# Shoreline Erosion Management Plan – Final Draft Report

## Hinchinbrook Shire SEMP

Hinchinbrook Shire Council

27 June 2023

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# GLOSSARY AND DEFINITIONS

| Term / Abbreviation | Definition |
|---|---|
| accretion | The accumulation of beach sediment on a shoreline, having been deposited by natural processes. |
| AEP | Annual Exceedance Probability: The measure of the likelihood (expressed as a probability) of an event equalling or exceeding a given magnitude in any given year. A 90% AEP flood has a high probability of occurring or being exceeded each year; it would occur quite often and would be relatively small. A 1%AEP flood has a low probability of occurrence or being exceeded each year; it would be fairly rare, but it would be relatively large. |
| AHD | Australian Height Datum (AHD) is the geodetic datum for altitude measurement in Australia. The level of 0.0 m AHD approximately corresponds to mean sea level. |
| ARI | Average Recurrence Interval (ARI) is a statistical estimate of the average period in years between the occurrences of an event of a particular size. For example, a 100-year ARI event will occur on average once every 100-years. Such an event would have a 1% AEP (probability of occurring in any particular year) |
| angle of repose | The steepest angle at which a sloping surface formed of loose unconfined material is naturally stable. |
| astronomical tide | Water level variations due to the combined effects of the Earth's rotation, the Moon's orbit around the Earth and the Earth's orbit around the Sun. It excludes and oceanographic or meteorological influences. |
| bathymetry | The term bathymetry originally referred to the ocean's depth relative to sea level, although it has come to mean "submarine topography," or the depths and shapes of underwater terrain. |
| calibration | The process by which the results of a computer model are brought to agreement with observed data by fine-tuning certain model parameters. |
| coastal inundation | Flooding of coastal land due to inundation by ocean waters. |
| coastal processes | The physical processes that act to shape the coast and the landforms that make up the coast. |
| Coriolis force | The Coriolis effect describes the pattern of deflection taken by objects not firmly connected to the ground, as they travel long distances around the Earth. This force is caused by the latitudinal gradient in the earth rotational speed. |
| CSIRO | The Commonwealth Scientific and Industrial Research Organisation, the federal government agency for scientific research in Australia. |
| dilation | The observed tendency of a compacted granular soil (such as sand) to expand in volume as it is sheared. |
| ebb tide | The outgoing tidal movement of water within an estuary. |
| EVA | Extreme Value Analysis. A statistical tool to estimate the likelihood of the occurrence of extreme values based on observed/measured data. |
| exceedance probability | The probability of an extreme event occurring at least once during a prescribed period of assessment is given by the exceedance probability. The probability of a 1 in 100-year event (1% AEP) occurring during the first 25 years is 22%, during the first 50 years the probability is 39% and over a 100-year asset life the probability is 63%. |

| Term / Abbreviation | Definition |
|---|---|
| fetch | The unobstructed water surface (e.g., ocean) that wind travels over in a constant direction to create wind-generated waves. A longer fetch length results in larger wave heights. |
| flood tide | The incoming tidal movement of water within an estuary. |
| fluvial | Fluvial processes are associated with the actions of rivers, creeks, and streams - and the deposits and landforms created by them. |
| foreshore | The area of shore between low and high tide marks and land adjacent thereto. |
| geophysical survey | A geophysical survey detects and maps subsurface features. |
| HAT | Highest Astronomical Tide: the highest water level that can occur due to the effects of the astronomical tide in isolation from meteorological effects. |
| hydrographic survey | A hydrographic survey maps the features of the sea bottom. |
| intertidal | The area of a shoreline that is above water at low tide and under water at high tide (in other words, the area between the low and high tide levels). |
| king tides | King tide is a non-scientific term, but the popular concept is that it is the higher high waters which occur around Christmas, when the earth is closest to the sun. |
| LAT | Lowest Astronomical Tide. the lowest water level that can occur due to the effects of the astronomical tide in isolation from meteorological effects |
| littoral | Relating to (or situated on) the shore of the sea. |
| littoral drift | The natural geographical process that consists of the transportation of sediments along a coast. |
| longshore | In the direction along the shoreline (i.e., parallel to the coast). |
| MHWN | Mean High Water Neap. The long-term mean of the heights of two successive high waters when the range of tide is the least at the time of first and last quarter of the moon. |
| MHWS | Mean High Water Springs. The long-term mean of the heights of two successive high waters during those periods of 24 hours (approximately once a fortnight) when the range of tide is greatest, during full and new moon. |
| MLWN | Mean Low Water Neap. The long-term mean of the heights of two successive low waters over the same periods as defined for MHWN. |
| MLWS | Mean Low Water Springs. The long-term mean of the heights of two successive low waters over the same periods as defined for MHWS. |
| MSL | Mean Sea Level. The mean level of the sea over a long period (preferably 18.6 years) or the mean level which would exist in the absence of tides. |
| MSLR | Mean Sea Level Rise. |
| neap tides | Neap tides occur during the time of first and last quarter of the moon, when the gravitational influences of the sun and moon are not aligned, resulting in high and low tides that are not as extreme as those during spring tides. |
| palustrine wetlands | Vegetated wetlands in a non-channel environment, including billabongs, swamps, bogs, springs, and soaks. They have more than 30% emergent vegetation |

| Term / Abbreviation | Definition |
|---|---|
| significant wave height | Due to the random nature and size of waves, the term “significant wave height” is used by engineers and scientists to quantify wave heights in a sea state. It represents the average of all the third highest waves that occur over a particular timeframe. It is typically written as Hs. It is important to appreciate that in deep offshore waters the largest individual wave in the sea state may be around twice the significant wave height |
| spring tide | In a lunar month, the highest tides occur at the time of the new moon and the full moon (when the gravitational forces of sun and moon are in alignment). These are called “spring” tides and they occur approximately every 14 days. |
| storm surge | The meteorological component of the coastal water level variations associated with atmospheric pressure fluctuations and wind setup. |
| storm tide | Coastal water level produced by the combination of astronomical and meteorological (storm surge) ocean water level forcing. |
| subaerial | On the earth’s surface, not underwater or underground. |
| subaqueous | Situated under water. |
| tidal planes | A series of water levels that define standard tides, e.g., 'Mean High Water Spring' (MHWS) refers to the average high-water level of Spring Tides. |
| wave height | The vertical difference between the elevation of a wave crest and a neighbouring trough. |
| wave frequency | The number of waves per second, measured in Hz. |
| wave length | The horizontal distance between two wave crests. |
| wave period | The time it takes for two successive wave crests to pass a given point. |
| wave run-up | The vertical distance between the maximum height that a wave runs up the beach (or a coastal structure) and the still water level, comprising tide and storm surge. |
| wave set-up | When waves break on a beach, they produce wave set-up, which is an increase in the nearshore water level above the still water elevation of the sea. Wave set-up can be considered as a piling up of water against the shoreline that is caused by breaking waves causing a transfer of kinetic to potential energy. |
| WRB | Wave Rider Buoy. A floating buoy design to measure wave height, period, and direction. |

# 1 INTRODUCTION

## 1.1 Background

Hinchinbrook Shire is located in North Queensland and has a coastline that extends from Crystal Creek in the south to Dungeness in the North, covering over 50 km of open coast and estuarine environments. Figure 1-1 shows a map of the Hinchinbrook Shire coastal zone, including the estuaries.

The coastal zone of Hinchinbrook Shire is an essential recreational and aesthetic asset for residents of the district and its visitors. The Hinchinbrook coastal zone includes high biodiversity, conservation, and cultural values. It is important to manage the coastal zone thoughtfully to maintain/enhance the coastal amenities into the future, to support the local coastal community aspirations, and to recognise the stakeholders' positions.

Hinchinbrook Shire Council (HSC) has completed a Coastal Hazard Adaptation Strategy (CHAS), known as ‘Hinchinbrook Coast 2100’, as part of the QCoast2100 State program. Future adaptation responses have been set out in the CHAS for different locations throughout the Shire for a number of planning horizons (present day, 2030, 2070 and 2100). The adaptation responses follow a general pathway where the response changes depending on the changing risk profile. Whilst the CHAS is intended to provide long term adaptation options for future management of risk, it is the immediate threat of coastal erosion on social, environmental, cultural, and economic values that requires short term attention. Therefore, Council has identified the need for a Shoreline Erosion Management Plan (SEMP) for its coastal settlements.

HSC has recognised the importance of the coastal zone to its community's natural, cultural, and socio-economic welfare and has embarked on developing a SEMP for the region to address erosion risk for its coastal settlements.

Specifically, this SEMP covers the following coastal precincts:

- Dungeness and Lucinda, as shown on Figure 1-2;
- Taylors Beach, as shown on Figure 1-3; and
- Forrest Beach and Cassady Beach, as shown on Figure 1-4.

## 1.2 Objectives of this Shoreline Erosion Management Plan

The Hinchinbrook SEMP will provide a framework for the long-term protection, sustainable use, and enjoyment of coastal public lands and assets. A SEMP is a non-statutory planning document that sets out an agreed framework and management strategy for responding to existing erosion problems and possible future erosion threats.

The objectives of the SEMP will be achieved by considering the physical coastal processes in conjunction with the environmental, cultural, social, and economic values associated with the management of public foreshore. The Hinchinbrook SEMP will detail potential short-term to medium-term and long-term management goals that are aligned with the Council and the community values. The SEMP will:

- Identify priority sites where Council controlled land and infrastructure are threatened by coastal erosion and provides appropriate, sustainable management responses for these sites;
- Enable Hinchinbrook Shire Council and the local community to proactively plan for erosion management in these vulnerable areas in a way that is consistent with best practice coastal management, community values, relevant legislation (Commonwealth, State and Local) and all relevant coastal and environmental policies;
- Investigate and address the underlying causes of shoreline erosion and its likely future progression;

- Determine cost-effective and sustainable erosion management strategies that maintain natural coastal processes and resources; and
- Consider community needs in both the short- and long-term.

The framework outlined in the QLD Coastal Management Plan (CMP) states that a SEMP is the Department of Environment and Science's (DES) preferred method to address shoreline erosion issues at the local government level. DES has published a guideline to assist local governments in the preparation of SEMPs to plan for erosion management within designated Erosion Prone Areas proactively. That guideline advocates[1] that a SEMP should "*be based on a planning period of up to 20 years*". The approach adopted for this SEMP is to adopt the maximum 20-year recommended planning horizon when determining appropriate erosion mitigation strategies.

This SEMP has been developed in accordance with the framework set out in the CMP. This SEMP is intended to guide Council in managing the erosion risk of the land under its control. However, it does not bind local government to take action to protect private land from coastal erosion (DEHP, 2013). It should be recognised that protection of private property is primarily the responsibility of the property owners.

The implementation of the actions included in the SEMP are subject to available funding, and Council's annual budget review process.

## 1.3 Structure of this Shoreline Erosion Management Plan

The Shoreline Erosion Management Plan has been structured as follows:

- Section 1 consists of an introduction and provides some background to the need for and development of the Plan.
- Section 2 provides an assessment of the environmental and social 'values' of the HSC coastline.
- Section 3 discusses the natural physical processes that have in the past, are currently, and will in the future, shape the project shoreline.
- Section 4 provides an overview of existing coastal protection works.
- Section 5 details how local coastal erosion affects the local coastal values and infrastructure.
- Section 6 offers a detailed description of the potential options to manage coastal erosion and how coastal erosion risk has been estimated.
- Section 7 summarises mitigation options and the options assessment process followed to identify the recommended actions proposed in the SEMP.





[1] Clause 3.3 of Department of Environment and Science (2018)


**Figure 1-1 Study locality and townships of interest**

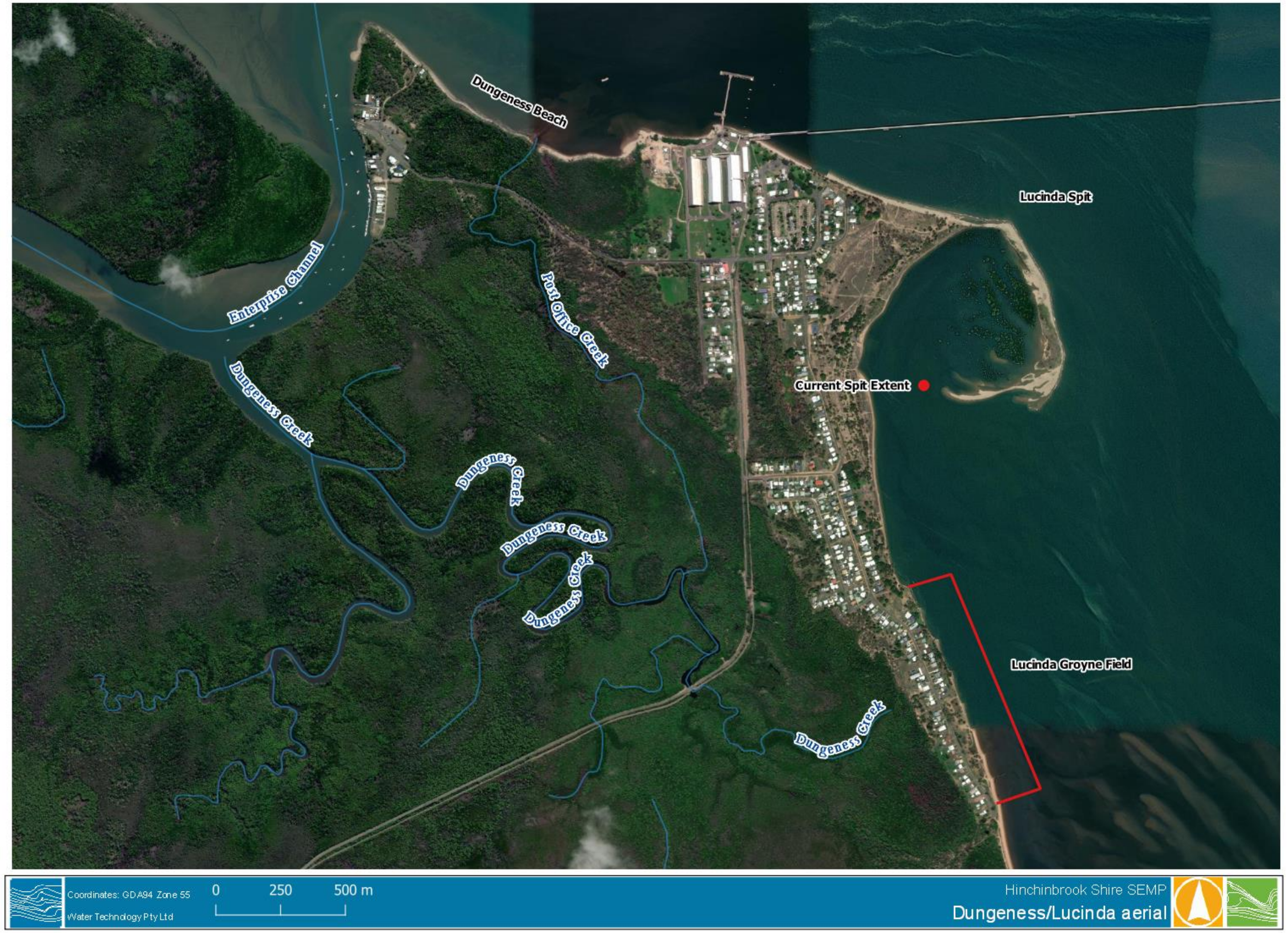


Figure 1-2 Dungeness and Lucinda

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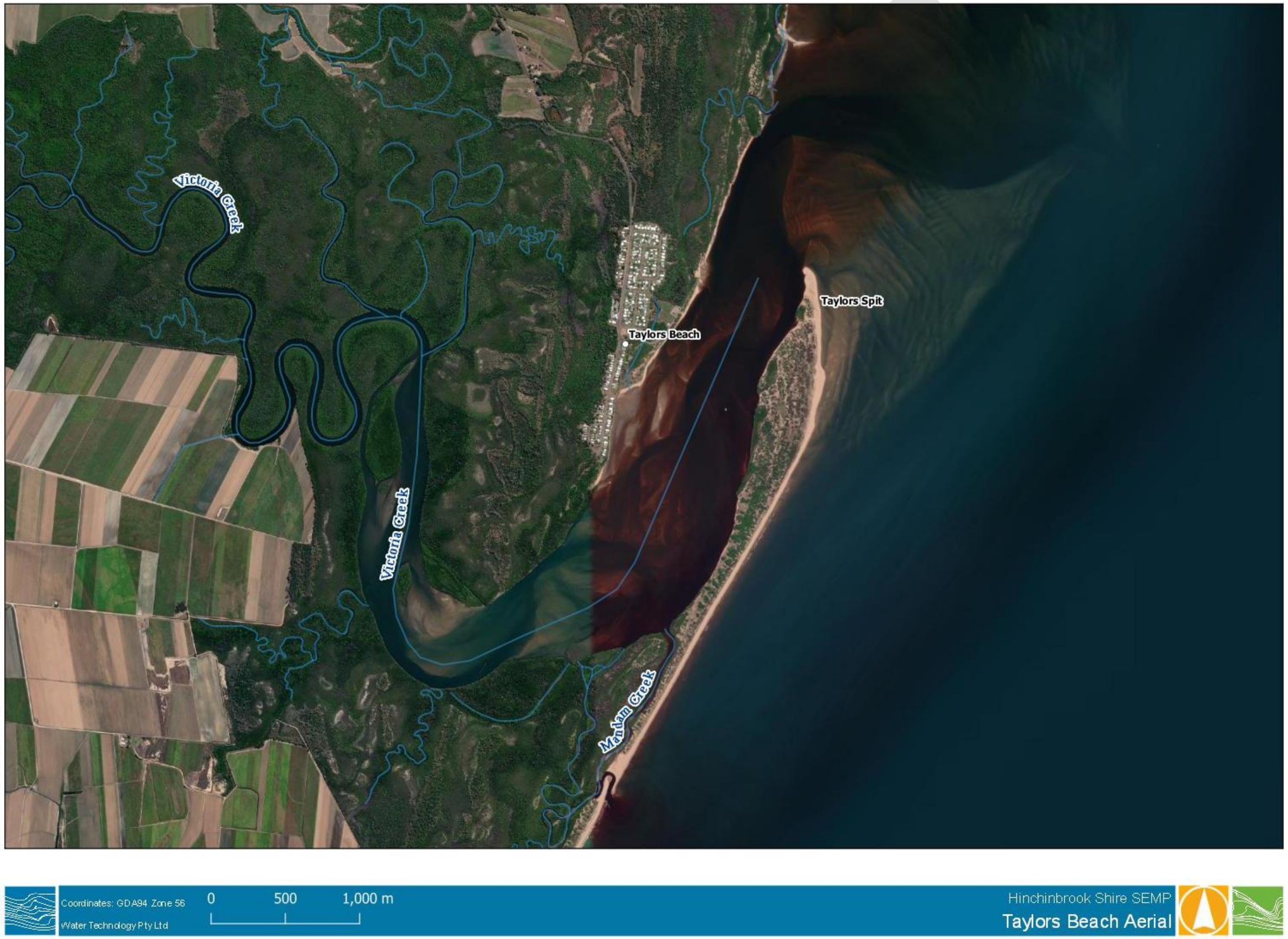


**Figure 1-3 Taylors Beach**

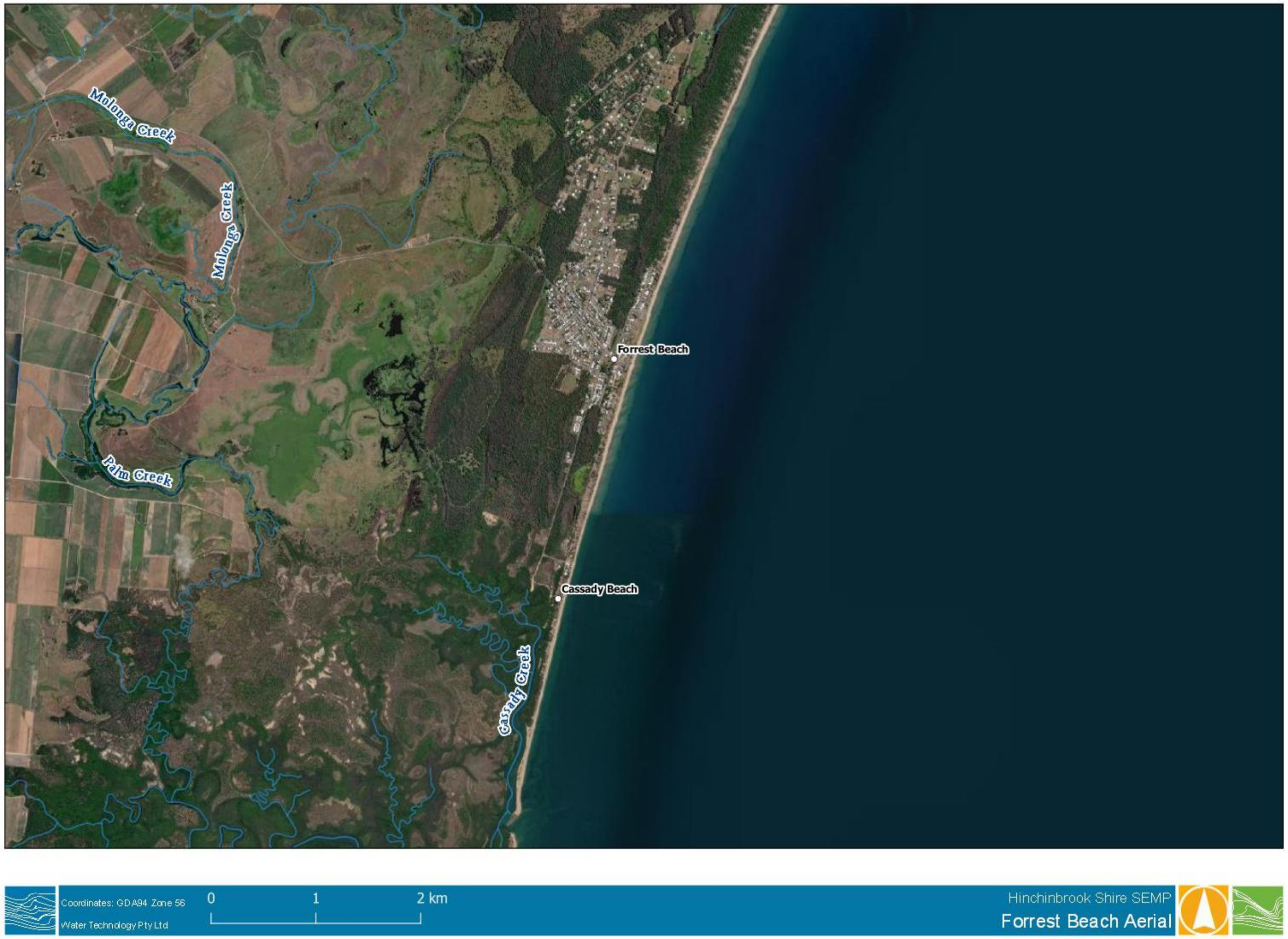


**Figure 1-4 Forrest Beach**

# 2 COASTAL VALUES

The Hinchinbrook coastal region extends over 50 kilometres, with Council-managed foreshore reserves at Taylors Beach, Forrest Beach, and Lucinda. These areas hold environmental, social, cultural, and tourism values for the region as the 'gateway to the wet tropics'. An overview of the environmental, heritage and social values is presented in the following sections for Lucinda, Taylors Beach, Forrest Beach and Cassady Beach coastal precincts.

## 2.1 Environmental Values

### 2.1.1 Natural features

The Hinchinbrook region contains several national parks, a large stretch of coastline, and offshore islands. The National EPBC Protected Matters[2] database was used to identify the natural features of this region, including:

- A number of **rivers, tributaries, and estuarine bays**, including Herbert River, Victoria Creek, Palm Creek, and Insulator Creek.
- Several **terrestrial protected areas**, including Girringun National Park and Indigenous Protected Area, and Halifax Bay Wetlands National Park.
- Several **marine protected areas**, including Girringun Indigenous Protected Area, Great Barrier Reef Coast Marine Park, Great Barrier Reef Marine Park, Hinchinbrook Island Area Dugong Protection Area, Lucinda to Allingham-Halifax Bay Dugong Protection Area, and Halifax Fish Habitat Area.
- A number of **offshore islands**, including Pelorus Island, Orpheus Island, and the Palms Islands.
- A **Key Ecological Feature** is identified offshore from Hinchinbrook Shire Council's coastline, being within the category of *reefs, cays, and herbivorous fish of the Queensland Plateau* within the Coral Sea marine region.
- The natural features of Hinchinbrook represent significant environmental value, including physical landforms, ecosystem types and species diversity of significance.

### 2.1.2 Environmental significance

Queensland Globe[3] spatial mapping was used to identify matters of environmental significance in these localities, as summarised in Table 2-1.





[2] Australian Government (Department of Agriculture, Water, and the Environment) 2022, *Protected Matters Search Tool.* Available: https://www.awe.gov.au/environment/epbc/protected-matters-search-tool
[3] Queensland Government (Department of Resources), Geoscience Australia, Earth-i 2022, *Queensland Globe mapping database*. Available: https://qldglobe.information.qld.gov.au/

Table 2-1 Environmental significance (QLD Globe)

| Environmental value | Lucinda | Taylors Beach | Forrest Beach / Cassady Beach |
|---|---|---|---|
| **Riverine conservation significance** | Very high, High | High | High |
| **Non-riverine wetlands significance** | Very high | Very high | Very high |
| **Biodiversity significance** | State habitat for EVNT taxa, State, Local or Other Values, Protected plants trigger. | State habitat for EVNT taxa, State, Local or Other Values. | State habitat for EVNT taxa, State, Local or Other Values. |
| **Queensland Wetlands mapping** | W_WB-Estuarine wetland, P-WB-Palustrine wetland. | W_WB-Estuarine wetland, P-WB-Palustrine wetland. | W_WB-Estuarine wetland, P-WB-Palustrine wetland, R-WB-Riverine wetland. |
| **Regional Ecosystem mapping** | 7.2.7a, 7.2.8 (endangered, dominant).<br>7.1.2a, 7.1.2b, 7.2.3a (of concern, dominant).<br>7.1.1 (no concern). | 7.2.7a, 7.2.8 (endangered, dominant).<br>7.1.2a, 7.1.2b, 7.2.3a, 7.2.5a (of concern, dominant).<br>7.1.1 (no concern). | 7.2.7a, 7.2.7c (endangered-dominant).<br>7.2.3f, 7.2.5a, 7.2.11e (of concern- sub-dominant).<br>7.1.1 (no concern). |
| **Land zone (pre-clear)** | LZ 1. Quaternary marine deposits.<br>LZ 2. Quaternary coastal dunes and beaches. | LZ 1. Quaternary marine deposits.<br>LZ 2. Quaternary coastal dunes and beaches. | LZ 1. Quaternary marine deposits.<br>LZ 2. Quaternary coastal dunes and beaches. |
| **Regulated Vegetation Management** | RVM Category B – remanent vegetation.<br>RVM Category X – exempt clearing. | RVM Category B – remanent vegetation.<br>RVM Category X – exempt clearing. | RVM Category B – remanent vegetation.<br>RVM Category C – high-value regrowth vegetation. |

### 2.1.3 Vegetation

To understand what environmentally significant plant communities may be present in these areas, Broad Vegetation Groups (BVG) were identified using Queensland Globe mapping. These vegetation groups are described comprehensively in the *Vegetation of Queensland*[4] publication. A summary is provided in Table 2-2 to assist the reader. There is some overlap of BVGs across the precinct as neighbouring ecosystems intercept across overlapping boundaries.

[4] State Government of Queensland 2021, *The Vegetation of Queensland - Description of Broad Vegetation Groups Version 5.0.* Available: (online) https://www.qld.gov.au/environment/plants-animals/plants/ecosystems/broad-vegetation

**Table 2-2 Broad Vegetation Groups (QLD Globe)**

| BVG # | Representative image *(Vegetation of Queensland)* | Description (1:2 million) | Lucinda | Taylors Beach | Forrest Beach / Cassady Beach |
|---|---|---|---|---|---|
| 3 |  | Notophyll vine forest / thicket (sometimes with sclerophull and/or Araucarian emergents) on coastal dunes and sandmass. | | ✓ | ✓ |
| 4 |  | Notophyll and mesophyll vine forest with feather or fan palms on alluvia, along streamlines and in swamps on ranges or within coastal sand masses. | ✓ | | |
| 9 |  | Moist to dry eucalypt open forests to woodlands usually on coastal lowlands and ranges. | ✓ | ✓ | |
| 22 |  | Melaleuca spp. on seasonally inundated open forests/woodlands of lowland coastal swamps and fringing lines (palustrine wetlands). | ✓ | ✓ | ✓ |
| 28 |  | Open forests to open woodlands in coastal locations. Dominant species such as *Casuarina* spp., *Corymbia* spp., *Allocasurina* spp (she-oak)., *Acacia* spp., *Lophostemon suaveolens* (swamp box), *Asteromyrtus* spp., *Neofabricia myrtifolia.* | ✓ | ✓ | ✓ |
| 32 |  | Closed tussock grasslands in coastal locations. | | | ✓ |
| 34 |  | Wetlands associated with permanent lakes and swamps, as well as ephemeral lakes, claypans and swamps. Includes fringing woodlands and shrublands. | | | ✓ |
| 35 |  | Mangroves and saltmarshes. | ✓ | ✓ | ✓ |

### 2.1.4 Biodiversity Values

The Hinchinbrook region is highly biodiverse. The Atlas of Living Australia[5] database summarises the number of species recorded within a five-kilometre radius of the focus localities (Table 2-3). The Atlas shows the diversity of species and the distribution of groups between the localities. A high proportion of birds, molluscs and arthropods have been reported in the Hinchinbrook coastal tropical biome.

However, it should be noted that The Atlas of Living Australia is not a complete record of the total number of species that could be found within an area. The data presented in Table 2-3 is only as good as the observations recorded. Nevertheless, the region is highly biodiverse across a range of plants and animals with a variety of important ecosystems.

Table 2-3 Number of species recorded within a 5km radius of locality (Atlas of Living Australia)

| Group | Lucinda | Taylors Beach | Forrest Beach / Cassady Beach |
|---|---|---|---|
| Mammals | 13 | 1 | 8 |
| Birds | 213 | 151 | 272 |
| Reptiles | 16 | 1 | 4 |
| Amphibians | 0 | 2 | 5 |
| Fishes | 15 | 1 | 37 |
| Molluscs | 109 | 3 | 30 |
| Arthropods | 52 | 6 | 101 |
| Crustaceans | 13 | 1 | 18 |
| Insects | 37 | 4 | 79 |
| Plants | 121 | 25 | 95 |
| Fungi | 3 | 0 | 17 |
| **Total** | **568** | **190** | **575** |

Lucinda is also the location of an important nesting colony of Little Terns, where the global population is estimated at only 1200 adults. They nest on sandspits and open beaches, which makes them vulnerable to the loss of eggs and chicks by both vehicles and dogs (pers comm. Birdlife Australia, 2023). In addition, Lucinda is a congregation location for migratory shorebirds, including the Eastern Curlew, Great Knot, Greater Sand Plover, Lesser Sand Plover, Grey-tailed Tattler, Whimbrel, and the Sharp-tailed Sandpiper. Of these, two are critically endangered, one is vulnerable, and one is endangered.

## 2.2 Heritage Values

The local heritage values within the region were assessed by inspecting The Australian National Heritage Database[6] (DEE, 2019) and the Queensland Heritage Register (DES, 2019). A summary of this assessment is provided in Table 2-4.





[5] Atlas of Living Australia 2022, *Explore Your Area.* Available: https://www.ala.org.au/
[6] Australian Government (Department of Agriculture, Water, and the Environment) 2022, *Australian National Heritage Database.* Available: https://www.awe.gov.au/parks-heritage/heritage/publications/australian-heritage-database

### 2.2.1 National and State Heritage

**Table 2-4 Summary of Heritage Items**

| Heritage Item | Place ID | Description of Significance | Class |
|---|---|---|---|
| Foam Shipwreck, Myrmidon Reef via Lucinda, QLD | 14836 | The 1893 wreckage of a wooden vessel is located approximately 115km east-north-east of Lucinda on the Myrmidon Reef. This is a registered heritage item, being listed on the Register of the National Estate (non-statutory archive).  The wreck of the Foam was discovered in 1982 by Queensland Museum maritime archaeologists and was declared protected in 1983. | Historic |
| Nypa Palms National Park, Halifax, QLD | 8997 | The Nypa Palms National Park supports a large relic and disjunct population of the palm *Nypa fruticans*, a monotypic plant of ancient origin. Nypa pollen has been recorded from lower cretaceous (110-120 million years ago) beds in England and South America, while pollen analysis suggests that it was widespread across Australia during the early Tertiary (60 million years ago). The occurrence of Nypa in the Herbert River mouth is the southernmost known global occurrence of this species. The Nypa Palms National Park population of *Nypa fruticans* is the only readily accessible Australian population, which, as an ancient and monotypic species, is of scientific importance. <br>Located within the delta of the Herbert River, the Nypa Palms National Park is an intertidal area of the Hinchinbrook Channel. The area consists of fine and organically rich silt deposits and is subject to a perennially high input of freshwater. Tidal flow, rich and fine silts and low salinity waters are all required for optimum growth and spread of the monotypic palm. Nypa dominates most of the National Park, though mangroves, including several species of Bruguiera and Rhizophora are present.<br>Nypa Palms are susceptible to increases in salinity, meaning their integrity is reliant on the continued strong flow of the Herbert River. The palms may also be adversely affected by pollutants carried in the waters of the Herbert. A tide gate has been erected to protect the palm stand from excessive tidal flooding, which has, however, had a detrimental effect on some of the other mangrove species and the area is presently in good condition. The integrity of the area may also be affected by climate change, particularly sea level rise, which is likely to increase the salinity and inundation depth of the water in the area. | Natural |

### 2.2.2 Indigenous Cultural Heritage

The Hinchinbrook region is home to several different Indigenous groups. The Girringun Aboriginal Corporation[7] represents the interests of Traditional Owners from nine tribal groups of the area, being the Bandjin, Djiru, Girramay, Gugu Badhun, Gulngay, Jirrbal, Nywaigi, Warrgamay and Warungnu. This corporation facilitates stewardship of the Girringun Region Indigenous Protected Areas (over 1.2 million ha of terrestrial, coastal, and marine environments). The Aboriginal people have an ancient and ongoing association with the area, including a complex cultural, spiritual, and social relationship with natural waterways and coastal foreshores.

It is understood that Halifax Bay Wetlands National Park, the adjoining Mungulla Station and the broader area of the Herbert floodplain are highly significant to the Nwaigi people. The Nwaigi people are involved in caring for Halifax Bay Wetland National Park as custodians and land managers. They are actively engaged by Queensland Parks and Wildlife Services (QPWS) as part of the broader Girringun ranger program.[8]

*Consider consulting heritage officers within Council and the Girringun Aboriginal Corporation to identify the presence of cultural items at focus locations, as well as Indigenous cultural heritage management plan recommendations.*

Research from the University of Queensland[9] has identified Indigenous cultural heritage items or 'material culture', such as clothing and dwellings, that were historically used in the region. However, colonial history bias and oral traditions have challenged the recording of Indigenous heritage and the inventory of culturally significant sites and values.

For instance, the Orpheus Island National Park management plan states that there are several Aboriginal cultural sites of significance on the island, including a midden at the Research Station. It also states that further work is required to identify further Aboriginal sites. This work has been further developed in subsequent studies and management plans, including the Great Barrier Reef Marine Park Authority publications[10]. However, considering the deep and lasting indigenous connections with Country, such research work is unlikely to be exhaustive.

A range of cultural items likely to be present in this region is presented in Table 2-5. Additionally, it is important to consider the potential impact of coastal erosion and salt water intrusion on natural environments, which also hold cultural and spiritual significance.

**Table 2-5 Summary of Indigenous Cultural Items in the Hinchinbrook region**

| Aboriginal Cultural Item | Description of Significance |
|---|---|
| Artefacts | Research discusses the use of swords, shields, clubs, spears, canoes in the Hinchinbrook region and some artifacts from this region having been transported to museums in other states. |

[7] Further information about The Girringun Aboriginal Corporation is available*:* https://www.girringun.com/
[8] Queensland Government 2013, *Halifax Bay Wetlands National Park Management Statement 2013.*
[9] H.C. Brayshaw 1977, University of Queensland. *Aboriginal Material Culture in the Herbert/Burdekin District: A cultural crossroads?* Corpus ID 129799991.
[10] The Great Barrier Reef Marine Park Authority 2019, *Monitoring islands within the Reef 2050 Integrated Monitoring and Reporting Program: Final Report of the Islands Expert Group.*

| Aboriginal Cultural Item | Description of Significance |
|---|---|
| Middens and fish traps | Shell middens are located on Orpheus Island, among other locations. Relatively undisturbed sites may contain features of cooking hearths, stone arrangements, artefact knapping horizons and terrestrial dietary remains.<br>Different kinds of middens and evidence of fish traps are found along the North Queensland coast and islands within the Great Barrier Reef. Some sites have been disturbed by visitors, pests or through coastal processes such as siltation and waves. |
| Pigment art | Aboriginal rock art represents a significant cultural record of human behaviour, spiritual values, and stories. |
| Quarry and knapping sites | Stone artefact scatters that illustrate past habitation, food processing and implement manufacturing activities. |
| Burials | It is important to know the location of historic Aboriginal burials, particularly in coastal areas and on islands. Aboriginal skeletal remains may become exposed during earthworks and as a result of natural processes such as foreshore erosion. |

## 2.3 The Social Environment

Social Values are beliefs and attitudes about what is considered important, desirable, or acceptable in a particular society or culture. Social Values can relate to a wide range of topics, such as family, education, work, community, justice, equality, and freedom. Social Values often shape individuals' behaviour and decision-making and influence the development of social norms and laws. They can also change over time as society evolves and new ideas emerge.

Across the HSC coast, Social Values may include beach activities (running, sitting, relaxing on the sand, beachcombing, etc.), water recreation (swimming, snorkelling, etc.), watercraft activities (kayaking, paddle boarding, etc.), fishing and/or boating. Vehicle beach access is a major recreational pursuit along Forrest Beach, and there are nominated zones where vehicle beach access is permitted (see Figure 2-1).

The HSC coast offers a quiet and less crowded opportunity to enjoy the natural environment of the Great Barrier Reef World Heritage Area. Still, it is nevertheless within a 2-hour driving distance from Townsville. Consequently, the coast contributes significantly to public recreation, relaxation, and enjoyment – not only for the local population of over 10,000 (Australian Bureau of Statistics, 2016), but also to the many visitors and tourists who visit the area.

When considering appropriate erosion management strategies, it is necessary to consider the following specific issues relating to the social environment:

- ensuring no adverse implications to Aboriginal cultural, spiritual, and social relationships with the foreshore;
- maintaining existing public use and access to the beaches, foreshore areas, and waterways;
- maintaining the high visual amenity of the foreshore.

As part of this SEMP, a community engagement survey was undertaken to ascertain the social values of the local community. The survey outcomes are discussed below in Section 2.4 and Appendix B.

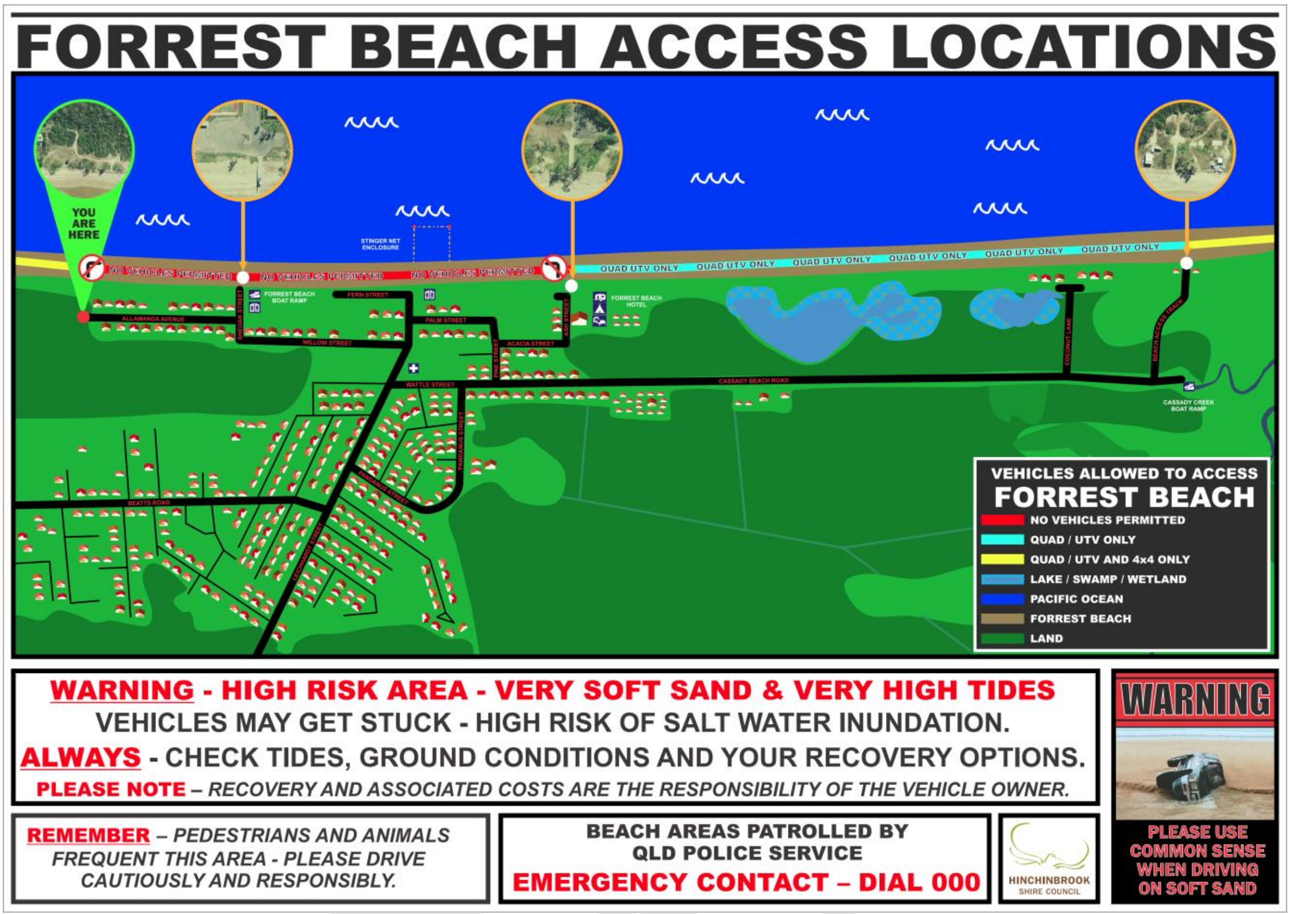


**Figure 2-1 Vehicle Access Zones at Forrest Beach**

## 2.4 Community Uses and Values

An online Community Engagement Survey was undertaken as part of the SEMP to inform the SEMP about what the local community considers to be the most important ecological, social, cultural, aesthetic, recreational, and economic values of the study area. The survey aimed to understand how often local people visit each of the three coastal precincts covered by the SEMP (Lucinda, Forrest Beach, and Taylors Beach), and what activities they engage in at the coast. The survey also aimed to understand community perceptions of coastal hazards (from storm tide, sea level rise and coastal erosion), and attitudes towards potential adaptation options.

The survey results and analysis are attached in Appendix B. A brief overview of the results shows that the community places a high value on maintaining access to the sandy beach system and the associated coastal dunes, as shown in Figure 2-2. The survey also highlighted the desire for intervention on the coast, particularly to manage coastal sand, dunes, to formalise access points and to control development, as shown in Figure 2-3.

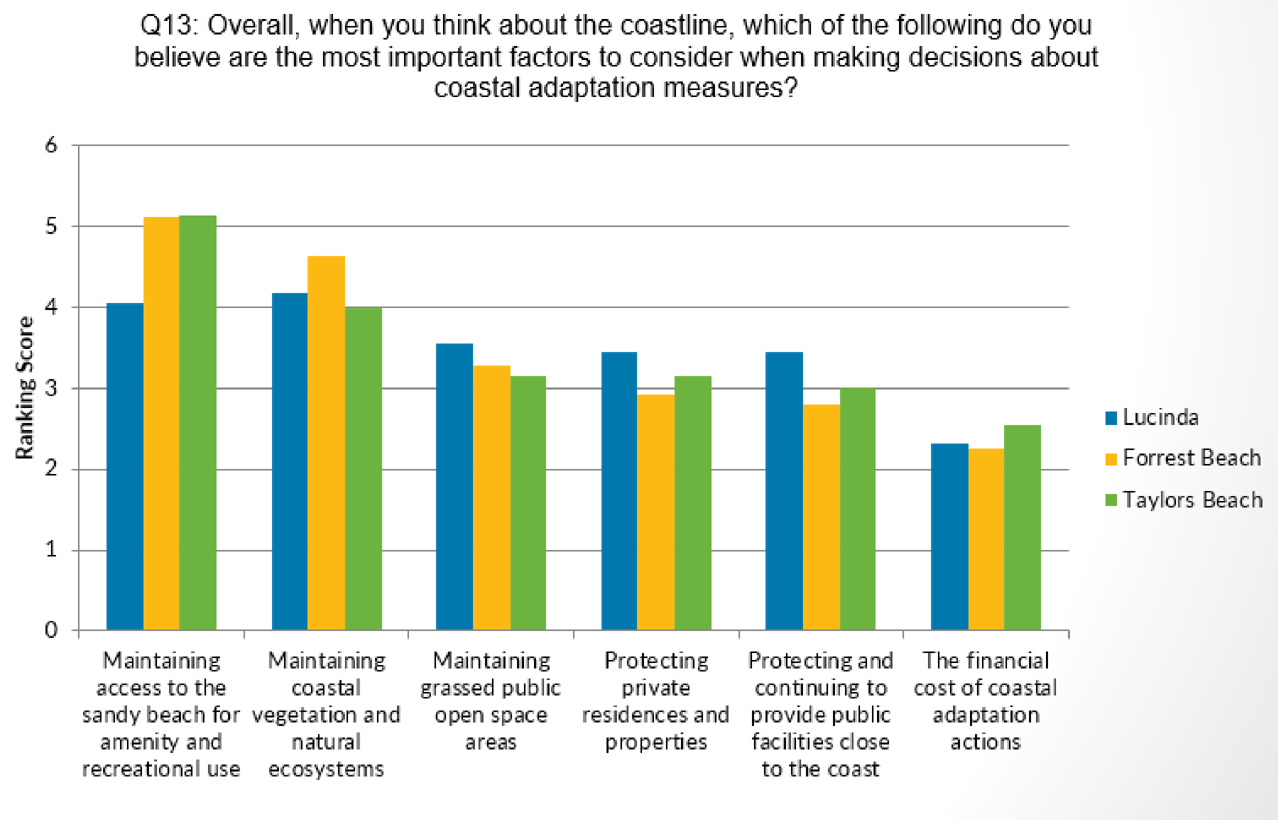


**Figure 2-2 Community values for coastal management planning**

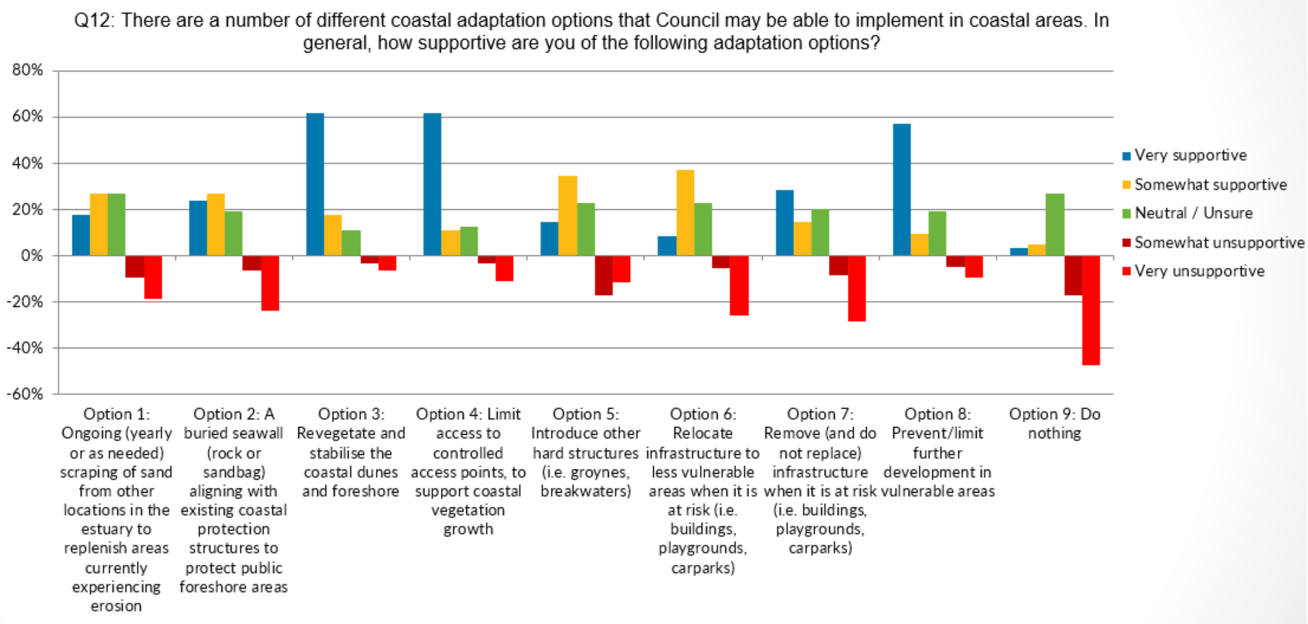


**Figure 2-3 Community viewpoints on potential management approaches**

# 3 SUMMARY OF PHYSICAL PROCESSES

The coastal environment responds continually to the ever-changing influences of waves, tides, ocean currents, winds, and the supply of littoral sediments. Collectively these complex and dynamic coastal processes shape the physical environment of the Hinchinbrook Shire foreshore.

This section of the SEMP defines and quantifies the natural processes contributing to the existing and future erosion threats on the shoreline. It is necessary to have a sound understanding of these processes to develop effective erosion mitigation strategies.

## 3.1 Oceanographic Processes

### 3.1.1 Wind Climate

Regional and local winds can influence the speed and direction of currents, waves, and sediment transport. The wind climate is measured by the Bureau of Meteorology (BoM) at several weather stations near Lucinda, which include:

- Lucinda Point {station 032141}
- Townsville Airport {station 032040} – 91 km south-east of Lucinda
- Cairns Airport {station 031011} – 193 km north-west Lucinda

A summary of the available data at each gauge is shown in Table 3-1.

**Table 3-1 Wind Data Summary**

| Location | Record | Data Provider |
|---|---|---|
| Lucinda Point | 1980 – Present | BoM |
| Townsville Airport | 1940 – Present | BoM |
| Cairns Airport | 1941 – Present | BoM |

The Lucinda anemometer was selected to use in the modelling for wind-generated waves. Data gaps in the Lucinda Point wind record occurred between February 2011 and June 2013, likely associated with damage to the anemometer incurred during Tropical Cyclone Yasi. The wind dataset was supplemented with data from the Cairns weather station for modelling over data gaps. Cairns wind data was a better proxy for Lucinda wind data than the Townsville wind data.

The annual wind climate of Lucinda is summarised within a wind rose presented in Figure 3-1. Lucinda is situated in the trade wind belt. As a result, the area's wind is dominated for most of the year by the south-to-south-east trade winds. There is, however, a pronounced seasonality in the local wind climate. For example, during the dry season from May to September, winds tend to arrive consistently from a more south-easterly direction. Conversely, during the wet season months of October to April, winds are more easterly and interspersed with afternoon northerlies (and occasionally tropical cyclone activity) – see Figure 3-2.

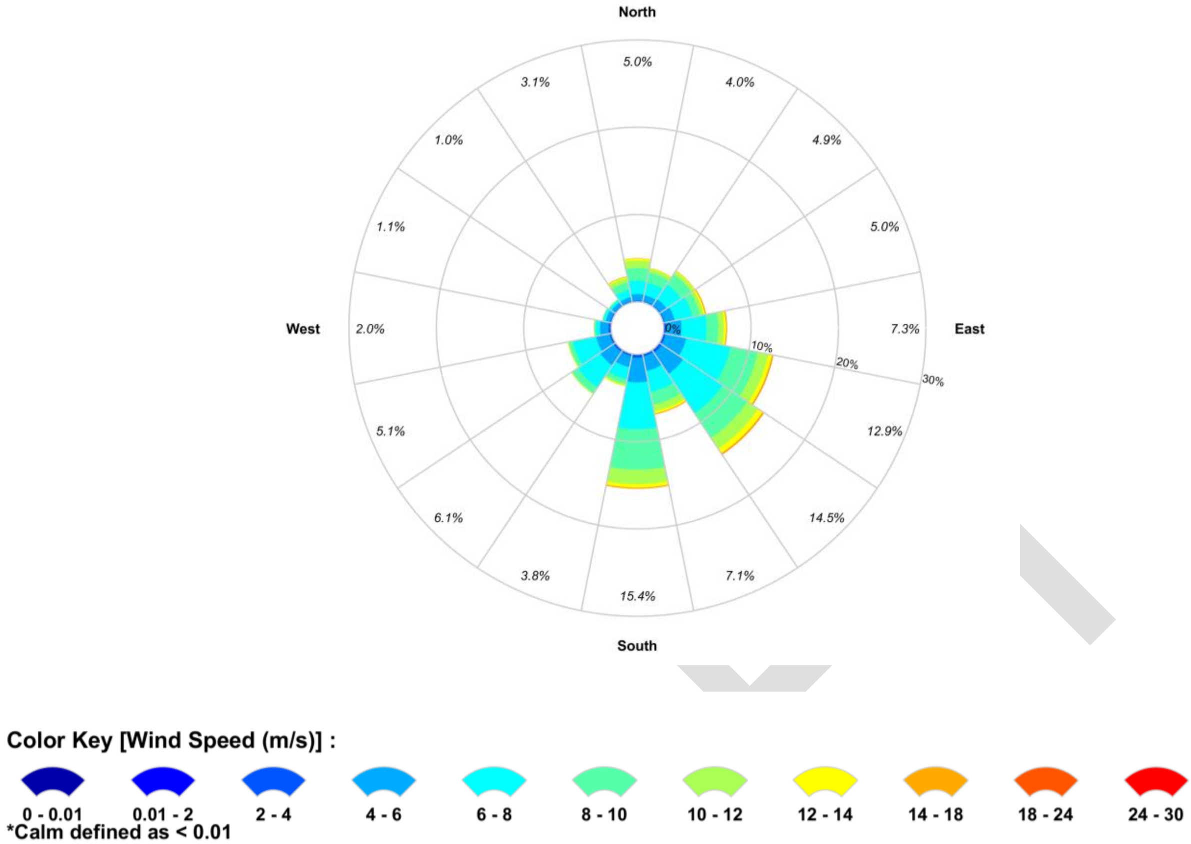


**Figure 3-1 Wind rose of Lucinda (1990 to 2022)**

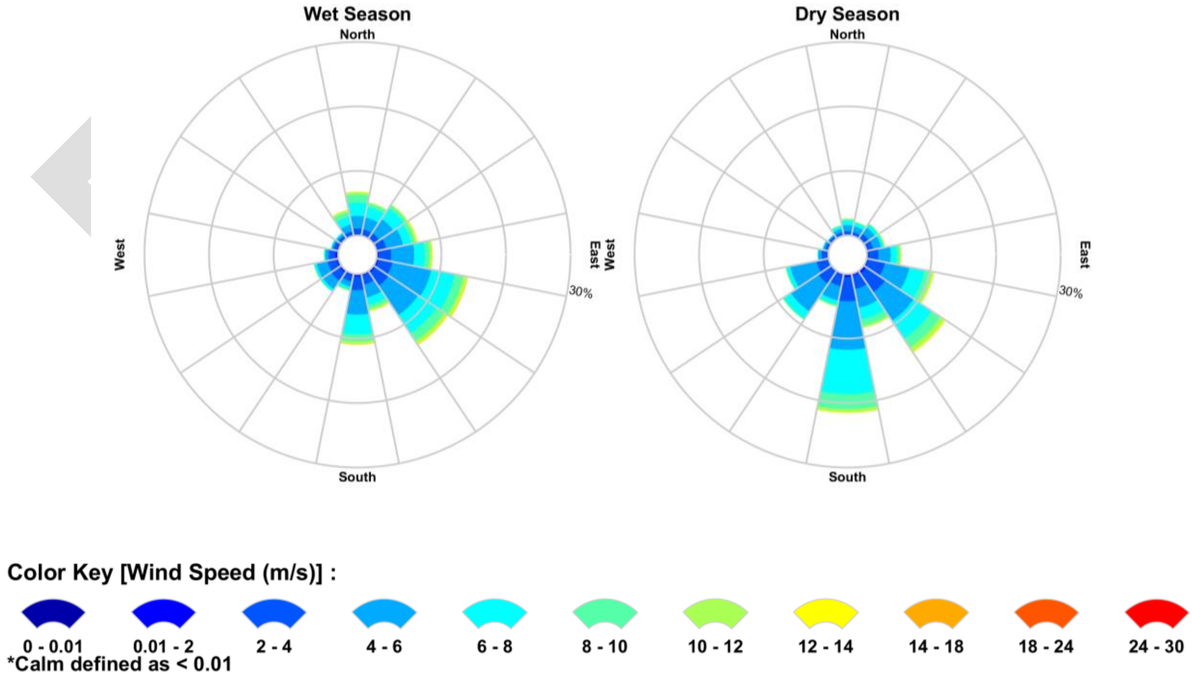


**Figure 3-2 Seasonal Wind Roses of Lucinda Point (1990-2022)**

### 3.1.2 Wave Climate

*Swell Waves*

Weather systems generate swell waves out in the Coral Sea, beyond the Great Barrier Reef. In order to reach the Hinchinbrook coast, these waves must pass through and over the extensive reefs and shallow shoals that constitute the Great Barrier Reef. Consequently, there is considerable attenuation of wave energy during this propagation process, and very little offshore swell wave energy reaches Hinchinbrook.

*Local Sea Waves*

Local sea waves are generated by winds blowing across the open water fetches between the mainland and the outer Great Barrier Reef system. The significant distances between the mainland and the Great Barrier Reef generate large waves. Waves growth is further increased during cyclones, which are relatively common in North Queensland.

The south-easterly trade winds dominate the direction of ambient waves (i.e., the "day-to-day"). Therefore, the majority of local sea wave energy arrives from the southeast. The study area coastline is relatively well protected from easterly and south-easterly waves by the Palm Islands archipelago. However, to the north of the study area, there are very long open water fetches across which winds can generate significant wave energy. It is from this sector that the largest waves approach the study area. These northerly waves generally occur during the wet season, particularly in the afternoon. Additionally, tropical cyclone activity can generate highly energetic northerly winds and waves. Waves from these sources can coincide, generating a cross-sea, which can confuse boating activity.

Waves primarily drive sand transport processes. However, while the dominant south-easterly ambient waves drive a net northerly longshore sediment transport along the HSC coast, the sediment transport is affected by all wave directions and storm events. Therefore, a significant focus of the Shoreline Erosion Management Plan is to investigate the combined effect of ambient waves and extreme waves (i.e., due to cyclones and severe storms) on sediment transport to understand beach stability. Numerical modelling techniques have been used to determine the complex wave and sand transport interplay.

#### 3.1.2.1 Available Wave Data

Queensland Government installed a wave rider buoy (WRB) at Lucinda and recorded hourly, non-directional wave parameters. The deployment period spanned 1995 and 1996 and covered approximately 1 year and 2 months, as detailed in Table 3-2.

**Table 3-2 Lucinda WRB History**

| Site | Latitude | Longitude | Time Period (approx.) | Recording Frequency | Directionality |
|---|---|---|---|---|---|
| Lucinda WRB | -18.5157 | 146.3833 | 1995 March – 1996 May | hourly | Non-directional |

Figure 3-3 timeseries of significant wave height ($H_s$) and peak wave period ($T_p$) indicates that the significant wave height ranged between approximately 0.1 m to 1.5 m and had an average Hs of 0.45 m. The peak wave periods were generally less than 8 seconds, indicating the area is dominated by local sea waves, with some moderate local swells occurring during storms or cyclonic events.

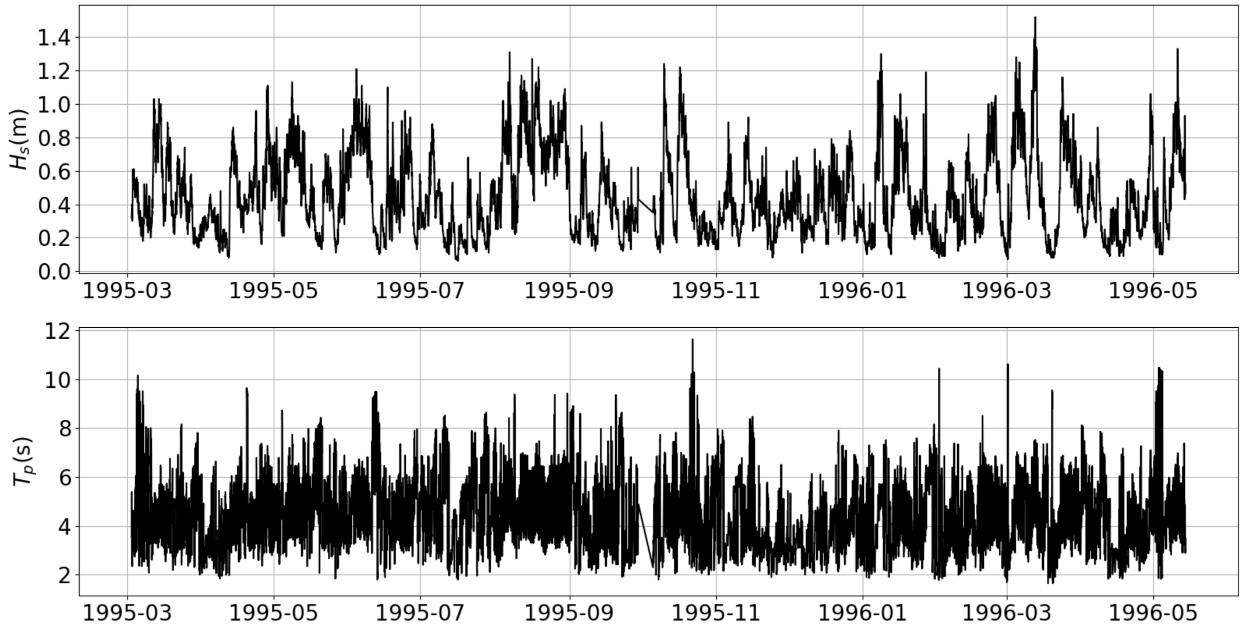


**Figure 3-3 Time Series of Recorded Wave Data at Lucinda WRB: 1995-1996**

Figure 3-4 shows the joint occurrence of $H_s$ against $T_p$. This plot allows the identification of potential swell occurrence in Hinchinbrook Shire coastal waters. It indicated that ambient significant wave heights were typically less than 1m with associated $T_p$ less than 5s. A large number of waves are locally generated waves (wind waves), with negligible long wave energy ($T_P$ > 9s) rather than long period swell incoming from the Coral Sea ($T_p$ > 12s).

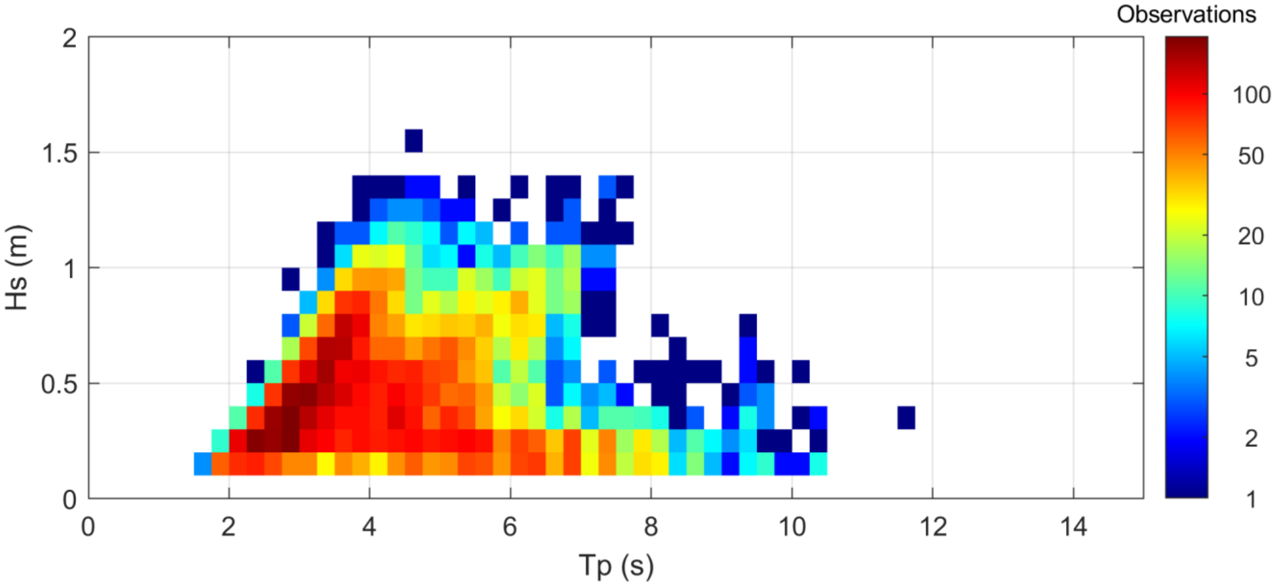


**Figure 3-4 Joint Occurrence of Hs v Tp at Lucinda offshore WRB: 1995-1996**

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#### 3.1.2.2 Numerical Wave Modelling

*Model setup*

The Shoreline Erosion Management Plan should be underpinned by an accurate understanding of sand transport processes along the coast. Waves have a significant effect on sand movements.

Waves along the coastline are strongly affected by local water depth and the geometry of the coast.

The generation and propagation of wind waves, how they are modified by wave refraction, diffraction, seabed friction, shoaling and breaking as they propagate from their offshore generation areas towards the Hinchinbrook coast is complex. In the absence of site specific long-term directional wave measurements at the site, it is possible to obtain an appreciation of the directional wave climate on the local beaches using numerical modelling techniques.

This Shoreline Erosion Management Plan adopted numerical wave modelling techniques to provide such an insight on local coastal processes.

A MIKE 21 Spectral Wave (SW) model was used to determine the wave climate along the Hinchinbrook coastline. Figure 3-5 shows the wave model unstructured flexible mesh extents. In order to maintain the computational efficiency of the model, mesh resolution is of the order of 5000 m farther afield from the coast. However, the mesh resolution in and around nearshore regions is of the order of 300m, which allowed for an accurate description of the local bathymetry (i.e., water depth) and a detailed description of local wave processes along the coastline.

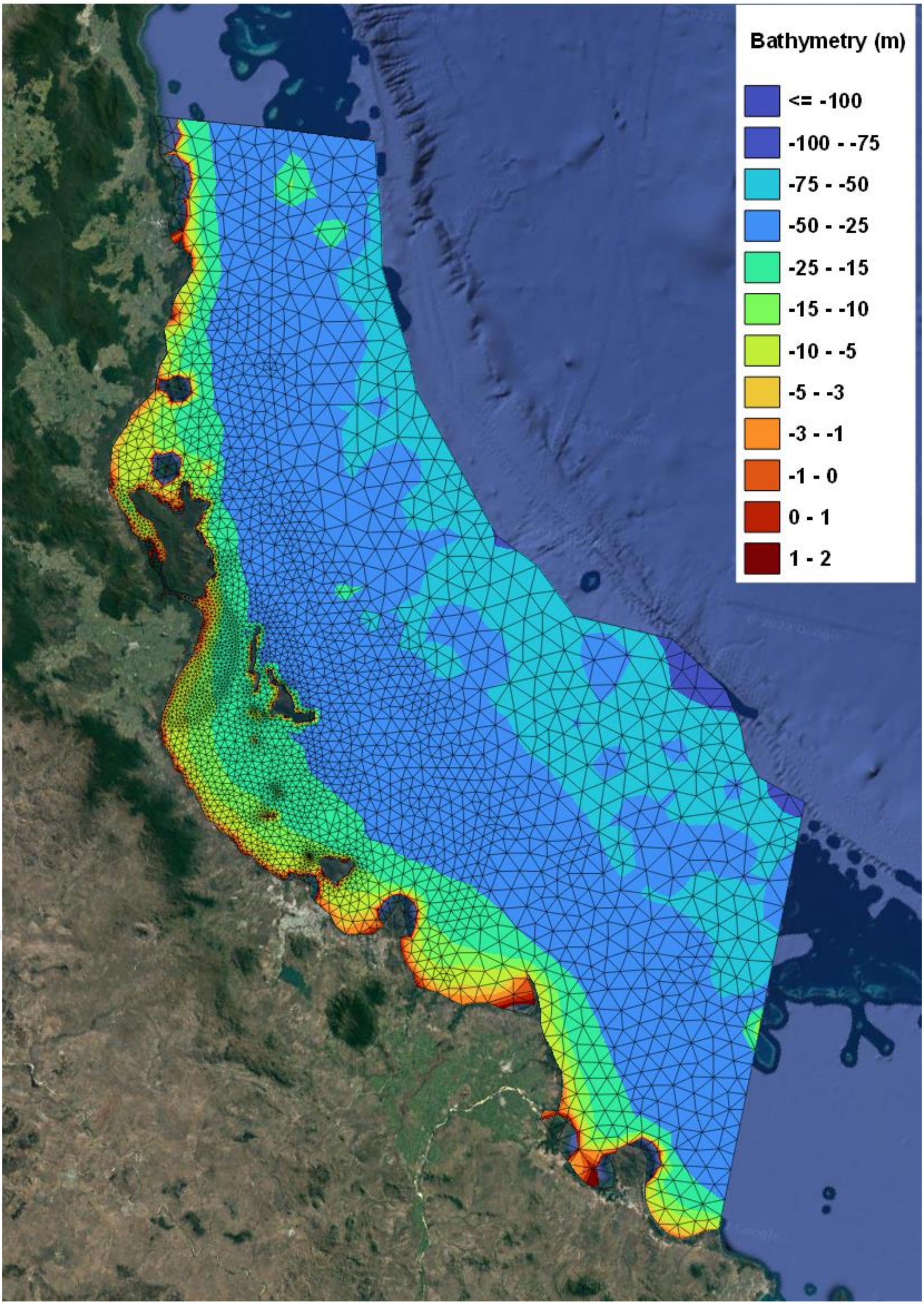


**Figure 3-5 MIKE21 Spectral Wave Model Domain**

### *Model calibration*

Numerical wave models use several parameters, some of which can be calibrated to improve the estimation of nearshore waves along the coast. The wave model results were compared with measurements from the 1995 Queensland Government's Lucinda Waverider buoy (WRB). Model calibration consisted of fine-tuning the Mike 21 SW model parameters to represent observed wave conditions.

Figure 3-6 compares modelled and measured significant wave height (Hs) and wave period (Tp) for a random period in the recorded wave history. The comparison includes both ambient weather conditions and storm conditions.

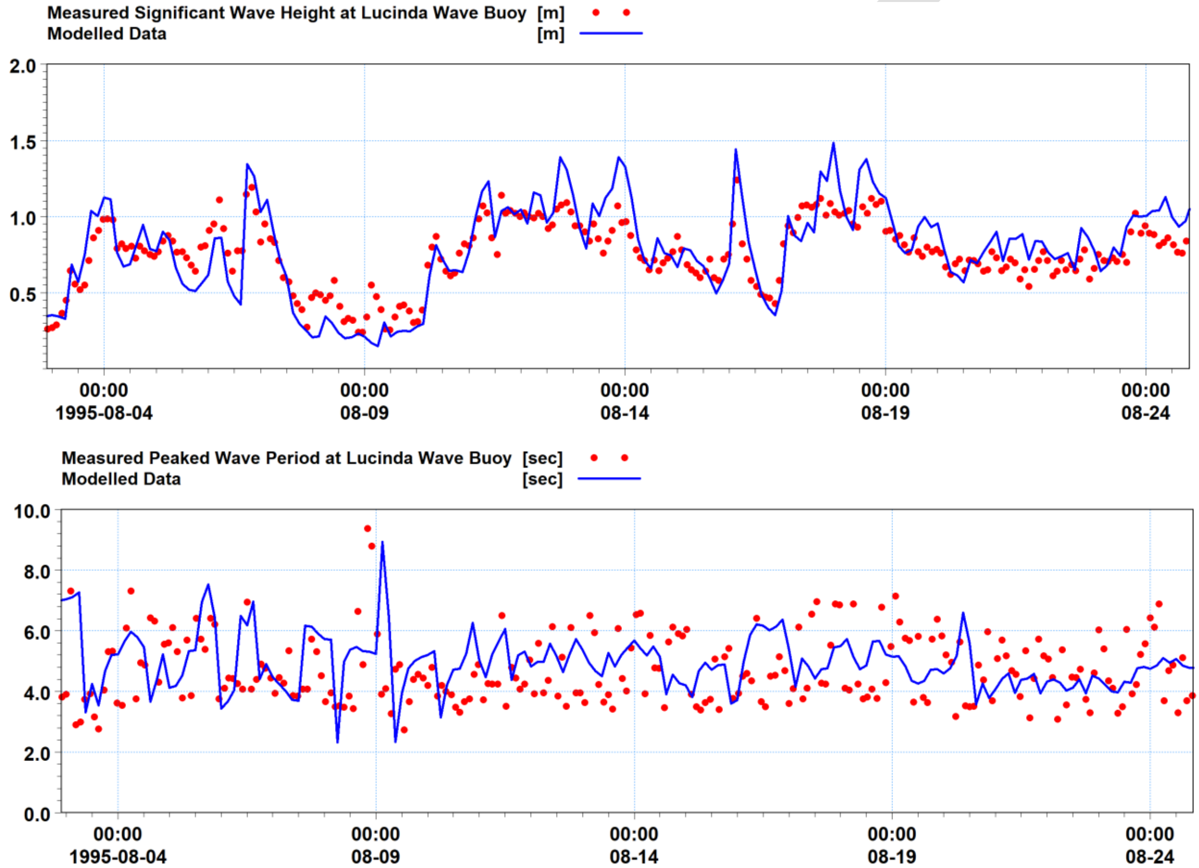


**Figure 3-6 Comparison of Measured and Modelled Waves at Lucinda, with the top plot showing significant wave height, and the bottom plot showing wave period.**

The results demonstrate that the model shows a reasonable agreement with the recorded wave data with:

- Hs, modelled wave height within 0.3m of the measurements 95% of the time, with no bias towards overestimation or underestimation
- Tp, wave period, with the numerical model typically within a one second variance of the measurements, with no bias towards overestimation or underestimation. Such a small spread is not concerning in the context of sediment transport and may be related to hydrodynamic effects partially blocking or pushing waves with the tidal ebbs and floods.

### *Long-term ambient wave modelling*

Once the model calibration was completed, wave hindcast modelling was undertaken at the study area to convert the 30 years of (directional) historical wind records over the study area into an equivalent set of modelled nearshore wave conditions. The outcomes of the wave hindcast provide a time series of wave height, period, and direction at hourly intervals for the 30-year hindcast period.

The design wave conditions for multiple annual exceedance probabilities (AEP's) within Hinchinbrook Region were calculated using the 30-year wave hindcast results. The data was extracted at the same locations as the storm tide analysis undertaken in Phase 3 of Coastal Hazard Adaptation Strategy (CHAS) (GHD, 2020).

A number of probability distributions were tested against the offshore significant wave height data. The probability distributions that were investigated are as follows: General extreme value (GEV), Gumbel, Log Normal, Log Pearson III, Weibull, and Generalised Pareto. The Weibull distribution showed the best data fit and was adopted for the analysis.

Table 3-3. summarises the key finding of this extreme wave analysis.

**Table 3-3 Wave Climate Statistics in Hinchinbrook Region**

| Wave Condition – (m) | Port of Lucinda | Lucinda | Taylors Beach | Allingham Beach - Forrest Beach |
|---|---|---|---|---|
| 50th Percentile (Median) | 0.08 | 0.11 | 0.14 | 0.15 |
| 90th Percentile | 0.28 | 0.31 | 0.36 | 0.48 |
| 99th Percentile | 0.39 | 0.44 | 0.63 | 0.81 |

The wave climate statistics highlight that Lucinda is more sheltered from wave energy than Taylors Beach and Forrest Beach. Forrest Beach is an open section of the coastline exposed to some of the largest waves in the region.

### 3.1.3 Ocean Water Levels

Ocean water levels also contribute to shaping shorelines. This occurs due to day-to-day tidal influences and during storms when water surges above tidal fluctuations. Climate change also significantly impacts sea levels over time, which is contributes to coastal flooding and erosion.

*Astronomical Tides*

Astronomical Tides are the 'normal' rising and falling of the oceans in response to the gravitational influences of the moon, sun, and other astronomical bodies. These effects are predictable, and consequently the astronomical tide levels can be forecast with a high degree of confidence.

In a lunar month, the highest tides occur at the time of the new moon and the full moon (when the gravitational forces of the sun and the moon are aligned). These are called spring tides and occur every 14 days. Conversely, neap tides occur when the gravitational influences of the sun and moon are not aligned, resulting in high and low tides that are not as extreme as those during spring tides.

Table 3-4 shows the Lucinda tide gauge tidal planes. The Highest Astronomical Tidal (HAT) at Lucinda is 4.06 m above the Lowest Astronomical Tide (LAT). The Highest Astronomical Tide level is 2.20 m above Australian Height Datum (AHD). The AHD level for Lucinda was approximated from nearby AHD permanent marks of Townsville, Magnetic Island and Cardwell as the Marine Safety Queensland (MSQ) permanent marks level for Lucinda could not be located on the Queensland Globe site.

Table 3-4 Tidal Planes at Lucinda relative to AHD (MSQ, 2022)

| Tidal Plane | Present Day m AHD | 2100 (+0.8 m SLR) mAHD |
|---|---|---|
| Highest Astronomical Tide (HAT) | 2.20 | 3.00 |
| Mean High Water Springs (MHWS) | 1.18 | 1.98 |
| Mean High Water Neaps (MHWN) | 0.37 | 1.17 |
| Mean Sea Level (MSL) | 0.08 | 0.88 |
| Australian Height Datum (AHD) | 0.00 | 0.80 |
| Mean Low Water Neaps (MLWN) | -0.21 | 0.59 |
| Mean Low Water Springs (MLWS) | -1.01 | -0.21 |
| Lowest Astronomical Tide (LAT) | -1.86 | -1.06 |

Spring tides tend to be higher than normal around the time of the Christmas / New Year period (i.e., December - February) and also in mid-year (i.e., around May - July). The various occurrences of particularly high spring tides are often referred to in lay terms as 'king tides' - in popular terminology, meaning any high tide well above average height. The widespread notion is that king tides are the very high tides that occur around Christmas or in the New Year. However, equally high tides occur in the winter months, but these are typically at night and therefore are not as apparent as those during the summer holiday period - which generally occur during daylight hours.

Tidal predictions are computed based on astronomical influences only, without considering meteorological effects that influence ocean water levels. When meteorological conditions change significantly from the average, they can cause significant differences between predicted tides and actual sea level observations. The deviations from predicted astronomical tidal heights are often caused by strong or prolonged winds, and/or by uncharacteristically high or low barometric pressures.

### *Storm Tides*

**Coastal water levels in the study area are dominated by the astronomical tide. However, variations from the predicted tide level can occur due to meteorological events, particularly during storms when high wind and low atmospheric pressure contribute to increased sea levels. These variations are referred to storm surges. The total water level resulting from predicted astronomical tides plus the increase in the storm surge is the storm tide.**

Figure 3-7 illustrates the components of a storm tide event, including the nearshore wave processes contributing to coastal flooding.

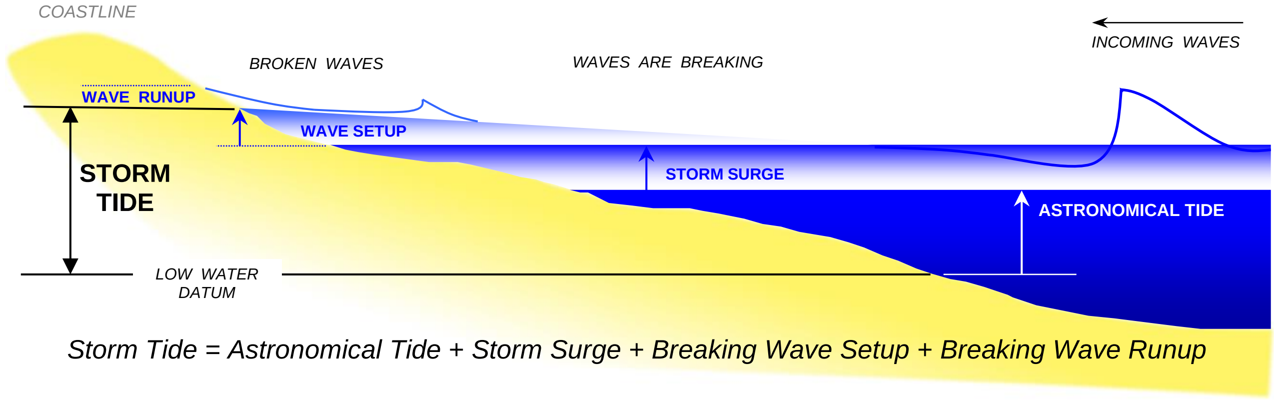


**Figure 3-7 Components of a Storm Tide Event**

Table 3 5 defines the storm tide components.

**Table 3-5 Components of Storm Tide**

| Water Level Component | Description |
|---|---|
| Astronomical Tide | The astronomical tide is the normal day-to-day rising and falling of ocean waters in response to the gravitational influences of the sun and the moon. |
| Storm Surge | Non-periodic variations from the astronomical tide are typically associated with the effect of wind on sea level. This increase in the ocean water level is caused by the severe atmospheric pressure gradients (barometric surge component) and the high wind shear induced on the surface of the ocean (wind setup component) by a severe storm or tropical cyclone. The storm surge magnitude depends upon several factors, such as the intensity of the storm, its overall physical size, the speed at which it moves, the direction of its approach to the coast, and the bathymetry and topography of the coastal zone. |
| Wave Set-up | The strong winds associated with severe storms generate waves. As these waves propagate into shallow coastal waters, they shoal and break as they interact with the seabed. The dissipation of wave energy during the wave-breaking process increases the water level shoreward of the wave breaking point; this effect is the wave setup. Wave set-up piles up of water against the shoreline because of breaking waves. |
| Wave Run-up | Wave run-up is the vertical height above the local still water level up to which incoming waves will rush when they encounter the land/sea interface. The level to which waves will run up a natural foreshore (or a structure) depends on the incident wave parameters as well as the porosity, slope, extent, and configuration of the land boundary. For example, the wave runup on a gently sloping beach differs from wave runup on a near-vertical concrete seawall. Wave run-up heights and levels also change on a wave-by-wave basis. |

Figure 3-8 shows a snapshot that highlights a neap tide, a spring tide, and a storm surge event that occurred during Cyclone Larry at the Lucinda storm tide station, back in 2011.

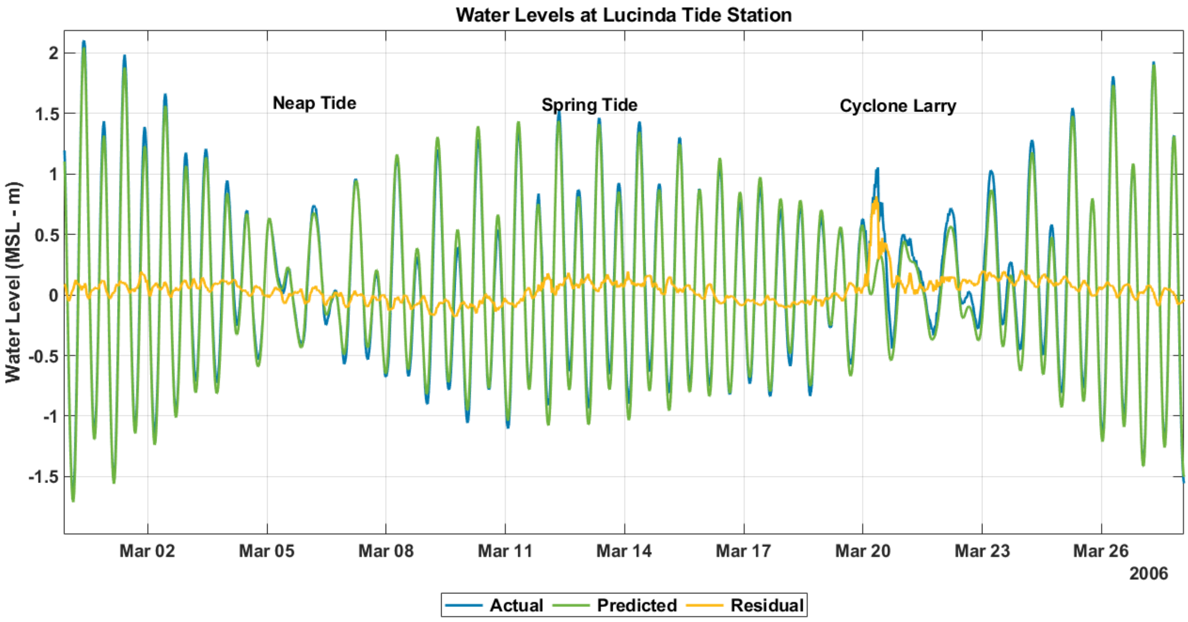


Figure 3-8 Water levels at Lucinda Tide Station

The predicted astronomical water level is shown as green, the actual measured water level is shown by the blue line and the residual, which is the difference between the measured sea level and predicted astronomical tide level, is the yellow line. This timeseries highlights the short-term impact of Cyclone Larry on water levels, which created a storm surge of approximately 0.75 m at Lucinda. For this event, the storm surge occurred during a neap tide, so despite the storm surge, water levels remained within the 'day-to-day' range at Lucinda.

*Design Storm Tide Levels*

As part of the Coastal Hazard Adaptation Strategy (CHAS) Phase 3, a storm tide assessment was undertaken by GHD (2020) to update the Connell Wagner storm tide study (2004). The updated assessment included:

- Estimation of tropical cyclone storm tide hazard at each of the nominated communities, derived from updated hydrodynamic and statistical storm modelling.
- Analysis of non-cyclonic water level statistics from long-term gauges representative of the study region, and
- Provision of a blended TC and non-cyclonic (non-TC) water level assessment for the study region, including both current and future climate scenarios

Figure 3-9 shows the combined Annual Exceedance Probability water levels for the present sea levels at Lucinda.

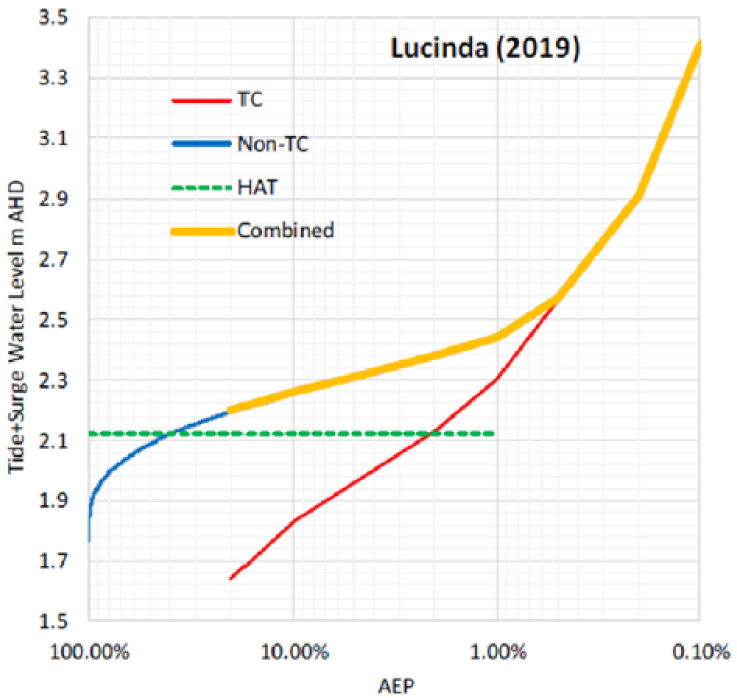


**Figure 3-9 Combined cyclonic and non-cyclonic water levels for Lucinda 2019**[11]

Tropical cyclones represent the most significant threat of storm tide inundation. However, tropical cyclones are also relatively rare events. More frequent and benign non-cyclonic storms were found to influence storm tide levels significantly below the 0.5% Annual Exceedance Probability event.

Figure 3-10 shows the CHAS Phase 3 reporting locations for the storm tide update.

Table 3-6 shows the storm tide levels *excluding* wave setup at these sites, and Table 3-7 displays the storm tide levels plus wave setup component.





[11] This analysis was undertaken in 2019 and the tidal planes have since been updated for Lucinda. In this figure HAT is plotted as being 2.12 m AHD, however the 2022 HAT is 2.20 m AHD.

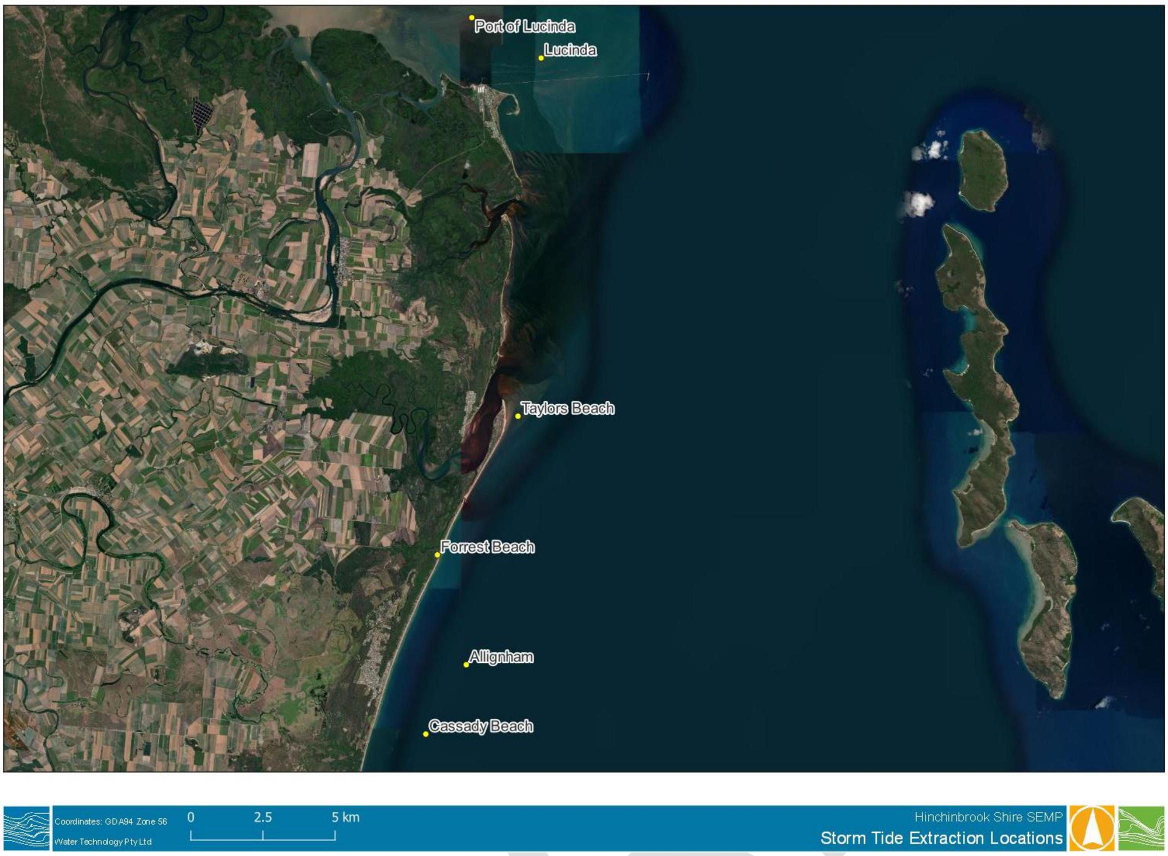


Figure 3-10 Storm Tide Extraction Locations

Table 3-6 Design Peaked Storm Tide Levels including wave setup (GHD 2020)

| ARI Years | AEP (%) | Port of Lucinda | Lucinda | Taylors Beach | Forrest Beach | Cassady Beach |
|---|---|---|---|---|---|---|
| 50 | 2% | 2.38 | 2.38 | 2.41 | 2.44 | 2.45 |
| **100** | **1%** | **2.46** | **2.44** | **2.50** | **2.59** | **2.66** |
| 500 | 0.2% | 3.04 | 2.91 | 3.20 | 3.46 | 3.61 |
| 1,000 | 0.1% | 3.60 | 3.41 | 3.50 | 3.70 | 3.86 |

Table 3-7 Design Peaked Storm Tide Levels excluding wave setup (GHD 2020)

| ARI Years | AEP (%) | Port of Lucinda | Lucinda | Taylors Beach | Forrest Beach | Cassady Beach |
|---|---|---|---|---|---|---|
| 50 | 2% | 2.38 | 2.55 | 2.71 | 2.61 | 2.70 |
| **100** | **1%** | **2.46** | **2.82** | **3.01** | **2.99** | **3.07** |
| 500 | 0.2% | 3.04 | 3.15 | 3.30 | 3.90 | 4.03 |
| 1,000 | 0.1% | 3.6 | 3.41 | 3.50 | 4.20 | 4.35 |

*Longer Term Sea Level Processes*

Water levels in the study area will also be affected by longer-term physical processes that act over timescales ranging from weeks to seasons, to decades. These processes include regional atmospheric and oceanographic processes such as the El Niño Southern Oscillation (ENSO) discussed in Section 3.1.6 and long-term mean sea level rise due to climate change discussed in Section 3.1.7.

### 3.1.4 Nearshore Currents

Nearshore currents are composed of tidal currents, waves-generated currents, and winds-induced currents, can play an important role in sediment transport.

The hydrodynamics and sediment morphology interact strongly, particular near sand bars, sand spits, river mouths and tidal inlets. For instance, currents are often stronger in the deep channel in the creek and estuary entrances as offshore currents are forced into a narrow area that erodes the seabed. As the current pattern expands away from the deep channel, ebb and flood shoals can form along the coast and in the river entrance.

Figure 3-11 demonstrates the ability of nearshore currents to mobilise sediments and to erode the seabed depends on the flow velocity and the sediment grain size.

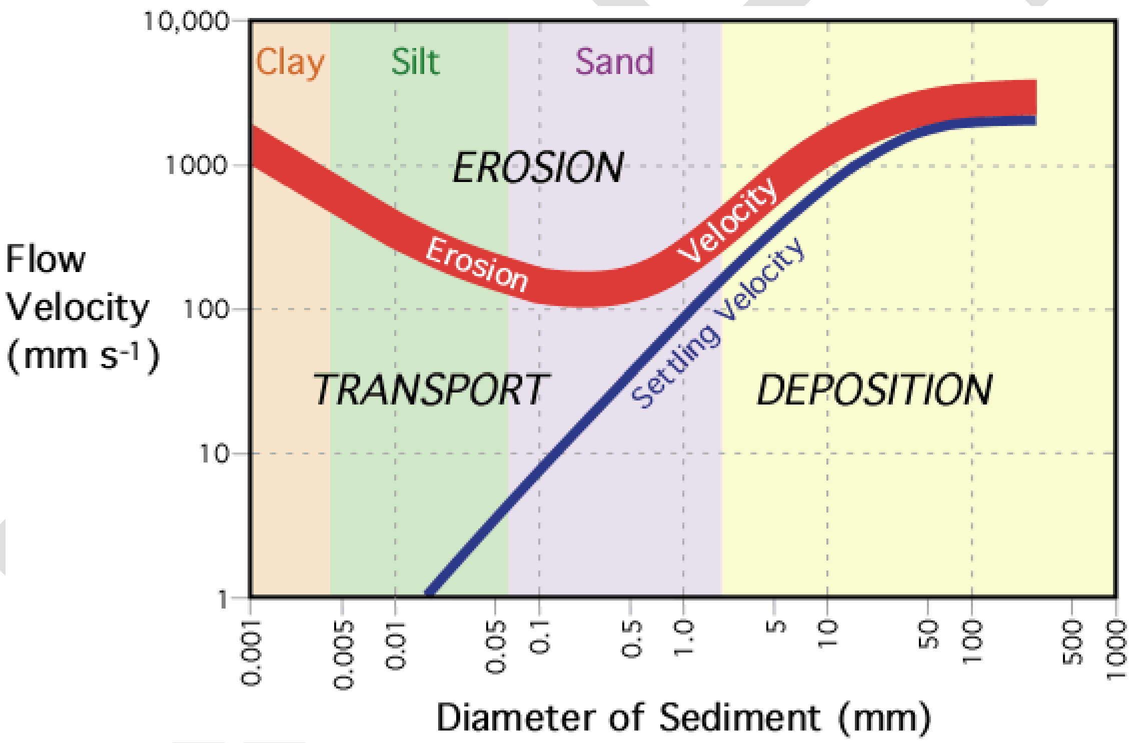


**Figure 3-11 Hjulström Curve (Physical Geography, 2009)**

A hydrodynamic model study was therefore carried out to understand the nearshore current in the study area.

*Hydrodynamic numerical model*

Water Technology calibrated a Mike 21 hydrodynamic model, which was updated to include the latest survey data. The 2019 Water Technology report provides further model setup and calibration dataset information, including ADCP data and coastal water fluctuations (Water Technology, 2019).

Figure 3-12 shows where the current flow UV components were extracted from the model. A summary of the findings for these four sites is provided below.


**Figure 3-12 UV Model Extraction Locations**

U and V represent two flow components as follows:

- U is the horizontal flow component in the east-west direction
- V is the horizontal flow component in the north-south direction

The scatter plots provide an overview of current distribution and patterns.

*Lucinda and Dungeness*

Of all sites, the nearshore tidal currents are greatest at Lucinda and Dungeness, as shown in the flood and ebb tide vector maps in Figure 3-13 and Figure 3-14. Currents during the flood tide are stronger than during the ebb, exceeding 1.2 m/s in some areas, particularly in the main deeper channel. A scatter plot of the UV current components for Dungeness is shown in Figure 3-15, whilst a UV scatter plot for eastern Lucinda foreshore is shown Figure 3-16. Current speeds are generally lower at the eastern Lucinda foreshore due the beach's orientation away from Hinchinbrook Channel. This beach orientation also influences the tidal axis, whereas at Dungeness tidal water flows east-west, at Lucinda the tide moves northwest-southeast. The Lucinda spit has formed in a low current area, adjacent to the high current Hinchinbrook Channel, as the northward flowing longshore currents interact with the higher energy tidal currents.

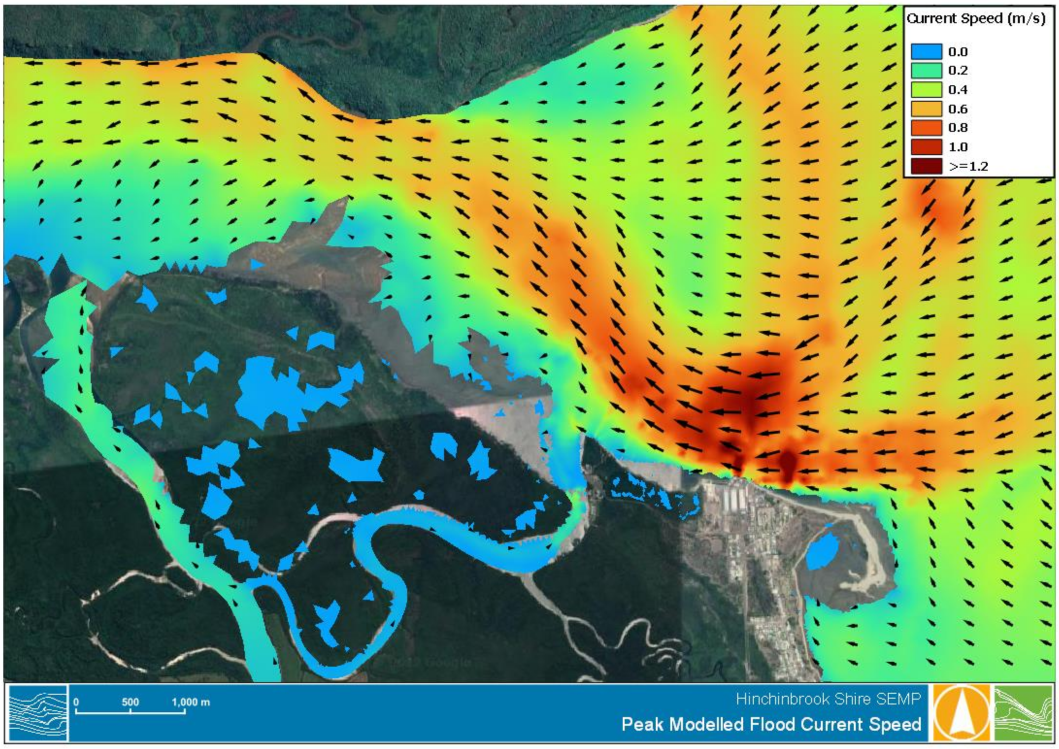


Figure 3-13 Lucinda and Dungeness – Spring Flood Tide Current vectors

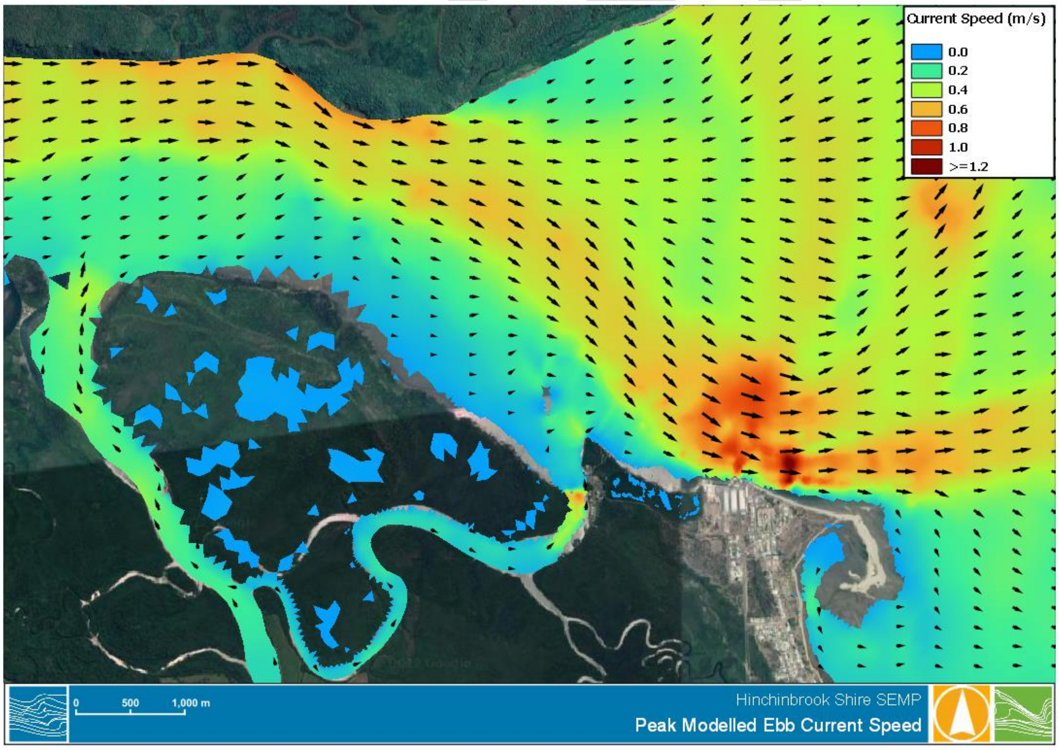


Figure 3-14 Lucinda and Dungeness – Spring Ebb Tide Current Vectors

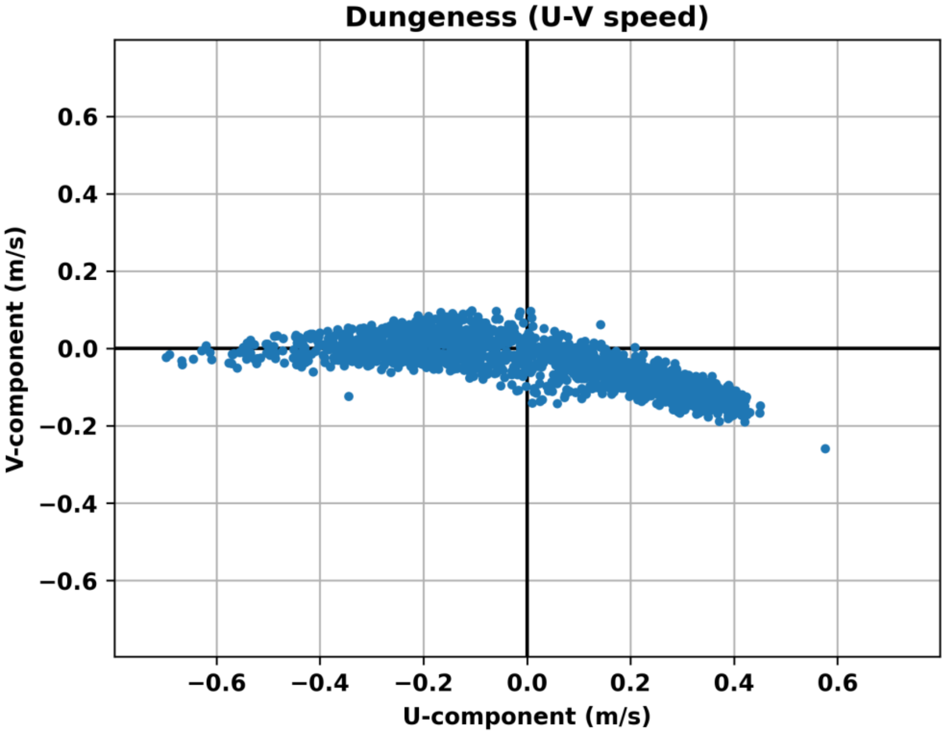


Figure 3-15 Dungeness – UV Scatter Plot

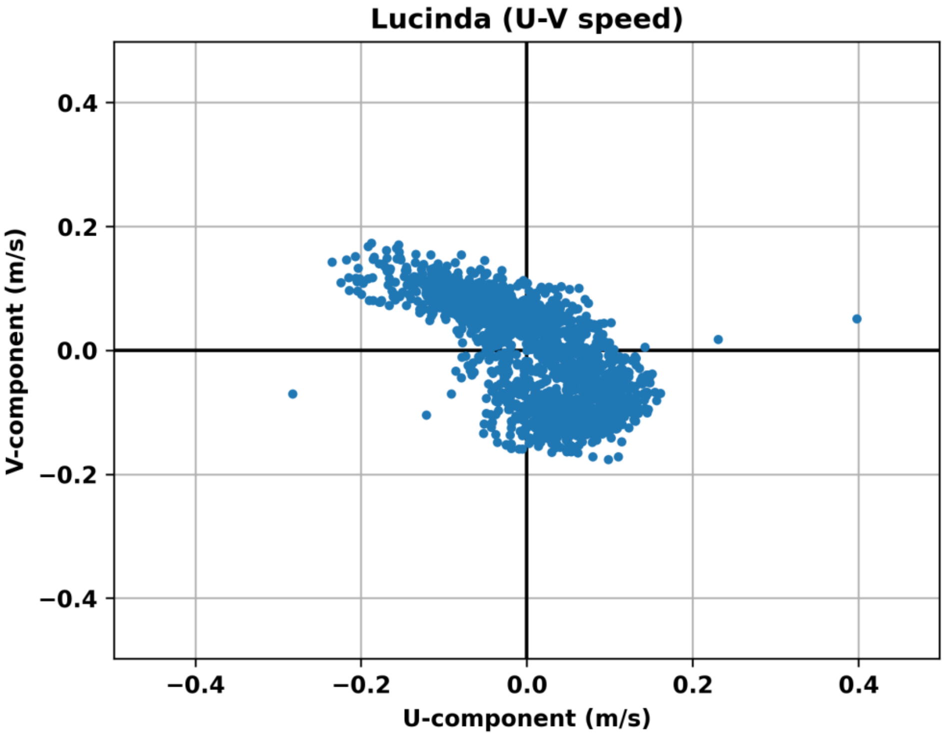


Figure 3-16 Lucinda – UV Scatter Plot

### *Taylors Beach*

Current speeds are slightly lower at Taylors Beach, as shown in the flood and ebb vector maps in Figure 3-17 and Figure 3-18. This is due to the morphology of the area, which is slightly shallower and has a much smaller tidal exchange than Hinchinbrook Channel. At Victoria Creek, the flood tide is stronger than the ebb, and the tidal axis at the mouth of Victoria Creek flows northeast to southwest, as shown in the UV scatter plot in Figure 3-19.

During the flood tide on the eastern side of the spit, current speeds are very low, however they increase during the ebb tide and flow in a north-easterly direction parallel to the spit. During the ebb tide these north-easterly flowing current curl around the tip of the spit and flow southwest into Victoria Creek.

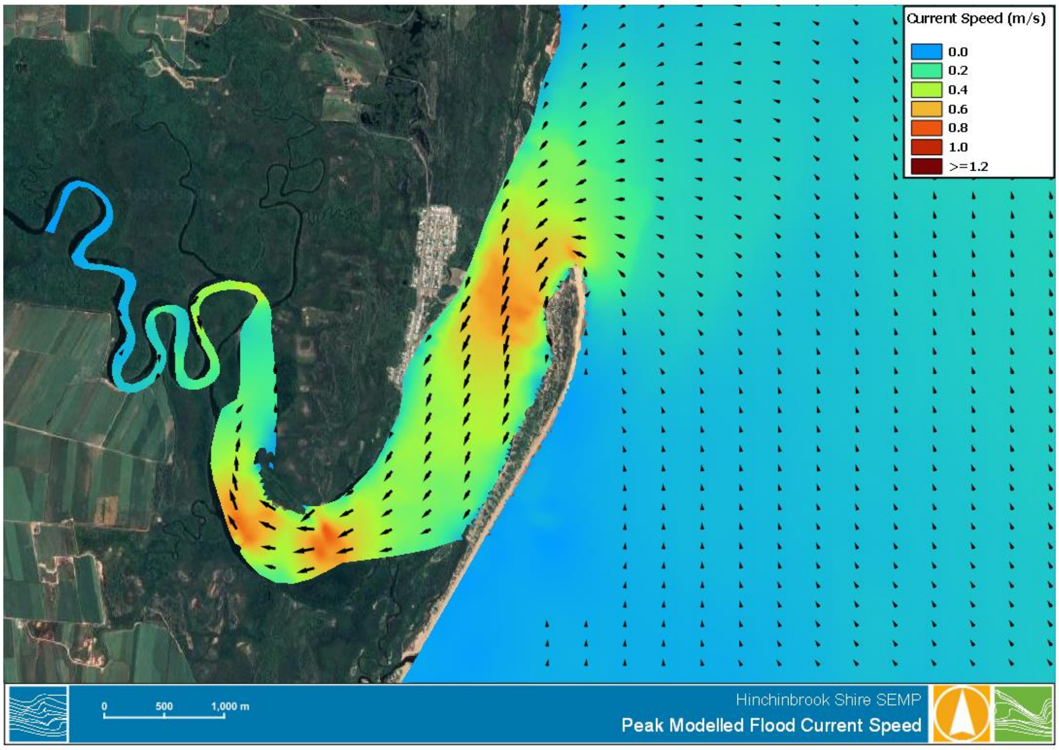


**Figure 3-17 Taylors Beach - Spring Flood Tide Current Vectors**

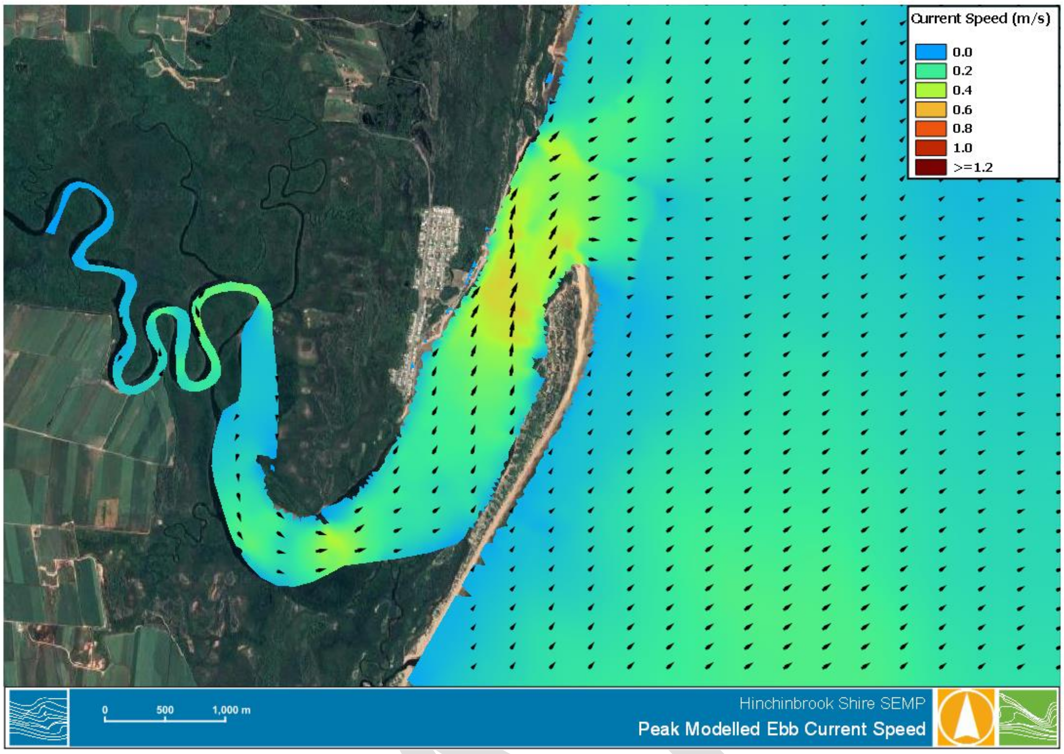


Figure 3-18 Taylors Beach - Spring Ebb Tide Current Vectors

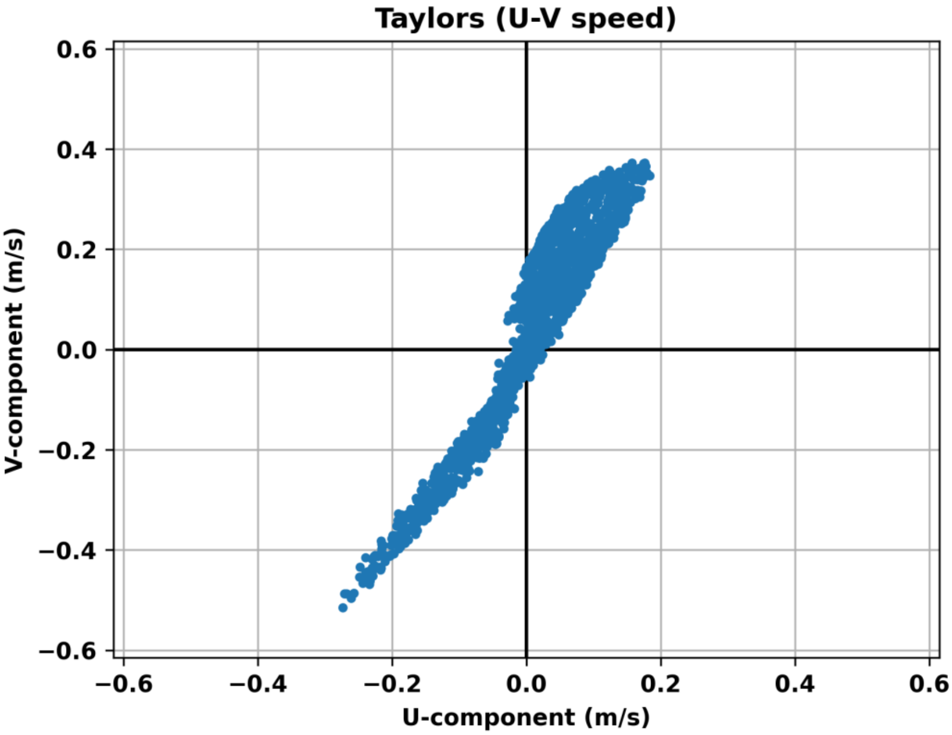


Figure 3-19 Taylors Beach – UV Scatter Plot

*Forrest Beach*

Forrest Beach has the lowest currents of all sites, as it does not possess a major estuary with a large tidal exchange nearby which can generate higher localised current speeds. The flood current vector plot (Figure 3-20) and ebb vector plot (Figure 3-21) highlight the low currents speeds in the area, with currents during the ebb tide being slightly stronger. The UV scatter plot in Figure 3-22 shows that tidal flows are orientated along a northeast-southwest axis.

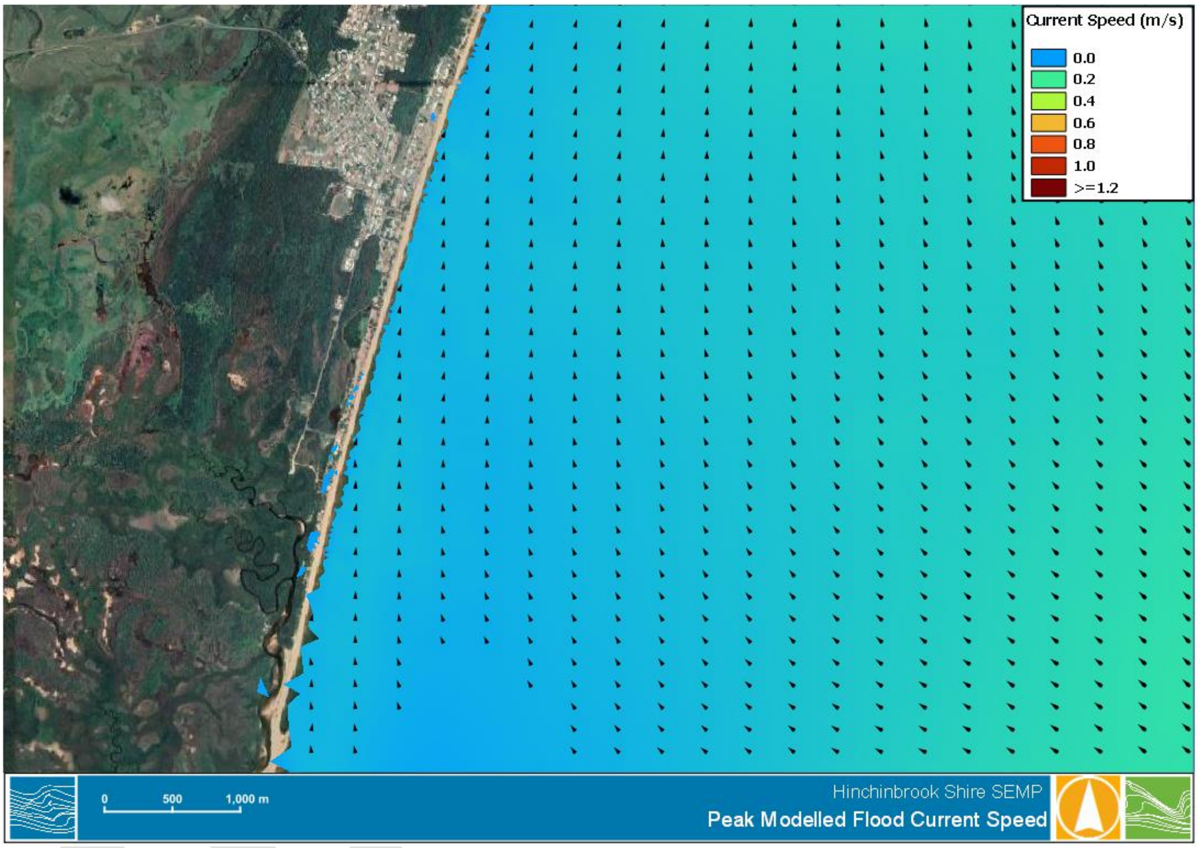


**Figure 3-20 Forrest Beach - Spring Flood Tide Current Vectors**

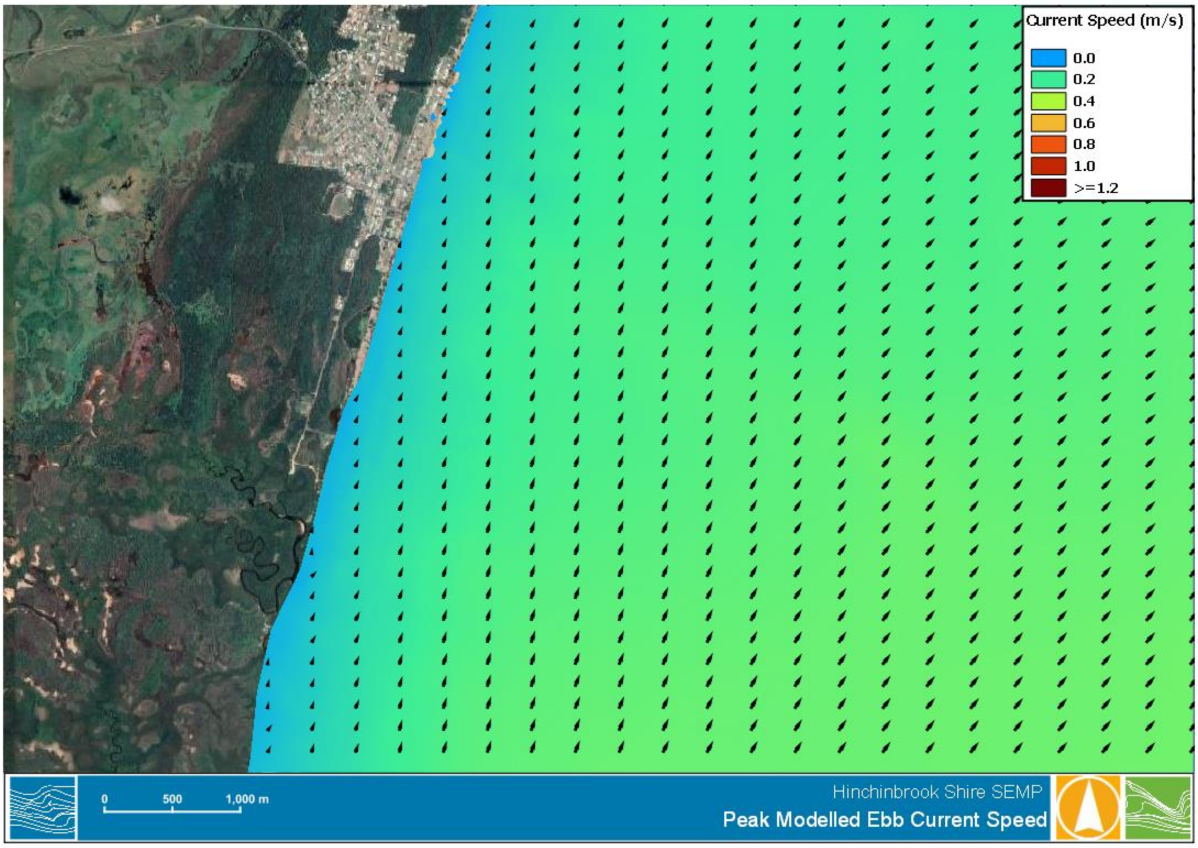


Figure 3-21 Forrest Beach - Spring Ebb Tide Current Vectors

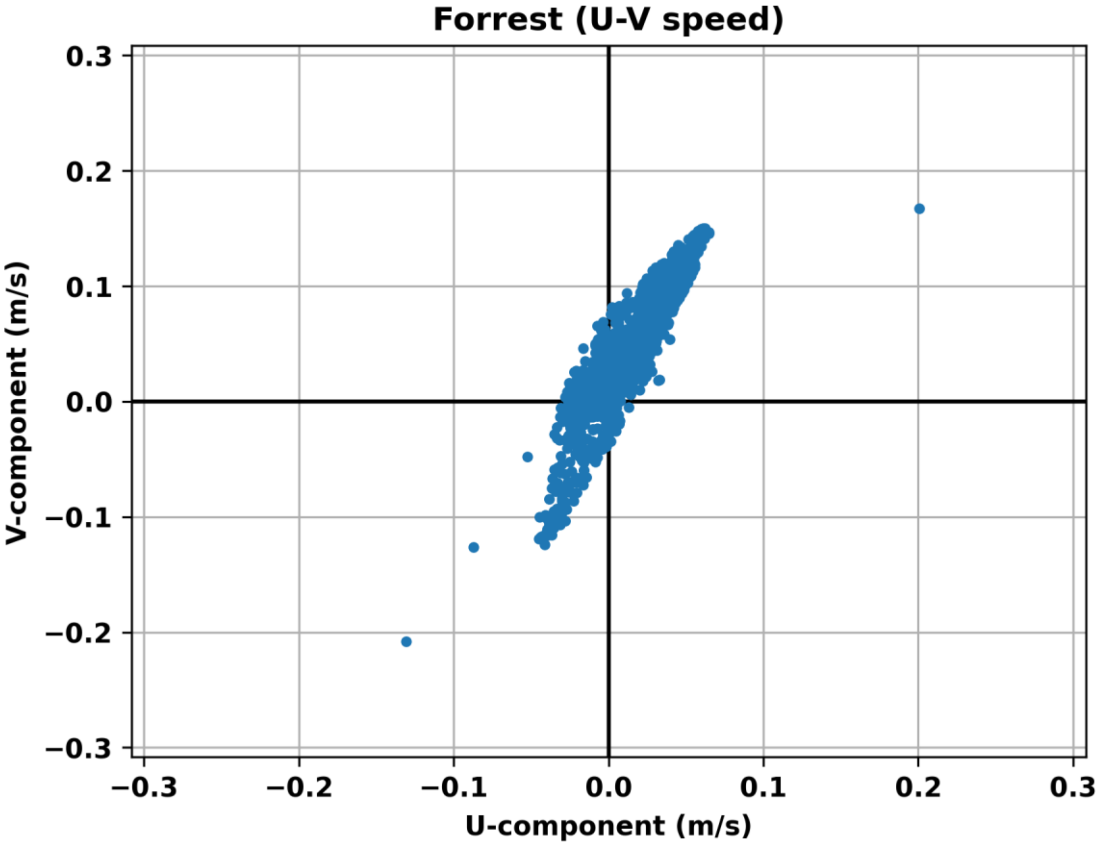


Figure 3-22 Forrest Beach – UV Scatter Plot

### 3.1.5 Tropical Cyclone Impacts

The most extreme waves and water levels at the study area are generated by infrequent, but severe, tropical cyclone activity. Therefore, an understanding of the tropical cyclone climatology is vital to understanding the recurrence of severe storm erosion events at Hinchinbrook Shire. To this end, an assessment of historical tropical cyclone activity has been undertaken by interrogating the Bureau of Meteorology's Southern Hemisphere Tropical Cyclone Data Portal (BOM, 2022).

Figure 3-23 depicts the most severe tropical cyclones (in terms of local wind speeds) affecting a radius of 300km around the area since 1950. It is important to note that whilst the Bureau's tropical cyclone records date back from the early 1900s, cyclone track data is considered more complete from the 1950s onward due to the development of radar and satellite technologies.

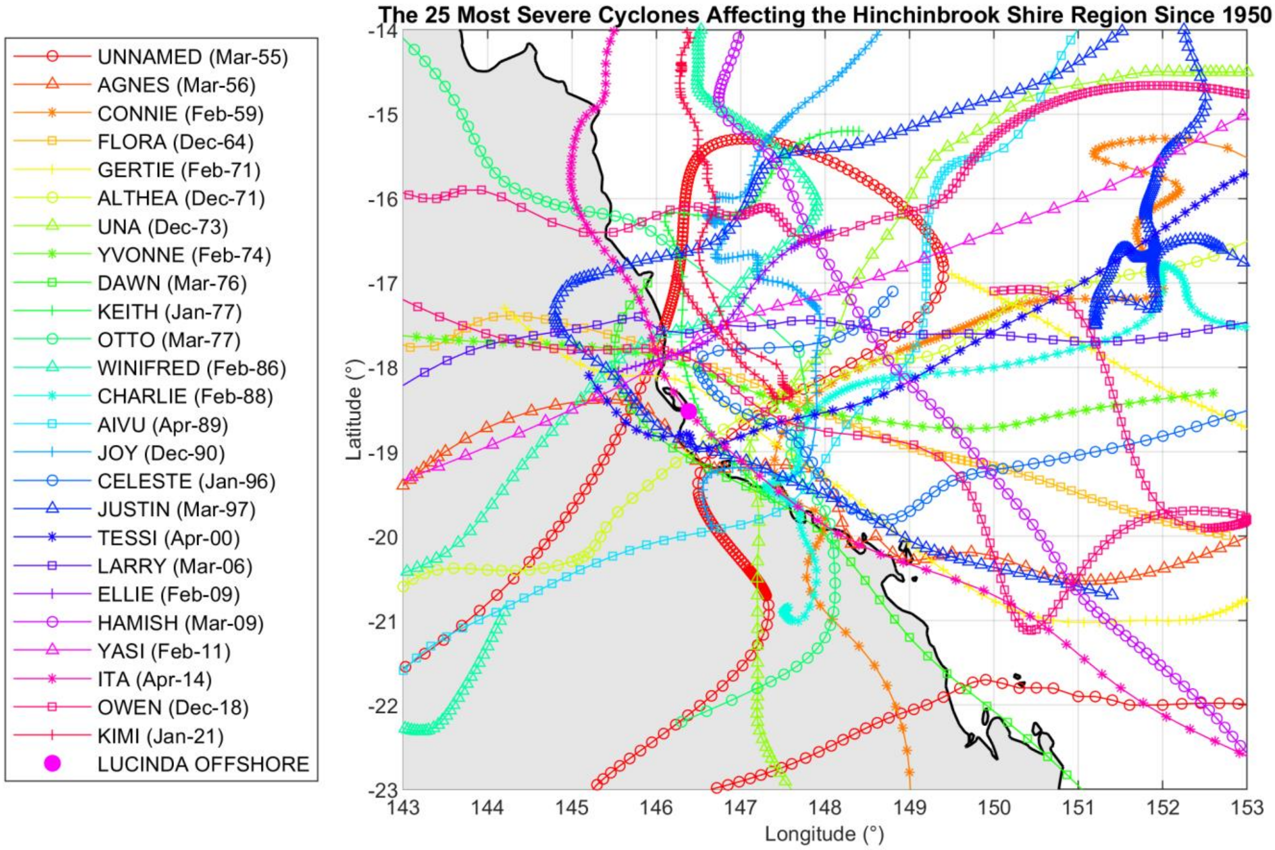


**Figure 3-23 Historically significant cyclones for the Hinchinbrook Shire region**

The most significant cyclones to have impacted the region include Cyclone Yasi (2011), which resulted in a 5 m storm surge in Cardwell, which is 2.3 m above the Highest Astronomical Tide level (HAT).

Due to the clockwise nature of cyclonic winds, cyclones which track north of Hinchinbrook Shire will have the most damaging storm tide impacts as the easterly winds push water and waves up onto the coast, resulting in flooding and erosion. Other notable cyclones to have impacted the area include Cyclone Winifred (1986), which recorded a storm surge of 1.6 metres at Clump Point and wave run-up on beaches of about 2 metres above the astronomical tide, and Cyclone Althea. Cyclone Althea remains one of the most intense cyclones to affect the Queensland Coast, causing a 3.66 m storm surge at Toolakea, 70 km south of Lucinda.

An analysis has been undertaken on the seasonality and frequency of all cyclones passing within 300 km of Lucinda since 1950. The top pane of Figure 3-24 depicts the month of cyclone formation (referred to as cyclogenesis). The lower pane of Figure 3-24 shows the number of cyclones per cyclone season. In Australia, the official tropical cyclone season runs from 1 November to 30 April.

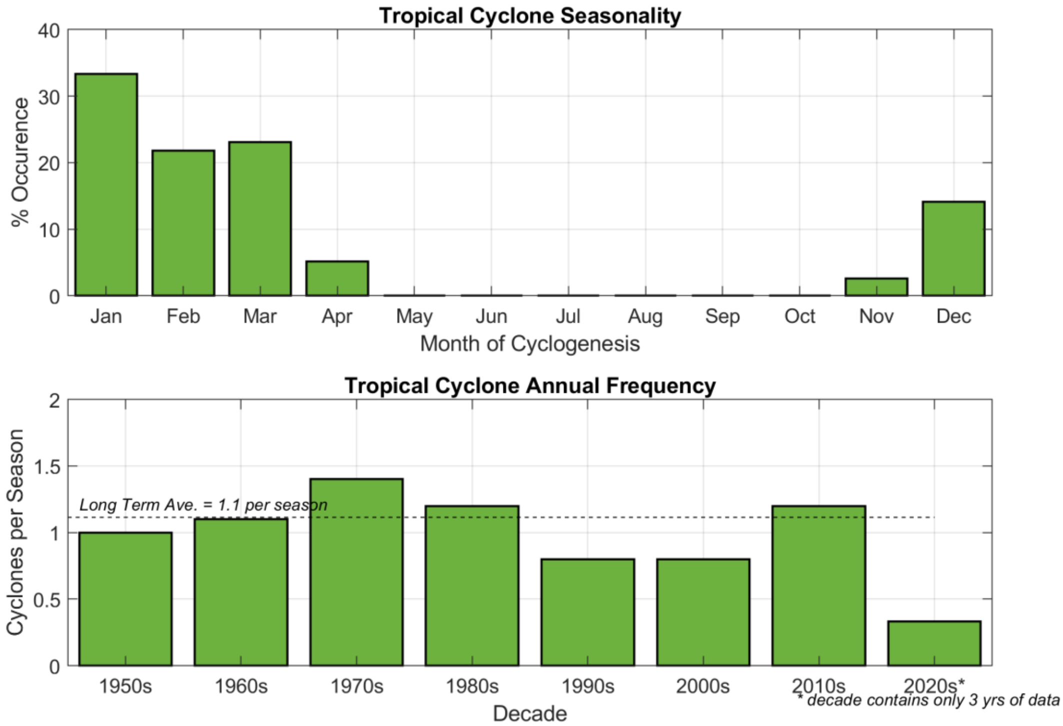


**Figure 3-24 Seasonality and historical frequency of tropical cyclones affecting Hinchinbrook Shire**

Cyclones forming as early as November and as late as April do occur, but they are relatively infrequent (accounting for less than 10% of all cyclone formations combined).

From January 1950 to December 2018, over 120 tropical cyclones have tracked within 300 km of Lucinda, which equates to a long-term average of around 1.1 cyclones per season. However, there is some interannual and interdecadal variability in the frequency of their formation. The frequency of tropical cyclones was above average throughout the 1970s, at around 1.4 per season (which included severe TC Althea (1971) and to a lesser extent the 1980s (1.2 per season). The frequency of cyclone formation dropped during the 1990s and 2000s and picked back up in the 2010s which had an average of 1.2 cyclones per season.

### 3.1.6 Medium Term Processes: ENSO

Tropical cyclone frequency is correlated with inter-annual phenomena such as the El Niño Southern Oscillation (ENSO). For instance, on average, there are fewer tropical cyclones in the Australian region during El Niño years (BOM, 2022). This is particularly true around Queensland, where cyclones are half as likely to cross the coast during El Niño years compared to La Niña years or neutral years.

La Niña phases have been declared over the past three years (2020 – 2023), which has skewed the annual tropical cyclone frequency in the early 2020's dataset. Future La Niña and neutral years will likely lead to more tropical cyclones affecting the Hinchinbrook region.

The ENSO phenomenon in the southern Pacific Ocean causes medium-term variations in mean sea level, occurring over several months to several years. During El Niño years, when the Southeast trade winds weaken, sea surface temperatures are cooler, and the mean sea level is lower than average. Conversely, during La Niña years, the Southeast trade winds strengthen, resulting in warmer than average sea surface temperatures and higher than average mean sea levels.

The phases of ENSO are tracked by a metric known as the Southern Oscillation Index (SOI), which measures the difference in surface air pressure between Tahiti and Darwin (BoM, 2017b). Sustained SOI values above about +8 indicate La Niña event conditions, while sustained values below about –8 indicate El Niño conditions.

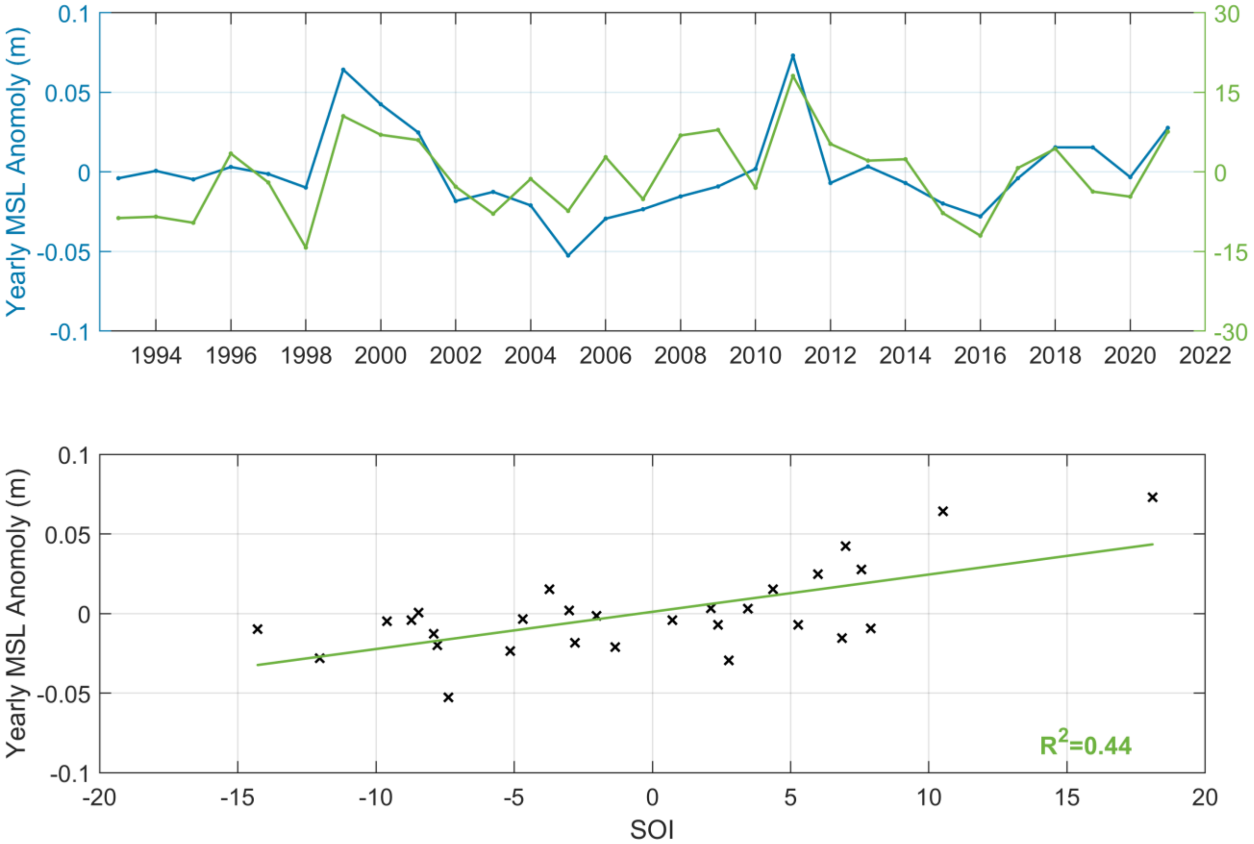


**Figure 3-25 Influence of SOI on Yearly MSL Anomaly at Cape Ferguson**

Table 3-8 summarises the sea level rise at Cape Ferguson over the 1992-2019 period, including the effect of ENSO.

**Table 3-8 Mean Sea Level Rise Recorded at Cape Ferguson from 1992 – 2019.**

| Rate of MSLR – Early 1990s to Present | MSLR |
|---|---|
| Cape Ferguson - Raw MSLR: 1993-2021 | 5.0 mm/yr |
| Cape Ferguson - MSLR with ENSO influence removed: 1993-2018 | 4.6 mm/yr |
| Australian Average (White et al, 2014): 1993-2009 | 3.1 mm/yr |
| Global Average (IPCC, 2013): 1993-2010 | 3.2 mm/yr |

The North Queensland coast would typically retreat during La Niña years in response to localised sea level rise along the coast.

### 3.1.7 Climate Change Impacts

The recently published IPCC 6th Assessment Report opens with a clear statement *"It is unequivocal that human influence has warmed the atmosphere, ocean, and land. Widespread and rapid changes in the atmosphere, ocean cryosphere and biosphere have occurred"* (IPCC, 2021).

Changes to the climate have occurred and will continue. Therefore, it is necessary to consider the impacts of climate change on local coastal processes and hazards.

Research into the implications of sea level rise (SLR) for Australia has been conducted by a broad spectrum of individuals and organisations that includes universities, research institutes, consultancies, government bodies and community groups. Numerous studies have assessed historical long-term global mean SLR. The IPCC Sixth Assessment Report indicates that the thermal expansion of the oceans and glacial melting have been the dominant contributors to 20th century global mean sea level rise, and this pattern is likely to continue to 2100. The report states that "*Global mean sea level increased by 0.20 m between 1901 and 2018. The average rate of sea level rise was 1.3 mm/yr between 1901 and 1971, increasing to 1.9 mm/yr between 1971 and 2006, and further increasing to 3.7 mm/y between 2006 and 2018 (high confidence). Human influence was very likely the main driver of these increases since at least 197*1".

Contemporary projections for SLR have since been recently provided under the 6th IPCC Assessment Report (2021). The speed of future sea level rise remains somewhat uncertain, mainly because future anthropogenic GHG emissions remain uncertain. As part of this assessment, SLR projections have been provided for five (5) future scenarios – referred to as Shared Socio-economic Pathways (SSPs) – that, in broad terms, refer to the following global greenhouse gas (GHG) emissions scenarios:

- **SSP1-1.9:** Very low GHG emissions: $CO_2$ emissions cut to net zero around 2050.
- **SSP1-2.6:** Low GHG emissions: $CO_2$ emissions cut to net zero around 2075.
- **SSP2-4.5:** Intermediate GHG emissions: $CO_2$ emissions around current levels until 2050, then falling but not reaching net zero by 2100
- **SSP3-7.0:** High GHG emissions: $CO_2$ emissions doubled by 2100.
- **SSP5-8.5:** Very high GHG emissions: $CO_2$ emissions tripled by 2075, this scenario trends along GHG emission over the last 10 years.

The local mean SLR for the study area associated with each of these scenarios is provided in Table 3-9 below.

**Table 3-9 IPCC 6th Assessment Report – sea level rise projections in metres. Values given include Median estimate (and Likely Range)**

| SSP Name | 2040 | 2070 | 2100 | 2150 |
|---|---|---|---|---|
| SSP1-1.9 | 0.13 (0.10, 0.18) | 0.27 (0.21, 0.38) | 0.42 (0.28, 0.61) | 0.63 (0.39, 0.95) |
| SSP1-2.6 | 0.15 (0.11, 0.20) | 0.31 (0.24, 0.42) | 0.47 (0.33, 0.68) | 0.75 (0.48, 1.13) |
| SSP2-4.5 | 0.15 (0.12, 0.20) | 0.36 (0.28, 0.48) | 0.59 (0.44, 0.83) | 0.98 (0.67, 1.44) |
| SSP3-7.0 | 0.16 (0.12, 0.21) | 0.39 (0.32, 0.52) | 0.73 (0.56, 0.99) | 1.29 (0.90, 1.81) |
| SSP5-8.5 | 0.17 (0.13, 0.23) | 0.44 (0.34, 0.58) | 0.84 (0.66, 1.13) | 1.44 (1.02, 2.07) |

The range of SLR projection is related to tipping points such as ice-sheets instability or deforestation.

The Queensland Department of Environment and Science presently adopts a SLR projection of +0.8 m above present-day levels by 2100. This is consistent with the SSP8.5 emission scenario and has been applied in the technical investigations for both this study and the CHAS. Whatever the SSP, a 0.8m SLR is projected for the 2100s.

## 3.2 Morphological Processes

### 3.2.1 Geological History

The coastal geology and geomorphology of the Hinchinbrook Coast region has been investigated and documented in the *Herbert River Coastal Sector* report, Marine & Coastal Geology Unit Project Report MA50/3, prepared by the Department of Minerals and Energy for the (then) Beach Protection Authority (BPA) in June 1993 (Holmes, BPA, 1993). The remainder of this section summarises the BPA findings for the study area and is complemented and supported by contemporary studies, aerial imagery, and site visits.

Historically, the Hinchinbrook coastline has experienced significant dynamic change. Two dominating factors have influenced the Hinchinbrook coastline over the past 18,000 years. As per (BMT, 2009), these include:

- Major sea level change between 18,000 and 6,500 years ago, rising by approximately 120 metres to the present sea level. As the sea rose, the shoreline moved landward, submerging the former coastal plain. During this transgression, the existing older Pleistocene alluvial and coastal sediments were reworked at the shoreface and, in part, transported onshore. In addition, fluvial sediments from the Herbert and other coastal rivers continued to supply fine and sandy sediments to the coast.
- The evolution of the Herbert River entrance since the “stillstand,” 6500 years ago, has seen it move progressively north. It is estimated that the annual supply of sediment to the Hinchinbrook coastline is in the order of 130,000 $m^3$/year. This sediment surplus has resulted in the accretion of the shoreline adjacent to the Herbert River entrance as it has progressively migrated north. Holmes (1993) hypothesised that as the Herbert River has migrated north, this may have resulted in a sediment supply deficit.

The Burdekin catchment, and to a lesser extent the Ross River catchment, supplies the coastal and shelf areas to the south of Hinchinbrook with annual sediment loads that can be resuspended and distributed north toward the coastal region in Hinchinbrook. A study by BMT (2018) of sedimentation in ports of the Great Barrier Reef found that major catchment loads are not contributing directly to sediment deposited in navigational channels (including Townsville and Cairns). This lack of connectivity is due to the vast quantities of sediment accumulated in coastal waters at geological timeframes. This study suggests that the dominant sediment supply to coastal areas would be existing sediment deposits on the GBR shelf and is not directly related to catchment inputs. As such, the movement of the Herbert River to the north is not likely to result in a significant sediment supply deficit in coastal waters.

The coast is highly dynamic even at human timescales, where modern processes such as floods, distributary channel switching, channel and estuary meandering and coastal realignment affect coastal stability. As a result, the Hinchinbrook coast generally has a moderate to high erosion potential, with some areas more vulnerable to erosion than others.

### 3.2.2 Sediment Composition

Sediment sampling was undertaken at the locations shown in Figure 3-26. The median particle size (D50) at each site is tabulated in Table 3-10.

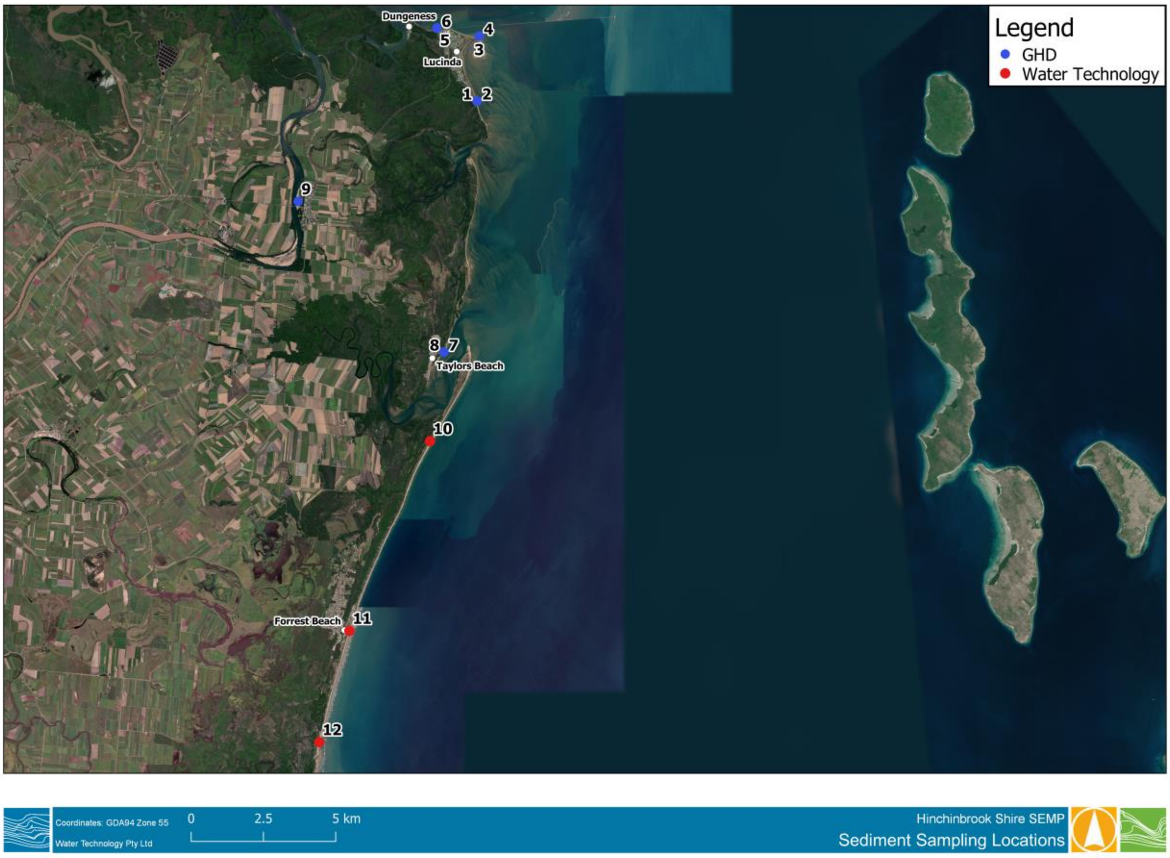


**Figure 3-26 Sediment Sampling Locations**

**Table 3-10 Particle Size Distribution Results (ALS Environmental, 2019)**

| Sample ID | Collected when/by | Location | Description | Median size – D50 (mm) |
|---|---|---|---|---|
| 1 | 2019/GHD | Lucinda Foreshore | Intertidal | 0.425 |
| 2 | 2019/GHD | Lucinda Foreshore | Above high tide line | 0.26 |
| 3 | 2019/GHD | Lucinda – the Spit | Intertidal | 0.21 |
| 4 | 2019/GHD | Lucinda – the Spit | Above high tide line | 0.225 |
| 5 | 2019/GHD | Lucinda/Dungeness | Intertidal | 0.25 |
| 6 | 2019/GHD | Lucinda/Dungeness | Above high tide line | 0.25 |
| 7 | 2019/GHD | Taylors Beach | Intertidal | 0.4 |
| 8 | 2019/GHD | Taylors Beach | Above high tide line | 0.26 |
| 9 | 2019/GHD | Halifax | River bank | 0.4 |
| 10 | 2022/Water Tech | Mandam Creek/Taylors Spit | Above high tide line | 0.4 |
| 11 | 2022/Water Tech | Forrest Beach | Above high tide line | 0.38 |
| 12 | 2022/Water Tech | Cassady Beach | Above high tide line | 0.6 |

Sediment from Cassady Beach to Mandam Creek/Taylors Spit is sand, with Cassady Beach having the coarsest sand. The sand around Lucinda and Dungeness was finer and is likely from fluvial sources.

During our site visit, large pockets of clay were observed on the Lucinda foreshore covered by coarse sand, which is indicative of a dynamic morphology.

### 3.2.3 Regional Morphological Processes

*Longshore Sediment Transport*

Longshore sediment transport is the movement of sand along the beach and occurs predominantly within the wave breaking zone (i.e., surf zone). Longshore sediment transport has a significant effect on shoreline stability, erosion, and accretion.

Waves arriving with their crests angled from the shoreline alignment create an alongshore current that initiates and maintains sediment transport along the beach. While the nearshore wave misalignment and wave height may appear small, the relentless wave action and episodic storms account for substantial volumes of sand moved annually.


**Figure 3-27 Longshore Sediment Transport**

On most coasts, waves arrive at the beach from several offshore directions - producing day-to-day and seasonal reversals in net sediment transport direction. At a particular beach location, transport may be to the left (looking seaward) during part of the year and to the right during other times of the year as the wind-wave rotates. If sediment transport volumes are equal in each direction, then there is no net change in the beach position over annual timeframes.

Typically, longshore sediment transport is greater in one direction than the other, resulting in a net annual longshore sediment movement. Whilst there may be a net longshore transport along a section of the foreshore, this does not mean sand is lost and that the beach erodes. There will be no net change to the beach volume if sediment is supplied at the same rate as it is transported.

The net longshore transport along the Hinchinbrook coastline is northwards and is driven by the predominant south-easterly wind and wind-waves. The Lucinda Spit alignment and the beach alignment around the groyne structures along Patterson Parade demonstrate that sand is typically flowing northward on the open coast, as shown in Figure 3-28.

**Figure 3-28 Sediment deposition at Lucinda Groyne Field**

Geological studies such as that by Holmes (1993) indicate that since the movement of the Herbert River delta northward from this area, most of the longshore sediment transport is provided by the erosion of the coastal plain (i.e., beaches to the south) and offshore areas. Despite concerns of a net sediment deficit due to the northward moving Herbert River mouth, the growth of the Lucinda Spit since the 1980s indicates the coastline receives a steady sediment supply. However, localised erosion and accretion have been observed at certain locations, particularly at Lucinda. This means there is an imbalance in the sand supply at the northern end of the coastline.

An estimate of the long-term longshore sand transport rate was calculated using the CERC formula (CERC, 1984) for the past 30 years. The calculation indicated that the net annual longshore sand transport potential from Lucinda to Forest Beach is approximately 25,000 $m^3$ per year in a northerly direction, on average. The net transport is driven by local sea waves from the south to the south-eastern quadrant. Sediment transport rates change from year to year due to seasonal, annual, and decadal variations of prevailing climatic conditions. This net annual sediment transport rate is consistent with previous coastal process modelling studies (BMT, 2009).

The sediment transport rate was also quantified at the Lucinda spit, using historical bathymetry data from BPA (1993) combined with the 2020 DEA Coastlines dataset and the National Intertidal Digital Elevation Model. The analysis found that the marine sands have accumulated at Lucinda between 16,000 to 27,000 $m^3$ per year - which broadly aligns well with the net longshore transport estimate.

*Cross Shore Sediment Transport*

Cross-shore sediment transport is the movement of sand perpendicular to the beach – in other words, onshore/offshore movement. Whilst this washing of sand up and down the beach profile occurs during ambient conditions (i.e., the normal day-to-day conditions), cross-shore movement becomes most evident during severe storms or cyclones.

Strong wave action and elevated ocean water levels during storms can cause severe beach erosion when sand is removed from the dunes and upper regions of the profile and deposited in a nearshore sandbar. Storm beach erosion is also called storm bite. Coastal erosion can threaten or damage foreshore infrastructure when the storm or cyclone is particularly severe. However, the sand is not lost. Instead, the dune and upper beach sand is moved offshore into the surf zone. Mild wave conditions return this sand onto the intertidal beach, where wave run-up and onshore winds can rebuild berm and dunes over time. Cross-shore beach erosion often occurs in a few hours, while the recovery of the beach berm and dunes can take many years.


**Figure 3-29 Cross-shore Sediment Transport – storm bite**

GHD (2020) undertook detailed SBEACH (Storm-induced BEAch CHange) modelling as part of the CHAS Phase 3 investigations. Section 4 summarises the findings storm erosion model.

### 3.2.4 Local Morphological Processes

Coastal geomorphology is the morphological development and evolution of the coast as it acts under the influences of rain, wind, waves, currents, and sea level rise. Two key geomorphological forcings influence the coastline morphology:

- Riverine processes related to the Herbert River and
- Offshore coastal processes (tides, waves, currents).

The variability in the shoreline character from Lucinda to Forrest Beach reflects the variation in wave energy along the coastline and the influence of the Herbert River.

### *Lucinda and Dungeness*

Lucinda is located on the north-eastern part of the Herbert River delta between Hinchinbrook and Channel and Gentle Annie Creek. The Lucinda coastal plain consists of a complex sequence of estuarine mangroves, beach ridges and barrier spits. The analysis of historical aerial photography demonstrates that the shoreline adjacent to the Enterprise Channel extending to the Lucinda Jetty has historically experienced significant variations in position (BMT, 2009).

Dungeness is located west of Lucinda and has a north-facing beach adjacent to the mouth of Enterprise Channel. The Enterprise Channel is the main distributary channel of the Herbert River. Since 1943 the alignment of the Enterprise Channel has progressively shifted eastward adjacent to Dungeness, evidenced by a reduction in the westerly extension of the Enterprise Channel spit (Dungeness Spit) and the growth and vegetation of the shoreline opposite Dungeness.

Meanwhile, the Hinchinbrook Channel has progressively narrowed due to the accumulation of sediments from the Herbert River ebb tide delta. This area is surrounded by extensive mangrove forests and is protected from wave action due to Hinchinbrook Island, with the dominant processes being tides and currents. This area is dominated by delta sand, which is poorly sorted grey-brown, medium to very coarse gravelly sand with varying mud content.

In the period from 1988 to present, Dungeness Beach has undergone steady erosion, with Dungeness Spit almost completely eroded. Using the Digital Earth Australia Coastlines tool, the evolution of the shoreline at Dungeness from 1988 to 2020 is depicted in Figure 3-30. This historical shoreline imagery suggests that during this time:

- The Dungeness spit has eroded by around 170 m (an erosion rate of approximately 5 m per year)
- The shoreline at Dungeness Beach has retreated around 30 to 65 m (equivalent to erosion rates of around 1-2 metres per year). A time series plot of the historical shoreline recession at Dungeness Beach is provided in Figure 3-31. The time series plot evidences the long-term shoreline recession rates and shows that the recession rate has slowed over the last 10 years. This reduction is likely due to a combination of the following factors:
  - Dungeness Beach is gradually reaching a new equilibrium alignment to the surrounding coastal infrastructure (such as the Port of Lucinda seawalls) and to the progression of the Lucinda Spit.
  - The gradual shoreline recession is slowing down due to the small-scale beach nourishment activities at the Port of Lucinda. This is described in more detail in Section 4.

East of Dungeness spit, the shoreline towards Lucinda has also experienced significant natural variation in recent decades Since 1943, the sand spit separating the Herbert River entrance from the east-facing beaches of Lucinda has accreted significantly. This natural accretion is likely to result from a combined influence of sediment supply from the Herbert River and wave-induced longshore sediment transport.

This growth of the Lucinda spit has had two major impacts:

- The extension of the sand spit acts similar to a groyne structure, trapping the northwards-directed longshore sediment transport that travels along the open coastline. This has resulted in significant shoreline accretion between the Lucinda spit and the Lucinda groyne field. From 1943 the shoreline in this location has accreted by approximately 230m. From 1988 to 2020, the rate of shoreline accretion behind the spit was between 0.5 m to 2 metres per year.

- The growth of the Lucinda spit has deprived the Herbert River estuary entrance and the Dungeness beach of marine sediments transported by coastal waves alongshore. This has contributed to the recession of the Dungeness spit and the thinning of Dungeness beach.

Using the Digital Earth Australia Coastlines tool, the evolution of the Lucinda Spit from 1988 to 2020 is displayed in Figure 3-30. This figure shows that:

- From 1988 to 1998, the Lucinda spit possessed an east-west (shore-perpendicular) orientation. During this 10-year period, the spit accreted approximately 530 m out in an easterly direction.
- From 1998 to 2002, the spit developed a pronounced clockwise curvature (or hook), with an arm extending southward around 400 m. This shape of the spit curvature strongly suggests that it is shaped by a combination of Herbert River ebb tide flows (fanning out from the outgoing tide), coastal tidal flow, and the south-easterly local sea waves.
- From 2002-2020, the spit has developed a second hook that runs back from west to east - giving it a “o” shape. During this period, the spit has been migrating back towards the shore. As a result, the spit is reattaching to the subaerial beach at Lucinda. The alongshore sediment transport will be restored (to a certain degree) towards the Dungeness beach when this occurs.


**Figure 3-30 Shoreline Change at the Lucinda and Dungeness Spits from 1988 – 2020**

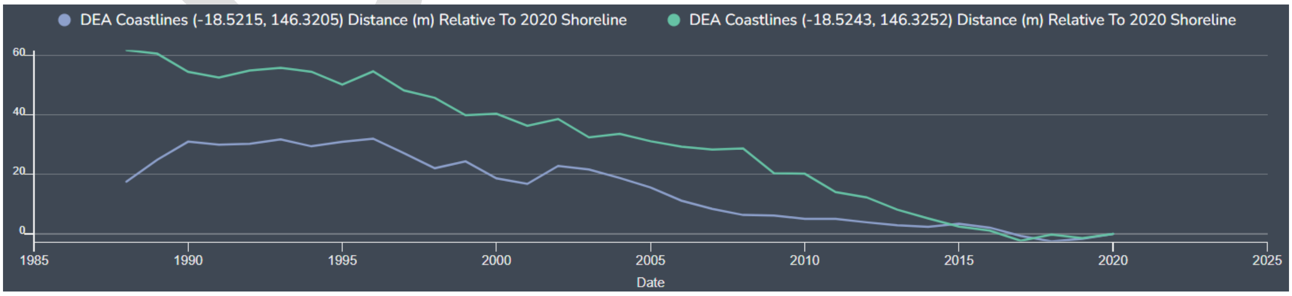


**Figure 3-31 Timeseries of long-term shoreline recession at Dungeness Beach from 1988 – 2020. Green line: Eastern end of the beach near the Port of Lucinda. Blue Line: Western end of the beach near Dungeness Spit.**

### *Taylors Beach*

Taylors Beach is located to the south of Gentle Annie Creek and borders Victoria Creek. The coastal plain consists of a complex sequence of beach ridges, barrier spits and estuarine mangroves through which the Victoria Creek meanders. Victoria Creek has a dynamic flood and ebb tide delta. The dominant beach sediment supply is of marine origin. Sediment is classified as nearshore sand and has less fines content than at Lucinda.

The Taylors beach sand spit is a noticeable local morphological feature at the Victoria Creek Mouth entrance. The orientation of the spit follows the direction of net longshore transport – as it runs in a northerly direction. The spit provides a crucial function to the settlement of Taylors Beach as it attenuates the penetration of offshore wave energy into the estuary mouth and provides a barrier to the settlement from easterly wave energy.

Analysis of historical aerial imagery has indicated that the spit has been generally stable over recent decades. An analysis of the long-term stability of the Spit was undertaken during Stage 3 of the CHAS, to estimate the likelihood of a breakthrough that would significantly change the coastal landscape at Taylors Beach. The Taylors beach sand spit's Erosion Prone Area Width (EPAW) was found to be 83 m. At its narrowest, the section of the spit protecting the town of Taylors Beach is 120 m wide – and therefore, a significant breakout was not considered likely during the SEMP planning period. The Stage 3 CHAS report notes that "*The spit appears to be relatively stable throughout the available long-term imagery however, it is not a hard structure and may become vulnerable over a longer time period, particularly if in becomes overtopped in higher water levels*."

The northern end of the spit (its downdrift end) experiences natural cycles of erosion and accretion, depending on the longshore sand supply and the balance between the prevailing coastal and fluvial forces operating in the estuary. As a result, the northern end of Taylors Spit has gone through cycles of growth and recession over the decades. During calmer periods, the spit steadily grows northward with the longshore sediment flux. However, during extreme conditions (which may comprise a tropical cyclone, or significant riverine outflows from Victoria Creek, or both), the sand lobe at the northern end of the spit can detach and migrate northwards.

An analysis of the historical growth and detachment of the Taylors sand spit from 1988 to 2020 is depicted in Figure 3-32. It shows that from 1988 to 2002, the spit grew by around 250 metres at a rate of 20 metres per year. In 2002, the sand lobe at the end of the spit detached, resulting in the spit receding by some 250 metres in 4 years. The spit then experienced relatively stable conditions for 10 years before growing again in 2016.

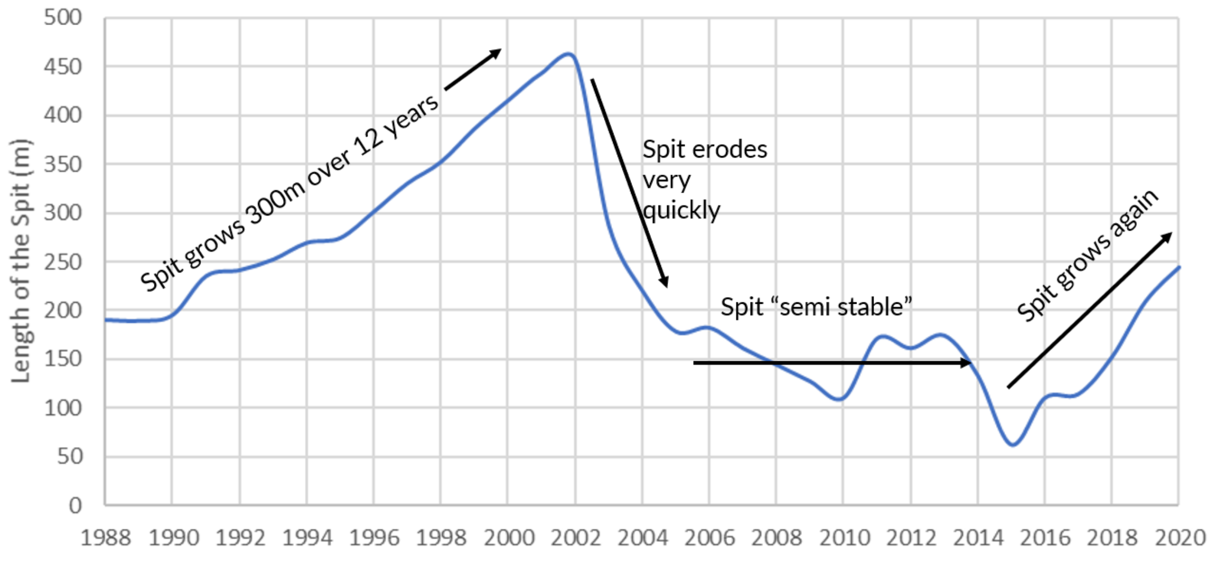


**Figure 3-32 The length of the Spit at Taylors Beach: 1988-2020**

*Forrest Beach*

Forrest Beach is the southernmost township of interest, and the coastal plain consists of a beach ridge barrier. Cassady Creek to the south is surrounded by mangrove forests which also occur north of Forrest Beach. The morphological processes at Forrest Beach are dominated by waves and relies on sediment supply from the littoral drift (longshore transport). The sediment at Forrest and Cassidy Beach was the coarsest observed at the study area, with the smallest amount of fines indicative of the coarse sand found offshore on the shelf.

Historically, Forrest Beach has been very stable – likely due to the stability provided by the local foredune system (the most developed of all sites across the study area) and some wave sheltering provided by the Palm Islands archipelago. Figure 3-33, extracted from the DEA Coastlines database, demonstrates this stability and even some beach growth since 1988, despite several major Tropical Cyclone events, including TC Yasi. This figure also shows that Forrest Beach experiences natural cycles of beach erosion and recovery.

Stage 3 of the CHAS assessed the potential for long-term shoreline recession at Forrest Beach to identify if there was any historical recession due to an imbalance in the net sediment budget. The study found no long-term shoreline recession trend and even reported that Forrest Beach was gradually accreting from 1961-2020 at a gradual rate of +0.05m/yr.

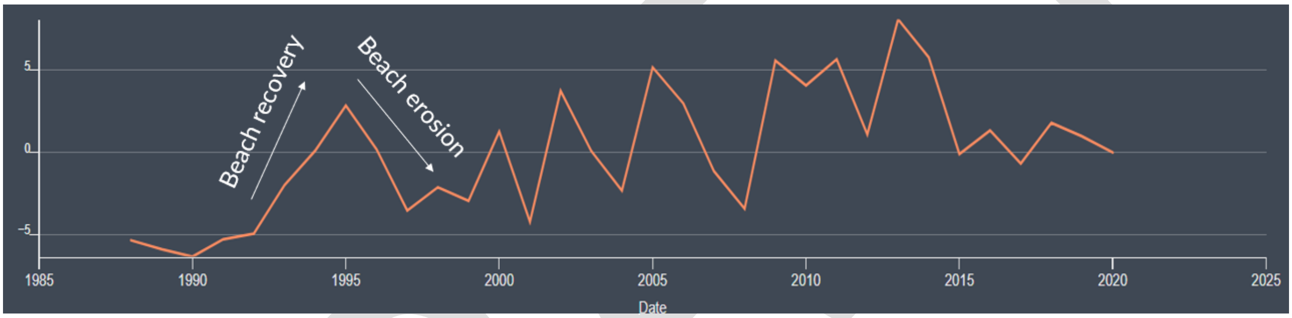


**Figure 3-33 Forrest Beach: Change in Shoreline Position over time**

### 3.2.5 The Local Dune Systems

*The Importance of Coastal Dune Systems*

Dunes are an integral part of our coastal environment. They provide protection from waves by absorbing and dissipating wave energy, thereby reducing coastal erosion. They are also the foundation of essential ecosystems, supporting valuable communities of plants and animals.

On sandy shorelines, coastal dunes represent the last line of defence against erosion by providing a reservoir of sand for waves to transport during storms. As well as limiting the landward intrusion of waves, wind and salt spray, dunes act as a barrier to oceanic inundation and provide a critical morphological and ecological transition from marine to terrestrial environments (DELWC, 2001).

The size and morphology of coastal dunes is dependent on the complex interaction between controlling winds, sediment supply, and the geomorphology of the nearshore and beach environment. At the most basic level, dunes can be divided into those that form from the direct supply of sediment from the beach face (primary dunes or foredunes), and those that form from the subsequent modification of primary dunes (hind dunes).

Vegetation in coastal areas plays an important role in stabilising the surface against erosion. For this reason, the protection of coastal vegetation is important for the long-term protection of beach front properties. Coastal plants have adapted to live in a harsh environment of salt spray, sandblasts, strong winds, high temperatures and flooding. Usually, three main zones of dune vegetation are arranged roughly parallel to the coastline (DELWC, 2001). The zones reflect changes in the nutrient status and moisture content of dune soils, which increase in a landward direction, and changes in the degree of exposure to strong winds, salt spray and sandblast, which decrease in a landward direction. These vegetation types and their role are depicted in Figure 3-34.

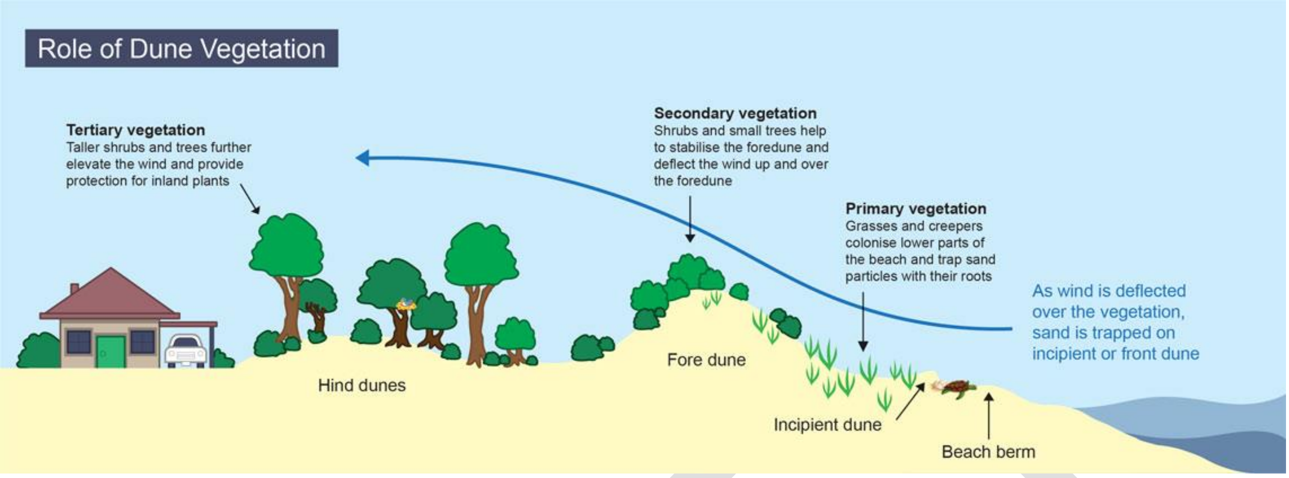


**Figure 3-34 The role of dune vegetation in coastal stabilisation (DEHP, 2015)**

Healthy, native dune vegetation plays a crucial role in coastal protection before, during, and after storms:

- **Before storms:** Primary zone species (grasses and creepers) colonise lower parts of the beach and trap abrasive sand particles forming a "foundation''. The foredune represents an elevated 'wall' that can be colonised by secondary zone species (mainly shrubs) to provide a wind deflecting 'shutter' near the shoreline. Finally, a "roof" forms from the growth of tertiary species (taller shrubs and trees), further elevating the wind and providing increased shelter to vegetation further inland.
- **During storms:** The vegetated sand buffer built up by the dune vegetation then provides a protective barrier to storm erosion – protecting foreshore assets & infrastructure. Vegetation itself also provides protection from waves – with root systems acting to hold the dune together (to a certain extent), and the above ground canopy helping to mitigate wave run-up and coastal inundation.
- **After storms:** Helps the dune rebuild naturally by trapping sand again and regrowing the buffer.

*Current Impacts on Study Area Dune Systems*

However, in some locations across the study area, the condition of the foreshore dune system is compromised due to:

- *A lack of appropriate dune vegetation species*. Non-native vegetation, such as lawn grasses, are common across much of the developed stretch of the Lucinda Foreshore, and across the northern end of the Forrest beach foreshore. Examples of this are provided in Figure 3-35. Lawn and turf grasses lack the crawling vine structure to trap windblown sand and do not possess the same deep root structure to withstand the ambulatory nature of the incipient foredune environment adequately. They also cannot withstand excessive salt spray. Furthermore, exotic plants compete with native dune vegetation and can potentially spread as environmental weeds.
- *Lack of sufficient density and cover of primary dune species*: In many places along the Lucinda and Forrest beach foreshore, the density of primary dune species is relatively sparse (see Figure 3-36), which increases the likelihood of potential sand blowouts, and ecosystem invasion by non-native species. It also reduces the stability of the foredune by hampering the sand-trapping potential.
- *Human use impacts:* At many locations across the study area, uncontrolled pedestrian traffic has damaged the foredune vegetation. Similarly, vehicles on beaches impact beach health, with several informal vehicle access tracks cut through the dunes at Forrest Beach (see Figure 3-37). HSC acknowledges the long

tradition of off-road vehicle use at Forrest beach and the significant recreational amenity that this provides. However, some management of these activities is required to preserve healthy dune conditions. Vehicle impacts to the dune environment include:

- Sand is moved downhill on bare slopes, lowering dune crests and infilling depressions. Blow-outs may occur where deep wheel ruts cross dune crests.
- Physical damages occur to plants above and below ground, impeding the regeneration and growth of new plants that are sensitive to disturbance.

- *Vegetation vandalism:* The intentional damaging of coastal vegetation is akin to environmental vandalism. It impacts the stability of dunes and their essential role in our coastal environment. Also, if an area of vegetation is damaged or removed, erosion becomes more susceptible. This can lead to a 'blow out' or gap in the dune. This gap can quickly grow and erode the rest of the dune system, impacting nearby properties and infrastructure.

**Figure 3-35 Examples of a lack of appropriate native dune vegetation at the study area. Top: Lucinda foreshore. Bottom: Forrest Beach**

**Figure 3-36 Examples of a sparse primary native dune vegetation at Forrest Beach**

Figure 3-37 Examples of informal vehicle access tracks cut through the Forrest Beach dune system.

# 4 EXISTING COASTAL PROTECTION WORKS

## 4.1 Dungeness and Lucinda

The layout of the various protection structures along Dungeness and Lucinda are provided in Figure 4-1, with additional detail provided below.


**Figure 4-1 Coastal Protection Structures at Lucinda and Dungeness**

### *Dungeness and North Lucinda*

In order to manage the historical migration of the Enterprise Channel, several ad hoc rock seawalls have been built along the eastern bank of the channel to stabilise it. The section of the existing rock wall along Enterprise Channel that is located on Council land is in good condition and effectively maintains the channel alignment. Therefore, apart from ongoing inspections/maintenance and damage repair after flood events, no specific action is required for this section of the shoreline. However, it should be noted that the upstream (western) end of the seawall (which is located within the Strategic Portland Boundary) is currently experiencing some end erosion effects that are presently being managed through beach nourishment.

The north-facing shore of Lucinda is vulnerable to the channel movement of the Herbert River. Erosion along this shoreline can potentially threaten the assets associated with the Lucinda Jetty. Significant seawalls have been constructed adjacent to the Jetty structure to protect these assets. East towards the Lucinda spit this seawall transitions to a smaller seawall structure, covered mainly by the frontal dune and vegetation (BMT, 2009).

### Dungeness Beach Nourishment

Sediment maintenance of the Lucinda Barge ramp is currently undertaken. Excavation works to remove sediment build up on the ramp is undertaken up to three times a week, and total just under 5,000t per year (pers comm. Port of Townsville Limited, November 2022). This equates to a volume of around 2,500m3 a year.

The sand is stockpiled adjacent to the ramp and then returned to the system upstream, at Dungeness Beach, at the Western end of the Port boundary.

**Figure 4-2 Dredge sand stockpiling at Lucinda Barge Ramp**



### Lucinda Groyne Field

Timber groynes were installed along Patterson Parade in approximately 1971 in an attempt to build up the beach by trapping northward-bound beach sediments. It is unclear how many groynes were constructed initially, but by 2001 a total of 11 groynes were installed between Johnson and Periwinkle Parks.

The timber groyne field also deteriorated in the harsh environment. Six slightly longer geotextile sand container (GSC) groynes in 2001 were approved for construction accompanied by beach nourishment (BMT, 2009).

By 2005 a further development approval was sought for an additional two groynes and further beach nourishment, as well as the construction of a rock revetment to protect the road pavement at the southern extremity of Patterson Parade from erosion. Refurbishment works on the GSC groynes were undertaken in 2019, costing nearly $300,000. This was the first significant refurbishment of the GSC groynes since their original construction in 2001-2002.

The GSC groynes are stacked 0.75 $m^3$ ELCOROCK® geocontainers (Carley, et al., 2011). Inspections of the structures in 2022 indicated they were in poor condition, with visible signs of GSC puncture, deflation, and displacement – see Figure 4-3. The reason for this poor condition is likely a combination of the following:

- The GSC groynes were constructed around 2005, and typically have a 10-20 year design life in such conditions. Therefore, the assets are reaching the end of their design life. It is noted that the previous SEMP (2009) recommended that the existing GSC structures should be: "*replaced or upgraded with a more permanent material (e.g., rock) in 10-15 years*".

- The GSC units are likely undersized for an open coast environment in a cyclone-prone region. The GSC units are comprised of 0.75 $m^3$ containers, which would have a saturated weight of around 1500 kg. Preliminary engineering analyses indicated these bags would resist a design wave condition of between H = 1.3 to 1.8 m. Design wave heights at the structures could potentially exceed 2 m at the Lucinda foreshore and therefore would be prone to displacement and damage.
- Placement pattern and configuration: The existing groynes do not appear to have an adequate interlocking placement pattern or even a “round head” at their seaward end.
- It is possible that the GSC bags may not have been adequately filled with coarse sand. Research by (Soysa, et al., 2012) shows that the stability of the GSC units drops off significantly when only filled to 80% capacity with suitable material. There is a proportion of fine material in the Lucinda beach sand.

Despite these limitations, previous assessments concluded that the groynes provided effective stabilisation of the shoreline position even though maintenance was required (BMT, 2009).

The beach level on the southern (i.e. updrift) side of most of the groynes is generally levelled with the crest of the structures, whilst the beach level on the northern (i.e. downdrift) side is generally notably lower – see Figure 4-3. This indicates that the sediment trapping capacity under ambient conditions has been reached, and that sediment routinely bypasses or overtops the groynes (BMT, 2009).

**Figure 4-3 GSC Groynes at Lucinda, in 2022**

*Lucinda Seawalls*

Informal revetments along the Lucinda foreshore have been constructed to supplement the groynes field and control beach erosion. By 2001 revetments had been constructed from Johnson Park to Periwinkle Park. The revetments were built on varying alignments, with various materials, and to multiple designs. Most of these structures are still present today, with some in poor condition (BMT, 2009). In addition, many of these walls are substandard and unlikely to meet the Queensland design standards for such structures.

Also, significant terminal scour has occurred immediately downdrift of the northernmost revetment that protects Johnson Park – see Figure 4-4. The shoreline movement assessment by BMT WBM (2009) indicates that this terminal scour pocket has been a feature on the shoreline since at least 1971. At present, the end effects are damaging the seawall through outflanking.

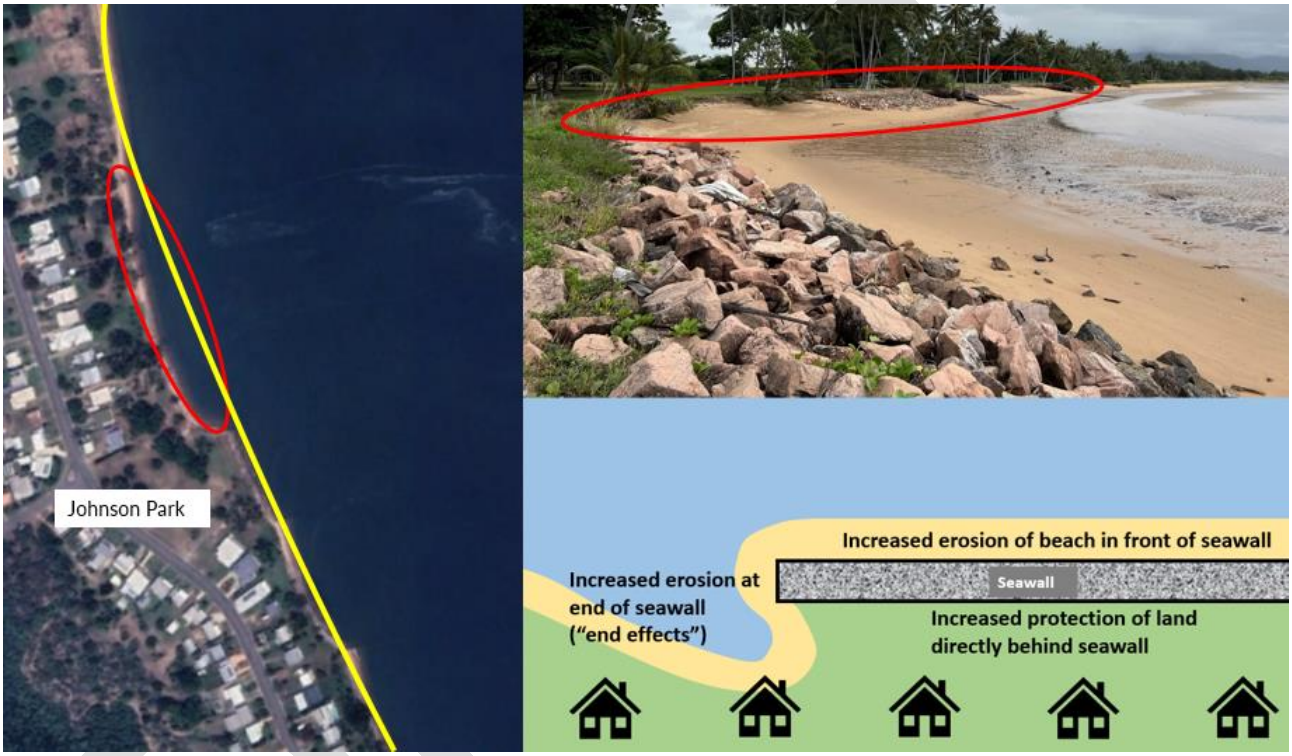


**Figure 4-4 Terminal Scour Observed at the downdrift (northern) end of the Johnson Park Seawall**

No official coastal protection works are in place north of Johnson Park. However, several small-scale informal seawalls are located on this stretch of the foreshore, presumably erected over the years by the community. These seawalls are not of engineering standard, with rock armour undersized, poorly packed, thinly layered and loosely interlocked.

While these seawalls may provide a useful psychological function for some community members (sense of control over Nature, the relative safety of a physical barrier, etc.), these structures are not providing much coastal protection function and these seawalls are unable to control coastal hazards such as coastal erosion and coastal flooding.

Instead, the small-scale end effects along the foreshore observed during our site inspections suggest that these seawalls exacerbate erosion. A severe tropical cyclone event will breach the seawall and leave rock units scattered across the beach, representing a public safety and amenity risk in the long term. Also, these structures provide a false sense of security, which is hazardous as they would be inconsistent with local emergency planning requirements.

## 4.2 Taylors Beach

Figure 4-5 localises the coastal protection assets along Taylors Beach.


**Figure 4-5 Coastal Protection Structures at Taylors Beach**

*Seawalls*

The northern end of Taylors Beach is protected by a small to medium-sized rock armouring; further upstream, beyond the boat ramp, the seawall transitions to gabion basket protection – see Figure 4-6. Immediately south of the gabion seawall is a 90 m long Geotextile Sand Container (GSC) seawall – see Figure 4-7.

The GSC structure was inspected in April 2022 and in November 2022. It was in poor condition, with numerous bags punctured and/or deflated. The structure was slumped with displaced bags at the crest. The area to the immediate south of the structure also appeared to be experiencing pronounced end-effect erosion (see Figure 4-7).

Upstream of the gabion basket protection (to the south), a rock seawall has been constructed adjacent to various residential properties. This section of seawall is currently an unapproved seawall that has been constructed using a range of material types of varying sizes – see Figure 4-8.

*Dredging*

Council currently undertakes regular maintenance dredging at the Taylors Beach boat ramp to maintain safe waterways access for recreational boaters. The volume of dredge material is variable with each dredging campaign, which occurs at approximately 1 to 3 year intervals, with a dredged volume typically between 2,000m$^3$ and 5,000m$^3$.

**Figure 4-6 Left: Taylors Beach Rock Seawall. Right: Gabion Basket Seawall.**

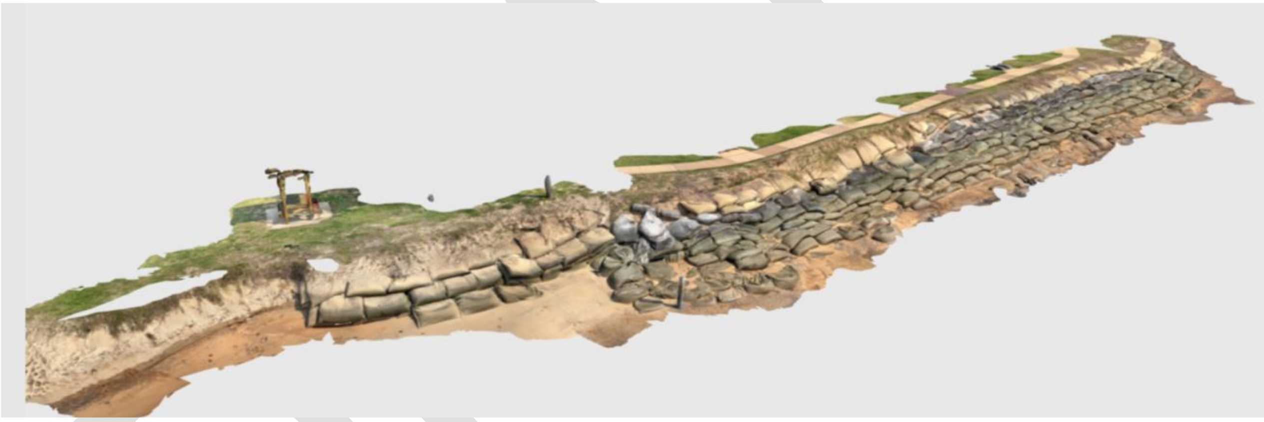

**Figure 4-7 GSC Seawall Structure**

**Figure 4-8 Informal rock armour seawalls at Southern Taylors Beach**

**Figure 4-9 Indicative dredge area at the Taylors Beach Boat Ramp**

## 4.3 Forrest Beach

There are no known coastal protection structures at Forrest Beach.

# 5 COASTAL HAZARD AND RISK ASSESSMENT

## 5.1 Erosion Prone Area Concept

A significant focus of coastal risk management is determining the extent of foreshore vulnerability to short-term and long-term erosion processes over a specified planning period.

In Queensland, the extent of this vulnerable area is delineated by the Erosion Prone Area Width (EPAW) calculation. The establishment of Erosion Prone Areas along Queensland's coastline has been an intrinsic part of the state's coastal management policy since 1968. The concept is to set aside undeveloped buffer zones along the shoreline, thereby implementing a philosophy that biophysical coastal processes should be accommodated rather than prevented. The most basic form of accommodation is to avoid locating development and vital infrastructure within dynamic coastal areas affected by the natural processes of shoreline erosion and accretion.

An adequate buffer zone allows for maintaining coastal ecosystems (including within littoral and sublittoral zones), beach amenities, public access, and the impacts of natural processes - without the high cost and potential adverse effects of property protection works.

The procedure adopted in determining the EPAW involves estimating long-term erosion rates, the extent of short-term erosion corresponding to a design storm event (in this case, a tropical cyclone) and adopting a specific 'planning period.' The planning period affects the width of the long-term erosion component, which is usually based on assessed annual erosion rates. It also influences the calculated short-term erosion width because the selection of the extreme event used to calculate storm erosion is based on the probability of its occurrence over the specified period.

The EPAW considers the possible extent of short-term and long-term erosion processes (as well as the implications of future climate change) over the development planning period. It is calculated using the following formula, as required by the QLD Coastal Hazards technical guidelines:

$$\boldsymbol{E} = [(\boldsymbol{N} \times \boldsymbol{R}) + \boldsymbol{C} + \boldsymbol{S}] \times (\mathbf{1} + \boldsymbol{F}) + \boldsymbol{D} \qquad \text{Equation 4.1}$$

Where:

**$E$ = erosion prone area width (metres)**

$N$ = planning period (years)

$R$ = rate of underlying long-term erosion (metres per year)

$C$ = short-term erosion from the design storm event (metres)

$S$ = erosion due to sea level rise over the planning period (metres)

$F$ = factor of safety (0.4 is applied)

$D$ = dune scarp component to allow for slumping of the erosion scarp (metres).

## 5.2 EPAW at the Study Area

The Hinchinbrook CHAS Phase 2 report identified no site-specific, sufficiently detailed, short- or long-term erosion studies for some locations within the Hinchinbrook Shire. While state-wide erosion mapping covers the Shire, it was deemed likely to be conservative. The conservative approach for the majority of the shoreline was accepted where built public or private assets did not exist within the declared erosion prone area (GHD, 2020). A more detailed EPAW assessment was recommended in the CHAS Stage 2 to cover the settlement areas. This assessment was carried out during the CHAS Stage 3.

Figure 5-1 shows the results of the EPAW. Stage 3 CHAS report provides further details regarding the methodology for calculating the various components of the EPAW.

This SEMP adopted these EPAW calculations to inform the extent of at-risk assets and to determine appropriate erosion mitigation management options.

| Location | EPA Beach Code[*] | Planning Period (N) (yrs) | | | Rate of Long Term Erosion (R) (m/yr) | Short Term Erosion (C) (m) | Erosion due to Sea Level Rise (S) (m) | | | Factor of Safety | Dune Scarp Component (D) (m) | Calculated EPA Width (rounded up to closest integer) (m) | | | | Current EPA Width (DEPH 2015) (m) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2030 | 2070 | 2100 | | | 2030 | 2070 | 2100 | | | 2019 | 2030 | 2070 | 2100 | |
| Forrest Beach | HIS004 | 10 | 50 | 80 | 0 | 11 | 2 | 10 | 14 | 0.4 | 0 | 42 | 45 | 56 | 62 | 165 |
| Taylors Beach Spit | HIS005 | - | - | - | 10[d] | 13 | 3 | 13 | 19 | 0.4 | 0 | 57 | 61 | 75 | 83 | 400 |
| Taylors Beach Southern Revetment | - | 10 | 50 | 80 | 0 | 0^ | 1 | 4 | 6 | 0.4 | 10 | 31 | 33 | 37 | 40 | - |
| Taylors Beach Middle Dune Area | - | 10 | 50 | 80 | 0 | 0^ | 4 | 19 | 27 | 0.4 | 0 | 0 | 6 | 27 | 38 | - |
| Taylors Beach Northern Revetment | - | - | - | - | - | - | - | - | - | - | - | 10[a] | 10[a] | 10[a] | 10[a] | - |
| Taylors Beach Northern Mangrove Area | - | 10 | 50 | 50[c] | 2 | 12 | 4 | 20 | 30 | 0.4 | 0 | 42 | 76 | 210 | 224 | - |
| Lucinda Groyne Field | HIS011 | 10 | 50 | 80 | 0 | 1 | 2 | 11 | 16 | 0.4 | 0 | 13 | 16 | 28 | 35 | 130 |
| Lucinda Eastern Beach Exposed | - | 10 | 50 | 80 | 0 | 17 | 3 | 16 | 23 | 0.4 | 0 | 41 | 45 | 63 | 73 | 130 |
| Lucinda Beach Eastern Protected | HIS012 | 10 | 50 | 80 | 0 | 24 | 4 | 19 | 27 | 0.4 | 0 | 47 | 52 | 73 | 86 | 400 |
| Lucinda Northern Beach | - | 10 | 50 | 80 | 0 | 10[b] | 2 | 10 | 15 | 0.4 | 0 | 16 | 19 | 30 | 37 | 75 |
| Lucinda Bulk Sugar Terminal | - | - | - | - | - | - | - | - | - | - | - | 10[a] | 10[a] | 10[a] | 10[a] | 130 |
| Dungeness Northern Beach | - | 10 | 50 | 50[c] | 3 | 17 | 3 | 17 | 24 | 0.4 | 0 | 37 | 83 | 271 | 280 | 400 |
| Dungeness Northern Spit | - | 10 | 50 | 50[c] | 6 | 17 | 3 | 17 | 24 | 0.4 | 0 | 37 | 125 | 481 | 490 | 400 |
| Dungeness Township | - | - | - | - | - | - | - | - | - | - | - | 10[a] | 10[a] | 10[a] | 10[a] | - |

**Figure 5-1 EPAW Calculations determined during Stage 3 of the CHAS (GHD, 2020)**

# 6 SHORELINE EROSION MANAGEMENT OPTIONS

## 6.1 Guiding Principles

Several approaches can be considered to manage shoreline erosion. The State Coastal Management Plan provides an integrated approach to the problem by requiring all planning for Queensland's coastal areas to address potential impacts through the following hierarchy of approaches as follows - from most desirable to less desirable:

- *Avoid* - focus on locating new development in areas that are not vulnerable to the impacts of coastal processes and future climate change;
- *Planned Retreat* - focus on systematic abandonment of land, ecosystems, and structures in vulnerable areas;
- *Accommodate* - focus on continued occupation of near-coastal areas but with adjustments such as altered building design; and
- *Protect* - focus on the defence of vulnerable areas, population centres, economic activities, and coastal resources.

## 6.2 Generic Management Options

### 6.2.1 Non-Structural Options

*Do Nothing*

A “do nothing” strategy of coastal management can be appropriate where foreshore land is undeveloped, or assets and property are of only limited value. It is well suited to situations where available erosion buffers are sufficient to accommodate long-term and short-term coastal erosion over the nominated planning period. However, the high social and financial costs associated with land use losses are generally unacceptable on foreshores where existing development and infrastructure are prone to coastal erosion.

*Avoid Development*

Along sections of the foreshore that remain substantially undeveloped, a key objective would be to prevent an erosion problem from occurring by allowing the natural beach processes of erosion and accretion to occur unimpeded. This also preserves the beach's natural ecosystem, amenity and character, the health of which is often the main reason for coastal developments to occur.

*Planned Retreat*

The intent of a planned retreat strategy is to relocate existing development outside of the area considered vulnerable to erosion, allowing this previously developed land to function as a future erosion buffer. This approach accommodates natural beach processes without attempting to influence them. There are many mechanisms for coastal retreats, such as relocation, buy-back schemes, etc.

*Beach Nourishment*

Beach nourishment involves placing additional sand on the active beach profile to restore an adequate erosion buffer. Earthmoving or dredging equipment can place the sand on the dry beach or into the surf zone. Beach nourishment has reduced adverse impacts on adjacent foreshores and maintains the beach for recreational use.

The feasibility of beach nourishment depends on the practical and cost-effective availability of a suitable source of sand. Sand should be suitable (grain size, colour, large enough volume etc.) and located near the site to reduce bulk transport costs.

Possible offshore sources of sand for beach nourishment purposes are limited in the region because of the extensive coverage of environmental conservation areas. If offshore areas away from environmentally sensitive areas were envisaged, then the general considerations for use would include:

- Identification of sand source(s);
- Suitability of the sand;
- Transport of the sand to the site;
- Rezoning and approval for sand extraction; and
- Potential environmental impacts.

As discussed in Section 4, there is currently ongoing sediment maintenance works at the Lucinda Barge ramp, with up to 2500m$^3$ per year of sand removed from the ramp and returned to the system upstream at Dungeness Beach.

*Sand Backpassing / Beach Scraping*

The concept of beach scraping entails moving sand from elsewhere within the local sedimentary system to the region of interest. Such sand is typically sourced from:

- lower levels of the cross-shore beach profile (typically from tidal flats immediately in front of a beach); or
- other locations along the foreshore downdrift of the study area

In essence, it is simply redistributing sand that is already within the active beach profile and does not provide a net long-term benefit unless applied as an ongoing program.

Beach scraping can be beneficial in reinstating or reshaping the dune following a storm event, thereby assisting, and accelerating natural processes that would otherwise rebuild the eroded dune system over much longer timeframes – which can take years to decades.

*Foreshore Management*

There are several interrelated components of foreshore and dune management, as follows:

- Dune rehabilitation through revegetation works: Vegetation plays an important role in dune growth and influences the ability of a coastline to support environmental, social and economic values. Revegetation works that focus on planting native species should focus on species specific to the correct dune zone (see Figure 3-34). This can help stabilise the foreshore by trapping windblown sand, roots will help prevent erosion by wind and waves, and pioneer plant species can extend beyond the dune toe, allowing it to advance seaward. An example of successful dune restoration works at Horseshoe Bay on Magnetic Island is provided in Figure 6-1.
- Fencing: Measures such as fencing, signage and enforcement can be used to minimise dune damage, support revegetation activities, and to trap wind-blown sand. These should target areas where dune erosion occurs due to artificial processes (e.g., pedestrians, vehicle traffic or camping) or dune restoration works are in progress.

These represent typical “working with nature” approaches, historically undertaken along the Forrest beach foreshore – see Figure 6-2.

Figure 6-1 Example of Revegetated Foreshore at Eastern End of The Esplanade at Horseshoe Bay (Water Technology, 2019). Before the Works in 2015 (Left) and Afterwards in 2018 (Right)


Figure 6-2 Example of historical dune care programs in the area

## 6.2.2 Structural Options

*Seawalls*

Seawalls are commonly used to provide a physical barrier to continuing shoreline recession. Properly designed and constructed seawalls can protect foreshore assets by stopping further coastal recession. However, seawalls can significantly interfere with natural beach processes by separating the active beach from sand reserves stored in beach ridges and dunes behind the wall. In other words, seawalls can protect property behind the wall, but they do not prevent in any way the erosion processes from continuing on the beach in front of them. Instead, seawalls often exacerbate and accelerate erosion in the overall beach compartment, because they reduce the volume of sand available to coastal processes.

Also, the beach level in front of the seawall tends to steadily lower as coastal erosion occurs due a lack of sand supply. The beach lowering is exacerbated by wave action washing against the wall, causing a high degree of turbulence in front of the structure - which scours the beach material. Wave energy reflected from the seawall also contributes to beach scour and contributes to the beach lowering processes. In many cases this lowering continues until the beach level is below tidal levels and the dry beach is not accessible anymore for recreational use. Seawalls degrade the beach and foreshore natural amenities.

The ongoing lowering of the sand level in front of seawalls can challenge the structure's overall stability. As a result, the seawall can slump and be undermined unless appropriate foundation and toe arrangements are constructed and maintained. When damaged, it can be difficult and expensive to repair existing seawalls damaged by undermining. When this occurs the most cost-effective solution is often to demolish and rebuild the structure with deeper and more robust foundations.

Another typically adverse impact of seawalls is that the erosion issues are relocated further alongshore rather than addressed. Natural beach processes can no longer access the sand reserves in the upper part of the active beach (beach berm and dune) behind the seawall. The deficit in sand supply to the beach magnifies erosion, ultimately requiring seawall extensions along the downdrift shoreline to protect it. In other words, constructing a seawall does not address the cause of erosion, it transfers and magnifies the erosion risk further along the beach.

Seawalls have an impact on the visual amenity, and this can be adverse when the wall is built but also overtime as ongoing beach lowering exposing the seawall. Such walls also inhibit access across the foreshore onto the beach. Typically access stairways or ramps are needed to provide beach access and these should be considered in the layout and cost of the seawall works as these require on-going maintenance and repairs to remain safe and functional.

Rock armour structures are subject to movement and settlement over time. Rock armour seawalls are also subject to damage during storm events, even if designed to withstand major wave attacks. A typical design criterion is for less than 5% rock armour damage during a 50-year storm event. However, intermediary damage occurs and compounds over time as successive storm events occur. As such, ongoing maintenance is required to maintain structural stability. Also, individual armour stones will dilapidate over the years in the corrosive coastal environment under chemical and mechanical wear and tear, slowly deteriorating and reducing armour stones shape and volume.

Maintenance works require construction equipment access to the top of the seawall to allow rock armour 'top-up' works. Inaccessible seawalls have very high whole-of-life costs because repair work may include partial demolitions and/or large-scale temporary works. Minor slumping of groyne and offshore breakwater structures after initial construction is generally not such an issue, but this can be an issue for a seawall built too close to a building; in these instances, soil improvement works can be substantial.

An ongoing maintenance cost of 1% per year is not unreasonable for an engineered and quality-built armour rock seawall.

*Groynes*

The longshore transport of sand on an eroding shoreline can be impounded by constructing groynes across the active beach. A groyne is a physical barrier that intercepts sand moving along the shore. Sand is gradually trapped against the updrift side of the structure, resulting in a wider beach on this "supply-side" of the structure. However, the downdrift beach is deprived of the sand trapped by the groyne and erodes.

This process of updrift entrapment and downdrift erosion continues until sand has accumulated on the updrift side of the groyne to the extent that it starts to bypass the groyne around the groyne seaward end. Sand supply is then reinstated to the downdrift foreshore. However, this maintains the shoreline on its eroded alignment.

Groynes cannot prevent the significant cross-shore erosion that typically occurs during cyclones. Nevertheless, they have an indirect effect in that by having trapped sand on their updrift side, they have created a wider beach and an enhanced erosion buffer on that section of foreshore. However, on the depleted downdrift side, the foreshore is more susceptible to cyclone erosion due to the depleted beach/buffer width. The construction of a groyne does not resolve the erosion problem, but merely transfers erosion further along the beach.

The length of updrift shoreline that benefits from such groyne is somewhat limited. Therefore, if long shoreline sections require protection, several groynes can be built at intervals along the shoreline, forming a groyne field. Such intervention can have a significant impact on the visual amenity of the foreshore. Structures such as groynes that cross the shore can also have an adverse impact on beach use since walking along the beach will entail crossing over the groynes.

## 6.3 Options Assessment Process

### 6.3.1 Development of Options

Once the guiding principles for the SEMP are confirmed, the next step is to develop a suite of potential actions (options) to address the risks identified and achieve the objectives of the SEMP. A "long-list" of potential options were developed through the following processes:

- *Review of the SEMP objectives:* – see Section 1.
- *Review of existing SEMPs and related documents:* A review and audit of related documents has been undertaken, including:
  - The previous Hinchinbrook Shoreline Erosion Management Plan (BMT, 2009)
  - The Lucinda Beachfront Protection Options Study (GHD, 2015)
  - The Hinchinbrook Foreshore Management Plan Review (GHD, 2017)
  - The Hinchinbrook Coastal Hazard Adaptation Study (GHD, 2020)
- *Stakeholder Engagement:* In August 2022, an "options workshop" was held to consult with representatives of the Queensland Department of Environment and Science (DES) and HSC. This workshop aimed to discuss potential options for inclusion in the SEMP.
- *Community Engagement:* Two rounds of community workshops were also held during the project to explain coastal hazard-related issues and to gather community views towards coastal management actions.
- *Engagement with the Water Technology Experience and Expertise:* The Water Technology team comprises a group of highly skilled geomorphologists, ecologists, coastal managers, town planners, coastal modellers, coastal engineers, and scientists with significant experience in coastal engineering and coastal management.

Based on these consultations, 14 potential coastal management options were identified for consideration. While most options can be considered independently from one another, in some instances, some options have been developed as alternatives for a specific action. These alternatives were affixed with letters such as "A" and "B" to identify a preferred coastal management option.


| Location | ID | Action |
|---|---|---|
| Lucinda | L1A | Upgrade existing groyne structures using GSC construction |
| Lucinda | L1B | Upgrade existing groyne structures using rock armoured construction |
| Lucinda | L2A | Sand back-passing and beach nourishment |
| Lucinda | L2B | Lucinda foreshore seawall |
| Lucinda | L3 | Foreshore dune restoration |
| Lucinda | L4 | Repair and maintain Johnston St seawall |
| Dungeness | D1 | Beach nourishment & shoreline monitoring |
| Dungeness | D2 | Dungeness Boating Safety Project |

**Figure 6-3 Potential Options for Dungeness and Lucinda**


| Location | ID | Action |
|---|---|---|
| Taylors Beach | T1 | Upgrade GSC seawall structure |
| Taylors Beach | T2 | Re-use of dredged sand for beach nourishment |

**Figure 6-4 Potential Options for Taylors Beach**


| Location | ID | Action |
|---|---|---|
| Forrest Beach | F1 | Dune restoration program |
| Forrest Beach | F2 | Update the vehicles on beaches policy |
| Forrest Beach | F3 | Upgrade / maintain safe vehicle access |

Figure 6-5 Potential Options for Forrest Beach

### 6.3.2 The Assessment Methodology

Decision-making in coastal and estuary management can be complex and multifaceted due to the inherent trade-offs required between social, environmental, economic, and political factors. Therefore, identifying appropriate management actions requires considering a range of criteria, many of which cannot be easily quantified into standard units or monetary values. Traditionally, optioneering undertaken as part of coastal management plans has applied heuristic approaches that aim to simplify this complexity. Whilst practical, this can sometimes lead to over-simplifications whereby important information may be lost, opposing points of view may be discarded, and elements of uncertainty may be ignored.

In order to identify a preferred option(s) for addressing the erosion issues at the study area, the potential options were assessed using a high-level, semi-quantitative multi-criteria matrix framework. The matrix provides a systematic and transparent approach to comparing different options that stakeholders and the community readily understand.

Options have been assessed considering several criteria, including feasibility/performance, environmental impacts, social and community impacts, and economic viability, as described in Table 6-1. For each option, scores ranging from -3 (strongly negative) to 0 (neutral or no impact) and +3 (strongly positive) were allocated for each criterion. A score of -3 may result in the option not being feasible.

**Table 6-1 Option Assessment Criteria**

| Assessment Criteria | Metrics |
|---|---|
| **Feasibility (Performance & Logistics)** | ▪ Protection of Infrastructure<br>▪ Logistical constraints / risk (constructability etc)<br>▪ Adaptability to future conditions (SLR etc) |
| **Environmental Impacts** | ▪ Impact on Coastal Processes<br>▪ Impact on Flora and Fauna |
| **Social & Community Impacts** | ▪ Impact on Social & Recreational Amenity<br>▪ Impact on Visual Amenity<br>▪ Level of Community Support |
| **Viability** | ▪ Capital Costs & Ongoing Maintenance<br>▪ Total Net Present Value (NPV) Costs over 20-year SEMP timeframe |

*Economic Viability and Cost Estimates*

Additionally, high-level estimates of the capital cost and ongoing maintenance costs for each option have been developed based on preliminary concept designs, and typical unit rates for materials, construction, and transportation. These estimates have been based on previous experience for coastal works and supplemented by discussions with local contractors and have included direct baseline costs, indirect costs, and a contingency. Then a 20-year net present value life cycle cost has been estimated, which includes the capital cost and ongoing maintenance costs for each option calculated using a 7% discount rate (as per the QLD State Government Cost Benefit Analysis Guide. This estimate method allows incorporating design life and frequency of maintenance for each option to draw lifecycle cost comparisons.

The resulting cost estimates are indicative. The estimates are valuable to compare SEMP options and to provide an order of magnitude of the effort required to deliver each option. However, the “detailed design” of the options has not been completed, and the costs could rise when the coastal management actions are scoped, and risk adjusted. Therefore, completing detailed design work before preparing a budget is prudent.

Additionally, construction market forces significantly affect coastal works construction costs. Coastal works are also intrinsically risky due to their interface to latent soil conditions and uncertain weather exposure during construction. With the construction market utilised nearing full capacity in 2022 and possibly contracting due to high inflation in 2023 onward, the cost of delivering each option indicated in the SEMP is likely to be no more accurate than ± 50%.

*Community Consultation*

Community consultation was undertaken during the development of the SEMP, in the form of an online community survey, as well as in-person community workshops at each of the three main localities. During this consultation, community members could peruse the initial long list of options and provide feedback on each option via:

- A tick box response to indicate the level of support > “Support”, “Neutral / No Opinion”, and “Do Not Support”; and
- A free text response to provide more detailed feedback and suggestions regarding each option.

This consultation provided direct, quantifiable data regarding the level of community support for each potential option on the long list. In order to rank the options in terms of community support, a “Net Approval Rating” was calculated for each option. The community support percentages and net approval ratings for each option is provided in Figure 6-6.

The results demonstrated:

- The majority (>50%) support almost all options.
- Very low levels of "Do Not Support" (0-27%) across all options.
- Options focused on dune management and soft infrastructure scored higher than options considering hard infrastructure. This finding is consistent with the community values survey undertaken earlier in the project and described in Section 2.

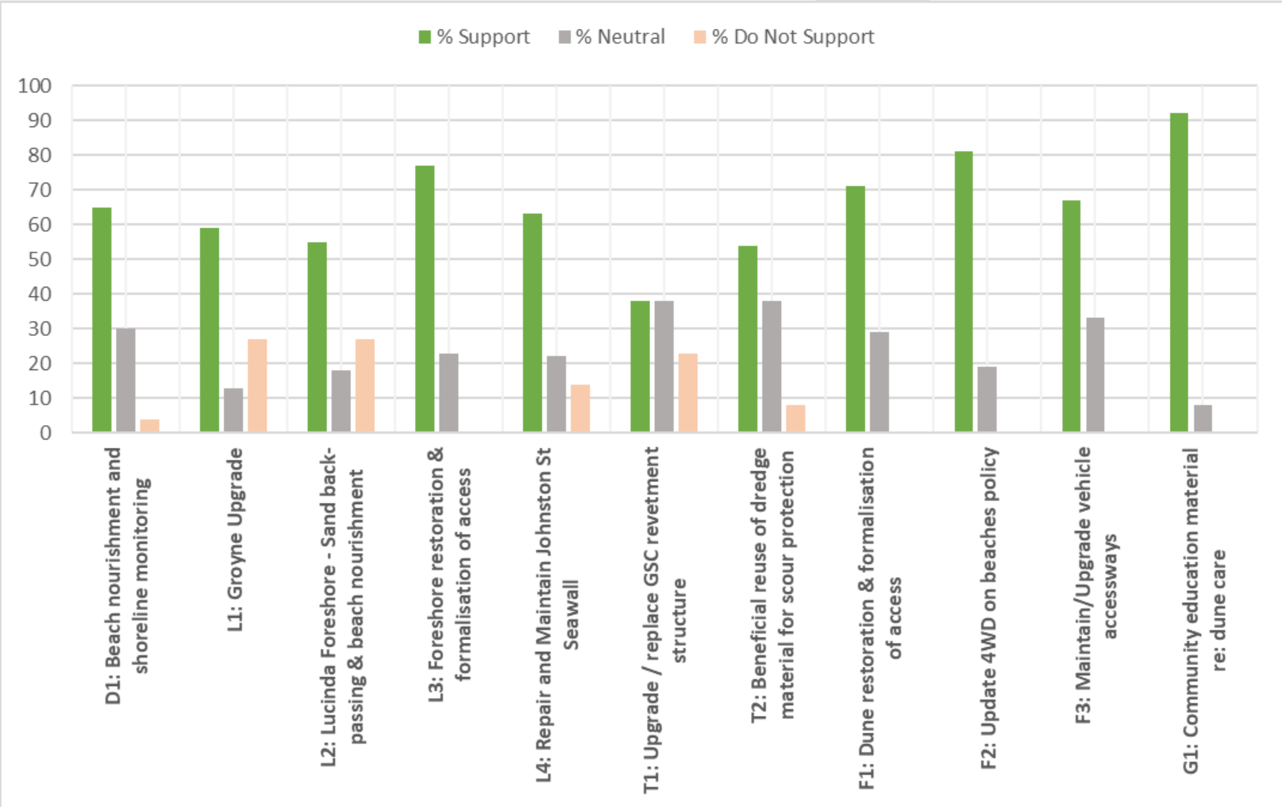


**Figure 6-6 Levels of community support (%) for potential actions**

*Options Assessment Outcomes*

- Options considered for Lucinda and Dungeness are depicted in Figure 6-3 and described in Section 6.4.
- Options considered for Taylors Beach are depicted in Figure 6-4 and described in Section 6.4.
- Options considered for Forrest Beach are depicted in Figure 6-5 and described in Section 6.5.
- One study area wide action was considered and is described in Section 6.7.

A summary of the options assessment outcomes and recommendations for SEMP Actions are provided in Section 7.

## 6.4 Description of Options for Lucinda and Dungeness

**Table 6-2 Option L1A: Groyne Upgrade: GSC construction**

**Description and Rationale**

- This option would involve replacing the existing groyne structures with a new groyne field comprised of new Geotextile Sand Containers (GSCs).
- If adequately designed and constructed, a design life of 15-20 years is expected.
- In the last 10-15 years, GSC products have benefited from improved design practices and construction quality control. Also, the geofabric material has become more durable, including denser bags, larger bags, vandalism deterrent materials and materials with increased algal and UV resistance.
- The success of GSC groynes is evident in other Queensland locations, such as Maroochydore, where the existing field of four groynes has been in place for 20 years and is well supported by the community.
- The GSC groynes are often popular with the local community, who may favour geotextile over rock for the renewal, as the community can more easily / safely traverse the GSC.

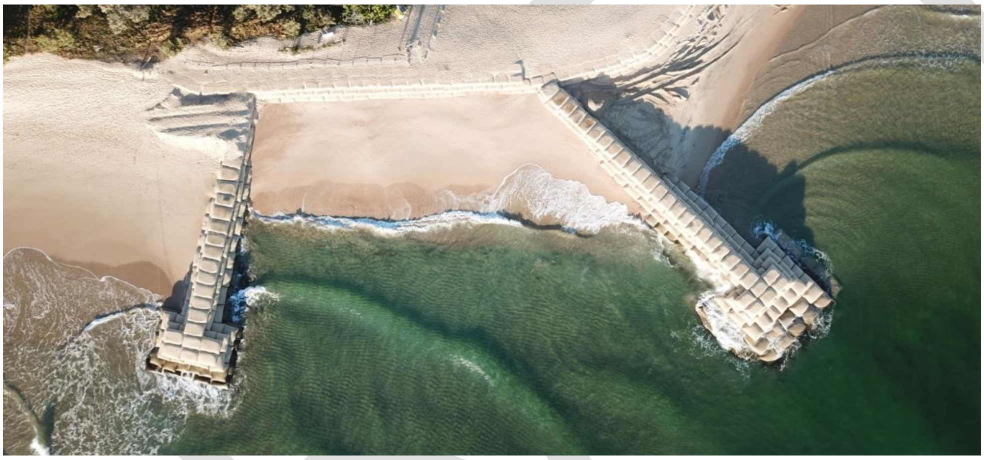

Figure 6-7 Example of GSC groynes at Maroochydore

| Assessment Criteria | Score | Details |
|---|---|---|
| Protection of Land and Infrastructure | ✓✓ | ▪ If designed to an adequate height, length, and layout, the structures can provide some resistance to changes in beach shoreline position.<br>▪ Groynes would be limited in their ability to protect from coastal inundation.<br>▪ Land levels along Patterson Parade are between 2.3mAHD and 3.3mAHD. The present-day HAT tide level is already 2.2mAHD, and the site is exposed to tropical cyclones storm surges. Future tidal fluctuations, including a 0.8m sea level rise, would reach 3.0 m AHD, and the tide would submerge Patterson Parade.<br>▪ As the sea level rises, properties along Patterson Pde will likely be affected by periodic “sunny day” tidal inundation, regardless of groyne construction. |
| Logistical constraints / risk (constructability etc) | ✓✓ | ▪ The smaller bags (0.75 $m^3$ and 1.2 $m^3$) can be dry filled using fill frames and placement cradles supplied by the manufacturer. Larger 2.5 $m^3$ bags can also be filled using a hydraulic filling method and placement cradles provided by the bag manufacturers. |

| Description and Rationale | | |
|---|---|---|
| | | ▪ Quality control will be essential to provide a durable groyne field.<br>▪ The fill material may be sourced directly from the beach. This will still require careful consideration since there are fines into the beach sand at Lucinda |
| Adaptability to future conditions (including SLR) | ✗✗ | ▪ The GSCs have a limited design life which is not ideal for a permanent solution. Some level of maintenance, upgrade and renewal will be required several times before 2100 and should be considered in the lifecycle cost.<br>▪ Like rock units, GSC units are difficult to move / adapt once constructed, and it is often more practical to cut bags open and replace them rather than move them. |
| Impact on Coastal Processes | - | ▪ If adequately designed to the same (or equivalent) configuration to the existing groyne field, there are unlikely to be significant impacts on coastal processes relative to the current condition. |
| Impact on Flora and Fauna | - | ▪ If adequately designed to the same (or equivalent) configuration to the existing groyne field, there are unlikely to be significant impacts on flora and fauna relative to the current condition. |
| Social & Recreational Amenity Impact | - | ▪ Relative to rock structures, GSCs are softer underfoot and have fewer hard/angular areas, which may benefit the public if any slips occur. Maroochydore Council has not had public injury claims from the sandbag groynes in over 17 years. |
| Visual Amenity Impact | ✓ | ▪ GSCs have a soft finish and can blend into the existing beach environment creating a less intrusive structure than a rock structure.<br>▪ The groynes would provide an improved visual amenity impact relative to the existing conditions (as the groyne field is currently in poor condition). |
| Level of Community Support | | ▪ Support: 59%<br>▪ Neutral: 13%<br>▪ Do not Support: 27% |
| Associated Costs: | | ▪ The groyne field cost estimate has been made based on the concept-level design. It is estimated that the initial capital costs would be around $2.0 million.<br>▪ Ongoing maintenance is necessary to maintain the serviceability of the groyne field.<br>▪ Annual maintenance costs were set at 5% of the capital per annum, equating to around $110,000 annually. This is similar to the $80k per year of maintenance costs for the Maroochydore Groynes.<br>▪ Lifecycle costing has conservatively assumed that the bags would need to be replaced after 15 years.<br>▪ 20 years NPV cost = $4.3 million. |

**Table 6-3 Option L1B: Groyne Upgrade: Rock armoured construction**

**Description and Rationale**

- This option would involve replacing the existing groyne structures with a new groyne field made of rock armour instead of GSCs.
- Rock armour sizing has been estimated based on concept level design, and its primary armour rock sizing would be of the order of 3 tonnes.
- Rock armoured structures would provide a longer design life.
- If adequately designed and constructed, a rock-armoured groyne structure can have a design life of 100 years.

Figure 6-8 Example of rock armoured groynes

| Assessment Criteria | Score | Details |
|---|---|---|
| Protection of Land and Infrastructure | ✓✓ | ▪ If designed to an adequate height, length, and layout, the structures can provide some resistance to changes in beach shoreline position.<br>▪ Groynes would be limited in their ability to protect from coastal inundation.<br>▪ Land levels along Patterson Parade are between 2.3mAHD and 3.3mAHD. The present-day HAT tide level is already 2.2mAHD, and the site is exposed to tropical cyclones storm surges. Future tidal fluctuations, including a 0.8m sea level rise, would reach 3.0 m AHD, and the tide would submerge Patterson Parade.<br>▪ As the sea level rises, properties along Patterson Pde will likely be affected by periodic “sunny day” tidal inundation, regardless of groyne construction. |
| Logistical constraints/risk (constructability etc) | ✓✓ | ▪ Minimal construction risk. The detailed design would require geotechnical investigations to ascertain subsurface conditions. |
| Adaptability to future conditions (including SLR) | ×× | ▪ Rock armoured structures generally need to be designed for future climate conditions because retrofitting such structures can be complex and involves high costs. |

| | | |
|---|---|---|
| Impact on Coastal Processes | - | ▪ If adequately designed to the same (or equivalent) configuration to the existing groyne field, there are unlikely to be significant impacts on coastal processes relative to the existing conditions. |
| Impact on Flora and Fauna | - | ▪ If adequately designed to the same (or equivalent) configuration to the existing groyne field, there are unlikely to be significant impacts on flora and fauna relative to the existing conditions. |
| Social & Recreational Amenity Impact | × | ▪ Rock armoured structure would create a pedestrian impediment along the foreshore. Rocks are not suited to pedestrian traffic. |
| Visual Amenity Impact | ✓ | ▪ Given there is an existing groyne field, it may not represent a significant impact relative to the existing condition. Nonetheless, the groynes would provide an improved visual amenity, as the current dilapidated groyne field is in poor condition. |
| Level of Community Support | | ▪ Support: 59%<br>▪ Neutral: 13%<br>▪ Do not Support: 27% |
| Associated Costs: | | ▪ The groyne field cost estimate was based on a concept-design level. It is estimated that the capital costs would be around $6.8 million.<br>▪ Ongoing maintenance is necessary to maintain the serviceability of the groyne field.<br>▪ Annual maintenance costs for armoured rock groynes are typically 1% of the capital per annum, equating to around $70,000 per year.<br>▪ 20 years NPV cost = $7.4 million<br>▪ Rocks are a longer-term investment than GSCs, which can be re-purposed into seawall revetment works beyond the structure's design life such as L2B |

**Table 6-4 Option L2A: Sand Backpassing and beach nourishment**

**Description and Rationale**

- The stretch of foreshore north of Johnson Park is experiencing erosion related to "terminal scour" downdrift of the seawall structure.
- This option involves nourishing the upper beach face north of the Johnston St Seawall with additional sand.
- Sand can be sourced from the Lucinda Spit, which accumulates sand in the long term. This method is called "backpassing" as it reuses sand collected from a downdrift location and recycled back within the system on an updrift location.
- As discussed in Section 3.2, there is a salient building due to the wave shadow of the Lucinda Spit halting sand transport past this point.
- The Spit may be considered a terminal sand deposit, separate from the coastal littoral processes along Patterson Parade. As such, the sand available in the Spit could be a potential sand source for local beach nourishment.
- Sand could be placed across a 230 m long stretch of foreshore to the north of Johnson Park, where development exists to the east of Patterson Parade, up to around 85 Patterson Pde.
- Earthmoving equipment can groom the imported sand to the desired beach shape. An additional 10 m of dry beach width could be placed to create an additional sand buffer. This would equate to an extra 30 $m^3/m$ of sand buffer along the beach.


Figure 6-9 Potential Sand Back-passing Scheme

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- This would equate to a total borrow volume of around 7,000 $m^3$, which could be harvested from a borrow area around 450 m long by x 15 m wide from the upper beach face of the foreshore behind the spit, using a shallow scrap depth of 1m.
- Sand can be groomed to match the existing beach slope of the upper beach face (1V:10H) and should therefore have the same level of stability as the current shoreline.
- This could be implemented yearly if needed. The volume backpassed in approximately 25% of the net longshore sand transport.
- Sand backpassing has been implemented successfully along many Queensland beaches including Townsville Strand, Woorim Beach (Moreton Bay) or Surfers Paradise (Gold Coast).
- Backpassing should be combined with the foreshore restoration and revegetation program to stabilise the sand placement and manage windblown sand.
- Informal seawalls should be removed prior to the sand backpassing implementation.
- Beach scarping and shoreline erosion will continue but will be mitigated by on-going works.

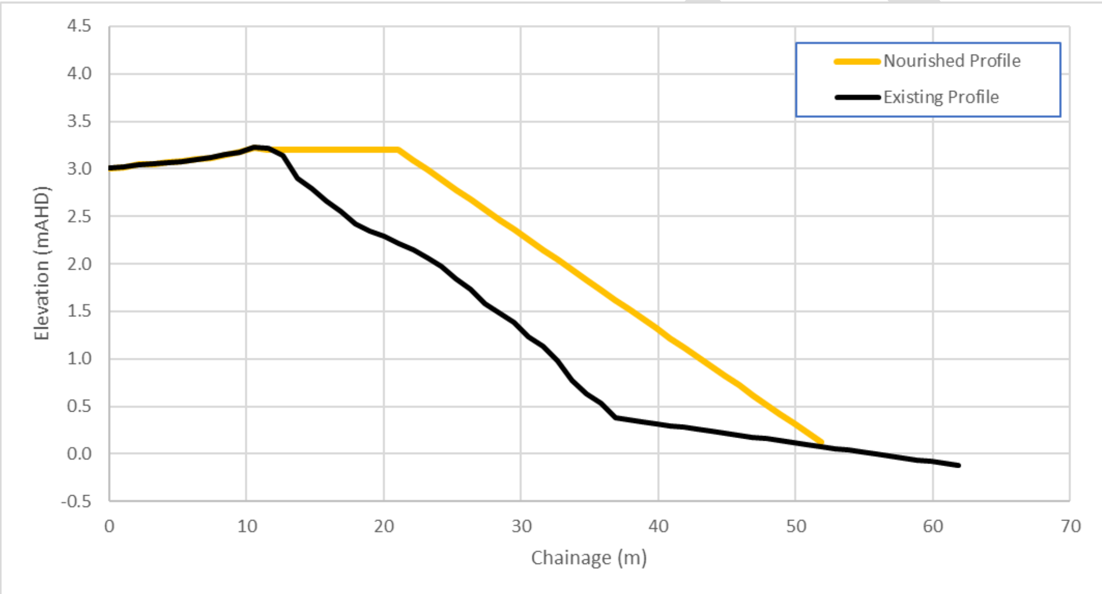
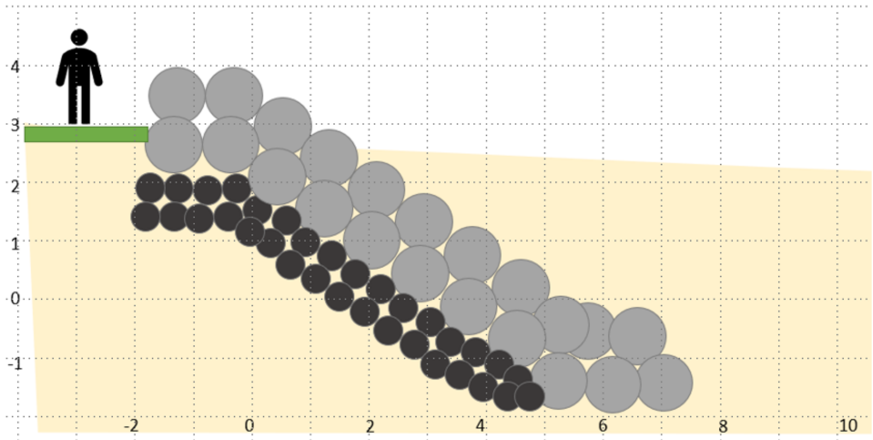



**Figure 6-10 Indicative placement profile**

| Assessment Criteria | Score | Details |
|---|---|---|
| Protection of Land and Infrastructure | ✓✓ | ▪ Backpassing would provide an additional 30 $m^3$/m of storm erosion buffer in front of the developed stretch of foreshore.<br>▪ An ongoing program of backpassing will provide an enduring solution to terminal scour effects.<br>▪ Adaptability of the program means that it can assist post-storm recovery and to mitigate the impacts of clustered storm events. |
| Logistical constraints / risk (constructability etc) | ✓✓ | ▪ Can be implemented with earthmoving machinery.<br>▪ Dozers fitted with wider tracks, colloquially known as “swampies”, can prove useful. Rubber tired vehicles can provide more rapid transport on the beach berm, particularly where sand has to be moved alongshore |
| Adaptability to future conditions (including SLR) | ✓✓✓ | ▪ The program can be highly adaptable and flexible to future needs.<br>▪ Backpassing can be implemented on an “as-needed basis”. Nominally, around once every 3-5 years will likely be required to mitigate terminal |

| | | |
|---|---|---|
| | | scour. However, beach scraping can be flexible to suit storm recovery after major storms.<br>▪ Learnings from cumulative backpassing runs will create efficiencies and allow for the optimisation of the program over time.<br>▪ Can be adapted/modified over time to mitigate future impacts of sea level rise and long-term shoreline recession. |
| Impact on Coastal Processes | ✓✓ | ▪ Keeps sand within the coastal zone, through a recycling process – and therefore highly unlikely to have major negative impacts on coastal processes.<br>▪ Backpassing will likely slow the current rate of the growth of the Lucinda Spit. However, with an annual LST rate of 30,000 $m^3$, backpassing 7,000$m^3$ every 3-5 years will likely have minimal impacts on the spit.<br>▪ Detailed design will assist in determining sand volumes, sand placement rates and beach configuration.<br>▪ Can be groomed with a dune crest and dune swale formation to prevent overland flows from exacerbating beach erosion. |
| Impact on Flora and Fauna | ✓✓ | ▪ Positive – when combined with foreshore restoration and planting of native dune species improve the biodiversity value of the foreshore.<br>▪ Will create a more expansive beach sandy beach berm for nesting shorebirds and turtles.<br>▪ The placement of sand is unlikely to increase the likelihood of mangrove growth at the placement site, relative to the existing conditions – as it replicates the existing sandy foreshore. |
| Social & Recreational Amenity Impact | ✓✓✓ | ▪ Will create a more expansive, natural beach for recreational use – up to 10 m of dry beach after construction.<br>▪ Will reduce the existing erosion scarping (which can be 1-1.5 m high), providing safer foreshore access. |
| Visual Amenity Impact | ✓✓ | ▪ Foreshore will have a clean, natural-looking visual aesthetic, matching the surrounding area's natural character. |
| Level of Community Support | | ▪ Support: 55%<br>▪ Neutral: 18%<br>▪ Do not Support: 27% |
| Associated Costs: | | ▪ Capital Costs: Using mechanical plants, moving sand costs between \$5 to \$25 / $m^3$.<br>▪ In TSV, historical costs of around \$12/$m^3$ at Horseshoe Bay<br>▪ Ongoing maintenance is necessary to maintain beach volume and buffer.<br>▪ Around \$170,000 per run – likely to be required on average around once every 3-5 years.<br>▪ 20 years NPV cost = \$530,000 |

**Table 6-5 Option L2B: Lucinda Seawall Structure**

| Description and Rationale | | |
|---|---|---|
| ▪ Option L2B comprise of a rock armoured seawall structure extending from the existing Johnson Park seawall, northwards for 490 m covering the stretch of foreshore where development exists east of Patterson Parade.<br>▪ Initial rock armour sizing (concept level only) indicates that the structure may require 3-tonne primary armour units (around 1.1 m diameter).<br>▪ The structure would require a crest level of around +4.0 to 4.5 m AHD to mitigate structural overtopping damage and accommodate future sea level rise over its design life (potentially even higher).<br>▪ This high crest level is required for the stability of the seawall, not for the stability and safety of assets located behind the seawall. A wider and taller coastal levee would provide coastal flood control and erosion control behind the seawall.<br>▪ The foundation level would be around -2 m AHD, meaning the overall structure would be 6 m high, sloping 1:1.5. The seawall would have a footprint over 10m across.<br>▪ If adequately designed and constructed, a seawall structure can have a design life of 100 years.<br><br>**Figure 6-11 Indicative seawall profile** | | |
| **Assessment Criteria** | **Score** | **Details** |
| Protection of Land and Infrastructure | ✓✓ | ▪ A seawall structure can provide erosion protection for properties along Patterson Parade for 100 years.<br>▪ The seawall would not protect from storm tide inundation. Ingress of storm tides would occur from the east (open coast) and west via Dungeness Creek.<br>▪ Land levels along Patterson Parade are between 2.3mAHD and 3.3mAHD. The present-day HAT tide level is already 2.2mAHD, and the site is exposed to tropical cyclones storm surges. Future tidal fluctuations, including a 0.8m sea level rise, would reach 3.0 m AHD, and the tide would submerge Patterson Parade.<br>▪ As the sea level rises, properties along Patterson Pde will likely be affected by periodic "sunny day" tidal inundation, regardless of groyne construction.<br>▪ The issue of the terminal scour ('end effects') will be moved further down the beach and will require additional consideration (as per option L4) |

| | | |
|---|---|---|
| Logistical constraints / risk (constructability etc) | ✓ | ▪ The detailed design would require geotechnical investigations to ascertain subsurface conditions. |
| Adaptability to future conditions (including SLR) | ×× | ▪ Rock armoured seawall structures generally need to be designed for future conditions up front, as retrofitting such structures at a later date is highly complex and involves very high costs. This is because:<br>▪ High sea levels and cyclone intensification means larger waves approach the structure in the future – and therefore larger/heavier rock units will inevitably be needed. This involves adding a new layer of heavier rock armour units on the outer face.<br>▪ Raising a rock armoured structure can be difficult and generally requires encroaching further landwards to continue the existing slope to a higher level. |
| Impact on Coastal Processes | ×× | ▪ Likely to cause erosion of the sandy beach in front of the wall, reducing the foreshore amenities. This is already the case in front of the Johnson Park seawall, where no dry beach is available at high tide.<br>▪ Option L2B does not "solve" the issue of the existing terminal scour ("end effects"), which will require a treatment similar to option L4. |
| Impact on Flora and Fauna | ××× | ▪ The structure footprint will cover the upper beach face and impact the foreshore vegetation and habitat for local fauna (such as nesting shorebirds and turtles). |
| Social & Recreational Amenity Impact | ××× | ▪ Likely to cause erosion of the sandy beach in front of the wall, reducing recreational amenities and use of the beach & foreshore. |
| Visual Amenity Impact | ×× | ▪ The structure would have a significant visual impact – detracting from the natural character of the foreshore.<br>▪ Preliminary concept design indicated that the seawall crest level would be approximately 4.0 to 4.5 m AHD.<br>▪ Ground levels landward of the frontal dune to Patterson Parade vary between 2.3 m AHD and 3.3 m AHD, which means that the structure's crest would be elevated around 1 m to 2 m above the existing local ground level.<br>▪ Such level would impact residential property visual amenities. |
| Level of Community Support | N/A | ▪ This option was suggested by several community members and has subsequently been assessed.<br>▪ This option was not assessed in the Community Survey.<br>▪ Future communication around this option will be necessary to inform the Community if this option is considered viable for implementation. |
| Associated Costs: | | ▪ A concept design was prepared for a 490m long seawall.<br>▪ The capital costs would be around $7.1 million. This capital cost averages to $14,500 per linear metre, within range of armoured seawalls built elsewhere recently.<br>▪ Ongoing maintenance is necessary to maintain serviceability.<br>▪ Maintenance for rock armoured seawall structures was estimated as a long-term average of 1% of the capital cost per annum. This translates into a maintenance cost of $70k p.a.<br>▪ 20 years NPV cost = $7.8 million |

Table 6-6 Option L3: Foreshore restoration and formalisation of access

| Description and Rationale |
|---|
| ▪ Native coastal dune vegetation plays a crucial role in building the natural resilience of the foreshore.<br>▪ Currently, the Lucinda foreshore contains a significant proportion of inappropriate vegetation – including non-native grasses and lawn. These species are impeding the foreshore's natural resilience to erosion.<br>▪ Foreshore erosion is also impacted by uncontrolled access, such as beach access and informal tracks.<br>▪ Foreshore/dune restoration would comprise of:<br>– Organising the foreshore into a series of restoration "compartments" typically 50m to 200m long, and approximately 20m to 30m wide.<br>– Access corridors can be maintained, fenced, and managed in between theses compartments.<br>– Removing weeds and inappropriate vegetation – and strategic and targeted planting and revegetation of native dune species. These should include establishing:<br>■ A primary vegetation layer for dune stabilisation and sand build-ups such as Spinifex and Goat's foot, and/or Birds Beak. The focus is to establish ground cover with native colonising species.<br>■ Secondary and tertiary vegetation layer for dune resilience. In these zones, plants act as a windbreak, protecting the vegetation and development behind them from salt and wind, stabilising dune features, and providing erosion resistance. These vegetation layers may include She-Oak, Wattle, Lollybush, Screw Pine, Nickernut, Beach bean, Soap tree, and Portia Tree.<br><br><br>Figure 6-12 Indicative rehabilitation zones<br>▪ Foreshore rehabilitation represents a low-cost, low-risk, and high-benefit action, commonly referred to as a "No regrets action". However, this requires a significant investment in |

maintenance, community support and education, as such buffers can be subject to vandalism and weed encroachment.

| Assessment Criteria | Score | Details |
|---|---|---|
| Protection of Land and Infrastructure | ✓ | ▪ Creates a foreshore and frontal dune system that is more resilient to erosion and quicker and more effective post-storm recovery. |
| Logistical constraints / risk (constructability) | ✓✓✓ | ▪ Logistics are inexpensive, low risk, and promote community buy-in/involvement |
| Adaptability to future conditions (including SLR) | ✓✓✓ | ▪ Will enhance the resilience of the dune system to sea level rise and long-term shoreline recession by allowing the dune system to accrete vertically and landwards over time, rather than letting sand "blow over the road" or diffused in the environment. |
| Impact on Coastal Processes | ✓✓✓ | ▪ Highly positive. Will promote natural upper beach face sediment dynamics and reduce impacts of weeds and uncontrolled access on the dune system |
| Impact on Flora and Fauna | ✓✓✓ | ▪ Highly positive. Will improve the biodiversity value and habitat value of the foreshore utilised by nesting shorebirds and turtles. |
| Social & Recreational Amenity Impact | ✓✓ | ▪ Will help mitigate erosion and reduce the frequency & severity of unsafe erosion scarping along the foreshore.<br>▪ Will help to provide a greater dry beach width on the upper beach face for recreational use. |
| Visual Amenity Impact | ✓✓ | ▪ Positive impacts due to reduction of erosion scarping and presence of weeds. Will return the foreshore to its natural character and appearance.<br>▪ Negative impacts on beachfront property views and restriction of direct access to the beach require a long-term commitment to be successfully implemented |
| Level of Community Support | | ▪ Support: 77%<br>▪ Neutral: 23%<br>▪ Do not Support: 0% |
| Associated Costs: | | ▪ Unit cost estimates based on typical restoration works have been made- Including all costs for plants, fertiliser, initial weed control, planting equipment, plant protection barriers, plus overhead costs.<br>▪ Revegetation activities can range from $5,000 to $50,000 per hectare, depending on the type of surface preparation required, the planting density, and any access to volunteer support.<br>▪ Given the complexities of the required restoration work at Lucinda, a unit rate estimate of $35,000 per hectare was allowed. Detailed design will be necessary to confirm this unit cost.<br>▪ The restoration to cover a 3.5 ha foreshore restoration along Patterson Parade, covering 1.4 km and 25m wide.<br>▪ Capital cost approximately $120,000 - likely spread out as $30,000 per year over the initial four years (works would be staggered)<br>▪ Ongoing maintenance is estimated at 25% capital cost per year, i.e., $30,000 per year.<br>▪ 20 Year NPV = $340,000 |

**Table 6-7 Option L4: Repair and Maintain Johnston St Seawall**

**Description and Rationale**

- The Johnson Park seawall is currently outflanked at its northern end due to terminal scour ("end effect erosion").
- The northern extent of the structure requires maintenance in the form of re-alignment and armour stone repacking to prevent outflanking failure and maintain long-term stability.
- This would also require the placement of some additional armour units to ensure adequate interlocking and filter layer configuration.


**Figure 6-13 Seawall outflanking issues**

| Assessment Criteria | Score | Details |
|---|---|---|
| Protection of Land and Infrastructure | ✓ | ▪ This would prevent outflanking failure of the existing structure and reduce the risk of long-term erosion impacts at the northern end of Johnson Park. |
| Logistical constraints / risk (constructability etc) | ✓✓ | ▪ Can be implemented with earthmoving machinery with minimal construction risk. |
| Adaptability to future conditions (including SLR) | - | ▪ Will provide added resilience to the existing seawall to long-term shoreline recession. |
| Impact on Coastal Processes | - | ▪ Minor impacts on coastal processes relative to the existing condition. |
| Impact on Flora and Fauna | - | ▪ Minor impacts on flora and fauna relative to the existing condition. |

| | | |
|---|---|---|
| Social & Recreational Amenity Impact | ✓✓ | ▪ Will remove loose rock armour units off the beach and improve public safety and recreational amenity use of the beach. |
| Visual Amenity Impact | ✓✓ | ▪ Will remove loose rock armour units off the beach and improve public safety and recreational amenity use of the beach. |
| Level of Community Support | | ▪ Support: 63%<br>▪ Neutral: 22%<br>▪ Do not Support: 14% |
| Associated Costs: | | ▪ Estimated costs for capital works = $70,000<br>▪ 20 Year NPV = $77,000 |

**Table 6-8 Option D1: Beach nourishment and shoreline monitoring**

**Description and Rationale**

- Option D1 involves the beneficial reuse of the sand currently being removed from the barge ramp to be placed further along Dungeness Beach The Dungeness beach has been experiencing steady erosion over recent decades due to a lack of sand supply resulting from the Lucinda Spit dynamics.
- Sediment maintenance of the Lucinda Barge ramp is currently undertaken. Excavation works to remove sediment build up on the ramp is undertaken up to three times a week, and total just under 5,000t per year. This equates to a volume of around 2,500m$^3$ a year. Currently, the Port places this sand on Dungeness beach. However, there are opportunities for the Port to establish a coordinated program with Council to optimise the beach fill location, configuration, and volume of placement on the beach.
- Such nourishment should be accompanied by ongoing monitoring of the foreshore. This can be undertaken through 6-monthly surveys of the beach.
- A low-cost monitoring solution involves the installation of a CoastSnap camera cradle at the port, looking west across Dungeness Beach.

Figure 6-14 Dungeness Beach

| Assessment Criteria | Score | Details |
|---|---|---|
| Protection of Land and Infrastructure | ✓ | ▪ The Dungeness beach is an undeveloped foreshore. So, whilst the foreshore has historically been eroding, there is a relatively low level of infrastructure risk, with the only exception being a 3-lot private property subdivision at the northern end of the beach. |
| Logistical constraints / risk (constructability etc) | ✓✓ | ▪ The works are currently being undertaken on as needed basis – and it is anticipated that little change to the existing works process would be required. |
| Adaptability to future conditions (including SLR) | ✓✓ | ▪ The program can be highly adaptable, and flexible to future needs.<br>▪ Learnings from cumulative nourishment works will create efficiencies and allow for the optimisation of the program over time. |

| | | |
|---|---|---|
| | | ▪ Can be adapted/modified over time to mitigate future impacts of sea level rise and long-term shoreline recession. |
| Impact on Coastal Processes | ✓ | ▪ Keeps sand within the current system and is therefore highly unlikely to negatively impact coastal processes.<br>▪ Beach nourishment will likely slow the current rate of erosion along the foreshore. |
| Impact on Flora and Fauna | ✓ | ▪ A properly designed placement pattern should have minimal impacts on coastal vegetation and associated wetland habitats. |
| Social & Recreational Amenity Impact | - | ▪ Will create a wider, natural beach for recreational use. |
| Visual Amenity Impact | ✓ | ▪ Will create a more expansive, natural-looking beach along the foreshore. |
| Level of Community Support | ✓✓ | ▪ Support: 65%<br>▪ Neutral: 30%<br>▪ Do not Support: 4% |
| Associated Costs: | | ▪ Costs likely to be borne by the Port.<br>▪ Council could envisage co-contribution for additional sand volumes.<br>▪ Ongoing maintenance is necessary to maintain serviceability.<br>▪ Estimated costs are of the order of $25 /m$^3$ or approx. $60,000 p.a.<br>▪ 2 x annual beach surveys = $10,000 p.a.<br>▪ Optional: Installation of *CoastSnap* camera cradle to monitor the foreshore = $5,000.<br>▪ 20 Year NPV = $110,000 |

**Table 6-9 Option D1: Dungeness Boating Safety Project**

| Description and Rationale |
|---|
| ▪ Option D1 includes progressing the design investigations for the proposed Dungeness breakwater and Enterprise Channel dredging to improve boating safety in the Enterprise Channel, following previous investigations:<br>– Dungeness Enterprise Channel Dredging. Hydrodynamic and Sediment Transport Study (Water Technology, 2019)<br>– Breakwater and Dredging (Water Technology, 2021)<br>▪ These studies have indicated that a breakwater would assist in maintaining safe navigational depth within the Enterprise Channel and in and out of the Hinchinbrook Channel.<br>▪ The study is predominantly related to improving boating safety at the Dungeness Boat Ramp within the Enterprise Channel as well as managing the erosion and morphological changes of the Dungeness spit, at the northern end of Dungeness beach.<br>▪ Recent studies (Water Technology, 2022) have indicated that a breakwater could stabilise the Dungeness spit, and trap longshore transport on its updrift side – along Dungeness beach.<br>▪ However, a breakwater would likely not reduce storm erosion loss. Under such conditions, sand would be eroded along Dungeness beach by storm waves and deposited in a nearshore bar which would bypass the breakwater. The sand would be transported further by strong estuarine tidal currents away from the active beach, reducing the available sand for beach recovery.<br>▪ As such, while dredging can be optimised, maintenance dredging would still be required from time to time.<br>▪ The Department of Environment and Science (DES) indicated during the development of this SEMP that the purpose of a potential breakwater should be to maintain vessel navigation in the Enterprise Channel. DES indicated that the breakwater is unlikely to meet the requirements for an erosion control structure under "State Code 8: Coastal development and tidal works - Performance Objectives (PO) 10 and 12", as follows:<br>**<u>State code 8: Coastal development and tidal works</u>**<br><br>**PO10** Erosion control structures (excluding revetments) are only constructed where there is an **imminent threat** to **significant buildings or infrastructure**, and there is no feasible option for either:<br>1. **beach nourishment**; or<br>2. relocation or abandonment of structures<br><br>**PO12** Erosion control structures minimise interference with **coastal processes** and reduce the severity of erosion on adjacent land.<br>▪ Historical erosion rates of the Dungeness Spit averaged around 6m/year from 1956 to 2017 (Water Technology, 2019b). If future erosion continues at this rate, the boating facilities around 250 m south of Dungeness Spit will likely be exposed to erosion risk in the next 50 years.<br>▪ Hinchinbrook Shire Council Report: *Maturing the Infrastructure Pipeline Program: Hinchinbrook Shire Coastal Access Improvement Program Strategic Assessment of Service Requirement* that:<br>▪ "It is also noted that the safe harbourage afforded by Dungeness may be compromised as a result of erosion due to the influences of northerly and north easterly winds. If further degradation of the spit occurs, then this vital safe harbourage will be lost".<br>▪ Additional studies should investigate the effectiveness of the potential structure to stabilise Dungeness Beach in the long term and the potential impacts of the structure on broader coastal and ecological processes.<br>▪ The coastal processes chapter of this report has demonstrated how energetic and dynamic the local hydrodynamic and morphological processes are. Therefore, from a due diligence perspective, it is essential to identify potential impacts as part of the design and approvals process. |

- A pathway for the design investigations for the Dungeness breakwater is outlined below. The purpose of this pathway is to progress the project in a manner that ensures that all DES requirements are investigated and assessed throughout the course of the project. Therefore, maintaining a high level of engagement with DES during this process is recommended.

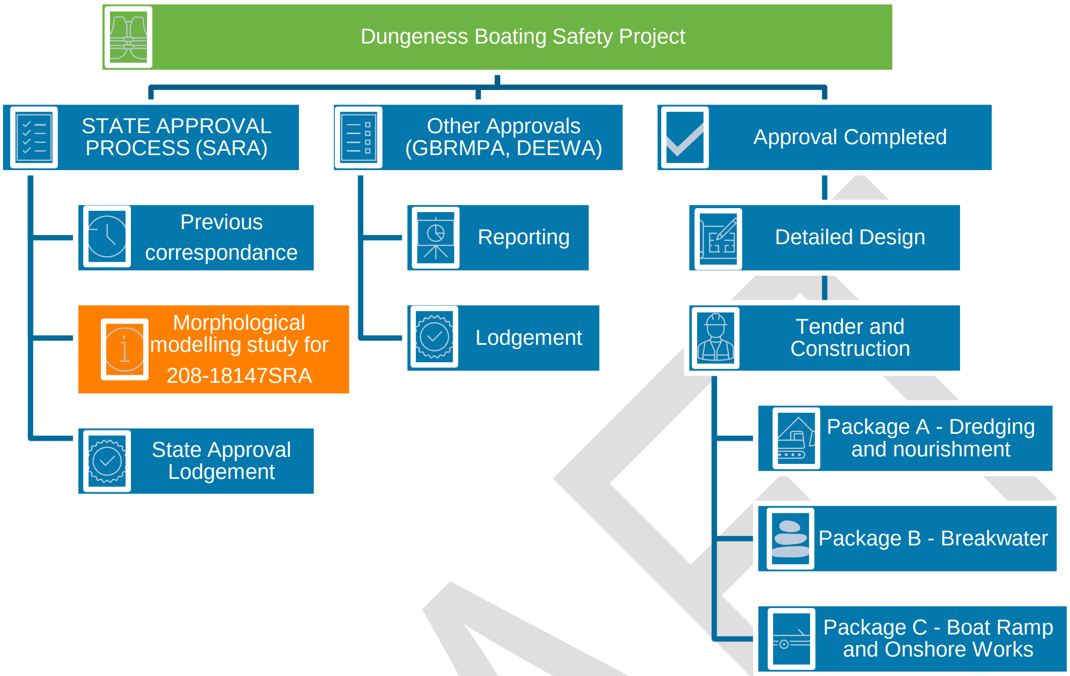



**Figure 6-15 Potential Pathway for the Dungeness Boating Safety Project**

**Additional morphological modelling study:**

- During the approval process, DES indicated that the initial modelling study did not sufficiently detail upstream, and far-field impacts related to the breakwater.
- DES provided a detailed Request For Information (RFI) requesting further studies of regional sediment transport processes, including the fluvial contributions from the Herbert River and morphodynamics processes in the Hinchinbrook channel.
- DES has outlined that for the approval of the proposed Dungeness breakwater to be granted, they require the following works:
  - Develop further numerical modelling studies to understand.
    - Comment 1: sediment transport rates or direction in this area westward past the spit end and onto the western face of the spit and sediment transport away from this area by tidal and riverine currents in Enterprise Channel within a broader geographical context (i.e., max 10kms surrounding the proposed breakwater and channel)
    - Comment 2: the impact of the breakwater and channel on the current day sediment to the west and the consequent impact of the sand deficit to the updrift coast, including possible bed lowering and coastal erosion.
    - Comment 3: the impact of the sand deficit created for the updrift coast to the west of the breakwater on coastal processes in the area and whether there would be any adverse long-term (10 years+) impacts on the coastal environment to the west of Dungeness Spit
  - From these comments, the project objectives have been defined as to provide information based on expert opinion and available information as follows:
    - a discussion of possible future erosion scenarios for this coast and the likely impact on environmental values and built assets.
    - describe future remediation options that may be needed to mitigate erosion impact.
    - specify a shoreline monitoring program for this area and reporting arrangement.

| Assessment Criteria | Score | Details |
|---|---|---|
| Protection of Land and Infrastructure | ✓ | ▪ The Dungeness beach is an undeveloped foreshore. So, whilst the foreshore has historically been eroding, there is relatively low infrastructure risk over the short to medium term. The only exception is a 3-lot private property subdivision at the northern end of the spit. The boating facilities located some 250 m south of the Dungeness spit.<br>▪ Additional studies regarding the breakwater and dredging are required to manage Dungeness beach long-term. |
| Logistical constraints / risk (constructability etc) | × | ▪ Water Technology consulted with local contractors to discuss the constructability of the breakwater (2019). The breakwater is located in shallow depth and can be built from land. This is more efficient than barge construction.<br>▪ Physical modelling should be undertaken during the detailed design phase to provide a cost-effective design for construction. Physical modelling is likely to result in substantial savings as it would optimise the rock volume, rock grading, breakwater height and the configuration of the breakwater head (Water Technology, 2021). |
| Adaptability to future conditions (including SLR) | ×× | ▪ Sea level rise, and increased storm intensity are both design considerations. Sea level rise and increased storms would result in potentially greater depths of water over the seabed approaches to Dungeness, increasing wave actions on the breakwater armour, such as wave breaking and overtopping.<br>▪ The breakwater design should accommodate the increased wave energy.<br>▪ The increase in wave actions could be addressed as subsequent upgrading and maintenance works. Upgrade and maintenance work may be expensive, particularly when unforeseen; therefore, the design process should consider lifecycle cost consideration to optimise the breakwater and dredging configuration |
| Impact on Coastal Processes | **TBD** | ▪ The coastal processes chapter of this report has demonstrated that the local hydrodynamic and morphological processes are highly energetic and dynamic.<br>▪ Placing a large-scale, hard structure into the system is likely to impact somewhat the local coastal processes. Therefore, managing those impacts will be a key consideration in the breakwater and dredging design.<br>▪ As discussed above, additional studies are required to determine the impacts of the structure on broader coastal processes in the long term and to consider the potential impacts on the Lucinda spit. |
| Impact on Flora and Fauna | **TBD** | ▪ As discussed above, additional studies are required regarding he potential impacts of the structure on broader ecological processes in the long term – including potential impacts on mangrove and seagrass habitat systems in the broader study area. |
| Social & Recreational Amenity Impact | ✓✓ | ▪ The breakwater and dredging would provide greater navigational safety at Dungeness.<br>▪ The Hinchinbrook Shire Council Report: *Maturing the Infrastructure Pipeline Program: Hinchinbrook Shire Coastal Access Improvement Program Strategic Assessment of Service Requirement* has stated that the boating facilities are "vital infrastructure" for the region |

| | | |
|---|---|---|
| Visual Amenity Impact | ✗ | ▪ The breakwater would be rather long, and it would have a pronounced visual impact on the natural character of the foreshore.<br>▪ The impact can be reduced by designing a low-crested breakwater |
| Level of Community Support | ✓ | ▪ This option was not assessed in the Community Survey. This allowed the SEMP consultation to focus on other shoreline erosion management actions across the Council.<br>▪ There is broad community interest in improving navigational boating safety at Dungeness |
| Associated Costs: | | ▪ Stage 1: Additional morphological studies, $300,000<br>▪ Stage 2: Breakwater and dredging approvals and detailed design, approx. $400,000 incl. physical testing<br>▪ Stage 3: Construction – Estimated capital cost $5.7 million (breakwater only), $6.7 million (incl. dredging and breakwater)<br>▪ Ongoing maintenance of breakwater and dredging is necessary to maintain serviceability.<br>– Ongoing breakwater maintenance, around 1% p.a. ($60,000)<br>– Ongoing dredging maintenance, around 5% pa ($50,000)<br>▪ 20 Year NPV = $6.3 million (breakwater only)<br>▪ 20 Year NPV = $8.0 million (breakwater plus dredging) |

## 6.5 Description of Options for Taylors Beach

**Table 6-10 Option T1: Upgrade GSC seawall structure**

| Description and Rationale |
|---|
| ▪ The GSC seawall structure at Taylors beach is exhibiting signs of dilapidation and failure. Numerous bags are punctured, slumped, deflated near the crest, and outflanked. Multiple community assets are located along the beach. Seawall failure is a financial risk and public safety risk.<br>▪ Option T1 consists of upgrading the dilapidated GSC revetment wall to a permanent rock armour seawall. The upgraded seawall would include two primary armour layers, filter layers and geotextile backing to prevent fill material washout from through/behind the structure.<br>▪ The proposed upgrade seawall would also include tie-back to prevent outflanking failure.<br>▪ The seawall upgrade would also provide safe community access to the foreshore and swimming enclosure as shown on Figure 6-16. |
| <br>**Figure 6-16 Concept Design for the structure upgrade** |

| Assessment Criteria | Score | Details |
|---|---|---|
| Protection of Land and Infrastructure | ✓✓✓ | ▪ The upgraded structure would be expected to have a design life of 50 to 100 years and to provide protection for community assets from erosion, including playground, recreational area, and car parking facilities. |
| Logistical constraints / risk (constructability etc) | ✓ | ▪ Can be implemented with earthmoving machinery with minimal construction risk.<br>▪ The contractor is to provide a suitable Construction Environmental Management Plan. Safety In Design process to be implemented during the project. |
| Adaptability to future conditions (including SLR) | ✗ | ▪ Would need to be designed to withstand future sea level rise impacts over its intended design life.<br>▪ Can be designed to be retrofitted at the crest to control overtopping. Such retrofitting may require relocation of the foreshore concrete promenade when this occurs. |
| Impact on Coastal Processes | - | ▪ As the structure would mostly retain the existing structure footprint, there would be minimal impacts on coastal processes relative to the existing condition. |
| Impact on Flora and Fauna | - | ▪ As the structure would mostly retain the existing structure footprint, there would be minimal impacts on ecological processes relative to the existing condition.<br>▪ The works are located adjacent to a Fish Habitat Area, and this will be a consideration for the design process |
| Social & Recreational Amenity Impact | ✓✓✓ | ▪ Will improve public safety along the foreshore by upgrading a degraded structure and providing safe access. |
| Visual Amenity Impact | - | ▪ As the structure would mostly retain the existing structure footprint, there would be minimal visual impacts relative to the current condition. |
| Level of Community Support | | ▪ Support: 38%<br>▪ Neutral: 38%<br>▪ Do not Support: 23% |
| Associated Costs: | | ▪ Estimated costs for capital works = $920,000<br>▪ Ongoing maintenance is necessary to maintain seawall serviceability.<br>▪ Maintenance for rock armour was estimated to be 1% of the capital per annum, which would cost approximately $10k p.a.<br>▪ 20 years NPV cost = $1.0 million |

**Table 6-11 Option T2: Beneficial reuse of dredge material for scour protection at Taylors Beach**

| Description and Rationale |
|---|
| ▪ Several locations along the Taylors Beach foreshore seawall terminal are scouring due to seawall “end effects”. These end effects are an issue because:<br>– It can cause outflanking of the seawall structures, which can lead to structural undermining (similar to option L4)<br>– It can cause erosion vertical erosion scarps that affect safe community access to the foreshore. Seawall end effects causing erosion - impacts the structural integrity of seawalls & beach safe access.<br>▪ This is particularly an issue at the southern end of the GSC seawall structure, where terminal scour is severe, and scarping exists adjacent to a highly utilised swimming enclosure.<br>▪ This is likely to remain on-going/recurring issue (i.e., no “one-off” solution)<br>▪ Council currently undertakes regular maintenance dredging at the Taylors Beach boat ramp to maintain safe waterways access for recreational boating. The volume of dredge material is variable with each dredging campaign, which occurs at approximately 1 to 3 year intervals. Typically, the volume of sand recovered is between 2,000 to 5,000 $m^3$ per year.<br>▪ Clean native sand material could be reused to alleviate nearby erosion impacts related to seawall end effects. Option T2 involve the beneficial reuse of dredging material from the boat ramp as beach nourishment along the foreshore erosion hot spots as shown on Figure 6-17. |

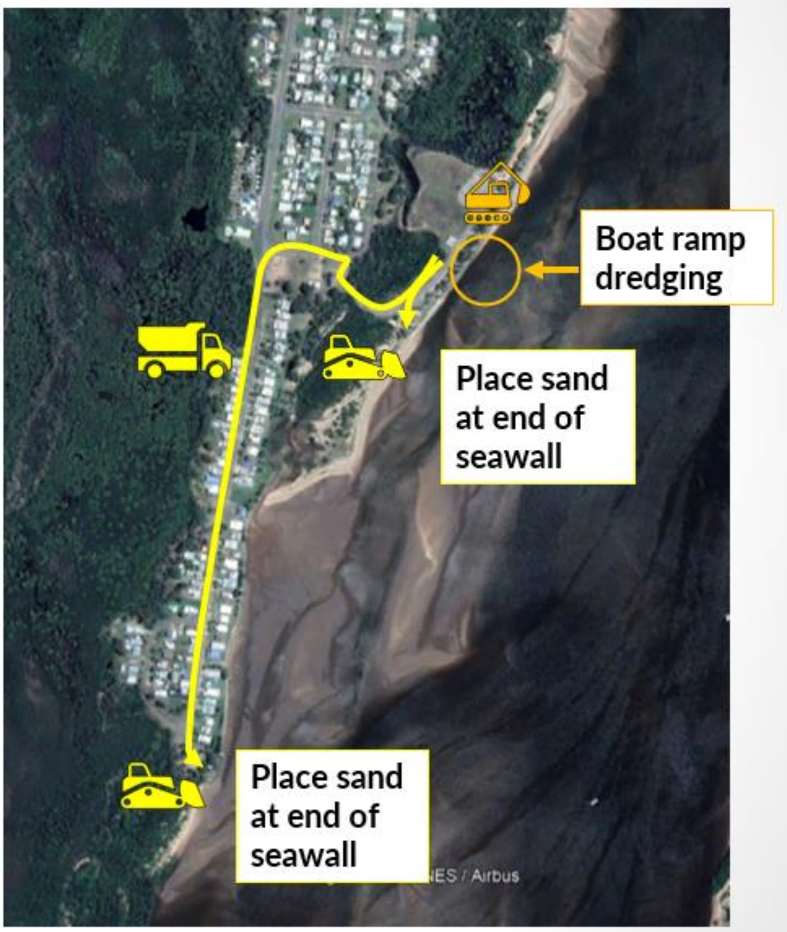



**Figure 6-17 Indicative arrangement of dredge material reuse at Taylors Beach**

| Assessment Criteria | Score | Details |
|---|---|---|
| Protection of Land and Infrastructure | ✓ | ▪ This will assist in preventing outflanking of the seawall structure and improve the erosion resilience of the surrounding foreshore.<br>▪ An ongoing nourishment program will provide an on-going solution to terminal scour effects.<br>▪ The adaptability of the nourishment program means that nourishment can be optimised over time to manage erosion hot spots. However, there will be a limitation in sand recovered at the boat ramp. |
| Logistical constraints / risk (constructability etc) | ✓✓ | ▪ These works would essentially comprise a logistical (and beneficial) extension of the existing dredging practices. |
| Adaptability to future conditions (including SLR) | ✓✓✓ | ▪ The program is flexible and can be adapted to future needs.<br>▪ Learnings from cumulative nourishment works will create efficiencies and allow for program optimisation over time. |
| Impact on Coastal Processes | - | ▪ Sand would be retained within the coastal system and placed nearby in the same beach compartment.<br>▪ No adverse impacts to coastal processes are expected relative to the existing condition. |
| Impact on Flora and Fauna | - | ▪ Sand is retained within the same coastal system.<br>▪ No adverse impacts to ecological processes are expected relative to the existing condition. The contractor is to develop a Construction Environmental Management Plan.<br>▪ Works should avoid impacts on coastal wetland ecosystems (such as mangroves).<br>▪ The works are located in a Fish Habitat Area, and this will be a consideration for the approval process |
| Social & Recreational Amenity Impact | ✓✓ | ▪ Will maintain sandy tracks at the end of seawalls for community access.<br>▪ Will alleviate unsafe erosion scarping that impacts safe access to the foreshore. |
| Visual Amenity Impact | - | ▪ Will provide a natural-looking beach access and reduce erosion scarping |
| Level of Community Support | | ▪ Support: 58%<br>▪ Neutral: 38%<br>▪ Do not Support: 38% |
| Associated Costs: | | ▪ Estimated costs for capital works = \$20 per $m^3$<br>▪ Assuming a nominal 5,000$m^3$ per dredging campaign = \$100,000 per campaign.<br>▪ 20 years NPV cost = \$590,000 (nominally assuming works every 2 years) |

## 6.6 Description of Options for Forrest Beach

**Table 6-12 Option F1: Dune restoration & formalisation of access**

| Description and Rationale |
|---|
| ▪ Currently, the primary dune system at Forrest Beach is in relatively good condition, with no significant historical erosion issues reported, suggesting that the foreshore is relatively stable. However, there are several issues pertaining to foreshore resilience and amenities:<br>– Lack of coastal and native vegetation<br>– Vegetation vandalism<br>– Vehicle impacts, locally<br>▪ The future resilience of the coastline can be enhanced through a targeted and strategic program of dune restoration work, which would comprise:<br>– Progressively organise the foreshore dunes into a series of dune restoration “compartments”. Compartments would typically be around 50m to 200m long and 20m to 30 m wide.<br>– The foreshore promenade would typically define the limit of works and the compartment boundaries defined by existing beach accessways.<br>– An example of a potential foreshore compartment system for Forrest Beach is shown in Figure 6-18. |

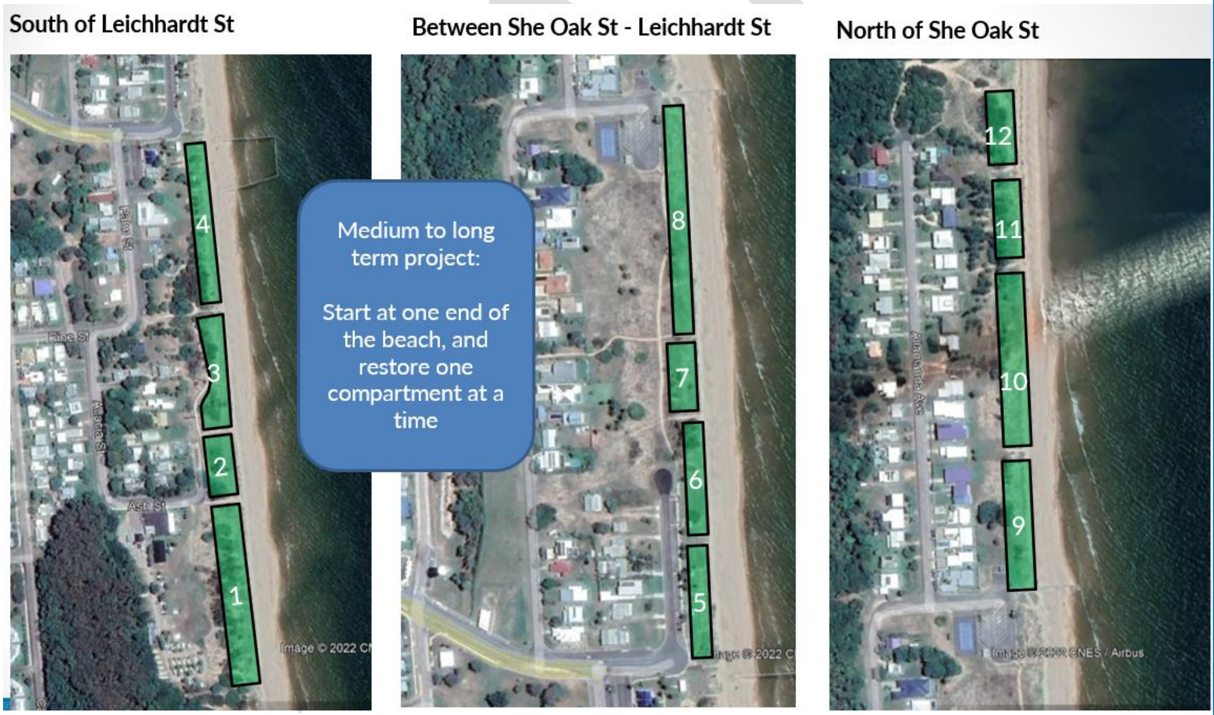



**Figure 6-18 Forrest beach dune restoration compartments**

– Works would include removal of weeds and inappropriate vegetation – and strategic and targeted planting and revegetation of native dune species. These may include:
  - Primary vegetation. Dune stabilisation and sand build-up is encouraged by planting Spinifex and Goat’s foot, and Birds Beak – see Figure 6-19. Particular focus should be paid to this zone and these species.

- Secondary and Tertiary Vegetation: These plants act as a wind break and protect the vegetation behind them from salt and wind, as well as binding and stabilising the dune by planting She-Oak, Wattle, Lollybush, Screw Pine, Nickernut, Beach bean, Soap tree, and Portia Tree as shown on Figure 6-19

– Where necessary: Low-key fencing of restoration areas to prevent trampling while vegetation is taking hold for minimal visual impact. Much of the Forrest Beach foreshore already includes timber bollards delineating dune compartments – they may be fit for purpose and could be retained.


**Figure 6-19 Typical foredune species**

- Foreshore rehabilitation represents a low-cost, low-risk, and high-benefit action, which can be referred to a "No regrets action".

| Assessment Criteria | Score | Details |
|---|---|---|
| Protection of Land and Infrastructure | ✓ | ▪ Creates a foreshore and frontal dune system that is more resilient to erosion and more effective in capturing sand during post-storm beach recovery. |
| Logistical constraints / risk (constructability etc) | ✓✓✓ | ▪ Logistics are inexpensive, low risk.<br>▪ Promote community buy-in/involvement |
| Adaptability to future conditions (including SLR) | ✓✓✓ | ▪ Will enhance the resilience of the dune system to sea level rise and long-term shoreline recession by allowing the dune system to accrete vertically and landwards over time. |
| Impact on Coastal Processes | ✓✓✓ | ▪ Highly positive. Will promote natural upper beach face sediment dynamics and reduce impacts of weeds and uncontrolled access on the dune system |
| Impact on Flora and Fauna | ✓✓✓ | ▪ Highly positive. Will improve the biodiversity value and habitat value of the foreshore, utilised by nesting shorebirds and turtles. |
| Social & Recreational Amenity Impact | ✓✓ | ▪ Will help mitigate erosion and reduce the frequency & severity of unsafe erosion scarping along the foreshore.<br>▪ Will help to provide a greater dry beach width on the upper beach face for recreational use. |
| Visual Amenity Impact | ✓✓ | ▪ Positive impacts due to reduction of erosion scarping and presence of weeds.<br>▪ Will return the foreshore to a more natural character and appearance. |
| Level of Community Support | | ▪ Support: 71%<br>▪ Neutral: 29% |

| | | |
|---|---|---|
| | | ▪ Do not Support: 0%<br>While the level of support is high a significant proportion of the feedback was Neutral |
| Associated Costs: | | ▪ Unit cost estimates based on typical restoration works have been made- Including all costs for plants, fertiliser, initial weed control, planting equipment, plant protection barriers, plus overhead costs.<br>▪ Revegetation activities can range from $5,000 to $30,000 per hectare, depending on the type of surface preparation required, the planting density, and any access to volunteer support.<br>▪ Given the existing foreshore vegetation, small scale, and access to the Council nursery: Unit rate estimate = $10,000 per hectare at Forrest Beach.<br>▪ Allow for restoration of 5.0 ha of developed foreshore from Ash Ave to Allamanda Ave, covering 1.6 km length of the foreshore with compartments 30 m deep.<br>▪ Capital Cost $50,000 spent in 4 x lots of $12,500 each per year over the initial four years.<br>▪ Ongoing maintenance estimated at 25% capital cost per year ($12,500 per year)<br>▪ 20 Year NPV = $140,000 |

**Table 6-13 Option F2: Update vehicles on Beaches Policy**

| Description and Rationale | | |
|---|---|---|
| ▪ Whilst the foredune of Forrest beach is generally in good condition, some localised impacts result from using vehicles on beaches. These impacts include:<br>– Vehicles driving along the incipient foredune, where pioneer plants grow and may be readily damaged or killed by vehicles. This inhibits the natural horizontal progradation of the foredune and prevents the accretion of a larger sand buffer.<br>– Vehicles driving through unofficial tracks through the primary and hind dune systems. This results in physical damage to plants, both above and below ground, and imped the regeneration and growth of new plants that are particularly sensitive to disturbance.<br>– Sand is moved downhill on bare slopes, lowering dune crests and infilling depressions.<br>▪ Council recognises the use of vehicles in beach environments when such activity is approved under relevant legislation. However, careful management of these activities is required to ensure that the practice does not compromise the state of the dune system.<br>▪ This action would therefore include an update and enforcement of Councils vehicles on beaches policy.<br>▪ This would include the development of a written Council policy document that includes specific details of the policy. These should include the following:<br>▪ Permitted Access Zones:<br>– Keep existing vehicles access zones (no loss of access)<br>▪ Where on the beach to drive:<br>– Driving is only permitted below the high-water mark (where the sand is firmer) except when entering or exiting the beach.<br>– Vehicles must keep 10 m clear of vegetated dunes, except at formalised beach access points.<br>▪ Temporary closures under rare/exceptional circumstances:<br>– Confirmed (official) sightings of turtles and endangered nesting shorebirds.<br>– During and immediately after coastal erosion events, where the beach is unsafe for driving. When storms remove considerable sand volumes and travel is impossible to access the foreshore because of an erosion scarp or at high tide (whichever is the most stringent reason for temporary closure), the beach should be closed until sand returns and an adequate beach width is restored via natural processes.<br>▪ This Action would also include enforcement of the policy under Councils general compliance and enforcement efforts. | | |
| **Assessment Criteria** | **Score** | **Details** |
| Protection of Land and Infrastructure | ✓ | ▪ Will increase the overall resilience of the primary foredune over time and promote natural recovery and recovery of the beach after storm events. |
| Logistical constraints / risk (constructability etc) | ✓✓✓ | ▪ Logistics are inexpensive, low risk.<br>▪ Promote community buy-in/involvement. |
| Adaptability to future conditions (including SLR) | ✓ | ▪ Will enhance the resilience of the dune system to sea level rise and long-term shoreline recession by improving the ability of the dune system to accrete vertically and landwards over time. |
| Impact on Coastal Processes | ✓ | ▪ Highly positive. Will promote natural upper beach face sediment dynamics and reduce the impacts of vehicles on the dune system |

| | | |
|---|---|---|
| Impact on Flora and Fauna | ✓✓ | ▪ Highly positive. Will prevent vehicle damage to primary foredune species and pioneer plats and improve the habitat value. Insects, reptiles, migratory and resident birds, and some mammals are commonly encountered on the back beach and incipient foredunes. The beach itself, between high and low tide levels, also supports a diverse range of small organisms such as worms, shell fish, crabs and other microfauna. |
| Social & Recreational Amenity Impact | - | ▪ The proposed action will not change the existing "zones" of vehicle access, and subsequently, will not reduce the recreational amenity value of beach driving enthusiasts. |
| Visual Amenity Impact | - | ▪ The proposed action would not have any impact on visual amenities. |
| Level of Community Support | | ▪ Support: 81%<br>▪ Neutral: 19%<br>▪ Do not Support: 0% |
| Associated Costs: | | ▪ Costs include $20,000 for initial policy document development and for updated signage at Forrest beach access points (if/where needed).<br>▪ On-going contribution for monitoring traffic and regulation is estimated to be primarily in-kind plus a nominal $5,000 contribution per year to be defined when the policy is drafted.<br>▪ 20 Year NPV = $72,000 |

**Table 6-14 Option F2: Maintain/Upgrade vehicle accessways.**

| Description and Rationale | | |
|---|---|---|
| ▪ The existing vehicular beach accessways at Forrest beach are currently comprised of sand track with no formal surfacing or boundary delineation to keep vehicles to clearly defined access points. As a result, the dunes are experiencing dune lowering and damage to adjoining vegetation.<br>▪ This Action would therefore involve the installation of a formal dune accessway infrastructure at Forrest Beach – at the northern end of Allamanda Avenue, and the southern end of Cassidy Beach Road.<br>▪ Works would include:<br>– Accessway surfacing, comprising typical vehicle access surfaces like board and chain or an equivalent durable recycled system such as EnduroPlank.<br>– Bollarding and/or fencing to ensure that vehicles remain within the defined access point and do not unnecessarily damage dune vegetation. | | |
| **Assessment Criteria** | **Score** | **Details** |
| Protection of Land and Infrastructure | ✓ | ▪ Will increase the overall resilience of the primary foredune by reducing damage to vegetation and the potential for dune blowouts at the access points. |
| Logistical constraints / risk (constructability etc) | ✓✓ | ▪ Logistics are relatively inexpensive and low risk. |
| Adaptability to future conditions (including SLR) | ✓ | ▪ The resilience of the dune system to sea level rise and long-term shoreline recession will be enhanced by preventing undue damage to vegetation. |
| Impact on Coastal Processes | ✓ | ▪ Highly positive. Will promote natural upper beach face sediment dynamics and reduce the impacts of vehicles on the dune system |
| Impact on Flora and Fauna | ✓ | ▪ Highly positive. Will prevent vehicle damage to primary foredune species and pioneer plants and improve the habitat value. |
| Social & Recreational Amenity Impact | ✓✓ | ▪ Relative to the existing condition will provide safer and more sustainable access to the foreshore for vehicles. |
| Visual Amenity Impact | - | ▪ The proposed action would not have any significant impact on visual amenities. |
| Level of Community Support | | ▪ Support: 67%<br>▪ Neutral: 33%<br>▪ Do not Support: 0% |
| Associated Costs: | | ▪ Costs include $20,000 for each accessway, which includes surfacing, bollards, and associated signage.<br>▪ Yearly nominal inspection and maintenance allowance of $4,000 p.a.<br>▪ 20 Year NPV = $81,000 |

## 6.7 Study Area Wide Actions

**Table 6-15 Option F3: Community Engagement & Education about dune care**

**Description and Rationale**

- This action will Produce educational material and advice to residents to inform them about the importance of coastal dune systems and healthy native dune vegetation – and information regarding best practice dune management.
- It is essential to let people know the problem, what is being done about it, and how they could help. This could comprise a similar program to the "Don't mow, let it grow" campaign employed in Townsville City Council It could involve:
  - Informative literature: Including flyers (see below) and online information.
  - Signage at beach locations
  - Engagement with residents about best practice foreshore vegetation management, with a focus of the program will be residents with properties directly abutting the foreshore.
- The program could also provide foreshore residents access to native dune vegetation seedlings through Council's nursery.

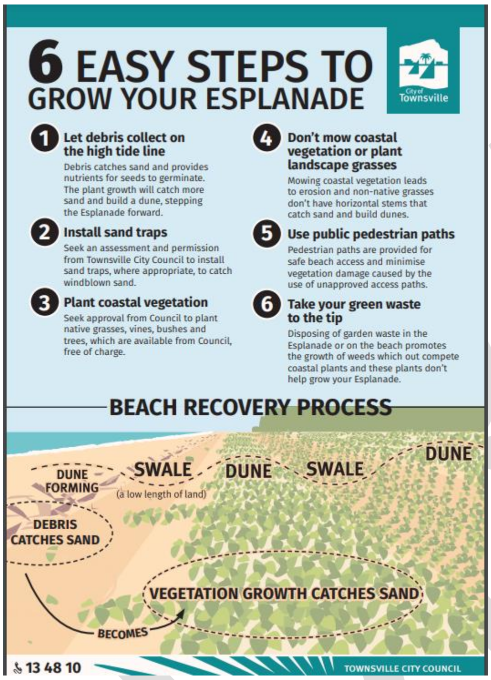


**Figure 6-20 Left: Example of community education about dune care from Townsville City Council. Right: The HSC Nursery**

| Assessment Criteria | Score | Details |
|---|---|---|
| Protection of Land and Infrastructure | ✓ | ▪ Will increase the overall resilience of the primary foredune by discouraging vegetation vandalism and encouraging local stewardship of best proactive coastal management. |
| Logistical constraints / risk (constructability etc) | ✓✓✓ | ▪ Logistics are relatively inexpensive and low risk. |

| | | |
|---|---|---|
| Adaptability to future conditions (including SLR) | ✓✓ | ▪ Maintaining proper dune vegetation coverage and healthy dune condition will enhance the resilience of the dune system to sea level rise and long-term shoreline recession. |
| Impact on Coastal Processes | ✓ | ▪ Highly positive. Will reduce the impacts of anthropogenic activities on the dune system. |
| Impact on Flora and Fauna | ✓✓✓ | ▪ Highly positive. Will prevent vehicle damage to primary foredune species and by discourage vegetation vandalism and encouraging foreshore residents to plant local native dune species. |
| Social & Recreational Amenity Impact | ✓ | ▪ Will help foster a sense of community buy-in and ownership of dune management.<br>▪ A healthier and more resilient dune system will provide a safer and more usable beach for recreation. |
| Visual Amenity Impact | ✓ | ▪ Over time, the proposed action should improve the dune system's amenity through removing weeds, etc. |
| Level of Community Support | | ▪ Support: 92%<br>▪ Neutral: 8%<br>▪ Do not Support: 0% |
| Associated Costs: | | ▪ Costs include:<br>– $10,000 for the development of content (including graphic design)<br>– $10,000 for signage and printing<br>– Engagement with residents can be undertaken in kind by Council staff.<br>▪ Provision of seed to residents can be undertaken at cost. |

# 7 RECOMMENDED SHORELINE EROSION MANAGEMENT

## 7.1 Summary of Outcomes and Recommendations

A summary table of options assessed during the process is provided in Table 7-1.

This table also identifies which actions are recommended to be included in the SEMP. All options identified in Section 6 have been recommended in this SEMP, except L1B and L2B.

The scheduling and dependencies of the various action are also outlined in Figure 7-1. This demonstrates that some actions in the SEMP should be implemented in a specific scheduled order, so that the full benefits of the SEMP can be realised.

At Lucinda Action L1A Lucinda GSC groyne field renewal groyne field has been prioritised over Action L1B rock groyne field for its lower procurement cost and higher community support. s to consider a longer planning period, out to say 100 years, the cost-benefit of the two structure types is more comparable. However, as discussed in Table 6-3, consideration of a 100 years+ planning period should also consider the future impacts of SLR on the Lucinda township - whereby by 2100 the properties along Patterson Pde will become exposed to periodic “sunny day” tidal inundation from the Dungeness Creek, regardless of any long-term groyne construction.

Option L1B – Lucinda beach seawall (erosion control) is neither compatible with existing State Policies nor commensurate to the site and the current community values.

Actions L3 and L4 are recommended for inclusion in the SEMP as these can deliver significant coastal management benefits for the next decade.

Nonetheless, the sand resource on the Lucinda spit may reduce in the next decades, and sand management options will need to evolve as the sand supply changes. Also, a severe Tropical Cyclone could erode a significant proportion of the existing dune buffer, threatening private foreshore properties on the exposed coast (Lucinda Beach and Forest Beach). This SEMP was prepared for a 20-years duration, and the shoreline will continue to evolve naturally along most of the Hinchinbrook coast.

A planning horizon of 20 years has been adopted for the SEMP. This is the longest of the range in planning horizons recommended by the State Government in guidelines when preparing a SEMP.

Therefore, to be prudent, it is recommended to establish a baseline alignment (A-Line) for a future coastal levee in coordination with the State Government Agencies (including DES) for Lucinda Beach, Taylors Beach, and Forrest Beach. The A-Line will assist in locating and upgrading informal rock revetments in the future and provide long-term readiness for the coastal community to manage the effect of climate change. This approach is compatible with the CHAS adaptation pathway to Climate Change for these settlements. The economic distribution of benefits and funding mechanisms should be considered when preparing such baseline alignment. Funding such large-scale coastal works will be a significant endeavour that may require public and private funds.

For Dungeness, Action D2 – Dungeness Safe Boating Facility is recommended to be progressed in consultation with DES. The pathway identified in Table 6-9 is intended to progress the project so that DES requirements are investigated and assessed throughout the project definition. Water Technology invites comments from DES on this proposed process during the draft review of this SEMP, and for the benefit of both DES and HSC it is recommended that a clear position on this is agreed upon before the finalisation of the SEMP.

**Table 7-1 Options Assessment Outcomes**

| | | | Performance and Logistics Issues | | | Environmental Impacts | | Social and Community Impacts | | | Economic Viability | | | | Outcome |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Location** | **ID** | **Option** | Protection of Infrastructure | Logistical constraints / risk (constructability etc) | Adaptability to future conditions (SLR etc) | Impact on Coastal Processes | Impact on Flora and Fauna | Social & Recreational Amenity Impact | Visual Amenity Impact | Level of Community Support | **Estimated Capital Cost** | **Estimated Annual Maintenance Costs (p.a)** | **Estimated 20 Yr NPV Cost (7% discount rate)** | **Estimated 50 Yr NPV Cost (7% discount rate)** | **Recommendation to proceed with Action / Option?** |
| Dungeness | D1 | Beach nourishment and shoreline monitoring | ✓ | ✓✓ | ✓✓ | ✓ | ✓ | ✓ | ✓ | ✓✓ | $10,000 | $10,000 | $110,000 | $150,000 | ✓ |
| Dungeness | D2 | Dungeness Boating Safety Project | ✓ | × | ×× | • | • | ✓✓ | × | ✓ | $6,700,000 | $130,000 | $8,000,000 | $8,500,000 | ✓ |
| Lucinda | L1A | Groyne Upgrade: GSC construction | ✓✓ | ✓✓ | × | • | • | • | ✓ | ✓ | $2,300,000 | $110,000 | $4,300,000 | $5,100,000 | ✓ |
| Lucinda | L1B | Groyne Upgrade: Rock-armoured construction | ✓✓ | ✓✓ | ×× | • | • | × | ✓ | ✓ | $6,800,000 | $68,000 | $7,400,000 | $7,700,000 | × |
| Lucinda | L2A | Lucinda Foreshore - Sand back-passing & beach nourishment | ✓✓ | ✓✓ | ✓✓✓ | ✓✓ | ✓✓ | ✓✓✓ | ✓✓ | ✓ | $170,000 | $170,000 | $530,000 | $690,000 | ✓ |
| Lucinda | L2B | Lucinda Foreshore - 480 m extension of Johnson St Seawall | ✓✓ | ✓ | ×× | ×× | ××× | ××× | ×× | • | $7,100,000 | $71,000 | $7,800,000 | $8,100,000 | × |
| Lucinda | L3 | Foreshore restoration & formalisation of access | ✓ | ✓✓✓ | ✓✓✓ | ✓✓✓ | ✓✓✓ | ✓✓ | ✓✓ | ✓✓✓ | $30,000 | $30,000 | $340,000 | $450,000 | ✓ |
| Lucinda | L4 | Repair and Maintain Johnston St Seawall | ✓ | ✓✓ | • | • | • | ✓✓ | ✓✓ | ✓ | $70,000 | $700 | $77,000 | $80,000 | ✓ |
| Taylors Beach | T1 | Upgrade / replace GSC revetment structure | ✓✓✓ | ✓ | × | • | • | ✓✓✓ | • | ✓ | $920,000 | $9,200 | $1,000,000 | $1,000,000 | ✓ |
| Taylors Beach | T2 | Beneficial reuse of dredge material for beach nourishment | ✓ | ✓✓ | ✓✓✓ | • | • | ✓✓ | ✓ | ✓ | $100,000 | $50,000 | $590,000 | $760,000 | ✓ |
| Forrest Beach | F1 | Dune restoration & formalisation of access | ✓ | ✓✓✓ | ✓✓✓ | ✓✓✓ | ✓✓✓ | ✓✓ | ✓✓ | ✓✓ | $13,000 | $13,000 | $140,000 | $180,000 | ✓ |
| Forrest Beach | F2 | Update 4WD on beaches policy | ✓ | ✓✓✓ | ✓ | ✓ | ✓✓ | • | • | ✓✓✓ | $20,000 | $5,000 | $72,000 | $89,000 | ✓ |
| Forrest Beach | F3 | Maintain/Upgrade vehicle accessways | ✓ | ✓✓ | ✓ | ✓ | ✓ | ✓✓ | • | ✓✓ | $40,000 | $4,000 | $81,000 | $95,000 | ✓ |
| General | G1 | Community education material re: dune care | ✓ | ✓✓✓ | ✓✓ | ✓ | ✓✓✓ | ✓ | ✓ | ✓✓✓ | $20,000 | $5,000 | $20,000 | $20,000 | ✓ |

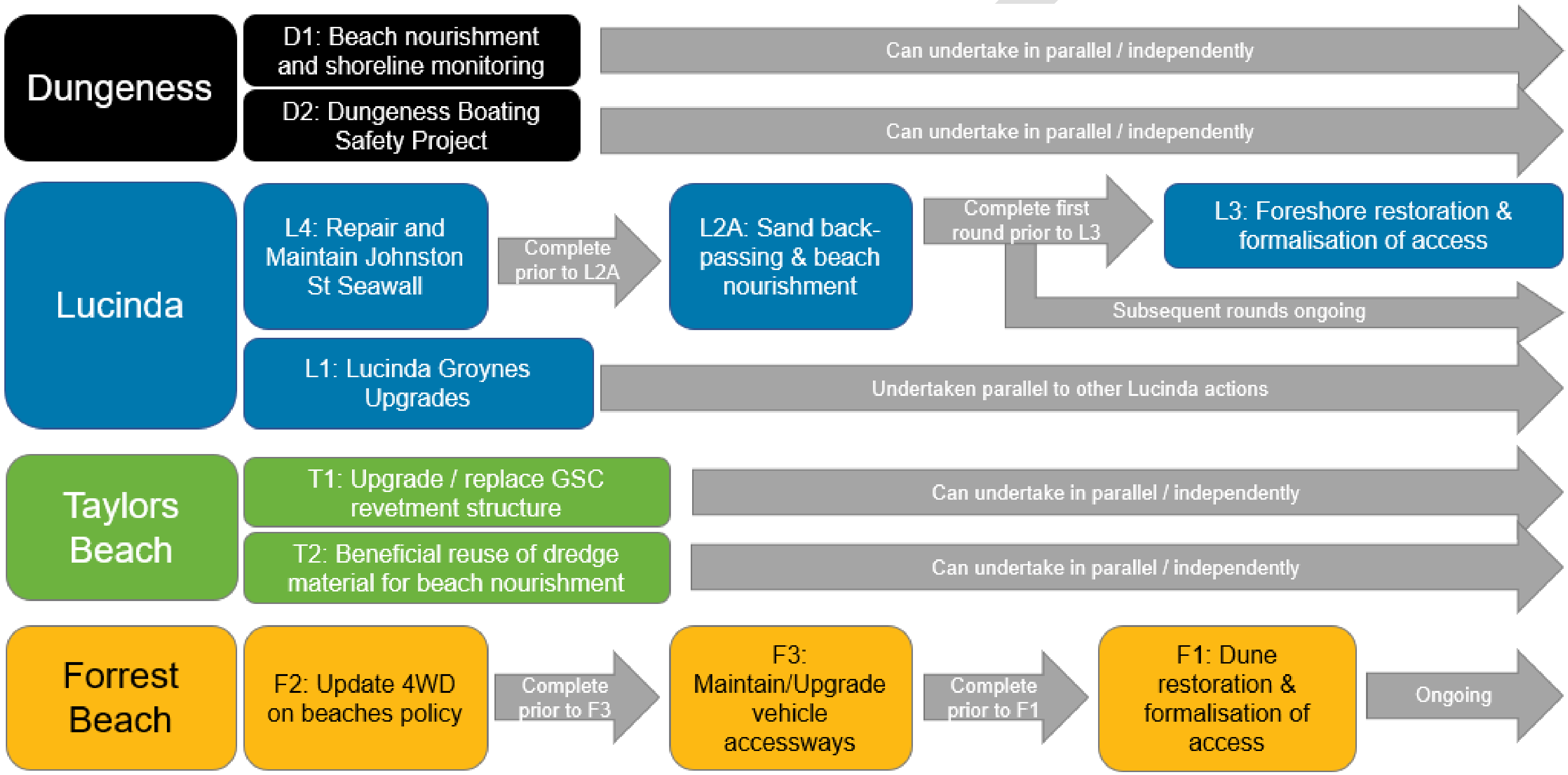



**Figure 7-1 Scheduling of SEMP Actions**

## 7.2 Monitoring, Evaluation, and Review (MER)

Monitoring the performance of the SEMP allows for proactively addressing potential threats to project outcomes. Given that the primary objective of the SEMP is to manage the erosion threat along the study area, regular foreshore surveys should be undertaken as part of the Plan. The following routine beach profile survey are recommended:

- Six-monthly (April and November) beach profile surveys should be performed routinely at the Dungeness Beach, Lucinda Beach, and Forrest Beach foreshore. The minimum spacing between beach profiles should be 400m, with coverage 800m on either side of the settlements. The beach profiles should extend from the foreshore property boundaries down to the Low Astronomical Tide. The six-monthly basis captures the prevailing wind and wave climate's seasonality and cyclonic seasons. Aerial drone-derived LiDAR or photogrammetry is relatively cost-effective for beach monitoring surveys with large coverage. It is recommended to engage a certified professional surveyor for a long-term beach survey program (typically three years) to efficiently use surveyor resources and generate a consistent baseline of repetitive surveys. The electronic survey result files should be issued to DES and Water Technology for archiving and future analysis in GAD2020. These surveys will enable to monitor beach volumes, scarp location, hind dune extents and primary dune evolution.
- Yearly inspections and condition assessment of the coastal management works, particularly seawalls, groynes, dredging and breakwater structures, at annual intervals to manage dilapidation and maintenance requirements.

Initial monitoring surveys should commence before implementing any physical works recommended by this SEMP, thereby providing a pre-project baseline.

The monitoring survey program should be reviewed every three years and modified to ensure seasonal and annual changes to beach profiles are captured. The monitoring program may be increased or decreased to maintain SEMP outcomes.

In the coming decades, the foreshores of HSC will experience the effects of climate change. This is likely to include gradual increases in sea level and changes to the beach profiles across the study area by natural processes and other environmental processes (ecological changes, etc.).

There will also be ongoing management of the coastal assets by other stakeholders, such as the Port of Lucinda. Similarly, conserving the Nypa Palms National Park values may require work beyond HSCs jurisdiction. Such stakeholder management actions may impact the SEMP, and integrating coastal management action with a broad base of stakeholders will be as critical as ever for the SEMP to be successful.

There remains significant uncertainty about the scale and effect of climate processes. Future GHG emissions will influence the magnitude and timing of sea level rise. Therefore, monitoring future shoreline response by a regular program of foreshore surveys serves an essential role in adapting the SEMP strategies in coming years and guiding future action. Monitoring and evaluation are critical to ensure the success of the SEMP.

## 7.3 Update and Review of this SEMP

A professional review of the SEMP actions should be undertaken every 5 years, as per the SEMP requirements set out by DES (2018).

Whilst this SEMP has been developed for a 20-year planning period, if at any point in the future, within or beyond the 20-year planning period, Council considers that additional erosion management strategies are required, then further measures beyond the scope of recommendations put forth in this SEMP should be investigated.

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# APPENDIX A
# PLANNING AND LEGISLATION REVIEW

# A-1 Background

This SEMP sits within the context of Commonwealth and State legislation and Council's local planning policies. This section provides a summary of the key legislative and planning requirements that may impact how coastal erosion is managed in the study area, and how the recommendations of the SEMP are affected by those requirements.

The basis and control of management of Queensland's coast is governed by the *Coastal Protection and Management Act 1995* (Coastal Act) and the *Planning Act 2016*. Under these Acts, the Coastal Management Plan (CMP), the Coastal Protection State Planning Regulatory Provision (Coastal SPRP), the State Planning Policy (SPP) and the State Development Assessment Provisions (SDAP) are the primary statutory planning instruments for development planning and assessment.

Legislation and policies considered in this SEMP require consideration of issues including, but not limited to:

- The use of coastal structures for property protection,
- Protection of species listed under State and Commonwealth legislation and conservation of their habitat,
- Management of shoreline erosion in a manner that is not detrimental to the adjacent Great Barrier Reef Marine Park, and
- The maintenance of local biodiversity.

The following sections describe these legislative and policy considerations in more detail.

# A-2 Coastal Protection and Management Act 1995

The *Queensland Coastal Protection and Management Act 1995* (Coastal Act) governs the way coastal land is managed in Queensland. The main objects of this Act are to:

- Provide for the protection, conservation, rehabilitation, and management of the coastal zone, including its resources and biological diversity; and
- Have regard to the goal, core objectives and guiding principles of the National Strategy for Ecologically Sustainable Development in the use of the coastal zone; and
- Ensure decisions about land use and development safeguard life and property from the threat of coastal hazards; and
- Encourage the enhancement of knowledge of coastal resources and the effect of human activities on the coastal zone.

The primary means of achieving these management objectives under the Coastal Act is through regulation of developments and allocations, and the preparation of management plans.

The coastal zone includes Queensland's coastal waters (to 3 nautical miles from the coast) and land and waters landward of coastal waters to a limit of 5 km from the coast, or to 10 m AHD elevation, whichever is further inland. The entire study area is within the coastal zone.

A Coastal Management District (CMD) has been declared under the *Coastal Act* over lots which are likely to be subject to inundation by tidal water or increased coastal erosion under future climate change. The CMD defines an area in which the Department of State Development, Manufacturing, Infrastructure, and Planning (DSDMIP) has assessment manager or referral agency powers and responsibilities to assess certain development applications. The Department of Environment and Science (DES) is a technical advice agency to DSDMIP for development proposals in coastal management districts.

Coastal Management Districts are shown on development assessment maps held by DSDMIP, as well as on coastal hazard maps prepared by DES.

Erosion prone areas are also declared over land vulnerable to short-term and long-term coastal erosion and tidal inundation. Such declarations are made under Part 4, section 70 of the *Coastal Act* by reference to erosion prone area plans that have previously been prepared by EHP (now DES).

The Queensland Government currently manages the coastal zone using the Coastal Management Plan (CMP) and the State Planning Policy (SPP). The Coastal Management Plan (prepared under the *Coastal Act* and commenced on 18 March 2014) provides non-regulatory policy guidance to coastal land managers (primarily local government) for the management of the coastal zone and works that are not assessable development under the *Planning Act 2016*.

The State Planning Policy (SPP) provides State interests with policies to be considered by land managers particularly when preparing planning schemes. State interests include the coastal environment, biodiversity, and natural hazards (i.e., coastal erosion). In addition, the SPP also provides development assessment criteria. The policy applies to a range of interests relevant to the SEMP, including coastal protection, water quality, native vegetation clearing, Queensland heritage, wetlands, and environmentally relevant activities.

## A-3 Planning Act 2016

In July 2017, Queensland began operating under new planning legislation – the *Planning Act 2016*, which replaced the *Sustainable Planning Act 2009* (SPA). Development within the coastal zone is regulated under the *Planning Act 2016*. The Act provides a framework to integrate planning and development assessment so that development and its effects are managed in a way that is ecologically sustainable.

The *Planning Act 2016* mandates a state-wide, applicant-driven development assessment system, by which local governments (and state agencies in some circumstances) assess and make decisions on the various land-use and development proposals.

The *Planning Act 2016* provides for the crafting of documents that guide strategic planning and development throughout Queensland. The foremost document is the planning scheme, which is created by local government taking into account the aspirations of their communities and the state's interests. Each scheme specifies the levels of assessment for all defined land uses, and the assessment requirements for each. The local planning scheme identifies what development and land-use proposals require an approval from council and what proposals do not need an approval.

The *Planning Regulation 2017* supports the principal legislation by outlining the mechanics for the operation of the Planning Act. It deals with practical matters such as: how development is categorised, who will assess a development application, and the state interest matters for development. In most cases, local government is the assessment manager. However, where the state identifies that it has a particular interest through the Planning Regulation, the state assesses those aspects of the development through the State Assessment and Referral Agency (SARA).

There are two statutory state planning instruments. These being:

- State Planning Policy (SPP) This instrument sets out the state planning matters considered as crucial to responsible land-use planning and development across the state. Councils must consider the state interests that apply to their local government areas when making, amending, and implementing their planning schemes.
- Regional Plans. A regional plan focuses on the growth and development of a specific part of Queensland. Regional planning matters are identified in collaboration with local governments, key industry groups and the wider community. Where a regional plan exists, the local government must consider it when making

or amending its planning scheme. The *North Queensland Regional Plan* (DSDMIP, 2017) includes the local government area of Hinchinbrook Shire Council.

Figure  (reproduced from Figure 28 of DLGP, 2017) shows a summary of the Queensland planning framework.

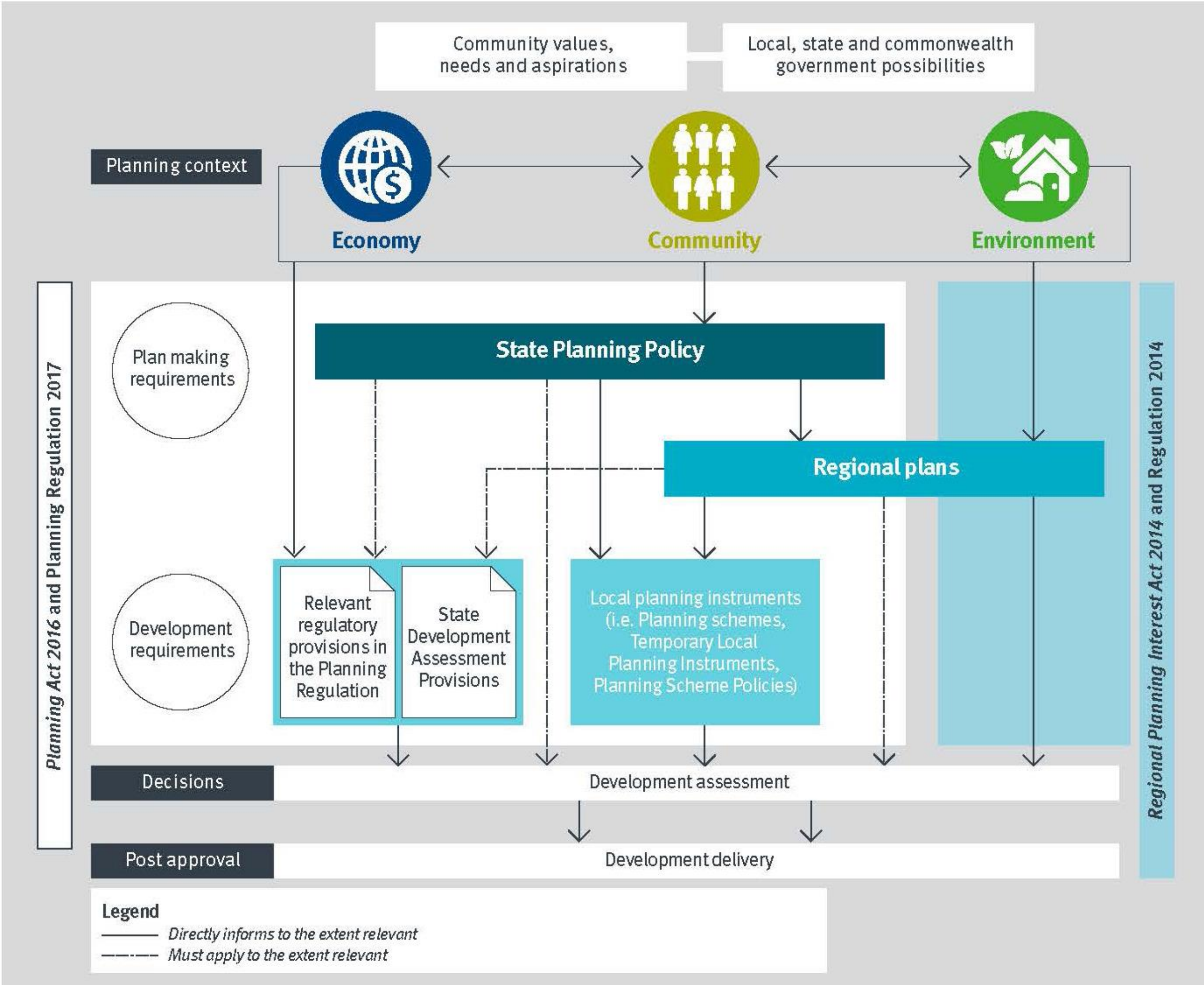


**Figure A-1 Queensland's Planning Framework**

## A-3-1 State Planning Policy (SPP) 2017

A new State Planning Policy (SPP) was introduced in July 2017 to replace a number of former state planning policies and instruments. The SPP is a statutory instrument which defines the Queensland Government's policies about matters of state interest in land use planning and development.

The SPP includes 17 state interests that must be considered in every planning scheme across Queensland. Each of the 17 state interests in the SPP is supported by guidelines which help councils to implement the SPP provisions. State interests are arranged under five broad themes. Those relating to this SEMP include:

***Environment and heritage***

- *Biodiversity*
    - Matters of environmental significance are valued and protected, and the health and resilience of biodiversity is maintained or enhanced to support ecological integrity.
- *Coastal environment*
    - The coastal environment is protected and enhanced, while supporting opportunities for coastal-dependent development, compatible urban form, and maintaining appropriate public use of and access to (and along) state coastal land.
- *Cultural heritage*
    - The cultural heritage significance of heritage places and heritage areas, including places of Aboriginal and Torres Strait Islander cultural heritage, is conserved for the benefit of the community and future generations.
- *Water quality*
    - The environmental values and quality of Queensland waters are protected and enhanced.

***Safety and resilience to hazards***

- *Natural hazards, risk, and resilience*
    - The risks associated with natural hazards, including the projected impacts of climate change, are avoided, or mitigated to protect people and property and enhance the community's resilience to natural hazards.

***Liveable communities and housing***

- *Liveable communities*
    - Liveable, well-designed, and serviced communities are delivered to support wellbeing and enhance quality of life.

The Department of State Development, Manufacturing, Infrastructure, and Planning (DSDMIP) provides mapping that spatially represents matters of state interest in the planning system. This is provided by way of two GIS (Geographic Information Systems) platforms: The *State Planning Policy Interactive Mapping System* (SPP IMS), which is a standalone mapping system, and the *Development Assessment Mapping System* (DAMS), which incorporates mapping used for a number of different functions in development assessment.

Both the SPP IMS and DAMS are updated as required to reflect the latest information and any relevant government policy and legislative changes.

## A-3-2 State Development Assessment Provisions

Development applications concerning certain matters of interest to the state are referred to the State Assessment and Referral Agency (SARA). In assessing applications, the state refers to both the SPP and the State Development Assessment Provisions (SDAP). The SDAP is a statutory instrument prescribed by the Planning Regulation 2017, which sets out the matters of interest to the State government when assessing a development application as either an assessment manager or a referral agency for a development application. The state uses SDAP to deliver a coordinated, whole-of-government approach to the state's assessment of development applications.

*State Code 8: Coastal development and tidal works* of the SDAP provides a state code for development in the coastal management district or for tidal works. The criteria outlined in State Code 8 will need to be followed in a development application for coastal erosion protection works, as such works will be located within the coastal management district. The assessment criteria in relation to erosion prone areas generally emphasise avoiding new development and intensification, avoiding disruption to existing coastal processes and adopting “soft” solutions to coastal protection in preference to “hard” erosion control structures. Relevant performance outcomes (assessment criteria) include:

- Natural processes and the protective function of landforms and vegetation are maintained in coastal hazard areas.
- Erosion prone areas in a coastal management district are maintained as development free buffers, or where permanent buildings or structures exist, coastal erosion risks are avoided or mitigated.
- Development avoids or minimises adverse impacts on coastal resources and their values, to the maximum extent reasonable.
- Coastal protection work is undertaken only as a last resort where erosion presents an imminent threat to public safety or permanent structures.
- Development avoids adverse impacts on matters of state environmental significance, or where this is not reasonably possible, impacts are minimised, and an environmental offset is provided for any significant residual impacts to matters of state environmental significance that are prescribed environmental matters.

Coastal protection work is only to be undertaken to protect permanent structures which cannot reasonably be relocated or abandoned from imminent adverse coastal erosion impacts. Coastal protection work should involve beach nourishment as a first priority. The construction of an erosion control structure should only be considered if it is the only feasible option for protecting permanent structures from coastal erosion and those structures cannot be abandoned or relocated. Coastal protection works to protect private structures should be located on private land where possible and should not increase the coastal hazard risk for adjacent areas.

### A-3-3 North Queensland Regional Plan

The *North Queensland Regional Plan* (DLGP, 2011) is currently being prepared. The purpose of the plan will be to set out clear goals that will protect the region's unique lifestyle, provide well-connected transport, communication, and social networks, safeguard the natural environment, and embrace diversity through a range of community, housing and employment and development styles.

The region includes five local government areas:

- Burdekin
- Charters Towers
- Hinchinbrook
- Palm Island
- Townsville.

The regional plan provides context for local level planning. The regional plan is implemented by the coordinated actions of state and local government and the community to achieve this shared vision for the future. The regional plan identifies the regional framework and desired regional outcomes for the North Queensland region. The regional plan is the pre-eminent plan for the region, and once finalised will take precedence over all planning instruments, other than state planning regulatory provisions.

The regional plan is a “whole-of-region” document. It is intended that the regional framework and desired regional outcomes in the plan will be additionally informed by more detailed and local assessment of issues by state and local governments, and more specific state planning policies and local government planning schemes.

# A-4 Coastal Management Plan

The Coastal Management Plan (CMP) seeks to manage all coastal land and coastal resources within the coastal zone as defined by the *Coastal Act*. It applies to all management planning, activities, decisions and works that are not assessable development under the SP Act, including the development of a SEMP.

The guiding principle for managing coastal landforms and processes is to preserve the long-term stability of dunes and other natural coastal landforms; and to allow physical coastal process, including erosion, accretion, and sediment movement to occur without interruption. However, the plan acknowledges that erosion can threaten communities and infrastructure. In this case, the CMP specifically calls for a Shoreline Erosion Management Plan (SEMP) to deliver a science-based solution to the erosion problem that considers social, environmental, and economic issues.

Other matters on which the CMP provides policy guidance include:

- Conserving matters of state environmental significance (MSES),
- Maintaining and enhancing the connection of Aboriginal People and Torres Strait Islanders to coastal and marine resources,
- Maintaining and enhancing public access and use of the coast,
- Ensuring continuous improvement in management outcomes through planning, monitoring, reporting and review, and
- Sharing knowledge of coastal resources and management with the community and engaging the community in decision-making processes.

The Coastal Management Plan is intended to guide land managers and the land under their control. However, it does not bind local government to take action to protect private land from coastal erosion.

# A-5 Commonwealth Legislation

## A-5-1 EPBC Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (*EPBC Act*) is the Federal Government's central piece of environmental legislation. Approval from the Minister responsible for the EPBC Act is required to take any action (e.g., project, development, activity) that is likely to result in a significant impact on a *matter of national environmental significance* (MNES).

## A-5-2 Native Title Act 1993

The *Native Title Act 1993* provides for the recognition and protection of native title in Australia. It is a recognition by Australian law that Indigenous people have rights and interests to their land that derive from their traditional laws and customs. Native title determinations are undertaken in the Federal Court, upon application by a native title claimant.

The *Native Title Act 1993* sets out procedures for dealing with "future acts", which are proposals to use land or change administration or legislative arrangements in a way that affects native title rights and interests. Examples include grazing, horticulture, water diversion, mining licences and construction of public infrastructure. The procedures for future acts depend on the nature of the act, and generally require more consultation and negotiation for acts that have higher impact on native title rights and interests.

In July 2012, the Queensland government granted native-title rights to a six-hectare parcel of Magnetic Island to the Wulgurukaba people. The land is situated at West Point on the western side of the Island. It was transferred under the Aboriginal Land Act 1991 and is the result of an Indigenous Land Use Agreement between the State Government and the Wulgurukaba People.

The recommendations in this SEMP have no direct or indirect implications to the exercise of the Wulgurukaba peoples' native title rights.

# A-6 State Legislation and Instruments

## A-6-1 Matters of State Environmental Significance

Matters of State Environmental Significance (MSES) are a component of the state's biodiversity interests that are defined under the State Planning Policy. MSES include certain environmental values that are protected under Queensland legislation, including the:

- Protected areas (including all classes of protected area except coordinated conservation areas) under the *Nature Conservation Act 1992*.
- Marine parks and land within a 'marine national park,' 'conservation park,' 'scientific research', 'preservation' or 'buffer' zone under the *Marine Parks Act 2004.*
- Areas within declared fish habitat areas that are management A areas or management B areas under the *Fisheries Regulation 2008.*
- Threatened wildlife under the *Nature Conservation Act 1992* and special least concern animal under the Nature Conservation (Wildlife) Regulation 2006.
- Regulated vegetation under the *Vegetation Management Act 1999* that is:
  - Category B areas on the regulated vegetation management map, which are 'endangered' or 'of concern' regional ecosystems;
  - Category C areas on the regulated vegetation management map that are 'endangered' or 'of concern' regional ecosystems;
  - Category R areas on the regulated vegetation management map;
  - Areas of essential habitat on the essential habitat map for wildlife prescribed as 'endangered wildlife' or 'vulnerable wildlife' under the *Nature Conservation Act 1992;*
  - Regional ecosystems that intersect with watercourses identified on the vegetation management watercourse map;
  - Regional ecosystems that intersect with wetlands identified on the vegetation management wetlands map.
- Strategic Environmental Areas under the *Regional Planning Interests Act 2014*.
- Wetlands in a wetland protection area or wetlands of high ecological significance shown on the Map of Referable Wetlands under the *Environmental Protection Regulation 2008*.
- Wetlands and watercourses in high ecological value waters as defined in the *Environmental Protection (Water) Policy 2009, Schedule 2.*
- Legally secured offset areas.

MSES mapping represents the definition for MSES under the SPP. The mapping generates individual layers using information from data including, but not limited to:

- marine parks

- fish habitat areas
- regulated vegetation mapping
- Queensland wetland mapping
- protected areas
- legally secured offsets included in the 'offsets register.'

The State Government's MSES mapping product is a guide to assist planning and development assessment decision-making. Its primary purpose is to support implementation of the SPP biodiversity policy. While it supports the SPP, the mapping does not replace the regulatory mapping or environmental values specifically called up under other laws or regulations. Similarly, the SPP biodiversity policy does not override or replace specific requirement of other Acts or regulations.

#### *Nature Conservation Act 1992*

The *Nature Conservation Act 1992* (the NC Act) relates to the protection of native flora and fauna and the declaration of protected areas.

Essential Habitat is vegetation in which a species that is Endangered or Vulnerable under the Nature Conservation Act (1992) has been known to occur.

The removal or destruction of native flora or fauna is unlawful unless it is authorised by a permit. If vegetation clearing is necessary for the purposes of implementing coastal protection works (including clearing to gain foreshore access) an appropriate permit under the NC Act must first be obtained. However, this does not apply to flora protected under the provisions of other Acts (e.g., marine plants).

No clearing of native coastal vegetation will be required as part of this SEMP.

#### *Environmental Protection Act 1994*

The *Environmental Protection Act 1994* (the EP Act) and the *Environmental Protection Regulation 2008* provide the main framework for controlling environmental harm and pollution resulting from development.

The EP Act establishes an environmental duty requiring entities to not cause adverse environmental effects unless all reasonable and practicable measures are undertaken to avert or lessen such harm. In the context of this SEMP, Townsville City Council is under an obligation to not undertake any activities that cause, or are likely to cause, environmental harm unless it takes reasonable and practicable measures to prevent or minimise harm. Environmental protection policies (EPPs) are also prepared under the EP Act to protect Queensland's environment. The objective of an EPP is to protect the environmental values and quality objectives for several attributes of the environment - including water, noise, air, and waste management.

Environmental values and water quality objectives within the *Environmental Protection (Water) Policy 2009*.

#### *Great Barrier Reef Marine Park Act 1975*

The *Great Barrier Reef Marine Park Act 1975* is the primary Act in respect of the Great Barrier Reef Marine Park. It includes provisions which:

- Establish the Great Barrier Reef Marine Park itself;
- Establish the Great Barrier Reef Marine Park Authority (GBRMPA), a Commonwealth authority responsible for the management of the Marine Park;
- Provide a framework for planning and management of the Marine Park, including through zoning plans, plans of management and a system of permissions;

- Prohibit mining operations (which includes prospecting or exploration for, as well as recovery of, minerals) in the Great Barrier Reef Region (unless authorised to carry out the operations by a permission granted under the Regulations, for the purpose of research or investigations relevant to the conservation of the Marine Park);
- Require compulsory pilotage for certain ships in prescribed areas of the Great Barrier Reef Region;
- Provide for regulations, collection of Environmental Management Charge, enforcement etc.

As a consequence of the findings of a review of the Act in 2006, amendments to the Act were made by the Australian Government in 2008, which came into force in two stages in 2008 and 2009. The purpose of the amendments was to update the Act, and better integrate it with other legislation in order to provide an effective framework for the protection and management of the Marine Park.

When assessing erosion management strategies for this Shoreline Erosion Management Plan, the permissible activities within this zone must be taken into account. Consideration of other zones in the Park may be required if sand sourcing or other activities associated with erosion mitigation are undertaken within those zones.

A permit for certain activities within the Park is required under the Act and its regulations; *Great Barrier Reef Marine Park Regulations 1983* and the *Great Barrier Reef Marine Park Zoning Plan 2003*.

### *Marine Parks Act 2004*

In Queensland, the State's main legislation and regulation pertaining to marine parks are the *Marine Parks Act 2004* (Act) and the *Marine Parks Regulation 2006* (Regulation). These are designed to complement the Commonwealth's *Great Barrier Reef Marine Park Act 1975*, indeed the zoning plan for the State Marine Park is the same as the zoning plan for the Great Barrier Reef Marine Park.

*The Marine Parks (Great Barrier Reef Coast) Zoning Plan 2003* (Zoning Plan) defines the zoning arrangements, including the objectives for each zone, the allowable and prohibited activities, and those that require a marine park permit.

Whereas the landward boundary of the Great Barrier Reef Marine Park is low water mark, the landward boundary of the State Marine Park is the high-water mark. The Department of Environment and Science defines high water as:

"…high water means the mean height of the highest high water at spring tide."

When considering erosion mitigation strategies for this Shoreline Erosion Management Plan, it is likely that any works or activities below the high-water line (and therefore within the State Marine Park) – a level at of +2.2 mAHD will require approval under the State Marine Parks Act 2004. Permits are obtained for such works from the Queensland Parks and Wildlife Service (QPWS) of the Department of Environment and Science.

The exception to this are works undertaken at Dungeness, Lucinda, and Taylors Beach – which are located outside the GBRMP boundary.

### *Fisheries Act 1994*

The *Fisheries Act 1994* sets out Queensland's Department of Agriculture and Fisheries responsibilities for the economically viable, socially acceptable, and ecologically sustainable development of Queensland's fisheries resources.

A declared fish habitat area (FHA) is an area protected under the Act against physical disturbance from coastal development, while still allowing legal fishing. Queensland's FHA network ensures fishing for the future by protecting all inshore and estuarine fish habitats (e.g., vegetation, sand bars and rocky headlands) contained within declared FHAs, which play the key role of sustaining local and regional fisheries.

Development works in declared FHAs require application for a resource allocation authority under *the Fisheries Act 1994* and a development approval under the *Planning Act 2016*, unless the works comply with accepted development requirements. There are no PHA's in the vicinity of the study area, and no works proposed under this SEMP will impact any FHAs.

### *Native Title (Queensland) Act 1993*

The *Native Title (Queensland) Act 1993* is state legislation which ensures that Queensland law is consistent with the Commonwealth *Native Title Act 1993* and validates pre-existing rights of the state. Certain past acts of the state, such as freehold grants, some leasehold grants, and public works are validated, such that they extinguish native title in relation to the land or waters concerned. The Act confirms other rights, such as existing ownership of natural resources, water and fishing access rights, and public access to and enjoyment of beaches and other public places. Native title determinations and ILUAs made under the commonwealth's *Native Title Act 1993* are valid under this state Act.

### *Aboriginal Cultural Heritage Act 2003*

Legislation exists under a number of Commonwealth and State Acts to protect Aboriginal and Torres Strait Islander cultural heritage. To ensure compliance with the *Aboriginal Cultural Heritage Act 2003*, when implementing erosion mitigation works Council must take all reasonable and practical measures to ensure that such works do not harm Aboriginal cultural heritage. This may include:

- following the statutory "duty of care" guidelines, which may require consultation with the relevant Aboriginal party; or
- development and approval of a Cultural Heritage Management Plan.
- The State's *Native Title (Queensland) Act 1993* and the Commonwealth's *Native Title Act 1993* should both be considered when planning foreshore protection works.

### *Land Act 1994*

The *Land Act 1994* regulates the management of non-freehold land for the benefit of the people of Queensland. The Act invokes principles of sustainable resource use and development, consideration of land capability, allowing sustainable development in the context of the State's planning framework, ensuring land is allocated to people or bodies who will facilitate the most appropriate use for the benefit of the people of Queensland, retention of land for community purposes, and protection of environmentally and culturally valuable and sensitive areas and features.

In coastal areas, any development of land other than private freehold land must demonstrate a clear public benefit or resource allocation.

Erosion mitigation measures proposed by this Shoreline Erosion Management Plan on Unallocated State Land and other State Land will require a resource entitlement permit with direct implications (such as sand extraction activities) or indirect implications (e.g., impact on access). These provisions are also covered through the IDAS process.

### *Vegetation Management Act 1999*

The *Vegetation Management Act 1999* prohibits the clearing of regional ecosystems (i.e., native vegetation communities) unless it is for a relevant purpose. Clearing may be exempt from the approval process where listed under Schedule 24 of the SP Regulation. One of the purposes of the Act is to regulate vegetation clearing in a way that prevents the loss of biodiversity. To fulfil this obligation, Vegetation Management within Department of Natural Resources, Mines and Energy (DNRME) uses essential habitat mapping as a tool when assessing vegetation clearing applications to assist in determining whether the vegetation is habitat for Endangered or Vulnerable species.

Vegetation communities throughout Queensland are characterised and mapped by a procedure known as *Regional Ecosystems*. A Regional Ecosystem is a specific vegetation community occurring in conjunction with a particular combination of geology, soil type and landform within a specific bioregion of Queensland.

Many people would have a colloquial name for the vegetation type on their properties (such as open scrub, or coastal vine thicket) and know the land type (e.g., floodplains or rocky slopes). A Regional Ecosystem basically defines a grouping of land types and vegetation. Defining Regional Ecosystems assists in classifying biodiversity, ecological processes, and vegetation communities on a landscape scale.

Regional Ecosystems are used to provide a consistent approach to planning, vegetation management and legislation across Queensland. Regional Ecosystem data is reported every two years to provide statistics on the extent of Queensland's remnant vegetation and regional ecosystems.

Each Regional Ecosystem (RE) is classified by a three-part code (e.g., 11.2.5). The first number of the RE classification is the bioregion, the second part signifies the geology, soil, and landform, while the third part refers to the vegetation. The grouping of these three factors produces a Regional Ecosystem.

As noted above, the first part of the RE classification is the bioregion. Queensland has been divided into thirteen different bioregions which are based on broad landscape patterns that indicate major differences in climate, geology, animals, and plants across Queensland. *Brigalow Belt* (of which Magnetic Island is a part) is designated as bioregion number 11.

The second number of a RE is the land zone. Twelve land zones have been defined in Queensland. Land zones represent considerable differences in geology, landforms, and soil types. Land zones largely match broad geological types and can therefore be identified using geological maps. The area covered by this SEMP is typically either:

- Land Zone 1: Tidal Flats and Beaches – which is land that is subject to tidal inundations (e.g., mangroves, beaches, tidal flats) or
- Land Zone 2: Coastal Dunes - such as coastal dunes, coastal lakes and swamps that do not get inundated by seawater.

The third number of a RE describes the vegetation type. A Regional Ecosystem describes vegetation by its structure (e.g., grassy woodland, open forest, or wet heathland), the dominant plants in the canopy, and associated plants in the understorey. Scientific names are used since common plant names vary from one locale to another; and can sometimes be unreliable.

Regional ecosystems around the study area include:

- 11.1.4 - Mangrove low open forest and/or woodland on marine clay plains
- 11.2.1 - Corymbia tessellaris woodland on flat coastal dunes
- 11.2.2 - Complex of Spinifex sericeus, Ipomoea pes-caprae subsp. brasiliensis and Casuarina equisetifolia grassland and herbland on fore dunes
- 11.2.3 - Microphyll vine forest (‘beach scrub’) on sandy beach ridges and dune swales
- 11.2.4 - Lagoons in coastal dune swales

Queensland’s Regional Ecosystem Description Database lists the biodiversity status (BD Status) and the vegetation management class (VM class) of each regional ecosystem. The biodiversity status is used for a range of planning and management applications. It is based on an assessment of the condition of remnant vegetation, in addition to the criteria used to determine the class under the *Vegetation Management Act 1999*. The VM class is listed in the *Vegetation Management Regulation* under the Act.

The study area is surrounded by high-value remnant terrestrial ecosystems of state significance. Regional ecosystems around the area include those listed above.

#### *Queensland Heritage Act 1992*

The object of the *Queensland Heritage Act 1992* is to provide for the conservation of Queensland's cultural heritage for the benefit of the community and future generations. This is achieved in part by the establishment of a register of places and areas of State cultural heritage significance called the Queensland Heritage Register. Any development that will occur in (or in association with) a heritage place listed on the Register by the Queensland Heritage Council requires assessment. However, no State heritage places have been identified within the SEMP study area.

### A-6-2 Other Considerations

Consultation with the following agencies may be required regarding the legislation detailed previously:

- Department of Environment and Science (DES) for matters concerning foreshore protection works, conservation values, tidal quarry material allocations, management under the QCP; marine parks and NC Act permits;
- Department of Natural Resources, Mines and Energy (DNRME) for matters concerning the allocation and use of State Land, vegetation management, Indigenous cultural issues and land title;
- Department of Agriculture and Fisheries (DAF) for matters concerning fisheries resources, marine plants, FHAs, and quarry operations.

# APPENDIX B
# COMMUNITY VALUES SURVEY

# B-1 Survey Development

In development of the survey the population demographics of the Hinchinbrook Shire were used to help curate the survey to ensure a high level of community engagement. Key information included: the median age (50 years), the percentage of permanent residence who have access to the internet at home (70.2%) and the portion of people who are proficient in English (85.4%).

The survey was developed as a central element of the community values assessment for the study and was delivered in an online format on Council's website. A number of recruitment techniques were used to maximise respondent numbers, including emails to potential participants, social media, local newspapers, and engagement with local community groups. The survey method uses a combination of tick box and Likert scale response options to gain a detailed insight into community attitudes, knowledge, and experiences. The survey questions tried to be as specific to the respective area as possible.

As this was an online survey, the potential for individuals to submit more than one survey in order to shape or influence overall results should be acknowledged. Some capacity for monitoring this process was provided through cross referencing of IP addresses, along with date and time submission points. However, the capacity for multiple submissions could not be precisely tracked. This means that, as is always possible within an online survey addressing issues of importance for community members, the potential for one person submitting more than one survey cannot be definitively discounted – and as such is flagged as a potential data validity issue.

# B-2 Survey Results

*Question 1: How old are you?*

The first question is used to gain an understanding of the demographic participating in the survey, indicating that almost all respondents were aged above 25 years old. Taylors Beach shows a majority population over 65+ while Forrest Beach and Lucinda had typically evenly distributed age groups between 25 and 65+.

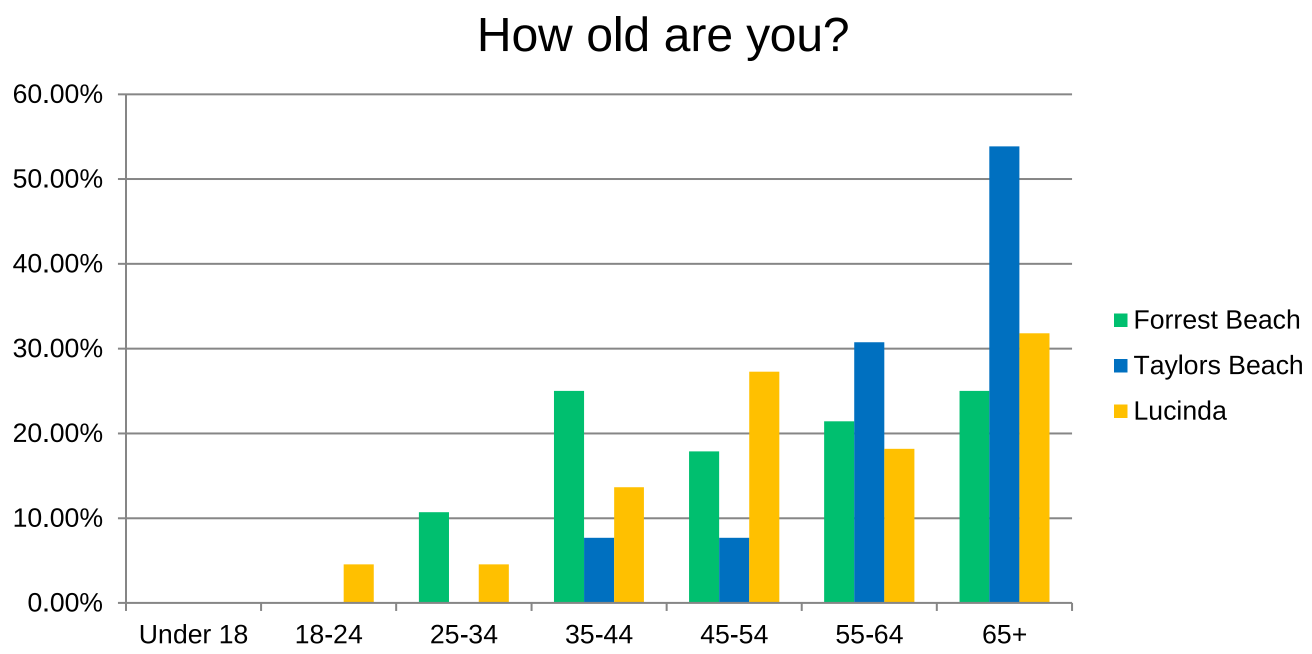


**Figure B-1 Community Survey Responses – Question 1**

*Question 2: What is your residential status?*

The purpose of this question was to gather information regarding the background and residential status of respondents. The results showed a large portion of the respondents live full time in their respective location with the next largest group being a visitor from either Hinchinbrook Shire or elsewhere. The survey allowed respondents to specify an 'other' response with most responses in this category related to building a residency in the location but have not yet moved in.

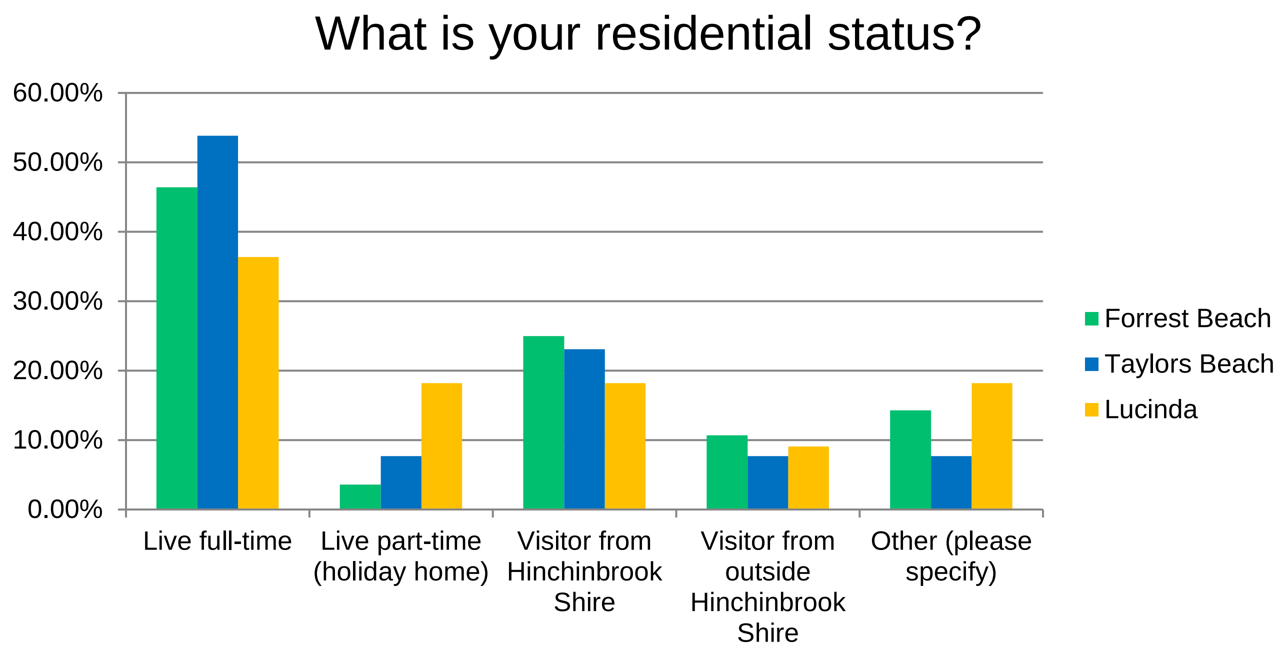


**Figure B-2 Community Survey Responses – Question 2**

*Question 3: How long have you been living at/visiting this area?*

The purpose of this question was to gain an understanding of how long the respondents have been in the local area with the vast majority having lived at or visiting their respective area for over 20 years and all other respondents between 2 and 20 years.

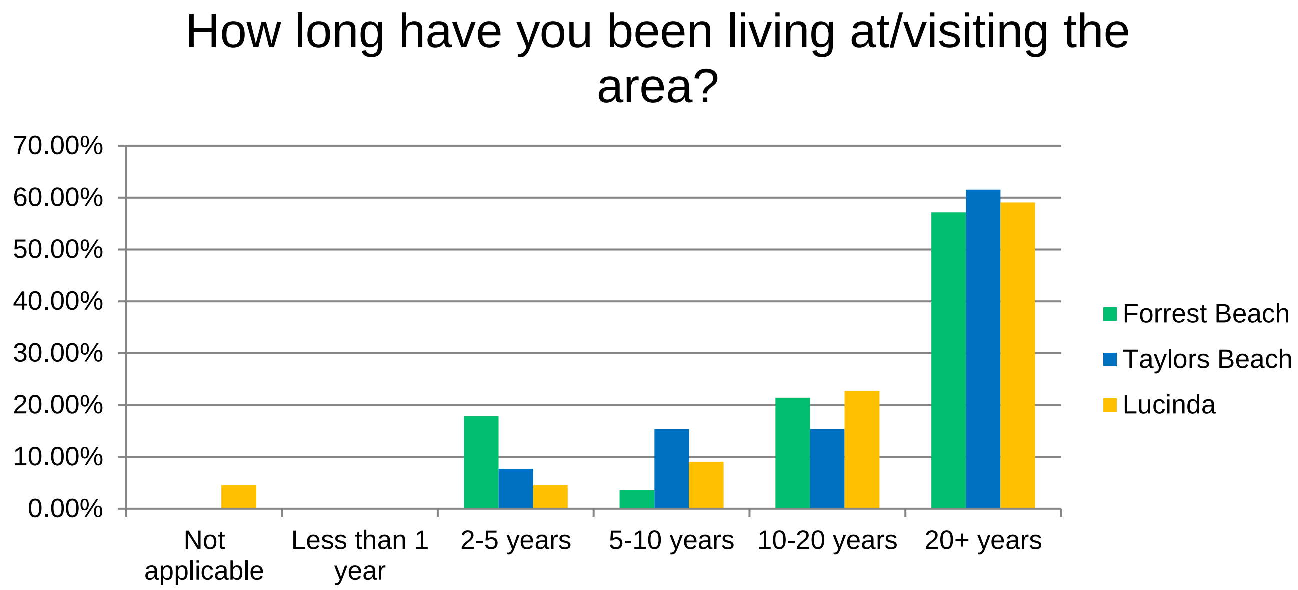


**Figure B-3 Community Survey Responses – Question 3**

*Question 4: How often do you visit the area?*

The purpose of this question was to determine the local usage of the area. Typically, between 53% and 69% of respondents visit the respective area on at least a weekly basis – and this is relatively consistent with the proportion of respondents who live in the area full time. This suggests that each area is highly utilised by the local residents.

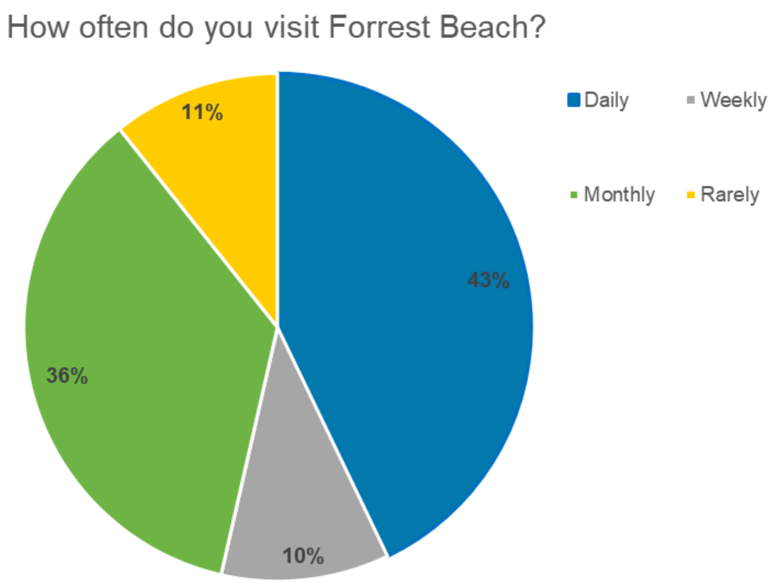


**Figure B-4 Community Survey Responses – Question 4 (Forrest Beach)**

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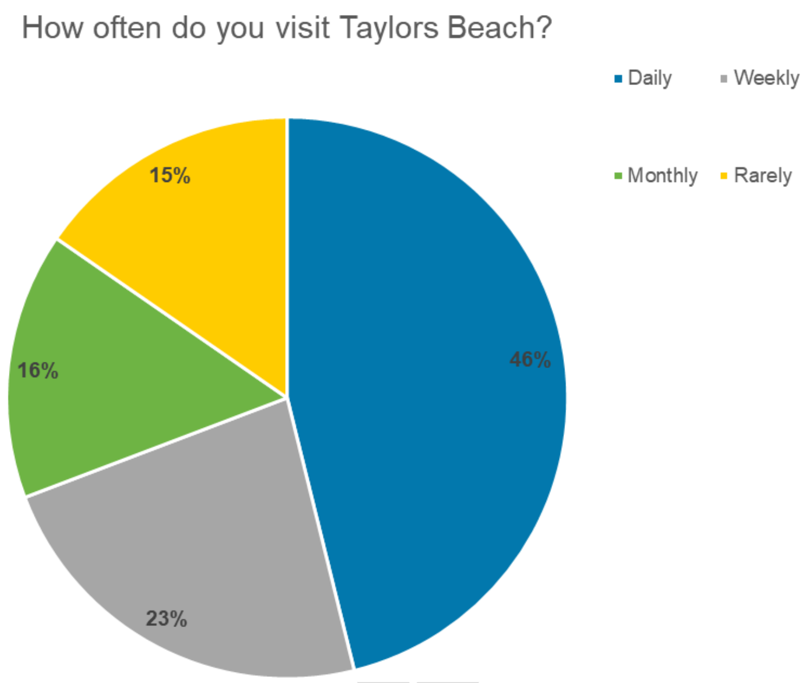


**Figure B-5 Community Survey Responses – Question 4 (Taylors Beach)**

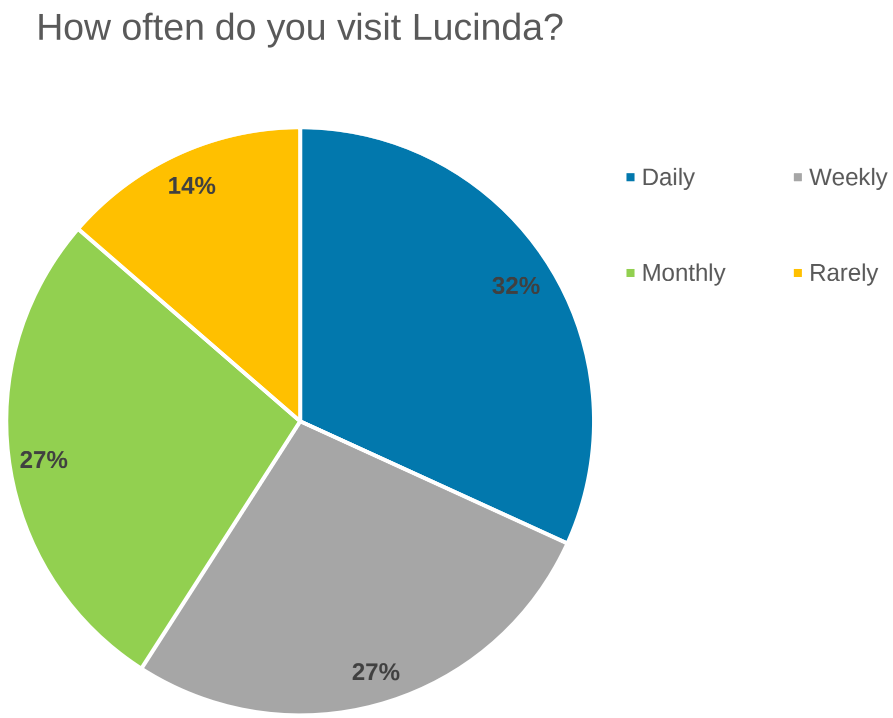


**Figure B-6 Community Survey Responses – Question 4 (Lucinda)**

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*Question 5: When you visit the area, do you usually participate in the following activities?*

The purpose of this question was to ascertain the most common usage and engagement points along the waterfront. Forrest Beach and Lucinda had relatively similar responses, where visiting the restaurants, shops, and Beach Activities (Running, sitting, relaxing on the sand) are the most common activities with 75% of respondents saying that they patronise these businesses when they visit the area.

Nature observation and use of the park are also popular and enjoyed by 60% and 57% of respondents respectively, suggesting that the foreshore is highly regarding and utilised, and that the natural beauty of the area is highly valued.

Water recreation varied amongst respondents ranging from low engagement in watercraft activities (kayaking, paddle boarding) at around 7% while a relatively high engagement in other water recreation activities such as fishing, swimming, and snorkelling enjoyed by around 40% and boating by around 35% at Lucinda and Taylors Beach.

'Other' responses specified by respondents include variations of the pre-described options and some interest in driving on the beach.

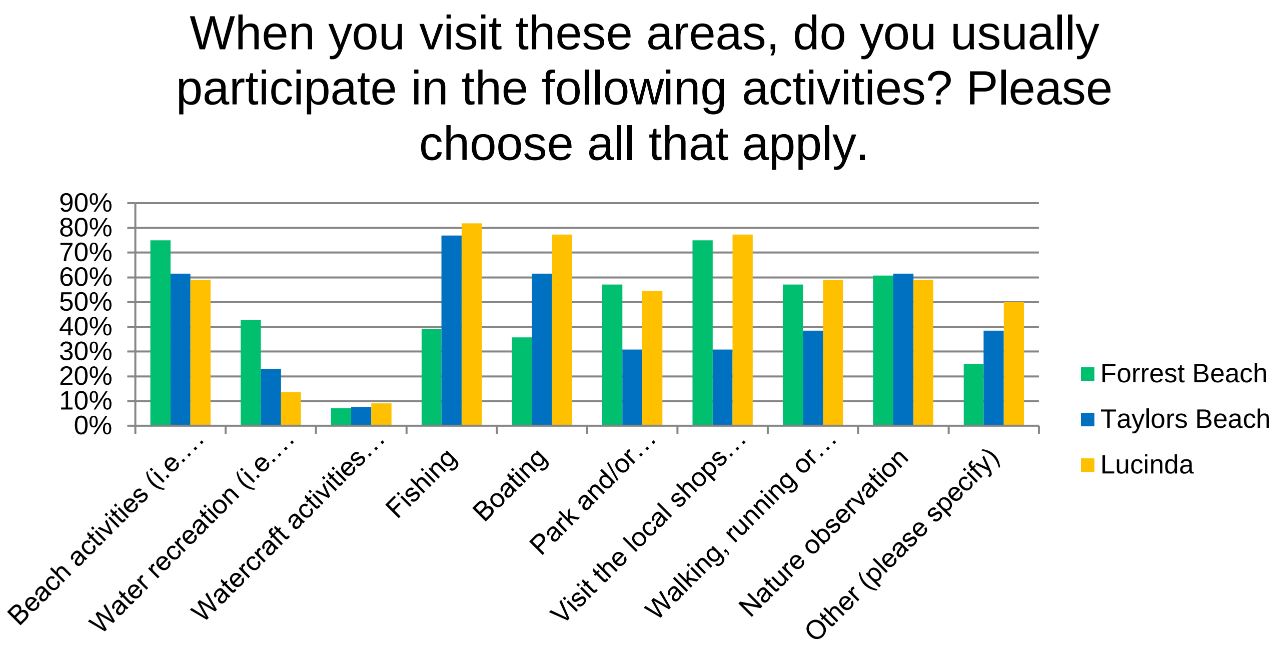



**Figure B-7 Community Survey Responses – Question 5**

*Question 6: What are your main reasons for choosing this coastal area?*

The purpose of this question was to ascertain why locals and visitors choose the area for their various activities, as opposed to other potential waterfront locations. This enabled an assessment of what makes the area special, preferrable, or unique in the eyes of the community.

The natural beach area is of high significance to the respondents, indicated by three of the highest scoring responses relating to the beach itself being undeveloped, natural, quiet, and good.

Access to the beach by the public and low regulation of the beach is also something that brought respondents into these coastal areas.

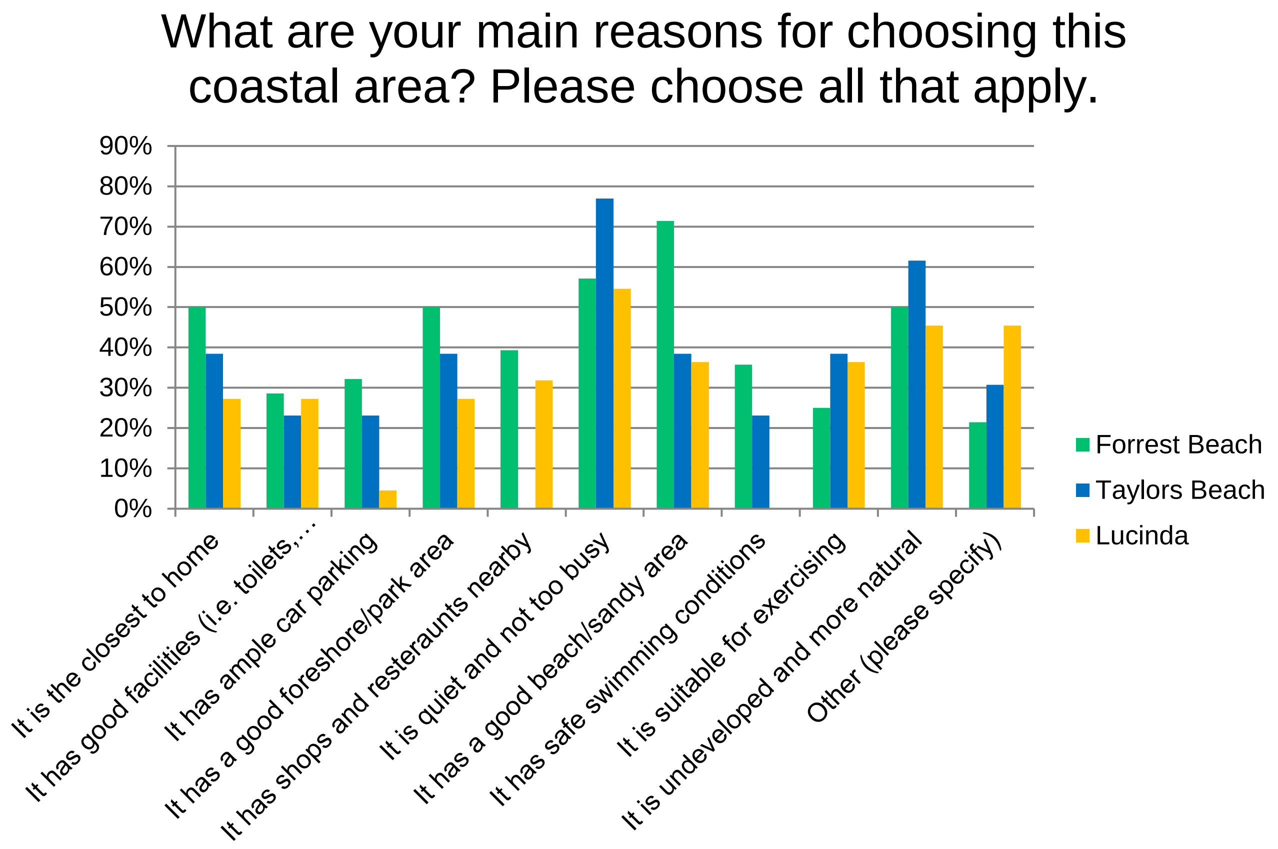



Figure B-8 Community Survey Responses – Question 6

*Question 7: Please rank the following coastal spaces of the area in order of (1) most valued to (7) least valued.*

In order to determine which coastal areas are most (and least) highly valued by the community, respondents were asked to provide responses in the form of a ranking. It is important to recognise the distinction between what is popular / utilised, with what is valued – as certain areas which are not commonly used may be highly valued (or highly regarded) nonetheless due to aesthetic or environmental significance.

For this assessment, a lower number corresponds to an area that is more valued (a ranking of 7 being the highest value). All responses were collated and then an average ranking was generated for each area.

Results showed that the beach and sandy area is the most valued space along the foreshore – by a significant margin. This area was commonly ranked either first or second by most respondents and is very clearly a highly regarded space.

The coastal dunes and foreshore park/esplanade were the next highest ranked. Subsequent questions allow conclusions to be drawn regarding the recreational, aesthetic, and environmental significance of these spaces.

Local infrastructure spaces ranked lower – with the private and public buildings typically scoring the lowest among respondents.

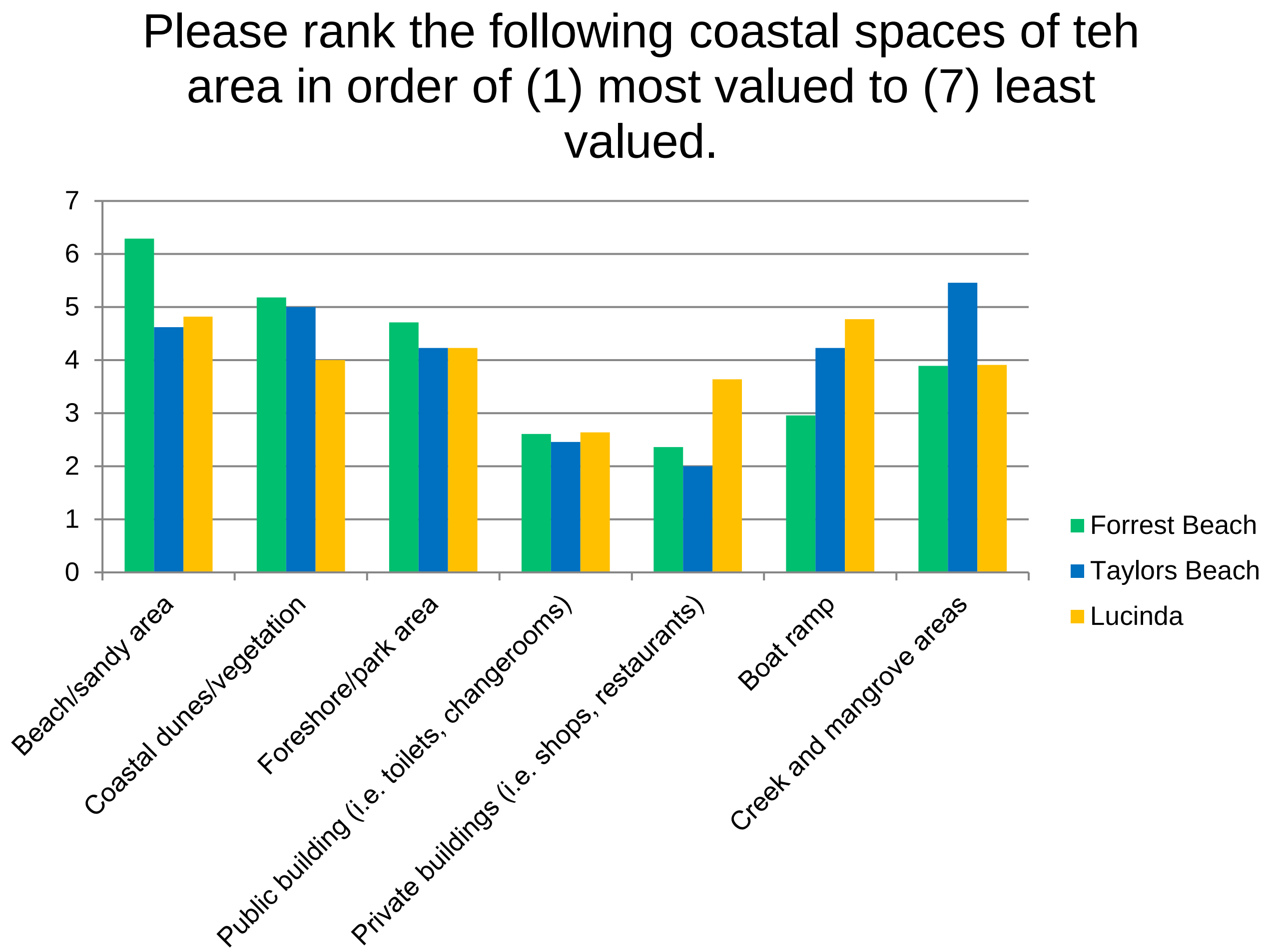



**Figure B-9 Community Survey Responses – Question 7**

### *Question 8: What do you value about the area?*

Respondents were asked to state what they valued (conceptually) about each area. Overall, the aesthetic beauty of the foreshore is very highly regarded – with scenery of the area valued by over 80% of respondents. This was the most highly valued aspect of each area with environmental values at a close second with between 68% and 82% of respondents.

Social and Recreational Amenity were more or less equally valued among the community, with each chosen by between 40 and 71% of respondents. The economic and cultural and heritage values are ranked lower amongst respondents.

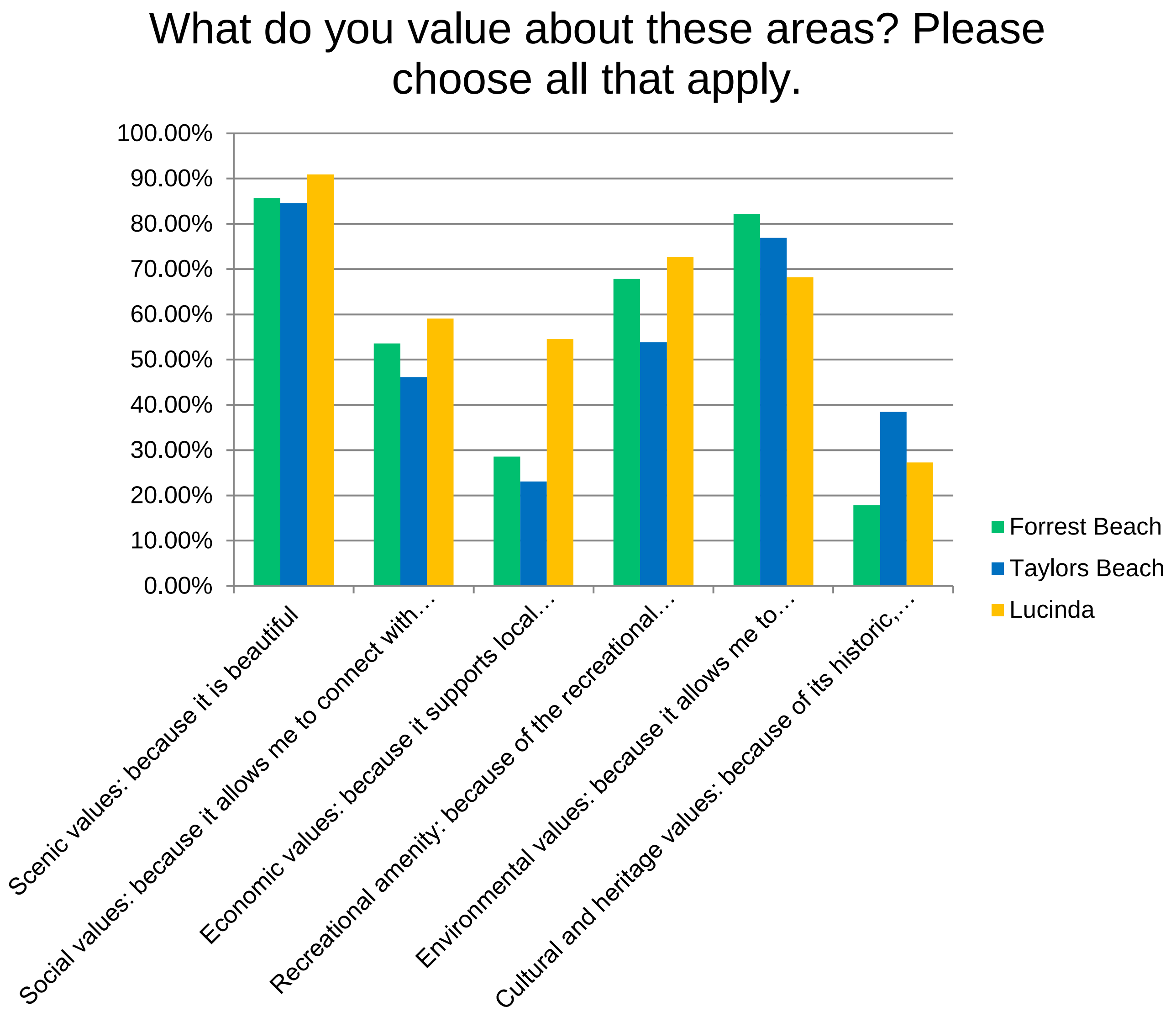



**Figure B-10 Community Survey Responses – Question 8**

*Question 9: How concerned are you about the effects of coastal change (from storm tide, sea level rise and coastal erosion) on:*

For this question, respondents were asked to state how concerned they are regarding the effects of coastal change on various foreshore locations and uses. For each area/usage, respondents were asked to select from one of three options including "Not Concerned," "Concerned," and "Extremely Concerned". A weighted average was used on a scale of 1 – Not Concerned, to 3 – Extremely Concerned, to present these responses.

Overall, the weighted average of responses shows a general concern about the effects of coastal change on each of the options. The highest concern can be seen for coastal vegetation and habitats, aligning with the results seen in the previous question regarding the publics' values of each area.

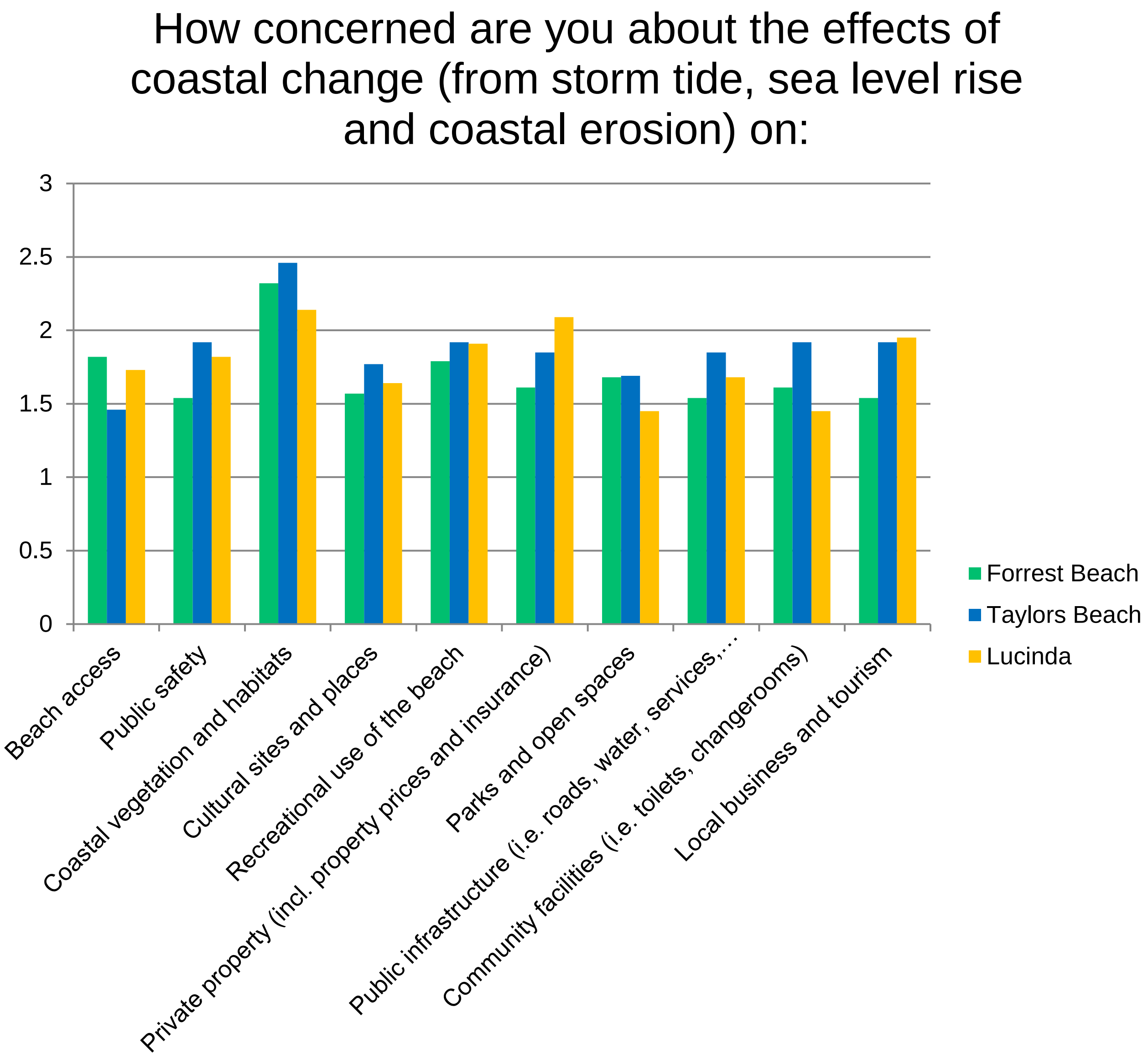



**Figure B-11 Community Survey Responses – Question 9**

*Question 10: How concerned are you about the following coastal changes in the area?*

For this question, respondents were asked to state how concerned they are regarding the various types of coastal change on public and private infrastructure in Forrest Beach. For each area/usage, respondents were asked to select from one of five options ranging from “Not Concerned” to “Extremely Concerned.” Generally speaking, there was greater concern amongst respondents for impacts to public/land infrastructure than to private land.

Overall, the issues of greatest concern were the potential impacts of cyclonic erosion. The relatively recent occurrences of tropical cyclones in the region, including TC Owen (2018), TC Debbie (2017), and TC Yasi (2011) appears to have left respondents cognisant of the potential impacts of storm erosion related to tropical cyclones. Between 36% and 61% of respondents were either “Very Concerned” or “Extremely Concerned” about cyclonic erosion impacts to public land and infrastructure. There was less concern for the associated cyclonic storm surge and temporary ocean flooding.

The next biggest issue of concern was that sea level rise and the gradual inundation of low-lying coastal land. Generally, around 23% to 40% of respondents were either “Very Concerned” or “Extremely Concerned” about such impacts on public and private land.

There was significantly less concern regarding gradual coastal erosion due to shoreline recession.

**Table B-1 Community Consultation – Question 10 (Forrest Beach)**

| Area | Not concerned | Slightly concerned | Moderately concerned | Very concerned | Extremely concerned |
|---|---|---|---|---|---|
| Some gradual coastal erosion on public land with minimal impact on buildings and infrastructure | 39% | 25% | 11% | 14% | 11% |
| Some gradual coastal erosion on private land with minimal impact on buildings | 39% | 29% | 14% | 11% | 7% |
| Coastal erosion from a cyclone resulting in permanent loss of public land (not to be replaced) | 14% | 18% | 14% | 25% | 29% |
| Coastal erosion from a cyclone resulting in permanent loss of private land | 18% | 21% | 21% | 14% | 25% |
| Temporary ocean flooding of public land and infrastructure due to storm tide | 32% | 18% | 21% | 7% | 21% |
| Temporary ocean flooding of private land and buildings due to storm tide | 36% | 18% | 25% | 7% | 14% |
| Gradual invasion of dry public land by water due to sea level rise | 21% | 14% | 25% | 18% | 21% |
| Gradual invasion of dry private land by water due to sea level rise | 21% | 29% | 25% | 11% | 14% |

Table B-2 Community Consultation – Question 10 (Taylors Beach)

| Area | Not concerned | Slightly concerned | Moderately concerned | Very concerned | Extremely concerned |
|---|---|---|---|---|---|
| Some gradual coastal erosion on public land with minimal impact on buildings and infrastructure | 8% | 54% | 31% | 0% | 8% |
| Some gradual coastal erosion on private land with minimal impact on buildings | 31% | 31% | 23% | 0% | 15% |
| Coastal erosion from a cyclone resulting in permanent loss of public land (not to be replaced) | 0% | 15% | 23% | 46% | 15% |
| Coastal erosion from a cyclone resulting in permanent loss of private land | 15% | 23% | 38% | 8% | 15% |
| Temporary ocean flooding of public land and infrastructure due to storm tide | 15% | 23% | 54% | 0% | 8% |
| Temporary ocean flooding of private land and buildings due to storm tide | 31% | 31% | 23% | 0% | 15% |
| Gradual invasion of dry public land by water due to sea level rise | 23% | 31% | 23% | 8% | 15% |
| Gradual invasion of dry private land by water due to sea level rise | 38% | 23% | 15% | 0% | 23% |

Table B-3 Community Consultation – Question 10 (Lucinda)

| Area | Not concerned | Slightly concerned | Moderately concerned | Very concerned | Extremely concerned |
|---|---|---|---|---|---|
| Some gradual coastal erosion on public land with minimal impact on buildings and infrastructure | 36% | 23% | 14% | 14% | 14% |
| Some gradual coastal erosion on private land with minimal impact on buildings | 32% | 27% | 18% | 9% | 14% |
| Coastal erosion from a cyclone resulting in permanent loss of public land (not to be replaced) | 36% | 5% | 23% | 18% | 18% |
| Coastal erosion from a cyclone resulting in permanent loss of private land | 23% | 27% | 23% | 5% | 23% |
| Temporary ocean flooding of public land and infrastructure due to storm tide | 32% | 23% | 18% | 9% | 18% |
| Temporary ocean flooding of private land and buildings due to storm tide | 32% | 27% | 14% | 9% | 18% |
| Gradual invasion of dry public land by water due to sea level rise | 41% | 14% | 18% | 18% | 9% |
| Gradual invasion of dry private land by water due to sea level rise | 45% | 23% | 18% | 5% | 9% |

*Question 11: Do you feel your local community is well prepared to respond to natural disasters?*

This question was aimed at identifying whether or not the community felt the respective area is well prepared to respond to natural disasters. A large proportion of respondents feel that the area is at least somewhat prepared and is likely the result of recent exposure to tropical cyclones in the region over the past 20 years.

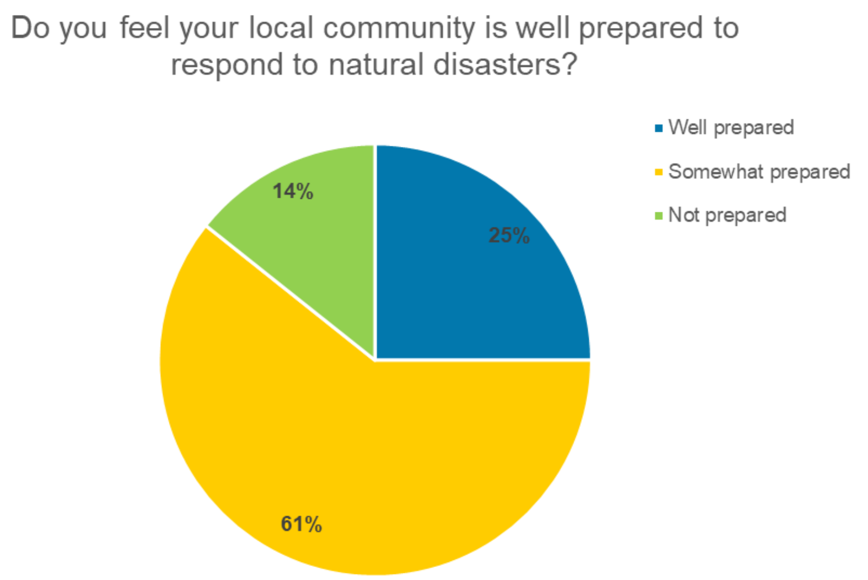



**Figure B-12 Community Survey Responses – Question 11 (Forrest Beach)**

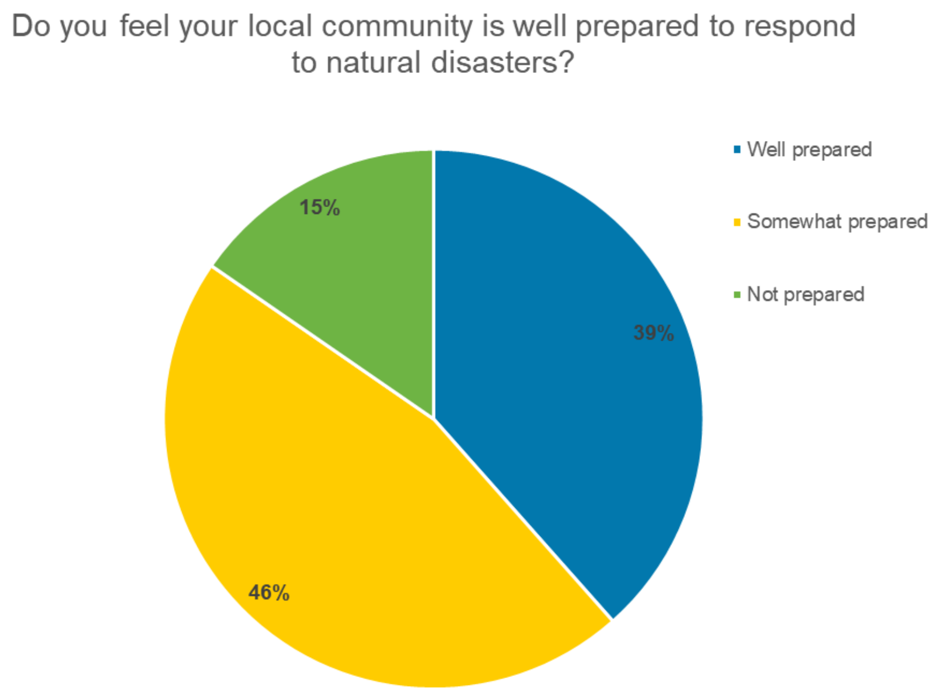



**Figure B-13 Community Survey Responses – Question 11 (Taylors Beach)**

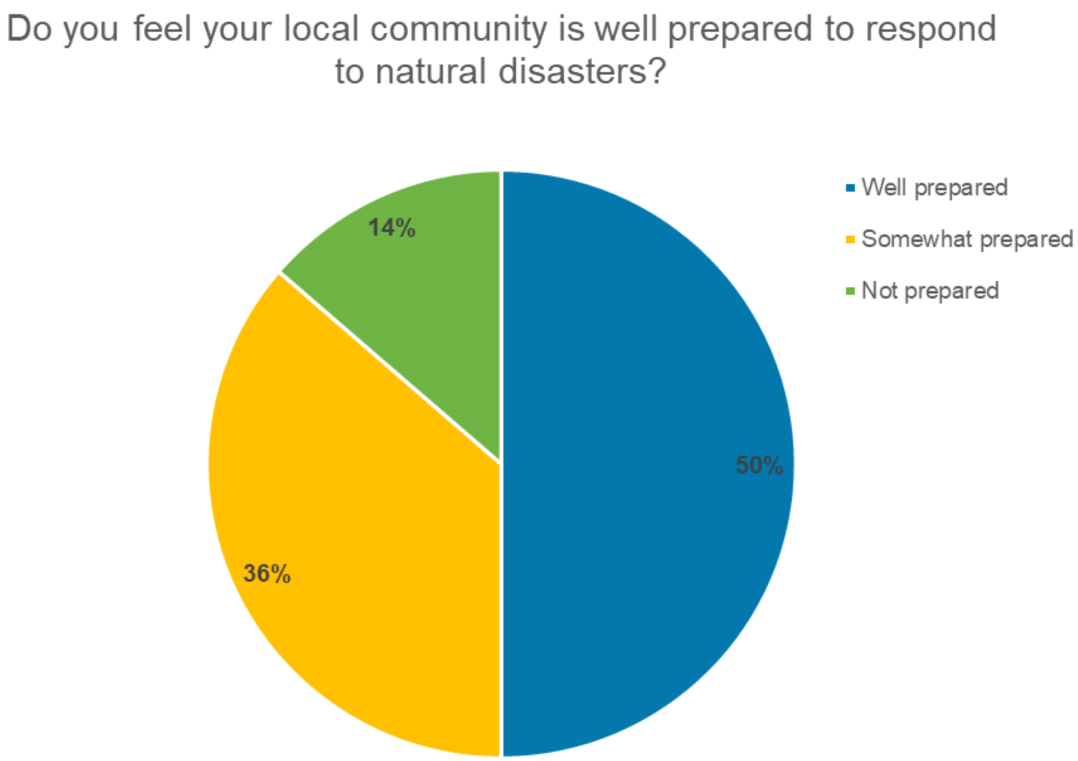



**Figure B-14 Community Survey Responses – Question 11 (Lucinda)**



*Question 12: There are a number of different coastal adaptation options that Council may be able to implement in the area. In general, how supportive are you of the following adaptation options?*

**Forrest Beach**

The purpose of this question was to ascertain the notional support amongst the local community for a range of generic coastal adaptation options. In order to determine the options that are generally most (and least) favoured by the community, respondents were asked to provide responses in the form of a ranking. All responses were collated and then an average ranking was generated for each option.

The results show a general support for Options 3, 4 and 5, indicating the view of the community is to revegetate the area and limit access where possible with the respondents being unsupportive of Option 6 which is to do nothing and keep the status quo.

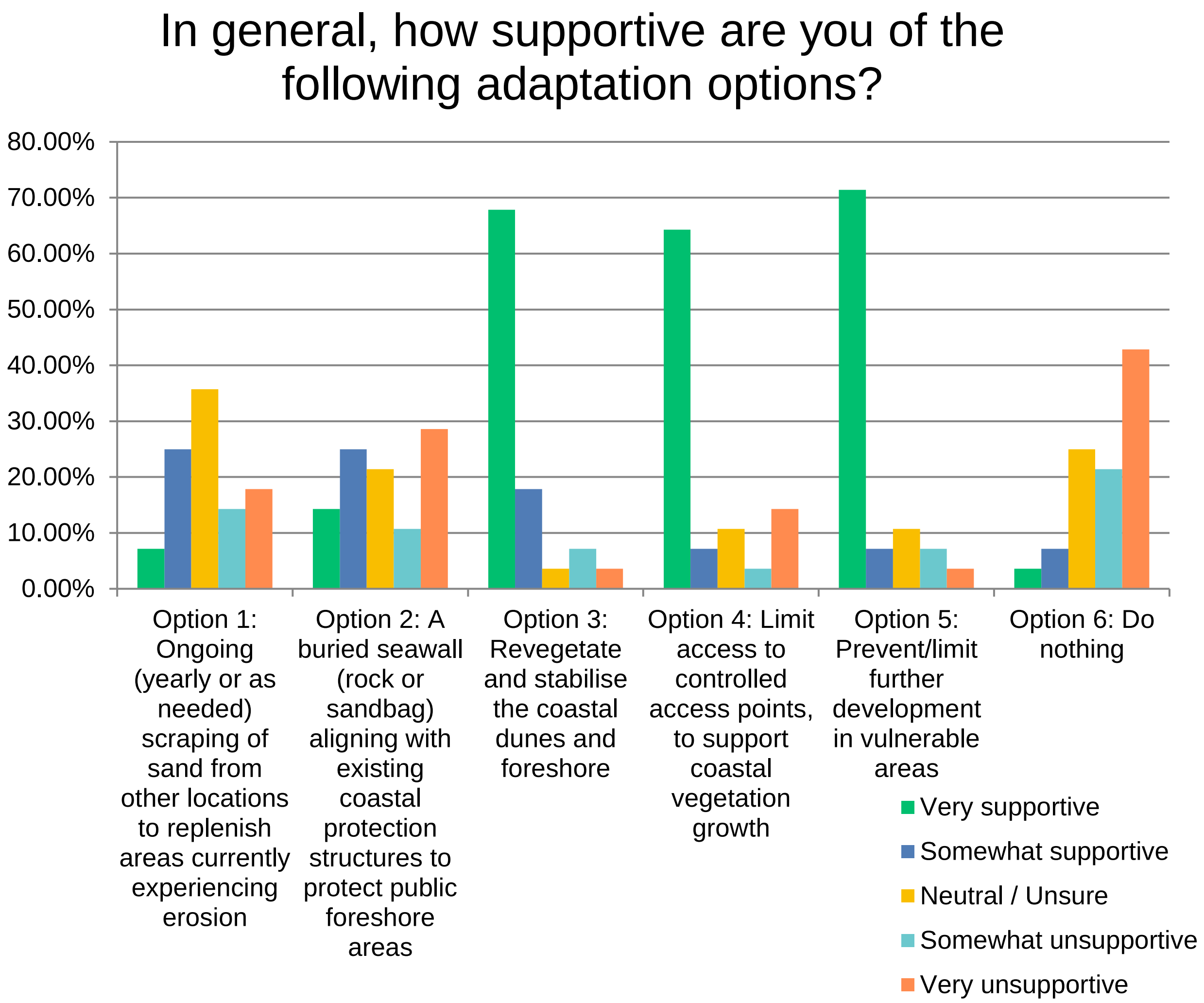



**Figure B-15 Community Survey Responses – Question 12 (Forrest Beach)**

### Taylors Beach

The results show a general support for Options 3 and 4, indicating the view of the community is to revegetate the area and limit access where possible with the respondents being unsupportive of Option 9 which is to do nothing and keep the status quo.

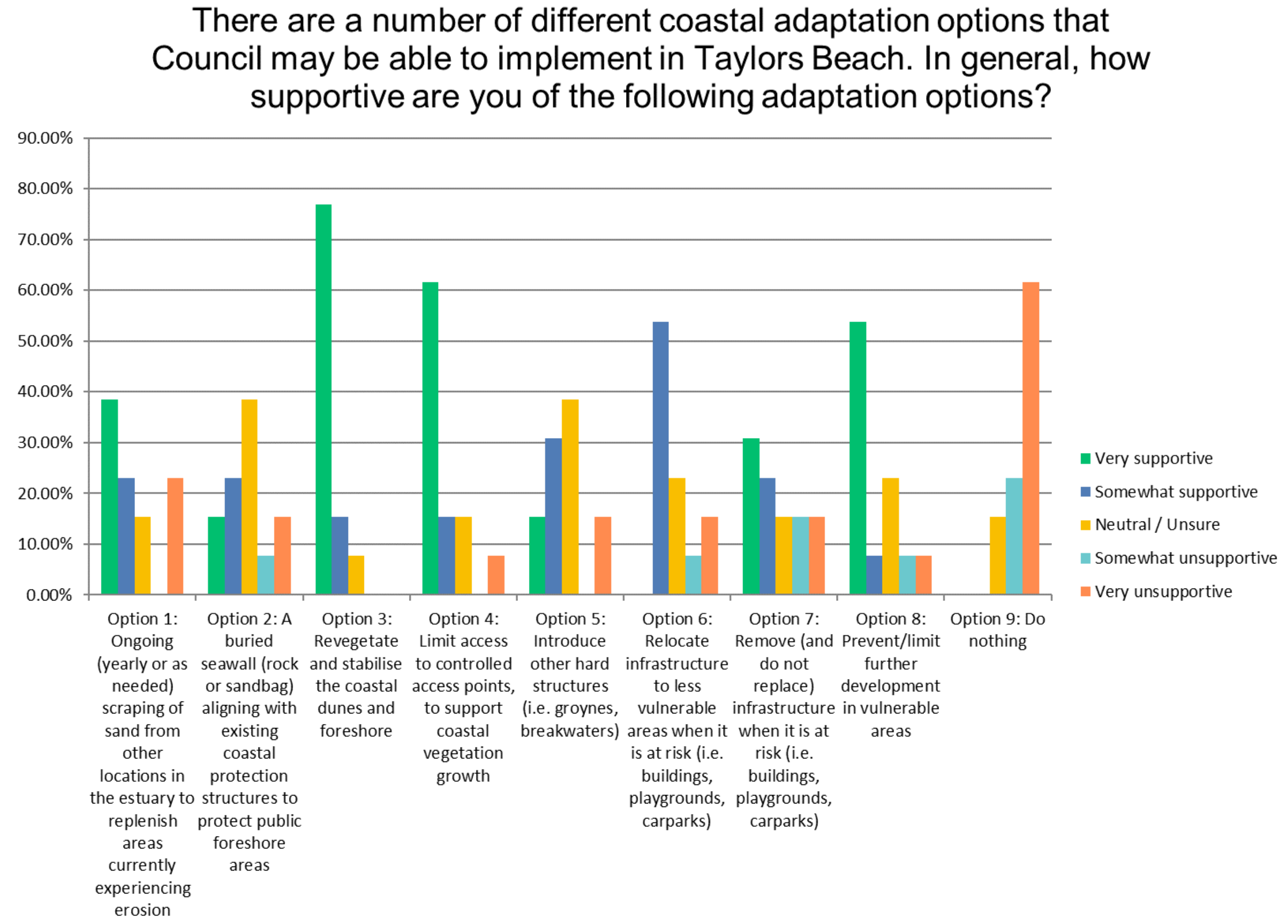



**Figure B-16 Community Survey Responses – Question 12 (Taylors Beach)**

### Lucinda

The results show a general support for Options 3 and 4, indicating the view of the community is to revegetate the area and limit access where possible with the respondents being unsupportive of Option 9 which is to do nothing and keep the status quo.

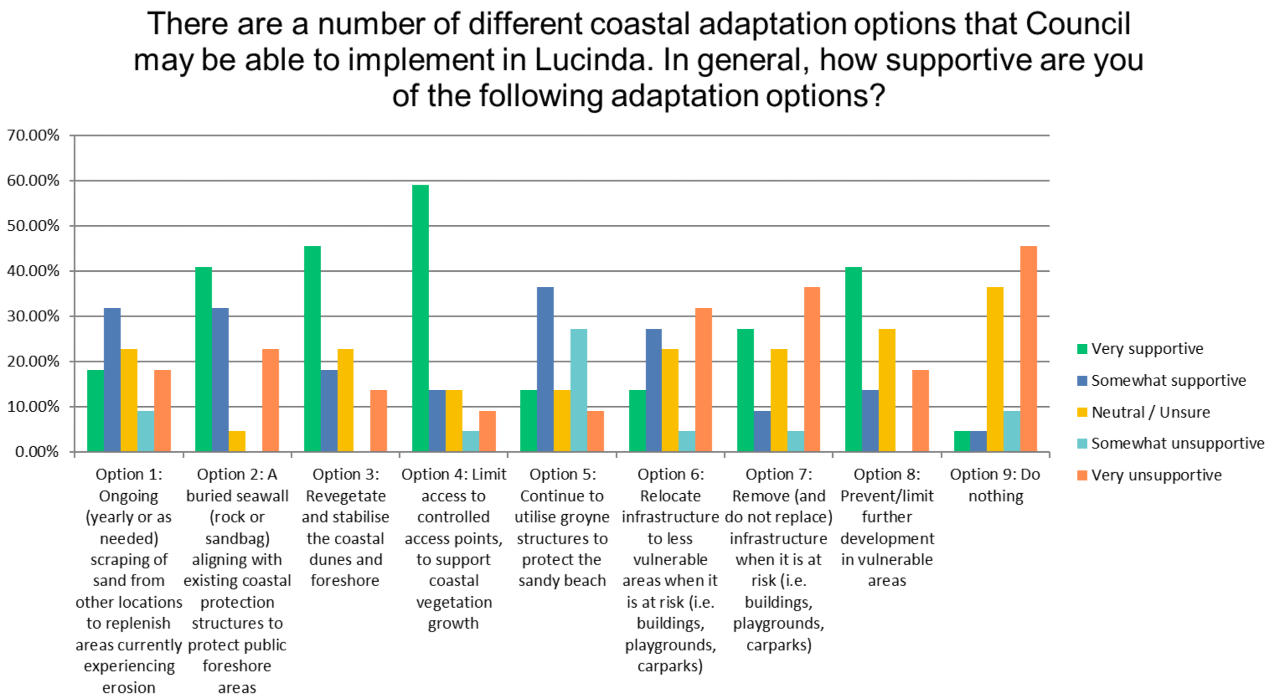



**Figure B-17 Community Survey Responses – Question 12 (Lucinda)**

*Question 13: Overall, when you think about the coastline, which of the following do you believe are the most important factors to consider when making decisions about coastal adaptation measures?*

The purpose of this question was to ascertain what the local community believes to be the most important considerations when determining coastal adaptation options. For this assessment, a lower number corresponds to a higher ranking. All responses were collated and then an average ranking was generated for each option.

The results showed a high level of correlation with the results of Question 6, which asked respondents why they visit the area. The highest priorities were the beach itself and followed closely by the fact that the area is undeveloped and natural. These results are also corroborated with the high regard the survey respondents had for the beach, coastal dunes and vegetations as found in Question 7 and reflect a desire to maintain these values of the area as part of any future coastal adaptation measures.

Overall, the financial cost of the option was considered to be the least important factor. This suggests that the community would support investment in options that protect and maintain the values of each area.

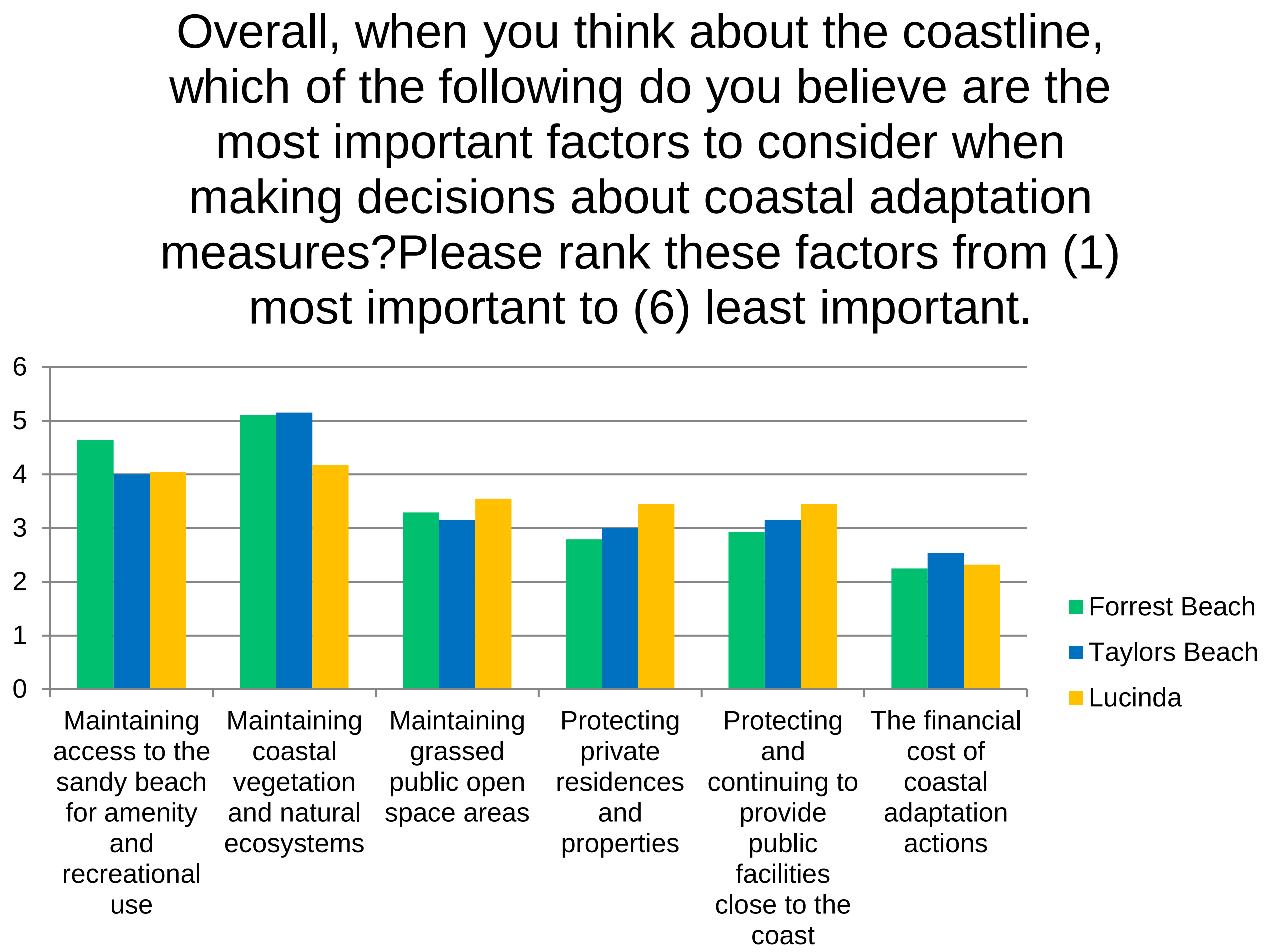



**Figure B-18 Community Survey Responses – Question 13**

*Question 14: Lastly, what words or phrases would you use to describe what you value about the area?*

This question was used to develop a 'word cloud,' which we have found to be a useful tool for conveying community values in similar projects. A word cloud is an image composed of words used in a particular dataset, in which the size of each word indicates how often they are used.

### Forrest Beach

The resulting word cloud is provided below, and several themes can be observed within. The first notable theme is the physical beauty and aesthetic amenity of the waterfront combined with the environmental values. The most common found words in the word cloud related to this theme include *beautiful*, *natural, environmental,* and *untouched*.

The recreational values were also evident, particularly the ability to utilise the beach for public vehicle access and for boat launching – as the responses included the words *boat, ramp* (as in, the boat ramp)*, vehicles* and *access.*


**Figure B-19 Community Survey Responses – Question 14 (Forrest Beach)**

### Taylors Beach

The resulting word cloud is provided below, and several themes can be observed within. The first notable theme is that of the recreational values of the area. The most common word was *fishing* which reflects the high level of recreational use of Taylors Beach. Additional words of this nature include *crabbing, parks, and recreational*.

The environmental values of the area also feature prominently. The words *environment, habitat, silting, erosion,* and *climate* also feature amongst respondents. Of a similar vein, the value people placed on the serenity of the beach was also evident, with *quiet, great,* and *beautiful* all featuring amongst the responses.

The economic values were also evident, with *economic* and *money* featuring prominently in the responses. Aside from this, *infrastructure* and *shops* also featured along with social representing the social values of Taylors Beach.


**Figure B-20 Community Survey Responses – Question 14 (Taylors Beach)**

**Lucinda**

The resulting word cloud is provided below, and several themes can be observed within. The first notable theme is that of the recreational values of the area. The most common words were *access* and *beach* which reflects the high level of recreational use of Lucinda. Additional words of this nature include *jetty* and *ramp*.

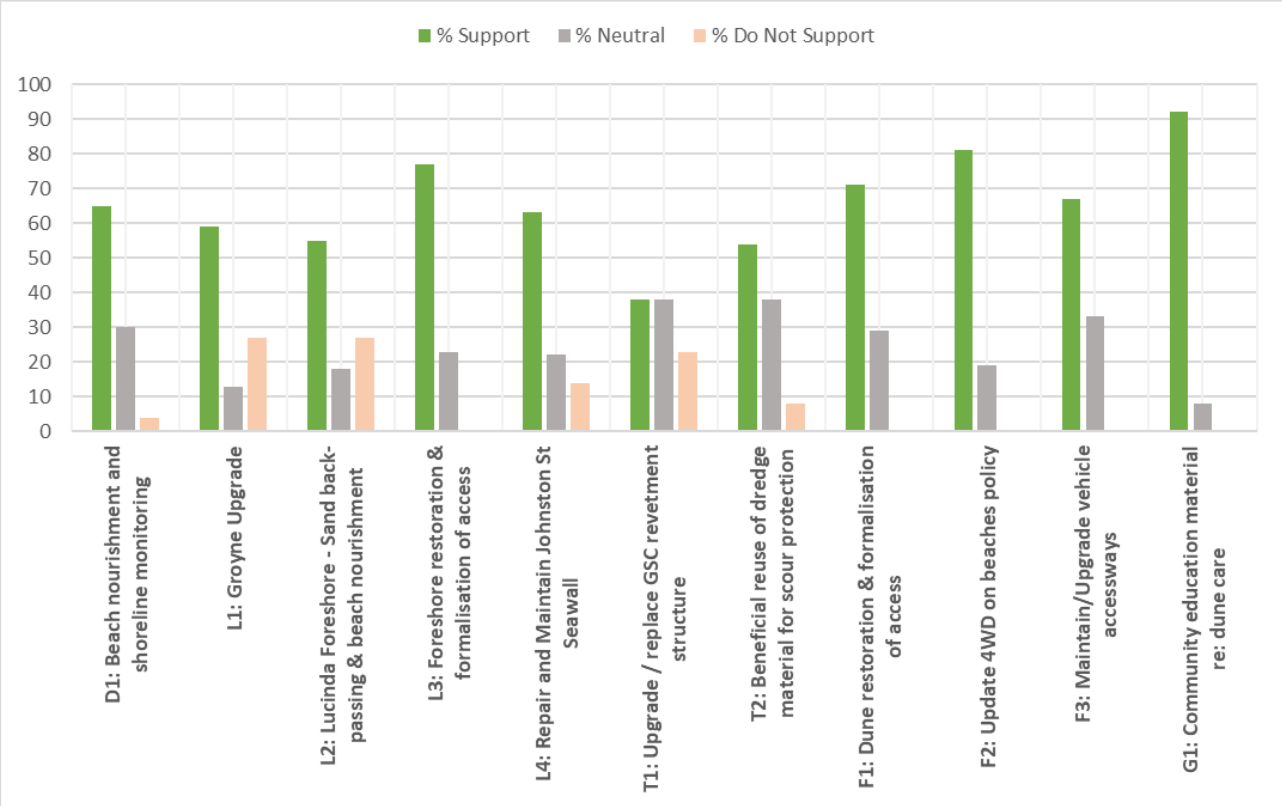
The environmental values of the area also feature prominently, with words such as *mangroves*, *climate*, *erosion* and *natural* all featuring amongst respondents. Of a similar vein, the value people placed on the serenity of the beach was also evident, with *beautiful* and *quiet* features.

The economic values were also evident, with *growth*, *value*, *cost*, *money,* and *infrastructure* featuring prominently in the responses.


**Figure B-21 Community Survey Responses – Question 14 (Lucinda)**

# APPENDIX C
# COMMUNITY CONSULTATION FEEDBACK ON POTENTIAL OPTIONS

## C-1 Overview




## C-2 Summary of Responses

*General Action, Question 1: Community engagement & education about dune care. Do you support this action?*

The first question is a general question which is used to gain an understanding of the respondents support for community engagement and education about dune care. This is important to understand how the community will receive education from specialists. Overall, the vast majority of respondents support this action, with 92% support and 8% neutral.

Respondents provide comments, with most indicating support for this action. Respondents feel that ongoing education is necessary for these proposals to work and feel they gain valuable information on coastal processes from the community engagement sessions.

*Forrest Beach, Question 1: Dune Restoration Program. Do you support this action?*

The first of three questions related to Forrest Beach is regarding the Dune Restoration Program. A majority support for this is seen among respondents with 69% support and 31% neutral. Among neutral responses, respondents felt that leaving nature to restore the dune with no external assistance was best. Supportive responses indicated that they support protecting vulnerable dunes with fencing and suitable plantings. Various suggestions for the dune restoration included shade trees and extra walkways.

*Forrest Beach, Question 2: Update 4WD on beaches policy. Do you support this action?*

The second question related to Forrest Beach is regarding updating the 4WD on beaches policy currently in place. A large portion of respondents, around 80%, support this action, with a split response on the direction the update should take. Some respondents believe that all driving on beaches should be banned, and others believe that the policy needs to be clearer that vehicles must only use sections of the beach outside of the dune zone. The remaining 20% of respondents are neutral on the action.

*Forrest Beach, Question 3: Upgrade vehicle accessways. Do you support this action?*

The third question follows on from the previous, determining community support for upgraded vehicle accessways at Forrest Beach. Around 64% of respondents support this action, commenting that typically vehicles access the beach over vulnerable sections of the dune with mitigation options, including a single, upgraded vehicle accessway. Around 36% of respondents were neutral, commenting that funds are better spent elsewhere or that if impacts cannot be managed sustainably, access should be cut off completely.

*Taylors Beach, Question 1: Upgrade sandbag (GSC) seawall structure. Do you support this action?*

The first question relating to Taylors Beach investigates the support for upgrading the Geotextile Sand Container (GSC) seawall structure. A mixed response for this question was received, with 42% support, 42% neutral and 17% not supporting the upgrade. Comments from the supportive respondents include noting the foreshore is a 'disaster' and that something needs to be done to secure the retaining wall, and that it is essential to maintain the foreshore area and protect recently installed infrastructure. The unsupportive responds noted that in their opinion, sandbagging is not suitable based on undermining and greater erosion risks and that funds should be directed towards protection, restoration and management of habitat as opposed to human activities.

*Taylors Beach, Question 2: Re-use of dredged sand for beach nourishment. Do you support this action?*

The second question for the Taylors Beach area looks at re-using dredged sand for beach nourishment. Another mixed response to this question, with 50% supportive, 42% neutral and 8% not supportive. Supportive respondents noted that they are supportive provided the sand does not go to private land reclamation and that the sand is taken from suitable areas. Unsupportive responses questioned the costs and futility of the operation.

*Lucinda, Question 1: Upgrade/refurbish existing groyne structures. Do you support this action?*

The first question for Lucinda looks at upgrading or refurbishing the existing groyne structures. A general support consensus was seen among respondents with 62% supporting the action, 14% neutral and 24% unsupportive. The supportive respondents noted that a long-term approach needs to be considered however, generally, the community believes that the groynes have served a reasonable purpose in the past and contributed to the protection of the beach. Neutral and unsupportive respondents questioned the applicability of the groynes to the area and their overall performance. Some respondents also disagreed with upgrading the existing groynes from sandbags to rock.

*Lucinda, Question 2: Sand backpassing and beach nourishment. Do you support this action?*

The second question for the Lucinda region regards the back-passing of sand and beach nourishment. Approximately 57% of respondents support this action, commenting that the erosion at Johnson Park needs action taken and that all existing rock walls should remain in place, with sand back-passing integrated. Around 24% of respondents did not support the back-passing and nourishment action stating that, in their opinion, this was a short-term fix that has high risk for other natural areas and high risk for current occupants living situations in the area. The remaining 19% were neutral on the action and said it might be useful short term however not a viable option long term.

*Lucinda, Question 3: Dune Restoration Program. Do you support this action?*

The third question is common among most of the areas in the Hinchinbrook Shire surveys. The vast majority of respondents, around 76%, support the Dune Restoration Program, stating that it is a sensible and viable option, and that the protection of dunes is of high importance. The remaining 24% were neutral on the action while questioning the effects of heightened dunes on residents' views of the water.

*Lucinda, Question 4: Repair and Maintain Johnson St Seawall. Do you support this action?*

The final question for the Lucinda region is on the repair and maintenance of the Johnson Street seawall. A mixed response was taken for this action, with around 62% supporting, 24% neutral and 14% unsupportive. The supportive respondents feel that it is in need of repair due to the erosion to the north and that additional pedestrian access from the park to the beach is required. The neutral respondents note that the wall was never designed to an engineering standard and will not provide adequate protection. Finally, the unsupportive respondents feel that the funds should be spent on the natural environment instead and that the seawall should continue across the eroded area.

*Dungeness, Question 1: Beach Nourishment and Shoreline Monitoring. Do you support this action?*

This question investigates the beach nourishment and shoreline monitoring at Dungeness. The majority of respondents are supportive of this, around 68%, noting that monitoring is a great idea and provided the goal is to increase natural habitat. Around 27% of respondents were neutral on the action, stating that nourishment is not their preferred option however, shoreline monitoring is likely to be a useful initiative. Various other suggestions were made on different engineering options such as 'soft bag' walls. Respondents were also unhappy with sand blocking the mouth to the creeks – unable to gain access with a boat. The remaining 5% of respondents were unsupportive of the action questioning whether sand from Dungeness Beach would wash into the channel and restrict all tidal access for boats.

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