WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

Capel to Leschenault CHRMAP

Chapter Report: Risk Evaluation and Treatment

Peron Naturaliste Partnership

30 August 2022

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EXECUTIVE SUMMARY

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). Rising sea levels and intensifying storm activity will increase the risk of coastal inundation (temporary coastal flooding), storm erosion and long-term shoreline recession. State governments across Australia have introduced statutory obligations that require local governments to consider and plan for these hazards. In Western Australia (WA), the governing policy is the Western Australian Planning Commission's (WAPC) State Planning Policy No. 2.6: State Coastal Planning Policy (WAPC, 2013, herein referred to as "SPP2.6"). SPP2.6 recommends management authorities develop a Coastal Hazard Risk Management and Adaptation Plan (CHRMAP) for land use or development that is potentially vulnerable to coastal hazards. Specific guidelines have been developed to assist in this process (WAPC, 2019).

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

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. The aim of the present study is therefore to investigate the nature and severity of coastal hazards which are likely to affect these regions from Capel to Leschenault over future planning horizons. Refer Figure 1-2 for locality and study area extent.

The objective of this CHRMAP project is to increase knowledge and understanding of coastal hazard risks, and identify risk management and adaptation measures for implementation. The outcomes will be used to inform local and state government policies, strategies and plans, including (but not limited to); planning strategies, community strategic plans, drainage strategies, asset management plans, emergency management plans, and foreshore management plans. The project will adhere to the WAPC (2019) guidelines with scope and deliverables to be consistent with the objectives identified by these guidelines and SPP2.6. The project will identify the strategic direction for coastal adaptation scenarios from the present-day to 2120 (100 yrs. management time frame), and identify an implementation plan to achieve this direction. Overall, this CHRMAP will develop a flexible adaptation pathway for the region and serve as a key reference for management, planning and policy making for the short-term (0-15 years), medium-term (15-30 years), and long-term (100 years).

This report presents the Risk Evaluation and Treatment Chapter Report, which identifies risks and presents and assesses treatment options using multi-criteria analysis. The flow chart displayed in Figure 1-1 indicates where this component sits with reference to the greater study; this analysis corresponds to the red bubble, also presented below.

Risk Evaluation & Treatment
- Identify existing controls and mitigation measures: physical & planning schemes to mitigate the above risks
- Priorities for Risk Treatment
- Update risks accordingly; identify prioritised risk action list based on Success Criteria & existing controls
- Identify Risk Treatment Options
- Multi-Criteria Analysis (MCA).

The vulnerability ratings assigned in the previous chapter report (Water Technology, 2022b) were assessed against any available controls. No changes to the vulnerability results are required: existing vulnerability results become final results.

The erosion and inundation vulnerability ratings were considered for each MU as a whole by averaging the vulnerability ratings of individual asset categories; see Table 2-1 and Table 2-2. All MUs at all planning horizons have unacceptable levels of vulnerability for both erosion and inundation (medium or above) and therefore need to be considered for risk treatment options. The tables depict the greater vulnerabilities to erosion in the study area compared to inundation, and the relativity of vulnerability to each hazard between MUs.

Potential risk treatment options are described in Sections 3 to 6 with context to the adaptation hierarchy and site-specific conditions. All relevant options are then assessed using a multi-criteria analysis in Section 7, with full results presented in Appendix B. The results summary table is replicated below.

The next report will present the cost benefit analysis and benefit distribution analysis of the positively scored adaptation options. Their adaptation pathways, including identifying triggers, will also be presented.

Table 1-1 MCA summary by MU: Options recommended for further investigation (+ve scores, green), unclear options (0 score, amber) & options not recommended (-ve scores, red).

Option	MU1	MU2	MU3	MU4	MU5	MU6	MU7	MU8	MU9	MU10	MU11
Locating assets in areas that will not be vulnerable to coastal hazards (AV)	11	11	11	11	11	11	11	11	11	11	11
Leaving assets unprotected (PMR1)	2	2	2	2	2	2	2	2	2	2	2
Demolition / removal / relocation of asset from inside hazard area (PMR2)	7	7	7	7	7	7	7	7	7	7	7
Prevention of further development / prohibit expansion of existing use rights (PMR3)	5	6	6	10	6	6	N/A	6	6	9	6
Voluntary acquisition (PMR4)	4	4	5	N/A	5	5	N/A	5	5	7	5
Design assets to withstand impacts (AC1)	9	10	N/A	10	9	10	12	9	9	9	9
Beach nourishment or replenishment (PR1)	3	-4	3	-7	3	4	4	2	3	3	3
Groynes (PR2)	0	-6	0	-11	1	3	3	0	0	-1	-1
Seawalls (PR3)	-6	-10	-6	-12	-2	0	0	0	0	-1	-1
Artificial reef (PR4)	-3	-6	-4	-10	-3	-4	-4	-5	-4	N/A	N/A
Offshore breakwater (PR5)	-5	-7	-6	-12	0	-3	-4	-1	0	N/A	N/A
Levy / Weir / Storm Surge Barrier (PR6)	4	6	N/A	N/A	4	3	N/A	1	1	1	1
Monitoring (NR1)	7	7	7	7	7	7	7	7	7	7	7
Protection Structure Audit (NR2)	N/A	N/A	N/A	N/A	6	6	6	6	6	N/A	N/A
Notification on title (NR3)	7	7	7	7	7	7	7	6	6	6	6
Emergency evacuation plans (NR4)	6	6	N/A	N/A	6	6	N/A	7	6	7	7
Do nothing (DN1)	-10	-8	-8	-8	-8	-8	-8	-8	-11	-8	-8

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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). Rising sea levels and intensifying storm activity will increase the risk of coastal inundation (temporary coastal flooding), storm erosion and long-term shoreline recession. State governments across Australia have introduced obligations that require local governments to consider and plan for these hazards. In Western Australia (WA), the governing policy is the Western Australian Planning Commission's (WAPC) State Planning Policy No. 2.6: State Coastal Planning Policy (WAPC, 2013, herein referred to as "SPP2.6"). SPP2.6 recommends management authorities develop a Coastal Hazard Risk Management and Adaptation Plan (CHRMAP) for land use or development that is potentially vulnerable to coastal hazards. Specific guidelines have been developed to assist in this process (WAPC, 2019).

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Delivery of this project will occur over 9 stages (as summarised in Figure 1-1), each of which represents a key hold point. The staged approached is developed according to the PNP's scope and is in line with the CHRMAP Guidelines (WAPC, 2019).

This report presents the Stage F: Risk Evaluation and Treatment Report, which identifies risks and presents and assesses treatment options using multi-criteria analysis. The red bubble displayed in Figure 1-1, indicates where this component sits with reference to the greater study.

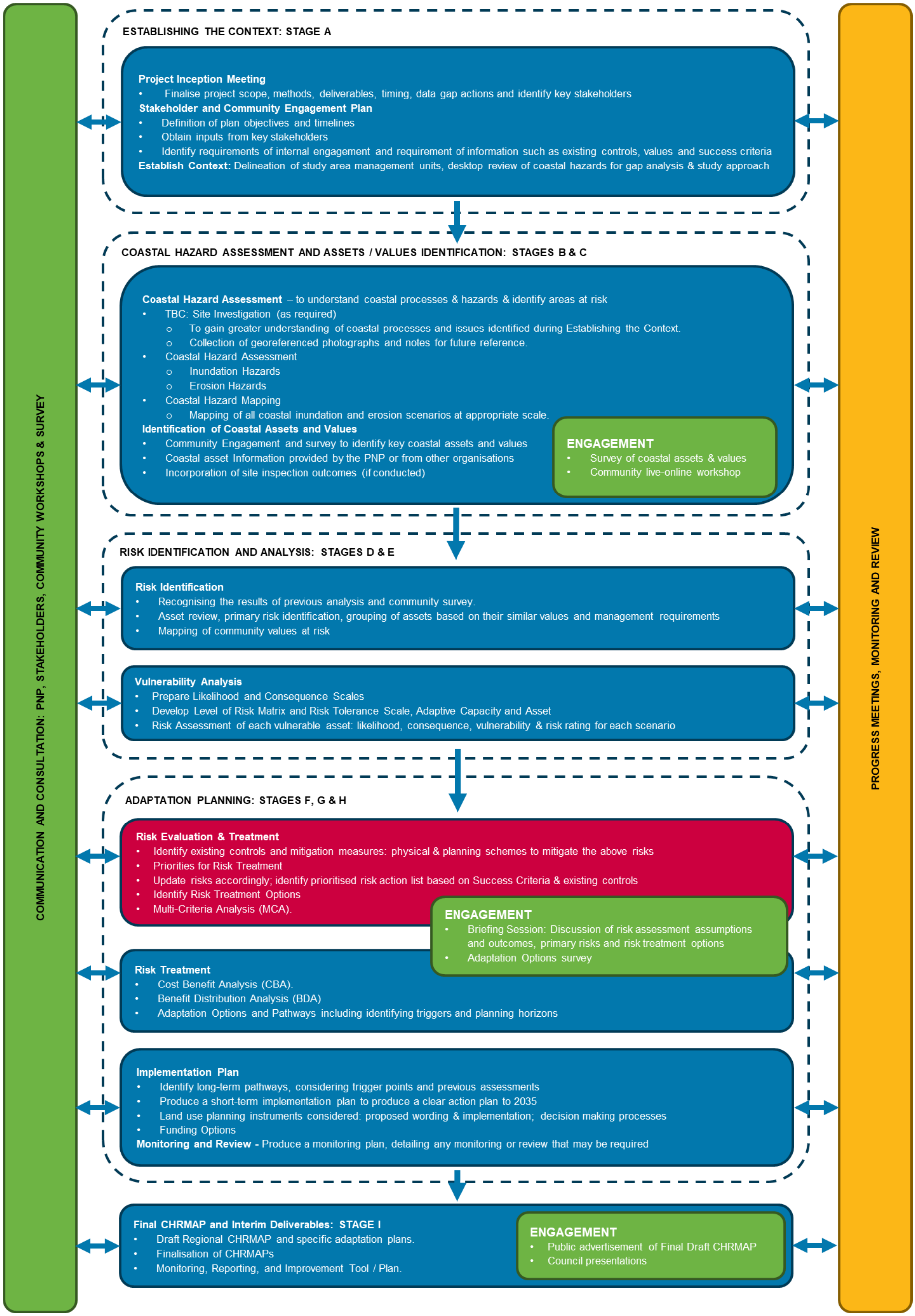

Figure 1-1 Methodology

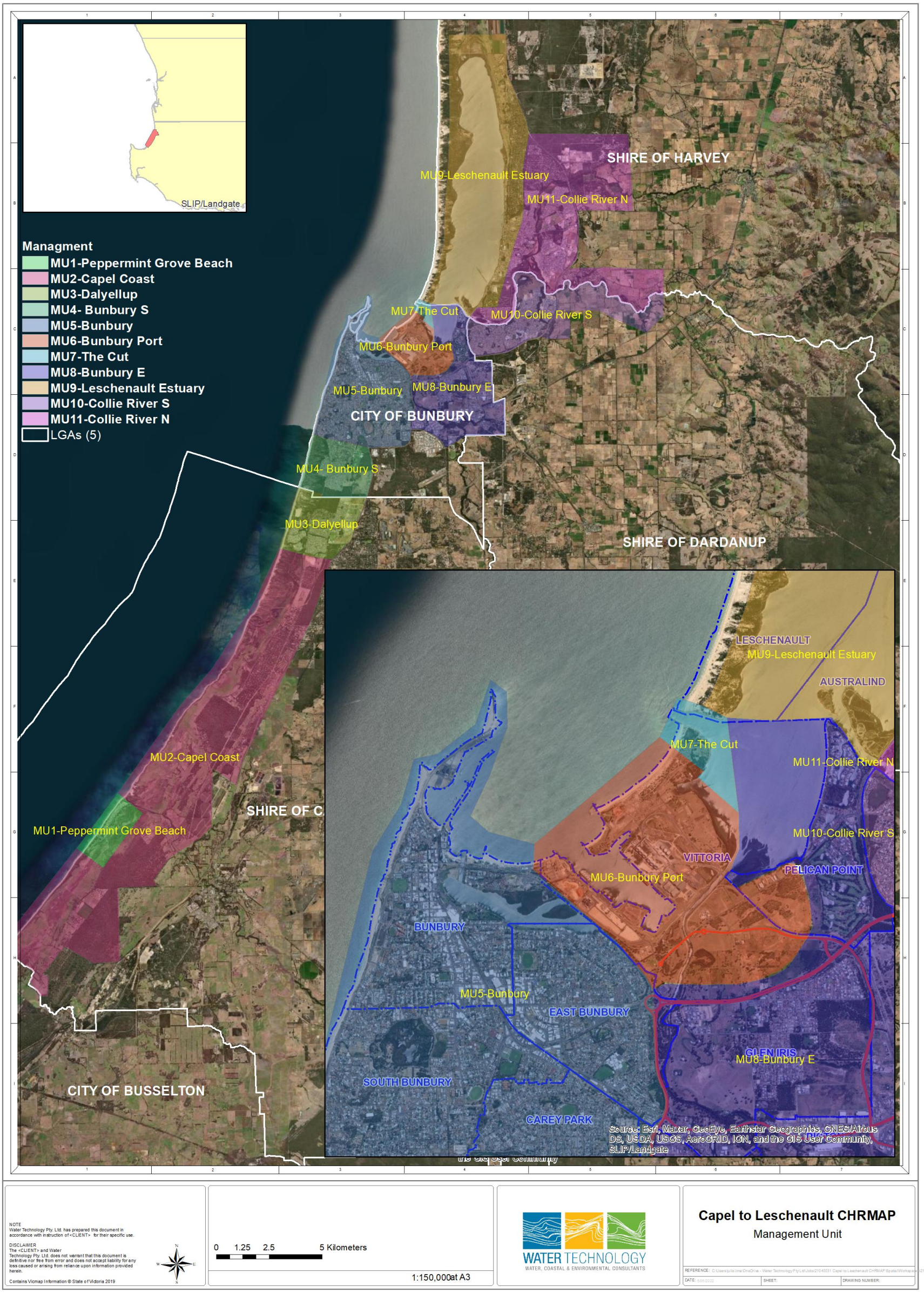

Figure 1-2 Study Area and Management Units

2 RISK EVALUATION

This section assesses any available controls against the vulnerability ratings assigned in the previous chapter report (Water Technology, 2022b). The coastal hazard assessment (Water Technology, 2022a) has already assigned any relevant physical controls.

2.1 Existing Controls

2.1.1 Planning Controls

A summary of relevant planning controls for the study area is provided in Water Technology (2021a). The study area contains a large array of planning documentation, most of which makes mention of coastal hazards, or values which will provide input into the CHRMAP process. With the exception of the Shire of Harvey however, none of the existing documents contain planning instruments that can be used to adapt to coastal hazards. As such, these planning controls do not change the assigned vulnerability ratings for the PNP CHRMAP study area.

This CHRMAP will consider what planning controls (existing or required) may be appropriate as adaptation measures within each management unit.

2.1.2 Physical Controls

The existing physical controls in the study area are reported in Water Technology (2021a and 2022a) and include coastal protection structures such as groynes/breakwaters and seawalls, preventative inundation structures such as the storm surge barrier and one way drainage valves and current management activities. Where appropriate, these have already been considered in the hazard and vulnerability assessment. As such, the vulnerability results remain the same as previously reported. No changes to the vulnerability results are required.

2.2 Priorities for Treatment

The erosion and inundation vulnerability ratings presented in the previous report have been considered for each MU as a whole by averaging the vulnerability ratings of individual asset categories; see Table 2-1 and Table 2-2. All MUs at all planning horizons have unacceptable levels of vulnerability for both erosion and inundation (medium or above) for one or more asset categories, and therefore need to be considered for risk treatment options. Table 2-1 and Table 2-2 depict the greater vulnerabilities to erosion in the study area compared to inundation, and the relativity of vulnerability to each hazard between MUs.

Table 2-1 Erosion vulnerability ratings by management unit & planning horizon

Management Unit	2020	2035	2050	2120
MU1 – Peppermint Grove Beach	High	Extreme	Extreme	Extreme
MU2 – Capel Coast	High	Extreme	Extreme	Extreme
MU3 - Dalyellup	High	Extreme	Extreme	Extreme
MU4 – Bunbury S	High	High	High	Extreme
MU5 - Bunbury	High	Extreme	Extreme	Extreme
MU6 – Bunbury Port	Extreme	Extreme	Extreme	Extreme
MU7 – The Cut	Extreme	Extreme	Extreme	Extreme
MU8 – Bunbury E	Extreme	Extreme	Extreme	Extreme
MU9 – Leschenault Estuary	High	Extreme	Extreme	Extreme
MU10 – Collie River S	Extreme	Extreme	Extreme	Extreme
MU11 – Collie River N	High	Extreme	Extreme	Extreme

Table 2-2 Inundation vulnerability ratings by management unit & planning horizon

Management Unit	2020	2035	2050	2120
MU1 – Peppermint Grove Beach	High	High	High	High
MU2 – Capel Coast	Medium	Medium	Medium	High
MU3 - Dalyellup	Medium	Medium	Medium	Medium
MU4 – Bunbury S	Medium	Medium	Medium	Medium
MU5 - Bunbury	High	High	High	High
MU6 – Bunbury Port	Medium	Medium	Medium	High
MU7 – The Cut	Medium	Medium	Medium	Medium
MU8 – Bunbury E	High	High	High	High
MU9 – Leschenault Estuary	High	High	High	High
MU10 – Collie River S	Medium	High	High	High
MU11 – Collie River N	Medium	Medium	Medium	High

3 RISK TREATMENT APPROACH

3.1 Risk Management and Adaptation Hierarchy

SPP2.6 provides a hierarchy of adaptation pathways to guide decision making in coastal areas. This should be used by planning authorities and development proponents when considering adaptation options to minimise coastal hazard risks at the local level. The hierarchy, presented in Figure 3-1, indicates a clear preference against the adoption of 'protect' as a long-term adaptation pathway. This preference is re-emphasised in SPP2.6, the policy guidelines, the CHRMAP Guidelines and the WA Coastal Zone Strategy. This hierarchy is discussed further below.

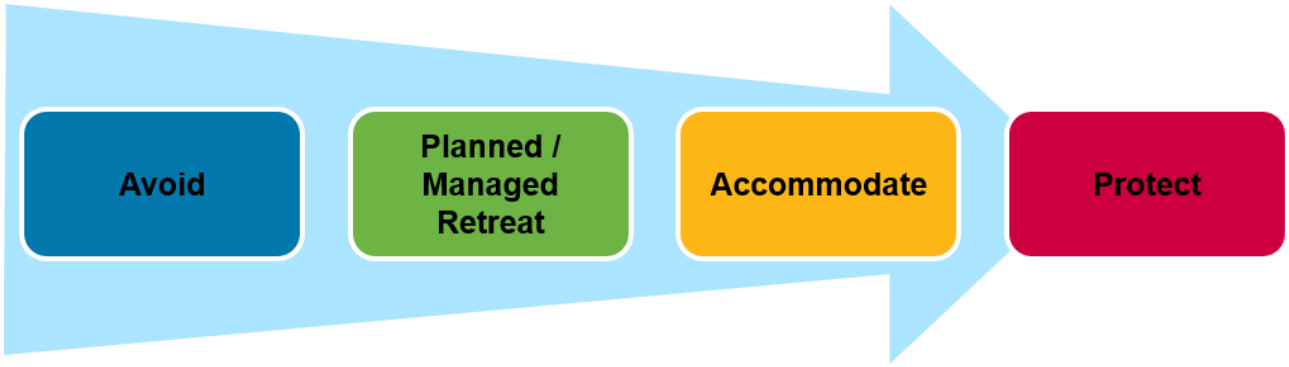

Figure 3-1 Coastal hazard risk management and adaptation planning hierarchy (adapted from WAPC, 2019)

3.2 Avoid

This option aims to avoid the construction of new public and private assets within areas identified to be affected by coastal hazards. The project lifetime of a new asset should be a key consideration in deciding the suitability of locating new assets in coastal hazard areas. For example, the construction of new public assets, such as picnic facilities and public toilets, should be avoided where these assets are likely to be impacted by coastal hazards within the lifetime of the asset. Similarly, the construction of new private assets which are likely to be affected by coastal hazards over their projected lifetimes should not be permitted. The option of avoid can be applied to manage coastal erosion and inundation hazard risks.

3.3 Planned or Managed Retreat

This option aims to relocate or remove assets which are located in hazard areas, in an orderly manner, where hazard risks are likely to be intolerable over relevant planning timeframes. In recognition of the increased risk to assets in the coastal zone, the DPLH, together with the Western Australian Planning Commission, provides guidance on how to implement a policy of planned or managed retreat through property acquisitions (WAPC, 2019).

Planned or managed retreat is mostly applicable to developed areas, where there is less potential to adapt to coastal hazards through development planning controls, such as setbacks in Greenfield areas. The strategy of retreat is based on social, environmental and economic sustainability, and ties into the SPP2.6 objectives and adaptation hierarchy (refer Figure 3-1). It allows for continuing public access to beaches, beach amenity, and the provision of a coastal foreshore reserve.

The CHRMAP Guidelines (WAPC, 2019) suggest a range of mechanisms for achieving managed retreat in developed areas, using compulsory or voluntary acquisition provisions outlined in state legislation. Alternatively, planned or managed retreat can be achieved through the early acquisition and leaseback of private property. This alternative can help to reduce overall implementation costs.

Planned or managed retreat is an option that can be applied to manage coastal erosion and inundation hazards; however, this option requires a significant investment of public resources to fund acquisitions. For implementation of managed retreat to be undertaken at scale, a significant funding contribution may need to be sought from the State or Commonwealth. At the time of writing such an undertaking has not known to have been successful for WA coastal projects. Therefore, landholders and the broader public should be aware of the risks in any decisions they make about purchasing or developing lands in coastal areas.

3.4 Accommodate

This option aims to utilise design and management strategies which render the risks from identified coastal hazards as acceptable. Design and management strategies include minimum finished floor levels (FFLs) and elevated electrical circuitry to minimise inundation risks. In this way, the 'Accommodate' option allows landholders to continue to use land until hazard risks become intolerable, while minimising the current and future risk of legal and financial liability for Council.

Accommodate is an option that can be applied to help minimise the effect of coastal inundation hazards on development and infrastructure. It should be noted that the current State legislative framework means that permanently inundated private land does not become Crown land, unlike in other Australian states (Robb et al 2017, Robb et al 2018). Therefore, if the shoreline is allowed to recede beyond private property boundaries, issues of public access and trespass may arise. This should be a key consideration when assessing the appropriateness of this option.

3.5 Protect

This option aims to stabilise the position of the shoreline using hard or soft coastal protection measures such as seawalls, groynes, offshore breakwaters, geotextile sand-containers, sand renourishment and levee banks. Protection is an option that can be applied to manage coastal erosion and inundation hazards.

The adaptation hierarchy considers the construction of new protection measures as the least preferred option of all potential options listed in the hierarchy. Protection measures, particularly hard measures such as rock groynes and seawalls, interfere with local coastal processes and can have detrimental effects on local ecological systems. Protection measures can also inflate property values in hazard areas, create expectations that protection measures will be maintained into the future, and may limit the capacity of future decision makers to change strategies as situations change.

Over the short to medium term, public authorities may need to consider the appropriateness of using interim protection measures to delay shoreline recession. This might be achieved through measures such as geotextile sand containers which may be less costly to remove than rock structures, regular sand renourishment, and revegetating coastal dunes. Where public and private assets are proposed to be constructed inland of interim protection measures, the design life of the protection measure should be a key factor in determining the appropriateness of the proposed asset or development.

3.6 No Regrets

No regrets risk treatment options allow for the undertaking of measures which improve resilience and preparedness for vulnerable assets. They are often undertaken at the same time as further investigations to finalise preferred risk treatment options, given the long lead time for the implementation of such decisions.

Management strategies can be facilitated through active monitoring and management tasks and modifications to local planning frameworks. Coastal monitoring can improve the understanding of hazards, risks and vulnerabilities as well as the effective life of existing coastal structures.

Modified planning frameworks need to provide clear direction for planning authorities when assessing applications for new development and for affected landholders. Planning frameworks might include the introduction or modification of the following instruments:

- Special control areas, to ensure planning discretion over new development
- Clear development assessment criteria, to ensure that new development gives due regard to coastal processes
- Notifications on title, to inform current and future property owners of hazard risks
- Time or event limited planning permits, to allow the continued use of land until hazards become intolerable
- Requirements for emergency evacuation plans (also relevant to some Accommodate scenarios)

3.7 Do Nothing

The do-nothing option assumes that no action will be taken, and all levels of risk are accepted. It is useful for baseline comparisons with other options but is often considered unacceptable because most developed sections of coastline require at least safety management of impacts and the continuation of basic public services.

3.8 Hierarchy Summary

Maintaining public access to the coast in developed areas is one of the main objectives of SPP2.6. The current State legislative framework means that where the shoreline recedes beyond private property boundaries, issues of public access and trespass are likely to arise. This situation means that public authorities have two main adaptation options available to them for preserving public coastal access:

- **Planned or Managed Retreat** i.e., maintaining a foreshore reserve through public acquisition of private property; or,
- **Protect** i.e., preventing the shoreline from receding beyond private property boundaries by stabilising the current shoreline position using various protection measures

Where public authorities cannot commit to either of these options over the long term, it is likely that public authorities will need to **Accommodate**, by modifying local planning frameworks to help ensure that new development is appropriately designed and located. Public authorities in this situation may also choose to consider the appropriateness of interim Protection measures to preserve public interests by delaying shoreline recession and minimising the effect of regular nuisance inundation events on existing development and infrastructure.

3.9 Site Constraints

The success criteria for the study identified in the Coastal Assets & Community Values Chapter Report are presented in Table 3-1. These criteria demonstrate that the stakeholder and community values in the study area reflect the requirements of the state, regional and local planning controls. The success criteria highlight the need for continuing public access to beaches, beach amenity, and the provision of a coastal foreshore reserve. They also identify protecting the natural environment.

Table 3-1 Success criteria

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

3.10 Summary for Decision Makers

Table 3-2 presents a summary of the relevant information for adaptation. It is important to note that there is no law requiring public authorities to provide protection of private property from natural hazards, nor compensation when land is lost due to coastal hazards. The CHRMAP process aims to minimise coastal hazard risks and maximise beneficial use of the coast.

Table 3-2 Adaptation consideration summary

- Adaptation options should minimise coastal process interference and legacy issues
    - The adaptation hierarchy is presented in Figure 3-1.
- 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 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.

4 RISK TREATMENT OPTIONS

4.1 General Options

Table 4-1 below presents a list of generally available adaptation options suitable for most coastal sites. These relate to both short term and long-term adaptation to coastal hazards in general, not just in relation to planning for climate change impacts. The column on the right-hand side provides some discussion as to the possibility of its application for the study area.

Whilst the risks and their corresponding adaptation options are assessed separately, triggers to adapt can occur at any time from either erosion or inundation.

4.2 Planning Control Options

This section outlines the key planning instruments which should be considered for incorporation into the LGAs' local planning frameworks. These instruments are particularly useful for implementing Accommodate and Planned or Managed Retreat options.

4.2.1 Special Control Area

Amend the local planning scheme to introduce a Special Control Area (SCA) over all land identified as being at risk of coastal erosion and/or inundation. The SCA would be delimited by the position of either the 2120 coastal processes setback line or the inundation extent of the 500-year ARI event in the year 2120, whichever is the more landward.

An SCA could be designed to cover erosion or inundation separately, or both as presented above. An SCA is an overlay that applies in addition to the underlying classification of the land and identifies planning controls that apply in addition to any other requirements relevant to the underlying zone. Development that might otherwise be exempt from development approval would then be required to obtain a planning approval in addition to building approval. An SCA can facilitate land use changes and development control within that area.

An SCA should be applied to relate specifically to land subject to coastal processes (as recommended in WAPC, 2019).

Each SCA is allocated a number and depicted on the Scheme Map.

WAPC (2019) provides draft amendment text including the purpose, objectives and provisions (see below). The purpose of the SCA is to provide guidance as to the appropriate scope of land use and development to be permitted within a coastal erosion and inundation hazard risk area. Its objectives would be:

a. To ensure land in the coastal zone is continuously provided for coastal foreshore management, public access, recreation and conservation.

b. To ensure public safety and reduce risk associated with coastal erosion and inundation.

c. To avoid inappropriate land use and development of land at risk from coastal erosion and inundation.

d. To ensure land use and development does not accelerate coastal erosion or inundation risks; or have a detrimental impact on the functions of public reserves.

e. To ensure that development addresses the PNP CHRMAP prepared in accordance with SPP 2.6.

The SCA would include additional provisions (over and above or overriding provisions for development not within the SCA), such as:

a. All proposed development within the SCA requires approval. (This would include development that would not ordinarily require development approval under the scheme).

b. Approval to be issued on a temporary or time limited basis. (The applicant could later apply for a further approval, which could be granted if the risk from coastal processes was still considered acceptable).

c. Referral of applications. (Any planning application should be referred to the Department of Transport, the Western Australian Planning Commission and any other relevant authority for advice and comment on the coastal risk.)

d. Minimum finished floor levels and/or other development standards.

4.2.2 Coastal /Waterway Local Planning Policy

Prepare/update a local planning policy (LPP) to clarify its attitude and expectations in relation to coastal development within an identified area, including the type of permanent or temporary assets it is prepared to accept within the coastal reserve and/or on land subject to coastal processes.

LPPs are prepared and adopted according to the provisions in Part 2 Division 2 of the Deemed Provisions of the relevant local planning scheme within each LGA. LGAs may prepare an LPP in respect of any matter related to the planning and development of the Scheme area. The LPP may apply to a particular class or classes of matter specified in the policy and may apply to the whole of the Scheme area or to parts specified in the policy.

An LPP can provide more detail and guidance on what sort of development would be acceptable and will also assist each Council in making planning decisions on coastal development requiring the exercise of discretion. For example, on land at risk of erosion within the life of a proposed development the LPP may encourage use of structures that can be disassembled and/or transported should erosion come within a specified distance of the structure. The policy would also identify the Council's intention to require notifications on title as a condition of development approval.

4.2.3 Notifications on Title

All freehold land identified as being at risk of impact from coastal processes should have a notification placed on its certificate of title/s to make the owner and future landholders aware of the potential for the land to be impacted.

Section 165 of the Planning and Development Act 2005 enables a local government or public authority to place a notification on the certificate of title of land. This aims to make owners and future owners of land aware of being within or proximate to a future coastal hazard that may affect the use and enjoyment of the land, as determined in accordance with SPP2.6 and an endorsed CHRMAP. The process requires the written consent of the landholder and payment of a fee, so it is usual for the requirement for placement of a notification to be a condition of development or subdivision approval. However, placement of a notification on the title does not have to be tied to an application and could take place at any time with owner consent.

Current wording recommended by the WAPC and in accordance with SPP2.6 is as follows:

This lot is located in an area likely to be subject to coastal erosion and/or inundation over the next 100 years from the date this notification is registered.

With regard to the above wording, the WAPC notes that a shorter timeframe than 100 years may be appropriate where identified in an endorsed CHRMAP.

4.2.4 Other Instruments

Other instruments may be useful for implementing adaptation options. These include:

- Restrictive Covenants, which can be used to restrict present and future landholders from constructing protection structures and, to internalise the risk of building in inherently hazardous locations.
- Special Area Rates, which can be used to ensure that the costs associated with protection options are equitably distributed across beneficiaries.
- The requirement for a structure plan could be considered, setting out development provisions and planning controls consistent with SPP2.6 for vulnerable areas with new development/subdivision proposed.
- Update of Local Planning Strategies to inform amendments to other related planning instruments.
- Implementation of LGA internal procedures, to provide a note to settlement agencies when they seek a property report linked to the sale of land (settlement agencies typically request these and they include details of rates paid, outstanding issues, approved development etc). This would elevate the potential impact to the prospective purchaser, ensuring that later planning controls are not a surprise.

The intent of these instruments aligns with guidance provided in the WA Coastal Zone Strategy, noting that private parties are responsible for managing risks to their private assets and incomes which might arise from coastal erosion and inundation hazards.

Table 4-1 Risk treatment options from WAPC (2019)

Option Category	Option Name	Option Code	Description of how it will help
Avoid	Locating assets in areas that will not be vulnerable to coastal hazards	AV	Assets will not be vulnerable to risk arising from coastal hazards.
Planned / Managed Retreat	Leaving assets unprotected	PMR1	Accept loss following hazard event. Only implement repairs to maintain public safety. Allow for retreat that allows natural recession of the shoreline over the long-term.
	Demolition / removal / relocation of asset from inside hazard area.	PMR2	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.
	Prevention of further development / prohibit expansion of existing use rights	PMR3	This risk treatment option would enable existing development and use rights to continue without increasing them, until such time that risk arising from coastal hazards is intolerable. Specified in a local planning scheme.
	Voluntary acquisition	PMR4	This risk treatment option would require the acquisition of affected properties, on a voluntary basis.
Accommodate	Design assets to withstand impacts	AC1	Where avoiding or relocating an asset is not an option, design of assets to withstand the impact of inundation.
Protect	Beach nourishment or replenishment	PR1	Placement of sand on the upper beach face and dunes to re-establish the sandy beach and provide a sediment supply.
	Groyne	PR2	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 supply or when partnered with sand nourishment.
	Seawall	PR3	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 beach nourishment or replenishment.
	Artificial reef	PR4	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.
	Offshore breakwater	PR5	Construction of an emergent offshore barrier (often referred to as an offshore breakwater). Offshore breakwaters effectively 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 a salient where sand accretes in the low energy environment.
	Levy / Weir / Storm Surge Barrier	PR6	Inundation protection to minimise inundation on low-lying land. This could be a levy on the banks of a river, a storm surge barrier at the entrance to an inlet / estuary and so on. Details would be specific to the relevant conditions of each MU.
No Regrets	Monitoring	NR1	Involves long term baseline monitoring and event-based monitoring following storm erosion events.
	Protection Structure Audit	NR2	Involves undertaking an audit of existing protection structures, to determine their current condition, effectiveness and future protection potential.
	Notification on title	NR3	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.
	Emergency evacuation plans	NR4	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	Do Nothing	DN1	Assumes all levels of risk are accepted and assumes 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 RISK TREATMENT OPTIONS: INUNDATION

This section discusses adaptation options identified to respond to inundation hazards.

5.1 All Management Units – Present Day

It is recommended for all LGAs to implement adaptation options in the present day that will facilitate flexible adaptation in the future:

- Prevention of further development / limiting existing use rights
  - Introduce 'Special Control Area - Coastal Hazard: Inundation' with a requirement for new development to achieve a minimum FFL of 3.1-3.9m AHD (depending on location) for habitable areas of buildings. Depending on the nature of development proposed, approval may be time limited or require structures to be removed by a specified date or when a specified trigger is reached.
  - Introduce a local planning policy outlining the LGAs' requirements for building construction, land fill, and other relevant matters within the Special Control Area, noting requirements will be slightly different for erosion and inundation.
- Any new assets should avoid the hazard zone. If they must be located within the hazard zone, they should be designed to withstand the inundation hazard. For example, new buildings to be constructed with permeable lower levels (e.g., a stilt arrangement), and services located above the flood level. This avoids the need to use fill to raise the FFL. Fill is expensive, and also alters the flood flow, which could lead to increased hazards.

5.2 All Management Units – Future Timeframe

The adaptation options discussed below in Section 7 are in addition to those discussed for the Present Day above. Economically, relocation or managed retreat options may be triggered by the physical costs of repair exceeding the relocation costs. As per the success criteria and adaptation hierarchy, consideration should be given to the continued allowance for a recreational reserve. This may mean relocating buildings ahead of their risk rating in order to continue to allow this space.

6 RISK TREATMENT OPTIONS: EROSION

This section discusses adaptation options identified to respond to erosion hazards.

6.1 All Management Units – Present Day

As per the inundation adaptation options, It is recommended to implement adaptation options in the present day that will facilitate flexible adaptation in the future:

- Prevention of further development / limiting existing use rights
  - Introduce 'Special Control Area - Coastal Hazard: Erosion'. Depending on the nature of development proposed, approval may be time limited or require structures to be removed by a specified date or when a specified trigger is reached.
  - Require notification on Title for all land located seaward of the 100-year hazard line for coastal erosion. This should be made a condition of any approval for development or subdivision/amalgamation of land. The LGAs should also negotiate with landholders whose land is not subject to an application for planning approval to place such a notification on the title with their consent.
  - Introduce a local planning policy outlining the LGAs' requirements for building construction, land fill, and other relevant matters within the Special Control Area, noting requirements will be slightly different for erosion and inundation.
- Any new assets should avoid the hazard zone.
- Coastal monitoring to regularly document changes to the shoreline and understand system; enables better prediction of management trigger timeframe
- Commence investigations to determine options for appropriate longer-term relocation of affected properties / assets.

6.2 All Management Units – Future Timeframes

The modelling has provided an indicative timeframe as to when adaptation will be required. However, it is recommended to employ the use of triggers for adaptation, including for relocation or managed retreat purposes. These are as per those of WAPC (2019).

- **Trigger 1**: Where the most landward part of the Horizontal Shoreline Datum (HSD) is within 40 metres of the most seaward point of a development / structure / foreshore reserve area.
  - The recreational and dune area is considered the asset in this case, as per the values and vulnerability assessment.
- **Trigger 2**: Where a public road is no longer available or able to provide legal access to the property
- **Trigger 3**: When water, sewage or electricity to the lot is no longer available as they have been removed/decommissioned by the relevant authority due to coastal hazards.

As per the inundation discussion, the management measures discussed above apply in the addition to those discussed below in Section 7.

7 MULTI-CRITERIA ANALYSIS

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.

7.1 Assessment Criteria

For this CHRMAP the key assessment criteria are:

- Effectiveness
  - Ability for the option to mitigate the coastal hazard risk
- Environmental Impact
  - Impact on existing native vegetation / dunes / coastal processes
  - Includes consideration of:
    - Any construction / clearing impacts
    - Impact of maintenance on the environment
- Social Impact
  - This considers stakeholder and community impacts from previous CHRMAP chapters
  - Potential impacts on Aboriginal and European heritage sites and values are considered in this criterion.
- Aesthetic Impact
  - The visual appeal of the option
  - Consideration of option aesthetics tying into the wider town / Management Unit vision
- Cost
  - Upfront capital costs
  - Ongoing maintenance costs
  - Economic affects – such as loss of businesses, income, value
- Future Adaptability
  - Whether the option is easily adaptable in future, such as for updated sea level rise actuals or predictions
  - If the option limits the feasibility of selecting other options in future

Initial assessment of options against the criteria was undertaken by Water Technology as coastal experts. The qualitative criteria (environmental, social and aesthetic) will then be reviewed and modified following review and confirmation by the Steering Group and the Coastal Community Advisory Group**. All ratings are somewhat subjective; however, all ratings will be discussed with the Steering Group to ensure the ratings are reflective of stakeholder knowledge. Community engagement will allow for additional feedback from the community and further review of the scores attributed. The ratings will then be updated to reflect these engagement activities.**

Information provided to date by stakeholders was included in the assessment of each value as required. Options are assessed using the multi-criteria assessment (MCA) matrix shown in Table 7-1 which indicates the rating given to each criterion for a given option and provides the recommendation for pursuing the option.

In most cases it shall be necessary to implement more than one option, and the options selected through the MCA may vary between management units and with implementation timeframes. The results of the MCA for each Management Unit are summarised in the sections below.

Succeeding the MCA will be a cost-benefit analysis (CBA) of options carried forward from the MCA, to be present in the next chapter report for the project. Separate to the score applied in the MCA for option costs, the CBA will allocate an estimated cost to all significant values and detractions of a given option, both at present and over the option's intended design life. This work will be presented as the net present value (NPV) of an option, allowing direct comparison to aid selection of a final strategy.

7.2 Assessment Framework

To perform the MCA, each identified option was assessed against each of the criteria shown below in Table 7-1 for each of the Management Units. The assessment criteria run across the top row whilst the ratings are shown below; each have a possible score from -2 to 2. This methodology is similar to other MCAs undertaken in Western Australia under the same CHRMAP Guidelines (for example: Cardno, 2017 and Water Technology, 2019).

Ratings were assessed by a professional coastal engineer with experience in risk management, adaptation options and their implementation. In this case initial capital and ongoing maintenance costs have been assessed under a single category. The possibility for potential losses is also considered in the cost category. For example, if an option is likely to lead to a drop in land value, that is considered to be a cost to the community, and therefore a lower score. Economic factors have been assessed in more detail within the CBA.

Following preparation of the draft MCA the results were reviewed by the Steering Committee. A Coastal Community Advisory Group (CCAG) was formed comprising community members from across the study area. Members attended a workshop to further review and calibrate the MCA scoring – with particular focus on the categories of Environmental, Social and Aesthetic Impact. This workshop is discussed further in the latest Engagement Outcomes Report (refer Appendix A). Several component category scores changed during this review process, but only one option in three MUs changed recommendations:

- MU1 – PR2 Groynes – changed from 'Recommended' to 'Suitability Unclear', so will still be retained in CBA process.
- MU3 – PR2 Groynes – changed from 'Recommended' to Suitability Unclear, so will still be retained in CBA process.
- MU8 – PR5 Offshore Breakwater – changed from 'Suitability Unclear' to 'Not Recommended', so will be excluded from CBA process.

7.3 Multi-Criteria Analysis Summary

The MCA Analysis for each management unit is provided in Appendix B with each adaptation option assessed. Table 7-2 summarises the evaluated status of each option for each management unit. Options receiving a positive score are recommended for further consideration.

Table 7-1 Multi-criteria assessment framework

Rating; Score	Effectiveness	Environmental Impact	Social Impact	Aesthetic Impact	Cost (Capital & Ongoing)	Future Adaptability	Final Recommendation
Positive; +2	Expected to be very effective	Significant positive impact; return to more natural coastline	Significant positive social impact; encourages community development	Positive aesthetics, improves existing coastline and place recognition	Low costs. Higher capital costs accepted if other criteria met. Very low economic loss.	Very adaptable, not likely to leave legacy issues	Further Investigation Recommended; Score > 0
Positive; +1	Expected to be effective	Positive impact; return to more natural coastline	Positive social impact; encourages community development	Positive aesthetics, retains the existing coastline and place recognition	Reasonable costs. Higher capital costs accepted if other criteria met. Low economic loss.	Adaptable, not likely to leave legacy issues	Further Investigation Recommended; Score > 0
Neutral; 0	May or may not be effective, possibly unable to predict	No (or unclear) environmental impact	No discernible social impact; indeterminate net impact	Neutral aesthetic	Moderate costs	May leave legacy issues	Suitability unclear; Score = 0
Negative; -1	Likely to be ineffective in the short or long term	Potential significant negative impacts, including losing beaches altogether	Negative social impact. May discourage new or existing people from the area	Coastline / foreshore appearance negatively altered	High initial or ongoing costs, especially if low likelihood of success. High economic loss.	Likely to create legacy issues	Not recommended; Score < 0
Negative; -2	Very likely to be ineffective in the short or long term	Significant negative impacts, including losing beaches altogether	Significant negative social impact. May discourage new or existing people from the area	Coastline / foreshore appearance degraded	Very high initial or ongoing costs, especially if low likelihood of success. Very high economic loss.	Will create legacy issues	Not recommended; Score < 0

Table 7-2 Multi-Criteria Analysis summary by MU. Green indicates recommended for further investigation; orange is unclear. Refer Appendix B for full MCA results

Option	MU1	MU2	MU3	MU4	MU5	MU6	MU7	MU8	MU9	MU10	MU11
Locating assets in areas that will not be vulnerable to coastal hazards (AV)	11	11	11	11	11	11	11	11	11	11	11
Leaving assets unprotected (PMR1)	2	2	2	2	2	2	2	2	2	2	2
Demolition / removal / relocation of asset from inside hazard area (PMR2)	7	7	7	7	7	7	7	7	7	7	7
Prevention of further development / prohibit expansion of existing use rights (PMR3)	5	6	6	10	6	6	N/A	6	6	9	6
Voluntary acquisition (PMR4)	4	4	5	N/A	5	5	N/A	5	5	7	5
Design assets to withstand impacts (AC1)	9	10	N/A	10	9	10	12	9	9	9	9
Beach nourishment or replenishment (PR1)	3	-4	3	-7	3	4	4	2	3	3	3
Groynes (PR2)	0	-6	0	-11	1	3	3	0	0	-1	-1
Seawalls (PR3)	-6	-10	-6	-12	-2	0	0	0	0	-1	-1
Artificial reef (PR4)	-3	-6	-4	-10	-3	-4	-4	-5	-4	N/A	N/A
Offshore breakwater (PR5)	-5	-7	-6	-12	0	-3	-4	-1	0	N/A	N/A
Levy / Weir / Storm Surge Barrier (PR6)	4	6	N/A	N/A	4	3	N/A	1	1	1	1
Monitoring (NR1)	7	7	7	7	7	7	7	7	7	7	7
Protection Structure Audit (NR2)	N/A	N/A	N/A	N/A	6	6	6	6	6	N/A	N/A
Notification on title (NR3)	7	7	7	7	7	7	7	6	6	6	6
Emergency evacuation plans (NR4)	6	6	N/A	N/A	6	6	N/A	7	6	7	7
Do nothing (DN1)	-10	-8	-8	-8	-8	-8	-8	-8	-11	-8	-8

8 SUMMARY & NEXT STEPS

This report presents the risk evaluation and multi-criteria analysis for the Capel to Leschenault CHRMAP. The MCA results are presented in full in Appendix B; a summary is presented in Section 7.3.

The next report will present the cost benefit analysis and benefit distribution analysis of the positively scored adaptation options. Their adaptation pathways, including identifying triggers, will also be presented.

9 REFERENCES

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APPENDIX A
ENGAGEMENT OUTCOMES REPORT

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APPENDIX B
MULTI-CRITERIA ANALYSIS

Table B-1 Multi-Criteria Analysis – MU1 – Peppermint Grove Beach

Option (Option Code)	Effectiveness	Environment Impact	Social Impact	Aesthetic Impact	Cost	Future Adaptability	Score	Comment
Locating assets in areas that will not be vulnerable to coastal hazards (AV)	2	2	1	2	2	2	11	This option applies to undeveloped land. In this MU most undeveloped land is already zoned as foreshore reserve. Any developable land in MU should be subject to this option. Community will benefit by appropriate foreshore reserve width and access throughout the planning timeframe.
Leaving assets unprotected (PMR1)	0	-1	1	0	1	1	2	Suitable for low-value public assets such as foreshore amenities.
Demolition / removal / relocation of asset from inside hazard area (PMR2)	1	2	2	1	-1	2	7	Suitable for low to medium value public assets such as car park and ablutions block. Potentially costly if triggers met before asset due for replacement.
Prevention of further development / prohibit expansion of existing use rights (PMR3)	1	1	-1	0	2	2	5	Allows for continued use of the land whilst viable, without creating legacy issues. May be unpopular with landholders.
Voluntary acquisition (PMR4)	2	1	0	1	-2	2	4	For private property. Effective but costly option. Ensures foreshore reserve retained. May be unpopular with landholders, depending on implementation strategy.
Design assets to withstand impacts (AC1)	2	2	2	0	1	2	9	For inundation hazard. Early design considerations mean implementation can occur as assets are routinely upgraded / renewed.
Beach nourishment or replenishment (PR1)	0	0	1	1	-1	2	3	Potentially very expensive if no nearby suitable and sustainable sand source available. Could create legacy issues for future.
Groynes (PR2)	1	-1	1	0	-1	0	0	A groyne field may assist to stabilise the shoreline. Groynes can lead to downdrift erosion issues if not designed and constructed appropriately. Would require sand nourishment as part of works, which can help provide a sandy beach.
Seawalls (PR3)	1	-2	-1	-1	-2	-1	-6	Expensive option. Likely to lead to reduction or loss of usable sandy beach.
Artificial reef (PR4)	0	1	0	0	-2	-2	-3	Difficult to design submerged structures to work effectively, and costly to build and maintain.
Offshore breakwater (PR5)	1	0	-1	-1	-2	-2	-5	Costly to build and maintain but can be designed to work effectively and provide usable sandy beach. Social concerns about ocean views likely.
Levy / Weir / Storm Surge Barrier (PR6)	1	1	1	1	-1	1	4	Some form of inundation protection on the banks / mouth of the Capel River to minimise inundation on the low-lying land behind the town. This would be costly but potentially effective. Impacts would need to be investigated thoroughly.
Monitoring (NR1)	2	2	1	0	0	2	7	Low-cost action which causes no problems. Resulting data is required for most management approaches.
Protection Structure Audit (NR2)							N/A	No existing protections structures in this MU.
Notification on title (NR3)	1	2	1	0	2	2	8	For private property. Effective low-cost option. May be unpopular with affected landholders, but appreciated by potential purchasers, depending on implementation strategy.
Emergency evacuation plans (NR4)	1	0	1	0	2	2	6	For inundation hazard. Doesn't directly address vulnerabilities of assets but low cost to plan for keeping people safe. Important for single-road access to town.
Do nothing (DN1)	-2	-2	-2	-1	-1	-2	-10	Not an effective adaptation option and may not be popular with the community.

Table B-2 Multi-Criteria Analysis – MU2 – Capel Coast

Option (Option Code)	Effectiveness	Environment Impact	Social Impact	Aesthetic Impact	Cost	Future Adaptability	Score	Comment
Locating assets in areas that will not be vulnerable to coastal hazards (AV)	2	2	1	2	2	2	11	This option applies to undeveloped land, which there are large areas of in this MU. Community will benefit by appropriate foreshore reserve width and access throughout the planning timeframe.
Leaving assets unprotected (PMR1)	0	-1	1	0	1	1	2	Suitable for low-value public assets such as foreshore recreational amenities.
Demolition / removal / relocation of asset from inside hazard area (PMR2)	1	2	2	1	-1	2	7	Suitable for low-value public assets such as foreshore recreational amenities. Potentially costly if triggers met before asset due for replacement.
Prevention of further development / prohibit expansion of existing use rights (PMR3)	1	1	0	0	2	2	6	Allows for continued use of the land whilst viable, without creating legacy issues. May be unpopular with landholders.
Voluntary acquisition (PMR4)	2	1	0	1	-2	2	4	For private property. Effective but costly option. Ensures foreshore reserve retained. May be unpopular with landholders, depending on implementation strategy. Will cost much less than protection given the sparse development in this MU.
Design assets to withstand impacts (AC1)	2	2	1	1	2	2	10	For inundation hazard. Early design considerations mean implementation can occur as assets are routinely upgraded / renewed.
Beach nourishment or replenishment (PR1)	-2	0	0	0	-2	0	-4	Potentially very expensive if no nearby suitable and sustainable sand source available. Could create legacy issues for future. Not feasible over large section of coastline.
Groynes (PR2)	-1	-2	1	-1	-2	-1	-6	Not feasible over large section of coastline. Groynes can be effective at stabilising shorelines but can also lead to downdrift erosion issues if not designed and constructed appropriately.
Seawalls (PR3)	-1	-2	-1	-2	-2	-2	-10	Expensive option, not realistic due to the length of MU, and number of impacted assets (and hence low funding potential).
Artificial reef (PR4)	-2	0	0	0	-2	-2	-6	Difficult to design submerged structures to work effectively, and costly to build and maintain.
Offshore breakwater (PR5)	-1	0	-1	-1	-2	-2	-7	Expensive option, not realistic due to the length of MU, and number of impacted assets (and hence low funding potential). Costly to build and maintain. Social concerns about ocean views likely.
Levy / Weir / Storm Surge Barrier (PR6)	1	2	1	2	-1	1	6	Some form of inundation protection on the banks / mouth of the Capel River to minimise inundation on the low-lying land. This would be costly but potentially effective. Impacts would need to be investigated thoroughly.
Monitoring (NR1)	2	2	1	0	0	2	7	Low-cost action which causes no problems. Resulting data is required for most management approaches.
Protection Structure Audit (NR2)							N/A	No existing protection structures in this MU.
Notification on title (NR3)	1	2	1	0	2	2	8	For private property. Effective low-cost option. May be unpopular with affected landholders, but appreciated by potential purchasers, depending on implementation strategy.
Emergency evacuation plans (NR4)	1	0	1	0	2	2	6	For inundation hazard. Doesn't directly address vulnerabilities of assets but low cost to plan for keeping people safe.
Do nothing (DN1)	-2	-1	-1	-1	-1	-2	-8	Not an effective adaptation option and may not be popular with the community.

Table B-3 Multi-Criteria Analysis – MU3 - Dalyellup

Option (Option Code)	Effectiveness	Environment Impact	Social Impact	Aesthetic Impact	Cost	Future Adaptability	Score	Comment
Locating assets in areas that will not be vulnerable to coastal hazards (AV)	2	2	1	2	2	2	11	This option applies to undeveloped land. In this MU most undeveloped land is already zoned as foreshore reserve. Any developable land in MU should be subject to this option. Community will benefit by appropriate foreshore reserve width and access throughout the planning timeframe.
Leaving assets unprotected (PMR1)	0	-1	1	0	1	1	2	Suitable for low-value public assets such as foreshore recreational amenities.
Demolition / removal / relocation of asset from inside hazard area (PMR2)	1	2	2	1	-1	2	7	Suitable for low-value public assets such as foreshore recreational amenities. Potentially costly if triggers met before asset due for replacement.
Prevention of further development / prohibit expansion of existing use rights (PMR3)	1	1	0	0	2	2	6	Allows for continued use of the land whilst viable, without creating legacy issues. May be unpopular with landholders.
Voluntary acquisition (PMR4)	2	1	0	2	-2	2	5	For private property. Effective but costly option. Ensures foreshore reserve retained. May be unpopular with landholders, depending on implementation strategy and timeframes.
Design assets to withstand impacts (AC1)							N/A	Only suitable for inundation hazard. In this MU only environmental assets are projected to be affected, so not applicable.
Beach nourishment or replenishment (PR1)	0	0	1	1	-1	2	3	Potentially very expensive if no nearby suitable and sustainable sand source available. Could create legacy issues for future.
Groynes (PR2)	1	-1	1	0	-1	0	0	A groyne field may assist to stabilise the shoreline. Groynes can lead to downdrift erosion issues if not designed and constructed appropriately. Would require sand nourishment as part of works, which can help provide a sandy beach.
Seawalls (PR3)	1	-2	-1	-1	-2	-1	-6	Expensive option. Likely to lead to reduction or loss of usable sandy beach.
Artificial reef (PR4)	0	0	0	0	-2	-2	-4	Difficult to design submerged structures to work effectively, and costly to build and maintain.
Offshore breakwater (PR5)	1	-1	-1	-1	-2	-2	-6	Costly to build and maintain but can be designed to work effectively and provide usable sandy beach. Social concerns about ocean views likely.
Levy / Weir / Storm Surge Barrier (PR6)							N/A	Inundation is not a high risk in this management unit
Monitoring (NR1)	2	2	1	0	0	2	7	Low-cost action which causes no problems. Resulting data is required for most management approaches.
Protection Structure Audit (NR2)							N/A	No existing protection structures in this MU.
Notification on title (NR3)	1	2	1	0	2	2	8	For private property. Effective low-cost option. May be unpopular with affected landholders, but appreciated by potential purchasers, depending on implementation strategy.
Emergency evacuation plans (NR4)							N/A	Suitable for inundation hazard that may affect people but given the few affected assets in this MU and their environmental nature this is not applicable.
Do nothing (DN1)	-2	-1	-1	-1	-1	-2	-8	Not an effective adaptation option and may not be popular with the community.

Table B-4 Multi-Criteria Analysis – MU4 – Bunbury S

Option (Option Code)	Effectiveness	Environment Impact	Social Impact	Aesthetic Impact	Cost	Future Adaptability	Score	Comment
Locating assets in areas that will not be vulnerable to coastal hazards (AV)	2	2	1	2	2	2	11	This option applies to undeveloped land. which there are large areas of in this MU. Community will benefit by appropriate foreshore reserve width and access throughout the planning timeframe.
Leaving assets unprotected (PMR1)	0	-1	1	0	1	1	2	Suitable for low-value public assets such as foreshore recreational amenities.
Demolition / removal / relocation of asset from inside hazard area (PMR2)	1	2	2	1	-1	2	7	Suitable for low-value public assets such as foreshore recreational amenities. Potentially costly if triggers met before asset due for replacement.
Prevention of further development / prohibit expansion of existing use rights (PMR3)	2	2	1	1	2	2	10	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.
Voluntary acquisition (PMR4)							N/A	For private property – none in hazard zone in this MU.
Design assets to withstand impacts (AC1)	2	2	2	0	2	2	10	For inundation hazard which is projected to affect very few assets in this MU. Early design considerations mean implementation can occur as assets are routinely upgraded / renewed.
Beach nourishment or replenishment (PR1)	-2	-1	-1	-1	-2	0	-7	Potentially very expensive if no nearby suitable and sustainable sand source available. Could create legacy issues for future. Not feasible over large section of coastline. Does not complement environmental focus of this MU.
Groynes (PR2)	-2	-2	-2	-2	-2	-1	-11	Not feasible over large section of coastline. Groynes can be effective at stabilising shorelines but can also lead to downdrift erosion issues if not designed and constructed appropriately. Does not complement environmental focus of this MU.
Seawalls (PR3)	-2	-2	-2	-2	-2	-2	-12	Expensive option, not realistic due to the length of MU, and nature of impacted assets. Does not complement environmental focus of this MU.
Artificial reef (PR4)	-2	-2	-2	0	-2	-2	-10	Difficult to design submerged structures to work effectively, and costly to build and maintain. Expensive option, not realistic due to the length of MU, and nature of impacted assets. Does not complement environmental focus of this MU.
Offshore breakwater (PR5)	-2	-2	--2	-2	-2	-2	-12	Expensive option, not realistic due to the length of MU, and number of impacted assets (and hence low funding potential). Costly to build and maintain. Social concerns about ocean views likely. Does not complement environmental focus of this MU.
Levy / Weir / Storm Surge Barrier (PR6)							N/A	Inundation is not a high risk in this management unit
Monitoring (NR1)	2	2	1	0	0	2	7	Low-cost action which causes no problems. Resulting data is required for most management approaches.
Protection Structure Audit (NR2)							N/A	No existing protection structures in this MU.
Notification on title (NR3)	1	2	1	0	2	2	8	For private property. Effective low-cost option. May be unpopular with affected landholders, but appreciated by potential purchasers, depending on implementation strategy.
Emergency evacuation plans (NR4)							N/A	Suitable for inundation hazard that may affect people but given the few affected assets in this MU and their nature this is not applicable.
Do nothing (DN1)	-2	-1	-1	-1	-1	-2	-8	Not an effective adaptation option and may not be popular with the community.

Table B-5 Multi-Criteria Analysis – MU5 - Bunbury

Option (Option Code)	Effectiveness	Environment Impact	Social Impact	Aesthetic Impact	Cost	Future Adaptability	Score	Comment
Locating assets in areas that will not be vulnerable to coastal hazards (AV)	2	2	1	2	2	2	11	This option applies to undeveloped land. In this MU most undeveloped land is already zoned as foreshore reserve. Any developable land in MU should be subject to this option. Community will benefit by appropriate foreshore reserve width and access throughout the planning timeframe.
Leaving assets unprotected (PMR1)	0	-1	1	0	1	1	2	Suitable for low-value public assets such as foreshore recreational amenities.
Demolition / removal / relocation of asset from inside hazard area (PMR2)	1	2	2	1	-1	2	7	Suitable for low-value public assets such as foreshore recreational amenities. Potentially costly if triggers met before asset due for replacement.
Prevention of further development / prohibit expansion of existing use rights (PMR3)	1	1	0	0	2	2	6	Allows for continued use of the land whilst viable, without creating legacy issues. May be unpopular with landholders.
Voluntary acquisition (PMR4)	2	1	0	2	-2	2	5	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.
Design assets to withstand impacts (AC1)	2	2	1	0	1	2	8	For inundation hazard. Early design considerations mean implementation can occur as assets are routinely upgraded / renewed / redeveloped.
Beach nourishment or replenishment (PR1)	0	0	1	1	-1	2	3	Potentially very expensive if no nearby suitable and sustainable sand source available. Could create legacy issues for future.
Groynes (PR2)	1	0	1	0	-1	0	1	A groyne field may assist to stabilise the shoreline. Groynes can lead to downdrift erosion issues if not designed and constructed appropriately. Would require sand nourishment as part of works, which can help provide a sandy beach. Already in use in this MU.
Seawalls (PR3)	2	-1	-1	-1	-1	-1	-3	Expensive option. Likely to lead to reduction or loss of usable sandy beach. Already in use in this MU. Likely more acceptable because familiar and this MU more developed than others.
Artificial reef (PR4)	0	0	1	0	-2	-2	-3	Difficult to design submerged structures to work effectively, and costly to build and maintain.
Offshore breakwater (PR5)	2	0	1	-1	-1	-1	0	Costly to build and maintain but can be designed to work effectively and provide usable sandy beach. Social concerns about ocean views likely. Concerns and some costs could be offset by designing shore-attached structures.
Levy / Weir / Storm Surge Barrier (PR6)	2	0	2	0	-1	1	4	The storm surge barrier is effective at reducing inundation, but the present design is predicted to be breached by the present day 500-year ARI event, and more frequent future events. Upgrades would be effective at reducing the inundation impact.
Monitoring (NR1)	2	2	1	0	0	2	7	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.
Protection Structure Audit (NR2)	2	0	0	0	2	2	6	An audit should be undertaken of all existing coastal protection structures.
Notification on title (NR3)	1	2	1	0	2	2	8	For private property. Effective low-cost option. May be unpopular with affected landholders, but appreciated by potential purchasers, depending on implementation strategy.
Emergency evacuation plans (NR4)	1	0	1	0	2	2	6	For inundation hazard. Doesn't directly address vulnerabilities of assets but low cost to plan for keeping people safe. Important for considering inundation of access roads to parts of MU.
Do nothing (DN1)	-2	-1	-1	-1	-1	-2	-8	Not an effective adaptation option and may not be popular with the community.

Table B-6 Multi-Criteria Analysis – MU6 – Bunbury Port

Option (Option Code)	Effectiveness	Environment Impact	Social Impact	Aesthetic Impact	Cost	Future Adaptability	Score	Comment
Locating assets in areas that will not be vulnerable to coastal hazards (AV)	2	2	1	2	2	2	11	This option applies to undeveloped land. In this MU most undeveloped land is already zoned as reserve. Any developable land in MU should be subject to this option. Community will benefit by appropriate foreshore reserve width and access throughout the planning timeframe.
Leaving assets unprotected (PMR1)	0	-1	1	0	1	1	2	Suitable for low-value public assets such as foreshore recreational amenities.
Demolition / removal / relocation of asset from inside hazard area (PMR2)	1	2	2	1	-1	2	7	Suitable for low-value public assets such as foreshore recreational amenities. Potentially costly if triggers met before asset due for replacement.
Prevention of further development / prohibit expansion of existing use rights (PMR3)	1	1	0	0	2	2	6	Allows for continued use of the land whilst viable, without creating legacy issues. May be unpopular with landholders.
Voluntary acquisition (PMR4)	2	1	0	2	-2	2	5	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.
Design assets to withstand impacts (AC1)	2	2	1	1	2	2	10	For inundation hazard. Early design considerations mean implementation can occur as assets are routinely upgraded / renewed / redeveloped.
Beach nourishment or replenishment (PR1)	1	0	1	1	-1	2	4	Potentially very expensive if no nearby suitable and sustainable sand source available. Could create legacy issues for future. Small ocean frontage and structure-controlled pocket beaches make it a potentially effective option.
Groynes (PR2)	1	1	1	1	-1	0	3	A groyne field may assist to stabilise the shoreline. Groynes can lead to downdrift erosion issues if not designed and constructed appropriately. Could require sand nourishment as part of works, which can help provide a sandy beach. Existing structures increase acceptability.
Seawalls (PR3)	1	0	0	0	-2	0	0	Expensive option. Likely to lead to reduction or loss of usable sandy beach. May be acceptable at this industrialised MU, especially because there are existing seawalls.
Artificial reef (PR4)	0	0	0	0	-2	-2	-4	Difficult to design submerged structures to work effectively, and costly to build and maintain.
Offshore breakwater (PR5)	1	0	0	0	-2	-2	-3	Costly to build and maintain but can be designed to work effectively and provide usable sandy beach.
Levy / Weir / Storm Surge Barrier (PR6)	2	0	2	0	-2	1	3	A storm surge barrier at the Cut may be effective at reducing inundation, combined with additional protection along Preston River. This would be costly; impacts would need to be investigated.
Monitoring (NR1)	2	2	1	0	0	2	7	Low-cost action which causes no problems. Resulting data is required for most management approaches.
Protection Structure Audit (NR2)	2	0	0	0	2	2	6	An audit should be undertaken of all existing coastal protection structures.
Notification on title (NR3)	1	2	1	0	2	2	8	For private property. Effective low-cost option. May be unpopular with affected landholders, but appreciated by potential purchasers, depending on implementation strategy.
Emergency evacuation plans (NR4)	1	0	1	0	2	2	6	For inundation hazard. Doesn't directly address vulnerabilities of assets but low cost to plan for keeping people safe. Important for considering inundation of main access roads.
Do nothing (DN1)	-2	-1	-1	-1	-1	-2	-8	Not an effective adaptation option and may not be popular with the community.

Table B-7 Multi-Criteria Analysis – MU7 – The Cut

Option (Option Code)	Effectiveness	Environment Impact	Social Impact	Aesthetic Impact	Cost	Future Adaptability	Score	Comment
Locating assets in areas that will not be vulnerable to coastal hazards (AV)	2	2	1	2	2	2	11	This option applies to undeveloped land. In this MU most undeveloped land is already zoned as reserve. Any developable land in MU should be subject to this option. Community will benefit by appropriate foreshore reserve width and access throughout the planning timeframe.
Leaving assets unprotected (PMR1)	0	-1	1	0	1	1	2	Suitable for low-value public assets such as foreshore recreational amenities.
Demolition / removal / relocation of asset from inside hazard area (PMR2)	1	2	2	1	-1	2	7	Suitable for low-value public assets such as foreshore recreational amenities. Potentially costly if triggers met before asset due for replacement.
Prevention of further development / prohibit expansion of existing use rights (PMR3)							N/A	No developed land parcels.
Voluntary acquisition (PMR4)							N/A	No developed land parcels.
Design assets to withstand impacts (AC1)	2	2	2	2	2	2	12	For inundation hazard which is projected to affect very few assets in this MU. Early design considerations mean implementation can occur as assets are routinely upgraded / renewed.
Beach nourishment or replenishment (PR1)	1	0	1	1	-1	2	4	Potentially very expensive if no nearby suitable and sustainable sand source available. Could create legacy issues for future. Small ocean frontage and structure-controlled pocket beaches make it a potentially effective option.
Groynes (PR2)	1	1	1	1	-1	0	3	A groyne field may assist to stabilise the shoreline. Groynes can lead to downdrift erosion issues if not designed and constructed appropriately. Could require sand nourishment as part of works, which can help provide a sandy beach. Existing structures increase acceptability.
Seawalls (PR3)	2	0	0	0	-1	-1	0	Expensive option. Likely to lead to reduction or loss of usable sandy beach. MU already has seawall for much of coastline.
Artificial reef (PR4)	0	0	0	0	-2	-2	-4	Difficult to design submerged structures to work effectively, and costly to build and maintain.
Offshore breakwater (PR5)	0	0	0	0	-2	-2	-4	Costly to build and maintain. Location means unlikely to very effective.
Levy / Weir / Storm Surge Barrier (PR6)							N/A	A storm surge barrier at the Cut may be effective at reducing inundation elsewhere, however not necessarily required in this MU.
Monitoring (NR1)	2	2	1	0	0	2	7	Low-cost action which causes no problems. Resulting data is required for most management approaches.
Protection Structure Audit (NR2)	2	0	0	0	2	2	6	An audit should be undertaken of all existing coastal protection structures.
Notification on title (NR3)	1	2	1	0	2	2	8	For private property. Effective low-cost option. May be unpopular with affected landholders, but appreciated by potential purchasers, depending on implementation strategy.
Emergency evacuation plans (NR4)							N/A	Suitable for inundation hazard that may affect people but given the few affected assets in this MU and their environmental nature this is not applicable.
Do nothing (DN1)	-2	-1	-1	-1	-1	-2	-8	Not an effective adaptation option and may not be popular with the community.

Table B-8 Multi-Criteria Analysis – MU8 – Bunbury E

Option (Option Code)	Effectiveness	Environment Impact	Social Impact	Aesthetic Impact	Cost	Future Adaptability	Score	Comment
Locating assets in areas that will not be vulnerable to coastal hazards (AV)	2	2	1	2	2	2	11	This option applies to undeveloped land. In this MU most undeveloped land is already zoned as foreshore reserve. Any developable land in MU should be subject to this option. Community will benefit by appropriate foreshore reserve width and access throughout the planning timeframe.
Leaving assets unprotected (PMR1)	0	-1	1	0	1	1	2	Suitable for low-value public assets such as foreshore recreational amenities.
Demolition / removal / relocation of asset from inside hazard area (PMR2)	1	2	2	1	-1	2	7	Suitable for low-value public assets such as foreshore recreational amenities. Potentially costly if triggers met before asset due for replacement.
Prevention of further development / prohibit expansion of existing use rights (PMR3)	1	1	0	0	2	2	6	Allows for continued use of the land whilst viable, without creating legacy issues. May be unpopular with landholders.
Voluntary acquisition (PMR4)	2	1	0	2	-2	2	5	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.
Design assets to withstand impacts (AC1)	2	2	1	0	2	2	9	For inundation hazard. Early design considerations mean implementation can occur as assets are routinely upgraded / renewed / redeveloped.
Beach nourishment or replenishment (PR1)	0	-1	1	1	-1	2	2	Potentially very expensive if no nearby suitable and sustainable sand source available. Could create legacy issues for future.
Groynes (PR2)	0	0	1	0	-1	0	0	A groyne field may assist to stabilise the shoreline. Groynes can lead to downdrift erosion issues if not designed and constructed appropriately. Would require sand nourishment as part of works, which can help provide a sandy beach.
Seawalls (PR3)	2	2	-2	0	-1	-1	0	Expensive option. Likely to lead to reduction or loss of usable sandy beach. Likely more acceptable because nature of MU means they can be smaller structures.
Artificial reef (PR4)	-2	0	1	0	-2	-2	-5	Difficult to design submerged structures to work effectively, and costly to build and maintain.
Offshore breakwater (PR5)	1	0	1	-1	-1	-1	-1	Costly to build and maintain but could potentially be designed to work effectively and provide usable sandy beach. Social concerns about ocean views likely. Concerns and some costs could be offset by designing shore-attached structures.
Levy / Weir / Storm Surge Barrier (PR6)	2	0	2	-1	-2	0	1	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.
Monitoring (NR1)	2	2	1	0	0	2	7	Low-cost action which causes no problems. Resulting data is required for most management approaches.
Protection Structure Audit (NR2)	2	0	0	0	2	2	6	An audit should be undertaken of all existing coastal protection structures.
Notification on title (NR3)	1	2	2	0	2	2	9	For private property. Effective low-cost option. May be unpopular with affected landholders, but appreciated by potential purchasers, depending on implementation strategy.
Emergency evacuation plans (NR4)	1	0	2	0	2	2	7	For inundation hazard. Doesn't directly address vulnerabilities of assets but low cost to plan for keeping people safe. Important for considering inundation of access roads to parts of MU.
Do nothing (DN1)	-2	-1	-1	-1	-1	-2	-8	Not an effective adaptation option and may not be popular with the community.

Table B-9 Multi-Criteria Analysis – MU9 – Leschenault Estuary

Option (Option Code)	Effectiveness	Environment Impact	Social Impact	Aesthetic Impact	Cost	Future Adaptability	Score	Comment
Locating assets in areas that will not be vulnerable to coastal hazards (AV)	2	2	1	2	2	2	11	Community will benefit by appropriate foreshore reserve width and access throughout the planning timeframe. This option applies to undeveloped land, which there are large areas of in this MU. Community will benefit by appropriate foreshore reserve width and access throughout the planning timeframe.
Leaving assets unprotected (PMR1)	0	-1	1	0	1	1	2	Suitable for low-value public assets such as foreshore recreational amenities.
Demolition / removal / relocation of asset from inside hazard area (PMR2)	1	2	2	1	-1	2	7	Suitable for low-value public assets such as foreshore recreational amenities. Potentially costly if triggers met before asset due for replacement.
Prevention of further development / prohibit expansion of existing use rights (PMR3)	1	1	0	0	2	2	6	Allows for continued use of the land whilst viable, without creating legacy issues. May be unpopular with landholders.
Voluntary acquisition (PMR4)	2	1	0	2	-2	2	5	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.
Design assets to withstand impacts (AC1)	2	2	1	0	2	2	9	For inundation hazard. Early design considerations mean implementation can occur as assets are routinely upgraded / renewed / redeveloped.
Beach nourishment or replenishment (PR1)	0	0	1	1	-1	2	3	Potentially expensive if no nearby suitable and sustainable sand source available. Could create legacy issues for future.
Groynes (PR2)	0	0	1	0	-1	0	0	A groyne field may assist to stabilise the shoreline. Groynes can lead to downdrift erosion issues if not designed and constructed appropriately. Would require sand nourishment as part of works, which can help provide a sandy beach.
Seawalls (PR3)	2	0	0	0	-1	-1	0	Expensive option. Likely to lead to reduction or loss of usable sandy beach / socially amenable shoreline. Likely more acceptable because nature of MU means they can be smaller structures.
Artificial reef (PR4)	-1	0	1	0	-2	-2	-4	Difficult to design submerged structures to work effectively, and costly to build and maintain.
Offshore breakwater (PR5)	1	0	1	0	-1	-1	0	Costly to build and maintain but could potentially be designed to work effectively and provide usable sandy beach. Could be social concerns about estuary views. Concerns and some costs could be offset by designing shore-attached structures.
Levy / Weir / Storm Surge Barrier (PR6)	2	0	2	-1	-2	0	1	A storm surge barrier at the Cut may be effective at reducing inundation. 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.
Monitoring (NR1)	2	2	1	0	0	2	7	Low-cost action which causes no problems. Resulting data is required for most management approaches.
Protection Structure Audit (NR2)	2	0	0	0	2	2	6	An audit should be undertaken of any existing coastal protection structures. Water Technology are not aware of any in this MU.
Notification on title (NR3)	1	2	2	0	2	2	9	For private property. Effective low-cost option. May be unpopular with affected landholders, but appreciated by potential purchasers, depending on implementation strategy.
Emergency evacuation plans (NR4)	1	0	1	0	2	2	6	For inundation hazard. Doesn't directly address vulnerabilities of assets but low cost to plan for keeping people safe. Important for considering inundation of main access roads.
Do nothing (DN1)	-2	-2	-2	-2	-1	-2	-11	Not an effective adaptation option and may not be popular with the community.

Table B-10 Multi-Criteria Analysis – MU10 – Collie River S

Option (Option Code)	Effectiveness	Environment Impact	Social Impact	Aesthetic Impact	Cost	Future Adaptability	Score	Comment
Locating assets in areas that will not be vulnerable to coastal hazards (AV)	2	2	1	2	2	2	11	This option applies to undeveloped land. In this MU most undeveloped land is already zoned as foreshore reserve. Any developable land in MU should be subject to this option. Community will benefit by appropriate foreshore reserve width and access throughout the planning timeframe.
Leaving assets unprotected (PMR1)	0	-1	1	0	1	1	2	Suitable for low-value public assets such as foreshore recreational amenities.
Demolition / removal / relocation of asset from inside hazard area (PMR2)	1	2	2	1	-1	2	7	Suitable for low-value public assets such as foreshore recreational amenities. Potentially costly if triggers met before asset due for replacement.
Prevention of further development / prohibit expansion of existing use rights (PMR3)	1	2	1	1	2	2	9	Allows for continued use of the land whilst viable, without creating legacy issues. May be unpopular with landholders.
Voluntary acquisition (PMR4)	2	2	1	2	-2	2	7	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.
Design assets to withstand impacts (AC1)	2	2	1	0	2	2	9	For inundation hazard. Early design considerations mean implementation can occur as assets are routinely upgraded / renewed / redeveloped.
Beach nourishment or replenishment (PR1)	0	0	1	1	-1	2	3	Potentially very expensive if no nearby suitable and sustainable sand source available. Could create legacy issues for future.
Groynes (PR2)	-1	0	1	0	-1	0	-1	A groyne field is not an effective erosion mitigation option for this MU...
Seawalls (PR3)	1	0	0	0	-1	-1	-1	Expensive option. Likely more acceptable because nature of MU means they can be smaller structures, however erosion risk based on application of policy so not necessarily required / appropriate.
Artificial reef (PR4)							N/A	Not appropriate in this riverine environment
Offshore breakwater (PR5)							N/A	Not appropriate in this riverine environment
Levy / Weir / Storm Surge Barrier (PR6)	2	0	2	-1	-2	0	1	A storm surge barrier at the Cut may be effective at reducing inundation. 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.
Monitoring (NR1)	2	2	1	0	0	2	7	Low-cost action which causes no problems. Resulting data is required for most management approaches.
Protection Structure Audit (NR2)							N/A	No existing protection structures in this MU.
Notification on title (NR3)	1	2	2	0	2	2	9	For private property. Effective low-cost option. May be unpopular with affected landholders, but appreciated by potential purchasers, depending on implementation strategy.
Emergency evacuation plans (NR4)	1	0	2	0	2	2	7	For inundation hazard. Doesn't directly address vulnerabilities of assets but low cost to plan for keeping people safe. Important for considering inundation of access roads to parts of MU.
Do nothing (DN1)	-2	-1	-1	-1	-1	-2	-8	Not an effective adaptation option and may not be popular with the community.

Table B-11 Multi-Criteria Analysis – MU11 – Collie River N

Option (Option Code)	Effectiveness	Environment Impact	Social Impact	Aesthetic Impact	Cost	Future Adaptability	Score	Comment
Locating assets in areas that will not be vulnerable to coastal hazards (AV)	2	2	1	2	2	2	11	This option applies to undeveloped land. In this MU most undeveloped land is already zoned as foreshore reserve. Any developable land in MU should be subject to this option. Community will benefit by appropriate foreshore reserve width and access throughout the planning timeframe.
Leaving assets unprotected (PMR1)	0	-1	1	0	1	1	2	Suitable for low-value public assets such as foreshore recreational amenities.
Demolition / removal / relocation of asset from inside hazard area (PMR2)	1	2	2	1	-1	2	7	Suitable for low-value public assets such as foreshore recreational amenities. Potentially costly if triggers met before asset due for replacement.
Prevention of further development / prohibit expansion of existing use rights (PMR3)	1	1	0	0	2	2	6	Allows for continued use of the land whilst viable, without creating legacy issues. May be unpopular with landholders.
Voluntary acquisition (PMR4)	2	1	0	2	-2	2	5	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.
Design assets to withstand impacts (AC1)	2	2	1	0	2	2	9	For inundation hazard. Early design considerations mean implementation can occur as assets are routinely upgraded / renewed / redeveloped.
Beach nourishment or replenishment (PR1)	0	0	1	1	-1	2	3	Potentially very expensive if no nearby suitable and sustainable sand source available. Could create legacy issues for future.
Groynes (PR2)	-1	0	1	0	-1	0	-1	A groyne field is not an effective erosion mitigation option for this MU. .
Seawalls (PR3)	1	0	0	0	-1	-1	-1	Expensive option. Likely more acceptable because nature of MU means they can be smaller structures, however erosion risk based on application of policy so not necessarily required / appropriate.
Artificial reef (PR4)							N/A	Not appropriate in this riverine environment
Offshore breakwater (PR5)							N/A	Not appropriate in this riverine environment
Levy / Weir / Storm Surge Barrier (PR6)	2	0	2	-1	-2	0	1	A storm surge barrier at the Cut may be effective at reducing inundation. 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.
Monitoring (NR1)	2	2	1	0	0	2	7	Low-cost action which causes no problems. Resulting data is required for most management approaches.
Protection Structure Audit (NR2)							N/A	No existing protection structures in this MU.
Notification on title (NR3)	1	2	2	0	2	2	9	For private property. Effective low-cost option. May be unpopular with affected landholders, but appreciated by potential purchasers, depending on implementation strategy.
Emergency evacuation plans (NR4)	1	0	2	0	2	2	7	For inundation hazard. Doesn't directly address vulnerabilities of assets but low cost to plan for keeping people safe. Important for considering inundation of access roads to parts of MU.
Do nothing (DN1)	-2	-1	-1	-1	-1	-2	-8	Not an effective adaptation option and may not be popular with the community.

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