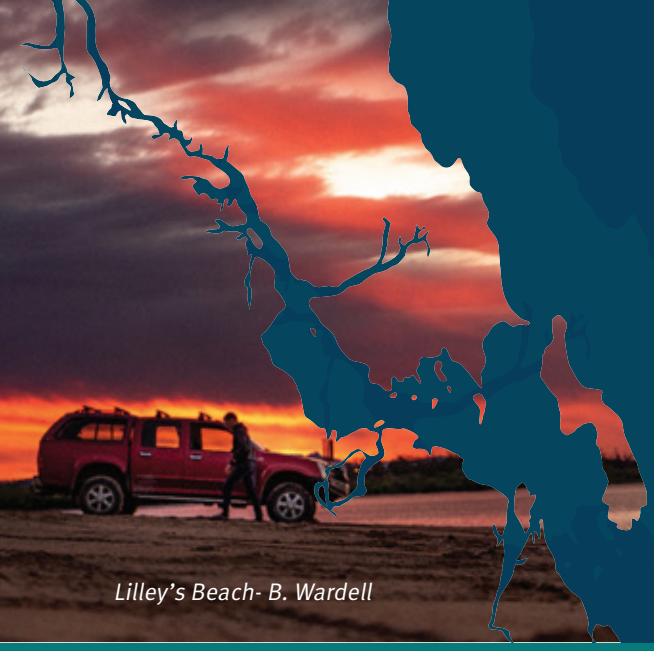
Our Coast. Our Future.

Strategic Plan

GLADSTONE
REGIONAL COUNCIL



Lilley's Beach- B. Wardell

Cover images:
Gladstone Marina - J. Patchett
Round Hill Creek - S. McKay

FOREWORD

The coastal landscape in the Gladstone region is a diverse and dynamic stretch of the Queensland coastline. The coastal zone is characterised by wide coastal plains, tidal embayments, creeks and inlets, rocky peninsulas, and a network of sandy barrier islands and beach ridge systems. The landscape supports a diversity of cultural, economic and environmental values.

The Traditional Owners of the land, including the Gooreng Gooreng, Gurang, Bailai (Byellee) and Taribelang Bunda peoples, have had a strong connection to country for thousands of years. These coastal areas have many culturally significant sites, artefacts and species, and sections of the Gladstone coastal land and waters are held as part of Native Title.

With a natural deepwater port sheltered by nearshore barrier islands, the region has one of the largest bulk commodity ports in the world, that enables our industry, resources and energy, engineering and manufacturing sectors to thrive.

The coastal environment has unique coastal features and natural beauty, helping to sustain sensitive and significant ecosystems across our dunes, estuaries and waterways, and offshore reefs.

Access to the coastal environments has an important role in the economy, lifestyle and livelihoods of our communities, Traditional Owners, and vistors.

Coastlines are dynamic, ever-changing with each tide and storm event. Erosion and storm tide inundation are natural processes that shape the coast over long timeframes. These processes are referred to as coastal hazards when they impact on how we use and enjoy the coast. Parts of Gladstone's coast are currently prone to coastal hazard impacts, driven by cyclones and storm events. Coastal hazard impacts are also predicted to increase with a changing climate.

The State Government and Local Government Association of Queensland (LGAQ) provided funding to Queensland coastal Councils to develop a strategic approach to managing coastal hazards. With the funding awarded to Gladstone Regional Council, we have been able to develop this *Our Coast. Our Future* Strategic Plan.

The Strategic Plan is a resource for the entire region that will guide how we manage and adapt to coastal hazards. Council's role in developing the *Our Coast. Our Future* Strategic Plan is limited to ensuring the continuity of the services it provides and making the information in the Plan available to support industries, organisations and residents to implement their own actions to adapt to coastal hazards.

As a consequence, some actions identified within the Strategic Plan will not be undertaken by Gladstone Regional Council and will be the responsibility of other Stakeholders within the region, as identified.

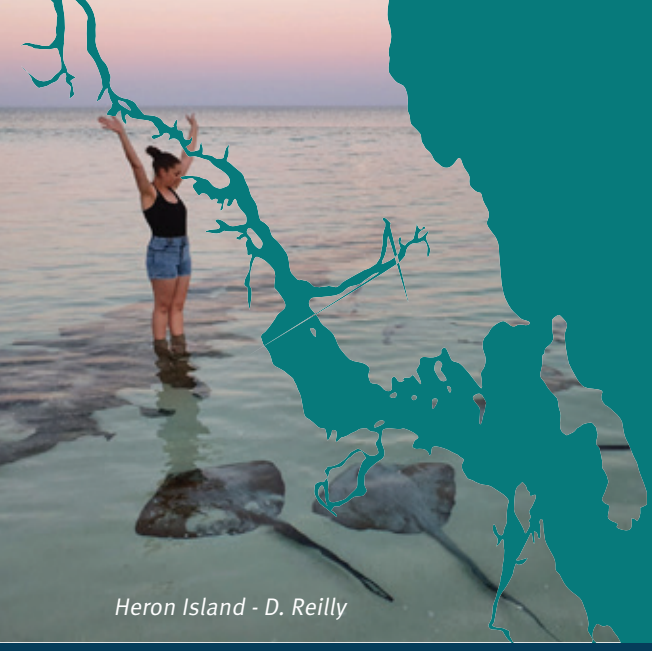
Our coastal lifestyle in the Gladstone region is unique and worth preserving for generations to come. This Strategic Plan enables Gladstone Regional Council and our stakeholders, including our Traditional Owners, industry and residents, to be better prepared to reduce the impacts of coastal hazards on our communities, environment, cultural values, infrastructure, lifestyle and services, both now and into the future (to 2100).

Gladstone Regional Council would like to acknowledge the traditional custodians of this land, the Byellee, the Gooreng Gooreng, the Gurang and the Taribelang Bunda people.

We pay respect to their Elders past, present and emerging.

We would also like to extend that respect to other Aboriginal and Torres Strait Islander people in our region.

Seventeen Seventy - A. Kruger



Heron Island - D. Reilly

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Gladstone Marina- C. Ward

1. INTRODUCTION

1.1 Our coastline

Located in Central Queensland, the Gladstone Local Government Area (LGA) includes over 150 km of coastline, extending from Baffle Creek in the south to Raglan Creek in the north, and includes several nearshore and offshore islands (Figure 1).

The Traditional Owners of the land, including the Gooreng Gooreng, Gurang, Bailai (Byellee) and Taribelang Bunda peoples have had a strong connection to country and have cared for the land and sea country for thousands of years. Sections of the Gladstone coastal land and waters are held as part of Native Title. The Port Curtis Coral Coast, which represents the Traditional Owners of the region, have a Traditional Use of Marine Resources Agreement (TUMRA) agreement which encompasses sea country in both the Great Barrier Reef Marine Park and the Great Sandy Marine Park. It is the largest of its kind, covering over 26,000 km^2, and includes areas within the Gladstone region.

Sandy beaches, tidal embayments and inlets, salt flats, coastal vine thickets and littoral rainforest characterise much of our coastal zone, along with residential settlements along the coast. These coastal areas also have places with significant cultural heritage, including sacred sites and shell midden sites.

The landscape has been shaped by coastal processes over many thousands of years. Erosion and accretion of the shoreline, and inundation of coastal areas, are part of these natural processes. However, these processes can become coastal hazards when they have the potential to impact on infrastructure, access, services, cultural heritage, our lifestyle and the economy.

1.2 The Coastal Hazard Adaptation Strategy

Context

The QCoast$_{2100}$ program is a state-wide initiative of the Queensland Government and Local Government Association of Queensland (LGAQ), to help coastal councils proactively plan for managing coastal hazard impacts, from present day to 2100.

Gladstone Regional Council was awarded funding through QCoast$_{2100}$ to undertake the *Our Coast. Our Future* program and develop this Strategic Plan for the Gladstone region.

The *Our Coast. Our Future* Strategic Plan has been:

- Developed to proactively manage the impact of coastal hazards, now and into the future;
- Developed in consultation with stakeholders and communities; and
- Tailored to include our full coastal landscape and communities.

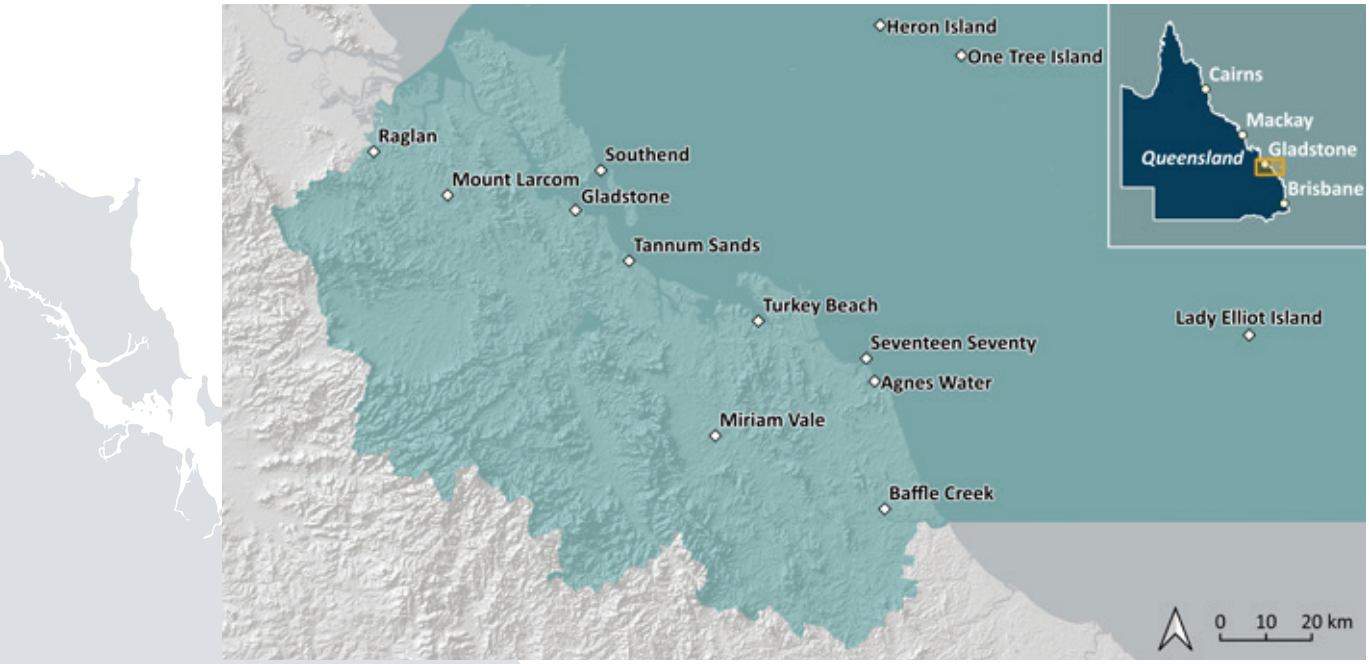


Figure 1. Gladstone region's coastline

Purpose

The purpose of the Strategic Plan is to:

- Inform future decisions regarding the protection and management of our coast and foreshore;
- Inform future land use planning;
- Guide the management of public utilities and facilities;
- Guide the management of areas of environmental and cultural significance; and
- Foster collaboration and the shared care of our coastline.

Approach

The *Our Coast. Our Future* Strategic Plan has been developed through an eight-phase process (Figure 2) as outlined in the $QCoast_{2100}$ Minimum Standards & Guideline (LGAQ and DEHP 2016)[1].

The process has included a series of studies and activities that sought to:

- Identify coastal hazard areas;
- Understand vulnerabilities and risks to assets;
- Engage with community to understand the preferred approaches to adaptation; and
- Determine adaptation actions, costs, priorities, and timeframes for implementation.

Figure 2. $QCoast_{2100}$ eight-phase process

1.3 Engagement

Process

The Strategic Plan development has been informed through consultation with key stakeholder groups and Gladstone region communities.

Engagement events and activities were carried in a range of virtual and face-to-face formats and included:

- Online community webinars in May, June and September 2020, including a session at EcoFest;
- Coastal Photo Competition, from June to August 2020, where the community were encouraged to submit their photos of favourite Gladstone coastal areas;
- Numerous school visits to speak with some of the region's youth and raise awareness of coastal hazards and adaptation;
- Community pop-up events in September 2020 at Gladstone, Boyne Island and Agnes Water;
- Community surveys (May to August 2020 and September to October 2020) and online knowledge sharing to inform an appreciation of coastal values, and adaptation opportunities and preferences;
- Stakeholder workshops with the Community Reference Group and other stakeholders - March, May, September and October 2020 - to help build awareness and prioritise important coastal values and assets;
- Targeted briefings to key stakeholder groups, including a range of Council departments, Traditional Owners and the Gidarjil Development Corporation, and ports and industry representatives; and
- A four-week public comment period on the draft Strategic Plan in late 2020 and early 2021.

[1] https://www.qcoast2100.com.au/

Spinnaker Park Gladstone- L. Downer

Community Reference Group

A Community Reference Group (CRG) was established to support the development of the *Our Coast. Our Future* Strategic Plan.

The CRG was chaired by Councillor Natalia Muszkat, and the Group participated in three full-group meetings. The CRG was supported by a number of Council staff, and included representatives from:

- Fitzroy Basin Association
- Gladstone Ports Corporation
- Gladstone Healthy Harbours Partnership
- Discovery Coast Environmental Group
- Great Barrier Reef Marine Park Authority
- South End Progress Association
- Bush Heritage Australia
- CQ University
- Surf Life Saving Queensland
- Port Curtis Coral Coast Trust
- Gladstone Region Youth Council
- Gladstone Conservation Council
- Gladstone Area Promotion and Development Ltd.
- Queensland Parks and Wildlife Service

Project Working Group workshop

Communication

A range of communications materials was produced during development of the Strategic Plan, including project updates, a video explainer for the project, and a series of tailored fact sheets relevant to coastal hazard adaptation. The fact sheets are provided as Supplement A to this Strategic Plan. The fact sheets include:

- Terminology;
- Coastal landscapes;
- Coastal hazards;
- Coastal adaptation;
- *Our Coast. Our Future* - values and threats;
- Adaptation framework; and
- Strategic Plan summary.

Council's 'Conversations' website was used for publicising the project, sharing information, and encouraging registration and participation[2].

The engagement and communication process across all phases of the Strategic Plan development was informed by planning undertaken in Phase 1 and 2.

[2] https://conversations.gladstone.qld.gov.au

Canoe Point- S. Griffin

Outcomes

All input and feedback assisted to shape the direction of technical investigations underpinning the Strategic Plan, and priority adaptation actions for the Gladstone region's coastline.

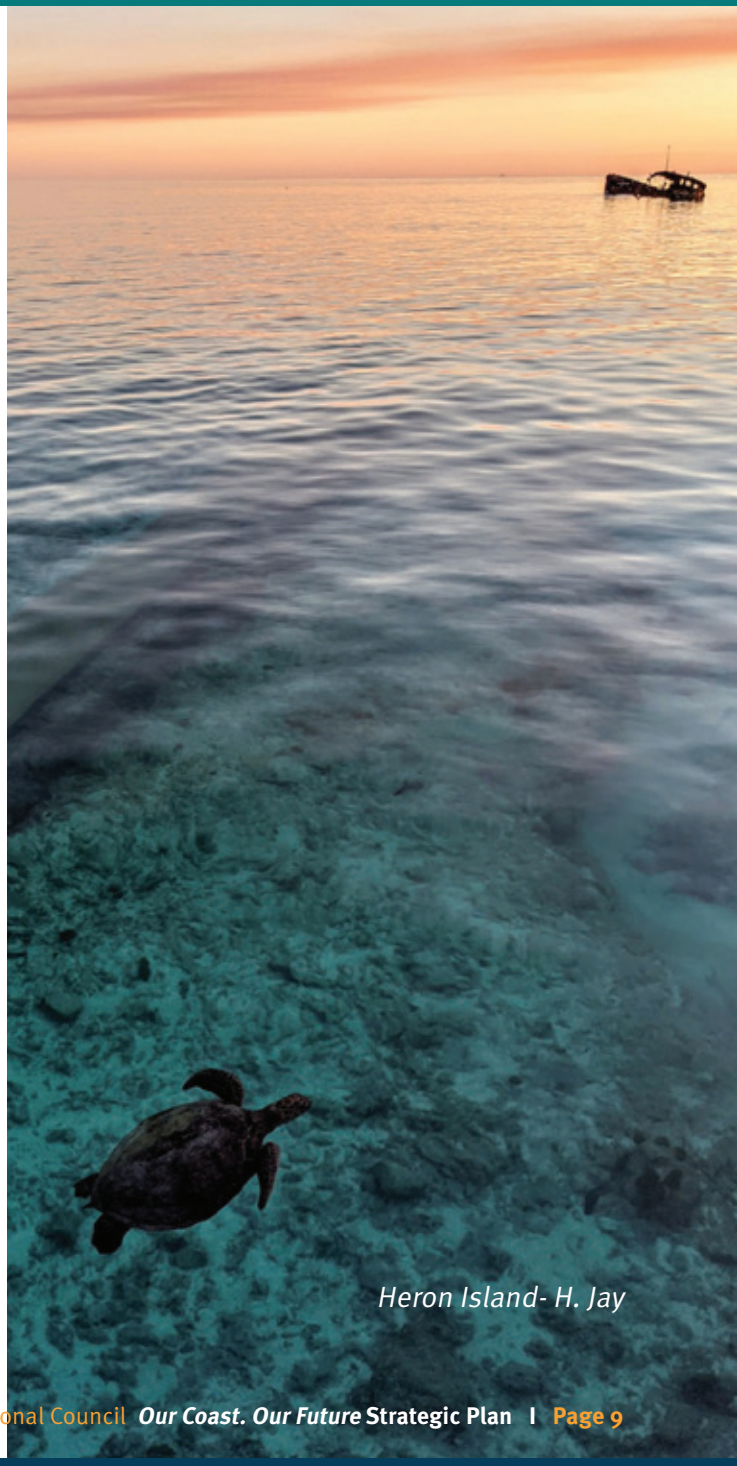
Additional outcomes included:

- A shared understanding of needs and opportunities in the adaptation planning process for the region's coastline; and
- Appreciation of objectives for coastal management, and preferred approaches to adaptation.

1.4 Content of the Strategic Plan

The *Our Coast. Our Future* Strategic Plan includes:

- **Section 2:** An overview of landscape features, values, history, and important elements of a resilient coastline for the Gladstone region.
- **Section 3:** An overview of coastal hazards, including erosion and inundation, areas that may be exposed to coastal hazards, and the implications of exposure including potential economic costs.
- **Section 4:** Gladstone Regional Council's approach to adaptation, including a framework for shared responsibilities, adaptation responses and options.
- **Section 5:** Priority adaptation actions across the region.
- **Section 6:** Locality summaries with tailored adaptation actions for different communities.
- **Section 7:** The approach to implementation, including adaptative management and change management planning.



Heron Island- H. Jay

Tannum Sands and Wild Cattle - Y. Crause

2. GLADSTONE REGION COASTAL ZONE

2.1 Coastal landscape

Values

As the traditional home of the Bailai (Byellee), Gooreng Gooreng, Gurang and Taribelang Bunda people, the Traditional Owners of the Gladstone region have a deep connection with country and continue to have a shared living culture with their environment. The coastal landscape, including freshwaters, tidal and coastal waters, has a high cultural significance for First Nations communities, who value the protection and sustainability of the land and sea (country).

The coastal environment underpins a diversity of environmental, social and cultural values, and supports lifestyle and recreational opportunities unique to the Gladstone region.

Access to the coast is a strong lifestyle value, including boating, camping, and fishing, at beaches, waterways and national park areas.

Well known features of our coastal areas include:

- The Great Barrier Reef Coast Marine Park and Great Barrier Reef World Heritage Area;
- Wetlands of National Importance (DIWA) located in Rodds Bay, Northeast Curtis Island, Port Curtis and The Narrows;
- Ecologically and culturally important turtle nesting and habitat, fish habitat and dugong protection areas; and
- Curtis Island, Facing Island and Wild Cattle Island.

Whale off Curtis Island- B. Sparshott

Key environmental values include:

- **Coastal landforms** – including extensive tidal inlets, estuaries, coastal plains and sandy beaches;
- **Vegetation communities and ecosystems** – including the wetlands, seagrass, mangroves and native dune vegetation; and
- **Significant and endangered species** – including both land and marine environments (e.g. turtles, dugongs, birds and fish).

Wild Cattle Island- B. Sparshott

2. GLADSTONE REGION COASTAL ZONE (Continued)

Community coastal values[3]

Respect and protect Traditional Owner values

Coastal region holds significant value for the traditional custodians.

Protected natural ecosystems

Coastal areas support unique biodiversity, including rare and endangered sea turtles, dugong, migratory shorebirds, and iconic pandanus and casuarina trees.

Access to beaches

Controlled and safe beach access, including Tannum Sands, Agnes Water, Seventeen Seventy, Rules Beach and the island beaches.

Access to the Great Barrier Reef

The region is blessed with open, sandy beaches, National Parks, expansive natural bush, along with the Calliope and Boyne River systems.

Safe places for recreation and exercise

Residents and visitors enjoy camping, 4WD, fishing, boating, as well as walking, cycling and swimming.

Nurture tourism opportunities

National and international visitors are attracted by the GBR, islands, fishing and wide-open beaches.

Economy

The economy of the Gladstone region is underpinned by mining, manufacturing, construction and energy industries. Gladstone Harbour services a number of industries and exports, including coal, bauxite, alumina, aluminium, cement and liquified natural gas (LNG). The region's coastal areas are also fundamental to its identity and economy.

Mining accounts for 23.4% of the total economic value, with oil and gas extraction as the largest contributor to this sector and is estimated to be worth more than $949.7 million annually to the local economy[4]. Other significant sectors are manufacturing, transport, postal and warehousing, and construction (12.9%, 10.1% and 9.1% respectively). These top four sectors account for more than 55% of the local economy.

The natural beauty of the coastal landscape, unique flora and fauna, and access to the coast, including the southern extent of the Great Barrier Reef are an important part of the region's tourism industry, attracting many visitors to the region.

Tourism contributes approximately $77 million annually to the local economy. Direct and indirect employment from the tourism and hospitality sector is estimated at 864 full-time equivalent jobs.

[3] *Our Coast. Our Future* - Values and threats factsheet

[4] National Institute of Economic and Industry Research [NIEIR] (2019). Gladstone Regional Council: economic profile – Value Add by Industry

2.2 Towards a Resilient Coast

Change and resilience

The coastline is a dynamic and picturesque part of the landscape, where the land meets the sea. One of the more challenging aspects of the coastal landscape is that it experiences constant, and often rapid change.

Wind and waves continually work to move sediment and shape the shoreline, and extreme weather events can periodically result in substantial erosion and inundation of coastal land.

A resilient coast has social, economic and environmental systems in place to avoid, manage and mitigate the impact of hazardous events or disturbances (e.g. coastal hazards). Resilience also means the ability to respond or reorganise in ways that maintain the essential function, identity and values of a region, while also being able to proactively adapt to change.

For the Gladstone region, coastal hazard adaptation options have been developed in keeping with the identity and values of our coastal communities.

Our coastal values and experiences – Survey #1

June – August 2020

Around 80 responses were received for the first community survey. The survey helped inform an understanding of key values, awareness of coastal hazards, and past experiences.

Highlights from the survey include:

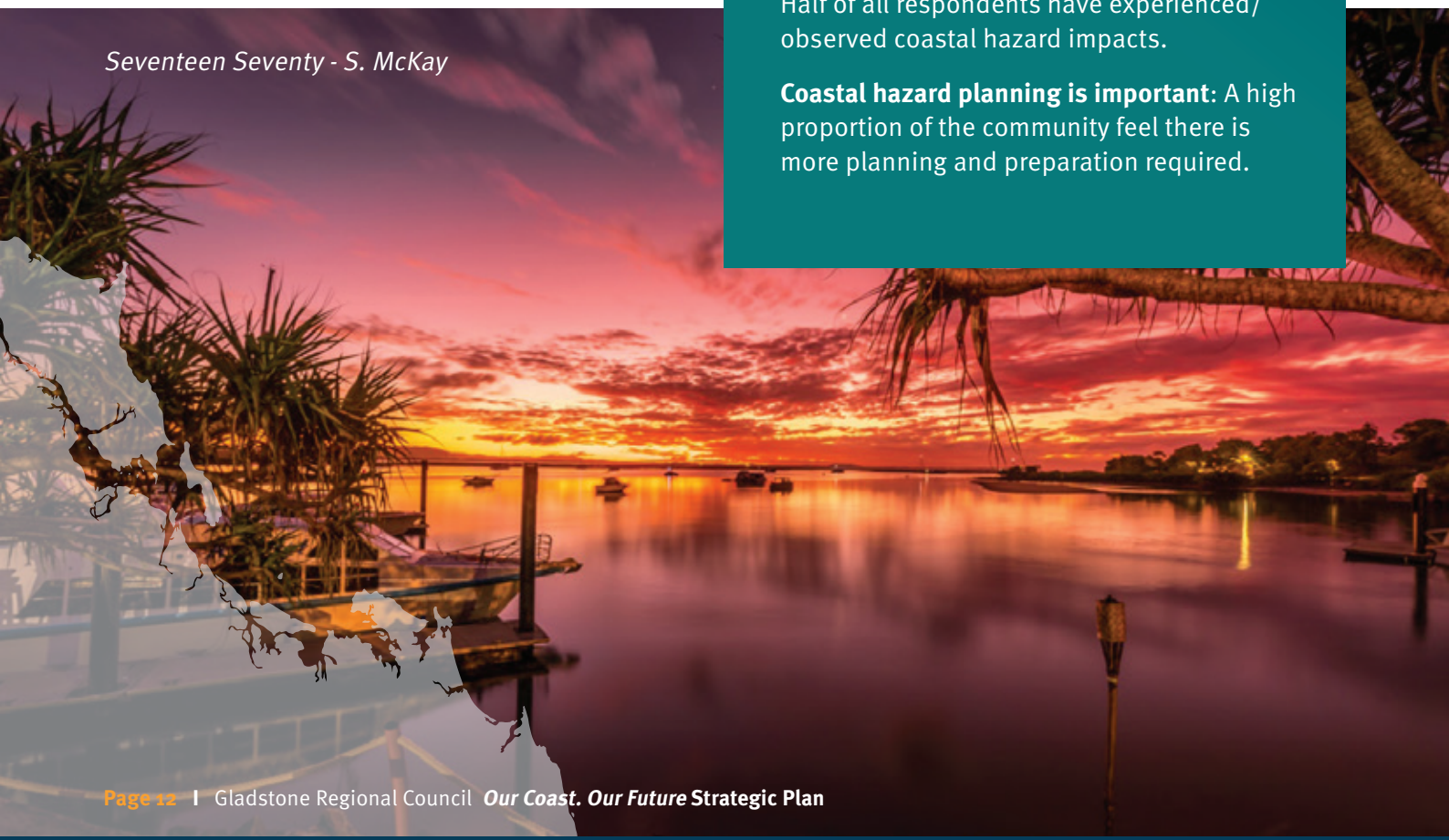
Natural beauty and access are key values:

The natural ecosystem and wildlife was identified by the majority of respondents as the most valued aspect of the coast.

Many also identified access to beaches and recreational opportunities as important and valued aspects of the region's coastal areas.

There is good awareness of coastal hazards: The majority of respondents had good awareness of coastal hazards and potential impacts on the foreshore/low-lying areas. Half of all respondents have experienced/ observed coastal hazard impacts.

Coastal hazard planning is important: A high proportion of the community feel there is more planning and preparation required.



Seventeen Seventy - S. McKay

3.1 Hazards

Coastal hazards include inundation of low-lying coastal land, and / or erosion of the shoreline.

Periodic inundation and erosion are natural processes that contribute to shaping the unique landforms of our coastal zone. However, when these processes have an adverse impact on communities, infrastructure and some natural assets, they are considered coastal hazards. In south-east Queensland, major coastal hazard impacts are typically associated with East Coast Lows and occasional Tropical Cyclones.

3.2 Storm tide inundation

Storm tide inundation is the flooding of low-lying coastal land from a locally elevated sea level (the 'storm tide'). The storm tide is a combination of the predicted tide, storm surge, and wave action (Figure 3). Storm surge is driven by the combined influence of low atmospheric pressure and high winds associated with events such as Tropical Cyclones.

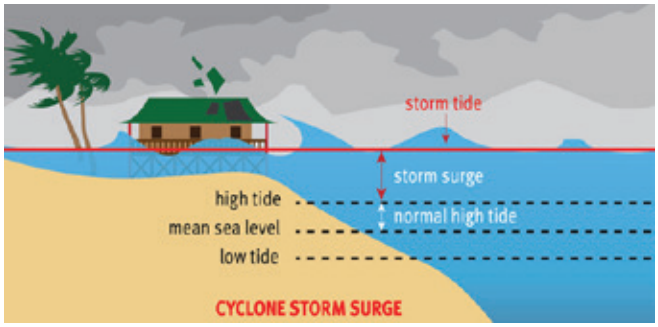


Figure 3. Components of storm tide

3.3 Coastal erosion

Coastlines naturally erode and build up over time, driven by variations in sediment supply (sand movement) and climate patterns.

Short-term erosion

Coastal erosion occurs when winds, waves and coastal currents act to shift sediment away from the shoreline. This can be a short-term shift, often associated with storm activity (termed storm bite), and the beach will then gradually rebuild (Figure 4).

When a beach is stable, all of the sand moved offshore during a storm eventually moves back onto the beach (over timeframes of months to years). In this case periodic beach erosion does not result in a long-term landward movement of the shoreline.

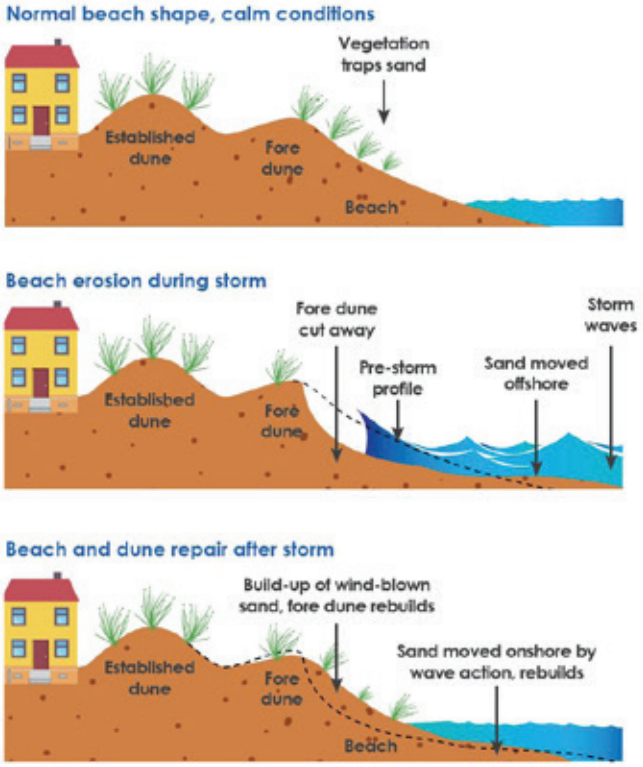


Figure 4. Natural short-term erosion and dune rebuilding process

Long-term erosion

In other cases, due to changing sediment supply or climate conditions, the beach may not have sufficient capacity to rebuild between storm events. In the absence of intervention, long-term erosion (termed recession) may occur, which is the landward movement of the shoreline over a longer timeframe (decades).

Both short-term and long-term erosion processes may impact on coastal assets, depending on how close to the foredune assets are located.

3.4 Tidal inundation due to sea level rise

Tidal inundation is regular or permanent inundation from the tidal cycle, including up to the Highest Astronomical Tide. Areas of low-lying coastal land will be prone to an increased extent of tidal inundation with sea level rise. A 0.8 m sea level rise by 2100 is currently planned for by the Queensland Government.

3.5 Current and future coastal hazard exposure

Updated mapping

The Gladstone region's coast is prone to cyclone and storm events, and coastal hazard impacts are predicted to increase with a changing climate.

State-wide mapping of areas that may be prone to coastal hazards by 2100 - including erosion and storm tide inundation - are already publicly available for the entire Queensland coastline[5].

As part of the *Our Coast. Our Future* program, the existing coastal hazard mapping has been updated for the Gladstone region coastline. This includes predicted storm tide inundation zones and Erosion Prone Areas, with tidal areas across the region and open coast erosion at targeted locations.

These updates have been based on the best available technical data, and have included:

- New modelling of open coast erosion;
- Application of the State Government approach to defining Erosion Prone Areas, tailored to the Gladstone region in consultation with State and LGAQ; and
- A new storm tide study based on previous study outputs and additional modelling. (See storm tide model textbox.)

Based on the state-wide approach to mapping, the Erosion Prone Area includes components of:

- **Open coast erosion:** A calculated component of open coast erosion potential, informed by erosion modelling.
- **Tidal areas:** Areas that may be prone to regular or permanent inundation by the Highest Astronomical Tide. This includes sea level rise and a default area applied by the State Government in certain scenarios.
- **Storm tide areas:** The mapped storm tide inundation area is an area that may be prone to temporary inundation driven by storm events.

Gladstone region coastal zone – new storm tide model

- Model extent covers approximately 400 km of coastline, from Fraser Island to Yeppoon extending 250 km offshore
- Combines tides, water levels, wave conditions and cyclones
- Tide level data, from Bundaberg, South Trees (Gladstone) and Port Alma as well as historic data recorded during tropical cyclone events - Simon (1980), Fran (1992) and Rewa (1993), has been used to help calibrate the model
- Over 5,000 unique cyclone tracks were synthesised for Gladstone region to inform the model
- Results have been extracted from almost 70 locations offshore of the region's coast and used to project inundation areas for a range of storm events.

As required by State Government, a sea level rise of 0.8 m by 2100 has been adopted (with 0.4 m by 2060).

Curtis Island - K. Connor

[5] Refer to Queensland Spatial Catalogue – Qspatial qldspatial.information.qld.gov.au

Table 1. Likelihood of occurrence scenarios

Likelihood of occurrence	Hazard AEP	Planning horizons
Likely	10%	Present-day, 2060, 2100
Possible	1%	Present-day, 2060, 2100
Rare	0.2%	Present-day, 2060, 2100

Planning horizons

Spatial data and maps for both erosion and storm tide inundation hazards include multiple planning horizons and event likelihoods (Table 1).

Relevant maps are provided as Supplement B to the Strategic Plan.

What is Annual Exceedance Probability (AEP)?

The Annual Exceedance Probability is the probability of a storm event occurring in a given year. The defined storm event for Queensland State coastal hazard mapping is a 1% AEP. This means that in any given year there is a 1% chance of that magnitude of event occurring.

FUTURE IMPACTS

Projected sea level rise and an increase in cyclone intensity for the Queensland coastline is anticipated to increase the extent and impact of coastal hazards.

Coastal erosion:

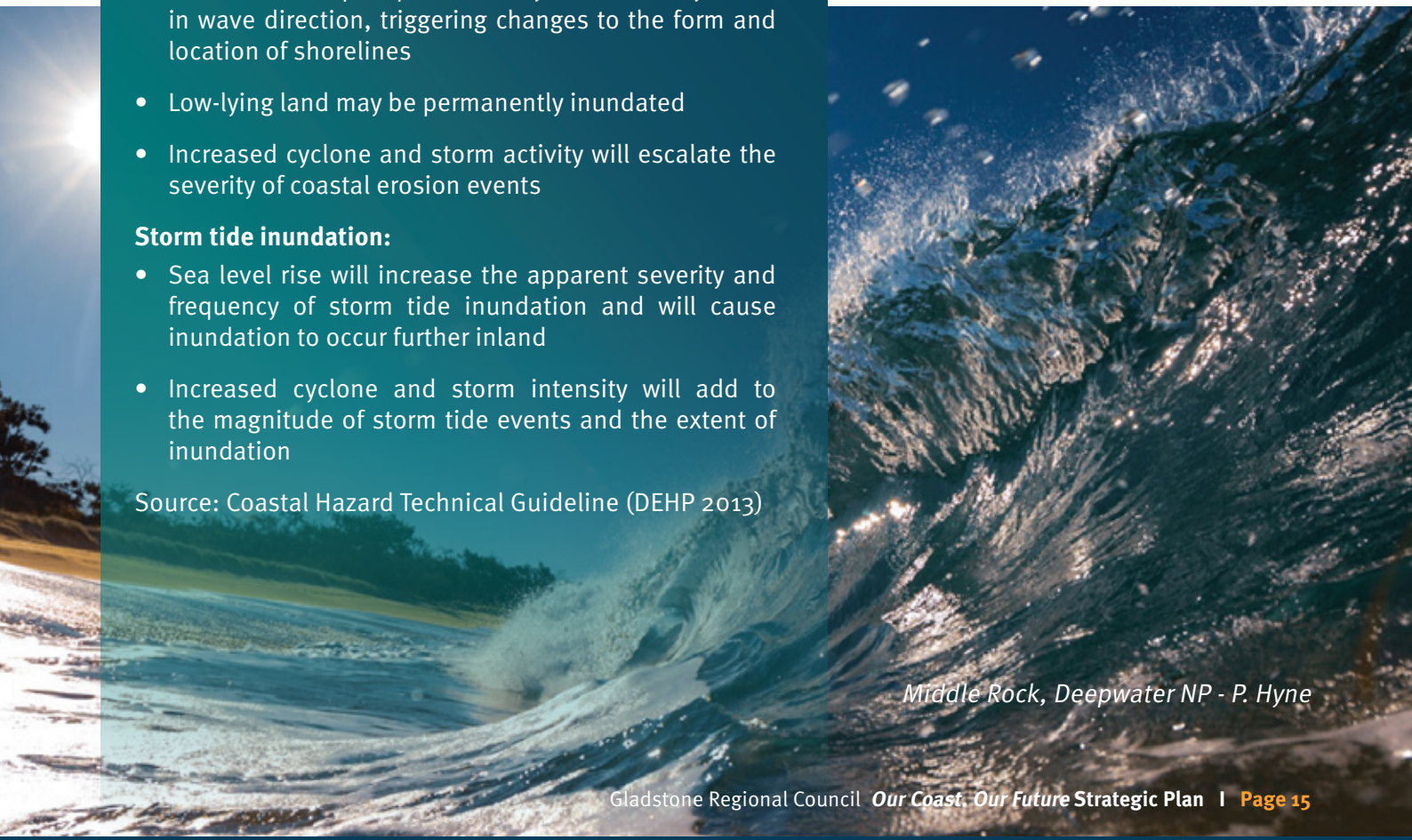
- Increased water levels will accelerate coastal erosion
- Sediment transport patterns may be altered by shifts in wave direction, triggering changes to the form and location of shorelines
- Low-lying land may be permanently inundated
- Increased cyclone and storm activity will escalate the severity of coastal erosion events

Storm tide inundation:

- Sea level rise will increase the apparent severity and frequency of storm tide inundation and will cause inundation to occur further inland
- Increased cyclone and storm intensity will add to the magnitude of storm tide events and the extent of inundation

Source: Coastal Hazard Technical Guideline (DEHP 2013)

Erosion Prone Areas and storm tide inundation zones do not represent a predicted loss of coastal land. Mapped hazard areas provide an indication of areas that may be exposed to erosion or inundation processes (now or in the future), and in many cases the impacts can be avoided, mitigated or managed through adaptation planning.



Middle Rock, Deepwater NP - P. Hyne

3.6 Potential impacts

Approach

Coastal hazards have the potential to have adverse impacts on the Gladstone region's coastal communities, services and lifestyle, in both the present day and by 2100.

As part of the *Our Coast. Our Future* program, new technical assessments have been undertaken to review coastal hazard risk for a range of assets across the region.

The assessment has included analysis of:

- Planning scheme areas and other land use overlays;
- Data on infrastructure assets (drainage, sewerage, electrical, telecommunications, water, roads, marine, beach and foreshore);
- Information collated on buildings (building footprints); and
- Areas of environmental and cultural significance, and other important overlays..

Using spatial data layers for these assets, extensive spatial analysis has been undertaken to assess which assets (or portions of assets) are exposed to the mapped coastal hazard scenarios.

The exposure and risk information is captured spatially for each asset or land parcel. Different asset types and localities can be summarised to inform the Strategic Plan, asset management planning and disaster management.

Exposure

Several planning scheme zones (and associated land use and infrastructure assets) have a notable increase in exposure to coastal hazards from present day to 2100.

These include land zoned for open space and rural zones throughout the region, and for minor tourism at Seventeen Seventy. It also includes the exposure of transport/access (roads and railway) at Turkey Beach and Barney Point, and some small areas of residential zones.

Special industry and special purpose zones also have an increasing likelihood of exposure to storm tide inundation by 2100. Exposure increases from 16% (special industry) and 7 % (special purpose) in present day, to 28 % and 10 % by 2100. These areas are concentrated around Targinnie, Callemondah, Parsons Point and Boyne Island.

Many environmental areas are already within tidal environments. Increasing exposed areas include turtle nesting, mangroves, fish habitat areas, dugong protection areas, high ecological value wetlands, Conservation Park zone and Marine national parks. Significant areas of turtle nesting (62%) and mangroves (almost 100%) are potentially exposed by 2100, while around 29% of both conservation and wetland areas are currently exposed, increasing by another 4% by 2100.

Depending on the specific dynamics of natural processes in the coastal zone, areas such as wetlands and mangroves may be able to migrate and re-establish themselves as sea levels rise, particularly where there is sufficient room for these assets to naturally adapt.

The spatial data and appreciation for coastal hazard exposure across the range of land and asset types provides a key input into the risk assessment process.

Risk

Risk is assessed based on the likelihood of an asset being exposed to a coastal hazard, combined with the consequence of that exposure (Table 2). Risk tolerance categories and the required level of action to manage this risk are also defined (Table 3).

A tailored approach to assessing consequence was developed, based on Gladstone Regional Council's risk management framework and targeted to important elements for the coastal zone (financial, reputation, environment, regulatory and legal, service delivery, health safety and wellbeing, and Traditional Owner values) (Table 4).

		Consequence				
		Negligible	**Minor**	**Moderate**	**Major**	**Extreme**
Likelihood	**Almost certain (HAT)**	Medium	Medium	High	Extreme	Extreme
	Likely 10% AEP	Medium	Medium	High	High	Extreme
	Possible 1% AEP	Low	Medium	Medium	High	High
	Unlikely 0.2% AEP	Low	Low	Medium	Medium	High

Table 2. Risk matrix

The risk tolerance (Table 3) and consequence (Table 4) categories were informed by:

- The Coastal Hazard Adaptation Strategy guidelines;[7]
- Similar assessments for adaptation planning around Australia;
- Key elements of the shared stakeholder values and vision for a resilient coast developed during the engagement activities; and
- Gladstone Regional Council's Risk Management Policy and Risk Management Framework Corporate Standard[8] and consultation with Council.

To complete the risk assessment:

- The likelihood of exposure (likely, possible, unlikely) was determined for each asset / land parcel, separately for erosion and inundation;
- The consequence of exposure (negligible, minor, moderate, major, extreme) was determined for each asset / land parcel, separately for erosion and inundation; and
- Coastal hazard risk was assessed (low, medium, high, extreme), based on the likelihood and consequence for each asset / land parcel, separately for erosion and inundation.

Risk	Action required	Risk tolerance
Extreme	Immediate and/or ongoing action is needed to eliminate or reduce risk to acceptable levels	**Extreme risk:** a risk that, following an understanding of the likelihood and consequences, is so high that it requires actions to avoid or reduce the risk.
High	Short-term action is needed to eliminate or reduce risk to acceptable levels	**Medium to high risk:** a risk that, following an understanding of the likelihood and consequences, is low enough to allow the exposure to continue, and at the same time high enough to require new treatments or actions to reduce the risk. Society can live with this risk but believe that as much as is reasonably practical should be done to reduce the risks further.
Medium	Short to longer term action (treatment) is needed to eliminate or reduce risk to acceptable levels	
Low	Manage the risk as part of current operations, provide for periodic maintenance.	**Low risk:** a risk that, following an understanding of the likelihood and consequences, is sufficiently low to require no new treatments or actions to reduce the risk further. Individuals and society can live with this risk without feeling the necessity to reduce the risks any further.

Table 3. Tailored risk tolerance categories

[7] Refer to Minimum Standards and Guidelines (LGAQ & DEHP, 2016)

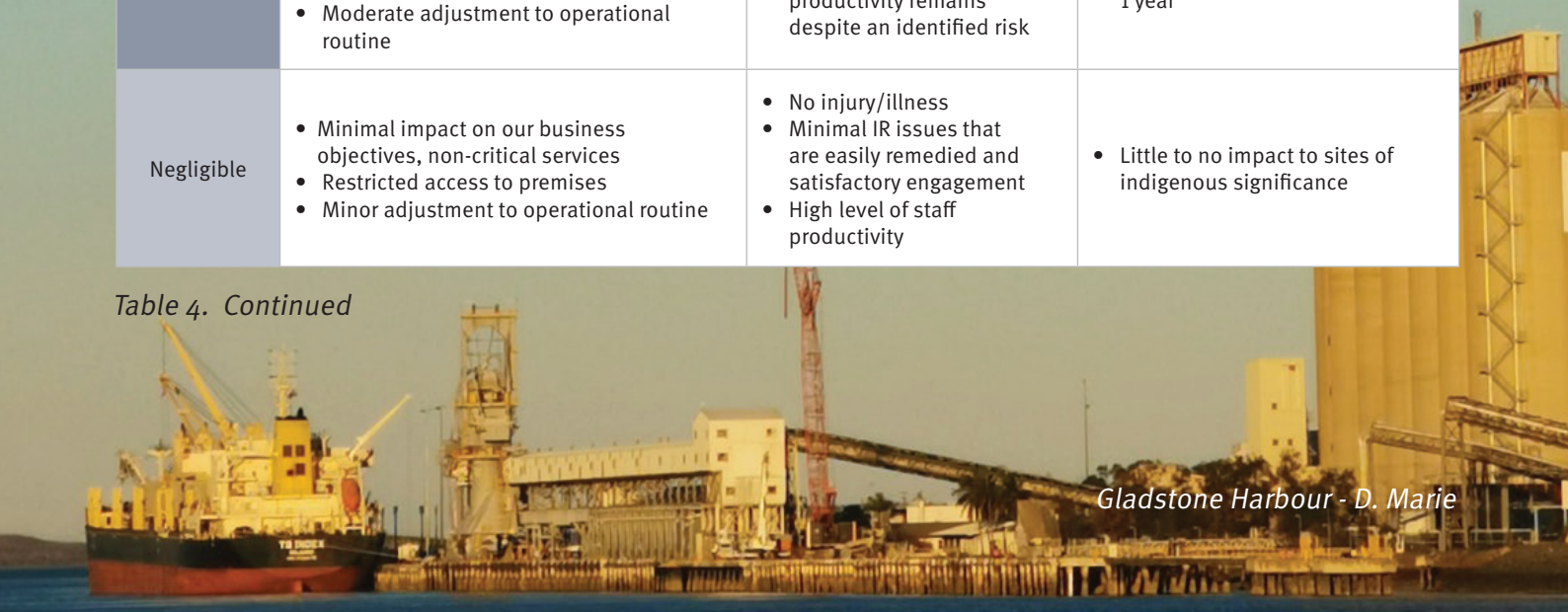
[8] Gladstone Regional Council's management framework (GRC 2020)

Consequence	Financial	Reputation	Environment	Regulatory and Legal
Extreme	›$8,200,000 ›10% of Net General Rates	• Prolonged adverse media attention. Staff and elected members forced to resign • One or more major industries (e.g. tourism, agriculture, construction, education, retail, fishing) within the Gladstone region interrupted or impacted	• Detrimental long-term impact, permanent loss of habitat or value, regionally or nationally significant ecosystem services and natural features of the region • Damage irreversible	• Regulatory breach, individual • Councillors/Management held personally liable • Loss of ability to deliver a critical service • Adverse outcome from a public or parliamentary enquiry • Revoke of licence/court proceedings • Major breach of legislation resulting in major corporation penalties/fines, CCC investigation that may result in legal action against staff, or class action
Major	$820,000 to ‹$8,200,000 2.5% to 10% of Net General Rates	• Significant State and National media coverage with some effect on Council's reputation • Moderate industry or community interruption or impact • Significant, substantiated complaints from the management of a broader group of stakeholders and community petitions	• Partial loss of habitat or value, one or more regionally or nationally significant ecosystem services and natural features of the region • Remediation/recovery possible. • Remediation achieved over long term (1 year +)	• Multiple breaches • Public and/or parliamentary enquiry • Penalty issued/sanctions imposed • Civil claim likely to be awarded against Council • Deliberate breach or gross negligence/formal investigation from a third party (CCC)
Moderate	$500,000 to ‹$820,000 1% to 2.5% of Net General Rates	• Negative Regional and State media coverage with minimal consequence • Businesses or community groups within the Gladstone region are put at risk or impacted • Substantiated complaints from key stakeholders and community groups	• Measurable/confirmed impact to habitat or value, one or more locally significant ecosystem services and natural features of the region • Remediation/recovery likely. • Remediation achieved over medium term (1 month - 1 year)	• Regulatory breach, penalty incurred • Formal notice • Civil claim received against Council • Council directed to undertake specific activities to remedy breaches in legislation that may require the involvement of legal firms
Minor	$205,000 to ‹$500,000 0.25% to 1% of Net General Rates	• Council is referenced in adverse, limited, media coverage • Inconvenience to a group of businesses or community groups within the Gladstone region • Substantiated complaints from the community	• Observed/expected impact to habitat or value, on isolated ecosystem services and natural features of the region. • Remediation/recovery certain. Remediation achieved over short term (1 week – 1 month)	• Minor regulatory breach, penalty may be incurred • Warning letter issued • Dispute resolved through legal advice
Negligible	‹$205,000 0.25% of Net General Rates	• Council is referenced in isolated comments in the media • None to minimal impact or inconvenience to single business or community group within the Gladstone region • Isolated, substantiated complaints from the community	• No harm to environment • Remediation immediate	• Oversight on reporting activity that is under control

Table 4. Consequence categories (modified after LGAQ and DEHP 2016) and Gladstone Regional Council's Risk management framework (GRC 2020)

Consequence	Service delivery	Health, Safety & Wellbeing	Traditional Owner values
Extreme	• Failure of critical business operations for an extended period • Strategic objectives unable to be delivered • Unable to access business premises for an extended period • Entire community affected for a short period • Complete failure of critical service delivery • Widespread, long-term loss of substantial key asset(s)	• Loss of life • Organisation wide poor internal culture hampering innovation and achievement • High staff turnover and ongoing loss of valued employees	• Severe and widespread, permanent impact on multiple sites of indigenous significance, including loss of land, connection to land, and ability to continue traditional practices • Recovery unlikely
Major	• Failure of a critical business operation for a period • Unable to access premises • High proportion of the local community affected for a short period • Significant impact on our operational objectives • Partial failure of several critical services • Widespread, short term to medium term loss of key assets(s)	• Permanent loss of function or disability • Poor internal culture within various departments hampering innovation and achievement • High level of reduced productivity due to IR issues and disengaged organisation	• Severe and widespread semi-permanent impact on one or more sites of indigenous significance, including loss of land, connection to land, and ability to continue traditional practices. • Partial recovery may take many years.
Moderate	• Business interruption to whole of business operations for a limited time • Access to premises restricted for several days • Extended impact on operational objectives • Isolated failure of several critical services within a contained area impacting limited population • Short to medium term loss of key asset(s)	• Lost time injury involving temporary loss of function or notifiable incident • Elements of poor HR culture • Reduced long-term productivity due to IR issues and poor organisational engagement	• Substantial impact on one or more sites of local indigenous significance • Full recovery may take several years
Minor	• Interruption to one business process or the limited short-term impact on our business objectives • Limited access to our premises for one day • Limited interruption to critical service delivery to a contained proportion of the population • Moderate adjustment to operational routine	• First aid or medical treatment required • Some IR issues within Council and low organisational engagement • Appropriate level of productivity remains despite an identified risk	• Small, contained and reversible short-term impact on sites of indigenous significance • Full recovery may take less than 1 year
Negligible	• Minimal impact on our business objectives, non-critical services • Restricted access to premises • Minor adjustment to operational routine	• No injury/illness • Minimal IR issues that are easily remedied and satisfactory engagement • High level of staff productivity	• Little to no impact to sites of indigenous significance

Table 4. Continued



Gladstone Harbour - D. Marie

Boyne Valley - B. Wardell

3. COASTAL HAZARDS (Continued)

Assets at risk

Outputs from the risk analysis were mapped for all localities across the region, to review the distribution of assets / land at risk from coastal hazards. At-risk assets are inclusive of any assets with a medium to extreme risk of adverse impacts from coastal hazards[9].

Risk is largely associated with storm tide inundation and increasing tidal area hazards. Potential open coast erosion risk is limited to localised areas.

[9] Relative to all assets in the coastal zone

Planning scheme zones

A range of planning scheme zones within the region's coastal areas have residential and tourism dwellings and facilities, including character residential, community facilities and emerging communities, low and medium density residential, township, tourism and rural zones. At present day, less than 5 % of these areas have medium to high risk from coastal hazards, with generally only a small increase (up to an additional 5 %) by 2100. Of these zones, character residential areas had the most notable risk increase, up to 11 % by 2100. (Table 5)

Areas with limited development, open space, and minor tourism have more notable coastal hazard risk at the present day (20 – 25 % of these areas), with some increase in risk by 2100 (30 – 50 %).

Round Hill Head - N. Dillon

	Erosion processes (EPA – all components)			Storm tide inundation		
% of area at risk Planning Scheme Zones	**Present day**	**2060**	**2100**	**Present day**	**2060**	**2100**
Centre (level 1 Zone)	-	-	-	0.6	2.9	5.7
Character residential	0.24	0.8	11.2	<0.01	<0.01	<0.01
Community facilities	3.3	5.6	8.0	3.3	4.2	5.3
Conservation	4.9	5.8	8.9	5.6	6.4	7.3
Emerging communities	1.4	2.1	2.8	0.6	1.8	2.3
Environmental management	1.8	2.7	4.8	2.9	3.5	4.3
Industry investigation area	0.7	1.2	2.1	1.7	3.5	5.4
Limited development (constrained land)	24.1	26.2	32.1	25.8	27.0	28.5
Low density residential	-	0.1	1.4	0.2	0.3	0.7
Low impact industry	0.2	0.6	3.1	2.8	17.5	21.7
Low-medium density residential	1.2	2.2	6.5	0.9	1.3	2.7
Major tourism	1.9	2.8	4.0	2.1	2.6	3.1
Medium density residential	0.2	1.0	2.7	0.8	2.2	4.5
Medium impact industry	5.1	8.7	13.0	6.7	9.8	11.1
Minor tourism	19.1	28.9	53.1	17.9	20.1	21.6
Mixed use	1.8	3.1	7.9	3.6	3.8	6.1
Neighbourhood centre	3.4	4.1	4.2	2.6	4.0	4.2
Not zoned	100	100	100	100	100	100
Open space	19.3	22.9	31.6	23.3	26.4	28.4
Principal centre	-	-	1.7	1.5	2.7	4.3
Rural	2.7	3.0	3.5	3.0	3.2	3.5
Rural residential	0.5	0.9	1.4	0.6	1.0	1.4
Special industry	8.3	12.8	26.2	16.0	23.1	27.6
Special purpose	4.8	5.7	7.5	6.7	8.6	9.6
Specialised centre	-	-	-	-	0.1	0.9
Sport and recreation	4.5	5.8	7.2	4.9	7.0	8.1
Township	0.4	1.2	3.7	1.4	3.1	4.2
Unknown	-	17.3	51.6	-	48.6	79.2

Table 5. Areas of planning scheme zones at risk (medium to extreme)

Port and industrial areas at risk

Port and industrial based sectors (mining, manufacturing, and construction) are a very significant part of the Gladstone region, contributing approximately 55 % of value added to the economy.

Special industry and special purpose planning scheme zones provide an indication of some port and industrial land use areas.

Port and industrial land, and associated infrastructure and facilities are within increasing coastal hazard extents, and may be impacted by increasing tidal and storm tide inundation. It is likely that many of the assets within these areas are robust, especially major assets (e.g. terminals).

Coastal hazard also present potential risks to port and industry operations through:

- disruption to processes and logistics
- disruption to access and movement
- changes to asset management and maintenance.

Gladstone Harbour

Boyne Island

Buildings and infrastructure

Around 350 buildings within the region are at risk from coastal hazards at the present day, mainly situated in inundation prone areas. By 2100, this may increase to 3,500 buildings across residential, commercial and industrial zones.

Various infrastructure assets may also be at risk. Approximately 5 % of roads and less than 1 % of railways are currently at risk from coastal hazards, increasing to approximately 9 % and 5 % (respectively) by 2100 (Table 6).

At-risk utilities include sewer network and water supply network, with effluent mains increasing from 8 % currently at risk to 25 % by 2100, and treated water pipelines increasing from 9 % currently at risk to 11 % by 2100.

Tannum Sands-B. Smart

3. COASTAL HAZARDS (Continued)

	Erosion processes (EPA – all components)			Storm tide inundation		
% transport assets at risk from coastal hazards	**Present day**	**2060**	**2100**	**Present day**	**2060**	**2100**
Cycle path	3.8	8.3	10.6	1.9	3.0	4.6
Railway	0.3	0.8	1.2	0.4	3.7	5.4
Railway siding	0.2	1.3	3.0	4.4	14	14.8
Footpath	2.7	6.3	9.2	0.7	1.8	4.2
4WD and tracks	2.9	4.2	7.2	2.7	3.7	4.8
Bikeways/walkways	11.7	14.1	16.0	9.0	11.4	12.6
Highways	0.3	1.2	1.5	0.3	1.0	1.3
Local connector roads	0.4	1.1	2.2	0.1	0.5	1.3
Private or restricted roads	1.4	2.9	3.8	1.0	1.7	2.4
Secondary roads	1.3	2.9	3.7	0.8	2.2	2.8
Street/local roads	0.8	1.6	2.5	0.8	1.6	2.4
Unconstructed and/or dedicated	4.9	7.1	8.6	3.7	4.8	5.7
Road bridge	38.2	42.9	46.0	39.4	43.3	44.5
Road overpass	-	-	-	-	9.3	17.6

Table 6. Transport assets at risk (medium to extreme)

Wild Cattle Creek - B. Sparshott

Reporting regions

Our understanding of coastal hazard risk for assets, planning zones, and land use across the region, provides a basis to begin targeting our adaptation response and actions.

For the purposes of the Strategic Plan, the Gladstone region has been divided into eight reporting regions (Table 7, Figure 5), with key coastal localities within each region. Adaptation effort, response and actions in the Strategic Plan are tailored to the location specific needs.

Reporting regions	Key localities	Implications for adaptation
Reporting region 1	Mount Larcom	- Small settlements with some industrial infrastructure - Adaptation actions associated with mitigating inundation risk and access disruptions
Reporting region 2	Curtis Island	- Small coastal settlements with industrial infrastructure and significant environmental value - Adaptation actions associated with mitigating inundation and erosion risk
	Facing Island	- Small coastal settlements with significant environmental value - Adaptation actions associated with mitigating inundation and erosion risk
Reporting region 3	Gladstone City	- Large coastal settlement with significant industrial infrastructure and residential areas - Low open coast erosion risk - Some adaptation already in place (sea wall) - Adaptation actions associated with mitigating inundation risk
	Barney Point	- Significant industrial infrastructure and some residential areas - Low open coast erosion risk - Adaptation actions associated with mitigating inundation risk
Reporting region 4	Boyne Island	- Large coastal settlement with industrial infrastructure - Limited inundation prone areas - Open coast erosion risk to areas near Boyne River mouth - Adaptation actions associated with mitigating inundation and erosion risk and access disruptions
	Tannum Sands	- Large coastal settlement - Limited inundation prone areas - Localised open coast erosion risk to erodible areas - Canoe Point, Tannum Sands Beach - Adaptation actions associated with mitigating future inundation and erosion risk and access disruptions
Reporting region 4	Wild Cattle Island	- Small coastal settlements and protected areas - Adaptation actions associated with mitigating open coast erosion and inundation risk
	Hummock Hill Island	- Some land allocated to proposed future development - Limited inundation prone areas - Adaptation actions associated with forward planning for future inundation and erosion risk

Table 7. Reporting regions and adaptation needs

Reporting region 5	Turkey Beach	- Small coastal settlement - Already experiencing inundation and associated erosion - Adaptation actions associated with adapting to inundation and erosion hazards and access disruptions
Reporting region 6	Seventeen Seventy	- Coastal settlement with significant tourism value - Already experiencing erosion - Adaptation actions associated with adapting to erosion hazards and small areas of inundation disrupting access
	Agnes Water	- Coastal settlement with significant tourism value - Already experiencing open coast erosion - Adaptation actions associated with mitigating open coast erosion risk
Reporting region 7	Rules Beach	- Small coastal settlement with recreational value - Adaptation actions associated with mitigating open coast erosion and inundation risk - Already experiencing open coast erosion
	Baffle Creek	- Small settlement - Adaptation actions associated with mitigating inundation risk
Reporting region 8	Heron Island	- Offshore islands with significant environmental, cultural and tourism values - Adaptation actions associated with forward planning for inundation risk
	One Tree Island	
	Lady Elliott Island	

Table 7. Continued.

Figure 5. Reporting regions for the Strategic Plan

Economic costs (base case)

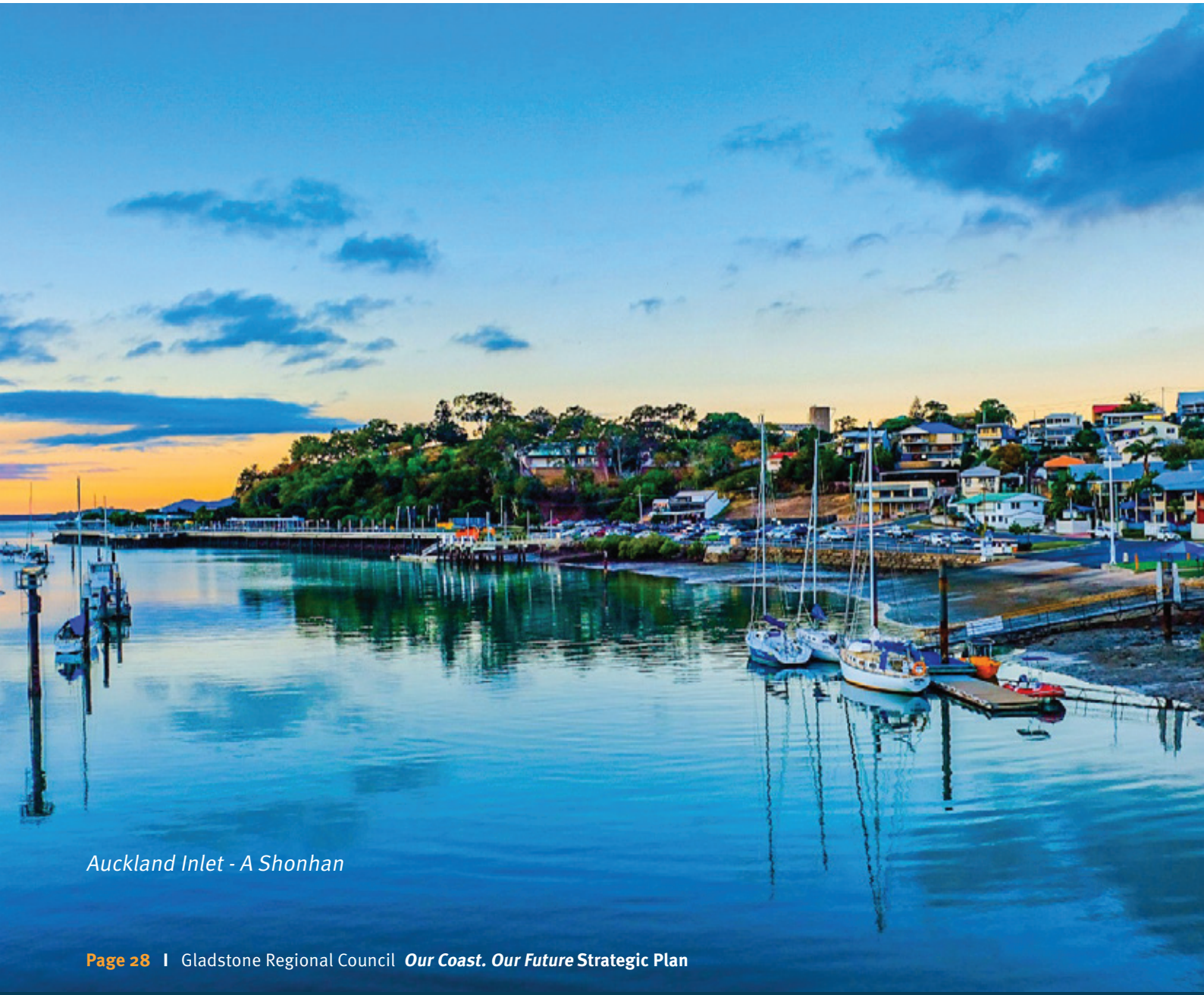
In the absence of intervention / adaptation, there are economic costs associated with coastal hazards.

Economic analysis is important for determining the best approach to coastal hazard adaptation for different localities. Economics is used in several ways including to:

- Value assets and key industries
- Define a base case (cost of no action)
- Assess adaptation options.

After assigning monetary values to key infrastructure and natural assets, the foundational step of an economic assessment in coastal hazard adaptation is to define a base case (Figure 6). This means determining the potential economic costs or losses associated with coastal hazards (and no additional adaptation/ intervention, i.e. business as usual). This becomes the baseline for a cost-benefit assessment of implementing adaptation options.

The base case for the Gladstone region has been determined by examining the likelihood and consequence ($ damage) of coastal hazard impacts on assets, and at different timeframes (e.g. present day, 2060 and 2100).



Auckland Inlet - A Shonhan

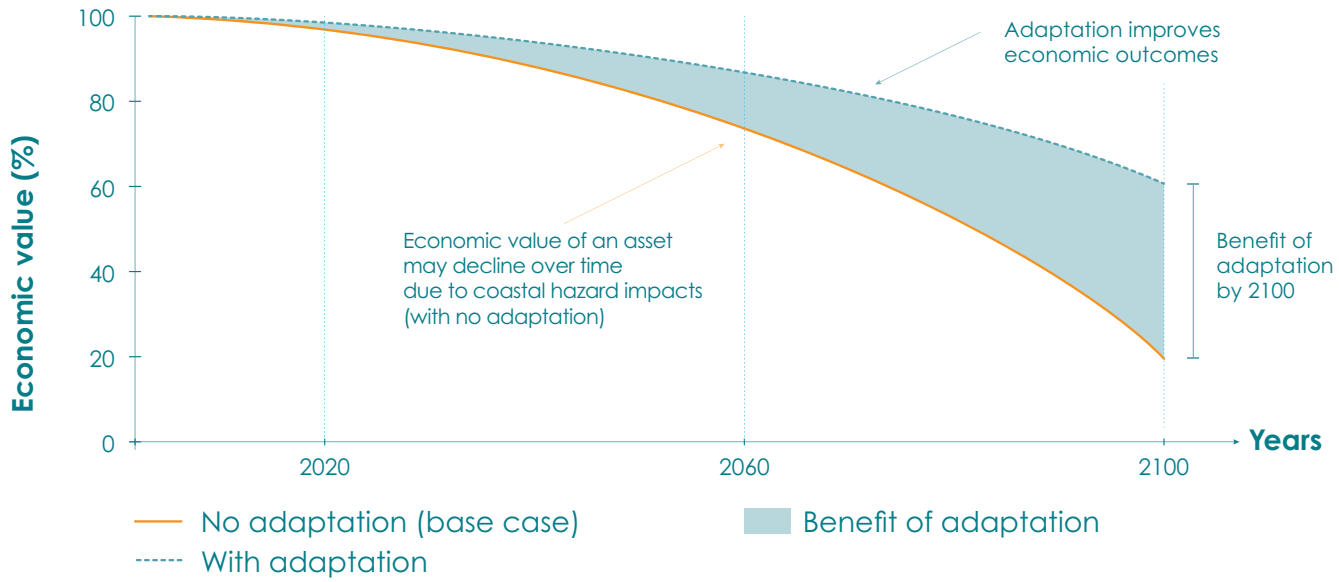


Figure 6. Economic base case and benefit of adaptation

Five key components of damages / losses have been considered for the base case:

1. **Damage to buildings and facilities** – Public and private buildings, and facilities such as car parks and park furniture, among others. This is the financial cost of repairing or replacing these assets.
2. **Damage to other infrastructure and facilities** – Such as electricity, sewerage, drainage, and water supply infrastructure.
3. **Damage to transport infrastructure** – Including roads, pathways, and bridges. This is the financial cost of repairing or replacing the aforementioned assets and can also trigger other economic losses where access to key sites is lost.
4. **Damage to beach and foreshore assets** – Including a variety of access tracks and walking trails.
5. **Loss of land, environmental and cultural assets** – Including natural assets such as wetlands, national park, and habitats for threatened species along with productive agricultural land. This is the lost value from a reduction of these assets.

For the Gladstone region, the present day average annual damages (AAD) associated with combined coastal hazard impacts on built assets is estimated to be in the order of $20 million (Figure 7).

In the absence of adaptation, this may increase up to $49 million (AAD) by 2060 and over $83 million (AAD) by 2100.

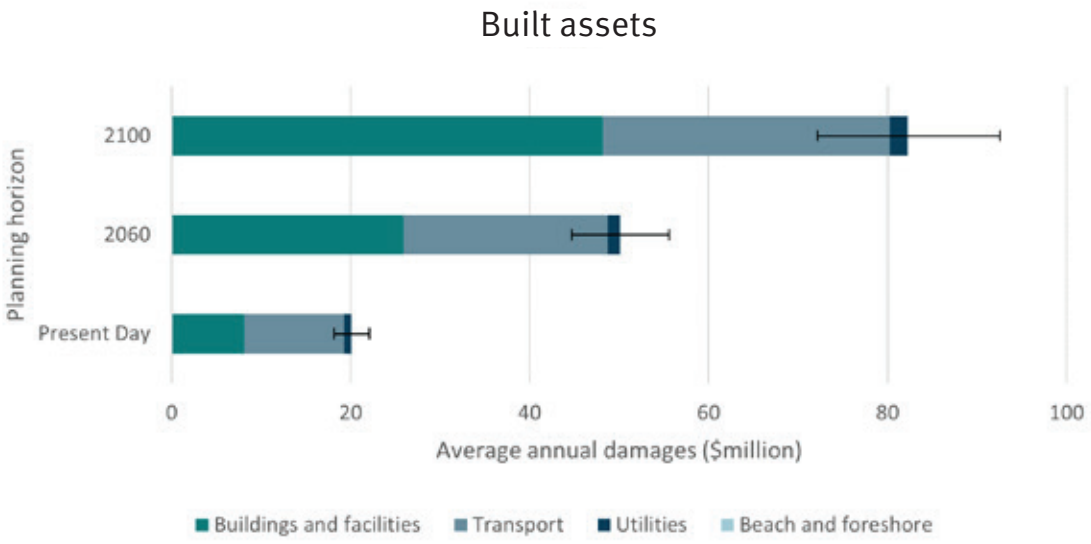
The predicted increase in tidal area linked to sea level rise is the main driver of the increase in potential damages over time. The majority of damages are linked to private dwellings, industrial and commercial buildings, and transport infrastructure.

Strategic adaptation can assist to avoid, mitigate and manage the impacts and potential economic damage associated with coastal hazards.

Implementing the adaptation approach and actions in the *Our Coast. Our Future* Strategic Plan will contribute to avoiding potential economic costs to the region of up to:

- Present day: $20 million dollars per annum
- By 2060: $49 million dollars per annum
- By 2100: $83 million dollars per annum

For built and natural assets, average annual damages (AAD) have been presented by asset type (Figure 7) and by hazard type (Figure 8).



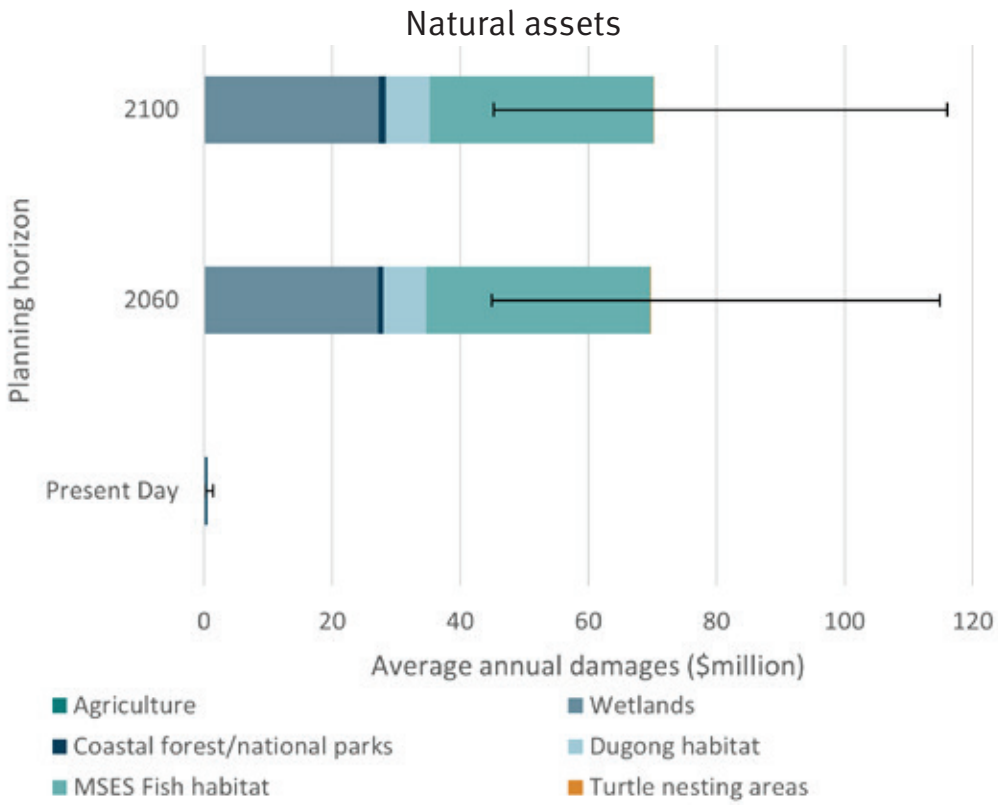


Figure 7. Potential average annual damages from coastal hazards for built and natural assets (base case), by asset type

Bustard Head Lighthouse - A. Kruger

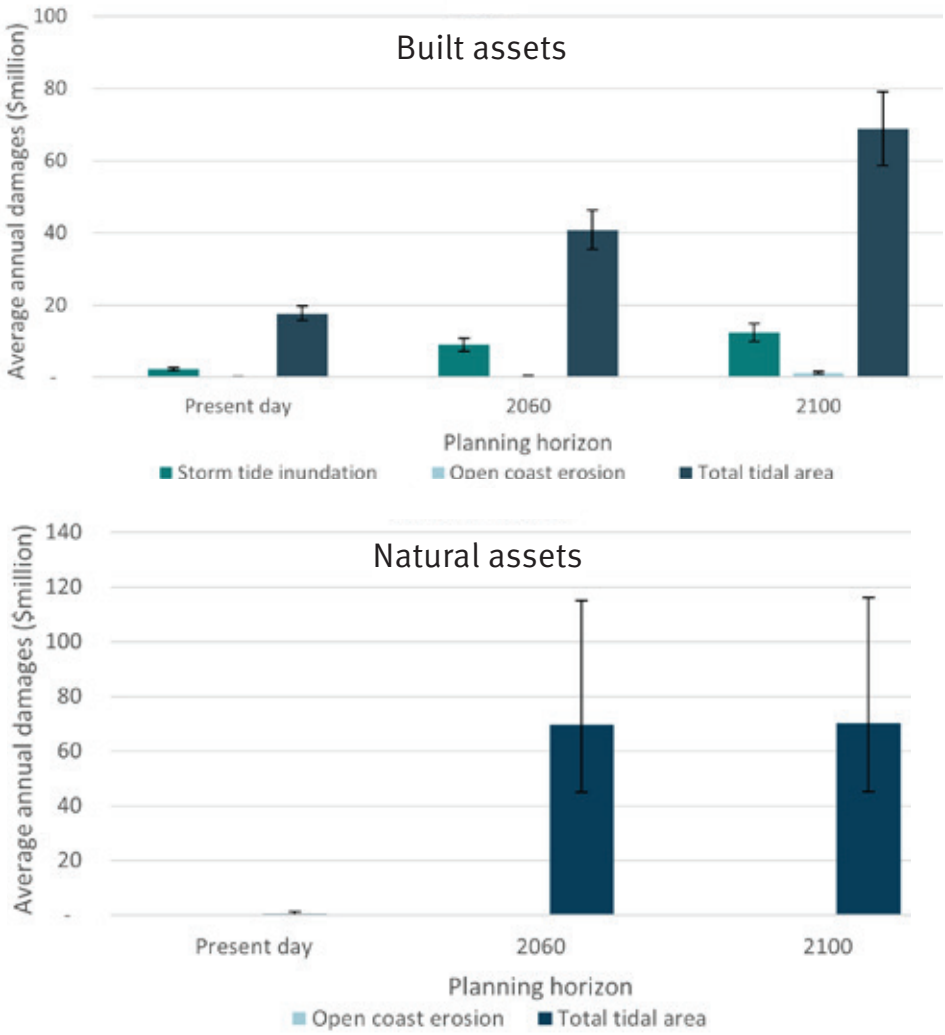
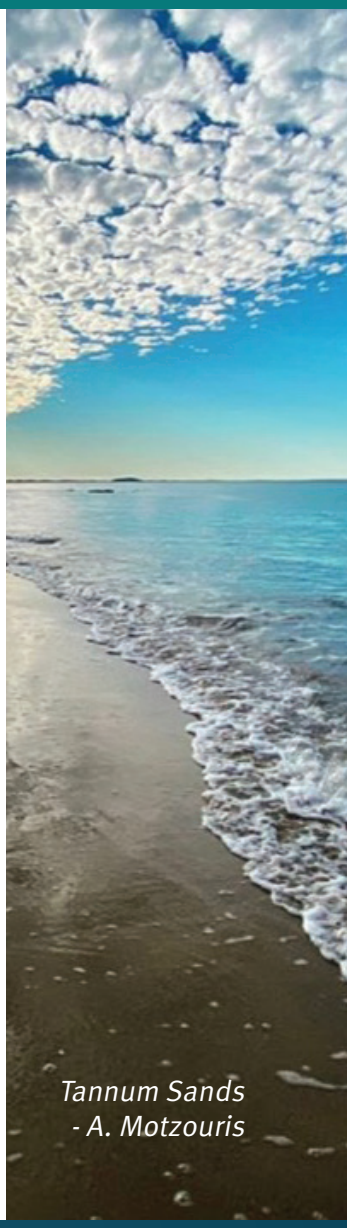


Figure 8. Potential average annual damages from coastal hazards for built and natural assets (base case), by hazard type.



Tannum Sands - A. Motzouris

Additional economic impacts on ports and industry

Additional economic impacts from coastal hazards for ports and industry may include:

- **Shipping displacement** - diversions of commodities to alternate ports, additional transport costs, associated loss of revenue
- **Access and movement** - restricted access for staffing and resources
- **Asset management and maintenance** - increase in assets deterioration and damage due to coastal hazard, changes to harbour sedimentation and dredging operations
- **Flow on impacts** – decline in port and industry revenue will flow through to spending and behaviour in the local economy.

Economic impacts on natural assets

Coastal hazard impacts for natural assets may include:

- Loss of wetland services
- Deepening of seagrass habitat, potentially restricting habitat range
- Erosion and inundation of turtle beach areas
- Loss of fish habitat impacting recreational values
- Loss of tourism value through loss of natural assets

The present day AAD associated with coastal hazard impacts on natural assets is estimated to be in the order of $0.6 million annually. In the absence of adaptation, this is likely to increase up to $70 million by 2100.

4. APPROACH TO ADAPTATION

4.1 Framework

Council's role

Gladstone Regional Council recognise a shared responsibility for the management of coastal hazard risk; shared by Council, other land managers, our Traditional Owners and private landowners. Council's primary responsibilities are the maintenance and protection of Council land and assets, and to inform statutory planning.

Council's role in adaptation varies depending on the type and ownership of different assets. Council's role includes to:

- **Make available** – Council will make available to all stakeholders (including public and private land and asset owners, and Traditional Owners) mapping on coastal hazard risk, to enable public and private land/asset holders to complete their own due diligence.
- **Observe** – Council will actively observe / monitor coastal hazard risk for Council owned land and assets.
- **Plan** – Council will develop strategic planning measures to mitigate the risk of coastal hazard impacts on Council owned land and assets, and to inform appropriate land use planning across the region.
- **Act** – Council will implement the strategic planning measures identified within this Strategic Plan to mitigate the risk of coastal hazard impacts on Council owned land and assets, and to inform appropriate land use planning across the region.

Initiatives in the Strategic Plan also seek to foster and enable other stakeholders to proactively manage coastal hazard impacts on their own assets in accord with the Strategic Plan and in consultation with Council.

A strategic approach

Across Australia and internationally, coastal land managers are taking a strategic approach to managing the risk of coastal hazards and enhancing the resilience of our coastal zones.

Common elements of this strategic approach include:

- Assigning a strategic adaptation response to different localities, to guide decision making with a pathways approach across present day, intermediate and 2100 planning horizons;
- Assessing the range of adaptation options suitable in different locations to help avoid, mitigate, and manage the risk of coastal hazards; and
- Developing a strategic plan for coastal adaptation, with prioritised actions over a 5—10 year timeframe.

A tailored approach has been developed to guide decision making on adaptation response and options across the Gladstone region coastal zone.

		Land or asset type		
		Council owned	Managed by other authorities	Privately owned
Council's role	Make Available	✓	✓	✓
	Observe	✓	✗	✗
	Plan	✓	✗	✗
	Act	✓	✗	✗

Table 8. Council's role in coastal hazard adaptation

Lady Musgrave Island- S. McKay

Adaptation objectives

The purpose of clarifying adaption objectives is to help guide an appropriate adaptation response, and to screen adaptation options, across different localities.

Objectives for the Gladstone region's coast, as informed by consultation with stakeholders, Traditional Owners and the community, include to:

- Retain the natural beauty of the coast
- Limit adverse impacts on scenic amenity
- Protect important ecosystems
- Protect freshwater and tidal waterways and wetland habitats that support our special and diverse wildlife such as turtles, dugongs and migratory shorebirds
- Maintain access to the region (including 4WD beach access)
- Minimise potential impacts on tourism
- Protect significant, protected and sensitive areas (environment and biodiversity)
- Retain sandy beaches
- Maintain access to beaches and assets
- Limit impact on assets and infrastructure (including new developments) within the hazard zone.
- Collaborate with Traditional Owners regarding the management of natural resources
- Continue connection and access to places of spiritual and cultural significance for the Gooreng Gooreng, Gurang, Bailai (Byellee) and Taribelang Bunda peoples.

These objectives provide a reference for considering the suitability of different coastal hazard adaptation options across the Gladstone region.

Adaptation response

The tailored framework includes four adaptation responses – Avoid, Monitor, Mitigate, and Transition (Table 9).

Avoid

The general first principle is to avoid placing new development or assets in coastal hazard areas. The preference is to ensure land use in coastal hazard areas is one that is low risk for coastal hazard impacts, while also being a use that maximises economic, social, and environmental value to region.

Any new development / infrastructure that is placed in coastal hazard areas will need to align with the State Planning Policy 2017 and the relevant approvals requirements and include necessary migration measures.

Monitor

In localities where the coastal hazard risk profile is low, Council will continue to monitor risk and undertake existing maintenance/asset management activities. If, over time, the risk profile is observed to increase (as indicated by local trigger levels), then the adaptation response may shift to mitigate.

Mitigate

In localities where coastal hazard risks have been identified, Council will actively manage the risk through implementing a range of adaptation options.

Mitigation will be tailored to each locality, incorporating site-specific processes, community, Traditional Owners input, Council's asset management and statutory planning considerations. If, over time, the risk profile is observed to increase (as indicated by local trigger levels), and mitigation becomes impractical (due to economic or other factors), then the adaptation response may shift to transition.

Transition

In some specific areas within a locality, if the coastal hazard risk profile is very high, and/or mitigation becomes impractical (due to economic or other factors), Council may make a strategic decision to transition to an alternative land use. Transition is likely to be a gradual process over time, where mitigating hazards for a period is part of the transition process. However, in some cases, transition may also be a more rapid response in relation to a threshold trigger or event.

Turtle hatchlings - M. Achilles

Adaptation response	Coastal hazard adaption			
	Avoid	**Monitor**	**Mitigate**	**Transition**
	Avoid placing new development or assets in coastal hazard areas.	Monitor the risk of coastal hazards. Monitor until local trigger levels are reached to initiate mitigation.	Actively mitigate the risk of coastal hazards through a range of adaptation options. Mitigate until local trigger levels are reached to initiate transition.	A strategic decision to transition to an alternative land use in some areas. Mitigation may be part of the transition process.
Adaptation options		Monitoring and initiatives to enhance adaptive capacity	Full range of adaptation options	

Table 9. Adaptation response

Adaptation options

Four themes of adaptation options have been defined for the Strategic Plan, with a range of options that relate to avoiding, mitigating and managing the risk of coastal hazards. The themes are:

1. Capacity building initiatives
2. Planning updates
3. Modifying infrastructure
4. Coastal management and engineering.

The range of common adaptation options across these themes are described in Table 10. More detailed descriptions of the options are provided in Supplement C to the Strategic Plan, along with preliminary screening of the relevance of options to different localities.

Theme	Adaptation options	Description	Supplement C summary sheet number
Capacity building initiatives	Community stewardship	Developing programs and partnerships to enhance stewardship of the coastline	Sheet 1
	Knowledge sharing	Facilitating knowledge sharing and education on hazards and adaptation	Sheet 2
	Monitoring	Monitoring changes in coastal hazard risk and effectiveness of adaptation.	Sheet 3
Planning updates	Land use planning	Informing statutory planning and strategic plans Includes consideration of land purchase or land swap/relocation	Sheet 4
	Disaster management	Updating emergency response planning	
Modifying infrastructure	Increase infrastructure resilience	• Modifying critical infrastructure (e.g. raising floor levels) • Modifying drainage networks • Building resilient homes	Sheet 5
	Relocate infrastructure	• Relocating critical infrastructure	
Coastal management and engineering	Dune protection and maintenance	Minimising dune disturbance, maintaining vegetation	Sheet 6
	Beach nourishment	Providing additional sand to the beach	Sheet 7
	Structures to assist with sand retention	Using structures (groynes, sand fencing) to help retain sand	Sheet 8
	Structures to dissipate wave energy	Constructing offshore breakwaters or artificial reefs to dissipate wave energy (submerged or exposed)	Sheet 9
	Last line of defence structures	Constructing seawalls / revetments	Sheet 10
	Structures to minimise inundation	Constructing levees / dykes	Sheet 11

Table 10. Adaptation options by theme

4.2 Adaptation response by locality

The adaptation response has been assigned for a series of key localities across the region. The adaptation response takes into consideration what is at risk (land and assets), and how the risk is changing over time – the emerging risk profile (present day, 2060 and 2100) (Table 11).

By 2100, there are some limited areas across the region, where transition to an alternative land use may be appropriate (due to increasing coastal hazard risk), subject to the outcome of initial priority adaptation actions for these locations.

Adaptation Response			
	Present Day	**2060**	**2100**
Reporting region 1: Including Mount Larcom	Monitor	Monitor	Monitor
Reporting region 2: Including Curtis Island and Facing Island	Monitor	Mitigate	Transition*
Reporting region 3: Including Gladstone	Mitigate	Mitigate	Transition*
Reporting region 4: Including Boyne Island and Tannum Sands	Mitigate	Mitigate	Transition*
Reporting region 5: Including Turkey Beach	Mitigate	Mitigate	Transition*
Reporting region 6: Including Seventeen Seventy and Agnes Water	Mitigate	Mitigate	Transition*
Reporting region 7: Including Rules Beach and Baffle Creek	Monitor	Monitor	Mitigate/ Transition*
Reporting region 8: Including Offshore Islands	Monitor	Mitigate	Transition*

** A transition response may be appropriate for limited areas within the locality*

Table 11. Adaptation response for each locality

4.3 Determining adaptation actions

A range of adaptation actions have been defined to enable a strategic approach to coastal hazard adaptation across the Gladstone region. A suite of priority actions across the four themes (Table 10) have been defined at:

- The regional scale (outlined in Section 5)
- The locality scale as part of the adaptation response pathway (outlined in Section 6).

The program of priority actions has been informed by the initial screening of options, as well as a detailed cost-benefit analysis for tailored coastal engineering options for Gladstone, Boyne Island, Tannum Sands, Turkey Beach, Seventeen Seventy and Agnes Water.

There is not currently a strong economic case for new infrastructure-based interventions to manage coastal hazard risk at the present day, however, a stronger case emerges for some localities by 2100.

Baseline actions of dune protection and maintenance, and mangrove protection and enhancement, will be critical for enhancing resilience.

Adaptation actions across the capacity building, land use planning and modifying infrastructure themes are the core focus for most localities, combined with some site-specific targeted investigations to inform future updates to the adaptation pathways.

Results may also change over time and should be the subject of future Strategic Plan updates.

Coastal Adaptation - Survey #2

September - October 2020

The coastal adaptation survey received almost 90 responses and was designed to assess the community's understanding of, and preferences for, different adaptation options.

Highlights from this survey:

- Young people (under 18 years) were the highest proportion of respondents
- Respondents had some degree of familiarity with different adaptation options and were most familiar with dune protection and maintenance
- Four out of five (80%) respondents felt that the most important consideration when selecting a coastal hazard adaptation option was the impact it may have on environmental and ecological values
- Most respondents felt that it was likely that additional adaptation options would be necessary in the future
- Respondents rated dune protection and maintenance as the most suitable adaptation option, followed by beach nourishment and land use planning.

East Shores Park - K. Patchett

What are resilient homes?

Making changes to your home over time can reduce damage from future flooding and help you get back to normal quicker after a flood event. In addition to elevating floor levels (in accordance with relevant planning contexts), top tips for a resilient home include:

Top tips for a resilient home:

Around the house

Raise electrical power outlets above waist height to reduce damage during a flood and allow power to be restored more quickly

Look at different floor and wall covering options. Tiles and waterproof grout are much easier to clean after a flood than wallpaper or carpet

Living room

Raise TVs, speakers, WiFi modems and other electricals above waist height or mount on walls if possible to reduce damage during a flood

Bathroom

If fitting a new bathroom, think about a free-standing bath or shower that is easier to clean around after a flood rather that a fixed bath

Kitchen and laundry

Raise fridges, freezers, kitchen appliances and cupboards on plinths or stands with removable kickboards to reduce damage and make cleaning up easier

If replacing electrical appliances think about appliances which can be lifted or placed in higher locations such as a front-loading washing machine on a shelf or plinth instead of a top loader on the ground.

Bedroom

Metal or raised bed frames and other furniture will be easier to clean up than divan or upholstered furniture

Outside

Place work benches along the inside of garage walls to help reinforce the walls and reduce damage from floodwaters and strong winds

More information can be found in the Factsheet: Resilient homes in Supplement A.

5. REGION-WIDE ACTIONS SUMMARY

The priority actions across the region include a range of actions relevant to the four themes identified for the Plan:

1. Capacity building initiatives
2. Planning updates
3. Modifying infrastructure
4. Coastal management and engineering

Priority 5 – 10 year actions to each of these themes are summarised in Table 12, with some additional information / guidance in Supplement C to the Strategic Plan.

Adaptation response and actions specific to different localities across the region are provided in the location summaries (Section 6).

Theme	Strategic action no.	Description	Priority strategic actions (completed within 5 – 10 years)
1. Capacity building initiatives	1.1 Community stewardship program	Develop programs and collaboration opportunities to enhance stewardship of the coastline	1.1.1 Establish internal resourcing to support Strategic Plan implementation and stewardship activities 1.1.2 Establish dune protection and maintenance program, and mangrove protection and enhancement program, utilising a mix of Council, Traditional Owner and community input – and implement at relevant localities (linked to 4.1 and 4.2) 1.1.3 Seek co-funding/resources for further initiatives through grants and stakeholder collaborations 1.1.4 Identify and promote opportunities for collaboration with Traditional Owners in managing coastal hazards
	1.2 Knowledge sharing and collaboration	Facilitate knowledge sharing and education on hazards and adaptation Knowledge sharing and collaboration	1.2.1 Continue to advance relationships and collaboration with Traditional Owners to further consider needs and aspirations for Aboriginal and Torres Strait Islander People in coastal hazard adaptation 1.2.2 Make the strategic plan available and provide communication materials on the Strategic Plan implementation and broader coastal management 1.2.3 Enhance community adaptive capacity to coastal hazards, including awareness of increasing coastal hazard exposure and risk (particularly inundation) and ways to improve individual preparedness and adaptive capacity – through training, education, events 1.2.4 Promote cross-sector collaboration and initiatives to enhance resilience and strategic adaptation for port and industry and associated operations

Table 12. Region wide actions

5. REGION-WIDE ACTIONS SUMMARY (Continued)

Theme	Strategic action no.	Description	Priority strategic actions (completed within 5 – 10 years)
1. Capacity building initiatives	1.3 Monitoring	Monitor changes in coastal hazard risk and effectiveness of adaptation	1.3.1 Establish photo point monitoring system (Coastsnap, drone or similar) at key areas, and event-based monitoring, linking to dune and mangrove stewardship programs 1.3.2 Create a platform/process for data monitoring and management identifying synergies and collaboration opportunities, with existing monitoring programs.
	1.4 Research opportunities	Boost collaborative opportunities and undertake additional investigations to support adaptation	1.4.1 Establish collaborative opportunities with key universities and research centres and define key research projects for implementation over the next 5-10 years 1.4.2 Investigate local ecosystem responses/sensitivities to changing coastal hazards and management implications (linked to research opportunities) 1.4.3 Local industry resilience investigation, sensitivities to changing coastal hazards and management implications, including sea level rise and groundwater dynamics (linked to research opportunities). 1.4.4 Investigate sensitivities of culturally significant areas to changing coastal hazards and management implications (linked to research opportunities)
2. Planning updates	2.1 Land use planning	Use the outcomes of the Strategic Plan to inform statutory planning and other strategic plans	2.1.1 Consider implications (within Council) and have regard to the new coastal hazard information presented in the Strategic Plan and Supplements, including: • Approval conditions for lots of undeveloped land • Implications for future development approvals and conditions. 2.1.2 Use the updated Erosion Prone Area and storm tide mapping and outcomes of the Strategic Plan in current and future Planning Scheme updates to inform decisions on development areas and strategic land use planning 2.1.3 Consult with State Government regarding the Hummock Hill redevelopment, with consideration of future coastal hazard risks 2.1.4 Consult with State Government on permit to occupy arrangements, with consideration of future coastal hazard risks 2.1.5 Develop a long-term transition plan for targeted areas at some coastal localities.
	2.2 Disaster management	Update emergency response planning	2.2.1 Use the updated Erosion Prone Area and storm tide mapping, risk assessment and economic implications to update the Gladstone Regional Council Local Disaster Management Plan 2.2.2 Review the long-term adequacy of evacuation facilities and evacuation routes.

5. REGION-WIDE ACTIONS SUMMARY

Theme	Strategic action no.	Description	Priority strategic actions (completed within 5 – 10 years)
3. Modifying infrastructure	3.1 Building resilience	Upgrading infrastructure, building resilient homes	3.1.1 Review at-risk infrastructure (from Strategic Plan data outputs) and embed risks into current asset management plans 3.1.2 Review access road renewals, upgrades (prioritisation), and design requirements with consideration of future coastal hazard risks 3.1.3 Promote resilient homes within the community (link in with knowledge sharing initiatives) 3.1.4 Make the Strategic Plan and new information of coastal hazard risks available to utility providers and collaborate on future services, upgrades and implications of coastal hazard areas 3.1.5 Make the Strategic Plan and new information of coastal hazard risks available to industrial and port infrastructure owners and collaborate on future infrastructure, upgrades and implications of coastal hazard areas.
	3.2 Relocate infrastructure	Relocate critical infrastructure	3.2.1 When updating asset management plans, consider the long-term (2100) coastal hazard risk, and consider options for relocation if needed 3.2.2 Develop a plan for the relocation of specific assets where defined in location-based pathways (if applicable).
4. Coastal management and engineering	4.1 Dune protection and maintenance	Minimise dune disturbance, maintain vegetation	4.1.1 Continue and expand the dune protection and maintenance program at Agnes Water and Tannum Sands using existing Shoreline Erosion Management Plans (SEMPs) at these locations as a foundation (linked to action 1.1.2) 4.1.2 Extend the dune protection and maintenance program more broadly to relevant locations (if needed).
	4.2 Energy dissipation approach – mangrove protection and enhancement	Protect and enhance mangrove communities that are providing shoreline protection	4.2.1 Develop a pilot a mangrove protection and enhancement program linked to existing Shoreline Erosion Management Plan (SEMP) actions 4.2.2 Extend and promote a mangrove protection and enhancement program more broadly (if needed).

Theme	Strategic action no.	Description	Priority strategic actions (completed within 5 – 10 years)
4. Coastal management and engineering	4.3 Targeted investigations	Region-wide studies to better inform decision making for coastal management and engineering, and other actions	4.3.1 Review and update existing Shoreline Erosion Management Plans (SEMPs) based on new hazard and risk information, and develop new SEMPs for priority areas. 4.3.2 Undertake coincident flood modelling for Boyne River estuary to understand implications of the combined coastal and riverine processes for inundation and erosion vulnerability for the Gladstone coast (potential link to research collaboration) 4.3.3 Consult with the State Government regarding the future management of Round Hill Creek, with consideration of future coastal hazard risks. This may include additional assessment (on geomorphology and hydrodynamics) and further exploration of management options if significant changes in sediment dynamics occur, which may impact on coastal hazard risk. Potential link to research and to maritime safety collaboration.
	4.4 Additional coastal hazard protection works	Structures to minimise erosion and inundation	4.4.1 Maintain and upgrade existing public coastal hazard protection structures, in accordance with adaptation pathway planning 4.4.2 Collaborate with Ports on dredging operations (maintenance and capital), and identify opportunities to utilise the dredge material in hazard mitigation 4.4.3 Consult with State Government regarding non approved coastal hazard protection structures to determine the management approach to existing and future structures. 4.4.4 Scope potential future works, in accordance with adaptation pathway planning.

6.1 Reporting region 1: Mount Larcom

Landscape

Mount Larcom is situated at the northern extent of the Gladstone region coastline. The land surrounding Mount Larcom is relatively low-lying and is characterised by tidal inlets, mangroves and estuaries (Figure 8). At the northernmost section of the region is Balaclava Island, which is located on the Fitzroy River estuary. Curtis Island shelters this region from open coast processes.

Sections of this region are protected under Rundle Range National Park and Rundle State Forest. There are wetlands of high ecological significance and fish habitat areas.

Sparsely populated, the area has limited built infrastructure and facilities, including roads, boat ramps and 4WD tracks. There are also major gas pipelines running between Curtis Island to Targinnie.

Coastal hazards exposure and implications

This region will primarily be impacted by tidal and storm tide inundation and is likely to be increasingly exposed in the future. Its sheltered location and estuarine frontage with a natural resilience, limit the coastal erosion risk.

Assets increasingly at risk from inundation include some roads and facilities (boat ramps, 4WD tracks). Major gas pipelines running from Curtis Island to Targinnie are also within inundation prone areas, along with associated infrastructure. However, infrastructure design is likely to be resilient.

Increasing inundation may also impact mangroves, fish habitats and wetlands of environmental significance, which may result in natural migration and re-establishment of these communities further inland with increasing tidal areas.

The present day adaptation response for Reporting region 1 is to monitor coastal hazard risk. The inundation risk is expected to remain low and minimal buildings and infrastructure are likely to be impacted by 2100 (Table 13).

The adaptation pathway for Reporting region 1 focusses on the region-wide actions, with consideration to updating disaster management arrangements.

Figure 8. Reporting region 1 (Mount Larcom)

	Present Day	2060	2100
Adaptation response	Monitor	Monitor	Monitor
Adaptation actions			
1. Capacity building	As per region-wide actions		
2. Planning updates	As per region-wide actions, including:		
2.2 Disaster management	Update local disaster management planning for this locality based on updated coastal hazard maps		
3. Modifying infrastructure	As per region-wide actions		
4. Coastal management and engineering	As per region-wide actions		

Table 13. Reporting region 1 adaptation pathway

Mount Larcom - A.Collins

6.2 Reporting region 2: Curtis Island/ Facing Island

Landscape

Curtis Island and Facing Island are large islands located directly east of Gladstone City (Figure 9).

The main community on Curtis Island is at Southend, and a small settlement is located on the north west side of the island. Three major LNG processing facilities are situated on the south west coast of Curtis Island. Facing Island has several small settlements at the northern, north western and southern extents of the island.

Significant proportions of Reporting region 2 are designated as strategic land of Gladstone Port Corporation, particularly Facing Island.

Each of these islands has very high cultural and environmental significance for the region. Large areas of Facing Island are covered by Native Title, held by the Bailai, Gurang, Gooreng Gooreng and Taribelang Bunda Peoples.

Figure 9. Reporting region 2 (Curtis Island/Facing Island)

Curtis Island has areas of National Park, State Forest and conservation park, significant species include coastal heath, littoral rainforest, saltmarsh, remnant wetlands and its sandy beaches act as a rookery for the Flatback Turtle. There are also several estuarine wetlands of high ecological significance on Facing Island, particularly on the west coast.

These islands have a high recreational value, and are popular locations for camping, boating, 4WD and ecotourism. There are various facilities on the islands to help support these activities.

Coastal hazards exposure and implications

These islands are exposed to periodic storm tide and tidal inundation, and are likely to be increasingly exposed in the future.

Assets that may be increasingly at risk from inundation include some settlement areas and associated roads and infrastructure. By 2100, the level of inundation exposure for some of these areas may be beyond tolerance levels for current land uses.

Increasing inundation may also impact significant ecological and cultural assets on these islands, including the turtle rookery.

Some beaches available for recreation and vehicle access are already impacted by high tides and the frequency of these impacts is likely to increase over time.

The present day adaptation response for Reporting region 2 is to mitigate coastal hazard risk and begin preparations for transition of some areas (land use / assets in inundation areas) in the longer term (Table 14).

The adaptation pathway for these islands focusses on dune and vegetation protection and maintenance, enhancing community adaptive capacity, updating disaster management arrangements, maintaining and upgrading existing infrastructure while undertaking some location-based transition planning for the long-term (2100). Region-wide actions also apply as applicable.

	Present Day	2060	2100
Adaptation response	Monitor	Mitigate	Transition*
Adaptation actions			
1. Capacity building	As per region-wide actions, including:		
1.2 Knowledge sharing and collaboration	Enhance community adaptive capacity to coastal hazards, including awareness of increasing coastal hazard exposure and risk (particularly inundation) and ways to improve individual preparedness and adaptive capacity		
	Make the Strategic Plan and new information of coastal hazard risks available to industry, port, residents, and other stakeholders, to communicate long-term coastal hazard areas and risks		
1.4 Research opportunities	Investigate local ecosystem responses/sensitivities to changing coastal hazards and management implications, including for Flatback turtle rookery (linked to research collaboration)		
2. Planning updates	As per region-wide actions, including:		
2.1 Land use planning	Consider implications (within Council) and have regard to the new coastal hazard information presented in the Strategic Plan and Supplements, including: • Approval conditions for lots of undeveloped land • Implications for future development approvals and conditions.		Revise permit to occupy conditions to inform transition planning
	In collaboration with relevant local stakeholders, develop an approach, including triggers, for a transition response for targeted areas of Facing Island in response to increasing long-term inundation exposure and risk.		Implement transition plan
2.2 Disaster management	Update local disaster management planning for this locality based on updated coastal hazard maps		
3. Modifying infrastructure	As per region-wide actions, including:		
3.1 Build resilience	Promote resilient homes within the community		
		Review and update Council asset management plans to incorporate upgrades and modifications to inundation prone areas of Curtis Island and Facing Island and other relevant infrastructure (where practical)	
		Review and update Council asset management plans to incorporate upgrades and modifications in inundation prone areas, and to other relevant community infrastructure (where practical).	
4. Coastal management and engineering	As per region-wide actions, including:		
4.1 Dune protection and maintenance	Collaborate with relevant land managers to scope potential future dune protection and maintenance program for targeted locations on Facing Island and Curtis Island (Southend, Yellow Patch)		

**A transition response may be appropriate for limited areas within zone*

Table 14. Reporting region 2 adaptation pathway

6.3 Reporting region 3: Gladstone / Barney Point

Landscape

Gladstone is situated along the coast at the mouth of the Calliope River (Figure 10). The city and surrounds are the major population centre in the Gladstone region.

This Reporting region is largely protected from coastal hazards by Facing Island. Much of the shoreline has been heavily modified, armoured with rock structures and seawalls, and breakwaters that shelter some areas from wave action. Land reclamation has resulted in additional land, including Spinnaker Park at Gladstone's marina and areas around Auckland Inlet.

Gladstone's natural deepwater harbour enables the operation of one of the largest, bulk commodity ports, servicing the mining and resources industry. In addition to the Port, this location also contains a high proportion of the region's industrial complexes and associated facilities.

Mangroves and wetlands of high ecological significance are some of the significant environmental values within the Gladstone area. There are also areas held under Native Title by the Bailai, Gurang, Gooreng Gooreng and Taribelang Bunda Peoples.

Coastal hazards exposure and implications

Gladstone is exposed to periodic tidal and storm tide inundation, and is likely to be increasingly exposed in the future. Low-lying areas, particularly around Auckland Inlet, Callemondah, and Barney Point are already being impacted by coastal hazards.

Gladstone's coastline, sheltered by Facing Island, experiences a relatively low energy wave climate and is not expected to be significantly impacted by open coast erosion.

The built up, urbanised nature of this coastline means there are a range of assets increasingly at risk of inundation, including ports and industrial infrastructure, utilities, dwellings and buildings in the Gladstone CBD, and roads and railways providing access to the city, port and marina.

The present day adaptation response for Reporting region 3 is to mitigate coastal hazard risk and begin preparations for transition of some areas (land use / assets in inundation areas) in the longer term (Table 15).

The adaptation pathway for Gladstone focusses on asset management planning, enhancing community adaptive capacity, updating disaster management arrangements, maintaining and upgrading existing infrastructure while undertaking some location-based transition planning for the long-term (2100). Region-wide actions also apply as applicable.

Figure 10. Reporting region 3 (Gladstone)

	Present Day	2060	2100
Adaptation response	Mitigate	Mitigate	Transition*
Adaptation actions			
1. Capacity building	As per region-wide actions, including:		
1.2 Knowledge sharing and collaboration	Enhance community adaptive capacity to coastal hazards, including awareness of increasing coastal hazard exposure and risk (particularly inundation) and ways to improve individual preparedness and adaptive capacity		
2. Planning updates	As per region-wide actions, including:		
2.1 Land use planning	In collaboration with asset stakeholders, develop and approach, including triggers, for a transition response for targeted areas of Gladstone in response to increasing long-term inundation exposure and risk. Incudes low-lying areas at Auckland Inlet, and residential areas at Gladstone East.		Implement transition plan
2.2 Disaster management	Update local disaster management planning for this locality based on updated coastal hazard maps		
3. Modifying infrastructure	As per region-wide actions, including:		
3.1 Build resilience	Review and update Council asset management plans to incorporate upgrades and modifications in inundation prone areas, and to other relevant community infrastructure (where practical).		
	Promote resilient buildings, homes, and infrastructure within the community		
3.2 Relocate infrastructure	Review and update Council asset management plans to develop a transition response for at-risk critical infrastructure (including commercial and industrial areas)		Relocate critical infrastructure
4. Coastal management and engineering	As per region-wide actions, including:		
4.2 Mangrove protection and maintenance	Collaborate with the relevant land manager to develop a mangrove protection and enhancement program within Gladstone Harbour, including at Auckland Inlet		
4.4 Additional coastal hazard protection works	Make the Strategic Plan and coastal hazard extents available to relevant asset and land managers to support maintenance and upgrade of existing public coastal hazard protection structures, in accordance with adaptation pathway planning. This includes rock revetments along Gladstone's foreshore, the marina and Spinnaker Park		
		In collaboration with relevant stakeholders, scope potential future works at Gladstone and Barney Point, in accordance with adaptation pathway planning, including concept options to manage increasing coastal hazards at Auckland Inlet and at-risk residential areas in Barney Point	

**A transition response may be appropriate for limited areas within zone*

Table 15. Reporting region 3 adaptation pathway

6.4 Reporting region 4: Boyne Island/ Tannum Sands

Landscape

Boyne Island and Tannum Sands are coastal communities situated south of Gladstone, and are separated by the Boyne River (Figure 11). Wild Cattle Island and Hummock Hill Island are located offshore, south west of the Tannum Sands. A number of small settlements are located within the coastal areas of this region.

Boyne Island, with Australia's largest aluminium smelter, is separated from the mainland by a series of narrow channels branching from the Boyne River. Lilley's Beach, a sensitive foreshore area on Boyne Island east coast, with tidal flats and seagrass meadows, is a popular spot for camping and 4WD.

Tannum Sands, east of the Boyne River, has a wide, sandy main beach along the east coast, and a sandy beach with low rock flats towards the north at Canoe Point.

Riverine flows from the Boyne River and Wild Cattle Creek have a role in sediment supply, water quality and sustaining coastal and estuarine habitats and influence the formation of sandy plains along sections of this coast.

Wild Cattle Island is a low-lying, vegetated sand island that is valued for recreation, including camping and fishing. The island is a National Park and has mangroves, turtle nesting beaches and fish habitat areas.

Hummock Hill Island is currently reserved for residential and tourism development. There are high ecological significance wetlands, fish habitat areas and mangrove habitats on Hummock Hill Island.

Reporting region 4 also holds significant cultural values with large areas covered by Native Title, held by the Bailai, Gurang, Gooreng Gooreng, Taribelang Bunda Peoples.

Coastal hazards exposure and implications

Areas of Boyne Island and Tannum Sands are exposed to periodic storm tide and tidal inundation, particularly along the Boyne River. These areas are likely to be increasingly exposed in the future. Low-lying areas on Wild Cattle Island and Hummock Hill island are at increasing risk of inundation.

Assets that may be increasingly at risk from inundation include low-lying residential areas, riverfront foreshore buildings and facilities, remote

Figure 11. Reporting region 4 (Boyne Island/Tannum Sands)

coastal settlements, roads and infrastructure, including sections of the main access road, Gladstone-Benaraby Road. Increasing inundation may also impact sensitive and significant ecological and cultural assets within the region. By 2100 the level of inundation exposure for some areas in these communities may be beyond tolerance levels for current land uses.

There are some known erosion hotspot risks at the mouth of Boyne River and the mouth of Wild Cattle Creek, likely driven by combined riverine and coastal processes. Some Island Esplanade residences and the Olunda Street carpark are currently impacted by erosion. An informal geofabric bag structure has been constructed to mitigate some of this erosion risk. In the longer term, a row of houses close to the Tannum Sands foreshore (on The Oaks Road), may be at risk of erosion.

The present day adaptation response for Reporting region 4 is to mitigate coastal hazard risk and begin preparations for transition of some areas (land use / assets in inundation areas) in the longer term (Table 16). This includes active mitigation of erosion hotspots for Boyne Island and Wild Cattle Creek.

The adaptation pathway for this area focusses on asset management planning, enhancing community adaptive capacity, updating disaster management arrangements, maintaining and upgrading existing infrastructure while undertaking some location-based transition planning for the long-term (2100). Region-wide actions also apply as applicable.

The future planning and development on Hummock Hill Island should consider potential tidal and storm tide inundation risks.

Tannum Sands - G. Meyer

	Present Day	2060	2100
Adaptation response	Mitigate	Mitigate	Transition*
Adaptation actions			
1. Capacity building	As per region-wide actions, including:		
1.2 Knowledge sharing and collaboration	Enhance community adaptive capacity to coastal hazards, including awareness of increasing coastal hazard exposure and risk (particularly inundation) and ways to improve individual preparedness and adaptive capacity		
2. Planning updates	As per region-wide actions, including:		
2.1 Land use planning	In collaboration with relevant stakeholders, develop an approach, including triggers, for a transition response for targeted areas of region in response to increasing long-term inundation exposure and risk. Includes low lying areas in Boyne Island, Wild Cattle Island, and smaller remote settlements in Reporting region 4		Implement transition plan
	Consult with State Government regarding the Hummock Hill redevelopment, with consideration of future coastal hazard risks		
	Consult with State Government on permit to occupy arrangements, with consideration of future coastal hazard risks for relevant properties		Revise permit to occupy conditions to inform transition planning
2.2 Disaster management	Update local disaster management planning for this locality based on updated coastal hazard maps		
3. Modifying infrastructure	As per region-wide actions, including:		
3.1 Build resilience	Review and update Council asset management plans to incorporate upgrades and modifications in inundation prone areas and assets, and to other relevant infrastructure (where practical)		
	Consult with relevant asset managers and owners, to review and update asset management plans to incorporate upgrades and modifications in inundation and erosion prone areas, and to other relevant infrastructure. This may include Gladstone Benaraby Road, private infrastructure and assets along Boyne River, Boyne River Boat Ramp		
	Promote resilient homes within the community		
3.2 Relocate infrastructure	Review and update Council asset management plans to develop a transition response for Olunda Street /Island Esplanade carparks		Relocate infrastructure

**A transition response may be appropriate for limited areas within zone*

Table 16. Reporting region 4 adaptation pathway

	Present Day	2060	2100
Adaptation response	Mitigate	Mitigate	Transition*
Adaptation actions			
4. Coastal management and engineering	As per region-wide actions, including:		
4.1 Dune protection and maintenance	Continue and expand the dune protection and maintenance programs at Canoe Point and Tannum Beach, Wild Cattle Creek using existing Wild Cattle Creek SEMP, including minimising disturbance to sensitive areas.		
4.3 Targeted investigations	Undertake coincident flood modelling for Boyne River estuary, to understand implications of the combined coastal and riverine processes for inundation and erosion vulnerability for the Gladstone coast (potential link to research collaboration)		
	Review and revise existing Shoreline Erosion Management Plans (SEMP) with a focus on Boyne River mouth and Wild Cattle Creek		
4.4 Additional coastal hazard protection works	Consult with State Government regarding unapproved coastal hazard protection structures to determine the management approach to existing and future structures		
		Scope potential future works at Boyne River and Tannum Sands, in accordance with adaptation pathway planning, including concept options to manage increasing coastal hazards on Boyne River foreshore and Tannum Sands Main Beach.	

Table 16. Continued.

6.5 Reporting region 5: Turkey Beach

Landscape

Turkey Beach is a small coastal community located on an estuary within Rodds Bay (Figure 12). The community is situated on relatively low-lying land and there are large extents of mangroves, wetlands and creeks along the coastal zone. Turkey Beach is sheltered from open coast process by Rodds Peninsula.

This region has significant environmental value, including Eurimbula National Park. Rodds Peninsula is protected under Eurimbula National Park and is also a dugong protection area. Extensive seagrass meadows help to sustain an array of marine species including dugongs.

Reporting region 5 also holds significant recreational value for boating and fishing for residents and visitors, providing convenient access to the coastal environment.

Coastal hazards exposure and implications

Areas of Turkey Beach are exposed to periodic tidal inundation, particularly around The Esplanade and boat ramp. These areas and low-lying areas further inland are likely to be increasingly exposed in the future.

Assets that may be at increasing risk from inundation include the boat ramp, residential dwellings and buildings, and the main access road into the community, Turkey Beach Road. Increasing inundation may also impact sensitive and significant ecological areas within the region. By 2100 the level of inundation exposure for some areas in these communities may be beyond tolerance levels for current land uses.

There are some known erosion hotspots at Turkey Beach foreshore currently being managed via a Shoreline Erosion Management Plan (SEMP).

The present day adaptation response for Reporting region 5 is to mitigate coastal hazard risk and begin preparations for the transition of some areas (land use / assets in inundation areas) in the longer term (Table 17).

The adaptation pathway for this region focusses on enhancing community adaptive capacity, updating disaster management arrangements, mangrove enhancement, dune protection and maintenance, maintaining and upgrading existing infrastructure, including access to Turkey Beach and Eurimbula National Park, while undertaking some location-based transition planning for the long-term (2100). Region-wide actions also apply as applicable.

Figure 12. Reporting region 5 (Turkey Beach)

	Present Day	2060	2100
Adaptation response	Mitigate	Mitigate	Transition*
Adaptation actions			
1. Capacity building	As per region-wide actions, including:		
1.2 Knowledge sharing and collaboration	Enhance community adaptive capacity to coastal hazards, including awareness of increasing coastal hazard exposure and risk (particularly inundation) and ways to improve individual preparedness and adaptive capacity		
2. Planning updates	As per region-wide actions, including:		
2.1 Land use planning	Consider implications (within Council) and have regard to the new coastal hazard information presented in the Strategic Plan and Supplements, including: • Approval conditions for lots of undeveloped land • Implications for future development approvals and conditions.		Revised permit to occupy conditions to inform transition planning
	Develop approach, including triggers, for a transition response for targeted areas of Turkey Beach in response to increasing long-term inundation exposure and risk.		Implement transition plan
2.2 Disaster management	Update local disaster management planning for this locality based on updated coastal hazard maps		
3. Modifying infrastructure	As per region-wide actions, including:		
3.1 Build resilience	Promote resilient homes within the community		
		Review and update Council asset management plans, including feasibility, to incorporate upgrades and modifications to inundation and erosion prone areas of Turkey Beach, and to other relevant infrastructure (where practical). This may include access roads to Turkey Beach and Eurimbula National Park (where practical)	
4. Coastal management and engineering	As per region-wide actions, including:		
4.1 Dune protection and maintenance	Continue and expand the dune protection and maintenance program at Turkey Beach, based on existing Turkey Beach SEMP, including minimising disturbance to sensitive areas through access control, education, signage and revegetation.		
4.2 Mangrove protection and maintenance	Develop a mangrove protection and enhancement program within Rodds Bay and Turkey Beach foreshore, exploring synergies with existing monitoring and research programs, including seagrass.		
4.4 Additional coastal hazard protection works	Implement actions outlined in the Turkey Beach Shoreline Erosion Management Plan (SEMP)		

** A transition response may be appropriate for limited areas*

Table 17. Reporting region 5 adaptation pathway

6.6 Reporting region 6: Agnes Water/ Seventeen Seventy

Landscape

Agnes Water and Seventeen Seventy are small coastal communities situated either side of Round Hill Headland (Figure 13). Round Hill Headland is a rocky outcrop that influences the sediment transport along this section of coastline.

Seventeen Seventy is located on the western, sheltered side of the headland, near the mouth of Round Hill Creek. Sandy beach ridges form barrier features across the estuary/delta zone. Tides and currents shape and change the Seventeen Seventy coastline.

Agnes Water is located on the eastern, exposed side of Round Hill Head. A parabolic dune system runs along the coastline at Agnes Water, which has experienced significant change in recent years, largely due to storm surges and wave action.

Round Hill Head is protected as a conservation park. There are also several areas at Seventeen Seventy containing wetlands of high ecological significance. Mangroves span the shoreline within Round Hill Creek inlet. The vegetated dunes at Agnes Water provide significant habitat and nesting areas for shorebirds and turtles.

This Reporting region is also important for tourism and recreation. Providing easy access for boating and fishing, and to the GBR, these communities are popular for Gladstone region residents and visitors. Agnes Water is the northernmost surf beach in Queensland. Seventeen Seventy also has significance in Australia's European history as the site of Captain Cook's landing. The region also provides opportunities for walking and camping.

Coastal hazards exposure and implications

Areas of Seventeen Seventy and Agnes Water are exposed to periodic erosion and inundation, particularly along Captain Cook Drive at Seventeen Seventy and Agnes Water Main Beach. These areas are at increasing risk of erosion and inundation in the future.

Assets that may be at increasing risk from erosion include Captain Cook Drive at Seventeen Seventy, 1770 campground, Agnes Water Main Beach, and dwellings and buildings within the hazard zone in both communities. Increasing erosion and inundation may also impact sensitive and significant ecological values, including turtle nesting sites and shorebird habitats.

The present day adaptation response for Reporting region 6 is to mitigate coastal hazard risk and begin preparations for transition of some areas (land use / assets in the Erosion Prone Area) in the longer term (Table 18). This includes active mitigation of open coast erosion at Agnes Water and Seventeen Seventy.

The adaptation pathway for this area focusses on dune protection and maintenance, mangrove enhancement, enhancing community adaptive capacity, updating disaster management arrangements, asset management planning, maintaining and upgrading existing infrastructure while undertaking location-based transition planning for the long-term (2100). Region-wide actions also apply as applicable.

Figure 13. Reporting region 6 (Agnes Water/ Seventeen Seventy)

	Present Day	2060	2100
Adaptation response	Mitigate	Mitigate	Transition*
Adaptation actions			
1. Capacity building	As per region-wide actions, including:		
1.2 Knowledge sharing and collaboration	Enhance community adaptive capacity to coastal hazards, including awareness of increasing coastal hazard exposure and risk (particularly inundation) and ways to improve individual preparedness and adaptive capacity, and behaviour (via education, signage and enforcement).		
2. Planning updates	As per region-wide actions, including:		
2.1 Land use planning	Develop approach, including triggers, for a transition response for targeted areas of region in response to increasing long-term inundation and erosion exposure and risk. Includes at risk areas in Seventeen Seventy, camping ground, Captain Cook Drive, and some residential properties in Agnes Water.		Implement transition plan
2.2 Disaster management	Update local disaster management planning for this locality based on updated coastal hazard maps		
3. Modifying infrastructure	As per region-wide actions, including:		
3.1 Build resilience	Review and update Council asset management plans to incorporate upgrades to inundation and erosion prone sections of road and other relevant infrastructure. Includes Captain Cook Drive, infrastructure along Seventeen Seventy foreshore.		
	Promote resilient homes within low lying areas of the community		
4. Coastal management and engineering	As per region-wide actions, including:		
4.1 Dune protection and maintenance	Continue and expand the dune protection and maintenance program at Agnes Water and Seventeen Seventy using existing SEMP as a foundation, including minimising disturbance to sensitive areas, access control.		

** A transition response may be appropriate for limited areas*

Table 18. Reporting region 6 adaptation pathway

	Present Day	2060	2100
Adaptation response	Mitigate	Mitigate	Transition*
Adaptation actions			
4.2 Mangrove protection and maintenance	Develop a mangrove protection and enhancement program within Round Hill Creek and Seventeen Seventy foreshore.		
4.3 Targeted investigations	Consult with the State Government regarding the future management of Round Hill Creek, with consideration of future coastal hazard risks. This may include additional assessment (on geomorphology and hydrodynamics) and further exploration of management options if significant changes in sediment dynamics occur, which may impact on coastal hazard risk. Potential link to research and to maritime safety collaboration.		
4.4 Additional coastal hazard protection works	Progress and implement priority actions outlined in the Agnes Water & Seventeen Seventy Shoreline Erosion Management Plan (SEMP), including concept designs and approvals (with triggers) for management options.	Implement works as per adaptation pathway planning.	
	Scope potential future works at Seventeen Seventy in accordance with adaptation planning, including concept options for beach renourishment and groyne, to manage increasing coastal hazards at Seventeen Seventy and its access road (for both inundation and open coast erosion impacts)	Implement works as per adaptation pathway planning.	

** A transition response may be appropriate for limited areas*

Table 18. Reporting region 6 adaptation pathway

Seventeen Seventy - A. Kruger

6.7 Reporting region 7: Rules Beach/Baffle Creek

Landscape

Rules Beach and Baffle Creek are located at the southernmost extent of the Gladstone region (Figure 14). Rules Beach is approximately 8 km long and extends south from Broadwater Creek to Baffle Creek. There are also small coastal settlements at Broadwater and Deepwater.

Figure 14. Reporting region 7 (Rules Beach/ Baffle Creek)

This area is popular for camping, beach-based 4WD and fishing. With areas of conservation park along Rules Beach and Baffle Creek, and fish habitat areas and wetlands of high ecological significance, this region also has significant environmental value.

Coastal hazards exposure and implications

The Reporting region has relatively low coastal hazard exposure and risk at present day. Inundation exposure is likely to increase in the future to low-lying parts of the region. While some isolate areas are exposed to periodic erosion, open coast erosion risk is likely to be low for majority of the region.

Assets that may be increasingly at risk from inundation include low-lying residential areas and roads at Deepwater, Baffle Creek and Broadwater. A small number of residences at Broadwater and Rules Beach, near to the open coast may be increasingly at risk of open coast erosion.

By 2100 the level of hazard exposure for some areas may be beyond tolerance levels for current land uses.

The adaptation response for Reporting Region 7 is to continue to monitor coastal hazard risk and begin preparations for additional hazard mitigation in the future (Table 19). Additional mitigation may be required if the dynamics of Baffle Creek alter substantially.

The adaptation pathway for this area focusses on enhancing community adaptive capacity, updating disaster management arrangements, dune protection and maintenance and asset management planning including resilient housing and upgrading inundation prone critical infrastructure.

	Present Day	2060	2100
Adaptation response	Monitor	Monitor	Mitigate/ Transition*
Adaptation actions			
1. Capacity building	As per region-wide actions, including:		
1.2 Knowledge sharing and collaboration	Enhance community adaptive capacity to coastal hazards, including awareness of increasing coastal hazard exposure and risk (particularly inundation) and ways to improve individual preparedness and adaptive capacity		
	Make the Strategic Plan and new information of coastal hazard risks available to community and stakeholders, to communicate long-term coastal hazard areas and risks.		
2. Planning updates	As per region-wide actions, including:		
2.1 Land use planning	Consider implications (within Council) and have regard to the new coastal hazard information presented in the Strategic Plan and Supplements, including: • Approval conditions for lots of undeveloped land • Implications for future development approvals and conditions.		Revised permit to occupy conditions to inform transition planning
	Develop approach, including triggers, for a transition response for targeted areas of region in response to increasing long-term inundation exposure and risk.		Implement transition plan
2.2 Disaster management	Update local disaster management planning for this locality based on updated coastal hazard maps		
3. Modifying infrastructure	As per region-wide actions, including:		
3.1 Build resilience	Promote resilient homes within the community		
		Review and update asset management plan to incorporate upgrades to inundation prone assets (including at Deepwater, Baffle Creek and Broadwater) and other relevant infrastructure where practical.	
4. Coastal management and engineering	As per region-wide actions		

** A transition response may be appropriate for limited areas*

Table 19. Reporting region 7 adaptation pathway

6.8 Reporting region 8: Offshore Islands

Landscape

Reporting region 8 includes three of the islands located off the coast of the Gladstone region - Heron Island, One Tree Island and Lady Elliot Island (Figure 15). These islands are located within the Great Barrier Reef Marine Park.

Heron Island is the northernmost island in this group and is a declared National Park. A research station and a resort are located on the island. Heron Island is an important island for turtle nesting and is a popular tourist destination for the region.

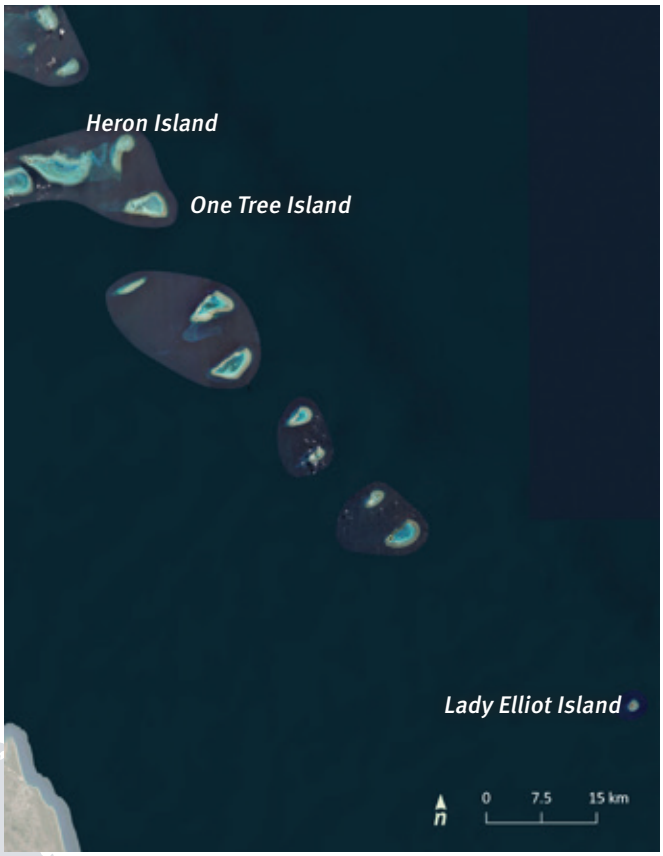


Figure 15. Reporting region 8 (Offshore Islands)

One Tree Island is also a National Park and has research station while Lady Elliot Island, the southernmost island, has a resort.

Coastal hazards exposure and implications

Low-lying areas of Heron and One Tree Island are exposed to periodic storm tide and tidal inundation, and are likely to be increasingly exposed in the future. Lady Elliot Island is at low risk to coastal hazard exposure.

Assets that may be increasingly at risk from inundation include buildings, roads and foreshore facilities on One Tree Island and Heron Island. By 2100 the level of inundation exposure for the settlement area may be beyond tolerance levels for current land uses on One Tree Island and low-lying areas of Heron Island.

The present day adaptation response for Reporting region 8 is to monitor the coastal hazard risk. Active mitigation of coastal hazard risks and preparations for transition of some areas (land use / assets in inundation areas) may be required in the longer term (Table 20).

The adaptation pathway for this area focusses on dune protection and maintenance, enhancing community adaptive capacity, updating disaster management arrangements, maintaining and upgrading existing infrastructure while undertaking location-based transition planning for the long-term (2100). Region-wide actions also apply as applicable.

	Present Day	2060	2100
Adaptation response	Monitor	Mitigate	Transition*
Adaptation actions			
1. Capacity building	As per region-wide actions		
1.2 Knowledge sharing and collaboration	Enhance community adaptive capacity to coastal hazards, including awareness of increasing coastal hazard exposure and risk (particularly inundation) and ways to improve individual preparedness and adaptive capacity		
2. Planning updates	As per region-wide actions, including:		
2.1 Land use planning	Develop approach, including triggers, for a transition response for targeted areas of region in response to increasing long-term inundation exposure and risk. Includes all of One Tree Island, limited areas of Heron Island		Implement transition plan
2.2 Disaster management	Update local disaster management planning for this locality based on updated coastal hazard maps		
3. Modifying infrastructure	As per region-wide actions, including:		
3.1 Build resilience	Promote resilient homes within the community		
		Review and update asset management plan to incorporate upgrades to inundation prone assets and other relevant infrastructure where practical.	
4. Coastal management and engineering	As per region-wide actions		

** A transition response may be appropriate for limited areas*

Table 20. Reporting region 8 adaptation pathway

7. IMPLEMENTATION

Adapting to coastal hazards is a shared responsibility for all stakeholders and the Gladstone region's community. Council will continue to seek opportunities to work together as the adaptation journey commences.

Gladstone Regional Council will implement the *Our Coast. Our Future* Strategic Plan through a range of mechanisms including:

- An adaptive management framework
- Embedding outcomes and actions from the Strategic Plan into existing Council process and activities
- Implementing new initiatives from the Strategic Plan.

To guide implementation, an implementation plan will be developed that includes additional detail on:

- Timeframes for actions
- Planning and resourcing, including costing, for priority 5 - 10 year actions
- Instruments, plans and processes (existing, modified, new) required to deliver adaptation options
- Potential funding sources
- Monitoring and evaluation
- Barriers to implementation and change management actions
- Partnership opportunities with stakeholders.

Gladstone Marina – B. Sparshott

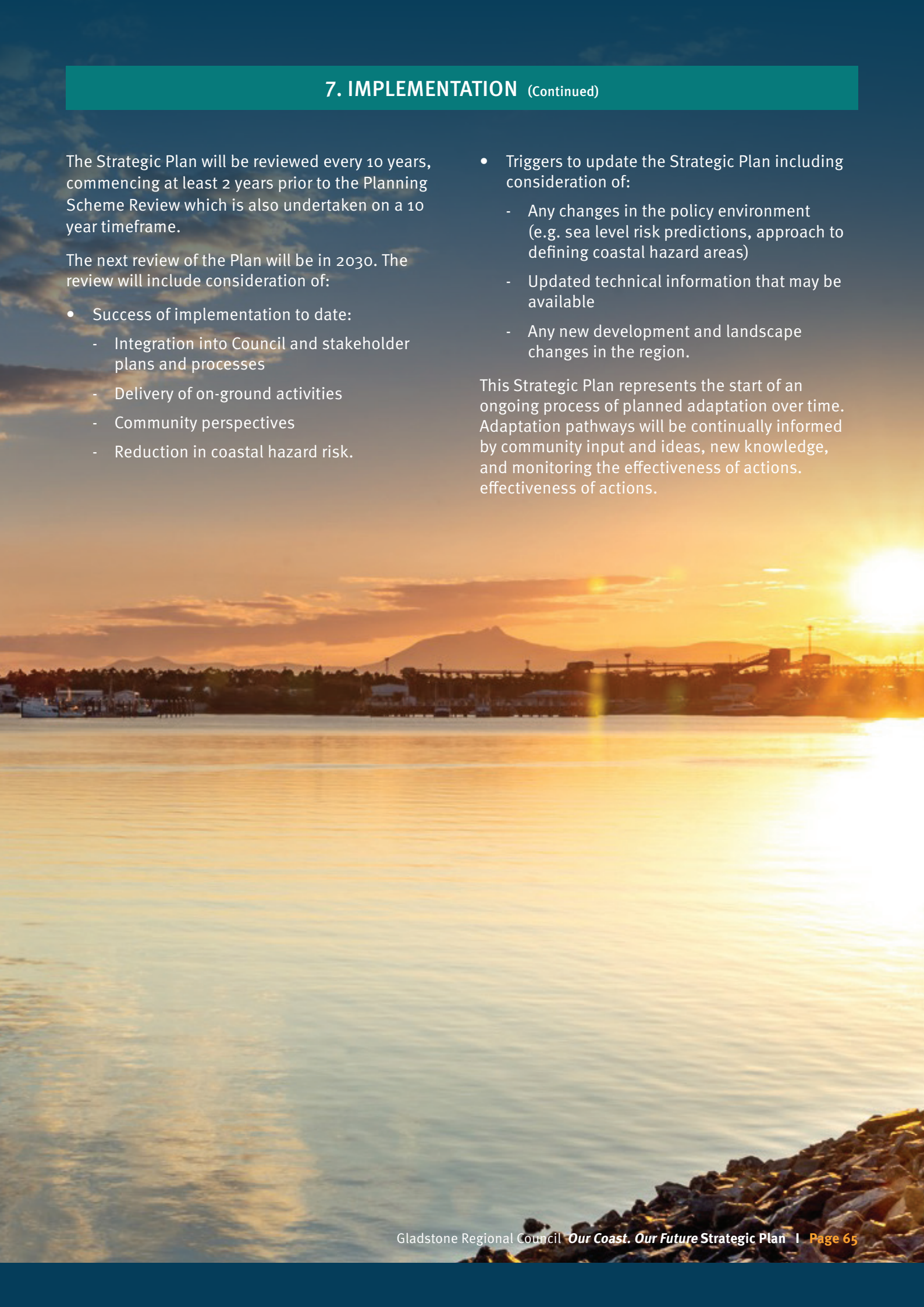
7. IMPLEMENTATION (Continued)

The Strategic Plan will be reviewed every 10 years, commencing at least 2 years prior to the Planning Scheme Review which is also undertaken on a 10 year timeframe.

The next review of the Plan will be in 2030. The review will include consideration of:

- Success of implementation to date:
  - Integration into Council and stakeholder plans and processes
  - Delivery of on-ground activities
  - Community perspectives
  - Reduction in coastal hazard risk.
- Triggers to update the Strategic Plan including consideration of:
  - Any changes in the policy environment (e.g. sea level risk predictions, approach to defining coastal hazard areas)
  - Updated technical information that may be available
  - Any new development and landscape changes in the region.

This Strategic Plan represents the start of an ongoing process of planned adaptation over time. Adaptation pathways will be continually informed by community input and ideas, new knowledge, and monitoring the effectiveness of actions. effectiveness of actions.



REFERENCES

ACKNOWLEDGMENT

We would like to thank everyone who submitted entries for our community Coastline Photo Competition, many which we've used throughout this Plan. A special mention to our finalists:

Jodie Patchett (Amateur Winner)
– Gladstone Marina

Jayden Head (Amateur Runner Up)
– Southend, Curtis Island

Angie Kruger (Professional Winner)
– Seventeen Seventy

Stuart McKay (Professional Runner Up)
– Seventeen Seventy

Heather Jay (Councillor Choice Winner)
– Heron Island turtle

Bianca Sparshott (Councillor Choice Runner Up)
– Wild Cattle Creek

Ben Wardell (Youth Winner)
– Boyne Valley

Kael Patchett (Children Winner)
– East Shores Park

Ben Lowry (Children Runner Up)
– Boyne River

SUPPLEMENT A

Fact Sheets

SUPPLEMENT B

Coastal hazard mapping

SUPPLEMENT C

Adaptation actions – summary sheets

South End Curtis Island - J. Head

Wild Cattle Island - S. McLeod

GLADSTONE
REGIONAL COUNCIL

Gladstone Harbour - N. Barrett