Department of **Planning, Lands and Heritage**

GOVERNMENT OF WESTERN AUSTRALIA

Western Australian Planning Commission

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Coastal hazard risk management and adaptation planning guidelines

July 2019

Coastal zones are vulnerable to adverse impacts from inundation and erosion. The risk to the environment from climate change is influenced by the level of preparedness and response of the community and its recovery capacity.

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PART A – OVERVIEW

INTRODUCTION

The vulnerability of assets within the Western Australian coastal zone to coastal hazards such as erosion and inundation is expected to increase in the future. The risk arising from vulnerability of assets is influenced by the level of preparedness and response of the community and its recovery capacity.

While the scientific community has established that anthropogenic climate change is occurring, uncertainty remains about the magnitude and extent of the impacts from these processes and changes. Despite the uncertainty, early consideration of coastal hazards and the management of appropriate planning responses can provide economic, environmental and social benefits.

National and international coastal planning practices are increasingly adopting a risk management approach to deal with uncertainty associated with the potential adverse impacts and their timeframes, arising from coastal hazards. This ensures that risks arising from coastal hazards are appropriately factored into decision-making processes for sustainable land use and development in the coastal zone. The State Government's coastal planning policy State Planning Policy 2.6 Coastal Planning Policy (SPP 2.6) requires a risk management approach and provides the framework for undertaking risk management planning for risks arising from coastal hazards in Western Australia. The SPP 2.6 Guidelines published 30 July 2013 Section 4 provides a brief introduction to coastal hazard risk management and adaptation planning (CHRMAP). These guidelines provide more detail on CHRMAP and should be read in conjunction with SPP 2.6 and its guidelines. https://www.dplh.wa.gov.au/spp2-6-coastal-planning

This publication is designed to assist statutory decision-makers (e.g. local governments, State Government agencies, the Western Australian Planning Commission and the State Administrative Tribunal), landholders and those conducting investigations on their behalf to:

a) consider the risks arising from coastal hazards through evaluating their consequence and likelihood, and the vulnerability of specific assets

b) identify risk management responses to those risks arising from coastal hazards

c) prioritise and implement the risk management responses.

I. PURPOSE

This guideline has been produced to support the implementation of SPP 2.6 by assisting statutory decision-makers, landholders and those conducting investigations on their behalf in developing and implementing effective CHRMAP. They provide an overview and explanation of:

- the process for undertaking CHRMAP
- determining appropriate content for CHRMAP
- assessing vulnerability of assets
- assessing options for appropriate risk management
- implementation of risk management.

II. ROLES AND RESPONSIBILITIES FOR MANAGING COASTAL RISKS

As outlined in the WA Coastal Zone Strategy (2017), governments at all levels and private parties (individuals, businesses and the community) each have important, complementary and differentiated roles in managing risk arising from coastal hazards[1]. The overarching principles for managing risk are:

(i) Private parties are responsible for managing risks to their private assets and incomes. To manage these risks private parties, need to:

- be aware of the risks and their responsibility for managing them
- take steps to understand the magnitude and nature of the specific risks to their assets and activities
- develop and implement strategies and actions to manage the risks.

(ii) Governments, on behalf of the community, are primarily responsible for managing risk to public goods and public assets which they own and manage. Governments also seek to:

- develop local policies and regulations consistent with State risk management approaches
- facilitate building resilience and adaptive capacity within the local community, including providing information about relevant known coastal hazards including erosion and inundation
- work in partnership with the community to identify and manage risks.

[1] 2012 Council of Australian Governments' (COAG) position statement on the Roles and Responsibilities for Climate Change Adaptation in Australia

This guideline encourages and guides decision-makers and landholders to address these differing responsibilities through the preparation of CHRMAP plans.

III. RISK MANAGEMENT

CHRMAP should be an integral part of decision-making, as it provides a method for testing risk (uncertainty) arising from coastal hazards and timeframes, and the treatment of this risk. Given that there is a direct relationship between risk and opportunity in all decision-making (trade-offs), decision-makers need to identify, measure and manage the risk arising from coastal hazards, to ensure they capitalise appropriately on those opportunities and achieve their goals and objectives.

Risk is the effects of uncertainty on objectives. It is measured by determining:

- what are the worst credible consequences
- how likely they are to occur.

Adaptation and mitigation is the adjustment (either natural or anthropogenic) of an asset in response to risk that moderates adverse impacts, included in a risk management plan, often as a part of risk treatment options and risk management measures.

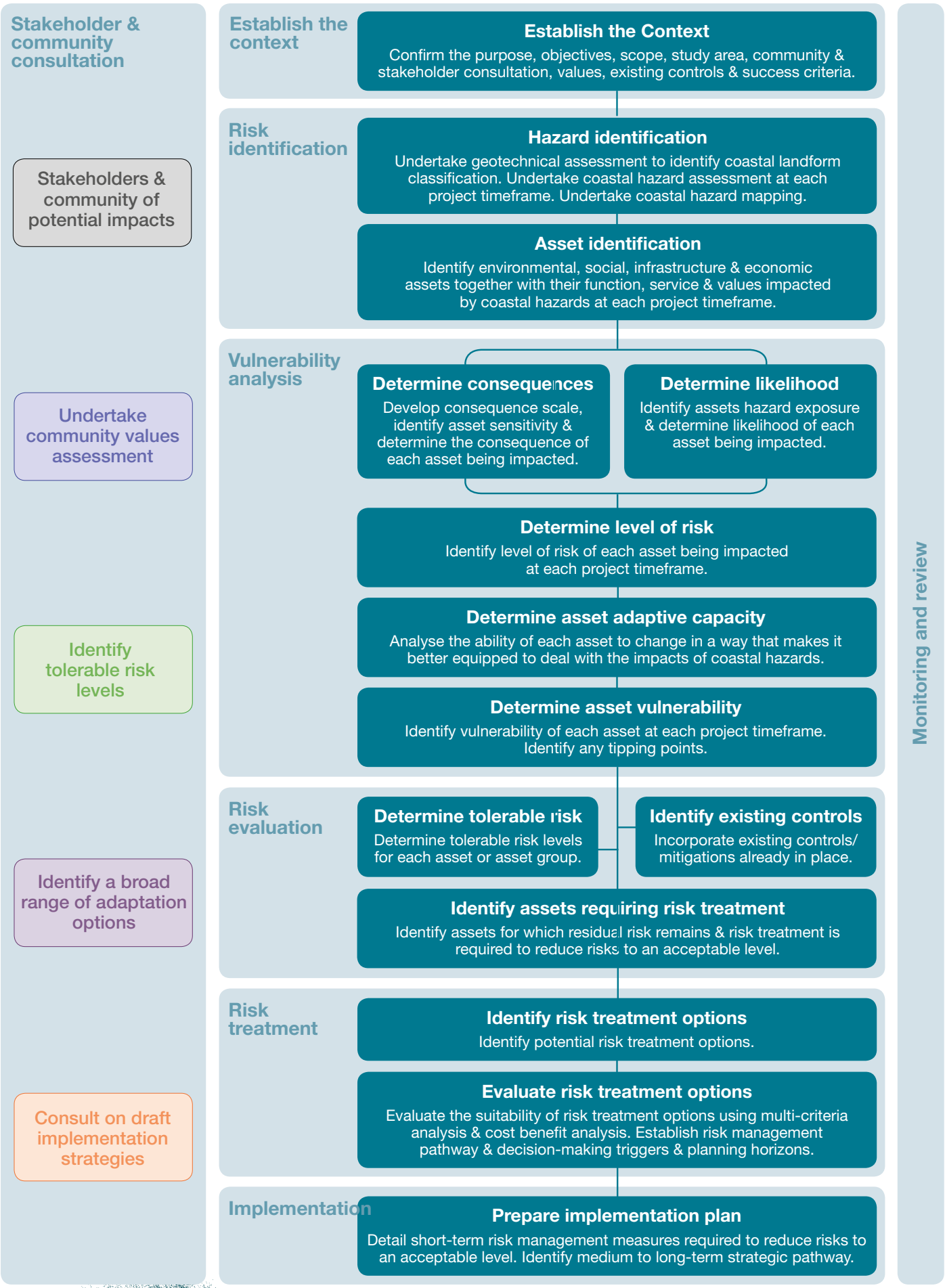
Put simply, risk management planning is the practice of systematically identifying risk, understanding coastal hazard impacts, and putting in place controls (being a measure that modifies risk) to manage (adapt to and/or mitigate) consequences and/or likelihood, and risk level and tolerance in association with the affected community and stakeholders.

Throughout Australia, AS ISO 31000:2018 is commonly used in risk management. This standard provides a set of internationally endorsed principles and guidance on how decision-makers can integrate decisions about risk and responses into their existing management and decision-making processes. In 2013, Standards Australia published AS 5334:2013 *Climate change adaptation for settlements and infrastructure - A risk based approach*, which was adapted from the ISO 31000:2009 to target the potential impacts of climate change on settlements and infrastructure.

The process outlined in SPP 2.6 follows a standardised approach (Figure 1) adapted from the risk management and vulnerability assessment processes identified in *Australian Standard: Risk management - Guidelines (*2018)*, Australian Standard: Climate change adaptation for settlement and infrastructure - A risk based approach* (2013)*, Climate Change Impacts and Risk Management: A Guide for Business and Government (*2007)*, Australian Standard Environmental risk management - Principles and Processes* (2006)*,* and *Climate Change Risk and Vulnerability: Promoting an efficient adaptation response in Australia, Report to the Australian Greenhouse Office* (2005).

Throughout its development, it is important to communicate, consult and involve key stakeholders and the wider community to provide, share and obtain information. This is particularly important because of the inherent diversity of community and stakeholder views. Undertaken effectively, communication, consultation and involvement of the community and stakeholders will contribute significantly to the success of the CHRMAP.

Figure 1: Risk management process flowchart adapted to coastal planning



As a minimum, CHRMAP should follow the preparation stages outlined in this document to ensure a comprehensive and consistent approach is completed. The stages are:

(i) Establish the Context – Purpose, objectives, scope, study area, community and stakeholder engagement, values, existing controls and success criteria.

(ii) Risk Identification – Planning timeframe and sea level rise, and hazard and asset identification.

(iii) Vulnerability Assessment – Sensitivity (consequences), exposure (likelihood), and level of risk, adaptive capacity and asset vulnerability.

(iv) Risk Evaluation – Existing controls, and assets requiring risk treatment as a priority

(v) Risk Treatment – Identify risk treatment options (hierarchy - avoid, retreat, accommodate, protect) and evaluate risk treatment options (multi-criteria analysis and cost benefit analysis), short and long-term risk management pathway, decision-making triggers, and planning horizons.

(vi) Implementation – Plan for short-term risk management, medium to long-term strategic risk management, land use planning instruments and funding.

(vii) Monitoring and Review.

A standard *Scope of Works* has been formulated (Appendix 1) to assist a decision-making organisation to obtain consulting services to complete the CHRMAP tasks.

IV. COASTAL HAZARDS

Erosion and inundation are the two primary coastal hazards targeted by this Guideline, especially in areas where they are expected to be exacerbated by sea-level rise. This is discussed in detail in Sections 2.1 *Planning timeframe and sea level rise and 2.2 Hazard identification*.

V. MULTI - DISCIPLINARY TEAM

CHRMAP sits within the land use and development planning process and outcomes are required to be implemented through the Western Australian planning framework and its instruments. CHRMAP involves several stages that require a broad range of professional input. Ideally, the process will be led by planning professionals with support and assistance from other professions.

VI. GOVERNANCE

A Steering Committee should be established to provide guidance and oversight on, and make decisions in relation to, all aspects of the CHRMAP process.

BOX 1 – example of Steering Committee membership

Where CHRMAP is being undertaken for a local government, it is important that the Steering Committee includes input and representation from all their major functional areas, including but not limited to:

- strategic and statutory planners
- asset and facility managers
- risk managers
- community and development consultation managers
- service managers
- finance staff
- coastal engineers
- emergency management coordinators
- natural resource/sustainability/environmental management staff
- marketing and communications staff
- education officers

As risk management requires ongoing and sustained commitment it is also important to have the commitment from champion(s) of the process, such as elected members and executive staff. This will enable a coordinated organisation-wide approach that is necessary to achieve desired outcomes.

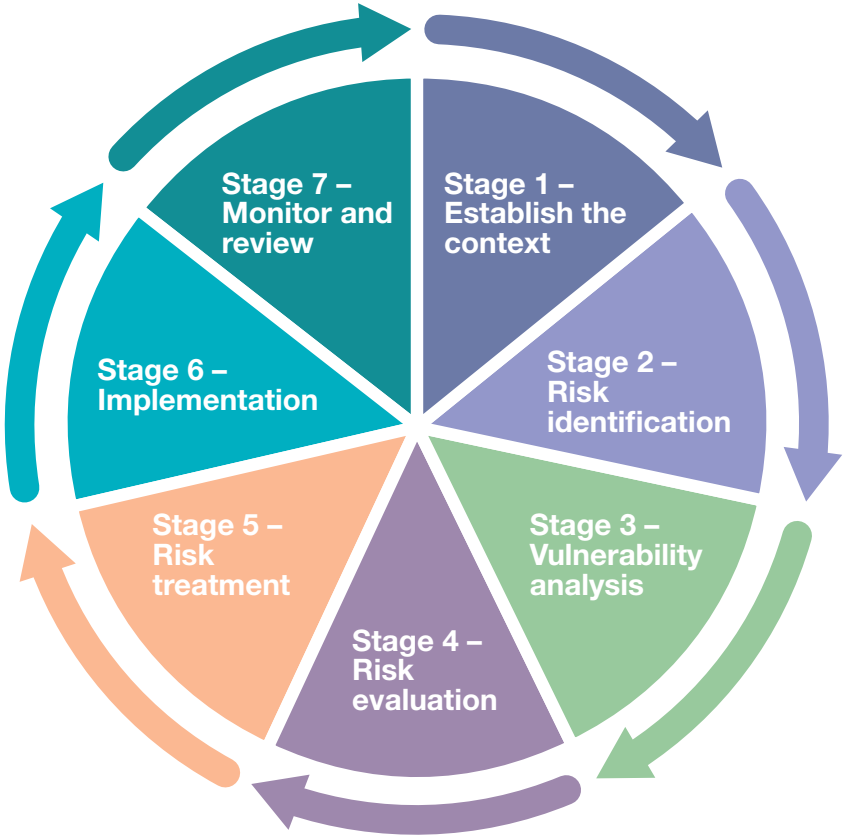
(Adapted from State of NSW and Office of Environment and Heritage 2011)

VII. STAGING

To simplify the CHRMAP process, its preparation should be completed in stages consistent with those identified in Section 1.3 *Risk management*. Staging enables for a structured, systematic approach to the process. Each stage should have clearly identified project deliverables. Figure 2 indicates the stages of the CHRMAP process.

After each stage, the project deliverables should be reviewed and signed off by the steering committee, prior to subsequent stages being initiated.

Figure 2: Staging flowchart



VIII. INTEGRATION

Further to Section 1.3 *Risk management*, it is important to be cognisant that many decision-making organisations will have risk management practices in place. Where a decision-maker has existing risk management processes/plans, risks arising from coastal hazards can be included.

IX. TERMINOLOGY AND DEFINITIONS

SPP 2.6 indicates that its application should be based on the best available information. For the purposes of this document, many of the following terminology and definitions have been sourced from AS ISO 31000:2018, AS 5334-2013, and ISO Guide 73:2009. They differ from those in SPP 2.6 because it is appropriate to take the terminology and definitions of risk management from the standards as it provides the basis for undertaking risk management processes and are terminology and definitions accepted at an international level.

acceptable	risks that do not need further treatment. The expression acceptable level of risk refers to the level at which it is decided that further restricting or otherwise altering the activity is not worthwhile. E.g. additional effort will not result in significant reductions in risk levels.
adaptation	changes made in response to the likely threats and opportunities arising from climate variability and climate change. Notes: 1. adaptation can be spontaneous or planned, and can be carried out in response to or in anticipation of changes in climatic conditions.

adaptive capacity	the ability of a system to respond to climate change to moderate potential damages, to take advantage of opportunities, or to cope with consequences. Notes: 1. adaptive capacity can be as inherent property, or it could have been developed because of established policy, planning or design decisions. 2. adaptive capacity reflects existing controls including contingency plans and their effectiveness.
assets	something that has potential or actual value to the decision-maker, community and stakeholders. Notes: 1. value can be tangible or intangible. 2. value includes consideration of risk and liabilities, and can be positive or negative at different stages of the assets life. 3. Assets may be natural or man-made and include the beach; foreshore reserve (including dunes, flora and fauna); foreshore reserve amenity (including car parks, paths, public ablutions, barbeque/picnic/shade areas, playground and other recreational equipment, infrastructure for public safety and pedestrian access structures such as ramps, stairs and paths), marinas for tourism, recreational boating facilities, facilities to benefit the broader public (such as short stay accommodation, cafes and restaurants), surf life-saving facilities, commercial and residential land, and protection structures such as groynes, seawalls and sand nourishment.
coastal hazard	source of potential harm. Note: 1. hazard can be a risk source.
coastal processes	action of natural forces on the coastal environment within the coastal zone.
coastal protection works	permanent or periodic work undertaken primarily to alter physical coastal processes and/or manage the effects of coastal hazards. The influence of coastal protection works should be evaluated at the sediment cell level.

communication and consultation	continual and iterative processes that an organisation conducts to provide, share or obtain information and to engage in dialogue with stakeholders regarding the management of risk. Notes: 1. the information can relate to the existence, nature, form, likelihood, severity, evaluation, acceptability, treatment or other aspects of the management of risk. 2. consultation is a two-way process of informed communication between an organisation and its stakeholders or others on an issue prior to deciding or determining a direction on an issue. Consultation is: (a) a process which impacts on a decision through influence rather than power; and (b) an input to decision-making, not just decision-making.
consequence	the outcome of an event affecting consequences. Notes: 1. a consequence can be certain or uncertain and can have positive or negative direct or indirect effects on objectives. 2. consequences can be expressed qualitatively or quantitatively. 3. Any consequence can escalate through cascading and cumulative effects.
control	measure that maintains and/or modifies risk. Notes: 1. controls include, but are not limited to, any process, policy, physical structure, practice, or other conditions and/or actions which maintain and/or modify risk. 2. controls may not always exert the intended or assumed modifying effect.
cost benefit analysis	technique used to determine the benefits or costs of a project, option or decision to aid decision-making.
development	has the same meaning as in the *Planning and Development Act 2005*.
environment	conditions or influences comprising built, physical and social elements, which surround or interact with the community (including the natural conditions, the natural as modified by human activity and the artificial).

erosion	shoreline movement where the shoreline shifts landward reducing the width of a coastal foreshore reserve and/or the distance to a fixed feature on the adjoining land.
establishing the context	defining the external and internal parameters to be considered when managing risk, and setting the scope and risk criteria for the risk management policy.
event	occurrence or change of a set of circumstances. Notes: 1. an event can have one or more occurrences, and can have several causes and several consequences. 2. An event can also be expected but does not happen, or something that is not expected which does happen. 3. an event can be a risk source.
exposure	extent to which an organisation and/or stakeholder is subject to an event.
hazard	Source of potential harm. Note: 1. hazard can be a risk source.
horizontal shoreline datum (HSD)	defines the active limit of the shoreline under storm activity. It is the line from which a physical processes allowance will be applied from.
inherent risk	the risk prior to applying controls.
intolerable	risk that is unacceptable in any circumstances or at any level.
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.

likelihood	chance of something happening. Note: 1. in risk management terminology, the word 'likelihood' is used to refer to the chance of something happening, whether defined, measured or determined objectively or subjectively, qualitatively or quantitatively, and described using general terms or mathematically (such as a probability or a frequency over a given time). 2. the English term 'likelihood' does not have a direct equivalent in some languages; instead, the equivalent of the term 'probability' is often used. However, in English, 'probability' is often narrowly interpreted as a mathematical term. Therefore, in risk management terminology, 'likelihood' is used with the intent that it should have the same broad interpretation as the term 'probability' has in many languages other than English.
monitoring	continual checking, supervising, critically observing or determining the status to identify change from the performance level required or expected. Note: 1. monitoring can be applied to a risk management framework, risk management process, risk or control.
mitigation	steps taken to reduce the level of risk, the consequences and/or the likelihood of an event.
multi-criteria analysis	decision-making tool that supports prioritisation of risk management options using multiple criteria that may be qualitative or otherwise unable to be compared directly.
residual risk	risk remaining after applying existing controls. Note: 1. residual risk can contain unidentified risk.
review	activity undertaken to determine the suitability, adequacy and effectiveness of the subject matter to achieve the established objectives. Note: 1. review can be applied to a risk management framework, risk management process, risk or control.

risk	the effect of uncertainty on objectives. Notes: 1. an effect is a deviation from the expected. It can be positive, negative or both, and can address, create or result in opportunities or threats. 2. objectives can have different aspects and categories, and can be applied at different levels. 3. risk is often characterised by reference to potential events and consequences, or a combination of these. 4. risk is usually expressed in terms of risk sources, potential events, their consequences and their likelihood. 5. uncertainty is the state, even partial, of deficiency of information related to, understanding or knowledge of an event, its consequences, or likelihood.
risk evaluation	process of comparing the results from the vulnerability analysis with risk criteria, to determine whether the risk and/or its magnitude is acceptable or tolerable. Note: 1. risk evaluation assists in the decision about risk treatment.
risk criteria	terms of reference against which the significance of a risk is evaluated. Notes: 1. risk criteria should be based on organisation objectives and internal and external context. 2. risk criteria can be derived from standards, laws, polices or other requirements.
risk identification	process of finding, recognising and describing risks. Note: 1. risk identification involves the identification of risk sources, events, their causes and their potential consequences.
risk management	coordinated activities to direct and control an organisation regarding risk.
risk management pathway	approach for enabling systematic adjustment of risk management strategies in response to new information or changing circumstances.
risk source	element which alone or in combination has potential to give rise to risk.

risk treatment	process to modify risk. Note: 1. risk treatment can create new risks.
sediment cell	natural units with a physical basis, identifying sections of the coast within which sediment transport processes are strongly related. Each sediment cell is a collection of marine and terrestrial landforms, inter-related by sediment transport between them. They include areas of sediment supply (sources), sediment loss (sinks) and areas through which sediment is moved between sources and sinks (pathways). Sediment transport pathways include both alongshore and cross-shore processes and therefore cells are best represented in two dimensions. Sediment cells provide a framework for coastal management by defining 'natural' management units that link the marine and terrestrial environments.
sensitivity	degree to which an asset is affected, either adversely or beneficially, by climate related stimuli. Note: 1. the effect may be direct or indirect.
sustainable	achieving as much as possible with as little as possible. This requires current generations to minimise consumption and imports on natural and other resources to continue their activities in the long-term and maintain future options. It involves wealth creation, while preserving our natural, biodiversity and ecosystem integrity and cultural heritage, for the benefit of current and future generations.
storm surge	increase in water level at the shoreline due to the forcing of winds (wind-setup) and atmospheric pressure.
stakeholder	person or organisation that can affect, be affected by, or perceive themselves to be affected by a decision or activity. Note: 1. a decision-maker can also be a stakeholder.
tolerable	the willingness to live with a risk to secure benefits and achieve objectives, on the understanding that it is being properly controlled. 'Tolerability' does not mean 'acceptability'. Tolerating a risk does not mean that it is regarded as negligible, or something we may ignore, but rather as something that needs to be kept under review and reduced further.

trigger	pre-determined point that is set to 'trigger' the commencement of planning and/or implementation action of a risk management option to avoid crossing a 'threshold'.
uncertainty	lack of precise knowledge arising from changes that are difficult to predict.
value	tangible or intangible, financial or non-financial.
vulnerability assessment	the systematic process to understand the nature of and to deduce the level of vulnerability of an asset.
vulnerability	intrinsic properties of something resulting in susceptibility to a risk source that can lead to an event with a consequence.

PART B – GUIDELINES

STAGE 1 – ESTABLISH THE CONTEXT

Establishing the context for CHRMAP outlines the framework within which the CHRMAP shall be undertaken. It enables stakeholders to start from a common understanding of the exercise, and how to approach the analysis.

Establishing the context assists in identifying and assessing risk treatment options later in the process. This step is also important for clearly outlining what the CHRMAP is to encompass and what it is to exclude.

1.1 – PURPOSE

The purpose of establishing the context for the CHRMAP is to articulate risk management measures to identified risks arising from coastal hazards. The CHRMAP may have been initiated due to:

a) direction from previous local or government studies or policies that recommend the CHRMAP as a risk management planning method to deal with uncertainty

b) the scale and extent of the existing or proposed land use and development assets area or values currently or potentially at risk

c) the flow-on effects to the social, environmental and economic elements of a specific decision-maker's area of responsibility.

BOX 2 – Example of purpose

Broome Townsite CHRMAP

The Shire of Broome is undertaking coastal hazard risk management and adaptation planning (CHRMAP) to provide strategic guidance on coordinated, integrated and sustainable management of coastal areas identified as being at risk of coastal hazard through erosion and storm surge inundation.

With a resident population of approximately 15,000 and up to 60,000 visitors annually the coastal regions are critically important as both a lifestyle and recreation focus, whilst for local businesses the coastal areas provide economic benefits that are both direct and indirect. Management of the coastal areas and foreshore reserves that surround the town, and the mitigation of the coastal hazard risk posed to the community is integral to Broome's ongoing and future success.

The Shire has recently completed a coastal vulnerability study (CVS) for the Broome town site, which identified the coastal hazard affecting the town in the present day and for future planning periods out to 2110. The CHRMAP process applies the findings of the CVS, and examines the coastal areas likely to be affected by coastal erosion and inundation, to identify areas that require management and adaptation strategies for mitigation of coastal hazard risk in future planning periods. (Baird 2017).

1.2 – OBJECTIVES

The CHRMAP objectives should be aligned to a decision-maker's strategic plans based on the principle of sustainable land use and development for current and future generations. Objectives should be broad and incorporate social, economic and environmental risk assessment and amelioration as appropriate; however, this should be done within the context of the objectives of SPP 2.6 that are to:

1. *ensure that development and the location of coastal facilities takes into account coastal processes, landform stability, coastal hazards, climate change and biophysical criteria*
2. *ensure the identification of appropriate areas for the sustainable use of the coast for housing, tourism, recreation, ocean access, maritime industry, commercial and other activities*
3. *provide for public coastal foreshore reserves and access to them on the coast*
4. *protect, conserve and enhance coastal zone values, particularly in areas of landscape, biodiversity and ecosystem integrity, indigenous and cultural significance*

BOX 3 – Example of objectives

General

- Improve understanding of coastal features, processes and hazards in the study area.
- Identify significant vulnerability trigger points for each sediment cell to mark the need for immediate or medium-term risk management action.
- Identify assets (natural and man-made) and the services and functions they provide situated in the coastal zone.
- Gain an understanding of assets vulnerability.
- Identify the value at risk of the assets that are vulnerable to coastal hazards.
- Determine the consequence and likelihood of the coastal hazards on the assets, and assign a level of risk.
- Identify effective risk management measures (and actions) and how these can be incorporated into short and longer-term decision-making.
- Engage stakeholders and the community in the planning and decision-making process.

Project Specific

- *Inform key stakeholders and the Broome community about the coastal hazard risks identified in the CVS.*
- *Undertake a widespread stakeholder and community engagement program that will identify the values of various coastal assets, inform the tolerance of the identified coastal hazard risks, identify potential adaptation options to address the risks and indicate the level of support for these options;*
- *Ensure stakeholders and the community are included in the planning and decision-making process*
- *Produce a Broome Townsite CHRMAP in accordance with the Western Australian Planning Commission's (WAPC's) CHRMAP Guidelines to be adopted by Council.*
- *Identify community and cultural values and the social value of environmental assets as well as key coastal infrastructure and assets*
- *Provide a clear pathway for the Shire of Broome and partners to address coastal hazard risks over time*
- *Guide investment decisions by the Shire in terms of the location and maintenance of coastal infrastructure*
- *Provide guidance for the development of statutory planning controls. (Baird 2017).*

1.3 – SCOPE

It is important to outline what the CHRMAP is specifically being formulated for and the intended application. It should specifically target risks that are identified as intolerable, and ensure risk management measures are formulated to reduce these risks down to acceptable or tolerable levels. In this regard the CHRMAP should provide strategic guidance on medium to long-term risk management strategies, with a focus on short-term risk management measures (<25 years).

BOX 4 – Example of purpose

Scope

This standard provides principles and generic guidelines on the management of the risks that settlements and infrastructure face from the consequences of climate change. It describes a systematic approach to planning the adaptation of settlements and infrastructure based on the risk management process given in AS/NZS ISO 31000:2018.

This standard is relevant to individuals and organisations concerned with all phases in the lifecycle of settlements or infrastructure that will be affected by climate change. These phases may involve –

(a) policy, planning and approvals

(b) commissioning and design

(c) construction, operation and maintenance

(d) decommissioning.

This document can be used throughout the life of the organisation and can be applied to any activity, including decision-making at all levels.

(Adapted from Australian Standard (2018) and Australian Standard (2013))

1.4 – STUDY AREA

It is important to define the spatial extent of the CHRMAP area. This may include the land use and development contexts present (or proposed), and/or an area of value for social, economic or environmental reasons. The total study area is to be identified ensuring it encompasses all the relevant coastal processes operating in the identified area.

Determination of the study area should follow the assessment requirements in SPP 2.6, for coastal processes regarding its physical and biological features based on the coastal geology and geomorphology. SPP 2.6 identifies the following coastal geomorphic types: sandy, rocky, mixed sandy and rocky, coastal lowlands, tidal reaches of inland waters, and islands. The study area should include the entire sediment cell, which are the natural management units with a physical basis, identifying sections of the coast within which sediment transport processes are strongly related.

BOX 5 – Sediment cells

Sediment cells are sections of the coast within which sediment transport processes are strongly related. They are commonly identified as self-contained units where little or no sediment movement occurs across cell boundaries. They include areas of sediment supply (sources), sediment loss (sinks), and the sediment transport processes linking them (pathways). Sediment cells provide a framework for coastal management by defining 'natural' management units which link the marine and terrestrial environments. Sediment cells also provide a framework for estimating sediment budgets. A sediment budget is a quantitative estimate of how much sediment is involved at each stage of movement within a cell. Sediment cells provide a platform that supports interpretation of historic trends, understanding of contemporary processes and most importantly the projection of future coastal change.

Further information can be obtained from Stul T, Gozzard JR, Eliot IG and Eliot MJ (2012) *Coastal Sediment Cells between Cape Naturaliste and the Moore River*, Western Australia. Report prepared by Damara WA Pty Ltd and Geological Survey of Western Australia for the Western Australian Department of Transport, Fremantle [available online at the Department of Transport].

1.5 – COMMUNITY AND STAKEHOLDER ENGAGEMENT

It is important to engage the community and stakeholders effectively throughout the entire CHRMAP process, to ensure a successful outcome for the risk management process.

The CHRMAP process requires consideration of coastal hazards, the consequences of those hazards, asset values, and risk management measures.

While characterising coastal hazards should be done by technical experts, assessing risk arising from coastal hazards, consequences, asset values, and risk management measures is best done through an open process with input from an informed community and stakeholders. This ensures that all stakeholders can understand the risk management measures and the trade-offs that have been agreed. Their viewpoints and values should be sought when developing the risk evaluation criteria, the consequence scale and success criteria, which will enable valuable local and regional knowledge and information to be drawn on in establishing them. Community and stakeholder engagement will assist in:

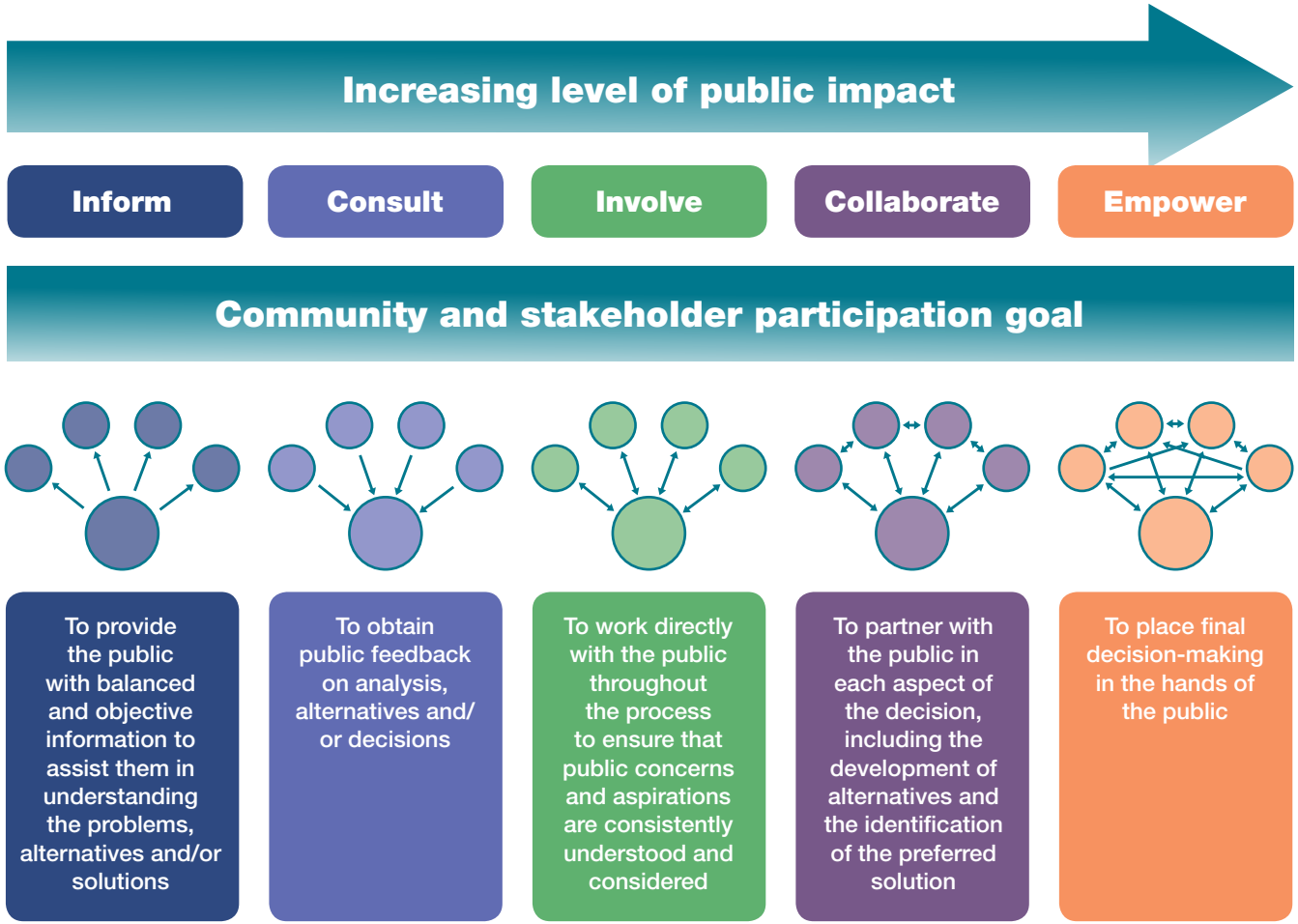
- providing community and stakeholders with multiple opportunities to be involved and provide input into the CHRMAP process, particularly in identifying values
- determining the consequences and their acceptability or otherwise of a given set of coastal hazards
- identifying potential responses to identified unacceptable and/or intolerable risks from as many sources as possible
- acceptance and success of the outcomes of the CHRMAP process given the community and stakeholders involvement in its development, encouraging a sense of community ownership for the CHRMAP.

Community or stakeholder groups might include:

- local communities
- community groups
- land management agencies/councils
- emergency management agencies
- emergency service organisations
- essential services
- local governments, State and Commonwealth government agencies, and government entities
- industry/business or industry/business associations.

A key component of designing a community and stakeholder engagement strategy for the CHRMAP is to determine what type of participation is appropriate for each key decision or stage of the process. The International Association of Public Participation (IAP2) provides guidance and resources in internationally recognised public participation practice. IAP2 outlines that community and stakeholder participation can be considered along a spectrum from seeking to inform (to impart information), consult (to seek advice or information) and involve (to engage or include as participants) through to collaborating (to work together) and empowering (to invest with legal power, to authorise). Most engagement plans will include activities that cross this spectrum as is suitable to the outcome being sought. The level of engagement selected should best suit the aims and context of the engagement required for the specific key decision or stage of the CHRMAP process. Figure 3 indicates these levels of engagement for community and stakeholder participation.

Figure 3: Levels of engagement for community and stakeholder participation



(Adapted from LGAQ 2014)

IAP2 also outlines several core values for community and stakeholder participation and determines that engagement should:

- be based on the belief that those who are affected by a decision have a right to be involved in the decision-making process
- includes the promise that the public's contribution will influence the decision
- promotes sustainable decisions by recognising and communicating the needs and interests of all participants, including decision-makers
- seeks out and facilitates the involvement of those affected by or interested in a decision
- provides participants with the information they need to participate in a meaningful way
- communicates to participants how their input affected the decision.

These values will guide the CHRMAP process, the fostering of support for the risk management outcomes, and should underpin the formulation of the community and stakeholder engagement strategy.

Determining the most appropriate type of participation should then guide the design of the engagement strategy, including the selection of appropriate engagement mechanisms. Such mechanisms include community reference groups; steering committees; general and specific community and stakeholder workshops; surveys and questionnaires; public information, education and consultation programs; and the release of a draft document for public feedback.

When designing the engagement strategy, it should be noted that participation rates in CHRMAP engagement have typically been low when compared to other town planning-related matters. Mechanisms should therefore be carefully selected to address this matter, to get the most benefit out of engagement activities. Further to the mechanisms identified above, consideration should be given to establishing a Community Engagement Panel (CEP).

A CEP consists of a representative sample of people from the community and stakeholders. Participants agree to take part in several deliberations on the elements, issues and outcomes captured within the CHRMAP process. Having a CEP also enables the multi-criteria analysis to be undertaken collaboratively, ensuring the outcomes are consistent with its views. This engagement mechanism enables validation by the CEP as a representation of the community and stakeholders of the CHRMAP process and outcomes.

1.5.1 – INTERNAL ENGAGEMENT

Internal engagement across all relevant divisions of the decision-making organisation will increase the likely effectiveness of the CHRMAP process. Good internal engagement will:

- inform the rest of the organisation of the purpose of the CHRMAP to promote understanding and support across the organisation
- help identify existing data sets that may be used in the CHRMAP process
- provide an understanding of existing planning controls and risk management procedures. This helps to identify activities that already address risks arising from coastal hazards and will identify the areas of the organisation most suited to implement risk management measures (which will ensure implementation is mainstreamed across the organisation and not carried out in isolation).

Formulation of the Community and Stakeholder Engagement Strategy should be carefully considered and in line with IAP2 core values. The IAP2 Public Participation Toolbox - Techniques to share information - and the Public Participation Spectrum providing further guidance and information on IAP2 is at Appendix 2.

1.5.2 – VALUES

As outlined in Section 1.5 *Community and stakeholder consultation*, it is necessary to identify and define the values of assets by the community and stakeholders, to determine the consequence and tolerability of risks arising from coastal hazards, and to assess the acceptability of risk treatment options designed to best manage the values of assets.

Coastal values that should be considered throughout the stages of the CHRMAP, and specifically incorporated in the multicriteria analysis, include:

- **Social** – values are generally those that support quality of life, health and wellbeing of a community. These values include social benefits and services provided by environmental or infrastructure assets or land. Examples include beaches and foreshore reserves (environmental), car parking, and formal access paths (public infrastructure) to them.
- **Environmental** – values are generally those that support coastal habitats for their geological, geomorphological, biodiversity and ecosystem integrity, landscape, seascape and visual landscape. Examples include ecosystem services provided by dune habitats for local flora and fauna, trapping of and storing sand, and providing a source of sand to replenish beaches following erosion events.
- **Infrastructure** – values of the assets that support economic, social and environmental values. Infrastructure generally includes physical assets for transport, services and the community. Examples include buildings, road and rail (transport), water and sewer and electricity (services), and Surf Life Saving Clubs and foreshore infrastructure including footpaths, dune fencing and ablution facilities (community).
- **Economic** – values are those that support industry, tourism, employment or relate to matters that have an economic implication.

CHRMAP should primarily be focussed on values and assets that support public values and provide public benefit, and private assets and associated values important to community and stakeholders. While the CHRMAP process may identify private assets and associated values to be at risk arising from to coastal hazards, public resources available for risk management should primarily be allocated to preserving assets and values which provide public benefit. Private parties are responsible for managing risks to their private assets and incomes. The roles and responsibilities of private and public parties in coastal planning and management are set out in Part A, Section 1.2 of this guideline and in the *WA Coastal Zone Strategy* (2017).

In identifying and defining values, it is acknowledged that it may be difficult to place an economic value on ‘non-market’ or intangible social and environmental values. Identifying and defining the value of natural assets through community engagement, and maintaining a focus on these values throughout the CHRMAP process is critical to its success. Assessing values for non-economic assets is further discussed in Section 5.3.1 *Multi-criteria analysis* and could be applied where appropriate.

NB: Community values change over time. A new values assessment should be undertaken every time a review of the CHRMAP is completed as values may have changed in the intervening years, which may change the community and/or stakeholder's willingness to implement different adaptation measures.

1.6 – EXISTING CONTROLS

In managing the coastal zone, many planning instruments and physical structures may be relevant. It is important to identify and summarise the key legislation, policies, guidelines, physical structures, and activities that need to be considered as part of the process, including their relevance and how they may inform, complement or enhance this process.

Existing controls may have a bearing on the consequence and/or likelihood and level or risk for assets and their values, vulnerability, risk tolerance and ultimately the risk management measures. Identifying existing controls is critical to undertaking Stage 4 *Risk evaluation* in prioritising risk treatment options to be investigated in Stage 5 *Risk treatment*, and Stage 6 *Implementation* to ensure that risk management measures are implementable within the WA planning framework and instruments.

Existing controls may include planning instruments such as: the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth); the *Planning and Development Act 2005* (Western Australia); *SPP 2.6;* and local planning schemes (special control area), strategies, policies, structure plans and foreshore management plans. Physical controls may include structures such as sea walls, groynes and break waters, and any protection activities such as existing sand by-passing and beach nourishment.

1.7 – SUCCESS CRITERIA

Success criteria determine if the objectives of the CHRMAP are achievable and sustainable. The success of the CHRMAP will be determined by the asset(s) identified through the CHRMAP process continuing to provide their present function, service and values or some adapted level still acceptable to the community and stakeholders, at an acceptable cost (socially, economically and environmentally). The success criteria need to reflect the function, service and values associated with the assets from the community and stakeholder viewpoint. In this regard, the success criteria should be developed based on the results of the identification of values at Section 1.5.2 *Values* as part of community and stakeholder consultation at Section 1.5 *Community and stakeholder engagement*.

BOX 6 – Example of success criteria:

- Maintenance of public safety.
- Protection and enhancement of the local economy.
- Protection of critical infrastructure (e.g. roads, sewerage treatment plants).
- Planned retreat and removal of indefensible minor infrastructure (e.g. temporary car parks, dual-used path, caravan parks).
- Protection of existing community structures and the lifestyle enjoyed by people in the region.
- Sustaining and enhancing natural environmental values/ conservation values/threatened species.
- Ensuring sound public administration and governance.
- Protect, conserve, enhance and maintain natural coastal values.
- Protect and restore foreshores along the coast, estuaries, and their wetlands.
- Maintain, restore and manage natural coastal processes.
- Facilitate and promote public usage and enjoyment of the coast.
- Retain the widest possible range of risk management options for future users of the coast.
- Ensure natural coastal resources are used in an equitable and sustainable manner.
- Undertake protection works only as a last resort when justified in the public interest to protect high value property and infrastructure – and ensure funding arrangements are based on cost-benefit and beneficiary pays principles.

(Adapted from Department of Climate Change (2006) and WA Coastal Zone Strategy (2017))

STAGE 2 – RISK IDENTIFICATION

Coastal hazard identification establishes an understanding of potential impacts of erosion and storm surge inundation on the assets, and their values, including from coastal physical processes and sea level rise. Erosion and inundation hazards need to be considered discretely and in combination when determining their likely impacts.

At Stage 2, inherent risk should be considered, with risk tolerance to be reassessed after existing controls are included as part of Stage 4 *Risk evaluation*.

Risk identification is important as coastal hazards often have multiple sources, pathways and receptors that need to be considered. Table 1 provides an example of erosion and inundation coastal hazards, their sources and pathways.

Table 1: Coastal hazards sources and pathways

Hazard	Source	Pathways
Inundation	• Sea level rise • Tides • Storm surges • Waves • Tsunami • Wind • Climate cycles (La Nino, El Nino)	• Direct inundation of low-lying land • Overtopping or breaching of dunes, natural or man-made barriers (protection works) • Back up of stormwater from rainfall unable to drain due to high sea level
Erosion – sandy coast	• Sediment supply (absence or reduction of sediment supply from offshore or from littoral drift) • Sea level rise (recession due to) • Tides • Storm surges • Waves • Wind • Climate cycles (La Nino, El Nino) • Modified currents, e.g. from introduction of protection measures or structures nearby	• Long-term continuous recession • Long-term fluctuating recession • Short-term fluctuations/cycles • Human induced changes
Erosion – rocky coast	• Geology/geomorphological controls • Sea level rise (response to) • Tides • Storm surges • Waves • Climate cycles (La Nino, El Nino)	• Slumping • Undermining • Removal of toe protection • Inundation of shore platform • Lowering of fronting beach • Weathering • Internal defects
Erosion – mixed sandy/ rocky coast	• Sediment supply (absence or reduction of sediment supply from offshore or from littoral drift) • Sea level rise • Tides • Storm surges • Waves • Climate cycles (La Nino, El Nino) • Modified currents, e.g. from introduction of protection measures or structures nearby	• Long-term continuous recession • Long-term fluctuating recession • Short-term fluctuations/cycles • Human induced changes
Damage to artificial structures	• Changes to sediment transport sources; sinks; and pathways. • Sea level rise (response to) • Tides • Storm surges • Waves • Tsunami • Climate cycles (La Nino, El Nino) • Modified currents, e.g. from introduction of protection measures or structures nearby	• Undermining • Overtopping • Increased wave forces • Deterioration

2.1 – PLANNING TIMEFRAME AND SEA LEVEL RISE

The planning timeframe shall be 100 years from when the CHRMAP is prepared.

Sea level rise (**SLR**) will influence assessment of the likelihood of coastal erosion and inundation for the areas and how those likelihoods may vary over the planning timeframe. In completing the CHRMAP, selecting years on which to assign SLR values is useful. For example, the current year, and projections for 10, 25, 50 and 100 years from the year of assessment may be used.

Tide gauge data in Western Australia indicate that sea level has risen since the mid-nineteenth century and is projected to continue to rise over the coming centuries, although there is uncertainty as to the extent. Selecting several different SLR values allows analysis of the likelihood of coastal hazards to identified assets over time, which will help determine when risk management measures should be implemented.

In accordance with SPP 2.6, a SLR not less than 0.9 metres by 2110 is to be considered. It is also important that the vulnerability assessment consider shorter and longer timeframe periods while maintaining consistency with SPP 2.6. Consistency will be achieved by ensuring other timeframe and SLR values are in accordance with those contained in the *Sea Level Change In Western Australia Application To Coastal Planning* (2010) document. For each year beyond 2110, a vertical sea level rise of 0.01m/year is to be added to 0.9m.

2.2 – HAZARD IDENTIFICATION

The hazard identification for the medium (25 - 50 years) to long term (50 - 100 years) planning timeframe should follow the methodologies in Schedule One of SPP 2.6. The allowance for coastal physical processes should be based on the coastal classification, and consider each of the factors listed for the coastal types. The study area for this calculation should be defined through the coastal geology/ geomorphology, including the entire sediment cell, which is the natural management units with a physical basis, identifying sections of the coast within which sediment transport processes are strongly related.

The allowance for erosion should be based on:

- (S1 Erosion) Allowance for the current risk of erosion
- (S2 Erosion) Allowance for historic shoreline movement trends
- (S3 Erosion) Allowance for erosion caused by future sea level rise.

On a sandy coast the allowance should also include 0.2 metres per year allowance for uncertainty.

The allowance for inundation should be based on:

- (S4 Inundation) Allowance for the current risk of storm surge inundation.

The storm event for erosion should be based on ocean forces and coastal processes that have a one per cent or one-in-one hundred probability of being equalled or exceeded in any given year over the planning time frame.

The storm event for storm surge inundation should be based on ocean forces and coastal processes that have at least a 0.2 per cent or one-in-five hundred probability of being equalled or exceeded in any given year plus the predicted extent of sea level rise over the planning time frame.

To assist with the short-term planning timeframe assessment, a standard local coastal hazard assessment scope of works has been developed to use for coastal physical processes assessment where existing development is at risk arising from coastal hazards within 25 years. The local coastal hazard assessment is limited to a relatively small area or a site, with the aim to predict in detail and quantify the coastal exposure to erosion and inundation. The assessment methodology is outlined in Appendix 3 *Scope of Works Local Coastal Hazard Assessment*.

2.3 – ASSET IDENTIFICATION

It is necessary to identify all assets (social, economic, environment) together with their function, services and value to help identify the consequences of coastal hazards. Once the assets have been identified, their function, service and values should reflect the community and stakeholder views.

Where assets share similar values or risk management requirements, or where risk management is likely to consider a group of assets, they may be grouped together. For example:

- private property, private property adjacent to the ocean
- local roads and utilities - local roads, and utilities such as power, sewage, and water within the road reserve
- foreshore reserve - where recreation assets are grouped together including car parks, public ablutions, barbeque/picnic/shade areas, playground, and pedestrian access structures such as ramps, stairs and paths
- coastal nodes - foreshore reserve, commercial, tourism, accommodation assets.

Table 2: Example of coastal assets and their functions, services and values

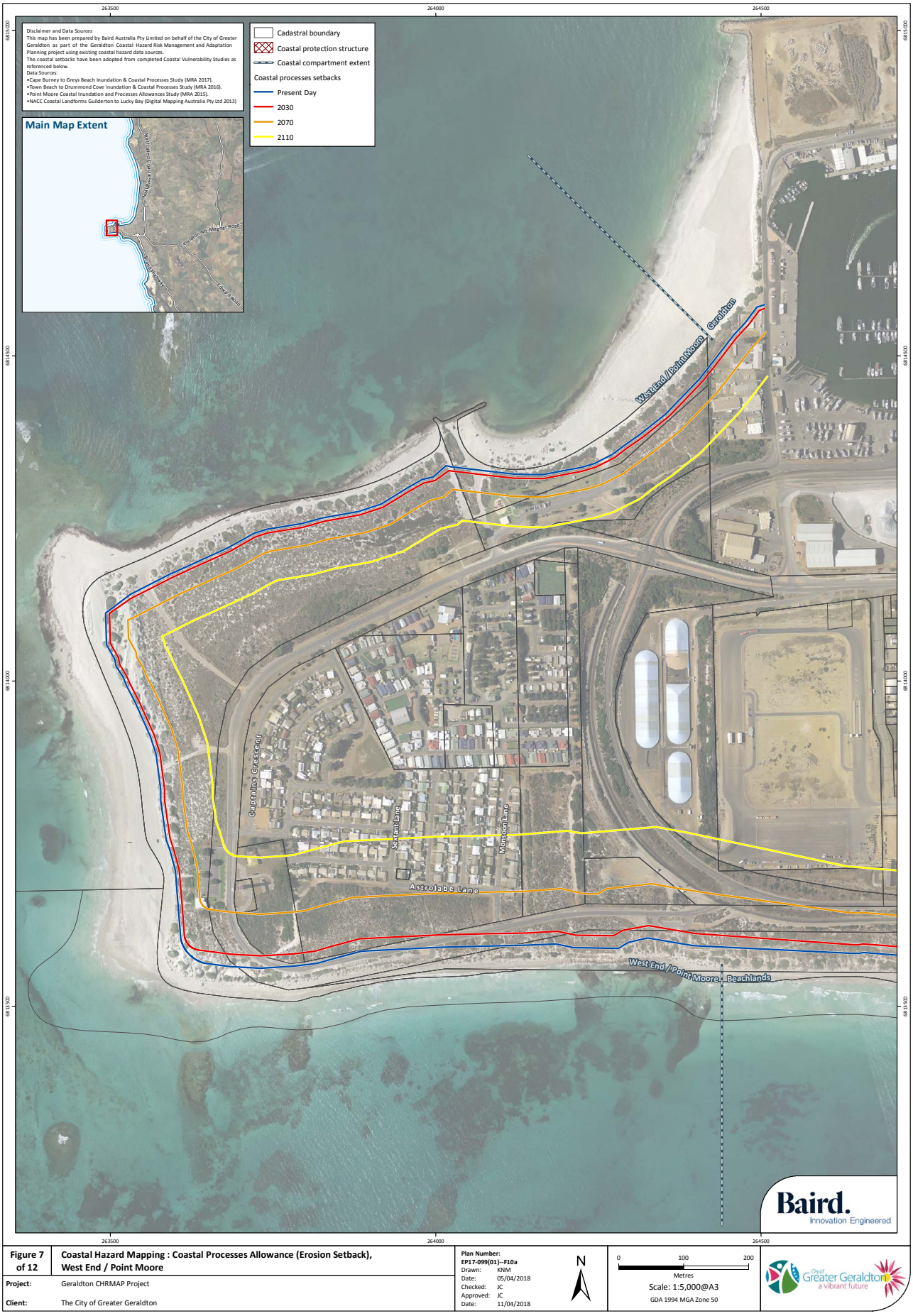
Assets	Functions, services and values
Environment	
Foreshore reserves and beaches	Coastal access, recreation and conservation. Tourist drawcard. Habitat for flora and fauna (conservation value for rare and threatened species). Supports biodiversity and ecosystem integrity. Geo-morphological features of locality. Buffer to other 'higher value' assets.
Social	
Surf Life Saving Club buildings	Strong community attachment and service.
Caravan parks	Provides local employment. Tourist drawcard. Seasonal population. Contributes to local economy.
Foreshore reserve amenity – dual use paths, toilet/picnic facilities	Ongoing access, community services, recreation and health benefits.
Residential (existing/future) development	Provides housing for resident population and future population.
Hospitals; schools; aged care facilities	Provides essential services, local employment.
Economic and Infrastructure	
Roads; railways	Provides transport services
Harbours, jetties, boat ramps	Provides recreation facilities. Provides local employment. Contributes to local economy.
Stormwater outlets and pipes; Sewerage pumping stations	Provides essential services
Commercial/industrial/institutional development and infrastructure	Provides employment and contributes to economy.

2.4 – HAZARD MAPPING

An important output of Stage 2 *Risk identification* is the formulation of coastal hazard risk maps for SLR over the chosen planning timeframes. These maps will spatially identify the current and projected extent of coastal erosion and inundation. This information is important when applying the consequence and likelihood, and tolerance levels during the vulnerability assessment and evaluation stages. Specifically, the consequences for assets can be mapped spatially using the coastal hazard maps to identify assets vulnerability over the planning timeframes. Figure 4 provides an example of coastal erosion hazard mapping.

To improve the way in which coastal hazards are communicated and understood across communities, it is highly desirable for hazard maps to apply titling, terminology, a legend, colour coding and disclaimers that are consistent with the example provided in Figure 4.

Figure 4: Example of coastal erosion hazard map



(Source: Baird 2018)

STAGE 3 – VULNERABILITY ASSESSMENT

Vulnerability assessment identifies how the effects of coastal hazards are likely to impact on assets within the coastal zone. It defines the degree to which an asset is susceptible to, and unable to cope with, the adverse effects of coastal hazards.

Vulnerability assessment is comparable to a conventional risk assessment, including the identification of risk by comparing the *consequence* and *likelihood* of coastal hazards, with the added component of adaptive capacity (see Box 7).

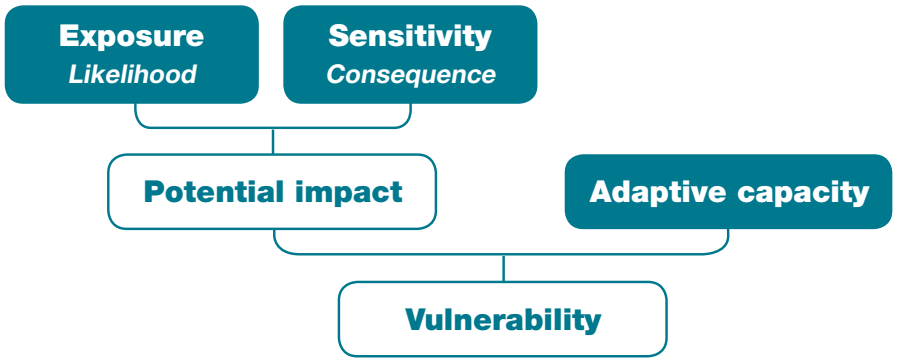
The vulnerability of coastal assets is a function of three overlapping elements: exposure, sensitivity and adaptive capacity of an asset. Potential impacts are a function of exposure and sensitivity, while vulnerability is a function of potential impacts and adaptive capacity. Figure 5 illustrates the components of a vulnerability assessment.

Stage 3 of the CHRMAP does not take into consideration existing or future controls as its purpose is to assess the inherent risk of coastal hazards on assets. Assessments of tolerable risk levels and inclusion of existing controls that may change risk levels are assessed in Stage 5 *Risk evaluation* of the CHRMAP process.

BOX 7 – Vulnerability assessment definition

It is important to note that in Western Australia coastal hazard assessments tend to be called vulnerability assessments. However, the term 'vulnerability assessment' should only be used where consideration of adaptive capacity is included in the assessment. This guideline uses vulnerability assessment as part of the CHRMAP process, consistent with Australian and international standards for vulnerability assessment that require adaptive capacity to be assessed.

Figure 5: Vulnerability assessment flowchart



(Adapted from Allen Consulting Group 2005)

3.1 – SENSITIVITY

Sensitivity is the consequence of the impact on an asset from coastal hazards. Sensitivity reflects the responsiveness of assets to the effects of coastal hazards. Sensitive assets are highly responsive to coastal hazard effects. Understanding asset sensitivity also requires an understanding of the thresholds at which an asset begins to exhibit changes in response to coastal hazard effects, whether these asset responses or adjustments are likely to be sudden 'step changes' or gradual, and the degree to which these changes are reversible. Sensitivity correlates to the determination of consequences, undertaken in Section 3.5.1 *Consequence*.

3.2 – EXPOSURE

Exposure is the likelihood of impact on an asset from coastal hazards. Exposure correlates to the determination of likelihood, undertaken in Section 3.5.2 *Likelihood*.

3.3 – POTENTIAL IMPACTS

Potential impacts reflect the combined level of risk of all the potential impacts that may occur to assets through coastal hazards effects, and is a product of the sensitivity (consequence) and exposure (likelihood) of those assets. However, it does not include consideration of any planned risk management measures. Potential impacts correlate to the determination of level of risk, undertaken in Section 3.6 *Level of risk*.

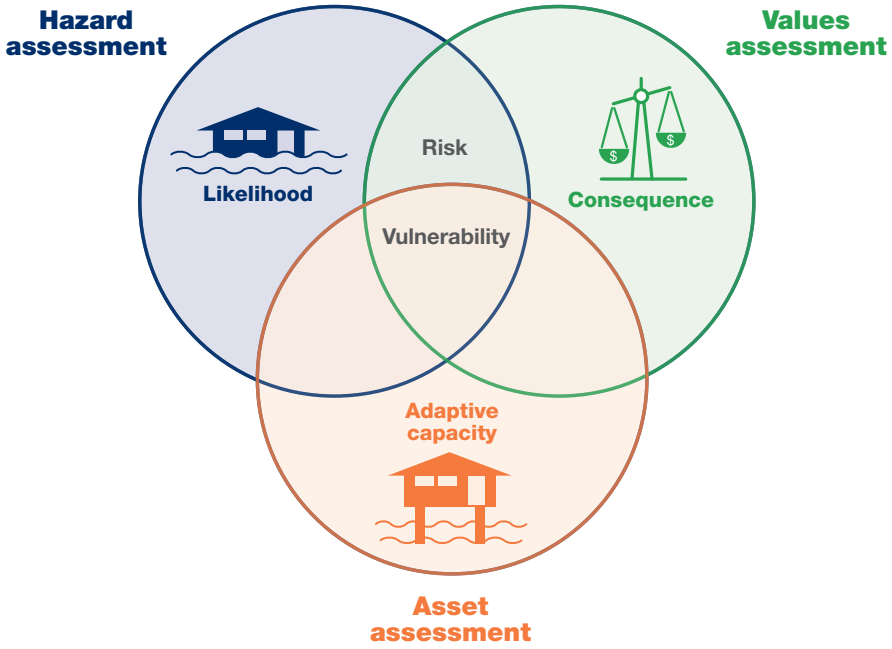
3.4 – ADAPTIVE CAPACITY

Adaptive capacity reflects the capacity of assets and activities to be modified in a way that makes assets better equipped to deal with negative impacts arising from coastal hazards effects (outlined further in Section 3.7 *Adaptive capacity and asset vulnerability*). However, adaptive capacity does not take into account planned risk management measures.

The approach to assessing adaptive capacity is summarised in Figure 6 and includes the following components:

- Sensitivity = *Consequence* of coastal asset being impacted.
- Exposure = *Likelihood* of coastal hazard occurring.
- Potential impact = *Risk* to coastal assets as a product of consequence and likelihood.
- Adaptive Capacity = The capacity for an asset to accommodate the coastal hazard impact and recover.
- Vulnerability = Final risk rating which incorporates the adaptive capacity of the asset (outlined further in Section 3.7 *Adaptive capacity and asset vulnerability*).

Figure 6: Vulnerability assessment elements



(Source, Cardno 2018a)

3.5 – CONSEQUENCE AND LIKELIHOOD

This stage involves consideration of the consequence and likelihood of the coastal hazards identified in Stage 2 *Risk identification*. This includes preparing consequence and likelihood scales for each planning timeframe being considered within the CHRMAP, and combining these scales into a risk matrix to determine the level of risk (separately for erosion and inundation). These scales allow the success criteria to be considered and identify the consequence and likelihood of their thresholds being exceeded. Undertaking this component will direct effort and guides the formulation of risk management measures for the areas of highest priority.

3.5.1 - CONSEQUENCE

Consequence is the impact of erosion and storm surge inundation on existing and future assets and the value assigned to that asset. Within the context of the vulnerability assessment, consequence is used to consider the sensitivity of an asset to coastal hazards. Consequence should be assessed for each planning timeframe being considered within the CHRMAP over the planning timeframe.

The consequence scale should be specifically tailored for application to coastal planning, adapted to the study area, be consistent with the local decision-makers' risk management framework (where relevant), be consistent with any local planning strategy (where relevant), and incorporate community values.

Once an understanding of the consequences has been established, they can be associated with the assets, their function, services and values.

Table 3: Example of a consequence (sensitivity) scale for coastal hazards

Rating	Social	Economic	Environment	Infrastructure	Safety
Catastrophic	Loss of life and serious injury. Large long-term or permanent loss of services, employment wellbeing, finances or culture (e.g. > 75% of community affected), international loss, no suitable alternative sites exist.	Permanent loss or damage to property, plant and equipment, finances > $5 million, or > 20% of annual operating budget.	Irreversible damage to local environmental asset that would compromise its viability, no alternate habitats exist.	Damage to majority or all of infrastructure (Greater than 75%). Asset with step change sensitivity and no adaptive capacity.	Death or permanent disabilities.
Major	Serious injury. Medium-term disruption to services, employment wellbeing, finances or culture (e.g. < 50% of community affected), national loss, very limited suitable alternative sites exist.	Permanent loss or damage to property, plant and equipment, finances > $2 - $5 million, or 10 - 20% of annual operating budget.	Irreversible damage to local environmental asset that would compromise its viability, local alternate habitat exists.	Damage to significant portion of infrastructure (50% - 75%) or asset with step change sensitivity. Asset with step change sensitivity and some adaptive capacity.	Extensive injuries or disabilities.
Moderate	Minor injury. Major short-term or minor long-term disruption to services, employment wellbeing, finances or culture (e.g. < 25% of community affected), regional loss, limited suitable alternative sites exist.	Permanent loss or damage to property, plant and equipment, finances > $100,000 - $2 million, or 5 - 10% of annual operating budget.	Environmental damage to local environmental asset that could be reversed or offset, no alternate habitats exist.	Damage to no more than half of the infrastructure (25% - 50%). Asset with step change sensitivity with adaptive capacity.	Medical treatment
Minor	Small to medium disruption to services, employment wellbeing, finances or culture (e.g. < 10% of community affected), local loss, many suitable alternative sites exist.	Permanent loss or damage to property, plant and equipment, finances > $10,000 - $100,000, or 2 - 5% of annual operating budget.	Environmental damage to local environmental asset that could be reversed or offset, local alternate habitat exists.	Minor damage to infrastructure (10% - 25%)	First aid treatment
Insignificant	Minimal short-term inconveniences to services, employment, wellbeing, finances or culture (e.g. < 5% of community affected), neighbourhood loss, many alternative sites exist.	Permanent loss or damage to property, plant and equipment, finances < $10,000, or 2% of annual operating budget.	Minimal damage to local environmental assets; recovery may take less than six months	Little or no damage to infrastructure (Less than 10%)	No injuries or illness

(Adapted from Ministry for the Environment 2008, Xviii and 149p. - Pg, 78, Wollongong CZMP 2017, Evocoast 2017, GHD 2017 and DLG 2013)

Table 4: Example of a consequence (sensitivity) scale for coastal hazards ascribed to assets

Coastal Assets	Consequence	Reason: Erosion	Consequence	Reason: Coastal Inundation
Foreshore reserve, Beaches				
Beaches	Major	The beach amenity itself is rated extremely highly by the community. Whether this is for scenic amenity, recreation, tourism or environmental reasons, many respondents noted the beauty and importance of beaches both to them and to the region's visitors. At the current time, the beach will generally recover from storm erosion events, although following large storm events this can take several years, during which time the beach may be less usable by community. Sea level rise has already commenced at measured rates; therefore, we may expect recovery following storms to become increasingly subdued until such point as the loss of sand is irreversible.	Insignificant	The impact of inundation (as separate from erosion) would occur over a short period (a few hours), resulting in a minor nuisance to the community, and causing little to no damage to the value of this asset.
Foreshore reserve	Moderate	These areas will remain functional even if reduced in size by erosion. They also serve as a buffer to allow roll back and therefore retention of the beach amenity. There may be some financial and social costs associated with specific facilities within foreshore reserves (e.g. BBQs, shelters, paths etc), that make impacts of greater consequence to community.	Minor	The impact of inundation (as separate from erosion) would occur over a short period (a few hours), resulting in a minor nuisance to the community, and causing little to no damage to the value of this asset.
Coastal Dune Systems	Major	It is recognised across the broader community that dunes are vitally important, providing sand reserves to buffer land and property from the impacts of erosion. In many places, the dunes have ecological value and they have significant value as an erosion buffer requiring maintenance into the future.	Insignificant	The impact of inundation (as separate from erosion) would occur over a short period (a few hours), resulting in a minor nuisance to the community, and causing little to no damage to the value of this asset.

Coastal Assets	Consequence	Reason: Erosion	Consequence	Reason: Coastal Inundation
Foreshore reserve, Beaches				
Surf Clubs	Major	Many community members noted the importance of the surf clubs both as assets to bring a sense of community, as well as tourism assets based upon the provision of patrolled beaches for visitors. There may be commercial value using clubs to provide restaurants / kiosks / bars for community and visitors in sought after beach setting. Loss of this asset through erosion would be irreversible.	Moderate	The impact of inundation (as separate from erosion) may cause damage to this asset and its interiors; however, the damages are repairable.
Caravan Parks	Minor	These facilities, while often being commercially / financially important to Council, may be important to visitors, but less so to the resident community. They are also easily relocated or adapted.	Minor	The impact of inundation (as separate from erosion) may cause damage to this asset and its interiors; however, the damages are repairable.
Heritage Norfolk Island Pines	Minor	Norfolk Island Pines are a marker of settlement in the coastal zone and the foreshore and there are currently restrictions on development near the pines or their removal. However, the pines have a limited lifespan and many of the pines are aging and likely to perish over the next 100 years. The trees can and will be replanted over the future, in which case they could be relocated. In a relative sense then, the pines would be considered lower importance / value than other assets, particularly as only a few specific trees may be affected, and which shall need to be replaced over time regardless.	Insignificant	Inundation of Norfolk Island Pines over a short period during a storm would cause little if any long-term impact. Norfolk Island Pines are a marker of settlement in the coastal zone and the foreshore and there are currently restrictions on development near the pines or their removal. However, the pines have a limited lifespan and many of the pines are aging and likely to perish over the next 100 years. The trees can and will be replanted over the future, in which case they could be relocated.
Cycleway / Shared Pathway	Moderate	The cycleway / shared pathway is an important, highly utilised community asset. It also offers an effective use of high risk coastal land that can be relocated in the future (e.g. as part of maintenance scheduling). Sections of cycleway have been relocated or maintained for coastal erosion in the past.	Minor	The cycleway / shared pathway is an important, highly utilised community asset. It also offers an effective use of high risk coastal land that can be periodically inundated during high water levels during storms. Permanent inundation due to sea level rise however would have a permanent impact upon the value of this asset, however this would be accompanied by erosion impacts (thus can be managed through this process).

Coastal Assets	Consequence	Reason: Erosion	Consequence	Reason: Coastal Inundation
Transport Infrastructure				
Major (arterial) roads, bridges	Major	Arterial roads are the key conduits for traffic flow within the regional community. Damage or loss that blocks or impedes these routes would indeed cause major disruption to the community.	Major	Inundation across major traffic routes may have impacts upon the safety and access for community particularly during storms where access is important.
Local Roads (including car parks)	Minor	So long as access to the beach, to private property or effective transport routes to major roads for residents can be maintained, the permanent loss of local roads is of lesser importance to the functioning of the greater community.	Moderate	Inundation across major traffic routes may have impacts upon the safety and access for community particularly during storms where access is important.
Railway systems	Major	Railway assets are of regional economic and social importance.	Moderate	Inundation across railway systems may have greater regional economic and community impacts while such systems are affected, however the impacts are reversible and not permanent.
Jetties, wharves, boat ramps	Minor	These features typically service few community members, compared with other transport infrastructure (and they can be raised or relocated easily).	Minor	These features typically service few community members, compared with other transport infrastructure (and they can be raised or relocated easily).
Harbours	Major	There are very few such features on the open coast; therefore, they are of high community and economic value. Permanent inundation due to sea level rise would have a permanent impact upon the functionality of the harbours as a community asset. Impacts from storm waves may also cause damage to these assets (albeit reversible).	Minor	There are very few such features on the open coast; therefore, they are of high community and economic value. The majority of harbours are also heritage listed. Periodic inundation during storms would typically be expected over the life of the harbour, and unlikely to permanently affect the functionality of the harbours as a community asset.
Water and sewage infrastructure				
Stormwater outlets and pipes	Major	These assets provide an important service to the community, and are often very expensive infrastructure with long expected design life (75 -100 years). Replacement can be difficult and costly. Careful design to maintain future functioning of this service will be required.	Major	These assets provide an important service to the community, and are often very expensive infrastructure with long expected design life (75 -100 years). Replacement can be difficult and costly. Careful design to maintain future functioning of this service will be required.
Sewage Treatment Plants, sewage pumping stations, water supply networks	Major	Provide a vital service to social health and functioning.	Major	Provide a vital service to social health and functioning. The impacts from inundation may potentially have significant environmental and community impacts, even where this is reversible.

Coastal Assets	Consequence	Reason: Erosion	Consequence	Reason: Coastal Inundation
Residential Development				
Existing Residences	Moderate	For the public, other community assets would be rated more highly. For the individual owner, this asset is of very high importance. Losses in relation to erosion are irreversible.	Moderate	For the public, other community assets would be rated more highly. For the individual owner, this asset is of very high importance. The economic impact from inundation of private residential property could potentially be substantial. However, damages are repairable.
Vacant Land (Future Development)	Minor	There may be financial implications for the owners of such land; however, impacts to vacant land have minimal effect upon the broader community.	Insignificant	Periodic inundation of vacant land may have minimal effect upon the broader community and cause little if any damage.
Institutional Infrastructure				
Hospitals, Hospices	Major	Such facilities are socially vital, while the building is typically highly financially costly to build and fit out, making relocation of the physical asset difficult.	Major	Such facilities are socially vital, while the building is typically highly financially costly to build and fit out, making relocation of the physical asset difficult. During periodic inundation events, damages or loss of services from this asset is of significant impact to community.
Schools, child care facilities	Moderate	Such facilities are highly important to the community; however, the grounds and buildings can be relocated / replaced.	Moderate	Such facilities are highly important to the community; however, the grounds and buildings can be relocated / replaced.
Aged care facilities	Moderate	Such facilities are highly important to the community; however, the grounds and buildings can be relocated / replaced.	Moderate	Such facilities are highly important to the community; however, the grounds and buildings can be relocated / replaced.

(Adapted from BMT WBM 2017)

3.5.2 – LIKELIHOOD

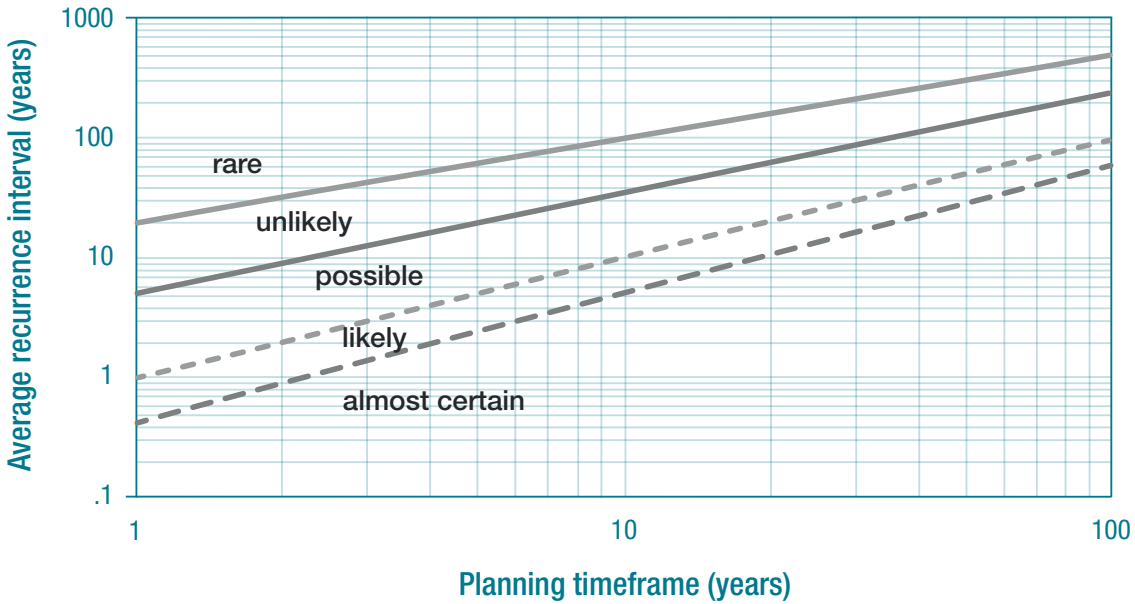
Likelihood is the probability of erosion and/or storm surge inundation impact on existing and future assets and their values. Within the context of the vulnerability assessment, likelihood is used to consider the exposure of an asset to coastal hazards. Likelihood should be assessed for each timeframe identified in Section 2.1 *Planning Timeframe and Sea Level Rise over the planning timeframe*.

Table 5: Example of timeframe dependant likelihood (Exposure) scale

	Rating	Almost certain	Likely	Possible	Unlikely	Rare
	Likelihood (Exposure)	It is likely that the hazard will impact the asset during the timeframe	It is moderately likely that the hazard will impact the asset during the timeframe	It is likely as not that the hazard will impact the asset during the timeframe	It is moderately unlikely that the hazard will impact the asset during the timeframe	It is unlikely that the hazard will impact the asset during the timeframe
100-year timeframe	Occurring Probability	82-100%	63-82%	37-63%	18-37%	<18%
	Average Recurrence Interval	less than 60 years	60-100 year	100-220 years	220-500 years	more than 500 years
10-year timeframe	Occurring Probability	90-100%	63-90%	25-63%	10-25%	<10%
	Average Recurrence Interval	less than 4.5 years	4.5-10 years	10-35 years	35-100 year	more than 100 years
1-year timeframe	Occurring Probability	95-100%	63-95%	20-63%	5-20%	<5%
	Average Recurrence Interval	Less than 0.3 year	0.3 -1 year	1-5 years	5-20 years	more than 20 years

Coastal hazard mapping does not take into consideration the likelihood of coastal hazards occurring. Therefore, a likelihood scale should be completed as part of the CHRMAP, showing the increasing likelihood of coastal hazards occurring, identified in Stage 2 *Risk identification*.

Figure 7: Example of timeframe dependant likelihood (Exposure) scale



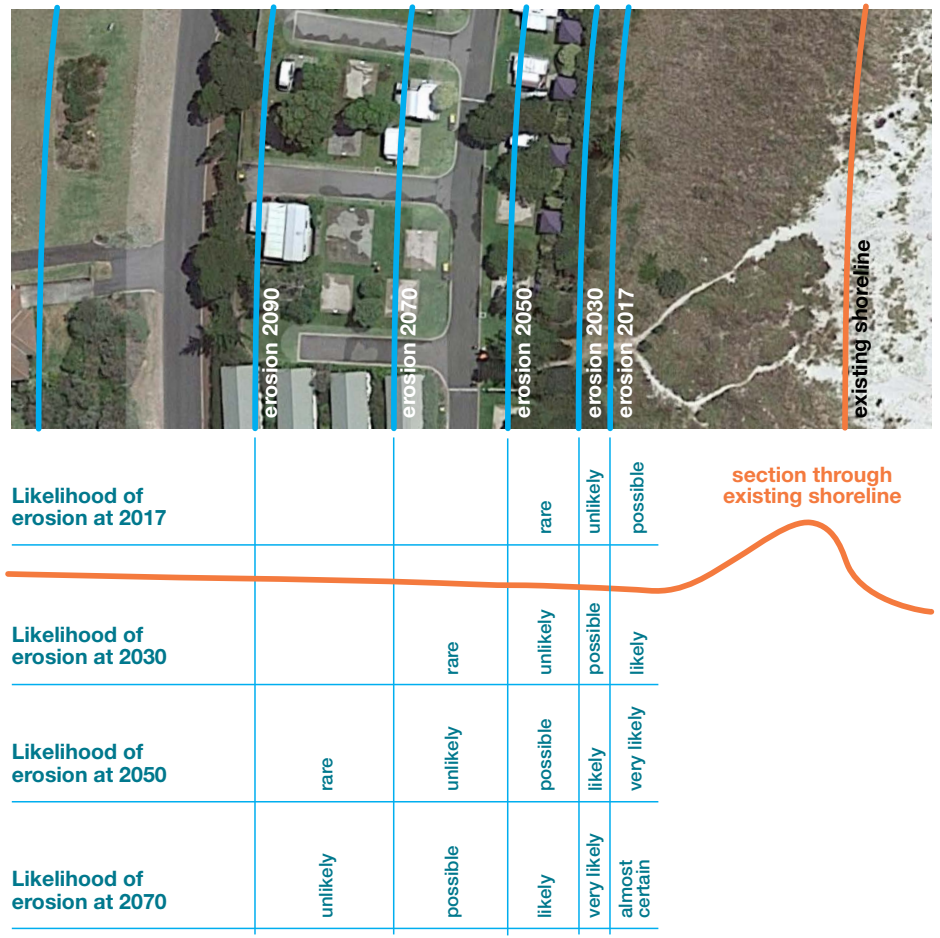
An example of how the likelihood scale can be applied to a location is seen in Table 6 and Figure 8.

Table 6: Example Likelihood (Exposure) of coastal hazards at different timeframes

Assets	Likelihood of Erosion					
	2019	2030	2050	2070	2090	2120
Beach	Possible	Likely	Almost certain	Almost certain	Almost certain	Almost certain
Foreshore Reserve	Possible	Likely	Almost certain	Almost certain	Almost certain	Almost certain
Toilets	Unlikely	Possible	Likely	Almost certain	Almost certain	Almost certain
Restaurant	Rare	Unlikely	Possible	Likely	Almost certain	Almost certain
Marine Tce/ Perth Cr	-	Rare	Unlikely	Possible	Likely	Almost certain
Developable land A	-	-	Rare	Unlikely	Possible	Likely
Developable land B	-	-	-	Rare	Unlikely	Possible
Surf Life Saving Club	Possible	Likely	Almost certain	Almost certain	Almost certain	Almost certain

(Adapted from Evocoast 2017)

Figure 8: Example Likelihood (Exposure) of coastal hazards at different timeframes



(Adapted from Evocoast 2017)

3.6 – LEVEL OF RISK

Risk level matrices identify assets level of risk arising from the consequence and likelihood scales, therefore, are important elements of the CHRMAP process. These matrices typically define four levels of risk:

- Extreme - risks are intolerable, requiring immediate implementation of risk management measures.
- High - risks are the most severe that can be tolerated and need monitoring in the short term as risk management measures are likely to be needed in the short-term.
- Medium - risk can be tolerated and need monitoring in the short to medium term.
- Low - risk can be accepted, no risk management measures will be required in the short to medium term other than monitoring.

Within the context of the vulnerability assessment, a risk level matrix is used to provide a ranking of the potential impact of coastal hazards on an asset. The risk level matrix should be determined for each planning timeframe being considered within the CHRMAP.

Once the risk level ranking has been established, it is important to define the level(s) at which risk is deemed acceptable, tolerable, or intolerable, where intolerable risks require risk management measures as a priority (particularly in terms of the changing risk across the timeframes). Levels of risk deemed acceptable, tolerable, and intolerable are best set by the decision-maker and the affected community and stakeholders.

For example, a risk that is rated under current conditions as low may simply be acceptable, requiring no further risk management measures other than monitoring. However, if the risk is identified as currently being high or extreme or will reach these levels before the

Table 7: Example of a risk level matrix

Consequence	Risk level				
Catastrophic	high	extreme	extreme	extreme	extreme
Major	high	high	extreme	extreme	extreme
Moderate	medium	medium	high	high	extreme
Minor	low	low	medium	high	high
Insignificant	low	low	low	medium	high
	Rare	Unlikely	Possible	Likely	Almost certain
	Likelihood				

(Adapted from Damara and CZM 2008)

end of the planning timeframes being considered in the CHRMAP, then these risks are likely to require more short-term or immediate risk management measures to reduce the risk back to tolerable or acceptable levels.

A risk tolerance scale will assist to inform which risk, locations and assets require risk management measures as a priority.

Table 8: Example of a risk tolerance scale

Risk level	Action required	Acceptance/tolerance
Extreme	Immediate action required to eliminate or reduce risk to acceptable levels	Intolerable
High	Immediate to short-term action required to eliminate or reduce risk to acceptable levels	Tolerable
Medium	Short to medium term action to reduce risk to acceptable levels, or accept risk	Tolerable/Acceptable
Low	Accept risk	Acceptable

(Adapted from BMT WBM 2017)

Once an understanding of the risk level and tolerance has been established, they can be associated with the assets, their functions, services and values identified.

Table 9: Example of coastal erosion risk

Asset	Consequence	Likelihood	Risk Level	Likelihood	Risk Level	Likelihood	Risk Level
	Erosion	2030	2030	2070	2070	2120	2120
Beach	Major	Almost Certain	Extreme	Almost Certain	Extreme	Almost Certain	Extreme
Beach Amphitheatre	Moderate	Likely	High	Almost Certain	Extreme	Almost Certain	Extreme
Beach Club Resort	Major	Unlikely	High	Possible	Extreme	Likely	Extreme
Residential Property	Major	Possible	Extreme	Likely	Extreme	Almost Certain	Extreme
Beach access stairs	Major	Likely	Extreme	Almost Certain	Extreme	Almost Certain	Extreme
Carparks	Moderate	Possible	High	Likely	High	Almost Certain	Extreme
Café	Major	Likely	Extreme	Almost Certain	Extreme	Almost Certain	Extreme
Toilets, playground	Minor	Likely	High	Almost Certain	High	Almost Certain	High
Access road	Minor	Likely	High	Almost Certain	High	Almost Certain	High

(Adapted from Baird 2017)

3.7 – ADAPTIVE CAPACITY AND ASSET VULNERABILITY

The adaptive capacity of an asset is its potential to adjust or be modified to address risk arising from coastal hazards with minimal disruption and cost. This stage involves preparing an adaptive capacity scale, a vulnerability matrix to determine the adaptive capacities of assets (prepared separately for erosion and inundation), and a vulnerability tolerance scale to inform which risk, locations and assets require risk management measures as a priority.

The vulnerability assessment does not take into consideration existing or future controls as its purpose is to assess the inherent risk arising from coastal hazards. Adaptive capacity should be assessed for each planning timeframe being considered in the CHRMAP.

3.7.1 – ADAPTIVE CAPACITY

The adaptive capacity scale identifies an asset's or activity's capacity to adjust or be modified to reduce intolerable risk arising from coastal hazards. The adaptive capacity scale takes into consideration the design and function or form of the assets.

Table 10: Example of adaptive capacity scale to erosion risk

Rating	Adaptive Capacity
Insignificant - No adaption required (NA)	Potential impact has insignificant effect on asset. Controls are re-established naturally or with ease before more damage would likely occur.
Very High	Good adaptive capacity. Functionality restored easily. Adaptive systems restored at a relatively low cost or naturally over time.
High	Decent adaptive capacity. Functionality can be restored, although additional adaptive measures should still be considered. Natural adaptive capacity restored slowly over time under average conditions.
Moderate	Small amount of adaptive capacity. Difficult but possible to restore functionality through repair and redesign.
Low	Little or no adaptive capacity. Potential impact would destroy all functionality. Redesign required.

(Source: Cardno 2016)

Once the adaptive capacity scale has been established, adaptive capacity can be associated with the assets, their function, services and values.

Table 11: Example of adaptive capacity of assets scale

Asset	Adaptive Capacity			Comment
	2030	2070	2120	
Beach	Moderate	Moderate	Moderate	Ability to naturally adapt lessens over time
Beach Amphitheatre	Low	Low	Low	Expensive to relocate
Beach Club Resort	Low	Low	Low	Expensive to relocate
Residential Property	Low	Low	Low	Expensive to relocate
Beach access stairs	Moderate	Moderate	Moderate	Relocatable, relatively inexpensive given asset value
Carparks	Low	Low	Low	Expensive to relocate
Café	Low	Low	Low	Expensive to relocate
Toilets, playground	Moderate	Moderate	Moderate	Relocatable, relatively inexpensive given asset value
Access road	Low	Low	Low	Expensive to relocate

(Adapted from Cardno 2016)

3.7.2 – ASSET VULNERABILITY

Vulnerability tolerance scales need to be established to identify asset adaptive capacity in conjunction with risk level arising from coastal hazards (identified in Section 3.6 *Level of risk*). As is the case for levels of risk, four levels of vulnerability are typically defined as:

- Extreme – Asset has minimal to no ability to adapt to impacts of coastal hazards without additional support. Significant further adaptation required to ensure asset not lost. Reconsideration of design required if vulnerability cannot be reduced. Risk management measures will need to be a priority.
- High – Asset has limited ability to adapt to impacts of coastal hazards. Immediate to short-term risk management measures required.
- Medium – Asset has some ability to adapt to impacts of coastal hazards. Short-term to medium-term risk management measures required.
- Low – Asset has high resilience and can adapt to impacts of coastal hazards without additional support. No immediate risk management measures required other than monitoring.

The vulnerability assessment should include each of the planning timeframes being considered in the CHRMAP.

Table 12: Example of a vulnerability matrix

Consequence	Adaptive Capacity Rating				
	Adaptive Capacity				
	Very Low	Low	Moderate	High	Very High
Catastrophic	extreme	extreme	extreme	high	medium
Major	extreme	extreme	high	medium	low
Moderate	extreme	high	medium	low	low
Minor	high	medium	low	low	low

(Adapted from Evocoast 2017)

It is important to define the level(s) at which vulnerability is deemed acceptable, tolerable or intolerable. Where vulnerability is intolerable, risk management measures are required as a priority (particularly in terms of the changing risk across the planning timeframes being considered in the CHRMAP).

For example, an asset that has a high adaptive capacity with a low risk arising from coastal hazards may simply be acceptable, requiring no further risk management measures other than monitoring. However, if the adaptive capacity is identified as currently being low with an extreme risk arising from coastal hazards, immediate risk management measures to reduce the vulnerability back to tolerable or acceptable levels will be required.

To assist with this determination a vulnerability tolerance scale will inform which risk, locations, assets and values require risk management measures as a priority.

Table 13: Example of a vulnerability tolerance scale

Risk level	Action required	Acceptance/tolerance
Very High (VH)	Asset has minimal ability to cope with the impacts of coastal hazards without additional support. Adaptation will need to be considered as a priority.	Intolerable
High (H)	Asset has limited ability to cope with the impacts of coastal hazards. Immediate to short-term adaptation is likely to be required to reduce risk to acceptable levels.	Tolerable
Medium (M)	Asset has some ability to cope with the impacts of coastal hazards. However short to medium term actions are likely to be required to reduce risk to acceptable levels.	Tolerable/Acceptable
Low (L)	Asset has high resilience; it is able to cope with the impacts of coastal hazards without additional support. No immediate action required.	Acceptable

(Adapted from Evocoast 2017)

Once an understanding of the adaptive capacity of assets has been established, vulnerability can be associated with the assets, their service, functions and values.

Table 14: Example of an asset vulnerability risk table

Asset	Adaptive Capacity	Risk Level	Vulnerability of Asset	Adaptive Capacity	Risk Level	Vulnerability of Asset	Adaptive Capacity	Risk Level	Vulnerability of Asset
	2030	2030	2030	2070	2070	2070	2120	2120	2120
Beach	Moderate	E	VH	Moderate	E	VH	Moderate	E	VH
Beach Amphitheatre	Low	H	VH	Low	E	VH	Low	E	VH
Beach Club Resort	Low	H	VH	Low	E	VH	Low	E	VH
Residential Property	Low	E	VH	Low	E	VH	Low	E	VH
Beach access stairs	Moderate	E	VH	Low	E	VH	Low	E	VH
Carparks	Low	H	VH	Low	H	VH	Low	E	VH
Café	Low	E	VH	Low	E	VH	Low	E	VH
Toilets, playground	Moderate	H	VH	Low	H	VH	Low	H	VH
Access road	Low	H	VH	Low	H	VH	Low	H	VH

(Adapted from Baird 2017)

STAGE 4 – RISK EVALUATION

Risk evaluation aims to prioritise risk management measures. It is an important part of the process as it may not be possible or necessary to treat every risk. Also, the cost of implementing risk management measures may outweigh the benefits.

Undertaking this component is important as it will help direct resources and guide the formulation of risk management measures to areas of highest priority, starting from those assets that have a high-risk level, with little to no adaptive capacity, and no existing risk management measures in place.

4.1 – EXISTING CONTROLS

The combination of the consequence and likelihood and adaptive capacity in Stage 3 *Vulnerability assessment* identifies the inherent risk. However there maybe existing controls and risk management measures already in place which have the potential to reduce the consequences and/or likelihood of a coastal hazard. Upon completion, remaining is the residual risk and vulnerability requiring risk management measures as a priority.

Prior to investigating the risk treatment options in the next stage, it is important to incorporate the existing controls identified in Stage 1 Section 1.6 *Existing Controls* that may reduce the level of risk, into the vulnerability assessment.

For example:

- In an area where inherent risk of inundation has been identified as being extreme, existing inundation development controls may reduce the risk level to low, so that it becomes acceptable and/or tolerable and does not require further risk management measures, as opposed to if it were extreme without any existing controls and risk management measures.

A seawall or existing sand by-passing regime may prevent erosion from occurring in relation to a specific asset. These forms of risk management measures need to be documented in relation to each asset, with consideration given to their sustainability (e.g. future sand supply), and the timeframe over which they remain effective (for example the height of a seawall relative to sea-level rise, or design life of structure). It may be the case however that the existing land use planning framework and instruments require modification to adequately modify the level of risk arising from coastal hazards in the future (and implement risk management measures). Consideration of the planning framework and instruments is outlined in Stage 6 *Implementation* Section 6.1 *Land Use Planning Instruments*.

4.2 – PRIORITIES FOR TREATMENT

Once existing controls have been considered it is important to reassess level of risk, risk tolerance and vulnerability established in Stage 3 *Vulnerability assessment*. This will determine which risks, locations assets and values, require risk management measures as a priority.

The asset vulnerability risk table (e.g. Table 14) should be modified accordingly so that risk treatment options can be focussed on those assets for which residual risk and vulnerability remain requiring risk management measures as a priority.

STAGE 5 – RISK TREATMENT

Risk treatment considers how to respond to the residual risk and asset vulnerability. Risk treatment options should be described and assessed including both a multi-criteria analysis and cost benefit analysis to assist with identifying risk treatment options that provide the greatest benefit (relative to cost and other key criteria) in treating the highest priority risks. The economic, environmental, and social costs and benefits of risk treatment options need to be considered in these analyses.

Risk treatment options need to be assessed in terms of their:

- potential benefits
- effectiveness in reducing losses; or maximising opportunities
- cost of implementation and ongoing maintenance (capital and recurrent costs, loss of revenue sources)
- equity implications (e.g. which stakeholders bear costs of options e.g. beneficiary pays? Are the costs and/or benefits shifted between stakeholders and if so is this fair and acceptable? Whose values are being protected and/or negatively impacted?)
- impact of the treatment option on other objectives, including the introduction of new risks or issues
- practicality
- reversibility/adaptability
- effectiveness over time
- implementation timing
- design life of man-made assets
- acceptance from community, stakeholders and decision-makers
- legal and approval barriers.

5.1 – RISK MANAGEMENT AND ADAPTATION HIERARCHY

Challenges to managing risks arising from coastal hazards include long timeframes associated with governance and land ownership and uncertainties that arise from complex climatic and coastal systems. In assessing potential risk treatment options, it is important to consider the ability of future decision-makers to maintain decision-making flexibility. This involves assessing the potential of a risk treatment option to restrict subsequent risk management opportunities.

Risk treatment options that maintain a wide range of potential future risk management opportunities should always be considered more favourably than those that (either directly or indirectly) act to limit future risk management opportunities. By allowing a greater range of risk treatment options to be considered by future decision-makers, processes can more effectively address the challenges of uncertainty and long timeframes associated with coastal hazards.

This concept to maintain future decision-making flexibility aims to create coastal communities that are resilient to the uncertainties associated with coastal hazards and their timeframes.

It is on this rationale that the risk management and adaptation hierarchy (Figure 9) has been established in SPP 2.6, where ‘Avoid’, ‘Planned or Managed Retreat’, ‘Accommodate’ and ‘Protect’ refer to four broad categories of potential risk treatment options.

Generally, as risk treatment options are selected further down this hierarchy (from avoiding areas with risk to protecting development from those risks), future risk management opportunities will diminish. As such, avoiding the placement of sensitive development within areas that are at risk from coastal hazards provides the most resilience to

future risk arising from coastal hazards. Conversely, using protection structures to allow sensitive development within areas that would otherwise be at risk from coastal hazards reduces the flexibility of future decision-makers to address risk arising from coastal hazard.

Further to the risk management and adaptation hierarchy identified in SPP 2.6, Figure 9 and discussed in this section, the 'no regrets' and 'do nothing' risk treatment options are relevant to the CHRMAP process and should be considered in conjunction with the risk management and adaptation hierarchy. These risk treatment options are identified in Section 5.2 *Risk treatment options.*

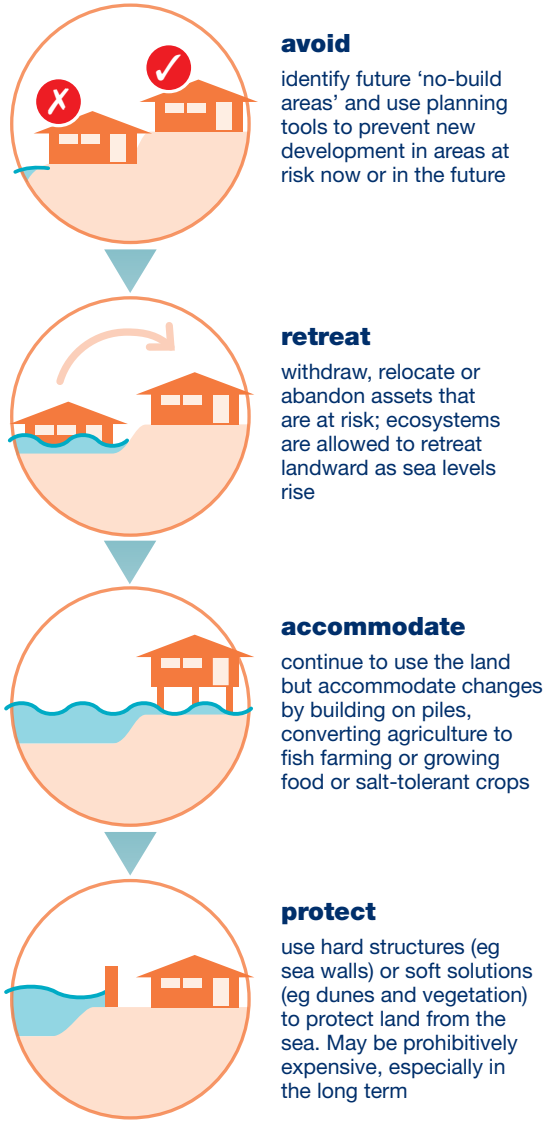
5.2 – RISK TREATMENT OPTIONS

It is important to list and describe all the available risk treatment options which have potential to address risk arising from coastal hazard. Risk treatment options should be separated into categories according to the risk management and adaptation hierarchy. This process is important as it will inform a multi-criteria analysis and cost-benefit analysis of risk treatment options against individual assets to ensure the most appropriate risk treatment option(s) is selected.

5.2.1 – AVOID

The aim of this risk treatment option is to avoid the construction of new public and private assets within areas identified to be impacted by coastal hazards. Avoidance risk treatment options are the best form of risk management (mitigation) and where possible should be the risk treatment option of choice. Avoidance risk treatment options ensure that risk management measures that eliminate hazards, activities and exposures that can negatively affect an asset can be formulated and implemented. Avoidance is particularly applicable to all land use and development in greenfield locations.

Figure 9: Risk management and adaptation hierarchy



(Adapted: Cardno 2018a)

5.2.2 – PLANNED OR MANAGED RETREAT

The planned or managed retreat risk treatment option aims to preserve beach and coastal foreshore assets, public access, recreation, conservation and coastal foreshore management. This risk treatment option allows coastal physical processes to occur with as little impediment from development as possible in the future, allowing natural dynamic movement and retreat in response to coastal physical processes, particularly sea level rise. Planned or managed retreat for existing development involves relocating or sacrificing infrastructure, both public assets and private property, when erosion and recession impacts reach action trigger points (discussed further in Section 5.4.1*Triggers*).

No new coastal structures would be constructed, and new development would be avoided or minimised within high risk areas. Where possible and practical, dunes would be restored or enhanced to maintain or create a buffer against storm erosion. As existing assets reach the end of their functional life (or if they are substantially damaged by a storm event), or if a trigger for removal is reached, they would be removed, including any associated coastal protection structures (e.g. temporary protection works that extended the life of the asset).

If planned or managed retreat is the approach selected for implementation, it will need to be implemented through the planning framework and instruments within Western Australia (outlined in Appendix 4) and its implementation detailed in Stage 6 *Implementation*.

5.2.3 – ACCOMMODATE

The accommodate risk treatment option aims to utilise design and management strategies which render the risks as tolerable/acceptable, allowing land to continue to be utilised until risks become intolerable. Design and management strategies may include a mix of structural or non-structural approaches. Structural approaches include minimum finished floor levels and elevated electrical circuitry, and relocatable structures which can be moved to a different location on- or off-site to manage risk arising from inundation coastal hazards.

Non-structural approaches such as modifications to local planning frameworks can also enable accommodate risk treatment options. These modified local planning frameworks should provide clear direction for decision-makers when assessing applications for new development, and to affected landholders. Planning frameworks might include a selection of the following instruments: clear development assessment criteria indicating what would be appropriate development; notifications on title, to inform current and future landholders of hazard; and, planning approval conditions which allow the continued use of land until risks become intolerable.

Accommodate risk treatment options can help to facilitate a switch to planned or managed retreat or protection risk treatment options later.

5.2.4 – PROTECT

Protect risk treatment options aim to protect assets from damage resulting from erosion and recession and storm surge inundation. Protect risk treatment options should be primarily proposed in the public interest, and enhance or preserve beach and foreshore reserve amenity. Common hard protection structures include seawalls; groynes; offshore breakwaters and artificial headlands; and soft protection measures such as beach nourishment. Protection should be congruent with the coastal physical process and assets, amenity

and value of any given location they are being imposed upon. When considering protection structures, it is important to understand they have off-site impacts, for example loss of beach in front and accelerated erosion at the edge of a seawall. Therefore, a protect decision must consider off-site impacts.

In the event protection is selected for implementation, comprehensive analysis as part of the CHRMAP process should include the policy requirements of SPP 2.6 Cl. 5.7 *Coastal protection works*. Of importance to such analysis will be governance matters of ownership and funding arrangements for the construction and ongoing care, control and maintenance, in particular where protection of private property is considered. Risk management measures will need to ensure these requirements are implemented.

Where public and private assets are proposed to be constructed inland of existing protection structures, such protection structures should only be considered as an interim risk management measure within the planning timeframes being considered in the CHRMAP. The design life of the protection structure should be a key factor in determining the appropriateness of the proposed asset or development.

Decision-makers and landholders may need to consider the appropriateness of using interim protection structures to delay shoreline recession over the short to medium term. This might be achieved through soft protection measures such as regular sand renourishment, and revegetating coastal dunes.

5.2.5 – NO REGRETS

The no regrets risk treatment options cover the period while a range of assessments and works are required to determine a preferred risk treatment option, prior to implementing specific asset risk management measures. This is particularly pertinent where a more costly or difficult risk treatment option may be required, or better understanding regarding the level of risk to an asset. No regret risk treatment options provide for risk management measures that will improve resilience and preparedness for risk arising from coastal hazards.

5.2.6 – DO NOTHING

The do-nothing risk treatment option assumes that all levels of risk is accepted and that no further action will be taken. This risk treatment option provides a basis for comparison of all other risk treatment options.

Table 15 provides a range of available risk treatment options for each of the risk management and adaptation hierarchy categories (note this is not an exhaustive list of all available risk treatment options).

Table 15: Risk treatment option

Option Category	Option name	Option code	Description how it will help	Multi-criteria and cost benefit analysis	Potential assets	Proposed measures/ triggers
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.	Financial resources will not be required to be spent on risk management.	All assets in the coastal zone.	Implement now.
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.	Save the financial resource for better use.	All low cost/ temporary/easily relocatable recreation amenities.	Measure 1. Amend local planning scheme to include Special Control Area. 2. Determine assets that are deemed sacrificial. 3. Monitoring (NR1) to identify when trigger is reached. Trigger 1. Low key structures in accordance with SPP 2.6 Schedule One 7 Variations can be repaired, maintained, upgraded until risk is intolerable. 2. This may be determined by the landward movement of the HSD over time which should then indicate when assets should be demolished/removed. 3. Indicative removal timelines should be continuously updated in Council's Asset Register.

Option Category	Option name	Option code	Description how it will help	Multi-criteria and cost benefit analysis	Potential assets	Proposed measures/ triggers
Planned/ Managed Retreat	Demolition/ removal/ relocation of assets from inside hazard area.	PMR2	This risk treatment option is 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.	Allows amenities to be retained realising the social and economic values until such time that the asset needs to be relocated. Can often coincide with asset replacement. This also enables the cost of relocation to be shared with the cost of asset replacement. This reduces the overall cost in present and future time.	All low cost/ temporary/easily relocatable recreation amenities.	Measure 1. Amend local planning scheme to include Special Control Area. 2. Determine assets that are deemed sacrificial or relocatable, and update Council's Asset register to reflect likely timeframe for impact to assist in prioritising asset relocation. 3. Monitoring (NR1) to identify when trigger is reached. Trigger 1. Low key structures in accordance with SPP 2.6 Schedule One 7 Variations can be repaired, maintained, upgraded until risk is intolerable. 2. This may be determined by the landward movement of the HSD over time which should then indicate when assets should be demolished and/or removed. 3. Indicative removal timelines should be continuously updated in Council's Asset Register. 4. Relocation when asset replacement is required or 5. When the HSD is XXm from the asset location (as identified through NR1) or 6. When frequency/extent of inundation becomes unacceptable (e.g. frequency of inundation >4 time/year). 7. Whichever occurs sooner.
	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.	Generally applicable where protection of assets is not viable.	All assets where it is impractical to ultimately implement protection.	Implement now through planning framework. Amend local planning scheme to include Special Control Area.

Option Category	Option name	Option code	Description how it will help	Multi-criteria and cost benefit analysis	Potential assets	Proposed measures/ triggers
Planned/ Managed Retreat	Voluntary acquisition.	PMR4	This risk treatment option would require the acquisition of affected properties, on a voluntary basis.	This risk treatment option enables for the removal of private property(s) located within a land use that would otherwise be permitted, to retreat to ensure land in the coastal zone is continuously provided for coastal foreshore management, public access, recreation and conservation, and where alternative risk treatment options are not viable for the property and adjacent land. Early acquisition and leaseback could be used as an alternative to help reduce overall costs.	All private property where it is impractical to ultimately implement protection.	Measure 1. Investigate/put in place funding for acquisition of priority properties. 2. Offer voluntary acquisitions reflecting asset value in light of hazard. Trigger When the HSD is XXm from the asset location (as identified through NR1).
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.	This risk treatment option is aimed at retaining existing assets in locations but reducing the consequences of the inundation hazard. It is cheaper to mitigate the impacts with initial design outcomes as opposed to retrofitting (adapting) existing assets in the future.	Roads, car parks, residential property, hospitals, aged care facilities, schools, child care facilities, surf life-saving clubs.	Measure 1. Amend local planning scheme to include Special Control Area. 2. Prepare local planning policy containing relevant erosion and wave overtopping development controls. 3. Approval of local planning policy by Council. 4. Implement local planning policy development controls to all properties within the special control area for coastal hazards within the local government area. Trigger 1. Implement local planning policy as properties are developed, redeveloped and assets are replaced. 2. As existing assets are affected by hazards, requiring repair.

Option Category	Option name	Option code	Description how it will help	Multi-criteria and cost benefit analysis	Potential assets	Proposed measures/ triggers
Protect	Beach nourishment or replenishment.	PR1	This risk treatment option involves the placement of sand on the upper beach face and dunes to re-establish the sandy beach and provide a sediment supply.	Availability of suitable sand sources. Where suitable sources are not readily available or a considerable distance away, costs are increased. If the nourishment sand is significantly finer than the existing beach sand the nourishment sand will be lost quickly.	High-use beaches and foreshore reserves where retreat is not an option.	Measures 1. Undertake investigation of sand sources for detailed costing, detailed design of nourishment profiles, planning approvals and to determine funding mechanisms. 2. Continued monitoring (NR1) for trigger point. Trigger Renourishment will be site specific and dependent on the beach width/sand volume required and the risk treatment option (protection/amenity).
	Groynes.	PR2	This risk treatment option involves the 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.	Groynes form a barrier that traps sand that moves alongshore. Groynes are not effective as a means of managing short-term storm erosion. Groynes could be expensive and change the nature and appearance of the coast. This needs to be weighed up against the value of the assets being protected.	High-use beaches and foreshore reserves where retreat is not an option. Where assets value is high, and relocation is not an option.	Measures 1. Undertake NR2, to investigate viability of existing walls on beaches. 2. Consider in accordance with Council's Asset Management Plan. 3. Undertake investigation of rock and sand sources for detailed costing's, design of groyne and nourishment, planning approvals and funding mechanisms. 4. Continued monitoring (NR1) for trigger. Triggers 1. For private development and public infrastructure that is not expendable, when the HSD is XXm from the asset location (as identified through NR1). 2. Alternatively for private development when the HSD is XXm from (as identified through NR1) the seaward property boundary. 3. For undeveloped reserve or public land, when the HSD is XXm from (as identified through NR1) the predetermined protection line along the beach.

Option Category	Option name	Option code	Description how it will help	Multi-criteria and cost benefit analysis	Potential assets	Proposed measures/ triggers
Protect	Seawalls.	PR3	This risk treatment option involves 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.	Seawalls are expensive and change the nature and appearance of the coast. Seawalls protect the land not the beaches. Needs to be accompanied by greater beach nourishment/replenishment, which adds to the cost of option. This needs to be weighed up against the value of the assets being protected.	High-use beaches and foreshore reserves where retreat is not an option. Where assets value is high, and relocation is not an option.	Measures 1. Undertake NR2, to investigate viability of existing seawalls on beaches. 2. Consider in accordance with Council's Asset Management Plan. 3. Undertake investigation of rock and sand sources for detailed costing's, design of seawall and nourishment, planning approvals and funding mechanisms. 4. Continued monitoring (NR1) for trigger. Triggers 1. Where seawalls are to be developed in sections a common alignment and design needs to be agreed. 2. For private development and public infrastructure that is not expendable, when the HSD is XXm from the asset location (as identified through NR1). 3. Alternatively for private development when the HSD is XXm from (as identified through NR1) the seaward property boundary. 4. For undeveloped reserve or public land, when the HSD is XXm from (as identified through NR1) the predetermined protection line along the beach.

Option Category	Option name	Option code	Description how it will help	Multi-criteria and cost benefit analysis	Potential assets	Proposed measures/ triggers
Protect	Artificial reef.	PR4	This risk treatment option involves construction of a submerged artificial reef off shore, 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 of the reef may be sufficient to allow waves to pass over the reef without breaking, reducing their effectiveness in protecting the beach from erosion. Artificial reefs offer the opportunity for other objectives such as creating marine habitat and surfing breaks. Artificial reefs are most suited to embayed coastlines where low or negligible net alongshore sediment transport reduces the impacts of the structure down drift on the beach, away from the reef location. Also, the location of bedrock close to the surface provides an opportunity to reduce scour and slumping of the reef once constructed, reducing maintenance costs.	The costs of artificial reefs (capital and maintenance) are high. On a low littoral drift coastline, protection provided is generally to a relatively short section of coast, possibly increasing erosion in nearby unprotected down drift beaches. The ability of an artificial reef to dissipate wave energy will diminish as sea levels rise. To date artificial reefs built for multi-purpose (e.g. creating marine habitat, provide surfing breaks) have had limited success in meeting all such objectives.	High-use beaches and foreshore reserves located within embayed coastlines where retreat is not an option. Where assets value is high, and relocation is not an option.	

Option Category	Option name	Option code	Description how it will help	Multi-criteria and cost benefit analysis	Potential assets	Proposed measures/ triggers
Protect	Off shore breakwater.	PR5	This risk treatment option involves the construction of an emergent off shore 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. Offshore breakwaters are most suited to embayed coastlines where low or negligible net alongshore sediment transport reduces the impacts of the structure down drift on the beach.	The costs of offshore breakwaters (capital and maintenance) are high. On a low littoral drift coastline, protection provided is generally to a relatively short section of coast, possibly increasing erosion in nearby unprotected down drift beaches. While breakwaters can be efficient in the short-term, a rise in sea level or substantial changes in wave energy and direction can alter their role in beach and shoreline stabilisation. The crest height of the structure can be submerged by rising sea levels, requiring further intervention to maintain functionality. Changes in the wave climate can require expensive changes to the design of the structure (e.g. orientation). Detached breakwaters can therefore be a measure to control the shoreline position in the 5 to 20 years' timeframe but their efficacy as a long-term strategy to maintain the current shoreline configuration is questionable.	High-use beaches and foreshore reserves located within embayed coastlines where retreat is not an option. Where assets value is high, and relocation is not an option.	

Option Category	Option name	Option code	Description how it will help	Multi-criteria and cost benefit analysis	Potential assets	Proposed measures/ triggers
No Regrets	Monitoring.	NR1	This risk treatment option involves long term baseline monitoring and event based monitoring following storm erosion events.	This risk treatment option enables assessment of the frequency and severity of events, the impact and consequences on various land uses, to revise risk levels and determine the effectiveness or appropriateness of risk management measures over time. Regular monitoring will support the identification of triggers for risk management measures to be implemented.	Whole coastline.	Measures 1. Set up a baseline monitoring programme for long term trend and condition following major events. 2. Review results for particular asset triggers regularly. 3. Re-run risk assessment based on monitoring results and revise risk management measures if risk level changes (i.e. increase or decrease in level of risk). Trigger 1. Erosion - Beach surveys and distance from HSD to structures/property boundaries every three years or following major events. 2. Inundation - Monitor inundation levels and extents following major events, and compare with continued mean sea level monitoring.
	Protection Structure Audit.	NR2	This risk treatment option involves undertaking an audit of existing protection structures, to determine their current condition, effectiveness and future protection potential.	Depending upon the expected life and future protection from existing protection structures, there may be updates to the hazard estimates (immediate, 2050) which assumed no protection provided. This will flow on to affect other risk treatment options, including risk management measures implementation.	All existing coastal protection structures.	Measures 1. Conduct audit of existing protection structures. 2. Update hazard lines where relevant to account for existing protection structures. 3. Update CHRMAP proposed actions to account for condition (life) of existing protection structures. 4. Protection structures added to Council's Asset Management Plan, and outcomes of audit used to determine asset replacement and maintenance schedules for the structures.

Option Category	Option name	Option code	Description how it will help	Multi-criteria and cost benefit analysis	Potential assets	Proposed measures/ triggers
No Regrets	Notification on title (also relevant to, planned/ managed retreat, accommodate and protect options).	NR3	Indicates to current and future land owners 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 decision 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.	This risk treatment option allows vulnerability of asset to hazards to be conveyed to existing and future owners. One means of implementation that is low cost, is through decision-making for subdivision and development.	All assets located within an area vulnerable to coastal hazards within the planning timeframe.	Implement now in accordance with the planning framework, and as conditions of approval for subdivision and development.
	Emergency evacuation plans (also relevant to accommodate options).	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.	This risk treatment option is a low-cost option in addressing the consequences of inundation regarding safety to lives as the impact occurs.	Roads (with regard to managing traffic flows during an event), car parks, residential property, hospitals, aged care facilities, schools, child care facilities, surf life-saving clubs.	Measures 1. Development evacuation plans for locations without existing inundation mapping as a priority. 2. Update evacuation plans with latest inundation mapping available or include coastal inundation area into existing evacuation plans. Trigger Implement evacuation plans as needed.

Option Category	Option name	Option code	Description how it will help	Multi-criteria and cost benefit analysis	Potential assets	Proposed measures/ triggers
Do Nothing	Do Nothing.	DN1	This risk treatment option 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).	This risk treatment option does not involve any new action. Where existing levels of risk are low, accepting the risk may be appropriate. However, it may not be appropriate for high risk locations/assets. The cost of "do nothing" may be substantially greater in the future than the current cost of implementing planning controls. This is because the value of land at risk continues to increase, as does the cost of mitigating recession impacts over time (such as retrofit, or even abandoning lost lands). Further, as the value of land at risk continues to increase over time, implementation of retreat risk treatment options in the future, to ensure land in the coastal zone is continuously provided for coastal foreshore management, public access, recreation and conservation, become increasingly desirable while more difficult to implement.	This risk treatment option is assessed at all locations.	Implement now. No new risk management measures necessary.

(Adapted from BMT WBM (2017))

5.3 – MULTI-CRITERIA ANALYSIS AND COST BENEFIT ANALYSIS

Having identified the risk treatment options available, it is necessary to assess them against the identified assets (and their function, services and values) in a more detailed analysis using a range of social, environmental and economic criteria.

This step is important as it assists in the selection of the set of risk treatment options that are most likely to effectively and efficiently achieve the success criteria that the CHRMAP is measured against. It will also help prioritise the most beneficial risk treatment options, where there is more than one option.

There is no single methodology that applies to this situation. However, an effective approach is to combine two appraisal techniques: multi-criteria analysis (**MCA**) and cost benefit analysis (**CBA**).

The first stage of the assessment should use a MCA, applied to all risk treatment options identified in Section 5.2 *Risk treatment*. The second stage of the assessment is to apply a CBA for risk treatment options selected through the MCA process.

5.3.1 – MULTI-CRITERIA ANALYSIS

A MCA provides a qualitative framework to rank risk treatment options. It is a systematic process for assessing the performance of different risk treatment options against a set of measurable criteria (e.g. performance in reducing the risk to assets), to narrow down the number of risk treatment options under consideration for further analysis (in a CBA), or to make a final decision on the preferred risk treatment option(s).

Undertaking a MCA should be done in collaboration with the community and stakeholders. In this instance a CEP (as discussed in section 1.5 *Community and Stakeholder Engagement*) provides an appropriate mechanism. Completing the MCA including a CEP will ensure validation of the outcomes.

The MCA should:

- identify assessment criteria and score the risk treatment options against these criteria (this process should be undertaken in collaboration with stakeholders)
- ensure criteria reflect a range of environmental, social, economic and cultural issues to benchmark the risk treatment option
- ensure the criteria reflect the ability of the risk treatment option to reduce the risk on the asset, and result in a reduction of risk treatment options so that CBA are only undertaken on a select number of risk treatment options.

Table 16 provides example criteria (note this is not an exhaustive list).

Table 16: Example MCA criteria

Category/ criteria	Sub-category/ criteria	Considerations
Technical	Design capabilities	Effectiveness in meeting design standards/objectives Technical viability Design longevity
	Construction and maintenance	Ease of construction Maintenance requirements
	Legal/approval	Legislative and approval requirements
Environmental and Social	Public amenity	Impact on amenity (on and off-site) Impact on recreational/ commercial users Access
	Natural environment	Impact on biodiversity Impact on natural environment (on and off-site)
	Landscape and visual	Impact on landscape
	Heritage	Impact on historic setting
	Climate change adaptation	Ability to be modified in the future Effectiveness over time Public acceptability
Financial	Financial cost	Capital investment Operating and maintenance cost

(Adapted from GHD 2012)

Once the criteria are set, the MCA then assigns weights to each criterion according to the criterion's perceived relative importance in the achievement of values and success criteria established in Stage 1 *Establish the context*. Risk treatment options are then each assigned scores against each criterion according to how effectively the risk treatment option achieves the criterion. Weighted scores are then computed for each risk treatment option, with the highest scoring deemed to be the best risk treatment option for implementation.

A summary of the procedure that may be followed for the MCA is provided in Table 17.

Table 17: Example MCA process steps

Process	Description
1. Decision Criteria	Develop a set of criteria (technical social, environmental and financial) to appraise/score potential risk treatment options.
2. Scoring	Assess the expected performance of each risk treatment option against the criteria.
3. Weighting	Assign weights for each of the criterion to reflect their relative importance to the decision
4. Weighted Scoring	Combine the weights and scores for each risk treatment option to derive an overall score. Scores are used to rank competing risk treatment options.
5. Sensitivity analysis	Conduct a sensitivity analysis to explore whether uncertainty in scoring or weights materially affect the results/overall ranking of the risk treatment options.
6. Recommendations	Document the findings and results of the analysis and recommendations for input into CBA.

(Adapted from GHD 2012)

Once the MCA is completed, a summary of the final preferred risk treatment options for input to the CBA can be provided. Table 18 provides an example summary of the preferred risk treatment options identified through the MCA (in accordance with the risk treatment options in Table 15 *Risk treatment options*).

Table 18: Example MCA summary of options (for input into CBA)

District	Locality	Preferred Risk Treatment Options for Input to the BCA
Rollingstone	Mutarnee	PMR3, PMR4, NR1
	Rollingstone Beach	PMR1, NR1
Balgal Beach	Balgal Beach	PMR1, NR1
	Toomulla	PMR2, NR1
Townsville North	Pallarenda	NR3, AC1, PMR3, PMR4, NR1
	Industrial Area	PR3, NR1, NR2
	Mt St. John Sewerage Treatment Plant	PR3, NR1, NR2
Townsville Inner Suburbs	The Strand	NR4, PMR1, NR1
	Ross Creek, South Townsville, Inner Suburbs, Railway Estate, Rowes Bay, Melrose Park and West End	PR1, PR2, PMR3, PMR4, NR1
River South	Oonoonba	PR1, PMR1, NR1
Stuart	Stuart/Cleveland Bay Sewerage Treatment Plant	PR3, NR1, NR2
Magnetic Island	Horseshoe Bay	DN1
	Arcadia (Geoffrey Bay)	PMR3, PMR4, NR1
	Nelly Bay	PR1, PR2, PR3, NR1
	Picnic Bay	PR1, PMR2, NR1
	Picnic Point Sewerage Treatment Plant	PR3, NR1, NR2
	West Point	DN1, PMR1, NR1
	Bolger Bay Pump Station	PR3, NR1, NR2
	Radical Bay	AC1, NR1, NR3, NR4
	Cockle Bay (LOTS)	PMR3, PMR4, NR1

(Adapted from GHD 2012) (Refer to Table 15 for acronyms)

As identified in Section 1.5.2 *Values* it is acknowledged that it may be difficult to place an economic value on 'non-market' or intangible social and environmental values. These include social and environmental values such as those associated with recreational opportunities, the aesthetics or amenity of an area, and the existence-related values of protecting habitats for flora and fauna. These 'non-market' values can be quantified through economic approaches that estimate financial-equivalent values for the intangible elements of social and environmental assets. By measuring intangible values in dollars, a unified evaluation can be made between the full set of costs and benefits.

To assist the MCA, a method for estimating 'non-market' or intangible values is at **Appendix 5** *Non-market valuation instruments for measuring community values affected by coastal hazards: guidance and an application*.

Note: this is one method (among others) of measuring 'non-market' or intangible values in dollars. It can be utilised within the CHRMAP process where considered appropriate.

5.3.2 – COST BENEFIT ANALYSIS

A CBA is a process commonly used to prioritise risk treatment options and inform decision-making about alternative courses of action. It can assist in identifying the risk treatment option that achieves maximum value for money benefit. It identifies many costs (losses) and benefits (gains) of a risk treatment option, including social and environmental values according to their net economic benefit.

The costs and benefits of a risk treatment option are forecast over the life of the risk treatment option, costs are subtracted from benefits to determine the net present economic value (**NPEV**) of the risk treatment option. The risk treatment option with the greatest NPEV should provide the greatest net benefit to the community or the most economic use of resources (i.e. benefit/cost ratio greater than one or a positive NPEV).

There is no one-size-fits-all approach when undertaking a CBA, however the following should be considered when scoping the preferred approach:

1. Cost inputs should include the whole-of-life costs associated with the implementation of a risk treatment option, including loss of existing and future revenue. The benefit inputs should represent the reduction in impact from the implementation of a risk treatment option.
2. The accurate determination of an assets value (both tangible and intangible) and implementation costs is critical to effectively carrying out a CBA.
3. An appropriate discount rate should be employed. A discount rate is a way of allowing future costs or benefits to be compared to today's equivalent value. The value of the discount rate can have a significant impact on whether a risk treatment options net benefit is positive or negative. Discount rate(s) should be consistent with WA Treasury guidelines.
4. A sensitivity analysis should be included, to account for variations and uncertainties in costs and benefits assumed for a risk treatment option. Sensitivity analysis allows for examination of how sensitive the financial and economic outcomes are to these assumptions.
5. The CBA should include information about the optimal timing for investment, i.e. the time when the benefits of risk treatment break even with the potential damage caused by coastal hazards. The optimal timing can be defined as the point in time where the benefits (the avoided impact) are greater than the costs of the risk treatment option.

6. When the costs of the risk treatment option are higher than the benefits (avoided damage or reduced risk), the risk treatment option is not considered viable, however, other socio-economic considerations may come into play (e.g. community willingness to pay to avoid damage and minimise risk which was not accounted for in the valuation process) and may still be a valid reason to proceed with a risk treatment option.
7. It should be noted that sea level rise will increase the risk of potential damage or consequences over time, and this should be factored into the CBA. The use of non-market valuation techniques is encouraged to price non-market goods and services (i.e. those values that don't have a market value, such as community or environmental values - as discussed in Sections 1.5.2 *Values* and 5.3.1 *Multi-criteria analysis*). Care should be taken when using market-based prices for private housing. This is because in many cases market prices do not reflect the true present or future level of risk arising from coastal hazards. In other words, the market may not accurately capture the vulnerability of the asset in some cases. This can lead to some risk treatment options becoming overly expensive to implement. Due consideration must also be taken to avoid perverse incentives (unintended consequences of policies). For example, signalling that an asset may be earmarked for future coastal protection because of the present level of economic intensity can incentivise further intensification under the assumption that as the risk rises, the asset will be prioritised for coastal protection works.

5.4 – RISK MANAGEMENT PATHWAY

Once the risk treatment options for implementation have been identified, the risk management pathway(s) and associated triggers for risk management measures can be established.

Coastal hazards and their associated risks can manifest over long time scales, generally not requiring implementation of costly response(s) until a significant level of change has occurred. The risk management pathway(s) approach enables the establishment of a decision-making strategy that is made up of a sequence of decision points over time, preventing a decision-maker 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, while not all decisions can be made today, they can be planned, prioritised and prepared for.

The risk management pathway approach enables the ability over time to continue to select risk treatment options from the risk management hierarchy outlined in Sections 5.1 *Risk management and adaptation hierarchy* and 5.2 *Risk treatment* options. This approach is useful for dealing with risk (uncertainty), ensuring that decisions made, and associated risk management measures undertaken today do not prevent alternative risk treatment options and management measures being chosen in the future.

The risk management pathway approach combines decision-making at trigger points for specific risk management measures within an ongoing strategic planning process that maintains the suite of risk treatment options available for each subsequent decision-making trigger point over time. An example of the risk management pathway approach including decision-making trigger points can be seen in Figure 10.

BOX 8 – Key advantages of the pathways approach are:

1. ***It buys time to plan and reduces the pressure of making decisions now.***

   An ongoing process of monitoring and evaluation identifies the trigger points at which further decisions or actions will need to be undertaken. It also creates time to build strategies for funding, gain community support and generate the necessary knowledge to implement future decisions. Importantly, it can help identify the first steps that can be taken.

2. ***It reduces uncertainty by using events not time as decision points***

   A key characteristic of the pathways approach is that the triggers for the decision points are scaled against events, not time. Events might be related to sea-level rise, flooding, or heat-waves – any climate-related occurrence that is expected to get worse as a result of climate change. Therefore, the pathway is independent of time, removing one source of uncertainty (the timing of the event).

3. ***Its flexibility enables the plan to reflect local circumstances***

   The flexibility of the pathways approach allows for plans to respond not only to changes in climate but also changes in the risk appetite of communities.

4. ***It keeps options open until there is more information, funding or support for options***

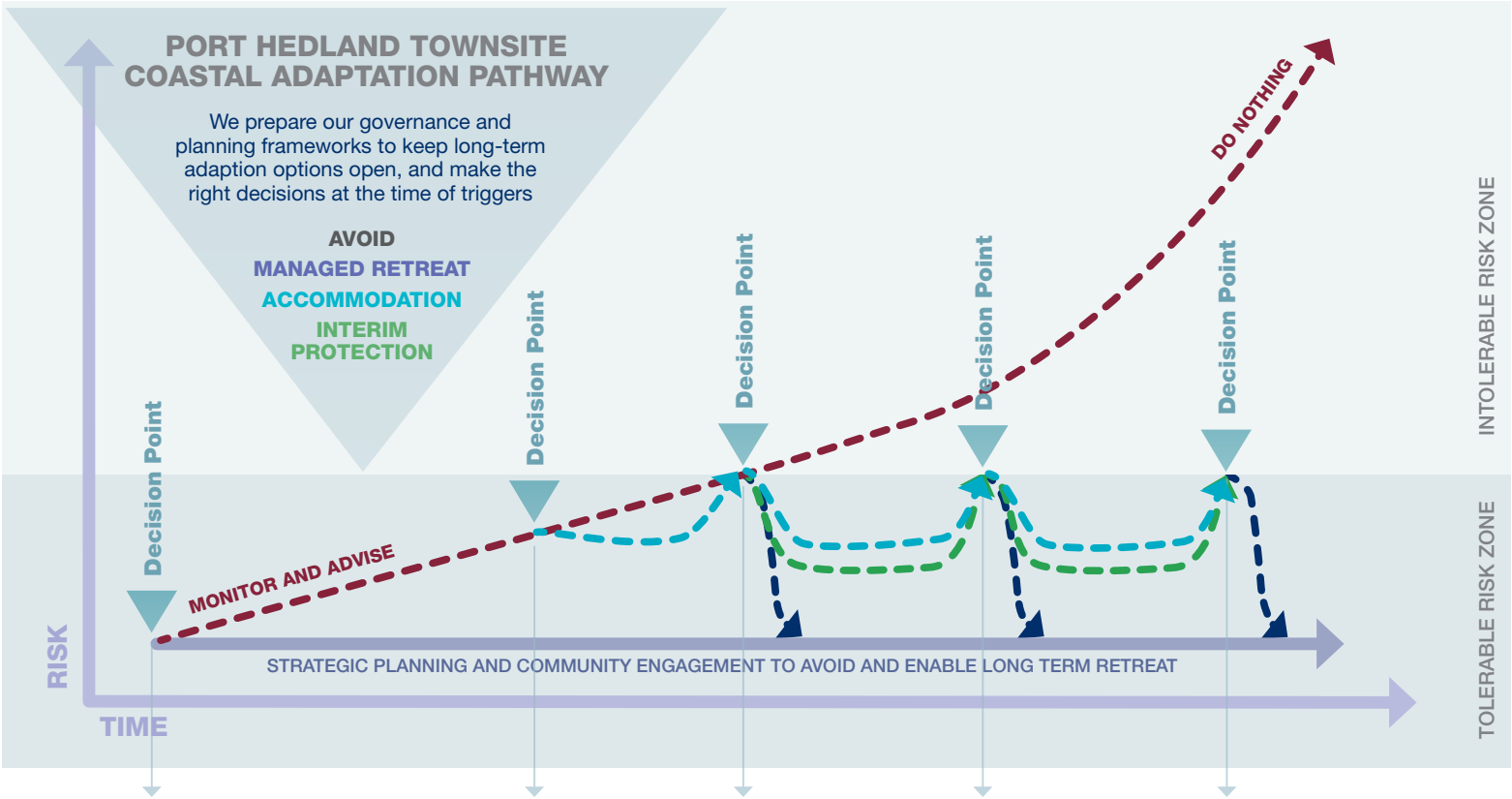
   Keeping options open enables managers to hold off making decisions that may be expensive, until better information is available about the impacts of climate change. It allows sequencing of adaptation options, starting from low controversy, soft options and only moving to higher impact more expensive options as certain thresholds are reached.

5. ***It allows for learning along the adaptation journey***

   Using the pathways approach allows the opportunity to learn from the outcome of past decision-making, to incorporate that learning into future decision-making, and to build a better understanding of managing future risks.

   (NCARFF, Available at https://coastadapt.com.au/pathways-approach)

Figure 10: Risk management pathway approach including decision-making trigger points



Trigger 1
Existing or proposed development in vulnerable coastal area. Risk is tolerable.

Trigger 2
Increasing likelihood of event presenting intolerable risk.

Trigger 3
Risk is intolerable. Accommodation/ interim protection may be feasible.

Trigger 3A
End of design life of accommodation/interim protection measure. Further accommodation/ interim protections may be available.

Trigger 4
Risk is intolerable. Accommodation or protection not feasible.

(Source GHD, 2019)

The characteristics of the risk management pathway are:

- Each decision-making point is triggered by some change (environmental or social). In the design of the strategy, the steps and the triggers must be identified.
- Each decision-making point has risk treatment options and risk management measures to implement the risk treatment options associated with it.
- Once the decision-making point is triggered, the risk treatment option(s) for that step are 'tested' against plausible futures and the acceptable risk to the community and stakeholders, and a selection is made.
- The selection leads to the next section of the risk management pathway, and in turn to the next decision-making point.
- The risk treatment options that are not selected will, if appropriate, be available for selection at the next decision-making point. The wide range of risk treatment options considered, evaluated, and left on the table for the future gives decision- makers flexibility and allows decisions to be responsive and progressive.

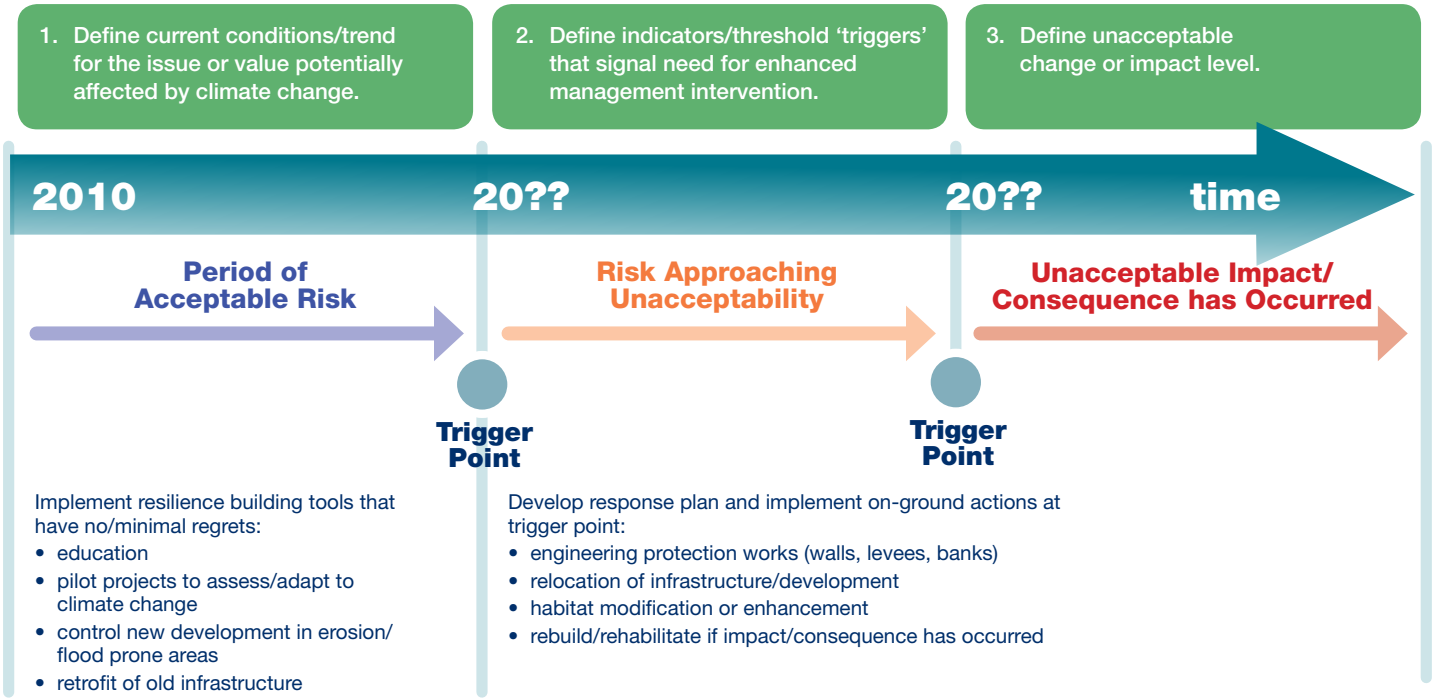
5.4.1 – TRIGGERS

The identification of short, medium and long-term triggers for implementation of the risk management measures, allows decision-makers to clearly map when risk management measures need to be taken. Triggers indicate the requirement for decisions which define or alter the risk management pathway in relation to a specific hazard or an asset in response to future conditions.

Fisk and Kay (2010) provide a method for setting triggers for implementation of the risk management measures along a time continuum. The trigger points are set to flag the level of acceptable change where risk management measures must be implemented to reduce risk levels. The use of triggers therefore sets the decision point for risk management measures such that risk management can be planned on an as needed basis, covering the urgently required and strategic risk management measures. Figure 11 shows the Adaptation Action Continuum Model formulated by Fisk and Kay (2010) and reproduced more recently in LGAQ (2016).

The coastal risks associated with erosion and inundation will increase over time so the intervening time before detrimental impact occurs can be used to implement resilience-building risk management measures, particularly where the risk management measure may be costly or difficult for the community to accept or implement. This lead time can also be used to source funding and prepare approvals and designs. This approach also recognises that some coastal hazards may not eventuate as projected. If this is the case, the trigger-based approach for risk treatment options and management measures means that the community has not been unnecessarily burdened by costly risk treatment options and management measures until they are necessary.

Figure 11: Adaptation Action Continuum Model



(Source, LGAQ 2016)

The method provided by Fisk and Kay can be applied to coastal hazards where the negative impact can be defined, but its timing is less well known.

An example of the risk management pathways method is provided below. Cardno (2018b) have applied this methodology identifying the triggers, decision-making and risk management measures that can be applied to the risk management pathway approach identified in Figure 10. Table 19 identifies 10 triggers as the basis for decision-making and risk management measures, and are formulated using a combination of factors identified in Stages 3 - 5 *Vulnerability analysis, Risk evaluation, and Risk treatment*.

The triggers, decision-making and risk management measures identified in Table 19 should then be applied to the risk management pathway(s) (identified in Figure 10 and Table 15) across short, medium and long-term planning horizons for assets within a specific locality within the CHRMAP area, and are seen in the illustration in Table 20.

Table 19: Example trigger, decision-making and measures

Trigger name	Trigger	Decision	Measures
T1	The HSD is within the S1 distance of an asset's most seaward extent	Ongoing shoreline monitoring (survey profiles) to determine present location of HSD S1 defined by modelling, with data collected during shoreline and storm monitoring used to validate/refine the S1 value	Remove major infrastructure (roads, carparks), residential and commercial buildings, transfer land to public realm Provide interim protection for major infrastructure (roads, carparks), residential and commercial buildings Prepare response plans for minor infrastructure that could be impacted
T2	A public road is no longer available or able to provide legal access to a property	Liaison with/notification by relevant level of government	Remove residential and commercial buildings, and transfer land to public realm
T3	Water, sewer or electricity to a lot is no longer available as they have been removed/decommissioned by the relevant authority due to coastal hazards	Liaison with/notification by utility providers	Remove residential and commercial buildings, and transfer land to public realm
T4	Residential or commercial property lies seaward of the most up to date 100-year coastal erosion hazard line	Definition of hazard extent through CHRMAP CHRMAP and hazard extent updates due to availability of more relevant/recent information (such as updated SLR predictions) and changes in environmental conditions (such as changes to MSL)	Include all affected land in a SCA and ensure the hazard information is incorporated in structure planning Provide notification of potential hazards on certificates of title where reasonably practicable and by direct contact with affected landholders
T5	An asset is damaged, destroyed or becomes unsafe due to coastal erosion	Inspection of coastal assets following storm events or during times of increased longshore erosion Remote coastal monitoring cameras Notification by the public	Remove assets and relocate to less hazardous area if possible/appropriate
T6	Assets are predicted to become highly or very highly vulnerable within the next planning timeframe or within 15-20 years	Definition of hazard extents through CHRMAP CHRMAP and hazard extent updates due to availability of more relevant/recent information (such as updated SLR predictions) and changes in environmental conditions (such as changes to MSL)	Undertake details cost-benefit analysis and assessment of community acceptance of interim protection vs. managed retreat of the affected asset; Identify sources and begin to allocate funding for risk management measures
T7	The overall community and stakeholders are no longer supportive of a specific risk management technique or approach	Ongoing community engagement; Cost-benefit analysis	Investigate, identify and implement a change in the risk management pathway, if appropriate
T8	A specific risk management technique is forecast to no longer be economically or physically feasible within 10 years	Ongoing shoreline and coastal asset monitoring Budget expenditure and forecasts Cost-benefit analysis	Investigate, identify and implement a change in the risk management pathway, if appropriate
T9	The beach and coastal foreshore reserve is significantly diminished with respect to its original state and function	Long-term coastal monitoring program Assessment of aerial imagery Feedback through ongoing community consultation	Investigate, identify and implement a change in the risk management pathway, if appropriate
T10	Undeveloped land is identified as lying within the hazard extents	Definition of hazard extents through CHRMAP CHRMAP and hazard extent updates due to availability of more relevant/recent information (such as updated SLR predictions) and changes in environmental conditions (such as changes to MSL)	Implement planning controls to avoid inappropriate development of the land

(Adapted from Cardno 2018b)

5.4.2 – PLANNING HORIZONS

Stage 2 *Risk identification*, Sections 2.1 *Planning timeframe and sea level rise* and 2.2 *Hazard identification*, identified the need to establish planning horizons as part of the CHRMAP hazard identification assessment process. The planning horizons need to be translated to the risk management pathways, to establish short, medium and long-term planning horizons for risk management measures to be implemented at the decision-making trigger points (Section 5.4.1 *Triggers*).

Medium to long-term planning horizons should focus on strategic planning measures, which maintain the ability to select risk treatment options from the risk management and adaptation hierarchy at any trigger point.

Short-term horizon planning should focus on identifying the trigger points that will arise in light of increasing risk, identifying the appropriate risk treatment option(s) and management measures. Establishing the necessary controls in local planning schemes and other planning instruments and commencing budgeting for required risk management measures is particularly important in the short term.

Table 20: Example Risk management pathway including triggers, decision-making and measures

Planning timeframe	2015 - 2030	2030 - 2070	2070 - 2120	2120 - future
Assets	**Undeveloped land**			
Pathway	*Avoid development (**AV**)*			
Trigger(s)	Undeveloped land lies within hazard extents (**T10**)			
Assets	**Minor Public Infrastructure and Drainage Infrastructure**			
Pathway	*Leave unprotected/repair, remove/relocate (**MR1, MR2**)*			
Trigger(s)	Asset damaged (**T5**)			
Pathway	*Emergency plans and controls (**AC2**)*			
Trigger(s)	HSD within S1 distance (**T1**)			
Assets	**Major Public Infrastructure and Residential Property**			
Pathway	*Planning controls, emergency plans and controls (**AC1, AC2**)*			
Trigger(s)	HSD within S1 distance (**T1**), Property lies seaward of 100-year erosion hazard (**T4**)			
Pathway	*Planning for managed retreat (**MR3**)*			
Trigger(s)	Property lies seaward of 100-year erosion hazard (**T4**), Assets predicted to be vulnerable in 15-20 years (**T5**)			
Pathway	*Dune care/sand management, beach nourishment (**PR1**, **PR2**)*	*Protect (**PR1**, **PR2**, **PR3**, **PR4**, **PR5**)*		*Remove/relocate (**MR2**)*
		and/or *Remove/relocate (**MR2**)*		
Trigger(s)	Diminished beach and foreshore reserve (**T9**)	**T1**, **T7**, **T8**, **T9**		***T1**, **T2**, **T3**, **T5**, **T7**, **T8**, **T9***
		T1, **T2**, **T3**, **T5**, **T7**, **T8**, **T9**		
Assets	**Beach and Dunes**			
Pathway	*Dune care/sand management, beach nourishment (**PR1**, **PR2**)*			
Trigger(s)	Diminished beach and foreshore reserve (**T9**)			

(Source: Cardno 2018b)

STAGE 6 – IMPLEMENTATION PLAN

Having identified risk treatment options for specific assets, it is important that the risk management measures required to implement the risk treatment options are identified and implemented. This can be done through an implementation plan, which details risk management measures to be undertaken to achieve selected risk treatment option(s).

The implementation plan should focus on risk management measures identified in Stage 5 *Risk treatment* in the short-term (25 years), but also include measures that allow the community and stakeholders to choose the most appropriate risk treatment options at future decision points for the medium and long-term risk management pathways.

The implementation plan should describe the proposed risk management measures and include:

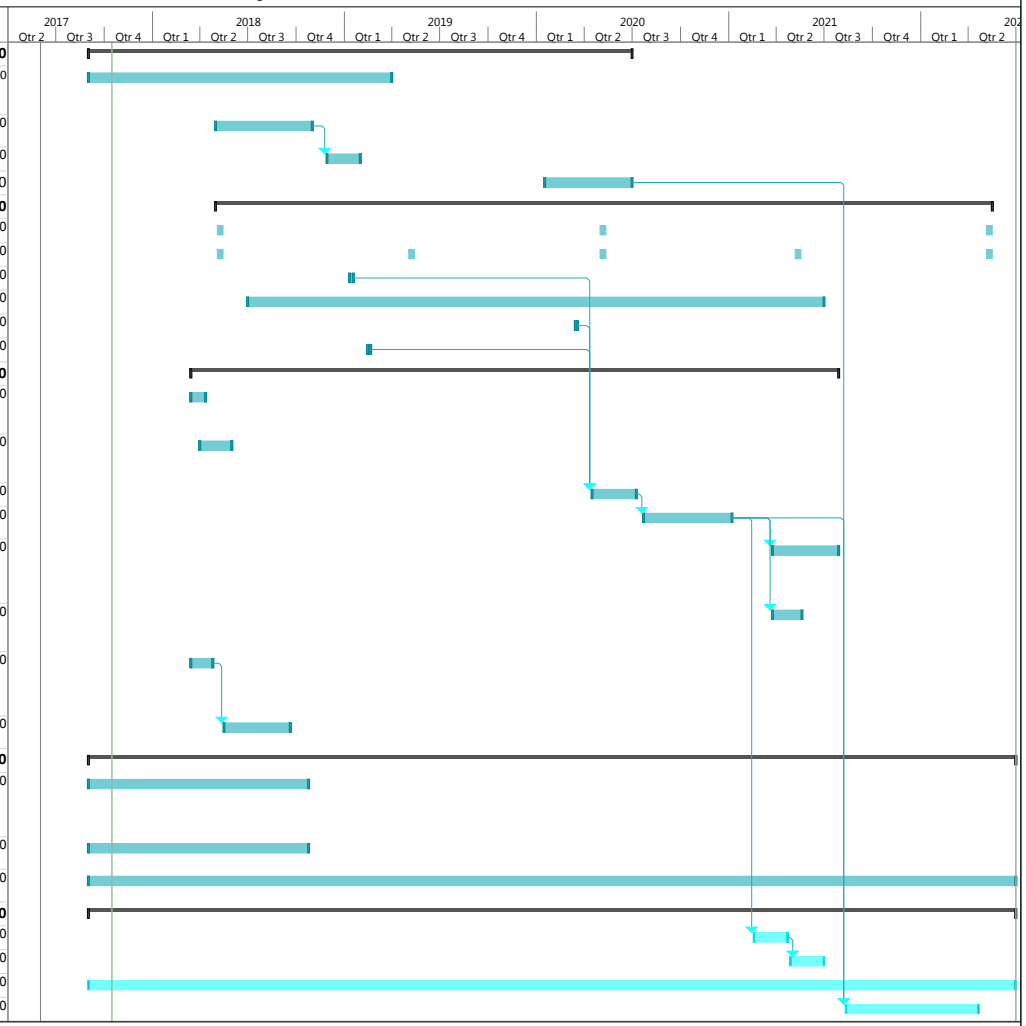
- Description – what is the selected risk treatment option? What is the required risk management measure to implement the risk treatment option? The reasons for selection, including expected benefits to be gained.
- Resource requirements – what is required to implement the risk management measure?
- Responsibility – who will be responsible for the implementation (risk management owner)?
- Planning framework – planning instrument requirements and amendments.
- Approval agencies – processes and requirements.
- Trigger – points for implementing risk management measures? Monitoring framework to determine if trigger occurs.
- Costs – associated with implementing selected risk management measures (capital and recurrent costs)? How will the risk management measures be financed?
- Performance measures – what will be the indicators that demonstrate progress of implementation and effectiveness of the risk management measures?
- Communications and monitoring – who needs to be informed during and at completion of implementation of the risk management measures and how will the implementation be monitored and how frequently?

A Gantt chart can be helpful as part of the implementation plan for the short-term. This is a simple way to clearly identify the priority order in which individual risk management measures should be implemented and their timing, and can be seen in Figure 12.

Figure 12: Short-term adaptation actions and timing Gantt chart

Onslow CHRMAP 5 Year Program

ID	Task Name	Start	Finish	Cost Estimate
1	**Planning and Development Controls Review**	**1 Sep '17**	**30 Jun '20**	**$80,000**
2	Review Planning and Development Controls and Recommend Amendments as required: Recommendations R1, R2, R9, R10, R12, R14, R15, R17, R18, R21, R22, R26	1 Sep '17	31 Mar '19	$80,000
3	Amend current zone and SCA boundaries: Recommendations R3, R4, R5, R7	1 May '18	31 Oct '18	$0
4	Update SCA special provisions	29 Nov '18	30 Jan '19	$0
5	TPS 7 Update and Endorsement by WAPC	17 Jan '20	30 Jun '20	$0
6	**Monitoring**	**1 May '18**	**16 May '22**	**$300,000**
7	Horizontal Shoreline Datum (Aerial Photo Analysis)	1 May '18	2 May '22	$40,000
11	Annual Beach Profile Surveys	1 May '18	9 May '22	$125,000
17	Post wave erosion Event (>2 yr ARI wave) Beach Profiles	11 Jan '19	17 Jan '19	$30,000
18	Assess Current and Future Sediment Budget in the Secondary Cell	1 Jul '18	30 Jun '21	$80,000
19	Cyclone storm surge flooding Event	15 Mar '20	18 Mar '20	$10,000
20	Pluvial Flood Event (>2 yr ARI Rainfall)	14 Feb '19	19 Feb '19	$15,000
21	**Specialist Investigations**	**15 Mar '1**	**28 Jul '21**	**$310,000**
22	Investigate sufficient coastal foreshore reserve width allowance to extend the 2110 Hazard line a sufficient distance to accommodate future relocation of foreshore assets: Recommendation: R6	15 Mar '18	11 Apr '18	$15,000
23	Investigate planning mechanisms to allow future changes to be triggered including the ultimate retreat strategy. Recommendations: R16, R19	1 Apr '18	31 May '18	$0
24	Analysis of Flood, Storm Surge and Erosion event monitoring	16 Apr '20	8 Jul '20	$40,000
25	Develop integrated Model - Coastal Inundation, Groundwater levels and Pluvial Flooding Scenarios	23 Jul '20	6 Jan '21	$100,000
26	Investigate Pluvial Drainage and Coastal Processes Interactions to define triggers, set FFL, CHRMAP, Water Management Plans and Emergency Managemenet Plan overlaps. Recommendations: R27, R28, R29, R30, R31, R32	25 Mar '21	28 Jul '21	$50,000
27	Investigate wave runup height component for the future inundated areas. Add to the current 100 yr ARI still water level (4.5m AHD) to define the Peak Water Level and SCA extent. Recommendation: R8	25 Mar '21	19 May '21	$10,000
28	Investigate Seawall concept design, rock availability and potential stage triggers for implementing seawall upgrades, extension to Sunrise Beach and potential renourishment requriements for beach amenity. Recommendations: R24, R25, R33, R34	15 Mar '18	25 Apr '18	$15,000
29	Economic Analysis Undertake economic analysis of options. Recommendations: R35, R36, R37	17 May '18	19 Sep '18	$80,000
30	**Operational**	**1 Sep '17**	**30 Jun '22**	**$50,000**
31	Establish Data Management and GIS system (time series, spot levels and remote sensing) relating to localised and general flooding in Onslow allow identification trends over time, and Trigger assesment. Recommendations: R11, R13	1 Sep '17	24 Oct '18	$50,000
32	Update Asset database to incorporate end of life date to facilitate future management of assets. Recommendation: R19	1 Sep '17	24 Oct '18	$0
33	Notifications - Potentially affected land owners by direct contact and property titles. Recommendations: R20, R22, R23	1 Sep '17	30 Jun '22	$0
34	**CHRMAP Review and Update**	**1 Sep '17**	**30 Jun '22**	**$195,000**
35	Review Hazard line estimates (S1, S2, S3 and S4)	18 Feb '21	21 Apr '21	$25,000
36	Review Risk Assesment and Future Pathway Options	29 Apr '21	30 Jun '21	$40,000
37	Community and Stakeholder Consultation	1 Sep '17	30 Jun '22	$50,000
38	Update CHRMAP	12 Aug '21	20 Apr '22	$80,000



Project: 5 Year Implementation
Date: 16 Oct '17

Task		Project Summary		Manual Task		Start-only		Deadline	
Split		Inactive Task		Duration-only		Finish-only		Progress	
Milestone		Inactive Milestone		Manual Summary Rollup		External Tasks		Manual Progress	
Summary		Inactive Summary		Manual Summary		External Milestone			

(Source: Baird 2018)

6.1 – LAND USE PLANNING INSTRUMENTS

Further to inclusion of the planning framework and instruments in the CHRMAP process in Stage 1 *Establish the Context* Section 1.6 *Existing Controls*, Stage 4 *Risk Evaluation* section 4.1 *Existing Controls*, and Section 6 *Implementation Plan*, it is essential that land use planning instruments (such as local planning strategies, local planning scheme, local planning policies, and structure plans) are used to respond to coastal risks.

It is important that the implementation plan identifies and provide details for any required changes, updates or amendments to existing or proposed land use planning instruments. The implementation plan should provide details on proposed wording, implementation method/ processes, and any other supporting information that may be needed to implement the risk management measures.

6.2 – DISCRETIONARY DECISION-MAKING AND THE PRECAUTIONARY PRINCIPLE

Planning decisions must be made on the merit of a proposal and include holistic consideration of planning issues. For strategic planning proposals, subdivisions and development applications in coastal hazard areas, discretionary decision-making should involve the application of the precautionary principle contained in SPP 2.6 cl 5.11. The outcome of this policy measure means that the potentially serious risk associated with coastal hazards to people, property and infrastructure warrants a conservative approach to decision-making when preparing a CHRMAP and considering land use planning instruments that will assist the decision-maker to implement the CHRMAP.

6.3 – FUNDING IMPLEMENTATION

Risk management measures will require funding to deliver effective implementation. This will require consideration of capacity of existing budget, revenue sources and mechanisms for raising additional funds for implementing risk management measures.

It is important that the implementation plan identifies the cost of recommended risk management measures and all revenue-raising mechanisms available for obtaining additional funds to assist implementation. Once identified, it should be outlined which revenue-raising mechanisms are recommended, and the governance framework through which such revenue is to be raised. For example, revenue-raising mechanisms available to local government include rates (differential rating), proportioning a percentage of annual operating budgets to coastal management, and funding from beneficiaries of risk management measures. Beneficiaries may include private parties, government agencies and government entities. For more information regarding roles and responsibilities see Part A Section II, Part B Section 1.5.2 and the *WA Coastal Zone Strategy*.

Stage 5 *Risk treatment* identifies the issue of equity and the need for equity implications to be included in the CHRMAP process. The decision-maker should consider equity in terms of who benefits, who is disadvantaged, who should pay and the subsequent allocation of public resources. For example, where a seawall benefits a private property owner, the costs (capital and recurrent) of the seawall and associated sand nourishment (to maintain the beach seaward of it) should be attributed to the private property owner.

6.3.1 – STATE GOVERNMENT

Western Australian Planning Commission

Coastal Management Plan Assistance Program (CMPAP)

CMPAP grants support eligible coastal land managers to develop adaptation and management plans and strategies for coastal areas that are, or are predicted to become, under pressure from a variety of challenges. CMPAP grants are administered by the Department of Planning, Lands and Heritage.

For further information visit:

www.dplh.wa.gov.au/cmpap

Coastwest

Coastwest grants support eligible coastal land managers and community organisations to undertake projects that manage and enhance WA's coastal environments through rehabilitation, restoration and preventative actions. Coastwest grants are administered by the Department of Planning, Lands and Heritage.

For further information visit:

www.dplh.wa.gov.au/coastwest

Department of Transport

Coastal Adaptation and Protection (CAP) grants

CAP grants provide financial assistance for local projects that identify and manage coastal hazards. The program seeks to preserve and enhance coastal assets for the community. It aims to build partnerships with local coastal managers, and help them understand and adapt to coastal hazards.

For further information visit:

www.transport.wa.gov.au/imarine/coastal-adaption-and-protection-cap-grants.asp

Department of Primary Industries and Regional Development

Royalties for Regions

Royalties for Regions promotes and facilitates economic, business and social development in regional Western Australia for the benefit of all Western Australians.

For further information visit:

www.drd.wa.gov.au/rfr/whatisrfr/Pages/default.aspx

Department of Local Government, Sport and Cultural Industries

Local Government Financial Assistance Grants

Grants funded by the Commonwealth Government are distributed among 137 local governments in Western Australia each year. The grants are un-tied in the hands of local government, allowing councils to spend the grants according to local priorities.

For further information visit:

https://www.dlgsc.wa.gov.au/localgovernment/forcouncils/Pages/Financial-Assistance-Grants.aspx

STAGE 7 – MONITORING AND REVIEW

Monitoring and review should be a planned part of the CHRMAP process, clearly defining responsibilities, and encompass all aspects of the CHRMAP process. Regular monitoring and review will ensure that the risk management measures identified and established remain relevant.

A monitoring and review process is crucial as risks arising from coastal hazards rarely remain static, especially as the understanding of coastal processes improves and given the long timeframes associated with some types of coastal processes and land use and development.

Monitoring and reviewing the CHRMAP ensures that risk management measures, consequences and likelihood, and the risk management priorities, remain suitable, effective, timely and cost appropriate. Where practical, principles of risk management should be applied which involve changes based on regular monitoring and revision of plans based on the best information available at the time.

Monitoring and reviewing should also always include consultation with community and stakeholders to ensure any changes are communicated, and their viewpoints and values continue to be reflected in the risk management outcomes.

Future revision and updates of the CHRMAP could be coordinated to coincide with: the review of strategic plans, local planning strategies and schemes, the release of IPCC assessment reports; legislation, policy and policy guideline change.

Partial review and amendments may be applicable, based on matters such as annual monitoring and ongoing suitability of implementation of risk management measures and triggers.

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