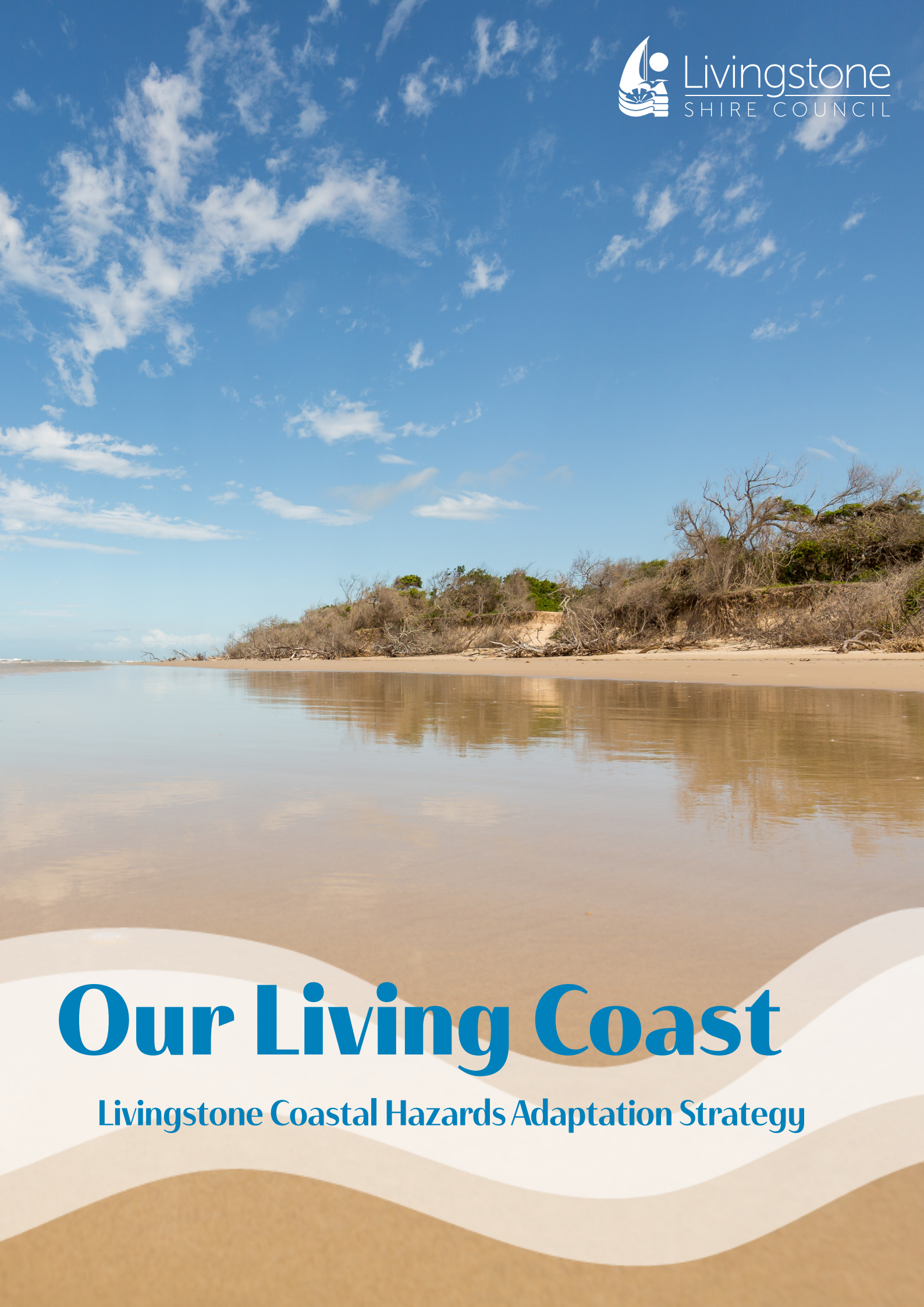

Livingstone
SHIRE COUNCIL

Our Living Coast

Livingstone Coastal Hazards Adaptation Strategy

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Mayor's Message

The Livingstone coast is a dynamic and varied landscape. Stretching for some 300 kilometres, our coastal zone encompasses pristine coastal wetlands, estuaries and inlets, extensive sandy beaches, unique coastal townships, offshore islands and a rich diversity of cultural, economic and environmental values.

Our coast is highly valued by our traditional owners, local communities, businesses and residents of the broader Livingstone shire, and visitors to the area. The coastal landscape and access to the coast underpins not only our economy but our lifestyle here. Everyone in our community has a role in caring for our coast and we all need to work together.

The Livingstone coastline is currently prone to coastal hazard impacts such as erosion and storm tide inundation, driven by cyclones and storm events. These coastal hazard impacts are predicted to increase with climate change.

The Queensland Government and the Local Government Association of Queensland (LGAQ) have provided funding and support to Livingstone Shire Council to develop a strategic approach to managing coastal hazards and to ultimately produce the Our Living Coast Strategy.

Our Living Coast provides a roadmap of actions that enables us to be better prepared to reduce the impacts of coastal hazards on our communities, environment, cultural values, infrastructure, liveability and services.

Mayor Andy Ireland

Acknowledgement of Country

Livingstone Shire Council acknowledges and pays respect to the Darumbal and Woppaburra people as Traditional Custodians of the land within Livingstone. Council also acknowledges and pays its respects to the Aboriginal and Torres Strait Islander people who now reside within this area.

The Our Living Coast Strategy commits to acknowledging the history and ongoing contributions of Aboriginal and Torres Strait Islander people to the Livingstone region and the fundamental role they play in shaping our region.

1.0 Introduction

1.1 Purpose of the Our Living Coast Strategy

The Our Living Coast Strategy provides direction for how we can work together to better manage and respond to coastal hazard risks and strengthen the resilience of our coastal places, our coastal economy and our coastal environment.

From Stanage in the north to Fitzroy River in the south, the Livingstone coast has countless picturesque sandy beaches, coastal townships and offshore islands which makes it an ideal tourist destination and place to live.

Coastal environments are always changing and being shaped by wind, tides and currents and changing sea levels. Impacts from these natural processes include storm tide inundation, coastal erosion and sea level rise. Referred to as coastal hazards, they can affect our region's natural and built environment, our day to day lives, our community's wellbeing and our economy.

The Our Living Coast Strategy provides an understanding of how our coast is being affected by coastal hazards today and how our coast might change in the future under the influence of a changing climate. Understanding current and future coastal hazard risks and how they might impact our community means we can proactively plan, prepare and respond to these risks over time.

The Our Living Coast Strategy focusses on the following coastal hazards:

Storm tide inundation is the temporary inundation or flooding of low lying coastal land by abnormally high ocean levels caused by cyclones and severe storms.

Source: Livingstone Shire Council, 2019

Climate change is the change in the present day climate due to warming of our atmosphere. This will influence how coastal hazards impact on our coastal areas.

Source: Queensland Times, 2016

Coastal erosion is the loss of land, beach or dunes by wave or wind action, tidal currents, water flows or permanent inundation from sea level rise. Coastal erosion can be short term or long term and is influenced by changing climate conditions, sand supply and human influences.

Source: The Morning Bulletin, 2016

Sea level rise is the increase in sea level caused by global warming due to climate change. This results in an increase in the extent of land subject to periodic tidal inundation, coastal erosion and storm tide inundation.

Source: The Chronicle, n.d.

THE QCOAST2100 PROGRAM

Livingstone Shire Council prepared the Our Living Coast Strategy using funding provided through the QCoast2100 program.

The QCoast2100 program is a state-wide initiative of the Queensland Government and Local Government Association of Queensland (LGAQ). The program has been designed to assist Queensland coastal local governments with funding and technical support to progress the preparation of plans and strategies to address climate change related coastal hazard risks.

The purpose of the Our Living Coast Strategy is to:

Provide a strategic framework for a coordinated and whole of coast response for what actions we will take to adapt to and manage coastal hazard risks.

The strategy will inform decision making and guide the management of our coastline. This includes:

- infrastructure and asset management
- land use planning
- foreshore management
- nature conservation
- recreation
- cultural heritage values
- other public assets

1.2 A community driven plan for a resilient coast

Caring for our coast now and into the future is a shared responsibility involving Council, State and Commonwealth Governments, stakeholders, business owners, Traditional owners, property owners, residents and the community. Having a shared vision and framework that underpins Our Living Coast Strategy is important. Council has sought to involve the community and a wide range of key stakeholders to provide input and share their experiences on our changing coast and to ensure the strategy responds to the needs and expectations of our community. This strategy has been developed in consultation with:

Council Representatives (Internal Technical Working Group & Councillors)

External Stakeholders

Community Reference Group

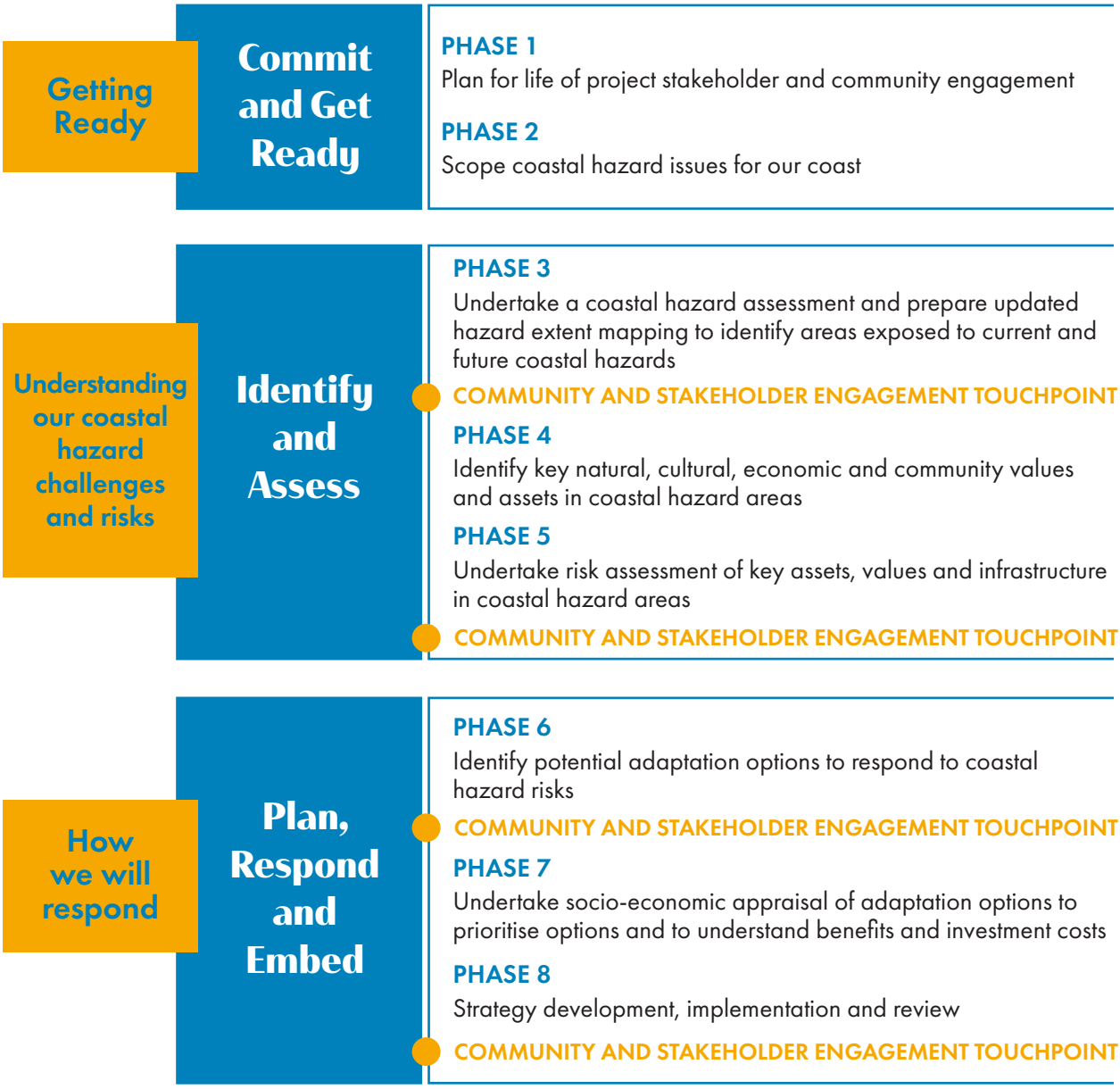
The Broader Community

Broad community engagement from May to August 2019 included participation in a community survey, more than eight events across the region's coastline and online material on Council's project website. Engagement also occurred in August 2020 through a series of community factsheets.

The Technical Working Group, Community Reference Group and External Stakeholders provided feedback at key decision points across all project stages.

1.3 How did we develop the Our Living Coast Strategy?

The Our Living Coast Strategy has been developed to align with the process and requirements of the QCoast$_{2100}$ *Minimum Standards and Guidelines for Queensland* (LGAQ & DEHP, 2016).



The process to develop the strategy has included technical studies and engagement activities that together form the evidence underpinning the strategy. The outputs from this work have:

- Identified existing coastal hazard extents for coastal erosion, storm tide inundation and sea level rise, and how these extents might be expected to change in the future under the influence of rising sea levels over different timeframes: present day, medium term (2050 – increase in sea level of 0.3m) and longer-term (2100 – increase in sea level of 0.8m), as part of Phase 3
- Assessed vulnerability and risks to a broad range of assets and environmental, social, cultural, recreational, infrastructure and economic values within coastal hazard areas, as part of Phases 4 and 5. This included identifying priortities and distinguishing which risks need responding to today and risks that can wait.

- Identified strategic adaptation options to 'treat' or manage coastal hazard risks, as part of Phases 6 and 7
- Identified 'tools' to deliver the adaptation options
- Outlined indicative timing and sequencing of strategic adaptation actions over time using 'pathways' approach
- Defined roles and responsibilities for implementing actions
- Identified potential funding sources
- Outlined monitoring and review expectations

Key considerations for strategic adaptation actions for the Livingstone Shire include:

Financial sustainability – adaptation can be expensive, and we can't protect the whole coastline. We need to focus on low cost solutions wherever we can, and prioritise where and when we invest in high cost adaptation responses

Protection of special places and infrastructure – protecting important assets should not be at the expense of what we value and love

Maximising benefits – when we invest in coastal hazard adaptation, we want to make sure that we maximise community benefits for the shire as a whole

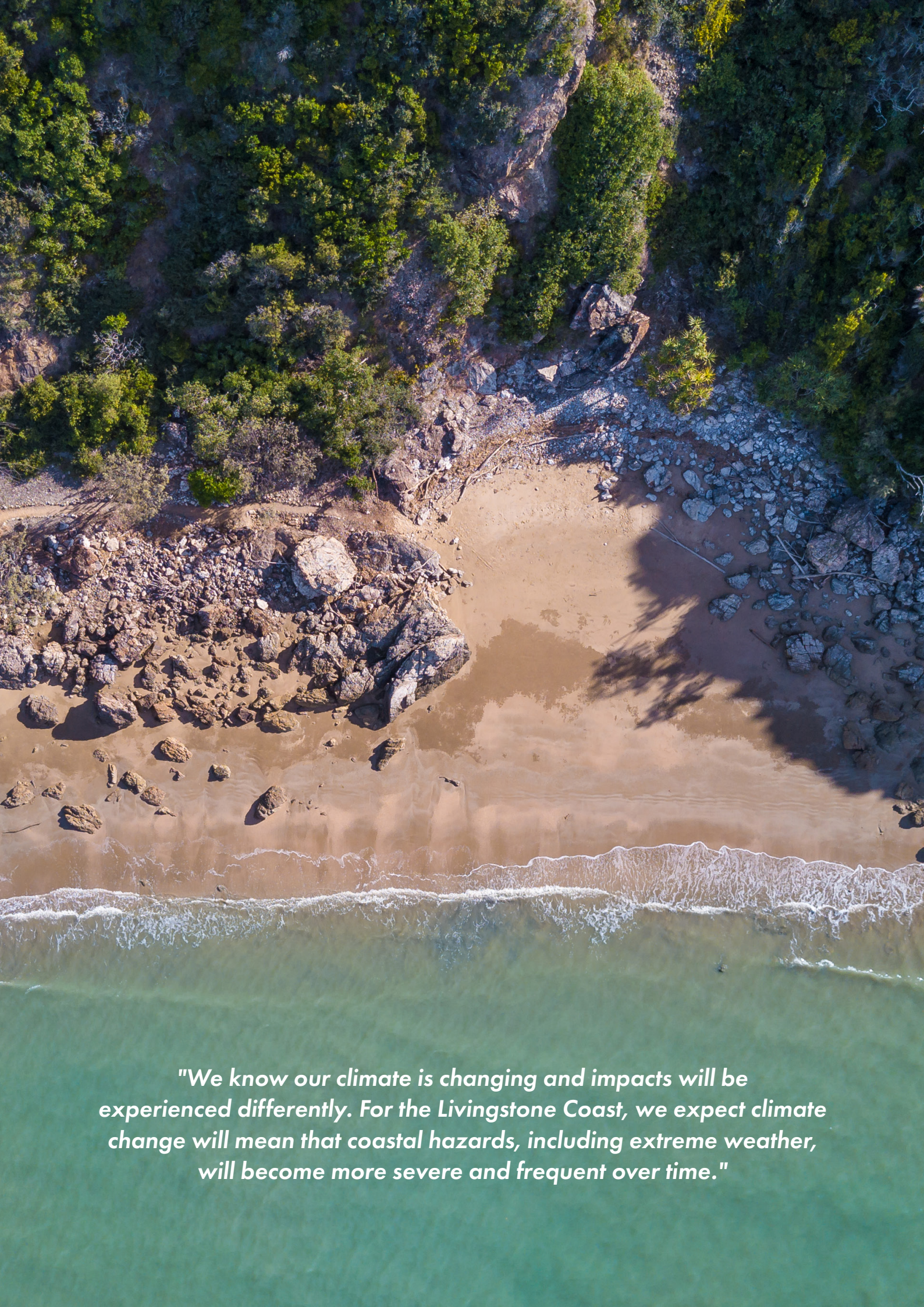
1.4 Our journey in responding to coastal hazards

Living with coastal hazards has been part of our history and will continue to be part of our future. Natural coastal processes have been ongoing for millennia and the people of the Darumbal nation and Woppaburra people have deep experience and knowledge of natural coastal processes, extreme weather and connection with sea and country.

Livingstone is leading the way in disaster management through their state-of-the-art Local Disaster Coordination Centre and Community Resilience Hub. The Hub provides a central location for all emergency service agencies to work cooperatively during natural disasters and it also functions as an important community resource for advice, guidance and education to help build community resilience and prepare for future extreme weather.

Council have already been undertaking various coastal activities and works to protect community infrastructure, for example a seawall adjacent to Yeppoon Beach, provision of an alternative road connection between Yeppoon and areas immediately north of Spring Head, and active management of the dunes on Kemp Beach.

Drawing on our collective experience of past coastal hazard events provides the foundation for us to build on what we know works well in our community, as well as improve and plan our response to future coastal hazards risks to minimise disruption and manage future change along our coastline.



"We know our climate is changing and impacts will be experienced differently. For the Livingstone Coast, we expect climate change will mean that coastal hazards, including extreme weather, will become more severe and frequent over time."

2.0 Our Coastal Values

2.1 Our Coast

Located on the Capricorn Coast in central Queensland, our shire has over 300 kilometres of coastline stretching from Stanage in the north to Fitzroy River in the south.

Our coastline is diverse – comprising scenic unspoilt coastlines, wetlands, waterways, islands, national parks, rainforest, seaside towns and expansive farmland. Located on the Tropic of Capricorn, we enjoy a subtropical climate with wet and humid summers and mild winters. This weather underpins our outdoor lifestyle which is centred around the coast where we live, work and relax.

LIVINGSTONE AT A GLANCE

36,300 residents in 2016

55,740 estimated residents by 2041

15 COASTAL COMMUNITIES

AGING POPULATION

RESIDENTS AGED **65+** (2018)

LIVINGSTONE **18.4%**

QLD **15.4%**

INCREASE IN RESIDENTS

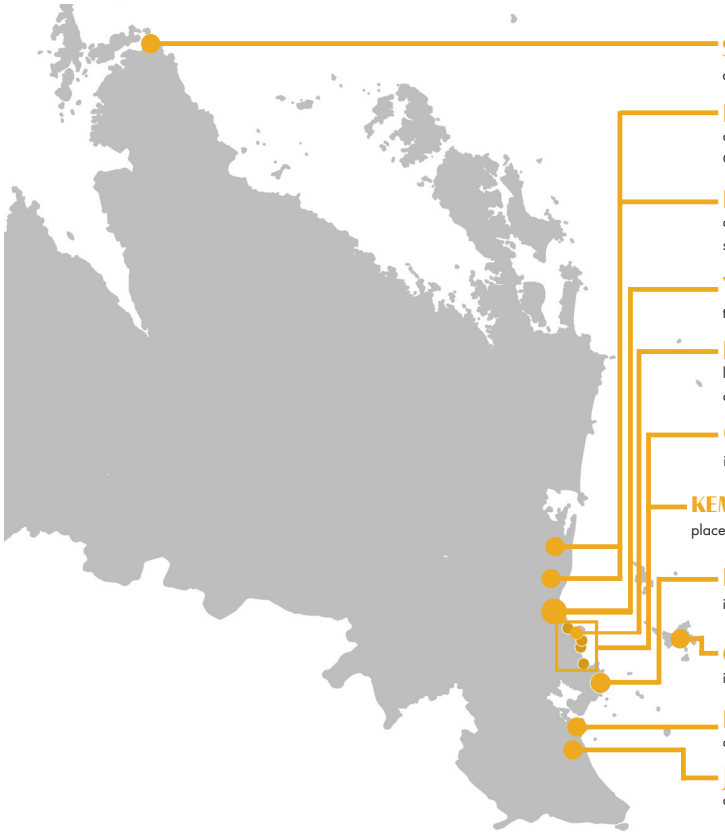
1.6% per year (2016 - 2041)

50% of population lives in the major coastal centres of Yeppoon and Emu Park

Source: Livingstone Shire Council's Corporate Plan 2020-2030 and Livingstone Community Plan - Towards 2050

Each part of our coast is different. Each coastal community has its own unique character, and identitying special places that people love for different reasons.

Each coastal community also has varying exposure to coastal hazards and will be impacted in different ways. The adaptation actions in this strategy respond to the unique needs and impacts of coastal hazards for different parts of our coast.



STANAGE
a remote fishing settlement located at the northernmost area of the Shire

FARNBOROUGH
a rural area that incorporates a large area of Byfield National Park and the former Capricorn International Resort

BANGALEE
a smaller coastal settlement that provide us with scenic views and endless swimming, walking and picknicking activities

YEPPOON
the bustling commercial and tourist centre

ROSSLYN BAY
links us with the marine industry and is an important gateway to the whole of the central Queensland coast

CAUSEWAY LAKE
is hotspot for tourists and residents and a hub for boating and fishing

KEMP, LAMMERMOOR, MULAMBIN & KINKA BEACHES
places where families, friends and visiting tourists can play and relax

EMU PARK
is a lively settlement which is touched by the legacy of Captain James Cook

GREAT KEPPEL ISLAND & THE KEPPELS
important destinations for locals and tourists

KEPPEL SANDS
a quiet coastal settlement spread along a long beach front road

JOSKELEIGH
a remote coastal settlement that provides scenic coastal views

2.2 Our Coastal Environment

Our coast is a beautiful scenic landscape characterised by a unique combination of coastal landforms including rocky headlands, pocket beaches, estuaries, bays, dunes and offshore reefs. Our wetlands, waterways, natural foreshores, beaches, islands and coastal vegetation support a diverse and flourishing ecosystem of plants and animals.

Waterways and wetland areas such as the Fitzroy River, Ross Creek, Cawarral Creek, Mulambin Creek and Corio Bay Wetlands are important habitat areas for native species.

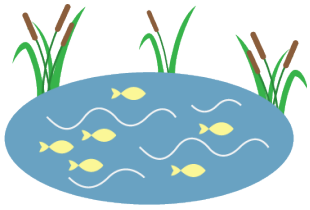
There are many important nature conservation areas that support large extents of protected ecosystems, including Byfield National Park, Capricorn Coast National Park and Broadsound Islands National Park.

Our lifestyle, liveability and the reasons why people love to visit our coast are underpinned by the natural beauty of our coastal landscapes and our bustling coastal towns. Our coastal environment support a variety of places that hold special cultural, natural, social and economic values to residents and visitors.

OUR COASTAL ENVIRONMENT AT A GLANCE:

11,800km²
SHIRE AREA[1]

3803 Wetland Wildlife Species[2]



1392km² Wetlands[2]

300km Coastline[1]

49 Rare or threatened plant species[2]

TOTAL PROTECTED AREA IN THE SHIRE
(State Forests, Conservation Parks, Resource Reserves and National Parks[1])

200km²

Source: *1. Council's Corporate Plan 2020-2030*
2. Queensland Government (DES), Wetland Info, 2020

2.3 Our Coastal Economy

Jobs and the economy are identified as important priorities for the future of the Livingstone Shire. Key employment areas for our shire include accommodation and food services, tourism, retail, education and training, manufacturing, construction, agriculture, forestry and fishing.

Coastal dependent infrastructure, particularly to support recreational boating and fishing, are important for the local economy and are key tourism drivers. Tourism is a key economic contributor that spans across retail, accommodation and food services. This sector added $52 million (5%) to the shire's economy in 2018/2019 and was also a high employer that generated approximately 20% of local jobs . New and existing tourist uses, such as those located at Great Keppel Island and Rosslyn Bay Harbour that are focussed on cultural or natural environment features, will continue to play an important role in our economy and tourism industry.

How we respond to coastal hazards today and in the future will directly influence the strength of existing businesses, our lifestyle and why people to choose to visit or live on the coast.

The Rosslyn Bay Marina is a regionally significant facility that attracts locals and people from surrounding areas. It is the only all-tide, open water access point on the Capricorn Coast.

15,346 average international visitors per year[3]

$52 million
valued added by tourism
(5% of shire's industry and 0.4% of QLD's industry[4])

Source: *3. Livingstone Community Plan 2020-2030*
4. id Livingstone Shire Economic Profile, 2020

2.4 Our Coastal Lifestyle

Our coastal places are the foundation for our outdoor, relaxed beach lifestyle. 65% of our population choose to live in the larger coastal centres in our shire – Yeppoon and Emu Park[5]. These places front sweeping sandy beaches and foreshore parklands with facilities that support boating, fishing, swimming, walking and community gatherings.

The engagement informing the Our Living Strategy has helped us understand what our communities value most on the coast and why these areas are important.

Some of our favourite ways to use our most loved coastal places include enjoying the scenic coastal views, appreciating the lush natural coastal environment and delighting in water or foreshore recreational activities, such as swimming, snorkelling, boating and fishing, running and cycling.

Our favourite ways to enjoy our coastal places include[6]:

- Recreational activities in the water, along the foreshore and at the water's edge
- Experiencing scenic views and natural coastal environment and landscapes
- Spiritual and cultural connection
- Picnics and BBQs with friends and family
- Community events, such as markets and festivals
- Visiting cafes, restaurants and shops

Our ideal qualities of the beach or foreshore include[6]:

- Sandy beaches
- Natural areas adjoining the coastal foreshore
- Naturally vegetated dunes
- Presence of wildlife
- Open parks and reserves adjoining the foreshore
- Infrastructure to support access and enjoyment of the foreshore

Source: *5. Based on ABS 2016 census data*
6. Data based on Phase 3&4 community survey results

3.0 Living with our Changing Coast

Our coastal areas are dynamic places that have been formed over a long time by natural processes, such as wave and wind action, ocean tides and currents. These natural coastal processes are also known as coastal hazards when they potentially impact on buildings, community infrastructure, places of cultural importance and our natural areas.

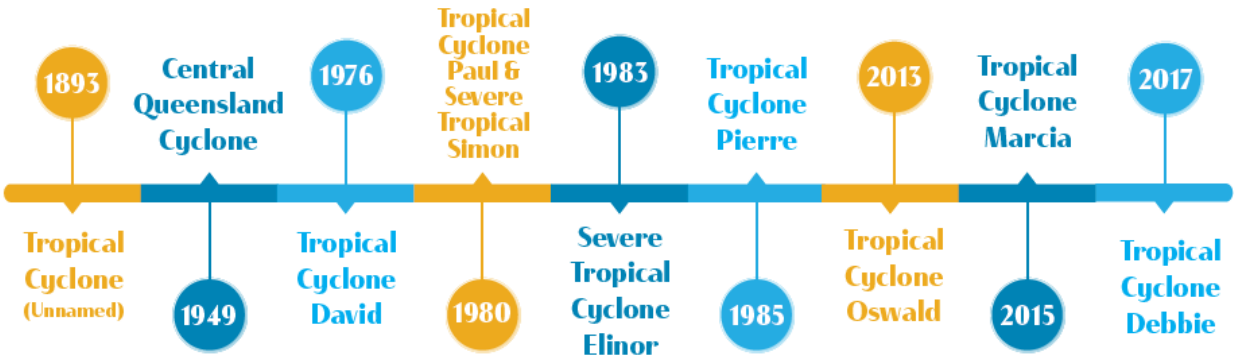
The Our Living Coast Strategy focuses on the coastal hazards of storm tide inundation and coastal erosion and how these coastal hazards are expected to change under the influence of sea level rise from future climate change. The extent of coastal land potentially impacted by coastal hazards, as well as the consequences of these coastal hazards, are expected to increase into the future.

Most people are aware of daily changes to our coast, beaches and dunes caused by the rise and fall of tides and actions of waves and wind. Some of us during our lifetime, have also experienced more extreme coastal hazard events in Livingstone, such as erosion associated with severe tropical cyclone Marcia in 2015 and tropical cyclone Debbie in 2017. Less obvious changes include the gradual widening of the dune system along most of Kinka Beach over the past 20 years.

These natural coastal processes, whether occurring daily or from more extreme weather events, have always impacted and shaped our coast.

Coastal hazards and their impacts – experienced past and present – will continue in the future and are part of living on the coast. How we have experienced past coastal hazards and how we choose to respond in the future will change over time. Improving our resilience to coastal hazards is a continual journey for everyone and it is important that we build on what we have learned works well for our region.

Our 'lived experience' with coastal hazards means we can build on what works well for our shire.



Climate change is expected to increase the extent, severity and frequency of coastal hazards. For example, tropical cyclones are expected to be more intense and a greater extent of low lying land will be affected by periodic inundation because of sea level rise.

One of the best lines of defence to protect our coastal infrastructure and valued places from coastal hazard impacts, is our natural environment – a wide beach, healthy dunes, coastal vegetation and intact habitats – which provides a protective buffer. These are also the qualities and features that our community values most on the coast.

We can expect to see a range of changes to our coast from coastal hazard impacts in the short and long-term.

Changes and Impacts we are experiencing now:

Erosion damage to buildings and private properties

Source: ABC, 2014

Narrowing of beaches and loss of sand

Source: Piorewicz, 2002

Limited natural access paths to beaches or loss of access

Source: Zimmer, 2010

Loss of coastal vegetation and natural habitat

Source: The Morning Bulletin, n.d.

Degraded natural systems and changing ecosystems adjoining coastal areas

Source: The Morning Bulletin, n.d.

Dune erosion from large tides

Source: Worldwide Elevation Map, 2020

Damage to road infrastructe and access being cut-off resulting in isolation risk.

Source: The Morning Bulletin, 2017

Other changes and impacts include:

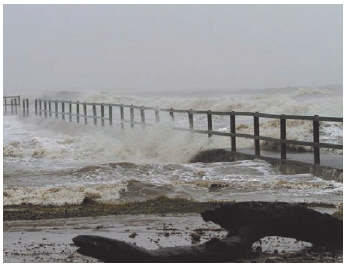
Increase in extent of land, buildings and infrastructure exposed to the sea

Source: Seniors, 2017

Changes to water flows in waterways and wetlands

Source: The Northern Star, 2017

Damage to important infrastructure (e.g. jetties, major roads, boat ramps)



Source: ABC Capricornia, 2014

Reduced effectiveness of coastal protection measures (e.g. sandbagging)

Source: Daily Mercury, n.d.

Disappearing foreshore areas

Source: Livingstone Shire Council, 2019

Changing patterns of sand movement and accretion

Source: The Morning Bulletin, 2016

3.1 What are the coastal hazards affecting our coast?

This strategy is forward-looking and considers coastal hazards to 2100. The Queensland State Planning Policy 2017 requires all Councils to adopt this same timeframe, year 2100, to account for climate change impacts in its strategic land use planning. By this time, it is projected that the Queensland coastline will experience a 0.8m sea level rise and a 10% increase in cyclone intensity.

The climate change projections for sea level rise in this strategy are based on best available international science from the Intergovernmental Panel on Climate Change (IPCC).

To inform the Our Living Coast Strategy, a coastal hazards assessment, including updated hazard extent mapping of storm tide inundation, coastal erosion and sea level rise has been prepared for three planning horizons – short term (present day), medium term (around 2050 – a 0.3m sea level rise) and long term (2100 – a 0.8m sea level rise) (available on Council's website).

The coastal hazard mapping indicates how coastal hazard extents may potentially change over time under the influence of sea level rise, and supports monitoring impacts and changes over time, preparing for change and making informed decisions about growth, development and investment on our coast. Council will also update the mapping as new and updated climate science becomes available.

HOW RISKS CHANGE ON THE LIVINGSTONE COAST - AT A GLANCE

An analysis of risk shows that:

- More of our beaches, public and community infrastructure and places that matter most (special places) will be at a very high risk of erosion because this is the most prevalent coastal hazard affecting our coast, and our communities are clustered along the coastline.
- Fewer special places will be outside the erosion hazard area or at a low risk over time. This means our exposure is increasing and more of our coastal assets will be exposed to erosion.
- Sea level rise presents a lower risk to our special places. This is because its impacts are gradual and experienced over time, and mainly confined to places close to our estuaries.
- Climate change will increase the level of risk to our special places because of sea level rise, with some becoming high risk over time.
- Storm tide inundation does not present as high a risk over time because these events are infrequent and are temporary. However, the number of special places at a low risk today will decrease over time as more places become vulnerable to inundation.

The main coastal hazard affecting Livingstone Shire is erosion, with the entire open coast frontage exposed. In parts of the coast like Yeppoon, natural landforms and coastal protection works have already been used to reduce erosion impacts.

There are also areas exposed to potential storm tide inundation, particularly along our coastal waterways, flooding adjoining low-lying land. Areas within Keppel Sands, Emu Park, Mulambin, Yeppoon, Farnborough and the Keppel Islands are susceptible. However, the dune system along our coast provides some protection against inundation directly from the sea.

The coastal hazard risk to these special places will increase over time.

Sea level rise is predicted to permanently or periodically inundate this same low-lying land – where natural habitats and grazing areas are located. Zilzie, Keppel Sands, Yeppoon and Farnborough areas are notably exposed to sea level rise in the future.

3.2 How may these changes impact us?

We all have special places, features or memories of the coast that are important to us for different reasons – economic, social, environmental, cultural or personal. These places are at risk when coastal hazards threaten to impact them.

RISK is the combination of likelihood (or how often we think a coastal hazard may occur) and the consequence of it occurring (or what we expect an impact of the coastal hazard to look like).

RISK= LIKELIHOOD OF A HAZARD OCCURRING x CONSEQUENCE OF IMPACT IF IT DOES OCCUR

Risk can be to people's safety, our natural environment and wildlife habitats, Traditional owner values, buildings, infrastructure (roads, stormwater, water and waste water), private property, community facilities, critical infrastructure (hospitals and emergency facilties), our places of social and cultural importance and our lifestyle and economic prosperity.

Risks can be either direct (e.g. inundation of a road) or indirect (e.g. inundation that isolates a community) and can be assessed across a range from low to extreme risk.

The community and stakeholders told us what coastal areas are valued the most and why. We used this information to understand the consequence of coastal hazards as part of the risk assessment.

Our coastal hazard risk today will be different to our future risk. For example, an area not exposed to coastal hazards today may be exposed in the future, therefore the risk to that area increases over time. This is true for important locations such as Bell Park, Emu Park Surf Life Saving Club and sections of the Scenic Highway which are not at risk of erosion today, but are expected to be at a high risk in the future (around 2050 and 2100). Residential areas and the caravan park at Keppel Sands are not currently exposed to sea level rise risks today, but will be by 2100.

To identify risk along our coast, we need to first understand the impact of coastal hazards: how much it affects (or what is exposed to coastal hazards) and how it impacts (or the consequences for) our special places and important infrastructure. We determine this by looking at our special places, land uses, communities and public infrastructure and how exposed they are to current coastal hazard impacts. This is undertaken from a social, economic and environmental perspective:

Social for example, impacts to the community, services, culture and wellbeing; disruption caused; loss of life or injury; and public attention from coastal hazards.

Economic for example, financial impacts to repair damaged properties, infrastructure and business e.g. loss of employment, business and tourism; failure of infrastructure; and recovery costs from coastal hazards.

Environment for example, impacts to the environment; level of harm and remediation required; length of recovery; potential for containment; and loss of species and habitat from coastal hazards.

The above elements help us to better understand the effects of coastal hazards. They explain the degree of impact to our community, economy and environment should a coastal hazard event occur. The scale and timeframe of the social, economic or environmental impact are also important. The value we place on the parts of the coast affected, how sensitive we are to impacts and how we cope with these impacts are considered in our overall risk.

To understand the potential impacts of coastal hazards in Livingstone Shire and what infrastructure and areas are exposed to coastal hazard risk today and by 2100, a technical analysis was undertaken of:

- Council asset databases to identify Council owned and managed infrastructure – e.g. buildings, roads, water supply, sewerage, drainage, foreshore park infrastructure, critical infrastructure, natural areas/ conservation parks;
- Data from external infrastructure and asset providers, including State agencies;
- The Livingstone Planning Scheme land use zoning.

The land use zoning analysis indicated a small area of our Shire's total existing urban area is expected to be impacted – with less than 1% being exposed to coastal hazard risks in the future. A summary of land use zones[7] exposed to coastal hazard risks to **2100** is provided below.

Coastal erosion out to 2100 to impact:

<1% of our urban land (148 ha)

19% of our community facilities land (179 ha)

15% of our conservation land (4,870 ha)

12% of our tourism land (50 ha)

11% of our future urban land (135 ha)

7% of our rural land (54,914 ha)

Source: *7. These categories include the following zones:*

- ***Community facilities*** *includes land in the Community facilities, Open space and Sport and recreation zones.*
- ***Conservation*** *includes land in the Environmental management and conservation zone.*
- ***Future urban*** *includes land in the Emerging communities zone.*
- ***Tourism*** *includes land in the Tourism area (major) zone.*
- ***Urban area*** *includes land in the following zones: Low density residential, Low-medium density residential, Medium density residential, Low impact industry, Medium impact industry, Major centre, Local centre, Neighbourhood centre, Specialised centre, Township, Special purpose and Limited development (constrained land).*
- ***Rural*** *includes land in the Rural and Rural residential zones.*

Temporary storm tide inundation out to 2100 is expected to impact:

<1% of our urban land (125 ha)

18% of our community facilities land (165 ha)

18% of our tourism land (73 ha)

16% of our conservation land (5,232 ha)

11% of our future urban land (129 ha)

8% of our rural land 63,824 ha)

Low-lying areas vulnerable to inundation from sea level rise out to 2100 is expected to impact:

<1% of our urban land (39 ha)

13% of our conservation land (4,259 ha)

9% of our community facilities land (87 ha)

4% of our rural land (31,527 ha)

3% of our tourism land (12 ha)

2% of our future urban land 24 ha)

These changes mean that our community and open space areas – like our foreshores, parks, and clubs – are more exposed to coastal erosion and storm tide inundation because they often co-locate on the coast to take advantage of natural values.

Our conservation and environmental areas are also exposed to coastal hazards over time. Coastal erosion and storm tide inundation are likely to affect these areas more than sea level rise. This will have implications for our coastal habitats and how we manage and care for these areas.

The locations of our coastal tourism assets, such as on Great Keppel Island, make them more exposed to storm tide inundation over time. Future urban areas close to the coast supporting our population growth will also experience increased exposure to storm tide inundation and erosion by 2100. This may reduce the development potential of these areas and have other implications for emergency management response. Outside of our urban areas, there is also rural land along the coast that is vulnerable to erosion and storm tide inundation by 2100.

The following special places and important infrastructure on our coast are also exposed to coastal hazard impacts –today and in the future. A technical risk assessment for the whole of Livingstone Shire identified the following at high or very high risk:

11 SEGMENTS OF IMPORTANT ROAD

multiple coastal hazard impacts, including erosion

7 BEACHES/ DUNE AREAS

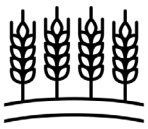
sea level rise and erosion impacts

3 CARAVAN PARKS

sea level rise and erosion impacts

COASTAL FRONTAGES OF NATURAL AREAS

multiple coastal hazard impacts



AGRICULTURAL LAND IN STANAGE

sea level rise impacts

5 COMMUNITY FACILITIES

mostly erosion but also sea level rise impacts

1 VILLAGE CENTRE (KEPPEL SANDS)

coastal erosion impacts

11 RESIDENTIAL AREAS + 1 FUTURE EMERGING COMMUNITY AREAS

mostly erosion but also sea level rise impacts

3 PIECES OF INFRASTRUCTURE - EMU PARK WASTE TRANSFER STATION, STANAGE COAST GUARD AND LOCAL BOAT RAMPS

multiple coastal hazard impacts

We know some of these special places are of shire-wide or regional significance:

- Fitzroy River to Corio Bay estuarine wetlands are at a high risk of sea level rise and erosion in the future.
- The open coast and natural wetlands at Stanage and the Keppel Islands are at a high risk of storm tide inundation in the future.
- Local boat ramps are at a high risk of storm tide inundation and sea level rise in the future.

The coastal hazard risk to these special places will increase over time.

4.0 What can we do? A STRATEGY FOR EVERYONE

The vision for the Livingstone Coast will be achieved by working towards six strategic coastal outcomes and aligning adaptation approaches with the agreed adaptation principles for the Livingstone Shire. The strategy identifies implementation actions to manage the risks from coastal hazards and to enhance the resilience of our coastal areas. This is essential to ensure our communities today, as well as future generations, can continue to enjoy our coast and valued lifestyle.

4.1 Our adaptation principles are a foundation for a resilient future coast

The development of this strategy and its implementation is underpinned by a set of principles and a hierarchy of preferred adaptation approaches, developed with input from key stakeholders and to reflect broader community engagement findings on key coastal values and best practice coastal hazard risk management approaches.

They form part of the strategy framework and provide a foundation for considering the suitability of different adaptation approaches and supporting consistent decision making for the implementation of shire-wide and tailored strategic adaptation actions for each community and locality.

The principles underpinning adaptation in Livingstone Shire are to:

Retain and enhance our shire's unique coastal identity and character. This means adaptation responses 'look good' and complement the landscape setting.

Protect the function of ecological processes, habitats and biodiversity values.

Prioritise public funding of solutions for key 'public good' infrastructure over private benefit.

Prioritise risk management for settlements in higher risk areas to reduce future exposure using sustainable and cost-effective means.

Prioritise natural ecosystem based options and 'soft' solutions over hard infrastructure options.

Look for opportunities to maximise investment value and achieve multiple benefits. This means adaptation responses are not solely designed for their engineering function.

Seek solutions that are evidence-based, reflect best practice and are tailored to the risk and local values.

Build community awareness of risk and resilience and partner together in the implementation of actions.

OUR VISION

Our Living Coast is part of who we are and underpins our lifestyle. Everyone in our community works together to look after our coast. The decisions we make today support us to be resilient to coastal hazards now and in the future.

The hierarchy of preferred adaptation approaches, in order of highest to lowest preference is:

1. Avoid placing new high value or long life assets into higher risk areas and transition existing assets out of higher risk areas over time.

2. Build resilience by protecting or reinstating natural coastal ecosystems in the first instance.

3. Build community resilience by strengthening individual capacity and awareness and understanding of coastal hazard risks.

4. Adapt and modify existing and future assets to accommodate risks and timeframes – e.g. build 'higher and stronger' in areas of tolerable risk.

5. Protect / defend assets to the impacts of a defined event, while also understanding limitations and residual risk.

4.2 Desired coastal outcomes

The vision for Our Living Coast will be achieved by working to six strategic outcomes:

1. Our resilience to coastal hazards is founded on community awareness, collaboration and sharing information across government, Traditional Owners, business, landowners and the community.

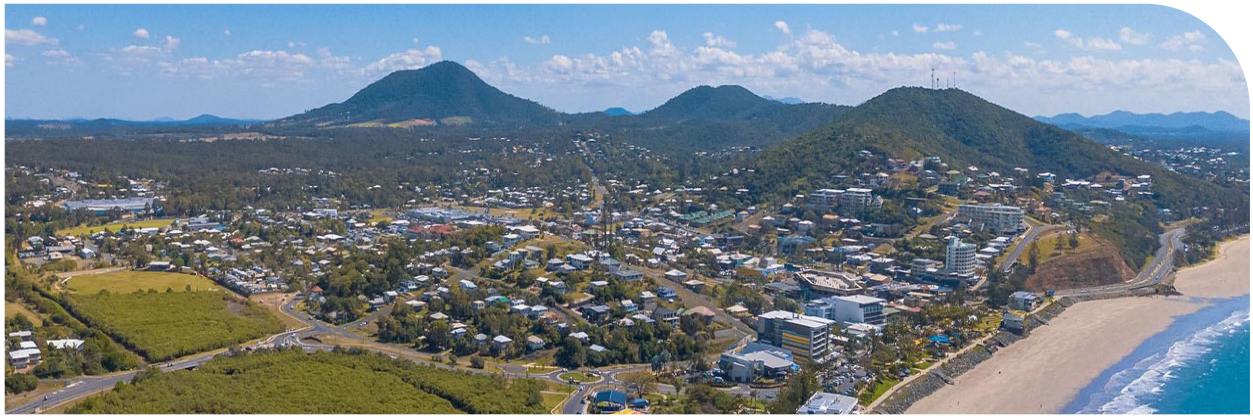
2. A holistic and shared understanding of current and future coastal hazard risks, based on up to date climate change information is used to inform coastal hazard adaptation actions and initiatives.

3. Adaptation options provide an integrated pathway response and align with best practice coastal management approaches appropriate to the level of risk.

4. Coastal hazard adaptation options complement the coastal landscape setting and character of local coastal places and provide multiple public benefits for our communities

5. Natural coastal environments, landforms and habitats are healthy, diverse and valued for their contribution to reducing and managing coastal hazard risks.

6. Coastal hazards and future climate change impacts are recognised, planned for and considered in decision making to improve the resilience of public infrastructure and reduce the future exposure of communities to coastal hazards.



4.3 Pathways for a resilient future coast

To respond to the challenge of not knowing precisely the timing of when coastal hazards may occur or the rate of coastal change, best practice adaptation planning calls for a flexible 'pathways' approach, which is a sequence of adaptation action/s (or combination of actions) to be implemented over time.

The implementation of actions relies on 'trigger points' linked to changing coastal hazard conditions over time, with decisions informed by regular monitoring of 'on the ground' changes and impacts. Once an adaptation action is implemented, it is used until it is no longer effective or viable to manage the risk or extent of change, at which time another action may be required and the next step is taken. This is called a trigger point. Trigger points can also be used in locations where hazards are not yet occurring but are projected to occur in the future.

The pathways approach supports flexible and informed decision making that responds to change as it is needed, supporting Council to take a coordinated and strategic approach to the sequencing, prioritisation and tailoring of adaptation actions.

There is no 'one size fits all' approach to adaptation and every community and locality will have its own locally responsive adaptation pathway and sequenced actions over the short, medium and longer term to respond to current and future coastal hazard risks.

Everyone has a responsibility to care for the coast and has a role in coastal hazard adaptation action. Council will be responsible for implementing actions for the protection and management of its infrastructure and land. External asset managers and private land owners will have the responsibility to maintain their assets in a way that supports the outcomes of the Our Living Coast Strategy. Council will be seeking opportunities for partnerships and collaboration with community stakeholders, residents, business, state agencies, other stakeholders, entities and traditional owners to deliver the outcomes of this strategy.

4.4 A strategic approach to adaptation

The range of adaptation actions included in this strategy support an adaptation pathways approach to mitigate coastal hazard risks and impacts over time.

Three themes for adaptation have been defined for the Our Living Coast Strategy – **Maintain and Improve, Modify, and Planned Transition.** For each theme, whole of shire strategic adaptation actions are defined and described and form the basis for adaptation pathways to be applied to different parts of the coast.
In addition to whole of shire strategic adaptation actions, there are also a suite of local adaptation option pathways that will need to be further considered in association with the attitude of the community at the time.

1. Whole of shire strategic adaptation actions

Implemented over the lifetime of the strategy

2. Local adaptation option pathways

Options that need to be further considered based on community attitudes at the time

These are described below.

MAINTAIN AND IMPROVE

Strategic adaptation actions maintain the current risk profile. These actions rely strongly on regular monitoring to understand the extent of coastal change at the local level and to identify when a trigger point is reached. These actions also include activities and programs often already being undertaken such as community awareness raising, active management of natural areas and ecosystems, emergency response, land use planning and asset management.

While these actions do not always directly reduce the risk of coastal hazards, they are important to improve and strengthen the resilience of our coast over time.

The strategic adaptation actions under the theme of 'Maintain and Improve' include:

MONITOR

Undertake monitoring to observe coastal changes and determine if trigger points are being reached for the implementation of adaptation actions.

Monitoring will inform how risk profiles are changing over time and if adaptation pathway actions are appropriate and effective or need adjusting. Monitoring also improves our understanding of coastal processes and coastal hazards over time. Monitoring covers a wide variety of activities and may involve examining beach condition, changes in mangrove and vegetation coverage, turtle nesting periods and use of beaches, changes in dune habitat coverage and dune stability, distance from an erosion escarpment, damage to beach access and other infrastructure, asset condition, performance and maintenance regimes, frequency of tidal inundation, number of properties impacted by hazard events etc.

COMMUNITY AWARENESS AND EDUCATION

Build community understanding, awareness and resilience for coastal hazard risk adaptation by providing ongoing information and messaging about coastal hazards, risks, monitoring and adaptation risks.

This includes building on existing Council programs and resources, for example in disaster preparedness, response and recovery, as well as coastal hazard specific campaigns and communications materials including signage, events and newsletters and social media.

EMERGENCY RESPONSE

Monitoring and early warning systems, including evacuation strategies and community engagement. Council, State Emergency Service, volunteers and local disaster management groups are particularly key in leading the response to keep the community safe. Council's Disaster Management Plan provides information on preparation, response and recovery to potential coastal hazard events.

ECOSYSTEM MANAGEMENT

Support and strengthen natural coastal habitats, dune processes and protect and restore degraded wetland habitat through habitat management programs such as planting of vegetation on dunes and within and around wetlands and waterways. Particular consideration will be given to the protection and management of turtle nesting areas. This provides both ecological and amenity benefits and provides an opportunity to involve and build community capacity to manage coastal hazard risks and undertake monitoring.

GEOTECHNICAL INVESTIGATION AND DETAILED EROSION STUDY

The selection of adaptation responses in some areas will benefit from site-specific geotechnical investigation and detailed erosion studies to better understand natural coastal hazard processes at the beach segment scale. Geotechnical investigations can also locate potential offshore sand reserves for beach nourishment purposes.

PLANNING RESPONSES

Implementing land use planning responses that are risk appropriate for the location in the coastal hazard area.

Getting the strategy right and making informed risk based decisisons for future land use, development and infrastructure will be based on a complete understanding of risk. Land use and development policy, zoning and development controls will be used to maintain the current risk profile in areas of acceptable and tolerable risk. In coastal hazard areas where the risk is high or intolerable, land use planning will be used to reduce or avoid increasing the future risk exposure of people, buildings, community facilities and infrastructure.

These actions build on current planning scheme requirements and may also involve development controls such as setbacks and planning processes such as master planning or trigger-based development approvals. Particular attention will be given to avoiding future vulnerable uses and people (e.g. aged care, schools, hospitals, emergency services) and reducing the future intensity of uses within higher risk areas.

MODIFY

Strategic adaptation actions that actively seek to 'modify' and reduce the risk of current and future coastal hazards and apply to coastal hazard areas where the risk is intolerable or will become so in the future. These actions include various engineering (soft and hard) options and hazard resilient design measures to protect assets and reduce the impacts of coastal hazards.

Under the theme of 'Modify' there are 4 strategic adaptation actions that seek to physically alter existing coastal environments to respond to coastal hazard risks affecting people and property.

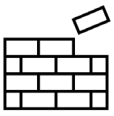
The strategic adaptation actions under the theme of 'Modify' include:

COASTAL ENGINEERING (SOFT)

Protect beaches and foreshore areas from coastal hazards using localised soft engineering solutions, such as:

- Dune construction and restoration - artificial construction of new dunes or improving the function of existing dunes using imported sand from inactive sand sources
- Dune augmentation - increasing the crest height or functional integrity of existing dunes through the addition of imported sand from offshore/inactive sand sources
- Beach nourishment - manual placement of sand on the beach using inactive sand sources to maintain existing beaches and dunes
- Beach scraping - manual pushing of a thin layer of sand from the beach face (above high tide) towards the dunes to stabilise dunes from further slumping; usually implemented following minor erosion.

Implementation of these actions is intended to compliment the existing function of natural areas and should only be undertaken where and when it is environmentally appropriate to do so.



COASTAL ENGINEERING (HARD) COASTAL ENGINEERING (SOFT)

Using hard engineering solutions to protect areas adjacent to foreshore and creek fronts from coastal hazards including:

- Levees/dykes - an artificial barrier often constructed of earth covered in vegetation to prevent inundation
- Seawalls/scour protection - a wall or embankment constructed of rock or concrete along the dune parallel to the beach or along a waterway to stop coastal erosion. Can be designed to also limit inundation
- Groynes and artifical headlands - an artificial barrier constructed perpendicular to the beach to trap and hold beach sediments
- Tide flaps or valves on stormwater pipes - permit one-way flow only and stop salt water flowing upstream
- Tide gates - permanent artificial barriers across a waterway to stop elevated water levels from moving to upstream areas

MODIFY INFRASTRUCTURE AND HAZARD RESILIENT DESIGN

Allow for continued use of infrastructure, buildings and assets where the coastal hazard risk is acceptable or tolerable, but when upgrading or building new assets, the design is to be resilient to or accomodate coastal hazard impacts.

Appropriately locating and designing roads, water, drainage, waste water and solid waste treatment, electricity and telecommunications can help services to remain operational during and after a coastal hazard event. Examples include raising land levels and building on piles to increase the height of building floor levels to reduce the level of exposure to temporary inundation. Asset management and maintenance decisions are informed by a complete understaning of coastal hazard risks and asset owners consider implications for the design life and resilience of assets to coastal hazards.

PLANNED TRANSITION

Planned or managed interventions to transition an area to an alternative land use; may involve relocation of assets that are exposed to unacceptable risks.

The strategic adaptation actions under the theme of the 'Planned Transition' include:

RELOCATE INFRASTRUCTURE

Relocate assets, infrastructure and buildings to lower risk areas or outside of the coastal hazard extent area. Monitoring will be important to determine when relocation may be socially and economically acceptable.

ACCEPT THE RISK AND EMBRACE COASTAL PROCESSES

Embrace natural coastal processes without intervention or change to current management arrangements, including:

- Accept loss of land affected by coastal hazards on unprotected shorelines
- Allow coastal dunes and habitats to migrate landward
- Allow dunes to recede without intervention and accept there will be damage or loss to infrastructure

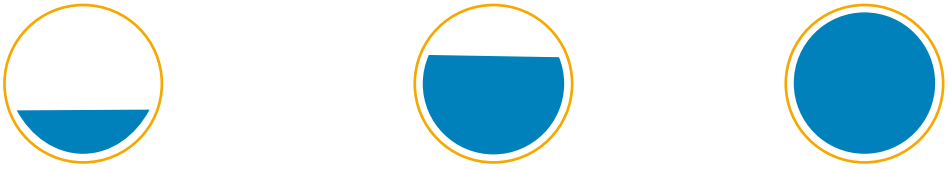
4.5 Our whole of shire strategic adaptation actions

This strategy includes a range of strategic adaptation actions that apply to the whole coast in Livingstone Shire and are intended to be implemented over the lifetime of the strategy.

A monitoring program, as well as community awareness and education, will be fundamental to underpin the implementation of all adaptation pathways at shire-wide and local levels.

Community and stakeholder feedback was very clear on the importance of keeping open coast beaches and maintaining existing dunes, as well as protecting built community assets in key locations against coastal hazards, particularly erosion. Some locations will also benefit from further geotechnical investigation and a detailed erosion study to better understand the nuances of coastal hazards at the beach segment scale.

Adaptation actions have been prepared based on short, medium and long-term preliminary priorities which are linked to projected sea level rise and indicative coastal hazard extent mapping prepared for three timeframes - present day, 2050 (0.3m sea level rise) and 2100 (0.8m sea level rise)



Short-term
Current coastal hazard risks

Medium-term
Coastal hazard risks around 2050 (0.3m sea level rise)

Long-term
Coastal hazard risks around 2100 (0.8m sea level rise)

The indicative timing for the implementation of the whole of shire strategic adaptation actions is shown below.

Themes	Strategic Adaptation Actions	Indicative Timing		
		Short-Term	Medium-Term	Long-Term
Maintain and Improve	Monitor	→	→	→
	Ecosystem management	→	→	→
	Community awareness and education	→	→	→
	Emergency response	→	→	→
	Planning response	→	→	→
	Geotechnical investigation and detailed erosion study	→	→	→

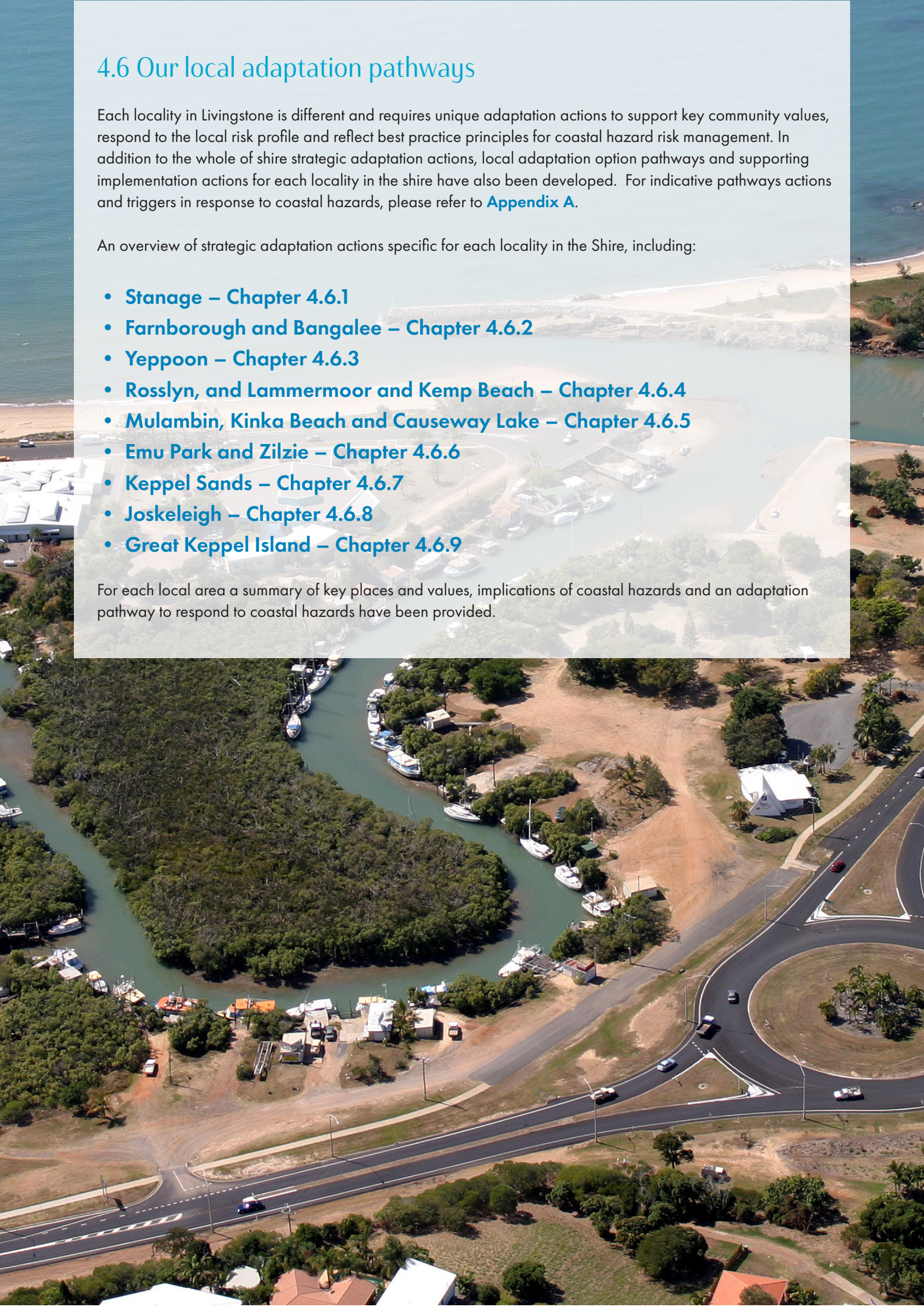
4.6 Our local adaptation pathways

Each locality in Livingstone is different and requires unique adaptation actions to support key community values, respond to the local risk profile and reflect best practice principles for coastal hazard risk management. In addition to the whole of shire strategic adaptation actions, local adaptation option pathways and supporting implementation actions for each locality in the shire have also been developed. For indicative pathways actions and triggers in response to coastal hazards, please refer to **Appendix A**.

An overview of strategic adaptation actions specific for each locality in the Shire, including:

- **Stanage – Chapter 4.6.1**
- **Farnborough and Bangalee – Chapter 4.6.2**
- **Yeppoon – Chapter 4.6.3**
- **Rosslyn, and Lammermoor and Kemp Beach – Chapter 4.6.4**
- **Mulambin, Kinka Beach and Causeway Lake – Chapter 4.6.5**
- **Emu Park and Zilzie – Chapter 4.6.6**
- **Keppel Sands – Chapter 4.6.7**
- **Joskeleigh – Chapter 4.6.8**
- **Great Keppel Island – Chapter 4.6.9**

For each local area a summary of key places and values, implications of coastal hazards and an adaptation pathway to respond to coastal hazards have been provided.



4.6.1 STANAGE

Located at the northernmost point of the shire overlooking Thirsty Sound is the tranquil coastal town of Stanage. Separated from other coastal communities in the shire by expansive agricultural and conservation areas, the town is home to 83 people in three village clusters[8] with a lifestyle centred on recreational boating and fishing.

The two villages near Alligator Point have direct access to a protected beach backed by a vegetated foreshore and beachfront properties on Schnapper Drive. Accommodation is available to visitors in the village near Alligator Point. The third and largest village is located further west along Banksia Road and features a boat ramp, Coast Guard, shop/post office and residential properties. While the settlement is largely located on elevated land, the area is characterised by low lying agricultural areas and extensive natural areas within Broadsound Islands National Park, Charon Point Conservation Park and Shoalwater Bay Conservation Park.

Engagement informing the strategy indicates there are many places in Stanage which are loved and cherished by the community. When we asked what your favourite places were and what you considered important infrastructure in Stanage, you said:

The Beaches

The natural areas, including the protected wetlands at Shoalwater Bay

Service by the Stanage Bay store

The Coast Guard

IMPLICATIONS OF COASTAL HAZARDS

Erosion hazards present the highest level of risk to the special places in Stanage. The places and infrastructure at risk from coastal hazards include:

RESIDENTIAL BEACHFRONT PROPERTIES

Residential beachfront properties in the township are at high risk from erosion in the medium-term and very high risk from erosion in the long-term.

AGRICULTURAL AREAS

The low-lying agricultural and rural areas on the Broadsound frontage of the peninsula, which are used mostly for grazing, are at high risk from long-term sea level rise.

NATURAL AREAS

Important natural areas in Broadsound Islands National Park, Charon Point Conservation Park and Shoalwater Bay Conservation Park are at high risk from long-term sea level rise.

IMPORTANT INFRASTRUCTURE

The Coast Guard is located at the beachfront adjacent to the boat ramp and is at high risk from erosion in the medium-term.

Source: 8. Based on 2016 ABS census statistics for the suburb of Stanage

LOCAL ADAPTATION PATHWAY ACTIONS

The strategic adaptation actions and local adaptation option pathways for Stanage include:

Themes	Strategic Adaptation Actions	Indicative Timing
		Short-Term / Medium-Term / Long-Term
Maintain and Improve	Monitor	→
	Ecosystem management	→
	Community awareness and education	→
	Emergency response	→
	Planning response	→
	Geotechnical investigation and detailed erosion study	→

Themes	Local Adaptation Option Pathways		Indicative Timing
			Short-Term / Medium-Term / Long-Term
Modify	Coastal engineering (hard)	Seawall/scour protection to protect community infrastructure and private properties in urban areas	→ →
Planned Transition	Accept the risk and embrace coastal processes	For rural areas - no changes to present management approach	→
	Relocate infrastructure	Relocate Coast Guard	→

For more information on the indicative pathway actions and triggers in response to coastal hazards (sea level rise and erosion hazard) see **Appendix A**.

4.6.2 FARNBOROUGH AND BANGALEE

Farnborough extends from Fishing Creek in the north to Barwell Creek in the south. The area is dominated by large extents of agricultural and conservation areas which form part of Byfield National Park. The infrastructure for the former Capricorn International Resort still covers a substantial area within Farnborough.

Rural residential properties are scattered throughout the southern area around Farnborough Road. The beach and dune system along the Farnborough coastline is mostly undeveloped except for Bangalee which consists of two streets of beachside residential properties that is home to 190 people[9].

Engagement informing the strategy indicates there are many places in Farnborough and Bangalee which are loved and cherished by the community. When we asked what your favourite places were and what you considered important infrastructure in Farnborough and Bangalee, you said:

Bangalee as a place to holiday

The natural areas and coastal vegetation

Bangalee as a place to live

The Capricorn International Resort

IMPLICATIONS OF COASTAL HAZARDS

Erosion hazards present the highest level of risk to the special places in Farnborough and Bangalee. The places and infrastructure at risk from coastal hazards include:

RESIDENTIAL BEACHFRONT PROPERTIES

Residential beachfront properties in Bangalee are at very high risk of long-term erosion impacts.

WATERWAYS

Natural areas around the waterways of Corio Bay are at high risk of impacts from sea level rise in the medium term and long-term erosion. The erosion hazard in these areas is mostly associated with sea level rise.

Source: 9. Based on 2016 ABS census data for the suburbs of Farnborough and Bangalee

LOCAL ADAPTATION PATHWAY ACTIONS

The strategic adaptation actions and local adaptation option pathways for Farnborough and Bangalee

Themes	Strategic Adaptation Actions	Indicative Timing
		Short-Term / Medium-Term / Long-Term
Maintain and Improve	Monitor	→
	Community awareness and education	→
	Planning responses	→
	Ecosystem management - active dune and habitat management (immediately seaward of Bangalee residential area)	→
	Emergency response	→

Themes	Local Adaptation Option Pathways		Indicative Timing
			Short-Term / Medium-Term / Long-Term
Modify	Coastal engineering (soft)	Beach scraping to stabilise erosion scarps[10]	→
		Beach nourishment	→
Planned Transition	Accept the risk and embrace coastal processes	No changes to present management approach	→

For more information on the indicative pathway actions and triggers in response to coastal hazards (sea level rise and erosion hazard) see **Appendix A**.

Source: *10. An erosion scarp is a vertical cut left in a sand dune after erosion. They are often steep and unstable slopes prone to collapse.*

4.6.3 YEPPOON

The Yeppoon area, including Cooee Bay, is the bustling commercial and tourist centre of the shire. Approximately 9,500 persons call the Yeppoon area home[11]. Yeppoon centre includes a variety of low to medium scale land uses that have commercial, retail, business, social and employment functions. The centre and surrounding residential areas are located adjacent to an expansive recreational foreshore parkland that is a hub for social and active play, and includes surf and sailing clubs.

Yeppoon Main Beach is a 1.4 km long sandy beach, extending from the low intertidal rocks at Spring Head to the mouth of Ross Creek, where there is a small breakwater. Ross Creek creates a natural separation between the long stretch of beach at Yeppoon and the small beaches of Fisherman's Beach and Cooee Bay.

Engagement informing the strategy indicates there are many places in Yeppoon which are loved and cherished by the community. When we asked what your favourite places were and what you considered important infrastructure in Yeppoon, you said:

The beach

The recreational foreshore parkland

Markets and festivals, including the Fig Tree markets

Beachside Caravan Park

IMPLICATIONS OF COASTAL HAZARDS

Erosion hazards present the highest level of risk to the special places in Yeppoon. The places and infrastructure at risk from coastal hazards include:

THE BEACH

A seawall was progressively constructed on Yeppoon Main Beach to protect the adjacent foreshore parkland from coastal erosion. No dune system remains in this area and there is no beach at high tide. The seawall condition and therefore level of protection is variable. More broadly, all of the beaches are at high risk from impacts from future sea level rise.

THE FORESHORE

Places within and along the foreshore that are at high risk of erosion consist of the playground (including the Keppel Kraken and Yeppoon Lagoon), the caravan park, the Keppel Bay Sailing Club and Yeppoon Surf Life Saving Club. Collectively these places are significant drawcards for tourists and are highly valued by the community.

RESIDENTIAL BEACHFRONT PROPERTIES

Residential beachfront properties in Yeppoon and Cooee Bay are at very high risk of erosion in the short, medium and long-term.

Source: 11. Based on 2016 ABS census data for the suburbs of Yeppoon, Cooee Bay and Taranganba

ROADS

Large extents of Appleton Drive and Scenic Highway, in the vicinity of Ross and Fig Tree Creek, are currently at risk from erosion and Yeppoon Road is at risk in the medium-term. Although partially protected by a seawall, Farnborough Road at Spring Head is also currently at risk from erosion impacts from wave overtopping or seawall failure, and long-term storm-tide inundation. Scenic Highway at Cooee Bay and Tanby Road around the industrial area in Yeppoon are at high risk from storm-tide hazard in the medium-term. Aside from being important local roads, for many residents these roads provide the most direct access to important facilities outside of directly impacted hazard areas, such as Yeppoon Hospital and the Yeppoon Cyclone Shelter. While alternative routes are available, these roads are presently the primary road access into Yeppoon from Rockhampton, areas north of Yeppoon and south of Cooee Bay.

WATERWAYS

Residential areas adjacent to Fig Tree, Ross and Yeppoon Creeks are at very high erosion risk now and in the future. Erosion risks around the creeks are largely associated with rising sea levels causing bank erosion.

LOCAL ADAPTATION PATHWAY ACTIONS

The strategic adaptation actions and local adaptation option pathways for Yeppoon include:

Themes	Strategic Adaptation Actions	Indicative Timing		
		Short-Term	Medium-Term	Long-Term
Maintain and Improve	Monitor	→	⇢	⇢
	Community awareness and education	→	⇢	⇢
	Planning responses	→	⇢	⇢
	Ecosystem management	→	⇢	⇢
	Emergency response	→	⇢	⇢

Themes	Local Adaptation Option Pathways		Indicative Timing		
			Short-Term	Medium-Term	Long-Term
Modify	Coastal engineering (soft)	Dune augmentation (Cooee Bay, Fisherman's Beach and Spring Head to Caravan Park only)	→		
		Beach scraping to stabilise erosion scarps or seawalls	→		
		Beach nourishment (Ross Creek to Spring Head only)	→		
		Dune construction (Ross Creek to Spring Head only)	→		
	Coastal engineering (hard)	Seawall to protect private properties	→		
		Seawall upgrade to protect public assets	→	→	
		Levee/dyke along waterways to protect infrastructure/erosion of roads		→	
		Scour protection along waterways to protect roads		→	
		Tidal gates at Ross Creek to limit high water level inflows		→	
	Modify infrastructure and resilient design	Hazard resilient design for upgraded roads (i.e. elevated roadway)		→	
Planned Transition	Accept the risk and embrace coastal processes	No changes to present management approach - allow foreshore recession (north of caravan park to Smith Street)	→		

For more information on the indicative pathway actions and triggers in response to coastal hazards (sea level rise and erosion hazard) see **Appendix A**.

4.6.4 ROSSLYN, LAMMERMOOR AND KEMP BEACH

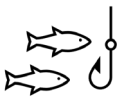
The Rosslyn Bay area, including Lammermoor Beach and Kemp Beach, forms the coastline area between Wreck Point and Bluff Point. It is home to 2,740 people with most of the residential properties located around Lammermoor Beach[12]. Lammermoor Beach and Kemp Beach are backed by vegetated foredunes and Scenic Highway, with beachfront residential properties at the northern end of Lammermoor Beach and in Statute Bay.

These beaches are loved by the community and visitors and provide important natural protection to landward infrastructure from coastal hazards.
Kemp Beach in particular is very popular with locals and visitors who travel long distances to visit the only surfable beach in the shire.

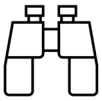
Rosslyn Bay harbour is in the centre of the area, nestled amongst iconic rocky outcrops which are a significant landmark along the coast. Sweeping views of the Keppel Islands, the surrounding coastline and volcanic formations are afforded from the summits. The harbour is a hub for marine industry, recreation and business activities within the shire and surrounding areas as it is the only all-tide, open water access point on the Capricorn Coast.

Engagement informing the strategy indicates there are places in this area which are loved and cherished by the community. When we asked what your favourite places were and what you considered important infrastructure in the Rosslyn Bay area, you said:

Natural areas surrounding the marina



Fisherman's markets at Rosslyn Bay



Headland and lookouts

The boat ramps

IMPLICATIONS OF COASTAL HAZARDS

Erosion hazards present the highest level of risk to the special places in the Rosslyn Bay area. The places and infrastructure at risk from coastal hazards include:

THE BEACHES

The beaches and dunes at Rosslyn, Lammermoor and Kemp Beaches are at high risk from erosion in the short, medium and long-term. These beaches are very popular with the community and play an important role in protecting beachside properties.

RESIDENTIAL PROPERTIES

Beachside residential properties located at Rosslyn, Lammermoor and along Williamson Creek are at very high risk of erosion now and in the future.

Source: 12. Based on 2016 ABS census data for the suburbs of Lammermoor and Rosslyn

ROADS

Scenic Highway follows the coastline closely throughout this area and large extents of the road at Lammermoor, Statute Bay and Kemp Beach are within the current hazard extents. Scenic Highway is assessed as being at very high risk of erosion. Coastal hazard impacts to one or all sections, particularly at Lammermoor or Kemp Beaches would disconnect direct coastal access between Yeppoon and Emu Park as well as access from these areas to Rosslyn Bay harbour.

Connecting Scenic Highway and Rosslyn Bay, Vin E Jones Memorial Drive skirts the edge of the National Park and is at very high risk of erosion in the medium-term. As it is the sole vehicle access to Rosslyn Bay harbour, any loss of access would be expected to have significant impacts for the broader economy as the harbour is the only all-tide, open water access point on the Capricorn Coast, supporting the lifestyles of many residents. The harbour is also home to emergency services (i.e. water police and Coast Guard) which may need to be accessed during coastal hazard events.

LOCAL ADAPTATION PATHWAY ACTIONS

The strategic adaptation actions and local adaptation option pathways for Rosslyn and Lammermoor Beach

Themes	Strategic Adaptation Actions	Indicative Timing		
		Short-Term	Medium-Term	Long-Term
Maintain and Improve	Monitor	→	→	→
	Community awareness and education	→	→	→
	Planning responses	→	→	→
	Ecosystem management - active dune and habitat management and manual creek mouth management to protect infrastructure	→	→	→
	Emergency response	→	→	→
	Geotechnical investigation and detailed erosion study	→	→	→

Themes	Local Adaptation Option Pathways		Indicative Timing		
			Short-Term	Medium-Term	Long-Term
Modify	Coastal engineering (soft)	Beach scraping to stabilise erosion scarps	→		
		Beach nourishment (Lammermoor and Statue Bay)	→	→	→
		Dune augmentation (Lammermoor Beach)		→	
	Coastal engineering (hard)	Seawall to protect Scenic Highway	→	→	→
Planned Transition	Accept the risk and embrace coastal processes	No changes to present management approach	→		
		Emergency management planning (e.g. alternative route provision, such as tunnel through Rosslyn Head)		→	

LOCAL ADAPTATION PATHWAY ACTIONS

The strategic adaptation actions and local adaptation option pathways for Kemp Beach include:

Themes	Strategic Adaptation Actions	Indicative Timing
		Short-Term / Medium-Term / Long-Term
Maintain and Improve	Monitor	→
	Community awareness and education	→
	Planning responses	→
	Ecosystem management - active dune and habitat management	→
	Emergency response	→
	Geotechnical investigation and detailed erosion study	→

Themes	Local Adaptation Option Pathways		Indicative Timing
			Short-Term / Medium-Term / Long-Term
Modify	Coastal engineering (soft)	Dune augmentation	→
		Beach scraping to stabilise erosion scarps	→
		Beach nourishment	→
	Coastal engineering (hard)	Seawall to protect Scenic Highway	→ → →
		Seawall to protect Vin E Jones Memorial Drive	→
	Modify infrastructure and resilient design	Hazard resilient design for Vin E Jones Memorial Drive	→
Planned Transition	Relocate infrastructure	Relocate road landwards outside the hazard extent where space permits	→ →
	Accept the risk and embrace coastal processes	No changes to present management approach	→

For more information on the indicative pathway actions and triggers in response to coastal hazards (sea level rise and erosion hazard) see **Appendix A**.

A high level Cost Benefit Analysis (CBA) of three adaptation options to protect important Kemp Beach values and infrastructure has been undertaken as part of this strategy. The purpose of the CBA are to help refine the selection of adaptation options and determine which option provides the most appropriate social/economic benefit.

The three adaptation action options for Kemp Beach are detailed in the table below.

OPTION	DESCRIPTION	TIMING
Option 1	Construction of a rock seawall along sections of the beach	Construction begins in 2020 with extensions undertaken in 2050 and 2100
Option 2	Landward relocation of roads, including Scenic Highway and Vin E Jones Drive	Partial relocation of Scenic Highway occurs in 2020, with further relocation and replacement of part of Vin E Jones Drive occurring in 2050
Option 3	Dune augmentation, maintaining sufficient sand volume to accomodate storm bite	Augmentation undertaken every 5 years from 2020 to 2050 and every 3 years to 2100

The quanitfied costs and benefits for each adaptation action option are described in the table below.

OPTION	NET BENEFIT	INVESTMENT COSTS	OTHER COSTS TO THE COMMUNITY	BENEFITS
Option 1 Seawall	$33.0 MILLION	$2.7 million » Construction of seawall » Ongoing maintenance	$22.7 million » Loss of beach over time for recreational use » Loss of existence value of beach	$58.4 million » Maintain access to Rosslyn Bay providing recreational fishing benefits and tourism benefits
Option 2 Road Relocation	$43.4 MILLION	$21.0 million » Relocation of Scenic Highway » Replacement of sections of Vin E Jones Drive with a bridge connection » Ongoing maintenance costs	$4.5 million » Loss of additional national park area due to road relocation	$69.4 million » Maintain access to Rosslyn Bay providing recreational fishing benefits and tourism benefits » Prevent damage to the dunes by allowing them to naturally migrate landward
Option 3 Dune Augmentation	$67.7 MILLION	$1.8 million » Reinforce dune by maintaining sand volume every 5 years to 2050 and every 3 years to 2100	**None quantified**	$69.4 million » Maintain access to Rosslyn Bay providing recreational fishing benefits and tourism benefits » Prevent damage to the dunes by allowing them to naturally migrate landward

Based on the assessment of the costs, benefits and risks of each option, dune augmentation is the less expensive option and provides the greatest benefits in the short to medium-term. In the longer term plans to relocate the road, should be progressed, to enable continued access to Rosslyn Bay Boat Harbour, once dune augmentation becomes unfeasible.

4.6.5 MULAMBIN, KINKA BEACH AND CAUSEWAY LAKE

Mulambin and Kinka Beaches form the coastline between Bluff Point in the north and Kinka Creek to the south. The area has a combined population of 1,663 people[13]. Mulambin Beach lies on the south side of Bluff Point and extends to the vegetated peak of Pinnacle Point which offers scenic coastal views. It is backed by casuarina-covered dunes and the Scenic Highway with residential areas including a popular caravan park.

Causeway Lake is a shallow, man-made lake located at the northern end of Kinka Beach which was created in 1939 by construction of a bridge and rock wall across the mouth of Mulambin Creek. This area is a popular destination for tourists based on the fishing and boating activities that it supports and proximity to the beach. Two caravan parks and a kiosk cater for the needs of tourists and local visitors.

Kinka Beach is a long beach with extensive tidal sand flats. Backed by a dune system, buried seawall and the Scenic Highway, the area supports a caravan park and residential properties. The beach ends at Kinka Creek which is an important wetland and a haven for native wildlife.

Engagement informing the strategy indicates there are many places in this area which are loved and cherished by the community. When we asked what your favourite places were and what you considered important infrastructure in the area, you said:

Water-based recreational activities at Causeway Lake / Mulambin Creek

The neighbourhood as a place to live

Caravan Parks

The shops and eateries at Kinka Beach

IMPLICATIONS OF COASTAL HAZARDS

Erosion hazards present the highest level of risk to the many special places in the Mulambin, Kinka Beach and Causeway Lake area. The places and infrastructure at risk from coastal hazards include:

THE BEACHES

Kinka and Mulambin Beaches and dunes are at high risk from erosion hazards now and in the future.

RESIDENTIAL PROPERTIES

At Kinka Beach, residential properties at the southern end of the beach are at a high risk from erosion which will increase to a very high risk in the medium-term. Residential properties close to Causeway Lake are also currently at a very high risk of erosion and a high risk from sea level rise in the medium term.

Source: 13. Based on 2016 census data for the suburbs of Mulambin, Kinka Beach and Causeway Lake

ROADS

Scenic Highway at the Kinka Creek crossing has a high erosion risk in the medium term and increasing to a very high erosion risk and high storm-tide risk in the long-term. Further north near Mulambin, Scenic Highway is exposed to a very high risk of erosion in the long-term which would impact on the movements of the local community and also access along the coast between Emu Park and Rosslyn Bay boat harbour.

WATERWAYS

Kinka Creek wetland is exposed to high risks from sea level rise in the medium term and high erosion risks in the long-term. Causeway Lake Conservation Park and surrounding wetland areas are also at high risk from sea level rise in the medium term and erosion in the long-term.

IMPORTANT INFRASTRUCTURE

The evacuation shelter at Coolwaters Holiday Village is currently unaffected by coastal hazards. Access to the site for Kinka Beach residents along Scenic Highway will be affected by long-term erosion and storm-tide hazards. The Emu Park Waste Transfer Station, situated on the edge of the Kinka Creek wetland, is also at high risk from long-term erosion hazards.

LOCAL ADAPTATION PATHWAY ACTIONS

The strategic adaptation actions and local adaptation option pathways for Mulambin, Kinka Beach and Causeway Lake include:

Themes	Strategic Adaptation Actions	Indicative Timing		
		Short-Term	Medium-Term	Long-Term
Maintain and Improve	Monitor	→	⇢	⇢
	Community awareness and education	→	⇢	⇢
	Planning responses	→	⇢	⇢
	Ecosystem management	→	⇢	⇢
	Emergency response	→	⇢	⇢
	Geotechnical investigation and detailed erosion study	→	⇢	⇢

Themes	Local Adaptation Option Pathways		Indicative Timing		
			Short-Term	Medium-Term	Long-Term
Modify	Coastal engineering (soft)	Beach scraping to re-bury exposed sections of seawall or erosion scarps	→	→	
		Beach nourishment		→	→
	Coastal engineering (hard)	Levee to protect road and Emu Park Waste Transfer Station		→	
		Groynes at Kinka Beach		→	→
		Levee to protect infrastructure (Causeway Lake)		→	→
		Modify existing weir to limit high water level inflows (Causeway Lake)		→	
		Extend seawall (Kinka Beach)			→
	Modify infrastructure and resilient design	Hazard resilient design for new development and upgraded infrastructure	→		
		Hazard resilient design for new/ upgraded road (Kinka Creek)		→	→
Planned Transition	Relocate infrastructure	Relocate and remediate Emu Park Waste Transfer Station site			→
	Accept the risk and embrace coastal processes	No changes to present management approach	→		

For more information on the indicative pathway actions and triggers in response to coastal hazards (sea level rise and erosion hazard) see **Appendix A**.

4.6.6 EMU PARK AND ZILZIE

The Emu Park area, including Zilzie, is a charming seaside area with a relaxed village atmosphere. It is the second most populated area in the shire with 4,840 people[14]. The coastline is characterised by a mix of long embayments and smaller beaches between rocky outcrops. Emu Park (Main) Beach and Fisherman's Beach are the most popular amongst the community and visitors.

The foreshore area is rich with history with the ANZAC Memorial Walk hugging the coastline and the Singing Ship on the headland commemorating the local legacy of Captain Cook's explorations. Bell Park and Kerr Park, also located on the foreshore, support a variety of active play activities and the Surf Life Saving Club. Further south of Emu Park is Zilzie which extends down to the mouth of Cawarral Creek. The southern end of Zilzie is an emerging residential area nestled between Svendsen's Beach foreshore and the creek. The Coorooman Creek boat ramp is a favourite amongst locals for boating and fishing activities.

Engagement informing the strategy indicates there are many places in the Emu Park area which are loved and cherished by the community. When we asked what your favourite places were and what you considered important infrastructure in the Emu Park area, you said:

The recreational foreshore parkland

The Surf Life Saving Club

The neighbourhood as a place to live

The beachside caravan park

Source: 14. Based on 2016 census data for the suburbs of Emu Park and Zilzie

IMPLICATIONS OF COASTAL HAZARDS

Erosion hazards present the highest level of risk to the many special places in Emu Park and Zilzie. The places and infrastructure at risk from coastal hazards include:

THE BEACHES

Popular beaches and associated dune systems from Musker's Beach to Fisherman's Beach are at high risk of erosion however, the less popular and more isolated beaches, being Zilzie, Tanby and Ritamada Beaches are at medium risk of erosion in the short, medium and long-term. The change in the level of risk is based on the value the community places on these beaches.

A seawall was constructed in 2014 at Musker's Beach in response to erosion close to beachfront residential properties. This seawall was constructed with a 25 year design life.

THE FORESHORE

Important community and private beachfront development from Cawarral Creek to Emu Park have a high to very high risk from erosion hazards. Buildings within Bell Park and the Surf Life Saving Club near Kerr Park are within the high hazard extent in the medium-term.

RESIDENTIAL BEACHFRONT PROPERTIES

At Zilzie and Keppel Cove, existing residential development, as well as land zoned for future residential development, is at very high risk to erosion now and in the future.

ROADS

Sections of the Scenic Highway close to Kinka Creek are at very high risk from erosion in the short, medium and long-term. This road is also at high risk from storm tide inundation impacts in the medium-term and very high risk from sea level rise in the long-term. Disruptions to this section of road would result in significantly increased travel times between Emu Park and areas from Kinka Beach north, as traffic would be diverted via Emu Park Road and Tanby Road.

WATERWAYS

Natural areas adjoining Coorooman/Cawarral and Kinka Creek wetlands are at very high risk to sea level rise impacts in the medium term. In the long-term these areas also have a high risk exposure to erosion.

IMPORTANT INFRASTRUCTURE

The Emu Park Waste Transfer Station adjoins the Kinka Creek wetland. In the long-term, the erosion hazard extent impacts the active waste disposal area, increasing this infrastructure's risk of exposure from medium to high.

LOCAL ADAPTATION PATHWAY ACTIONS

The strategic adaptation actions and local adaptation option pathways for Emu Park area include:

Themes	Strategic Adaptation Actions		Indicative Timing		
			Short-Term	Medium-Term	Long-Term
Maintain and Improve	Monitor		→	→	→
	Community awareness and education		→	→	→
	Planning responses - general land use planning responses including reducing intensity of future development within hazard areas (Svendsen's Beach)		→	→	→
	Ecosystem management	Active dune and habitat management	→	→	→
		Land management to support migration of dune forms and habitat as sea levels rise		→	
	Emergency response		→	→	→
	Geotechnical investigation and detailed erosion study		→	→	→

Themes	Local Adaptation Option Pathways		Indicative Timing		
			Short-Term	Medium-Term	Long-Term
Modify	Coastal engineering (soft)	Beach scraping to re-bury exposed sections of seawall or erosion scarps (Emu Park Beaches)	→		
		Beach scraping to re-bury exposed sections of seawall or erosion scarps (Musker's Beach)	→		
		Beach scraping (Svendsen's Beach)		→	
		Dune augmentation (Musker's Beach)		→	
		Beach nourishment (Emu Park Beaches)		→	
		Beach nourishment (Musker's Beach)		→	
		Dune augmentation (Svendsen's Beach)			→
		Beach nourishment (Svendsen's Beach)			→
	Coastal engineering (hard)	Upgrade seawall to protect Surf Life Saving Club and Kerr Park once existing structures are no longer suitable		→	
		Upgrade seawall to protect infrastructure once existing structure is no longer suitable (Musker's Beach)		→	
		Seawall to protect Bell Park		→	
		Groynes at Bell Park			→

Themes	Local Adaptation Option Pathways		Indicative Timing		
			Short-Term	Medium-Term	Long-Term
Modify	Modify infrastructure and resilient design	Hazard resilient design for new development and upgraded infrastructure (Svendsen's Beach)	→	→	
		Hazard resilient design for new/ upgraded Surf Life Saving Club		→	
		Hazard resilient design for non-heritage infrastructure within Bell Park		→	
	Relocate infrastructure	Relocate Surf Life Saving Club and important infrastructure at Bell Park		→	
Planned Transition	Accept the risk and embrace coastal processes	No changes to present management approach	→		

For more information on the indicative pathway actions and triggers in response to coastal hazards (sea level rise and erosion hazard) see **Appendix A**.

4.6.7 KEPPEL SANDS

Keppel Sands is a beachside town home to 360 people[15]. It is separated from the larger towns of Emu Park and Yeppoon to the north by Coorooman Creek and the rural settlement of Joskeleigh to the south by Pumpkin Creek. The town includes a caravan park, motel, school, post office, local store, important emergency facilities, residential properties, several boat ramps and a helipad.

The town is surrounded by dense wetlands which are important habitat for native wildlife. Schofield Parade has historically experienced erosion, resulting in the construction of an informal seawall and a groyne which assisted in reforming the dunes in the northern foreshore area.

Engagement informing the strategy indicates there are places in the Keppel Sands area which are loved and cherished by the community. When we asked what your favourite places were and what you considered important infrastructure in Keppel Sands, you said:

Recreational foreshore areas, including Mabel Edmond Park

Keppel Sands School

The beachside caravan park

The boat ramps

IMPLICATIONS OF COASTAL HAZARDS

Erosion hazards present the highest level of risk to the many special places in the Keppel Sands area. The places and infrastructure at risk from coastal hazards include:

THE BEACHES

Keppel Sands Beach and dunes are at a medium risk from erosion hazards now and in the future.

RESIDENTIAL BEACHFRONT PROPERTIES

Residential properties fronting Schofield Parade have a very high erosion risk, particularly towards the southern end of the beach. Properties backing onto Pumpkin Creek are also at a very high erosion risk from tidal inundation.

ROADS

Keppel Sands Road is the only vehicle access route into the community. Under elevated water levels inundation from Pumpkin Creek and Cawarral Creek could isolate the township. This road is at very high risk from erosion now and into the future and high risk from long-term sea level rise.

Source: 15. Based on 2016 census data for the suburb of Keppel Sands

WATERWAYS

The natural values of Cawarral Creek and Keppel Sands Conservation Park are at high risk from sea level risk impacts in the medium-term.

IMPORTANT INFRASTRUCTURE

Keppel Sands School, located adjacent to Cawarral Creek is at high risk from erosion hazards and long-term sea level rise. Erosion on the site in the short and medium-term does not impact on any current buildings. The caravan park is also at high risk from long-term sea level rise.

LOCAL ADAPTATION PATHWAY ACTIONS

The strategic adaptation actions and local adaptation option pathways for Keppel Sands include:

Themes	Strategic Adaptation Actions	Indicative Timing
		Short-Term / Medium-Term / Long-Term
Maintain and Improve	Monitor	→
	Community awareness and education	→
	Planning responses	→
	Ecosystem management	→
	Emergency response - explore potential to close vehicles access to Schofield Parade but remain open to pedestrians	→
	Geotechnical investigation and detailed erosion study	→

Themes	Local Adaptation Option Pathways		Indicative Timing
			Short-Term / Medium-Term / Long-Term
Modify	Coastal engineering (soft)	Beach scraping	→
		Dune augmentation	→
		Beach nourishment	→
	Coastal engineering (hard)	Groynes/artificial headlands	→
		Upgrade seawall	→
		Levee/dyke to protect infrastructure (creek frontages)	→
	Modify infrastructure and resilient design	Hazard resilient design for new development and upgraded infrastructure	→
Planned Transition	Accept the risk and embrace coastal processes	No changes to present management approach	→

For more information on the indicative pathway actions and triggers in response to coastal hazards (sea level rise and erosion hazard) see **Appendix A**.

4.6.8 JOSKELEIGH

Joskeleigh is small rural settlement 5km south of Keppel Sands and is the southernmost coastal community in the shire. It is home to 70 people and has 40 houses on large properties[16].

The 18km long beach (locally known as Long Beach) which stretches from Pumpkin Creek to the mouth of the Fitzroy River provides expansive views of the ocean and Curtis Island. This beach experiences low levels of community use given the rural nature of and limited access to the area. The beach is backed by a broad foreshore area characterised by grassy dunes and coastal wetlands which have important ecological functions. The area has high historical cultural significance associated with South Sea Islander settlements.

Engagement informing the strategy indicates the key places in this area which are loved and cherished by the community. When we asked what your favourite places were and what you considered important infrastructure in Joskeleigh, you said:

Natural areas for native wildlife

Historical South Sea Islander heritage

IMPLICATIONS OF COASTAL HAZARDS

Erosion hazards present the highest level of risk to the special places in the Joskeleigh area. The places and infrastructure at risk from coastal hazards include:

THE BEACHES

Long Beach and its dune systems are at high risk from long-term sea level rise. This level of risk takes in account the low level of usage but ecological importance of the beach.

ROADS

Joskeleigh Road is the only road access to the settlement and has been constructed across the tidal flats. It is at high risk from erosion hazards now and in the future and is also at high risk from sea level rise in the medium-term. Damage to this road will result in the isolation of the Joskeleigh community. The risk exposure is lower than Keppel Sands given the smaller number of properties serviced by this road.

Source: 16. Based on 2016 ABS census data for the suburb of Joskeleigh

LOCAL ADAPTATION PATHWAY ACTIONS

The strategic adaptation actions and local adaptation option pathways for Joskeleigh include:

Themes	Strategic Adaptation Actions	Indicative Timing		
		Short-Term	Medium-Term	Long-Term
Maintain and Improve	Monitor	→	→	→
	Community awareness and education	→	→	→
	Planning responses	→	→	→
	Ecosystem management - active dune and habitat management and land management to support habitat migration		→	
	Emergency response	→	→	→

Themes	Local Adaptation Option Pathways		Indicative Timing		
			Short-Term	Medium-Term	Long-Term
Modify	Coastal engineering (soft)	Beach scraping		→	
	Coastal engineering (hard)	Low earth levee next to Joskeleigh Road	→		
		Raise land levels for new road	→		
		Construct alternative route to provide access when Joskeleigh Road is unavailable (eventually will become primary access route)		→	
	Modify infrastructure and resilient design	Hazard resilient design for new development and upgraded infrastructure		→	→
Planned Transition	Relocate infrastructure	Relocate the Joskeleigh Road landward		→	
	Accept the risk and embrace coastal processes	No changes to present management approach	→		

For more information on the indicative pathway actions and triggers in response to coastal hazards (sea level rise and erosion hazard) see **Appendix A**.

4.6.9 GREAT KEPPEL ISLAND

Keppel Bay includes a variety of picturesque islands. The two largest islands of Great Keppel and North Keppel are surrounded by 16 smaller islands and several prominent rocky outcrops. All the islands, except for Great Keppel Island, are included in the Keppel Bay Islands National Park and Keppel Islands National Park (Scientific). Great Keppel Island is the main island with tourist infrastructure and therefore, is the focus of the CHAS.

Great Keppel Island is located 15km east of Rosslyn Bay. Home to 50 people, the 1,450 hectare island is an important tourist destination in Queensland. A majority of the island is undeveloped and contains large tracts of bushland which is a haven for native plants and animals. Tourist facilities on the island are concentrated around Putney and Fisherman's Beaches. The island has 17 beaches which are protected by the surrounding reefs, making them very popular for swimming, snorkelling and paddling.

Engagement informing the strategy indicates there are many special places in The Keppels which are loved and cherished by the community. When we asked what your favourite places were and what you considered important infrastructure on Great Keppel Island, you said:

The beaches

The natural areas

The island facilities

The cultural heritage areas of the Woppaburra People

IMPLICATIONS OF COASTAL HAZARDS

Erosion hazards present the highest level of risk to the many special places in The Keppels. The places and infrastructure at risk from coastal hazards include:

THE BEACHES AND ISLAND FACILITIES

All islands in The Keppels are at high risk from long-term sea level rise.

The main resort beaches, dunes and tourist facilities at Great Keppel Island are at high risk from erosion now and in the future. The tourist area around Putney Beach is at high risk from long-term storm tide and the village area at Fisherman's Beach is at high risk from long-term erosion. All other resort areas have low to medium risks from coastal hazards.

WATERWAYS

Important wetlands around Putney and Leekes Creeks on Great Keppel Island and similar natural areas more generally throughout the Keppel Bay National Park are at high risk from long-term sea level rise.

LOCAL ADAPTATION STRATEGIES

While all beaches and within the Keppels are at risk from erosion, the focus of adaptation actions are the buildings and infrastructure around Putney and Fisherman's Beaches on Great Keppel Island.

The island has previously experienced impacts from coastal hazard events. A temporary seawall was constructed on Putney Beach in response to erosion from tropical cyclone Marcia in 2015, which caused damage to several buildings. The seawall has significantly changed the recreational beach.

The strategic adaptation actions and local adaptation option pathways for Great Keppel Island include:

Themes	Strategic Adaptation Actions		Indicative Timing		
			Short-Term	Medium-Term	Long-Term
Maintain and Improve	Monitor		→	→	→
	Community awareness and education		→	→	→
	Planning responses	General land use planning responses	→	→	→
		Master planning (Fisherman's Beach Resort)	→		
	Ecosystem management		→	→	→
	Emergency response		→	→	→

Themes	Local Adaptation Option Pathways		Indicative Timing		
			Short-Term	Medium-Term	Long-Term
Modify	Coastal engineering (soft)	Beach scraping	→		
		Dune augmentation	→		
		Beach nourishment	→	→	
	Coastal engineering (hard)	Seawall to protect infrastructure (Putney Beach Tourist Park and Village Centre)	→		
	Modify infrastructure and resilient design	Hazard resilient design for new development and upgraded infrastructure	→		
Planned Transition	Relocate infrastructure	Relocate important infrastructure (Putney Beach Tourist Park)	→		
	Accept the risk and embrace the coastal processes	No changes to present mangement approach	→		

For more information on the indicative pathway actions and triggers in response to coastal hazards (sea level rise and erosion hazard) see **Appendix A**.

5.0 Our Implementation Plan

Everyone has a role in caring for our coast – Livingstone Shire Council, State agencies, Traditional Owners, businesses, other infrastructure entities, community organisations, private landowners and the community. These roles include understanding the risks of coastal hazards and implementing adaptation actions in the Our Living Coast Strategy.

The Council has an important role in protecting and managing the coast and will be responsible for implementing adaptation actions relating to Council managed public infrastructure and assets. Successful implementation of adaptation actions for many localities will require collaboration and partnerships between Council, community and other stakeholders, including the State Government.

An internal implementation plan has been prepared to guide how Livingstone Shire Council will embed adaptation actions and consideration of coastal hazard risks across all Council business areas, programs and processes. This will include reviewing and updating existing plans, strategies, policies and procedures and creating new initiatives and activities to support the implementation of adaptation actions.

The implementation plan provides details on:

- Indicative timeframes for delivery of actions
- Cost estimates (where available) for short term 5-10 year actions and potential funding sources
- Council plans, policies, strategies and processes to be updated or created to support action delivery
- Monitoring and evaluation approaches
- Potential partnership and collaboration opportunities with the community, other stakeholders and external infrastructure providers

Council will implement adaptation actions into its 'business as usual' activities using the following existing tools:

- Community Plan, Corporate Plan and visioning
- Risk management policy and processes
- Emergency response and recovery planning
- Land use planning, including updates to the planning scheme
- Asset management plans and processes
- Infrastructure planning and decision making
- Community facilities planning
- Parks planning and management
- Natural environment protection and management

The Our Living Coast Strategy will be reviewed every 10 years and at least 2 years before the planning scheme is reviewed, to enable updated technical information to inform our strategic land use planning and infrastructure forward planning processes.

For a summary of key short-term (5-10 years) implementation actions for the whole of shire and specific localities see below.

Summary of Key Implementation Actions

TABLE 1. SUMMARY OF KEY IMPLEMENTATION ACTIONS FOR THE WHOLE OF SHIRE FOCUSING ON THE SHORT TERM (5-10 YEARS)

Theme	Strategic Adaptation Actions	Description	Indicative priority implementation actions (to be completed within 5-10 years)
Maintain and Improve	Monitor 	Monitoring will be critical to understanding how coastal hazards and their risks are changing over time. As the coastline changes so should adaptation actions we take to respond. Each locality with an adaptation pathway will have a monitoring and review program to determine if trigger points for adaptation action remain relevant, effective, timely and cost appropriate.	» Establish a photo monitoring program (coast snap or similar) across the coast, prioritising key sites and localities. » Establish a beach monitoring program. » Undertake an internal audit and establish a register to monitor the frequency and location of beach scraping works. » Undertake monitoring for key select areas.
	Community Awareness and Education 	Ongoing knowledge sharing, awareness and education is key to enhancing community understanding of coastal processes, changing coastal hazards and risks and adaptation actions. Being 'risk aware' can build resilience in the community through communication and messaging and empowering people to respond. Council will also strongly advocate for collaboration and partnerships with other stakeholders and community to share information and the responsibility in delivering adaptation actions.	» Establish and secure ongoing funding for a Coastal Resilience Program Officer to support the delivery of adaptation actions and implementation of the Our Living Strategy across the organisation. » Identify existing and new networks to share and promote knowledge sharing and understanding of coastal hazard risks and adaptation. » Establish and strengthen partnerships with Traditional Owners to support and implement adaptation actions. » Facilitate training and education workshops, community awareness raising, community events across the Shire and also for higher risk localities. » Facilitate resident and community awareness raising on the value of dunes and their role in dune management and protection.

Theme	Strategic Adaptation Actions	Description	Indicative priority implementation actions (to be completed within 5-10 years)
Maintain and Improve	Emergency Response 	Emergency response and disaster management is everyone's responsibility. Council, State Emergency Service, volunteers and local disaster management groups are particularly key in leading the response to keep the community safe. Council's Disaster Management Plan provides information on preparation, response and recovery to potential coastal hazard events.	» Review and update the Livingstone Shire Local Disaster Management Plan with updated coastal hazard mapping and embed risk outcomes in emergency management and response planning. » Review and update emergency management response for higher risk areas of key localities. » Monitor frequency and nature of emergency management responses and call outs.
	Ecosystem Management 	Supporting natural dune processes through dune care and habitat management programs is an action that is currently being done in areas across the coastline and will continue to be undertaken in the future. It provides both ecological and amenity benefits and provides an opportunity to involve and educate the community to manage coastal hazard risks and undertake monitoring.	» Identify priority management areas and develop a plan for active dune and habitat protection, improvement and management. The plan needs to consider the ongoing viability of sand scraping in the area. » Establish an active dune and habitat protection, maintenance and improvement program using Council, Traditional Owners and volunteer resources. » Expand Council officer resources to implement the active dune and habitat protection, maintenance and improvement program. » Review and update the whole of coast Livingstone Shoreline Management Plan 2007.
	Planning Response 	Land use planning establishes certainty for community and development expectations. Council will ensure its planning frameworks and controls allow for only risk appropriate land uses to be located in hazard areas and reduce infrastructure exposure to future coastal hazard risk areas through implementation of setbacks, hazard resilient design requirements and minimum floor planning levels	» Review planning scheme to include updated coastal hazard mapping and embed risk assessment outcomes into land use and development policy responses. » Council to consider updated coastal hazard mapping and risk assessment outcomes for deciding new land use and development in hazard areas as part of the development assessment process » Integrate coastal hazard risk considerations into all strategic planning processes for future communities and master plan and structure plan areas.

Theme	Strategic Adaptation Actions	Description	Indicative priority implementation actions (to be completed within 5-10 years)
Maintain and Improve	Geotechnical investigation and detailed erosion study 	Further technical investigations and studies are needed at a Shire scale and for specific localities, to better understand coastal hazard processes and effectiveness of adaptation options over time.	» Undertake a shire wide sand sourcing investigation to inform the feasibility of dune augmentation and beach nourishment activities. » Instigate implications of catchment flooding and rainfall on coastal hazard risks and adaptation options. » Undertake geotechnical studies of select localities to determine proximity of underlying bedrock in coastal hazard areas. » Undertake a detailed assessment of tidal penetration into the stormwater system in low-lying areas.
Modify	Modify infrastructure and hazard resilient design 	Allow for continued use of infrastructure, buildings and assets where the coastal hazard risk is tolerable, but when upgrading or building new assets, the design is to be resilient to or accommodate coastal hazard impacts.	» Review and update asset management plans for priority infrastructure at risk and integrate consideration of current and future coastal hazard risks. » Liaise with other external asset providers / entities about implications of coastal hazards for future services and infrastructure upgrades.

TABLE 2. SUMMARY OF KEY IMPLEMENTATION ACTIONS FOR EACH LOCALITY FOCUSING ON THE SHORT TERM (5-10 YEARS)

Strategic Adaptation Actions	Description
STANAGE	
Monitor	» Monitoring of expanding tidal areas from sea level rise on agricultural and rural areas, partnering with landowners and natural resource management groups. » Investigate provision of a tide gauge at Stanage to better understand long term sea level changes, partnering with DTMR
Geotechnical investigation and detailed erosion study	» Undertake a geotechnical study to determine the extent of bedrock underlying the erosion hazard area.
Planned transition	» Commence investigation of alternative sites for relocating Coast Guard infrastructure.
FARNBOROUGH AND BANGALEE	
Monitor	» Photo point monitoring site at Bangalee to better understand and inform adaptation actions for at risk areas and important infrastructure » Active dune and habitat protection, improvement and management, using partnerships with other stakeholders.
Ecosystem management	» Active dune and habitat protection, improvement and management, using partnerships with other stakeholders. » Investigate the preparation of a 4WD management plan for beach roads. This should include likely beach access constraints into the future, guidance for 4WD users to protect dune systems, and the addition of safe 'pull out' locations along with possible alternative routes.
YEPPOON	
Monitor	» Photo monitoring at the Caravan Park and at Yeppoon along the seawall » Monitoring of water levels inside of Ross Creek. » Investigate provision of a tide gauge at Ross Creek to better understand long term sea level changes, partnering with DTMR. » Investigate implications of coincident catchment flooding and rainfall on coastal hazards, risks and adaptation options, prior to undertaking a CBA of any adaptation options affecting Ross Creek. » Monitor the position of Barwell Creek mouth.
Geotechnical investigation and detailed erosion study	» Undertake a geotechnical study to determine proximity of underlying bedrock in coastal erosion hazard areas for Vin E Jones Drive (Kemp Beach) and Statue Bay (Rosslyn).
Coastal engineering (hard)	» Undertake condition assessment, design review and remediation works as appropriate to the existing seawall to determine functional integrity of the structure. » Investigation to explore alignment of seawall within private property boundaries to determine if wall can be accommodated on private property and not result in loss of public access to the coast.
Coastal engineering (soft)	» Prepare preliminary designs to reinforce dune integrity to accommodate a severe storm event for Cooee Bay, Fisherman/s Beach and Spring Head to the Caravan Park.

ROSSLYN	
Monitor	» Photo point monitoring site at Lammermoor Beach and Kemp Beach.
Ecosystem management	» Document interventions at the mouth of Wiliamson Creek and prepare a creek mouth management plan.
Coastal engineering (soft)	» Prepare preliminary designs to reinforce dune integrity to accommodate a severe storm event for Kemp Beach. » Prepare preliminary design of beach nourishment at Lammermoor and Statute Bay.
Coastal engineering (hard)	» Prepare preliminary design for seawall at Lammermoor Beach and Statute Bay to protect sections of Scenic Highway.
Planned transition	» Commence investigation into relocation of roads at Kemp Beach.
MULAMBIN, KINKA BEACH AND CAUSEWAY LAKE	
Monitor	» Photo point monitoring site at Kinka Beach and Mulumban, partnering with community. » Monitoring of the position of the Causeway Lake outlet channel (Mulambin Creek). » Investigate provision of a tide gauge in Causeway Lake and undertake tidal study to understand tidal range in the lake. » Instigate implications of coincident catchment flooding and rainfall on coastal hazard risks and adaptation options, prior to undertaking a cost benefit analysis of any adaptation options affecting Causeway Lake.
EMU PARK AND ZILZIE	
Planning response	» Review planning responses in Emerging Community zoned areas to reduce intensity of future development and avoid increasing the future risk profile adjacent to Svendsen's Beach. Consider options of changing zoning, development setbacks and master planning to avoid future urban uses in coastal hazard areas. » Future land use and activities in undeveloped areas allow for landward habitat migration. » Photo monitoring at Bell Park and consider the requirement for a Shoreline Erosion Management Plan (SEMP) depending on the outcomes of the photo monitoring.
Ecosystem management	» Active dune and habitat protection, improvement and management, using partnerships with other stakeholders.
Geotechnical investigation and detailed erosion study	» Undertake a detailed erosion study for select areas including: - Svensdens Beach, to better understand creek mouth migration and the extent of erosion (to be undertaken by the landowner); - Bell Park and Emu Park Surf Life Saving club to further refine coastal hazard extents and to determine proximity of underlying bedrock.

KEPPEL SANDS	
Monitor	» Focussed monitoring of Keppel Sands Road and Joskeleigh Road to determine the frequency of inundation (to be undertaken by Council's Road Asset Manager).
Coastal engineering (hard)	» Undertake condition assessment, design review and remediation works as appropriate to the existing seawall to determine functional integrity of the structure.
Modify infrastructure and resilient design	» Investigate design life of Keppel Sands Road and Joskeleigh Road to further inform decisions for future major upgrades. » Drainage study to understand implications of coincident flooding, coastal hazards and rainfall for adaptation options, specifically for Keppel Sands Road and Jo-skeleigh Road (combine with Joskeleigh Road study). » Cost benefit analysis to inform option selection and be informed by road and drain-age studies.
Community education awareness Emergency response	» Focussed community awareness and education around risk and emergency management planning and evacuation response.
JOSKELEIGH	
Modify infrastructure and resilient design	» Drainage study to understand implications of coincident flooding, coastal hazards and rainfall for adaptation options, specifically for Keppel Sands Road and Joskeleigh Road (combine with Keppel Sands Road Study). » Cost benefit analysis to inform option selection and be informed by road and drainage studies.
GREAT KEPPEL ISLAND	
Monitor	» Site specific monitoring of Putney Beach to understand the rate of erosion.
Planning response	» Prepare a Shoreline Erosion Management Plan (SEMP) for developed areas on Great Keppel Island (GKI). » Use SEMP outcomes to inform and clarify the long term intent for development on Great Keppel Island and ensure that uses and infrastructure are risk appropriate. Further clarity around the long-term intent for developed areas is required to support refinement of the specific options and a cost benefit analysis. Council as a key stakeholder will proactively liaise with the State to progress the GKI Rejuvenation Project and advocate for risk reduction and planned transition/relocation of infrastructure. Council liaises with the State and shares updated coastal hazard mapping and risk assessment outcomes. » Integrate SEMP outcomes with the Great Keppel Island Rejuvenation project presently being undertaken by the State. » Review planning response to avoid any new development from locating or rebuilding in the coastal hazard area and include a policy direction of planned transition/retreat.

Glossary

Coastal hazard risk

The Our Living Coast Strategy focuses on the coastal hazards of storm tide inundation and coastal erosion and how these coastal hazards are expected to change under the influence of sea level rise from future climate change.

The extent of coastal land potentially impacted by coastal hazards, as well as the consequences of these coastal hazards, are expected to increase into the future. Risk is the combination of likelihood (or how often we think a coastal hazard may occur) and the consequence of it occurring (or what we expect an impact of the coastal hazard to look like).

Coastal hazard adaptation

Actions undertaken to eliminate or limit the risks posed by a coastal hazard (i.e. sea level rise, storm-tide inundation and coastal erosion). Adaptation can involve many small steps over time or major transformation with rapid change. Climate change is expected to increase the extent, severity and frequency of coastal hazards. For example, tropical cyclones are expected to be more intense and a greater extent of low lying land will be affected by periodic inundation because of sea level rise.

Resilience to coastal hazards

Strengthening our understanding of current and future risk, better management of risk, and improving how we prepare for, respond to and recover from coastal hazard events.

References

Livingstone Shire Council (2017). Livingstone Shire Coastal Hazard Adaptation Strategy (CHAS) Phase 1 Report – Stakeholder And Community Engagement Strategy. Report by Ethos Urban and BMT for Livingstone Shire Council.

Livingstone Shire Council (2018). Livingstone Shire Coastal Hazard Adaptation Strategy (CHAS) Phase 2 Report – Coastal Hazards Scoping Study. Report by BMT for Livingstone Shire Council.

Livingstone Shire Council (2019). Livingstone Shire Coastal Hazard Adaptation Strategy (CHAS) Phase 3-8 Engagement Summary Report. Report by Ethos Urban for Livingstone Shire Council.

Livingstone Shire Council (2019). Livingstone Shire Coastal Hazard Adaptation Strategy (CHAS) Phase 3 Erosion Hazard Assessment. Report by BMT for Livingstone Shire Council.

Livingstone Shire Council (2019). Livingstone Shire Coastal Hazard Adaptation Strategy (CHAS) Phase 3 Storm Tide Hazard Assessment. Report by BMT for Livingstone Shire Council.

Livingstone Shire Council (2020). Livingstone Shire Coastal Hazard Adaptation Strategy (CHAS) Phase 4 Asset Identification. Report by BMT for Livingstone Shire Council.

Livingstone Shire Council (2020). Livingstone Shire Coastal Hazard Adaptation Strategy (CHAS) Phase 5 Risk Assessment. Report by BMT for Livingstone Shire Council.

Livingstone Shire Council (2020). Livingstone Shire Coastal Hazard Adaptation Strategy (CHAS) Phase 6 Adaptation Options. Report by BMT for Livingstone Shire Council.

Livingstone Shire Council (2020). Livingstone Shire Coastal Hazard Adaptation Strategy Cost Benefit Analysis for Kemp Beach. Report by Aither for Livingstone Shire Council.

Local Government Association Queensland (LGAQ) and Department of Environment and Heritage Protection (DEHP) (2016). QCoast2100 Developing a Coastal Hazard Adaptation Strategy: Minimum Standards and Guidelines for Queensland Local Governments. LAQ and DEHP, QLD.

Appendix A

Indicative Pathway Actions and Triggers for Localities

How to read the grapths

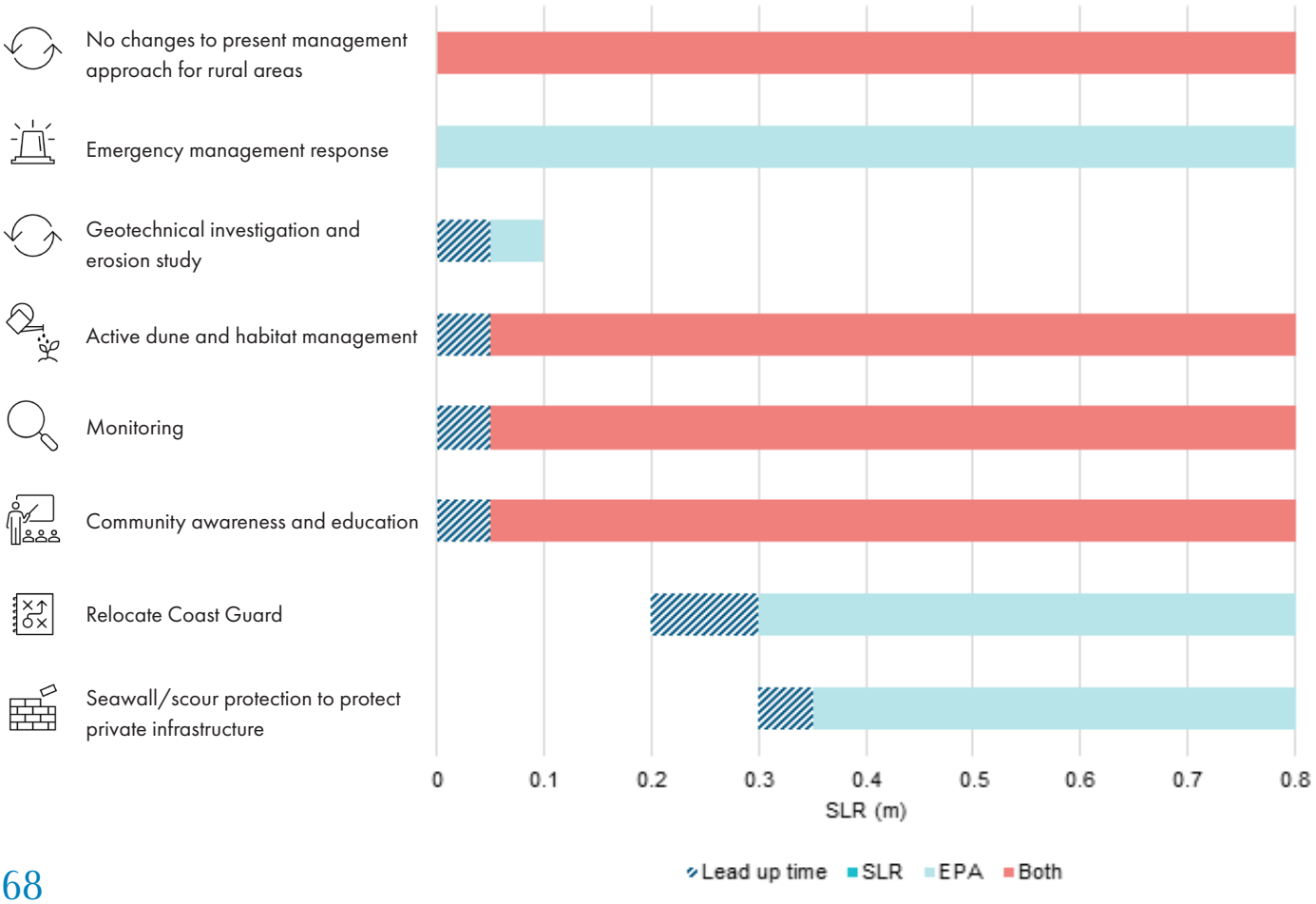
- The following graphs include whole of shire adaptation actions and local adaptation option pathways linked to sea level rise and erosion triggers
- Whole of shire strategic adaptation actions form the basis for adaptation pathways to be applied to different parts of the coast and local adaptation option pathways will need to be further investigated and defined based on community attitudes at the time
- These graphs should be read in conjunction with the local adaptation strategy tables in section 4.0 of the strategy which identify the indicative short, medium and long-term timing for actions and pathways

Legend

SLR	sea level rise
EPA	erosion prone area
Both	sea level rise and erosion prone area
Lead up time	indicates the time typically taken before an option can be physically implemented. More complex options require a greater lead up time to undertake tasks such as completing investigations, obtaining approvals, sourcing funding etc.

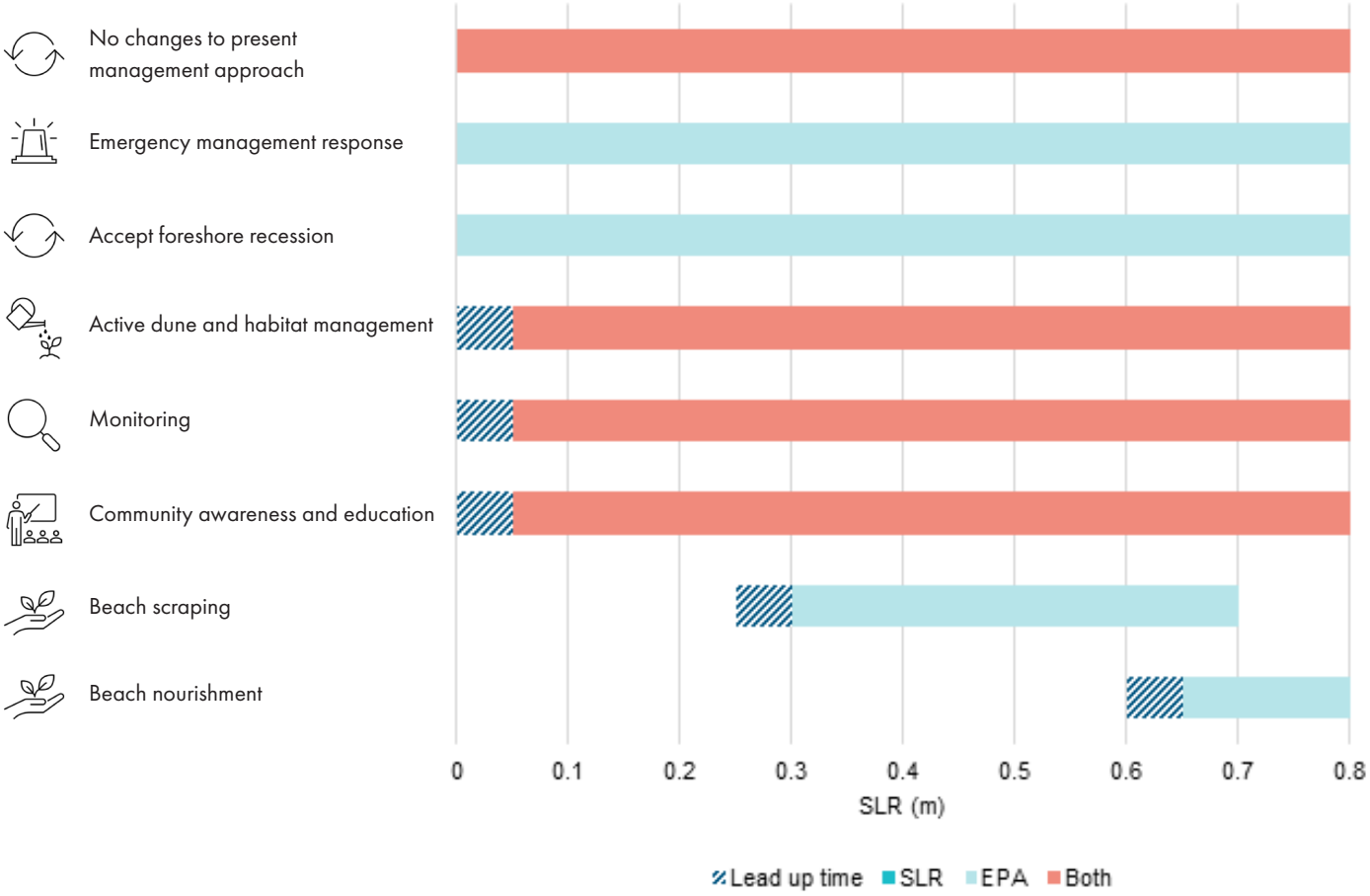
STANAGE

The indicative pathway actions and triggers in response to coastal hazards (sea level rise and erosion hazard) is illustrated in the graph below.



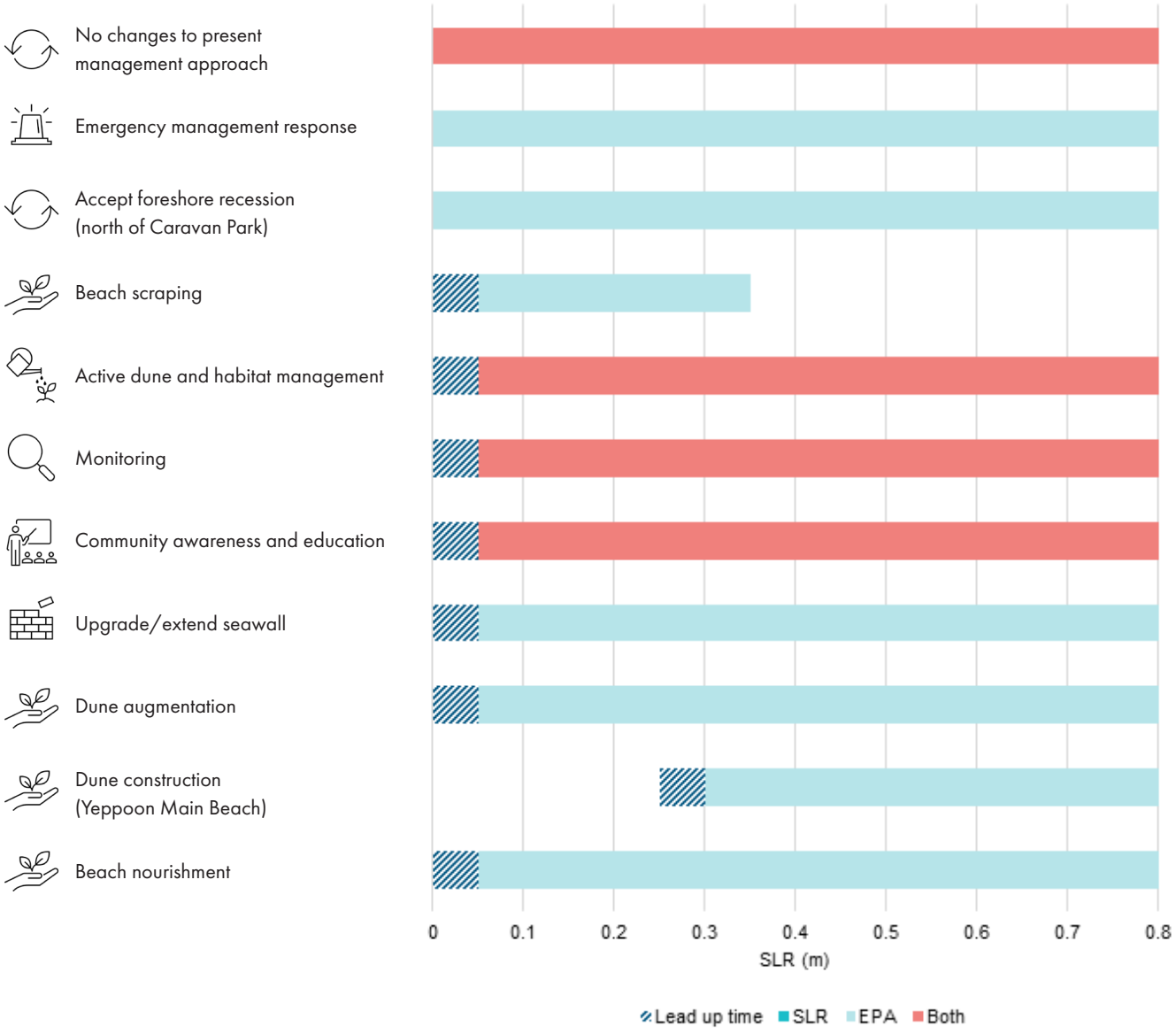
FARNBOROUGH AND BANGALEE

The indicative pathway actions and triggers in response to coastal hazards (sea level rise and erosion hazard) is illustrated in the graph below.



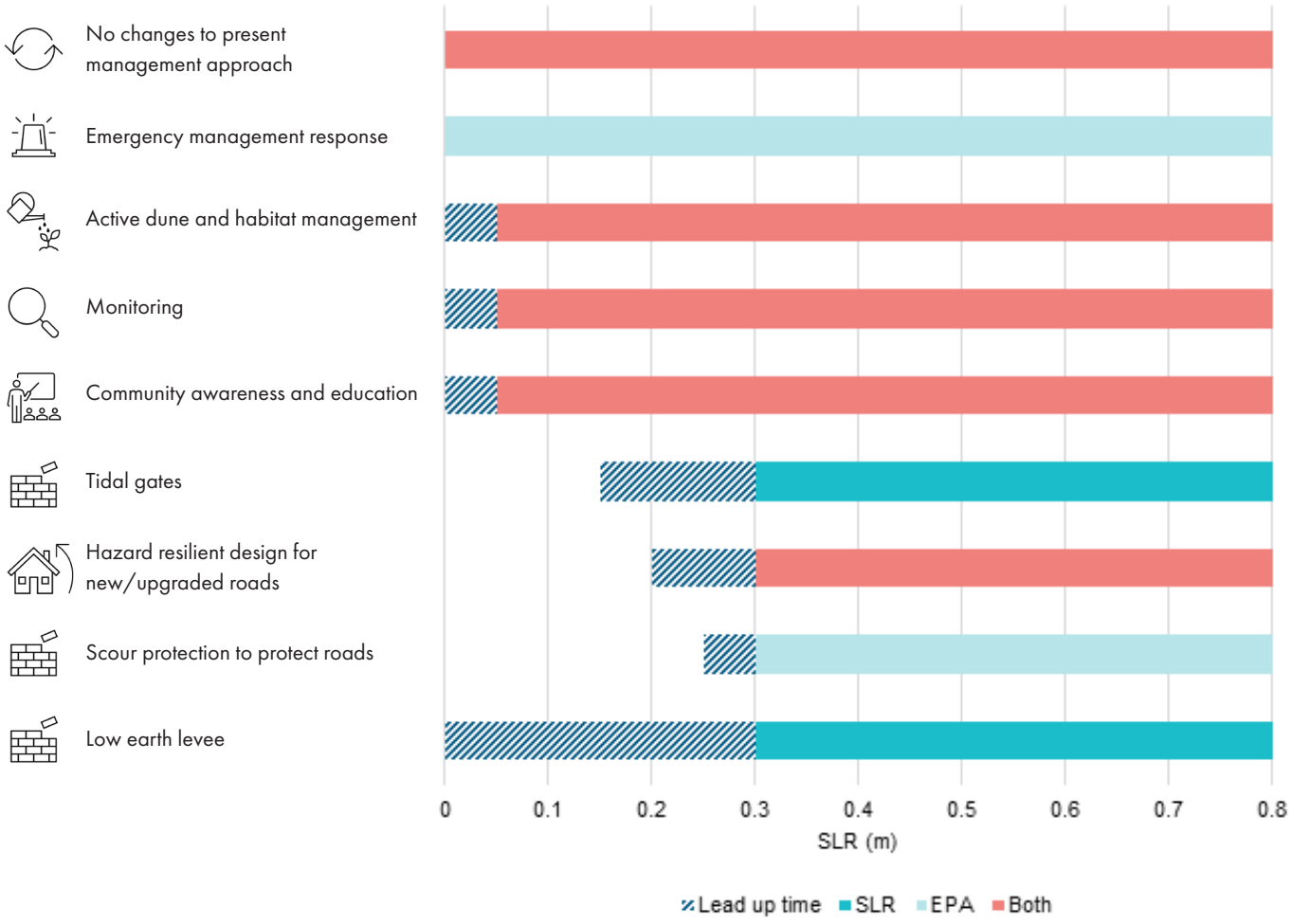
YEPPOON

The indicative pathway actions and triggers in response to open coast coastal hazards (sea level rise and erosion hazard) is illustrated in the graph below.



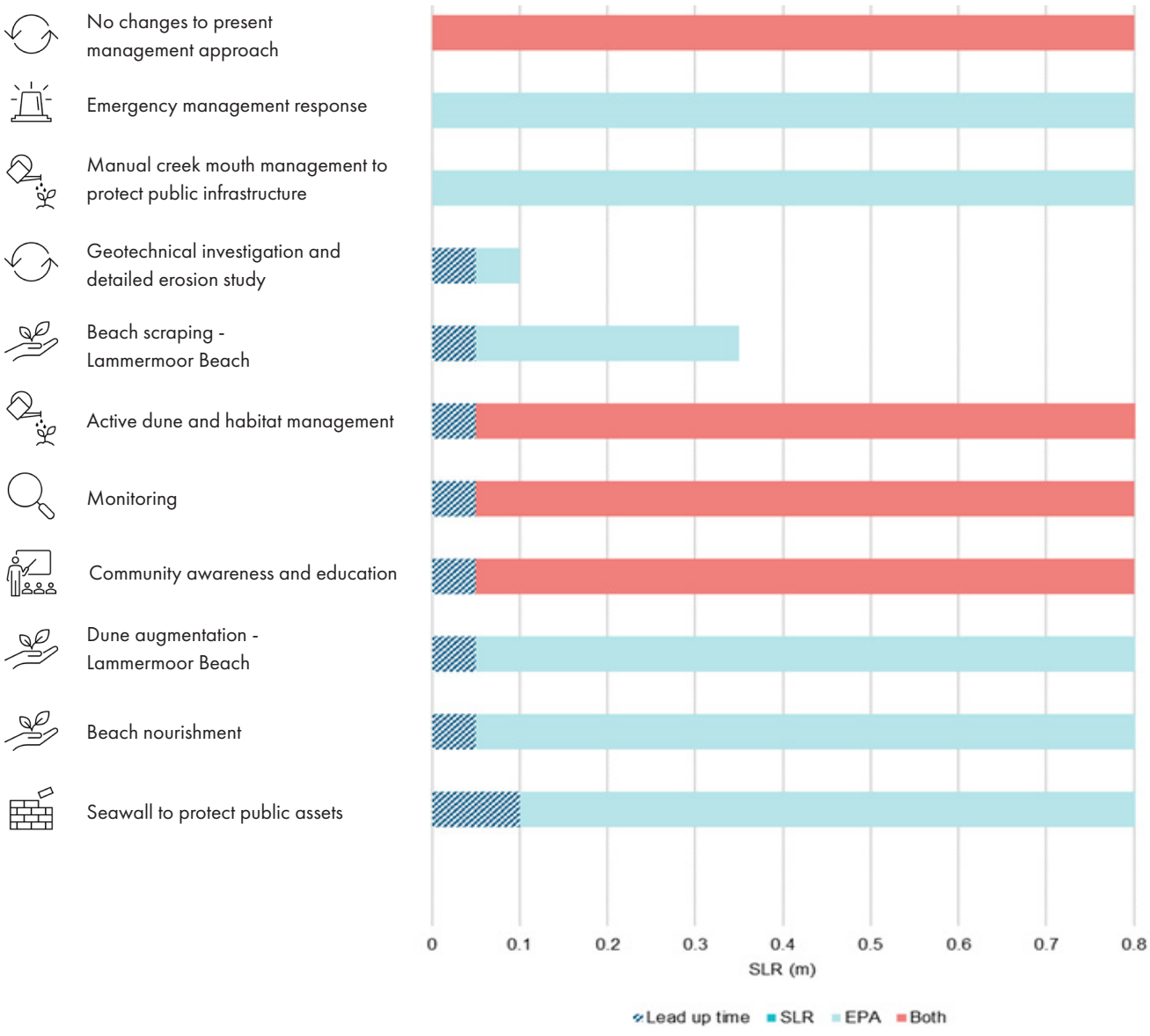
YEPPOON

The indicative pathway actions and triggers in response to waterway coastal hazards (sea level rise and erosion hazard) is illustrated in the graph below.



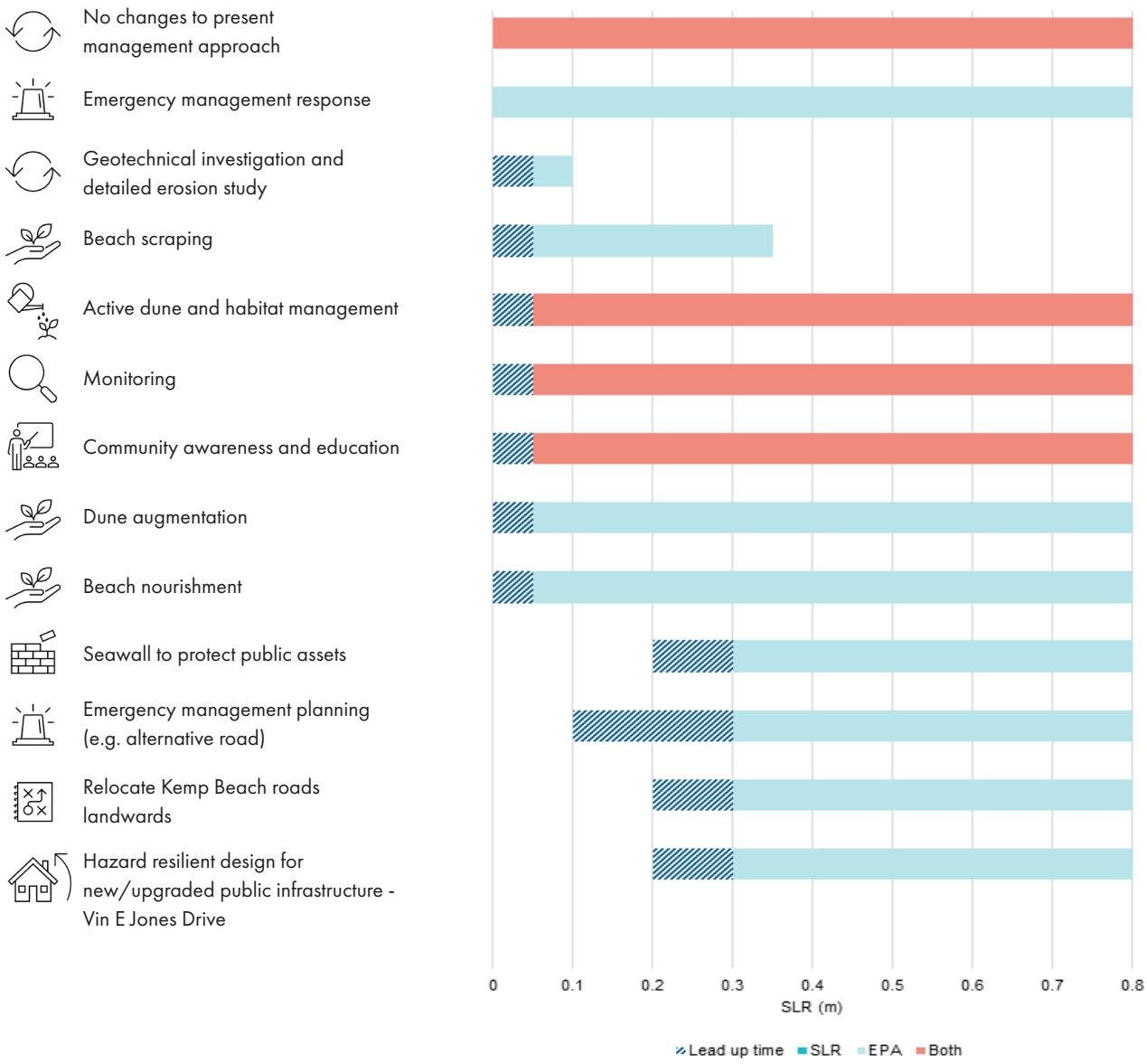
ROSSLYN AND LAMMERMOOR BEACHES

The indicative pathway actions and triggers in response to coastal hazards (sea level rise and erosion hazard) is illustrated in the graph below.



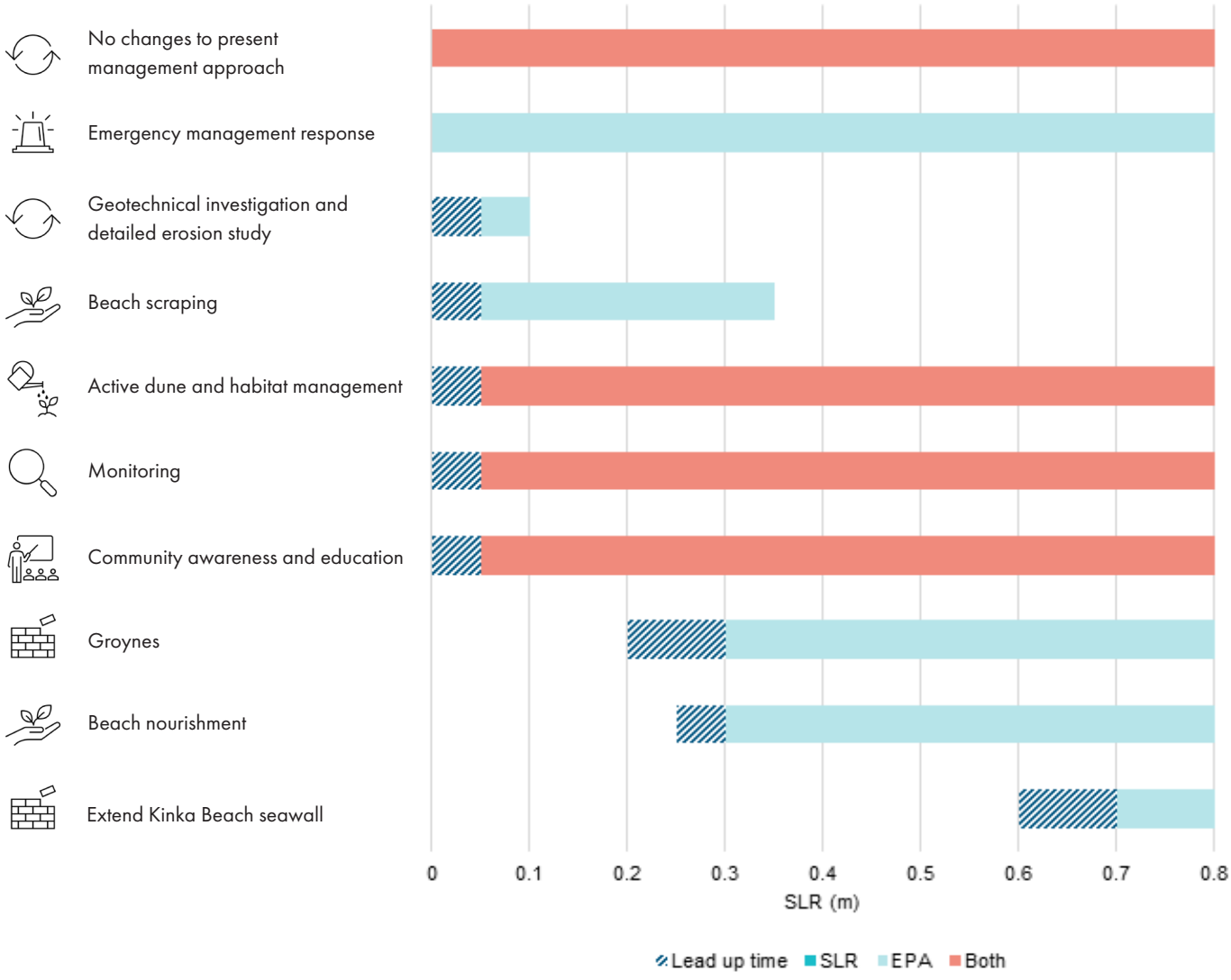
KEMP BEACH

The indicative pathway actions and triggers in response to waterway coastal hazards (sea level rise and erosion hazard) is illustrated in the graph below.



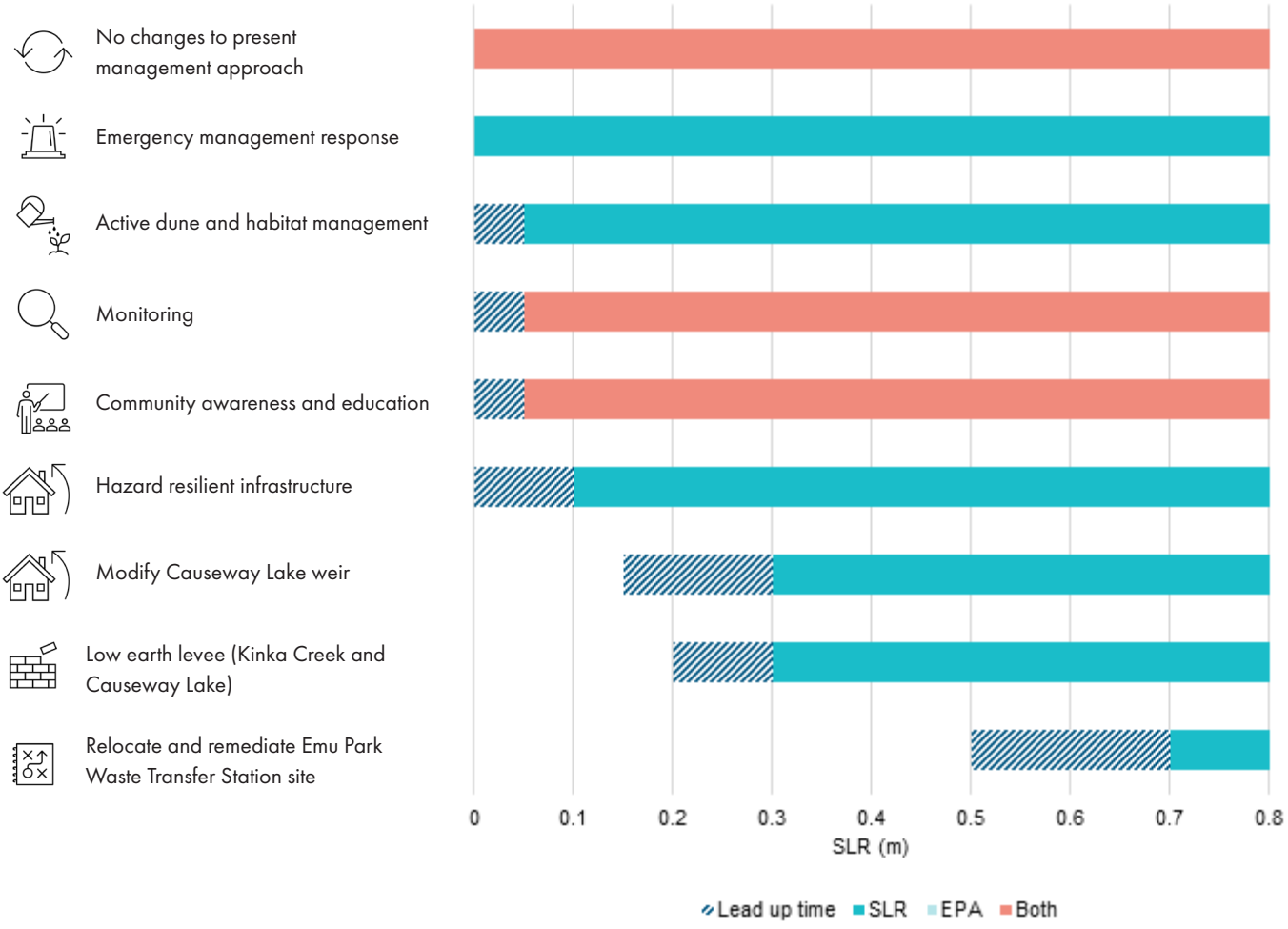
MULAMBIN, KINKA BEACH AND CAUSEWAY LAKE

The indicative pathway actions and triggers in response to open coast coastal hazards (sea level rise and erosion hazard) is illustrated in the graph below.



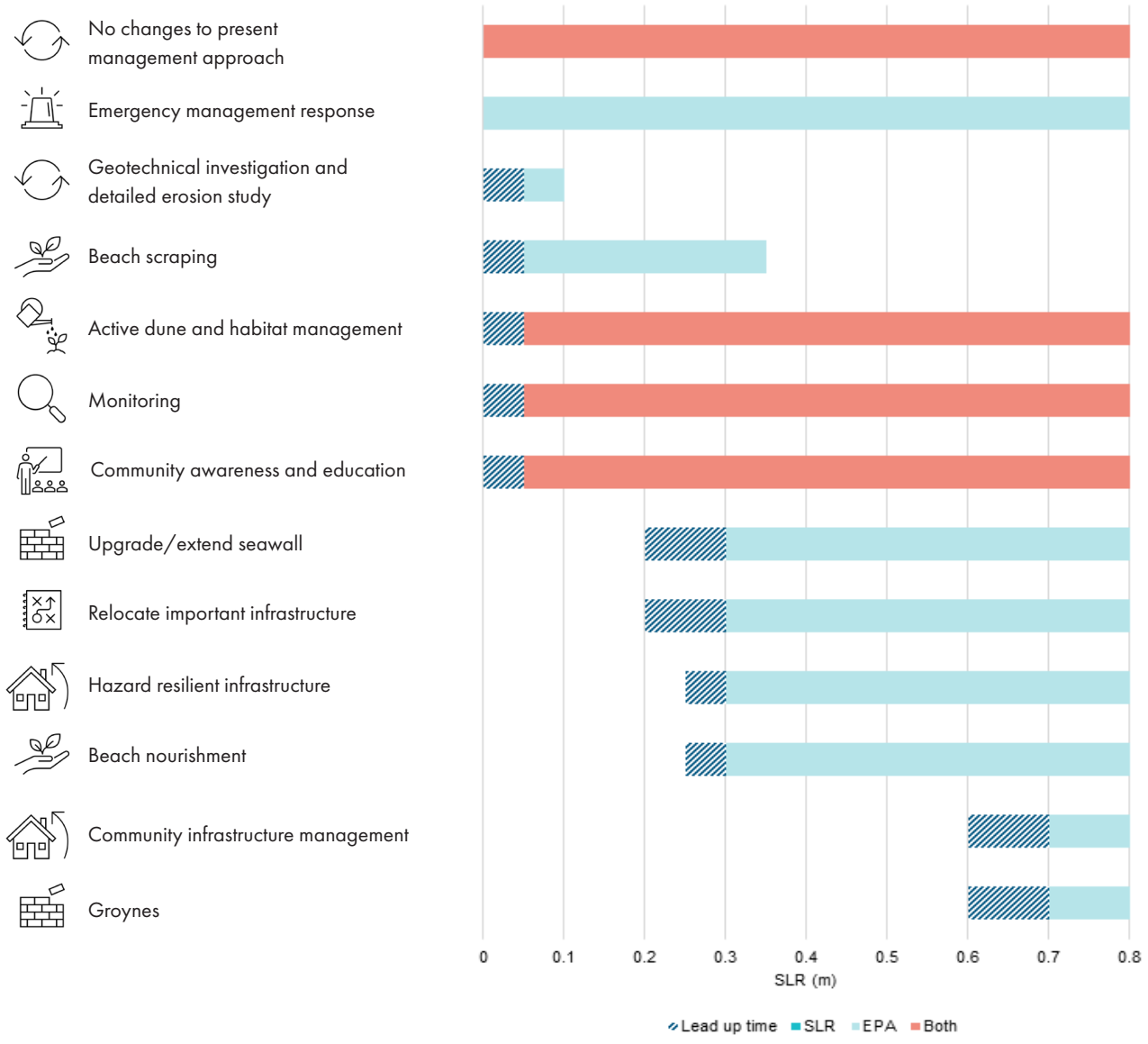
MULAMBIN, KINKA BEACH AND CAUSEWAY LAKE

The indicative pathway actions and triggers in response to waterway coastal hazards (sea level rise and erosion hazard) is illustrated in the graph below.



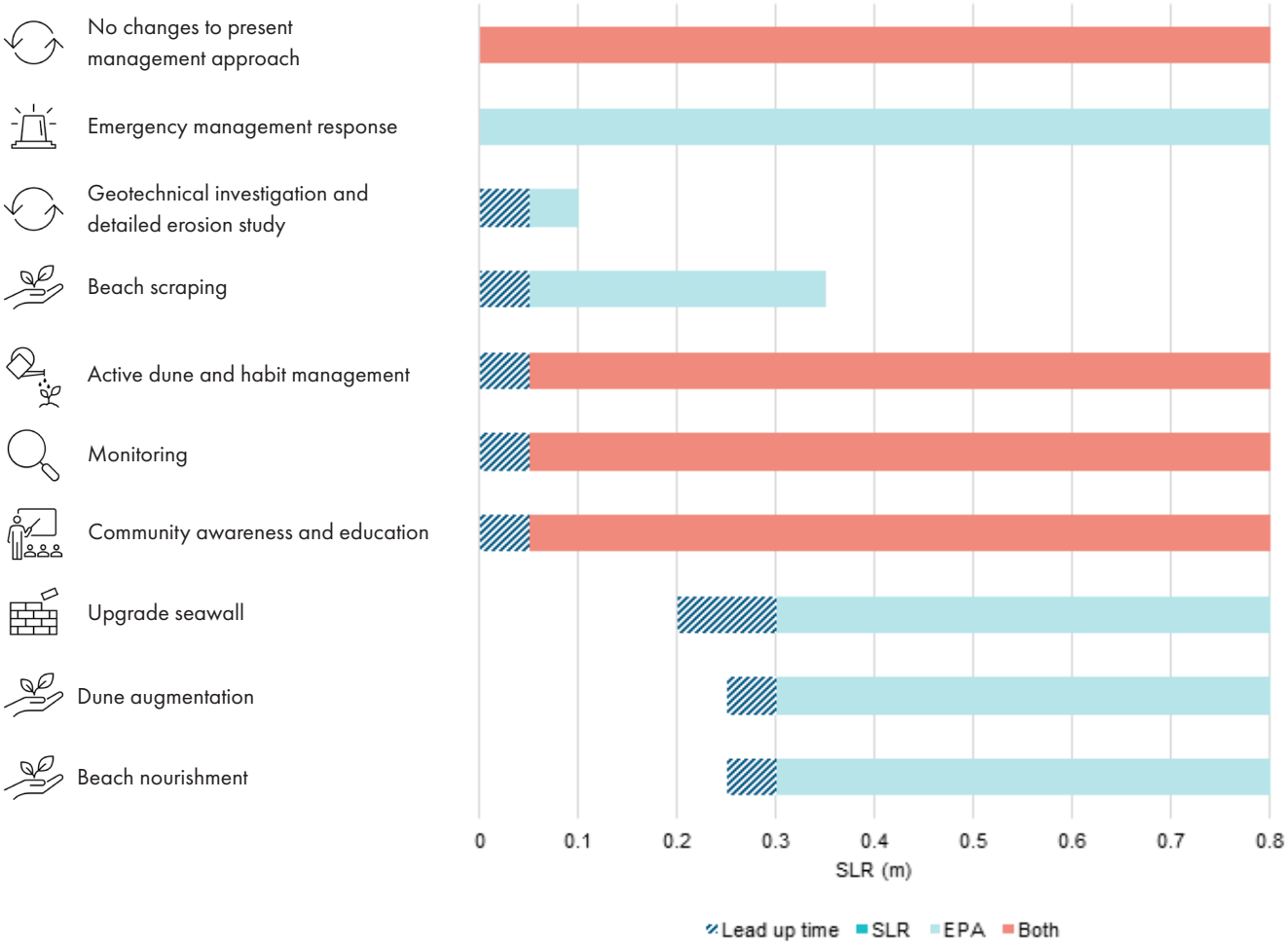
EMU PARK AND ZILZIE

The indicative pathway actions and triggers in response to coastal hazards (sea level rise and erosion hazard) affecting the Emu Park beaches is illustrated in the graph below.



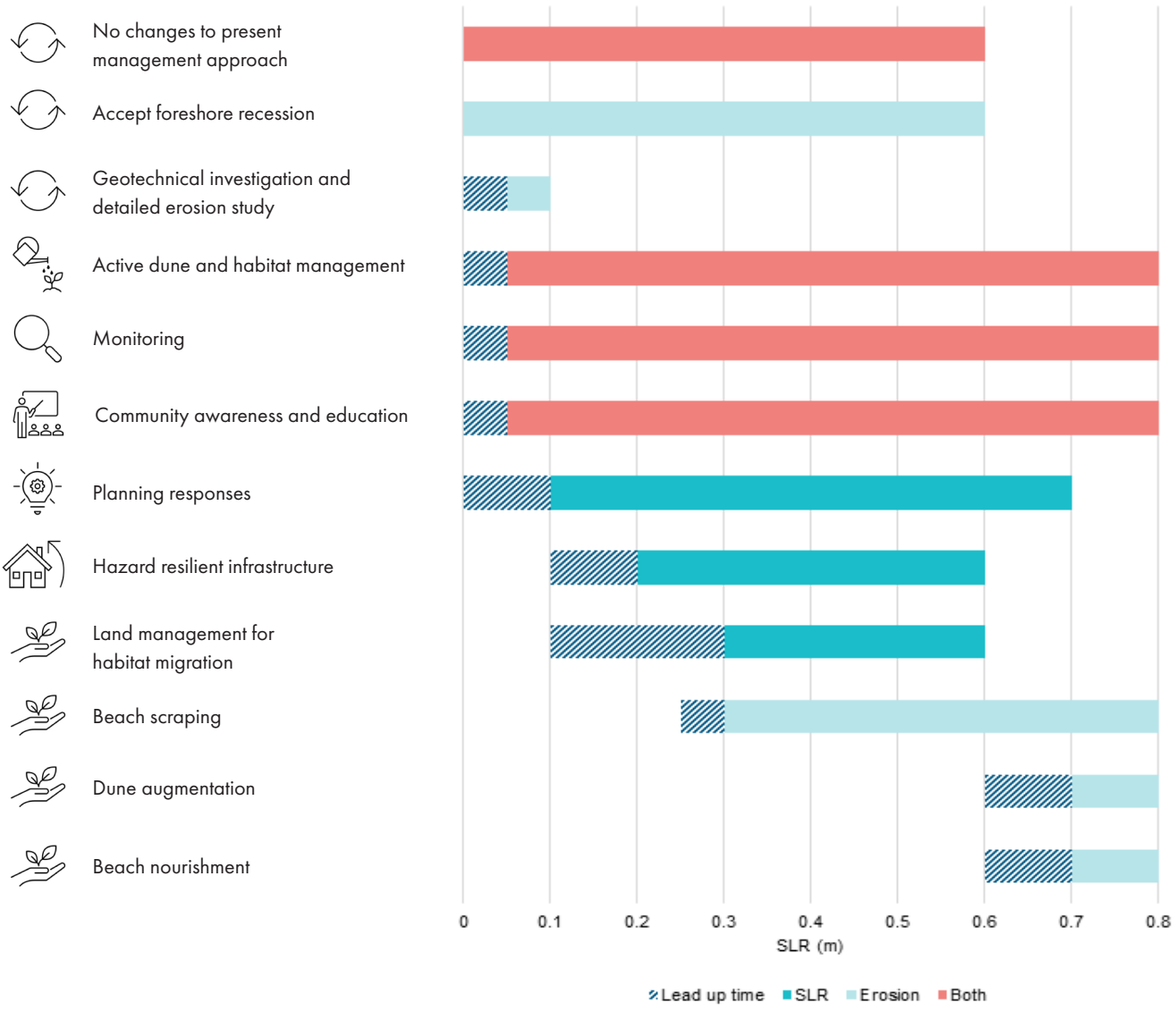
EMU PARK AND ZILZIE

The indicative pathway actions and triggers in response to coastal hazards (sea level rise and erosion hazard) affecting Musker's Beach is illustrated in the graph below.



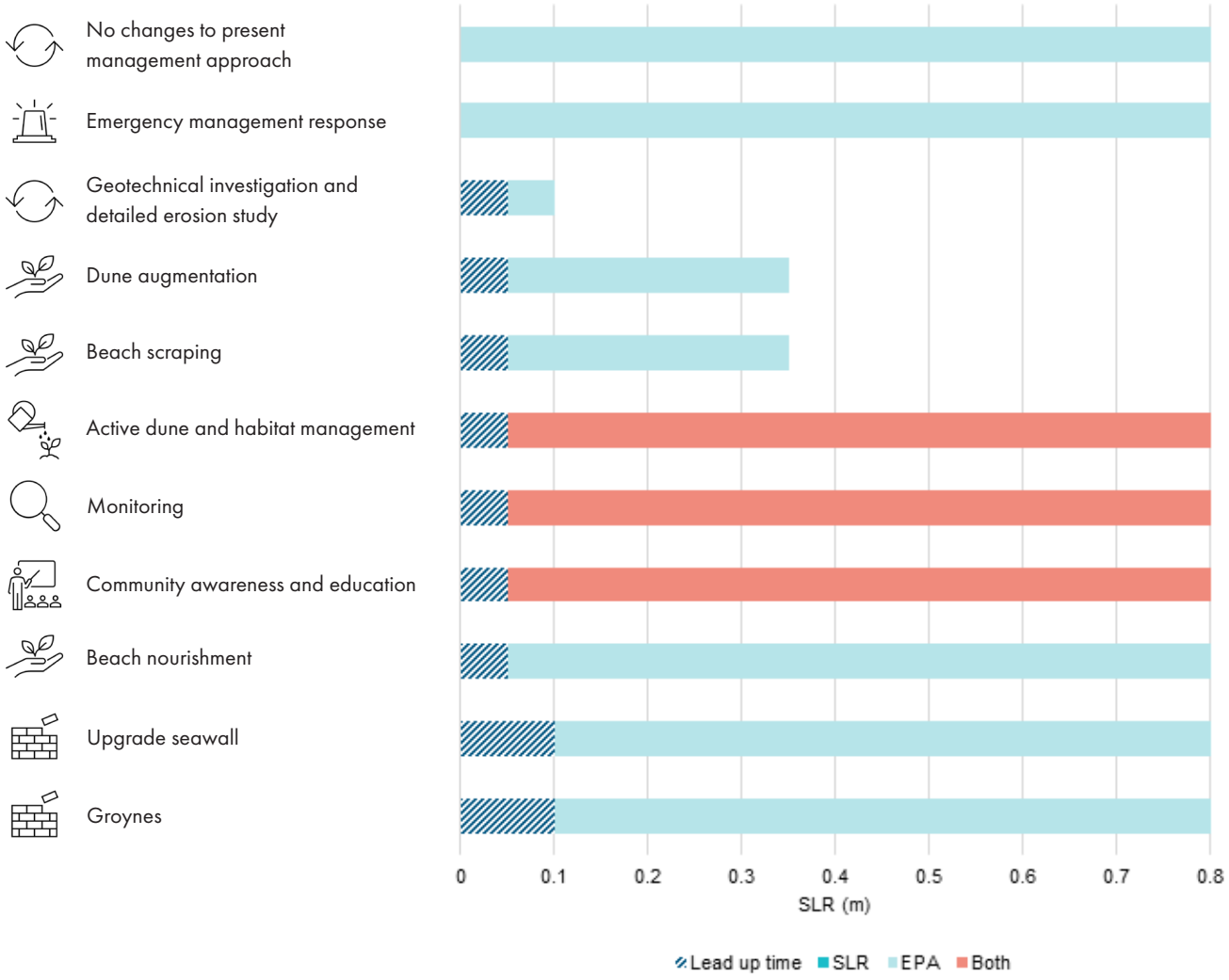
EMU PARK AND ZILZIE

The indicative pathway actions and triggers in response to coastal hazards (sea level rise and erosion hazard) affecting Svendsen's Beach is illustrated in the graph below.



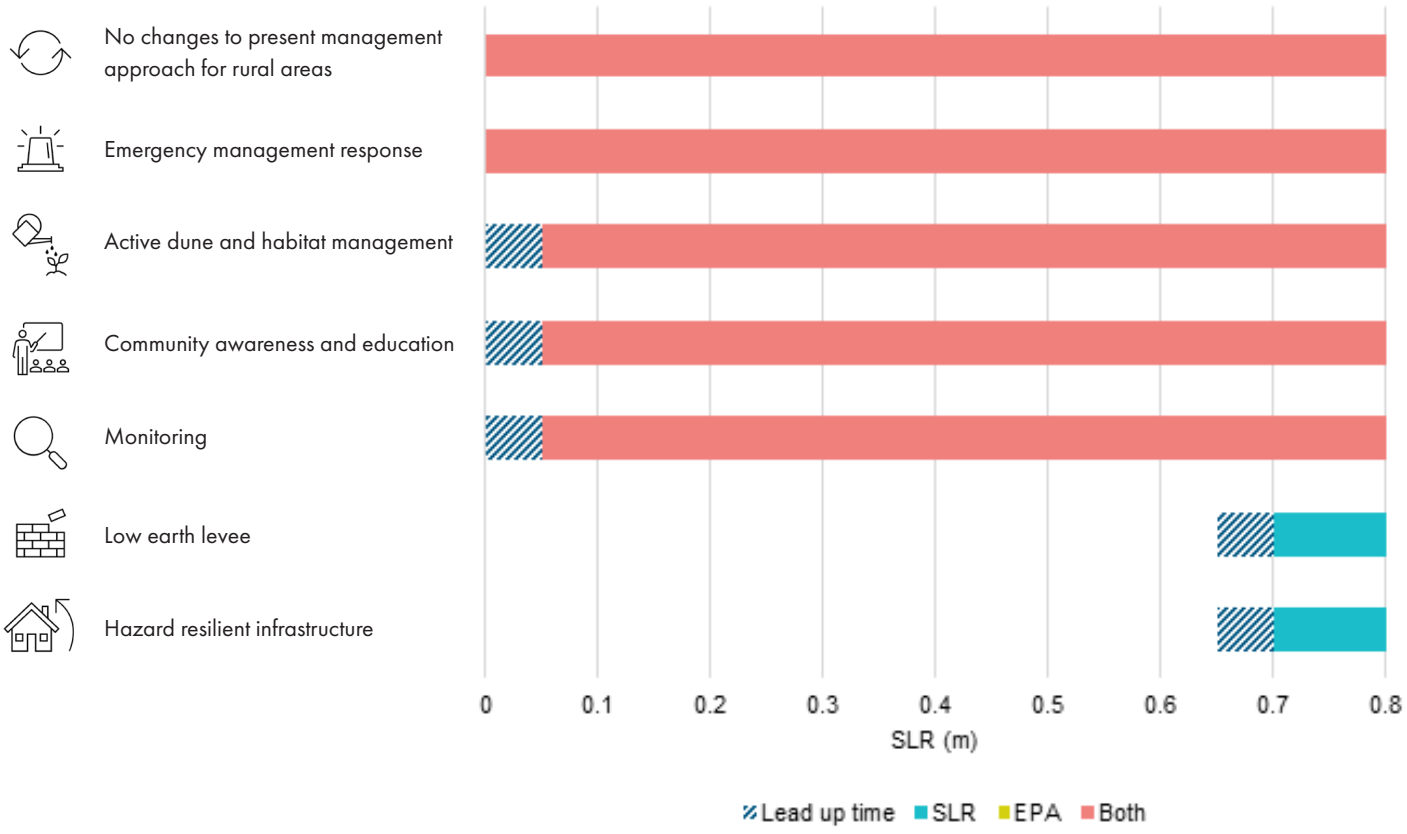
KEPPEL SANDS

The indicative pathway actions and triggers in response to open coast coastal hazards (sea level rise and erosion hazard) is illustrated in the graph below.



KEPPEL SANDS

The indicative pathway actions and triggers in response to waterway coastal hazards (sea level rise and erosion hazard) is illustrated in the graph below.



JOSKELEIGH

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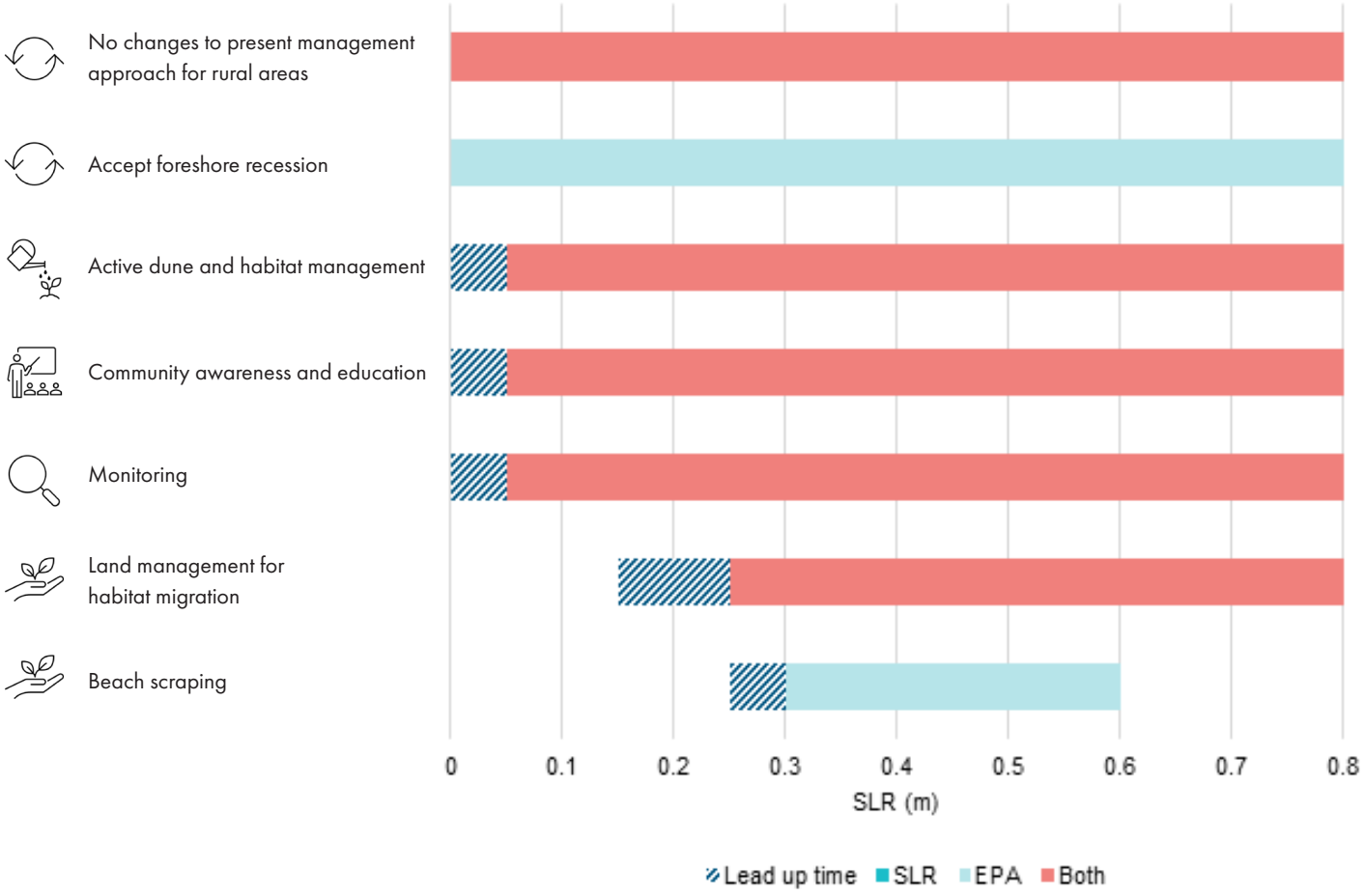
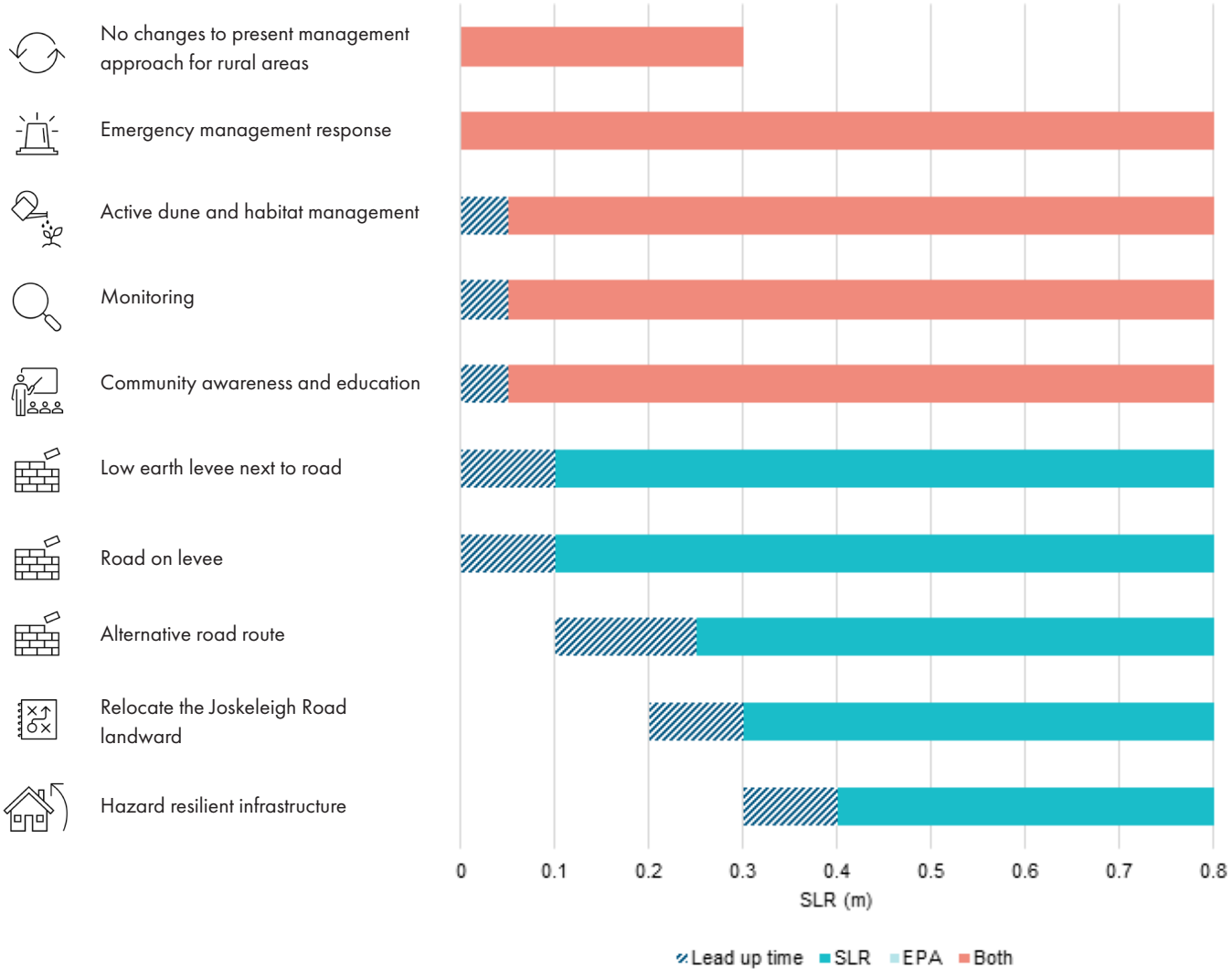


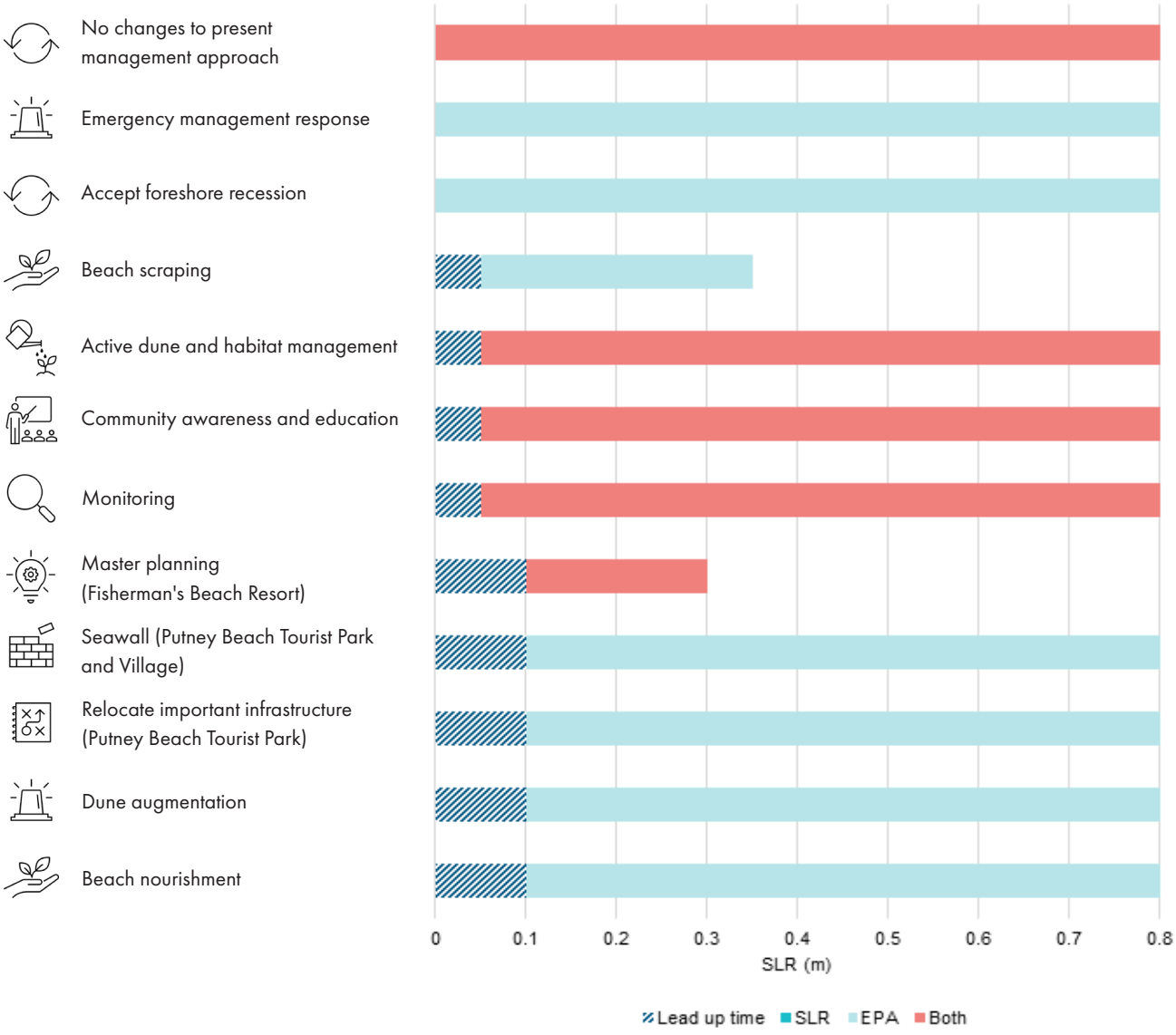
JOSKELEIGH

The indicative pathway actions and triggers in response to waterway coast coastal hazards (sea level rise and erosion hazard) is illustrated in the graph below.



GREAT KEPPEL ISLAND

The indicative pathway actions and triggers in response to coastal hazards (sea level rise and erosion hazard) is illustrated in the graph below.



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Our Living Coast Strategy (Version 2 - January 2021)