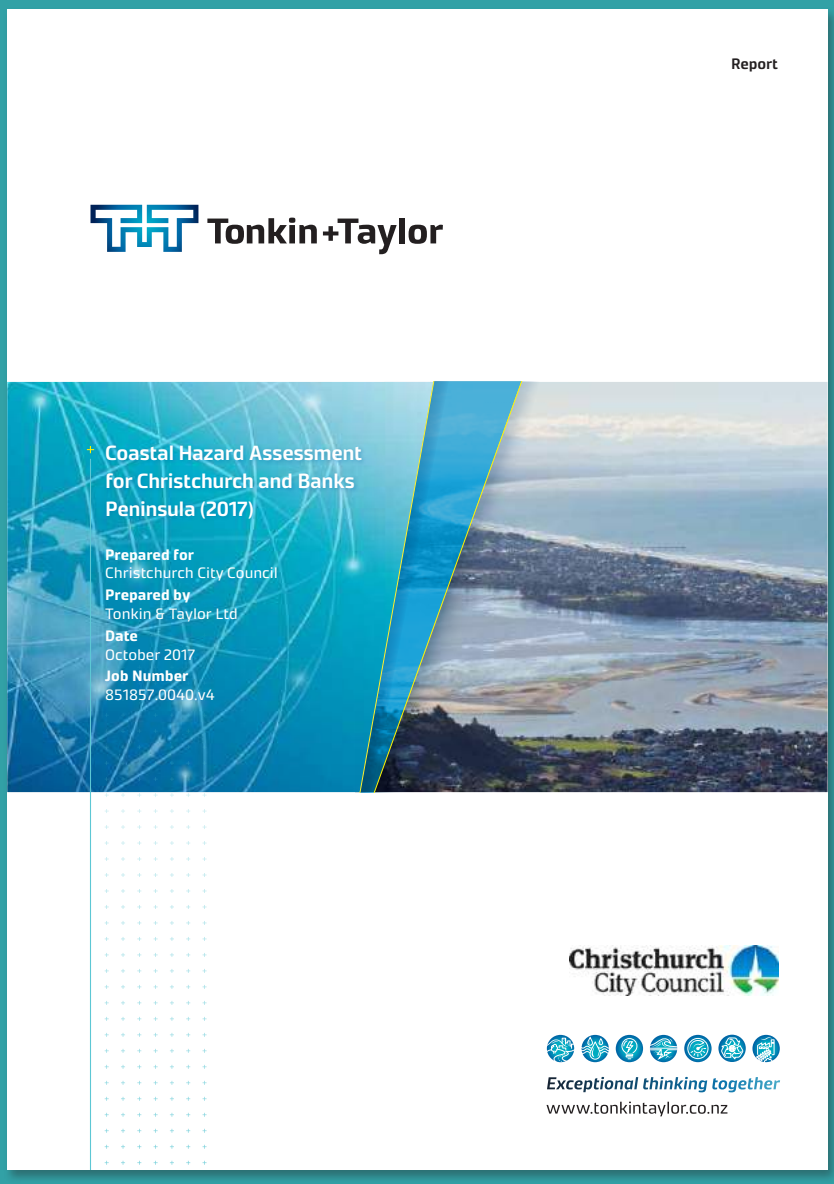
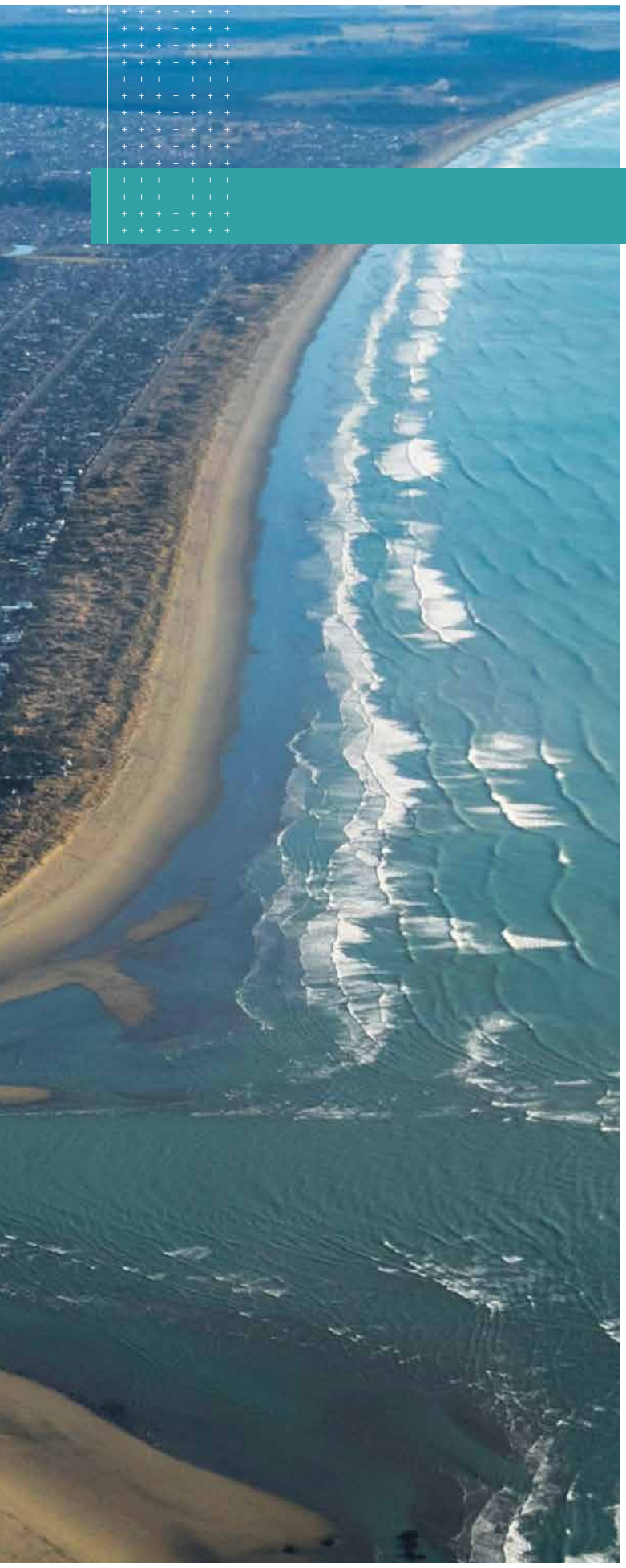
SUMMARY OF

2017 Coastal Hazard Assessment *for* Christchurch and Banks Peninsula

(Tonkin & Taylor Ltd.)



Christchurch City Council



Introduction

Coastal communities around New Zealand, and across the world, face challenges with the impacts of climate change and sea-level rise. A changing climate will increase the risk of coastal flooding by the sea (inundation) and coastal erosion.

Improving our knowledge and planning for the effects of climate change is a practical response to creating resilient communities. Central to this is understanding the potential risks.

Christchurch City Council commissioned Tonkin & Taylor Ltd. to prepare the report – *2017 Coastal Hazard Assessment for Christchurch and Banks Peninsula* (the 2017 Report). The 2017 Report investigates potential erosion and inundation in coastal areas where people live, and considers a 50-year (out to 2065) and 100-year (out to 2120) timeframe.

The 2017 Report is the result of a thorough and independent peer review of an earlier report, the *2015 Coastal Hazard Assessment Report* (the 2015 Report). A peer review panel made recommendations for changes to the 2015 Report, including further investigations. These recommendations have been addressed in the 2017 Report. The 2017 Report has also been independently peer reviewed to ensure it met the panel's recommendations.

The 2017 Report is the most detailed and up-to-date information on coastal hazards for Christchurch and Banks Peninsula. The 2017 Report will inform any future changes to coastal hazard provisions in the Christchurch District Plan, and help the Council and communities make informed decisions about adapting to challenges in coastal areas.

This is a summary of the 2017 Report.

The full 2017 Report is available on the Council's website: **ccc.govt.nz/coastalhazards**

Definitions for key words used in the 2017 Report

Coastal inundation (flooding)

Coastal inundation is when normally dry, low-lying coastal land is flooded by the sea. Coastal inundation is primarily caused by severe weather events (storms) along the coast, impacting on estuaries and rivers.

Coastal erosion

Coastal erosion is a natural and ongoing process that occurs when the sea wears away the land. Some coasts undergo short term periods of erosion but then recover (i.e. build out again) while other parts of the coast may continuously erode with no cycle of recovery.

Climate change, sea-level rise, inundation and erosion

Climate change (warming) is slowly raising the level of the sea. Sea-level rise is caused by the expansion of the oceans caused by warmer water temperatures and by the melting of the Antarctic and Greenland ice sheets, and glaciers. This will cause high-tides and storm effects to reach further inland than they do currently. This means that more land may be subject to coastal erosion.

Wave setup

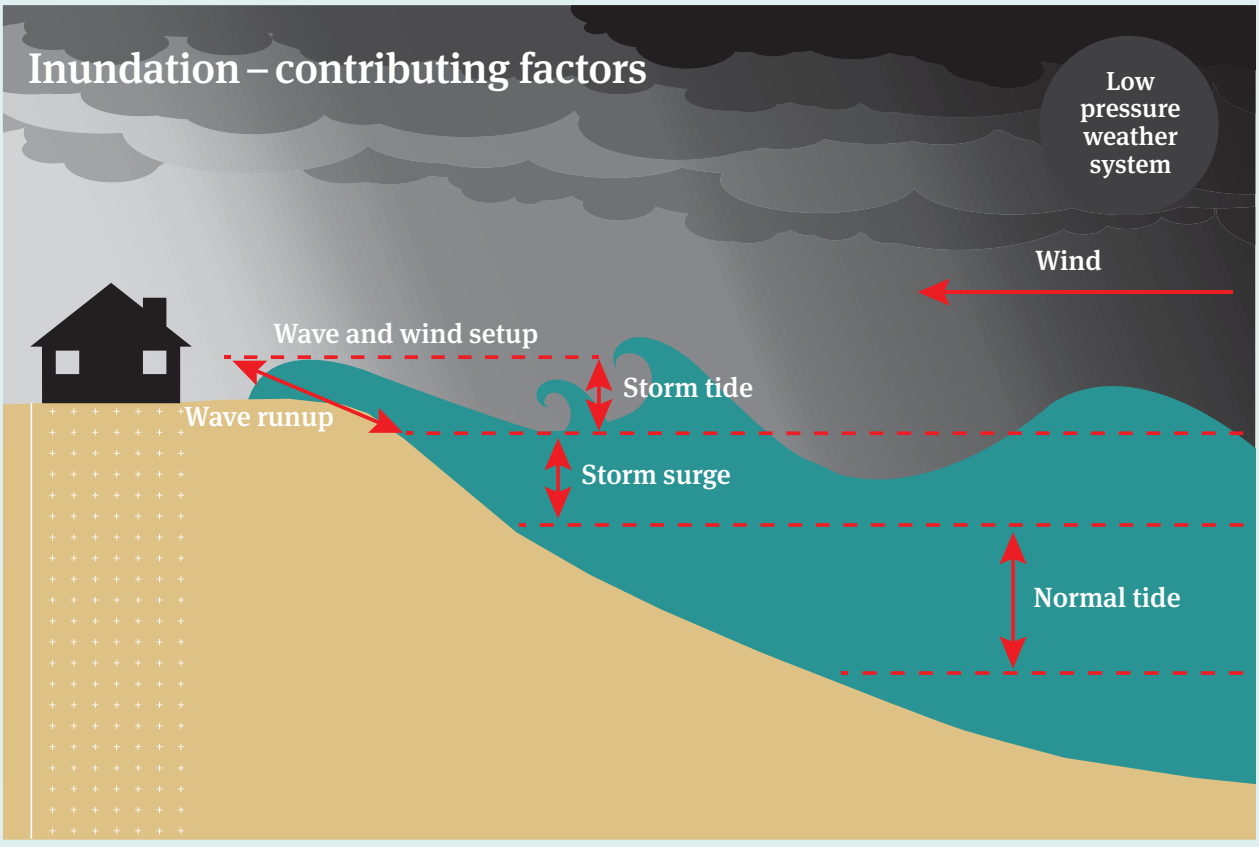
Wave setup is the increase in water level due to the presence of breaking waves. Wave setup primarily exists in and near the coastal surf zone.

Wind setup

Wind setup is the increase in water level on the 'sheltered' side of a water body caused by wind pressures on the surface of the water.

RCPs

RCP stands for Representative greenhouse gas Concentration Pathway. RCPs are five possible future climate scenarios adopted by the Intergovernmental Panel on Climate Change (IPCC) and used for climate modelling and research. These are RCP2.6, RCP4.5, RCP6, RCP8.5, and RCP8.5+ and are named after how much solar radiation the earth receives. The larger the number, the greater the amount of radiation.



The 2017 Coastal Hazard Assessment *for* Christchurch and Banks Peninsula Report

Why the Council is assessing coastal hazards

The Council has responsibilities to manage coastal hazards under the Local Government Act 2002 and the Resource Management Act 1991.

The New Zealand Coastal Policy Statement (NZCPS) is a national policy statement prepared under the Resource Management Act 1991. The Council must follow the national policy within its district plan. This includes:

- Identifying priority areas of the coast that are potentially affected by coastal hazards.
- Reducing hazard risk in areas of significant existing development.
- Locating new development away from risk-prone areas.
- Considering responses, including managed retreat for existing developments.
- Protecting or restoring natural coastal hazard defences.

The Canterbury Regional Policy Statement and Regional Coastal Environment Plan both support the NZCPS by managing the region's natural and physical resources within the coastal environment.

The Council will continue to work with Environment Canterbury to monitor coastal hazards and provide current and accurate information to coastal communities.

Climate change is expected to accelerate sea-level rise in the future. Sea-level rise is a key driver for coastal hazards. The NZCPS requires the Christchurch City Council to consider coastal hazards over the long term – at least 100 years.

The NZCPS is consistent with the recommendations made by the Intergovernmental Panel on Climate Change (IPCC). The IPCC is the international body for assessing the science related to climate change. The IPCC regularly assesses climate change, its impacts and future risks, and options for adaptation and mitigation. Its assessments provide a scientific basis for governments worldwide to develop climate change-related policies.

The IPCC 2015 assessment (the most recent assessment) provides sea-level rise projections based on a number of potential future scenarios. The scenarios are based on greenhouse gas concentrations. New Zealand Government guidance includes four climate scenarios within IPCC guidelines; three median projections, and an upper range projection.

The 2017 Report considers two timeframes (out to 2065 and 2120) for the four climate scenarios.

Areas the report covers

The 2017 Report covers the key inhabited coastal areas within the Council's boundaries. The report classifies the areas into two coastal environments; **open coast** and **harbour coast**. The harbour coast areas include estuaries and the Banks Peninsula harbours. These areas are:

Open coast *(see map on page 8)*

- Southern Pegasus Bay (from Waimairi Beach to Southshore)
- Sumner and Taylors Mistake

Harbour coast *(see map on page 8)*

The estuaries

- Avon-Heathcote Estuary
- Brooklands Lagoon

Banks Peninsula *(see maps on page 10 and 11)*

- Lyttelton Harbour
  - Allandale
  - Teddington
  - Charteris Bay
  - Purau
- Akaroa Harbour
  - Akaroa
  - Takamatua
  - Duvauchelle
  - Wainui

Sea-level rise projections (metres)

	IPCC RCP values			
Year	RCP* 2.6	RCP* 4.5	RCP* 8.5	RCP 8.5+ (83rd percentile)
2065	0.30m	0.33m	0.41m	0.55m
2120	0.55m	0.67m	1.06m	1.36m

* Representative greenhouse gas Concentration Pathways (median projections)

Inundation and erosion assessment methodology

The 2017 Report has used best-practice methodology in its coastal hazard assessment for Christchurch and Banks Peninsula. The models adopted were used in conjunction with aerial photograph imagery, GPS (satellite) surveys, beach profile mapping, statistical modelling, LiDAR (laser measurement) technology, bathymetric data, comparative analysis, site visits and results from other technical investigations.

Inundation methodology
Two approaches are used to assess inundation along harbour coasts – the bath tub method and the hydrodynamic model method. The open coast is generally protected from inundation by foredunes.

The bath tub method maps flood levels inland to the same level as at the coast. The bath tub method is used where the backshore topography is relatively steep such as the Lyttelton and Akaroa harbours.

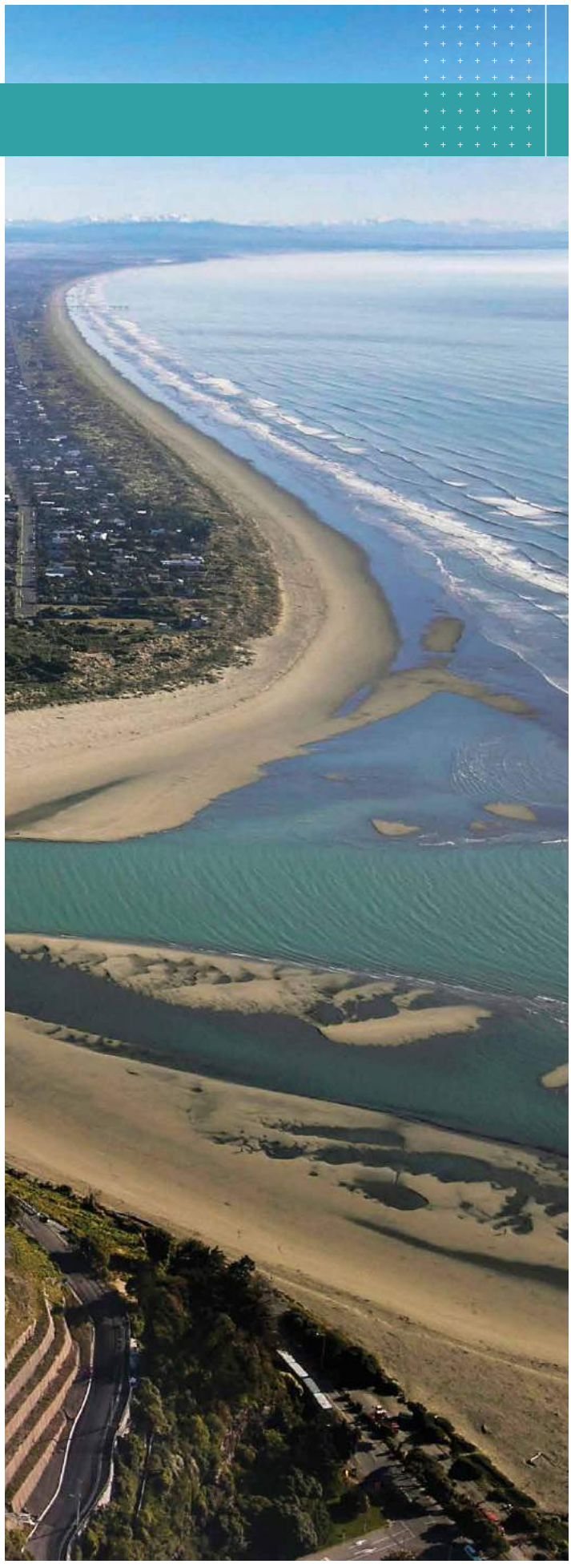
The hydrodynamic model method uses flood and tide simulation software (called TUFLOW) that defines inundation more accurately in low-lying and wide flat areas such as the Avon-Heathcote Estuary and Brooklands Lagoon.

Erosion methodology
Separate methodologies, recognising the different natural coastal processes, were used to assess and map coastal erosion along the open coast and the harbour coast.

A probabilistic model is used to map erosion along the open coast. A probabilistic model, where there are multiple possible outcomes with each having varying degrees of certainty, uses historic data to determine the probability of the shore being at a certain position within a defined period of time (for this study being 2065 and 2120).

The methodology used to assess harbour coast erosion takes into account the low-lying morphology of parts of harbour coasts. Although the methodology does not include a probabilistic approach, the method used is in accordance with best practice.

Open coast



Waimairi Beach to Southshore

Inundation
The open coast shore, 16 kilometres long from Waimairi Beach to the Avon-Heathcote Estuary mouth, is generally protected from inundation by the foredunes, the sand dunes closest to the sea.

However, potential inundation pathways exist where the foredunes have been removed or where the height of the dune has been lowered. The pathways at these locations are relatively narrow, restricting the volume of water that could pass through during a storm event. The extent of inundation at these and similar locations will also be determined by the 'roughness' of the land – the friction as the water flows inland.

The source of inundation risk at South New Brighton and Southshore is more likely to be storm tide levels within the Avon-Heathcote Estuary.

At some sites where the foredunes have been removed or lowered, the inundation risk could be reduced by restoring the foredunes and planting vegetation.

Further analysis is required to more accurately identify the extent of open coast inundation for New Brighton.

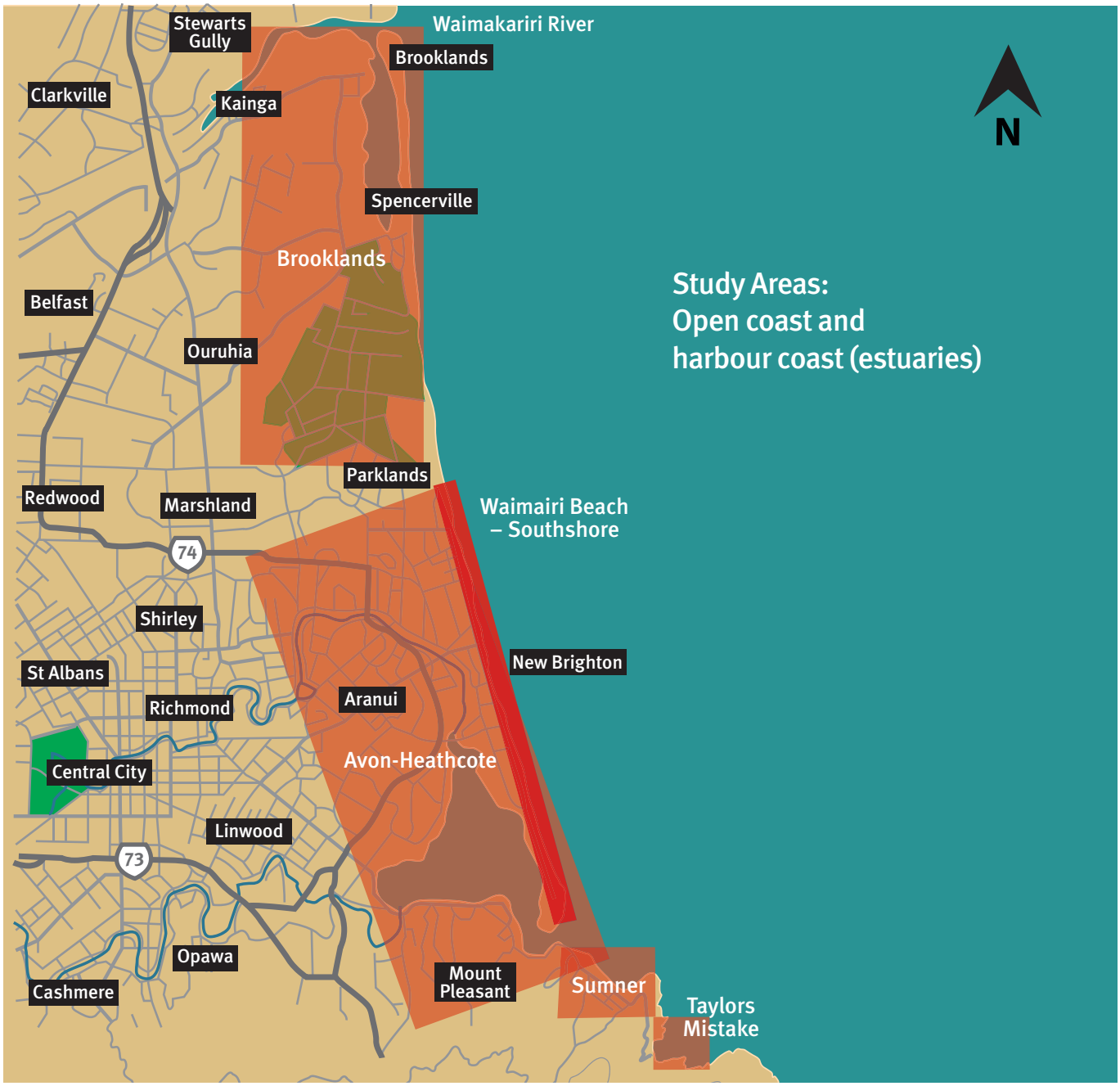
Erosion
There has been comprehensive monitoring and mapping of coastal erosion from Waimairi Beach to Southshore over about 75 years.

Erosion protection structures have been built along parts of the New Brighton shore to protect public assets and infrastructure. Such structures can be to the detriment of the natural beach system by focusing and concentrating wave energy, causing erosion. Dune planting and fencing has been carried-out at various locations adjacent to New Brighton to reduce erosion. On-going maintenance of the dunes is needed to reduce future erosion.

While Christchurch's open coast is currently accreting (building out seaward) storm events will cause localised erosion.

Sediment from the Waimakariri River replenishes the coast from Waimairi Beach to Southshore. However, there are many factors that impact on sediment supply including climate and anthropogenic (human) factors.

Wind, wave and rainfall patterns, earthquakes, water abstraction from the Waimakariri River and


Stewarts Gully
Waimakariri River
Brooklands
Clarkville
Kainga
N
Spencerville
Brooklands
Belfast
Study Areas:
Open coast and
harbour coast (estuaries)
Ouruhia
Parklands
Redwood
Marshland
Waimairi Beach
– Southshore
74
Shirley
New Brighton
St Albans
Richmond
Aranui
Avon-Heathcote
Central City
Linwood
73
Opawa
Mount
Pleasant
Sumner
Cashmere
Taylors
Mistake

aquifers, and gravel extraction in the lower reaches of the Waimakiriri River are some of the natural processes and human activities that may impact on future sediment supply to the open coast. Periodic accretion can be attributed to pulses of sediment supply from the Waimakariri River.

Areas of the coast that have been modified for carparks, buildings and beach access have reduced dune vegetation and lower rates of accretion (build-up of sand).

The overall result of a decrease in sediment supply and a rise in sea-level will be the erosion of the land.

Brighton Spit is a dynamic landform with the southern part in particular regularly changing in shape and position. The spit is susceptible to erosion from both the open coast and the Avon-Heathcote Estuary. The full width of the spit from Caspian Street to Spit Reserve is likely to be affected by erosion for at least the next 100 years.

Sumner and Taylors Mistake

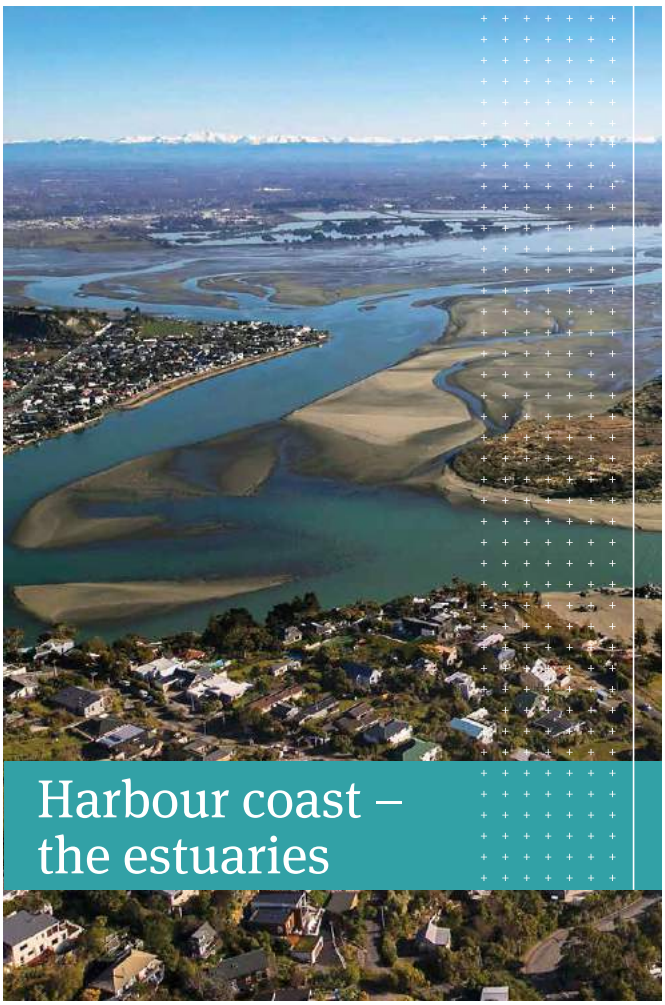
Inundation
The Sumner shore is a combination of man-made structures such as seawalls and rock revetments (sloping blankets of rock), and sand beaches. The existing seawall is not continuous, and inundation could occur. 'Non-return' flood gates in Sumner allow water to flow in one direction, from the land to the sea. The flood gates are located in waterways (channels) at the coast. The waterways are low points and provide potential inundation pathways to low-lying 'inland' parts of Sumner.

Taylor's Mistake is also susceptible to inundation over the next 50 years as inundation pathways exist.

Erosion
Sumner's shore is divided into three different coastal environments:

- A sheltered shore protected by a rock wall from Shag Rock to the Avon-Heathcote Estuary entrance.
- An unprotected shore from the Avon-Heathcote Estuary entrance to Cave Rock – a dynamic shore due to its position at the estuary entrance, similar to the end of Brighton Spit.
- An exposed shore protected by a seawall and rock revetment from Cave Rock to the Sumner Lifeboat Club.

For the open coast shore, the potential coastal erosion hazard zone 'width' (distance inland) is based only on horizontal coast retreat from sea-level rise.



Harbour coast – the estuaries

Avon-Heathcote and Brooklands Lagoon Estuaries

Inundation
The extent of inundation of the low-lying areas adjacent to the Avon-Heathcote Estuary and Brooklands Lagoon Estuary is tide dependent.

The extent of inundation around the estuaries during a storm event will depend on the height of the tide. Friction from the water flowing over the land determines how far inland the water extends.

The water level at the entrance to the Avon-Heathcote Estuary is also subject to the effects of waves breaking on the adjacent Southshore and Sumner beaches during storm surges. The waves push up the level of the water.

Erosion
The Avon-Heathcote Estuary shore has been subject to significant modification. From Windsurf Reserve to the estuary entrance the estuary shore is a protected and managed edge because of the adjacent major transport route. The Christchurch Wastewater Treatment Plant on the western side of the estuary also has shore protection. The eastern side of the estuary is a mix of 'protected' and natural shore, with evidence of erosion and failure of protection works.

Harbour coast – Banks Peninsula

Lyttelton and Akaroa harbours

Inundation
The extent of inundation within the Banks Peninsula harbours is based on the unique geographic attributes of each location combined with four main factors:

- storm tide (tide + storm surge + fluctuations)
- wave setup (waves elevate the mean water level during the breaking process)
- wind setup (wind conditions can cause an increase in water height)
- sea-level rise.

Parts of some Banks Peninsula communities are very low-lying. Because of this, sea-level rise will have a significant impact on inundation in these areas over the next 100 years.

Erosion
The Akaroa Harbour and Lyttelton Harbour shores are predominantly cliffs which are not expected to be significantly affected by coastal erosion.

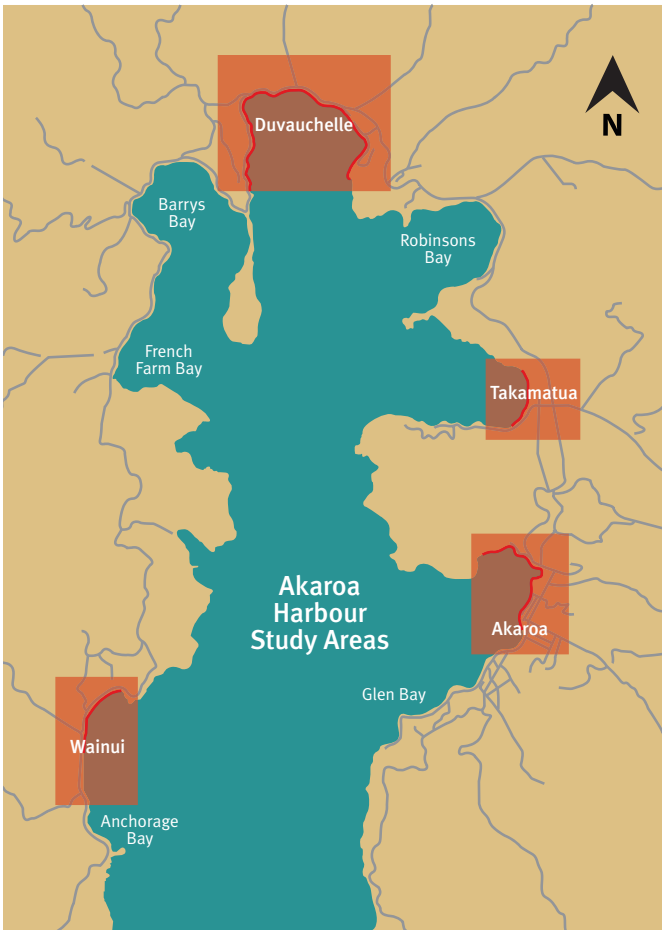
However, within the harbours, there are communities located on 'soft shores' with narrow beaches consisting of either silty sand, fine sand, shell or mixed sand and gravel, with low-lying backshores. These beaches, characteristically at the head of bays, do not have dune systems, and are therefore more susceptible to storm-induced erosion.

The main settlements within Lyttelton Harbour, and Duvauchelle Bay and Takamatua Bay in Akaroa Harbour have wide, shallow, intertidal nearshore zones while French Bay and Wainui have relatively steep nearshore zones.

Within Akaroa Harbour, Wainui has experienced the greatest change to its shore with a four metre retreat at the northern end of the bay since the 1980s.

Lyttelton Harbour has a mainly stable shore with some minor zones of accretion and erosion. The exception is Charteris Bay with its shore having eroded 5–10 metres over a 35–45 year period.

Although minor accretion has occurred along parts of the shore it appears that sea-level rise is happening at a greater rate. Sea-level rise will increase the erosion potential.



The 2017 Report can be found online at **ccc.govt.nz/coastalhazards**

To view the 2017 Report visit ccc.govt.nz/coastalhazards

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