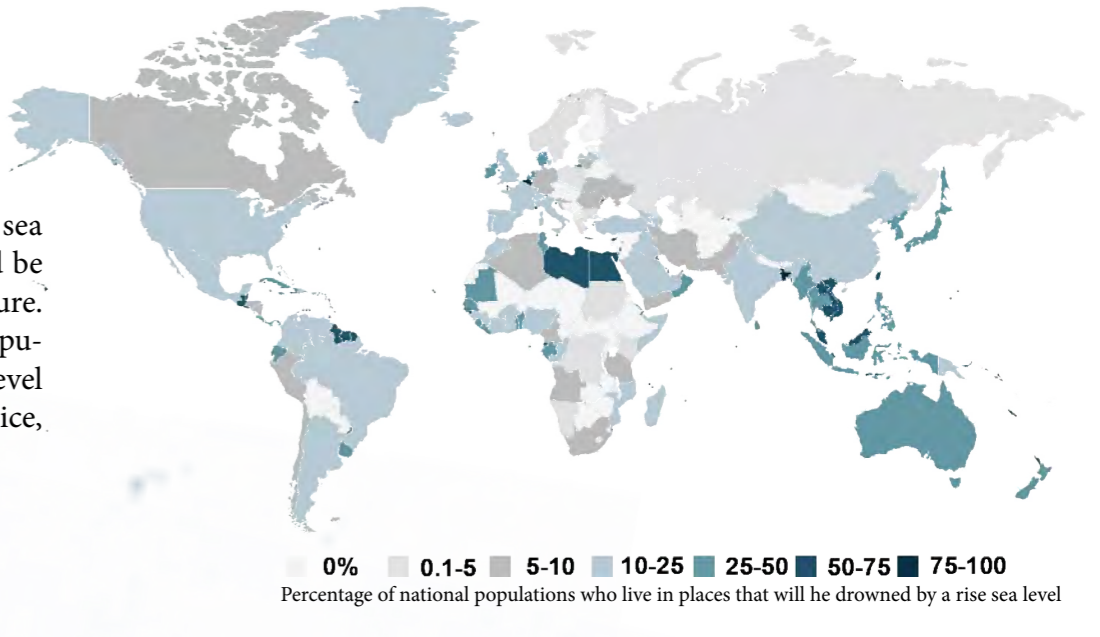


300 million of global population will be effected by sea level rise by 2050

Sea level rise has been one of the most widely discussed issues about global warming. In the last century, the world's sea level has risen by 10-20 cm on average. A large portion of the population on the earth live in coastal areas that could be influenced by rising sea levels. Furthermore, the population living near the coast will potentially increase in the future. The coastal area is often the most economically and socially prosperous district, in which about 60% of the world's population lives. These areas will be the hardest hit area with the rising sea level. In terms of relevant research, when sea level rises above 1 meter, some of the world-class cities will face serious inundation risks, such as New York, London, Venice, Bangkok, Shanghai, and Sydney.



Sea Level Rise in NEW ZEALAND

As an island country, New Zealand will be massively influenced by the sea-level rise in the environment, society, and economy. In the 20th century, the sea level had risen to 200 mm in New Zealand, and is expected to rise by 300-400 mm in the next 3 to 4 decades. Moreover, research also has shown that sea level will increase by 5-10% more than the global average in New Zealand and eastern Australia because of the geographical location. More serious and frequent flooding will occur as a result of rising sea levels. A recent study has demonstrated that after sea level rise for 0.8m, 150000 New Zealanders will live in areas with the risks of being inundated by an extreme storm flood.

1m sea level rise as projection for 2100

The flooding hazards are changing by location. Canterbury and Hawke's Bay faces the highest risk. The plain in Canterbury is extremely vulnerable, caused by the low-lying topography. Christchurch is a coastal city in east Canterbury, with a large amount of population in the coastal area. With merely 80cm of sea-level rise, about 33640 people will potentially suffer from flood risk during an extreme storm event.

Site Location

South New Brighton is a coastal suburb in the east of Christchurch and approximately 10 km from the city centre. Surrounded by water on both sides, the area is deeply connected to water. Residents, visitors, and Ngāi Tahu all highly appreciated the views of the beach, the ocean to the east, Avon river, and the estuary to the west. Therefore, South New Brighton offers excellent entertainment opportunities and a strong sense of community, making it an ideal place to live with a unique natural environment.

In 2011, the earthquake caused huge damage in this area, with coastal suburb affected by a series of natural hazards such as flooding, Tsunami risk, and land damage. With the rise of sea-level, the area will face more risks. However, this dynamic coastal environment has opened up a lot of potentials to create a resilient community.

Design Vision

South New Brighton will revolutionize into a stronger, more resilient coastal community which has ability to adapt to risks caused by 1 meter sea level rise. The design will relink human to water, create a harmony between life and nature, to create space for better quality of life.

- Goal one**
Protecting lives, properties and the land from future natural hazards caused by sea level rise (SLR), especially flooding.
- Goal two**
Restoring biodiversity and maintain natural character of the estuary and coastal environment.
- Goal three**
Strengthening the local community, make the place attractive to people again.

Design strategy

PROTECT

Sea level rise and flooding events and the multiple values of the coastal area pose a critical need for protection. We need to adapt the existing structures and lifestyle to the effects of climate change.

RESTORE

Rising sea level and more frequent storm events will result in higher inundation risks in the low lying area. We need help restore the local ecological functions while increasing its retention capacity. The restored natural framework could also become a resource for community growth. And we also need to restore the connection between the community and the water.

CONNECT

To improve the accessibility of the community by introducing new innovative transit modes. We also need to connect the community to more nature, activities, and open spaces, while connecting resources and infrastructures in a sustainable way.

GROW

To help invest in local education, training and culture to help empower the community around its identity, economic development and growth.



Reformatting urban building, streets and lifestyle. Breaking the boundary between urban life and natural environment. Propose a intimate relationship between community and water.

- More adaptive housing type
- Introducing floating house
- Introduce water transport
- Food and energy production
- Water purification
- Extended river corridor

- LEGEND**
- Wetland restoration
 - Extended flood plain
 - Proposed amphibious community
 - Urban stormwater management
 - Existing green space
 - Stop banks
 - Proposed Walking/Cycling trail
 - Proposed water transport
 - Elevated road
 - Existing Bus route
 - Proposed bus route
 - Education center

Design Phasing



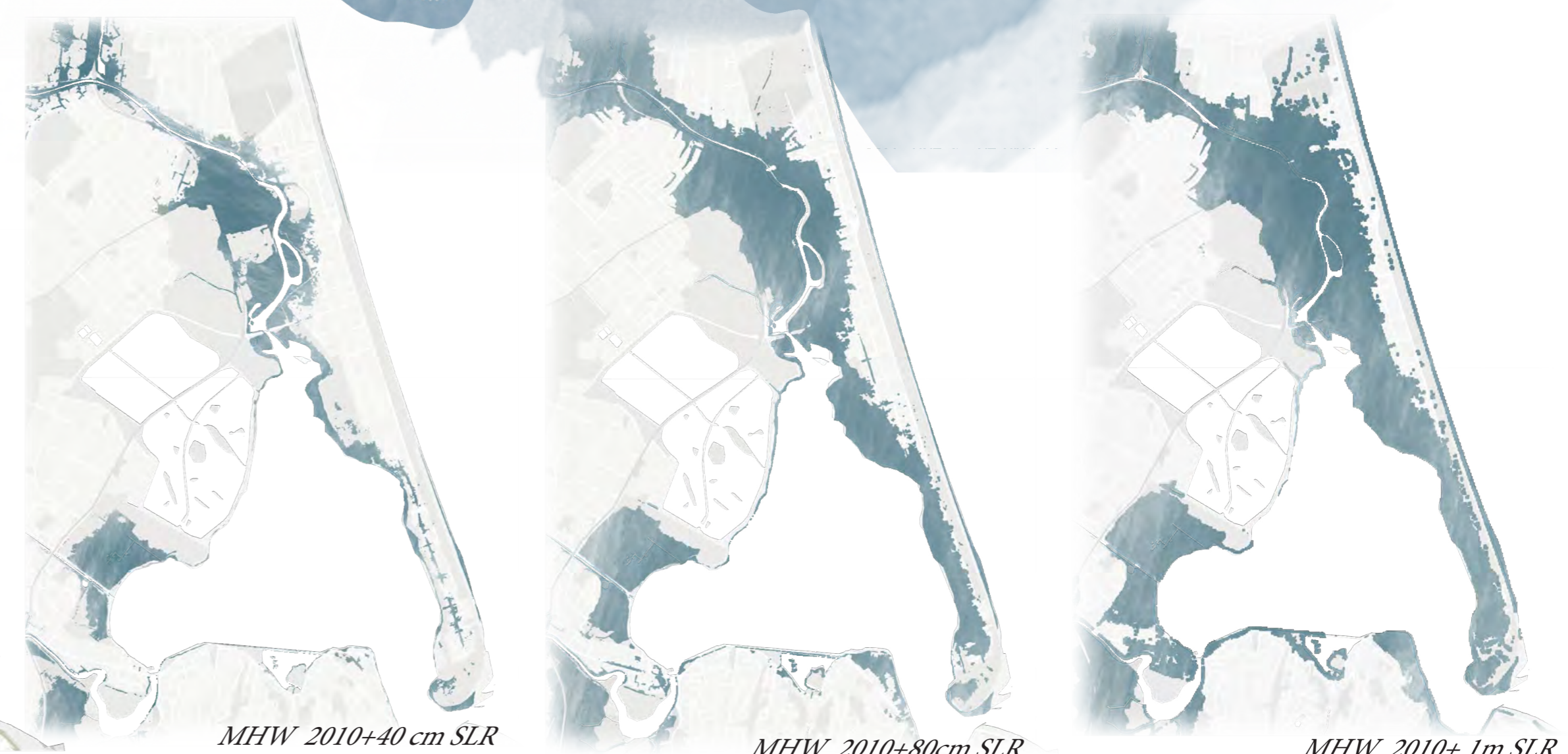
A combination of soft and hard protect strategies have employed to mitigated impacts of rising sea level and annual flooding event. The design strategy will be to minimize encroachment on private property and alter only public land uses.

- Living shoreline(flood plain)
- Green infrastructures such as bioswale and rain gardens applied along streets
- Dam repair
- Regenerated native ecosystem

Building further robust ecological edges along both shoreline and river bank of the neighborhood.

- Gradual retreat urban development from low-lying area to higher ground.
- Sand dune enhancement and nourishment.
- More water front recreation and education opportunities
- Dam reinforce and retreat
- Introducing new public transport route
- Introducing elevated house

"Business As Usual"



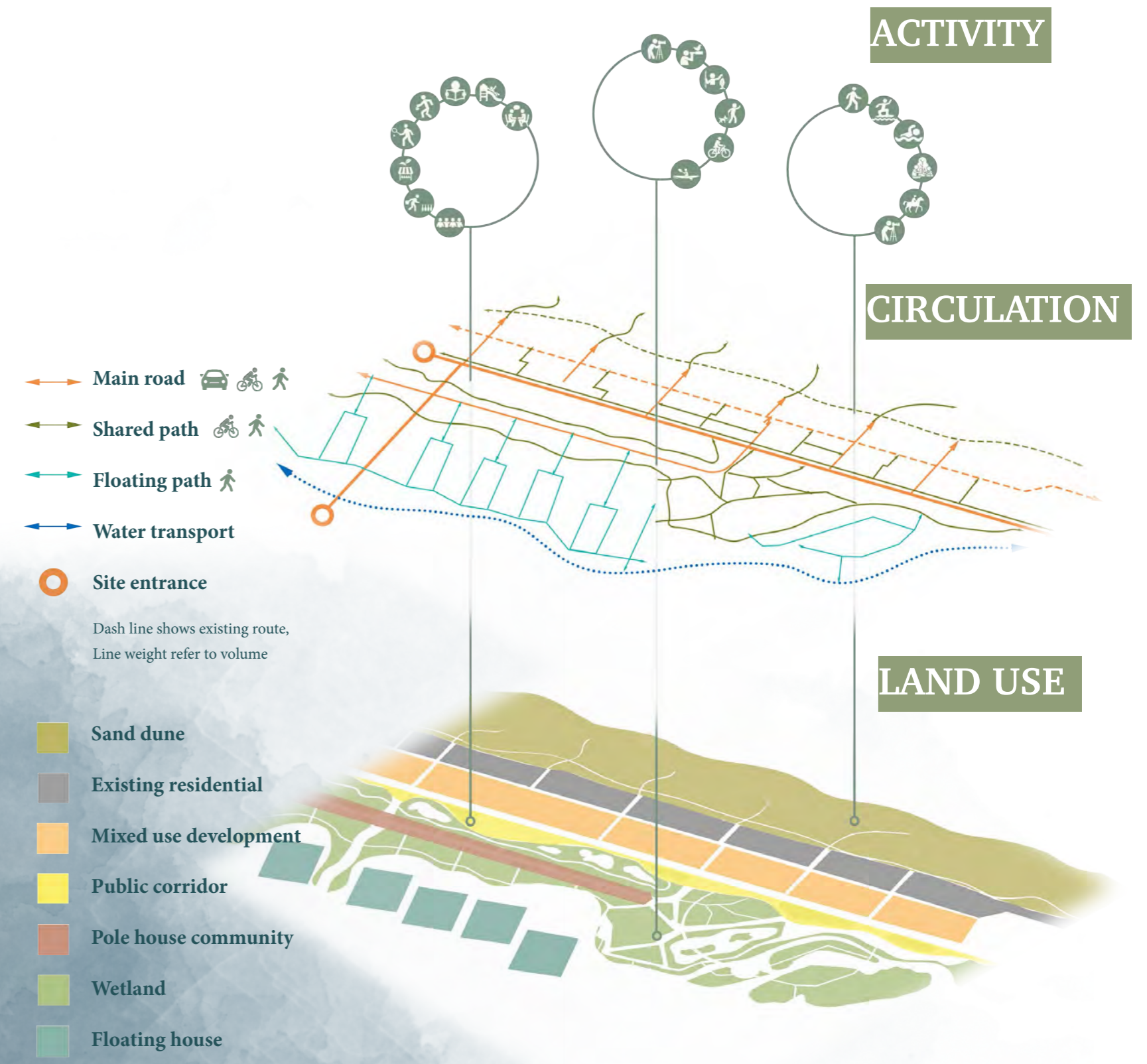
Rational

Approximately 10 km from the city centre, South New Brighton is a coastal suburb located in the east of Christchurch. Surrounded by water on both sides, the area has a deep connection to the sea. South New Brighton is a coastal suburb in the east of Christchurch and approximately 10 km from the city centre. Surrounded by water on both sides, the area is deeply connected to water. Residents, visitors and Ngāi Tahu all highly appreciated the views of the beach, the ocean to the east, Avon river and the estuary to the west. Therefore, South New Brighton offers great entertainment opportunities, and strong sense of community, which makes it an ideal place to live with the unique natural environment.

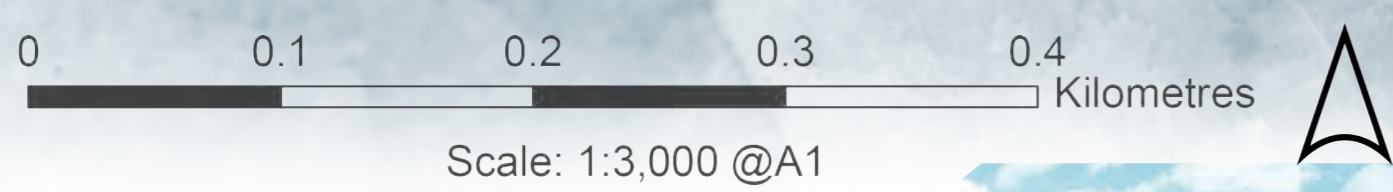
In 2011, the earthquake has caused huge damage in this area, with coastal suburb affected by a series of natural hazards such as flooding, Tsunami risk, and land damage. With the rise of sea-level, the area will face more risks. However, this dynamic coastal environment has opened up a lot of potentials to create a resilient community.

Design Concept

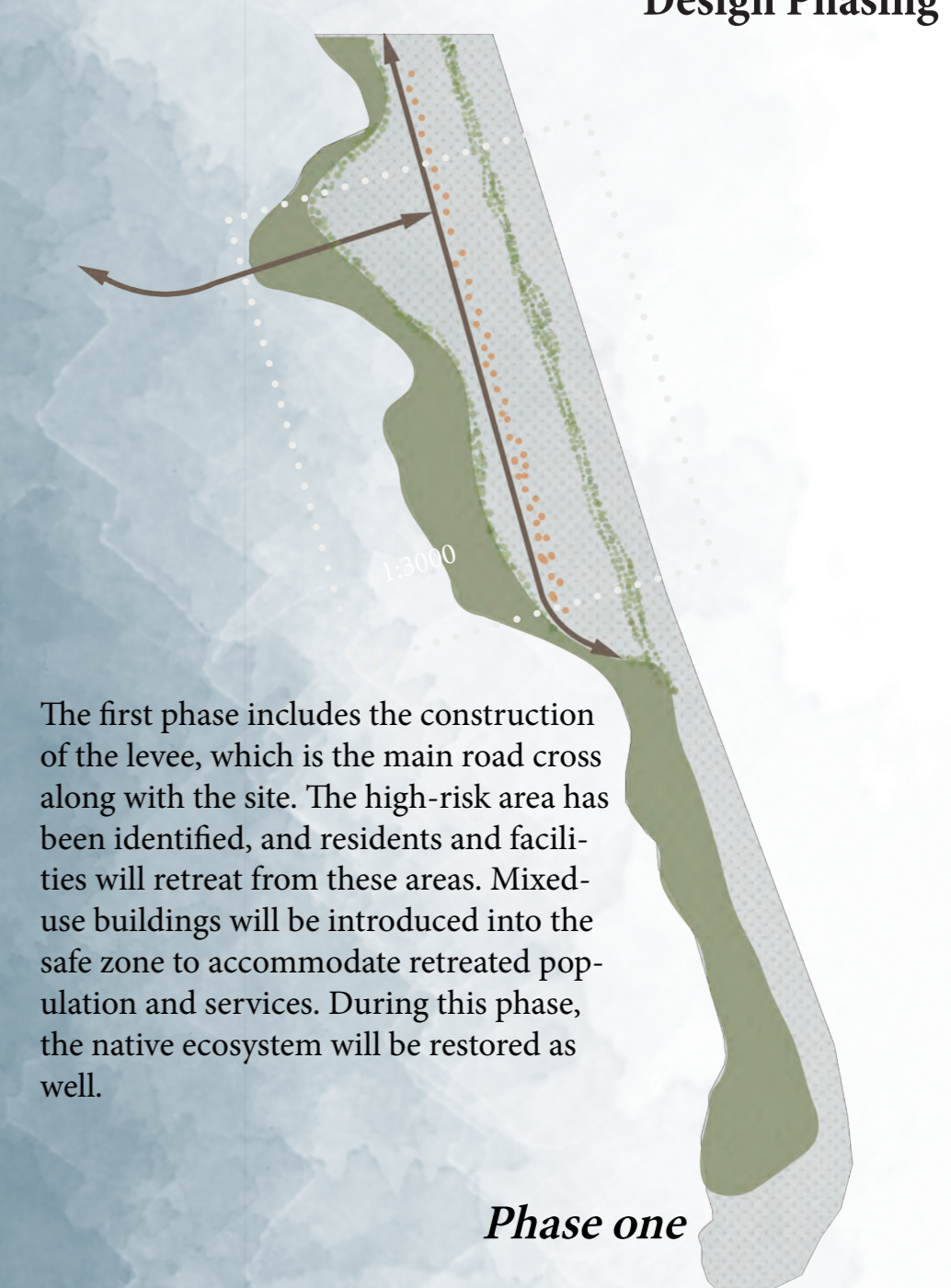
The Master plan aiming to address the site issues caused by sea level rise. Series of design intents make the community stronger when facing risks caused by sea level rise. Rather than keep people away from water, this design tends to welcome the water into the community, people can live with water. South New Brighton will become a resilient coastal community.



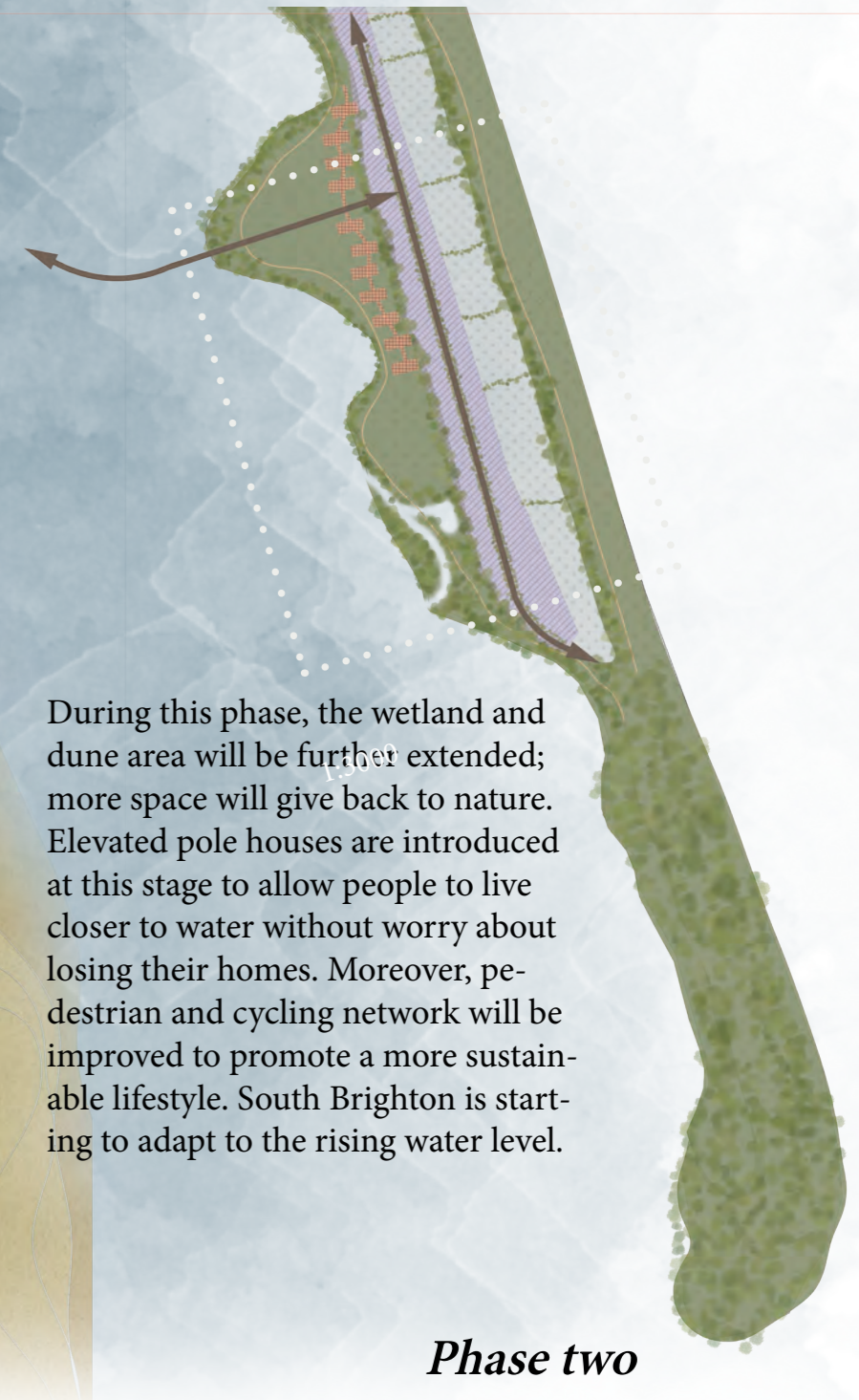
- LEGEND**
1. Wetland community
 2. Boardwalk
 3. Restored saltmarsh
 4. Proposed floating community
 5. South New Brighton school
 6. Yacht club
 7. Native coastal forest
 8. Viewing bridge
 9. Stormwater basin
 10. Sport field
 11. Camping park
 12. Bird island
 13. Outdoor gallery
 14. Proposed mixed use building
 15. South New Brighton surfing club
 16. Proposed water transport



Design Phasing



The first phase includes the construction of the levee, which is the main road cross along with the site. The high-risk area has been identified, and residents and facilities will retreat from these areas. Mixed-use buildings will be introduced into the safe zone to accommodate retreated population and services. During this phase, the native ecosystem will be restored as well.



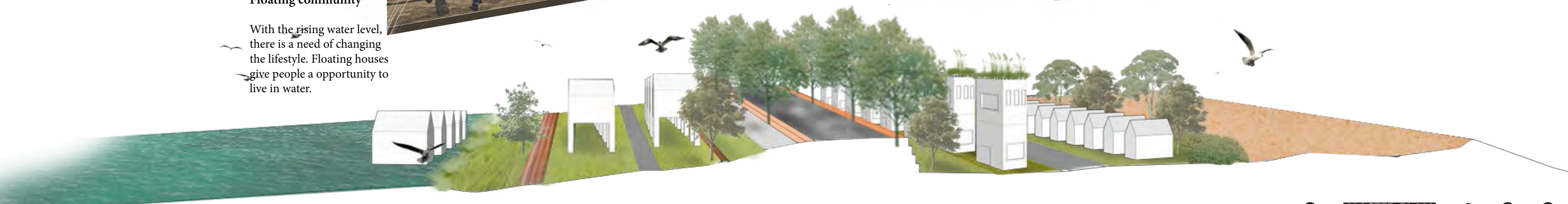
During this phase, the wetland and dune area will be further extended; more space will give back to nature. Elevated pole houses are introduced at this stage to allow people to live closer to water without worry about losing their homes. Moreover, pedestrian and cycling network will be improved to promote a more sustainable lifestyle. South Brighton is starting to adapt to the rising water level.



With the rising water level, there is a need of changing the lifestyle. Floating houses give people a opportunity to live in water.



This area used to be the residential red zone and a series of open spaces. By restoring the native vegetation, this area will become a cohesive greenbelt along the estuary as a natural buffer to protect the community from future flood events and also provide habitats for wildlife, especially migratory birds.



Design Concept

The intermediate plan shows the site, which is an important area of South New Brighton. The plan showcase how the design strategies have been applied to the site. This area is the center where the community connects with the rest of Christchurch. Improved main street providing a better connection between the site and other places; Proposed pedestrian network and cycle route promoting a sustainable lifestyle; Vibrant streetscape and recreation activities make this area more attractive to visit and live.

This area is also where water meets the land. Elevated streets and multi-purpose levee provide safe access and flood protection for this area; Constructed wetland increase the water capacity, reduce the flooding risk; Urban infrastructures help with stormwater management in this area.

Retreated residents return part of the land back to nature. Regenerated native vegetation provides habitats for wildlife; the Proposed wetland community provides a chance to live closer to nature.

To carry out the design vision, this plan aiming to break the boundary between nature and urban. By inviting water into the community, the community will become more resilient to adapt to various sea-level rise risks.

Wetland Community

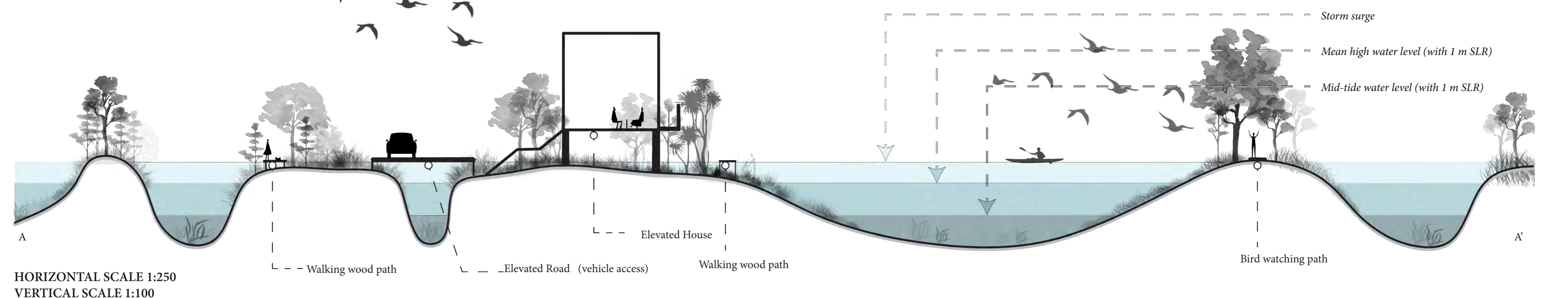
The New community is built in the constructed wetland, due to the high inundation risk caused by sea level rise, original residence has been retreated to a safer ground. Houses in the wetland community are 3 m elevated from the ground, ensure the property is safe with 1 meter SLR. Each house their own front yard and parking space. Residents who live here can get great wetland view from their window.

Developed Estuary Road

The Estuary road is the main road cross the community. To against the flood and rising sea level, the street will be developed as a part of the stopbank along the Avon river and the estuary. Also, rain gardens and bioswale are designed for stormwater management. Shared bike station and improved sidewalk promoting a more sustainable lifestyle.



Wetland Community Cross Section

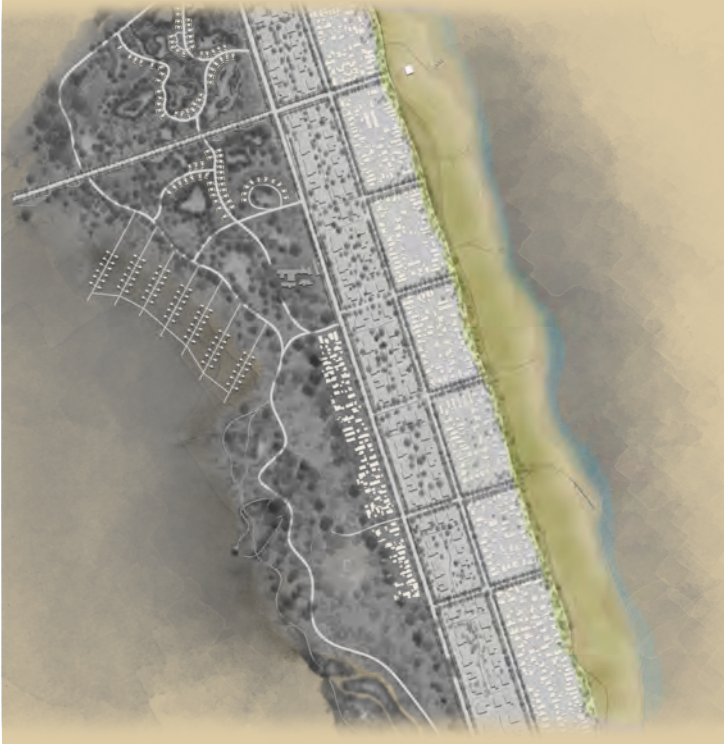


Design Concept

In order to achieve the more resilient South New Brighton, the design has selected multiple native plant groups so that plants can adapt to local growing conditions and restore the natural environment. Plants will help improve the water quality, provide habitats for wildlife and birds, control coastal erosion, and, more importantly, plants can help mitigate the impacts of sea-level rise and flooding. Four planting zones will express the design strategy: Sand dune; Urban green infrastructure; Wetland; Estuary salt marsh. This is a dynamic environment. The planting strategy will also help visualize the evolution of the ecological community over time.

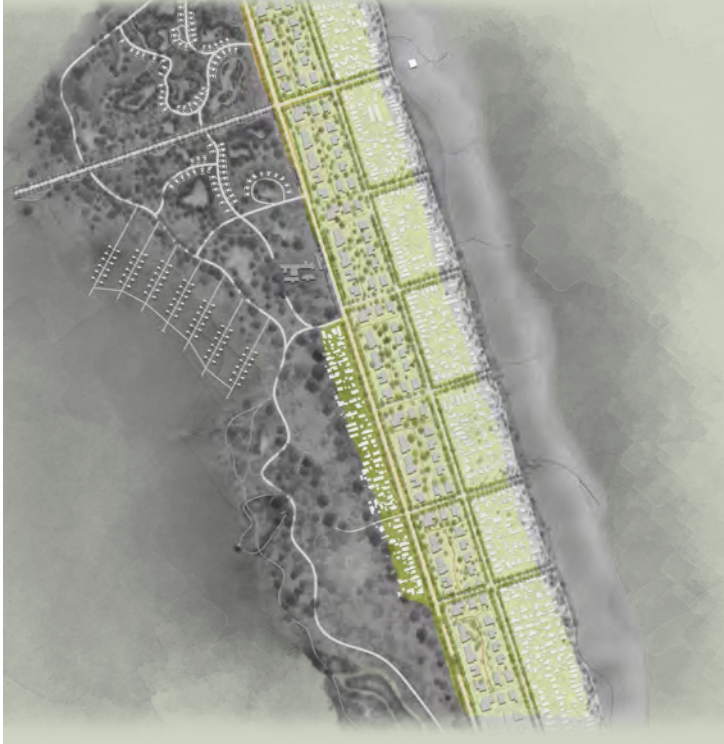
SAND DUNE

Replanting native species in this area will help keep the sand in place and prevent erosion. In the meantime, native plants create habitats for wildlife such as lizards and birds. However, the sand dune form is dynamic; the erosion will eventually alter the dune structure. So the design aims to leave room for the sand dune to grow and move landward with sea-level rise, break the boundary between natural dune system and urban space, and provide a chance for people to better understand the natural environment.



GREEN INFRASTRUCTURE

Green infrastructure refers to the vegetation areas in the community, such as street planting, rain gardens, and roof gardens, aiming to capture and store stormwater during heavy rain and flood events. Vegetations can help with water purification, improve the run-off quality. Some native plant species have been chosen to face the landward tidal salinity. Besides, vegetations bring important aesthetic value to the community, to create a pleasant place for the residents.



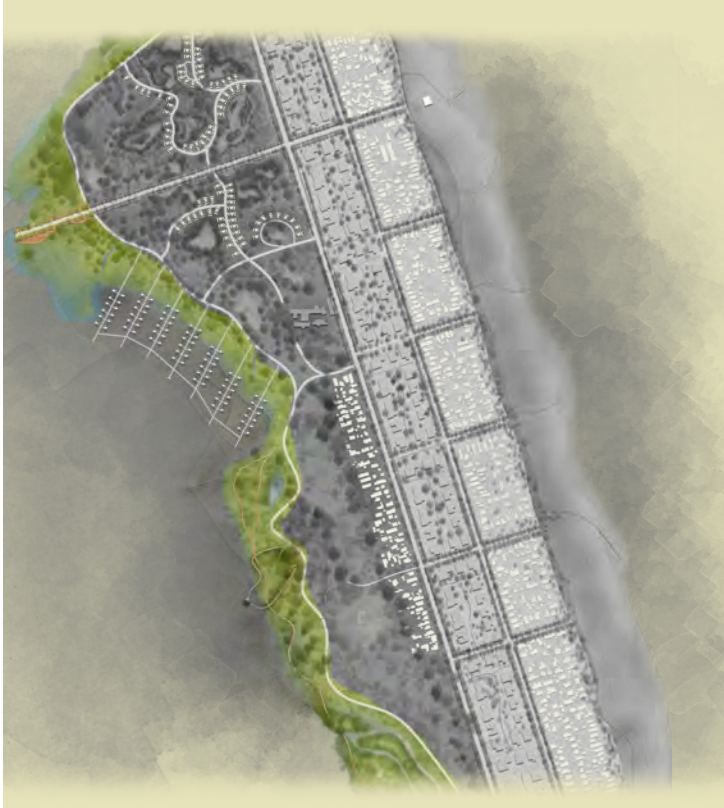
WETLAND

The constructed water channel and wetlands will create a living shoreline that allows natural tidal influxes. This area acts as an important buffer zone to connect people with water. Multiple plant groups have been chosen for water purification and soil erosion control. Salt tolerance is another crucial criteria for plant choices to face the landward tidal salinity. This area will be exciting with high recreation and education values associated with elevated paths and buildings while providing high flood protection.



ESTUARY SALT MARSH

Avon and Heathcote estuary is an important area where support significant migratory bird population. Saltmarsh around the estuary provides roosting and nesting habitat for birds and wildlife, in particular, Godwits. The design aims to restore the saltmarsh habitat. With the rising water level, freshwater species will gradually be replaced by salt-tolerant species, and the planting strategy shows the progress of the evolution of the plant community.



PLANTING PROCESS

Sand Dune	Green Infrastructure	Wetland	Salt marsh
<p>Existing Condition</p>	<p>Existing Condition</p>	<p>Existing Condition</p>	<p>Existing Condition</p>
<p>Stage one: Replanting native species to re-habitat the diversity of planting</p>	<p>Stage one: Site preparation, planting native species</p>	<p>Stage one: Preparing site for earthwork. Changing topography.</p>	<p>Stage one: Preparing site for earthwork. Changing topography. Planting salt-tolerant species</p>
<p>Stage two: Let the environment do the natural succession through time</p>	<p>Stage two: Regular maintenance and developing micro-habitats</p>	<p>Stage two: Planting and seeding</p>	<p>Stage two: Further planting landward</p>
<p>Stage three: Healthy sand dune landscape with various activities</p>	<p>Stage three: Natural succession, clean up pollutant and replant every ten years</p>	<p>Stage three: Natural succession, plant community will adapt to the rising water level and salinity</p>	<p>Stage three: Natural succession, plant community will adapt to the rising water level and salinity</p>

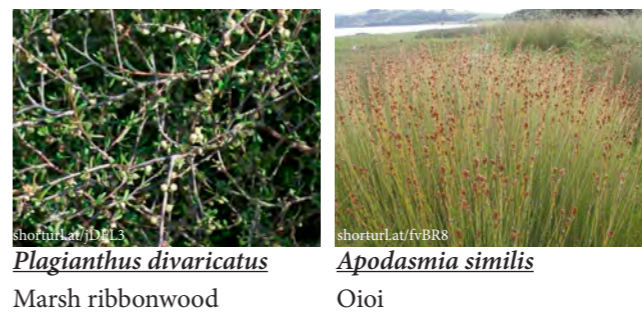
COASTAL FOREST



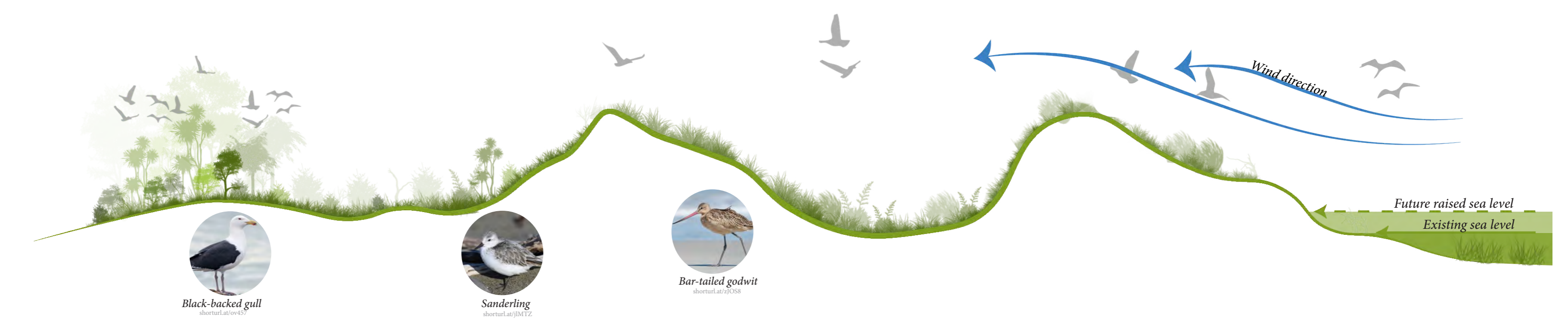
BACK DUNE



SWAMPY HOLLOW



FORE DUNE



TREES



Pseudopanax crassifolius
Lancewood
Height 10m
Spread 3m
Slow growth rate
Attractive foliage, provide food for birds, good for erosion control

Sophora microphylla
South island kowhai
Height 8m
Spread 3m
Tall shelter, attracts birds/bees, semi deciduous

Cordyline australis
Cabbage tree
Height 4m
Spread 2.5m

SHRUBS



Dodonaea viscosa
Green Ake Ake
Height 2m
Spread 1.5m
Hardy coastal shrub with attractive foliage, attracts insects and lizards

Muehlenbeckia astonii
Shrubby tororaro
Height 0.5m
Spread 1m
Hardy coastal plants, erosion control, attracts birds/bees

GRASS



Cortaderia richardii
South island toe toe
Height 1m
Spread 1m
Rapid growth rate
Provide shelter for insects and birds underneath

Astelia fragrans
Bush flax
Height 1m
Spread 1m
Has attractive broad-green, architectural leaves and scented spring flowers. Orange berries on female plants attract birds

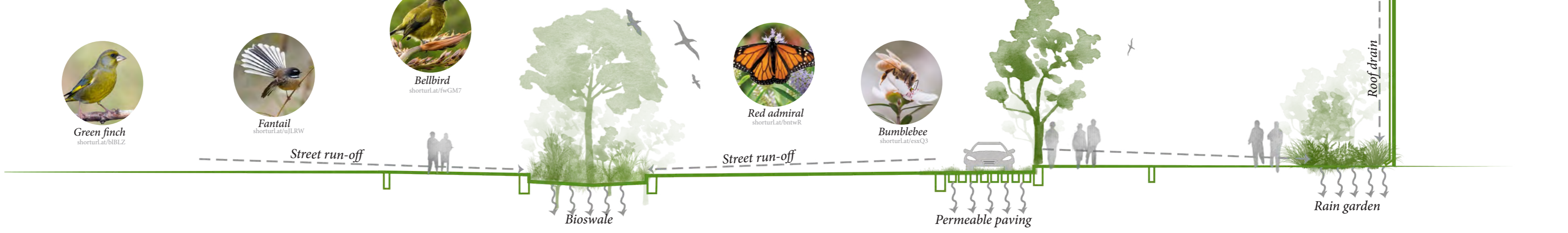
Libertia ixioides
NZ Iris
Height 0.3m
Spread 1m
Medium growth rate
Hardy native grass-like plant suits for various conditions

GROUND COVERS



Isotoma fluviatilis
Blue star creeper
Height 0.1m
Spread 0.4m
Medium growth rate
Native ground cover with attractive dark green foliage and blue flower

Mazus radicans
Swampy Musk
Height 0.05m
Spread 0.8m
Rapid growth rate
Native ground cover for swamp area such as the edge of rain garden.



BANK ZONE



Melicytus ramiflorus
Māhoe
Height 8m
Spread 2.5m
Provide food and shelter for birds

Schefflera digitata
Pātē
Height 8m
Spread 4m
Food resource for birds

Pittosporum species
Kohuhu
Height 6m
Spread 3m
Erosion control
Attractive birds

MARGIN



Carex virgata
Pukio
Height 1m
Spread 1m

Austroderia spp.
Toetoe
Height 3m
Spread 2m
Fast growing
Provide shelter for birds
Erosion control

Typha orientalis
Raupo
Height 4m
Spread 1m
Habitat for native birds and fish

SHALLOW WATER



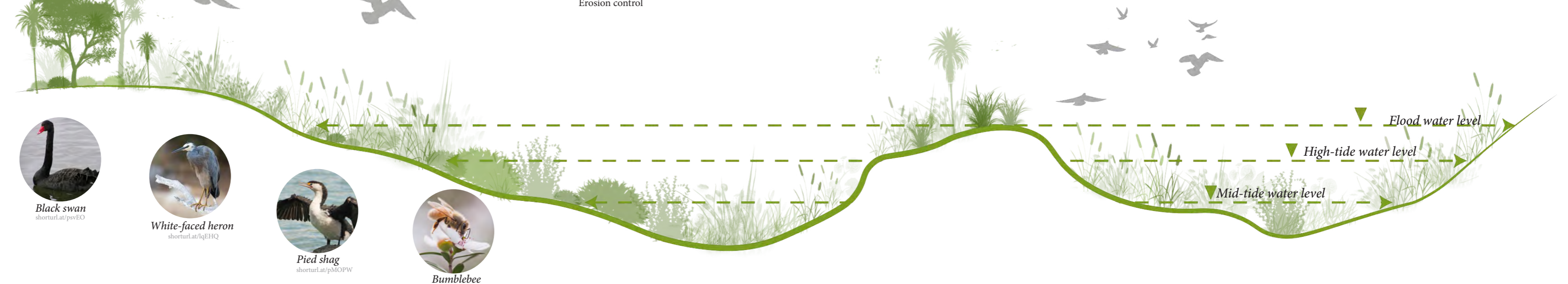
Juncus kraussii
Salt Marsh Rush
Height 1.5m
Spread 1m
Salt tolerant species

Schoenoplectus pungens
Three square bulrush
Height 1m
Spread 1m

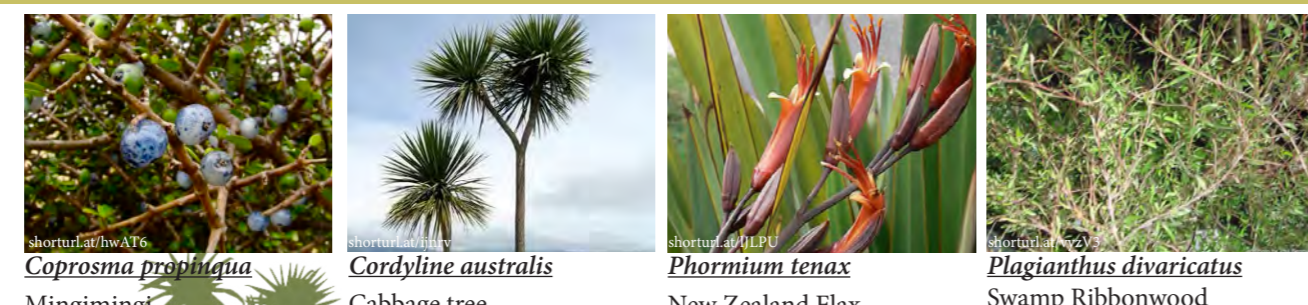
Eleocharis sphacelata
Bamboo Spike Sedge
Height 2m
Spread 5m

Carex secta
Makura Sedge
Height 1m
Spread 1.5m
Erosion Control

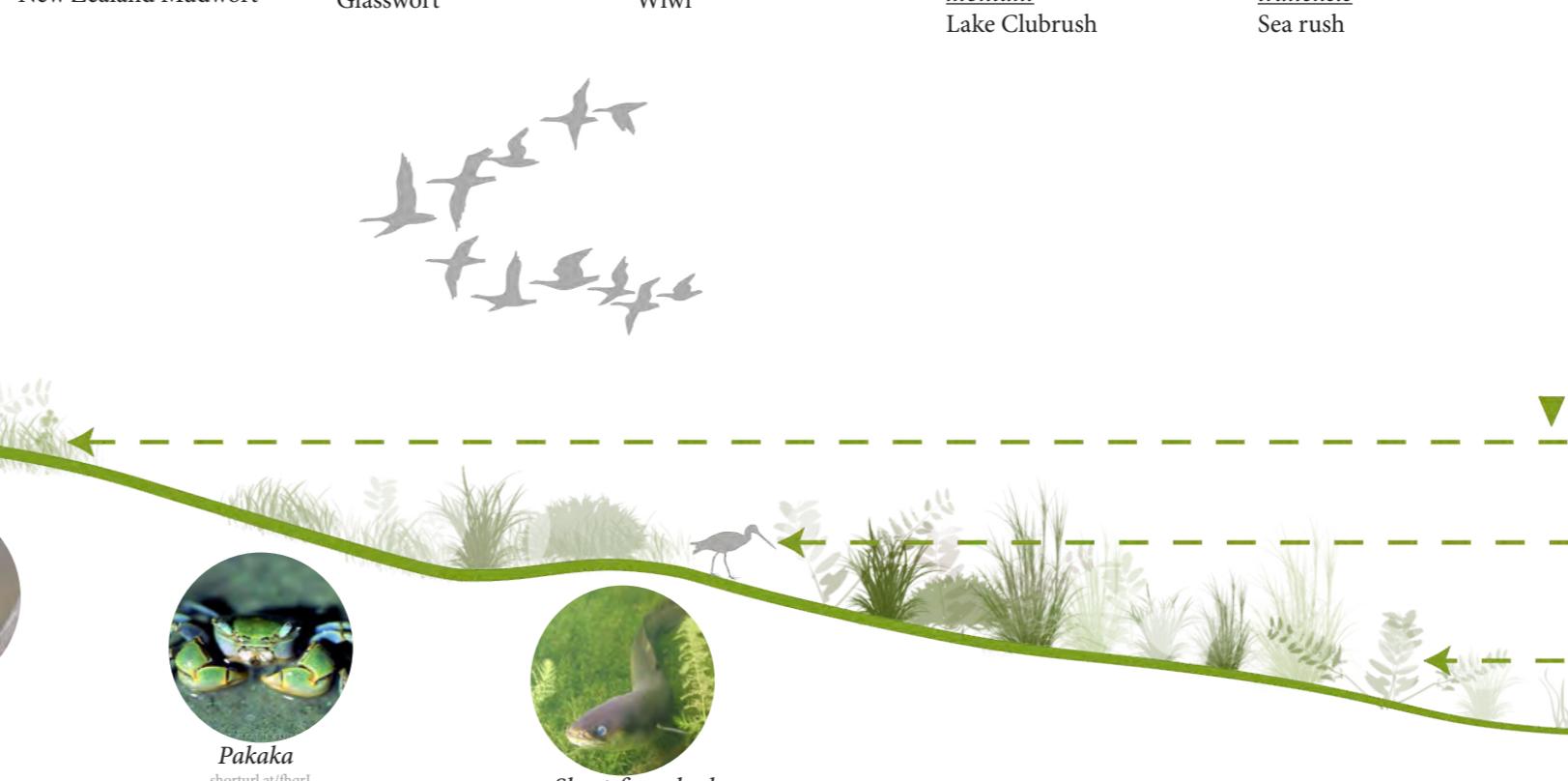
Potamogeton cheesemantii
Red Pondweed
Height 0.1-0.4m
Floating plants
Water purification



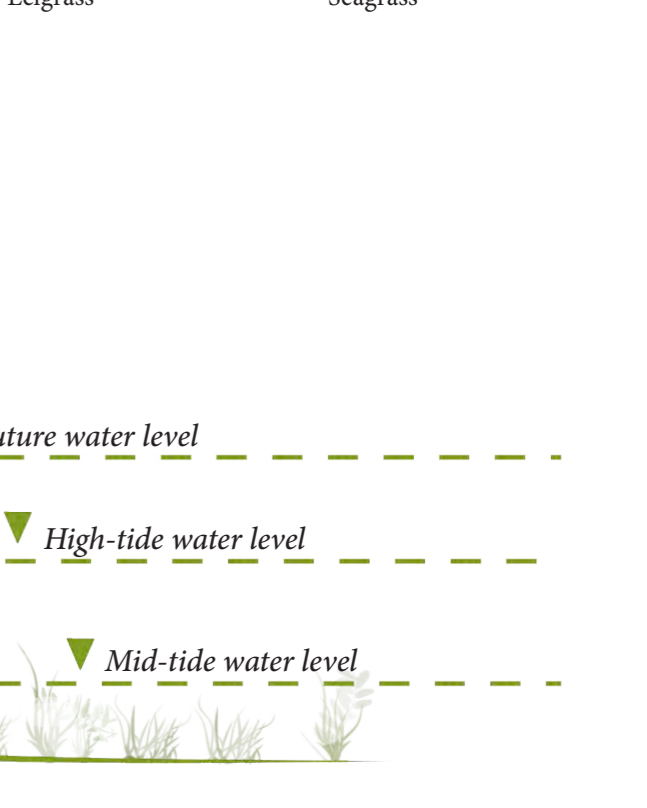
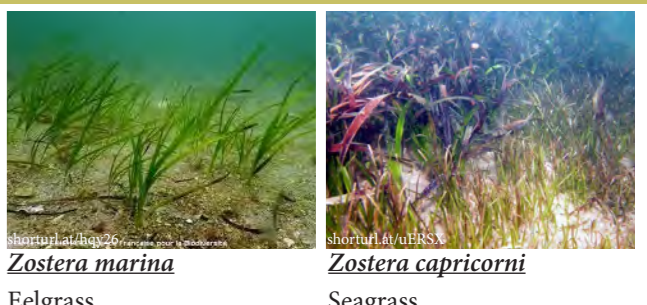
UPPER MARSH



HIGH-TIDE ZONE



INTER-TIDAL ZONE



Design Concept

The material strategy echoing the four design strategies: **Protect, Restore, Connect, and Grow** and aiming to achieve the vision of the resilient community. South New Brighton is a dynamic landscape shaped by nature, and it is changing over time. Recycled or recyclable materials have been selected. With the passage of time, materials will change its appearance, location, and function. Local materials with vivid characters can easily blend into the environment and bring the place's senses, which help build up community identity. Locally sourced material also has a smaller carbon footprint and more Eco-friendly. Rather than directly enjoy the implanted materials and structures, the community is encouraged to involve in the process. This allows people to know the material and the environment better, building up a close relationship between people and the place. Water is one of the keywords in this area. Selecting permeable materials could help with water management as well as benefit the environment.

Material Palette



- Native beech sleeper**
 Use: Wetland boardwalk/ wetland bridge
 Description: Made from "seasoned" Beech. H4 treated. With a clean appearance and very durable and stable. Rough texture brings a natural feeling which will blend in well with the wetland environment.
- Radiata Pine**
 Use: Footbridge/Road side decking
 Description: H3.2 treated. Light Brown in colour, which matches the sandy coastal character. The pine also reflects the planting history in the 19th century when European settlers planted pine forests in New Brighton area to stabilize the sand dune.
- Open graded asphalt**
 Use: Road surface
 Description: Open-graded asphalt with permeable surface treatment will enhance safety and reduce traffic noise. The paving has long durability for more than 20 years. Porous asphalt surface will also help infiltrate street run-off. This material requires less energy to manufacture and maintain.
- Reclaimed Cobblestone**
 Use: Sidewalk/Paving area
 Description: Cobblestones are extremely strong and durable, low maintenance requirements. Cobblestone pavers are easy to install and remove.
- Permeable paver**
 Use: Off-road parking
 Description: Permeable paver with vegetation filled gaps has up to 80% run-off infiltration rate. The permeable paving grid is made from recycled material, and it has long durability. Also, at the end of their lifespan, materials can be easily recycled. It is an environmentally friendly material with a low carbon footprint.
- Rubble concrete block**
 Use: Wetland stepping-stone
 Description: Recycled from the foundation of the retreated house in this area. It can be easily cut into a geometric shape. The hard surface has a strong contrast with the dynamic wetland environment.
- Exposed aggregate concrete**
 Use: Cycle lane/ Drive way
 Description: This is a permeable and durable material that can be sourced locally. Associated with a natural element such as broken shells will enrich the coastal environment. This is also a material that required low maintenance.
- River stone**
 Use: Rain garden/ Bioswale
 Description: Recyclable local material. They are used to reduce flow speed while improving water quality. The natural look will match with native planting. They are also providing habitat for small insects between the gaps.
- Reno mattress**
 Use: Estuary edge
 Description: They are placed along the edge of the estuary. Highly permeable. Prevent erosion while promoting the regeneration of plants.
- Sand**
 Use: Sand dune nourishment
 Description: Placed on the beach to replace eroded materials, built-up sand dune, and prevent future erosion, pushing the sand dune seaward. Associated with planting, which can also help to prevent erosion and provide habitats.
- Shells**
 Use: Surface finishing of exposed aggregate concrete/ Vegetation bed edges
 Description: Local natural material can be found on the beach and estuary mouth. Echoing the coastal character of the site and enhance the local identity.
- Driftwood**
 Use: Street art/ Rain garden decoration
 Description: Driftwood pieces found on the beach can be used for street sculpture and art pieces to emphasize the local character.
- Corten Steel**
 Use: Outdoor furnitures, Planting box
 Description: Corten steel is a strong, long life cycle material. With an attractive appearance, corten steel structures can blend well with the coastal natural environment. It is a sustainable and environmentally friendly material since it doesn't need chemical paint and blast cleaning.

Keep the Memory

The material is recycled from the foundation of retreated houses from this area. Concrete is a hard, artificial material that brings a strong contrast with the water and surrounding wetland plants.

People are welcomed to crave on the stepping stone, whether their old home address or any thought about the place. This will make every stepping stone unique and carry out a lot of memory, strengthening the community's connection with the land.

Comparing to the boardwalk, stepping stones provide a chance for people to close to nature furthermore. Some of the bigger stepping stone can be used for bird observation and fishing.

The stepping stone also plays a role as a water level indicator. Two photos show the condition with different water levels.



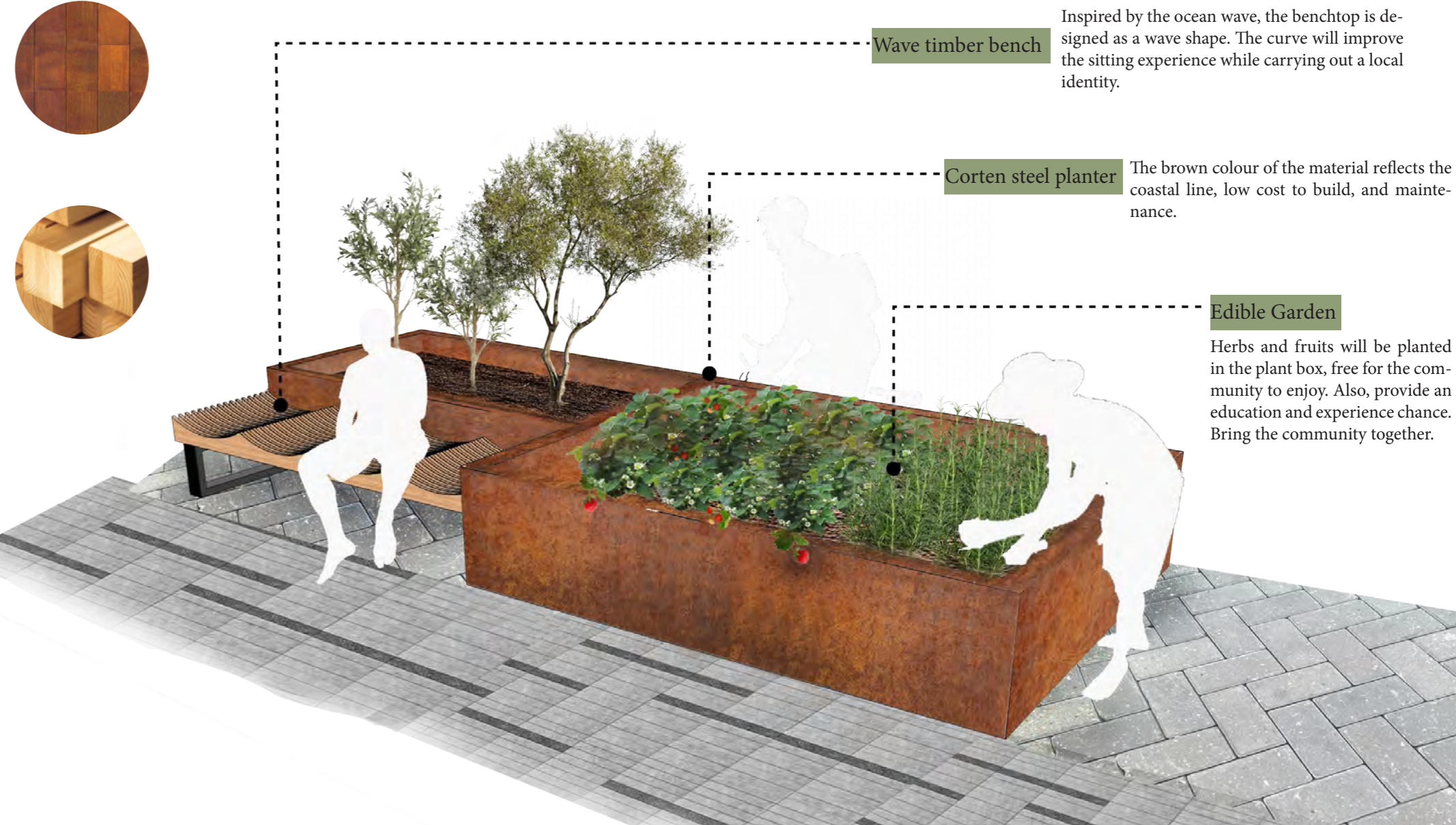
Wetland Boardwalk And Signage post

The boardwalk and signage board located in the wetland area. By walking on the boardwalk, people can get closer to the wetland. It also provides access to a series of waterfront activities. The designed signage board along the way shows people the right direction and provides an educational opportunity.



Green Bench

The Green bench is placed along the estuary road. It is a combination of street seating and planting. As a barrier, it separates the cyclist from pedestrians, provides a safer walking environment. In the meantime, it is a public space for people to rest. Also, plants and the structure themselves add aesthetic value to the street.



Pedestrian Crossing

The redeveloped Estuary road is aiming to improve walkability, provide a safer environment for pedestrians. A Zebra crossing is placed at the intersection for people to cross the street. Echoing the local coastal environment, the design has chosen to use exposed aggregate concrete with broken shell finishing. Shell is a high reflective natural material. This design is aiming to add a local identity to the road while providing a better crossing experience.



Reference list

Skye Xu 1123818

Regional plan

CFGphoto. (n.d.). *Avon/Heathcote estuary*. Retrieved from <https://www.cfgphoto.com/data/media/699/CFGcc50.jpg>

Womentravel NZ. (2014). *Pegasus Bay*. Retrieved from <https://www.womentravelnz.com/wp-content/uploads/2014/07/P7230002.jpg>

Planting strategy

New Zealand Plant conservation network. (2020). *Kunzea robusta*. Retrieved from <https://www.nzpcn.org.nz/site/assets/files/0/50/609/kunzea-robusta-12a.jpg>

Southernwood. (2020). *Pittosporum tenuifolium*. Retrieved from <https://www.southernwoods.co.nz/shop/pittosporum-tenuifolium/>

Southernwood. (2020). *Cordyline australis*. Retrieved from <https://www.southernwoods.co.nz/shop/cordyline-australis/>

Southernwood. (2020). *Ozothamnus leptophyllus*. Retrieved from <https://www.southernwoods.co.nz/shop/ozothamnus-leptophyllus>

Plantrescue. (2020). *Muehlenbeckia complexa*. Retrieved from <https://www.plantrescue.co.nz/images/378739/pid1138211/muelenbeckia.jpg>

Kauri Park. (2020). *Coprosma acerosa*. Retrieved from <https://www.kauriparknurseries.co.nz/plants/coprosma-acerosa/>

Greenleaf nursery. (2020). *Plagianthus-divaricatus*. Retrieved from <https://greenleafnurseries.co.nz/wp-content/uploads/2013/06/plagianthus-divaricatus-500.jpg>

New Zealand Plant conservation network. (2020). *Apodasmia similis*. Retrieved from <https://www.nzpcn.org.nz/site/assets/files/0/38/365/apadasmia-similis-large.jpg>

Staticflickr. (2020). *Carex pumila*. Retrieved from https://live.staticflickr.com/5521/29958813823_6d6cd3f10a_b.jpg

New Zealand Plant conservation network. (2020). *Austrofestuca littoralis*. Retrieved from <https://www.nzpcn.org.nz/site/assets/files/0/24/051/austrofestuca-littoralis-01.1200x0-u0i1s1q90f1.jpg>

Staticflickr. (2020). *Pingao*. Retrieved from https://live.staticflickr.com/67/196436363_7fe7cfef0f_b.jpg

Bowater, R. (2018). *Black gull*. Retrieved from <http://www.nzbirdsonline.org.nz/species/southern-black-backed-gull>

Johnson, K. (2019). *Sanderling*. Retrieved from <http://www.nzbirdsonline.org.nz/species/sanderling>

Rees, G. (2012). *Bar-tailed Godwits*. Retrieved from <http://www.nzbirdsonline.org.nz/species/bar-tailed-godwit>

Portraits of wildflowers. (2020). *Lancewood*. Retrieved from <https://portraitsofwildflowers.files.wordpress.com/2015/06/fierce-lancewood-trees-5552.jpg>

Southernwood. (2020). *Sophora microphylla*. Retrieved from https://www.odt.co.nz/sites/default/files/styles/odt_story_slideshow/public/slideshow/node-311905/2016/04/the_south_island_kowhai_is_just_one_of_eight_varie_53e2fb595f.JPG?

Wals plant land. (2020). *Green Ake Ake*. Retrieved from www.walsplantland.co.nz/images/Dodonaea%20Viscosa%20Akeake%202.jpg

Stuff. (2020). *Tototaro*. Retrieved from <https://resources.stuff.co.nz/content/dam/images/1/p/m/j/h/m/image.related.StuffLandscapeSixteenByNine.1420x800.1pmj4a.png/1525122127010.jpg>

Southernwood. (2020). *Hebe*. Retrieved from www.southernwoods.co.nz/shop/hebe-albicans/

Green machine. (2020). *South island toe toe*. Retrieved from <https://greenmachine.nz/products/cric-5-7>

Southernwood. (2020). *Bush flax*. Retrieved from <https://www.southernwoods.co.nz/shop/astelia-fragrans/>

Feather and flora (2020). *Nz iris*. Retrieved from <https://feathersandflora.co.nz/collections/native-plants/products/new-zealand-iris>

Gardenista. (2020). *isotoma fluviatilis*. Retrieved from <https://www.gardenista.com/products/isotoma-fluviatilis/>

Southernwood. (2020). *Mazus radicans*. Retrieved from <https://www.southernwoods.co.nz/uploads/Shoppingcart/product-2456-2.jpg>

Bowater, R. (2020). *Greenfinch*. Retrieved from <http://www.nzbirdsonline.org.nz/species/european-greenfinch>

Torr, O. (2012). *Fantail*. Retrieved from <http://www.nzbirdsonline.org.nz/species/new-zealand-fantail>

Mckenzie, C. (2009). *Bellbird*. Retrieved from <http://www.nzbirdsonline.org.nz/species/bellbird>

Mitre 10. (2020). *Red admiral*. Retrieved from <https://assets.mitre10.co.nz/sys-master/images/h35/h16/8925453156382/Butterfly-Banner.jpg>

- Breyer, M. (2020). *Bumble bee*. Retrieved from <https://www.treehugger.com/bumble-bees-could-vanish-forever-within-few-decades-4847529>
- Odt. (2020). *Melicytus ramiflorus*. Retrieved from https://www.odt.co.nz/sites/default/files/story/2016/04/mahoe__i_melicytus_ramiflorus_i__p_hoto_by_gerard_o_4d819122d9.JPG
- Kauri park. (2020). *Schefflera digitate*. Retrieved from <https://www.kauriparknurseries.co.nz/wp-content/uploads/2013/11/Schefflera-DigitataPate-in-a-2L-pot.jpg>
- Southernwood. (2020). *Pukio*. Retrieved from https://lh3.googleusercontent.com/proxy/0dTUqEzK0Ys7fDefjuop-RYCG2feZrmABIVAIWTb5ZZjidgpLYmhkskO3Kz35zOaaEnGE3joRLIDY7b2HpCC9bsAF8OYz0OcG0ohWR5jdmWzxXTYimT2UZpQBAOad6M3bmrk48h7WeizX3RenGqe_PK3Jg4I2RbZ_40
- Static flickr. (2020). *Toe toe*. Retrieved from https://live.staticflickr.com/2746/4161607125_b08318bde2_b.jpg
- Herbs. (2020). *Bullrush*. Retrieved from <https://herbs.org.nz/wp-content/uploads/2016/04/bullrush-raupo-1.jpg>
- New Zealand Plant conservation network. (2020). *Juncus kraussii*. Retrieved from <https://www.nzpcn.org.nz/flora/species/juncus-kraussii-subsp-australiensis/>
<https://www.nzpcn.org.nz/site/assets/files/0/39/332/juncus-kraussii-2.jpg>
- Static flickr. (2020). *Three square bulrush*. Retrieved from https://live.staticflickr.com/4446/37970573016_73a75fc540.jpg
- Bluedale. (2020). *Eleocharis sphacelata*. Retrieved from <https://bluedale.com.au/wp-content/uploads/2020/06/Eleocharis-sphacelata-Tall-Spike-Rush-wetland-plant-macrophyte-3-.jpg>
- Mid land hort. (2020). *Carex secta*. Retrieved from <https://midlandhort.co.nz/wp-content/uploads/2016/03/carex-secta.jpg>
- New Zealand Plant conservation network. (2020). *Potamogeton cheesemii*. Retrieved from <https://www.nzpcn.org.nz/site/assets/files/0/39/757/potamogeton-cheesem-lroto2.jpg>
- Whitehead, T. (2009). *Black swan*. Retrieved from <http://www.nzbirdsonline.org.nz/species/black-swan>
- Clarke, A. (2012). *White-faced heron*. Retrieved from <http://www.nzbirdsonline.org.nz/species/white-faced-heron>
- Reese, P. (2008). *Pied shag*. Retrieved from <http://www.nzbirdsonline.org.nz/species/pied-shag>
- Temotukairangi. (2020). Retrieved from <https://www.temotukairangi.co.nz/assets/img/plants/Mingimingi.JPG>

Feather and flora (2020). *NZ flax*. Retrieved from <https://feathersandflora.co.nz/products/harakeke-flax>

Amazon aws. (2020). *Plagianthus divaricatus*. Retrieved from https://citscihub.s3.amazonaws.com/thumb/Plagianthus_divaricatus_.JPG/680px-Plagianthus_divaricatus_.JPG

Static flickr. (2020). *Mudwort*. Retrieved from https://live.staticflickr.com/787/26351256547_cba675834a_b.jpg

Rose, H. (2007). *Sarcocornia quinqueflora*. Retrieved from <https://encrypted-tbn0.gstatic.com/images?q=tbn%3AANd9GcQkxRffp8ETJf9aFmoJeHQok6w3srLBr36oNg&usqp=CAU>

South Australia seed conservation center. *Juncus Kraussii*. Retrieved from <https://spapps.environment.sa.gov.au/sosa.services/api/SpeciesImages/07032017/Juncus%20kraussii%20p%20Denzel%20Murfet%20Goolwa.jpg>

Louis, M. (2008). *Schoenoplectus tabernaemontani*. Retrieved from https://www.calflora.org/cgi-bin/species_query.cgi?where-calrecnum=9611

Andrew, J. (n.d.). *eel grass*. Retrieved from <https://www.sciencephoto.com/media/16414/view/eel-grass>

Smithsonia, (2020). *Sea grass*. Retrieved from <https://ocean.si.edu/ocean-life/plants-algae/seagrass-and-seagrass-beds>

Mckenzie, C. (2012). *South island pied oystercatcher*. Retrieved from <http://www.nzbirdsonline.org.nz/species/south-island-pied-oystercatcher>

Whitehead,T. (2008). *Pied stilt*. Retrieved from <http://www.nzbirdsonline.org.nz/species/pied-stilt>

Bowater, R. (2008). *Kingfisher*. Retrieved from <http://www.nzbirdsonline.org.nz/species/sacred-kingfisher>

Google earth. (2020). *South New Brighton*. Retrieved from <https://www.google.com/earth/>

Form and material strategy

Fair oaks sleepers. (2020). *Beech sleeper*. Retrieved from <https://fairoaksleepers.co.uk/hardwood-sleepers>

Nzpec. (2020). *Pine timber*. Retrieved from <https://www.nzpec.co.nz/2012/pine-showcase/pine-timber/>

M2pp. (2017). *Open graded asphalt*. Retrieved from <https://www.flickr.com/photos/m2ppalliance/32872886892/>

Darling downs. (2020). *Cobblestone*. Retrieved from <https://www.ddbs.com.au/shop/pavers/edenstone-cobble-pavers-100x100x40mm-charcoal/>

Pining. (2020). *Permeable paver*. Retrieved from <https://i.pining.com/originals/20/33/c9/2033c96afb6b75ceed46c4dc82f4b10b.jpg>

Homedepot. (2020). *Concrete block*. Retrieved from https://homedepot.scene7.com/is/image/homedepotcanada/p_1000180541.jpg?wid=1000&hei=1000&op_sharpen=1

Bw concrete. (2020). *Open-graded aggregate*. Retrieved from https://www.bwconcrete.com/cmss_files/attachmentlibrary/Aggregate%203.jpg

Composting. (2020). *River stone*. Retrieved from <https://www.compostingnz.co.nz/products/decorative-stone/>

Pingu. (2020). *Reno mattress*. Retrieved from <https://www.pinguwiremesh.com/Gabion-series/3.html>

Adamczyk. (2006). *Sand*. Retrieved from <https://www.sharecg.com/v/2245/View/6/Texture/Red-Sea-Sand>

Calvert, C. (2018). *Broken shell*. Retrieved from <https://www.trusttheprocess316.com/single-post/2018/07/16/The-Beauty-of-a-Broken-Shell>

Buy the sea. (2020). *Driftwood*. Retrieved from <https://www.buythesea.co.uk/driftwood-mirrors-22-c.asp>

Adle0048. (2012). *Conten steel*. Retrieved from <https://arch3150.wordpress.com/2012/12/07/cor-ten-steel/>