

Executive Summary

The Town of East Fremantle (the Town) has completed a Coastal Hazard Risk Management and Adaptation Planning (CHRMAP) project to develop a greater understanding of its river areas and support its future coastal management and planning decisions. The purpose of the CHRMAP is to identify coastal hazards (eg erosion and inundation) in the Town and to provide a framework for adaptation that can guide decision making in the short to medium term (next 10-20 years) and provide management and adaptation strategies to mitigate hazard in future planning periods (next 100 years).

The study area encompasses all of the East Fremantle foreshore area and is considered in three distinct shoreline management units (SMU) as shown in Figure E.1 termed:

1. Walled Zone – East Street to Niergarup Reserve (Leeuwin Boat Ramp)
2. Reclaimed Zone – Niergarup Reserve (Leeuwin Boat Ramp) to W Wayman Reserve eastern end
3. Natural Zone – W Wayman Reserve to Petra Street

The CHRMAP has been developed under WAPC (2019) guidelines with input from stakeholders and the local community. A Steering Group was appointed to review project milestones and technical deliverables with representatives from the Town, Department of Planning, Lands & Heritage (DPLH), Department of Transport (DoT), Department of Water and Environmental Regulation (DWER) and Department of Biodiversity, Conservation and Attractions (DBCA). A Community and Stakeholder Engagement Plan (CSEP) was prepared to guide the engagement process and ensure that the community and stakeholders were effectively and actively involved in the CHRMAP preparation. A range of engagement activities were delivered during the project including information sessions, workshops a survey and meetings with the Community and Business reference group (CBRG).

A Coastal Hazard Assessment (CHA) was completed for the study area (Baird 2023) in accordance with the requirements of the State Coastal Planning Policy, State Planning Policy 2.6 (SPP2.6). The CHA has provided mapping of coastal hazard to assess the impact of erosion and inundation on coastal assets in current and future planning periods in the CHRMAP.

- The planning timeframes examined in the hazard assessment are 2025, 2035, 2050, 2075 and 2125 and these are carried into the CHRMAP.
- Sea level rise is incorporated into the hazard assessment. The sea level rise allowance is applied across the planning timeframes based on a projected +1.05m increase in sea level by the year 2125.
- Mapping of the coastal erosion hazard across the planning timeframes is presented with existing control structures maintained to their present function and with structures removed (Appendix B).
- In its assessment of erosion hazard for the Town's shoreline areas, Baird has recommended that a coastal processes allowance of 50m over the 100-yr planning timeframe be adopted. DoT have accepted that 50m erosion setback for the study area is appropriate for coastal hazard due to the heavily engineered shorelines in the study area limiting the exposure areas. Whilst this is the case for the Town's shoreline areas this should not be seen as a precedent for river shorelines in other locations.
- Flood mapping associated with the SPP2.6 extreme 500-yr return period storm (S4) is shown in Appendix C.

Coastal asset types through the study area have been identified in the general categories of Social, Economic, Environmental and Heritage and Culture assets. Stakeholder views captured through the community engagement activities (Appendix A) have been used to define the coastal asset function, service and values.



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Figure E.1: Shoreline Management Units for the CHRMAP project. The Walled Zone, Reclaimed Zone and Natural Zone.

The risk assessment framework for the project has been developed based on WAPC (2019) and considers the impact to coastal assets in the shoreline areas based on the projected coastal hazard in the present and future timeframes (2025, 2035, 2050, 2075 and 2125). The framework assesses likelihood and consequence of coastal hazard impacts and considers the adaptive capacity of the respective coastal assets.

The level of coastal hazard risk for the coastal assets through the study area is generally low for the present day, however this risk is projected to increase associated with sea level rise in future years.

Residual risk and priority assets for risk treatment are presented in Section 11 of the report for each SMU, summarised as follows:

1. In the Walled Zone the continuous shoreline protection along the shoreline of the Walled Zone is assumed to be maintained in future years and assumed to continue to provide erosion protection afforded to the coastal assets presently. The Marine Education boatshed is rated as Highly vulnerable in 2035 and Extreme in the 2075 period. The risk from inundation for the Carpark at the Dome Café is rated as Highly vulnerable by 2050. Riverside Road is rated as Highly vulnerable by 2125.
2. In the Reclaimed Zone the areas of focus are the natural shorelines without any current erosion protection. This includes the beach at Niergarup Reserve, Norm Mckenzie and W Wayman Reserve foreshore reserves and coastal pathways which are all rated as Highly vulnerable to erosion in 2035. The 8 Knots Tavern is rated as Highly vulnerable to inundation in 2035 and Extreme in 2050. The buildings of the Navy cadets, Cool Beans café and Rowing Club are all rated as Highly Vulnerable to inundation in 2075. Riverside Road is rated as Highly vulnerable to inundation in 2075. There are six carparks around the area which are rated as Highly vulnerable from 2075 onwards. At the 2075 to 2125 planning timeframe the sea level rise projections of +0.5m to +1.05m lead to many assets becoming Highly vulnerable or Extremely vulnerable.
3. In the Natural Zone The foreshore, beach and stairs at the base of Jerrat Drive are rated as Highly vulnerable to erosion by 2035. For inundation the buildings at the Sea Scouts and East Fremantle Yacht Club and the lower carpark areas at the East Fremantle Yacht Club are rated Highly vulnerable in 2075

The Swan and Canning Rivers Management Act 2006 (SCRM Act) makes provision for the protection of the Swan and Canning Rivers to ensure ecological values and community benefits are maintained. Under the SCRM Act, the Swan Canning Development Control Area (DCA) has been established which covers the land and waters adjacent the Swan River in the study area. The DBCA, SRT, WAPC and State and local governments are responsible for the effective planning and management of land use and development within, abutting and affecting the waters and associated land within the DCA, at all stages of the planning process.

The DCA covers the majority of the shoreline area affected by coastal hazard in the study area, with the DBCA the key decision maker. A discussion with representatives from the DBCA regarding adaptation approaches was undertaken which provided the following guidance:

For the Walled Zone

- Maintaining shoreline revetments and riverwalls to ensure the protection of Riverside Road and raising the height at shoreline in response to future sea level rise needs to be done in balance with the viability of the road over the long term. In this CHRMAP, maintaining the current extent of river walls to provide protection to the foreshore and Riverside Road has been adopted.
- Under projected sea level rise the inundation hazard for Riverside Road will increase in extreme events in the future. At present the risk is manageable. At the time when sea level rise of approximately 0.5m to 1m above the present-day level is realised (projected to be in the 2075 to 2125 period) the risk management will be more difficult (expensive). The coastal hazard risk to Riverside Drive and the foreshore area will be reviewed in future revisions of the CHRMAP.

Within the Reclaimed Zone

- there is presently 'hard engineering' river walls and revetments that offer protection; however, it is not a given that this type of foreshore edge treatment will continue to be used in the future. As the infrastructure ages in the shoreline areas there will need to be consideration and discussion on what is appropriate in terms of replacement. The intention will be to deliver an outcome that satisfies the community need whilst being environmentally sensitive. For the Reclaimed Zone, using fill in the foreshore areas to address inundation risk is not supported. There may be nature-based options or engineering alternatives that are yet to emerge that could provide the right solution.
- In future there may be a point where it becomes too difficult and expensive to provide protection to the shoreline areas from erosion and inundation hazard (with rising sea level) and planning the process of Managed Retreat may be required. A future scenario could be to retreat the foreshore areas back to Riverside Road and use this as the interface to the shoreline, due to the land levels being generally higher from this section landward.
- For the foreseeable future the Leeuwin Barracks site will remain under the ownership of the Department of Defence. Any changes to the use of the site with regard to residential development would need to consider the coastal hazard from the CHRMAP.

Within the Natural Zone

- For the Jerrat Drive escarpment section of foreshore, this is highly regarded as a key coastal asset for the Community as a site of recreation and environmental importance. Further understanding of the processes driving changes in this area is required – assessment of the present state of the foreshore (vegetation cover, habitat, drainage, underscoring at the shoreline and tree loss) and development and update to the existing foreshore management plan to guide future actions is considered a priority of the CHRMAP.

For areas outside of the DCA, the Town would be responsible for planning controls to manage coastal hazard risk. A detailed review of the planning controls applicable to land use and development within the Town was completed (Section 10.2). Based on the review, the use of Local Structure Plans, a Special Control Area (SCA) within the local planning scheme (LPS 3) and a CHRMAP Local Planning Policy (LPP) are recommended.

A multi-criteria analysis (MCA) of adaptation options and an economic analysis of assets in the reclaimed Zone was completed to support decision making. The MCA incorporates community and stakeholder feedback gained through the engagement process. The outcomes are used to inform selection of adaptation pathways in future planning periods for each of the SMU. The economic analysis in the Reclaimed Zone evaluates impacts from inundation hazard associated with projected sea level rise, using the value of assets to assist in understanding the economic costs of a Managed Retreat approach. The results provide a preliminary estimate of the magnitude of the economic cost of sea level rise and timing of asset loss within the Reclaimed Zone. The total undiscounted cost of sea level rise on the Reclaimed Zone is conservatively estimated at \$46.2 million. The economic analysis has been used to inform selection of adaptation pathways in future planning periods for each of the SMU in Section 15. The pathways and triggers are summarised across the planning timeframes present to 2035, 2035 to 2050, 2050 to 2075 and 2075 to 2125.

The recommendations in this CHRMAP include:

- Avoid development on land within the erosion hazard area over the 100-year planning period.
- Accommodate coastal hazard risk from inundation to commercial and habitable buildings through improved building design and the use of planning controls (minimum floor levels).
- Accommodate coastal hazard risk to infrastructure in the foreshore areas until such time that a managed retreat pathway may be required, as a result of sea level rise.

- Protect foreshore area and assets landward in the Walled Zone from erosion through maintaining present riverwalls and revetments.
- Accommodate flood risk to Riverside Road through periodic incremental raising of the road level in accordance with the rate of sea level rise and general road upgrade / maintenance schedule.
- Implement nature-based solutions to provide resilience to shorelines including Niergarup Reserve, Jerrat Drive foreshore, John Tonkin Reserve, supported through grant funding and local volunteer groups.
- For the Reclaimed Zone, the short to medium term adaptation pathway is to maintain existing erosion protection along the foreshore areas through traditional ‘hard engineering’ methods currently in place - river walls, revetments and detached groynes. Examine alternative methods of protection that can be achieved through other ‘soft engineering’ methods (eg Nature Based Solutions) and look for opportunities to implement as part of the asset replacement lifecycle.
- For the Reclaimed Zone the long-term adaptation pathway is expected to require a managed retreat approach, triggered by the difficulty and cost of mitigating inundation hazard with projected sea level rise of 1.05m in the 100-yr planning period. This scenario is driven by future sea level rise where the current foreshore areas are inundated regularly in the general tides and it is too difficult and/or expensive to maintain the current extent of the foreshore. There is a general presumption against using fill in the foreshore areas to address inundation risk.
- A future scenario of Managed Retreat of the foreshore area and associated infrastructure along the Reclaimed Zone should consider retreat to the area landward of Riverside Road. This decision is contingent on the future of the Leeuwin Barracks site and potential for land being made available.
- If there is a future change in the land use at the Leeuwin Barracks site to redevelop the location for residential and commercial property, then this would need to address the risk from erosion and inundation across the 100-years planning timeframe through planning-based approaches.
- For the shoreline area at the base of the Jerrat Drive escarpment use of nature-based solutions to increase resilience of the shoreline area.
- Update foreshore management plans for the Town’s 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. They provide a strategy to deliver the recommendations of this CHRMAP for foreshore reserves throughout the Town.

Long term adaptation pathways for the key at risk assets identified in each of the SMU are summarised in Table E.1 for the Walled Zone, Table E.2 for the Reclaimed Zone and Table E.3 for the Natural Zone.

The colour legend in the table is based on the general adaptation categories in the table below. Sea level rise plays a key role in triggering actions on the adaptation pathways, and the projected increase in mean sea level from the 2025 baseline within each planning period are noted at the top of the table.

Avoid
Planned or Managed Retreat
Accommodate
Protect
No Regrets
Do Nothing

Table E.1: Risk management pathway and triggers for the Walled Zone (SMU1)

Planning Timeframe	Now – 2035	2035 - 2050	2050 - 2075	2075 - 2125
Sea Level Rise projection. End of period	0.1m	0.2m	0.5m	1.05m
Assets Foreshore Areas and All Assets Landward – Erosion Hazard				
Pathway	Protect against Erosion Hazard using Riverwalls and Revetments (Pr.4)			
Pathway	Protection Structure Audits (NR.4)			
Assets Carparks and Coastal Pathway – Inundation Hazard				
Pathway	Accommodate inundation hazard. <ul style="list-style-type: none"> Design to withstand impacts (AC2) Raise level in step with SLR (AC3) 		Managed Retreat Remove and relocate the assets at a distance appropriate for the asset design life / lifecycle (MR1, MR2).	
Trigger	T4 - Asset lies seaward of the most up to date 100-year coastal erosion hazard line or coastal inundation hazard extent		T5: Damaged/ unsafe T6: Highly Vulnerable T7: Lack public support T9: Economic feasibility	
Assets Riverside Road – Inundation Hazard				
Pathway	Accommodate inundation hazard. <ul style="list-style-type: none"> Design to withstand impacts (AC2) Raise surface level in step with SLR (AC3) 			
Trigger	T4 - Asset lies seaward of the most up to date 100-year coastal inundation hazard extent			
Pathway	Develop emergency planning for use of Riverside Road in extreme events (NR.4)			
Assets Residential Properties (Riverside Road near Pier St and East St). Inundation Hazard				
Pathway	Accommodate Inundation (Ac.1, Ac.2, Ac.3, Ac.4) <ul style="list-style-type: none"> Amend local planning scheme to include Special Control Area which encompasses all areas affected by either erosion or inundation hazard over the 100-year planning period. Establish planning-based controls that only allow development in the SCA that can address coastal hazard. 			
Trigger	Property lies seaward of 100-year planning period erosion and/or inundation extent (T4,T10)			

Table E.2 Risk management pathway and triggers for the Reclaimed Zone (SMU2)

Planning Timeframe	Now – 2035	2035 - 2050	2050 - 2075	2075 - 2125
Sea Level Rise projection. End of period	0.1m	0.2m	0.5m	1.05m
Assets	Foreshore Areas and All Assets Landward – Erosion Hazard			
Pathway	Protect against Erosion Hazard using offshore detached groyne field, riverwalls and revetments (Pr.4) where currently in use. Apply Nature based solutions (Pr.2) to areas that are currently unprotected			Managed Retreat Remove and relocate the assets at a distance appropriate for the asset design life / lifecycle (MR1, MR2).
Pathway	Protection Structure Audits (NR.4)			T9: Economic feasibility
Assets	Carparks and Coastal Pathway – Inundation Hazard			
Pathway	Accommodate inundation hazard. <ul style="list-style-type: none"> Design to withstand impacts (AC2) Raise level in step with SLR (AC3) 			Managed Retreat Remove and relocate the assets at a distance appropriate for the asset design life / lifecycle (MR1, MR2).
Trigger	T4 - Asset lies seaward of the most up to date 100-year coastal erosion hazard line or coastal inundation hazard extent			T5: Damaged/ unsafe T6: Highly Vulnerable T7: Lack public support T9: Economic feasibility
Assets	Riverside Road – Inundation Hazard			
Pathway	Accommodate inundation hazard. <ul style="list-style-type: none"> Design to withstand impacts (AC2) Raise surface level in step with SLR (AC3) 			
Trigger	T4 - Asset lies seaward of the most up to date 100-year coastal inundation hazard extent			
Pathway	Develop emergency planning for use of Riverside Road in extreme events (NR.4)			

Planning Timeframe **Now – 2035** **2035 - 2050** **2050 - 2075** **2075 - 2125**

Assets		Commercial Properties - Inundation Hazard	
Pathway	Accommodate Inundation (Ac.1, Ac.2, Ac.3, Ac.4) <ul style="list-style-type: none"> Amend local planning scheme to include Special Control Area which encompasses all areas affected by either erosion of inundation hazard over the 100-year planning period. Establish planning-based controls that only allow development that can address coastal hazard. 		
Trigger	Property lies seaward of 100-year planning period erosion and/or inundation extent (T4,T10)		
Assets		Minor Infrastructure – Inundation Hazard	
Pathway	Accommodate inundation hazard. <ul style="list-style-type: none"> Design to withstand impacts (AC2) 	Managed Retreat Remove and relocate the assets at a distance appropriate for the asset design life / lifecycle (MR1, MR2).	
Trigger	T4 - Asset lies seaward of the most up to date 100-year coastal erosion hazard line or coastal inundation hazard extent	T5: Damaged/ unsafe T6: Highly Vulnerable Next 10-ys T9: Economic feasibility	

Table E.3: Risk management pathway and triggers for the Natural Zone (SMU3)

Planning Timeframe	Now – 2035	2035 - 2050	2050 - 2075	2075 - 2125
Sea Level Rise projection. End of period	0.1m	0.2m	0.5m	1.05m
Assets	Foreshore Areas - East Fremantle Yacht Club and Sea Scouts – Erosion Hazard			
Pathway	Protect against Erosion Hazard using Riverwalls and Revetments (Pr.4)			
Pathway	Protection Structure Audits (NR.4)			
Assets	Jerrat Drive Escarpment Foreshore Area – Erosion Hazard			
Pathway	Protect against Erosion Hazard using Nature Based Solutions (Pr.2)			
Pathway	Shoreline Monitoring (NR.1)			
Assets	Carparks and Coastal Pathway adjacent East Fremantle Yacht Club – Inundation Hazard			
Pathway	Accommodate inundation hazard. <ul style="list-style-type: none"> Design to withstand impacts (AC2) Raise level in step with SLR (AC3) 		Managed Retreat Remove and relocate the assets at a distance appropriate for the asset design life / lifecycle (MR1, MR2).	
Trigger	T4 - Asset lies seaward of the most up to date 100-year coastal erosion hazard line or coastal inundation hazard extent		T5: Damaged/ unsafe T6: Highly Vulnerable T7: Lack public support T9: Economic feasibility	
Assets	Sea Scouts Building and East Fremantle Yacht Club Building - Inundation			
Pathway	Accommodate Inundation (Ac.1, Ac.2, Ac.3, Ac.4) <ul style="list-style-type: none"> Amend local planning scheme to include Special Control Area which encompasses all areas affected by either erosion or inundation hazard over the 100-year planning period. Establish planning-based controls that only allow development in the SCA that can address coastal hazard. 			
Trigger	Property lies seaward of 100-year planning period erosion and/or inundation extent (T4,T10)			

Planning Timeframe	Now – 2035	2035 - 2050	2050 - 2075	2075 - 2125
Assets	Minor Infrastructure – Inundation Hazard			
Pathway	Accommodate inundation hazard. <ul style="list-style-type: none"> Design to withstand impacts (AC2) 		Managed Retreat Remove and relocate the assets at a distance appropriate for the asset design life / lifecycle (MR1, MR2).	
Trigger	T4 - Asset lies seaward of the most up to date 100-year coastal erosion hazard line or coastal inundation hazard extent		T5: Damaged/ unsafe T6: Highly Vulnerable Next 10-yr T9: Economic feasibility	

In Section 17 of the report the short-term implementation actions over the period to 2035 are presented which include recommendations for:

1. Planning Actions;
2. Annual Monitoring Program;
3. Additional Technical Studies; and
4. Adaptation Actions in Shoreline Areas.

It is recommended that an annual monitoring program commence following the adoption of the CHRMAP. This will be used to support the CHRMAP and to further develop the understanding of the shoreline dynamics in the key locations where the risk from erosion and / or inundation has been identified. The annual monitoring report will combine desktop analysis with collection of locally captured data from:

- Photo Monitoring.
- Capture of survey and aerial oblique photos using unmanned aerial vehicle (UAV).

The monitoring program would be used to target key locations in the Town’s shoreline areas to improve understanding of coastal erosion and inundation impacts in the coming years. It will also provide the mechanism to assess where established triggers are being approached, to provide early indication of a change in management.

The cost for the monitoring activities is estimated at approximately \$15,500 (ex GST) annually, with a five-year total of \$77,500 ex GST. Co-funding of up to 50% of the cost of the program could be made available if the Town is successful in grant funding opportunities outlined in Section 19.

In conjunction with annual monitoring activities, a general review of the CHRMAP approximately every 5-years would be used to implement the findings from the monitoring program and address updates to the CHRMAP recommendations where required.

The following technical studies and planning based studies are recommended over the short term (by 2035):

- Jerrat Drive escarpment foreshore stability study.
- Catchment based flooding study based on the existing stormwater network.
- Study to determine appropriate Nature Based Solutions for target shoreline areas.
- Update and implement actions in the Foreshore Management Plan.
- Update to Emergency Response and Evacuation Plan.

Adaptation options for implementation of nature-based solutions are recommended over the next 10-years to improve the resilience of the natural shoreline areas through the Reclaimed Zone and the Natural Zone. The selection of nature-based solutions is supported by the outcomes of the MCA, discussion with DBCA and the community engagement.

Budget estimates for the short-term implementation actions for the period over the first 5-years 2024 to 2028 inclusive is estimated at \$427,500. This is comprised annual monitoring, technical studies and planning studies and funding for nature-based adaptation approaches.

The implementation budget over the 12-year short-term period from 2024 to 2035 is estimated at approximately \$596,000. This will cover the cost of annual monitoring, complete the additional technical / planning studies recommended including two reviews of the CHRMAP (2028, 2033) and undertake nature-based work in the shoreline areas. All figures quoted are order of magnitude estimates and are excluding GST.

The grant funding options that can support the funding of coastal management activities is summarised in Section 18. These funding mechanisms generally require a co-funded approach whereby 50% of the funding which is matched.