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Auckland as a Water-City
Utilisation of the urban waterways for settlement development

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Abstract

Auckland’s waterways are being repressed and pushed into the background of our daily lives. The artificial land and road structure dominates the urban environment, and when it comes to accommodating urban functions, infrastructure, and urban growth, the waterways are disregarded. By repressing the city’s waterways, Auckland’s charm, unique sense of place, and identity is consequently being obliterated. It is architecture’s role to gather the environmental characteristics of the place and bring them closer to man. This research project devises a plan to regain the significance of the waterways and bring them to the forefront of our daily lives. What is proposed is the utilisation of the waterways as the building ground for urban development so that water, as well as land, can be the carrier of urban functions and infrastructure. The scheme, a residential development built on Auckland’s Waitemata Harbour, is proposed for the design.
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1.0 INTRODUCTION
1.1 Project Outline

Auckland is a city that is naturally rich with a system of water hollows, bays, and harbours. It is due to the city’s unique location—on an isthmus that is less than two kilometres wide at its narrowest point—that the city is able to occupy the entire width of land between the adjacent Tasman Sea and the Pacific Ocean. This isthmus has a remarkable degree of interpenetration of land and sea, which arguably gives Auckland a higher proportion of water surface to land area than any other city of its size, with around 70% of the Auckland region consisting of coastal waters.¹

The coastline encompasses distinctive physical features that range from boisterous west coast beaches to sheltered harbours and coastal cliffs. The Kaipara Harbour is known for its spiritual and remote wilderness. The Manukau Harbour has been popular for its resourceful waters. The Waitemata Harbour, with high recreational and aesthetic values, provides a stunning location for surrounding suburbs and the city centre. The smaller harbours, such as Mahurangi and Whangateau, also offer aesthetic, recreational and ecological values.

It is not the aesthetic and recreational values alone that give importance to Auckland’s waterways. Auckland’s ports have been vital to the successful progress of the city and region. The Waitemata’s navigable channels and the sheltered bays are what helped to determine Auckland as the site for New Zealand’s capital in 1840, and the Waitemata the site of Auckland’s chief port.² The Manukau Harbour is the site of Auckland’s western sea port and has long been a valuable link with northern and southern ports.

It is evident that the sea and the coast have shaped Auckland’s history and are central to Auckland’s culture. It is the intricate series of bays and water inlets, the fragmentation of land and sea that are an intrinsic part of Auckland’s charm and contribute largely to the reasons for which this city is loved and reputed. These unique physical attributes establish the context for Auckland’s unique sense of place and become defining features of Auckland’s identity.

What is beginning to threaten Auckland’s charm is the repression of these waterways by the dominating land and road structure. The issue is that, for most Aucklanders, the waterways are being pushed further into the background and disregarded as far as daily living is concerned. The waterways have been relegated to the superficial status of recreation and view. When it comes to accommodating urban functions, infrastructure, and urban growth, the waterways are extrinsic to this matter. By simply looking at the way in which the Auckland area has traditionally expanded, it becomes clear that the water is regarded as an urban obstacle that needs to be bridged.³ What is essentially a geographical attribute of Auckland’s site is being considered a geographical limitation. By repressing the city’s water structure, Auckland’s charm, unique sense of place, and identity is consequently being obliterated. This is the underlying issue that this research project seeks to architecturally address.

Figure 1.1.1   Overlooking Auckland City Centre and the Waitemata Harbour

³ Refer to appendix for settlement patterns
1.2 Aims and Objectives

Auckland’s waterways should not be considered an urban barrier, but, rather, a physical asset to the city as it essentially is. A city that is endowed with such an intricate system of water hollows, bays, and harbours, should utilise these as an integrated element of urban design. Auckland’s waterways are key elements in creating a unique sense of place, and should, therefore, be key elements in defining Auckland’s future growth. Urban design should not ignore the physical habitat that characterises Auckland as a city, but should instead recognise and respond to it, with development that enriches character, quality and legibility that creates a sense of place that Aucklanders can identify with.

The objective of this project is to challenge traditional methods of urban development in Auckland and propose an alternative method that would have greater consideration of the waterways. What is proposed is the utilisation of the waterways as the building ground for urban development so that water, as well as land, can be the carrier of urban functions and infrastructure. This calls for the full integration of water and architecture so that water may become an intrinsic element of urban living. The proposed design would abolish preconceptions of cities having to be land based, and instigate the shift towards the identification of Auckland as a Water-City. What this would mean for Auckland to be a Water-City is not merely the presence of water in the city, but the full integration of day-to-day life with the water so that places of residence, work, recreation, as well as transportation and services are all accommodated on the waterways.

The aim of this project is to enable water to be an integral part of how Auckland is identified as a city with the intention of reviving Auckland’s image as an attractive world-class, water based city. It is aimed at urban growth that will enhance the unique physical conditions that Auckland is endowed with, as opposed to traditional urban development which repress it.
1.3 Research Question

How can architecture enable Auckland to be identified as a Water-City?

Figure 1.3.1  Sailing on the Auckland Harbour
2.0 METHODOLOGY
2.0 Methodology

This project has been undertaken using three research methods that provide a diverse range of resources that help to architecturally address the research question posed.

Literature Survey
Literature sources were surveyed to identify important theoretical positions that defined and enhanced the project’s argument. Literature from mediums such as books, journal articles, online articles, and council documents has been investigated.

Precedents Survey
A selection of existing built and unbuilt projects that demonstrate possible architectural solutions to the research question have been studied. These precedents also give an indication of how solutions may be practically and technically applied. Precedents include those at an urban scale, as well as those of an architectural nature.

Research by design
The literature survey and precedent survey both informed and guided the project through its design phase. Research by design is a method that explored, tried, and developed possible design solutions before ultimately implementing or abandoning these ideas. This method made use of conceptual drawings, paintings, physical models, and computer models.
3.0 EXISTING KNOWLEDGE
3.1 Literature Survey

3.1.1 Architecture as Identity

In his book *Genius Loci: Towards a Phenomenology of Architecture*, Christian Norberg-Schulz presents his view on architecture as having an overriding, central purpose beyond its practical implications. He believes that the “genius loci” or “spirit of place” is a concrete reality that man has to face and come to terms with in his daily life, and that it is the essential purpose of architecture to understand and visualise this spirit of place. He states:

*The basic act of architecture is therefore to understand the ‘vocation’ of the place. In this way we protect the earth and become ourselves part of a comprehensive totality. What is advocated here is not some kind of environmental determinism. We only recognise that man is an integral part of the environment, and that it can only lead to human alienation and environmental disruption if he forgets that. To belong to a place means to have an existential foothold in a concrete everyday sense.*

Norberg-Schulz explains that to gain an existential foothold, man has to be able to identify himself with the environment. In this context “identification” means to become “friends” with a particular environment so that the environment is experienced as meaningful. He states that “human identity presupposes the identity of place”, and therefore believes it is important that our environment has a spatial structure that consists of objects of identification — these objects being concrete environmental properties. Architecture comes into being when the total environment is made visible, and this is done by buildings that gather the properties of the place and bring them close to man. Architecture, then, is understood as a means to visualise the genius loci.

In expressing the concrete environmental character of the place, the object of man’s identification is expressed. In modern society, attention has almost exclusively been concentrated on “practical” functions, and man’s friendship with the natural environment has been reduced to fragmentary relations. As a result, true dwelling has been by alienation as man has had to identify with man-made things, such as streets and houses. The essence of architecture is to put aside preconceptions and to understand the nature of “things in themselves”. This is turn creates meaningful places with which man can identify himself.

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5 Ibid., 21
6 Ibid., 22
7 Ibid., 23
3.1.2 The Essential Nature of Auckland

Kenneth Cumberland
Auckland at Full Stretch — The Essential Nature of Auckland

As Christian Norberg-Schulz argued, it is architecture’s purpose to understand and visually communicate the true nature of the environment in order to create meaningful places with which man can identify himself. It is then necessary to understand what the true nature of Auckland is in order to reinforce this project’s intention to identify Auckland as a Water-City.

In his paper *The Essential Nature of Auckland*, Kenneth Cumberland, a Professor of Geography at the University of Auckland, discusses the intrinsic characteristics of Auckland’s environment and how they contribute to the spirit of place, what he refers to as the “essential nature” of a place. Cumberland recognises that the way in which a city is viewed is coloured and conditioned by an individual’s own values, experiences and perceptions. Nevertheless, he affirms that although Auckland is experienced differently by different people, it is fundamentally the “unusual physical attributes of Auckland’s site, location, environs and hinterland [that] contribute to its essential nature.”

Cumberland explains that Auckland’s isthmian site is unique for its intrusion of estuaries, inlets, harbours, and arms of the sea that result in a remarkable degree of fragmentation and interpenetration of land and water, and a uniquely high proportion of water surface to land area. Auckland, he states, is therefore a “peculiarly scenic, maritime-urban complex” and is one of few cities that enjoy such a lengthy extent of coastline, such physical and scenic variety, and an abundance of yachts and powerboats.

It is this interpenetration of land and sea, and the abundance of water that are a basic part of Auckland’s charm. And, as Norberg-Schulz believed, human identity presupposes the identity of place, the water becomes the underlying characteristic by which Auckland and its people identify themselves, and should therefore be the characteristic that Architecture visualises.

Figure 3.1.1  Depicting the interpenetration of land and water
3.1.3 Auckland as a Water City

Richard Toy
Auckland at Full Stretch – Auckland: Water City of the South Pacific

If it is accepted that the water hollows of Auckland’s site dominate the natural structure and is therefore the underlying characteristic by which Auckland and its people identify themselves, then, as Christian Norberg-Schulz advocated, settlement should intensify and reinforce this particular characteristic in order to provide a framework for meaningful settlement.

Richard Toy, an Auckland architect and academic, explored an alternative approach to traditional urban development in Auckland that did just that. Toy argued the need for Auckland to adhere to its given, natural, own spatial typology, and the need for any artificial structure to be congruent and not in conflict with the natural structure. Like Norberg-Schulz, Toy believed that doing so would shift attention back to place and achieve “fundamental social and psychological satisfaction.”

Toy explained that firstly a switch in perception is required — a recognition of the main harbours, the inland waterways and their innumerable bays as the main living elements of the city; as the places, of residence, work, recreation and movement. He proposed a new utopian approach to settlement development in Auckland. Instead of development that privileges the isthmus with buildings centred and concentrated on the isthmus, his proposal privileges the bay as the communal centre, with pockets of sub-centres that support and are supported by it. These bay centres are directed towards the space of the waters with buildings around their perimeters. The centre of such a development is therefore space and not building. He explains that such a development would involve “Occupation of these bays so that the future city is mainly a decentralised complex of its immensely varied bays, each able to develop its own community identity to its maximum. Bay community would include not only residence but also other social services and functions, including decentralised work.”

It would also involve a different movement system that would distribute the main movements of freight as well as people over the waterways — the areas shared by the bay communities. Toy believes it to be a plan that would provide a basis for better balance in future growth and enhance Auckland’s unique place as the water-filled hollows and bays are “permeated through and through with this potential for human place and connectedness, too.”

11 Ibid., 72
12 Ibid, 70

Figure 3.1.2 Toy's Concept Sketches
Bay community directed towards the waterways | Decentralised city made up of various bays | Movement system over the waterways
3.1.4 Architecture to Combat Urbanisation

Koen Olthuis

Float!

Koen Olthuis is a Dutch architect and founder of the architectural firm, Waterstudio.NL, which specializes in floating structures. In his book FLOAT! Olthuis introduces other advantages of water-based urban development and advocates a truly alternative way of building: floating on water instead of on land to combat concerns of urbanisation.

Olthuis recognises that in a majority of world cities, water was the reason for the city’s foundation, prosperity, and was important for increasing the opportunities for trade and transport. In these cities, water is also an important spatial element. Olthuis proposes a transformation of these water cities (a city located on the water but built on land) into what he dubs Hydrocities. A hydrocity is a city structure where both land and water are the carriers of urban functions, infrastructure, and identity. He explains: “Hydrocities are the cities of the future. It is the improved version of an existing city on the water, where the boundary between wet and dry is no longer relevant.”

Another issue that Olthuis brings to attention is the ever-increasing speed at which changes are taking place. The architectural problem is that buildings can hardly keep up with these changes. Buildings are static, whereas humans and our demands are dynamic. Our dynamic demands have to be met during the building’s lifespan, but the speed and the magnitude of these changes make it virtually impossible to anticipate in advance. Olthuis believes that planning for these changes is to design without necessarily knowing all the things that are going to change. This requires a high level of flexibility. He claims that the ultimate form of flexibility is floating and moveable buildings.

By removing the permanent connection between the building and its location, a floating building can be easily relocated and used by different users during its lifetime. This has remarkable economic benefits, especially in a growing city with increasing spatial pressure, because the price of land in the central location rises faster than the material value of the building situated there. The consequence is that a building in relatively good condition is demolished due to the development potential of the location. Having the possibility to relocate means that buildings will no longer be demolished before their technical lifespan has ended just because their economic lifespan has ended. The building instead can be relocated to a spot where the remaining economic value of the construction is more consistent with the economic value of the location, and can serve out the rest of its technical lifespan.

14 Ibid., 25
15 Ibid., 37
In the report *Vulnerability and adaption to sea-level rise in Auckland New Zealand*, Georgina Hart states that the global mean sea level is rising as a result of anthropogenic climate change, and will continue to rise for hundreds of years. New Zealand’s mean sea level rose at an average rate of 1.6mm per year throughout the twentieth century. The Ministry for the Environment recommends incorporating a sea-level rise of at least 0.8m (relative to 1990) for the timeframe to the year 2100, into long-term council planning and coastal-hazards management. Some studies, however, have found that sea-level rise of 1.6m to 2.0m by 2100 cannot be ruled out. The serious risks associated with these higher estimates of sea-level rise affirm the need for strategic response measures when making decisions for long-lasting infrastructure and settlement development.

The three broad strategic options for responding to sea-level rise is to *Protect* landward property using coastal engineering structures, *Retreat* from coastal-hazard-prone areas of the coast, or *Accommodate* human settlements to the changing conditions through structural changes to buildings. Current coastal protection works include sea walls, revetments, breakwaters, and dune creation. Coastal protection attempts to “manage” natural processes rather than managing people and land use to avoid coastal hazards.

If we want long-lasting response measures, we cannot continue to modify the natural environment in order to accommodate human structures and behaviour. We must adapt human structures and behaviour to suit the natural environment. Using accommodation measures to respond to rising sea levels doesn’t attempt to control the natural processes, but rather, adjusts human structures and behaviour to minimise risk. When land is threatened by water, the safest place to be is, ironically, on the water.

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16 Georgina Hart, “Vulnerability and adaption to sea-level rise in Auckland New Zealand” (The New Zealand Climate Research Institute, Victoria University of Wellington, 2011)
17 Ibid.
18 Ibid.
3.2 Precedent Survey

Figure 3.2.1  Water edge conditions in various cities

Copenhagen  Hamburg  Venice  IJburg (Amsterdam)  Sausalito
3.2.1 Venice

Venice, Italy

Venice is a city of small islands formed by canals and connected by bridges, forming a close relationship between the urban fabric, waterways, and the sea. The city has adapted over time developing from the compact mercantile medieval republic to the present complex of a cultural emporium, industrialised port, airport, and leisure resort. 19

Dykes were used to reinforce existing islands and new islands were created by the dredging of soils to raise the ground above sea level. The basic form of the city consists of two principal canals, a network of minor canals, a pattern of small civic spaces, pedestrian streets and alleyways. The layout of the alleyways is haphazard because there had been no previous Roman settlement to provide a grid structure and no vehicular traffic to demand easy bends or wide carriageways. As the islands grew together, the streets were linked on reclaimed land or with bridges, without pre-alignment, causing offsets, twists, angles, and dead ends. 20

In most European cities, the reliance of vehicular transport has resulted in traffic dominance, but for Venice, water transportation within the city has been maintained as the only alternative to walking. The canals serve as roads, with everything travelling by water, such as rubbish collection, deliveries, transport of goods, and public and private transport. Venice is unique for having remained a sizable functioning city in the 21st century entirely without motorcars.

The buildings of Venice were constructed on closely-spaced wooden piles that were driven into the mud. 21 The most valuable properties were placed along the Grand Canal. These buildings have open elevations with two-storey facades along the waterfront. More modest houses line the canals and alleyways. Bricks, tiles, and stone were there common building materials.

20 Ibid., 38
21 Ibid., 35
Figure 3.2.3  Clustered Organisation
Organised about curvilinear line
Decentralised
Non-Heirarchical

Figure 3.2.4  Arrangement of Building Forms
Approach to building perpendicular to circulation network
Building forms used to define edges of Piazzaz
Figure 3.2.5  Circulation Network

Full integration of water-based and land-based network

Haphazard

Figure 3.2.6  Grand Canal
3.2.2 Plan for Tokyo Bay, 1960

Tokyo Bay, Japan
Kenzo Tange

Between the years of 1945 and 1960, Tokyo’s population exploded from 3.5m to 9.5 million. A significant portion of Tokyo was destroyed in the war, and the city, therefore, suffered severe land shortages and traffic congestion. The Metabolists — a new generation of architects, planners, and artists — realised the potential of Tokyo Bay. With the land in Tokyo not available for urban extension, the Metabolists proposed to simply create artificial land to build upon on the 922km$^2$ of empty sea that was right next to Tokyo’s intolerably-crowded central area of 622km$^2$. What was previously thought of as a geographical limitation was suddenly realised to be a new zone for free urban growth.

Kenzo Tange’s Plan for Tokyo 1960 is the most well known in a series of competitive schemes for the creation of an entirely new city at sea. Tange believed the cause of Tokyo’s problems to be the medieval centripetal pattern of the city and the only way to alleviate Tokyo from these problems would be a radical restructuring of the city. He believed that as a city becomes more complex in its functions, it needs to shift from a centripetal pattern to a linear pattern. Tange explains that:

“Mass communication has released the city from the bonds of a closed organization and is changing the structure of society itself. In the society with an open organization, [...] the mobility involved in free, individual communication is assuming a larger and larger scale. This movement [...] has led to extreme confusion in the larger cities.”

Tange’s Plan for Tokyo was, therefore, determined by the flows of communication and road traffic. Tange was aware of the critical role that private motor vehicles played in the transformation of city life and the shaping of new city form. He projected a linear civic axis (composed of bridges, piers, and reclaimed land) above the existing urban structure. The organisation of this axis is a linear sequence of repetitive spaces that are linked by a separate linear circulation space. The circulation space has primary roads that extend 80km from the city centre all the way across Tokyo Bay, and secondary roads that branch out perpendicular to this.

2.5 million people would work along the central axis in mega structures that would be zoned for government buildings, offices, shopping, hotels, recreation, a new central station, and new harbour for ferries. Roads that branch out from the central axis lead to the residential areas, which would house a further 5 million people in giant A-frame mega-structures made up of multiple levels up to 138m tall. On these levels residents may build their own dwellings to suit their individual tastes.
3.2.3 IJburg District

Amsterdam
Palmbout Urban Landscapes

The district of IJburg is an urban development located on the IJmeer (lake) to the east of Amsterdam. It was developed due to the demand for new housing close to Amsterdam city centre and the lack of available land to build on, and in response to future flood risks from rising water levels.\(^\text{25}\)

The IJburg master plan proposes a city model built on a loose arrangement of artificially-constructed islands. There are currently six islands and will be four more when fully completed. Although the composition of the islands as a whole is irregular, the islands themselves are organised in a simple geometric manner. The presence of several islands allows for differing water-edge conditions — some islands take on a more natural organic character with waterside gardens and beaches, whilst others take on the character of a hard-surfaced urban harbour with quayside promenades and facades dropping directly onto the water’s surface. As a whole, the urban structure is determined by two major roads — a tram and a metro line. Several bridges connect IJburg to the mainland.

Although predominantly a residential development, the buildings of IJburg are of mixed aesthetics and mixed typologies. When completed, IJburg will consist of 18000 homes as well as schools, offices, shops, leisure centres, restaurants, a beach, and a cemetery. The dwellings are a mix of apartments, townhouses, terraced houses and houseboats, many of which are self-commissioned by the occupants. There is, therefore, a high degree of variation in regards to facade arrangement and the choice of colours and materials used.

IJburg boasts the largest floating neighbourhood in the world — the Waterbuurt.\(^\text{26}\) It is a compact neighbourhood consisting of 150 floating homes at a density of 60 homes per hectare. The floating homes are constructed on concrete bases and are prefabricated allowing for customisation. The floating homes are connected to floating jetties and are plugged into the mains supply of water, heat, and electricity via these jetties. The houseboats can change and adapt to future conditions because although they are plugged in, they can always be detached, moved and plugged in elsewhere.


Figure 3.2.14 Waterbuurt

Figure 3.2.15 Master Plan determined by Metro and Tram Lines

Figure 3.2.16 Clustered organisation
Clustered, yet forms adhere to simple geometries/grid
Organised by axis
Significance of forms is articulated by size

Figure 3.2.17 Circulation Network
Grid Configuration
Figure 3.2.18  Arrangement of Islands and Circulation

Blue - Commercial Development
Yellow - Educational Facilities
Green - Recreational Areas
3.2.4 Houseboat, 2007
Eilbek Canal, Hamburg, Germany
Rost Niderehe Architects

As part of a competition for the design of ten floating homes that would be moored as a settlement on the Eilbek Canal, Rost Niderehe put forward a design that blended a traditional family home with the integral characteristics of a houseboat. The 110m² home is a compact and modern mixed-use space that incorporates home and office.

The design expresses a clear architectural language — a single wall that wraps like a spiral from the outside to the inside. The entrance is on the upper level and has the kitchen and dining room while the lower deck has the bedroom, bathroom and living area.

The material choice was influenced by the technical requirements of naval architecture. The house is constructed of a prefabricated steel wall system with wood-wrapped skin. It is intended for adaptive use as it can simply be moved to a new destination with the help of a tug.

28 Ibid.,

Figure 3.2.19 Section showing internal arrangement
Figure 3.2.20 Houseboat
3.2.5 Water Villa de Omval, 2010

Amstel River, Amsterdam, Netherlands
+31 Architects

Water Villa de Omval is a floating house that was modelled after the design of traditional floating houses but with the use of modern methods. It’s a structure that combines functionality and minimalist design. The 200m² home has two levels with the upper being level with the water and the lower level being underwater — a decision based on a height restriction of 3m imposed by the local rules. The upper-level houses the Living, kitchen and dining area from where there is a panoramic view at the Amstel River. Following from the upper level is the bedroom located on a split level. The split level is the route to the lower level and, at the same time, forms a terrace on the roof of this level without exceeding the maximum building height. The lower level houses a bedroom, bathroom, study, and technical room.

The curve of the exterior facade is constructed of white corrosion-resistant aluminium composite panels. These are bonded to a thermoplastic core, which has a strength-to-weight ratio that is nearly double that of steel. The interior walls and ceilings are of white plaster, which follow the curve of the exterior facade, creating a seamless transition from the exterior to the interior.

3.2.6 Mega Float, 1988

The largest floating structure ever built is the Mega-Float, a floating airport runway prototype constructed in Tokyo Bay. It was used until the end of 2000 for technological research to verify taking-off and landing tests with use of light aircraft, and to verify commercialization. All reports of the tests show that the results were even better than expected with the platform behaving very stably, with basically no movement caused by waves or planes landing or taking off.³⁰

The Mega-Float has a deck area of 84,000m² with dimensions 1000m in length, 60m in width, and 3m in depth. It consists of six units, which were welded into one huge structure. The Mega-Float was constructed of steel with walls or pillars inside a box structure and was designed for a lifetime of 100 years.

Although the Mega-Float has been used to land small planes on, its size is only about a quarter of the real proposed airport runway. The floating runway proposed for Tokyo International Airport Haneda has a length of 3600m and will be dubbed the Ultra Large Floating Structure.³¹

³⁰ Alexey Andrianov, “Hydroelastic Analysis of Very Large Floating Structures” (PhD diss, Technical University of Delft, 2005)
³¹ Ibid
3.3 Methods of Building on Water

3.3.1 Land Reclamation

Reclamation by Dredging
One method of constructing new land is to use sand, clay or rock that has been excavated from the bottom of the sea. Dredging vessels are used to gather the material from the seabed and redistribute it at the required location.

Drained Reclamation
The method of Drained Reclamation involves depositing layers of earth and sand on the seabed and then consolidating it through a pressurisation process into new land. Water is extracted from within the layers of earth through weep-holes, which is similar to pressing down on a sponge full of water. This is a simple process and is relatively cheap compared to other methods of reclaiming land.

Reclamation by Deep Cement Mixing
Deep Cement Mixing slowly injects and blends cement into the soft mud of the seabed, stiffening it into the form of cement columns. New land is then built on top of these columns.

Downfalls of Reclamation
Land reclamation in whichever method, however, can create adverse environmental impacts. The creation of new land can be damaging to the marine habitat, disturbing to the aquatic ecosystems, and create coastal erosion due to the disruption of natural currents and wave patterns.

3.3.2 Pile Structures

Fixed Pile Structure
Another means to occupy the water is through the construction of a raised, fixed structure which is typically supported by widely-spread piles. Such a structure may include platforms, bridges, or walkways. The platforms can range in size and complexity from a simple lightweight wooden structure to major structures that extended over 1600 metres. Using lighter pile structures to support the platform allows tides and currents to flow almost unhindered. Using more solid foundations or closely-spaced piles (such as for a wharf) allows the structure to act as a breakwater, but is more liable to silting.

Telescoping Pile Structure
The Telescoping Pile Structure is a floating platform system that combines the benefits of a traditional pile system with the clean visual look of an anchored dock system. The pile features an outer sleeve that is secured into the seabed and an inner piston pile that is attached to the underside of the dock. As the sea level changes with the tides, the piston pile moves up and down within the sleeve keeping the pile fixed to the dock and the dock floating at sea level.

Figure 3.3.1  Pier in Olypia, Washington
Wood and Concrete
3.3.3 Floating Structures

Standard Floating Structure
The standard floating structure is a solid body made of reinforced concrete and an inner chain of chambers that are filled with a lightweight impermeable material, typically polystyrene. Such a structure is designed to be buoyant using the exact same principle as ships: displacement. Floating homes and commercial structures are able to be built in one piece where launching and transportation is practical, but may otherwise be built in components and assembled closer to the site. Such platforms are also fully insulated.

Very Large Floating Structures
Very Large Floating Structures may be classified under two broad categories, namely the semi-submersible type and the pontoon type.

Semi-submersible
The semi-submersible type is necessary in open seas where wave heights are relatively large. They are fixed in place by column tubes, piles, or other bracing systems to minimise the effects of waves while maintaining a constant buoyant force. VLFSs of the semi-submersible type are typically used for oil or gas exploration at sea.

Pontoon type
The pontoon type is a simple flat box structure that simply floats on the sea surface and is, therefore, very flexible compared to semi-submersible structures. The pontoon type is a reliable structure typically constructed of steel and concrete with the interior being divided into many buoyancy air chambers. Even if water leaks into one or two chambers, the neighbouring chambers will provide sufficient buoyancy for the complete structure. The structures may be very large in size, from 500 to 5000 meters in length and 100 to 1000 meters in width, while their thickness can be from 2 to 10 meters. When such a large surface area is needed, the structure may be constructed by joining a number of floating units together.

32 Alexey Andrianov, “Hydroelastic Analysis of Very Large Floating Structures” (PhD diss, Technical University of Delft, 2005)
Advantages of Floating Structures

Floating structures are advantageous over traditional land reclamation due to several reasons:

Manufacturing
The system has low manufacturing costs and is easier and faster to construct than reclaimed land due to the components being prefabricated in a shipping yard and then assembled at the site. All services can be designed to be incorporated into the platform. The structure can also be easily expanded by attaching additional floating units.

Durable
The system has a lifetime of about 100 years and is easy to maintain and repair if needed. Standard structures are maintenance free and never need to be hauled out for painting or scraping below water line. The system is also fireproof and non-combustible.

Portable
Although, floating structures are generally moored at the same site for a long time, the system can easily accommodate future changes as it can be easily removed, transported and relocated to a new site.

High stability
Platforms are heavy with a low centre of gravity providing a safe structure that is unsinkable under any conditions. Very small local deflection occurs in the structure but the movement is so slight that it can hardly be noticed. A limitation is that the structure is only suitable for use in calm waters associated with naturally-sheltered coastal formations, often in bays, lakes, harbours or sea areas near the shoreline. To reduce the impact of waves, breakwaters are usually constructed nearby. Special anti-motion devices, anchoring or mooring systems can also be used to stabilize the platform. The system is also protected against seismic shock as the forces are dissipated by the sea.

Environmentally friendly
Floating structures have less adverse effects on the environment than reclaimed land would as it does not damage the marine ecological system, silt up deep harbours, or disrupt the sea currents as reclaimed land would. The materials used are also non-toxic and inert. Studies have shown that floating structures have only a minute impact on the natural ecosystem.

33 Alexey Andrianov, “Hydroelastic Analysis of Very Large Floating Structures” (PhD diss, Technical University of Delft, 2005)
3.4 Summary of Research

The literature and precedent surveys provided some strong examples of architectural theory and design language that could be incorporated into and developed in the design phase of this research project.

The theories to be adopted by this project are notably:

- The theory expressed by Christian Norberg-Schulz that the central purpose of architecture is to understand and visualise the essential nature of a place in order for the built environment to become a meaningful object of man’s identification.

- The theory that the essential nature of Auckland, as expressed by Kenneth Cumberland, derives from the uniquely high proportion of water to land, and the scenic interpenetration of the two. It can, therefore, be concluded that it is architecture’s purpose to visualise Auckland’s particularly water-full environment, and by doing so, the object by which man identifies himself is expressed and is able to be experienced as meaningful.

- The notion introduced by Richard Toy that the harbours and waterways be recognised as the main living elements of the city, and serve as the communal centre. Also, his concept of a city that is connected rather than separated by water that utilises the waterways to accommodate the city’s movement and transportation systems, and connect sub-centres to one another.

- Koen Olthuis’s concept of a Hydrocity, so that Auckland be a city where both land and water are the carriers of urban functions and where the boundary between wet and dry is no longer relevant.

- The idea of urban structures to be floating on water in order to respond to issues of urbanisation as well as environmental issues, and sea-level rise as a result of climate change.

Established in the precedent examples are certain design principles that may be incorporated into the design phase. While each example exhibits design principles that differentiate one from the other, this project intends to extract and integrate the design strengths while disregarding the design weaknesses.

The design principles to be adopted in the design phase of this project are notably:

- The clustered, cellular organisation of the Venetian islands. The clustered organisation allows for variation in size and shape of the design, which results in interesting spaces. Venice also exhibits a good balance between the land-based and water-based structure, and intricately integrates the two in the network of circulation spaces. A downfall of the plan of Venice, however (in terms of modern master planning), is the absolute randomness and lack of order that it possesses, and the inability to accommodate for vehicular transport.

- The concept of linear circulation spaces, as exemplified by Kenzo Tange’s Plan for Tokyo Bay, designed for smooth-flowing movement and a hierarchy to be achieved through design between primary and secondary circulation routes. A downfall of the Plan for Tokyo bay is the prioritised vehicular circulation network and the extreme segregation of vehicular and pedestrian traffic.

- Master planning based on simple geometries as exemplified in the plan of IJburg. Although seemingly irregular because of a clustered arrangement, the islands themselves are based on a simple structural grid.

- The concept of floating homes that are connected to floating jetties and plugged into the mains supply of water, heat, and electricity via these jetties. The floating homes can change and adapt to future conditions because they can always be detached, moved and plugged in elsewhere.
4.0 PROJECT DEVELOPMENT
4.1 Design Bief

The objective of the design phase is to design a floating Water-Complex. A Water-Complex may be defined as an urban development located on an urban waterway that comprises of residential, recreational, commercial, and public facilities.

The concept for this Water-Complex is based on Richard Toy’s concept of the Bay Community, in that it is intended to be one of many, and act as the prototype for further future developments on the water. Collectively, the numerous Water-Complexes located on the urban waterways will form a Water-City; i.e., Auckland will become a Water-City. In this Water-City, the waterways will serve as communal open space as well as accommodate the movement systems, including public and private transport, freight, and servicing, such as rubbish collection.

The majority of infrastructure making up the Water-Complex is intended to be floating. This includes floating buildings, floating roads and floating open public spaces. Although the concept of the Water-Complex intends it to be a mixed-use development, this project will focus primarily on the design of the residential development within the complex. Residential development will comprise of various housing types and accommodate the changing demographic. Housing for young couples, families, and single-parent families will be provided, along with a number of private spaces to provide these residences with a level of individual identity within the wider community. A progression from private, to semi private, to public spaces will also allow for an environment that is attractive to visitors and the public without compromising residential comfort. The open public spaces provided will cater to a range of users and include parkland, recreational facilities, and public walkways.

The Water-Complex will essentially be an integration of the land structure and the water structure. The complex will be accessible from both land and water. Circulation spaces will accommodate land-based vehicular traffic, water-based vehicular traffic, and pedestrian traffic. Vehicular use on site will be minimised, but not eliminated. The vehicular access to individual dwellings will be investigated as well as space for parking, including public visitor parking. Mooring areas for residences water vehicles will be provided.
4.2 Site

Figure 4.2.1  Map of New Zealand

Figure 4.2.2  Map of the Auckland Region
4.2.1 Site Selection

Site Selection Criteria
The selection of an appropriate site for the Water-Community was dependent on the following criteria:

- Proximity/ connection via water to the CBD
- Accessibility via land and water
- Connection to public transport system (bus and ferry), or potential for connection.
- Public visibility
- Location without pre-existing urban development

The Water-Community needed to be tactfully located within reasonable proximity to Auckland’s Central Business District and have direct connection to it via water. This relationship to the CBD is essential to the success of such a proposal to re-establish Auckland as a Water City because of the potential to demonstrate how Auckland and its sub-regions can be a city that is connected by water, as opposed to the current impression of Auckland being a city that is segregated by water. Consequently, accessibility to the site and the connection to the public transport system (via water as well as land) are also important.

As a re-invention of Auckland’s image as a Water-City would require a change in people’s perception of what Auckland’s image is, a location with high public visibility would be advantageous to the success of this proposal. A location with high public visibility would enable the Water-Community to self-promote the advantages of the integration of urban functions with water, allowing public awareness of this new mode of urban development.

Because this is a proposal for an unprecedented mode of urban development in Auckland, it seemed logical to locate this Water-Community away from existing urban centres so that the full extent of possibilities of urban development on water can be demonstrated.

Waitemata Harbour

Due to the requirement for the location of the Water-Community to be within reasonable proximity of Auckland’s Central Business District, the analysis of Auckland’s waterways for site selection has been restricted to that of the Waitemata harbour.

The Waitemata Harbour is an arm of the Hauraki Gulf and is located to the north of the Auckland isthmus. With an area of 120m², the harbour extends 18km west from the end of the Rangitoto Channel. To the north lies North Shore City, with coastal suburbs, including Birkenhead, Northcote, and Devonport. To the south lies the heart of Auckland City, with the Auckland waterfront and coastal suburbs, such as Mission Bay, Parnell, Herne Bay, and Point Chevalier.

The harbour is the main access by sea to Auckland City and has been the main anchorage and port even before European settlement. The sheltered bays and navigable channels are what made it an important waterway for Maori, and subsequently the determining factors in choosing Auckland as the site for New Zealand’s founding capital in 1840.

Figure 4.2.3  Map of the Waitemata Harbour

Use of Harbour

The recreational opportunities that the Waitemata Harbour provides are of great importance to Auckland’s identity and liveability. Our water features have significant natural and cultural values, and contribute to our sense of place. Many residents and visitors enjoy beaches, coastlines, lakes, wetlands and streams for swimming, boating, diving, surfing, fishing and other activities.

Figure 4.2.4 is an indication of the current degree of use of the harbour. The brighter to lighter shaded areas indicate a high level to low level of recreational use of the harbour respectively. Shipping routes and smaller commuter ferry routes are indicated, showing that the more active area is at the mouth of the harbour between Auckland Central and Devonport.

In selecting a site, it seemed important to choose a location for the Water-Community that would cause little disruption to the pre-existing flow of activity within the harbour.
Ecology
The preservation of marine areas is fundamental to the future quality of Auckland’s waterways. Ecological areas have to be taken into serious consideration when selecting the site for the Water-Community. It is important that the Water-Community has little adverse effects on the marine environment.

Figure 4.2.5 indicates the significant ecological areas of the Waitemata Harbour.

The inner harbour is strongly influenced by tidal rivers, particularly in the west and north of the harbour. Mudflats covered by mangroves, and saltmarshes flourish in these conditions. The bright blue indicates the protected coastal ecological areas, and the darker blue to the south-west is the protected Pollen Island Marine Reserve, which is the best example of a mangrove saltmarsh in Auckland.
Tidal levels
The Auckland region experiences one of the highest tidal ranges in New Zealand, sometimes experiencing a range up to 3.5m. Because of this, coupled with shallow seabed depths in certain areas, a significant portion of the Waitemata Harbour becomes drained at low tide. A site is preferable in a location with a continuous presence of water that isn’t drained at low tide. This enables a continual connection via water to the CBD.

Figure 4.2.6 indicates the water area in the harbour and how this area progresses from low tide to high tide (brighter shaded area to lighter shaded area respectively). The navy blue indicates the current land area that would become inundated and a part of the harbour area should the sea level rise 1m as a result of climate change.

4.2.2 Selected Site

Taking into consideration the site selection criteria set out above and the analysis of the Waitemata Harbour, the site for the Water-Community was chosen to be located on the waterway adjacent to Birkenhead Wharf and Hinemoa Park.

This site, located 4km from Auckland Central, is advantageous because of its close proximity to the CBD and its accessibility via both land and water. There are already existing public transport connections via ferry between Birkenhead Wharf and the CBD, and via bus between Birkenhead Wharf and Albany Station. The location has the opportunity to be strongly connected to the CBD by the water and to act as an extension of the city centre in the same way that existing city-fringe villages, such as Ponsonby, Parnell, and Newmarket, do.

The chosen site is also advantageous because of its visible but not dominating location. It is visible predominantly from Northcote Point, Westhaven, Herne Bay, Te Atatu and while travelling over the Harbour Bridge. Visibility from several locations around Auckland gives this proposed development the opportunity to act as a strong statement in favour of the re-invention of Auckland’s image and the shift towards it becoming recognised as a Water-City.

The site is conveniently located at the base of a 60m cliff, with the adjacent existing residential community starting at 40m above the site. This means that although there is high visibility into the site, development on the site would not dominate the existing community or disrupt their valued views of the Harbour Bridge or the cityscape. This also means that there is no urban development directly adjacent the site, so that the possibilities of urban development solely on the water can be fully explored.

The site is also located in an area of the harbour where there is a medium level of recreational use. This means that development there would not disrupt the areas of high recreational use or shipping and commuter ferry routes.

Development on this site would not affect any protected ecological areas, marine areas, or bird wading areas. The closest significant ecological area is Little Shoal Bay, which is a significant bird wading area.

The location of this site is also continuously connected to the CBD as it is one of the few coastal areas of the harbour that does not drain out at low tide.
4.2.3 Site Analysis

Site Usage and Activity
Currently located around the site are the Birkenhead Wharf and Ferry Terminal, Hinemoa Park, and Aratica Water Sports Club.

The site is accessed by water via commuter ferry or by land via Hinemoa Street. The red dashed lines indicate the area used for vehicular parking, which is highly used on the weekdays by working commuters who park and take the ferry to the CBD. Indicated in orange is the pedestrian access from the existing community through the conservation area to Hinemoa Park.

The water is an area of medium-intensity recreational use. Use of the boat ramp is highly popular on the weekends. The dashed blue lines indicate a designated mooring area of the harbour.

The existing community is comprised of detached single housing with predominantly a New Zealand-European demographic. This community is somewhat visually and physically disconnected from the site because of a 40-60m vertical separation. Adding to this separation is the highly-vegetated conservation bush area in between the community and the site.
**Tidal Levels**
Auckland tidal levels in relation to chart datum (approximately lowest astronomical tide)\(^{36}\) are:

- Mean high water spring (MHWS) = 3.30m
- Mean high water neap (MHWN) = 2.78m
- Mean low water neap (MLWN) = 0.95m
- Mean low water spring (MLWS) = 0.41m

The values for the MHWS, MHWN, MLWN and MLWS tidal levels are the averages of the levels of all spring and neap tides predicted to occur under average meteorological conditions during the period 1 January 2000 - 31 December 2018. A spring tide is a tide just after a new or full moon. A neap tide is a less-than-average tide occurring at the first and third quarters of the moon.

The average tidal range for a spring tide is 2.89m. Auckland experiences one of the highest tidal ranges in New Zealand, and tidal ranges exceeding 3.5m do occur.\(^{37}\)

**Topography and Bathymetry**
Figure 4.2.8 shows the terrain heights of the land and the subterranean depths of the harbour. Land heights are measured in meters above Mean High Water Spring. Sea depths are the underlined figures that are measured in meters below chart datum.

The brightest blue area indicates the area of water that dries at low tide. The image depicts the rapid increase in depth of the sea bed and the steepness of the land adjacent to the site. The existing wharf and shoreline adjacent to the existing park is 3m above MHWS.

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\(^{37}\) Maximum tidal ranges exceeding 3.5 metres occur at Onehunga, Port Taranaki, Nelson, Westport and Auckland. Early February of 2014 saw high tide reach 3.7m in Auckland, 0.6m higher than normal due to king tides, which occur when a spring tide occurs at the same time as the moon is at its closest to the earth.
Climate

Figure 4.2.9 sows the impact of wind and sun on the site. Prevailing winds are from the southwest, west, and northeast.

4.2.10 shows the effect of sun and shadows on certain areas of the site. Where the land gradient is gradual there is minimal shadows created. However, the diagram shows that land areas with a steeper gradient are affected with shadows extending out up to 35m from the land.
Viewpoints
Figure 4.2.11 indicates the direction of the viewpoints from the site with the darkness of the shaded area indicating the degree of significance of the view, and the length of the shaded area indicating the distance of the viewpoint from the site.
5.0 DESIGN PROCESS
5.1 Conceptual Master Planning

5.1.1 Initial Concept

The initial concept for the Water-Complex consists of one large floating structure that accommodates the main residential area and integrated commercial development. The complex is accessed by two bridges — one from the existing wharf and another from the eastern side of the park. The main laneway is positioned on the south-east length of the complex and provides a direct route between both bridges. Secondary laneways branch off the main laneway. The buildings, depicted in black, take on the form of an urban city block with a central courtyard. They are two to four storeys in height, with commercial development on street level and residential above. The ferry building is located on the southern end of the complex. On the north-east length of the complex is a mooring dock for water vehicles as well as detached floating homes. Off the south-eastern length of the Water-Complex floats a recreational park. The entire Water-Complex is orientated towards the views of the Harbour Bridge and city.

The main issue with this concept was that it lacked integration of the waterways with the land structure, which should be the central aspect of design. The design is also somewhat frivolous in that it does not relate to the architectural language uncovered in the precedents research. Also uncovered in the research were the great benefits of a floating structure being able to detach itself from a development and relocate to a location elsewhere or perhaps another Water-Complex built in the future. Having one large floating structure on which buildings are fixed eliminates the possibility of relocation of individual housing units. The building typology also needed to be reconsidered as it is in conflict with the adjacent existing residential area, which comprises of traditional detached family homes. Because of all of these issues, the concept was abandoned.
5.1.2 Combining the Cluster, Tree, and Grid

Intended for the Water-Complex master plan is the employment of the architectural language that was uncovered in the precedent studies. Each of the precedent examples of Venice, Plan for Tokyo Bay, and IJburg, however, exhibit a distinct and differentiating architectural language. Therefore, intended for the master plan of the Water-Complex is the adoption and integration of each of the design strengths while abandoning the design weaknesses.

The architectural language to be adopted from the precedent examples are:

- **Figure 5.1.2 Combining the Cluster, Tree and Grid**
  - Venice: Clustered organisation of the Islands
  - Plan for Tokyo Bay: Linear Circulation Network with secondary network branching off Islands based on simple/grid geometries
5.1.3 Fracture Patterns

Initial conceptual design was instigated by sketches and paintings of fracture patterns found in the rocks of local Auckland beaches. The fractures are caused by excess stress that causes the rock to lose cohesion and form a network of crevices. The network of crevices allows for water movement through the rocks. What is interesting about these fracture patterns is that this natural occurrence coincidentally has strong formal parallels to the cluster, tree and grid concepts combined.

The fractures divide the rock into clustered forms, which could be interpreted as island forms. While each cluster form is organic, there exists some sort of regularity between them due to the evident grid-like pattern. The network of crevices that allow for natural water movement through the rocks could be interpreted as a water-based circulation network between islands. There is a network of crevices that are larger and clearly defined, and a second network of crevices which are narrower and less defined. This could parallel a hierarchical circulation network, such as one with a primary circulation route of higher traffic flow with a secondary circulation route of lesser traffic flow branching off.
Drawings progressed from pencil sketches to watercolour paintings of fracture patterns. These paintings depict an intentional distinction of figure and ground in order to bring the crevices, i.e. waterways, to the forefront of the painting. This elevates the status of water from a background element to a primary element of design. The intention is that when it comes to translating these paintings into conceptual design, emphasis is placed on the design of the waterways — the communal space, the open space, the public space — rather than the land.

What these paintings highlight is that although the fractures are all natural and organic, there are remarkable inherent geometries present within the formations. There are evident parallel lines and grid-like patterns along with strong bold diagonals that break up the regularity of the grid. Since it is all natural, there are, of course, variances with every form being unique. When translated into a design, it is these variances, these little accents and quirks that create evocative and interesting spaces.
Figure 5.1.6  Water Colour Painting of Fracture Patterns
Figure 5.1.7  Translating Painting of Fracture Patterns into linear forms
The Water-Complex is primarily a residential development, but also includes a recreational park area and a wharf area with a ferry terminal and commercial development. The residential area is to dominate in size and be situated nearest to the shore in order to have a direct relationship with the existing residential area. This way, it also has more of a private positioning as it is set back from the wharf. The wharf area is more public and positioned farthest out from the shore in order to have direct ferry connection to the city centre as well as being visually connected to the city centre. The additional park area will be located opposite the existing park in order to create a connection between the two recreational areas. All three zones are positioned triangularly to make each zone easily accessible by one another, and positioned in such a way to allow all areas to maintain a visual connection to the city centre.
5.1.5 Design Concept

This concept of the Water-Complex developed directly from the previous exploration of the formal qualities found in fracture patterns. The concept also displays design principles that derived from the precedent studies. The islands are clustered in nature, yet each adheres to a simple geometric grid. The circulation network comprises of primary laneways with secondary tree-like laneways branching off from it.

The Water-Complex is accessed by vehicles via a laneway that extends out from the east of the existing wharf and meanders its way through the plan. At the centre of the plan is water — a marina serving as communal open space and a mooring site for water vehicles. A raised pedestrian boardwalk extends out from the existing park all the way to the ferry terminal area, providing a leisurely walk rich in sea and city views. It also provides more of a direct connection to the existing residential area for local commuters. Park area located north-east of the plan is orientated towards the city views. Dwellings, at this stage of design, are expressed as a simple massing and aim to demonstrate possible private courtyard spaces created by their arrangement.

With this concept model, however, there were several issues to address. One major issue was that the circulation route through the site is meandering and indirect. The wharf area needs to be more easily accessible, and vehicular entry to the Water-Complex could be more appropriately located. An alternative is also needed for the dead end laneways, and more of a destination created at each end. Orientation was another major issue, as the majority of residential massing was not ideally located to benefit from the beautiful city views. The residential buildings, indicated as blocked masses, are suggestive of several housing units occupying an island cluster. A clustered island form, on which several housing units would be situated, eliminates the possibility of relocating individual dwellings. Additional to this, the wharf area lacked open space and the building sizes were too dominating for a primarily residential complex.
5.2 Master Plan Development
5.2.1 Circulation Network

The Water-Complex is an integration of the land structure with the water structure, and is a concept that promotes circulation via the waterways. However, due to Auckland’s current reliance on cars and the current conditions of public transport, the master planning calls for a scheme that will also accommodate for vehicular use.

The circulation network is a combination of a primary circulation network, secondary circulation network, and pedestrian network. The primary network is comprised of laneways that accommodate both vehicular and pedestrian traffic. The implementation of shared street space reduces the dominance of vehicles and regains vitality within the street space. The secondary network is comprised of narrower laneways with one-way vehicular traffic. These laneways are more private and are provided primarily for residential access. The pedestrian network is an even narrower laneway accommodating only foot traffic.

The circulation network from the Design Concept needed to be reconsidered; though, major improvements to the network were achieved through minor variations in the design. This phase of design explores the development of the primary circulation network. One design consideration was that the laneways be arranged in a manner that will allow all areas of the complex to be accessed not only by land, but also by water. No area should be enclosed unless able to be bridged, or not intended to be occupied by dwellings.
Figure 5.2.2  Initial Concept’s Circulation Network

Figure 5.2.3  Circulation Network 2
Same circulation route as, but a direct route to the wharf is added

Figure 5.2.4  Circulation Network 3
Vehicular access to the Water-Complex is relocated to extend from the southern end of the existing wharf. This creates a more direct connection to the existing road, as well as a direct connection to the new wharf area. This is the circulation configuration chosen to be developed.

Figure 5.2.5  Circulation Network 4
An additional laneway is added to the previous concept to eliminate the dead end and to provide better access to the dwellings
In the preceding design concepts, the buildings were indicated as blocked masses, which was suggestive of several housing units (whether that be apartment, townhouse, or detached housing) occupying an island cluster. A clustered island form, on which several housing units would be situated, eliminates the possibility of future relocation of individual dwellings. For this reason, clustered island forms were abandoned for residential purposes, but maintained in other areas. The buildings thereafter progressed into single detached floating homes. Another reason for this change was to relate to the surrounding residential context by employing the same housing typology — detached family homes.

The individual floating homes were initially orientated with the shorter face of the building fronting the laneways. The way in which the dwellings were orientated meant that the majority of the interior spaces would be orientated towards the façade of the neighbouring dwelling, leaving only the shorter façades to be subjected to natural light, or have outside views. To solve this issue, the floating homes were rotated to have the longer face of the building fronting the laneway, allowing for more natural light to penetrate the interior spaces, as well as more of the interior spaces being presented with outside views. One of the issues with the general positioning of the dwellings was that outdoor deck areas and courtyard spaces would be subject to prevailing south-west winds. Dwellings were shuffled into positions that would create sheltered and more intimate communal outdoor spaces.

5.2.2 Building Arrangement

Figure 5.2.6 Concept with revised circulation route
It was decided to retain a few apartment blocks on the northern side of the complex. The mixed housing typologies mean that the Water-Complex could accommodate a wider range of residents and cater for the changing demographics that require smaller housing units. The greater height of the apartment blocks and their position on the northern side mean that the top levels will still have city views without restricting the views of the other residences. Ground level of the apartment blocks will also accommodate small commercial businesses, which is another reason for their location — the laneway linking the vehicular entrance to the site and the ferry terminal, and the laneway leading to the recreational parkland are the busier areas of the complex.

Figure 5.2.7 Concept with dwelling forms

Figure 5.2.8 Concept with dwelling forms reorientated
5.2.3 Parking

**Water vehicle parking**
Every area of the complex is accessible by water, and mooring facilities for motor vehicles are provided in the central marina. Each floating home is also accessible by water, with mooring provided for residents’ water vehicles on the sea-facing deck of the home.

**Car Parking**
Although the concept for the Water-Complex does promote transportation via the waterways, the plan does accommodate for car use, and, with the complex’s location on sea water and subject to salt sprays, car parking schemes needed to be investigated. The easy option would be to provide open car parking spaces along the laneways adjacent to the floating homes and ferry terminal area. This would be a reasonable option for short-term parking, but not for long-term residential parking as salt spray has long-term implications, causing rust damage to vehicles. For this reason it was important to provide parking spaces that would be protected from the elements.

The first scheme provides grouped garages that are positioned at several points along the laneways on the opposite side of the floating homes. The idea is to have the garages integrated into the landscape and disguised as terraces so to not to be visually intrusive. There are a couple of issues with this scheme, however. One is that although the garages are integrated into the landscape, having a row of garage doors facing the floating homes is visually unappealing yet unavoidable. The second was that having garages detached from the homes is in opposition to modern housing design where the car port would typically be connected to the home for comfortable and easy access from the car to the home.

The second scheme relocates the garages to be connected to each floating home. As obvious as this solution seems, it was not the initial response as it was thought that the weight of the vehicle could cause imbalance in the floating structure. With that determined not an issue, the garages were positioned on the western side of each home so to not obstruct from solar gain or city views.
5.2.4 Environmental Considerations

Floating Wetland
An environmental issue that is posed by the Water-Complex being built directly on the water is the potential adverse effects that contaminated storm water runoff could have on the harbour’s water. Therefore, implemented into the design of the Water-Complex is a storm water detention basin that utilises a constructed wetland water treatment system. Like the majority of the infrastructure of the Water-Complex, the basin itself is also floating. The basin is a large, shallow pond that will intake storm water runoff and treat it before discharging it into the harbour. The wetland system will provide a relatively passive, natural, low-maintenance and operationally simple treatment solution that will filter the water and remove sediments and contaminants.

Traditional constructed wetlands involve the use of sediment-rooted emergent wetland plants, with water flowing amongst the stems. The Water-Complex, however, will employ a variant of this system — a floating wetland system — that involves the use of emergent plants that grow as a consolidated floating mat on the surface of the water rather than rooted in the sediments. Because they float on the water surface, floating wetlands are affected little by water-level fluctuations (during times of high rainfall), that may submerge and adversely stress sediment-rooted plants. Treatment occurs as water flows through the root zone of the plants, rather than amongst the stems, and the plants acquire their nutrition directly from the water, rather than from the soil. The emergent species that are recommended for New Zealand and are able to grow well in floating wetlands are species such as Carex, Cyperus, Schoenoplectus, Baumea, and Juncus.

The storm water-detention basin is to be located between the two residential laneways to the southwest of the complex, which is an ideal location as vehicular access is required for both the inlet and outlet structure for maintenance purposes. The constructed wetland will additionally provide home and shelter to wildlife, as well as add aesthetic and recreational value to the Water-Complex. The floating vegetated mats may consist of one large mat, or several smaller mats. Either way, an open water zone is required for re-oxygenation of water prior to discharge.
Tidal Energy
Tidal energy is a form of hydropower that captures the energy from masses of water due to tidal force. Greater tidal ranges can dramatically increase the potential of a site for tidal electricity generation, and as Auckland has one of the highest tidal ranges in New Zealand, the implementation of a small-scale tidal basin was investigated for the design of the Water-Complex. The tidal basin is a dam-like structure that makes use of the potential energy in the difference in height between high and low tides. When the sea level rises and the tide begins to come in, the water flows through turbines into the basin. At high tide, the sluice gates close, holding a large amount of potential energy until the tide goes out. At low tide, the large mass of water is released rapidly back through the turbines. The turbines capture the energy as water flows in and out, and the energy is then converted into electricity through the use of generators. Because tides occur due to the gravitational interaction with the Moon and Sun and the Earth’s rotation, tidal power is practically inexhaustible and classified as a renewable energy resource. Tides are also predictable occurrences. This means that this system can operate simply by measuring the tidal flow and controlling the sluice gates at key times of the tidal cycle.
The tidal basin is to be positioned in between the land and the Water-Complex. It is created using the existing shoreline and additional constructed barrages. The energy available from a basin is dependent on the volume of water. It is estimated that from the volume of water retained by the basin, 60622 kWh of electricity could be generated per annum. This is equivalent to the average annual electricity consumption of 7.8 standard New Zealand homes and means that once divided amongst the 52 dwellings in the Water-Complex, each household could reduce its annual electricity consumption by 15%.

There are several uncertainties with this proposition of tidal energy generation. Tidal energy schemes have very high capital costs and, as calculated, a low rate of return. Some sources state that a tidal range of at least 5m is required in order for a scheme to be successful. There are many recent technological developments, both in design and turbine technology, that indicate that the total availability of tidal power may be much higher in the future, and that costs may be brought down to competitive levels. Tidal energy could become a vital part of Auckland’s energy future, but based on current calculations, the implementation of a tidal basin into the design of the Water-Complex was discontinued.
5.2.5 Reorientation

A continuing issue present in Design Concept 2 is that its orientation prevents the majority of the residential area from having city views — which is a very attractive characteristic of the site, and should, therefore, be taken full advantage of. The solution to this was to rotate the plan so that the circulation network remained somewhat the same, but the vehicular access is yet again relocated to extend out from the east of the existing wharf.

The geometries of the previous circulation network were redefined so that the raised boardwalk is orientated at an angle that is directed towards the harbour bridge and city views. The laneway from the residential area to park area runs perpendicular to this boardwalk, so that dwellings located on this laneway will also be directed towards the views. The laneway that provides vehicular access to the Water-Complex is orientated west to east.
5.3 Building Design

5.3.1 Dwelling Design

This phase of design explores the spatial arrangement of the internal spaces. Room size, orientation, placement within the dwelling, privacy levels, interior flow, and connection between internal spaces and the exterior were considered.

When designing the internal spatial arrangements there was a constant battle between orientation of the living areas towards the Sun to the north and orientation towards the stunning sea and city views to the south. The challenge was to create an interior arrangement so that the overall design would benefit from both. Despite this conflict, it was ultimately decided that for both forms, the living rooms should be orientated towards the north.
**Floating Home**

Initially (when the dwelling masses were orientated with the shorter face fronting the laneway), two different plans were drawn for the floating homes. Both are of the same width, but one is a longer single-storey dwelling and another is a shorter double-storey dwelling. Both plans have two variations because although each variant is orientated in the same direction, one allows for the entrance on the south face and the other on the north face, depending on its location within the Water-Complex.

The single-storey floating home is a one-bedroom, one-bathroom unit with living and dining facing north and the bedroom facing south. There are two deck areas — one to the north and a smaller one to the south. The identified issues are the lack of storage space, and the entrance of the 2nd variation results in an impractical foyer area and a restricted dining area. It was decided that the single-storey plan would not be implemented as floating homes because of its impractical use of space within the complex. The plans would instead be implemented as apartment units.

The double-storey floating home is a two-bedroom, one-and-a-half bathroom unit. The lower level has an open floor plan with the living room to the north, dining in the middle, and kitchen to the south. On the upper level is the study and master bedroom to the north, and second bedroom and bathroom to the south. The identified issues are the study facing north, no en suite bathroom for the master bedroom, and lack of storage space.
Figure 5.3.2 Double Storey, Two Bedroom

Figure 5.3.3 Floating Homes
As mentioned in the building arrangement section, the way in which the dwellings are orientated creates issues. The length of the dwellings being orientated towards the neighbouring façade means that only the shorter facades have reasonably sized apertures to let light and sea views in. Following the rotation of the forms to have the longer face of the building fronting the laneway, a new plan for the double storey floating home was developed. The plan is for a three-bedroom, two-bathroom unit with attached garage. There are also two variations of this plan — one with the entrance from the south and the other with the entrance from the north.

The lower level comprises of living room, dining, kitchen, reading room, first bedroom, bathroom, garage with laundry. Both variations in the plan have the living area orientated to the north and have a double-height sloping ceiling. In the plan where the southern façade is fronting the laneway, the northern deck is larger and has the living room, dining, and first bedroom opening up onto it, while the southern deck is smaller and has the reading room opening out onto it. Where the northern façade is fronting the laneway, both decks are of the same depth because although the northern deck will be orientated towards the Sun, it is less private facing the laneway, and although the southern deck is not orientated towards the Sun, it is more private and orientated towards the stunning sea and city views. In this plan, the northern deck has the living room and reading room opening up onto it while the southern deck has the dining room, kitchen, and first bedroom opening up onto it. Both plans have the garage and laundry positioned on the west side. The upper levels of both variations are identical and comprise of the master bedroom with en suite and walk-in wardrobe, second bedroom, study, and roof deck.

It was important that the form of the building be designed as a physical response to the climatic conditions. With the homes being a floating structure on water, the aerodynamics of the buildings form was taken into consideration in order to minimise lateral instability due to wind. The site has prevailing winds from the south-west; therefore, the floating homes are designed with sloping roofs in this direction. The roofs are also fitted with solar panels.
Figure 5.3.3  Double Storey, Three Bedroom

Variation 1

Variation 2
**Apartment Block**

Each apartment block is made up of four adjacent masses which are three storeys high. The ground level is allocated for commercial use, including but not limited to retail, hospitality, entertainment, and small businesses. The upper two levels consist of residential apartment units.

The commercial units are accessed directly off the laneways from the south and have through connection to north facing decks with views of the existing park. Between the building masses are voided spaces that contain the vertical circulation to the upper levels.

The plans of the apartment units were adapted and developed from the plan of the single-storey floating home. They are likewise a one-bedroom, one-bathroom unit. The main difference is the position of the entrance which is now located on the side of the unit. There are also two variations of this developed plan because of the entrance doors having to be located at opposite ends of the unit on the different levels. In the first variation, the living room is also orientated to the north, the kitchen/dining and bathroom central to the plan, and the bedroom and study to the south. In the second variation, both the living room and kitchen/dining is orientated to the north. The units have a north-facing deck onto which the living areas open up. The aspects that have improved on the single-storey floating home plan are the more practical entrance and foyer space, more comfortable internal flow, provision of adequate study space, and provision of adequate storage space.
Similarly to the design of the master plan, the design of the ferry building took its visual clues from a product of nature. The design of the ferry building was based loosely on the formal characteristics of the water cabbage — an aquatic plant with thick leaves that floats freely on the surface of the water. Again, this object of nature was taken to because of the similarities it shares with the formal concepts of this project — free-floating urban structures.

Initial conceptual design developed from stylised sketches of the aquatic plant. The characteristics accentuated were the formation of the leaves in a rosette and the way in which they rise up and out diagonally from the centre point. These sketches then progressed to plaster models that were experimented with to see how these characteristics could be translated into an architectural language. The models are of triangular-shaped wedge forms that are arranged in ways to create different spatial qualities.

The developed design for the ferry building is comprised of four masses which are arranged radially in plan. The four masses have avoided space between each of them, which is a formal characteristic relating to the design of the apartment blocks. The roof of the building slopes up and out, and the building itself is orientated towards the sea and the city.

It is a way of visually emphasising the connection the Water-Complex has with the city, in that it is an extension of the city centre - connected rather than segregated by the water.

The entrance to the ferry building is on the north-west face. To the north of the building is the terminal area and mooring wharf for the incoming and outgoing ferries. The building is integrated with commercial development — retail and cafés positioned on the south-western edge and orientated towards the public open space adjacent to the building.
Figure 5.3.8  Experimental models of radial building forms
6.0 DESIGN OUTCOMES
6.0 Design Outcomes

Site Arrangement
The Water-Complex is predominantly a residential development with wharf, ferry, commercial and recreational facilities integrated into the design. Residential apartment blocks are located north of the complex. They are positioned on the laneways, which are likely to be more public and have more traffic due being the connecting routes between the existing land and the new wharf and ferry building, and the new park area. Their position on the northern side also means that the greater height of the apartment blocks will not disrupt the sea and city views from other areas of the complex. Residential floating homes are located south-west of the complex and are integrated with semi-private, shared open parkland. The new wharf area and ferry building is located south-east of the complex, which is the ideal location in order to have ferry connection with the city centre. Commercial development is integrated in the new ferry building as well as on the ground level of the apartment blocks. The new public park is located north-east of the complex and has a close connection to the existing park. There is a central marina and floating wetland, which boasts aesthetic and recreational quality.

Circulation
The Water-Complex’s main access is from the southern edge of the existing wharf. The primary circulation network is comprised of the laneway, which extends from the existing wharf to the new wharf, and the intersecting laneway, which extends from the residential area to the new park. The secondary laneways are the narrower one-way lanes accessing some of the floating homes. These laneways are a shared space between vehicles and pedestrians. The raised pedestrian boardwalk is the second access point to the complex and extends from the existing park to the new wharf. Every area of the Water-Complex is accessible by water.

Transportation
The concept of the Water-Complex encourages public transportation — via water and land. Although the complex incorporates vehicular use, residents are encouraged to commute via ferry to the city centre or any other area of Auckland connected by water. The existing ferry building will be re-established as a bus station so that public transportation via bus will be encouraged for areas inaccessible by water.

Mooring
Mooring facilities for motor boats are provided in the central marina. Mooring facilities for sail boats are also provided in this marina, but on the edge of the new park because the raised boardwalk may prevent the entry of sailboats with tall masts. This marina is located adjacent to the existing official open-water mooring site.

Car Parking
Uncovered public car parking is provided at a few points along the laneways, and adjacent to the new wharf and new park. Although some public parking is provided, it is not encouraged by the design. The majority of public parking remains on the land as it is currently positioned. Each floating home has one private car park.

Public Open Spaces
The public open spaces are namely the new wharf area, the new park, around the central marina and floating wetland, and public walkways. These are leisurely, recreational areas that are landscaped. The residents are provided with semi-private open spaces that serve as a communal back yard.
Floating Wetland
The floating wetland is located in the enclosed water area amongst the residential development. The wetland is beautifully landscaped offering aesthetic and recreational amenities and shelter for wildlife, additional to serving its technical purpose of treating the complex’s storm water runoff before releasing it to the harbour’s water.

Dwellings
The floating homes make up the majority of the residential area. The complex will incorporate both two-storeyed floating home plans, which were explored in the design phase. The first one of which is the two-bedroom plan, the second is the three bedroom plan. The apartment blocks comprise of one bedroom plans. The provision of a range of dwelling sizes means that the Water-Complex can accommodate a range of demographics, which will ultimately result in a livelier settlement development. The floating homes are provided with garages; apartment blocks are provided with street parking.

Services
The laneways of the Water-Complex are connected to Auckland’s main water supply, wastewater network, electrical grid, and telecommunication network. The floating homes, apartment blocks and ferry building are connected to the laneways and hence plugged into the city’s services. Rubbish collection is in the traditional manner via the laneways. However, if more Water-Complexes are to be developed in the future, rubbish collection will be possible via the waterways.
**Connection to land**

The existing wharf and shoreline adjacent to the park is 3m above Mean High Water Spring. With the finished floor level of the Water-Complex situated at 1m above the water level, there is a 2m height difference between the floating structure and the land at MHWS. At Mean Low Water Spring there is a 4.89m difference between the floating structure and the land, which is rounded to 5m for design sake. The Water-Complex is connected to the land via a ramp to enable vehicle access. Even at the ramp’s steepest, with the height difference of 5m between the floating structure and land, a ramp with a horizontal length of 60m would enable a comfortable slope ratio of 1:12.

The raised boardwalk is a concrete pile structure constructed at 5m above MHWS that is fixed to the land and seabed. The boardwalk doubles as an anchor to which the floating infrastructure is tied by a ring mechanism that provides it with lateral stability while simultaneously enabling free vertical movement with the tides. Pedestrian connection between the boardwalk and new wharf is via telescoping terraced steps that allow the riser heights to increase and decrease with the changing tides. At its maximum, the terrace riser height will be 25cm.

**Structure**

The Water-Complex utilises the technology of the pontoon-type Very Large Floating Structure, which is constructed of concrete and steel. The floating structure of the floating homes, although not categorised as VLFSs, are prefabricated constructions and also constructed of concrete and steel. Both floating structures are proven to have high stability and buoyancy. Floating breakwaters are employed in the scheme to minimise wave movement. The breakwaters are visually and environmentally unobtrusive as the majority of the structure is below the water surface, yet allows free movement of the current below it.
Figure 6.0.4 Residential area and floating wetland
7.0 CONCLUSION
7.0 Conclusion

The suppression of Auckland’s waterways and the dominance of the man-made land structure in our urban environment is an underestimated yet critical issue. It is a trend that risks the alienation of Aucklanders within their own city because of being forced to identify with a meaningless man-made urban structure rather than the natural environment. This research project explores an architectural solution to this issue that would offer Auckland and its people a meaningful environment to identify with. Christian Norberg-Schulz’s theory that human identity presupposes the identity of place establishes that humans require a spatial structure that consists of objects of identification — these objects being the environmental properties of the place, and that the underlying purpose of architecture is to visually express these environmental properties. Auckland’s environment boasts a remarkable degree of fragmentation and interpenetration of land and sea. It is a city with an abundance of water — this becoming an intrinsic part of Auckland’s charm. The water, therefore, is the environmental property, and hence the object of identification, which architecture is required to visualise. The notion is that by offering an architectural solution that expresses the city’s water structure, Auckland’s charm, unique sense of place, and identity will be enhanced.

The research explores the opportunities of a city structure where both land and water are the carriers of urban functions, infrastructure, and identity. Floating architecture is introduced as a building solution for the future. The ability of floating architecture to accommodate for unknown future changes, relocate entire buildings to another location, and be a proactive response to the threats posed by climate change and rising sea levels, has remarkable long-term economic and environmental benefits. The proposed design of the Water-Complex makes formal references to several architectural precedents, namely, Venice, Plan for Tokyo Bay, and IJburg that all exhibit unique formal characteristics making each particular plan successful. The design also makes formal references to patterns found in nature. The combination of these references results in a plan that is functional yet full of character. In this plan, the boundary between wet and dry is no longer relevant. It brings water into the public eye, provoking a change in our perception of the urban structure and promoting the integration of the natural environment with our everyday lives. It is a plan that recognises the physical habitat that characterises Auckland and responds to it with development that enriches character, quality, legibility, and, thereby, creating a sense of place that Aucklanders can identify with.

The Water-Complex is a concept that has a lot of promise for the future. It may be seen as a prototype for further future developments on the water. If such an idea is implemented, and a number of these developments are built on Auckland’s waterways, the city may very well be recognised and identified as a Water-City, not only by its residents, but by the world. Such a scheme would be made even more achievable with Auckland Transport’s plan to increase ferry transportation and the number of ferry terminals in Auckland by 2040. In such a city, the waterways may serve as a communal open space accommodating a majority of the city’s movement systems, including public and private transport, freight, and servicing, such as rubbish collection.

If this concept were to be further investigated, it is suggested that the economic implications of such a scheme be investigated. If economically feasible, this plan, which already technically feasible, could be transformed from an architectural idea into a concrete reality. This project focused primarily on residential development. If investigated further, it is suggested that mixed-use developments also be explored — a development that integrates office buildings, civic buildings, commercial buildings, and public amenities. If realised, the development need not be the work of a single architect. Such a scheme may be comprised of the works of several architects. The buildings may be designed according to the client’s specific needs and each unique to its neighbour.

Water based settlement would be a complete switch from the land-orientated occupation we are implementing at the moment, although, ultimately, the two could be richly complementary.
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**Tidal Energy Calculation**

The potential energy contained in a volume of water is \( E = \frac{1}{2} A \rho g h^2 \)

where:
- \( h \) = vertical tidal range = 2.35m (median tidal range between spring and neap tides)
- \( A \) = horizontal area of the basin = 19577m²
- \( \rho \) = density of water = 1025 kg/m³ (seawater varies between 1021 and 1030 kg/m³)
- \( g \) = acceleration due to the Earth’s gravity = 9.81 m/s²

The factor half is due to the fact that as the basin flows empty through the turbines, the hydraulic head over the dam reduces.

Potential energy content of the water in the basin at high tide = \( \frac{1}{2} \times \text{area} \times \text{density} \times \text{gravitational acceleration} \times \text{tidal range squared} \)

\[ = \frac{1}{2} \times 19577 \times 1025 \times 9.81 \times (2.35)^2 \]

\[ = 543556561 \text{ J} \]

There are two high tides and two low tides every day. At low tide the potential energy is zero. Therefore the total energy potential per day is

\[ = 54356561 \times 2 \]

\[ = 108711322 \text{ J} \]

Assuming the energy conversion efficiency of the generators to be 55%, the daily energy potential is

\[ = 108711322 \times 0.55 \]

\[ = 597912217 \text{ J} \]

With 365 days in the year, the annual energy potential is

\[ 597912217 \times 365 = 218237959200 \text{ J} \]

Converted to kilowatt-hours is

\[ = 60622 \text{ kWh} \]

The New Zealand national average annual electricity consumption per occupied dwelling is 7,800 ± 420 kWh, therefore the potential electricity generated by this scheme is equivalent to

\[ = 60622 \div 7800 \]

\[ = 7.8 \text{ standard New Zealand homes} \]
Appendix 2