Executive summary

This Coastal Hazard Risk Management and Adaptation Plan (CHRMAP) identifies and considers coastal hazards and risks for the City of Mandurah's Northern Beaches, which is the coastline between Roberts Point and Madora Bay, culminating in a recommended adaptation pathway with actions to assist in adapting to immediate coastal inundation and erosion risks, and undertaking appropriate planning to address increasing risk over time. This CHRMAP considers hazards and risks in the immediate-term (2020), short-term (2020 to 2030), medium-term (2030 to 2070) and the long-term (2070 to 2120).

Table 1 Planning horizons

Planning period	Outcome
Immediate-term (2020):	Actions recommended to address current intolerable risks
Short-term (2020 to 2030):	Actions recommended to address short term intolerable risks to 2030
Medium-term (2030 to 2070):	Planning decisions, additional investigations and decision making required to address risks that will become intolerable between 2030 and 2070
Long-term (2070 to 2120):	Planning approaches to assist the Shire prepare for long-term risks to 2120

The areas of the City's Northern Beaches that are vulnerable to coastal erosion and flooding have been identified via a Coastal Hazard Assessment. This assessment provides a representation of the areas within the study area expected to be vulnerable to erosion and/or coastal flooding based on coastal modelling for the timeframes of 2020, 2030, 2050, 2070, 2090 and 2120.

The hazard assessment considers erosion and flooding risk associated with different storm scenarios. In the context of coastal hazard assessments, likelihood is defined as the chance of a coastal hazard occurring and how often it may impact an asset, land use or value. In the coastal hazard assessment, for each planning horizon, the CHRMAP considers three scenarios with relative levels of likelihood – almost certain, possible and rare.

Once the exposure (likelihood) of an asset being impacted is determined through the coastal hazard assessment, a vulnerability assessment is undertaken which combines the exposure risk with the sensitivity (consequence of the risk occurring) to provide a potential impact. A coastal hazard assessment then further considers the adaptative capacity of that asset to provide a vulnerability assessment at each timeframe. The outcome of this is whether the risk is considered acceptable, tolerable or intolerable, noting that this can change over time scales as the potential exposure to the risk increases (due to sea level rise for example). The erosion and inundation risk tolerance scales are shown in Table 2 and Table 3.

Table 2 Erosion Tolerance Matrix

Risk Level	Vulnerability		
	Low	Medium	High
Low	Acceptable	Acceptable	Tolerable
Medium	Acceptable	Tolerable	Intolerable
High	Tolerable	Intolerable	Intolerable
Extreme	Tolerable	Intolerable	Intolerable

Table 3 Inundation Tolerance Matrix

Risk Level	Adaptative Capacity		
	Low	Medium	High
Low	Tolerable	Acceptable	Acceptable
Medium	Intolerable	Tolerable	Acceptable
High	Intolerable	Intolerable	Tolerable
Extreme	Intolerable	Intolerable	Tolerable

Based on this assessment, the assets in each planning unit at intolerable risk from either erosion and inundation are noted in Table 4. Generally, the Northern Beaches of Mandurah have more exposure to erosion risk than inundation, with risk from inundation primarily observed around the lower lying areas of the Mandurah Marina.

Table 4 Summary of coastal hazard risk tolerance levels

Management Unit	Immediate (2020 risk)	Current (to 2070 risk)	Long-Term (2070-2120)
01A. Roberts Point	Intolerable – Residential and ocean access structures	Intolerable – Multiple asset types	
01B. Halls Head	Intolerable – Coastal pathways		Intolerable – Multiple asset types
2A. Mandurah Marina	Intolerable – Residential		
2B. Mandurah Marina / Seashell Resort	Intolerable – Residential and carparks	Intolerable – Multiple asset types	
3. Town Beach	Intolerable – Residential and coastal pathways	Intolerable – Multiple asset types	
4. Silver Sands	Intolerable – Multiple asset types		
5. Orion Rd Groyne to Wade St Groyne	Intolerable – Multiple asset types		
6. Watersun Beach	Intolerable – Multiple asset types		
7. San Remo (South of Surf Club)	Intolerable – Multiple asset types		
8. Surf Club to Abeona Pde	Intolerable – Multiple asset types		
9. Abeona Pde to Diadem Pl	Intolerable – Multiple asset types		
10. Madora Beach	Intolerable – Multiple asset types		

Where areas were exposed to intolerable risk, potential adaptation pathways were developed for short to long term responses. A number of pathways were identified for each planning unit and then subjected to a multi criteria assessment (MCA) as well as a cost benefit analysis (CBA). The MCA process considered a number of factors, including coastal values, environmental, safety and amenity. The preferred adaptation pathways for each unit is summarised in Table 5 and shown in Figure 1.

Table 5 Flexible adaptation pathways per planning unit for Mandurah Northern Beaches

Planning Unit	Short-term (2020 – 2030)	Medium-term (2031 – 2070)	Long-term (2071-2120)
1A	Protect	Renew protection	
1B	Monitor and maintain, improve dune vegetation	Protect (Buried Seawall)	Renew protection
2A	Maintain current protection structures	Renew/upgrade protection (end of design life)	Raise land levels (accommodate)
2B	Nourish, dune revegetation, maintain existing protection structures	Protect	Renew protection
3 - 9	Nourish, dune revegetation Maintain groynes / existing protection structures where relevant (units 3, 4, 5 and 8)	Protect	Renew protection
10	Monitor		Protect

A key assumption for entire study area is that sand bypassing across the Mandurah Ocean Entrance (as well as further south at Dawesville) needs to continue via whatever means (mechanical, pump, permanent or discrete event) to ensure that the key coastal value of sandy beaches is supported as well as assisting in providing protection and a buffer to coastal erosion, thus delaying the need for engineered protection measures. The type of bypassing should be further investigated as there is potential benefit to be gained both economically and from a

coastal protection perspective by installing a permanent system which would move sand periodically, rather than once per year, more closely mimicking natural events.

In addition to the identified adaptation pathways, Table 6 provides a consolidated list of all recommended actions from across the implementation plan for delivery by relevant stakeholders to manage immediate risk and commence planning to adapt to increasing risk to 2070.

Table 6 Consolidated short-term action plan

Action	Timing	Key stakeholders
All areas		
Investigate site specific coastal processes and geotechnical stability of dunes to prioritise adaptation planning and investment for the current planning horizon (to 2070).	Within 5 years	City of Mandurah Department of Transport Department of Planning, Lands and Heritage Peron Naturaliste Partnership Coastcare groups Mandurah Environment and Heritage Group
Continue with a general foreshore and coastal hazard monitoring program for whole assessment area	Immediate	City of Mandurah Department of Transport Department of Planning, Lands and Heritage Peron Naturaliste Partnership Coastcare groups Mandurah Environment and Heritage Group
Engage with state government, private industry, and the community to complete a Cost Benefit Analysis then use the results to prepare a long-term funding strategy for strategic, appropriate coastal adaptation (Benefit Distribution Analysis)	Immediate	City of Mandurah Department of Transport Department of Planning, Lands and Heritage Private industry (including within Mandurah Marina)
Identify sources of construction materials for protection options	Within 1-2 years	City of Mandurah Landcorp
Amend LPS No.12 to apply provisions of SPP 2.6 as part of the scheme and incorporate a SCA over residential areas at risk by 2070	Immediate	City of Mandurah Department of Planning, Lands and Heritage
Develop planning policy to support LPS amendment to define the coastal hazard zone (and which will define where notifications should be placed on title)	Within 1-2 years	City of Mandurah Department of Planning, Lands and Heritage
Review and update the Local Planning Strategy to consider the incorporation of a SCA over the area at risk of coastal inundation and erosion over the 100 year timeframe	Immediate	City of Mandurah Department of Planning, Lands and Heritage
Develop and deliver a community awareness campaign on coastal hazards and risk	Within 1-2 years	City of Mandurah Department of Transport Department of Planning, Lands and Heritage Peron Naturaliste Partnership Coastcare groups Mandurah Environment and Heritage Group
Planning Unit 1A – Roberts Point		
Investigate feasibility of hard active versus hard or soft passive protection options and implement preferred protection.	Within 1-2 years	City of Mandurah Department of Transport Department of Planning, Lands and Heritage
Planning Units 1B and 2B – Halls Head and Mandurah Marina / Seashell Resort		

Action	Timing	Key stakeholders
Undertake localised sediment transport assessment and review of coastal process to support feasibility assessment of permanent sand bypassing.	Within 1-2 years	City of Mandurah Department of Transport Department of Planning, Lands and Heritage
Undertake additional assessment including detailed CBA, business case assessment and other feasibility level assessments as required.	Within 5 years	City of Mandurah Department of Transport Department of Planning, Lands and Heritage
If deemed feasible and is supported by economic assessment, design and deliver permanent sand bypassing	5 – 10 years	City of Mandurah Department of Transport Department of Planning, Lands and Heritage
Continue to implement regular condition assessment and maintenance program for existing protection structures and develop where not already in place. Frequency of condition inspection and maintenance activities to be relevant to the structure's condition and value of protected assets. Include allowance for inspections immediately after significant storm events.	Immediate Post storm event Every 1 – 5 years	City of Mandurah Department of Transport Department of Planning, Lands and Heritage Peron Naturaliste Partnership Coastcare groups Mandurah Environment and Heritage Group
Planning Unit 2A – Mandurah Marina		
Prepare a short-term inundation accommodation and evacuation plan	Immediate	City of Mandurah Department of Fire and Emergency Services
Continue to implement regular condition assessment and maintenance program for existing protection structures and develop where not already in place. Frequency of condition inspection and maintenance activities to be relevant to the structure's condition and value of protected assets. Include allowance for inspections immediately after significant storm events.	Immediate Post storm event Every 1 – 5 years	City of Mandurah Department of Transport Department of Planning, Lands and Heritage Peron Naturaliste Partnership Coastcare groups Mandurah Environment and Heritage Group
Planning Units 3 through 9 – Town Beach through to Diadem Place		
Continue/update the existing monitoring program at fixed locations along the shoreline to monitor key erosion locations for targeted sand nourishment and revegetation campaigns, comprising both quantitative and qualitative monitoring. Monitoring should be undertaken at a minimum of biannually (winter/summer) and during/post significant storm events.	Within 1-2 years Post storm events 1 – 2 times per year	City of Mandurah Department of Transport Department of Planning, Lands and Heritage Peron Naturaliste Partnership Coastcare groups Mandurah Environment and Heritage Group
Undertake sand nourishment and dune stabilisation at acute erosion points to provide a buffer from the immediate erosion hazard.	Immediate	City of Mandurah Department of Transport Department of Planning, Lands and Heritage Peron Naturaliste Partnership Coastcare groups Mandurah Environment and Heritage Group
Develop and implement revegetation program, with focus on erosion prone areas identified during monitoring activities.	Immediate	City of Mandurah Department of Transport Department of Planning, Lands and Heritage Peron Naturaliste Partnership Coastcare groups Mandurah Environment and Heritage Group

Action	Timing	Key stakeholders
Continue to implement regular condition assessment and maintenance program for existing protection structures and develop where not already in place. Frequency of condition inspection and maintenance activities to be relevant to the structure's condition and value of protected assets. Include allowance for inspections immediately after significant storm events.	Immediate Post storm event Every 1 – 5 years	City of Mandurah Department of Transport. Department of Planning, Lands and Heritage. Peron Naturaliste Partnership Coastcare groups Mandurah Environment and Heritage Group
Planning Unit 10 – Madora Beach		
Continue/update the existing annual monitoring program at fixed locations along the shoreline to identify erosion trends. If identified as required during monitoring activities, transition to targeted sand nourishment and revegetation campaigns.	Within 5 years Post storm events Annually	City of Mandurah Department of Transport Department of Planning, Lands and Heritage Peron Naturaliste Partnership Coastcare groups Mandurah Environment and Heritage Group

The risk of coastal erosion and inundation will increase between 2070 and 2120. In the lead up to 2070, future iterations of coastal adaptation plans will need to engage with the community to understand the values and assets at risk, confirm risk levels, and make appropriate adaptation decisions.

To enable all options being available for future decisions on coastal risk beyond 2070, it is important that strategic planning for the growth of Mandurah maintains the future opportunity to both protect or retreat from areas of intolerable risk without increasing the cost to the future community of doing so. Changes to the planning framework are required to achieve two key adaptation outcomes:

1. Build resilience and flexibility into coastal planning frameworks to enable long-term retreat if required; and
2. Facilitate land use change to implement retreat as required.

These changes may include measures such as the expansion of current coastal planning reserves and the continued requirement for foreshore management plans for new developments. The ability to retreat is supported through the inclusion SPP 2.6 provisions in the Local Planning Scheme and development of a special control area.

This plan should be reviewed regularly, alongside the review of the City of Mandurah strategic plans and/or five-yearly reviews of local planning strategies. It is important to note the CHRMAP is an ongoing process and does not lay out a prescriptive pathway for what will happen into the future but provides a strong foundation and considered direction for decision makers, including the community, as these risks are addressed. Decisions will still be required to determine the most appropriate adaptation options for implementation and what funding models will allow this to progress. Any future updates to the plan will need to account for improved understanding of coastal hazard risks for Mandurah and/or changes to relevant planning policies in Western Australia. Where new information or methods become available that significantly modify the understanding of the coastal hazards, then adaptation approaches within coastal compartments would need to be reviewed through the CHRMAP hierarchy, as part of the ongoing monitoring and review process.

This report is subject to, and must be read in conjunction with, the limitations set out in section 1.3 and the assumptions and qualifications contained throughout the Report.

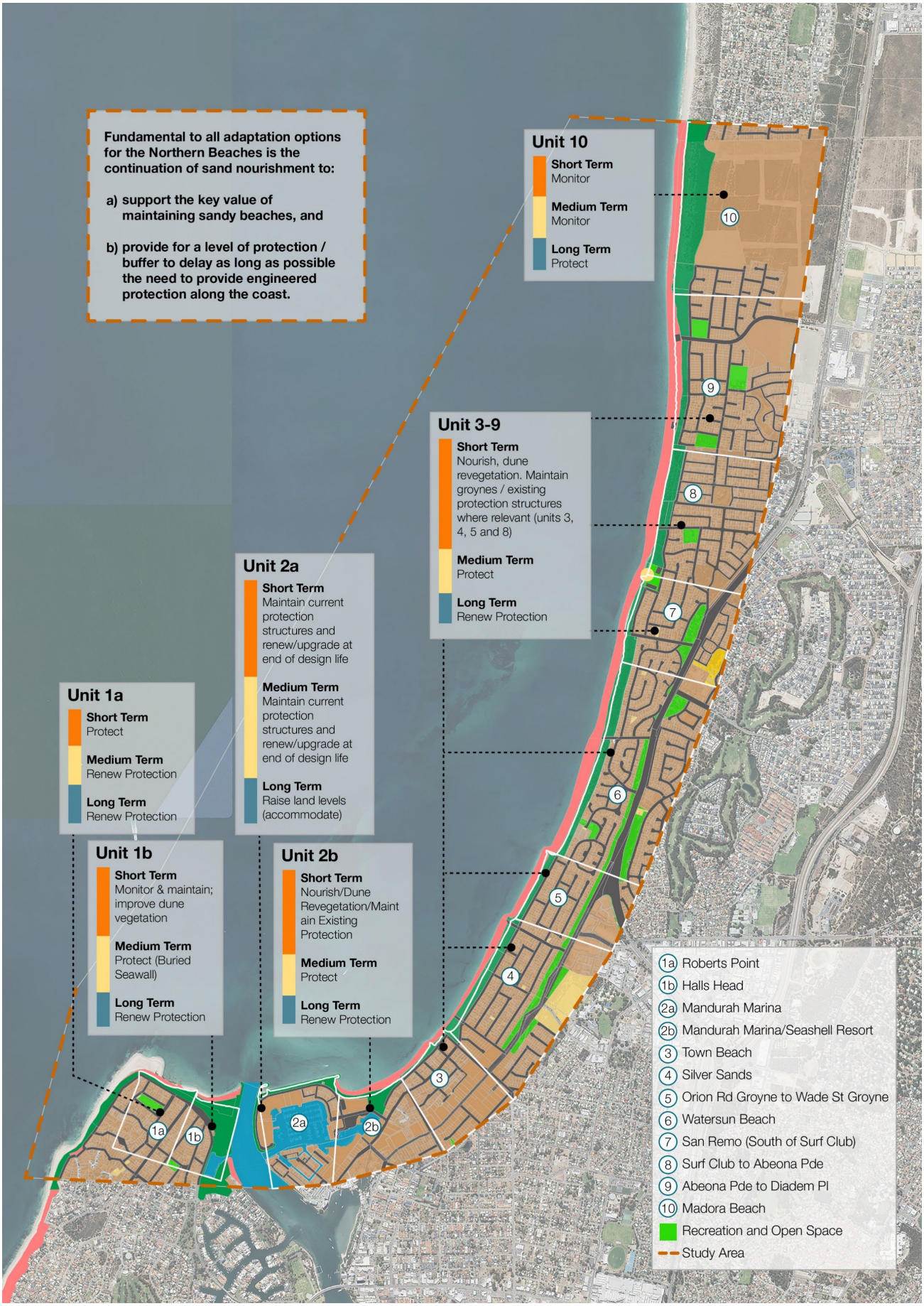

Figure 1 *Summary of Adaptation Options*