

SUMMARY DOCUMENT  
FOR ADVERTISING PURPOSES



PRINCESS ROYAL HARBOUR

# Coastal Hazard Risk Management and Adaptation Plan (CHRMAP)

**View of Princess Royal Harbour, painted by Lt Robert Dale - 1833. The Noongar name for Princess Royal Harbour is Mamang Koort which translates as 'whale heart'.**

## Paying Respect to the Noongar People

The City of Albany and its people recognise the cultural and spiritual links that Noongar people have to the land and sea, and acknowledge they are the Traditional Owners of Country known today as Albany. The local Noongar people witnessed the European settlement of the Princess Royal Harbour area and endured the massive changes this brought to their land and lifestyle.

The City of Albany and its people are committed to working with the Aboriginal people of Albany to establish an accord, which will promote a greater understanding throughout the community of Aboriginal and Non-Aboriginal people's history and culture.



### Project Details

**Client** City of Albany  
**Client Project Manager** Adrian Nicoll  
**Consultant support** Water Technology

### City of Albany

102 North Road, Albany

**Version:** V2  
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# Consultation

The Princess Royal Harbour Coastal Hazard Risk Management and Adaptation Plan (CHRMAP) is being advertised to the public, key landholders and government agencies, seeking comment on proposed **adaptation measures** - for areas around the harbour that may be impacted by coastal processes.

The final Draft CHRMAP Technical Report can be found at [www.albany.wa.gov.au/council/projects/current-projects](http://www.albany.wa.gov.au/council/projects/current-projects)

Recommended measures of the draft CHRMAP may affect different people in different ways depending on where they live and how they access, use and enjoy the coastline. The recommendations for managing coastal processes associated with the Princess Royal Harbour into the future include:

- Protecting potential erosion areas via **sand nourishment**.
- Protecting potential inundation areas via the development of **levees**.

Details on potential hazard areas and recommended actions for dealing with hazards can be found in this summary document at Attachment 1.

### Private property owner in a coastal hazard area

If a planning or development application is submitted for a lot located in a coastal hazard area then the State Coastal Planning Policy requires a notification to be placed on the certificate of title as a condition of approval, identifying that the lot may be vulnerable to coastal hazards.

### User of the City's coastline

Some areas of the City's coastline may become vulnerable over the next 100 years. This includes beaches, access ways, footpaths, carparks, toilets, roads and public open space areas. This Coastal Hazard Risk Management and Adaptation Plan provides short to long-term management actions to be undertaken over the next 100 years.

Long-term, adaptation strategies such as protection or managed retreat may be required if and when coastal hazards are realised.

In areas identified for protection, levee banks and sand nourishment may be undertaken in the future. In areas identified for future managed retreat, existing infrastructure may gradually be permanently removed or relocated if coastal hazards cause damage during storm events.

### A lessee or user of one the City's coastal buildings

If you lease or use a City building that is located in a coastal hazard area, it may be impacted within the 100 year planning timeframe.

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Princess Royal Harbour – Erosion/Protection – Nature based

## Executive Summary

This document provides a summary for advertising purposes, of the draft Coastal Hazard Risk Management and Adaptation Plan (CHRMAP) – pertaining to the Princess Royal Harbour.

The draft CHRMAP is located on the City's website at: [www.albany.wa.gov.au/council/projects/current-projects](http://www.albany.wa.gov.au/council/projects/current-projects)

The CHRMAP has been developed to increase knowledge and understanding of **coastal hazard risks** pertaining to the Princess Royal Harbour and to identify **risk management and adaptation measures for implementation**.

The development of the CHRMAP adheres to the Western Australian Planning Commission (2019) CHRMAP guidelines with scope and deliverables consistent with their objectives and the State Planning Policy 2.6 – Coastal

Planning (SPP2.6).

The CHRMAP area was broken into five (5) Management Unit (MU) areas.

Assessment and recommendations were made for each MU area. Detailed implementation recommendations for each MU are presented at Attachment 1 of this summary document.

Recommendations are including assumptions provided throughout the document and a multi-criteria analysis based on technical, economic, social and environmental criteria.

It's proposed that the recommended measures of the CHRMAP are used to inform the City's Local

Planning Scheme, local planning policies, planning strategies, asset management plans, emergency management plans, and foreshore management plans.

The two recommended primary coastal management pathways for mitigating **erosion** hazards at PRH are **Managed Retreat** and **Protection** (via sand nourishment).

The two recommended coastal management actions mitigating **inundation** hazards at PRH are **Accommodate** and **Protection** (via levees).

The specific details of these preferred pathways need to be confirmed following further data collection and analysis in the years ahead to make sure the best methods are used.

Individual maps depicting each hazard and the extent of proposed treatment options for each MU are provided in Attachment 1 of this summary document.

## What are coastal hazards?

The two main coastal processes that are considered hazards are erosion (i.e. loss of land) and inundation (i.e. flooding).

## What is CHRMAP?

- Identifies coastal hazards within 25, 50 and 100-year timeframes
- Identifies adaptation strategies

## Adaptation Strategies



**avoid**  
identify future 'no-build areas' and use planning tools to prevent new development in areas at risk now or in the future



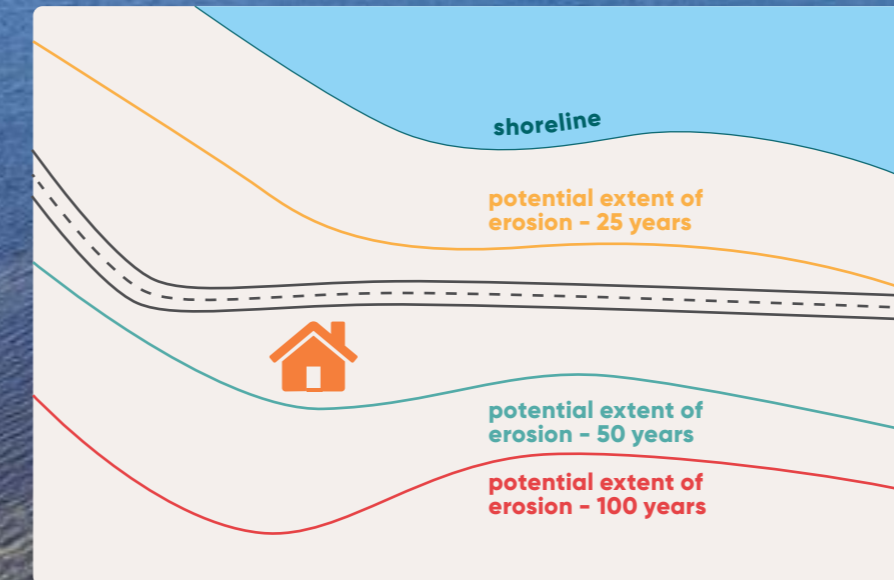
**retreat**  
withdraw, relocate or abandon assets that are at risk; ecosystems are allowed to retreat landward as sea levels rise



**accommodate**  
continue to use the land but accommodate changes by building on piles, converting agriculture to fish farming or growing food or salt-tolerant crops



**protect**  
use hard structures (eg sea walls) or soft solutions (eg dunes and vegetation) to protect land from the sea. May be prohibitively expensive, especially in the long term



# Introduction

Globally, mean sea level has risen since the 19th century and is predicted to continue to rise, at an increasing rate, through the 21st century bringing changes to coastal areas.

Under the State Planning Policy 2.6 – Coastal Planning, the City of Albany is required to consider a projected sea level rise of 0.9 m over the next 100 years.

For low lying sandy coastlines such as the Princess Royal Harbour, increases in local mean sea level generally result in shoreline recession, with the rule of thumb being that a 1 cm rise in sea level will result in the shoreline moving 1 m further inland. As such, the City of Albany is putting measures in place to ensure that communities understand the risks to values and assets on the coast, with a plan to adapt over time.

The coast is a dynamic zone where the atmosphere, ocean and land interact. Ocean temperature, waves, tides, ocean currents and wind all contribute energy to form and shape the coast. Coastal change, resulting from these processes and interactions, occurs on short, medium and long time scales.

There are two common coastal hazards under the present climate:

- **Coastal erosion:** Erosion occurs when winds, waves, tides, storm surges and coastal currents act to shift sediments away from an area of the shore, often during a storm. In

most locations this is a short-term process and the shore gradually regains sediment.

- **Coastal inundation:** Means the flow of ocean 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.
- Coastal hazards can result in property damage, loss of life and/or environmental degradation. The impacts are generally greatest where the shoreline has been modified and developed for infrastructure or settlements.



# Protection measures

Undertaken by private properties – Little Grove



Camp Quararup



Princess Royal Drive



Frenchman Bay Road



## The Final Draft CHRMAP Technical Report identifies hazard scenarios around the harbour.

A CHRMAP is a long-term plan to address the impact of coastal hazards on our coastline. It looks at various hazard scenarios within 25, 50 and 100-year timeframes and, with input from the community and key stakeholders, identifies the most appropriate adaptation strategies and options.

The following figure provides an example of hazard areas identified for different years (Little Grove)



## The Final Draft CHRMAP Technical Report recommends adaptation measures for hazard areas around the harbour.

Adaptation measures may include:

- Avoid undertaking any subdivision or development
- Relocating development to safer places (managed retreat)
- Supporting development subject to design criteria (accommodate)
- Protecting development

The following figures show proposed protection for dealing with inundation (Levee) and erosion (sand nourishment) – Little Grove.

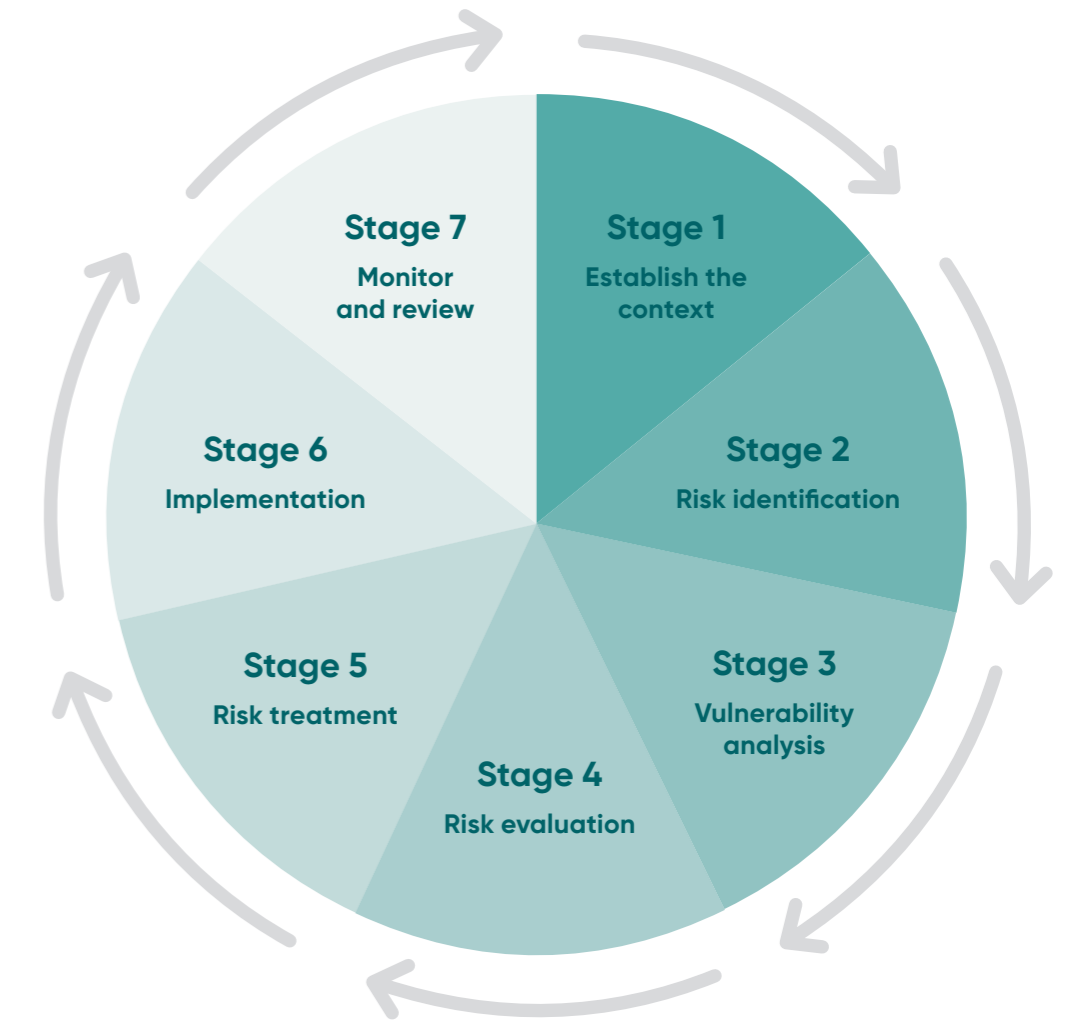


The draft CHRMAP recommends adaptation measures for hazard areas around the harbour.

## Process – Developing the CHRMAP

The development of the draft Princess Royal Harbour CHRMAP has occurred in accordance with the State Planning Policy 2.6 – Coastal Planning, considerate of the following key steps:

1. **Establishing the context** – Understanding the economic, social (including heritage) and environmental values of the coastal area.
2. A **risk identification** was undertaken to understand the potential extent of coastal erosion and inundation around the harbour.
3. A **vulnerability assessment** was undertaken to define the degree of impact coastal hazards are likely to have on coastal assets over a 100-year planning timeframe.
4. A **risk evaluation assessment** was undertaken comparing the results from the vulnerability analysis with risk criteria, to determine whether the risk and/or its magnitude is acceptable or tolerable.
5. A **risk treatment assessment** was undertaken to identify the suitability of risk treatment/adaptation options.
6. An **implementation plan** was developed taking into consideration results from the previous stages, including community values.
7. The CHRMAP also identified options for **monitoring and review**.





## STEP 1. Establishing the Context

Fundamentally, this first step in the CHRMAP process determined that the environmental attributes of the Princess Royal Harbour are very important to the community.

The adjacent figure shows the foreshore area fronting the suburbs of Little Grove and Robinson. The foreshore is an important habitat to bird species and including marine life. Any adaptation measures would need to consider the environmental attributes.

Establishing the context outlines the framework within which the CHRMAP has been undertaken. In doing so, the CHRMAP defines the study area, captures community values, outlines existing planning controls, identifies established controls, identifies environmental attributes and defines the purpose, key objectives and success criteria of the CHRMAP.



## Study Area

The adjacent figure illustrates the CHRMAP study area, which is broken into five segments of shorelines called Management Units (MU). The Management Units have been defined as follows:

- **MU1** – Point King to Melville Point: hardened shoreline with natural rocks and coastal rock protection. Area of Albany Port and Albany Waterfront Marina.
- **MU2** – Melville Point to Rushy Point: sandy coastline with intertidal flats. Paths and roads close to the shoreline.
- **MU3** – Rushy Point to Limekilns Point: sandy and rocky coastline fronted with private properties. It is the Little Grove area and contains the Princess Royal Sailing Club.
- **MU4** – Limekilns Point to Geake Point: sandy and rocky coastline. Contains the major area of Vancouver Peninsula.
- **MU5** – Geake Point to Possession Point / Uredale Point: sandy and rocky coastline with presence of seawalls.



## Community and stakeholder engagement

Community input is the cornerstone of an effective CHRMAP process and is required to understand how the community uses and values the coast, and how the coast should be managed in the future.

Community values collated from surveys and public information sessions have been used to generate preliminary success criteria for the risk assessment component of the CHRMAP.

The following community values were rated at two public information sessions:

- For **environmental health** – 81% chose strongly agree
- For **recreation** – 67% chose strongly agree
- For **cultural significance** – 52% chose strongly agree
- For **tourism** – 42% chose strongly agree

For people to be able to **live nearby** – 35% chose strongly agree

Throughout the development of the CHRMAP, the City has engaged and sought feedback from key stakeholders through a **Project Steering Committee** and a **Community and Business Reference Group (CBRG)**.

Furthermore, small group sessions and one-on-one sessions have been facilitated with immediately affected landowners to discuss the project outcomes.

Stakeholder communications have included targeted letters and emails, a project website landing page, social media posts, Online E-news notices and Newspaper notices.

All submissions received for the project will be assessed and taken into account in the finalisation of the CHRMAP technical document. Once finalised and endorsed by Council, the CHRMAP will be published on the Citywebsite.



Public Information sessions were undertaken at the Albany Waterfront



## Existing planning controls

The State Coastal Planning Policy (SPP2.6) provides guidance for decision-making within the coastal zone including managing development and land use change; establishment of foreshore reserves; and to protect, conserve and enhance coastal values.

The policy applies to the West Australian coast including tidal reaches of inland waters.

The City's Local Planning Scheme has defined a Special Control Area around the Princess Royal Harbour, to recognise potential hazards and to manage development.

## Existing physical controls around the harbour

There are existing man-made protection measures (physical controls), which have been developed at different locations around the Princess Royal Harbour.

These physical controls include structures that have the potential to interact with oceanographic conditions and coastal processes.

Such structures include seawalls, groynes and breakwaters.

Controls also include ongoing management/intervention activities, such as beach nourishment, dredging and hard protection.

Existing physical controls identified for the study area include:

- Port of Albany rock seawall and sheet-piled wharf
- Albany Waterfront Marina – breakwaters and seawalls
- Seawall in front of Albany Wool Stores
- Rock protection along Frenchman Bay Road
- Informal rock protection along Rushy Point shoreline
- Princess Royal Sailing Club Seawalls
- Camp Quaranup Seawall

## Environmental Attributes

The coastal zone is recognised as being a very important environmental asset and therefore any recommendations need to account for environmental values.

Examples of environmental values include, the natural landscape, remnant vegetation, biodiversity of life, ecological corridors, threatened and ecological communities and recreational attributes such as bird watching and trails.



## Purpose

Having understood various characteristics associated with the harbour and including assets developed (roads, utilities, housing) on the fringe of the coastal zone, the CHRMAP defined its purpose, which is:

- To identify areas that may be impacted by coastal processes; and
- To manage risks associated with coastal processes.

## Objectives

Based on the purpose and picking up on the context assessment, the CHRMAP defined the following overarching objectives:

- Improve understanding of coastal processes and hazards in the study area for five (5) management unit areas located around the harbour
- Consider rainfall and catchment flooding in addition to erosion and storm-surge inundation
- Identify significant vulnerability trigger points and respective timeframes, to mark the need for short- to long-term risk management measures.
- Identify the value of the assets that are vulnerable to adverse impacts from coastal hazards.
- Determine the consequence and likelihood of coastal hazards on the assets and assign a level of risk. Identify possible (effective) risk management measures (or '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
- Guide necessary changes to the City of Albany Local Planning Strategy, Local Planning Scheme and other relevant strategies and local planning policies.

## Success Criteria

Ultimately, the 'success' of the CHRMAP will be determined by the assets identified through the CHRMAP process continuing to provide their present function. Taking into consideration Western Australia's coastal planning policy position and including the coastal characteristics and community values specific to the Princess Royal Harbour, the following is the determined preliminary success criteria for the PRH CHRMAP:

- Ensure future land use and development does not accelerate coastal erosion or inundation risks or have a detrimental impact on the functions of public reserves.
- Manage land at risk of coastal erosion and inundation to avoid inappropriate land use and development.
- Maintain the harbour for environmental health, including flora and fauna habitat.
- Conserve, enhance and maintain the natural environment and character of the study area.
- Sustain the ability for the current and future generation to recreate along the harbour.
- Protect and or manage appropriately the provision of recreational assets in the coastal zone.
- Maintain safety for all.
- Retain the widest possible range of risk management options for future users of the coast.

## STEP 2. Risk Identification

A key outcome of the risk assessment was the confirmation that both coastal erosion and coastal inundation hazards are present along the PRH shoreline.

Some key risk factors include:

- Potential future breach of the isthmus located between Camp Quaranup and Point Possession/Uredale.
- Potential inundation and erosion to the Frenchman Bay Road, which is the main distributor of vehicles to and from the Little Grove, Big Grove and Goode Beach residential areas.
- Inundation and erosion impact to existing housing and infrastructure servicing (roads, sewer, and water) settlement areas.
- Potential loss of natural elements, including flora and fauna and ecosystems.
- Impact to foreshore recreational areas, including passive recreation and developed recreational areas such as the Yacht Club located at Little Grove.
- Potential wave impact to Port infrastructure.



*Princess Royal Harbour - Looking west toward Camp - Quaranup*

The risk assessment evaluates the potential impacts of erosion and inundation on assets around the harbour.

The hazard information has been produced defining the erosion and inundation extents for present day, 2047 (25 years), 2072 (50 years) and 2122 (100 years).

The sea is expected to rise by 90cm over the next 100 years.

For every 1 cm rise in sea level, the shoreline (sandy beach) is expected to retreat by 1m.

### Erosion Hazard Assessment

The erosion hazard assessment was carried out in the following steps:

- Classification of the coast based on geology (e.g. sand or rock).
- Understanding of the Horizontal Shoreline Datum (where the water meets the land).
- Simulation for storm erosion.
- Evaluation of historic shoreline movement trends.
- Evaluation of sea level rise impacts for present day, 2047, 2072 and 2122.
- Apply corrections for controlled (protected) shoreline segments.
- Calculation of an uncertainty allowance as per State Planning Policy 2.6.
- Evaluate total erosion values for each coastal management unit at different time periods.
- Mapping of erosion hazard lines defined by the horizontal shoreline together with erosion, historic shoreline movement trends, predicted sea level rise, storm surge inundation and uncertainty.

### Inundation Hazard Assessment

The inundation hazard assessment was carried out in the following steps:

- The allowance for the extent of coastal inundation has been calculated as the maximum extent of storm inundation during the 500-year average recurrence interval storm event.
- An allowance for catchment inundation has also been provided, to account for freshwater runoff from adjacent land catchments. This was calculated using hydrological and hydraulic modelling to estimate the localised increase in water level at the major surface water discharge locations within PRH.

This figure illustrates areas potentially affected by inundation for different timeframes.

Impact to assets, including housing and roads, is not expected for at least 50 years (2072).



This figure illustrates areas potentially affected by erosion for different timeframes.

The Frenchman Bay Road may be impacted within the next 25 years (2047), with Little Grove and the Albany Waterfront impacted by 2072 (50 years).





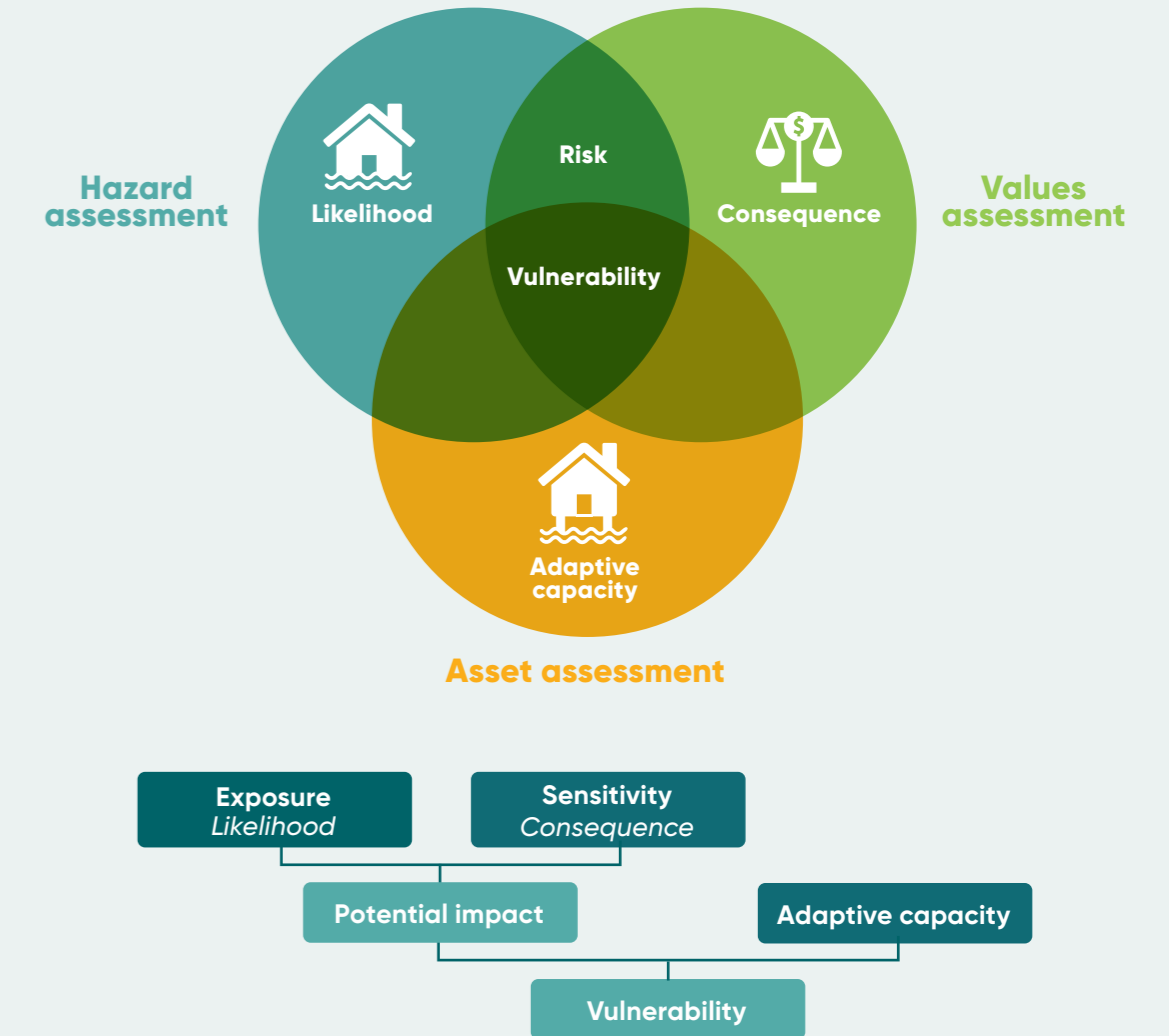
Princess Royal Harbour - View to the old Woolstores site

### STEP 3. Vulnerability Analysis

The vulnerability assessment determined that both erosion and inundation processes are likely to impact on assets within the coastal zone.

The results of the vulnerability assessment are summarised as follows:

- Erosion presents the largest vulnerability ratings and a higher number of assets at risk than inundation. This is due to the bigger extent of erosion hazard impact and the lower adaptive capacity to the erosion hazard.
- Extreme vulnerability to erosion has been identified from the present day onwards for more than one asset category in all MUs except MU1. Overall, the most common vulnerability is related to erosion.
- The inundation vulnerability ratings are categorized as being generally low and medium. At the 100-year timeframe the inundation vulnerability ratings are generally medium, with residential, public and commercial categories presenting high levels of vulnerability.



The process to identify how the effects of coastal hazards are likely to impact on assets, involved community workshops where community members were informed of potential hazards and the impact of the hazards on assets.

Key issues and concerns identified by workshop participants included:

- Potential loss of access to the beach and foreshore
- Beach erosion and its environmental, social and financial impacts
- Vegetation retention, revegetation and the need to do more to protect coastal areas from erosion
- Human impact on the coastal natural assets and values to the community

Key values identified by workshop participants across the whole study area are as follows:

- Access to beaches and foreshore areas for activities like walking, cycling, visiting nearby venues, fishing, swimming, exercise, views, residing nearby
- Health of environmental areas for their flora and fauna diversity which participants could appreciate – by birdwatching for example
- Coastal recreation and tourism
- Cultural significance (Aboriginal and European Heritage)

In terms of consequence there was a number of infrastructure items noted as having catastrophic consequences for the community including road access (Frenchman Bay Rd), power, water, sewer and fibre optic supply. In addition, the consequence for the Port and residential properties and the foreshore areas were also noted as being catastrophic. Overall, the effect on the management unit area No.2 was seen as the most catastrophic, with MU1 and MU5 having minimal catastrophic consequences.

At the workshops, community members also identified preferred adaptation strategies for prioritised areas. Adaptation strategies were explained (Avoid, Retreat, Accommodate or Protect) and examples of potential management options (dwellings designed to withstand inundation events) were presented to assist with this task, although it was made clear participants could also suggest their own.

Whilst avoid and accommodate were the most mentioned adaptation strategies, protect also featured highly.

**Avoid** was the major strategy for future housing and infrastructure.

**Planning controls** as a management option was seen as a way of avoiding future issues for residential development in affected areas.

Frenchman Bay Road was identified as an essential asset for the area. Participants wanted this asset to be built up or rerouted. A seawall was also mooted in the longer term.

The following vulnerability can be described for the different management unit areas:

- **MU1** – The Port of Albany, Albany Waterfront Marina and carpark, Anzac Park are affected in this MU.
- **MU2** – All the natural foreshore area and a significant amount of commercial and residential properties are affected.
- **MU3** – Princess Royal Sailing Club, a significant amount of Developed Foreshore reserve, residential and commercial are affected in this MU.
- **MU4** – All the natural and developed foreshore area and some residential properties are affected.
- **MU5** – Large areas of heritage environmental land are affected in this MU.



## STEP 4. Risk Evaluation

The risk evaluation process aims to identify and prioritise risk management measures.

This step determined that unacceptable vulnerability exists in each of the Management Units and therefore, risk treatment options and further analysis should be carried out.

Erosion and inundation vulnerability was considered for each Management Unit as a whole by averaging the vulnerability ratings of individual asset categories. All Management Units, at all planning horizons (2022, 2037, 2052, 2122), have unacceptable levels of vulnerability for both erosion and inundation, and therefore need to be considered for risk treatment options.

There are greater vulnerabilities to erosion in the study area compared to inundation. A vulnerability rating above "medium" require risk management.

- **For the Management Unit 1 area**, it was recommended that the seawall is maintained and that assets are relocated from

inside hazard areas.

- **For the Management Unit 2 area**, it was unclear whether or not seawalls should be developed and further investigation is undertaken for beach nourishment.
- **For the Management Unit 3 area**, it was recommended that seawalls are not developed and further investigation is undertaken for beach nourishment.
- **For the Management Unit 4 area**, it was recommended that seawalls are not developed and that further development is prohibited.
- **For the Management Unit 5 area**, it was unclear whether or not beach nourishment should occur.



Princess Royal Harbour - Sailing Club - Boat Pens

### Erosion vulnerability rating by management unit and planning horizon

Management Unit	2022	2037	2052	2122
MU1 - Point King to Melville Point	High	High	High	Extreme
MU2 - Melville Point to Rushy Point	High	High	Extreme	Extreme
MU3 - Rushy Point to Limekilns Point	High	Extreme	Extreme	Extreme
MU4 - Limekilns Point to Geake Point	High	High	High	Extreme
MU5 - Geake Point to Point Possession / Uredale Point	High	High	Extreme	Extreme

### Inundation vulnerability ratings by management unit and planning horizon

Management Unit	2022	2037	2052	2122
MU1 - Point King to Melville Point	Medium	Medium	Medium	High
MU2 - Melville Point to Rushy Point	Medium	Medium	Medium	High
MU3 - Rushy Point to Limekilns Point	Medium	Medium	Medium	High
MU4 - Limekilns Point to Geake Point	Medium	Medium	Medium	High
MU5 - Geake Point to Point Possession / Uredale Point	Medium	Medium	Medium	Medium

## STEP 5. Risk Treatment Analysis

Following on from the risk evaluation process of different adaptation options, this stage presents an Assessment of Risk Treatment Options by using a Cost Benefit Analysis (CBA). The CBA seeks to ensure that a selected adaptation option is economically defensible.

For erosion, four out of the five MUs (not MU4) resulted in Beach Nourishment having a positive benefit/cost ratio, and/or outperforming the other analysed options. A key assumption for this option is that a suitable sand source is available (grain size, volume, cleanliness and proximity).

For inundation, four out of the five MUs (not MU1 as no options were recommended for CBA for this MU) resulted in levee development having a positive benefit/cost ratio. Further investigations are required to confirm the assumptions used in the analysis to develop a more accurate scope for the recommended options.

In summary, it was deemed appropriate to incorporate some level of protection for all the management unit areas, as opposed to retreating.



Princess Royal Harbour - eastern locality - Quarunup Road

### Do we protect our assets or do we retreat? What are the costs and benefits associated with these two options?

The CBA has been used as an additional tool to assist decision-making when assessing adaptation options with which to proceed.

The CBA was performed over the project timeframe – notionally 2022 to 2122, to match the project planning timeframe and meet the requirements of the CHRMAP.

The CHRMAP CBA addressed valuing the loss of assets (e.g. Frenchman Bay Road), the managed retreat option and physical protection options.

It is important to note that the CBA was undertaken at a concept-level, using high-level cost estimates, and a long time frame economic analyses, meaning results should be used cautiously.



Princess Royal Harbour - view to Albany Central - note the existing protection for the Princess Royal Drive

Options recommended to proceed are presented in the following Tables. The recommendations have considered the CBA results holistically as well as being cognisant of the findings of previous stages of the CHRMAP.

#### Recommended CBA options for erosion for each MU

Management Unit	Recommended Option	Notes
MU1	Beach Nourishment	<ul style="list-style-type: none"> <li>Beach Nourishment or replenishment is best value for all discount rates and has a positive benefit/cost ratio for all rates.</li> <li>Seawall is not recommended as it would mean the loss of the beach. Should the objectives of this MU change in the future, a Seawall may be suitable in the long-term.</li> <li>Beach Nourishment could also later be transitioned to both Groynes or Seawall if required.</li> <li>Retreat by voluntary acquisition is the worst value option for all discount rates.</li> </ul>
MU2 and MU3	Beach Nourishment	<ul style="list-style-type: none"> <li>Beach Nourishment is best value for all discount rates and has a positive benefit/cost ratio for all rates.</li> <li>Seawall is not recommended as it would mean the loss of the beach. Should the objectives of this MU change in the future a Seawall may be suitable in the long-term.</li> <li>Retreat by Voluntary Acquisition is the worst value option for all discount rates.</li> </ul>
MU4	Retreat by Voluntary Acquisition	<ul style="list-style-type: none"> <li>Retreat by Voluntary Acquisition is considered the best value option for this management unit.</li> </ul>
MU5	Beach Nourishment	<ul style="list-style-type: none"> <li>Beach Nourishment has a positive benefit-cost ratio for this management area.</li> </ul>

#### Recommended CBA options for inundation for each MU

Management Unit	Recommended Option	Notes
MU1	N/A	<ul style="list-style-type: none"> <li>Following the Multi Criteria Assessment, no suitable options were identified for cost benefits.</li> <li>Recommended management will focus on Monitoring, Accommodate and Emergency Evacuation Plans.</li> </ul>
MU2-MU5	Levee	<ul style="list-style-type: none"> <li>A Levee has a positive benefit/cost ratio.</li> </ul>

The following table is a Multi-Criteria Analysis summary for the different Management Unit areas. Green indicates options recommended for further investigation (Cost Benefit Analysis); orange cells are unclear, so need to be further analysed; red cells are not recommended for inclusion or further analysis.

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

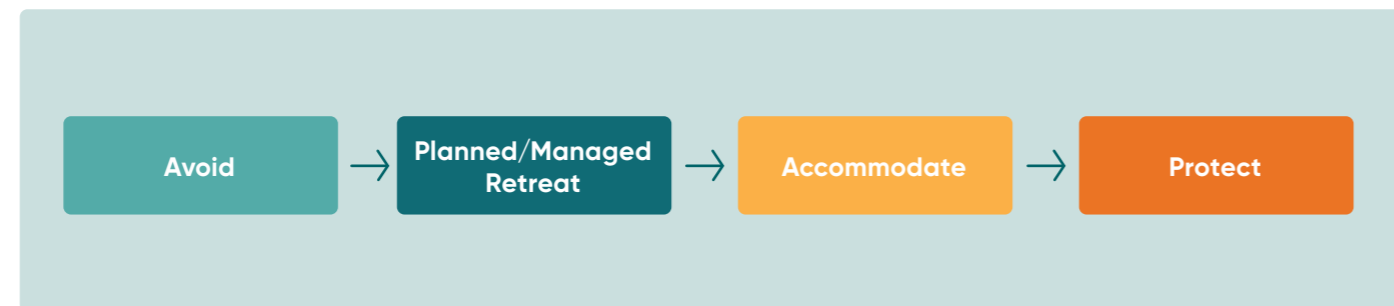


As already determined, all the management units at all planning horizons (Present day, 25, 50, 100 years) have unacceptable levels of vulnerability for both erosion and inundation (medium or above) for one or more asset categories, and therefore need to be considered for risk treatment options.

There are greater vulnerabilities to erosion in the study area compared to inundation. A vulnerability rating above "medium" requires risk management.

The State Planning Policy 2.6 provides a hierarchy of adaptation pathways to guide decision-making in coastal areas to be used by planning authorities and development proponents when considering adaptation options to minimise coastal hazard risks at the local level.

The hierarchy, presented in the below figure, indicates a clear preference against the adoption of 'protect' as a long-term adaptation pathway. This preference is re-emphasised in State Planning Policy 2.6, the policy guidelines, the CHRMAP Guidelines and the WA Coastal Zone Strategy.



Coastal hazard risk management and adaptation planning hierarchy (adapted from WAPC, 2019)

The below presents a summary of the relevant information for adaptation. The CHRMAP process aims to minimise coastal hazards and maximise the beneficial use of the coast.

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



Erosion/protection - Princess Royal Harbour

## STEP 6. Implementation Strategy

### Detailed implementation recommendations for Management Units are presented at Attachment 1.

The two primary coastal management pathways proposed for mitigating **erosion** hazards at PRH are **Managed Retreat and Protection**.

The two coastal management actions proposed for mitigating **inundation** hazards at PRH are **Accommodate and Protection**. For inundation, its recommended that assets are designed to withstand impacts – limit damage from inundation events through finished floor level requirements. This option increases resilience but is often not suitable as an isolated pathway.

The specific details of these preferred pathways need to be confirmed following further data collection and analysis in the years ahead to make sure the best methods are used. The CHRMAP recommendations have been made based on community consultation, technical reports, a multi-criteria analysis and economic, social and environmental criteria.

Controls for managing recommendations may include actions stipulated in a Local Planning Strategy, provisions within a Local Planning Scheme and guidelines within a Local Planning Policy.



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



**protect**  
use hard structures (eg sea walls) or soft solutions (eg dunes and vegetation) to protect land from the sea. May be prohibitively expensive, especially in the long term



**accommodate**  
continue to use the land but accommodate changes by building on piles, converting agriculture to fish farming or growing food or salt-tolerant crops



**avoid**  
identify future 'no-build areas' and use planning tools to prevent new development in areas at risk now or in the future



Princess Royal Harbour – Big Grove

## Managed Retreat

Managed retreat is a planning approach which contemplates existing development or land uses being able to continue until the coastal hazard risk becomes unacceptable.

Removal of 'at risk' development is recommended upon the occurrence of certain events. While retreat measures reduce vulnerability to climatic events they can be costly and potentially have social implications due to changes in community structures and sense of place.

As illustrated in the below figure, once the shoreline reaches the development, its expected that measures should be undertaken to relocate the development to a safer location.

Under the managed retreat pathway, its proposed that:

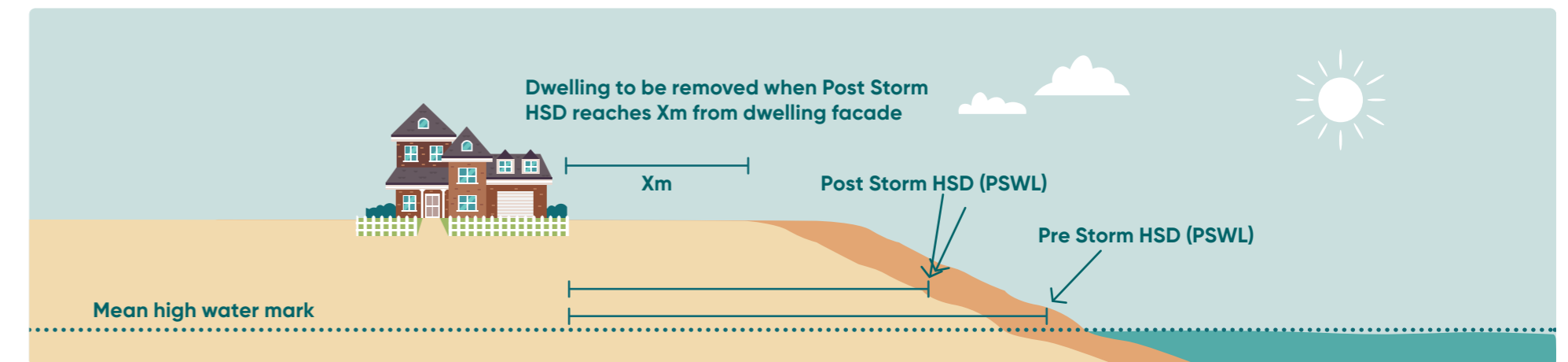
- Development approval is granted for a limited period and shall expire upon the earliest occurrence of the shoreline reaching Xm from edge of the development, or permanent legal access to the property via a public road no longer being available, or when water, sewerage or electricity is no longer available as the service has been removed or decommissioned by the relevant authority due to a coastal hazard and the development has become uninhabitable.
- Once the development approval expires in accordance with the above, at the landowners cost

and to the satisfaction of the City of Albany, the development, the subject of the application shall be removed, and the site made good.

- A notification, pursuant to Section 70A of the Transfer of Land Act 1893 is to be placed on the Certificate of Title of the proposed development lot advising of the existence of a hazard. The notification is to state as follows:

*'VULNERABLE COASTAL AREA - This lot is located in an area likely to be subject to coastal erosion and/or inundation over the next 100 years from the date this notification is registered and is subject to conditions which require removal and rehabilitation of the land to pre-development conditions at the landowner's cost.*

The following provides an example of managed retreat

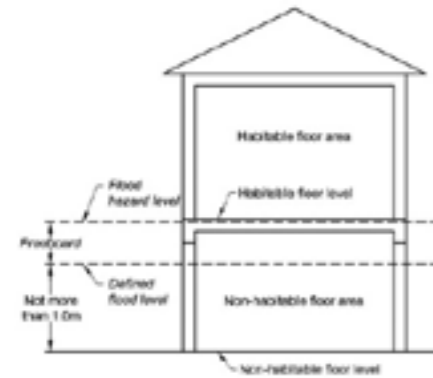


## Accommodate

Accommodate strategies reduce exposure and vulnerability with 'non-defensive' measures, such as building modifications (e.g. raising houses). Essentially, where avoiding or relocating an asset is not an option, the Accommodate strategy is about designing assets to withstand the impact of inundation. They are implemented to minimise climate impacts and designed mainly for storm surge and flooding. While accommodate measures allow a degree of 'business as usual' and may be the least costly strategy in the short-term, in order to persist they may need to be continually improved or re-engineered and may not be feasible over longer time periods.

In accordance with the accommodate pathway, the City's Local Planning Scheme is recommending that development on a lot should have a minimum finished floor level of 3.02 AHD to ensure adequate protection from inundation. To achieve the minimum finished floor level, the scheme recommends against using fill and instead using pole/stilts/stumps footings and a modular design. In some instances, fill may intensify the extent of flooding on other adjacent properties.

Pole, stilts or stumped homes will allow for water to enter the property and then retreat whilst keeping living areas free from flooding. Modular design will allow for the removal of the dwelling to another part of the site or to another lot should total and permanent inundation occur. This scenario allows for the retention of the asset and avoids total financial loss.



*An example of construction of buildings in flood hazard areas ABCB Standard 2012.3*

## Protection

Protection involves activities or works to reduce the impacts of coastal hazards on land adjacent to tidal waters including, but not limited to, beach nourishment, seawalls,

revetments and groynes. The PRH CHRMAP is recommending the use of soft protection (sand nourishment) and hard protection (levees).



*Beach nourishment example – Sunshine Coast QLD*



*Earth levee example from the Netherlands (California Water Blog, 2015)*

## Funding

Funding mechanisms for managing the different recommendations may include:

- Local Government:
  - Operating budget, general rates and coastal management fund;
  - Special area rates/differential rating;
  - Levies;
  - Lease land management;
  - Beneficiary pays;
- State Government grants, and
- Federal Government grants.

It is important that funding from all beneficiaries is secured. Key beneficiaries are likely to include:

- State Government (e.g. utilities such as roads, water, electricity that are being protected)
- Business and industry (e.g. cafés and other businesses that are being protected)
- Private land holders (e.g. residential property that is being protected)
- Local community (e.g. local users of public assets such as beaches, parks, estuaries etc that are being protected – provided proposed works enhance rather detract from the value of those assets)
- Broader community (e.g. users of public assets who reside outside of the local area and community members who value the assets for altruistic reasons)



*Princess Royal Harbour – looking south east*

## Benefit Distribution Analysis

A Benefit Distribution Analysis (BDA) has been developed as part of the Princess Royal Harbour CHRMAP, following the Cost-Benefit Analysis (CBA) undertaken as part of Stage 5 of the CHRMAP (Risk Treatment). The BDA forms the basis for a funding proposal for the identified risk management measures, and often this includes infrastructure options for mitigation against the identified hazard.

Coastal adaptation principles and Stage 6 of the CHRMAP process stipulate that risk management plans should be implemented using a 'beneficiary pays approach'. Applying this approach to coastal management actions will minimise the burden on taxpayers and ratepayers and avoid subsidies.

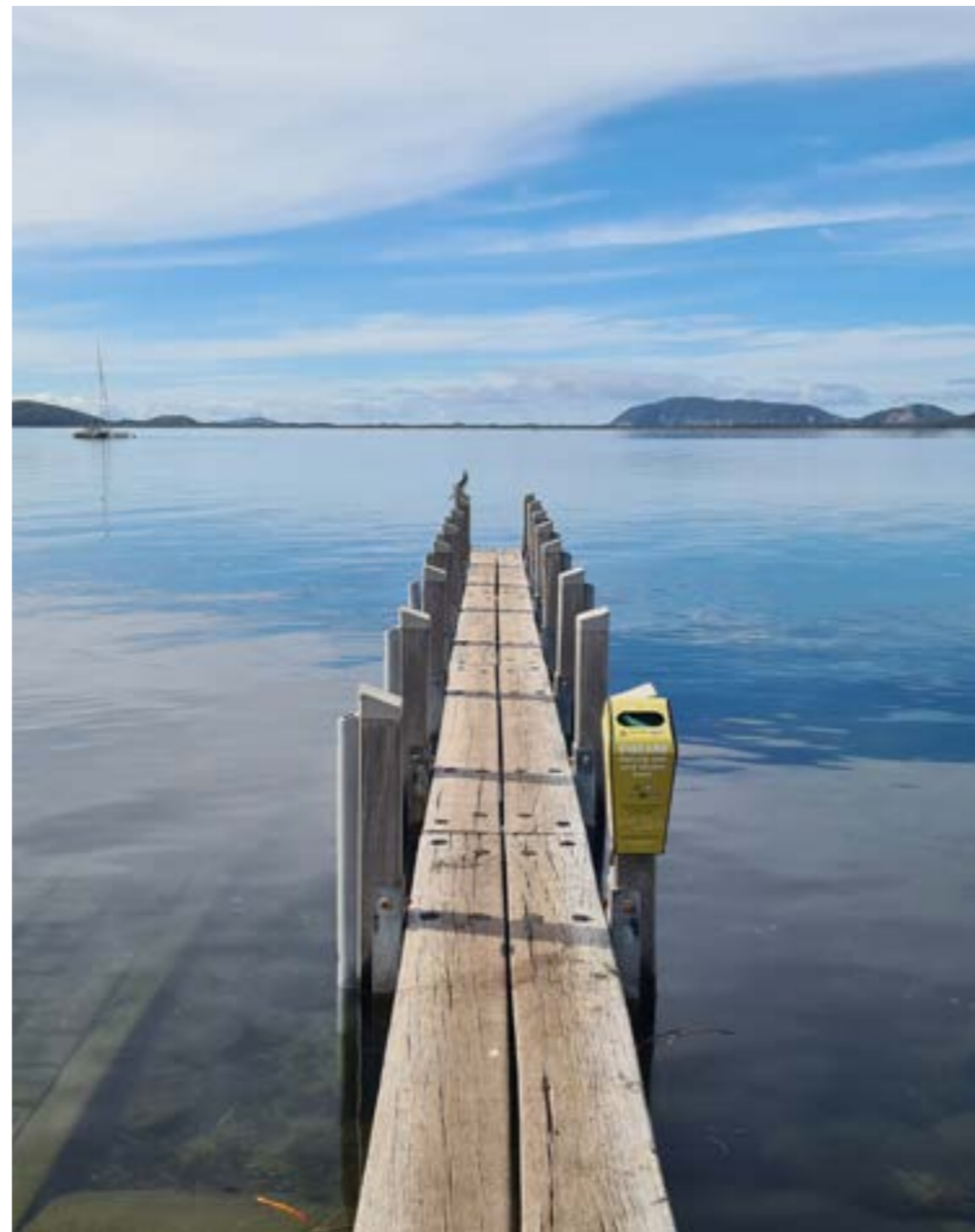
Under a beneficiary pays approach, the cost of coastal works is recovered from identified beneficiaries of those works. Beneficiaries generally include those who directly and indirectly benefit from the proposed works. A direct beneficiary of the proposed works will typically be a land/property owner who is situated in an identified threatened coastal area, with the level of threat being mitigated due to the works. An indirect beneficiary will be a group or individual who derives value from knowing that the otherwise threatened coastal area is being protected.

The BDA provides an indication of how funding should be organised i.e., what proportion of the cost of works should be paid for by each beneficiary. It does this by:

- Considering the coastal assets identified in Section 4 of the CHRMAP and the estimated damage that would arise for each type of asset, impacted by either erosion or inundation.
- Focusing on the five Management Units (MUs) and the preferred management option as identified for each of these areas.
- Identifying the proportion of the total benefits that falls to each stakeholder group (private property owners, City of Albany, WA State government and local community) and using this proportion to allocate the costs of the intervention to that group.

The full BDA results are detailed for each of the MUs, and corresponding beneficiaries, in the BDA report which can be found on the City of Albany website.

<https://www.albany.wa.gov.au/council/projects/current-projects/princess-royal-harbour-coastal-hazard-risk-management-adaptation-plan-chrmap.aspx>



*Princess Royal Harbour – view to Vancouver Peninsula*



*Princess Royal Harbour – natural rock protection – near Camp Quarunup*



*Princess Royal Harbour – looking west from Camp Quarunup*

## STEP 7. Monitoring and Review Plan

### Coastal Monitoring

All the CHRMAP recommendations still need further investigation. Monitoring the coastal environment is essential to the success of coastal management actions. Monitoring and review tasks include:

- Drone surveys to identify the movement of sand and the horizontal shoreline.
- Coastal monitoring activities to identify trigger points, to record dilapidation, to record when trigger points occur and to include indicative costs of monitoring works,
- Recommend CHRMAP review.

Trigger points are used to identify when actions should be taken. CHRMAPs consider four types of trigger points, as follows:

- Proximity trigger: Where the most landward part of the Horizontal Shoreline Datum (HSD) is within the Current Risk of Storm Erosion Allowance of the most seaward point of a public asset of interest or private property lot boundary. Due to the high value of the foreshore reserve, the foreshore reserve may be considered to be "the most seaward point". If individual assets have a specific distance-based

trigger relating to the HSD then the beach and dune survey activities described above should be used to collect topographic data that can be used to map the updated HSD position.

- Access trigger: Where a public road is considered no longer available or able to provide legal access to the property.
- Utilities trigger: When water, sewage, communications or electricity to the lot is no longer available as they have been removed/ decommissioned by the relevant authority due to coastal hazards.
- Damage trigger: Any property within the hazard zone and within a dedicated Special Control Area, that is damaged by a coastal hazard from an extreme weather event shall require LGA approval before being repaired. The review process should involve re-fit of minor or moderately damaged assets to accommodate coastal hazards in the future; or removal and redevelopment outside the hazard zone for damaged assets.

By mapping beach change over time, we can learn how different beaches respond to changing ocean conditions.

*The following illustrates the Horizontal Shoreline Datum (HSD) and a trigger line. Should the HSD reach the trigger line, action should be undertaken to manage potential coastal risks.*



### CHRMAP Review

CHRMAPs should be updated at least every 10 years to maintain currency and should be considered a "living document". An earlier review should be considered if any of the following events occur:

- Substantial storm events generating severe coastal hazards approaching or exceeding the CHRMAP projections.
- Significant changes to land-use planning – such as complex amendments to, or full review of, the Local Planning Scheme.
- New information becomes available which substantially affects the summary of local community values and assets (natural or built). This may typically occur when consulting the community regarding other documents such as the Local Planning Scheme or Foreshore Management Plan, or the occurrence of a significant storm event.

Hazard modelling for the study area should be updated given any of the following:

- Recent data collection
- Planning changes
- Updates in climate change science, specifically local sea level rise projections
- Changes in coastal engineering methodology
- Changes to the CHRMAP success criteria by coastal land managers
- Triggers are reached.

Ongoing coastal management operations within the study area should consider the status of both short and long-term adaptation strategy progress, including assessment of the performance and review of any identified strategies.

Monitoring of CHRMAP outcomes, actions and future updates should always include consultation with stakeholders and the community to make sure any changes are communicated, and that the stakeholders' positions are reflected in the coastal management outcomes.

It is recommended that further work is undertaken to identify priority sections of MUs and consider the use of composite treatment options in these MUs. This may see some sections of the current MUs being managed in different ways rather than one option for each MU.

Appropriate supporting analysis is needed to propose preferred treatment options on smaller sections of coastline than the MUs presented in this CHRMAP as the cost benefit analysis has considered these boundary extents and quantities. It is anticipated the current MUs could be further split based on the identified hazards, management jurisdiction, predominant foreshore use such as urban, residential, undeveloped etc.

It is recommended further investigation is undertaken to consider the potential for dual-purpose treatment options to address both erosion and inundation hazards. Following prioritisation, and decision-making by the City (post-CHRMAP), dual-purpose treatments could potentially be scoped and designed that may be able to mitigate both hazards at the same time.

## Timeframes

The recommendations for the Princess Royal Harbour CHRMAP include short-term, medium-term and long-term actions.

- Short-term actions are anticipated to be implemented within the next 25 years;
- Medium-term actions implementation would occur between 25-50 years;
- Long-term actions would be implemented beyond 50 years towards 100 years' time.

The timeframes envisaged in the coastal adaptation pathways are not absolute. These timeframes are related to the current state of local land planning, coastal processes knowledge and climate projections, as outlined in the CHRMAP. Therefore, the timeframes are typically not aligned on "worst-case" scenarios but instead consider risk-adjusted and/or consensus-based adjustments and quantifications. Other options may be envisaged, particularly if

land planning practices, coastal processes knowledge or climate projections are changed. Therefore, the implementation pathway will evolve overtime.

Long-term adaptation strategies/pathways have been recommended for each MU for both erosion and inundation that will allow for the continuous function of local communities whilst accommodating the increasing burden of coastal

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



*Princess Royal Harbour - areas naturally protected and un-protected*

# ATTACHMENT 1 Adaptation Recommendations

## Adaptation Recommendations Summary (Pertaining to all areas)

### 1. Funding

Where adaptation options are designed to protect specific sections of coastal land and assets, such as private property, it is recommended that the City progress the establishment of a specified area rate in line with the outcomes of a benefit distribution analysis.

### 2. Update online mapping tool for Management Unit areas

Ensure erosion and inundation hazard data provided in the CHRMAP is included on the City's online mapping tool. This will ensure staff and the community have access to information on any affected land and how the adaptation measures may impact on future development.

### 3. Avoid intensification of land – avoid subdivision or rezoning of land, including land proposed for protection.

The best form of risk management is to eliminate hazards, activities and exposures that can adversely affect an asset. Accordingly, the primary planning response shall be to avoid further intensification of development through rezoning or subdivision.

The Local Planning Strategy must consider the coastal hazard risks identified in this CHRMAP alongside other relevant planning matters including environmental, economic and social considerations to holistically inform and shape future expansion, as a precursor to future amendments to the City's Local Planning Scheme.

### 4. Accommodate development prone to erosion (temporary approval), subject to conditions requiring removal or relocation of the development once the Horizontal Shoreline Datum (HSD) is within a default value derived from the SPP2.6 (e.g. 40m) of the most seaward point of the development.

Development should be designed to enable removal and relocation (e.g. modular design).

### 5. Accommodate development prone to inundation provided certain design requirements can be achieved, in accordance with a Local Planning Policy.

Development should be designed to withstand inundation. Finished floor levels should be raised using methods other than fill (stumps), to withstand high inundation periods, without transferring the inundation impact elsewhere. Substantial areas of fill should be avoided – Fill may intensify inundation of adjacent areas.

### 6. Update the Local Planning Scheme 2 (LPS2), Special Control Area 16

The City's LPS 2 contains the Special Control Area 16 (SCA) which prescribes certain requirements in response to inundation and erosion along the PRH coastline. To ensure the planning response is concise and easy to interpret, it is recommended that SCA 15 is updated to align with recommendations of the CHRMAP, this includes the SCA boundary alignment depicted on the scheme map.

### 7. Foreshore Management Planning

Prepare Foreshore Management Plans to deliver the recommendations of this CHRMAP for particular foreshore areas. Foreshore management plans can be a key tool for communication and engagement with the community as they include detailed planning for community places and facilities. Foreshore management planning provides guidance for the ongoing management of foreshore reserves, monitoring of assets and the triggers for the managed retreat of public assets and infrastructure at risk of erosion.



Entrance to Princess Royal Harbour - from King George Sound

## Adaptation Recommendations Summary (Pertaining to all areas)

### 8. Undertake a review of public assets and their location and consider relocating to areas that will not be vulnerable to coastal hazards

The audit shall inform subsequent preparation of an Asset Management Plan to identify existing infrastructure and recreational facilities in the coastal erosion and inundation hazard zone.

### 9. Undertake coastal monitoring to identify the impacts of coastal hazards on recommended Options and to record the evolution of the coastal trigger points.

Define shoreline and trigger points. Use photos and drone surveys to understand sand and shoreline movement.

### 10. Put notification on property titles – warning of potential hazards

Notifications inform future land holders of the potential hazards and expectations for intensification.

### 11. Develop emergency evacuation plans

The City should prepare an emergency evacuation and response plan to ensure the safe evacuation of occupants during a severe coastal inundation event and/or severe erosion event.

### 12. Consider land leasebacks

Investigate opportunities for leaseback of land and land swaps in the context of planned and managed retreat. Seek legal advice regarding the basis of agreements with landholders and whether opt-ins can be time constrained.

### 13. Undertake an audit of any existing Protection Structures

Item cost to inspect coastal asset condition, influence on sediment transport and inundation and remaining design life on all coastal management structures

Includes Port revetments, Tug harbour and Albany Waterfront Marina breakwaters and revetments for Frenchman Bay Road, Anzac Peace Park and Princess Royal Drive.

### 14. Undertake a sand source feasibility study

The availability of suitable sand for beach nourishment works is unfortunately not well understood in the study area. It is recommended that a sand source feasibility is undertaken to determine the capacity and cost of local sand supplies. This study should consider both land-based and marine sand sources as well as evaluate potential environmental impacts and approvals required. Cost estimates in this CHRMAP have assumed that a reliable source of sand in reasonable proximity to the study area may be available. If this assumption is incorrect, costs may increase and affect the CHRMAP recommendations.

## Management Unit 1 Adaptation Recommendations

### Point King to Melville point recommendations in priority order.

#### Recommendations – MU1

##### SHORT – LONG TERM

###### 1. Protection with existing seawalls

Protection is currently provided by various structures which while maintained are likely to continue to provide adequate protection.

There is no projected impact from inundation during the short-term for this MU.

###### 2. Implementation shall focus on Monitoring

Should an unexpected inundation event occur it can be managed via Accommodate and Emergency Evacuation Plans.

##### MEDIUM – LONG TERM

###### 3. Address erosion via Protection

The Management Unit 1 area is currently protected. Undertake maintenance of existing protection measures where required into the future. Recommended Medium and Long-term pathway to address Erosion via Protection with Beach Nourishment.

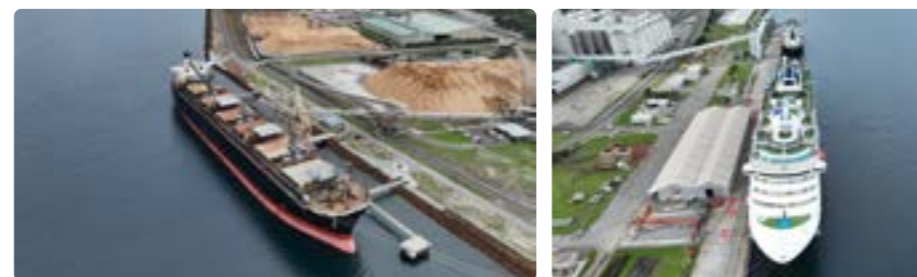
###### 4. Address Inundation via Accommodate

Accommodate development where protection measures have been undertaken in accordance with the CHRMAP and/or any other relevant assessment endorsed by a suitably qualified coastal engineer.

Future consideration of erosion protections options should consider their influence on, and capacity to provide protection from, inundation. Existing protection measures may need redevelopment to protect areas against inundation (high tidal and wave topping events).



Areas associated with MU1 – existing protection mechanisms





## Management Unit 2 Adaptation Recommendations

### Melville Point to Rushy Point recommendations in priority order.

#### Recommendations – MU2

##### SHORT TERM

##### 1. Investigate and prepare for Protection with Beach Nourishment

Beach nourishment is recommended to manage erosion.

It is noted the old Woolstores Site is currently subject to localised hard protection measures and is therefore likely to become a prioritised sub-section of this MU. Any coastal protection works to this area alone, will need to address a number of requirements including those found in SPP2.6 (Clause 5.7).

##### 2. Address Inundation as a Levee

Assumes 3500m of levee required comprising three sections to protect the three areas most at risk of inundation. Other areas not at risk in the short-term.

##### MEDIUM - LONG TERM

##### 3. Address Erosion via Protection with Beach Nourishment.

Monitoring will determine the need for additional works beyond those recommended.

##### 4. Address Inundation via development of a Levee

- Monitoring and maintenance of infrastructure and design and performance reviews in accordance with new information and CHRMAP updates.
- Secondary components may include the need for additional levees and drainage improvements as sea level rise progresses.

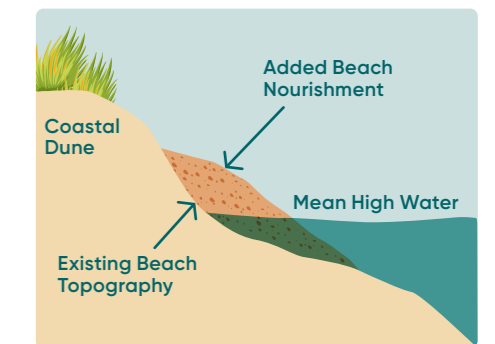
Areas associated with MU2 – unprotected assets close to coastal zone



##### Beach Nourishment

For erosion, its recommended that beach nourishment is undertaken. This is anticipated as relatively small scale works to maintain approximately the same level of beach and foreshore amenity currently experienced. If significant storm damage occurs or pre-emptive works are preferred larger scale works with additional foreshore vegetation rehabilitation could occur. If more frequent management works are undertaken the sandy beach could be rebuilt as required with small beach width amounts and volumes. Further investigations are required to complete relevant designs and identify the best sources of nourishment sand.

Figure illustrating beach with sand added



##### Levees

The development of levee banks is recommended to prevent or limit inundation of land, assets and infrastructure exposed along the coast. Future design work would need to confirm dimensions, toe design, surface treatments, necessity for a crest trafficable via vehicles, and varying cross-section designs for different locations.

Figure illustrating an example of levee development





## Management Unit 3 Adaptation Recommendations

### Rushy Point Point to Limekilns Point recommendations in priority order.

#### Recommendations – MU3

##### SHORT TERM

##### 1. Leave low value public assets unprotected to 2047

- Assumes a clean-up rate following damage/loss
- No private land acquisition included
- Maintenance assumes ongoing allowance for foreshore reserve

##### 2. Address Erosion via investigating and preparing for Protection with Beach Nourishment

- Undertake a detailed Sand Source Feasibility Study
- Currently the option assumes protection with beach nourishment at different timeframes for either side of Princess Royal Sailing Club
- 1400m shoreline treated to northwest of Princess Royal Sailing Club, with present day implementation
- Assumes 3850m shoreline treated from Princess Royal Sailing Club to southeast, with 2047 implementation
- Protection by existing seawalls at the Princess Royal Sailing Club
- Assumes suitable sand source available (grain size, volume, cleanliness, proximity)
- Sections of this MU could be considered for further prioritised analysis.

##### 3. Address Inundation via Monitoring, Accommodate and Emergency Evacuation Plans

There is no projected impact from inundation during the short-term for this MU.

Implementation shall focus on Monitoring and should an unexpected inundation event occur it can be managed via Accommodate and Emergency Evacuation Plans.

##### MEDIUM - LONG TERM

##### 4. Address Erosion via Protection with Beach Nourishment

Monitoring will determine the need for additional works beyond those recommended in the short-term

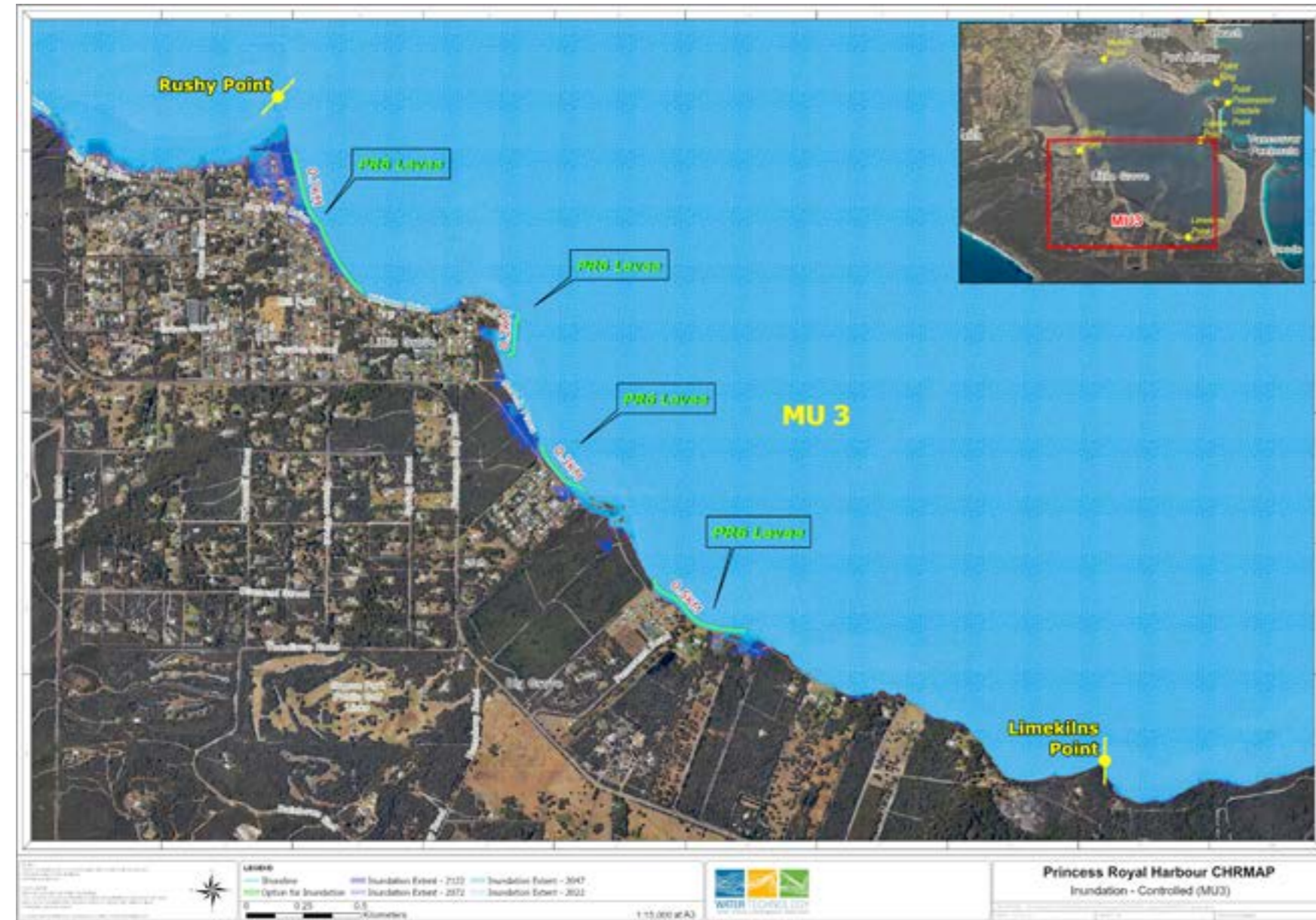
##### 5. Address Inundation via Levee development

Assumes 1700m of levee required split across four sections across MU to protect the four areas most at risk of inundation. Other areas not at risk in the short-term.

Assumes 2072 implementation, so there are no priority actions in short-term

Areas associated with MU3 – assets subject to erosion





## Management Unit 4 Adaptation Recommendations

### Limekilns Point to Geake Point recommendations in priority order.

#### Recommendations – MU4

##### SHORT TERM

##### 1. Address Erosion via investigation and preparation for Planned / Managed Retreat by Voluntary Acquisition

Acquisition assumed in the same year as hazard line identifies parcels as vulnerable

Coastal hazards impact few properties in the short term, so the focus is to manage foreshore reserves and coastal amenities, undertake coastal monitoring, and prepare for implementation in medium to long-term

##### 2. Address Inundation via Levee development

Assumes one 1250m section of levee required along coast near Lake Vancouver

Assumes 2047 implementation

##### MEDIUM – LONG TERM

##### 3. Address Erosion via Planned / Managed Retreat by Voluntary Acquisition

Implement when triggers are met

See explanation in Land Use Planning Section of CHRMAP

##### 4. Address Inundation via Levee development

Monitoring and maintenance of infrastructure and design and performance reviews in accordance with new information and CHRMAP updates.

Secondary components may include the need for additional levees and drainage improvements as sea level rise progresses

Areas associated with MU4 – natural elements with some evidence of erosion





# Management Unit 5 Adaptation Recommendations

## Geake Point to Point Possession/Uredale Point recommendations in priority order.

### Recommendations – MU5

#### SHORT TERM

##### 1. Address Erosion via investigation and preparation for Protection with Beach Nourishment

CHRMAP analysis has found that the Protection Pathway is appropriate for this MU with provision of a sandy beach via nourishment

Currently the option assumes the following:

- Protection of Camp Quararup is currently provided by various structures which while maintained are likely to continue to provide adequate protection for the short-term.
- Assumes treatment of 750m beach and 150m of Camp Quararup shoreline with 2047 implementation
- Assumes suitable sand source available (grain size, volume, cleanliness, proximity)

##### 2. Address Inundation via Monitoring, Accommodate and Emergency Evacuation Plans

There is no projected impact from inundation during the short-term for this MU.

Implementation shall focus on Monitoring (NR1) and should an unexpected inundation event occur it can be managed via Accommodate (AC1) and Emergency Evacuation Plans (NR4).

#### MEDIUM – LONG TERM

##### 3. Address Erosion via Protection with Beach Nourishment

Monitoring will determine the need for additional works beyond those recommended in the short-term.

##### 4. Address Inundation via Levee development

Assumes 300m of levee required around Camp Quararup and 50m for depression in Isthmus

Assumes 2072 implementation, so there are no priority actions in short-term

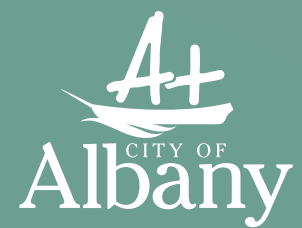
Areas associated with MU5 – developed and undeveloped areas, with some existing protection measures.





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