SUPPLEMENT C

Adaptation actions – summary sheets

SHEET 1 TO 3 – ADAPTATION ACTIONS – REGION-WIDE INITATIVES TO ENHANCE ADAPTATIVE CAPACITY

SHEET 1 - COMMUNITY STEWARDSHIP

Active community stewardship of the coastline provides a strong foundation for long term success in coastal management. Supporting the shared care of the Carpentaria shores will maximise resilience and adaptive capacity.

Enhancing stewardship of the coastline
Community involvement in coastal management is important for enhancing the resilience of our beaches to coastal hazards.

A priority action for coastal hazard adaptation is the ongoing coordination and support of stewardship initiatives that will seek to further empower and equip communities to:

- Contribute to on-ground beach protection and maintenance
- Promote and advocate for the care and protection of the flora and fauna
- Share knowledge on observed changes to the coast
- Contribute to monitoring and evaluation of the implementation and success of adaptation actions.

Community groups engaged in shoreline ecosystems have not been identified for Carpentaria Shire, however, a strong role in environmental management is being played by the Carpentaria Land Council Aboriginal Corporation, in particular through their landscape remediation and marine debris programs. Initiatives and activities that Council may undertake as part of a coastal stewardship program may include:

- Liaise with Carpentaria LCAC to identify priority areas for community engagement in coastal stewardship
- Leverage council social media channels to engage with the community through target initiatives
- Seek new funding and grant opportunities (e.g. Landcare grants)
- Co-ordinate and facilitate community events
- Provide support to volunteer groups
- Seek additional partnerships and collaboration opportunities
- Deliver education and training programs
- Promote use and development of innovative tools and products
- Encourage participation and awareness.
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Coastal vegetation protection and enhancement
Community programs at Karumba may focus on native coastal vegetation surveys and enhancement and removal of invasive species near the foreshore and on coastal dunes where applicable.

Relevant and priroity areas
Delivery of community stewardship program initiatives is a priority across all localities.

While Normanton is not located on the shoreline, community stewardship programs may focus on riparian vegetation management and removal of invasive species.

Community stewardship		
	Programs and partnerships to enhance stewardship of the coastline	Coastal vegetation protection, maintenance and monitoring
Karumba Point		
Karumba Township		
Normanton		
Other areas*		

	Relevant / feasible
	Priority
	Not applicable

SHEET 1 TO 3 – ADAPTATION ACTIONS – INITIATIVES TO ENHANCE ADAPTIVE CAPACITY

SHEET 2 - KNOWLEDGE SHARING

An important element to growing adaptive capacity is knowledge sharing. Knowledge sharing includes initiatives to promote education and awareness of coastal hazards, what the adaptation options are, and how other agencies and individuals can meaningfully be involved / act to reduce the risk of coastal hazards.

Co-ordination of a knowledge sharing initiatives will further empower and equip stakeholders to:

- Understand coastal hazard risk and adaptation options
- Contribute to community stewardship initiatives
- Be informed, empowered and equipped to manage risk to private assets
- Be informed of implementation progress of adaptation actions
- Contribute to monitoring.

Initiatives and activities that Council may undertake as part of co-ordinating a knowledge sharing program include to:

- Promote collaborative action across stakeholder groups (host meetings, facilitate cross-agency communication)
- Establishing coastal-specific collaborative partnership with Traditional Owners
- Generate communications materials to raise awareness of coastal hazard risk and the adaptation options being implemented
- Seek to manage perceptions on:
    - Levels of risk and tolerance
    - Shared responsibilities in the management of coastal hazard risks.
- Communicate the need for adaptive management
- Deliver / facilitate training programs and workshops (and link in with community stewardship education initiatives)
- Co-ordinate information sharing across agencies (data, maps, monitoring data).

Relevant and priority areas

Delivery of knowledge sharing initiatives is a priority, region-wide action across all localities.

Knowledge sharing		
	Facilitating knowledge sharing and education on hazards and adaptation	Other
Karumba Point		
Karumba Township		
Normanton		
Other areas*		

	Relevant / feasible
	Priority
	Not applicable

SHEET 1 TO 3 – ADAPTATION ACTIONS – INITIATIVES TO ENHANCE ADAPTIVE CAPACITY

SHEET 3 - MONITORING

Targeted monitoring provides a means to assess how the coastal environment is changing over time, and the effectiveness of adaptation options in mitigating the risk of coastal hazards.

The development and implementation of a targeted monitoring program to inform adaptive management is an important component of all adaptation strategies.

A useful approach to monitoring coastal environments may include:

- Simple and frequent photo point monitoring and on-ground observations suitable for community participation
- Event based monitoring (beach profile elevations)
- More detailed surveys (on-ground or aerial) every 5 – 10 years.

Monitoring observations may include:

> Dune movement
> Erosion extent
> Sand characteristics
> Sand coverage / beach shape
> Vegetation coverage, type, density and health
> Mangrove watch
> Seagrass watch
> High water mark
> Flood extent
> Exposure of rock
Exposure of structures

Initiatives and activities that Council may undertake as part of a broader monitoring program include to:

- Launch a photo point monitoring system
- Confirm a program of monitoring actions
- Create a platform and process for data management
- Tailor the monitoring program to align with / inform a 5 - 10 year review of adaptation response and options.

Photo point monitoring
Photos posts with a defined outlook/viewpoint can be installed to enable photos to be captured from the same perspective each time. Systems use an email address or online app to help collect and collate photos, creating a photo record over time. This approach provides a simple way for community members and visitors to contribute to monitoring of the beach. Formal or informal versions of this system can be estabslihed for any section of coast. A photo point monitoring spot should be established at Karumba Point

Periodic aerial imagery / drone survey can be added to provide an aerial perspective of shoreline changes over time. The drone surveys can also provide elevation data that can be analysed to quantify changes in the beach profile over time (i.e. dune width, slope, toe position, berm height). Elevation surveys can also be undertaken with on-ground equipment (survey stations and GPS).

Relevant and priority areas
Targeted monitoring is a priority action across all localities.

Monitoring		
	Monitoring changes in coastal hazard risk and effectiveness of adaptation	Photo point monitoring
Karumba Point		
Karumba Township		
Normanton		
Other areas*		

	Relevant / feasible
	Priority
	Not applicable

SHEET 4 – ADAPTATION ACTIONS - PLANNING UPDATES

Planning instruments can assist to mitigate the risk (likelihood and consequence) of coastal hazards, including erosion and storm tide inundation.

Statutory planning / planning scheme
Updated Erosion Prone Area and storm tide inundation mapping is produced as part of Council's adaptation strategy and will be adopted by State Government and Council. Once adopted, Council will have reference for planning overlays and controls. The updated maps, together with the Council's adaptation initiatives, will enable Council to:

- Ensure coastal hazards and risks are identified and considered
- Avoid development in high-risk inundation or erosion prone areas
- Enable Council to manage and control / condition development and statutory approvals
- Incorporate flexibility and adaptability (i.e. triggers)
- Maintain values that are integral to the community
- Promote/encourage appropriate design and mitigation as part of new developments (resilience opportunities)
- Protect areas of environmental significance
- Plan ahead for required mitigation / transition actions
- Rezone areas unsuitable for new development in long-term.

Other strategic planning
Adaptation response and actions also informs other planning related to infrastructure, open space, foreshore master plans and asset management.

Integrating an up-to date understanding of coastal hazards and appropriate mitigation options into existing and new relevant strategies will assist to mitigate risk, enhance resilience, and achieve multiple benefits from adaptation (e.g. aesthetic and recreation benefits combined with risk mitigation). As part of strategic planning, Council may look to consider options of land purchase / swap / relocation for limited areas where coastal hazard risk becomes very high and a long-term transition response is required.

Disaster management
A review and update of emergency response planning based on outcomes of adaptation planning will allow Council to plan accordingly with an aim to minimise the consequence of coastal hazard impacts during extreme events.

Up-to-date understanding of coastal hazard prone areas, likely event magnitudes and extents, and possible access and infrastructure constraints, will improve planning and preparation as well as response and recovery efforts.

Priority areas
Planning updates are relevant across all localities.

Planning updates			
	Statutory planning / planning scheme updates	Other strategic planning – including land purchase / swap / relocation	Update emergency response planning
Karumba Point			
Karumba Township			
Normanton			
Other areas*			

	Relevant / feasible
	Priority
	Not applicable

SHEET 5 – ADAPTATION ACTIONS - MODIFYING INFRASTRUCTURE

Modifying infrastructure is a practical way to mitigate the risk (likelihood and consequence) of coastal hazards, including erosion and storm tide inundation.

Upgrading infrastructure
Upgrades can be made to critical infrastructure that cannot be readily relocated out of a coastal hazard zone. Typical upgrades include raising floor levels to reduce inundation risk, and changing infrastructure design and materials to be more flood tolerant (reduce the consequence of inundation).

For efficiency, upgrades would typically coincide with upgrades and renewals scheduled in an asset management / maintenance program. Updated coastal hazards zones, identified risks to infrastructure assets, and recommendations from adaptation planning will inform updates to asset management plans.

Relocating infrastructure
Where it is feasible to do so, critical infrastructure can be relocated out of the high-risk coastal hazard zone. This requires long term planning in assets management, as the location of critical infrastructure is driven by demand, and the need to support for settlements and services.

Improving drainage networks
Improving drainage networks in the areas immediately surrounding infrastructure and in the main settlement areas can reduce the duration and consequence of storm tide inundation. This should be considered as part of the adaptation strategy and asset management plan for a locality.

Building resilient homes
In coastal areas, private dwellings may be exposed to impacts from coastal hazards, including flooding associated with storm tide inundation. Smart choices in the design of homes can reduce the impact of flooding. This is applicable for rebuilding, renovating, or building a new dwelling. Some of these changes may have higher initial upfront costs, but provide a longer term benefit. Making these changes over time can reduce damage and disruption from future flooding.

Relevant and priority areas
Modifying infrastructure has a higher priority for areas with higher tidal and storm tide inundation risk.

Modifying infrastructure				
	Upgrading infrastructure	Relocating infrastructure	Improving drainage networks	Resilient homes
Karumba Point				
Karumba Township				
Normanton				
Other areas*				

Relevant / feasible
Priority
Not applicable

SHEET 6 TO 11 – ADAPTATION ACTIONS – COASTAL MANAGEMENT AND ENGINEERING

SHEET 6 – NATURAL FORESHORE AND DUNE PROTECTION AND MAINTENANCE

The natural foreshore and dune system are the primary natural defence from coastal hazards. In Karumba, the natural foreshore and foredunes and vegetation dissipate wave energy and protect the land behind from impacts of erosion and storm tide inundation.

Dune protection and maintenance is important to encourage sand to accumulate across the dunes, and be stabilised by vegetation. In most cases a well vegetated, stable dune system can be achieved through actively reducing disturbance and facilitating native vegetation establishment.

Native vegetation has an important role in dune development and stabilisation. Native vegetation actively captures windblown sand, which accelerates the build-up of dune volume and height, which in turn provides increased protection from coastal hazards to the land behind.

In the Carpentaria coast, the area covered by natural dunes is limited and mixed with other forms of natural protections, including mangroves and sedimentary rock. These form a functional ecosystem which has a clear role in maintaining the shoreline in place.

Reduce disturbance

Reducing disturbance to the dune system can be achieved through fencing, signage, and providing defined / formalised access points and walkways / boardwalks at the most appropriate locations. Minimising through-traffic across the dune system is important to allow native vegetation to establish and contribute to building the dune system.

Weed removal and native vegetation regeneration

Native vegetation is best adapted to the role of enhancing dune development and stability in different localities. Exotic / weed species can inhibit native vegetation establishment, and therefore controlled weed removal is an important part of dune protection and maintenance. In most locations, controlled weed removal, combined with reduced disturbance, will be sufficient to allow native vegetation to regenerate from existing seek banks.

Revegetation (if required)

In some cases, if the native vegetation seek bank has been diminished due to clearing or other disturbance, revegetation with local species may be required as part of dune protection and maintenance. Vegetation plans can be tailored to consider suitable species, access, views and other site-specific needs. Matting (bio-degradable materials) can also assist in vegetation establishment.

Relevant and priority areas

Dune protection and maintenance is a priority action for all localities with open coast sandy shorelines.

Dune protection and maintenance			
	Reduce disturbance (fencing)	Weed removal and encourage native regeneration	Native revegetation if required
Karumba Point			
Karumba Township			
Normanton			
Other areas*			

	Relevant / feasible
	Priority
	Not applicable

SHEET 6 TO 11 – ADAPTATION ACTIONS – COASTAL MANAGEMENT AND ENGINEERING

SHEET 7 – BEACH NOURISHMENT

Beach nourishment involves providing additional sand to increase the volume of sand on the upper beach.

Sand can be sourced from quarries, offshore (if appropriate) or other sources. Beach nourishment is typically combined with dune maintenance and protection to enhance resilience to coastal hazards.

Beach nourishment has the benefit of providing increased protection from coastal hazards while maintaining the natural values and aesthetics of the beach and coastline. Beach nourishment is typically achieved through sand scraping or importing sand.

Importing sand
Importing sand to nourish the beach involves sourcing and distributing sand to increase sand volume and build up the dune system. Sand can be placed through a variety of methods, including pumping via a pipeline, sand rainbowing from off-shore, or direct profile nourishment and dune nourishment with excavators.

Beach nourishment volumes can be designed to mitigate coastal hazards at specific sites for a number of years. A routine beach nourishment program can often be a more cost-effective adaptation option (with added recreational / aesthetic benefits) for mitigating coastal hazards than last line of defence structures (seawalls).

Sand scraping
Whilst not beach nourishment as no new sand is not being introduced to the system sand scraping can offer protection through the use of natural sand. Sand scraping involves mechanically moving sand from the intertidal zone to the dune or upper beach zone, mimicking the natural beach recovery processes (at an accelerated rate). The overall sediment budget of the beach remains the same.

Relevant and priority areas
A detailed beach nourishment assessment is required wherever major beach nourishment is pursued, to evaluate site specific issues including:

- Potential sources of sediment and longevity of sediment supply
- Characteristics of desired sediment (e.g. colour, grain size, material)
- Volume of material required over the short and long term.

Beach nourishment is only relevant to Karumba Point, and a priority action in areas of high erosion risk.

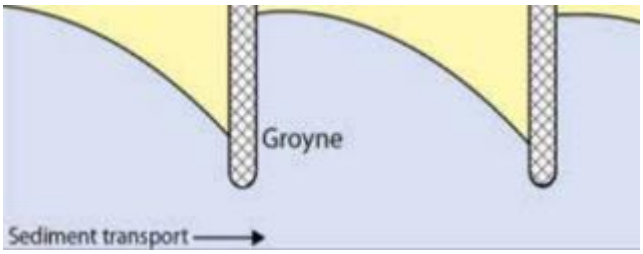
Beach nourishment		
	Sand scraping	Import sand to nourish the beach
Karumba Point		
Karumba Township		
Normanton		
Other areas*		

	Relevant / feasible
	Priority
	Not applicable

SHEET 6 TO 11 – ADAPTATION ACTIONS – COASTAL MANAGEMENT AND ENGINEERING

SHEET 8 – STRUCTURES TO ASSIST WITH SAND RETENTION

Structures can be installed to assist with retaining sand in a specific area of the shoreline. Groynes are the most common structure used for this purpose, extending perpendicular to beach. Groynes are typically combined with beach nourishment to provide the most enduring benefit to the beach.



Groynes intercept the longshore movement of sand, and assist to retain sand on the beach between structures. Sand will accumulate to the side of the structure where sediment is moving towards. Some localised erosion can occur on the lee-side. Permeable groynes allow water to flow through at reduced velocities, while impermeable groynes block or deflect the current.

Groynes can be constructed from a range of materials including rock, geotextile bags (geo-bags), wood and other materials (sheet piles, gabions, concrete). The design of rock or geo-bag groynes are most common in Australian marine environments, linked to the durability and availability of materials, suitability for design standards, and aesthetics.

Rock groynes
Groynes constructed of rock become relatively permanent features of the landscape. Rock grounds are typically used to assist with retaining large volumes of sand in a localised area on an on-going basis.

Geo-bag groynes
Geo-bag groynes are becoming increasingly more favourable in coastal management. Groynes are constructed of large geo-textile containers (bags) filled with sand. These groynes will be periodically covered and exposed. Geo-bags have a shorter design life than rock, however they are more suited to adaptive management (can be removed or changed if the management approach changes).

Relevant and priority areas
Groynes are a relevant action for beaches across all sandy beach localities with a dominant long-shore drift direction. The feasibility of groynes is assessed on a site by site basis. Feasibility may change with changing coastal hazard risk and adaptation objectives.

	Rock groynes	Geo-bag or groynes
Karumba Point		
Karumba Township		
Normanton		
Other areas*		

	Relevant / feasible
	Priority
	Not applicable

SHEET 6 TO 11 – ADAPTATION ACTIONS – COASTAL MANAGEMENT AND ENGINEERING

SHEET 9 – STRUCTURES TO DISSIPATE ENERGY OFF-SHORE

Structures can be installed off-shore to create a zone where wave energy will break and dissipate prior to reaching the beach. These structures include breakwaters and artificial reefs.

Breakwaters are erosion control structures most frequently placed parallel to the coast. Breakwaters are typically constructed using rock or geo-bags. **Exposed breakwaters** have a crest that rises above the surface of the water, whereas **submerged breakwaters** do not.

Artificial reefs can similarly be used to reduce wave energy and erosion of shorelines and are typically composed of base materials such as rock or geo-bags. They are submerged structures that function through wave dissipation and wave rotation, leading to salient growth in the lee of a reef. To a greater extent than breakwaters, artificial reefs can also be used to enhance marine biodiversity and recreational amenity.

Mangroves
Mangroves have an important role in providing natural dissipation of wave energy. The role of Mangrove communities in providing coastal hazard protection is becoming increasingly recognised.

The protection, enhancement, and restoration of mangrove communities along shorelines is becoming a key focus of coastal hazard adaptation initiatives. Where extensive Mangrove communities are established, such as around the Wellington Point and Geoff Skinner Reserve, these should be protected and encouraged to expand to provide additional protection for the shoreline from wave energy. This is typically an extension of dune protection and maintenance activities.

Relevant and priority areas
Protection and enhancement of mangroves is a priority across all localities where they are established / can be established. Breakwaters and artificial reefs require careful design and construction to ensure they work effectively. This is often cost prohibitive for many locations. Mangroves and other energy dissipating techniques may be effective for some area along Karumba Point, however, would require further design and investigation to assess suitability. Mangrove management is, in general, feasible and suitable along the Norman River banks.

Structures to dissipate energy off-shore			
	Breakwaters	Artificial reef	Mangrove protection and enhancement
Karumba Point			
Karumba Township			
Normanton			
Other areas*			

	Relevant / feasible
	Priority
	Not applicable

SHEET 6 TO 11 – ADAPTATION ACTIONS – COASTAL MANAGEMENT AND ENGINEERING

SHEET 10- LAST LINE OF DEFENCE STRUCTURES

Last line of defence structures can be used to protect critical assets from coastal hazards. These structures are typically in the form of a seawall that provides a barrier between the ocean and adjacent coastal land.

Seawalls can be vertical or sloped structures and are typically made of rock, concrete or geo-textile containers (geo-bags), and can be designed as buried revetments or exposed walls.

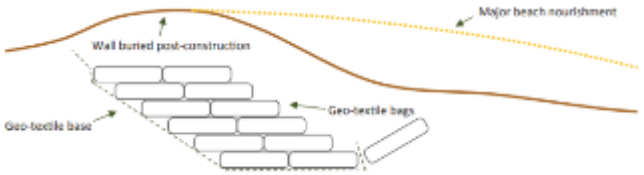
Figure adapted from USACE Coastal Engineering manual

Seawalls are normally very large structures designed to withstand extreme events. A seawall structure must be appropriately engineered to ensure the design (size, height, grade, layers, filters and material) meets the required standards to provide sufficient protection from the local wave climate.

Exposed seawall
An exposed seawall is a hard barrier to wave energy. Unlike a dune system, a seawall has limited capacity to dissipate (spread out and absorb) energy when it hits the wall. Consequently, waves refract off the seawall and can scour sand from the base, resulting in a change in, or progressive loss of the sandy beach.

An exposed seawall will change the natural aesthetics of the beach and coastline. Exposed seawalls are typically used only as a last line of defence to protect critical assets (a last access road or other critical infrastructure) and in urbanised foreshore environments.

Buried seawall
In some cases, seawalls can be constructed as a buried revetments. In these cases, the wall is buried, and dune system revegetated, and effort is made to ensure sufficient sand is retained to keep the wall buried (in all except extreme events).



Buried geo-bag seawall at Zilzie, QLD

A buried seawall provides protection from extreme events while maintaining natural beach aesthetics, however will may involve additional costs of periodic beach nourishment to ensure the wall remains buried.

Relevant and priority areas
Seawalls are currently established in several areas along the Karumba foreshore, in areas of high erosion risk. In many cases, these seawalls are temporary and not design to applicable standards.

New / upgraded seawalls are feasible as a last line of defence structure, and based on implementation triggers consistent with State planning policy.

Last line of defence structures		
	Exposed seawall	Buried seawall
Karumba Point		
Karumba Township		
Normanton		
Other areas*		

	Relevant / feasible
	Priority
	Not applicable

SHEET 6 TO 11 – ADAPTATION ACTIONS – COASTAL MANAGEMENT AND ENGINEERING

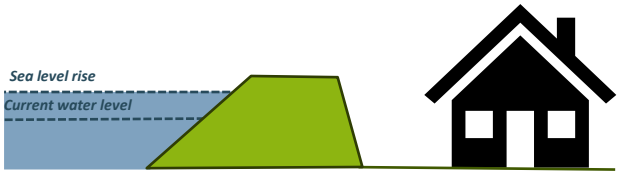
SHEET 11 - STRUCTURES TO MINIMISE FLOODING

Structures such as dykes, levees and storm surge barriers can be used to protect low-lying coastal land from inundation.

Dykes and levees take the form of elevated mounds or walls that can be made of earth, rock, concrete, geo-fabric bags or other materials.

The terms dyke and levee are often used interchangeably to refer to a structure that prevents water from flooding a specific area. However, dykes more commonly refer to structures that prevent low-lying land from being permanently inundated (land that in the absence of the dyke would be under water).

Levees more commonly refer to structures that prevent land from being inundated from flood events (land that in the absence of the levee would only be occasionally inundated).



Storm surge barriers (tidal barrages or gates) are physical barriers that prevent storm surges travelling inland along rivers, lagoons, inlets or other waterways.

Storm surge barriers can generally be opened and closed and are most effectively implemented at narrow tidal inlets. They can vary in size from a flow valve on pipes and culverts to large scale barrages.

Relevant and priority areas
Storm surge barriers require major investigation into design and effectiveness to assess site specific feasibility.

Structures to minimise inundation of low lying land (levees and dykes) are relevant to inundation prone areas across all localities/zones. Existing levee networks are present in some low-lying areas.

Structures to minimise flooding			
	Dykes	Levees	Storm surge barriers
Karumba Point			
Karumba Township			
Normanton			
Other areas*			

	Relevant / feasible
	Priority
	Not applicable