging more concentrated housing developments. The last remains of the ‘traditional’ quarter acre (the dream\(^2\)) are still visible in our suburbs, although the growth in patterns of subdivision have withered away at their presence. Additionally, new patterns of development, brought on by planning policy for increased densities, see further deterioration of the classic Kiwi dream. This research project seeks to examine these patterns and questions their suitability for the often-conflicting purposes of increasing density, minimising demands on infrastructure and providing a quality place to live.

The foundation of this project is a combination of two different theories. The first is the depiction of our urban environment as a collection of patterns, a vernacular; taking inspiration from the works of Christopher Alexander (A Pattern Language/A Timeless Way) and Geoffrey Broadbent (Design in Architecture). The second part looks to the concepts of evolution (Darwinian theory) and uses this as a metaphor for the adaption and selection of the various mutations of patterns that have evolved. The resulting coalition of both these theories intends to create potential patterns of development that maintain the legacy of the quarter acre, while at the same time balancing the demands of intensification with environmental and infrastructural issues.

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1.1.2. Underlying Environmental Issues in Planning

One of the essential elements that planning policy is concerned with are environmental issues. In the Auckland Plan, an entire chapter is devoted to the natural environment, within it emphasising the importance of considering the environmental consequences of all decisions. Accordingly, when increasing the density of our urban areas we potentially reduce the problems around ‘sprawl’, but there are subsequent consequences; for example, the loss of an individual’s food-producing land or conversely the reduction in carbon emissions from transportation. There are also economic consequences when increasing density; particularly the increased cost of ‘hard’ infrastructure.

3 Auckland Council, “The Auckland Plan”

1.1.3. Critique of the Auckland Unitary Plan

The current planning policy that is attempting to guide the intensification of Auckland is the Unitary Plan, operative in part; this is the pragmatic approach of planning that works alongside the visionary views of the Auckland Plan.

A common description of the Unitary Plan portrays it as a ‘developer-friendly’ planning policy; this label does, however, have both positive and adverse consequences.

On the positive side, there is a connotation to the promotion of intensifying. The enticement of developers coincides with the underlying intentions of the Unitary Plan in wanting to increase our urban densities. Additionally, there is also recognition of the laissez-faire culture that exists in Auckland towards private ownership and suburban subdivision; but this now needs to occur at a greater scale.

Conversely, the Unitary Plan is essentially designing Auckland; or at least for those solely concerned with return on investment (ROI). Each of the

Unitary Plan Zones has specific development restrictions, aimed at outlining what the maximum potential of a site is. The problem with this approach is that developers who are driven by ROI take this as a challenge to see how much they can push the boundaries of what is permitted.

We are currently experiencing the ‘testing’ of what the Unitary Plan encourages, which could be said to be having teething problems. An example of a current development still on the drawing board (Figures 1.1. and 1.2.) sees five, three-storey townhouses being squeezed onto a 607m² site in a ‘Mixed Housing Urban’ zone. Even though there are minor breaches in height in relation to boundary and maximum building coverage, in addition to more than double the maximum number of dwellings allowed, this scheme has received resource consent; much to the displeasure of local residents.

What the Unitary Plan does lack is an accompanying guide that demonstrates quality methods of applying the development restrictions in the different zones. The outcome of this research project aims to provide some design inspiration to help fill this gap.

10 Ibid.

Figure 1.1.: Site Plan of the Proposed Development at 34 Seaview Terrace, Mount Albert (Derived from: Auckland Council Property File)
1.2. Focus of the Project

1.2.1. Housing Patterns and the Urban Environment

This project is concerned with housing patterns, and how the urban environment can be observed as a collection (or family tree) of patterns. Auckland already has a range of housing patterns, and this project sets out to analyse the existing patterns and examine what new patterns could be implemented to help Auckland intensify. This approach to design adopts concepts from the work of Christopher Alexander\textsuperscript{11} to an Auckland context, as elaborated on in Section 2.1.

\textsuperscript{11} Christopher Alexander, \textit{A Timeless Way}, (New York: Oxford University Press, 1979), 167-210

\begin{itemize}
  \item \textbf{Figure 1.2.}: Simplified Form of the Proposed Development at 34 Seaview Terrace, Mount Albert (Derived from: Auckland Council Property File)
\end{itemize}
1.2.2. Iconic Kiwi Housing Pattern

There is one urban pattern, more than any other, that embodies the characteristics of the New Zealand culture. Over the past century, the quarter acre has established itself as the most popular pattern of housing in this country. Its longevity is highlighted by the fact it is more than just a measure of land; it is a lifestyle. Figure 1.3. demonstrates one example of the quarter acre in use, facilitating a family gathering. The quarter acre has supported the ‘dream’ mentality in several ways including:

- As a means of survival; producing own food supplies (e.g. vegetables, eggs, milk) to provide for the family. 
- Delivering for the unprecedented high rate of home-ownership.
- Being influential on most housing policies since the turn of the 20th Century.

Despite all these, we are now witnessing the decay of this Kiwi icon. The characteristics of and the challenges faced by the quarter acre pattern are explored further in Section 2.2.

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Figure 1.3.: An example of the traditional Kiwi quarter acre in use (Source: Personal Collection)

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12 Matthew Wright, *Illustrated History of New Zealand*, (Auckland, New Zealand: David Bateman Ltd, 2013), 141-42
13 Ibid
1.2.3. What are Housing Patterns?

In this research project, a housing pattern is considered as the possible configuration of dwellings on a site that represent the geometric relationship between the arrangement of the built form of the dwellings and the spaces that exist between and around them. The presentation of a housing pattern focuses on the plan form, heights and resulting bulk of the development in its most basic form. For that reason, it does not include style, fenestration or minor patterns (e.g. roof, deck, balcony or other protrusions).

However, from this description, the conclusion is reached that housing patterns are more than simply geometric representations of form; there is a need to consider the contextual relationship of a pattern when judging its success. For that reason, housing patterns must be respected for their cultural significance. The forcing of foreign patterns can lead to detrimental outcomes. An extreme example is the super high-rise housing of Hong Kong (Figure 1.4.), which works well because of the cultural situation of that country but would not translate well to Auckland. Section 2.3. develops this discussion.

Figure 1.4.: Super high-rise housing patterns of Hong Kong (Source: Google Maps)
1.3. Project Methodology

1.3.1. Using an Evolutionary Analogy

To analyse patterns of housing developments, this research project adopts an ‘evolutionary analogy’\(^\text{16}\) to assess the performance of housing patterns (described in further detail in Section 3.2). In this analogy, the quarter acre site is the starting point; the common ancestor. It is then ‘artificially evolved’ by a set of ‘rules’ to produce various species, sub-species and variety patterns that are then analysed; Figure 1.5. illustrates the basic layers of the artificial evolution.

![Figure 1.5.: Layers of the Artificial Evolution (refer to Section 3.1.3. for analogy with housing patterns included)](image)

1.3.2. Forming Rules (of Evolution)

There are several layers of rules that help shape the creation and relationships of patterns, corresponding to the evolutionary layers (as outlined in Section 3.3.). These fall into two categories:

1) Common Rules: aspects that apply across the species layer, intended to provide an even playing field for comparison of development patterns (e.g. all dwellings will be two-bedroom), or rules that are shared between different development approaches (e.g. development restrictions).

2) Specific Rules: aspects that help define the different approaches to patterns of development and are unique to a single sub-species, or variety layer of patterns (e.g. compliance to TP58 for on-site wastewater treatment\(^\text{17}\)).


1.3.3. Pattern Generation

Using these rules, it is possible to generate patterns of housing developments on a given site. These patterns of development on the quarter acre common ancestor site then become species that fall into three main areas (as illustrated in Figure 1.6):

1) The ‘Developer-led’ patterns where densities are maximised to increase return on investment. These artificially evolved patterns are compact and inevitably highly dependent on new infrastructure, consequently compromising quality of environment for high intensity.

2) The ‘Ecologically-led’ patterns where intensity is limited by the rule of being autonomous through on-site electricity generation, fresh water collection and sewage disposal. Surprisingly, it is possible to achieve densities of up to 40 dwellings per hectare; which is considered medium-density in Auckland. However, the densities are typically 1/10 those of the ‘Developer-led’ species, so have a poor return on investment.

3) The ‘Socially-led’ patterns. This species is a balance between 1) and 2). Density is exchanged for an improvement in environmental quality.

Another species, Natural Progression, artificially evolves the common ancestor using existing patterns of subdivision as a control; to consider the outcome if no larger development intervention takes place.

Figure 1.6.: Four different species of development patterns
1.3.4. Pattern Testing

From these basic species, over 500 patterns have been generated and tested. Testing the performance of each case (the selection process) applies three different areas of criteria as follows:

1) The density ratio of the development; measured in dwellings/hectare (dph). This broadly conveys the economics of the development, as increased density generally relates to maximising profit.

2) The dependency of the development on hard infrastructure (the utility services that accompany a dwelling) measured by the extent of its infrastructural autonomy (the ability not to rely on reticulated services or grid-supplied electricity).

3) Geniality; the quality of the physical environment. While density (1) and demands on infrastructure (2) can be measured empirically, qualitative aspects of the built environment are more difficult to measure. In this instance, previous case studies of developments known to have a high-quality environment are used as reference models of development.

1.3.5. Artificial Evolution of Patterns

The process of developing housing patterns is referred to as an ‘artificial evolution’. This is an extension of the current housing situation into multiple directions to examine how Auckland could develop under different circumstances. Initial investigations into the existing and extreme species of housing patterns establish the suitability of density and infrastructure; what the achievable extents of development are. The findings are then put forward in the quest for determining the quality of the environment. To try and identify developments that exhibit quality, a collection of award-winning housing schemes from around the world have been categorised into various typologies (sub-species) so that a taxonomy of developments with a reasonable high quality could be examined. The taxonomy then informed the housing patterns that were applied to an Auckland context as the suitable patterns of development. Importantly, it is not considered that there is a single optimal layout, rather, that different patterns are more appropriate in different circumstances and locations within our urban context.
1.4. Defining the Project

1.4.1. Research Question

How can the legacy of the quarter acre inform the future urban form of a denser Auckland?

1.4.2. Aims/Objectives

- To explore how future generations of Kiwis can enjoy aspects of the quarter acre culture

- To maintain core attributes of the quarter acre’s legacy, while responding to the requirements of higher density.

- To investigate patterns of development with regards to their economic and environmental conditions, as well as the quality of life, attempting to find an appropriate balance.

- To generate a design reference that could potentially inform other designers, planners and policymakers looking at suburban intensification in Auckland.
1.4.3. Limits to the Scope of the Research

It is important to note that this analysis is focused on the density and environmental impacts of development patterns. These are determined using two- and three-dimensional form, which highlight attributes including site coverage, plan layout, sectional arrangements and heights. Moreover, they are not influenced by architectural style; the application of an aesthetic language, above the implications of formal arrangement, is regarded as a secondary consideration in this research project. The patterns are generic forms that could be adapted to many different styles.

Additionally, site topography and orientation are excluded from the comparative analysis of this research project to help minimise the number of variables. Both factors are considered as being typical for an Auckland context; topography as approximately flat (+/- 10°) and orientation suited to the sun's path. Site conditions are explored in more detail in the final design solutions since these are specific applications of housing patterns onto chosen sites.

1.4.4. Key Definitions

There are several terms central to this research project; their interpretation is defined as follows:

**Quarter Acre:** The traditional method of housing in New Zealand; representing a single dwelling per section of land (typically 1012m² in area, but varies and can include smaller sized sections); low-density housing (approx. 10 dwellings per hectare).

**Housing Pattern:** The design components in this research project. Refer to Section 2.1.1. for a detailed explanation.

**Patterns of Development:** The broader collection of housing patterns, categorised under a species.

**Evolutionary Analogy:** Concepts of evolution are adapted to an architectural context (see Section 3.1. and 3.2.); emphasis is placed on the idea of process as the underlying methodology of this project research.

**Density:** The measurement of dwellings in the patterns of development; expressed as dwellings per hectare (dph).
Infrastructural Autonomy: An important consideration in this research project is the dependence on city infrastructure; measured in how self-sufficient (autonomous) a development pattern is.

> Soft vs Hard Infrastructure: The type of infrastructure referred to throughout this research project is ‘hard’ infrastructure; electricity supply, water supply, waste treatment. All urban environments require ‘soft’ infrastructure (e.g. libraries, schools), but are not included in the scope of this research project.

Quality: The successfulness of a housing pattern’s characteristics; the relationship between a dwelling and its occupants.

Form: Consideration of two- and three-dimensional elements with respects to a housing pattern; generation of a pattern reflects a geometry and bulk of a housing layout.

Urban Form/Built Form: The consideration of form in a wider context (e.g. neighbourhoods, suburbs or the entire city). Also, the relationships between different parts of the urban form (one suburbs connection to another).

Language/Vernacular: The descriptive term for the collection(s) of housing patterns; drawing on Christopher Alexander’s method of classifying/describing urban form.19

Typology: An alternative term for the collection of housing patterns, specific to the design adaption that occurs in the Socially-led patterns (Chapter 7).

Environment: The external spaces in between and around dwellings; the treatment of these spaces in a development pattern is referred to as the quality of the environment.

Style: The aesthetic ornamentation of architectural form (not included in the scope of this research project); applied to evoke a specific emotional response. The form of a housing pattern can employ style through the likes of eaves, materiality, roof treatment, balconies or colour.
2. Urban Patterns in Architecture
2.1. The Urban Patterns of Auckland

2.1.1. Describing the Urban Environment Using Patterns

The process of observing a city can be interpreted through many different lenses; one of the more logically driven approaches is using patterns. This project adopts concepts of pattern language from the work of Christopher Alexander,\(^\text{20}\) to help analyse and categorise Auckland’s urban environment and establish a collection, or language, of the housing patterns that already exist in Auckland, as well as patterns that could inform the intensification of Auckland.

In this research project, housing patterns are defined as the arrangement of a group of dwellings on the ground (in plan) and in the air (vertically). Taking into consideration the concept of four distinct methods of design that architects utilise in generating form,\(^\text{21}\) there are several inter-related factors that influence the form of housing patterns:

- Culture; common perceptions (imagery or icons) of what housing should look be,
- Pragmatism; efficiently fitting buildings onto a site.

In any given housing pattern, there will be a combination of these factors. However, excluded from this is the issue of style; design elements such as roof form, eaves, positioning of glazing, materiality, balconies, colours, shading devices and decks. These do not determine patterns as defined in this research project; they are merely embellishments that only impact the aesthetics of a pattern.

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2.1.2. Our Individual Patterns

As individuals, we are concerned with our own dwellings and those immediately around us. The individual dwelling is part of a pattern that may not be easily observed unless in a regimented layout (e.g. a block of apartments or a row of terraced housing). Nevertheless, these ‘patterns’ do influence our everyday lives.22 Alexander’s argument that an urban pattern language is unique to an individual, and relates to the society they live in, emphasises this point. Putting that into an Auckland context, we all have our own dwelling that we live in; this is part of the pattern of our urban environment that we are most familiar with. Our friends, family members, colleagues, associates and neighbours all have their own (dwelling) part of the pattern in the urban environment that we share with them. Their part of the pattern may or may not be the same as yours, but overall, they all contribute to the collection of patterns that forms the urban language of Auckland (Figure 2.1.).

2.2. The Quarter Acre Pattern

2.2.1. Traditionally, the Most Common Housing Pattern in New Zealand

There is one urban pattern that stands out more than the rest; and not only in Auckland but across the country (also with close similarity to that of Australia). The quarter acre is the most significant phenomenon in New Zealand’s housing history.\(^{23}\) Tracing back to its origins, there are two principles that have underpinned the role of quarter acre:\(^{24}\)

1) The ability to deal with sewage on-site
2) The capacity for settlers to grow their own food and thereby reduce dependency on expensive imported food

Therefore, the quarter acre ‘dream’ is founded on a piece of land that can give a household independence from city supplied provisions.

The formal representation of this housing pattern consists of a single dwelling on its own section of land; a low-density (approximately 10 dwellings per hectare, net) urban form that has offered freedom to individuals to establish their own slice of paradise. Figure 2.2. illustrates the typical spatial arrangement and common elements of the quarter acre as they have developed over the past century in New Zealand.

\(^{23}\) Wright, *Illustrated History*, 141-142

\(^{24}\) Kellett, “The Australian Quarter Acre Block”
Its role in our urban environment has been as a means of suburban division, peaking in popularity during the 1950’s/60’s. Although criticism of its sprawl-promoting nature has led to its decay, there remains an underlying grid in Auckland (Figure 2.3.) based on the measure of the quarter acre; in this context, the exact size of sections does vary from the traditional 1012m$^2$ quarter acre. Nevertheless, the division of suburbs is still based on the individual dwelling and its own section. Therefore, the opportunity exists to use the suburban foundations of the quarter acre as a driver for both the shape of sites that could be developed and for the cultural identity associated with the quarter acre.

25 Wright, Illustrated History, 379
26 Peter Clark, Problems of the New Zealand Urban Environment (Christchurch, New Zealand.: Whitcoulls Publishers, 1972), 15-23
2.2.2. Housing that Embodies the Kiwi Culture

The reason that the quarter acre has become traditionally the most common housing pattern in New Zealand is its close relationship to the Kiwi culture; further emphasis of the ‘the dream’ lifestyle aspirations. There are three primary characteristics that demonstrate the intertwined relationship between the quarter acre and the Kiwi culture:

1) The importance of the outdoors; having a section allows for own food production and a secure space to raise a family.

2) Homeownership; most people desire to have their own slice of paradise.

3) The DIY/self-sufficient culture; ingenuity is an underlying characteristic of the Kiwi culture, and the quarter acre provides a platform for its occurrence.

These characteristics define the uniqueness of the culture that exists in New Zealand and is similar with regards to that of Australia.

2.3. Housing Patterns are Cultural, Not Simply Geometric

2.3.1. Other Cultural Housing Patterns

Much like the quarter acre in New Zealand, there are other housing patterns that suit different cultures from around the world and would not necessarily translate well into other contexts. The following are a range of housing patterns that demonstrate different perceptions of what people accept as housing.
Rio, Brazil (Favelas)

The two-sided societal segregation that exists in Rio is reflected in the distinct housing patterns of the lower/working class citizens. Based on an informal network of narrow roads and alleyways that climb into the mountains, the Favelas embody the challenge of the individual to stake their place in society. This type of housing pattern is epitomised by the ad hoc approach to planning and construction.

Hong Kong (Super High-Rise)

In a country that needs to squeeze over seven million people$^{27}$ into roughly the same area as Auckland’s urban region,$^{28}$ it is no wonder that Hong Kong has resorted to super high-rise housing blocks. This type of housing pattern suits a very compact city with well-established public transportation systems in place. It also favours a more internal lifestyle and is part of a very large ordered structure. This development style is primarily driven by private developers.

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Sangha, Mali (Dogon Village)

A very traditional approach, but exemplifying longevity, the housing patterns of Mali are extremely reliant on societal conformity. Again, based on an informal grid, this housing pattern is limited to basic geometric forms with construction and materiality primarily consisting of mud. This type of housing has a strong community orientation.

Barcelona, Spain (Superblock)

An example of urban order at its grandest scale. The division of Barcelona into regular blocks establishes a very formal city structure and breaks down the urban environment clearly into its different functions; transportation routes determine the extent of building form. This housing pattern is deeply dependent on the involvement of state resources, which emphasises the idea of control by a larger body in society.

Figure 2.6.: Dogon village housing pattern: Driven by a strong cultural icon that has lasted millennia, this pattern is highly rule-driven by the community but results in a pragmatic layout due to topography and short-lived building structures. (Source: Arctic Photos)

Figure 2.7.: Superblock housing pattern: A highly rule-driven development with the intention of being both dense and socially acceptable while trying to retain traditional imagery. (Source: Google Maps)
Venice, Italy (Houses on Water)

The dominant characteristic of Venice is its setting on water, rather than land. This change in environment has significant influence on all daily aspects of life. The obvious feature of this housing pattern is the informal division by a network of canals, which provides a unique interface between the building and urban connections. Additionally, the role of a larger governing body is evident in making this housing pattern achievable.

Manchester, England (Row Houses)

Finally, possibly the closest relative to the quarter acre. Row houses have symbolised the working-class lifestyle of England since the Industrial Revolution. This housing pattern consists of regularly repeated dwellings lining street fronts, often with a private courtyard space behind. These are driven by private or public developers following iconic housing patterns (‘model dwellings’ set by 19th-century philanthropists such as Cadbury). They also offer a sense of ownership within society.

Figure 2.8.: Houses on Water housing pattern: A pragmatic layout that was developed incrementally over time. Proximity largely determined by commercial activity and height limited by available materials and structural issues with ground conditions. (Source: Google Maps)

Figure 2.9.: Row houses housing pattern: A highly rule-driven and pragmatic approach to development aimed at providing housing that conformed to the local preconceptions. (Source: Google Maps)

2.3.2. Adaption of Foreign Housing Patterns

In New Zealand, we are trying to import housing patterns that have worked, or have been successful, in other cities and countries to solve our issue of intensification. This practice has the potential to force foreign housing patterns onto our landscape, which can be detrimental to our urban environment; we are losing the traditional culture of New Zealand housing. Just because one housing pattern can be translated into another society does not mean it should be, or is in fact good. The housing patterns from other cultures need to be carefully considered, with regards to their impact on the Kiwi culture, before applying them to a New Zealand context.
3. Artificial Evolution Framework
3.1. Defining Evolution

3.1.1. Definitions of Evolution

The term ‘evolution’ always has strong roots to its biological origins. The Oxford Dictionary acknowledges this, primarily defining evolution as a biological process that involves consecutive iterations of improvement. This definition acknowledges the work of Charles Darwin and his publication ‘On the Origins of Species’, which explains his scientific theory of how the branching pattern of evolution is based on the process of natural selection.

A broader description articulates that evolution is a process of gradual development. This definition illustrates how a principally biological expression can be adopted into many different disciplines. Regardless of its specific interpretation, evolution has an underlying definition of involving process; highlighting why it can be easily adapted.

Evolution is embraced in two respects in this research project (Figure 3.1.). Firstly, the concept of process outlines the project methodology; an investigation into what patterns of development can inform the intensification of Auckland. Secondly, specific biological terminologies are utilised to emphasise the metaphor of life; generation of an artificial evolution looks at how the legacy of the quarter acre can evolve.

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3.1.2. Using Darwinian Theory in Architecture

Evolution exists in natural domains under the ‘survival of the fittest’ rule; the judgement of a living organism’s existence is dependent on its own ability to survive.\(^\text{33}\) When translating this concept to a non-living entity (e.g. a building), the idea of ‘life’ and ‘survival’ must take on a metaphoric disposition and evolution consequently develops in an ‘artificial’ manner.\(^\text{34}\)

The quarter acre is not a living entity, but it can be broken down and defined by different stages of ‘life’\(^\text{35}\) (Figure 3.2.); it has origins, growth, prosperity and has now been argued to be extinct.\(^\text{36}\) An extension of this metaphor is established as the basis of this research project; how can the legacy of the quarter acre ‘evolve’, maintaining its core characteristics, in response to the pressure of increasing density.

Figure 3.3. is a seminal evolution diagram from Darwin, explaining his ‘tree of life’ structure. This diagram demonstrates his thoughts on how different species, over generations, relate to one another; ranging from opposing branches (‘an immense gap’; A-B) to branches of close similarity (‘the finest gradation’; B-C).

\(^{33}\) Darwin, *On the Origins*, 49-62
\(^{34}\) Armstrong, “Artificial Evolution: A Hands-Off”

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Figure 3.2.: The ‘life’ of the quarter acre
As part of the artificial evolution in this research project, Darwin’s diagram is manipulated to express the quarter acre’s ‘tree of life’ (Figure 3.4.). This diagram illustrates how the four different development approaches that are explored in this research project relate to each other. There are two opposing extremes; the Developer-led approach ‘D’ (where a site is developed to its maximum dwelling concentration) and the Ecologically-led approach ‘E’ (where development can be self-sufficient and not dependent on any infrastructure – electricity, water, sewage). Between the extremes are the Socially-led ‘S’ and Natural Progression ‘N’ approaches; representing a compromise between the extremes and the status quo, respectively. These development approaches are discussed further in Section 3.6.

An integral part of evolution is the selection process; the determination of survival. For living organisms, a ‘natural selection’ process takes place, which relates back to the ‘survival of the fittest’ governance. When adopted to an artificial evolution, the selection process must take an ‘un-natural’ stance. The survival of non-living entities cannot be determined by their will to survive, instead, must be assessed on their performance. The artificial evolution of the quarter acre is concerned with the performance of housing patterns in three key areas; their density, their infrastructural demands (degree of autonomy) and their quality. The un-natural selection process used in this research project is discussed further in Section 3.5.1.

37 Darwin, *On the Origins*, 63-100
3.1.3. Adopting Evolutionary Structure

Delving further into the ‘tree of life’ structure we start to engage with the different layers of each branch of the evolution; the taxonomic ranks. In a natural setting, the terminologies that help describe the ranks (from highest to lowest status) are common ancestor, species, sub-species and variety (Figure 3.5.).
3.2. Analogies, Evolution and Architecture

3.2.1. Defining Analogy

Analogies, like the evolutionary analogy in this case, play a significant role in problem-solving, decision making and creativity, and have proved useful since the time of the ancient Greek philosophers through to current logic concerning artificial intelligence. Their purpose is to assist in explaining a problem by integrating a foreign subject that may not have a direct correlation to the problem but offers an easy path to the solution through similarity.

However, common to all analogies is that, although the similarities can be faithful in some respects, they are ultimately unfaithful in others. For example, an architect’s drawing of a building is an analogy and may have faithful similarities of form, proportion, colour and even scale. However, it does not have the construction or materials of the real building and is, therefore, unfaithful.

These are the terminologies adopted to describe the layers of the artificial evolution in this research project. The quarter acre assumes the highest rank (the common ancestor pattern). Below that are the different development approaches (the species patterns). Under each of these are a range of site arrangements (the sub-species patterns). The next level down consists of the different types/arrangements of dwellings (the variety patterns). An additional step at this lowest rank involves applying the variety patterns (either singular or in combination) to generate iterative housing patterns based on the research project’s initial site; these are the patterns of development that are analysed.

Figure 3.6.: The adopted taxonomic ranks of the artificial evolution and their relation to the layers of housing patterns

In this research project, the patterns of housing in Auckland are described, generated and analysed through an evolutionary analogy. Furthermore, the analogy remains reasonably true to Darwinian theory in all aspects, except for the selection process.

3.2.2. Analogies in Man-Made Evolutions

Evolutions that are not in the natural world are artificial, or man-made. As outlined previously (in Section 3.1.2.), these types of evolution follow a selection process that is driven by performance. The use of analogy in man-made evolutions employs a correlation to iterative development and growth to define how progress is made. The transformation of human ‘tools’ is one area where the analogy of evolution helps to illustrate how changes have been determined by the performance of the tool. Two examples of performance-driven selection are Figure 3.7., which demonstrates the evolution of weaponry, and Figure 3.8, the progression of early automobiles.

An evolutionary analogy is also not uncommon in architecture and has been used to describe such things as the refining of a design solution, a progression of style over time and even the inspiration of a design.


Steadman, The Evolution of Designs
Figure 3.7.: The evolution of weaponry (Source: Steadman – The Evolution of Design)

Figure 3.8.: The evolution of early automobiles (Source: Steadman – The Evolution of Design)
3.3. Rules of the Artificial Evolution for Generating Housing Patterns

3.3.1. Base Design Criteria

In this research project, three base criteria have been selected to underline the design of housing patterns in each of the different development approaches. Having these criteria aims to establish the foundations of a fair comparison when analysing the housing patterns. The three criteria are:

1. Two-bedroom dwellings

Auckland has an occupancy rate of 2.93 people per dwelling, highlighting the suitability of dwellings with two-bedrooms. Usually, apartment/townhouse developments do provide a range of dwelling types (one-, two-, three-bedroom dwellings), however, for this project a single type of dwelling has been utilised to provide a better comparative scale between the different development approaches.

2. One carpark space

A single carpark space has been included for each dwelling as we are still a vehicular dependent city; the provision for only one carpark space attempts to encourage better practices around personal vehicle use and public transportation but recognises a necessity for a vehicle.

3. Single bathroom

A single bathroom is included in each dwelling to offer the expected amenities at a reasonable level of comfort. As there will be a maximum of four people in a two-bedroom dwelling, a single bathroom will adequately suffice.

Other aspects (such as outdoor space or a lockable garage) have been excluded as the base design criteria, as these are secondary design elements that can be shaped by, and help to define, the different development approaches characteristics/requirements.
3.3.2. The Initial Site

This research project is a case study on patterns of development; therefore, the research does not rely on the immediate or specific context of a single site. However, to ground the project and provide a tangible foundation for exploration, an initial site situated in Mount Wellington has been chosen. The latter part of the research project does draw conclusions from the analysis about the suitability of the varying development approaches in different parts of Auckland; this process is explained in the next section (3.3.3.).

A Mount Wellington site (Figure 3.9.) has been chosen because of the diverse layering of the suburb; elements of past, present and future planning (Figure 3.10.) all exist in this part of Auckland. The quarter acre is still readily identifiable as parts of the suburb are still original, while others have been significantly subdivided and the area is now aired for higher densities under Auckland’s Unitary Plan. Mount Wellington is also home to Sylvia Park (New Zealand’s largest shopping centre), four primary/intermediate schools, is only a 12km drive to the CBD and contains nearly 8,500 households.

The specific initial site for this project is 45-51 Aranui Road, Mount Wellington, Auckland (Figure 3.11.). It consists of four adjacent quarter acre sections that are still typically ‘traditional’ in the sense there are only five dwellings across the entire site; this gives a density of 12.1dph, which falls into the low-density definition of housing. The selection of four adjacent sections provides an opportunity to investigate development schemes based on, but at a larger scale, than the single quarter acre can offer.
Artificial Evolution Framework

Figure 3.12.: Plan of the initial site (Source: Auckland Council Geomaps)

Total Site Area = 4140m$^2$
Total Current Density = 12.1dph
3.3.3. Application to Other Sites

Auckland Council has set the goal of accommodating up to 70% of the 400,000 new homes required by 2040, inside the Metropolitan Urban Limit (MUL); emphasised by Figure 3.13. The subsequent effect of this statement relies heavily on the redevelopment of brownfield sites, which is where an investigation into patterns of development offers guidance as to how this can be achieved in considering the effects of density, infrastructure demands and geniality of different housing patterns.

The latter part of this research project attempts to answer the challenge of intensifying our existing suburbs by applying the patterns of development generated on the initial site to other sites around Auckland, adjusting them to suit the context where necessary.

The process of selecting and applying housing patterns to other sites follows three key considerations. Firstly, the application of housing patterns acknowledges the zones of the Unitary Plan but does not strictly adhere to them. Possible layers of intensification have been established, however, a suitable site may sit outside what has been outlined. Secondly, the development restrictions set out in Section 3.3.4. are maintained to define the design, regardless of what zone the new site may be classified as under the Unitary Plan. The reason for this is to minimise any new variables; introducing new ‘rules’ of development at this stage of the process counteracts the development of the pattern and removes the opportunity for a fair comparison. Finally, consideration of the context should inform the site selection. For example, an extremely high density (200+ dph) Developer-led scheme will not function well in an area occupied by detached single storey dwellings.

Figure 3.13.: Indicative map illustrating the intended distribution of new homes in Auckland (Base Map Source: Auckland Council Geomaps)
3.3.4. Relevant Unitary Plan Restrictions

As the current planning policy in Auckland, the Unitary Plan plans a key role in shaping the urban environment. Acknowledging the importance of the Unitary Plan, the development of housing patterns follows a range of main restrictions that outline the limitations of allowable design, to ensure patterns are viable propositions of how Auckland’s urban form can develop. These restrictions are utilised by all the development approaches that are included in the artificial evolution.

The restrictions employed are taken from the ‘Terraced Housing and Apartment’ Building Zone; this is the highest density allowance for residential areas and allows for a wide scope of housing patterns to be explored. The main constraints encompass maximum height, height in relation to boundary, minimum boundary offsets, building/site coverage and minimum dwelling size. Refer to Appendix 12.2. for the full description of these constraints.

Figure 3.14.: Illustrations of the key Unitary Plan restrictions as applied to the initial site in this research project (Source: Unitary Plan, H6: Residential – Terraced Housing and Apartment Building Zone)
3.3.5. Approach to Infrastructural Demands

A significant criticism faced by any new development is the degree to which it impacts, or relies on the city’s infrastructure.\(^\text{50}\) The importance of considering infrastructure is reflected in the un-natural selection process implemented in the artificial evolution of the quarter acre; infrastructural demand is one the three aspects that assess the performance of housing patterns to determine their survival.

The autonomy (or infrastructural self-sufficiency) of housing patterns developed in this research project also reflects the characteristics of the development approach they are derived from. Exploration of housing patterns looks at what is the current situation, to begin with, followed by the extreme circumstances and then tries to find what level of autonomy can be achieved by balancing the extremes. Section 3.6. expands on the characteristics of the different development approaches.

3.4. Generating Patterns as an Artificial Evolution Process

3.4.1. Using Existing Patterns of Subdivision

The first method of generating patterns, in the artificial evolution, simply borrows the patterns of subdivision that already exist within the suburbs of Auckland (Figure 3.15.) and applies them to the initial site. The borrowed patterns explore the possible developments across a combination of one, two, three or four of the original quarter acre sections as the baseline of development. This is considered as the path of ‘Natural Progression’ from Figure 3.4.

Figure 3.15.: Borrowing the patterns of subdivision from existing suburbs (Map Source: Auckland Council Geomaps)
3.4.2. Formula-driven Patterns

The second method of generating patterns is a bit more complicated but is made simpler as it is effectively formulaic. The patterns of the Developer-led and Ecologically-led approaches are derived from formulas specific to each of them; the latter is driven by calculations of infrastructural autonomy (e.g. area of land required for sewage treatment onsite, volume of rainwater tanks, area of roof for photovoltaics (Figure 3.16.)), while the former tries to exploit the maximum potential out of the Unitary Plan restrictions (e.g. maximizing development height and height in relation to boundary, building coverage and impermeable areas). The potential of both development approaches can be achieved by means of computing.

3.4.3. Design Adaption of Quality Housing Patterns

The final method of generating patterns again steps up the level of complexity. The Socially-led housing patterns look to balance density, infrastructural autonomy and geniality (a less contentious term of livability). To achieve this balance a collection of ‘quality’ housing patterns (selected from international award-winning housing projects) are analysed from which patterns of successful housing layout ‘sub-species’ are generated, to suit an Auckland context. In this description, ‘quality’ refers to housing developments from around the world that have received recognition, in particular from occupants, for the success of their design; schemes that are award-winning, peer-reviewed or have been published.

Figure 3.16.: An illustration of the formulae that determine the Ecologically-led approach
3.5. Testing the Patterns of the Artificial Evolution

3.5.1. The un-Natural Selection Process

As outlined earlier, the performance of housing patterns is what determines their survival as part of the artificial evolution, and there are three key criteria which patterns are tested against; their density, infrastructural demands and level of quality.

The execution of the first two criteria is straightforward to determine since these are numerical representations of the housing patterns. Firstly, the analysis of density ascertains the number of dwellings and degree of site coverage, presenting a range of values summarized by the dwellings per hectare (dph). Secondly, the analysis of infrastructure utilises external data averages relating to water\(^51\) and electricity\(^52\) to establish the infrastructural demands of a housing pattern. The values are presented in their relevant units and summarized by how autonomous the housing pattern is (expressed as a %). The analysis system of these first two criteria has been derived from that used in Housing New Zealand’s ‘Best Practises in Medium Density Housing Design’\(^53\).

The analysis of the third criteria, quality of the housing patterns, is a more complicated characteristic to measure. The Housing New Zealand report\(^54\) does attempt to analyse different development schemes with respect to the quality of their environment; their method indicates a scheme to have either a positive, neutral or negative impact in a range of attributes. The limitations of this system are the requirement of a certain foundation of knowledge to fairly analyse a development scheme, as well as the prospect of developments being designed around a formulaic methodology. Likewise, Beacon Pathway are developing their own assessment system for medium-density housing,\(^55\) concentrating on classifying core principles.

Importantly, both systems include attributes that are all individually of interest but do not assist in designing an appropriate form. Using these rules cannot generate an architectural form that has an identity, spirit or sense of place; doing so could, in fact, result in a lack of character or individuality, as the overall architectural form is more important than the sum of its parts determined by formulae.

53 Turner et al., Best Practises
54 Turner et al., Best Practises
With relation to the artificial evolution, the Developer-led, Ecologically-led and Natural Progression housing patterns all look to architectural precedents to inform the potential quality that can be achieved from their generated urban forms. The Socially-led patterns take a different approach and start by assessing what are common typologies of ‘quality’ housing patterns, as discussed in Section 3.4.3., and then develop patterns that portray that ‘quality’ in an Auckland context.

Figures 3.17. and 3.18. illustrate what does happen when design is driven by rules. The BedZED Development (Figure 3.17.), often promoted by environmentalists, was strongly driven by environmental emphasis but has resulted in architecturally monotonous form, which lacks individuality. The Southeast False Creek Development (Figure 3.18.), promoted by Beacon Pathway, similarly was shaped by strict planning guidelines.

Figure 3.17.: BedZED Development (Source: Greenroofs.com)

Figure 3.18.: Southeast False Creek Development (Source: VIA Architecture)

With relation to the artificial evolution, the Developer-led, Ecologically-led and Natural Progression housing patterns all look to architectural precedents to inform the potential quality that can be achieved from their generated urban forms. The Socially-led patterns take a different approach and start by assessing what are common typologies of ‘quality’ housing patterns, as discussed in Section 3.4.3., and then develop patterns that portray that ‘quality’ in an Auckland context.
3.5.2. Table of Quarter Acre Characteristics

As the ‘tick box’ measuring system does provide a clear indication of the presence of attributes, a table has been created (Figure 3.19.) to analyse the level of compromise in the generated housing patterns, of quarter acre characteristics; this will also allow for comparison between different development approaches, but does not set out the criteria for generating housing patterns (unlike the Housing New Zealand and Beacon Pathway methods). The definition of characteristics in this context are attributes that have had a significant influence on the legacy of the quarter acre including the ability to produce own food, catering to outdoor activities, space to raise a family, homeownership and supporting the DIY culture. Noteworthily, not all characteristics may be present in every example of a quarter acre, but the potential for them is what is considered.

The table analysis system operates in a similar manner to the likes of the Green Star or the Homestar Rating Systems, which allocate points to attributes and give an overall score. In this research project, each characteristic is worth a single point and the overall total is out of 12 points. Half a point may be awarded if there is limited opportunity for a given attribute.

<table>
<thead>
<tr>
<th>Area for:</th>
</tr>
</thead>
<tbody>
<tr>
<td>A  Food Production (Vegetable Garden)</td>
</tr>
<tr>
<td>B  Food Production (Fruit Trees/Vines)</td>
</tr>
<tr>
<td>C  Recreational Gardening</td>
</tr>
<tr>
<td>D  Private Outdoor Entertaining</td>
</tr>
<tr>
<td>E  Children to Play</td>
</tr>
<tr>
<td>F  Additional Storage (for bikes, kayaks, ...)</td>
</tr>
<tr>
<td>G  DIY Activities (Vehicle Maintenance, Construction)</td>
</tr>
<tr>
<td>H  Secure Vehicle Storage</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Other Attributes:</th>
</tr>
</thead>
<tbody>
<tr>
<td>I  Homeownership / Owning Private Land</td>
</tr>
<tr>
<td>J  Connection to the outdoors</td>
</tr>
<tr>
<td>K  DIY Eco Addons (solar coll., solar hot water, water coll., sewage)</td>
</tr>
<tr>
<td>L  Ability to personalise dwelling</td>
</tr>
</tbody>
</table>

Figure 3.19.: Table of quarter acre characteristics

3.6. Different Approaches to Development

The exploration into housing patterns, through an artificial evolution, seeks to accelerate the process of developing the urban environment to investigate what are the possibilities and their subsequent effects. Development is classified into four primary categories that represent no development intervention, the two opposing extremes of development and a balance between them. In addition, Mies’ famous phrase, ‘form follows function’, is manipulated to express the formal characteristics of each approach.

3.6.1. No Intervention

As a baseline (control) of development, the existing patterns of subdivision found in Auckland’s suburbs are explored to observe how a collection of adjacent sections could develop if there was no larger scale development intervention. This approach embodies the laissez-faire response to planning that has shaped Auckland for over a century and tests how current methods of subdivision perform against the demand for intensification. These patterns, entitled Natural Progression (‘form follows status quo’), are explored in Chapter 4.
3.6.2. The Extremes (Economy vs Ecology)

At each end of the development spectrum, there are two mentalities that signify contrasting priorities of housing developments. One extreme (‘Developer-led’ patterns) is focused on maximising the number of dwellings that can be fitted onto a site; subscribing to the notion that more dwellings result in a higher end profit. The other extreme (‘Ecologically-led’ patterns) is motivated by the ability to be completely autonomous; taking individual responsibility for infrastructural demands takes pressure off city supplies. Although there is a juxtaposition between these two extremes, both can be broken down into formula-driven processes. The Developer-led patterns (‘form follows finance’) are explored in Chapter 5 and the Ecologically-led patterns (‘form follows autonomy’) in Chapter 6.

3.6.3. Balancing the Extremes

The ideal new housing patterns for Auckland should possess the benefits of both the economy and ecology extremes; the challenge is determining the balance between them, and where to make compromises. This final approach attempts to find that balance by examining ‘quality’ housing patterns (refer to Section 3.4.3 for the description of ‘quality’) from around the world and establish typologies of the common urban forms to generate housing patterns suitable for an Auckland context. The Socially-led patterns (‘form follows quality’) are explored in Chapter 7.

Figure 3.21.: Developer-led and Ecologically-led development approaches

Figure 3.22.: Socially-led development approach
4. Natural Progression Patterns
(form follows status quo)
4.1. Introduction of Approach

The first species of the artificial evolution establishes and analyses the existing housing patterns of Auckland’s urban environment. This development approach is included as a baseline indicator of what could possibly happen if a larger development scheme is not implemented; i.e. suburbs run their own natural course of densification.

4.1.1. Defining Characteristics/Rules

The key characteristic of the Natural Progression patterns is subdivision. In this context, subdivision is the process of dividing a single section into multiple titles, with the intent of increasing the number of independent dwellings on the original section.\(^{58}\) The process of dividing land has occurred in New Zealand since European settlement (mid-19\(^{th}\) century),\(^{59}\) with the demand for legislative measures following not too long after.\(^{60}\)

More recently, planning policies have used subdivision as a means of increasing Auckland’s density,\(^{61}\) as it complements the laissez-faire mentality that exists towards the city’s urban form.\(^{62}\) Additionally, this emphasises the precaution of policymakers in relation to altering the urban landscape; the need to counter the effects of urban sprawl was brought to attention in the 1982 Regional Plan,\(^{63}\) although we are only now (three and a half decades later) starting to see significant actions taking place. Consequently, the patterns of suburban growth have been an expression of piecemeal subdivision. Control of increasing the density of suburbia has been left up to the motivations of

\(^{58}\) Auckland Council, “Auckland Unitary Plan”

\(^{59}\) Giselle Byrnes, Boundary Markers: Land Surveying and the Colonisation of New Zealand (Wellington, New Zealand: Bridget Williams Ltd, 2001), 15-38


\(^{61}\) Auckland Council, “Auckland Unitary Plan”


\(^{63}\) Auckland Regional Authority – Regional Planning Committee, Auckland Regional Plan (Auckland: Auckland Regional Authority, 1982).
the individual, reflecting the influence of homeownership in a New Zealand context. However, this has resulted in a diverse, detached urban environment, evident in Figure 4.1.

The observation of suburban growth gives an interesting insight into how the suburbs of Auckland have developed through subdivision. Figure 4.2. provides snapshots of the immediate area around the initial site in Mount Wellington, at six different years between 1940 and 2010/2011. After the initial significant growth between 1940 and 1996, the development of this area relied on the individual subdivision of properties. By the final snapshot (2010/2011), the diverse range of colours in this part of Auckland emphasises the piecemeal growth that has occurred.

Figure 4.1.: The results of piecemeal subdivision in suburban Auckland (Source: Auckland Council Geomaps)
Natural Progression Patterns

Figure 4.2.: The suburban growth patterns of Mount Wellington - 1940-2011 (Source: Auckland Council Geomaps)
4.1.2. Infrastructure Mentality

As this approach is established by individual dwellings, it is hard to establish a larger agreement on the appropriate nature of what the demands/intentions on infrastructure should be. There is no legislation that dictates the source of utilities, therefore it is up to the individual household to make those decisions. In analysing these housing patterns, the approach for determining the infrastructural dependency has looked at what the maximum potential autonomy could be based on the characteristics of the dwellings.

4.1.3. Specific Evolutionary Elements

The different methods of subdividing a site contribute to the range of Natural Progression patterns utilised.

The sub-species element of the Natural Progression approach uses the existing individual property boundaries of the initial site, singular or in combination. The use of the quarter acre section as the initial unit of measure relates back to individualistic nature of subdivision that has occurred over the decades.

The variety elements of this approach are derived from the patterns of suburban growth observed across the surrounding area and other parts of Auckland. The patterns observed are forms of subdivision based on individual sections.
4.1.4. Target Audience

This approach to development has a wide range of potential audience as these are familiar patterns in the suburbs of Auckland. The patterns of Natural Progression cater to the desires of suburban life, therefore are more likely to attract families and couples with homeownership aspirations. Nonetheless, investors are also drawn to these housing patterns, which in addition attracts people who want the suburban life, but cannot afford to buy (e.g. groups of younger people or young couples).

4.1.5. Specific Assumptions and Limitations

The layers of patterns discussed in this chapter are by no means the extent of what housing patterns could work in the Natural Progression approach. Those included have arisen from their suitability and support of this species’ characteristics in the limited time of undertaking this research project.
4.2. Generating Patterns

In this development approach, there is a very simple process of design adaption. The initial site is utilised to inform the sub-species patterns, while design precedents are established as the housing patterns of the Natural Progression approach.

4.2.1. Sub-species Patterns

The Natural Progression patterns at the sub-species rank are based on the boundaries of the four existing adjacent sections of the initial site. They are considered either individually or in combinations.

The code for each of these patterns consists of a letter and a number, respectively; the letter is the initial of the development approach (Natural Progression = N); the number starts at one and count upwards.

![49 N2](image)
This sub-species pattern is the section which is currently 49 Aranui Road

![47 N3](image)
This sub-species pattern is the section which is currently 47 Aranui Road

![51 N1](image)
This sub-species pattern is the section which is currently 51 Aranui Road

![45 N4](image)
This sub-species pattern is the section which is currently 45 Aranui Road

Figure 4.3.: Natural Progression sub-species patterns (N1-N10)
This sub-species pattern combines the sections which are currently 51 and 49 Aranui Road.

This sub-species pattern combines the sections which are currently 49 and 47 Aranui Road.

This sub-species pattern combines the sections which are currently 47 and 45 Aranui Road.

This sub-species pattern combines the sections which are currently 51, 49, and 47 Aranui Road.

This sub-species pattern combines the sections which are currently 49, 47, and 45 Aranui Road.

This sub-species pattern combines the sections which are currently 51, 49, 47, and 45 Aranui Road.
4.2.2. Variety Patterns

The Natural Progression patterns at the variety level are arrangements of dwellings adapted from the existing suburban patterns of Auckland.

The code for each pattern consists of 3-4 numbers and/or letters and is an acronym of the pattern description; e.g. **AED** = Addition to Existing Dwelling.

As these patterns observe what are the existing circumstances, the generation of the iterative housing patterns does not take into account the ‘base design criteria’ (set out in Section 3.3.1.); the important differences are the number of bedrooms and the dwelling sizes, which are based on the precedent where the design is adapted from. The values representing the characteristics of each precedent in this section have been taken from *Auckland Council Geomaps*\(^6^6\) (for dwelling and section sizes) and *Homes.co.nz*\(^6^7\) (for average number of bedrooms per dwelling).

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\(^{65}\) Auckland Council, “Geomaps - Property Data”

Natural Progression Patterns

**Figure 4.5:** 20 Panorama Road, Mount Wellington Housing Pattern  
*Map Source: Auckland Council Geomaps*

- **2011 Existing Dwelling and 2 New Dwellings**
- **2015**

**Summary:**
- Average Dwelling Size: 157 m²
- Average Section Size: 340 m²
- Density (Before): 9.8 dph
- Density (After): 29.4 dph
- Average No. of Bedrooms: 4

**Figure 4.6:** 22 Commissariat Road, Mount Wellington Housing Pattern  
*Map Source: Auckland Council Geomaps*

- **2011 2 New Dwellings with Existing Dwelling relocated**
- **2015**

**Summary:**
- Average Dwelling Size: 173 m²
- Average Section Size: 375 m²
- Density (Before): 8.9 dph
- Density (After): 26.7 dph
- Average No. of Bedrooms: 4
Figure 4.7.: 372 Ellerslie-Panmure Highway, Mount Wellington Housing Pattern (Map Source: Auckland Council Geomaps)

- Average Dwelling Size: 262 m²
- Average Section Size: 572 m²
- Density (Before): 11.6 dph
- Density (After): 17.5 dph
- Average No. of Bedrooms: 4

Figure 4.8.: 259-261 Penrose Road, Mount Wellington Housing Pattern (Map Source: Auckland Council Geomaps)

- Average Dwelling Size: 149 m²
- Average Section Size: 405 m²
- Density (Before): 12.4 dph
- Density (After): 24.7 dph
- Average No. of Bedrooms: 3.5
Natural Progression Patterns

Figure 4.9: 70-72 Panorama Road, Mount Wellington Housing Pattern
(Map Source: Auckland Council Geomaps)

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<th>Year</th>
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<th>New Dwellings</th>
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<td><img src="image2" alt="New Dwellings" /></td>
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<tr>
<td>2015</td>
<td><img src="image3" alt="Existing Dwelling" /></td>
<td><img src="image4" alt="New Dwellings" /></td>
</tr>
</tbody>
</table>

Average Dwelling Size: 198 m²
Average Section Size: 414 m²
Density (Before): 9.7 dph
Density (After): 24.1 dph
Average No. of Bedrooms: 3.5

Figure 4.10: 198-200 Main Highway, Ellerslie Housing Pattern
(Map Source: Auckland Council Geomaps)

<table>
<thead>
<tr>
<th>Year</th>
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<th>New Dwellings</th>
</tr>
</thead>
<tbody>
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<td><img src="image6" alt="New Dwellings" /></td>
</tr>
<tr>
<td>2015</td>
<td><img src="image7" alt="Existing Dwelling" /></td>
<td><img src="image8" alt="New Dwellings" /></td>
</tr>
</tbody>
</table>

Average Dwelling Size: 200 m²
Average Section Size: 435 m²
Density (Before): 7.6 dph
Density (After): 23.0 dph
Average No. of Bedrooms: 4
Addition to Existing Dwelling

2011

2015

Figure 4.11: 83 Waipuna Road, Mount Wellington Housing Pattern
(Map Source: Auckland Council Geomaps)

Average Dwelling Size: 230 m²
Average Section Size: 860 m²
Density (Before): 11.6 dph
Density (After): 11.6 dph
Average No. of Bedrooms: 5

Addition to Existing Dwelling and 1 New Dwelling

2011

2015

Figure 4.12: 74 Ashby Avenue, St Heliers Housing Pattern
(Map Source: Auckland Council Geomaps)

Average Dwelling Size: 146 m²
Average Section Size: 477 m²
Density (Before): 10.5 dph
Density (After): 21.0 dph
Average No. of Bedrooms: 4
Natural Progression Patterns

Addition to Existing Dwelling and 2 New Dwellings

2011

2015

Figure 4.13.: 9 McCracken Road, Mount Wellington Housing Pattern
(Map Source: Auckland Council Geomaps)

- Average Dwelling Size: 173 m²
- Average Section Size: 414 m²
- Density (Before): 8.0 dph
- Density (After): 24.1 dph
- Average No. of Bedrooms: 3

1 New Dwelling

2006

2011

Figure 4.14.: 113 Celtic Crescent, Ellerslie Housing Pattern
(Map Source: Auckland Council Geomaps)

- Average Dwelling Size: 310 m²
- Average Section Size: 958 m²
- Density (Before): 0.0 dph
- Density (After): 10.4 dph
- Average No. of Bedrooms: 4
Figure 4.15: 79 Waipuna Road, Mount Wellington Housing Pattern
(Map Source: Auckland Council Geomaps)

- Average Dwelling Size: 250 m²
- Average Section Size: 467 m²
- Density (Before): 10.7 dph
- Density (After): 21.4 dph
- Average No. of Bedrooms: 4

Figure 4.16: 56 Maskell Street, St Heliers Housing Pattern
(Map Source: Auckland Council Geomaps)

- Average Dwelling Size: 277 m²
- Average Section Size: 461 m²
- Density (Before): 7.2 dph
- Density (After): 21.7 dph
- Average No. of Bedrooms: 4
Natural Progression Patterns

Figure 4.17: 57 Millen Avenue, Pakuranga Housing Pattern
(Map Source: Auckland Council Geomaps)

Average Dwelling Size: 279 m²
Average Section Size: 480 m²
Density (Before): 5.2 dph
Density (After): 20.8 dph
Average No. of Bedrooms: 4

Figure 4.18: 89 Waipuna Road, Mount Wellington Housing Pattern
(Map Source: Auckland Council Geomaps)

Average Dwelling Size: 300 m²
Average Section Size: 522 m²
Density (Before): 0.0 dph
Density (After): 19.1 dph
Average No. of Bedrooms: 5
4.2.3. Iterative Housing Patterns

The next stage of generating patterns in this development approach looks at applying the variety patterns to the sub-species ones; the adaption of Auckland’s existing housing patterns to the combination of sections in the initial site. Some patterns may not be able to fit onto one of the sub-species section options, because of its current arrangement of dwellings, and is noted as being ‘Not Applicable’.

The iterative housing patterns are informed by the numbers (dwelling size and number of bedrooms) in the design precedents from section 4.2.2. Dwellings are represented by a regular rectangular form measuring the approximate dwelling size. The subdivision of sections attempts a reasonably even split into the required numbers or in response to the arrangement of dwellings. Following, are three elaborated examples of iterative housing patterns of this development approach. A collection of more iterative housing patterns of the Natural Progression approach can be found in Appendix 12.5.

The code for each pattern consists of the sub-species code and a number/letter combo; the number of this combo is the sub-species number and a lowercase letter signifies what iteration it is (starting from ‘a’ and progressing through the alphabet). E.g. N1-1c = N1 sub-species + 1 from the sub-species and this is the third iteration, therefore, ‘c’.

A detailed explanation of how to read the iterative housing patterns can be found in Appendix 12.4.
Iterative Housing Pattern Example 1: N1-1m (3ND)

This first example of the Natural Progression approach divides one of the original sections into three new sections, each with its own new dwelling. This achieves an increase in density from around 10 dph up to 29 dph and offers an average section of 345m² per dwelling. The new dwellings are all detached, two storey and have four bedrooms. A shared driveway runs along the western boundary for access to the rear sections. The 3ND pattern suits this site because the single dwelling that currently occupies the site is in a rather run-down state; by removing it there is then sufficient space to accommodate three new sections/dwellings.

Figure 4.20.: Natural Progression iterative housing pattern example 1
Iterative Housing Pattern Example 2: N3-3b (E2N)

The next example of Natural Progression is a common approach to a larger section which has only one existing dwelling upon it. There was a time when the ample backyard was sought after for raising a family, but we are now seeing these backyards subdivided and new dwellings filling them in. The two new dwellings are both detached and two storey, each with four bedrooms, which contrasts to the existing single storey, three-bedroom dwelling. There is a similar increase in density to what’s achieved in the N1-1m pattern (from 10 dph to 29 dph) as the total dwelling count over the original section is now three. One of the requirements for this pattern to be applied is a shared driveway needs to be able to squeeze past the existing (front) dwelling to access the new rear sections.

Figure 4.21.: Natural Progression iterative housing pattern example 2
Iterative Housing Pattern Example 3: N6-6p (6ND)

The final elaborated pattern of the Natural Progression approach is a variation of the first example (N1-1m), but utilises two adjacent sections. This pattern represents housing developments that start to provide a larger scale solution to intensification, but are still conforming to the housing patterns that have shaped Auckland to date. In this pattern the two existing dwellings are removed to allow for a more efficient site plan that can accommodate six new dwellings. One shared driveway is situated in the middle of the new site, with the new dwellings oriented around it. Like the N1-1m pattern, all new dwellings are detached, two storey and each have four bedrooms. The increase in density is also like the N1-1m and N3-3b patterns (from 10 to 29 dph). The application of the 6ND pattern is more suited to adjacent sections where the original dwelling(s) may be run-down or inefficiently located on the site.

Figure 4.22.: Natural Progression iterative housing pattern example 3
How do these relate to the original section boundaries?

The Natural Progression approach relates closest to the original section boundaries, as development occurs in a piecemeal fashion and is shaped primarily by the means of subdivision. These two factors result in individual sections being developed one at a time, preserving the existing external boundaries and only adding new internal boundaries. This process has occurred for many decades now and is evident in the underlying grid that exists in suburban Auckland (illustrated previously in Figure 2.3.).
5. Developer-led Patterns

(form follows finance)
5.1. Introduction of Approach

The second species of the artificial evolution pursues a more economic focus in relation to the intensification of Auckland. This development approach is concerned with accommodating as many dwellings on the site as economically achievable, which is a common mentality of land developing. These housing patterns attempt to demonstrate how the restrictions of the Unitary Plan can be manipulated and the subsequent outcomes.

5.1.1. Defining Characteristics/Rules

One of the flaws of the Unitary Plan is its lack of guidance in the application of building zone restrictions; it has been left up developers to put forward schemes that ‘test’ what is allowable. The Developer-led patterns take advantage of this freedom to develop a site to its maximum potential and examine what these patterns can contribute to a denser Auckland. The key restrictions outlined in Section 3.3.4. are what these housing patterns utilise as their defining characteristics.

Another example of a development scheme testing the Unitary Plan, in a similar manner to the Developer-led patterns, is a five-storey apartment development at 32-34 Tennyson Avenue in Takapuna. This proposed scheme will see a site currently containing three dwellings increase to 53 dwellings (Figure 5.1); a significant increase in density from 16 to 283 dwelling per hectare (based on a site area of 1,872m²), an indication of the expected density values of housing patterns in this species of the artificial evolution.

The consequence of packing the maximum number of dwellings comes at the expense of the development’s natural environment. There are

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69 Ibid.
numerous schemes across Auckland that exhibit this compromise, which often results in damp and uninviting external spaces that are mostly impervious surfaces and almost entirely shaded throughout the day (Figure 5.2.). Additionally, the consequence of being one of the first development schemes to test the rules results in a vast contrast to the existing adjacent properties and the ensuing criticism.
5.1.2. Infrastructure Mentality

The housing patterns in this approach look at providing utility services that require the least amount of maintenance, to offer residents easy to occupy dwellings. What this comes down to are development schemes that are fully reliant on city infrastructure; freshwater is reticulated, wastewater is processed off-site, electricity is taken from the grid supply and waste is collected at the kerbside. Furthermore, there is little or no importance placed on the use of public transportation, with most dwellings using their own petrol/diesel dependent vehicle.

5.1.3. Specific Evolutionary Elements

The Developer-led sub-species patterns have been developed by considering ways of dividing the site to allow for maximum potential building mass; the thought being that the taller and greater volume of mass, the larger the number of dwellings possible. The sketch in Figure 5.3. illustrates one site layout consisting of two driveways and three building areas/masses.

Figure 5.3.: Dividing the site in developing the sub-species pattern
The variety patterns for this approach draw together different types of dwellings commonly found in higher density schemes; following detached, terraced and apartment forms. Individual dwellings types or combinations of types are applied to the various site layouts to exhaust the possible iterations. Figure 5.4. demonstrates two of the dwelling type patterns included in this approach.

5.1.4. Target Audience

This approach to development has been promoted as the possible current alternative to the traditional quarter acre. It aims at attracting owner-occupiers and investors; occupants may be single people, couples or elderly, and even young/small families could be attracted. The low maintenance nature of these dwellings would suit business professionals or people who lead busy lives, with no extra time to spend tending to maintenance. The compromise of natural landscaping in place of more dwellings also works well in attracting investors as there are lower amounts of regular maintenance required.

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73 Turner et al., Best Practises
5.1.5. Specific Assumptions and Limitations

It is acknowledged that not all developers have the same motivations; while some are purely driven by economics, there are others who do take into consideration the quality of the environment. However, in this research project, this species of development is analysing the extreme circumstances of what density is achievable on a given site.

Additionally, the layers of patterns discussed in this chapter are by no means the extent of what housing patterns could work in the Developer-led approach. Those included have arisen from their suitability and support of this species’ characteristics in the limited time of undertaking this research project.

5.2. Generating Patterns

In this development approach, formulas help drive the generation of patterns, followed by the incorporation of precedents to inform potential style. Design precedents are utilised as a reference in this species to infer the potential character of these housing patterns; if their formal expression was developed to include stylistic representation.

5.2.1. Sub-species Patterns

The Developer-led patterns at the sub-species level consider the division of the initial site into building masses.

The code for each pattern consists of a letter and a number, respectively; the letter is the initial of the development approach (Developer-led = D); the number starts at one and counts upwards.
This pattern divides the site with two straight driveways to create three areas for building mass.

Figure 5.5: Developer-led sub-species pattern (D1)

This pattern divides the site with a ‘U’ shaped driveway to create perimeter areas and a central area for building mass.

Figure 5.6: Developer-led sub-species pattern (D2)
This pattern divides the site with three straight driveways to create two areas for building mass.

**Figure 5.7:** Developer-led sub-species pattern (D3)

This pattern wraps one driveway around the outside and another part way into the middle, and creates a ‘U’ shaped mass.

**Figure 5.8:** Developer-led sub-species pattern (D4)
This pattern divides the site with a ‘T’ shaped driveway to create three areas for building mass.

Figure 5.9: Developer-led sub-species pattern (D5)

This pattern has two driveways along the side boundaries and two running between them to create three areas for building mass.

Figure 5.10: Developer-led sub-species pattern (D6)
This pattern is a variation of the ‘T’ driveway with two additional paths, which creates five areas for building mass.

This pattern divides the site with three straight driveways to create four areas for building mass.

**Figure 5.11:** Developer-led sub-species pattern (D7)

**Figure 5.12:** Developer-led sub-species pattern (D8)
This pattern is a variation of D6 with an extra driveway running across the site to create four areas for building mass.

Figure 5.13: Developer-led sub-species pattern (D9)

This pattern is a further variation of the ‘T’ driveway with two additional paths, which creates seven areas for building mass.

Figure 5.14: Developer-led sub-species pattern (D10)
5.2.2. Variety Patterns

The Developer-led patterns at the variety rank are the types of dwellings that are commonly associated to higher density housing developments.

The code for each pattern consists of 3-4 letters that reflect an abbreviation of the pattern description, with numbers used to indicate multiple storeys; e.g. 2Sin = 2 Storey, Single Aspect Dwelling.

Typical floor plans are based on the minimum dwellings requirements\textsuperscript{73} and the base criteria of spaces required. The spatial arrangement of dwellings ensures all bedrooms and living spaces have a view to the outside.
Single Aspect Dwelling
East or West Aspects
Single Level
Floor Area = 54m²

Two-Storey Single Aspect Dwelling
East or West Aspects
Two Levels
Floor Area = 63m²

Figure 5.16.: Typical floor plan of Single Aspect Dwelling

Figure 5.17.: Typical floor plan of Dual Aspect Dwelling

Figure 5.18.: Typical floor plan of Two-Storey Single Aspect Dwelling
Two-Storey Dual Aspect Dwelling
East + West Aspects
Two Levels
Floor Area = 78m²

Ground Floor
- ENTRY
- LIV / DIN / KIT
- BED
- BED
- BATH

First Floor
- BED
- BED

Dual Aspect Dwelling (Rotated)
East + West Aspects
Single Level
Floor Area = 57m²

Figure 5.19: Typical floor plan of Two-Storey Dual Aspect Dwelling

Figure 5.20: Typical floor plan of Dual Aspect Dwelling (Rotated)
Townhouse Dwelling
East + West Aspects
Three Levels
Floor Area = 120m²

Detached Dwelling
Three Aspects
Single Level
Floor Area = 69m²

Duplex Dwelling
Three Aspects
Single Level
Floor Area = 69m²

**Figure 5.21.** Typical floor plan of Three-Storey Townhouse Dwelling

**Figure 5.22.** Typical floor plan of Detached Dwelling

**Figure 5.23.** Typical floor plan of Duplex Dwelling
Developer-led Patterns

**Figure 5.24.** Typical floor plan of Two-Storey Detached Dwelling

**Figure 5.25.** Typical floor plan of Two-Storey Duplex Dwelling
5.2.3. Iterative Housing Patterns

The next stage of generating patterns in this development approach looks at applying the variety patterns to the sub-species ones; the types of dwellings, either singular or in combination, are applied to the site arrangements. Design precedents are then referenced to infer the potential stylistic character of the iterative housing patterns’ formal arrangements.

These patterns are formula-driven designs (using Unitary Plan restrictions). Dwellings from section 5.2.2. are represented as a rectangular form and arranged accordingly to their characteristics (e.g. single/dual aspect) and to suit the spatial arrangement of each site. Following, are three elaborated examples of iterative housing patterns of this development approach. A collection of more iterative housing patterns of the Developer-led approach can be found in Appendix 12.6.

The code for each pattern consists of the sub-species code and a number/letter combo; the number of this combo is the sub-species number and a lowercase letter signifies what iteration it is (starting from ‘a’ and progressing through the alphabet). E.g. \textbf{D2-2e = D2} sub-species + 2 from the sub-species and this is the fifth iteration, therefore, ‘e’.

A detailed explanation of how to read the iterative housing patterns can be found in Appendix 12.4.
Iterative Housing Pattern Example 1: D1-1u (Dup)

The first of the Developer-led iterative patterns establishes the benchmark of the minimum densities Auckland should be aiming for, while exploiting a planning approach associated more to the Natural Progression species. The D1 sub-species pattern offers a simple site arrangement that conforms to the existing section boundaries and divides the site around two shared driveways. By then applying single storey duplex dwellings, a medium-density housing pattern is created, which offers a compact form that can be applied to most suburbs of Auckland without significant disruption of the local character. The nature of this iterative pattern also means that it could easily be split in half and still function the same. Additionally, this housing pattern provides each dwelling with its own section; a quality that resonates with quarter acre characteristics.

Figure 5.26.: Developer-led iterative housing pattern example 1
Iterative Housing Pattern Example 2: D2-2y (Tow)

The second elaborated pattern of this species steps up the level of density by cramming in more dwellings, at a compromise of individual section sizes. The site arrangement is a variation of the previous example (D1-1u) and offers a driveway that loops through the site; meaning there are two possible ways to exit the site, if necessary. This iterative housing pattern could also be divided into two halves, like D1-1u, when being applied to alternative sites. The townhouse variety pattern (Tow) stacks the layers of the dwelling (garage, living, bedrooms) vertically, which generates a smaller footprint and allows for a high-density to be achieved. Each dwelling does have its own private outdoor space, but this is based on the minimum requirement. Another downside to this housing pattern, is the space between dwellings start to become ‘canyons’ as the building mass grows in height, and they are often completely impervious ground surfaces (concreted).

Figure 5.27: Developer-led iterative housing pattern example 2
Iterative Housing Pattern Example 3: D3-3b (Sin)

The final Developer-led iterative pattern once again ramps up the level of intensification; on this occasion in an extreme case that aims at pushing the limitations of allowable design. The two building masses mirror each other and directly respond to the site restrictions (maximum height and height in relation to boundary). The variety pattern utilised (single aspect dwellings) compliments the approach of two building masses and enables a greater number of dwellings to be included. A significant feature of this housing pattern is the congregation of vehicles in an underground carpark; although this does have financial consequences, it is balanced out by the ability to include more dwellings. In comparison to D2-2y, this housing pattern has a lower building coverage, but a noticeably higher density. The benefit of pushing the vehicles underground and lower building coverage is the opportunity to landscape and pedestrianise the ground level plane.

Figure 5.28.: Developer-led iterative housing pattern example 3
How do these relate to the original section boundaries?

The housing patterns of the Developer-led approach tend to stray away from the original boundaries of the initial site, although the first two examples have exhibited the potential to work in halves. The mentality of the developer adopted in this species is to make the most economical use of any given site; therefore, when a site of four adjacent sections arises any existing internal boundaries become secondary design drivers. Some attempts have been made to consider a site of two or three adjacent sections; however, this does provide limitations to the number of iterations achievable.

Two design precedents have been included in the Developer-led approach. These are an expression of the possible aesthetic treatment in relation to the elaborated examples of this species. The chosen precedents have a direct correlation to iterative housing pattern examples 1 and 2, offering one potential manner that these forms can have style applied. Both precedents also give a taste of the current nature of existing housing developments in Auckland.
**Developer-led Patterns**

**Design Precedent: Howden and Ko Lane Housing Development**

*Address:* 279 Botany Road, Auckland  
*Year:* 2015  
*Site Area:* 3,900m²  
*No. of dwellings:* 16  
*Type of dwellings:* One-storey, two-bedroom duplex dwellings  
*Density 1 (dph):* 41.0  
*Density 4 (ppl/ha):* 165

This project found out in Auckland’s eastern suburbs is a recent example of medium-density housing that attempts to include qualities of low-density suburban housing patterns, but at a denser scale. Subdivision makes its presence as the entire site, which closes in on an acre, is divided into 16 sections with two shared driveways. Four duplex units are oriented around each driveway, meaning the front side of dwellings are dominated by concrete ground covering, with a touch vegetation here and there (Figure 5.30.). The rear side of the dwellings makes use of the leftovers, offering low maintenance, outdoor living spaces (Figure 5.31.).

The good thing about this design is its density; at 41 dwelling per hectare, it falls into the medium-density classification, which is where Auckland needs to be heading. However, the design concentrates primarily on maximising dwellings and consequently relies heavily on city infrastructure.

*Figure 5.29.*: Howden and Ko Lane Housing Development Site Plan  
(Source: Auckland Council Geomaps)
**Developer-led Patterns**

**Precedent Superimposition onto Initial Site**

This precedent has been chosen as it resembles the housing pattern of example 1 in Section 5.2.3. Comparing the site plan of this design precedent to that housing pattern, this is a good example of how the same approach to site arrangement (sub-species pattern) and dwelling type (variety pattern) can be adapted to suit a different location. Notably, solar orientation and site dimensions differ; however, the same patterns have been able to be applied.

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**Figure 5.30.:** Front side of dwelling (Source: Ray White)

**Figure 5.31.:** Rear side of dwelling (Source: Ray White)

**Figure 5.32.:** Initial site (45-51 Aranui Road) with Howden and Ko Lane Housing Development overlaid
**Design Precedent: Ellerslie Oaks**

**Address:**
Cnr Main Highway and Cawley Street, Ellerslie, Auckland

**Year:**
built 2004, refurbished 2014

**Site Area:**
7,300m²

**No. of dwellings:**
62

**Type of dwellings:**
Two-storey, two-bedroom terraced dwellings

**Density 1 (dph):**
84.9

**Density 4 (ppl/ha):**
340

This design precedent is another example of higher density housing in Auckland. Ellerslie Oaks is slightly older than the other Developer-led precedent, with its origins in the ‘leaky homes’ era of Auckland’s housing. Like many housing developments from that time, this one has undergone remedial work giving it a new lease of life. The common features of this housing pattern are its division by driveways, often fully concreted, and the two distinct sides of the dwellings as highlighted in Figures 5.34. and 5.35.

The benefit of this housing pattern is its density achievement; pushing 85 dwellings per hectare means this project falls into the high-density category. Although again, this comes at a compromise of limited green spaces and high dependency on city infrastructure.

*Figure 5.33.: Ellerslie Oaks Housing Development Site Plan (Source: Auckland Council Geomaps)*
Precedent Superimposition onto Initial Site

The selection of this precedent relates closely to the housing pattern of example 2 in Section 5.2.3. Ellerslie Oaks is based on a larger site and has two street frontages; however, dwellings are arranged into linear blocks orientated around driveways. Most dwellings are also only dual aspect with two opposite sides (public and private).
6. Ecologically-led Patterns
(form follows autonomy)
6.1. Introduction of Approach

The third species of the artificial evolution prioritises the environmental aspects when approaching patterns of development. The drivers behind this path take a stronger influence from the fundamentals of the quarter acre; the importance of the site and the getting your hands dirty mindset. This development approach strives to present and analyse housing patterns that can cater to their own infrastructural demands.

6.1.1. Defining Characteristics/Rules

The Ecologically-led patterns look at employing ‘off-grid’ processes in an urban setting to counter the stigma that surrounds increasing densities and the requirement for new infrastructure. There are three main elements required for an ‘off-grid’ development (Figure 6.1); the ability to collect own freshwater, treat own wastewater and generate own electricity. These three elements are the underlying drivers in the design of all Ecologically-led patterns and emphasise, like the Developer-led patterns, the reliance on numbers and calculations for design decisions.

The collection of rainwater aims to make use of this natural resource, rather than simply sending it to the stormwater system, and requires two components; a roof for collecting the rain and a tank for storing collected rainwater. A combination of change in mentality and the introduction of water-efficient fixings are also required.

The other end of the water cycle requires localised action too, with dwellings treating their own wastewater. The role of the section becomes paramount in assisting the transformation of grey and black water into safe water to be released back into the ecosystem. The guidelines followed for the on-site wastewater systems are taken from Auckland Council’s TP58

75 Auckland Council, “Auckland Economic Quarterly (May 2017)”
a summary of the key design aspects can be found in Appendix 12.3.

The final of the three main elements looks at solar energy and self-generation of electricity. The presence of solar energy gathering at a domestic scale is a concept that has been around for some years now, which has allowed the cost of systems, the public acceptance of the idea and the availability of systems to be extremely common and affordable. Furthermore, the current criticisms we face of low-density sprawl in Auckland are in fact a favourable condition for the large-scale distribution of individual energy gathering.

There are also several secondary elements that help to define the Ecologically-led approach. Placing emphasis on the spatial planning of dwellings to make the most of potential natural daylighting and thermal heating/cooling, can provide healthier, warmer and more attractive homes. Food production has been one of the cornerstones of the quarter acre, initially as a means of necessity but later more of a hobby. Being able to produce as much of your own food as possible is now lending weight to the argument of sustainability and reducing our ecological footprints. The incorporation of electric vehicles to complement the gathering of solar energy is another element embodying the ideas of this development approach.

77 Auckland Regional Council, "(Technical Publication No. 58)"
79 Ho, “Energy Efficient Suburbia”
81 Munya, “Implications of Urban Form”
6.1.2. Infrastructure Mentality

In contrast to the Developer-led patterns, this development approach endeavours to be completely self-sufficient (‘off-grid’), meaning it will have no reliance on city (hard) infrastructure. To achieve this however, there does need to be some significant infrastructural elements built into the individual dwelling; collecting rainwater requires at least a 30,000L tank; wastewater treatment requires a 4,500L septic tank, secondary filtration and drip irrigation systems; solar gathering requires photovoltaic panels and a small plant room; solar hot water requires a rooftop panel and plumbing. These can all be installed retrospectively, but by incorporating during construction stage saves additional cost and hassle.

6.1.3. Specific Evolutionary Elements

The Ecologically-led sub-species patterns have been developed by considering the individual dwellings’ requirement for a section, to satisfy the ‘off-grid’ classification; the section as the primary concern emphasises the importance of the outdoor space. The sketch in Figure 6.2. demonstrates the division of the entire initial site into 16 sections, based on the existing internal section boundaries. The range of patterns reflects attempts at dividing the entire initial site into a whole number of sections, based on all, some or none of the existing internal property boundaries.

![Figure 6.2.: Dividing the site in developing the sub-species patterns](image-url)
The variety patterns for this approach are formulated based on the ideal spatial arrangements in dwellings; living spaces are given northern priority, while bedrooms make the most of eastern or western locations and utilities are pushed to the south. Additionally, the dwellings are defined by their dominant axis. Figure 6.3. presents one of the dwelling patterns illustrating these two aspects.

6.1.4. Target Audience

This approach to development aims at attracting primarily owner-occupiers. Since there is a reasonable level of upkeep of the dwellings and modification of personal habits, the interest from investors would work against the concepts behind what the Ecologically-led approach stands for. A strong correlation can be made to the ideals of the quarter acre and the type of people that would be the targeted audience for this approach; the self-sufficient lifestyle and the self-builder personalities would work well in these patterns.

6.1.5. Specific Assumptions and Limitations

The layers of patterns discussed in this chapter are by no means the extent of what housing patterns could work in the Ecologically-led approach. Those included have arisen from their suitability and support of this species’ characteristics in the limited time of undertaking this research project.
6.2. Generating Patterns

In this development approach, the generation of patterns is also driven by formulae. Like the Developer-led approach, the incorporation of precedents aims to inform the potential style that can be achieved from the generated forms. In this case, design precedents are utilised as a reference to infer the potential character of housing patterns when employing ‘off-grid’ techniques.

6.2.1. Sub-species Patterns

The Ecologically-led patterns at the sub-species level consider the division of the initial site into individual sections to cater to the requirements of being ‘off-grid’.

The code for each pattern consists of a letter and a number, respectively; the letter is the initial of the development approach (Ecologically-led = E); the number starts at one and counts upwards.

Figure 6.4.: Ecologically-led sub-species pattern (E1)
E2

Existing Section Boundaries
(Average Section Size = 1035m²)

16 New Sections
4 Shared Driveways
(Average Section Size = 259m²)

This pattern is similar to the previous, although on this occasion there are four shared driveways.

E3

Existing Section Boundaries
(Average Section Size = 1035m²)

20 New Sections
2 Shared Driveways
(Average Section Size = 207m²)

This pattern is again similar to E1, however in this case each of the existing sections is divided into five new sections; giving a total of 20 new sections, with two shared driveways.

**Figure 6.5.** Ecologically-led sub-species pattern (E2)

**Figure 6.6.** Ecologically-led sub-species pattern (E3)
This pattern ignores the existing internal section boundaries, instead dividing the site into three rows of five sections; 15 new sections in total. There are two shared driveways; one internal, the other on the external perimeter.

**Figure 6.7:** Ecologically-led sub-species pattern (E4)

This pattern also ignores the existing internal section boundaries and breaks a regular grid, dividing the site into three rows of four/five sections; 14 new sections in total. There are two shared driveways; one internal, the other on the external perimeter.

**Figure 6.8:** Ecologically-led sub-species pattern (E5)
This pattern retains only the central existing internal boundary, and creates two rows of eight sections; in total 16 new sections. The is one shared driveway along the central internal boundary.

**Figure 6.9.:** Ecologically-led sub-species pattern (E6)

This pattern is similar to E6, although in this one there are two shared driveways along the external boundaries.

**Figure 6.10.:** Ecologically-led sub-species pattern (E7)
This pattern is a variation of E6, with the two rows of eight sections rotated 90 degrees; now in a North-South orientation. There is one shared ‘L’ shaped driveway running through the middle of the site and along the one external boundary.

**Figure 6.11.** Ecologically-led sub-species pattern (E8)

This pattern is a variation of E8 with two differences: a ‘T’ shaped driveway and an additional section.

**Figure 6.12.** Ecologically-led sub-species pattern (E9)
Figure 6.13: Ecologically-led sub-species pattern (E10)

This pattern features a combination of the different section forms found in the previous patterns; eight short/wide and eight long/narrow sections, based around an ‘H’ shaped shared driveway. The three existing internal boundaries are utilised in this pattern.

Figure 6.14: Ecologically-led sub-species pattern (E11)

This pattern is another combination site arrangement. On this occasion a half-half split of long/narrow sections; eight North-South oriented, the other eight East-West. An alternative ‘T’ shaped shared driveway runs through the middle of the site.
6.2.2. Variety Patterns

The Ecologically-led patterns at the variety rank are the type of dwellings that complement this approach to development.

The code for each pattern consists of 3-4 letters that express an acronym of the pattern description, with numbers used to indicate multiple storeys; e.g. 1NS = (1)(NS) = (Single/1 Storey)(North-South Orientated Dwellings).

Typical floor plans are based on the minimum dwellings size requirements\textsuperscript{81} and the base criteria of spaces required. The spatial arrangement of dwellings considers the sun’s path across the day.
Figure 6.17.: Typical floor plan of One-Storey, North-South Oriented Duplex Dwelling
Total Floor Area = 63m²

Single-Storey North-South Oriented Duplex Dwelling
Total Floor Area = 63m²

Figure 6.19.: Typical floor plan of One-Storey, East-West Oriented Dwelling (Reversed)
Total Floor Area = 66m²

Single-Storey East-West Oriented Dwelling (Reversed)
Total Floor Area = 66m²

Figure 6.18.: Typical floor plan of One-Storey, East-West Oriented Dwelling
Total Floor Area = 66m²

Figure 6.20.: Typical floor plan of One-Storey, East-West Oriented Dwelling (Duplex)
Two-Storey
North-South Oriented Dwelling
Total Floor Area = 84m²

Figure 6.21.: Typical floor plan of Two-Storey, North-South Oriented Dwelling

Two-Storey
North-South Oriented Dwelling (Reversed)
Total Floor Area = 84m²

Figure 6.22.: Typical floor plan of Two-Storey, North-South Oriented Dwelling (Reversed)

Two-Storey
North-South Oriented Dwelling (Duplex)
Total Floor Area = 84m²

Figure 6.23.: Typical floor plan of Two-Storey, North-South Oriented Dwelling (Duplex)

Two-Storey
East-West Oriented Dwelling
Total Floor Area = 80m²

Figure 6.24.: Typical floor plan of Two-Storey, East-West Oriented Dwelling
Also included in the variety patterns are 45-degree variations of the single-storey, North-South and East-West floor plans (Figure 6.27.). The inclusion of these patterns takes into account situations where a section may not be perfectly oriented towards north.

Another variation that could be explored, which would be more suited to the narrower sites, is a terraced type of dwelling. Terraced dwellings would offer a better use of the site (pushing dwellings together would remove the offsets between dwellings and boundaries); however, the dwellings would be confined primarily to only two aspects.

Figure 6.27.: 45° floor plan options of Ecologically-led variety patterns
6.2.3. Iterative Housing Patterns

Like the previous two development approaches, the next stage consists of applying the variety patterns to the sub-species ones; in this case, the types of dwellings, either singular or in combination, are applied to the site arrangements.

The Ecologically-led patterns are formula-driven designs; based on the requirements of being infrastructurally independent. Rectangular forms represent the dwellings from section 6.2.2., which are arranged on the sections according to their characteristics (e.g. internal spatial orientation) and to suit the arrangement of each site.

This section of pattern generation starts by examining the dwellings relationship to its section; the required size of the section and where the dwelling sits upon it, taking into consideration the requirements of treating wastewater. Two design precedents are then analysed, exploring the potential aesthetic treatment of forms that employ ‘off-grid’ techniques. Followed by three elaborated examples of iterative housing patterns of this development approach. A collection of more iterative housing patterns of the Ecologically-led approach can be found in Appendix 12.7.

The code for each pattern consists of the sub-species code and a number/letter combo; the number of this combo is the sub-species number and a lowercase letter signifies what iteration it is (starting from ‘a’ and progressing through the alphabet). E.g. E1-1a = E1 sub-species + 1 from the sub-species and this is the first iteration, therefore, ‘a’.

A detailed explanation of how to read the iterative housing patterns can be found in Appendix 12.4.
The required size of a section is influenced by the dwelling’s location, including its internal spatial arrangements, and the minimum offsets of the wastewater treatment system elements (septic tank location and drainage area). Using these design drivers, exploration into site planning informed how the different variety patterns (dwelling types) could be fitted onto the sub-species patterns (site arrangements).

Figure 6.28.: Examining the relationship between a dwelling and its required section
Design Precedent: Zero Energy House

Address: Tui Street, Point Chevalier, Auckland
Architect: A Studio Architects
Year: 2012

Site Area: 404m²
No. of dwellings: 1
Type of dwelling: Two-storey, three-bedroom detached dwelling
Density 1 (dph): 24.7
Density 4 (ppl/ha): 149

The intent of this precedent’s design is to showcase how off-grid techniques can be implemented in a suburban setting while managing to achieve close to a medium-density classification. There is a primary focus on solar power generation (as its name indicates), but there is also the consideration of rainwater collection and water recycling, as well as the spatial arrangement of the dwelling to suit solar orientation. Figures 6.30. and 6.31. also demonstrate the design decisions regarding facade treatment influenced by orientation.

The Zero Energy House is a good example of how we should be looking to intensify Auckland, and the attitude taken of readily sharing the design information of this project certainly helps with that. Conversely, this dwelling still relies on city infrastructure for the majority of its wastewater treatment and misses an opportunity of integrating an electric vehicle into the scheme, which could utilise the excess power generated.
Precedent Superimposition onto Initial Site

This precedent represents most of the characteristics that epitomise the Ecologically-led approach, and in an Auckland context. The Zero Energy House is only a stand-alone implementation of off-grid techniques, which is where it varies from the housing patterns found in this section of the research project. The similarities that do exist highlight the importance of the section, in relation to the design benefits and the cultural expectations of housing in Auckland.
Design Precedent: Stevens Street Housing Development

Address: 58 Stevens Street, Fremantle, Australia
Architect: Officer Woods Architects
Year: 2011

Site Area: 1,460m²
No. of dwellings: 4
Type of dwellings: Two-storey, three-bedroom townhouse dwellings
Density 1 (dph): 27.4
Density 4 (ppl/ha): 165

The Stevens Street Housing Development offers a good insight into how a section that resembles the traditional quarter acre could be intensified using underlying environmental motivations. Like the Zero Energy House, this precedent includes a long list of features that attempt to reduce reliance on city infrastructure; including completely catering to own energy requirements, collecting rainwater, recycling greywater and utilising passive techniques. One of the key design aspects is the private courtyard space (Figure 6.34.), which highlights how the quarter acre can have an influence on intensification. Another way is through incorporating local materiality (Figure 6.35.).

The environmental features of the Stevens Street Housing Development are what make it stand out, along with the incorporation of quarter acre qualities. However again, this precedent only falls into the higher end of low density.

Figure 6.33.: Stevens Street Development Site Plan
(Source: City of Fremantle Intramaps)
Precedent Superimposition onto Initial Site

The selection of this precedent offers a housing type that aligns with the Ecologically-led development approach and acknowledges the preservation of quarter acre qualities. However, Stevens Street does not fully comply with the characteristics of this development approach as there is no room for onsite wastewater treatment. The design ideas are what have the greatest correlation to this research project.
Iterative Housing Pattern Example 1: E1-1h (1NS + 1NSR + 1NSD)

The first of the elaborated Ecologically-led housing patterns utilises a sub-species pattern that conforms to the existing section boundaries, adding some extra perpendicular divisions to create a four by four grid of new sections (sixteen in total). The variety patterns applied to this site are three variations of the North-South oriented plan (normal, reversed and duplex varieties); all three are employed to provide efficient site planning and to suit dwelling orientations around the shared driveways. At a density of 38.7dph, these dwellings are classified as medium-density and are in fact able to cater to their own demands for electricity generation, freshwater collection and sewage treatment. In addition, there is sufficient external space to accommodate gardens (flower or vegetable) and for recreational activities.

Figure 6.37: Ecologically-led iterative housing pattern example 1
Iterative Housing Pattern Example 2: E4-4k (1NSR + 1EWD)

The next of the Ecologically-led iterative patterns demonstrates a layout of sections that challenges the original internal section boundaries, instead establishing a three by five grid of new sections (fifteen in total). Two different variety patterns (North-South reversed and East-West duplex) are applied to the site as an initial exploration of diversity; attempting to provide a range of dwelling options on the one site. Further combinations could be explored for more diversity (e.g. the dwellings along the western boundary could alternate between NS and EW varieties). As in E1-1h, the dwellings have been arranged to suit orientation towards the shared driveways and to provide northern outdoor spaces. The E4-4k pattern also manages to fall into the medium-density classification (at 36.2dph) and can cater to its own core infrastructural demands (electricity, water and sewage).

Figure 6.38.: Ecologically-led iterative housing pattern example 2
Iterative Housing Pattern Example 3: E7-7g (1EWD)

The final elaborated pattern of the Ecologically-led approach further challenges the original section boundaries of the site, in a manner that justifies combining adjacent sections. This site arrangement consists of two rows of eight narrow sections (total of 16 new sections) and has one variety pattern applied to it (East-West duplex). Since the new sections are long and narrow, with the common boundary in the middle of the site, there is only one pattern from section 6.2.2. that suits this arrangement (1EWD). Now even though this pattern is infrastructurally independent and is classified as medium-density, there is a shortfall in the combination of these sub-species and variety patterns. There is limited external space to the north of the dwellings, which restricts the connection between the internal and external spaces, as well as the benefits of passive heating and cooling. Exploration into a terraced dwelling type could provide a better option for the E7 sub-species.

**Figure 6.39:** Ecologically-led iterative housing pattern example 3
How do these relate to the original section boundaries?

The Ecologically-led species patterns are like those of the Natural Progression, with regards to how they relate to the original section boundaries. Since these patterns require a section (for infrastructural independence), pattern generation initiates by dividing the site (in other words subdivision). The range of sub-species patterns look at alternative ways of utilising some of, or all, the existing section boundaries of the initial site. This consequently makes the Ecologically-led patterns more adaptable to sites where there are one, two or even three adjacent sections.
7. Socially-led Patterns

(form follows quality)
7.1. Introduction of Approach

The final species of the artificial evolution searches for a balance of the economic and ecological drivers, emphasising the quality of the environment as the important factor. This approach captures the benefits of both the Developer-led and Ecologically-led housing patterns, although design decisions are instead driven by the process of design adaption.

7.1.1. Defining Characteristics/Rules

Consideration of the urban environment is a key point in both the Auckland Plan and the Unitary Plan. The problem with both policies is, defining ‘quality’ in relation to the environment is an ambiguous issue; its interpretation had been left up to planners, developers and designers to use their best judgement in shaping Auckland’s urban form. The Urban Design Protocol does provide an outline of what seminal attributes that create quality urban design are; however, these do not offer any explanation of how the urban form should look. Likewise, Statistics New Zealand provide a definition of what housing quality is, but still evade an indication of the what quality housing forms are.

The Socially-led patterns set out to find an answer to how can the form of housing patterns influence the quality of the environment in a development; and secondly, how can this be applied to an Auckland context. A wide range of design precedents have been sourced as part of this design adaption process. For a precedent to have qualified for selection, it must have received acknowledgement of its design success through either a design award

83 Auckland Council, “The Auckland Plan”
84 Auckland Council, “Auckland Unitary Plan”
7.1.2. Infrastructure Mentality

Since this development approach looks at balancing the extremes, the consideration of infrastructure follows the same direction. The integration of self-sufficient elements (e.g. photovoltaic systems, rainwater collection, onsite sewage treatment) aims to achieve the maximum potential autonomy (infrastructural independence) for any of the Socially-led housing patterns. In some circumstances, certain elements will be less effective for all dwellings; if solar energy is gathered on a multi-storey block of dwellings, it could be used in numerous ways including offsetting the energy requirements of the communal spaces or utilised for charging electric vehicles.

A taxonomy system then analyses the selected housing patterns to establish common formal principles; classifying the patterns draws on Darwinian theory,87 as well as taking influence from the formation of pattern language.88 The resulting typologies of housing patterns inform the generation of patterns in the Socially-led species to be analysed for their suitability of being imported into an Auckland context.

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87 Darwin, “On the Origin of Species,”
88 Alexander, “A Timeless Way,” 305-324
7.1.3. Specific Evolutionary Elements

The different categories of the developed typologies of housing patterns, those that exhibit quality environmental treatment, form the Socially-led sub-species patterns. In contrast to the other species, the generation of patterns jumps one step in the evolutionary chain directly applying the sub-species patterns to the initial site (creating the iterative housing patterns).

The variety patterns from the Developer-led (i.e. single aspect, dual aspect dwellings) and Ecologically-led (i.e. North-South or East-West orientated dwellings) approaches are adapted in as the types of dwellings applied to the iterative housing patterns; further emphasis of the design adaption that takes place in this development approach.

7.1.4. Target Audience

The range of different housing patterns in this development approach will attract slightly different audiences depending on the context; for example, the presence of a communal green space will be more attractive to families, whereas a concentration of dwellings might be more likely to appeal to a young couple. Therefore, the diversity of dwellings attempts to capture as wide of an audience as possible.

7.1.5. Specific Assumptions and Limitations

The layers of patterns discussed in this chapter are by no means the extent of what housing patterns could work in the Socially-led approach. Those included have arisen from their suitability and support of this species’ characteristics in the limited time of undertaking this research project.
7.2. Generating Patterns

The Socially-led pattern generation varies slightly from the other species. The two previous species (Developer-led and Ecologically-led) have both generated patterns following formulae, then referenced design precedents for the potential aesthetic qualities that can be achieved. In this development approach, the process is reversed; design precedents are collated, which then inform the generation of patterns.

7.2.1. Sub-species Patterns

The Socially-led patterns at the sub-species rank start off by establishing a collection of quality housing patterns (as described in Section 3.4.3.) and then categorise them into distinctive typologies. A diagrammatic plan portrays each housing pattern, capturing its formal qualities and key features, as well as an indication of its density through a three letter code (as explained in Figure 7.1.). The individual typologies represent the sub-species patterns of the Socially-led approach. A selection of these typologies are then explored further as the core of this species.

The code for each sub-species pattern (the typologies) consists of a letter and a number, respectively; the letter is the initial of the development approach (Socially-led = S); the number starts at one and counts upwards.
Figure 7.2.: Socially-led sub-species patterns - establishing a collection of quality housing patterns
Socially-led Patterns
Categorising Quality Housing Patterns

Adaptable

Villa Verde Housing [HrH]

Cockaigne Housing Development [HrL]

Quinta Monroy [MrH]

Courtyard

242 Social Housing Units (Salburua) [HrH]

High Kingsdown Development [HrM]

46 Social Houses [LrH]

The Whale [MrH]

Sorenga Block 6 [LrH]

Mieres Social Housing [LrM]

Redfern [MrH]

Kingo Houses [HrM]

Solarsiedlung (Solar Settlement) [HrM]

Villa Verde Housing [HrH]

Grow Community Bainbridge (‘The Village’) [MrM]

Le Havre Student Accommodation [HrH]

Bamboo Social Housing [MrL]

Eureka Dragon Court Village [LrM]

High Kingsdown Development Redfern [HrH]

Quinta Monroy Redfern [MrH]

Casa O [MrH]

Figure 7.3.: Socially-led sub-species patterns - categorising into typologies of quality housing patterns
### Lane
- The Barkly [MrH]
- Claredale Street Housing [MrM]
- George [MrH]
- San Damian Housing Estate [MrL]
- Donnybrook Quarter [LrH]
- EDO [MrH]
- Eureka Dragon Court Village [LrM]
- Le Havre Student Accommodation [HrH]
- Grow Community Bainbridge (‘The Village’) [MrM]

### Linear
- Fredensborg Housing [LrH]
- Claredale Street Housing [MrM]
- The Caspar Initiative [LrH]
- 3 Green Bars [LrH]
- VM Houses [HrH]
- Byker Wall [HrH]
- Kingo Houses [HrM]
- Smiley Zeeburgereiland Apartments [HrH]
- Alvenaria Social Housing [MrH]
- Hannibal Road Gardens [LrM]
- Grow Community Bainbridge (‘The Grove’ and ‘The Park’) [MrM]
- Europian 10 Project [MrM]
- High Street Cohousing [MrM]
- The Mountain [HrH]
- Heller Street [LrM]
- Odhams Walk [MrH]

### Hannibal Road Gardens [LrM]
Defining the Categories (of Quality Housing Patterns)

The collection of quality housing patterns has been classified into six distinct typology categories; Adaptable, Courtyard, Grid, Lane, Linear and Village. The names of these categories aim to evoke an emotional response to their formal representation. The definition of each is given as follows, including a brief description, any sub-categories and an example illustration(s).

From these typology classifications, three have been chosen to be explored in further detail in this development approach; they are the Adaptable, Courtyard and Village housing patterns. These three typologies have been selected as they feature attributes that could best suit a denser quarter acre.

A design precedent has been selected from within the Adaptable, Courtyard and Village typologies, and analysed for its key features and how they could be adapted to suit an Auckland context; this includes an initial attempt of directly adapting each precedent to the initial site (45-51 Aranui Road) and then exploring possible variations that embody that precedent.
Grid

Formal: Ordered arrangement with regular narrow pathways

Informal: Atypical arrangement with irregular pathways

Vertical: Three-Dimensional grid based on modular elements

Figure 7.6.: Socially-led sub-species pattern definition (Grid)

Linear

 Terraced (attached) housing extruded into alphabetic forms

Figure 7.8.: Socially-led sub-species pattern definition (Linear)

Lane

Vehicular: Housing oriented around vehicle access lane(s)

Pedestrian: Housing oriented around pedestrian access lane(s)

Figure 7.7.: Socially-led sub-species pattern definition (Lane)

Village

English (Formal): Detached/semi-detached housing, surrounding communal green space.

Italian (Informal): Housing stepped horizontally and vertically, with enclosed communal spaces.

Figure 7.9.: Socially-led sub-species pattern definition (Village)
Design Precedent (Adaptable): Cockaigne Housing Development

Address: Hatfield, Hertfordshire, England
Architect: Phillip Randall Parkes
Year: 1967

Site Area: 11,000m²
No. of dwelling: 28
Type of dwellings: One-storey, three- to five-bedroom terraced dwellings
Density 1 (dph): 25.5
Density 4 (ppl/ha): 408

The Cockaigne Housing Development is a slightly unconventional housing pattern; it consists of long, single-storey terraced dwellings, based around internal private courtyards. Nevertheless, the quality of its design has been recognised with the awarding of a heritage listing.

The seminal feature of this precedent is the defining boundaries of the dwellings as emphasised in Figure 7.11.; each dwelling is based between two solid walls. The spacing of these walls provides an interesting opportunity for the formation of the dwellings spaces; Figure 7.12. illustrates how this precedent could be developed as a core dwelling with the possibility of leaving room for expansion. Another key attribute is the level of interaction with outdoor spaces and vegetation (Figure 7.10.).
**Figure 7.13.** Direct design adaption of Cockaigne Housing Development to initial site.

**Figure 7.14.** Variation of patterns for exploration based on Cockaigne Housing Development.

Developed patterns to be a combination of both dwelling width and axial orientation.
Design Precedent (Courtyard): Bristol Courtyard Housing

Address: High Kingsdown, Bristol, England
Architect: Whicheloe and Macfarlane
Year: 1974

Site Area: 19,000m²
No. of dwellings: 103
Type of dwellings: Two-storey, three- to five-bedroom courtyard dwellings
Density 1 (dph): 54.2
Density 4 (ppl/ha): 430

The High Kingsdown Development arose from an opportunity to redevelop a neglected area. The awarding of a heritage listing is evidence of the quality of this development and its longevity.

One successful element is the establishment of a simple pattern (Figure 7.16.); the use of a square plan form provides flexibility around the interaction of multiple adjacent dwellings. In this instance, the individual elements are formed into zig-zag formation. The use of a courtyard style allows for secure, individual outdoor space; illustrating that interaction between internal and external spaces are achievable at a more compact scale (Figure 7.15.). Furthermore, the placement of openings only on the internal wall reiterates the patterns and the connection. This development also implements a separation of vehicles and dwellings as demonstrated in Figure 7.17.

Key Features of Precedent

Figure 7.15.: Connection to outdoor space
Figure 7.16.: Establishing a simple pattern
Figure 7.17.: Separating vehicles from dwellings (Source: Google Maps)
Socially-led Patterns

**Figure 7.18.** Direct design adaption of High Kingsdown Development to initial site.

**Figure 7.19.** Variation of patterns for exploration based on High Kingsdown Development.
Design Precedent (Village): Odhams Walk

Address: Odhams Walk, Covent Garden, London
Year: 1981

Site Area: 6,600m² (incl. footpaths)
No. of dwelling: 102
Type of dwellings: One- to four-bedroom terraced units and ground level commercial units
Density 1 (dph): 154.5
Density 4 (ppl/ha): 552

Odhams Walk presents a project that challenged the normality of housing, adopting a Mediterranean terraced housing style in the middle of London. In addition, the role of the community has been significant in shaping the development.

Odhams Walk was presented with a Historic Award in 2007, reiterating the longevity and value of its design. The success of this precedent lies in the stacking and concentration of dwellings around the perimeter of the site (Figure 7.21.); this achieves layering of private internal courtyard spaces (Figure 7.20.) and a strong sense of a safe community. Another successful feature of this development is the minimisation of vehicular dominance on the outdoor spaces by using an underground carpark (Figure 7.22.).
Figure 7.23.: Direct design adaption of Odhams Walk to initial site.

Figure 7.24.: Variation of patterns for exploration based on Odhams Walk.
7.2.2. Variety Patterns

The Socially-led patterns at this level again differ from the previous species; this layer of patterns has explored the dwelling types (typical floor plans that could be applied to their associated iterative housing patterns) in correlation to the other approaches. In the Socially-led approach, the variety patterns are the variations of the defined typologies from Section 7.2.1. and consider how each of them can be adapted to suit an Auckland context. Figure 7.24. demonstrates some of the variety patterns that can be achieved from the sub-species typologies.

In conjunction with those variations, the variety patterns (typical floor plans) from the Developer-led and Ecologically-led approaches (Section 5.2.2. and 6.2.2., respectively) are adapted when required, as the floor plans of the Socially-led iterative housing patterns.

The code for each Socially-led variety pattern consists of 3-4 letters that express an acronym of the pattern description, with numbers used to indicate multiple storeys; e.g. **FLT** = Full Loop Terrace dwelling arrangement.

![Variety Patterns Diagram](image)

*Figure 7.25.* Variations of the sub-species typologies for application to an Auckland context.
7.2.3. Iterative Housing Patterns

The next stage of generating patterns in this development approach looks at combining the range of variety patterns and how they can be applied to the initial site; the variations of the typologies are explored in the initial Auckland context, with assistance from the variety patterns of other species.

These patterns are layered iterations of design adaption (from the collection of typologies to the use other species housing patterns). Dwellings are represented as rectangular forms, arranged to suit the spatial configuration specific to a typology and are adapted where their characteristics (e.g. single/dual aspect) are appropriate. Following, are three elaborated examples of iterative housing patterns of this development approach. A collection of more iterative housing patterns of the Socially-led approach can be found in Appendix 12.8.

The code for each pattern consists of the sub-species code and a number/letter combo; the number of this combo is the sub-species number and a lowercase letter signifies what iteration it is (starting from ‘a’ and progressing through the alphabet). E.g. S6-6a = S6 sub-species + 6 from the sub-species and this is the first iteration, therefore, ‘a’.

A detailed explanation of how to read the iterative housing patterns can be found in Appendix 12.4.
Iterative Housing Pattern Example 1: S1-1e (N6m)

(N6m = Northern Dwelling Axis with 6m dwelling widths)

The first of the elaborated Socially-led housing patterns has derived from the ‘Adaptable’ typology, taking design inspiration from the Cockaigne Housing Development (as analysed in Section 7.2.1.). The arrangement of the site is similar to the E8 sub-species (from Section 6.2.1.); an ‘L’ shaped driveway runs along the external eastern boundary and then perpendicular through the middle of the site. This allows for two rows of dwellings based on a Northern axis (the N6m variety pattern), separated by the shared driveway. Furthermore, the shape of the driveway helps concentrated traffic to a single entry/exit location. The dwellings are a variation of the 1EW housing pattern (from Section 6.2.2.); the only differences are the separation of internal spaces, to create an internal courtyard, and the inclusion of a garage. This pattern of development illustrates how a collection of single-storey dwellings, consciously arranged, can achieve a medium-density and still offer a dwelling its own section.

Figure 7.26.: Socially-led iterative housing pattern example 1
Iterative Housing Pattern Example 2: S2-2r (SqP)

(SqP = Square Patterned Courtyards)

The next iterative housing pattern of the Socially-led species has originated from the ‘Courtyard’ typology, utilising design features from the Bristol Courtyard Housing precedent in Section 7.2.1. The organisation of dwellings on the site has developed through exploration of how the base module (the square patterned courtyard dwelling) can be arranged, with consideration of dwelling orientation and access, the relationship between adjacent dwellings, the concentration of carparking and the development restrictions. The design of these dwellings has adopted the two upper floor plans from the townhouse dwelling variety pattern (Section 5.2.2); dimensions and possible external opening locations have been adjusted accordingly. The outcome of this design is the presentation of a housing pattern that consists of only two-storey building masses capable of providing individual, private dwellings, all at the low-range end of high-density.

Figure 7.27.: Socially-led iterative housing pattern example 2
Iterative Housing Pattern Example 3: S6-6d (SRS)

(SRS = Single Raked Terrace towards South)

The final developed Socially-led housing pattern has stemmed from the ‘Village’ typology, adopting design attributes from the Odhams Walk precedent explored in Section 7.2.1. The way the site is organised implements one of the developed variety patterns from that precedent study. Odhams Walk is contained by four street frontages, whereas the initial site in this research project only has one; hence, the ‘single raked terrace’ option has been applied and the stacking of dwellings occurs along the southern (street) boundary in response to the local context. In this example, the dwellings have utilised the dual aspect floor plan from Section 5.2.2., as well as giving each dwelling its own private courtyard space. This combination of site arrangement and dwelling type variations creates a development pattern that consists of staggered layers of building mass, organised in a way that promotes individual privacy as part of a greater form. Once again, by utilising a considered approach to arranging the dwellings a high-density housing pattern has been produced that can support underlying qualities of the quarter acre.

Figure 7.28.: Socially-led iterative housing pattern example 3
How do these relate to the original section boundaries?

The Socially-led species strives to balance the benefits of the extreme development approaches, which is reflected in the relationship to the original section boundaries. In some instances, the typologies enable some housing patterns to conform to the existing boundaries and even suit only two or three adjacent sections. On the other hand, some of these patterns follow the lines of the developer mindset and make the most of the entire site, disregarding the original section boundaries.
8. Analysis of the Housing Patterns from the Artificial Evolution
8.1. Explanation of Testing Process

As mentioned earlier (Section 3.5.1.), an un-natural selection process determines whether the patterns of the artificial evolution will survive or become extinct. This selection process is implemented in Section 8.2. to the iterative housing pattern examples from the four development approaches (Natural Progression, Developer-led, Ecologically-led and Socially-led). It consists of three key areas of analysis: the density values, infrastructural independence and the quarter acre characteristics.

Analysis Table 1 (Density):

The density of a housing pattern evaluates the statistical data relating to the number of dwellings. The values included are: number of dwellings, average dwelling size, total site area, building coverage, dwellings per hectare, average area of each dwelling, floor area ratio and people per hectare. All these values are summarised into a description expressing the density, comprising of two parts; the overall density category (low, medium or high), as well as a finer range locator (low-, mid- or high-range). The blue arrow in Figure 8.1. illustrates a “mid-range, medium-density” housing description.

Analysis Table 2 (Infrastructure Autonomy Index):

The infrastructural demands of a housing pattern are assessed to determine its independence (autonomy) from city supplied utilities. An ‘Infrastructure Autonomy Index’ is established, which simplifies the values of infrastructure into three categories: electricity (generated/reticulated), fresh water (collection/reticulation) and sewage (on/off site treatment). Each of these categories is worth up to 10 points depending on the level of autonomy, with a higher level of independence awarded more points. Figure 8.2. outlines how each category determines the scoring of its points. A maximum of 30 points can be achieved by a housing pattern (3 categories x 10 points each = 30); the total score is then converted into a percentage, which summarises how autonomous that housing pattern is.
The underlying assumptions made in this index are:

- The closer a dwelling’s roof area (available area for photovoltaic panels) is its floor area, the higher chance it has of catering to its own electricity demands.
- Harvesting rainwater primarily relies on storage capacity, but also requires the roof area to collect rainwater.
- Discharge field area for wastewater treatment is based on TP58 requirements (refer to Appendix 12.3.).
- Recycling greywater is a solution to utilising only a portion of wastewater and does require additional plumbing/tanks.

Analysis Table 3 (Quarter Acre Qualities):

The final area of analysis looks at how many of the quarter acre characteristics are present in a housing pattern. This table lists the attributes by letter (refer to Section 3.5.2. for a full description of attributes) and awards an overall mark out of 12.
8.2. Analysis of Individual Species

Natural Progression Patterns:

All three elaborated examples in the Natural Progression species produced very similar results; with regards to their density, autonomy and the quarter acre qualities they possess.

The approach of subdividing a section in a piecemeal fashion (adopting the existing suburban housing patterns of Auckland) does help with increasing suburban density, but the examples explored all only managed to reach the high-range end of low-density (29.0dph).

As for the potential autonomy of these housing patterns, there are some opportunities to help reduce dependency on city infrastructure. However, the actual autonomy of these housing patterns would be lower since greywater recycling and collecting fresh water are not currently of great concern in Auckland.

Unsurprisingly, each of these patterns includes the potential for almost all the quarter acre characteristics.

<p>| Iterative Housing Pattern Example 1: N1-1m (3ND) |
| Analysis Table 1 (Density): |</p>
<table>
<thead>
<tr>
<th>No. of Dwellings</th>
<th>Average Dwelling Size (m²)</th>
<th>Total Site Area (m²)</th>
<th>Building Coverage (% and m²)</th>
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<td>3</td>
<td>260</td>
<td>1035</td>
<td>390</td>
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<td>Density 1: Dwellings per hectare (dph)</td>
<td>Density 2: Average area for each dwelling (m²/dwelling)</td>
<td>Density 3: Floor Area Ratio (FAR)</td>
<td>Density 4: People per hectare (ppl/ha)</td>
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<p>| Analysis Table 2 (Infrastructure Autonomy Index): |</p>
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<th>Sewage</th>
<th>Total</th>
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<td>5</td>
<td>1</td>
<td>11</td>
</tr>
</tbody>
</table>

<p>| Analysis Table 3 (Quarter Acre Qualities): |</p>
<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
<th>K</th>
<th>L</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓</td>
<td>1/2 ✓</td>
<td>✓</td>
<td>1/2 ✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

37% Autonomous

11/12 (92%)

Figure 8.3.: Analysis tables of Natural Progression, iterative housing pattern example 1
**Iterative Housing Pattern Example 2: N3-3b (E2N)**

### Analysis Table 1 (Density):

<table>
<thead>
<tr>
<th>No. of Dwellings</th>
<th>Average Dwelling Size (m²)</th>
<th>Total Site Area (m²)</th>
<th>Building Coverage (% and m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>140</td>
<td>1035</td>
<td>300 29.0</td>
</tr>
</tbody>
</table>

Density 1: Dwellings per hectare (dph)  
Density 2: Average area for each dwelling (m²/dwelling)  
Density 3: Floor Area Ratio (FAR)  
Density 4: People per hectare (ppi/ha)

29.0 345 0.41 213

**High-Range Low Density**

### Analysis Table 2 (Infrastructure Autonomy Index):

<table>
<thead>
<tr>
<th>Electricity</th>
<th>Fresh water</th>
<th>Sewage</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>5</td>
<td>1</td>
<td>11</td>
</tr>
</tbody>
</table>

37% Autonomous

### Analysis Table 3 (Quarter Acre Qualities):

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
<th>K</th>
<th>L</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

12/12 (100%)

*Figure 8.4.: Analysis tables of Natural Progression, iterative housing pattern example 2*

---

**Iterative Housing Pattern Example 3: N6-6p (6ND)**

### Analysis Table 1 (Density):

<table>
<thead>
<tr>
<th>No. of Dwellings</th>
<th>Average Dwelling Size (m²)</th>
<th>Total Site Area (m²)</th>
<th>Building Coverage (% and m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>260</td>
<td>2070</td>
<td>780 37.7</td>
</tr>
</tbody>
</table>

Density 1: Dwellings per hectare (dph)  
Density 2: Average area for each dwelling (m²/dwelling)  
Density 3: Floor Area Ratio (FAR)  
Density 4: People per hectare (ppi/ha)

29.0 345 0.75 232

**High-Range Low Density**

### Analysis Table 2 (Infrastructure Autonomy Index):

<table>
<thead>
<tr>
<th>Electricity</th>
<th>Fresh water</th>
<th>Sewage</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>5</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

37% Autonomous

### Analysis Table 3 (Quarter Acre Qualities):

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
<th>K</th>
<th>L</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

11/12 (92%)

*Figure 8.5.: Analysis tables of Natural Progression, iterative housing pattern example 3*
Developer-led Patterns:

The three iterative housing patterns of the Developer-led species provide a good insight into the effects of increasing density and the subsequent compromises that are made.

The density of these three housing patterns highlights the desired intensification that Auckland is seeking, demonstrating a range of what is achievable (from 38.6dph up to 357.5dph). The progression from example 1 through to 3 is a good indication of the layers of density that could be utilised for intensification.

Reliance on infrastructure is the compromise made in these housing patterns; as density increases the degree of potential autonomy decreases. The first two patterns also convey the idea that there is some decent potential for independence from city infrastructure. Although again, the likelihood of these measures being employed (e.g. rainwater collection tanks or greywater recycling) are minimal in this development approach.

Like the compromise of infrastructural independence, the number of quarter acre qualities that each housing pattern possess decrease as the density increases.

Iterative Housing Pattern Example 1: D1-1u (Dup)

Analysis Table 1 (Density):

<table>
<thead>
<tr>
<th>No. of Dwellings</th>
<th>Average Dwelling Size (m²)</th>
<th>Total Site Area (m²)</th>
<th>Building Coverage (% and m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>69</td>
<td>4140</td>
<td>1105 26.7</td>
</tr>
</tbody>
</table>

Density 1: Dwellings per hectare (dph) 38.6 Density 2: Average area for each dwelling (m²/dwelling) 259 Density 3: Floor Area Ratio (FAR) 0.27 Density 4: People per hectare (pp/ha) 155

Analysis Table 2 (Infrastructure Autonomy Index):

<table>
<thead>
<tr>
<th>Electricity</th>
<th>Fresh water</th>
<th>Sewage</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>10</td>
<td>1</td>
<td>21</td>
</tr>
</tbody>
</table>

70% Autonomous

Analysis Table 3 (Quarter Acre Qualities):

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
<th>K</th>
<th>L</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

12/12 (100%)
Analysis of the Housing Patterns from the Artificial Evolution

**Iterative Housing Pattern Example 2: D2-2y (Tow)**

Analysis Table 1 (Density):

<table>
<thead>
<tr>
<th>No. of Dwellings</th>
<th>Average Dwelling Size (m²)</th>
<th>Total Site Area (m²)</th>
<th>Building Coverage (% and m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>52</td>
<td>120</td>
<td>4140</td>
<td>2080 50.2</td>
</tr>
</tbody>
</table>

Density 1: Dwellings per hectare (dph) 125.6
Density 2: Average area for each dwelling 80
Density 3: Floor Area Ratio (FAR) 1.50
Density 4: People per hectare (pp/ha) 503

**Iterative Housing Pattern Example 3: D3-3b (Sin)**

Analysis Table 1 (Density):

<table>
<thead>
<tr>
<th>No. of Dwellings</th>
<th>Average Dwelling Size (m²)</th>
<th>Total Site Area (m²)</th>
<th>Building Coverage (% and m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>148</td>
<td>70</td>
<td>4140</td>
<td>1764 42.6</td>
</tr>
</tbody>
</table>

Density 1: Dwellings per hectare (dph) 357.5
Density 2: Average area for each dwelling 28
Density 3: Floor Area Ratio (FAR) 2.50
Density 4: People per hectare (pp/ha) 1430

Analysis Table 2 (Infrastructure Autonomy Index):

<table>
<thead>
<tr>
<th>Electricity</th>
<th>Fresh water</th>
<th>Sewage</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5</td>
<td>0</td>
<td>0</td>
<td>2.5</td>
</tr>
</tbody>
</table>

Analysis Table 3 (Quarter Acre Qualities):

<table>
<thead>
<tr>
<th>A B C D E F G H I J K L</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2 1/2 1/2 1/2 1/2 1/2</td>
</tr>
</tbody>
</table>

9.5/12 (79%)

**Figure 8.7:** Analysis tables of Developer-led, iterative housing pattern example 2

**Figure 8.8:** Analysis tables of Developer-led, iterative housing pattern example 3
Ecologically-led Patterns:

The Ecologically-led iterative housing patterns are all examples of medium-density developments, which can be completely autonomous and represent the qualities of the quarter acre.

All three iterative examples have produced housing patterns that fall into the low-range, medium-density category. This surprisingly means that there are housing patterns that can conform to the desires of increasing density (albeit at the lower end of the spectrum) and be independent from city infrastructure.

The underlying characteristic of this development approach has been to apply ‘off-grid’ techniques to a more compact urban form. Each pattern has been successful in allowing for complete autonomy, with regards to the demands for electricity, fresh water and onsite sewage treatment.

The Ecologically-led housing patterns have also been able to include most of the quarter acre qualities, thanks largely to the ability for individual sections.

Analysis Table 1 (Density):

<table>
<thead>
<tr>
<th>No. of Dwellings</th>
<th>Average Dwelling Size (m²)</th>
<th>Total Site Area (m²)</th>
<th>Building Coverage (% and m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>63</td>
<td>4140</td>
<td>1008 24.3</td>
</tr>
</tbody>
</table>

Density 1: Dwellings per hectare (dph) 38.7
Density 2: Average area for each dwelling (m²/dwelling) 259
Density 3: Floor Area Ratio (FAR) 0.24
Density 4: People per hectare (ppl/ha) 155

Analysis Table 2 (Infrastructure Autonomy Index):

<table>
<thead>
<tr>
<th>Electricity</th>
<th>Fresh water</th>
<th>Sewage</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>10</td>
<td>10</td>
<td>30</td>
</tr>
</tbody>
</table>

100% Autonomous

Analysis Table 3 (Quarter Acre Qualities):

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
<th>K</th>
<th>L</th>
</tr>
</thead>
<tbody>
<tr>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
</tbody>
</table>

12/12 (100%)

Figure 8.9.: Analysis tables of Ecologically-led, iterative housing pattern example 1
**Analysis of the Housing Patterns from the Artificial Evolution**

---

### Iterative Housing Pattern Example 2: E4-4k (1NSR + 1EWG)

**Analysis Table 1 (Density):**

<table>
<thead>
<tr>
<th>No. of Dwellings</th>
<th>Average Dwelling Size (m²)</th>
<th>Total Site Area (m²)</th>
<th>Building Coverage (% and m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>65</td>
<td>4140</td>
<td>975 23.5</td>
</tr>
</tbody>
</table>

**Density 1:** Dwellings per hectare (dph)  
**Density 2:** Average area for each dwelling (m²/dwelling)  
**Density 3:** Floor Area Ratio (FAR)  
**Density 4:** People per hectare (ppl/ha)  

| 36.2 | 276 | 0.24 | 145 |

---

**Analysis Table 2 (Infrastructure Autonomy Index):**

<table>
<thead>
<tr>
<th>Electricity</th>
<th>Fresh water</th>
<th>Sewage</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

**100% Autonomous**

---

**Analysis Table 3 (Quarter Acre Qualities):**

<table>
<thead>
<tr>
<th>A B C D E F G H I J K L</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
</tbody>
</table>

**12/12 (100%)**

---

**Figure 8.10:** Analysis tables of Ecologically-led, iterative housing pattern example 2

---

### Iterative Housing Pattern Example 3: E7-7g (1EWG)

**Analysis Table 1 (Density):**

<table>
<thead>
<tr>
<th>No. of Dwellings</th>
<th>Average Dwelling Size (m²)</th>
<th>Total Site Area (m²)</th>
<th>Building Coverage (% and m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>66</td>
<td>4140</td>
<td>1056 25.5</td>
</tr>
</tbody>
</table>

**Density 1:** Dwellings per hectare (dph)  
**Density 2:** Average area for each dwelling (m²/dwelling)  
**Density 3:** Floor Area Ratio (FAR)  
**Density 4:** People per hectare (ppl/ha)  

| 38.6 | 259 | 0.25 | 155 |

---

**Analysis Table 2 (Infrastructure Autonomy Index):**

<table>
<thead>
<tr>
<th>Electricity</th>
<th>Fresh water</th>
<th>Sewage</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>10</td>
<td>10</td>
<td>30</td>
</tr>
</tbody>
</table>

**100% Autonomous**

---

**Analysis Table 3 (Quarter Acre Qualities):**

<table>
<thead>
<tr>
<th>A B C D E F G H I J K L</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
</tbody>
</table>

**12/12 (100%)**

---

**Figure 8.11:** Analysis tables of Ecologically-led, iterative housing pattern example 3
Socially-led Patterns:

The analysed iterative housing patterns from the Socially-led species have all offered higher range densities, as well as a decent potential for infrastructural autonomy and qualities of the quarter acre.

The density varied from mid-range medium (45.9dph) to mid-range high (108.7dph) in these housing patterns, expressing the characteristics of the three different precedents utilised. These patterns also represent one, two and three-storey housing forms, which related directly to their density achieved, but more importantly demonstrates that higher densities are possible when the quality of the environment is considered.

The potential autonomy of these housing patterns corresponded in an inversely proportional manner to their respective densities; the more dwellings included in a development, the lower the independence from city infrastructure. However, the overall ability to be autonomous is possible more so than not.

Although some compromises were made, the Socially-led patterns have been able to support most of the quarter acre’s qualities. The desire for higher density was the significant factor in the compromise of qualities.

### Iterative Housing Pattern Example 1: S1-1e (N6m)

#### Analysis Table 1 (Density):

<table>
<thead>
<tr>
<th>No. of Dwellings</th>
<th>Average Dwelling Size (m²)</th>
<th>Total Site Area (m²)</th>
<th>Building Coverage (% and m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>84</td>
<td>4140</td>
<td>1596</td>
</tr>
<tr>
<td>Density 1: Dwellings per hectare (dph)</td>
<td>Density 2: Average area for each dwelling (m²/dwelling)</td>
<td>Density 3: Floor Area Ratio (FAR)</td>
<td>Density 4: People per hectare (ppl/ha)</td>
</tr>
<tr>
<td>45.9</td>
<td>218</td>
<td>0.38</td>
<td>184</td>
</tr>
</tbody>
</table>

#### Analysis Table 2 (Infrastructure Autonomy Index):

<table>
<thead>
<tr>
<th>Electricity</th>
<th>Fresh water</th>
<th>Sewage</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>10</td>
<td>1</td>
<td>21</td>
</tr>
</tbody>
</table>

#### Analysis Table 3 (Quarter Acre Qualities):

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
<th>K</th>
<th>L</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

**Figure 8.12:** Analysis tables of Socially-led, iterative housing pattern example 1
### Analysis of the Housing Patterns from the Artificial Evolution

#### Iterative Housing Pattern Example 2: S2-2r (SqP)

**Analysis Table 1 (Density):**

<table>
<thead>
<tr>
<th>No. of Dwellings</th>
<th>Average Dwelling Size (m²)</th>
<th>Total Site Area (m²)</th>
<th>Building Coverage (% and m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>27</td>
<td>100</td>
<td>4140</td>
<td>1350</td>
</tr>
</tbody>
</table>

- Density 1: Dwellings per hectare (dph)
- Density 2: Average area for each dwelling (m²/dwelling)
- Density 3: Floor Area Ratio (FAR)
- Density 4: People per hectare (ppl/ha)

| 65.2             | 153                       | 0.65                 | 260 |

#### Analysis Table 2 (Infrastructure Autonomy Index):

<table>
<thead>
<tr>
<th>Electricity</th>
<th>Fresh water</th>
<th>Sewage</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>5</td>
<td>1</td>
<td>16</td>
</tr>
</tbody>
</table>

53% Autonomous

#### Analysis Table 3 (Quarter Acre Qualities):

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
<th>K</th>
<th>L</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>1/2</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>1/2</td>
</tr>
</tbody>
</table>

10/12 (83%)

---

#### Iterative Housing Pattern Example 3: S6-6d (SRS)

**Analysis Table 1 (Density):**

<table>
<thead>
<tr>
<th>No. of Dwellings</th>
<th>Average Dwelling Size (m²)</th>
<th>Total Site Area (m²)</th>
<th>Building Coverage (% and m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>45</td>
<td>57</td>
<td>4140</td>
<td>3708</td>
</tr>
</tbody>
</table>

- Density 1: Dwellings per hectare (dph)
- Density 2: Average area for each dwelling (m²/dwelling)
- Density 3: Floor Area Ratio (FAR)
- Density 4: People per hectare (ppl/ha)

| 108.7          | 92                         | 0.61                 | 435 |

#### Analysis Table 2 (Infrastructure Autonomy Index):

<table>
<thead>
<tr>
<th>Electricity</th>
<th>Fresh water</th>
<th>Sewage</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.5</td>
<td>3.75</td>
<td>1</td>
<td>12.25</td>
</tr>
</tbody>
</table>

41% Autonomous

1.25 points given as approx. half of the dwellings have their own roof for collecting rainwater

#### Analysis Table 3 (Quarter Acre Qualities):

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
<th>K</th>
<th>L</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓</td>
<td>1/2</td>
<td>✓</td>
<td>1/2</td>
<td>1/2</td>
<td>✓</td>
<td>✓</td>
<td>1/2</td>
<td>✓</td>
<td>1/2</td>
<td>✓</td>
<td>1/2</td>
</tr>
</tbody>
</table>

7.5/12 (63%)

---

**Figure 8.13.**: Analysis tables of Socially-led, iterative housing pattern example 2

**Figure 8.14.**: Analysis tables of Socially-led, iterative housing pattern example 3
8.3. Comparison of All Species

The final portion of this analysis section provides some comparisons between all twelve of the iterative housing patterns discussed in this research project; based on the three tables of analysis (density, autonomy and quarter acre qualities) and an overall comparative summary.

Analysis Table 1 (Density):

There is almost complete segregation of the species when comparing the densities of their housing patterns, as illustrated in Figure 8.15. This reflects the characteristics that define each of the development approaches. The Natural Progression (pink) patterns of development are the current solution to intensification; however, these are limited to the low end of the density spectrum (only up to 29.0dph). The Developer-led (blue) patterns are the desired outcome for Auckland when considering what they can offer to intensification; the ability to achieve high levels of dwelling concentration on a given site (over 100dph). The Ecologically-led (green) housing patterns demonstrate the opposing development mentality and can reach medium-density classification (around 38 dph), while still allowing for dwellings to have individual sections. The Socially-led (orange) housing patterns aim to balance the extreme development circumstances, which aligns with the medium to high level of density that they accomplish (45-100dph).

Figure 8.15.: Ranking of iterative housing patterns by density
Analysis Table 2 (Environmental Autonomy Index):

Examining the potential infrastructural independence (autonomy) of these housing patterns further emphasises the defining characteristics of each development approach. In Figure 8.16, the Developer-led (blue) and Natural Progression (pink) species offer the least dependent housing patterns (only up to 40% independence); a reflection of the prioritising of economic drivers in the design of these patterns. The outlier D1-1u is an exception to this (up to 70% autonomy), as it consists of semi-detached dwellings with their own section of land. These attributes prove crucial in supporting autonomy as highlighted by the Ecologically-led species (green); which set out to provide, and has been successful in generating, housing patterns that have the potential of being fully independent (100% autonomous) from city infrastructure. Finally, the Socially-led housing patterns (orange) cement their balancing act by allowing for more autonomy than the Developer-led patterns, but less than the Ecologically-led ones (between 40 and 70% autonomy). In most cases, the level of potential autonomy is inversely proportional to the density achieved; higher density housing patterns are more reliant on city infrastructure.

The important consideration of this analysis table is that there exists the potential for all housing patterns to reduce at least some of their reliance on city infrastructure. However, that does not always translate to the implementation of the three types of systems focussed on (electricity generation, fresh water collecting and sewage treatment).

Figure 8.16.: Ranking of iterative housing patterns by autonomy
Analysis Table 3 (Quarter Acre Qualities):

The underlying aim of this research project has been to investigate what housing patterns can best sustain the qualities of the quarter acre (as identified in Section 3.5.2.) at higher densities; Figure 8.17. outlines how the iterative patterns have performed in response to this. Generally, the possibility of these housing patterns supporting the quarter acre characteristics is reasonably high; out of the twelve patterns, ten of them can feature at least 80% of the quarter acre qualities. The common determining factor of how many characteristics could be supported was the intensification of the housing pattern; as density increased the number of achievable qualities decreased. The presence of a section was also a significant influence; the larger an area of land accompanying a dwelling, the better the chance of the quarter acre being present.

![Figure 8.17.: Ranking of iterative housing patterns by amount of quarter acre qualities supported](image-url)
Overall Comparative Summary:

The individual tables of analysis have been useful in evaluating each of the housing patterns against the three defining aspects; density, dependence on city infrastructure and preservation of the quarter acre characteristics. However, the iterative housing patterns need to be considered for their overall impact in all three aspects. Figure 8.18. presents the analytical data from all three tables in a single graph. Each housing pattern is represented as a circle and located on a grid with the x- and y-axes defining autonomy and density; the dimension of each circle corresponds to the amount of quarter acre qualities it can support (a larger circle = more qualities supported). There is also a trend line that links the three patterns of each species.

The initial conclusion drawn from this comparative analysis (Figure 8.18.) is that all of the Developer-led, Ecologically-led and Socially-led development approaches have benefits that can advance where the Natural Progression species current sits; whether that is in an economic or environmental direction. Another more significant conclusion drawn, is that density is the influential aspect with respect to preservation of quarter acre qualities; the common trend appears to be that as density increases the size of the circles (the potential for quarter acre qualities) shrinks. This emphasises how the quarter acre ‘dream’ (detached dwelling on a section) has been led to extinction in the face of intensification. The Socially-led species was established to explore methods of balancing the advantages of the extreme development

**Figure 8.18.:** Graphical summary of comparative analysis
approaches (the Developer-led and Ecologically-led species). The comparative analysis illustrates how in regards to density, infrastructural independence and maintaining the quarter acre, the generated Socially-led housing patterns have in fact managed to position themselves between the two extremes. One last notable feature of the comparative analysis is that the Natural Progression and Ecologically-led approaches both have a fairly narrow scope of housing patterns, whereas the Developer-led and Socially-led approaches present more diverse schemes. Moreover, the range of the Socially-led patterns fits between those of the extreme development approaches.
9. Conclusions
9.1. Initial Conclusions

This research project originated from the quarter acre ‘dream’; a unit of land that allowed for a level of autonomy for a household, whether out of necessity or by choice, which became culturally adopted by Kiwis. Achieving a density of approximately 10 dwellings per hectare, the traditional quarter acre has almost become extinct, but the dream lives on. The reason for its disappearance is the densification of urban areas, which has both environmental and quality-of-life consequences.

Moreover, one of the early conclusions arrived at in this research project is that housing patterns are more than simply geometric representations of form. Some of the most distinctive housing patterns from around the world respond to the cultural context of their environment. Section 2.3. elaborated on this point, emphasising that housing patterns could reflect a range of different circumstances (e.g. conformity to local building restrictions, construction using certain materials or the individuals place in society), but were not necessarily able to be translated exactly to another location. In a local context, the quarter acre has become the accepted cultural housing pattern in Auckland, and the threat of intensification needs to be tackled so that we can preserve the legacy of the quarter acre.

9.2. Development Approaches

In the urban areas of Auckland that have densified, the form of housing developments have not followed function, they have instead followed finance. The characteristics of subdivision (represented by the ‘Natural Progression’ species in this research project) have directly influenced property owners into exploiting the maximum economic potential of a site, as determined by planning policy ‘rules’, and this has occurred over an extended period. This approach to development operates in a piecemeal nature that epitomises the laissez-faire planning approach, which has shaped Auckland for decades. Additionally, the resulting increase in density is up to about 30 dwellings per hectare; only just reaching a medium-density classification. Furthermore, there may still exist the potential for characteristics of ‘the dream’ (a detached house with its own section), but since dwellings are crammed onto sites, there are only limited opportunities to experience the characteristics of the traditional quarter acre dream.

The most recent planning legislation in Auckland (The Unitary Plan) allows for even more compact growth (examined in the ‘Developer-led’ species of this research project). Exploration of possible housing patterns guided by the Unitary Plan’s restrictions have shown that densities of up to 500 dwellings per hectare are possible; provided that a development is completed in a single stage. From an economical and density perspective, these patterns of development are the perfect solution for Auckland’s current housing demands. However, the consequences of such high concentrations of dwellings are
significant; the amount and quality of open space and the characteristics of individual dwellings (e.g. solar access, views and privacy) become secondary concerns. Therefore, it is argued that this development approach, driven by a developer’s financial gain, is changing the Kiwi housing culture for the worse.

On the other end of the spectrum, this research project also investigated the possibility of an ‘Ecologically-led’ development approach; the idea that housing patterns can be autonomous (self-sufficient in energy, water and sewage treatment) on their own section of land and not require any form of reticulated services. The intent of this development approach is to challenge planning policy that promotes compact urban forms, as well as critics of greenfield developments, who argue that suburban development always results in higher (hard) infrastructure costs. The housing patterns explored in the Ecologically-led species have demonstrated that in using simple technologies of photovoltaic (PV) roof panels, rainwater harvesting and septic aeration systems, housing developments of about 40 dwellings per hectare can be achieved, which is beneficial to the environment and helps reduce the dependency on city infrastructure. Despite these advantages, the expense of implementing these technologies, as well as the low profitability that accompanies lower densities, means these patterns of development are unlikely to be widely adopted across Auckland.

After exploring the two opposing extremes of development (economic vs environmental), the research project then examined whether there was some form of compromise that could exist between the ‘Developer-led’ and ‘Ecologically-led’ approaches; a way of capturing the benefits of increasing density and providing infrastructural independence, that could possibly support the characteristics of ‘the dream’.

Both the ‘Developer-led’ and ‘Ecologically-led’ housing patterns have been driven by rules, conforming to planning restrictions or guidelines in some form or another; this requires very little design imagination. Conversely, the final approach explored in this research project (defined as the ‘Socially-led’ species) considers the quality of life on a given site; the spaces around dwellings are designed and not simply leftover from planning constraints. Determining the ‘quality’ of a housing pattern is a subjective matter and is a difficult entity to measure. There have been previous attempts to do so in New Zealand; however, these have resulted in check-lists that are valuable but do not fully capture quality since the whole is often greater than the sum of the parts.

This research project has taken a different approach to evaluating quality, by collating international precedents of award-winning housing developments that have comparable circumstances to the quarter acre. The formal attributes of these developments were analysed for their ability to maintain characteristics of the quarter acre. The final part of this research project then utilises these precedents to inform the design of housing patterns at different densities that, although may contain a necessary compromise, might preserve aspects of ‘the dream’.
9.3. Methodology

One of the fundamental elements of architectural design is the exploration of form. This research project is based on examining the extent and limitations of housing form, in relation to the urban environment of Auckland; specifically questioning how the legacy of the quarter acre can be maintained more densely. The primary focus of this research project has been on the formal representation of different ‘patterns’ of housing, with the consideration of architectural style a secondary concern.

A harmonious relationship has emerged from this research project, in the pairing of evolution and pattern language concepts. Firstly, an evolutionary analogy was established as the project methodology because of its underlying definition as a process and its recognised structural properties that could be adapted to suit an architectural context. Similarly, the concept of pattern language offered a system of describing an urban environment that could be adopted into this research project to help express characteristics of housing. Utilising the concept of pattern language, in tandem with an evolutionary analogy, has enabled a process of generating (defining rules), classifying (describing and arranging in an artificial evolution) and determining suitability (the selection process) of different housing patterns with respect to their density, infrastructural autonomy and geniality; ultimately trying to determine how the quarter acre ‘dream’ can be maintained in Auckland.

The overall investigation of housing patterns is more beneficial to the broader spectrum of architecture; the intent of this research project is to possibly advise the formal decisions of others (designers, planners or policymakers) who are interested in the more detailed design of housing.
10. Intended Design Presentation

Between the submission of this explanatory document (October 11th, 2017) and the final presentation (November 6-10th, 2017) further exploration will be undertaken into three of the Socially-led patterns and how they can each be applied to a specific Auckland context. Three different patterns will be developed (reflecting the favoured typologies discussed in Section 7.2.) to express the application of this approach to development at different densities; illustrating a medium- to high-density range of dwellings. Suitable locations (‘application to other sites’) will be chosen that best embody the qualities of each Socially-led pattern, as well as demonstrating the intensification of different parts of Auckland.


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12.2. Summary of Unitary Plan Restrictions of H6: Residential (Terraced Housing and Apartment Building Zone)

The following restrictions are utilised as the key design drivers for the Developer-led species, and also guide the designs of the Natural Progression, Ecologically-led and Socially-led species:

- Buildings are enabled up to five, six or seven storeys in identified Height Variation Control areas, depending on the scale of the adjoining centre, to achieve a transition in height from the centre to lower scale residential zones.

- **H6.6.5. Building Height**: Building must not exceed 16m in height.

- **H6.6.7. Alternative Height in relation to boundary within Residential Terraced Housing and Apartment Building Zones**:  
  > A building must not project beyond a 60-degree recession plane measured from a point 8m vertically above ground level alongside and rear boundaries within 20m of the site frontage (Figure 12.1.).  
  > A building further than 20m from the site frontage must not project beyond a 60-degree recession plane measured from a point 8m vertically above ground level, and 2m perpendicular to side and rear boundaries. (Figure 12.2.).

![Figure 12.1.: Alternative height in relation to boundary within 20m of the site frontage (Source: Auckland Unitary Plan)]
- **H6.6.9 Yards**: A building must be set back from the relevant boundary by the minimum depth listed in Figure 12.3.

<table>
<thead>
<tr>
<th>Yard</th>
<th>Minimum Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Front</td>
<td>1.5m</td>
</tr>
<tr>
<td>Side</td>
<td>1m</td>
</tr>
<tr>
<td>Rear</td>
<td>1m</td>
</tr>
</tbody>
</table>

**Figure 12.3.**: Yard offset dimensions (*Source: Auckland Unitary Plan*)

- **H6.6.10. Maximum Impervious Area**: The maximum impervious area must not exceed 70 per cent of site area.

- **H6.6.11. Building Coverage**: The maximum building coverage must not exceed 50 per cent of the net site area.

- **H6.6.15. Outdoor Living Space**: A dwelling at ground floor level must have an outdoor living space that is at least 20m$^2$.

- **H6.6.17. Minimum Dwelling Size**: 30m$^2$ for studio dwellings and 45m$^2$ for one+ bedroom dwellings.
12.3. Summary of TP58’s Relevant Guidelines

Below is a summary of the specific design aspects relevant to the Ecologically-led species in this research project and how they comply with TP58: Onsite Wastewater Systems (3rd Edition, 2004).

- **Soil Category:** 3 (Medium-fine and loamy sand – good drainage) [Table 5.1]

- **Land Disposal System According to Soil Category:** Pressure Compensating Dripper Irrigation [Figure 5.2]

- **Minimum Distances of Septic Tank:** from Buildings/Houses – 3m, from Property Boundary – 1.5m [Table 5.2]

- **Reserve Disposal Area:** Subsurface Drip Irrigation (Pressure Compensating) 33-100% [Table 5.3]

- **Occupancy Allowance:** Number of bedrooms = 2, Occupancy for Design Purposes = 4 [Table 6.1]

- **Domestic Wastewater Flow Allowances (per capita):** (for On-site Roof Water Tank Supply) E. Households with Full Water Reduction Fixtures without Permanent Electricity Supply = 100L/p/d [Table 6.2]

- **Septic Tank Capacity:** All Waste, for 2 bedrooms = 4500L [Table 7.2]

- **Drip Irrigation Design Criteria:** Line Spacings = 1.0m, Design Areal Loading Rates = 15mm/day, Depth of lines = 50-200mm [Table 9.2]

- **Area of Disposal:**  
  Peak Daily Wastewater Flow = **400L/day** (100L/p/d x 4 occupants)  
  Design Areal Loading Rate = **15mm/day**  
  - 400/15 = 26.67 m$^2$ Area of Disposal  
  - Reserve Area (33-100%) = 8.8-26.67 m$^2$  
  - **Total Area of Disposal = 35.5-53.3 m$^2$**

The following tables and figures have been extracted from the TP58: Onsite Wastewater Systems document, highlighting the specific design aspects discussed in this section.
### Table 5.1: TP68 Soil Category Description (comparison with AS/NZS:1547:2000)

<table>
<thead>
<tr>
<th>Soil Category</th>
<th>Soil Description TP 68 3rd Edition</th>
<th>Soil Category</th>
<th>Soil Description AS/NZS 1547:2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Gravel, coarse sand - rapid draining</td>
<td>1</td>
<td>Gravels and sands - rapidly drained</td>
</tr>
<tr>
<td>2</td>
<td>Coarse to medium sand - free Draining</td>
<td>2</td>
<td>Sandy loams - well drained</td>
</tr>
<tr>
<td>3</td>
<td>Medium-fine and loamy sand - good drainage</td>
<td>3</td>
<td>Loams - moderately well drained</td>
</tr>
<tr>
<td>4</td>
<td>Sandy loam, loam and silt loam - moderate drainage</td>
<td>4</td>
<td>Clay loams - imperfectly drained</td>
</tr>
<tr>
<td>5</td>
<td>Sandy clay-loam, clay-loam and silty clay-loam - moderate to slow drainage</td>
<td>5</td>
<td>Light clays - poorly drained</td>
</tr>
<tr>
<td>6</td>
<td>Sandy clay, non-swelling clay and silty clay - slowly draining</td>
<td>6</td>
<td>Medium to heavy clays - very poorly drained</td>
</tr>
<tr>
<td>7</td>
<td>Swelling clay, grey clay, hardpan - poorly or non-draining</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Figure 5.2: On-Site Land Disposal Systems According to Soil Categories

- Specific Requirements
- Specific Option 1
- Specific Option 2
- Specific Option 3
- Specific Option 4
- Specific Option 5
- Specific Option 6
- Specific Option 7
### Table 5.2: Recommended Minimum Separation Distances According to Treated Wastewater Discharge Quality

<table>
<thead>
<tr>
<th>Minimum Recommended Separation Distance</th>
<th>Primary (Septic tank plus effluent outlet filter)</th>
<th>Secondary (AWTS)</th>
<th>Advanced Secondary (Packed Bed Reactor)</th>
<th>Tertiary (Disinfection Note 9)</th>
<th>Advanced Tertiary* (Nutrient reduction &amp; disinfection)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buildings/Houses¹</td>
<td>3m</td>
<td>1.5 to 3m</td>
<td>1.5 to 3m</td>
<td>1.5 to 3m</td>
<td>1.5 to 3m</td>
</tr>
<tr>
<td>Property Boundary¹</td>
<td>1.5m</td>
<td>1.5m</td>
<td>1.5m</td>
<td>1.5m</td>
<td>1.5m</td>
</tr>
<tr>
<td>Surface Water²</td>
<td>Note 4</td>
<td>10m</td>
<td>10m</td>
<td>10m</td>
<td>10m</td>
</tr>
<tr>
<td>Soil Category 1²</td>
<td>20m</td>
<td>10m</td>
<td>10m</td>
<td>5 - 10m¹</td>
<td>5m²</td>
</tr>
<tr>
<td>Soil Category 2 - 3</td>
<td>20m</td>
<td>15m</td>
<td>15m</td>
<td>5 - 10m¹</td>
<td>5m²</td>
</tr>
<tr>
<td>Soil Category 4 - 6</td>
<td>Note 4</td>
<td>15m</td>
<td>15m</td>
<td>5 - 10m¹</td>
<td>5m²</td>
</tr>
<tr>
<td>Soil Category 7</td>
<td></td>
<td>15m</td>
<td>15m</td>
<td>5 - 10m¹</td>
<td>5m²</td>
</tr>
<tr>
<td>Water Supply bore³</td>
<td>Note 4</td>
<td>20m</td>
<td>20m</td>
<td>10m</td>
<td>10m</td>
</tr>
<tr>
<td>Soil Category 1</td>
<td>20m</td>
<td>20m</td>
<td>20m</td>
<td>10m</td>
<td>10m</td>
</tr>
<tr>
<td>Soil Category 2 - 3</td>
<td>20m</td>
<td>20m</td>
<td>20m</td>
<td>10m</td>
<td>10m</td>
</tr>
<tr>
<td>Soil Category 4 - 6</td>
<td>Note 4</td>
<td>20m</td>
<td>20m</td>
<td>10m</td>
<td>10m</td>
</tr>
<tr>
<td>Soil Category 7</td>
<td></td>
<td>20m</td>
<td>20m</td>
<td>10m</td>
<td>10m</td>
</tr>
<tr>
<td>Groundwater***</td>
<td>Note 4</td>
<td>1500mm</td>
<td>1200mm</td>
<td>1000mm</td>
<td>900mm</td>
</tr>
<tr>
<td>Soil Category 1</td>
<td>1500mm</td>
<td>1200mm</td>
<td>900mm</td>
<td>600mm</td>
<td>600mm</td>
</tr>
<tr>
<td>Soil Category 2 - 3</td>
<td>1200mm</td>
<td>900mm</td>
<td>600mm</td>
<td>600mm</td>
<td>600mm</td>
</tr>
<tr>
<td>Soil Category 4 - 6</td>
<td>Note 4</td>
<td>600mm</td>
<td>600mm</td>
<td>600mm</td>
<td>600mm</td>
</tr>
<tr>
<td>Soil Category 7</td>
<td></td>
<td>600mm</td>
<td>600mm</td>
<td>600mm</td>
<td>600mm</td>
</tr>
<tr>
<td>Floodplain¹ (Return Period Storm)</td>
<td>One in 100 year</td>
<td>One in 20 year</td>
<td>One in 20 year</td>
<td>One in 20 year</td>
<td>One in 20 year</td>
</tr>
<tr>
<td>Embankments/Retaining Walls*</td>
<td>3m from the drainage material/cut batter interface or 45° angle from toe of wall excavation (which ever is the greatest)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

[All separation distances may vary dependant upon territorial authority requirements]

### Table 5.3: Reserve Disposal Area Requirements

<table>
<thead>
<tr>
<th>Land Disposal Method</th>
<th>Minimum Reserve Area Allocations*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subsurface Drip Irrigation (Pressure Compensating)</td>
<td>33% - 100%</td>
</tr>
<tr>
<td>Surface Drip Irrigation (Pressure Compensating)</td>
<td>50% - 100%</td>
</tr>
<tr>
<td>Shallow Trenches</td>
<td>100%</td>
</tr>
<tr>
<td>Standard/Deep Trenches</td>
<td>100%</td>
</tr>
<tr>
<td>ETS Beds**, Aerobic Soakage Beds and Trenches</td>
<td>100%</td>
</tr>
<tr>
<td>Shallow Trenches (with Secondary Treated Effluent)</td>
<td>50% - 100%</td>
</tr>
<tr>
<td>Secondary Effluent to Trenches or Beds (with double loading rate***</td>
<td>150 - 200%</td>
</tr>
<tr>
<td>Infiltration systems</td>
<td>100%</td>
</tr>
<tr>
<td>Mound systems</td>
<td>100%</td>
</tr>
</tbody>
</table>
## Table 6.1: Occupancy Allowances

<table>
<thead>
<tr>
<th>Facility</th>
<th>Occupancy For Design Purposes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Homes</strong></td>
<td></td>
</tr>
<tr>
<td>Number of Bedrooms [Notes 1, 2 &amp; 3]</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td><strong>Hotels &amp; Motels</strong></td>
<td></td>
</tr>
<tr>
<td>Guests</td>
<td>Maximum Occupancy/number of beds</td>
</tr>
<tr>
<td>Staff</td>
<td>Maximum number of staff.</td>
</tr>
<tr>
<td><strong>Hospitals</strong> [Note 4]</td>
<td></td>
</tr>
<tr>
<td>Patients</td>
<td>1 per bed [Note 3]</td>
</tr>
<tr>
<td>Staff</td>
<td>Maximum Number of Staff</td>
</tr>
<tr>
<td><strong>Retirement Villages</strong> [Note 4]</td>
<td>1.3p per unit</td>
</tr>
<tr>
<td>1 bedroom</td>
<td>1.3p to 2.0p per unit</td>
</tr>
<tr>
<td>2 bedroom</td>
<td>2p – 4p per unit</td>
</tr>
<tr>
<td>3 bedroom</td>
<td>Maximum Number</td>
</tr>
</tbody>
</table>

## Table 6.2: Domestic Wastewater Flow Allowances – Per Capita

<table>
<thead>
<tr>
<th>SOURCE</th>
<th>Typical Wastewater Flow Allowance (Litres/Person/Day)</th>
<th>[Note 1 and Note 2]</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-site Roof Water Tank Supply</td>
<td>220</td>
<td>220</td>
</tr>
<tr>
<td>Reticulated Community or Bore Water Supply</td>
<td>180 – 200</td>
<td>200</td>
</tr>
<tr>
<td>Permitted Activity Flow Allowances in the Auckland Region [Note 3]</td>
<td>100</td>
<td>180</td>
</tr>
<tr>
<td>A. Up market/Luxury households with Extra Wastewater Producing Fixtures including fixtures such as garbage grinders, dishwashers, modern shower or bath facilities or other comparable fixtures [Note 4]</td>
<td>145</td>
<td>165</td>
</tr>
<tr>
<td>B. Households with Standard Fixtures including 11 litre flush water cistern, automatic washing machine and dishwasher [Note 5]</td>
<td>100</td>
<td>180</td>
</tr>
<tr>
<td>C. Households with 11/5.5 or 6/3 Flush Toilet(s) and Standard Fixtures, low water use dishwasher and NO garbage grinder [Note 6]</td>
<td>120</td>
<td>145</td>
</tr>
<tr>
<td>D. Households with 6/3 Flush Toilet(s) And Standard Water Reduction Fixtures and NO garbage grinder [Note 7]</td>
<td>100 – 120</td>
<td>120</td>
</tr>
<tr>
<td>E. Households with Full Water Reduction Fixtures on all water outlets, NO bath and NO garbage grinder [Note 8]</td>
<td>100 to &lt;115</td>
<td>135</td>
</tr>
<tr>
<td>F. Households with Full Water Reduction Fixtures Without Permanent Electricity Supply [Fixtures as per Note 7, and Note 9 also applies]</td>
<td>95 to 100</td>
<td>100 to 115</td>
</tr>
</tbody>
</table>

A water meter is to be fitted to either the water supply tank outlet or secondary treated wastewater discharge where the design per capita flow rate is less than 145L/p/d and sites without permanent electricity supply where the per capita design flow is less than 120 L/p/d.
### Table 7.2: Septic Tank Capacities for Dwellings

<table>
<thead>
<tr>
<th>Type of Wastewater</th>
<th>AS/NZS 1547-2000</th>
<th>USEPA 2002</th>
<th>TP58 2004</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of Persons</td>
<td>No. of Bedrooms</td>
<td>No. of Bedrooms</td>
</tr>
<tr>
<td>1 to 5</td>
<td>3000</td>
<td>4500</td>
<td>6200</td>
</tr>
<tr>
<td>6 to 10</td>
<td>2500</td>
<td>4500</td>
<td>6200</td>
</tr>
<tr>
<td>1 to 3</td>
<td>3000</td>
<td>4500</td>
<td>6200</td>
</tr>
<tr>
<td>4 to 6</td>
<td>3000</td>
<td>4500</td>
<td>6200</td>
</tr>
<tr>
<td>4 to 6</td>
<td>3000</td>
<td>4500</td>
<td>6200</td>
</tr>
<tr>
<td>1 to 4</td>
<td>3000</td>
<td>4500</td>
<td>6200</td>
</tr>
</tbody>
</table>

**Notes:**
1. TP58 tank size calculation is based on sludge accumulation rate of 80 litres per person per year, a pump out frequency of seven years and 24 hour retention time for the peak daily flow volume, using 200 litres per person per day (This provides a buffer hydraulic retention capacity for pulse flows. A lower per person per day flow volume allowance does not provide such capacity and should not be used.)
2. In general allow 1000 litres for sludge and scum accumulation over 7 years for greywater tanks and 1200 litres for blackwater tanks.
3. Tank capacity allowance of 200 litres/person for all waste tanks is greater than the per capita daily flow allowances to provide for hydraulic buffering. For greywater, the design capacity is 33% greater to compensate for the same flow intensities as the larger all-waste tanks.
4. TP58 tank volumes are based on a tank including an outlet filter. Larger tank sizes are necessary with an outlet filter so that there is less hydraulic load on the filter surface.

### Table 9.2: Drip Irrigation Design Criteria Summary

<table>
<thead>
<tr>
<th>Line Spacing</th>
<th>Variable (Typically 0.3m, 0.5m or 1.0 metre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emitter Spacing</td>
<td>Variable (Typically 0.3m, 0.6m or 1.0 metre)</td>
</tr>
<tr>
<td>Emitter Rates</td>
<td>Typical rates 1.2 l/hr, 1.8 l/hr, 2.0 l/hr, 2.3 l/hr, 3.5 l/hr, 4.0 l/hr.</td>
</tr>
<tr>
<td>Design Areal Loading Rates</td>
<td></td>
</tr>
<tr>
<td>Soil Category</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>35mm/d to 50mm/day [Note 1]</td>
</tr>
<tr>
<td>2</td>
<td>25mm/d [Note 2]</td>
</tr>
<tr>
<td>3</td>
<td>15mm/day to 20mm/day [Note 2 &amp; 3] [Dependent on environmental constraints]</td>
</tr>
<tr>
<td>4</td>
<td>5mm/day</td>
</tr>
<tr>
<td>5</td>
<td>3 mm/day to 4 mm/day [Notes 3 and 4]</td>
</tr>
<tr>
<td>6</td>
<td>2 mm/day to 3 mm/day</td>
</tr>
<tr>
<td>7</td>
<td>2 mm/day or less</td>
</tr>
<tr>
<td>Depth of Lines</td>
<td>50mm to 200mm or pinned to ground surface and covered with mulch or bark.</td>
</tr>
</tbody>
</table>

**Notes:**
1. Category 1 soil requires special design, such as installation of drainage control trenches under the irrigation lines. In this instance the PCDI becomes a distribution method.
2. PCDI is a distribution method when used in Category 1, 2 & 3 soils.
3. The higher loading rates are only applicable where there is at least 50% reserve area.
4. Loading rates of up to 5mm/day may be appropriate in Category 5 soils where the depth of topsoil is 250mm or more.

Effective distribution in lawns is best achieved using closely spaced lines and emitters (0.3m x 0.3m) and use very conservative loading rates of less than 3mm.
The land disposal area and/or linear length of irrigation lines are to be adjusted when the line spacing is varied from 1.0m [Ref 17].
12.4. Detailed Explanation of the Elements of an Individual Iterative Housing Pattern

Variety Code Identification:
- Sub-species
- Variety name
- Dwelling type(s) included in this iteration

Existing Dwelling
- New section boundaries
- Existing section boundaries

New Dwelling
- Iterative Site Plan
- Existing section boundaries
- Street boundary
- Max Height
- Iterative Section
- Existing section boundaries
- Height in relation to boundary recession planes

Site data:
- Dwelling count and density values
- Problems with this site design

Critical dimensions
- Existing section boundaries
- Iterative Site Plan
- Side boundaries
- Street boundary
- Max Height
- Iterative Section
- Height in relation to boundary recession planes

Dwelling
- Circulation Space

Problems with this site design
- Subsequent iterations attempt to remedy mentioned problems

Appendix 12.4.  Page 183
### E1-1a (1NS)

**1. North-South Dwellings**

- **Total no. of dwellings**: 16
- **Density**: 38.7 dph (155 ppl/ha)
- **Building Coverage**: 1008 m² (24.3%)
- **Average Section Size**: 258.75 m²

**Comments:**
- Insufficient space for wastewater drainage
- Dwelling orientation conflicting with section layout

### S2-2q (SqP)

**2. Courtyard Dwellings (Square Pattern)**

- **Total no. of dwellings**: 27
- **Density**: 65.2 dph (260 ppl/ha)
- **Building Coverage**: 1350 m² (32.6%)

**Comments:**
- No space for enough garages?
- Too many paths? (Wasted space)
- Communal public space?
- Shading in southern spaces?

---

**Variety Code Identification:**
- **Sub-species**
- **Dwelling type(s) included in this iteration**

**Max Height**
- **Dwelling type(s) and no. of storeys**

**Site data:**
- **Dwelling count and density values**

**Problems with this site design**
- Subsequent iterations attempt to remedy mentioned problems

---

**Iterative Site Plan**
- **Street boundary**
- **Side boundaries**
- **Internal boundaries**

**Iterative Section**
- **Height in relation to boundary recession planes**

**Variety name**
- **Dwelling arrangement(s) included in this iteration**

**Borrowed/Adapted Dwelling type(s)**
- **Street boundary**
- **Parking space (Garage or carpark)**

**Height in relation to boundary recession planes**
- **Problems with this site design**
- Subsequent iterations attempt to remedy mentioned problems
12.5. Further Examples of Natural Progression’s Iterative Housing Patterns

12.6. Further Examples of Developer-led Iterative Housing Patterns

12.7. Further Examples of Ecologically-led Iterative Housing Patterns

12.8. Further Examples of Socially-led Iterative Housing Patterns

The following pages are a limited selection of further examples of the iterative housing patterns from the four different species. The inclusion of these housing patterns is to illustrate the exploration that has been undertaken as part of this research project (the iterative development of housing patterns).
**N1-1b (E2N)**

**Exising Dwelling (2 bed)** 1

**New Dwellings (4 bed)** 2

**Total no. of dwellings** 3

**Density** 29.0 dph (194 ppl/ha)

**Building Coverage** 350m² (33.8%)

**Comments:**

New Dwelling 2st. 260m² 4 Bed

**N1**

**Existing Dwelling**

1st. 2 Bed

**N1-1a (E1N)**

**Exising Dwelling (2 bed)** 1

**New Dwelling (4 bed)** 2

**Total no. of dwellings** 3

**Density** 19.3 dph (116 ppl/ha)

**Building Coverage** 220m² (21.3%)

**Comments:**

Existing Dwelling 2 Bed

New Dwelling 2st. 260m² 4 Bed

**N1-1c (2NE)**

**NOT APPLICABLE**

The Existing Dwelling is already well situated for subdivision of site for new dwellings to be added.

**N1-1d (2EN)**

**NOT APPLICABLE**

There is only one Existing Dwelling

**N1-1e (2E2N)**

**NOT APPLICABLE**

There is only one Existing Dwelling

**N1-1f (2E3N)**

**NOT APPLICABLE**

There is only one Existing Dwelling
NOT APPLICABLE
There is only one Existing Dwelling
**N1-1m (3ND)**

New Dwellings (4 bed)    3

Total no. of dwellings    3

Density      29.0dph (232 ppl/ha)

Building Coverage    390m$^2$ (37.7%)

Comments:

**N1-1k (1ND)**

New Dwelling (4 bed)      1

Total no. of dwellings      1

Density      9.7dph (78 ppl/ha)

Building Coverage    300m$^2$ (29.0%)

Comments:

**N1-1l (2ND)**

New Dwellings (4 bed)    2

Total no. of dwellings    2

Density      19.3dph (155 ppl/ha)

Building Coverage    300m$^2$ (29.0%)

Comments:
12.6. Further Examples of Developer-led Iterative Housing Patterns

**D1-1a (Sin)**
- Single Aspect Dwellings: 252 (over 6 floors)
- Total no. of dwellings: 252
- Density: 608.7dph (2,435 ppl/ha)
- Building Coverage: 2646m² (63.9%)
- Comments:
  - No space for parking
  - HIRB infringements (N, S, E + W) + max height
  - Tall narrow ‘canyons’
  - Space for vertical circulation?
  - No outdoor space (Ground Floor)

**D1-1b (Sin)**
- Single Aspect Dwellings: 233 (over 6 floors)
- Total no. of dwellings: 233
- Density: 562.8dph (2,252 ppl/ha)
- Building Coverage: 2646m² (63.9%)
- Comments:
  - HIRB infringements (N, S, E + W) + max height
  - Space for rubbish bin storage
  - Tall narrow ‘canyons’

**D1-1c (Sin)**
- Single Aspect Dwellings: 205 (over 4-6 floors)
- Total no. of dwellings: 205
- Density: 495.2dph (1,981 ppl/ha)
- Building Coverage: 2646m² (63.9%)
- Comments:
  - Minor HIRB infringements (N, E + W) + max height
  - HIRB infringements (S)
  - Space for rubbish bin storage
  - Tall narrow ‘canyons’

**D1-1d (Sin + 2Sin)**
- Single Aspect Dwellings: 205 (over 4-6 floors)
- Total no. of dwellings: 216
- Density: 521.7dph (2,087 ppl/ha)
- Building Coverage: 2646m² (63.9%)
- Comments:
  - Minor HIRB infringements (N, E + W) + max height
  - HIRB infringements (S)
  - Space for rubbish bin storage
  - Tall narrow ‘canyons’
Dual Aspect Dwellings 198 (over 6 floors)
Total no. of dwellings 198
Density 478.3 dph (1914 ppl/ha)
Building Coverage 2178 m² (52.6%)
Comments:
- HIRB infringements (N, S, E + W) + max height
- Tall narrow ‘canyons’
- No space for parking
- Space for vertical circulation?
- No outdoor space (Ground Floor)

Dual Aspect Dwellings 160 (over 5-6 floors)
Total no. of dwellings 160
Density 478.3 dph (1914 ppl/ha)
Building Coverage 2106 m² (50.9%)
Comments:
- HIRB infringements (N, S, E + W) + max height
- Tall narrow ‘canyons’
**D1-1q (Dua + DuaR)**

- Dual Aspect Dwellings: 160 (over 5-6 floors)
- Rotated Dual Aspect Dwellings: 12 (over 1 floor)
- Total no. of dwellings: 172
- Density: 415.5dph (1662 ppl/ha)
- Building Coverage: 2106m² (50.9%)

**Comments:**
- Minor HIRB infringements (N, E + W) + max height
- HIRB infringements (S)
- Tall narrow 'canyons'

**D1-1r (Dua + DuaR)**

- Dual Aspect Dwellings: 130 (over 4-5 floors)
- Rotated Dual Aspect Dwellings: 12 (over 1 floor)
- Total no. of dwellings: 142
- Density: 343.0dph (1372 ppl/ha)
- Building Coverage: 2106m² (50.9%)

**Comments:**
- Minor HIRB infringements (N, E + W) + max height
- HIRB infringements (S)
- Tall narrow 'canyons'

**D1-1s (Dua + DuaR)**

- Dual Aspect Dwellings: 130 (over 4-5 floors)
- Rotated Dual Aspect Dwellings: 12 (over 1 floor)
- Total no. of dwellings: 142
- Density: 343.0dph (1372 ppl/ha)
- Building Coverage: 2106m² (50.9%)

**Comments:**
- Minor HIRB infringements (N, E + W) + max height
- HIRB infringements (S)
- Tall narrow 'canyons'

**D1-1t (Tow)**

- 3 St. Townhouses: 52
- Total no. of dwellings: 52
- Density: 125.6dph (502.4 ppl/ha)
- Building Coverage: 2080m² (50.2%)

**Comments:**
- Narrow driveways?
1st. N-S Dwellings 16
Total no. of dwellings 16

Density 38.7 dph (155 ppl/ha)
Building Coverage 1008 m² (24.3%)
Average Section Size 258.75 m²

Comments:
- Insufficient space for wastewater drainage
- Dwelling orientation conflicting with section layout

Single Storey North-South Axis Dwellings

Single Storey North-South Axis Dwellings
Single Storey North-South Axis Dwellings

1st. N-S Dwellings  16
Total no. of dwellings 16
Density: 38.7 dph (155 ppl/ha)
Building Coverage: 1008 m² (24.3%)
Average Section Size: 258.75 m²

Comments:
- Insufficient space for wastewater drainage?
- Dwelling orientation conflicting with driveway location

Single Storey North-South Axis Dwellings

1st. N-S Dwellings  16
Total no. of dwellings 16
Density: 38.7 dph (155 ppl/ha)
Building Coverage: 1008 m² (24.3%)
Average Section Size: 258.75 m²

Comments:
- Dwelling orientation conflicting with driveway location
- Boundary setback infringements (S + E)

Single Storey North-South Axis Dwellings

1st. N-S Dwellings  16
Total no. of dwellings 16
Density: 38.7 dph (155 ppl/ha)
Building Coverage: 1008 m² (24.3%)
Average Section Size: 258.75 m²

Comments:
- Boundary setback infringements (S + E)

Single Storey North-South Axis Dwellings

1st. N-S Dwellings  16
Total no. of dwellings 16
Density: 38.7 dph (155 ppl/ha)
Building Coverage: 1008 m² (24.3%)
Average Section Size: 258.75 m²

Comments:
- Boundary setback infringements (S + E)
- Proximity of dwellings?
**1st. N-S Dwellings (Duple)**
- Total no. of dwellings: 16
- Density: 38.7 dph (155 ppl/ha)
- Building Coverage: 1008m² (24.3%)
- Average Section Size: 258.75m²

**Comments:**
- Driveways blocked to rear sections

**1st. E-W Dwellings**
- Total no. of dwellings: 16
- Density: 38.7 dph (155 ppl/ha)
- Building Coverage: 1056m² (25.5%)
- Average Section Size: 258.75m²

**Comments:**
- Insufficient space for wastewater drainage
- Dwelling orientation conflicting with section layout
- Boundary setback infringements (E + W)

**1st. E-W Dwellings (Duplex)**
- Total no. of dwellings: 8
- Density: 38.7 dph (155 ppl/ha)
- Building Coverage: 1056m² (25.5%)
- Average Section Size: 258.75m²

**Comments:**
- Insufficient space for wastewater drainage
- Boundary setback infringements (S, E + W)
### Details of 1st. N-S Dwellings (Duplex)

- **Total no. of dwellings**: 16
- **Density**: 38.7 dph (155 ppl/ha)
- **Building Coverage**: 1032 m² (24.9%)
- **Average Section Size**: 258.75 m²

**Comments:**
- Insufficient space for wastewater drainage?
- Boundary setback infringements (S, E + W)

### Details of 1st. E-W Dwellings (Reversed)

- **Total no. of dwellings**: 16
- **Density**: 38.7 dph (155 ppl/ha)
- **Building Coverage**: 1032 m² (24.9%)
- **Average Section Size**: 258.75 m²

**Comments:**
- Insufficient space for wastewater drainage?
- Boundary setback infringements (S, E + W)
2st. Courtyard Dwellings (Square Pattern)

Total no. of dwellings: 36
Density: 87.0dph (348 ppl/ha)
Building Coverage: 1800m² (43.5%)

Comments:
- No access to rear dwellings
- Boundary infringements (E + W)
- Stale repetition of dwelling form
- No space for garages/limited space for carparks
- Communal public space?

Comments:
- Boundary infringements (E + W)
- Stale repetition of dwelling form
- No space for garages/limited space for carparks
- Too many paths? (Wasted space)
- Communal public space?

Total no. of dwellings: 30
Density: 72.5dph (290 ppl/ha)
Building Coverage: 1500m² (36.2%)

Comments:
- Boundary infringements (E + W)
- Stale repetition of dwelling form
- No space for garages/limited space for carparks
- Too many paths? (Wasted space)
- Communal public space?

Total no. of dwellings: 28
Density: 67.6dph (271 ppl/ha)
Building Coverage: 1400m² (33.8%)

Comments:
- Boundary infringements (E + W)
- Stale repetition of dwelling form
- Too many paths? (Wasted space)
- Communal public space?
2st. Courtyard Dwellings (Square Pattern) 28
Total no. of dwellings 28
Density 67.6ph (271 ppl/ha)
Building Coverage 1400m² (33.8%)
Comments:
- Boundary infringements (N)
- Stale repetition of dwelling form
- No space for enough garages
- Too many paths? (Wasted space)
- Communal public space?
2st. Courtyard Dwellings (Square Pattern)

Total no. of dwellings: 28
Density: 67.6ph (271 ppl/ha)
Building Coverage: 1400m² (33.8%)

Comments:
- Shading in southern spaces?
- No space for enough garages
- Too many paths? (Wasted space)
- Communal public space?
- Driveway too narrow?
- No access to one unit
2nd Courtyard Dwellings (Square Pattern) 24
Total no. of dwellings: 24
Density: 57.9ph (232 ppl/ha)
Building Coverage: 1200m² (29.0%)
Comments:
- Boundary infringement (W)
- Stale repetition of dwelling form
- No space for enough garages
- Too many paths? (Wasted space)
- Communal public space?
2st. Courtyard Dwellings (Square Pattern)

Total no. of dwellings: 25
Density: 60.4ph (242 ppl/ha)
Building Coverage: 1250m² (30.2%)

Comments:
- No space for enough garages?
- Too many paths? (Wasted space)
- Communal public space?
- Shading in southern spaces?

2st. Courtyard Dwellings (Square Pattern)

Total no. of dwellings: 27
Density: 65.2ph (260 ppl/ha)
Building Coverage: 1350m² (32.6%)

Comments:
- No space for enough garages?
- Too many paths? (Wasted space)
- Communal public space?
- Shading in southern spaces?
13. Final Presentation Material

13.1. Presentation Pin-up
13.2. Developed Adaptable Housing Pattern
13.3. Off-grid Adaptable Option
13.4. Developed Courtyard Housing Pattern
13.5. Developed Village Housing Pattern
13.6. Potential Stylistic Representations of Three Developed Housing Patterns
13.7. Supporting Quarter Acre Information
13.8. Layered Collection of Housing Patterns
13.1. Presentation Pin-up
Achieving a Fully Autonomous Development

Conditions:
> MAX: 2-bedroom dwellings (Studio, 1 bed and 2 bed variations only)
> NO Garage (only permeable parking space)
> Permeable shared driveway
> Small Plant Room included
> All dwellings pushed to external site boundaries

Adaptable Housing Pattern Typology

External Spaces
Private

Analysis Table 1 (Density):

<table>
<thead>
<tr>
<th>No. of Dwellings</th>
<th>Dwellings per ha</th>
<th>Total Site Area (ha)</th>
<th>Building Area (ha)</th>
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<tbody>
<tr>
<td>18</td>
<td>70</td>
<td>4000</td>
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Analysis Table 2 (Infrastructure Autonomy Index):

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<th>Infrastructure</th>
<th>Autonomy</th>
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<tbody>
<tr>
<td>Electricity</td>
<td>100%</td>
</tr>
<tr>
<td>Fresh water</td>
<td>100%</td>
</tr>
<tr>
<td>Sewage</td>
<td>100%</td>
</tr>
</tbody>
</table>

Mid-Range Medium Density

Aerial Perspective From South-West

Site Plan 1:200

Variations of Housing Form

Possible Additional Spaces:
- Garage
- Bedroom
- Study
- En-Suite

Dwelling Types:
- Studio
- 1-Bed
- 2-Bed
- 3-Bed

Dwelling Spaces Legend:
- Bedroom
- Bathroom
- Laundry
- Carpark

Dashed lines indicate potential additions
13.3. Off-grid Adaptable Option

Achieving a Fully Autonomous Development

Conditions:
> MAX. 2-bedroom dwellings (Studio, 1-bed and 2-bed variations only)
> NO Garage (only permeable parking space)
> Permeable shared driveway
> Small Plant Room included
> All dwellings pushed to external site boundaries

Individual Section Plan 1:100

Aerial Perspective From South-West
Courtyard
Housing Pattern Typology

Aerial Perspective
From North-East

Variations of Dwelling Form

Location Plan
1:1000

Analysis Table 1 (Density):

<table>
<thead>
<tr>
<th>No. of Dwellings</th>
<th>Average Dwelling Area (m²)</th>
<th>Total Site Area (m²)</th>
<th>Building Density (% of Site)</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>90</td>
<td>3900</td>
<td>102.5</td>
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Analysis Table 2 (Infrastructure Autonomy Index):

<table>
<thead>
<tr>
<th>Infrastructure</th>
<th>Total</th>
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<tbody>
<tr>
<td>Electricity</td>
<td>5</td>
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<tr>
<td>Freshwater</td>
<td>5</td>
</tr>
<tr>
<td>Sewage</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>11</td>
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</tbody>
</table>

37% Autonomy
Potential Stylistic Representation of Housing Patterns

Adaptable

Connection between rear garden and internal spaces
Image Source: The Modern House

An aesthetic treatment of an internal courtyard
Image Source: The Modern House

An alternative aesthetic treatment of an internal courtyard
Image Source: The Modern House

Courtyard

The potential landscaping of a private courtyard space
Image Source: Right Move

Connection between internal spaces and private courtyard
Image Source: Right Move

An aesthetic treatment of the private courtyard facade
Image Source: Right Move

Village

An aesthetic treatment of the street facades
Image Source: The Sun

Private courtyard space
Image Source: Winkworth

Layering of vegetation from the internal communal space, reflecting the layers of individual courtyard spaces
Image Source: Winkworth
13.7. Supporting Quarter Acre Information

Typical Quarter Acre Housing Pattern

Table of Quarter Acre Characteristics

<table>
<thead>
<tr>
<th>Area for:</th>
<th>S1</th>
<th>S2</th>
<th>S6</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Food Production (Vegetable Garden)</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>B Food Production (Fruit Trees/Vines)</td>
<td>✔</td>
<td>✔</td>
<td>1/2</td>
</tr>
<tr>
<td>C Recreational Gardening</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>D Private Outdoor Entertaining</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>E Children to Play</td>
<td>✔</td>
<td>✔</td>
<td>1/2</td>
</tr>
<tr>
<td>F Additional Storage (for bikes, kayaks, ...)</td>
<td>✔</td>
<td>✔</td>
<td>1/2</td>
</tr>
<tr>
<td>G DIY Activities (Vehicle Maintenance, construction)</td>
<td>✔</td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td>H Secure Vehicle Storage</td>
<td>1/2</td>
<td>✔</td>
<td>1/2</td>
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</table>

Other Attributes:

<table>
<thead>
<tr>
<th>Attribute</th>
<th>S1</th>
<th>S2</th>
<th>S6</th>
</tr>
</thead>
<tbody>
<tr>
<td>I Homeownership / Owning Private Land</td>
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<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>J Connection to the outdoors</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>K DIY Eco Addons (solar coll., solar hot water, water coll., sewage)</td>
<td>✔</td>
<td></td>
<td>1/2</td>
</tr>
<tr>
<td>L Ability to personalise dwelling</td>
<td>1/2</td>
<td>✔</td>
<td>1/2</td>
</tr>
</tbody>
</table>

TOTAL SCORE (___ / 12 points) 11.5 (96%) 11.5 (96%) 8 (67%)
13.8. Layered Collection of Housing Patterns

## Layered Collection of Housing Patterns

<table>
<thead>
<tr>
<th>Common Ancestor Pattern (Quarter Acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Species Patterns (Development Approaches)</td>
</tr>
<tr>
<td>Sub-Species Patterns (Site Arrangements)</td>
</tr>
<tr>
<td>Variety Patterns (Dwelling Type/Arrangement)</td>
</tr>
<tr>
<td>Iterative Housing Patterns</td>
</tr>
</tbody>
</table>
Research Ethics Committee Approval Number: A/A

Research for this work has been conducted in accordance with the Unitec University Regulations and Policies.

The contribution of supervisors and others to this work was consistent with the

This Thesis/Dissertation/Research Project represents my own work.

| Candidate's Declaration |

Associate Supervisor: [Signature]

Principal Supervisor: [Signature]

This Thesis/Dissertation/Research Project entitled:

Name of Candidate: Edward N'dince

Declaration