CITY OF BUNBURY

Coastal Hazard Risk Management and Adaptation Plan

May 2024

Project Partners

The Peron Naturaliste Partnership (PNP) comprises membership of nine Local Government authorities. The PNP's Coastal Adaptation Pathways Project identified the coastal areas of Capel, Leschenault and Greater Bunbury as being particularly exposed to coastal hazards and climate change, which triggered the need for this CHRMAP. Therefore, the present study aims to investigate the nature and severity of coastal hazards that are likely to affect these regions over future planning horizons.

The PNP worked with the steering group and a consultant team to develop a CHRMAP for the coastal, river and inlet environments of Capel, Bunbury, Dardanup and Harvey (Leschenault), with the support and technical advice of the State Government departments.

This study produced four separate CHRMAPs with substantial information available in technical documents for those wishing to view detailed analysis. This report summarises all findings related to the land areas within the City of Bunbury.

The steering group:

- City of Bunbury
- Shire of Capel
- Shire of Dardanup
- Shire of Harvey
- Department of Biodiversity, Conservation and Attractions (DBCA)
- Southern Ports Authority (SPA)

Support and technical advice:

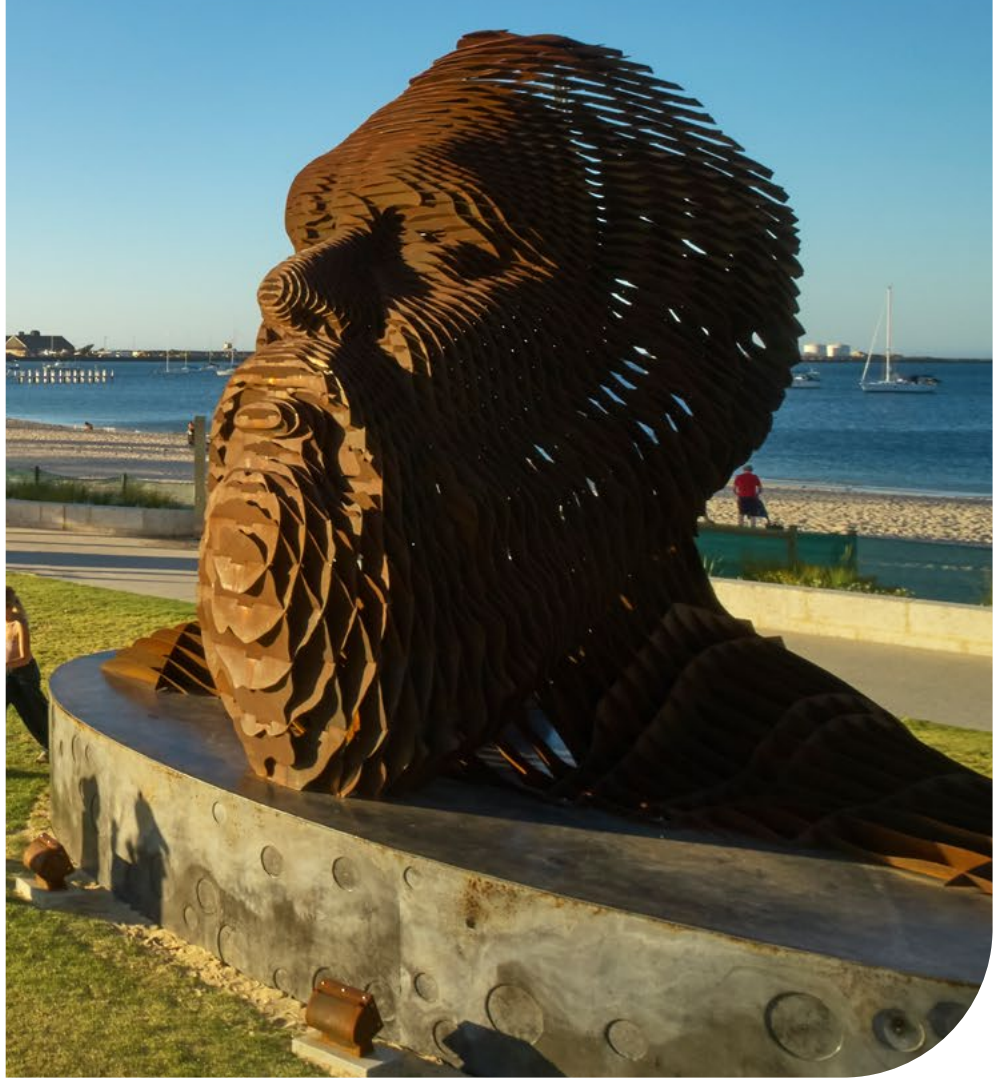
- Department of Water Environment and Regulation (DWER)
- Department of Planning Lands and Heritage (DPLH)
- Department of Transport (DoT)

Disclaimer

This Coastal Hazard Risk Management and Adaptation Plan (CHRMAP) has been completed by Water Technology Pty Ltd, commissioned by the Peron Naturaliste Partnership and the City of Bunbury. All information presented in this document is a reproduction of the findings from the City of Bunbury CHRMAP document finalised on 4 December 2023.

Acknowledgement of Country

The City of Bunbury acknowledges the traditional owners of the land, the Noongar Wardandi people and their continuing connection to the land, waters and community. We pay our respects to all members of the Aboriginal communities and their culture; and to Elders past, present and emerging.



Message from the Mayor

To our community,

On behalf of Bunbury City Council, City of Bunbury and our community, I am pleased to present the City's Coastal Hazard Risk Management and Adaptation Plan.

Bunbury is renowned as a city surrounded by three waters so the importance of having a coastal management plan in place is obvious.

But more than that, we know that sustainability and climate change are one of our community's highest priorities and it is internationally recognised that rising sea levels are an element of this.

So, while we have a long way to go and further investigations and assessments to complete, I am pleased we now have a plan to help us prioritise those studies and to move forward with our coastal planning.

Our CHRMAP has been developed following extensive community consultation to help understand our community's goals and aspirations, and to provide the opportunity for direct input. Thank you to everyone who has already contributed to this important project.

Implementing this plan now requires a coordinated approach and ongoing community and stakeholder engagement to action the recommendations identified and to ensure the City is ready to respond to coastal hazard challenges moving forward.

I encourage everyone to have a read through the CHRMAP and to stay involved.

If anyone in our community needs help reading, reviewing or understanding the information in this plan, please reach out to City staff.

We look forward to working with our community towards protecting the beautiful and unique coastline we are so lucky to enjoy in Bunbury.

Jaysen de San Miguel

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Frequently Asked Questions

What is a CHRMAP?

CHRMAP is the acronym for a Coastal Hazard Risk Management and Adaptation Plan. It is a study developed to communicate information about future coastal planning. It includes a technical assessment to understand the existing and predicted coastal processes, includes a social assessment to understand the community values associated with the coastline being studied, and considers financial and environmental implications.

What does a CHRMAP do?

The CHRMAP estimates where the coastline is likely to move to in the short, medium and long-term future. By understanding where the coastline is likely to be in the future and which areas of land may become impacted, it allows us to understand what infrastructure may be impacted by coastal processes and investigate which options for managing these impacts might be appropriate in particular areas.

Why do we need a CHRMAP?

It is important to understand areas that may be impacted so we don't place people or assets in harms way, if we can avoid it.

The WA State Government's Coastal Hazard Risk Management and Adaptation Planning Guidelines, established under the Western Australian Planning Commission's *State Planning Policy 2.6 - State Coastal Planning Policy* (SPP 2.6), provides guidance for decision makers to develop and implement effective CHRMAPs, based on internationally recognised science.

What are coastal hazards?

The two main coastal processes that are considered coastal hazards are:

- **Erosion** – the loss of beach and vegetation
- **Inundation** – flood from sea water

A CHRMAP identifies areas that could potentially be impacted by these hazards over the next 100 years, relative to storm events and projected sea level rise. CHRMAP uses vulnerability as a way of identifying impact, which includes an analysis of how likely the impact is to occur, the consequence of the impact, and how easy it is to adapt before or after the impact.

What will the outcomes of the CHRMAP be?

The CHRMAP outlines a plan to address future risks identified across the coastal areas, on the basis of current and future use, existing or planned protection and current technology and knowledge. The components of a CHRMAP include:

- Coastal hazard risk identification and assessment;
- Coastal risk evaluation based on community and stakeholder engagement and an assessment of community safety;
- Identification of adaptation options to mitigate coastal hazard risk; and
- Assessment of adaptation options to identify preferred options.

The CHRMAP process takes into account the uncertainty associated with predictions of coastal change and provides a flexible decision-making pathway that decision makers can use as coastal hazards become more apparent or new hazards emerge.

What are the options for adapting to coastal hazards?

The WA State Government's State Planning Policy 2.6 – State Coastal Planning Policy (SPP 2.6) identifies a hierarchy of four pathways for adapting to coastal hazards:

Avoid

Identify future no build areas and use planning controls to prevent new development in areas at risk now or in the future

Retreat

Withdraw, relocate or abandon assets that are at risk; ecosystems are allowed to retreat landward as sea levels rise

Accommodate

Continue to use the land but accommodate changes by raising buildings, converting land uses or growing flood or salt-tolerant plants

Protect

Use hard structures (e.g. seawalls) or soft solutions (e.g. dunes and vegetation) to protect land from the sea. May be prohibitively expensive, especially in the long term

Please refer to *section 5 Management Options* to learn more about these pathways and the additional pathways of No Regrets and Do Nothing that have been considered in the risk treatment assessment.

When will recommendations be implemented?

All recommended options still require further investigation. Although the multi-criteria assessment (*section 5.4 Multi Criteria Analysis (MCA)*) considered options against a range of criteria, and did identify preferred options, detailed design and other investigations are still required before actions are implemented.

The recommendations of this CHRMAP include those detailed design and other investigations, and the preferred adaptation options are typically not recommended to be implemented in the short term.

Who will pay for adaptation?

Financial support for coastal hazards management will need to be tailored, with funding found through existing rates and City financial reserves, or sought through advocacy.

The CHRMAP itself is an advocacy tool, essentially functioning as a business case for future investment decisions and presenting viable options to be considered by decision makers.

The endorsement of the CHRMAP is an important first step to achieve funding.

In WA, grants are managed by the Department of Planning, Lands and Heritage and the Department of Transport. Some other minor grants are available for actions such as planting and redeveloping coastal infrastructure.

Commonwealth grants are available from time to time, but not committed over longer term cycles.

Knowing that any type of coastal adaptation will be expensive, the CHRMAP recommendations should be used to commence advocacy with the relevant organisations that will likely be party to any funding.

How will this affect me?

Coastal hazards will affect different people in different ways depending on where they live and how they access, use and enjoy the coastline. Please refer to the table for a summary of information.

I AM A...	I MAY BE AFFECTED BY...
Private property owner in the coastal hazard zone	*Land Use Planning* - The land use planning framework may be changed as a result of the recommendations of this plan to help limit or remove the impact to property and safety over longer timeframes.
	Notifications on Titles - This CHRMAP recommends that notifications be placed on the property's certificate of title, to help them make informed decisions about the possibility of longer term coastal hazard risk, and that risk management and adaptation is likely to be required. The location that will be subject to this recommendation will be identified through future investigations.
User of the coastline	Some areas of the City of Bunbury coastlines will become vulnerable over the next 100 years. This includes beaches, access ways, footpaths, carparks, foreshore areas, toilets, roads and public open space areas. *Section 6.1 Recommended Actions by Priority* provides a summary of the recommended management actions to be undertaken. These are largely focused on behind the scenes actions such as monitoring, planning controls, and emergency management plans to better prepare decision makers for future coastal hazard management . Long term, adaptation strategies such as protection or managed retreat will be required when coastal hazards are realised, as explained in *section 6.2 Recommended Medium to Long Term Pathways*. In areas identified for potential future protection, the construction of structures such as groynes, levees and storm surge barriers will mean that the natural sandy beach may eventually be lost in these locations and that access to those stretches of coastline might be affected. In areas identified for future managed retreat, existing infrastructure may gradually be removed or relocated if coastal hazards cause damage during storm events. In those cases the natural sandy beach and dunes will be given room to move, and thus the natural foreshore be retained.

Am I responsible if my property is affected?

This is complex, but the short answer is yes, you are responsible for management of your own property.

There is no legal obligation on the State or Local governments to protect private assets within coastal hazard areas, or to compensate for any losses incurred due to coastal hazards. Should damaged assets pose a risk to public safety, removal may be required.

State or Local Government are also not obliged to protect public assets, although they would need to ensure public safety. This might result in the need to remove assets that would be of danger to the community, if maintaining the asset is not an option.

SPP 2.6 requires that Local Governments prepare a CHRMAP to identify coastal hazard areas, outline potential adaptation pathways and share this information with the community, so we can all plan together.

Groups of landowners may be willing and have the capacity to fund protection works privately that the City cannot afford or seek funding for via other means. In this case, detailed planning and engineering works will still be required and funding for both capital and maintenance expenses will need to be committed by the landowners.

Engineering design would need to prove that the works would not have a negative impact on adjacent coastlines, areas or valued natural assets. Financially, the City would need to be certain that the landowners had the financial resources to continue maintenance, and may require guarantees or bonds to that effect.

Recommended actions at a glance

This page summarises the CHRMAP's recommended actions for each management unit (MU) area that is at risk of coastal hazards. It does not indicate a precise location for implementation. For a more detailed explanation, please refer to *section 6 Recommendations*.

No Regrets

(all Management Units)

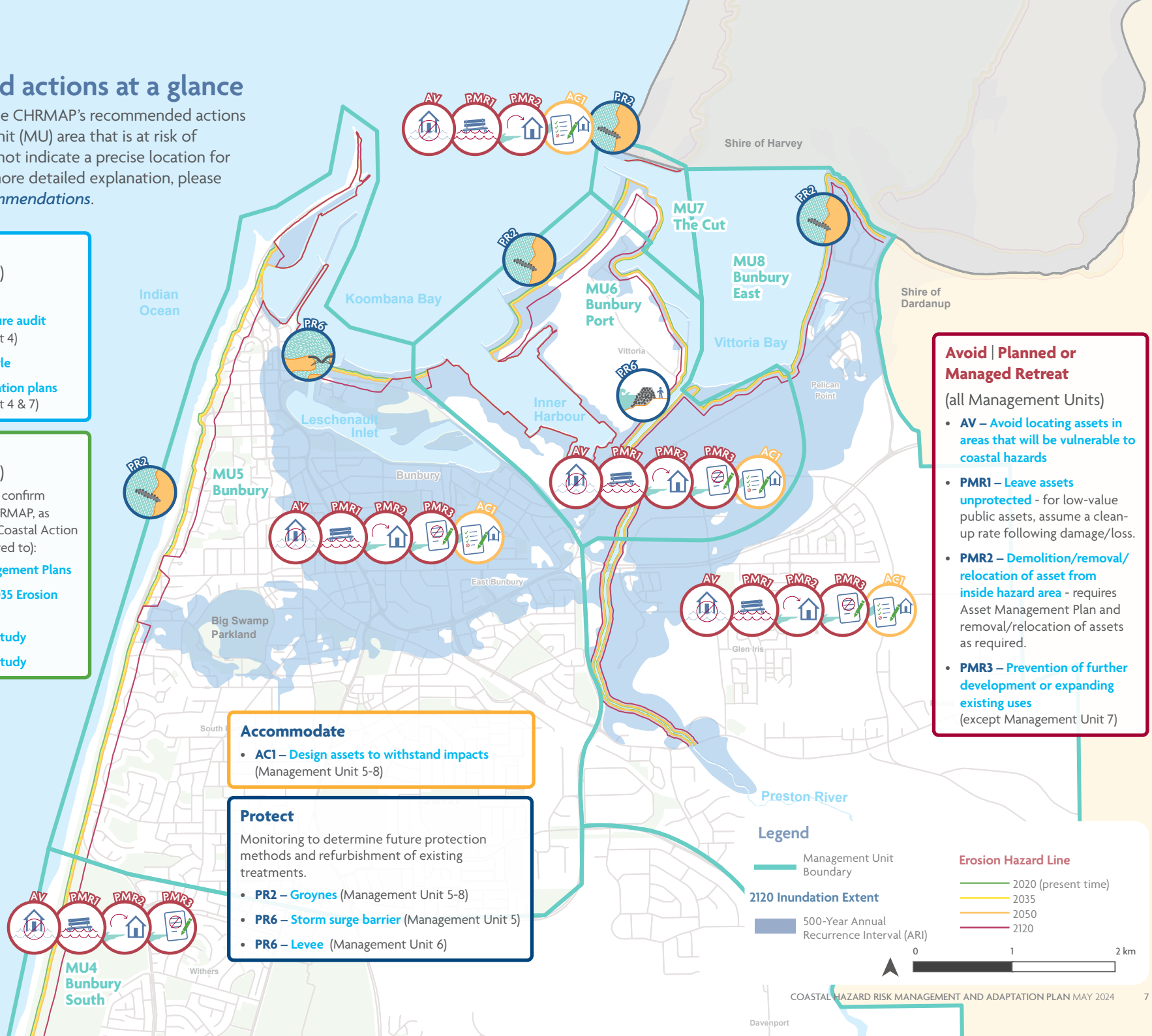
- **NR1 – Monitoring**
- **NR2 – Protection structure audit** (except Management Unit 4)
- **NR3 – Notification on title**
- **NR4 – Emergency evacuation plans** (except Management Unit 4 & 7)

Investigations

(all Management Units)

Undertake investigations to confirm assumptions used in the CHRMAP, as outlined in the Short-term Coastal Action Plan, including (but not limited to):

- **Update Foreshore Management Plans**
- **Audit of assets within 2035 Erosion hazard zone**
- **Sand Source Feasibility Study**
- **Rock Source Feasibility Study**



Avoid | Planned or Managed Retreat

(all Management Units)

- **AV – Avoid locating assets in areas that will be vulnerable to coastal hazards**
- **PMR1 – Leave assets unprotected** - for low-value public assets, assume a clean-up rate following damage/loss.
- **PMR2 – Demolition/removal/relocation of asset from inside hazard area** - requires Asset Management Plan and removal/relocation of assets as required.
- **PMR3 – Prevention of further development or expanding existing uses** (except Management Unit 7)

Accommodate

- **AC1 – Design assets to withstand impacts** (Management Unit 5-8)

Protect

Monitoring to determine future protection methods and refurbishment of existing treatments.

- **PR2 – Groynes** (Management Unit 5-8)
- **PR6 – Storm surge barrier** (Management Unit 5)
- **PR6 – Levee** (Management Unit 6)

Implementation

Implementing a CHRMAP requires a coordinated and orderly approach, prioritising appropriate actions to ensure the City is well placed to respond to coastal hazard challenges.

The coastal adaptation pathway includes short-term, medium-term and long-term actions. Short-term actions are anticipated to be implemented by 2035, corresponding to a 10-15 year planning horizon; medium-term actions implementation would occur before 2050 (15-30); while long-term actions would be implemented beyond 2050, towards 2120.

Key assumptions

The timeframes envisaged in the coastal adaptation pathways are not absolute – read more in *section 5.5 Options and Triggers*. Other options may be envisaged, particularly if land use planning practices, new coastal information or climate projections change the current understanding. Therefore, the implementation pathway will evolve overtime.

Options have been selected based on information gathered through the CHRMAP process, however, the preparation of the Multi-Criteria Analysis and Cost Benefit Analysis required interpretation and approximations, particularly regarding the criteria and cost quantifications.

Further investigations, surveys, policy review, impact investigations (environmental, visual and social), development approval and authorities endorsement, local stakeholder and community engagement, preliminary design, detailed design, costing and any other applicable preparation work are all required prior to being implemented.

The CHRMAP is set to be reassessed every ten years at a minimum. This reassessment will involve a re-modelling stage that will incorporate comprehensive data derived from short-term actions, such as information about buried seawalls and geotechnical data.

Short-term Implementation

Further Investigations

This CHRMAP provides a number of short, medium and long term actions, which are quite broad in nature and are recommended over long time periods.

Information gaps identified in the CHRMAP should be gathered early. Some of these gaps can be closed by the collection of data. Other information gaps can be closed during the preliminary and/or detailed design phase when specific or detailed analysis of available data, information, modelling, and projections are carried out. Options should be optimised and modified following such additional investigations.

The following investigations and legislative changes are recommended for Short Term implementation:

Monitoring

Monitoring is recommended to understand when proposed actions need to be implemented, including medium and long term actions. Monitoring recommendations also help to provide a higher level of accuracy to implementation costs.

Monitoring includes physical surveys, photographic surveys and audits of existing structures.

Sand source feasibility study

Several MUs have recommended options which require sand nourishment, both for erosion management (such as beach groynes including sand nourishment) and inundation management (such as raising beach levels).

The availability of suitable sand for beach nourishment works is unfortunately not well understood in the study area. It is recommended that a sand source feasibility is undertaken to determine the capacity and cost of local sand supplies.

Emergency evacuation planning

Review emergency evacuation plans in the study area to assess if the evacuation plans are suitable for managing the projected coastal hazards. Existing documents may need to be updated or revised as required, until protection measures can be fully implemented.

Asset Management Plan

Prepare an Asset Management Plan, which identifies existing infrastructure and recreational facilities in the coastal erosion and inundation hazard zone and provides direction to:

- Progressively relocate non-critical assets away from the coastal hazard zone, which may include car parks; public ablutions; barbeque/picnic/shade areas; playgrounds, ramps, stairs and paths and fences, etc.
- Plan for the relocation of critical service infrastructure outside of the coastal hazard zone once they reach the end of asset life.

Foreshore Management Plans (FMPs)

Updated foreshore management plans for the study areas may provide more conscious management of foreshore areas and increase the protective capacity of the natural dune system. Foreshore management plans should address the findings of this CHRMAP, and:

- Asset audits and management
- Potential environmental impacts and benefits, and monitoring of flora and fauna species
- Closure or consolidation of beach access points
- Management and monitoring of four-wheel drive access and permissibility
- Educational programs and signage
- Bushfire management requirements

Rock source feasibility study

Similar to sand sourcing but for armour rock suitable for building coastal management structures. Several MUs have recommended options requiring armour rock which needs to be fit for purpose. An analysis of the availability of such rock suitable for marine works, with suitable density, quarry yields, close location and tolerable costs should be undertaken.

Short-term Coastal Action Plan

Table 1 provides a Short-term Coastal Action Plan to assist the City's Staff and Elected Members in prioritising, budgeting, scoping, and implementing the various coastal management actions that are recommended in the CHRMAP *over the next 5-years* (2024-25 to 2028-29). These actions relate to coastal monitoring, investigation, and adaptation actions.

Table 1: Short-term Coastal Action Plan

	ACTION OVERVIEW	LOCATION	COST ESTIMATES	ESTIMATED TIMING
1	**Storm impact monitoring** NR1 Prepare for, and undertake, storm impact monitoring during and immediately after severe ocean storm events.	ALL	$ 10,000	2024-25 & ongoing
2	**Coastal management register** NR1 Implement and maintain a coastal management register for monitoring and management actions.	ALL	$ N/A	2024-25 & ongoing
3	**Field photos** NR1 Collect beach and foredune monitoring photos at the same time as Peron Naturaliste Partnership's planned drone photography (or the provisional beach and foreshore topographic survey if undertaken by the City).	ALL	$ 15,000 (excl. GST)	2024-25 2025-26 2026-27 Review in 2027-28
4	**Coastal management training for City staff** NR The City will develop an internal coastal management training program for relevant staff.	N/A	Less than $ 5,000	2024-25 & ongoing

Table 1: Short-term Coastal Action Plan (continued)

	ACTION OVERVIEW	LOCATION	COST ESTIMATES	ESTIMATED TIMING
5	**Sand source feasibility study** INVESTIGATION The City will investigate potential sand sources to use for coastal protection works.	ALL	$ 75,000	2024-25
6	**Coastal protection structure audit** NR2 The City will undertake an audit of the coastal protection structures the City is responsible for the care, control and maintenance of, for including – buried seawalls at Hungry Hollow and Hayward Street on Ocean Drive, and exposed seawalls at the Bunbury Surf Life Saving Club and car park at Back Beach, Marlston Waterfront seawalls, and Koombana Bay beach groynes.	MU5 MU6 MU7 MU8	$ 48,000	2024-25
7	**Geotechnical investigations** INVESTIGATION Geotechnical investigations are proposed to identify the potential presence and depths of local bedrock strata below the beach. When bedrock is located relatively near the surface, it can provide some natural resistance to erosion and help inform the refinement and design of coastal management options.	MU5 MU6	$ 102,000	2025-26
8	**Emergency evacuation plan** NR4 The City will ensure that a preliminary emergency evacuation and response plan is prepared, maintained, and implemented to ensure the safe evacuation of occupants within the City during a severe coastal inundation event and/or severe erosion event.	MU5 MU8	$ 55,000	2025-26
9	**Foreshore asset audit** INVESTIGATION Undertake a Foreshore Asset Audit in response to coastal hazard projections to 2035. The City will undertake an audit to identify existing infrastructure and recreational facilities in the coastal erosion and inundation hazard zone.	MU5 MU8	$ 71,000	2025-26
10	**Develop Foreshore Management Plans** INVESTIGATION The City will prepare updated Foreshore Management Plans. These can increase the protective capacity of the natural dune system and provide an avenue for increased awareness and education for stakeholders and the community about coastal processes and management.	ALL	$ 145,000	2025-26 for MU4, MU5 & MU6 2026-27 for MU7 & MU8
11	**Rock source feasibility study** INVESTIGATION The City will investigate potential rock sources to use for coastal protection works.	MU5 MU6 MU7 MU8	$ 49,000	2026-27
12	**Bathymetric survey** INVESTIGATION Collect additional nearshore bathymetry data (water depths) at Bunbury back beach and Koombana Bay for future coastal processes investigations and structural option development.	MU4 (south to in line with Westwood Street) MU5 MU6 (to The Cut)	$ 43,000	2027-28

Table 1: Short-term Coastal Action Plan (continued)

	ACTION OVERVIEW	LOCATION	COST ESTIMATES	ESTIMATED TIMING
13	**Metocean data collection** NR1 Collect additional nearshore data (ocean waves, currents, and water levels) for structural option development for 12 months at Bunbury back beach in approximately 10m water depth.	Approximately 10m water depth in line with Hayward Street South Bunbury	$ 130,000	2028-29
14	**Review of Short-term Coastal Action Plan** The City will undertake a review of this Short-term Coastal Action Plan and identify the next five years of priority actions.	ALL	$ 25,000	2028-29
	Beach and foreshore topographic survey – provisional NR2 It is recommended to engage a certified professional surveyor for a long-term beach and foreshore topographic survey data collection program (assumed as three years) at Bunbury back beach and Koombana Bay.	MU5 MU6 MU7	$ 120,000	Provisional from 2024-25 if needed

Planning Actions

The medium and long-term strategy requires the consideration of planning conditions that can support good strategic decision making, regardless of the long term adaptation options proposed. The following planning instruments are also recommended to be progressed over the coming years, as Short-term Coastal Actions confirm priority management.

Advice to Real Estate and Settlement Agents

Notify landholders, real estate agents and settlement agents and prospective purchasers through direct email to affected properties and stakeholders and by implementing a procedure through the orders and requisitions process with information relating to land that may be affected by coastal hazards by 2120.

Planning Scheme Amendment

Prepare an amendment to the Local Planning Scheme No. 8 to include provisions for a Special Control Area (SCA) relating to the coastal erosion and inundation hazard zones as confirmed.

Reservation of Land

Prepare an amendment to the Local Planning Scheme No. 8 to include a Foreshore Reserve encompassing public land within the coastal erosion and inundation hazard zones.

Notifications on Titles

Supported by an SCA, require the provision of a Section 70A notification on the Title of land as a condition of any planning approval to alert landowners of the potential coastal hazard impacts on the lot, as required by SPP2.6.

Local Planning Policy

Prepare a Local Planning Policy (LPP) to be linked to the SCA. The policy may include recommended finished floor levels where impacted by inundation or siting of development to the least vulnerable portion of a lot for both erosion and inundation where possible.

Leaseback of land and land swaps

Investigate opportunities for leaseback of land and land swaps in the context of planned and managed retreat.

Structure Planning

Review existing and proposed structure plans to ensure they adhere to SPP2.6 and account for the risks identified in the CHRMAP.

Compulsory Acquisition

Investigate compulsory acquisition where no other planning instrument has been able to suitably set aside land for coastal hazard processes, when hazards have advanced to a stage where land exceeds tolerable risk thresholds.

Other Instruments

Review existing leasehold facilities located within the hazard zone and notify the lessee of the CHRMAP.

Coastal Hazard Mapping Study

Establish an advocacy program to achieve a state-wide coastal mapping database similar to the Fire and Emergency Services (FESA) mapping of bushfire prone areas.

Medium and Long-term Implementation

Medium (15-30 years) and long-term (30-100 years) implementation recommendations provide strategic consideration of how the City of Bunbury will adapt to long-term climate change impacts. Therefore, medium and long-term implementation are not described in detail in the CHRMAP.

Longer-term responses include:

- Actioning revised planning instruments
- Managing coastal retreat
- Exhausting the SPP2.6 hierarchy of actions, where high value assets may be protected if sustainable impacts and funding are identified/prioritised
- Providing temporary/interim hazard protection until too costly or a change in adaptation pathway is required. For example, as sea level rise progresses, it is likely that options using sand or rock resources to protect assets near the coast may become unsustainable.

For erosion

The two primary coastal management actions mitigating erosion hazards are:

Planned or Managed Retreat, PMR4 – Voluntary acquisition

Use the planning instruments and long-term plan to systematically move assets with low adaptive capacity out of the hazard zone

Protect Options – e.g. Groynes

Undertake design and construction of final protect options endorsed.

For inundation

The three coastal management actions mitigating inundation hazards are:

Planned or Managed Retreat, PMR4 – Voluntary acquisition

Use the planning instruments and long-term plan to systematically move assets with low adaptive capacity out of the hazard zone

Accommodate, AC1 – Design assets to withstand impacts

Limit damage from inundation events through planning and building requirements

Protect Options – e.g. Levees

Undertake works as necessary to prevent or limit inundation of assets exposed along the coast

Common Definitions

The following definitions apply to these words and phrases through the report:

Acceptable Risk

These are risks that do not need further treatment. The term acceptable risk refers to the level at which it is decided that controls (further restrictions or otherwise altering the activity) is not worthwhile, as the current risk does not warrant further action.

Adaptation

Changes made in response to the likely threats and opportunities arising from climate variability and climate change.

Adaptation Pathway

Adaptation planning is about being ready to manage the risks and impacts of coastal processes a location experiences, by planning for the most appropriate decisions and options to implement over time.

A flexible adaptation pathway approach enables the establishment of a decision-making strategy that is made up of a sequence of decision points over time, preventing a decisionmaker from being locked into a risk treatment option (and associated risk management measures), which may not be appropriate for dealing with the long-term problem. The intent is for decision-making to be responsive to changing circumstances over time.

Annual Recurrence Interval (ARI)

An annual recurrence interval is the average number of years that it is predicted will pass before an event of a given magnitude occurs. For example, a 50 year ARI event would happen every 50 years on average.

Assets

Something that has value to the decision-maker, community and stakeholders – this can be tangible or intangible, includes consideration of risk and liabilities, and can be positive or negative at different stages of the assets life.

Assets may be natural or man-made and include:

- Beach
- Foreshore reserve (including dunes, flora and fauna)
- Foreshore reserve amenity (including things like car parks, paths, public ablutions, barbeque/picnic/shade areas, playgrounds, infrastructure for public safety and pedestrian access structures such as ramps, stairs and paths)
- Marinas
- Recreational boating facilities
- Facilities to benefit the broader public (such as cafés and restaurants)
- Surf life-saving facilities
- Commercial and residential land
- Protection structures such as groynes, seawalls and sand nourishment.

CHRMAP (Coastal Hazard Risk Management and Adaptation Plan)

A study that identifies the key hazards and assesses the risk to assets of coastal erosion and inundation.

Coastal Processes

Any action of natural forces on the coastal environment (and for the purposes of a CHRMAP, natural forces that affect land areas).

Coastal Zone

Area of water and land that may be influenced by coastal processes. This includes tidal areas of the lagoon or inland water bodies.

Erosion

Refers to shoreline movement where the shoreline shifts landward as a result of sediment being transported away by waves, winds and currents, reducing the size (width) of a coastal foreshore reserve and the distance to an asset on the adjoining land.

Habitat

The areas in which an organism and/or assemblage of organisms lives. It includes the abiotic factors (e.g. substrate and topography), and the biotic factors.

Horizontal Shoreline Datum (HSD)

The active limit of the shoreline under storm activity. It is the line from which the erosion hazard allowance will be applied from.

Inundation

The flow of water onto previously dry land. It may either be permanent (for example due to sea level rise) or a temporary occurrence during a storm event.

In the context of CHRMAP, inundation does not include circumstances where groundwater or stormwater runoff may sit at the surface of land and be unable to infiltrate back into the soil.

Intolerable Risk

Risk that is unacceptable in any circumstances or at any level.

Longshore

Parallel to the shoreline.

Multi-Criteria Analysis (MCA)

A decision-making tool that supports the prioritisation of risk management options using multiple criteria as reviewed by the community and government stakeholders.

Mean Sea Level (MSL)

The average surface level of coastal bodies of water (from which elevation may be measured).

Rehabilitation

The re-establishment of vegetation and other ecological attributes, acknowledging that the area and the environmental asset will remain modified.

Sand Nourishment

Sand nourishment is one possible protection adaptation option to coastal hazards. It may be a standalone measure for protection, or be used to improve the beach amenity when used in combination with other adaptation measures such as a seawall.

It is considered to be a soft management option and usually mimics natural beach and dune systems.

Sandy Coast

Comprises unlithified and/or unconsolidated sediments, rock is either not present or not dominant. They typically feature gently to moderately sloping shores and are often backed by dunes or beach ridges, which may contain dune blowouts. The shoreline can quickly alternate between accretion and erosion but is likely to retreat as a result of sea level rise.

Sediment Cell

A length of shoreline in which interruptions to the movement of sediment along the beaches or near shore sea bed do not significantly affect beaches in the adjacent lengths of coastline. Within a sediment cell the sediments sources, transport pathways and sinks should be clearly definable.

Storm Surge

The increase in water level at the shoreline due to the forcing of winds (wind-setup) and atmospheric pressure.

Trigger

A pre-determined point that is set to trigger the commencement of planning and /or implementation actions; a catalyst for decision making.

Unacceptable Risk

These are risks that require action or treatment, as the current risk is intolerable to the community, the economy or the environment.

Vulnerability

The underlying properties of an asset which result in susceptibility to a risk source that can lead to an event with a consequence.

Wave Overtopping

Water carried over the top of a structure or landform due to wave run-up or surge action exceeding the crest.

Abbreviation List

AHD	Australian Height Datum
ARI	Annual Recurrence Interval
BDA	Benefit Distribution Analysis
CBA	Cost Benefit Analysis
CHRMAP	Coastal Hazard Risk Management and Adaptation Plan
CSEP	Community and Stakeholder Engagement Plan
DPLH	WA State Government Department of Planning, Lands and Heritage
DoT	WA State Government Department of Transport
FAQs	Frequently Asked Questions
HSD	Horizontal Shoreline Datum (See SPP 2.6)
IPCC	International Panel on Climate Change
LGA	Local Government Area
MCA	Multi Criteria Analysis
MSL	Mean Sea Level
MU	Management Unit
P&D Act	*Planning and Development Act 2005 (WA)*
PNP	Peron Naturaliste Partnership
SLR	Sea Level Rise
SPA	Southern Ports Authority
SPP 2.6	*State Planning Policy 2.6 – State Coastal Planning Policy*
The City	City of Bunbury
WAPC	Western Australian Planning Commission

Contents

1 Introduction

It is internationally recognised that the mean sea level has been rising globally since the nineteenth century and is predicted to rise at an increasing rate in the future (IPCC, 2021).

The City of Bunbury is a highly populated coastal settlement that is facing the increased risks from sea level rise and intensifying storm activities.

Management of risks to the land areas adjacent to the ocean coast, estuaries and rivers is very important for the social, environmental, infrastructure and economic assets and values of the local communities.

1.1 Background

Some work on coastal hazards has been undertaken in the past. A coordinated approach which identifies areas likely to be affected by erosion and/or inundation and requiring management and adaptation to mitigate the risks, will provide increased resilience to the coastal communities.

The Western Australian Planning Commission's (WAPC) State Planning Policy No. 2.6: State Coastal Planning Policy (SPP 2.6) recommends that management authorities develop a Coastal Hazard Risk Management and Adaptation Plan (CHRMAP), in accordance to a specific guideline for the **CHRMAP process** (*Figure 1*).

The purpose of the CHRMAP is to provide strategic guidance for coordinated, integrated, and sustainable decision making for future coastal land use planning, including management of, and adaptation to, coastal hazard risks (coastal erosion and inundation).

SPP2.6 requires adequate risk management planning is undertaken where the existing or proposed development is in an area at risk of being affected by coastal hazards over the **100-years planning timeframe**.

SPP2.6 and the CHRMAP Guidelines provide the risk assessment framework to be applied to identify risks that are intolerable to the community, and other stakeholders such as Local Governments, indigenous and cultural interests, and private enterprise. Risk management measures are then developed according to the adaptation hierarchy outlined in SPP2.6.

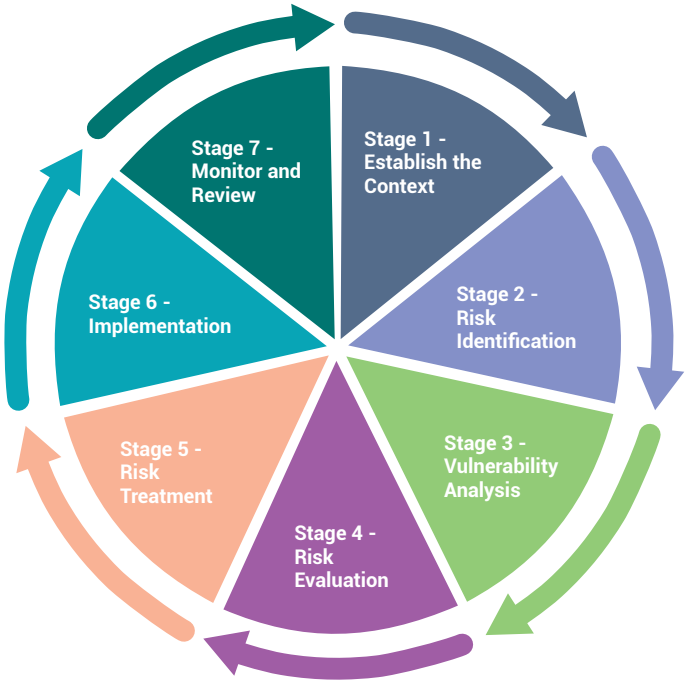


Figure 1: CHRMAP stages per the CHRMAP Guidelines (Source: WAPC 2019)

Stage 1 – Establish the Context

- Project inception
- Stakeholder and Community Engagement Plan
- Confirm the purpose, objectives, scope, study area

Stage 2 – Risk Identification

- Coastal hazard assessment
- Coastal hazard mapping
- Identify coastal assets and values – community engagement and survey

Stage 3 – Vulnerability Assessment

- Prepare likelihood and consequences scales
- Develop level of risk matrix and risk tolerance scale
- Risk assessment for coastal assets against erosion and inundation to determine the vulnerability ratings

Stage 4 – Risk Evaluation

- Identify existing controls and mitigation measures
- Priorities for risk treatment
- Identify risk treatment options
- Multi-Criteria Analysis (MCA)

Stage 5 – Risk Treatment

- Cost Benefit Analysis (CBA)
- Benefit Distribution Analysis (BDA)
- Adaptation options and pathways including identifying triggers and planning horizons

Stage 6 – Implementation

- Identify long-term pathways
- Produce a short-term implementation plan to 2035
- Land use planning instruments considered
- Funding options

Stage 7 – Monitor and Review

- Develop monitoring plan, detailing any monitoring or review that may be required.

1.2 Objectives

This report is a summary document outlining the CHRMAP process and presenting content from the technical reports. It has been prepared to provide an overview that is more accessible to a wider audience.

For a comprehensive understanding, this report should be read alongside the detailed technical reports included in the appendices. This document contains references throughout, which point to the documents and references sourced in corresponding technical reports.

The overall objectives of the CHRMAP were to:

- Summarise the existing policies and planning controls, existing physical controls, and jurisdiction boundaries
- Improve understanding of existing coastal processes, features, and hazards within the study domain
- Identify coastal assets and values through stakeholder and community engagement
- Identify coastal hazard risks in terms of both coastal erosion and inundation, as well as potential vulnerability trigger points
- Improve understanding of asset risk and vulnerability to coastal hazards
- Determine the consequence, likelihood, and tolerance of assets to the identified risks
- Identify effective risk management measures through Multi Criteria Analysis and Cost Benefit Analysis
- Identify short, medium, and long-term risk management actions
- Engage with stakeholders and the community to inform local values, adaptation pathway selection, and the implementation plan

Scope

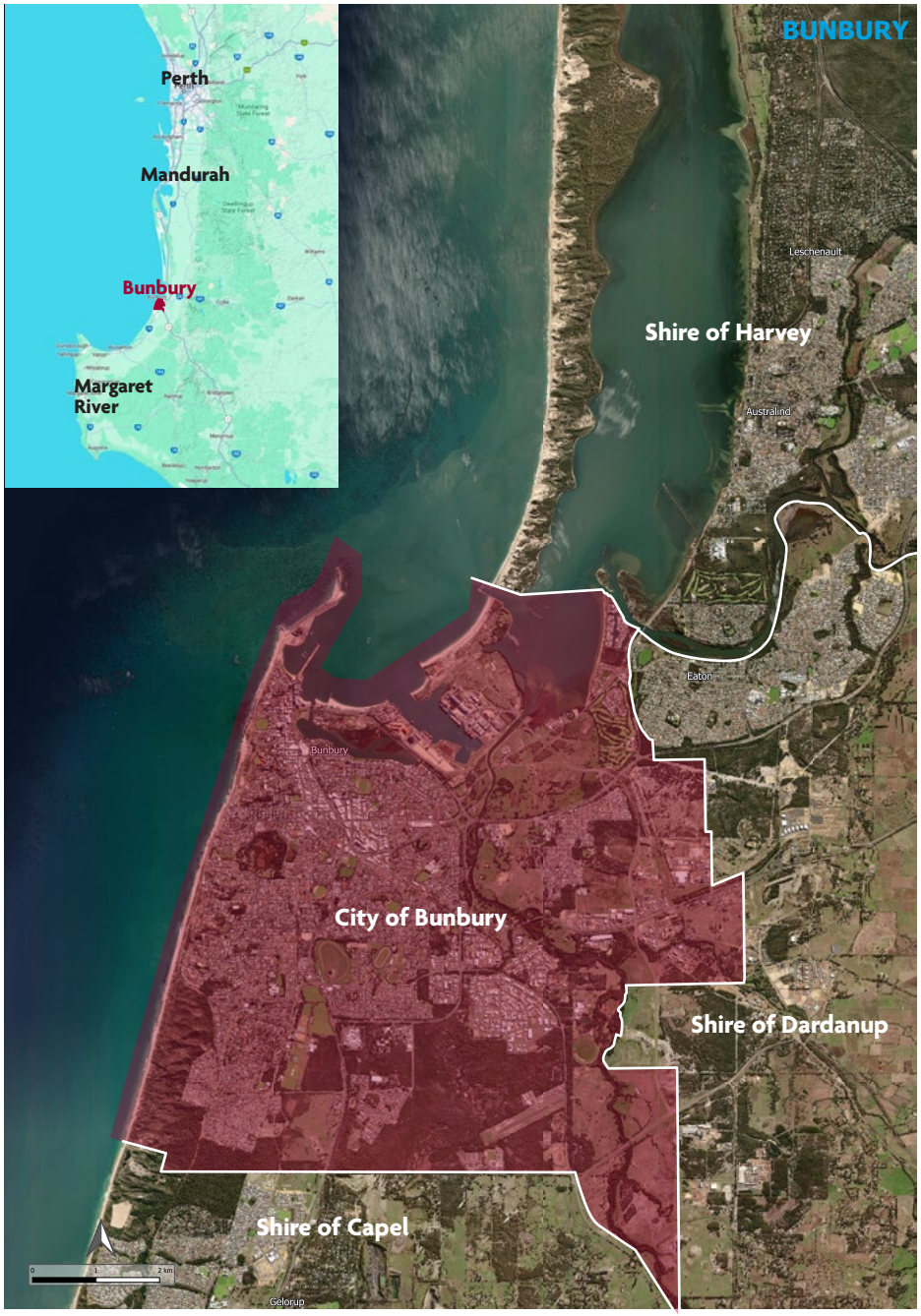
The CHRMAP identifies values and assets that are vulnerable to coastal erosion and inundation hazards within the study area.

Risk management measures are then considered that reduce risk to levels that would be considered tolerable to the community (which is tested through engagement).

Detailed information is provided for short-term (less than 25 years) management measures.

Strategic guidance on medium and longer-term risk management is also included.

The CHRMAP focuses on preserving assets and values which provide benefit to all members of the community, noting that private at-risk assets are also acknowledged and considered.



1.3 Study Area

The broader study area covers four Local Government Areas (LGAs) namely Shire of Harvey, City of Bunbury, Shire of Dardanup, and Shire of Capel. This report addresses coastal hazard vulnerabilities for the City of Bunbury.

Goomburrup (Bunbury) is located in the Gnarla Karla Boodja region of WA and the traditional owner of this land is the Wardandi people of the Noongar nation.

The City is located approximately 180 km south of Perth covering about 65 km area (*Figure 2*). The area was first established as the Municipality of Bunbury in 1871.

In 1961, it became the Town of Bunbury under the Local Government Act 1960. It assumed its current name in October 1979. The 2016 census figures indicate the City has an established population of almost 32,000. The City is a regional hub and has numerous developments along its coast.

Near coast infrastructure and assets located within the study area includes shops, restaurants, foreshore areas and playgrounds, houses, natural vegetation, community facilities, arts precincts, civic buildings, roads, car parks, paths, breakwaters, jetties, groynes, seawalls, bridges, the storm surge barrier, as well as the surf club, sailing club, Dolphin Discovery Centre, Casuarina Harbour and the Bunbury Port.

Coastal considerations

The study area within the City comprises many different sections of coastline with variable shore types and degrees of development (*Figure 3*).

Low-lying land is present along Five Mile Brook (e.g., the Big Swamp Wetland), surrounding the Leschenault Inlet (East Bunbury), and along the Collie and Preston Rivers.

These areas are susceptible to coastal inundation.

Areas likely to experience coastal erosion are located along the Indian Ocean frontage, Koombana Bay, Vittoria Bay and the Leschenault estuary.

Collectively, inundation and erosion are likely to impact large parts of the City's Local Government area. Consideration of coastal hazards and adaptation constraints of assets will be crucial for successful risk management and implementation plans across the City.

Figure 2: City of Bunbury location (source: Google Maps, Esri Satellite Imagery)

Management Units

To facilitate the coastal hazard assessment and development of adaptation options, the study area was delineated into several management units which are determined according to a set of factors:

- Jurisdiction boundaries
- Presence of coastal assets and relevant stakeholders
- Coastal processes and potential hazard types.

The City shoreline can be divided into **five primary management units**:

- MU4 - Bunbury South
- MU5 - Bunbury (including Five Mile Brook district, Koombana Bay, Leschenault Inlet)
- MU6 - Bunbury Port (Inner Harbour)
- MU7 - The Cut
- MU8 - Bunbury East

NB: the numbering of these management units recognise the broader technical CHRMAPs developed for the Capel to Leschenault area, comprising the Local Government areas of Bunbury, Capel, Dardanup and Harvey.

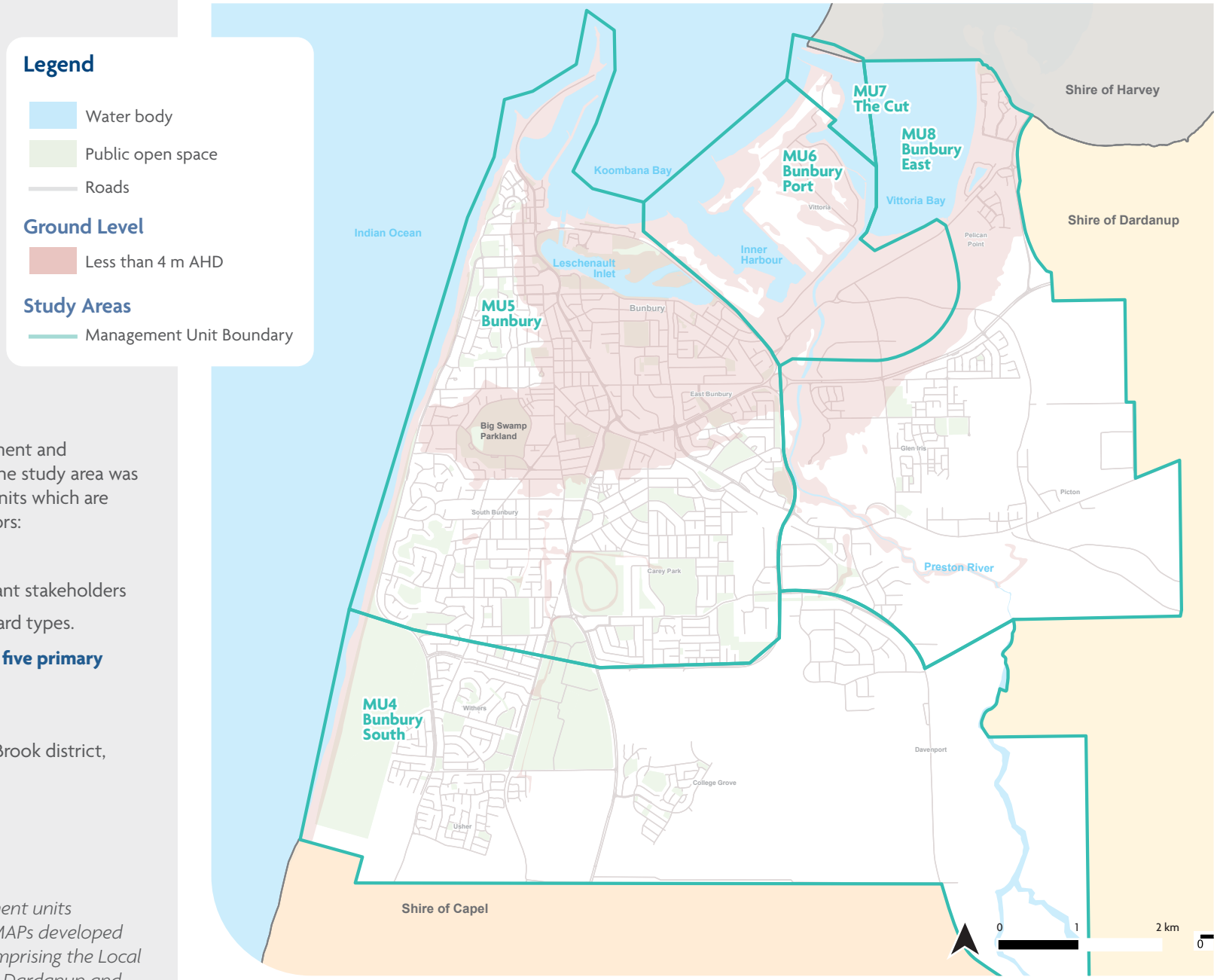


Figure 3: Bunbury CHRMAP study areas (overlaid are suburbs and roads)

2 Existing Environment

Figure 4: City of Bunbury Shoreline Characteristics

Table 2: Shoreline Characteristics

	ASSESSMENT ZONES		TYPE	SHORELINE DESCRIPTION
MU4	1	• Mindalong Beach	Sandy	• Straight open coast, sandy beach backed by coastal reserve (Maidens Reserve) • Populated town site with public assets such as playground, lookout, car parks etc.
MU5	2	• Hungry Hollow Beach • Back Beach	Sandy Buried Seawalls	• Populated coast at Bunbury • Straight open coast, sandy beach • Presence of buried seawalls[1]
MU5	3	• Five Mile Brook & Big Swamp Wetland	Drainage Channel	• Inland area with a low elevation
MU5	4	• Point Casuarina	Mixed	• Low rock (basalt) outcrops • Presence of numerous assets
MU5	5	• Casuarina Drive (South of the Spur Groyne)	Sandy	• Backed by Casuarina Drive, sandy beach
MU5	6	• Casuarina Drive (outer Harbour breakwater, Casuarina Harbour)	Physical Control	• Bunbury Port sand trap • Bunbury Outer Harbour Berths, breakwater and Casuarina Harbour • Key protection for Koombana Bay • Casuarina Harbour currently under redevelopment
MU5	7	• Jetty Baths Beach • Ski Beach • Koombana Beach	Sandy	• Protected beach backed by Casuarina Drive • Small sandy beach under protection of the Plug storm surge barrier and breakwater/groynes • Key public space and assets; significant developments and recreational facilities
MU5	8	• Marlston Waterfront	Seawall	• Key public space and assets
MU5	9	• Koombana Bay Sailing Club • Storm surge barrier	Sandy	• Small sandy beach under protection of the storm surge barrier & Koombana Beach breakwater/groyne • Potential breakwater protection

	ASSESSMENT ZONES		TYPE	SHORELINE DESCRIPTION
MU5	10	• Leschenault Inlet	Foreshore protection Mangrove habitats	• Enclosed water • Storm surge barrier • Protection on southern side • Shallow water
MU6	11	• Port area on eastern Koombana Beach	Seawall	• Presence of seawall control • Port land
MU6	12	• Inner Port Berths	Seawall	• Erosion allowances are not directly relevant
MU6	13	• Point Hamilla	Sandy	• Short stretch of sandy beach between two groynes
MU6	14	• Port area at south of The Cut	Sandy	• Short stretch of sandy beach
MU6	15	• Lower Preston River	Riverbank	• North of Australind Bypass • River flood plain
MU7	16	• Turkey Point	Sandy	• Unprotected on both the seaside and estuary side
MU7	17	• The Cut	Seawall	• Some segments are not built to required design standard
MU8	18	• Vittoria Bay	River delta	
MU8	19	• Pelican Point	Sandy, Man-made canal	• Sandy shoreline on western side • Houses connected by canal with physical protection
MU8	20	• Upper Preston Point	Sandy, Tidal flat	• River flood plain

1 Two buried seawalls - near Hayward Street and William Street - were considered in this study. It is acknowledged there are other structures which may provide some coastal protection but they require further investigation.

2.1 Shoreline Type

The current shoreline of Bunbury is a result of combined effects of coastal processes and human intervention.

The City is subject to coastal erosion and inundation, despite the numerous physical controls that have been implemented.

Figure 4 shows the natural and man-made shoreline type in the City of Bunbury study area. *Table 2* describes the shoreline characteristics of each assessment zones. The following information describes the key man-made infrastructure and natural physical controls that exist along the shoreline.

A **Koombana Beach** has experienced westwards movement and progressive erosion on the eastern end. The issue has been studied previously to develop a feasible adaptation option. A seawall structure has been constructed to prevent further erosion. Koombana Beach has been identified as an erosion hotspot (Seashore 2019).

B A breach of the northern training wall occurred at **The Cut** channel into **Leschenault Estuary** in 2012 causing erosion of a sand bar along the northern bank. Emergency remedial work such as minor excavation of the sand bar and landward extension of the northern breakwater (training wall), was undertaken in 2014, however it was not built to specification due to erosion of the site access point. This area has also been identified as an erosion hotspot (Seashore 2019).

(source: Apple maps)

C **Ocean Drive** includes rock outcrops north of Wellington Street along Bunbury Ocean Drive and Baudin Terrace. These rocks in general have a low elevation backed by sandy soil. The shoreline further north is protected by the **Outer Harbour breakwater** and **spur groyne**. Ocean Drive is on the watchlist of coastal erosion (Seashore 2019).

D Shorelines within **Koombana Bay** are either modified by engineering controls e.g., breakwaters and seawall, or within the scope of large-scale developments (such as the Port).

All beaches in Koombana Bay are heavily modified due to the construction of the Port's inner harbour and river diversion. Sandy beaches are also present inside the bay, e.g., within **Casuarina Harbour**, **Koombana Beach**, and near **Turkey Point**.

E **Leschenault Inlet** and surroundings have a low-lying nature and are vulnerable to present and future inundation hazards. A **tidal gate** (Bunbury storm surge barrier, or the Plug) was installed near the entrance to prevent coastal flooding.

F **Five Mile Brook** is one of the main drainage paths of the City. The surrounding areas, including the **Big Swamp Reserve**, have a low ground elevation. There are one-way valves at the outfall location.

G **Preston River** flood plain. Riverbank protections were built to restrict the spreading of river flood.

2.2 Historic Shoreline Changes

2.2.1 Development in Koombana Bay

Koombana Bay has experienced **significant development since the 1900s** (see *Figure 5*).

- The outer harbour breakwater was constructed in the early 1900s which formed the current layout of Koombana Bay.
- Since then, numerous coastal infrastructure projects have been implemented, including the construction of the Inner Harbour and various groynes, breakwaters, and jetties to stabilise the shoreline, including:
  - » The storm surge barrier in the 1970s
  - » Inner Harbour in the 1970s
  - » The Cut in the 1950s-1970s
  - » Northern Breakwater Arm in the 1980s

Investment in Bunbury's coastline has increased in recent years, including:

- Planned, yet to be implemented, **Inner Harbour expansion** (*Figure 6*) by Southern Ports Authority (SPA).
  - » The expansion of the inner harbour has been in discussion for at least three decades.
  - » In 2009, Bunbury Port drafted a structure plan as a policy document to guide the development and decision making of the Inner Harbour.
  - » More recently, a draft master plan has been prepared.

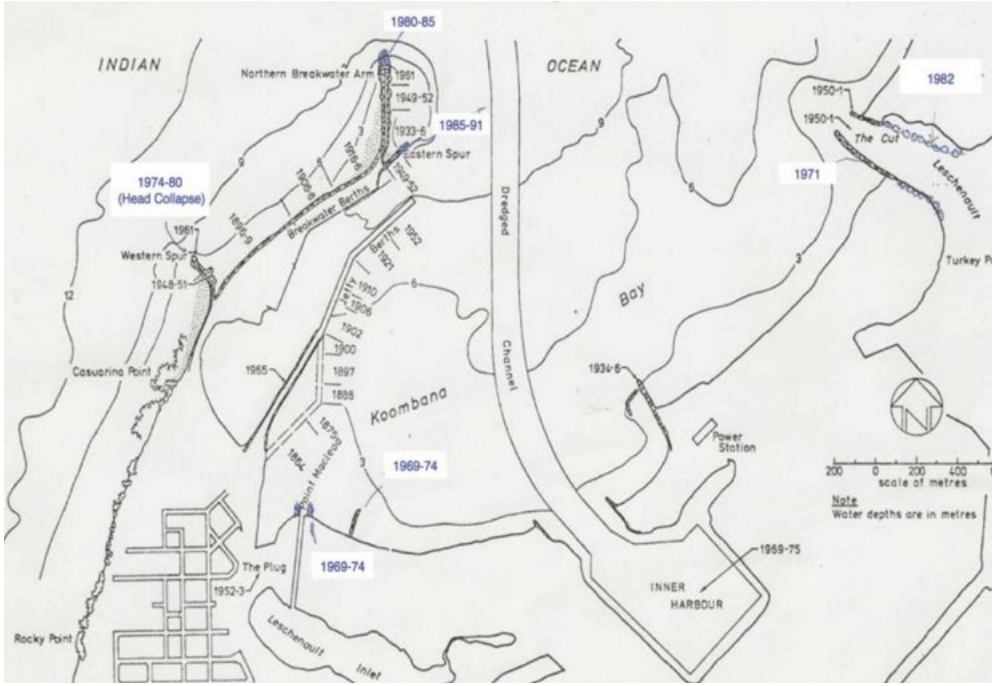


Figure 5: Historic Developments in Koombana Bay (until 1990s) (Taken from Water Technology 2023)

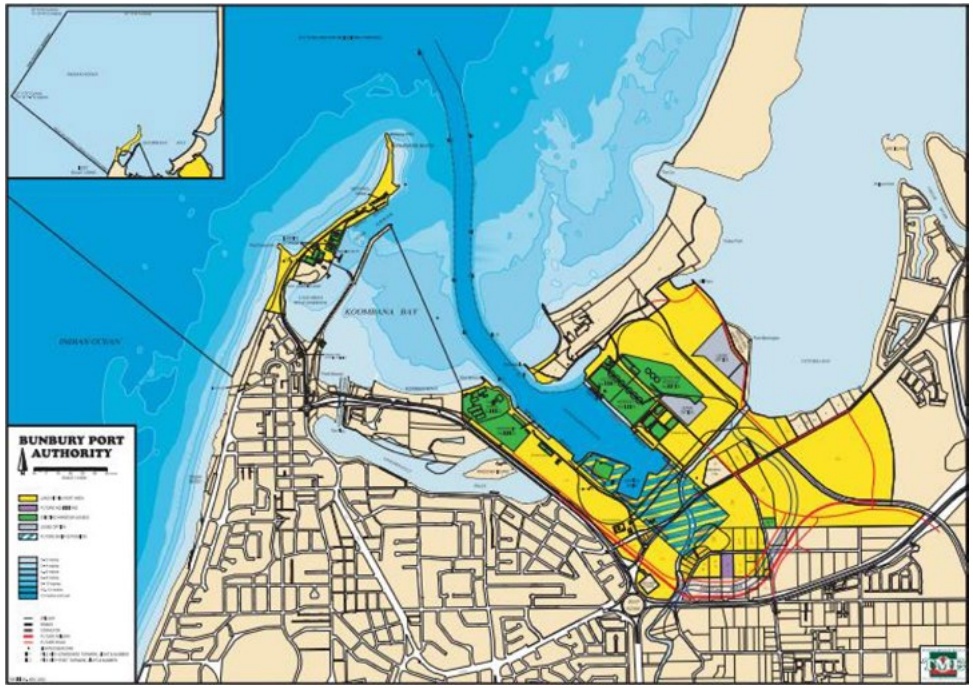


Figure 6: Expansion of the Inner Harbour (taken from 2009 Inner Harbour Structure Plan)

- **Transforming Bunbury's Waterfront** (*Figure 7*) by the Department of Transport and South West Development Commission. This development includes multiple stages:
  - » Koombana Foreshore revitalisation and Dolphin Discovery Centre Redevelopment (completed)
  - » Jetty Road Causeway upgrade (completed)
  - » Casuarina Drive Redevelopment (underway)
  - » Construction of new breakwaters for Casuarina Harbour (funding announced, planning in progress subject to approvals, including environmental approvals)
  - » Koombana Sailing Club Marina, (planning in progress - subject to approvals, including environmental approvals)

Figure 7: Bunbury Waterfront transformation - Marina Structures (Taken from RPS 2015)

2.2.2 Developments in Leschenault Inlet

Leschenault Inlet is a remnant of the lower section of the Leschenault Estuary, which was separated from the main water body by the construction of the Inner Harbour in the 1970s. The inlet has an area of approximately 70 hectares and is now one of Bunbury's most important recreational waterfronts. Since the 1980s, the inlet has undergone significant development including construction of foreshore protection (seawalls), boat ramps, jetties, boat clubs, discovery park, car parks, foreshore reserves, and boardwalks.

In 2013, the City prepared a **Leschenault Inlet Master Plan** to guide future development and planning for the area (*Figure 8*). The plan prioritised management of the inlet for the future.

Currently, the inlet comprises a mangrove reserve, and segments of engineered shoreline protecting the foreshore area. The foreshore is backed by paved roads and urban development and has limited setback for shoreline management. The Bunbury storm surge barrier (the Plug) limits high ocean water levels impacting the inlet and surrounding lands.

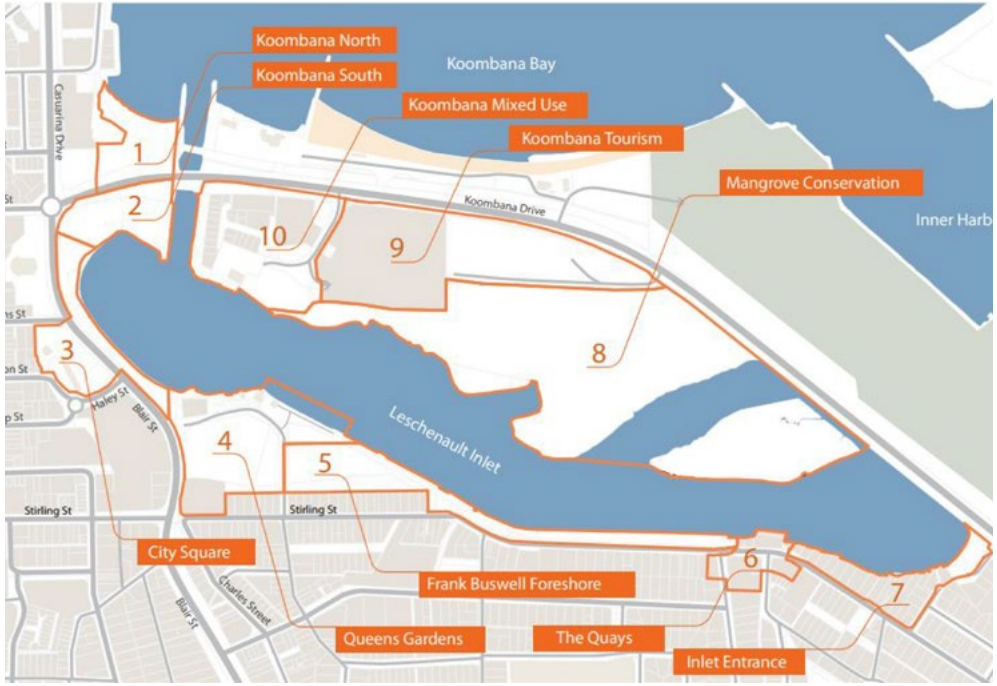


Figure 8: Leschenault Inlet Master Plan (City of Bunbury, 2013)

2.3 Metocean Conditions

Key documents and datasets have been reviewed to provide context for this CHRMAP, including data on metocean (meteorological and oceanographical) processes, coastal processes and existing coastal hazard information. Sources of information identified as directly relevant to inform this CHRMAP have been utilised and referenced and reported in *Chapter Report: Coastal Hazard Assessment*.

This significant detail can be summarised as follows:

2.3.1 Water Levels

Ocean water levels over the project region comprise variations from astronomical tide, wind and wave setup, atmospheric pressure, seasonal and interannual anomalies, riverine discharge, and periodic impacts of tropical cyclones, coastal trapped waves and tsunamis.

Tidal Planes - tidal motion of the region can be characterised by one high tide and one low tide per day. Tidal range is approximately 0.8 m during spring tide and can be much smaller during the neap phase.

Non-tidal Water Level Variability - oceanographic processes have a substantial influence on variability in coastal sea levels, related to the El Niño Southern Oscillation (ENSO) cycle. Impacts may be enhanced in the future due to the increased risk of extreme La Nina events under a warmer climate.

Storm Surge - storm surges arise in relation to strong winter storms moving out of the Southern Ocean, as well as tropical cyclones travelling from the tropics.

Tsunami - although usually occurring at a lower frequency than storm surge and river flood events, inundation levels are likely to be similar to that of the 500 years ARI storm surge levels; with a predicted wave height of 1.6-1.8m.

Seal Level Rise (SLR) - recommended SLR for 2120 is at +0.9 m above current levels, per the requirements of SPP2.6.

Wind Climate - average wind speeds are around 18 km/h, peaking at 36 km/h. The strongest storm winds can reach about 71 km/h for a 1-year event and over 94 km/h for a 100-year event, especially from the west.

Tropical/Extra-tropical Cyclones - most likely from December to April, the southwest region seldom experiences cyclones. However, when they do occur such as Tropical Cyclone Alby or Tropical Cyclone Bianca, tropical cyclones can pose greater coastal hazards than winter storms due to extreme winds often surpassing 108 km/h, extreme waves, severe storm surges and intense rainfall, particularly affecting low-lying areas like the Leschenault Inlet and Estuary (Bunbury, East Bunbury, Picton, South Bunbury and Pelican Point/the Grand Canals).

2.3.2 Wave Climate

Wave climate is largely influenced by deep-water swell waves from the Indian and Southern Oceans, with significant seasonal variations. Four main wave sources occur in Bunbury:

- Offshore swells, larger during winter
- Storm waves from winter storms
- Local wind seas from sea breezes
- Tropical/extra-tropical cyclones

Extreme Wave Conditions -

Offshore: wave height predictions varied from 6.7 m to 11 m.

Koombana Bay: wave height predictions varied from 0.9 m to 3.4 m with a reduction in heights attributed to the Outer Harbor breakwater.

Casuarina Harbour: wave height predictions varied from 0.2 m to 0.6 m with a reduction in heights attributed to the Casuarina breakwater and Jetty Road Causeway. The proposed new breakwater in this location is expected to keep this wave energy low.

Leschenault Estuary: wave height predictions suggest a maximum of 0.6 m in this low wave energy environment, with significant winds required to generate more substantial wave height.

Leschenault Inlet: wave height information was not available for this water body, although as a small and confined water body, it is expected to be low energy.

2.4 Coastal Processes

2.4.1 Geomorphological Setting

Landforms and shorelines are formed over many thousands of years. Over 6,000 years, significant shoreline changes have occurred, influenced by geological factors like rock formations and mobile sand ridges.

The foreshore features simple seabed contours, parallel sand dunes, and wetlands or lakes between dunes. While limestone rock is sometimes found, it's rarely above sea level. Outcropping basalt rock is present between Rocky Point and Casuarina Point at Bunbury.

Over the next 10 years, the majority of change is expected to be the result of storms and seasonal shoreline variability. Over the 100 year timescale of the CHRMAP, change is expected to be the result of local landform changes and metocean climate and weather events

2.4.2 Sediment Cell

Sediment (predominantly sand) cells are areas of the coast within which marine and terrestrial landforms are likely to be connected. Sediment cells are used to assist coastal planning, management, engineering, science, and governance along the coast.

2.4.3 Sediment Transport

Sediment transport within the project predominantly flows in a northwards direction, driven by the dominant westerly/south-westerly swells throughout the year.

2.4.4 Local Processes

Ocean Drive, Casuarina Breakwater and the Outer Harbour

Although sediment moves predominantly northwards, basalt outcrops have stabilised the shoreline at Point Casuarina, leading to a wider beach at Bunbury Back Beach on the southern side of Wyalup Rocky Point. Sand drift has caused sand accumulation against the Spur groyne north of Rocky Point and then again at the Casuarina Breakwater near McKenna Point. This sand build up can be mobilised by a southerly storm around the head of the breakwater.

Seawalls along this coast, especially at Bunbury Back Beach, offer extra protection to crucial foreshore areas.

Jetty Baths Beach & Ski Beach

The Jetty Baths and Ski Beach have remained stable, likely influenced by a lower wave energy compared to more exposed beaches like Koombana and Back Beach. Physical barriers, such as Jetty Road and the storm surge barrier training wall, have created isolated, stable sediment cells at these beaches, supported by larger sand grain sizes (that move less readily).

Koombana Beach

Sand transport along Koombana Beach predominantly moves westward. There's been significant sand buildup on the western part and minor erosion, while the eastern side continuously erodes. Studies suggests potential for 6-20 m of erosion during severe storms.

Koombana Beach has undergone extensive engineering with groynes, revetments, and edge treatments affecting its shape. These structures, including those protecting the Dolphin Discovery Centre influence the beach's future morphology.

Sand is trapped between groynes most of the year, though sand may be lost during storms.

Leschenault Inlet

The shoreline is protected by rock revetments and mangrove habitats, with minimal landscape changes observed, and sediment movement is low due to the area's low wave energy. The City undertakes minor maintenance of the Sykes Foreshore beaches through sand replenishment.

Leschenault Estuary

The estuary was altered by the construction of The Cut entrance in the 1950s, division into Leschenault Inlet and Estuary in the 1970s, and various industrial and dredging activities.

Overall, the Leschenault Estuary has seen little change since the early 2000s, with low sediment transport rates except near river mouths and The Cut entrance.

Riverbank Erosion

The various riverbanks are generally stable. Historically, the Preston River has been realigned with flood levees extending to the Forrest Highway.

The Collie River and catchment have moderately degraded banks, but few engineered responses. Satellite images show that the location of riparian zone did not change significantly in past 20 years.

Coastal Management

Coastal management currently includes activities such as monitoring, revegetation, repairs and maintenance of the storm surge barrier, sand nourishment (bringing in sand) and management and maintenance of coastal structures (breakwaters, groynes, seawalls).

2.5 Existing Physical Controls

Physical controls have been implemented primarily along Casuarina Drive, inside Koombana Bay (including the inner Harbour) and Leschenault Inlet.

Table 3 lists some major physical controls in Bunbury region and may not provide a complete list of physical controls over the entire study domain.

The influence of existing physical controls has been considered throughout the CHRMAP.

Table 3: Physical Controls

LOCATION	PHYSICAL CONTROL	STRUCTURE TYPE	MATERIAL	JURISDICTION
Leschenault Inlet	Pat Usher Foreshore	Seawall	Limestone Block and Mortar	CoB
	Rowing Club	Seawall	Basalt and Concrete	CoB
	Queens Gardens	Seawall	Basalt and Concrete	CoB
	Stirling Street	Seawall	Limestone Block and Mortar	CoB
	Frank Buswell Foreshore	Seawall	Limestone Block and Mortar	CoB
	Richmond Reserve	Seawall	Coffee Rock and Concrete	CoB
	Koombana Boardwalk	Seawall	Sheet Piling and Rock Armour	CoB
	Sykes Foreshore	Seawall	Rock Armour	CoB
	Power Boat Club	Seawall	Limestone Block	CoB
	The Plug – Les D Vorak	Seawall	Rock and Mortar	CoB
	The Plug – Youth Precinct	Seawall	Rock Armour	CoB
Ocean Drive	Five Mile Brook outfall	Unclear		TBC
	Ocean Drive Spur	Groyne	Rock	SPA
	Casuarina Drive Outer Harbour Breakwater	Breakwater	Rock	SPA
	Ocean Drive – Hungry Hollow	Revetment Wall	Unknown	CoB
	Ocean Drive – Hayward Street	Revetment Wall	Unknown	CoB
Koombana Bay	Koombana Bay Jetty Road	Breakwater	Rock	DoT
	Marlston Waterfront	Seawall	Rock Armour	CoB
	Ski Beach Groyne	Groyne	Rock	TBC
	Storm Surge Barrier	Storm Surge Barrier		DoT
	Koombana Bay Sailing Club Groyne	Groyne	Rock	TBC
	Koombana Foreshore – Sailing Club	Revetment	Unknown	CoB
	Koombana Foreshore – Dolphin Discovery	Revetment	Unknown	CoB
	Koombana Beach Eastern Seawall	Seawall	Rock Armour	SPA
	Point Busaco Groyne	Groyne	Rock	SPA
	Point Hamilla Groynes	Groyne	Rock	SPA
Pelican Point	Pelican Point – Taylor Foreshore	Seawall	Limestone Block and Mortar	CoB
Turkey Point	The Cut	Seawall	Rock Armour	CoB
Inner Harbour	Inner Harbour Berth	Berth	Rock	SPA
Rivers	Weirs/gates/riverbank protection			TBC

CoB = City of Bunbury DoT = Department of Transport SPA = Southern Port Authority

2.6 Asset Identification

Coastal assets (both natural and built) were identified in the following ways:

1. Asset information was provided for use in this study by the City and included in a GIS database.
2. Landgate was accessed to identify assets, including roads.
3. The coastal values survey(s) and other engagement activities identified additional assets of importance and value to the community.
4. Site visits investigated locations where information required greater detail or clarity.
5. Further assets were identified manually from aerial photography (e.g., developed areas of foreshore reserve).

2.6.1 Asset Categories

One of the main challenges of this CHRMAP is the numerous assets and management zones. This asset classification was developed to address the main coastal adaptation issues and key locations and enable a simple yet effective method for adaptation planning.

At the time of identification, each asset was categorised into a classification. This streamlines the adaptation planning process in subsequent phases of the project. The study team grouped assets as follows:

1. **Roads**.
2. **Residential Properties**, including both occupied and vacant land.
3. **Commercial Land and Assets**, e.g., bars, shops, markets etc.
4. **Public and Community Assets** not located in the foreshore reserve e.g., car parks, recreational facilities.
5. **Developed Foreshore Reserve**, including coastal, estuary and river foreshore areas containing public assets, e.g., car parks, public ablutions, playgrounds, walkways, access structures.
6. **Undeveloped Foreshore Reserve**, including coastal, estuary and river foreshore areas.
7. **Environmental Assets**
   - » Contaminated sites.
   - » Matters of National Environmental Significance (such as black cockatoo species and Western Ringtail Possums).
   - » Threatened and Priority Ecological Communities.
   - » Known locations of threatened flora.
8. **Agricultural/Rural Lots**.
9. **Aboriginal Heritage** e.g., Registered sites and other heritage places.

3 Community and Stakeholder Engagement

3.1 Why We Engage

The key to the success of the CHRMAP project was to ensure that the plan is underpinned by community and stakeholder values and knowledge.

To this end, a Community and Stakeholder Engagement Plan was developed in order to identify relevant stakeholders and determine the structure and pathways for their engagement throughout the CHRMAP process. The plan intended to be tailored to identified stakeholders, open to any other interested stakeholder, and be commensurate with the size and scope of the CHRMAP.

This plan was prepared in accordance with the requirements of, and for consistency with, the following documents:

- Capel to Leschenault Communications Framework (PNP, 2020).
- The International Association of Public Participation (IAP2).

Engagement Objectives

The overarching objectives of the community and stakeholder engagement plan for the CHRMAP were to:

1. Establish strong working relationships with community networks and stakeholders.
2. Ensure all stakeholders have up to date information about the CHRMAP.
3. Provide the community and relevant stakeholders the opportunity to have direct input into the development and delivery of the CHRMAP.
4. Understand community goals and aspirations for the coastal zone and community views on values, assets, opportunities and priorities.
5. Aid in identifying key issues and selecting site-specific CHRMAP management actions to address them, based on knowledge of the area developed over years of interaction.
6. Increase community and stakeholder understanding of, and support for, actions and priorities in the CHRMAP.

3.2 How We Engaged

The engagement activities for the initial stage of the project included:

- Use of an **interactive mapping** tool to gather feedback on values, use of the coastal and riverine environment and other comments.
- **A survey** mirroring the online task.
- **A community workshop** held in September 2021 to discuss coastal processes, map community values and understand issues and concerns of the community for the study area.
- **Direct engagement** with Traditional Owners and Indigenous representatives.
- **Key stakeholder meetings.**

This initial stage was undertaken from July to September 2021.

Briefings to key City staff members and regular meetings with the steering group comprising administrative staff from PNP, the Department of Planning, Lands and Heritage, the Department of Water, Environment and Regulation, the Southern Ports Authority and the Department of Transport were also included in initial engagement, to ensure technical rigour.

Following this early engagement, a second engagement phase was undertaken to present the draft adaptation options. This phase comprised the convening of a Coastal Community Advisory Group in September and November 2022, made up of key stakeholders within the study area who nominated to be involved via an Expression of Interest process.

The final engagement was undertaken during public advertising of the draft CHRMAP, and received limited responses from City residents and stakeholders.

Notwithstanding, the feedback received confirms the need for ongoing and detailed engagement with the community, especially those users groups with direct interface or regular use of the coastal environment.

Engagement Outcomes

The project team received a total of 181 responses and 56 additional comments provided spatially in the first phase (see example in *Figure 9).* The second phase comprised 10 members. Just five people provided feedback during the formal advertising phase. A drop-in session event was held at the surf club during formal advertising which was well attended.

Overall the engagement achieved an approximate reach of more than 445 local community members and organisations.

Refer to *Chapter Report: Coastal Assets and Community Values* and *Chapter Report: Implementation* for detailed community and stakeholder engagement methods and outcomes.

Figure 9: Online mapping tool on Social Pinpoint (snippet)

3.3 What We Heard

The values collated from the engagement were used to **generate the success criteria** for the vulnerability and risk assessment component of the CHRMAP. These ultimately drive the selection of adaptation options. It is important to recognise that ongoing engagement is required to ensure that the CHRMAP is understood and becomes increasingly applicable to all stakeholders.

Assets and values

Key coastal, estuarine and riverine values identified by participants across the whole study area as follows:

- Beaches and estuarine areas for activities like walking, swimming, snorkelling, exercise, views, fishing, surfing, 4WDing
- Wetlands and environmental areas for their flora and fauna diversity which participants could appreciate
- Coastal views, walks and scenery
- Coastal vegetation and the natural environment generally
- Opportunities for observing wildlife at various locations and protecting habitat for these communities and species

Issues and Concerns

Key issues and concerns/risks to the coastal values:

- Beach erosion and its environmental, social and financial impacts
- Vegetation retention, revegetation and the need to do more to protect coastal areas from erosion
- Environmental protection is very important
- Sea level rise and climate change was also a key discussion point, with participants encouraging Local Government to actively addressing climate change impacts
- Contamination and pollution impacts on fauna and flora and the health of waterways from industrial activities along the coastline and river environment, including the Bunbury Port
- Protection of coastal wetlands that mitigate against impacts of extreme events and that are home to birds and wildlife
- Biodiversity and habitat loss
- Human impact on the coastal and estuarine natural assets and values to the community

Success Criteria

The success criteria established for the CHRMAP reflected all stakeholder views, as presented throughout the process.

1. **Conserve**, **enhance** and **maintain** the natural environment and character of the study area.
2. **Facilitate** and **promote** public usage and enjoyment of the natural environment, coast, estuaries and rivers.
3. **Protection** of the cultural values of the coastline.
4. **Manage** impacts to the existing residential areas from erosion and inundation.
5. **Maintain** critical infrastructure supporting the community (roads, utilities).
6. **Manage** and **maintain** coastal infrastructure that provides access to the water and supports the lifestyle enjoyed by people in the region.
7. **Retain** the widest possible range of risk management options for future users of the coast.

The success criteria highlight the need for continuing public access to beaches, beach amenity, and the provision of a coastal foreshore reserve, and also identify the high value placed on protecting the natural environment.

4 Coastal Hazard and Vulnerability

The study area covers a complex shoreline with various types of environments – the presence of rivers, an estuary and inlet has increased the complexity of the broader study area, in particular the assessment of inundation hazards where river flooding plays an important role.

4.1 Coastal Hazard Assessment

The CHRMAP produces hazard maps defining the potential extent of erosion and inundation over long term timeframes. This CHRMAP presented the timeframes of Present day (2020), 2035, 2050 and 2120.

The hazard identification component of the CHRMAP was undertaken to provide a broad understanding of the potential extent, to support government planning at a regional level based on known data and required technical inputs.

It must be acknowledged that once site-specific studies become available, particularly at the estuary/inlet and along the river courses, some of the modelling may change. However, what is always the case, is that a CHRMAP identifies the most robust information available at any given point in time, to allow decision makers to make the best possible decisions.

More detailed risk assessments, and studies such as geotechnical assessment and analysis will be required for the development of detailed responses.

For this reason, the CHRMAP provides a number of recommendations for more research, whilst planning pathways are being modified.

Erosion Hazard Modelling

SPP 2.6 requires the following be considered to assess erosion:

1. Simulate the current risk of storm (S1).
2. Evaluate historic shoreline movement trends (S2).
3. Allow for sea level rise impacts for present day (2020), 2035, 2050 and 2120 (S3).
4. Apply corrections where shorelines comprise existing hazard controls (e.g. seawalls etc).
5. Evaluate erosion for each coastal management zone over the planning timeframes; 2020 (present day), 2035 (short term), 2050 (medium term) and 2120 (long term).

The output is mapping of erosion hazards, represented by lines.

Inundation Hazard Modelling

SPP2.6 requires that modelling allow for the current risk of storm surge inundation, based on processes that have at least 0.2 percent or one-in-five hundred years probability of occurring or being exceeded (S4).

The predicted extent of sea level rise is also required to be modelled.

For Bunbury, the inundation level is modelled through the simulation of a representative cyclone based on the existing Tropical Cyclone Alby track, with adjustments to locate the cyclone eye near the Bunbury region.

The output is mapping of inundation areas.

Refer to *Chapter Report: Coastal Hazard Assessment* for the erosion and inundation study approach, including the modelling tools, considerations and limitations.

A quick reminder:

Erosion

When sediment (sand) is transported away by waves, winds and currents, reducing the size (width) of a coastal foreshore reserve and/or the distance to an asset on the adjoining land.

Inundation

The flooding of a portion of previously dry land with ocean water. It may be a temporary occurrence during a storm event or high tide, or permanent due to sea level rise.

The next four sections provide a summary of the erosion hazard lines and inundation extents that have been modelled in this CHRMAP for each of the City's Management Units.

4.1.1 MU4 – Bunbury South

The Bunbury South Management Unit (MU4) is the City's least affected management unit, with a predicted loss of the natural environment from a wide and flexible foreshore reserve.

- Erosion is predicted to impact natural assets within this management unit with adequate foreshore allowing for natural processes over time.
- Inundation is not anticipated in this management unit, with adequate foreshore allowing for natural processes over time.

Assets at Risk (MU4)

from Present Day (from erosion)

- Developed and undeveloped foreshore

by 2120 (from erosion)

- Public and community assets (coastal paths)
- Environmental assets

by 2120 (by inundation)

- Environmental assets

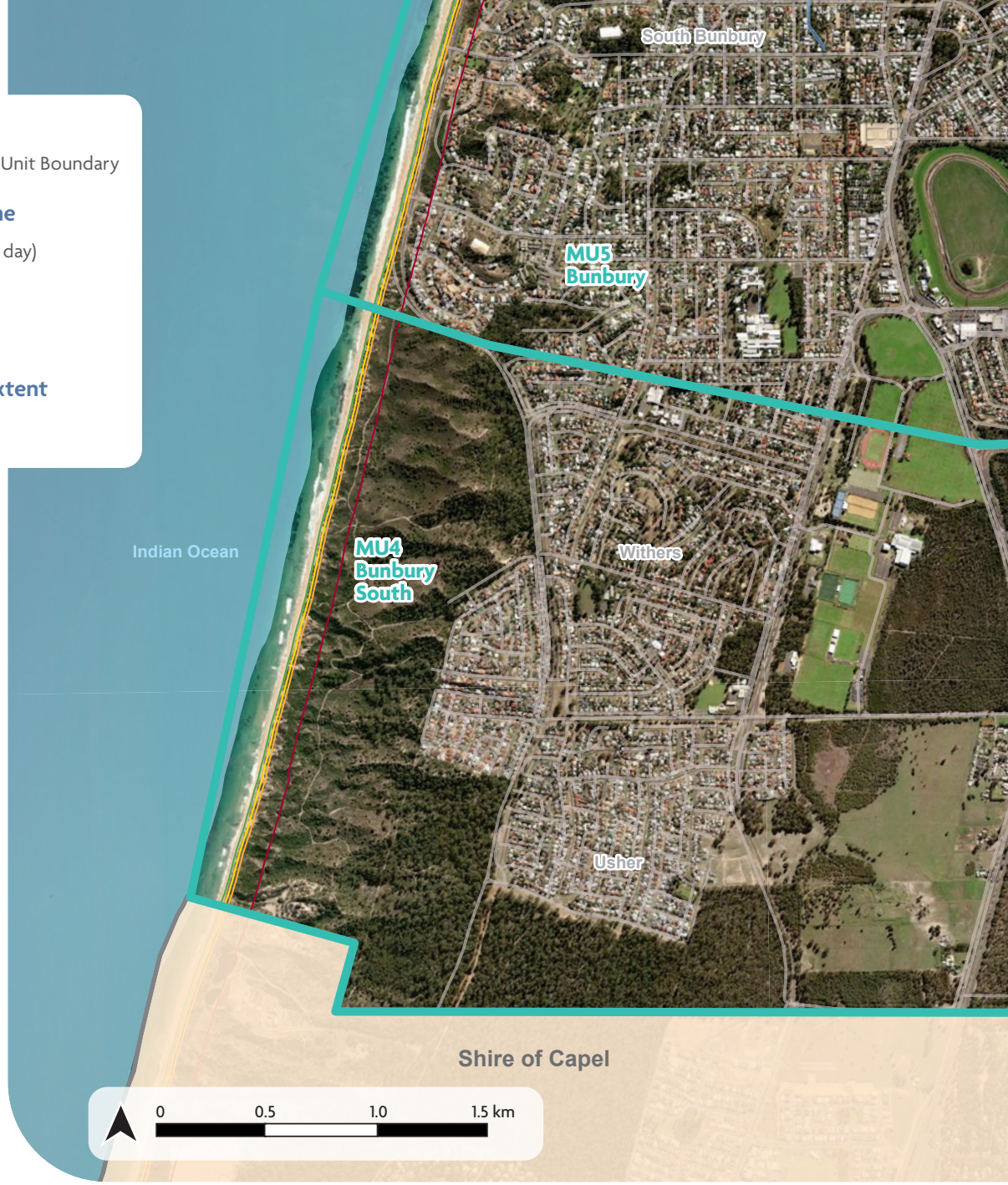


Figure 10: Hazard mapping focusing on MU4 - Bunbury South

Figure 11: Hazard mapping focusing on MU5 - Bunbury)

4.1.2 MU5 – Bunbury

The Bunbury Management Unit (MU5) is particularly at risk.

- Erosion is a significant risk for buildings and natural assets along Back Beach.
- Koombana Bay and Leschenault Inlet are heavily engineered. Erosion may still occur along shorelines not protected by structures. Access to the outer harbour (Casuarina Drive) is at risk from 2035.
- Inundation is a significant risk across much of this management unit, and predicted to increase from present day to 2120. By 2120, the 100-year ARI is predicted to inundate a significant residential and commercial area.
- The storm surge barrier (the Plug) plays a key role in inundation control. Risk will increase if the barrier is not in operation.
- Much of the CBD is predicted to be under water during a 100-year and 500-year ARI storm by 2120. The crest of the current storm surge barrier is about 2.1 m AHD, which and may require modification to withstand these storms in 2120.

Assets at Risk (MU5)

from Present Day (both erosion and inundation)

- Aboriginal Heritage assets, developed and undeveloped foreshore, public and community assets

by 2120 (from erosion)

- Substantial extent of roads
- Significant numbers of environmental assets
- More than 200 residential properties
- Several commercial assets

by 2120 (by inundation)

- Extensive road networks
- Extensive environmental assets
- More than 2,000 residential properties
- Hundreds of commercial assets

4.1.3 MU6 – Bunbury Port

Largely developed with port infrastructure design to withstand and work with the coastal environment, MU6 is at risk over longer timeframes.

- By 2120, the land near the entrance to the inner port will be at risk from erosion. Reinforcement may be required for shoreline segments not protected.
- The area is at risk from inundation at the port and other lower ground areas, although main port facilities are not affected.

4.1.4 MU7 – The Cut

The man-made Cut is at risk over the long term.

- The Cut entrance is vulnerable to erosion by 2120. Seawater may erode the sand dune behind the seawall if not upgraded to higher standards. Overtopping and breaching of the sand dune behind the seawall may occur.
- MU7 is not vulnerable to Inundation in any substantial way.

Assets at Risk (MU6 & MU7)

from Present Day (both erosion and inundation)

- Public and community, developed and undeveloped foreshore

by 2120 (from erosion)

- Several roads (MU6)
- Significant numbers of environmental assets (MU6 & MU7)
- A small number of agricultural/rural lots (MU6)
- Several commercial assets (MU6)

by 2120 (by inundation)

- Several roads (MU6)
- Extensive environmental assets (MU6 & MU7)
- A small number of agricultural/rural lots (MU6)
- Several commercial assets (MU6)

Figure 12: Hazard mapping focusing on MU6 - Bunbury Port and MU7 - The Cut

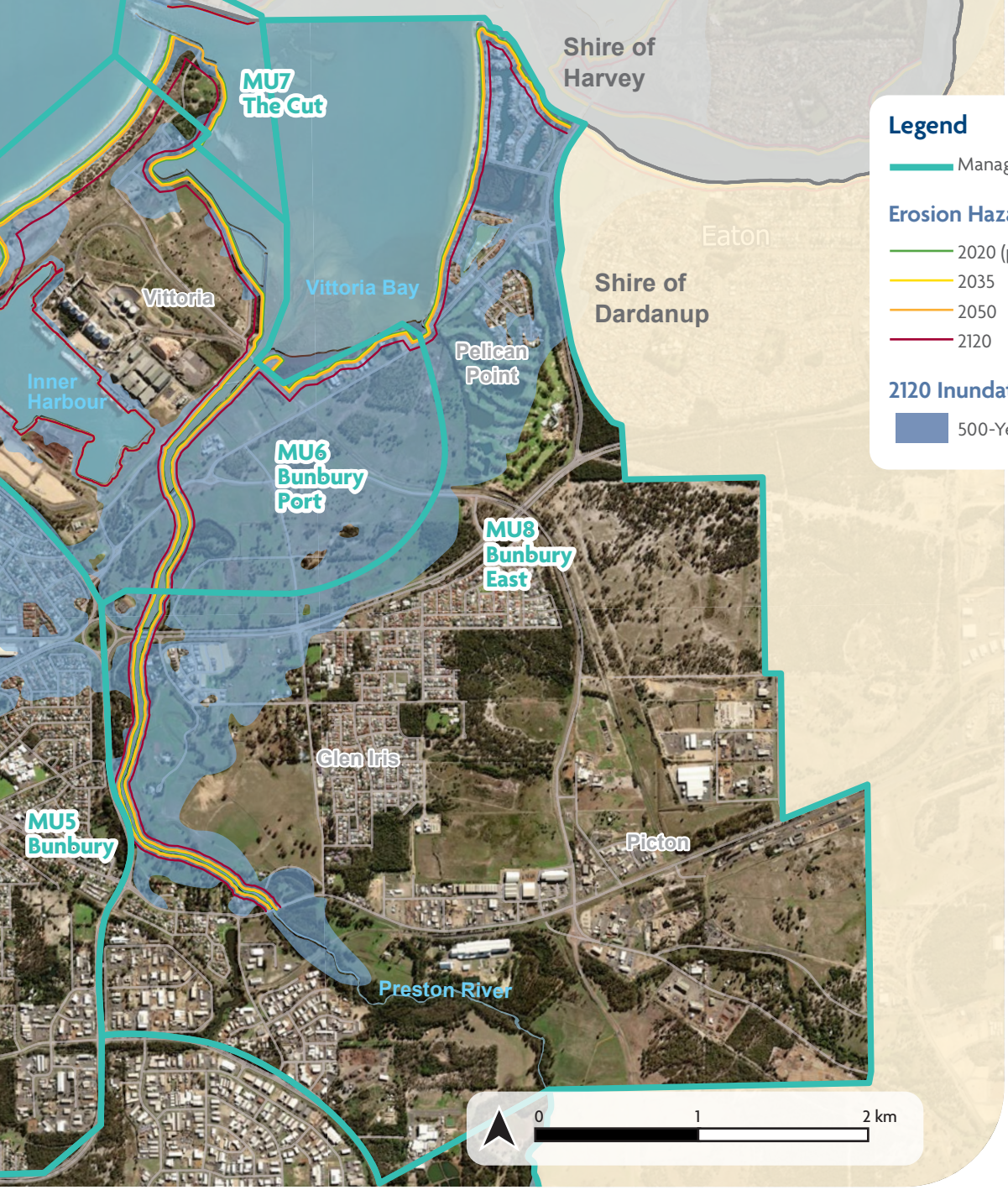


Figure 13: Hazard mapping focusing on MU8 - Bunbury East

4.1.5 MU8 – Bunbury East

The Bunbury East Management Unit (MU8) is particularly at risk.

- The areas surrounding Preston River and the Estuary are at risk from, and experiencing, inundation. Pelican Point, including the Grand Canals, are included in this assessment.
- Foreshore assets and the commercial properties on Estuary Drive are predicted to be at risk from coastal erosion by 2120.
- It is assumed the canal infrastructure will be maintained; however, the canal properties are at risk from erosion along the river and estuary fronts by 2120. Should canals not be maintained, further analysis will become increasingly necessary.

Assets at Risk (MU8)

from Present Day (both erosion and inundation)

- Public and community, developed and undeveloped foreshore

by 2120 (from erosion)

- A small number of roads
- Significant numbers of environmental assets
- Nearly 100 residential properties
- A small number of commercial assets
- Aboriginal Heritage assets

by 2120 (by inundation)

- Substantial extent of roads
- Significant numbers of environmental assets
- More than 400 residential properties
- Several commercial assets
- Aboriginal Heritage assets

4.2 Vulnerability Assessment

Vulnerability analysis constitutes the second stage of the risk identification process. A vulnerability assessment defines the degree of impact coastal hazards are likely to have on coastal assets over the planning timeframe.

The **vulnerability** of coastal assets to coastal hazards is related to its **exposure** to the hazard, its **sensitivity** to that exposure, and the **adaptive capacity** of the **asset at risk** (modified or adapted) to manage this exposure. This is displayed diagrammatically in *Figure 14.*

The vulnerability results are presented in full in the *Chapter Report: Vulnerability Analysis*. A summary is presented in the following pages by management unit and asset category, for the planning horizons of 2020 (present day), 2035, 2050 and 2120.

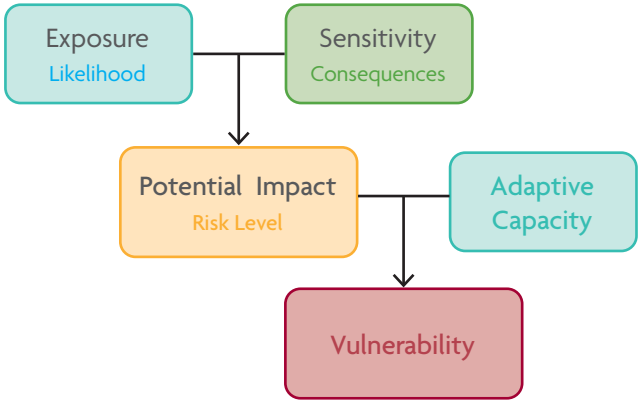


Figure 14: Vulnerability relationship

4.2.1 Vulnerability Ratings

Vulnerability ratings for each category within each management unit at each planning horizon is presented in *Table 4* for erosion and inundation respectively. There is a substantive number of at-risk assets, a total of approximately 48,000 across the broader study area.

The vulnerability ratings are assessed based on the grouping of **nine asset categories** as detailed in *section 2.6.1 Asset Categories*.

Note: Asset categories with Not Applicable results for both erosion and inundation are omitted from these tables.

Table 4: Vulnerability Rating for asset categories of all Management Units in Bunbury

ASSET CATEGORIES	VULNERABILITY RATINGS				SUMMARY
	2020	2035	2050	2120	
MU4 Bunbury South					● **4 categories** are vulnerable to **Erosion** from Medium to Very High levels. Adaptation in some form is required from the present day. ● **3 categories** are vulnerable to **Inundation** at a Medium level. Adaptation in some form may be required from the present day.
Public and Community	⊘	⊘	⊘	⊘	
Foreshore - Developed					
Foreshore - Undeveloped					
Environmental					
MU5 Bunbury					● **8 categories** are vulnerable to **Erosion** from Medium to Very High levels. Adaptation in some form is required from the present day. ● **6 categories** are vulnerable to **Inundation** at Medium to High levels. Adaptation in some form may be required from the present day. ● **Residential and commercial assets** are vulnerable to **Inundation** at a Very High level. For these categories, adaptation in some form is required from the present day.
Roads					
Residential	<5				
Commercial	<5				
Public and Community	<5	<5			
Foreshore - Developed					
Foreshore - Undeveloped					
Environmental					
Aboriginal Heritage					

Legend

- ⊘ Not Applicable (for erosion or inundation respectively)
- <5 Where there are 5 assets or less having a higher vulnerability rating

Erosion Vulnerability

- Low
- Medium
- High
- Very High

Inundation Vulnerability

- Low
- Medium
- High
- Very High

Table 4: Vulnerability Rating for asset categories of all Management Units in Bunbury (continued)

ASSET CATEGORIES	VULNERABILITY RATINGS				SUMMARY
	2020	2035	2050	2120	
MU6 Bunbury Port					● **6 categories** are vulnerable to **Erosion** from Medium to Very High levels. Adaptation in some form is required from the present day. ● **5 categories** are vulnerable to **Inundation** at Medium to High levels. Adaptation in some form may be required from the present day. ● **Commercial assets** are vulnerable to **Inundation** at a Very High level. For these categories, adaptation in some form is required from the present day.
Roads	● ○	● ○	● ○	● ○	
Commercial	● ●	● ●	● ●	● ●	
Public and Community	● ○	● ○	● ○	● ●	
Foreshore - Undeveloped	● ○	● ○	● ○	● ○	
Environmental	● ○	● ○	● ○	● ○	
Agricultural/Rural	○ ○	○ ○	○ ○	● ○	
MU7 The Cut					● **2 categories** are vulnerable to **Erosion** from High to Very High levels. Adaptation in some form is required from the present day. ● **2 categories** are vulnerable to **Inundation** at Medium to levels. Adaptation in some form may be required from the present day.
Foreshore - Undeveloped	● ○	● ○	● ○	● ○	
Environmental	● ○	● ○	● ○	● ○	
MU8 Bunbury East					● **8 categories** are vulnerable to **Erosion** from Medium to Very High levels. Adaptation in some form is required from the present day. ● **7 categories** are vulnerable to **Inundation** at Medium to High levels. Adaptation in some form may be required from the present day. ● **Residential and commercial assets** are vulnerable to **Inundation** at a Very High level. For these categories, adaptation in some form is required from the present day.
Roads	● ○	● ○	● ○	● ○	
Residential	<5 ● ●	● ●	● ●	● ●	
Commercial	● ●	● ●	● ●	● ●	
Public and Community	● ●	● ●	● ●	● ●	
Foreshore - Developed	○ ○	○ ○	○ ○	○ ○	
Foreshore - Undeveloped	● ○	● ○	● ○	● ○	
Environmental	● ○	● ○	● ○	● ○	
Agricultural/Rural	⊘ ○	⊘ ○	⊘ ○	⊘ ○	
Aboriginal Heritage	● ●	● ●	● ●	● ●	

Risk Treatment is Needed for All Management Units

Very High vulnerability has been identified from the present day (2020) onwards. Most of this is predicted to be from erosion, with the exception of residential and commercial, which is vulnerable to inundation.

All Management Units at all planning horizons have unacceptable levels of vulnerability for both erosion and inundation (medium or above) for one or more asset categories.

5 Management Options

SPP2.6 provides a hierarchy of adaptation pathways to guide decision-making in coastal areas to be used by planning authorities and development proponents when considering adaptation options to minimise coastal hazard risks at the local level.

5.1 Adaptation Hierarchy

The hierarchy **describes a clear preference against the adoption of protect** as a long-term adaptation pathway.

This preference is emphasised in SPP2.6, the policy guidelines, the CHRMAP Guidelines and the WA Coastal Zone Strategy.

The objectives of SPP 2.6 are to:

- Ensure that the location of coastal facilities takes into account coastal processes, hazards and climate change projections.
- Ensure the identification of appropriate areas for the sustainable use of the coast.
- Provide for public coastal foreshore reserves and access to them on the coast.
- Protect, conserve and enhance coastal zone values, particularly in areas of landscape, biodiversity and ecosystem integrity and cultural significance.

It is important to note that no law requires public authorities to protect private property from environmental hazards nor provide compensation when property or assets are damaged due to coastal hazards.

Adaptation Considerations for Decision Makers

The CHRMAP process aims to minimise coastal hazard risks and maximise the beneficial use of the coast. The following summarises the considerations for adaptation actions.

- Adaptation options should **minimise coastal process interference and legacy issues**
- Coastal **development must be sustainable** in the long term, and must balance the community, economic, environmental and cultural needs
- **Local Governments are responsible for managing risks to public assets and any assets they manage**. They should also:
  - » **Develop local policies and regulations** consistent with state legislation and policy
  - » **Facilitate building resilience and adaptive capacity** within the local community
  - » **Work in partnership with the community** to identity and manage risks/impacts
- Management strategies that **preserve the natural coastline** and **move development away from the active coastal zone** in an orderly manner are considered ideal. Of particular relevance to the CHRMAP process is the **user pays principle**, whereby those who benefit most from protection must provide the greatest financial contribution.
- Adaptation options should **maintain future flexibility**, in order to build resilient coastal communities.
- A key adaptation option will be the use of **planning instruments**, including managed retreat.

5.2 Risk Treatment Options

Seventeen risk treatment options have been identified to tackle coastal erosion and inundation hazards.

These options, suitable for both immediate and long-term adaptation, are briefly evaluated for their potential use in Bunbury, anticipated benefits, and possible impacts.

It is important to note that while erosion and inundation risk and treatment options are assessed separately, the need for adaptation can arise at any time due to either erosion or inundation.

Avoid

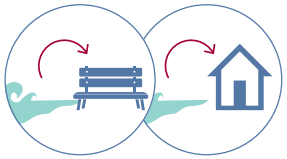
AV – Avoid locating assets in areas that will be vulnerable to coastal hazards

Assets will not be vulnerable to risk arising from coastal hazards.

Planned or Managed Retreat

PMR1 – Leaving assets unprotected

For low values assets, accept loss following event. Only implement repairs to maintain public safety. Allow for retreat that allows natural recession of the shoreline over the long-term.



PMR2 – Demolition/removal/relocation of asset from inside hazard area.

Relevant for assets of low value where it is impractical both technically and financially to design the asset to withstand the impact of the coastal hazards instead of relocating it.

PMR3 – Prevention of further development/prohibit expansion of existing use rights

This risk treatment option allows all assets to maintain current development and usage rights, without expanding those development rights, until the risk from coastal hazards becomes intolerable. This would be outlined in the local planning scheme.

PMR4 – Voluntary acquisition

For private property assets, this risk treatment option would propose the acquisition of affected properties, on a voluntary basis.

Accommodate

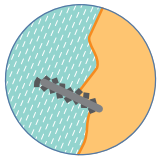
AC1 – Design assets to withstand impacts

Where avoiding or relocating an asset is not an option, design of assets to withstand the impact of inundation.

Protect

PR1 – Sand nourishment

Placement of sand within the beach profile and/or dunes to activate beach coastal processes and provide a sediment supply.



PR2 – Groyne

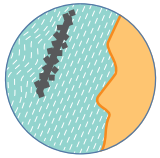
Construction of groynes to stop or restrict the movement of sand around the end of the structure, to provide protection to assets behind the beach/foreshore reserve. They are primarily effective where there is longshore sand movement or when partnered with PR1 sand nourishment.

PR3 – Seawall

Construction of a seawall usually along an entire section of shoreline. Where a beach is to be retained, this risk treatment option should generally be accompanied with PR1 beach nourishment or replenishment.

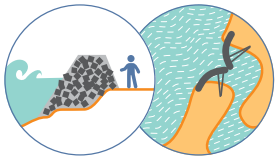
PR4 – Artificial reef

Construction of a submerged artificial reef offshore, to dissipate wave energy impacting the shore by causing waves to break on their seaward side and reducing wave energy on the leeward side. Artificial reefs do not block waves and during storm events water depths over the reef may be sufficient to allow waves to pass over the reef without breaking, reducing their effectiveness in protecting the beach from erosion.



PR5 – Offshore breakwater

Construction of an emergent offshore barrier (often referred to as an offshore breakwater). Offshore breakwaters block wave energy by absorbing wave impact on their seaward side. They create a lower wave energy section of beach immediately in its lee, which is characterised by sand accreting in the low energy environment, when designed appropriately.



PR6 – Levee/weir/storm surge barrier

Inundation protection to minimise inundation on low-lying land. This could be a levee on the banks of a river, a storm surge barrier at the entrance to an inlet/estuary etc. Details would be specific to the relevant conditions of each MU.

No Regrets

NR1 – Monitoring

Involves long-term baseline monitoring and event-based monitoring following storm erosion events.

NR2 – Protection structure audit

Involves undertaking an audit of existing protection structures, to determine their current condition, effectiveness and future protection potential.

NR3 – Notification on Certificates of Title

Indicates to current and future landowners that an asset is likely to be affected by coastal erosion and/or inundation over the planning timeframe. Helps current and future owners make informed decisions about level of risk they are/may be willing to accept, and that risk management is likely to be required at some stage within the planning timeframe.

NR4 – Emergency evacuation plans

Where existing assets may be affected by inundation and are not already identified in an existing emergency evacuation management plan. Such plans are important in managing the safety of community and stakeholders.

Do Nothing

DN1 – Do nothing

Assumes all levels of risk are accepted and that there is no change in existing planning controls, and no actions are implemented (i.e., no controls are implemented to treat known coastal risks).

5.3 Land-Use Planning Instruments

Many of the risk treatment options available rely on land use planning instruments for implementation or to ensure long term outcomes.

This section explores the relevant state and local planning instruments that can be used to increase coastal resilience.

There is a direct relationship between coastal hazard exposure and development. How buildings and assets are designed and located determines their exposure, ultimately impacting risk to people and property. Therefore, the policy instruments that govern development are an important tool to reduce risk exposure.

The City and its partners have acknowledged coastal based hazard for many decades since the flooding experienced from Cyclone Alby in 1978. Planning conditions have been used to support an Accommodate option in the suburb of East Bunbury since that time. A recent CHRMAP has also been prepared for Koombana Bay, and the Koombana Bay, Casuarina Drive and Leschenault Inlet Master Plans refer to flooding and coastal vulnerability, as well as the importance of the waterfront environment.

Notwithstanding, few provisions exist within the City's planning instruments to directly respond to the broader coastal hazard challenge.

This section describes changes to the land use planning framework and other property related matters that may be suitable to support the options described in *section 5.2 Risk Treatment Options*.

Refer *Chapter Report: Implementation* for more detailed background discussion and specific detail on the recommendations.

Local Planning Scheme Amendment - Special Control Area

A Local Government Authority (LGA) can declare a Special Control Area (SCA) over areas that are regarded as significant and where special provisions need to apply.

An SCA overlay typically includes a mapped area where those special development conditions apply. The requirements of a SCA apply in addition to the underlying planning controls dictated by the planning scheme and state framework, such as zoning, building requirements and matters of significance.

The effect of the SCA includes further development regulation, which can then be assessed on a case-by-case basis to control the intensification of land where coastal risks are prominent.

This instrument supports many Avoid, Planned and Managed Retreat, Accommodate and No Regrets options.

AV PMR AC NR

Notifications on Titles

Requiring the provision of a Section 70A Notification on the Certificate of Title of land as a condition of any planning approval to alert prospective purchasers of the potential coastal hazard impacts on the lot, as required by SPP2.6, supports Avoid, Accommodate and No Regrets options.

AV AC NR

Local Planning Policy (LPP)

An LPP can provide more detail and guidance on what sort of development would be acceptable to assist the City in making planning decisions on coastal development (e.g., design responses for setbacks; finished floor levels etc). It could foreshadow the City's intention to require notifications on certificates of title and supports many Avoid, Planned and Managed Retreat and Accommodate options.

AV PMR AC

Reservation of Land

Subject to consistency with other legislation, land within the Local Planning Scheme may be reserved as Foreshore. This is particularly the case for public assets such as public amenities, seating, shelter, playground etc, where such a reservation would give rise to improved asset management and planning of the foreshore.

This instrument supports many Avoid, Planned and Managed Retreat and Accommodate options.

AV PMR AC

Structure Planning

Structure Plans are prepared and approved prior to the subdivision or development of land in development areas identified within the Local Planning Scheme, or where required by Western Australian Planning Commission (WAPC).

In areas where further development or redevelopment of land is possible or anticipated, structure plans incorporating the requirements of the CHRMAP supports many Avoid and Accommodate options.

AV AC

Advice to Real Estate and Settlement Agents

Real estate agents and settlement agents are usually the first people that a prospective landowner will meet on their journey to buying into a town or region. Real estate agents have an obligation to provide information to prospective purchasers, whilst settlement agents are often in touch with the Local Government during settlement to ascertain the current monies owed or conditions applying to land. Although not a catch-all, providing information about the CHRMAP to these parties may help to alert prospective purchasers of the potential coastal hazard impacts on the lot.

This instrument supports No Regret options.

NR

Compulsory Acquisition

Compulsory acquisition is an option where no other planning instrument has been able to suitably set aside land for coastal hazard processes, when hazards have advanced to a stage where land exceeds tolerable risk thresholds. Options include:

- Purchase of the land by the LGA if the owner is willing to sell it by ordinary sale under Section 190 of the Planning and Development Act (2005) (PD Act)
- Compulsory taking by the LGA without agreement under Section 191 of the PD Act coupled with the Land Administration Act (1997).

This instrument supports Planned and Managed Retreat options.

PMR

Other Instruments

Innovative planning instruments, such as leaseback of land and land swaps may be considered. While there is growing interest in these and much work interstate on these matters, these instruments have not been tested in the WA planning context and are not explicitly provided for or anticipated under the State's current planning framework.

Considerations of other instruments, informed by research and implementation case studies from other locations, suitability to the local context, and receptiveness of decision-makers and the community may enable better decision making.

Reviewing existing leasehold facilities located within the hazard zone and notifying the lessee of the CHRMAP may help with determining the suitability and/or length of future leases.

This supports many Avoid, Planned and Managed Retreat, Accommodate and No Regrets options.

AV PMR AC NR

5.4 Multi Criteria Analysis (MCA)

Successful risk management and adaptation planning requires identification and diligent assessment of suitable options to ensure selection of the best strategy. The chosen option should mitigate risk to an acceptable level whilst maximising the values important to the stakeholders and community. In most cases it is necessary to implement more than one option, and the options selected through the MCA may vary between management units and with implementation timeframes.

For this project, the criteria comprised the themes of Environment Impact, Social Impact, Aesthetic Impact, Effectiveness, Future Adaptability and Cost (combined capital and maintenance).

MCA Process and results

An initial assessment of options against the criteria was carried out by the project team. The initial MCA results were then reviewed by the steering group to ensure the ratings reflected stakeholder knowledge and community feedback.

A Coastal Community Advisory Group (CCAG) was subsequently formed, comprising community members from across the study area. Members attended a workshop to further review and to calibrate the MCA scoring, focusing on the **environmental**, **social** and **aesthetic impact** categories. Several scores changed during this review process, but only one overall score substantively changed, which was the Offshore Breakwater in MU8 (changed from Unclear to Not Recommended).

Each option is evaluated based on the six criteria. A score is assigned to each option for each criterion, ranging from negative (-2 or -1), neutral (0), to positive (+1 or +2). *Table 5* summarises the cumulative MCA score of each option for each management unit.

A positive score is shown in green and is considered suitable and further for detailed investigations are complete. A negative cumulative score is shown in red and is not recommended. A neutral cumulative score is shown in yellow and is considered unclear (and may require further investigation or discussion with stakeholders if criteria change over time). N/A is applied where the option is unsuitable for managing a particular hazard.

The MCA methods and results are presented in full in *Chapter Report: Risk Evaluation and Treatment*.

Table 5: Multi-Criteria Analysis summary by Management Unit

RISK TREATMENT OPTIONS			MU4	MU5	MU6	MU7	MU8
AV Avoid	AV	Locating assets in areas that will not be vulnerable to coastal hazards	11	11	11	11	11
PMR Planned or Managed Retreat	PMR1	Leaving assets unprotected	2	2	2	2	2
	PMR2	Demolition/removal/relocation of asset from inside hazard area	7	7	7	7	7
	PMR3	Prevention of further development/prohibit expansion of existing use rights	10	6	6	N/A	6
	PMR4	Voluntary acquisition	N/A	5	5	N/A	5
AC Accommodate	AC1	Design assets to withstand impacts	10	9	10	12	9
PR Protect	PR1	Beach nourishment or replenishment	-7	3	4	4	2
	PR2	Groynes	-11	1	3	3	0
	PR3	Seawalls	-12	-2	0	0	0
	PR4	Artificial reef	-10	-3	-4	-4	-5
	PR5	Offshore breakwater	-12	0	-3	-4	-1
	PR6	Levee/Weir/Storm Surge Barrier	N/A	4	3	N/A	1
NR No Regrets	NR1	Monitoring	7	7	7	7	7
	NR2	Protection Structure Audit	N/A	6	6	6	6
	NR3	Notification on Certificates of Title	7	7	7	7	6
	NR4	Emergency evacuation plans	N/A	6	6	N/A	7
DN Do Nothing	DN1	Do nothing	-8	-8	-8	-8	-8

MCA Results Key Observations

Avoid/Accommodate

Very High Positive Scores (all MUs)

AV – Avoid locating assets in areas that will be vulnerable to coastal hazards

This option applies to undeveloped land. Community will benefit by appropriate foreshore reserve width and access throughout the planning timeframe.

- Most undeveloped land is already zoned as reserve.
- Any undeveloped land should be subject to this option.

AC1 – Design assets to withstand impacts

For inundation hazard only. Early design considerations mean implementation can occur as assets are routinely upgraded/renewed/redeveloped. This option affects very few assets in MU4 and MU7.

Do Nothing

Very High Negative Scores (all MUs)

DN1 – Do nothing

Not an effective adaptation option and may not be popular with the community.

Planned & Managed Retreat

Moderate to High Positive Scores (all MUs)

PMR1 – Leaving assets unprotected

Suitable for low-value public assets such as foreshore recreational amenities. This option was the lowest positive score, with 2 in all MUs.

PMR2 – Demolition/removal/relocation of asset from inside hazard area.

Suitable for low-value public assets such as foreshore recreational amenities. Potentially costly if triggers met before asset due for replacement.

PMR3 – Prevention of further development/prohibit expansion of existing use rights

Allows for continued use of the land whilst viable, without creating legacy issues. May be unpopular with landholders. Nature of environmental reserve can be maintained effectively with this approach.

MU7 N/A

No developed land parcels.

PMR4 – Voluntary acquisition

For private property. Effective but costly option. Ensures foreshore reserve retained. May be unpopular with landholders, depending on implementation strategy and timeframes. Likely to cost less than protection.

MU4 & MU7 N/A

No developed land parcels.

No Regrets

Moderately Positive Scores (all MUs)

NR1 – Monitoring

Low-cost action which causes no problems. Resulting data is required for most management approaches. Also a source of data for identifying triggers for other management options.

NR2 – Protection structure audit

An audit for all existing coastal protection structures is logical in the context of the long timeframes of a CHRMAP. Resulting data is required for most management approaches where structure already exist. Source of data for identifying triggers for other management options.

MU4 N/A

No existing protection structure in MU4.

NR3 – Notifications on Certificates of Title

For private property. Effective low-cost option. May be unpopular with affected landholders, but appreciated by potential purchasers, depending on implementation strategy.

NR4 – Emergency evacuation plans

For inundation hazard only. Doesn't directly address vulnerabilities of assets but low cost to plan for keeping people safe. Important for considering inundation of access roads to any part of an MU.

MU4 and MU7 N/A

Suitable for inundation hazards that may affect people, but given the few affected assets in this MU and their nature, this is not applicable.

Protect

Protect options had divergent scoring results across Management Units.

Low to Moderately Positive Scores (all MUs)

PR6 – Levee/weir/storm surge barrier

The storm surge barrier is effective at reducing inundation, but the present design is predicted to be breached by the present day (2020) 500-year ARI event, and more frequent future events. Upgrades would be effective at reducing the inundation impact.

A storm surge barrier at The Cut may be effective at reducing inundation, potentially combined with additional protection along Preston River. This would be costly; impacts would need to be investigated. Future adaptability scored neutral because it creates reliance on protection but can be modified for increasing SLR if required.

MU4 & MU7 N/A

Inundation is not a high risk in MU4 and not necessarily required in MU7.

Mixed Scored/Unclear

PR1 – Beach nourishment or replenishment

MU5 3 **and MU8** 2

Potentially very expensive if no nearby suitable and sustainable sand source available. Could create legacy issues for future.

MU6 & MU7 4

Small ocean frontage and structure-controlled beaches make it a potentially effective option.

MU4 -7

Not feasible over large section of coastline. Does not complement environmental focus of MU4.

PR2 – Groyne

MU5 1 **MU6 & MU7** 3 **and MU8** 0

A groyne may assist in stabilising the shoreline. Groynes can lead to downdrift erosion issues if not designed and constructed appropriately. It would require sand nourishment as part of the work, which helps provide a sandy beach. Existing structures already in use in MU5.

MU4 -11

Not feasible over large section of coastline. It does not complement the natural environment of MU4.

Negatively Scored

PR3 – Seawall

Expensive option. Likely to lead to reduction or loss of usable sandy beach.

MU4 -12 **MU5** -3

Does not complement the natural environment of MU4.

Already in use in MU5. Likely more acceptable because familiar and MU5 is more developed than others.

MU6, MU7 & MU8 0

May be acceptable at the industrialised area of MU6, especially because there are existing seawalls.

MU7 already has seawall for much of coastline.

For MU8, it is likely more acceptable because nature of MU8 allows smaller structures.

PR4 – Artificial reef

Difficult to design submerged structures to work effectively, and costly to build and maintain. Did not perform well through MCA for any MUs.

PR5 – Offshore breakwater

Costly to build and maintain but can be designed to work effectively and provide usable sandy beach.

MU6 -3 **MU7** -4

MU7 location indicates unlikely to very effective.

MU4 -12 **MU5** 0 **and MU8** -1

Social concerns about ocean views likely. Concerns and some costs could be offset by designing shore-attached structures.

Not realistic due to the length of MU4, and number of impacted assets (and hence low funding potential). Does not complement environmental focus of MU4.

5.5 Options and Triggers

The CHRMAP uses triggers to suggest when adaptation responses (options) should be implemented rather than focusing directly on a specific date or time. Triggers help decision making to occur and when relevant, rather than focusing on predicted timescales.

In this way, implementation of a CHRMAP recommendation can be relevant and timely.

The CHRMAP identifies four types of triggers, as follows:

Proximity trigger: Where the storm erosion allowance (S1) is close to a public asset of interest or private property lot boundary.

Access trigger: Where a public road is considered no longer available or able to provide legal access to nearby property.

Utilities trigger: When water, sewerage, communications or electricity to the nearby property is no longer available as they have been removed/decommissioned by the relevant authority due to coastal hazards.

Damage trigger: Where any property is damaged by a coastal hazard.

An asset at the end of its design life might also constitute a trigger, if monitoring suggests that in-situ replacement is not suitable.

The preference is that triggers are sequential. That is, a **proximity trigger** is recommended over a **damage trigger**.

Figure 15 illustrates how these triggers might be occur over time, reflecting the likely order in which the trigger will result in action being required. Note that many of the triggers will occur when monitoring indicates the need (see *Short-term Implementation*).

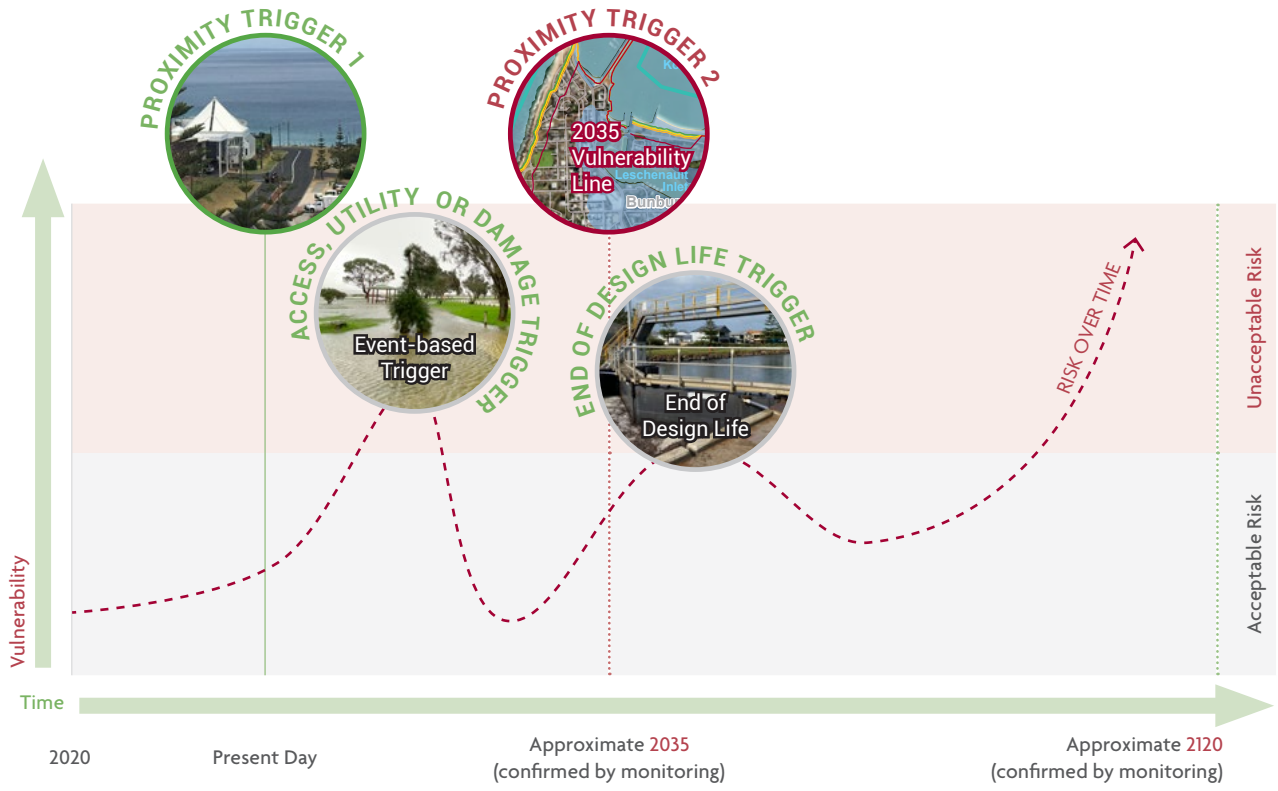


Figure 15: Triggers and How they apply

5.6 Cost Benefit Analysis (CBA)

CBA is a tool used to assist decision-making for selecting coastal adaptation options.

The CBA aims to examine the selection of coastal adaptation options through economic analysis, allowing consideration of coastal adaptation options which are economically more defendable than other options.

While the CBA process assists in comparing the cost of options against each other, it is not a final decision-making tool. Changing scientific, environmental, social and macro-economic considerations can alter cost estimates in the future.

CBA Outcome

MU4 – Bunbury South

No options in the Bunbury South Management Unit (MU4) required further consideration through an economic analysis.

MU5 – Bunbury

The CBA identified PR2 - Groynes, PMR4 - Voluntary Acquisition, PR1 - Beach Nourishment and PR6 - Storm Surge Barrier as suitable for further consideration based on the economic analysis.

MU6 – Bunbury Port

The CBA identified PR2 - Groynes, PR1 - Beach Nourishment and PR6 - Levee as suitable for further consideration based on the economic analysis.

A storm surge barrier option at The Cut did not perform better than the base case and requires more detailed investigation of costs and benefits.

MU7 – The Cut

The CBA identified PR1 - Beach Nourishment as suitable for further consideration based on the economic analysis.

MU8 – Bunbury East

The CBA identified PR2 - Groynes and PR1 - Beach Nourishment as suitable for further consideration based on the economic analysis.

A storm surge barrier option at The Cut did not perform better than the base case and requires more detailed investigation of costs and benefits.

Recommended options for further consideration

The review of the CBA results shows that the ranking of options for each MU changes based on different assumptions, making few options clearly preferable to others.

Refer *Chapter Report: Risk Treatment* for the CBA in detail.

5.7 Benefit Distribution Analysis (BDA)

BDA is a tool used to understand who should be expected to pay when a protect option is selected to be implemented.

A BDA is undertaken to allocate the derived benefits from the options identified to the relevant stakeholder. The relevant stakeholders are all those who are expected to benefit from the protection of the identified area.

Key beneficiaries include:

- Private landholders directly affected
- Local community (direct users of the area under threat)
- Broader community (indirect users, such as occasional beachgoers)

Identifying the beneficiaries and accurately evaluating their individual share of benefits is important. This paves the way for the next step in the BDA: identifying funding options and a funding model.

The CHRMAP guidelines require consideration of a **beneficiary pay principle**; that is, that the beneficiaries of a coastal adaptation option should contribute a proportion of the cost.

BDA Outcome

In general, the BDA finds that various beneficiaries should contribute to the cost of adaptation options.

The amount of contribution ranges from 1% of the cost of the option to 45%, and varies from private property owners through to the State Government.

Generally, the BDA suggests that private land owners should contribute where their assets are vulnerable and being protected, and that the Local Government through rates or the State Government through whole-of-WA taxes should contribute where the assets have a shared value, such as environment, public and community assets and Aboriginal Heritage protection.

The BDA has found that allocating beneficiaries when forecasting coastal management is a complicated process. The process provides information to assist decision-makers with information about the approximate proportion of beneficiaries between private and public parties.

However, while indicative funds appear to be relatively small compared to the value delivered and the overall cost, the costs are not insignificant and further work remains necessary to detail each intervention (ie risk treatment option selected in the CHRMAP), their extent, design standard, program and costs through additional detailed technical studies.

Refer *Chapter Report: Risk Treatment - Benefit Distribution Analysis* for BDA in detail.

5.8 Funding Options

This section identifies all revenue-raising mechanisms available for obtaining funds to assist implementation, assuming that a decision has been made to progress an option.

City of Bunbury Operating Budget and General Rates

The City and other individual land managers within the study area should consider establishing a coastal management fund that includes specific allowance for managing and adapting to the risk posed by coastal erosion and inundation. The purpose of this fund includes:

- To allocate a percentage of the organisation's operating budget for coastal management.
- Retention of funds so that management actions can be implemented efficiently when required and where the cost benefit has been determined as positive.

Specified Area Rate

Where adaptation options are designed to protect specific sections of coastal land and assets, such as private property, it is recommended that the City progress the establishment of a specified area rate. It is recommended that the City consider the need and suitability of a Specified Area Rate in conjunction with further detailed investigations and design.

Levies

It is recommended the City investigate the feasibility of establishing a particular levy for coastal management that would be a transparent source of the coastal management fund discussed above.

Lease Land Management

Coastal land leased to third parties represents a unique scenario whereby implementation of some options may require specific lease clauses. During considerations of lease renewal, coastal managers should consider the land use, vulnerability of the land, projected timeframe of unacceptable vulnerability, length of lease, recommended implementation options and need for any specific clause for implementation by the lessee.

Beneficiary Pays

Mechanisms for fund raising may include:

- **Specified Area Rates**
- **Mechanisms for visitors** to the town, as users of the coastline, to contribute. This could be in the form of a levy applied to their accommodation, or paid parking at key tourist sites.
- **Developer contributions** where specific developments benefit from their coastal location.

State Grants

A number of grants programs exist in WA that may support implementation.

Department of Transport grants:

- **Coastal Adaptation and Protection (CAP)** grants, which fund up to 50% of project costs.
- **Hotspot Coastal Adaptation and Protection (H-CAP) Major Project Fund**, invitations to apply are sent directly to eligible coastal managers (completed CHRMAP and an identified erosion hotspot).

Department of Planning, Lands and Heritage grants:

- **Coastwest grants** support eligible coastal land managers and community organisations to undertake projects such as rehabilitation and restoration of the natural environment.
- **Coastal Management Plan Assistance Program (CMPAP)** grants support eligible coastal land managers to develop adaptation and management plans and strategies.

Other WA grant programs which may provide funding for coastal projects include Royalties for Regions and Local Government Financial Assistance Grants.

- **Royalties for Regions** is facilitated by Department of Primary Industries and Regional Development.
- **Local Government Financial Assistance Grants** are administered by the Department of Local Government, Sport and Cultural Industries.

Federal Grants

Federal grants are variable and often unpredictable, but it is important for coastal managers to stay aware of any funding and grant programs available.

- **Disaster Ready Fund** aims to decrease impacts of natural hazards, and eligible projects include direct investment in flood levees, seawalls, constructed wetlands and reefs.

6 Recommendations

The CHRMAP recommendations are based on currently available information, and made based on a number of assumptions recognising the gaps in information that still need to be resolved.

Future investigations are required to confirm they are suitable, including further consultation with stakeholders and the community. The next step is to develop a program of investigative works over the short to medium term, to help inform the timing and scope of future investigations.

A likely outcome is that a combination of options may be the preferred approach in some locations. Additional considerations may be incorporated into future analyses.

All recommendations still need further research. The CHRMAP provides the basis for which for the City may access grant funding to undertake this work and how recommendations may be updated, improved, or confirmed. This process requires ongoing engagement with affected communities.

Refer *Chapter Report: Implementation* for all recommendations in detail.

6.1 Recommended Actions by Priority

How to read the recommendations

Table 6 lists the recommended management actions by priority including short term recommendations to address erosion and inundation for each specific management unit are summarised.

In addition, long-term adaptation strategies/pathways have been recommended for erosion and inundation that will allow for the continuous function of local communities whilst accommodating the increasing burden of coastal hazards.

The long-term strategy informs future planning instruments, supports monitoring, recommends planning reviews and underpins collaboration between coastal land managers, stakeholders and the community.

The medium and long term adaptation strategies/pathways are summarised in *Table 7*.

All recommendation tables are presented with the elements in the legend for easy reference.

Legend

- Management Unit - relevant management unit
- Responsibility - responsible authority
- Funding - related funding options
- $$ Cost - estimated funding and cost requirement
- Timeframe - when the action should be taken
- Trigger - factors to inform decision-making

Table 6: Recommended management actions to address coastal hazards

	RECOMMENDATION	RESPONSIBILITY	FUNDING AND COST	TIMEFRAME AND TRIGGER
1	**INVESTIGATION 1 – Detailed action plan* followed by investigations to confirm assumptions used in the CHRMAP** MU5 MU6 MU7 MU8 Undertake detailed investigations to confirm assumptions used in the CHRMAP; and consider protect options (e.g. rock groynes). *A Short-term Coastal Action Plan has been prepared as part of the CHRMAP and can be found in *Implementation*.	City of Bunbury	Operational $$ up to $1 million	2023-2030 Completed CHRMAP
2	**INVESTIGATION 2 – Update Foreshore Management Plans (FMPs)** ALL Prepare an updated Foreshore Management Plan. • MU6 - Incorporate appropriate clauses into operational and strategic planning and lease conditions (Southern Ports). • MU7 - Joint approach with Southern Ports.	City of Bunbury • MU4, MU5, MU6, MU7, MU8 Southern Ports • MU6, MU7	Operational Grants $$ up to $500k	2025-2120 Completed CHRMAP
3	**INVESTIGATION 3 – Audit of assets within 2035 Erosion hazard zone** ALL Audit of assets within 2035 erosion hazard zone and identification of assets where damage would be unacceptable. • MU4 - Investigation to determine acceptable foreshore amenity within hazard zone. • MU8 - Further investigation, feasibility analysis and further civil and maritime design considerations.	City of Bunbury Neighbouring LGAs State Government	Operational Grants Specified Area Rate Levies User Pays $$ up to $200k	2023-2035 Completed CHRMAP Monitoring Confirmation of Design/Cost/Funding Confirmation of 2035 SLR

Legend: Management Unit | Responsibility | Funding | $$ Cost | Timeframe | Trigger

Table 6: Recommended management actions to address coastal hazards (continued)

	RECOMMENDATION	RESPONSIBILITY	FUNDING AND COST	TIMEFRAME AND TRIGGER
4	**INVESTIGATION 4 – Sand Source Feasibility Study** ALL Determine the capacity and cost of local sand supplies, including both land-based and marine sources. • MU4 - For ad hoc sand nourishment. • MU5 - For ocean coast sand nourishment, and potentially to raise the height of land in the inundation hazard zone. • MU6 - For Southern Ports ocean and estuary frontage sand nourishment, and potentially to raise the height of land in the inundation hazard zone. • MU7 - For ocean and estuary frontage sand nourishment, and potentially to raise the height of land in the inundation hazard zone. • MU8 - For estuary coast sand nourishment, and potentially to raise the height of land in the inundation hazard zone.	City of Bunbury • MU4, MU5, MU8 - Seek support from neighbouring LGAs, PNP, State Southern Ports • MU6 - Seek support from neighbouring LGAs, PNP, Southern Ports, State To be confirmed • MU7 - between LGAs, DoT, DBCA and Southern Ports, Bunbury	Operational Grants $ up to $500k	2023-2030 2035-2050 Completed CHRMAP
5	**INVESTIGATION 5 – Rock Source Feasibility Study** MU5 MU6 MU7 MU8 Analyse availability of rock. • MU5, MU6 & MU7 - Focus for armour and core rock of all sizes. • MU8 - Focus for small to medium armour rock.	City of Bunbury • MU5, MU8 - Seek support from neighbouring LGAs, PNP, Southern Ports, State • MU6 - Seek support from neighbouring LGAs, PNP, State To be confirmed • MU7 - between LGAs, DoT, DBCA and Southern Ports	Operational Grants $$ up to $500k	2023-2030 2035-2050 Completed CHRMAP
6	**Avoid, AV – Avoid locating assets in areas that will be vulnerable to coastal hazards** ALL Item cost for investigations and management plans.	City of Bunbury • MU4, MU5, MU7, MU8 Southern Ports • MU6	Operational $$ up to $500k	2023-2030 Completed CHRMAP
7	**Accommodate, AC1 – Design assets to withstand impacts** MU5 MU6 MU7 MU8 Item cost for investigations and management plans – primarily any case-by-case work needed for public assets	City of Bunbury • MU5, MU7, MU8 Southern Ports • MU6	Operational Grants Levies (MU7) $$$ up to $1 million	2023-2030 • MU4, MU5, MU6, MU8 2023-2035 • MU7 Completed CHRMAP

Legend: Management Unit | Responsibility | Funding | $$ Cost | Timeframe | Trigger

Table 6: Recommended management actions to address coastal hazards (continued)

	RECOMMENDATION	RESPONSIBILITY	FUNDING AND COST	TIMEFRAME AND TRIGGER
8	**No Regrets, NR4 – Emergency evacuation plans** MU5 MU6 MU8 Item cost for investigations and evacuation plans.	City of Bunbury • MU5, MU8 Southern Ports • MU6	Operational Grants $$ up to $500k	2023-2030 Completed CHRMAP
9	**No Regrets, NR1 – Monitoring** ALL Beach survey for storm behaviour and to track HSD and inundation. • MU4, MU7 - Routine beach profiles every two years in Spring. • MU5, MU6 - Routine beach profiles every year in Spring. • MU8 - Routine 6-monthly beach profiles following the summer and winter periods. Minimum every two years in Spring.	City of Bunbury • MU4, MU5, MU8 - Seek support from DoT Southern Ports • MU6 - Seek support from State City of Bunbury • MU7 - Seek support and assistance from Southern Ports and DoT	Operational Grants $ up to $100k	2023-2035 Completed CHRMAP Severe storm event(s)
10	**Planned or Managed Retreat, PMR1 – Leaving assets unprotected** ALL For low-value public assets, assumes a clean-up rate following damage/loss.	City of Bunbury • MU4, MU5, MU7, MU8 Southern Ports • MU6	Operational $$$$ up to $10 million	2023-2035 Storm damage Audit of assets
11	**Planned or Managed Retreat, PMR2 – Demolition/removal/ relocation of asset from inside hazard area.** ALL Preparation of Asset Management Plan. Removal/Relocation of assets as required.	City of Bunbury • MU4, MU5, MU7, MU8 Southern Ports • MU6	Operational Grants $$$$ up to $10 million	2023-2035 Audit of assets • (MU4) Audit of assets within 2035 erosion hazard zone • (MU5, MU6, MU7, MU8) Audit of assets within 2035 erosion and inundation hazard zone

Legend: Management Unit | Responsibility | Funding | $$ Cost | Timeframe | Trigger

Table 6: Recommended management actions to address coastal hazards (continued)

	RECOMMENDATION	RESPONSIBILITY	FUNDING AND COST	TIMEFRAME AND TRIGGER
12	**Protect, PR2 – Groynes** Investigate and prepare for groynes.			
	MU5 Engagement, technical analysis, detailed design and delivery.	City of Bunbury	Operational Grants Specified Area Rate Levies User Pays $$$$$ up to $100 million	2023-2035 Completed CHRMAP Completed Investigation #1 Monitoring Confirmation of Design/Cost/Funding Construction likely to be staged
	MU6 Engagement, technical analysis, detailed design and delivery.	City of Bunbury Southern Ports	Operational Grants $$$$ up to $10 million	
	MU7 Monitoring and confirmation of concept design.	City of Bunbury	Operational Grants Levies $$$ more than $2 million	
	MU8 Engagement, technical analysis, detailed design and delivery.	City of Bunbury	Operational Grants Specified Area Rate Levies User Pays $$$ more than $2 million	
13	**No Regrets, NR2 – Protection structure audit** MU5 MU6 MU7 MU8 Inspect asset condition, influence on sediment transport and inundation, and remaining design life on all coastal management structures. • MU5 - Includes seawalls, breakwaters and spur groynes, causeway. • MU6 - Includes Port seawall and Port Breakwaters for Inner Harbour. • MU7 - Includes structures at The Cut. • MU8 - Includes walls along Collie River.	City of Bunbury • MU5, MU8 Department of Transport • MU5 Koombana Sailing Club • MU5 Southern Ports • MU5, MU6 To be confirmed • MU7 - between LGA's, DoT, DBCA and Southern Ports	Operational Grants $$ up to $500k	2025-2035 Completed CHRMAP

Legend: Management Unit | Responsibility | Funding | $$ Cost | Timeframe | Trigger

Table 6: Recommended management actions to address coastal hazards (continued)

	RECOMMENDATION	RESPONSIBILITY	FUNDING AND COST	TIMEFRAME AND TRIGGER
14	**No Regrets, NR3 – Notification on title** ALL • MU6 - Incorporate appropriate clauses into operational and strategic planning and lease conditions (Southern Ports).	City of Bunbury • MU4, MU5, MU7, MU8 - Seek support and assistance from DPLH, WALGA Southern Ports • MU6 - Seek support and assistance from LGA, DPLH, WALGA	Operational Grants $$ up to $500k	2025-2035 Completed CHRMAP
15	**Planned or Managed Retreat, PMR3 – Prevention of further development/prohibit expansion of existing use rights** MU4 MU5 MU6 MU8 Investigate opportunities for leaseback of land and land swaps in the context of planned and managed retreat. • MU6 - Incorporate appropriate clauses into operational and strategic planning and lease conditions (Southern Ports).	City of Bunbury • MU4, MU5, MU8 Southern Ports • MU6	Operational Grants $$ up to $500k	2025-2035 Completed CHRMAP
16	**Protect, PR6 – Storm surge barrier** MU5 Engagement, technical analysis, detailed design and delivery.	Lead agency: State Government Department of Transport Supporting agency: City of Bunbury	Operational Grants Specified Area Rate Levies User Pays $$$$ up to $20 million	2035-2050 Completed CHRMAP Monitoring Confirmation of Design/Cost/Funding Confirmation of 2035 SLR
17	**Protect, PR6 – Levee** MU6 Engagement, technical analysis, detailed design and delivery.	Southern Ports	Operational Grants $$ up to $2 million	2035-2050 Completed CHRMAP Monitoring Confirmation of Design/Cost/Funding Confirmation of 2035 SLR

Legend: Management Unit Responsibility Funding $$ Cost Timeframe Trigger

6.2 Recommended Medium to Long Term Pathways

Table 7: Recommended medium and long term pathways to address erosion and inundation

	RECOMMENDED MEDIUM TO LONG TERM PATHWAYS	RESPONSIBILITY	FUNDING AND COST	TIMEFRAME AND TRIGGER
	For erosion			
1	**Planned or Managed Retreat, PMR1** – Leaving assets unprotected **Planned or Managed Retreat, PMR2** – Removal of asset from inside hazard area **Planned or Managed Retreat, PMR3** – Prevention of Further Development MU4	City of Bunbury	Operational Grants $ in other actions	2035-2120 Proximity Trigger • HSD within 11m of low value public assets, equivalent of approximately half of storm erosion allowance for this MU (21m)
2	**Protect, PR2** – Groyne			2035-2120 Monitoring Updated CHRMAP
	MU5 Monitoring to determine future protection methods and refurbishment of existing treatments	City of Bunbury	Operational Grants Specified Area Rate Levies User Pays $$$ up to $1 million • Annual maintenance estimate	
	MU6 Monitoring to determine future protection methods and refurbishment of existing treatments	City of Bunbury Southern Ports	Operational Grants $$ up to $200k • Annual maintenance estimate	
	MU7 Monitoring to determine future protection methods and refurbishment of existing treatments	City of Bunbury	Operational Grants Levies $$ up to $100k • Annual maintenance estimate	
	MU8 Monitoring to determine future protection methods and refurbishment of existing treatments	City of Bunbury	Operational Grants Specified Area Rate Levies User Pays $ up to $50k • Annual maintenance estimate	

Legend: Management Unit | Responsibility | Funding | $$ Cost | Timeframe | Trigger

Table 7: Recommended medium and long term pathways to address erosion and inundation (continued)

	RECOMMENDED MEDIUM TO LONG TERM PATHWAYS	RESPONSIBILITY	FUNDING AND COST	TIMEFRAME AND TRIGGER
	For inundation			
1	**Protect, PR6 – Storm surge barrier** MU5 Monitoring to determine maintenance, design and performance reviews, additional protection methods and refurbishment of existing treatments.	City of Bunbury	Operational Grants Specified Area Rate Levies User Pays $ up to $20k • Annual maintenance estimate	2035-2120 Monitoring Updated CHRMAP
2	**Protect, PR6 – Levee** MU6 Monitoring to determine maintenance, design and performance reviews, additional protection methods and refurbishment of existing treatments.	Southern Ports City of Bunbury	Operational Grants $ up to $20k • Annual maintenance estimate	2035-2120 Monitoring Updated CHRMAP
3	**Accommodate, AC1 – Design assets to withstand impacts** MU7 Monitoring Reviews to consider additional protection methods and refurbishment of existing treatments.	City of Bunbury	Operational Grants Levies $ in other actions • Included as part of Monitoring (NR1)	2035-2120 Monitoring Updated CHRMAP
4	**INVESTIGATION – Ongoing audit of assets within hazard zone** MU8 Further investigation, feasibility analysis and further civil and maritime design considerations.	City of Bunbury Neighbouring LGAs State Government	Operational Grants Specified Area Rate Levies User Pays $ unknown • To be determined following further investigations	2035-2120 Monitoring Updated CHRMAP

Legend: Management Unit | Responsibility | Funding | $$ Cost | Timeframe | Trigger

CHRMAP Review

The CHRMAP should be updated at least every 10 years to maintain its currency and ensure it remains a **living document**. The CHRMAP should be revisited when triggers are reached to ensure it includes an up-to-date and accurate coastal hazard assessment.

As described in *section 5.5 Options and Triggers*, physical triggers provide clear pathways, but provide limited flexibility, rely on monitoring, and assume that conflicting interests have been resolved.

It is essential to also recognise that environmental and societal considerations significantly affect the implementation of management actions. These external triggers would include:

Environmental Triggers

- Substantial storm events generating severe coastal hazards approaching or exceeding the CHRMAP projections
- Environmental Impacts

Societal Triggers

- Change to governance, planning and/or laws, such as a significant change to State land-use planning or a major change in a Local Planning Scheme or the Greater Bunbury Region Scheme
- New information becomes available that substantially affects the understanding of local community values
- Major societal events such as macro-economic, public protests, etc.

Such unplanned external triggers will also guide implementation of the CHRMAP. An earlier review of the CHRMAP may be considered necessary when such an external trigger occurs.

Therefore, it is essential to support coastal zone managers to be opportunistic and reactive to such external triggers rather than only follow the CHRMAP recommendations.

To prepare a coherent CHRMAP update it may be necessary to update the hazard modelling/assessment to include:

- Recent monitoring data
- Planning changes and changes to the CHRMAP success criteria and stakeholder feedback
- Updates in climate change science, specifically local sea level rise projections
- Updated coastal engineering science and methodologies, and emerging adaptation options

References

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Seashore Engineering, 2019, Assessment of Coastal Erosion Hotspots in Western Australia for the DoT

Western Australian Planning Commission (WAPC, 2013). State Planning Policy No. 2.6 – State Coastal Planning Policy, prepared under the Planning and Development Act 2005.

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Appendices

All Chapter Reports can be accessed at:

https://www.bunbury.wa.gov.au/coastal-hazard-risk-management-and-adaptation-plan

CITY OF BUNBURY

How to Get Involved

Want to help build a better, brighter Bunbury?

Please reach out to your Elected Member or the responsible officer at the City of Bunbury to share your thoughts and ideas.

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