Fraser Coast Coastal Hazard Adaptation Strategy (CHAS)

Coastal Futures: Planning Our Changing Coastline

Phase 6 – Adaptation Options

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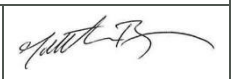
0	27th November 2020	KOJ		MPB	
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Executive Summary

Suitable adaptation options for the Fraser Coast mainland coastline have been identified. The shortlisting of potential options for each locality was based on:

- Community engagement, including a survey with 587 respondents; and
- Multi-Criteria Analysis (MCA) delivered through a series of workshops with the Technical Working Group (TWG).

At most localities, a mixture of adaptation actions and responses is promoted whereby a combination of nature-based, planning, soft engineering, and hard engineering options existing have been identified to protect existing development and maintain values. Implementation timeframes have also been estimated, with actions classified as either present/ongoing, before the year 2050 or before the year 2100. Further detailed investigations and consultation is needed before significant investment decisions can be made.

Several strategic adaptation actions apply generally throughout the region and are promoted on an ongoing basis. These are typically low cost and with little to no further studies required for approval and/or implementation, for example:

- Development master planning
- Emergency management response
- Hazard resilient design for new/upgraded infrastructure
- Community education and consultation
- Monitoring.
- Active dune and habitat management
- Wetland restoration
- Tide flaps/valves on stormwater network.

Soft engineering options such as beach nourishment and beach scraping have been identified as potential actions at several localities. These actions help to protect land-based assets, while maintaining the social and recreational values of the beach and can delay the need for hard engineering structures (such as seawalls). Currently there is no permitted sand source to support regional beach nourishment activities, and beach scraping is also limited by environmental constraints at many localities. For the Coastal Futures project, it has been assumed that a viable beach nourishment sand source for the Esplanade beaches can be established. Hard engineering options are generally recommended where the precedence has already been set and important infrastructure is already in place.

The findings presented in this report provide the basis for developing an adaptation pathway for each locality. This approach supports flexibility by allowing options to be adapted to changing circumstances. Once an adaptation approach is implemented the selected options are used until they no longer deliver the intended outcomes and a trigger point (threshold) is reached, at which time another option or suite of options is required. Socio-economic analysis will be used to refine the preferred adaptation responses and pathways and is the focus of Phase 7 of the project (reported separately).

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1 Introduction

1.1 Purpose of the Report

Fraser Coast Regional Council (FCRC) has commenced studies to support preparation of a Coastal Hazard Adaptation Strategy (CHAS) under the QCoast$_{2100}$ program, known locally as the *Coastal Futures: Planning Our Changing Coastline* project. Phase 2 of the CHAS identified potential risks to the community, assets and values associated with coastal hazards, specifically:

- Temporary flooding of coastal areas due to storm tide;
- Temporary loss of land due to coastal erosion; and
- Loss of land due to coastal erosion and/or permanent inundation due to sea level rise.

The subsequent Phases 3, 4 and 5 defined the hazard extents, identified the potentially vulnerable assets and completed a risk assessment to identify the high and extreme risks.

This report to support Phase 6 describes the approach for shortlisting the coastal hazard adaptation options to treat the high and extreme risks, including:

- Coastal hazard adaptation option principles;
- The stakeholder engagement and multi-criteria analysis (MCA) framework used to compare and identify options to be considered in more detail through social-economic analysis; and
- How the various options can be used to develop adaptation pathways – options that evolve over time to respond to emerging pressures or changes in risk profile.

The CHAS Phase 3, 4 and 5 studies provide the basis for understanding the nature and extent of the coastal hazards and for identifying the at-risk assets and values. These preceding reports and mapping products must be read in conjunction with this report as they provide important background information and context to the assessments presented.

1.2 QCoast$_{2100}$ Program

The QCoast$_{2100}$ program has been designed to assist Queensland coastal councils with funding and technical support to progress the preparation of plans and strategies to address climate change related coastal hazard risks. Governed by a Board comprising members from LGAQ, DES and Department of Local Government, Racing and Multicultural Affairs (DLGRMA), the program is intended to guide decision-making across key areas of local government planning and operations, including:

- Corporate and operational planning and financial planning;
- Land use planning and development assessment;
- Infrastructure planning and management including roads, stormwater and foreshores;
- Asset management and planning including nature conservation, recreation, cultural heritage values and other public amenities;
- Community planning; and

- Emergency management.

The QCoast$_{2100}$ Minimum Standards & Guidelines (MS&G) (DEHP, 2016) provide guidance to local government on preparing a CHAS. The guidelines set minimum requirements that are to be included in a CHAS, as well as providing information on leading practices to facilitate continuous improvement.

The minimum standards set a benchmark for undertaking such studies in Queensland so that coastal hazard adaptation decision-making is approached in a consistent and systematic manner. The MS&G are structured to address the key phases of a CHAS which are illustrated in Figure 1-1. This report is a key output of Phase 6 – identify potential adaptation options.

Figure 1-1 QCoast$_{2100}$ Phases (DEHP, 2016)

1.3 Risk Assessment Key Outcomes (Phase 5)

The risk assessment undertaken in Phase 5 of the CHAS applied a risk framework compliant with *ASNZS ISO 31000:2018 Standard Risk Management Principles and Guidelines*, developed in consultation with the Fraser Coast Regional Council Technical Working Group and tested with external stakeholders through a series of workshops and online surveys. Full details of the engagement approach and activities undertaken as part of Phases 3 and 4 (Ethos Urban 2019) and Phases 5 and 6 (Ethos Urban 2020) are reported separately.

Determining which risks to treat is based upon Council and the community's tolerance to risk. The different risk ratings help to identify priorities for adaptation action, with the 'high' and 'extreme' rankings representing the most pressing risks that should be prioritised for implementation of risk treatment responses. The high and extreme risks that may require more immediate action, further evaluation and/or monitoring are listed in Table 1-1. Mapping provided in Appendix A illustrates the areas potentially at-risk from coastal hazards and highlights assets in Table 1-1.

Table 1-1 Assets at Extreme and High Risk (also refer to mapping in Appendix A)

Reporting Area	Asset	Erosion			Sea Level Rise		Storm Tide		
		Present day	2050	2100	2050	2100	Present day	2050	2100
Burrum Heads & Surrounds	Open coast beach and foreshore areas				H	H			
	Bushnell Road (seaward end), Traviston Park				H	H			
	Cheeli Lagoon, Ivor Drive					H			
	Burrum Heads Fire Station						H	H	H
	Sewage pump stations (x 2)		E	E	H	H			
	Water storage protected by Burrum Heads weir			H					
	Burrum Heads Road (seaward end)	H	H	H		H		H	E
	Orchid Drive (seaward end)		H	H				H	E
	Ivor Drive					H		H	E
	Riverview Drive					**E**		H	E
	Ross Street							H	E
Toogoom	Pialba-Burrum Heads Road (O'Regan Creek crossing)				**E**	**E**	H	**E**	E
	Toogoom Road	H	H	H	H	**E**	H	**E**	E
	Lorikeet Avenue					**E**	H	**E**	E
	O'Regan Creek Road			H	H	H	H	**E**	E
	Toogoom Rural Fire Brigade							H	H
	Toogoom Boat Ramp & Jetty				**E**	**E**		H	H
	Fixter Park					H			
Craignish & Dundowran Beach	Pialba-Burrum Heads Road								**E**
	Petersen Road								H
	Sawmill Road								H

Reporting Area	Asset	Erosion			Sea Level Rise		Storm Tide		
		Present day	2050	2100	2050	2100	Present day	2050	2100
Eli Waters to Urangan	Open coast beach and foreshore areas				H	H			
	Piers		E	E	E	E			
	Urangan Boat Harbour & boat ramps	E	E	E	E	E	H	H	H
	Wetside Water Education Park	H	H	H					
	Seafront Oval, Pialba			H		H			
	Dayman Park			H					
	Caravan & Holiday Parks (Scarness, Torquay & Urangan)								H
	Booral Road		E	E			H	E	E
	Esplanade (Point Vernon)				H	E	H	E	E
	Esplanade (Urangan)					E	H	E	E
	Serenity Drive (Eli Waters)					E	H	E	E
	Pier Street					H	H	E	E
	Sewage pump station (Pialba)			E		E			
	Pulgul Water Water Treatment Plant			H		H			
Booral to River Heads	Barge ramp and boat ramp	E	E	E	H	H			
	Booral Homestead Complex (privately owned)					E			
	Bunya Creek effluent reuse facility site			E		E			
Maaroom	Graville Road					H			H
	Maaroom Foreshore Reserve and beach			H		H			
	Maaroom Boat ramp			E					
Boonooroo	Boonooroo Boat ramp			E		H			
	Boonooroo Caravan Park			E		H			

Reporting Area	Asset	Erosion			Sea Level Rise		Storm Tide		
		Present day	2050	2100	2050	2100	Present day	2050	2100
	Wilkinson Road	H	H	H		H			
	Eckert Road				H	H			
	Rawson Road					H			
Tuan	Tuan foreshore				H	H			
	Turton Street					H			H
	Wilkinson Road	H	H	H		E			H
Poona	Poona Foreshore Reserve and beach		H	E	H	E			
	Boronia Drive					H			H
Tinnanbar	Tinnanbar Foreshore Reserve and beach				H	H			
	Tinnanbar Boat ramp	H	H	H	E	E			
Mary River	Maryborough Hervey Bay Road	H	H	H					
	Bruce Highway	H	H	H					
	Tiger Street	H	H	H					
	Beaver Rock Road	H	H	H	H	H		E	E
	Island Plantation Road					E		H	E
	Boat ramps and jetties (numerous)	E	E	E	E	E			
	Queens Park			H		H			
	Prickett Aquatic Area			H		H			
	Aubinville Waste treatment plant	H	H	H	H	E			
	Maryborough Sailing Club and Rowing Club	H	H	H	E	E			
K'gari (Fraser Island)	Wangoolba Barge Landing	H	H	H	E	E			
	Transmitter Station	H	H	H	E	E			

Reporting Area	Asset	Erosion			Sea Level Rise		Storm Tide		
		Present day	2050	2100	2050	2100	Present day	2050	2100
	Kingfisher Bay Ferry Landing	E	E	E	E	E		H	H
	Beaches used as roads				H	H			
	North White Cliffs	E	E	E	H	H			H

2 Potential Adaptation Options

2.1 Adaptation Principles

There are numerous adaptation options that may be considered to mitigate risks from coastal hazards across the Fraser Coast region. As a precursor to the identification of adaptation options, high level principles were identified that underpin the proposed adaptation approach to coastal hazard risks through the region. The following eight principles were developed with input from the TWG, key external stakeholders and reflect broader community engagement findings on key values and assets:

- Avoid placing new assets into hazard areas and transition existing assets out over time (in areas of unacceptable risk)
- Retreat existing buildings and infrastructure out of high-risk areas over time
- Empower communities to be resilient through awareness, education and stewardship
- Enhance coastline resilience by protecting or reinstating natural coastal ecosystems, like stabilising dunes or revegetate mangrove areas
- Adapt existing and future buildings, structures and infrastructure to accommodate changes and risks over time, such as building things 'higher and stronger'
- Protect/defend priority shorelines, localities and infrastructure using beach nourishment, seawalls, groynes or other engineered structures.

2.2 Adaptation Themes & Options

The options considered for each locality reflect a variety of adaptation responses that support the development of adaptation pathways.

For the Coastal Futures project, the adaptation options have been refined into themes:

- **Accommodate**
  - Allow foreshore recession
  - Build redundancy into network systems
  - Contaminated site management
  - Development master planning
  - Emergency management planning (e.g. alternative route provision)
  - Emergency management response
  - Hazard resilient design for new/upgraded private infrastructure
  - Hazard resilient design for new/upgraded public infrastructure
  - Insurance
  - Manual creek mouth management to protect public assets
  - Urban design (WSUD focus).

- **Avoid**
  - Coastal building lines / development setbacks
  - Community infrastructure management
  - Raise land levels
  - Reduce intensity of future development.
- **Community Resilience**
  - Community education and consultation
  - Geotechnical investigation & detailed erosion study
  - Monitoring.
- **Natural Ecosystem Strengthening**
  - Active dune and habitat management
  - Beach scraping
  - Dune restoration / augmentation
  - Establish buffers around wetlands
  - Green belts and riparian corridors
  - Land management to support habitat migration
  - Small-scale beach nourishment
  - Wetland restoration.
- **Planned Transition**
  - Land buy back (no lease back)
  - Land buy back with lease back opportunity
  - Land swap
  - Maintain status quo (no changes to present management approach)
  - Partial land transition
  - Relocate important infrastructure
  - Trigger related development approvals (refer Appendix E).
- **Protect**
  - Groyne and artificial headlands
  - Large-scale beach nourishment
  - Seawall/scour protection on private land to protect private assets
  - Seawall/scour protection to protect public assets
  - Tide flaps/valves on stormwater network.

Further detail on these options are provided in the Coastal Futures Adaptation Options Compendium included in Appendix B.

2.2.1 No Regrets Adaptation Options

No regrets or preliminary/intermediate actions can be devised to support the implementation of existing development and future development options. This allows the collection of further information (including trial works or approvals) that may be required prior to implementing larger scale options for specific assets, particularly where a more costly or difficult option may be needed. The no regrets options can also include complementary measures that will improve resilience and preparedness for coastal risks, without limiting the ability to change a management approach and without negative long-term impact should risks change in the future (for example, monitoring and community education).

2.3 Pathways Approach

Adaptation planning using the pathways approach supports flexibility by allowing options to be adapted to changing circumstances (e.g. new knowledge) or as a result of the uncertainty surrounding the timing and extent of coastal hazards. Adaptation pathways comprise a sequence of steps (adaptation options or decision points) that are triggered by a change in the coastal hazard risk profile. Once an adaptation option is implemented the selected option is used until it no longer delivers its intended outcomes and a trigger point (threshold) is reached, at which time another option or suite of options is required. Due to the inherent uncertainty in future climate change projections, societal evolution and available adaptation options it is unlikely that any one adaptation option will be sufficient, therefore an adaptation pathway provides the flexibility to be adaptable to changing circumstances.

Trigger points can also be used in locations where hazards are not yet occurring but are likely to occur in the future. This approach effectively defers action until an identified point or event in the future (such as a distance from an erosion escarpment or a frequency of inundation or water level) whereby the appropriate action should then be implemented. Planning controls, “no regrets” actions and preliminary investigations should still be undertaken to effectively reduce the scale and cost of risk treatment required in the future, and monitoring is essential.

2.4 Community Engagement

2.4.1 Locality Factsheets

Locality-based factsheets were prepared to present technical information and consultation findings to the community (see Appendix C). Each factsheet contained an overview of the six guiding principles for coastal adaptation which are intended to underpin the development of actions in the CHAS (refer Section 2.1). The factsheets also provided an overview of the values, vulnerabilities and opportunities identified for each locality.

2.4.2 Survey

The survey was available on Fraser Coast Regional Council’s Engagement Hub between 31 July and 23 August 2020. Hardcopy surveys were available at Council’s Customer Service Centres in

Hervey Bay and Maryborough and were distributed to various locations throughout the region by Councillors, including general stores and cafes. The survey was promoted by:

- Media release and Council website links from multiple pages (including “Latest News”, “have Your Say”, “Major Projects”, “Beaches and Coastlines”);
- Sending direct links to the Key Stakeholder Group, community panel nominees, and various contact databases such as project followers, small communities advisory group and indigenous contacts;
- Inclusion in the Fraser Coast Weekly e-newsletters during the consultation period;
- Multiple Facebook posts;
- Advertisement in community newsletter – Toogoom Chatter;
- At the Maryborough and Hervey Bay School Captains Network meetings; and
- Internally to staff to share with their social media networks.

The survey was based on seven (7) key localities within the region (as listed above). Respondents were able to select the most relevant survey based on the locality, or localities. The survey comprised open- and closed- questions to understand:

- Levels of support for the guiding principles for responding to coastal hazards which will underpin the Fraser Coast CHAS, namely:
  (1) Avoid building new things in hazard areas
  (2) Retreat existing buildings, structures, and infrastructure out of high risk areas, over time
  (3) Empower communities to be resilient through awareness, education and stewardship
  (4) Enhance coastline resilience by protecting and/or reinstating natural coastal ecosystems – like stabilising the foreshore, revegetating mangroves.
  (5) Adapt existing and future development, infrastructure and assets to be able to accommodate coastal changes – building things ‘higher or stronger,’ evacuation planning.
  (6) Protect / defend the shoreline and assets/infrastructure through the construction of seawalls, levees, groynes or other structures.
- Feedback on how each strategy should be applied within the locality
- How the respondent would like to be involved in the ongoing implementation of the Fraser Coast CHAS.

Respondents were also provided with links to coastal hazard mapping and adaptation option compendium, to ensure community members were informed before undertaking the survey.

A total of 587 surveys were completed with a snapshot of the responses and findings provided in Figure 2-1 and key findings for each locality summarised throughout Section 4 of this report. Full details of the Phase 6 community engagement activities and survey is provided in Ethos Urban (2020).

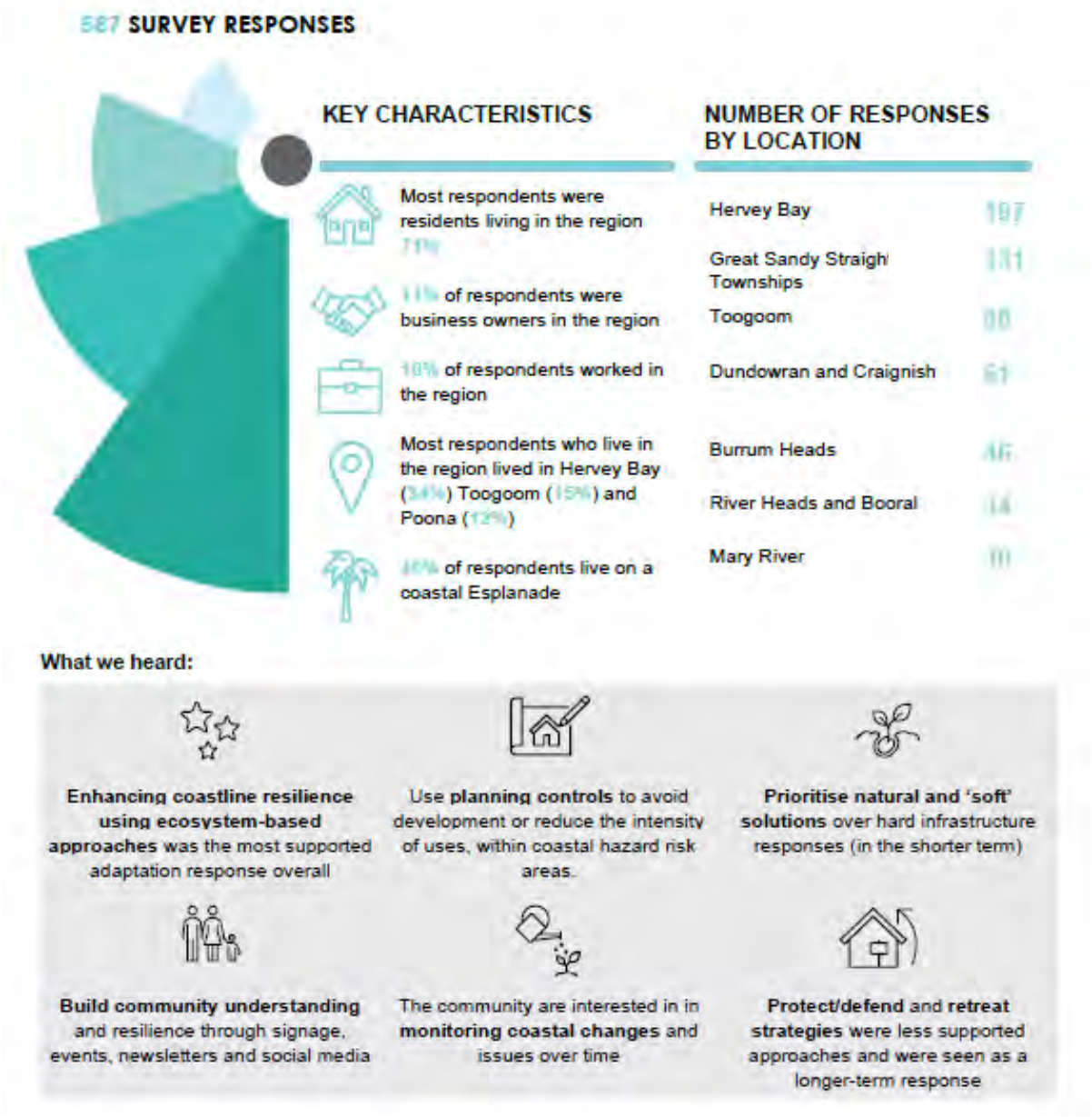


Figure 2-1 Snapshot of survey responses and findings (Ethos Urban 2020)

3 Multi-Criteria Analysis

The QCoast$_{2100}$ Guidelines require Councils to develop criteria for ranking or prioritising adaptation options. For the Fraser Coast CHAS, an MCA process was applied to potential adaptation and coastal hazard mitigation options for locations where risks have been assessed as High or Extreme in the Phase 5 risk assessment. The locality-based consideration of options spans Phases 6 and 7 of the CHAS and involved input and feedback from the TWG (confirmation of the overall process), community and Councillors.

For the Fraser Coast CHAS, the adaptation options assessment approach includes the MCA as part of option screening, particularly as the suitability of an option is dependent upon MCA considerations such as its effectiveness at treating coastal hazard risks. This avoids duplication of process and improved understanding of the unique considerations for each site prior to undertaking the socio-economic analysis in Phase 7. This workflow is illustrated in Figure 3-1.

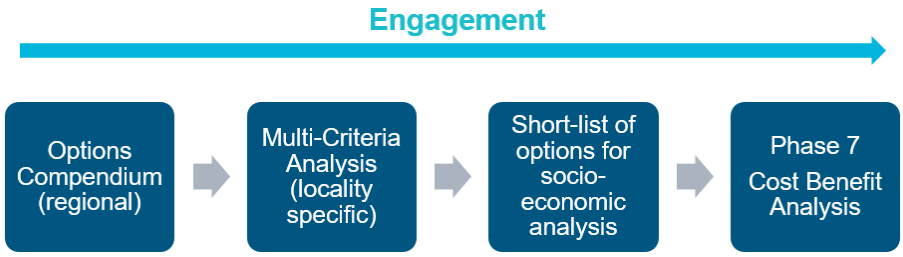


Figure 3-1 Workflow for shortlisting adaptation options

3.1 Initial filter

The initial filter applied to each option is to test is relevance and suitability for implementation to mitigate the coastal hazard risk at a specific location. This involves consideration of:

- The type of hazard – does the option address inundation or erosion or both?
- The ownership of the asset at risk – some options only apply to private or public assets.
- Existing vs planned assets – additional options may apply where built assets are planned but have not yet been constructed.

3.2 MCA

The filtered option list was then be assessed against a set of weighted criteria. The criteria and their weightings discussed and confirmed with the TWG are shown in Table 3-1.

Note that at this stage of option assessment the cost criterion only considers the indicative “whole of life” implementation cost. It does not consider broader economic implications such as the impacts of the option on social, recreational and/or environmental values which are addressed as part of Phase 7.

Table 3-1 MCA assessment criteria & weighting

Criteria	Criteria Description	Weighting
Cost	Order of magnitude monetary costs to build/implement an adaptation option (further detailed studies to confirm costs would be required), either by Council or private landowners	40%
Environmental Impact	Whether an adaptation option will have adverse impacts on environmental values e.g. Matters of State Environmental Significance	10%
Social Impact	Whether an adaptation option will have adverse impacts on other social values or is likely to have community support e.g. access, amenity, property values	10%
Reversible/ adaptable	Whether an option is able to be 'reversed' or adapted to cater for future needs	10%
Effectiveness	Whether an option is technically feasible (i.e. is effective in mitigating the risk and is implementable),	15%
Approvability	Whether an option is able to be readily approved (i.e. is consistent with current planning policy or legislative requirements)	10%
Timing	Whether an option provides a long-term solution to the coastal hazard risk, or is only suitable for use as an interim option	5%

An initial 'rating' has been developed to apply broadly to options available at key locations, to indicate:

- "Very Positive" (rating = +2) where an adaptation option has very positive outcome
- "Positive" (rating = +1) where an adaptation option has a somewhat positive outcome
- "Neutral" (rating = 0) where an adaptation option has neither a positive nor negative outcome
- "Negative" (rating = -1) where an adaptation option is has a somewhat adverse outcome
- "Very Negative (rating = -2) where an adaptation option has a significantly adverse outcome.

Descriptions for the ratings for each criterion are summarised in Table 3-2. With respect to the Timing criterion, short term options may not necessarily lead directly to adverse outcomes, but the high frequency of maintenance and/or renewal is considered negative in the context of implementation. Short term options that are also high cost are likely to be unacceptable for Council.

Once a rating has been assigned to each criterion and the weightings applied, a total score is calculated, and the scores are ranked in order of preference (i.e. highest score is ranked 1st, lowest score is ranked last). A "traffic light" system is then used to group the options for further consideration as follows:

- "GO" (Total Score =>+1): an option is considered suitable with no other adverse impacts, and requires no further development (i.e. studies, design etc). These could also be defined as no regrets options.

- “SLOW” (Total Score = >-1 to <+1): an option may be suitable but should be subject to further detailed assessment at specific locations (including Phase 7 socio-economic analysis).
- “STOP” (Total Score =<-1): an option is not considered suitable at a location and is not considered for further analysis as part of the Coastal Futures project.

Ratings were applied initially to each option and locality by the BMT project team. The assessment was discussed in detail with the TWG in a workshop setting to confirm ratings, results, and the shortlist of options for each locality. The locality-based MCA results are summarised in Section 4 with full details of the final ratings provided in Appendix D.

Table 3-2 Assessment criteria rating descriptions

	Cost	Environmental Impact	Social Impact	Reversible / Adaptable Future	Effectiveness	Approvability	Timing
Weighting:	**40%**	**10%**	**10%**	**10%**	**15%**	**10%**	**5%**
Very Negative (-2)	Very high cost (over $10M)	Will have significant adverse impact on environmental values (i.e. MSES)	Will significantly impact negatively on social values (i.e. access, amenity, loss of services)	Completely irreversible once implemented; or Limits any alternative options in the future	Is not technically viable at the location	Is very unlikely to achieve approval under existing planning/legislative requirements	Short term / temporary solution
Negative (-1)	High cost Expensive ($3M to $10M)	Will have somewhat adverse, but not significant impact on environmental values	Will have somewhat adverse, but not significant impact on social values	Difficult to reverse once implemented, but can be done with effort Limits some alternative options in the future	Is only technically viable with substantial engineering (or other) design investigation and capabilities for implementation	Will require an EIS and/or Govt program to implement; or There is a residual risk that approval will not be obtainable for the proposed works / strategy	Short to medium term solution
Neutral (0)	Medium cost ($1M to $3M)	No net impact	No net impact	Reversible or adaptable, but at some cost / effort	Has neither a positive or negative impact on effectiveness; or Is likely to be technically viable at the site, but would require further investigations to clarify	Will require Govt approvals, or assistance through existing Govt program; or Generally, approvals/ assistance would be granted assuming requirements are met	Requires further resources / changes to be effective over long term
Positive (+1)	Moderate cost ($300,000 to $1M)	Will slightly benefit environment	Will slightly benefit social values	Can be adapted for future circumstances or would have only minor impact on future generations	Is technically viable with some effort	Minimal government approvals required to implement	Medium to long term solution
Very Positive (+2)	Limited cost (<$300,000)	Will significantly benefit environment, (e.g. improve habitat value/increase total available habitat)	Will significantly benefit social values (i.e. improve access, amenity or services provision)	Can be easily adapted for future circumstances or should impacts not occur; or Would positively impact future generations	Is technically viable and easily implementable at the site / location	No government approvals required to implement	Long term solution

4 Stakeholder Engagement and MCA Outcomes

For the purposes of the MCA, options to mitigate High and Extreme risks within each locality were considered, and the analysis summaries are provided in Appendix D, along with maps illustrating the potential application of highly ranked options. The outcomes of the assessment for each locality are discussed in the following sections.

Several strategic adaptation actions apply generally throughout the region over the lifetime of the CHAS. These options received a “GO” MCA score and are typically low cost and with little to no further studies required for approval and/or implementation. These so-called no regrets actions include:

- **Accommodate**
  - Development master planning
  - Emergency management response
  - Hazard resilient design for new/upgraded private infrastructure
  - Hazard resilient design for new/upgraded public infrastructure.
- **Community resilience**
  - Community education and consultation
  - Monitoring.
- **Natural Ecosystem Strengthening**
  - Active dune and habitat management
  - Wetland restoration
  - Tide flaps/valves on stormwater network.

Monitoring, community awareness and education, and natural ecosystem strengthening actions are fundamental, and stakeholder feedback indicates a high level of support for these actions. **For brevity they have not been repeated through this document.** Further understanding of geotechnical conditions to support more detailed erosion assessment at certain sites has been flagged in the MCA. This mainly pertains to open coast sites.

The development of the adaptation pathway at each locality will tend to draw from the highly ranked, no regrets options as being be most suitable for short-term implementation over expensive or complex options. Potential implementation timeframes associated with the options are provided in the tables and maps presented in this section, noting that the more expensive or complex options can require years of planning and details analysis before implementation is possible, or are preceded by no regrets actions until such time as costs become untenable.

Any planned or future works at the identified locations should consider the outcomes of the CHAS, and particularly the risk assessment and options assessment outputs, as part of any decision-making at the earliest possible stages of works planning.

4.1 Management Zone 1 – Burrum Heads & Surrounds

4.1.1 Risk Assessment Summary

For Burrum Heads and surrounds the number of properties at risk increases significantly between the 2050 and 2100 future climates. By the 2100 future climate, nearly 180 parcels of low density residential land are at high or extreme risk from sea level rise, and all are at extreme risk from erosion. The presence of the existing seawall lining the Burrum River and adjacent open coast frontage of the community, if maintained to a "fit for purpose" standard, is assessed as nearly halving the number of properties at extreme risk from erosion.

The key assets and values at high or extreme risk identified by the Phase 5 risk assessment are:

- Open coast and foreshore areas: high risk from sea level rise by 2050
- Roads:
  - Bushnell Road (seaward end): high risk from sea level rise by 2050
  - Burrum Heads Road (seaward end): present day high risk from erosion, high risk from sea level rise by 2050, high and extreme risk from storm tide inundation by 2050 and 2100
  - Orchid Drive (seaward end): high risk from erosion by 2050, high and extreme risk from storm tide inundation by 2050 and 2100
  - Ivor Drive: high risk from sea level rise by 2100, high and extreme risk from storm tide inundation by 2050 and 2100
  - Riverview Drive: extreme risk from erosion by 2050, high and extreme risk from storm tide inundation by 2050 and 2100
  - Ross Street: high and extreme risk from storm tide inundation by 2050 and 2100.
- Water storage proposed by Burrum Heads weir: high risk from erosion by 2100
- Sewerage pump stations (x2): extreme risk from erosion by 2050, high risk from sea level rise by 2050
- Burrum Heads Fire Station: present day high risk from storm tide
- Cheeli Lagoon: high risk from sea level rise by 2100.

4.1.2 Community Feedback

There were high levels of support for all the adaptation types. The build, enhance and avoid/ accommodate responses had the highest levels of community support. Protect/defend and retreat responses had comparatively lower levels of support, but with still more than 50% of respondents either strongly agreeing or agreeing with these approaches in some circumstances. The key messages included:

- Stabilise and protect foreshore areas by re-establishing native vegetation buffers. Sirenia Beach and Beach Drive are key locations to implement natural protection measures.

- Stop unlawful vegetation clearing on private properties in foreshore areas to enhance coastline resilience - there is support for stronger regulation and punishment of unlawful clearing in these areas.
- Prevent new development in at-risk areas through planning scheme responses (e.g. zoning). The Open Space and Sport and Recreation zone could be used to discourage inappropriate development and land uses in vulnerable areas.
- New development in areas of current and future risk should be designed and constructed using resilient and adaptable construction methods (e.g. 'pier and pole' construction). There is concern with 'slab on ground' construction methods in these areas, due to the difficulty in relocating buildings constructed using this method. Some respondents emphasised the need to protect new development in foreshore areas, referencing the 'On the Beach' and 'Dolphin Waters' estates.
- The upgrade of Burrum Heads Road is important to ensure it remains 'inundation proof' into the future and allows evacuation and access during a hazard event.
- Key public infrastructure and community services such as the Rural Fire Service, SES and Community Hall, should be re-located or protected.
- Access to information can assist in building community resilience. Community education should be achieved through circulating collateral (fridge magnets etc.), partnerships with community organisations (schools, fishing club, outrigger clubs etc.) and development of a community evacuation plan for Burrum Heads. Education on coastal hazards and evacuation should prioritise residents in at-risk locations, such as Sirenia Beach, and vulnerable people (e.g. older people; people with a disability).
- Hard engineering measures, such as seawalls, should only be used where necessary. There is concern about their potential impacts on scenic amenity. If implemented, they should be combined with walking paths and protect marine habitat in important areas like Beelbi Creek.

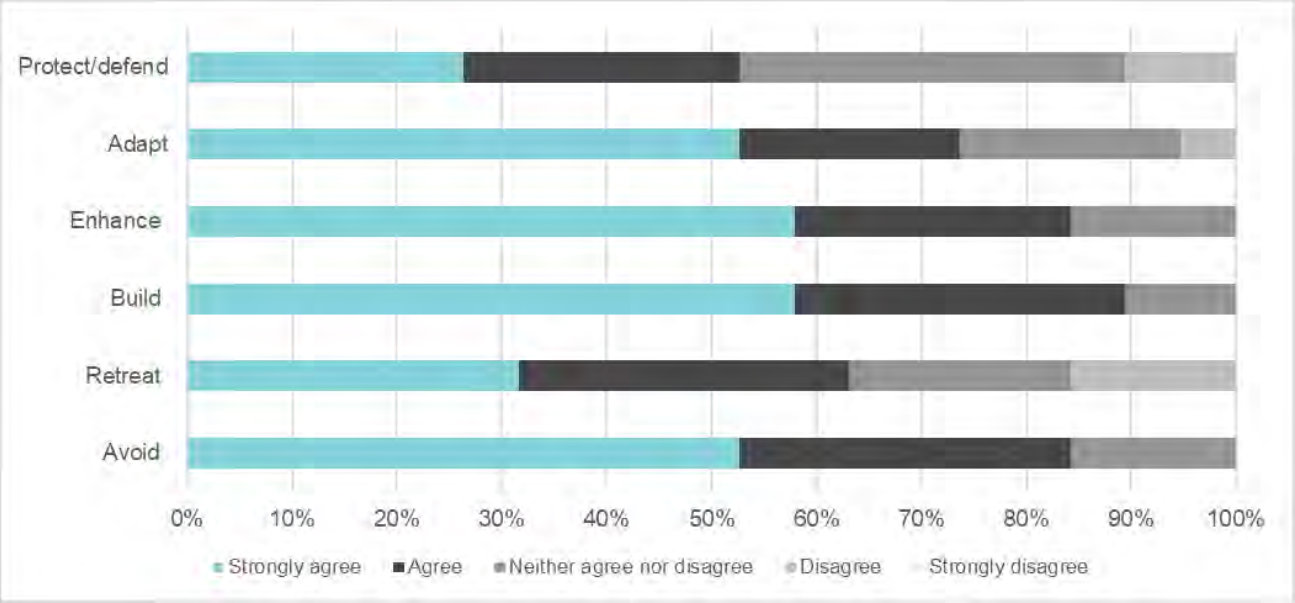


Figure 4-1 Preferred response strategies for Burrum Heads & Surrounds

4.1.3 Technical Working Group and MCA outcomes

Adaptation options unlikely to reduce coastal hazard risks for the Burrum Heads & Surrounds coastline are summarised in Table 4-1. These options have not been considered further as part of the Coastal Futures project but could be reconsidered as part of other studies.

Adaptation options considered viable for the Burrum Heads & Surrounds coastline and shortlisted through the MCA process are summarised in Table 4-6.

The community feedback and MCA outcomes have been considered and sections of coast where the response type and options could possibly be implemented to mitigate the identified high and extreme risks are illustrated below in Figure 4-2. These options will be subject to socio-economic assessment as part of the Coastal Futures project, but in most cases will also need further detailed investigations and consultation prior to implementation.

Table 4-1 Adaptation options unlikely to reduce coastal hazard risk for Burrum Heads & Surrounds

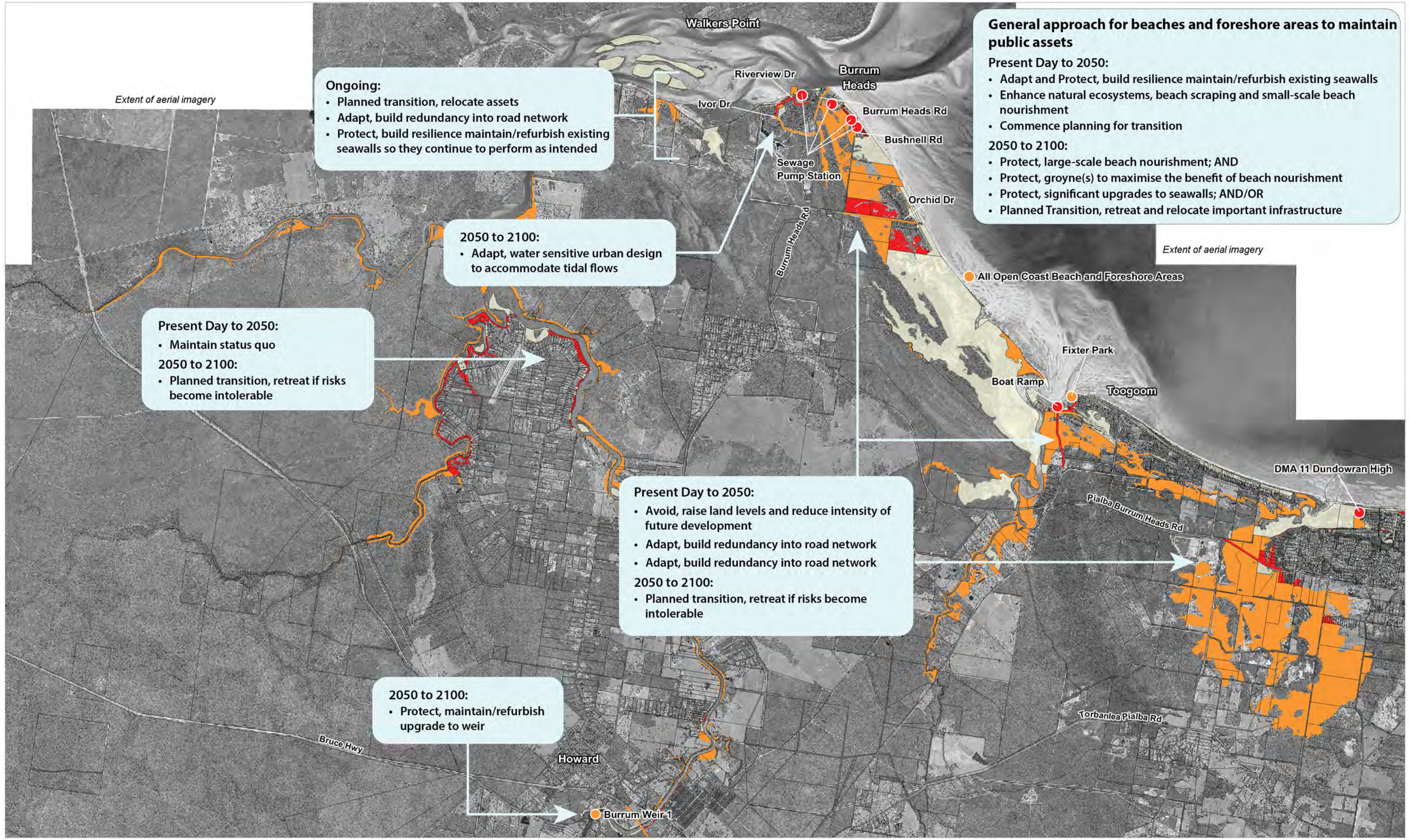
Adaptation type	Option	Comment
Accommodate	Contaminated site management	No known contaminated sites
Accommodate	Emergency management planning (e.g. alternative route provision)	Not considered at this time but should be reviewed as part of future evacuation planning studies
Accommodate	Floating development (residential)	Not considered suitable for mitigating coastal hazard risks
Accommodate	Manual Creek Mouth Management to Protect Private Assets	Not considered suitable for mitigating coastal hazard risks at this locality
Accommodate	Manual Creek Mouth Management to Protect Public Assets	Not considered suitable for mitigating coastal hazard risks at this locality
Natural ecosystem strengthening	Dune construction	Limited opportunity for this action; preference to restore/maintain existing dune system
Natural ecosystem strengthening	Reduce extents of hard surfaces	Not considered suitable for mitigating coastal hazard risks at this locality; this action may provide other benefits (e.g. heat reduction)
Planned Transition	Rolling easement	Limited to no opportunity to implement at this location
Protect	Artificial reef	Not considered suitable for mitigating coastal hazard risks at this locality; this action may provide other benefits (e.g. fish habitat)
Protect	Levees / dykes	Likely to impact catchment flooding, not considered further at this time
Protect	Tidal barrage / gates / surge barriers	Tidal control of the Burrum River not considered viable at this time

**options may be reconsidered as part of future studies and/or may provide other benefits*

Table 4-2 Burrum Heads and Surrounds adaptation options shortlisted through the MCA

Implementation timeframe (no later than)*	Hazard	Adaptation type	Option
Present/Ongoing	Erosion, SLR	Adapt/Accommodate	Allow foreshore recession in locations where a suitable foreshore buffer exists
Present/Ongoing	All	Adapt/Accommodate	Insurance, dependent on asset and cost to replace (if insurable)
Present/Ongoing	Erosion	Avoid	Coastal building lines / development setbacks to ensure only risk appropriate development occurs within coastal hazard areas
Present/Ongoing	All	Avoid	Community infrastructure management, relocate assets when the cost to replace is unsustainable
Present/Ongoing	Storm Tide	Avoid	Raise land levels to reduce exposure and damage from storm tide inundation
Present/Ongoing	Erosion	Community resilience / complementary measures	Geotechnical investigation & detailed erosion studies, continually reviewed and update to captured observations and new information (such as projected sea level rise)
Present/Ongoing	Erosion	Natural ecosystem strengthening	Beach scraping, relocating sand from the lower beach to upper beach face and dune
Present/Ongoing	Erosion	Natural ecosystem strengthening	Small-scale beach nourishment and dune stabilisation, currently limited by lack of approved sand sources
Present/Ongoing	All	Planned Transition	Maintain status quo (no changes to present management approach)
Present/Ongoing	All	Planned Transition	Trigger related development approvals, develop a process that gives coastal managers and asset owners certainty that the preferred adaptation options can be implemented in a timely manner
Present/Ongoing	Erosion	Protect	Seawall/scour protection to protect private assets
Present/Ongoing	Erosion	Protect	Seawall/scour protection to protect public assets, maintain/refurbish existing structures with significant upgrades by 2100
2050	All	Adapt/Accommodate	Build redundancy into network systems, high and extreme risk roads include Bushnell Road, Burrum Heads Road, Orchid Drive, Ivor Drive, Riverview Drive and Ross Street
2050	All	Avoid	Reduce intensity of future development
2050	Storm Tide, Erosion	Planned Transition	Partial land transition, erosion prone and low-lying land at Burrum St, Bushnell Rd and Orchid Dr
2050	All	Planned Transition	Relocate important infrastructure
2050	Erosion	Protect	Groyne and artificial headlands, to be used to maximise the benefit of beach nourishment
2050	Erosion	Protect	Large-scale beach nourishment to mitigate sea level rise and maintain beaches, no known sand source at present
2100	SLR	Adapt/Accommodate	Urban design, water sensitive urban design to accommodate tidal flows to Cheeli Lagoon
2100	Storm Tide, Erosion	Planned Transition	Land buy back (no lease back), erosion prone and low-lying land at Burrum St, Bushnell Rd and Orchid Dr
2100	Storm Tide, Erosion	Planned Transition	Land buy back with lease back opportunity, erosion prone and low-lying land at Burrum St, Bushnell Rd and Orchid Dr
2100	Storm Tide, Erosion	Planned Transition	Land swap, erosion prone and low-lying land at Burrum St, Bushnell Rd and Orchid Dr

**subject to further detailed investigations and consultation*



LEGEND

Cadastral Boundaries

Risk Rating

Extreme

High

Low/Medium

Title:

Risks and Potential Adaptation Options
2100 Erosion and Permanent Inundation due to Sea Level Rise

Figure:

Rev: **A**

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Approx. scale

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4.2 Management Zone 2 – Toogoom to Dundowran Beach

4.2.1 Risk Assessment Summary

The beach and dune area for the Toogoom to Dundowran Beach coastline provides a well vegetated buffer to development, although the dune elevation is low. Areas of conservation significance are generally at low to medium risk for all hazards and climates, although some conservation parcels already exposed to tidal inundation are at high risk from sea level rise under all climates. Inland from the coastline, a substantial section of Pialba Burrum Heads Road is at extreme risk from sea level rise and storm tide and high risk from erosion under all planning climates at the crossing of O'Regan Creek. This includes nearly 250 m of road at extreme risk from sea level rise increasing to over 1 km at extreme risk by the 2100 future climate. Over 650 m is at high risk from erosion under the present climate. This road is an evacuation route and is a critical link for several communities between Burrum Heads and the main population and commercial centre of Hervey Bay.

The key assets and values at high or extreme risk identified by the Phase 5 risk assessment are:

- Roads:
  - Pialba-Burrum Heads Road (O'Regan Creek crossing): extreme risk from sea level rise by 2050, present day high risk from storm tide and extreme risk by 2050
  - Pialba-Burrum Heads Road (Craignish): extreme risk from storm tide by 2100
  - Toogoom Road: present day high risk from erosion, high and extreme risk from sea level rise by 2050 and 2100, present day high risk from storm tide and extreme risk by 2050
  - Lorikeet Avenue: extreme risk from sea level rise by 2100, present day high risk from storm tide and extreme risk by 2050
  - O'Regan Creek Road: high risk from erosion by 2100, present day high risk from sea level rise, present day high risk from storm tide and extreme risk by 2050
  - Petersen Road: high risk from storm tide by 2100
  - Sawmill Road: high risk from storm tide by 2100.
- Toogoom Rural Fire Brigade
- Toogoom Boat Ramp & Jetty: extreme risk from sea level rise by 2050, high risk from storm tide by 2050
- Fixter Park: high risk from sea level rise by 2100.

4.2.2 Community Feedback

Toogoom

All adaptation strategies received high levels of support from respondents. Enhance responses have significantly higher levels of community support. Adapt, avoid and build responses has similar levels of support as secondary preferences. Retreat had comparatively lower levels of support for this locality. The key messages from the Toogoom community included:

- Planning controls and Council decisions should avoid new development in areas subject to coastal hazard risk. Development should be minimised near creeks/beaches and within 200 m of high tide and low-lying areas. New buildings should also avoid reliance upon earthworks and slab-on-ground construction, this is a perceived issue in new housing estates.
- Enhance shoreline resilience through natural measures such as mangrove and foreshore revegetation. This provides fewer adverse environmental impacts and better amenity outcomes in comparison to man-made interventions.
- Beelbi Creek and O'Regans Creek are key locations to enhance and protect through natural measures. It was acknowledged that this type of response may not provide long-term protection and hard infrastructure interventions (e.g. groynes or sea walls) may be necessary at these locations.
- Fixter Park is a key asset to protect and enhance through revegetation (from both Council and community). The extension of the existing seawall/rock wall along Kingfisher Parade was identified as a potential protection measure for Fixter Park and the surrounding foreshore.
- The relocation of existing public assets from at risk areas, with the exception of the Toogoom Boat Ramp, should be a last-resort strategy due to prohibitive cost.
- Identify and deliver an alternative to Pialba Burrum Heads Road as an emergency evacuation route for Toogoom residents.
- Community resilience through educating the public on the value and management of foreshore vegetation and by introducing stronger penalties for removing vegetation. It is also important to provide pre-warning to the community on coastal hazard events.

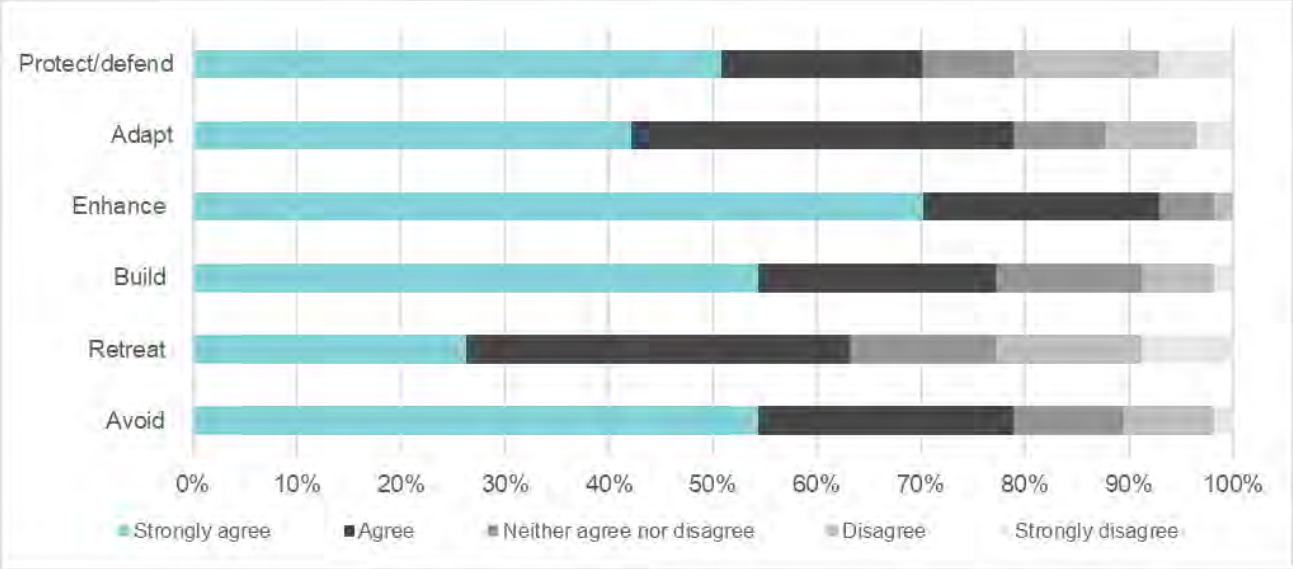

Figure 4-3 Preferred response strategies for Toogoom

Dundowran & Craignish

All adaptation strategies received high levels of support from respondents. The enhance and avoid strategies had the greatest support while retreat and protect/defend had comparatively lower levels of support than other responses. The key messages from the Dundowran and Craignish community included:

- Avoid new development in high risk areas, particularly in proximity to the foreshore and Eli Creek and O'Regan Creek. It was suggested that land at Ansons Road could be resumed and revegetated, rather than developed for residential use.
- Planning scheme responses such as zoning amendments, increasing development setbacks, and preventing clearing within 100 m of the high tide mark are potential ways to manage development in vulnerable areas.
- Preference for natural responses to enhance the resilience of at-risk areas such as foreshore and mangrove revegetation, dune stabilisation and the creation of natural buffer areas. These options were generally preferred over man-made interventions as they have fewer environmental impacts. The Mungomery's Vine Forest, foreshore areas between Ansons Road and Petersons Road, and vegetation at creek mouths are key locations for protection and enhancement through revegetation.
- Increase community awareness and knowledge of coastal hazards, evacuation plans and the importance of dune protection and rehabilitation are key strategies for building community resilience. This could be achieved through social media, letter drops and community information sessions.
- Develop a stronger evacuation plan which details evacuation routes to identified safe assembly centres such as Dundowran Hall.
- Public infrastructure (toilet blocks and picnic areas) and residential development are key assets requiring relocation to out of at-risk areas or protection through flood mitigation barriers. There were divergent views as to whether Council or the landowner should fund land acquisition and relocation costs.

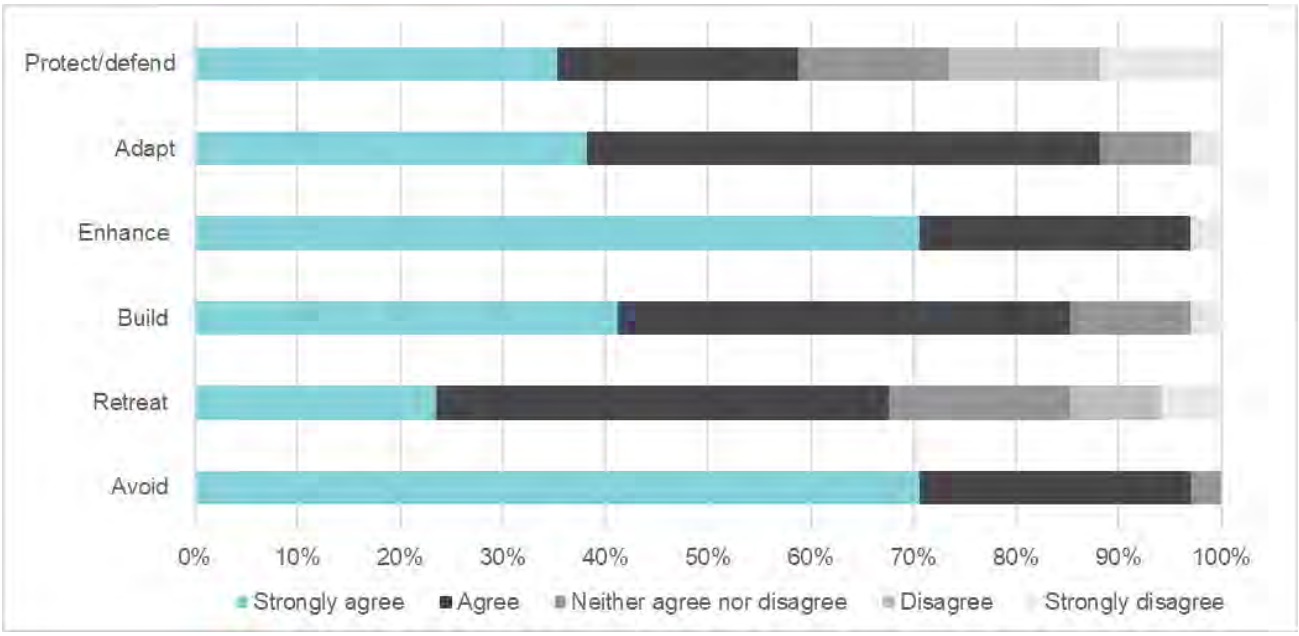

Figure 4-4 Preferred response strategies for Dundowran and Craignish

4.2.3 Technical Working Group and MCA outcomes

Adaptation options unlikely to reduce coastal hazard risks for Toogoom to Dundowran Beach are summarised in Table 4-3. These options have not been considered further as part of the Coastal Futures project but could be reconsidered as part of other studies.

Adaptation options considered viable for the Toogoom to Dundowran Beach coastline and shortlisted through the MCA process are summarised in Table 4-4.

The community feedback and MCA outcomes have been considered and sections of coast where the response type and options could possibly be implemented to mitigate the identified high and extreme risks are illustrated below in Figure 4-4. These options will be subject to socio-economic assessment as part of the Coastal Futures project, but in most cases will also need to further detailed investigations and consultation prior to implementation.

Table 4-3 Adaptation options unlikely to reduce coastal hazard risk for Toogoom to Dundowran Beach

Adaptation type	Option	Comment
Accommodate	Contaminated site management	No known contaminated sites
Accommodate	Floating development (residential)	Not considered suitable for mitigating coastal hazard risks
Accommodate	Manual Creek Mouth Management to Protect Private Assets	Not considered suitable for mitigating coastal hazard risks at this locality
Accommodate	Manual Creek Mouth Management to Protect Public Assets	Not considered suitable for mitigating coastal hazard risks at this locality
Natural ecosystem strengthening	Dune construction	Limited opportunity for this action; preference to restore/maintain existing dune system
Natural ecosystem strengthening	Reduce extents of hard surfaces	Not considered suitable for mitigating coastal hazard risks at this locality; this action may provide other benefits (e.g. heat reduction)
Natural ecosystem strengthening	Small-scale beach nourishment	Small-scale beach nourishment unlikely to provide tangible benefit due to the extent of beach compartment
Planned Transition	Rolling easement	Limited to no opportunity to implement at this location
Protect	Artificial reef	Not considered suitable for mitigating coastal hazard risks at this locality; this action may provide other benefits (e.g. fish habitat)
Protect	Groyne and artificial headlands	To be reconsidered if large scale beach nourishment is planned
Protect	Levees / dykes	Likely to impact catchment flooding, not considered further at this time
Protect	Tidal barrage / gates / surge barriers	Tidal control of Beelbi and O'Regan Creeks not considered viable at this time

**options may be reconsidered as part of future studies and/or may provide other benefits*

Table 4-4 Toogoom to Dundowran Beach adaptation options shortlisted through the MCA

Implementation timeframe (no later than)*	Hazard	Adaptation type	Option
Present/Ongoing	Erosion, SLR	Adapt/Accommodate	Allow foreshore recession in locations where a suitable foreshore buffer exists
Present/Ongoing	Storm Tide	Adapt/Accommodate	Emergency management planning (e.g. alternative route provision) to avoid 'flood islands' communities during storm tide events
Present/Ongoing	All	Adapt/Accommodate	Insurance, dependent on asset and cost to replace (if insurable)
Present/Ongoing	Erosion	Avoid	Coastal building lines / development setbacks to ensure only risk appropriate development occurs within coastal hazard areas
Present/Ongoing	All	Avoid	Community infrastructure management, relocate assets when the cost to replace is unsustainable
Present/Ongoing	Storm Tide	Avoid	Raise land levels to reduce exposure and damage from storm tide inundation
Present/Ongoing	Erosion	Community resilience / complementary measures	Geotechnical investigation & detailed erosion studies, continually reviewed and update to captured observations and new information (such as projected sea level rise)
Present/Ongoing	Erosion	Natural ecosystem strengthening	Beach scraping and/or dune stabilisation
Present/Ongoing	All	Planned Transition	Maintain status quo (no changes to present management approach)
Present/Ongoing	Erosion	Planned Transition	Trigger related development approvals, develop a process that gives coastal managers and asset owners certainty that the preferred adaptation options can be implemented in a timely manner
Present/Ongoing	Erosion	Protect	Seawall/scour protection to protect public assets, maintain/refurbish existing structures with significant upgrades by 2100
2050	SLR, Storm Tide	Adapt/Accommodate	Build redundancy into network systems, Pialba-Burrum Heads Road (O'Regan Creek Crossing), Toogoom Road, Lorikeet Avenue, O'Regan Creek Road
2050	All	Avoid	Reduce intensity of future development
2050	Erosion, SLR	Protect	Large-scale beach nourishment to mitigate sea level rise and maintain beaches, no known sand source at present
2050	Erosion	Protect	Seawall/scour protection on private land to protect private assets
2100	SLR	Adapt/Accommodate	Urban design, water sensitive urban design to accommodate saline instruction to lagoon
2100	SLR, Storm Tide	Planned Transition	Land buy back (no lease back), low-lying land Beelbi Creek and O'Regan Creek
2100	SLR, Storm Tide	Planned Transition	Land buy back with lease back opportunity, low-lying land Beelbi Creek and O'Regan Creek
2100	SLR, Storm Tide	Planned Transition	Land swap, low-lying land Beelbi Creek and O'Regan Creek
2100	SLR	Planned Transition	Partial land transition, low-lying land Beelbi Creek and O'Regan Creek
2100	Erosion, SLR	Planned Transition	Relocate important infrastructure and assets, including Toogoom Boat Ramp and Jetty, Fixter Park

**subject to further detailed investigations and consultation*

2050 to 2100:
- Planned transition, relocate asset if risks become intolerable

General approach for beaches and foreshore areas to maintain public assets

Present Day to 2050:
- Adapt and Protect, build resilience maintain/refurbish existing seawalls (Toogoom only)
- Enhance natural ecosystems, beach scraping and small-scale beach nourishment

2050 to 2100:
- Protect, large-scale beach nourishment; AND/OR
- Planned Transition, retreat and relocate important infrastructure

Extent of aerial imagery

Present Day to 2050:
- Adapt, build redundancy into road network

Present Day to 2050:
- Avoid, raise land levels and reduce intensity of future development
- Adapt, build redundancy into road network

2050 to 2100:
- Planned transition, retreat if risks become intolerable

Present Day to 2050:
- Avoid, raise land levels and reduce intensity of future development

2050 to 2100:
- Adapt, build redundancy into road network

Fixter Park
Toogoom Boat Ramp
Toogoom
Lorikeet Av
Toogoom Rd
O'Regan Creek Rd
Pialba Burrum Heads Rd
Pialba Burrum Heads Rd
Torbanlea Pialba Rd
Nikenbah

LEGEND

Cadastral Boundaries

Risk Rating

Extreme
High
Low/Medium

Title:

Risks and Potential Adaptation Options
2100 Erosion and Permanent Inundation due to Sea Level Rise

Figure:

Rev: **A**

N

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4.3 Management Zone 3 – Eli Waters to Urangan

4.3.1 Risk Assessment Summary

The intensive urban development between Eli Waters and Urangan is exposed to intolerable risks from all coastal hazards over all climates, except for Point Vernon where development is generally outside of the hazard areas. The greatest number of land parcels at extreme (mixed use and medium impact industry zones) or high risk from erosion are in Urangan under the present climate, however by 2050 Torquay and Scarness have overtaken Urangan. The greatest number of parcels at extreme risk from erosion by the 2100 future climate are in Urangan and Eli Waters, most of which are low density residential.

Extreme risks in Eli Waters from sea level rise affect land parcels in the emerging communities zone under all climates. By the 2100 future climate, 90 low density residential parcels in Eli Waters are at high or extreme risk from sea level rise. Scarness is similarly affected, with more than 70 high and medium density residential land parcels at high or extreme risk under the same climate. High risks from storm tide are notable by the 2050 future climate, mainly affecting low density residential parcels in Eli Waters and high density residential parcels in Scarness and Torquay. By the 2100 future climate, high risks affect significant numbers of land parcels in Eli Waters and from Scarness to Urangan.

The key assets and values at high or extreme risk identified by the Phase 5 risk assessment are:

- Open coast beach and foreshore areas: high risk from sea level rise by 2050
- Piers and jetties: extreme risk from erosion and sea level rise by 2050
- Urangan Boat Harbour & boat ramps: present day extreme risk from erosion, extreme risk from sea level rise by 2050, present day high risk from storm tide
- Wetside Water Education Park: present day high risk from erosion
- Pialba Oval: high risk from erosion and sea level rise by 2100
- Dayman Park: high risk from erosion by 2100
- Caravan & Holiday Parks (Scarness, Torquay & Urangan): high risk from storm tide by 2100
- Roads:
    - Booral Road: high risk from erosion by 2050, present day high risk from storm tide and extreme risk by 2050
    - Esplanade (Point Vernon): high and extreme risk from sea level rise by 2050 and 2100, present day high risk from storm tide and extreme risk by 2050
    - Esplanade (Urangan): extreme risk from sea level rise by 2100, present day high risk from storm tide and extreme risk by 2050
    - Serenity Drive (Eli Waters): extreme risk from sea level rise by 2100, present day high risk from storm tide and extreme risk by 2050

  - Pier Street: high risk from sea level rise by 2100, present day high risk from storm tide and extreme risk by 2050.
- Sewage pump station (Pialba): extreme risk from erosion and sea level rise by 2100
- Pulgul Creek Water Treatment Plant: extreme risk from erosion and sea level rise by 2100.

4.3.2 Community Feedback

There were high levels of support for all the adaptation types. The enhance and avoid/accommodate responses had the highest levels of community support. The protect/defend and retreat approaches had comparatively lower levels of support, but with still more than 60% of respondents either agreeing or strongly agreeing with these approaches in some circumstances. The key messages included:

- Enhance coastline resilience through ecosystem-based responses, such as dune stabilisation, protection and restoration of native vegetation, and increasing natural buffers. Point Vernon and Eli Creek were key areas identified for foreshore protection.
- Amend planning scheme zones and implement a long-term land buy back strategy to minimise risk and prevent new development in coastal hazards risk areas. High-risk areas could be rezoned to open space and sport and recreation zones to ensure only risk-appropriate uses such as natural vegetation reserves, parks, sporting fields, camping grounds or dog parks occur. Prohibit further development around the foreshore and Esplanade and lower lying areas of Eli Creek/Point Vernon.
- Develop a staged relocation plan for development affected by coastal hazards. Buildings, infrastructure, and services should be moved further inland as they become redundant or exposed to high hazard risk.
- The development of rock walls can be considered where proven to not cause detrimental impacts on the natural environment or scenic amenity. Other hard engineering responses suggested for Hervey Bay include the use of artificial reefs, tidal barrage and floating barriers.
- Planning controls should be implemented to ensure existing coastal dependent development, such as the Urangan Boat Harbour and Pier, are upgraded and enhanced to increase resilience. Planning controls should also ensure that new development subject to current and future coastal hazard risk is designed and constructed using stronger, more adaptable materials.
- The highest priority public infrastructure and community services that should be protected from coastal hazards impacts through their relocation out of at-risk areas are emergency services, schools, road transport, WetSide Water Park, Point Vernon Sewage Pump and Seafront Oval.
- Increased community education and awareness through better access to information and warning systems are integral in building community resilience. School programs, open forums, online education tools and fixed displays at beachside locations (i.e. Urangan Pier, Enzos and Aquavue) are key tools to increase community awareness and education of coastal hazards. Council should also notify property and business owners located in at-risk areas.

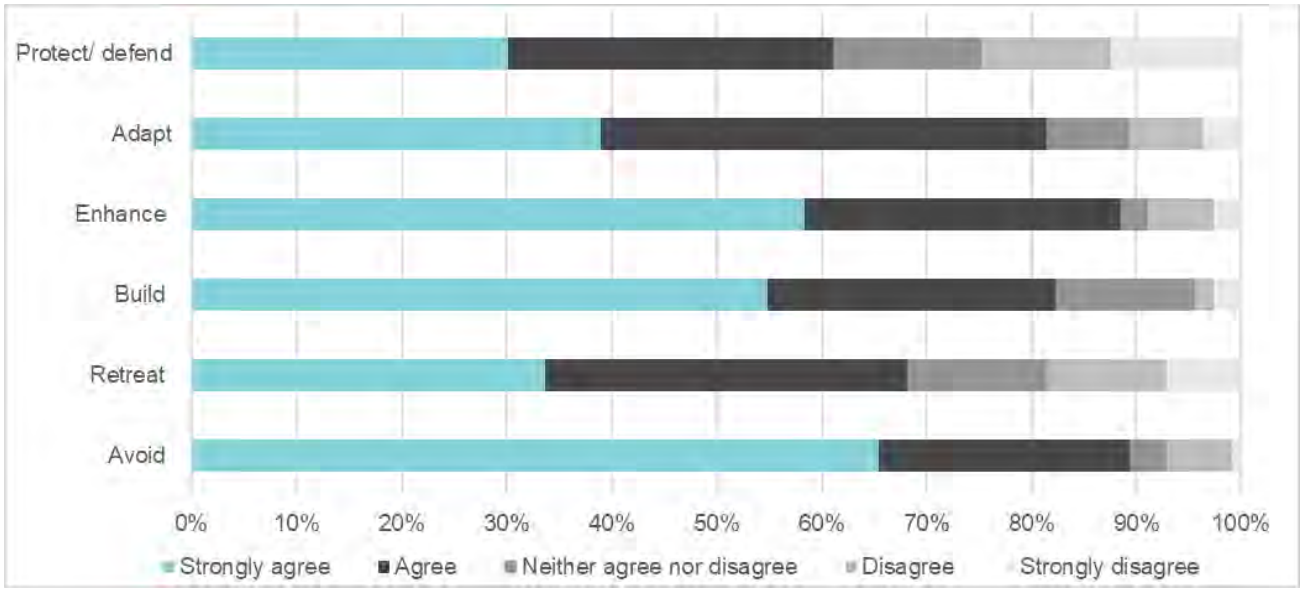

Figure 4-6 Preferred response strategies for Eli Waters to Urangan

4.3.3 Technical Working Group and MCA outcomes

Adaptation options unlikely to reduce coastal hazard risks for the Eli Waters to Urangan coastline are summarised in Table 4-5. These options have not been considered further as part of the Coastal Futures project but could be reconsidered as part of other studies.

Adaptation options considered viable for the Eli Waters to Urangan coastline and shortlisted through the MCA process are summarised in Table 4-6.

The community feedback and MCA outcomes have been considered and sections of coast where the response type and options could possibly be implemented to mitigate the identified high and extreme risks are illustrated below in Figure 4-7. These options will be subject to socio-economic assessment as part of the Coastal Futures project, but in most cases will also need to further detailed investigations and consultation prior to implementation.

Table 4-5 Adaptation options unlikely to reduce coastal hazard risk for Eli Waters to Urangan

Adaptation type	Option	Comment
Accommodate	Emergency management planning (e.g. alternative route provision)	Not considered at this time but should be reviewed as part of future evacuation planning studies
Accommodate	Floating development (residential)	Not considered suitable for mitigating coastal hazard risks
Accommodate	Manual Creek Mouth Management to Protect Private Assets	Not considered suitable for mitigating coastal hazard risks at this locality
Accommodate	Urban design	Not considered in detail as part of the CHAS; to be considered as part of future master planning (for example)
Natural ecosystem strengthening	Dune construction	Limited opportunity for this action; preference to restore/maintain existing dune system
Natural ecosystem strengthening	Establish buffers around wetlands	Not considered suitable for mitigating coastal hazard risks at this locality
Natural ecosystem strengthening	Green belts and riparian corridors	Not considered suitable for mitigating coastal hazard risks at this locality
Natural ecosystem strengthening	Land management to support habitat migration	Not considered suitable for mitigating coastal hazard risks at this locality
Natural ecosystem strengthening	Reduce extents of hard surfaces	Not considered suitable for mitigating coastal hazard risks at this locality; this action may provide other benefits (e.g. heat reduction)
Planned Transition	Rolling easement	Limited to no opportunity to implement at this location
Protect	Artificial reef	Not considered suitable for mitigating coastal hazard risks at this locality; this action may provide other benefits (e.g. fish habitat)
Protect	Levees / dykes	Likely to impact catchment flooding, not considered further at this time
Protect	Seawall/scour protection to protect private assets	Generally not relevant to location; seaward public assets including the Esplanade likely to be protected

**options may be reconsidered as part of future studies and/or may provide other benefits*

Table 4-6 Eli Waters to Urangan adaptation options shortlisted through the MCA

Implementation timeframe (no later than)*	Hazard	Adaptation type	Option
Present/Ongoing	Erosion, SLR	Adapt/Accommodate	Allow foreshore recession in locations where a suitable foreshore buffer exists
Present/Ongoing	Erosion, Storm Tide	Adapt/Accommodate	Build redundancy into network systems
Present/Ongoing	Erosion	Adapt/Accommodate	Contaminated site management, Pialba seafront oval and proximity to Tooan Tooan Creek is a known previous landfill site
Present/Ongoing	All	Adapt/Accommodate	Insurance, dependent on asset and cost to replace (if insurable)
Present/Ongoing	Erosion	Adapt/Accommodate	Manual creek mouth management to protect open space and amenity at Tooan Tooan Creek and Beach Road, Pialba
Present/Ongoing	Erosion	Avoid	Coastal building lines / development setbacks to ensure only risk appropriate development occurs within coastal hazard areas
Present/Ongoing	All	Avoid	Community infrastructure management, relocate assets when the cost to replace is unsustainable
Present/Ongoing	Storm Tide	Avoid	Raise land levels to reduce exposure and damage from storm tide inundation
Present/Ongoing	Erosion	Community resilience / complementary measures	Geotechnical investigation & detailed erosion studies, continually reviewed and update to captured observations and new information (such as projected sea level rise)
Present/Ongoing	Erosion	Enhance natural ecosystems	Small-scale beach nourishment and dune stabilisation, currently limited by lack of approved sand sources
Present/Ongoing	All	Planned Transition	Maintain status quo (no changes to present management approach)
Present/Ongoing	Erosion	Planned Transition	Trigger related development approvals, develop a process that gives coastal managers and asset owners certainty that the preferred adaptation options can be implemented in a timely manner
Present/Ongoing	Erosion, Storm Tide	Protect	Seawall/scour protection to protect public assets, maintain/refurbish existing structures with significant upgrades by 2100
2050	All	Avoid	Reduce intensity of future development
2050	Erosion	Protect	Groyne and artificial headlands, to be used to maximise the benefit of beach nourishment
2050	Erosion, SLR	Protect	Large-scale beach nourishment to mitigate sea level rise and maintain beaches, no known sand source at present
2100	SLR, Storm Tide	Planned Transition	Land buy back (no lease back), low-lying land at Point Vernon and Eli Waters
2100	SLR, Storm Tide	Planned Transition	Land buy back with lease back opportunity, low-lying land at Point Vernon and Eli Waters
2100	SLR, Storm Tide	Planned Transition	Land swap, low-lying land at Point Vernon and Eli Waters
2100	SLR	Planned Transition	Partial land transition, low-lying land at Point Vernon and Eli Waters
2100	All	Planned Transition	Relocate important infrastructure

**subject to further detailed investigations and consultation*

Extent of aerial imagery

General approach for beaches and foreshore areas to maintain public assets

Present Day to 2050:
- Adapt and Protect, build resilience maintain/refurbish existing seawalls
- Enhance natural ecosystems, beach scraping and small-scale beach nourishment
- Protect, large-scale beach nourishment

2050 to 2100:
- Protect, groyne(s) to maximise the benefit of beach nourishment
- Protect, significant upgrades to seawalls; AND/OR
- Planned Transition, retreat and relocate important infrastructure

2050 to 2100:
- Planned transition, relocate asset

2050 to 2100:
- Protect seawall; OR
- Planned transistion, relocate asset if risks become intolerable

Present Day to 2050:
- Avoid, raise land levels and reduce intensity of future development

2050 to 2100:
- Adapt, build redundancy into road network
- Planned transition, retreat if risks become intolerable

Present Day to 2050:
- Protect, seawalls; OR
- Planned transition, gradually relocate at risk assets

Ongoing:
- Adapt and Protect, build resilience maintain/refurbish pier and jetties

2050 to 2100:
- Planned transition, relocate asset if risks become intolerable

General approach for harbour

Ongoing:
- Adapt and Protect, build resilience maintain/refurbish existing structures

Present Day to 2050:
- Avoid, coastal building lines/development setbacks

2050 to 2100:
- Planned transition, retreat if risks become intolerable

Esplanade
North St
Martin St
Sewage Pump Station
Wetside Water Education Park
Pialba
Sewage Pump Station
All Open Coast Beach and Foreshore Areas
Esplanade
Pier
Serenity Dr
Pialba Oval
Jetty
Jetty
Pier St
Boat Harbour Dr
Dayman St
Dayman Park and Surrounds
Urangan Boat Harbour
Urangan Boat Harbour Ramps
Pulgul St
Pulgul Waste Water Treatment Plant
Booral Rd
Nikenbah

LEGEND

Cadastral Boundaries

Risk Rating

Extreme
High
Low/Medium

Title:

Risks and Potential Adaptation Options
2100 Erosion and Permanent Inundation due to Sea Level Rise

Figure:

Rev: **A**

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0 1 2km

Approx. Scale

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4.4 Management Zone 4 – River Heads

4.4.1 Risk Assessment Summary

The River Heads community is generally outside the coastal hazard areas, noting around 14 low density residential properties at high or extreme risk by 2100. Land parcels zoned as emerging communities are at extreme risk from sea level rise and high risk from erosion from the 2050 future climate onwards. The barge and boat ramps at the end of the peninsula are important connections to Fraser Island and into Great Sandy Strait.

The key assets and values at high or extreme risk identified by the Phase 5 risk assessment are:

- Barge ramp and boat ramp: present day extreme risk from erosion, high risk from sea level rise by 2050
- Booral Homestead Complex: extreme risk from sea level rise by 2100
- Bunya Creek effluent reuse facility site: extreme risk from erosion and sea level rise by 2100.

4.4.2 Community Feedback

All adaptation strategies received high levels of support from respondents. Protect/defend had lowest levels of support. Enhance, avoid and adapt were the preferred adaptation strategies. The key messages included:

- Protection and enhancement of foreshore areas and mangrove habitat is strongly supported by the community, particularly in Turtle Cove. The community are keen to be involved in revegetation activities. Littering and vegetation clearing in foreshore areas should be penalised.
- The strong preference is for natural adaptation interventions which protect the Great Sandy Strait for future generations and tourists. It is acknowledged that there may be a need for man-made structures, like sea walls to protect at risk areas, over time.
- Avoid residential development in proximity to the foreshore and other at-risk areas, particularly in Turtle Cove and adjacent to Waterman's Way. At-risk land could be zoned Open Space zone or similar, some suggested these areas should be acquired by government for education or tourism purposes.
- Buildings that are coastal dependent (e.g. boat storage) should be designed to allow for removal or relocation where possible, to respond to coastal hazard risk.
- Land at 2-4 Ariadne Street, River Heads should be resumed by Council and revegetated, rather than being developed for a car park.
- Hard infrastructure protection should be combined with a new walking track and boardwalk from River Heads Boat Ramp to Urangan Harbour.

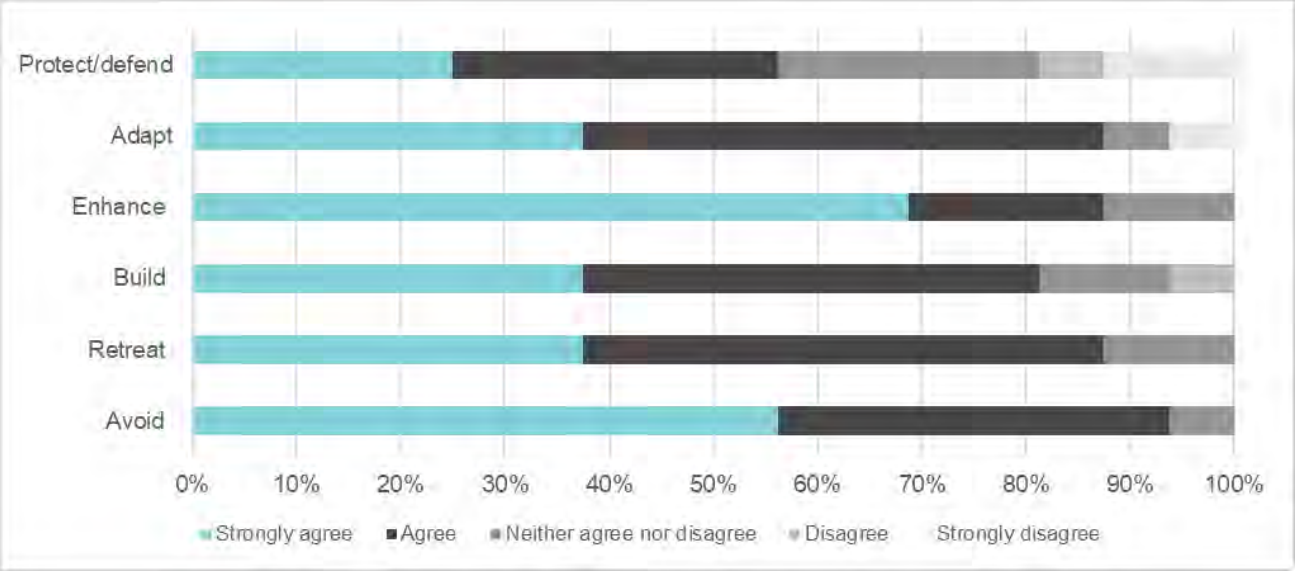

Figure 4-8 Preferred response strategies for River Heads

4.4.3 Technical Working Group and MCA outcomes

Adaptation options unlikely to reduce coastal hazard risks for the River Heads coastline are summarised in Table 4-7. These options have not been considered further as part of the Coastal Futures project but could be reconsidered as part of other studies.

Adaptation options considered viable for the River Heads coastline and shortlisted through the MCA process are summarised in Table 4-8.

The community feedback and MCA outcomes have been considered and sections of coast where the response type and options could possibly be implemented to mitigate the identified high and extreme risks are illustrated below in Figure 4-9. These options will be subject to socio-economic assessment as part of the Coastal Futures project, but in most cases will also need to further detailed investigations and consultation prior to implementation.

Table 4-7 Adaptation options unlikely to reduce coastal hazard risk for River Heads

Adaptation type	Option	Comment
Accommodate	Contaminated site management	No known contaminated sites
Accommodate	Emergency management planning (e.g. alternative route provision)	Not considered at this time but should be reviewed as part of future evacuation planning studies
Accommodate	Floating development (residential)	Not considered suitable for mitigating coastal hazard risks
Accommodate	Manual Creek Mouth Management to Protect Private Assets	Not considered suitable for mitigating coastal hazard risks at this locality
Accommodate	Manual Creek Mouth Management to Protect Public Assets	Not considered suitable for mitigating coastal hazard risks at this locality
Accommodate	Urban design	Not considered in detail as part of the CHAS; to be considered as part of future master planning (for example)
Natural ecosystem strengthening	Beach scraping	Limited to no opportunity to implement at this location due to local intertidal geology
Natural ecosystem strengthening	Dune construction	Not considered suitable at this location, no existing dune habitat; preference to restore maintain existing habitats
Natural ecosystem strengthening	Dune restoration / augmentation	Limited to no opportunity to implement at this location due to local intertidal geology
Natural ecosystem strengthening	Reduce extents of hard surfaces	Not considered suitable for mitigating coastal hazard risks at this locality; this action may provide other benefits (e.g. heat reduction)
Natural ecosystem strengthening	Small-scale beach nourishment	Limited opportunities due to local intertidal geology
Planned Transition	Land buy back (no lease back)	Private assets generally outside of the coastal erosion hazard area
Planned Transition	Land buy back with lease back opportunity	Private assets generally outside of the coastal erosion hazard area
Planned Transition	Land swap	Private assets generally outside of the coastal erosion hazard area
Planned Transition	Partial land buy-back	Private assets generally outside of the coastal erosion hazard area
Planned Transition	Rolling easement	Limited to no opportunity to implement at this location
Protect	Artificial reef	Not considered suitable for mitigating coastal hazard risks at this locality; this action may provide other benefits (e.g. fish habitat)
Protect	Groyne and artificial headlands	Limited to no opportunity to implement at this location due to local intertidal geology
Protect	Large-scale beach nourishment	Limited opportunities due to local intertidal geology
Protect	Levees / dykes	Likely to impact catchment flooding, not considered further at this time
Protect	Seawall/scour protection to protect private assets	Private assets generally outside of the coastal erosion hazard area
Protect	Seawall/scour protection to protect public assets	No major public assets at risk; preference to transition minor assets rather than protect
Protect	Tidal barrage / gates / surge barriers	Not considered suitable for mitigating coastal hazard risks at this locality

**options may be reconsidered as part of future studies and/or may provide other benefits*

Table 4-8 River Heads options shortlisted through the MCA

Implementation timeframe (no later than)*	Hazard	Adaptation type	Option
Present/Ongoing	Erosion, SLR	Adapt/Accommodate	Allow foreshore recession in locations where a suitable foreshore buffer exists
Present/Ongoing	All	Adapt/Accommodate	Build redundancy into network systems
Present/Ongoing	All	Adapt/Accommodate	Insurance, dependent on asset and cost to replace (if insurable)
Present/Ongoing	Erosion	Avoid	Coastal building lines / development setbacks to ensure only risk appropriate development occurs within coastal hazard areas
Present/Ongoing	All	Avoid	Community Infrastructure Management, including boat and barge ramp and associated facilities
Present/Ongoing	Storm Tide	Avoid	Raise land levels to reduce exposure and damage from storm tide inundation
Present/Ongoing	Erosion	Avoid	Reduce intensity of future development
Present/Ongoing	All	Community resilience / complementary measures	Geotechnical investigation & detailed erosion studies, continually reviewed and update to captured observations and new information (such as projected sea level rise)
Present/Ongoing	Erosion	Planned Transition	Maintain status quo (no changes to present management approach)
2100	All	Planned Transition	Relocate important infrastructure, including effluent reuse facilities
2100	SLR, Storm Tide	Planned Transition	Trigger related development approvals, develop a process that gives coastal managers and asset owners certainty that the preferred adaptation options can be implemented in a timely manner

** subject to further detailed investigations and consultation*

2050 to 2100:
- Planned transition, relocate asset if risks become intolerable

Present Day to 2050:
- Avoid, coastal building lines/development setbacks

2050 to 2100:
- Planned transition, retreat if risks become intolerable

Effluent Reuse Facility Bunya

Effluent Reuse Facility Vanderwolf

2050 to 2100:
- Planned transition, retreat if risks become intolerable

Maryborough Hervey Bay Rd

River Heads

Boat Ramps

General approach for barge ramp and boat ramp

Ongoing:
- Adapt and Protect, build resilience maintain/refurbish

LEGEND

Cadastral Boundaries

Risk Rating

- Extreme
- High
- Low/Medium

Title:

Risks and Potential Adaptation Options
2100 Erosion and Permanent Inundation due to Sea Level Rise

Figure:

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Approx. scale

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4.5 Management Zone 5 – Great Sandy Strait Communities

4.5.1 Community Feedback

Enhance strategies received the strongest support, followed by build, protect/defend and avoid responses. Retreat received the lowest level of support from respondents. The key messages included:

- Use planning controls and policy to reduce development in high risk areas. To offset this, it may be appropriate to increase densities in lower risk areas. Specific policy responses of this nature should be incorporated into a Poona foreshore masterplan.
- Retain areas subject to coastal hazards as green and open space, with limited infrastructure and development (e.g. only low cost public amenities). Where located within at-risk areas, development should incorporate resilient building design approaches, specified in building codes and design standards.
- Protect and maintain existing buildings and infrastructure in at-risk areas and make best use of the coastline today, rather than risk over-expenditure on relocating and retreating assets that would limit their use in the short to medium term.
- The new toilet block at the Poona boat ramp is a key asset. Some expressed that it should be located outside of the hazard area, while others stated that there is no point siting it far away from the boat ramp as it will be underutilised.
- Divergent views on the Poona boat ramp – most recognised that it is important to relocate or enhance the boat ramp to ensure it is protected, others believe it should be abandoned.
- The Poona foreshore is a key community asset and should be stabilised and protected through a hard infrastructure response (e.g. rock wall).
- The Tinnanbar and Tuan foreshores are key assets to be protected and enhanced in the future. Re-establishing mangrove vegetation in key areas (e.g. between Tinnanbar boat ramp & Mosquito Beach) is the preferred strategy to achieve this. It is acknowledged that a hard infrastructure (e.g. sea walls) response may be needed in the long term.
- Empower communities to be resilient through awareness. The community should be educated about appropriate and responsive construction methods, benefits of mangrove trees and impacts of removing trees etc. This is important to instil commitment and change behavioural patterns across both young and old.

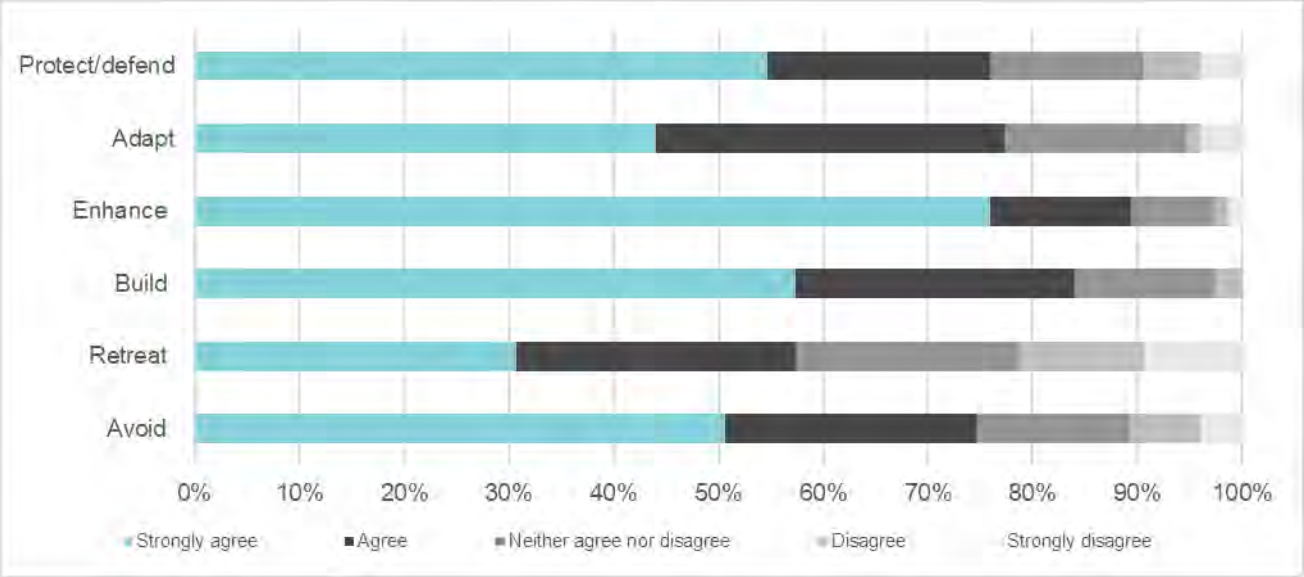


Figure 4-10 Preferred response strategies for Great Sandy Strait communities

4.5.2 Risk Assessment Summary

The central area of Maaroom is the main part of the settlement at risk from coastal hazards. Seventeen (17) properties zoned as low density residential are at extreme risk from erosion by the 2050 future climate, increasing to 44 by the 2100 future climate. Many of these properties are at extreme risk from sea level rise by the 2100 future climate. Several rural properties at extreme risk of sea level impacts are heavily inundated under all climates.

A substantial portion of the Boonooroo community covering low density residential, rural residential and rural properties are at high to extreme risk from present and future climate coastal hazards. While a small number of properties are already at high risk from tidal inundation under the present climate, nearly 30 residential land parcels are at high or extreme risk from sea level rise by the 2050 climate, increasing to nearly 90 parcels by the 2100 climate. More than 60 of these are at extreme risk.

Residential land parcels at Tuan are at high to extreme risk from sea level rise and extreme risk from erosion under all climates, with approximately 100 parcels at risk from erosion by the 2100 climate, which is a notable increase from the 2050 climate. The reserve lining the Tuan foreshore is zoned as open space; this land is at high risk from sea level rise under all climates.

The community of Poona is exposed to high and extreme risks from sea level rise and erosion, with the greatest increase in risk occurring between the 2050 and 2100 climates. Areas of higher risk exposure for the community are close to the foreshore north of the boat ramp site, and on the north-western frontage of the community. By the 2100 climate, more than 100 low density residential parcels are assessed as being at high or extreme risk from sea level rise, and at extreme risk from erosion. The foreshore reserve which includes the beach is at medium risk from erosion under all climates.

There are limited risks to the settlement at Tinnanbar, with the main risk at the boat ramp site which is assessed as being at extreme risk from sea level rise and high risk from erosion under all climates.

The open space zone, which includes consideration of the beach and the foreshore reserve, is at high risk from sea level rise and medium risk from erosion under all climates.

The key assets and values at high or extreme risk identified by the Phase 5 risk assessment are:

Maaroom

- Granville Road: extreme risk from erosion and sea level rise by 2100
- Maaroom Foreshore Reserve and beach: high risk from erosion by 2100, high and extreme risk from sea level rise by 2050 and 2100
- Maaroom Boat ramp: extreme risk from erosion by 2100.

Boonooroo

- Boonooroo Boat ramp: extreme risk from erosion by 2100, high risk from sea level rise by 2100
- Boonooroo Caravan Park: extreme risk from erosion by 2100, high risk from sea level rise by 2100
- Wilkinson Road: present day high risk from erosion, high risk from sea level rise by 2100
- Eckert Road: high risk from sea level rise by 2050
- Rawson Road: high risk from sea level rise by 2100.

Tuan

- Tuan foreshore: high risk from sea level rise by 2050
- Turton Street: high risk from sea level rise by 2100
- Wilkinson Road: present day high risk from erosion, extreme risk from sea level rise by 2100.

Poona

- Poona Foreshore Reserve and beach: high and extreme risk from erosion and sea level rise by 2050 and 2100
- Boronia Drive: high risk from sea level rise and storm tide by 2100.

Tinnanbar

- Tinnanbar Foreshore Reserve and beach: high risk from sea level rise by 2050
- Tinnanbar Boat ramp: present day high risk from erosion, extreme risk from sea level rise by 2050.

4.5.3 Technical Working Group and MCA outcomes

Adaptation options unlikely to reduce coastal hazard risks for the Great Sandy Strait communities are summarised in Table 4-9. These options have not been considered further as part of the Coastal Futures project but could be reconsidered as part of other studies.

Adaptation options considered viable for the Great Sandy Strait communities coastline and shortlisted through the MCA process are summarised in Table 4-10.

The community feedback and MCA outcomes have been considered and sections of coast where the response type and options could possibly be implemented to mitigate the identified high and extreme risks are illustrated below in Figure 4-11 (noting that Maaroom is shown on Figure 4-13). These options will be subject to socio-economic assessment as part of the Coastal Futures project, but in most cases will also need to further detailed investigations and consultation prior to implementation.

Table 4-9 Adaptation options unlikely to reduce coastal hazard risk for the Great Sandy Strait communities

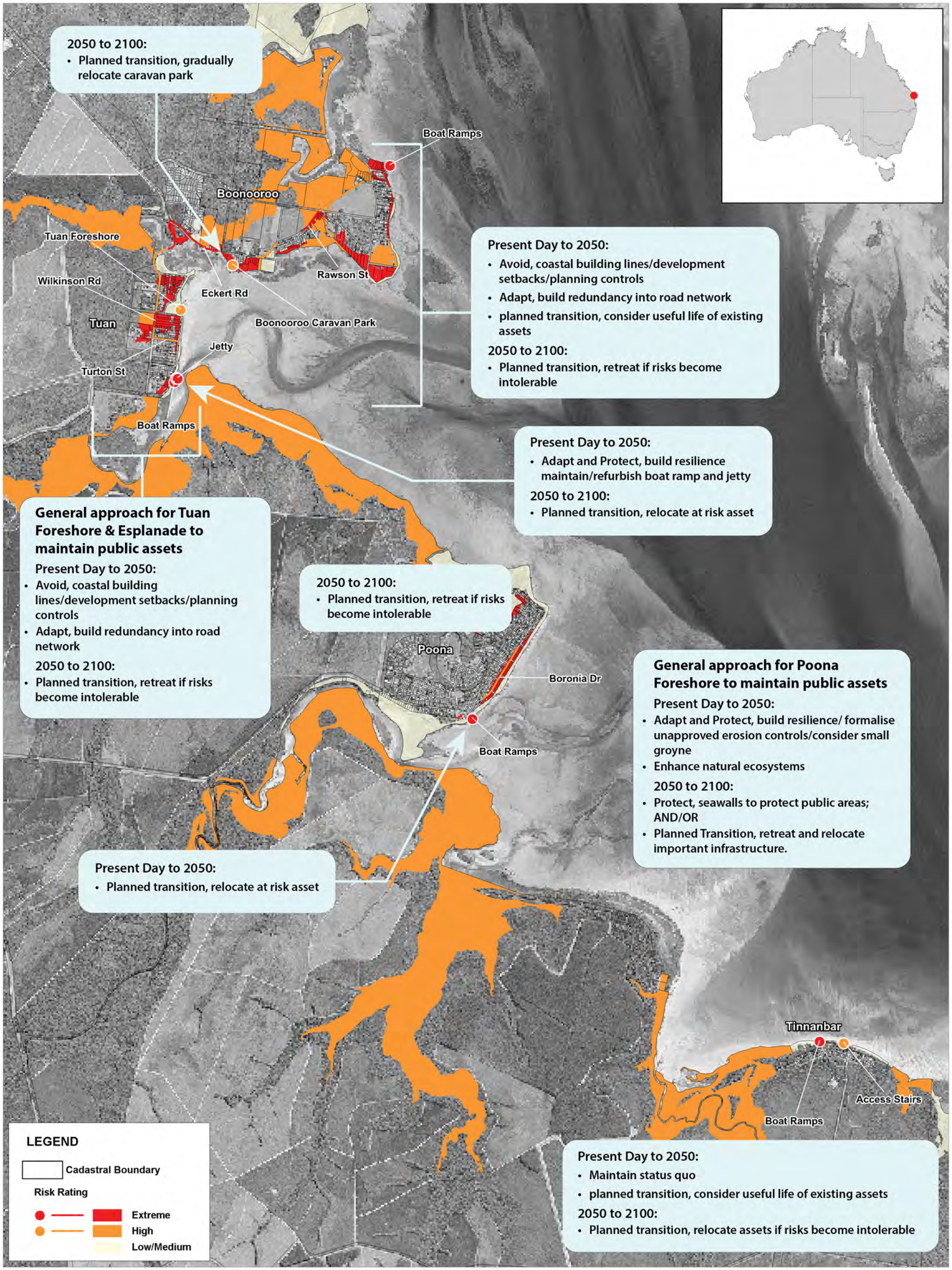
Adaptation type	Option	Comment
Accommodate	Contaminated site management	No known contaminated sites
Accommodate	Floating development (residential)	Not considered suitable for mitigating coastal hazard risks
Accommodate	Manual Creek Mouth Management to Protect Private Assets	Not considered suitable for mitigating coastal hazard risks at this locality
Accommodate	Manual Creek Mouth Management to Protect Public Assets	Not considered suitable for mitigating coastal hazard risks at this locality
Accommodate	Urban design	Not considered in detail as part of the CHAS; to be considered as part of future master planning (for example)
Natural ecosystem strengthening	Beach scraping	Limited to no opportunity to implement at this location; no viable sand source and environmental constraints
Natural ecosystem strengthening	Dune construction	Not considered suitable at this location, no existing dune habitat; preference to restore maintain existing habitats
Natural ecosystem strengthening	Dune restoration / augmentation	Not considered suitable at this location, no existing dune habitat; preference to restore maintain existing habitats
Natural ecosystem strengthening	Reduce extents of hard surfaces	Not considered suitable for mitigating coastal hazard risks at this locality; this action may provide other benefits (e.g. heat reduction)
Natural ecosystem strengthening	Small-scale beach nourishment	Limited to no opportunity to implement at this location; no viable sand source and environmental constraints
Planned Transition	Rolling easement	Limited to no opportunity to implement at this location
Protect	Artificial reef	Not considered suitable for mitigating coastal hazard risks at this locality; this action may provide other benefits (e.g. fish habitat)
Protect	Groyne and artificial headlands	Limited to no opportunity to implement at this location; longshore sand transport assumed too low to be effective
Protect	Large-scale beach nourishment	Limited to no opportunity to implement at this location; no viable sand source and environmental constraints
Protect	Levees / dykes	Likely to impact catchment flooding, not considered further at this time
Protect	Tidal barrage / gates / surge barriers	Not considered suitable for mitigating coastal hazard risks at this locality

**options may be reconsidered as part of future studies and/or may provide other benefits*

Table 4-10 Great Sandy Strait communities options shortlisted through the MCA

Implementation timeframe (no later than)*	Hazard	Adaptation type	Option
Present/Ongoing	Erosion, SLR	Accommodate	Allow foreshore recession in locations where a suitable foreshore buffer exists
Present/Ongoing	All	Accommodate	Build redundancy into network systems, particularly roads including Granville Road (Maaroom), Wilkinson Road, Eckert Road, Rawson Road (Boonooroo), Turton Street, Wilkinson Road (Tuan) and Boronia Drive (Poona)
Present/Ongoing	Storm Tide	Accommodate	Emergency management planning (e.g. alternative route provision) to avoid 'flood islands' communities during storm tide events
Present/Ongoing	All	Accommodate	Insurance, dependent on asset and cost to replace (if insurable)
Present/Ongoing	Erosion	Avoid	Coastal building lines / development setbacks to ensure only risk appropriate development occurs within coastal hazard areas
Present/Ongoing	All	Avoid	Community Infrastructure Management, relocate assets when the cost to replace is unsustainable
Present/Ongoing	Storm Tide	Avoid	Raise land levels to reduce exposure and damage from storm tide inundation
Present/Ongoing	Erosion	Community resilience / complementary measures	Geotechnical investigation & detailed erosion studies, continually reviewed and update to captured observations and new information (such as projected sea level rise)
Present/Ongoing	All	Planned Transition	Maintain status quo (no changes to present management approach)
Present/Ongoing	Erosion	Protect	Groynes, new small structures and the removal of informal (illegal) structures to improve amenity
2050	All	Avoid	Reduce intensity of future development
2050	SLR, Erosion	Planned Transition	Partial land transition, low-lying or erosion prone land at Maaroom Boonooroo and Tuan
2050	All	Planned Transition	Relocate important infrastructure
2050	All	Protect	Seawall/scour protection or bund on private land to protect private assets
2100	SLR	Planned Transition	Land buy back (no lease back), low-lying land at Maaroom Boonooroo and Tuan
2100	SLR	Planned Transition	Land buy back with lease back opportunity, low-lying land at Maaroom Boonooroo and Tuan
2100	SLR	Planned Transition	Land swap, low-lying land at Maaroom Boonooroo and Tuan
2100	All	Protect	Seawall/scour protection or bunds to protect public assets along foreshores or creeks

**subject to further detailed investigations and consultation*



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Risks and Potential Adaptation Options
2100 Erosion and Permanent Inundation due to Sea Level Rise

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4.6 Management Zone 6 – Mary River

4.6.1 Risk Assessment Summary

Along the tidal extent of the Mary River risks are generally confined to the fringes of the river and its tributaries, particularly where the channel is well defined. Many land parcels extend across the riverbank and into the river and have been identified as being at risk even though there may be no active usage of the impacted portion of the land parcel.

The key assets and values at high or extreme risk identified by the Phase 5 risk assessment are:

- Roads:
  - Maryborough Hervey Bay Road: present day high risk from erosion
  - Bruce Highway: present day high risk from erosion
  - Tiger Street: present day high risk from erosion
  - Beaver Rock Road: present day high risk from erosion, high risk from sea level rise by 2050
  - Island Plantation Road: extreme risk from sea level rise by 2100, high and extreme risk from storm tide by 2050 and 2100.
- Boat ramps and jetties (numerous): present day extreme risk from erosion, extreme risk from sea level rise by 2050
- Queens Park: high risk from erosion and sea level rise by 2100
- Prickett Aquatic Area: high risk from erosion and sea level rise by 2100
- Aubinville Waste Treatment Plant: present day high risk from erosion, high and extreme risk from sea level rise by 2050 and 2100
- Maryborough Sailing Club and Rowing Club: present day high risk from erosion, extreme risk from sea level rise by 2050.

4.6.2 Community Feedback

Enhance, build, avoid and adapt responses were the most supported adaptation strategies. Protect/defend and retreat responses, were less preferred strategies. Although the enhance strategy also had the highest number of strongly agree responses, it also had the highest number of strongly disagree responses. Key messages included:

- Preference for natural responses such as the protection of existing vegetation and revegetation of foreshore areas. The protection of natural assets should be prioritised over built assets, man-made interventions should only be implemented where risk and impact cannot be avoided.
- Need for better education on the modelling undertaken through the Coastal Futures project, in addition to the sustainability principles of the Great Sandy Biosphere.
- Avoid new development through planning controls in areas at-risk areas.

- Man-made and hard infrastructure interventions should be implemented to prioritise protection of key community facilities, public assets and places of cultural significance, given their community importance and cost of relocation.
- Convert CBD areas subject to inundation to lower intensity and risk-tolerant land uses, such as car parking.

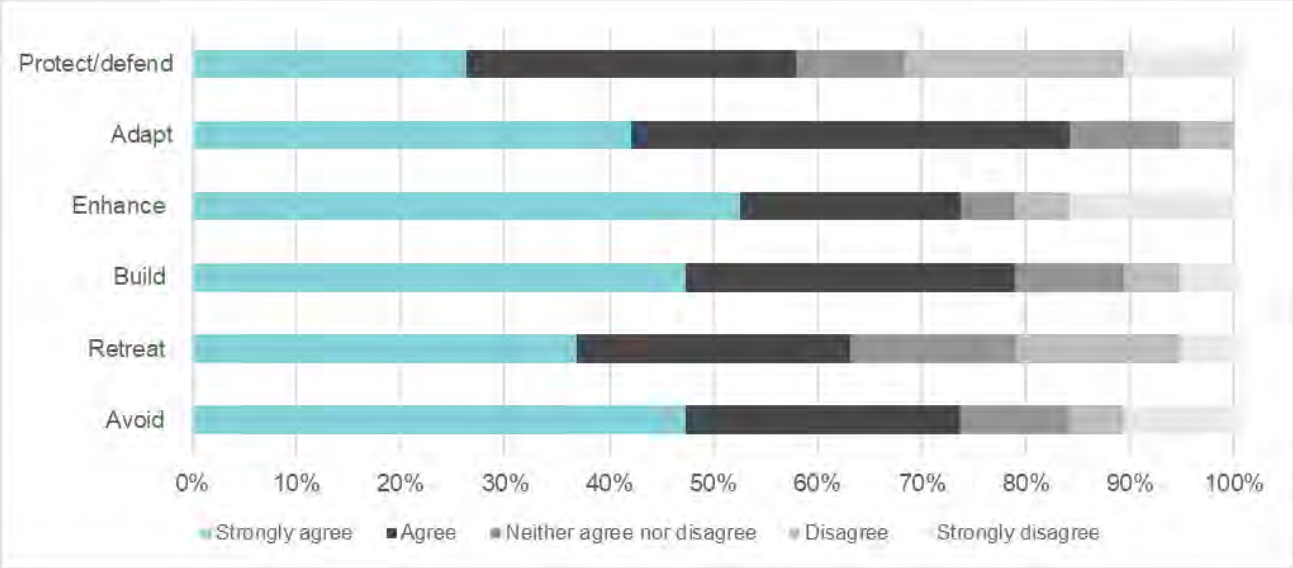


Figure 4-12 Preferred response strategies for the Mary River

4.6.3 Technical Working Group and MCA outcomes

Adaptation options unlikely to reduce coastal hazard risks for the Mary River are summarised in Table 4-11. These options have not been considered further as part of the Coastal Futures project but could be reconsidered as part of other studies.

Adaptation options considered viable for the shoreline of the Mary River and its tributaries and shortlisted through the MCA process are summarised in Table 4-12.

The community feedback and MCA outcomes have been considered and sections of coast where the response type and options could possibly be implemented to mitigate the identified high and extreme risks are illustrated below in Figure 4-13. These options will be subject to socio-economic assessment as part of the Coastal Futures project, but in most cases will also need to further detailed investigations and consultation prior to implementation.

Table 4-11 Adaptation options unlikely to reduce coastal hazard risk for the Mary River

Adaptation type	Option	Comment
Accommodate	Urban design	Not considered in detail as part of the CHAS; to be considered as part of future master planning (for example)
Accommodate	Contaminated site management	No known contaminated sites
Accommodate	Emergency management planning (e.g. alternative route provision)	Not considered at this time but should be reviewed as part of future evacuation planning studies
Accommodate	Floating development (residential)	Not considered suitable for mitigating coastal hazard risks
Accommodate	Manual Creek Mouth Management to Protect Private Assets	Not considered suitable for mitigating coastal hazard risks at this locality
Accommodate	Manual Creek Mouth Management to Protect Public Assets	Not considered suitable for mitigating coastal hazard risks at this locality
Natural ecosystem strengthening	Beach scraping	Limited to no opportunity to implement at this location; no viable sand source and existing environmental constraints
Natural ecosystem strengthening	Dune construction	Not considered suitable at this location, no existing dune habitat; preference to restore maintain existing habitats
Natural ecosystem strengthening	Dune restoration / augmentation	Not considered suitable at this location, no existing dune habitat; preference to restore maintain existing habitats
Natural ecosystem strengthening	Reduce extents of hard surfaces	Not considered suitable for mitigating coastal hazard risks at this locality; this action may provide other benefits (e.g. heat reduction)
Natural ecosystem strengthening	Small-scale beach nourishment	Generally not viable for riverbank locations
Planned Transition	Land buy back (no lease back)	Private assets generally outside of the coastal erosion hazard area
Planned Transition	Land buy back with lease back opportunity	Private assets generally outside of the coastal erosion hazard area
Planned Transition	Land swap	Private assets generally outside of the coastal erosion hazard area
Planned Transition	Partial land buy-back	Private assets generally outside of the coastal erosion hazard area
Planned Transition	Rolling easement	Limited to no opportunity to implement at this location
Protect	Artificial reef	Not considered suitable for mitigating coastal hazard risks at this locality; this action may provide other benefits (e.g. fish habitat)
Protect	Groyne and artificial headlands	Not considered suitable for mitigating coastal hazard risks at this locality
Protect	Large-scale beach nourishment	Generally not viable for riverbank locations
Protect	Levees / dykes	Not considered suitable for mitigating coastal hazard risks at this locality
Protect	Tidal barrage / gates / surge barriers	Not considered suitable for mitigating coastal hazard risks at this locality

**options may be reconsidered as part of future studies and/or may provide other benefits*

Table 4-12 Mary River adaptation options

Implementation timeframe (no later than)*	Hazard	Adaptation type	Option
Present/Ongoing	Erosion, SLR	Accommodate	Allow foreshore recession
Present/Ongoing	All	Accommodate	Build redundancy into network systems
Present/Ongoing	All	Accommodate	Insurance
Present/Ongoing	Erosion	Avoid	Coastal building lines / development setbacks
Present/Ongoing	All	Avoid	Community Infrastructure Management, relocate assets when the cost to replace is unsustainable
Present/Ongoing	Storm Tide	Avoid	Raise land levels to reduce exposure and damage from storm tide inundation
Present/Ongoing	Erosion	Community resilience / complementary measures	Geotechnical Investigation & Detailed Erosion Study
Present/Ongoing	All	Planned Transition	Maintain status quo (no changes to present management approach)
Present/Ongoing	Erosion	Planned Transition	Trigger related development approvals, develop a process that gives land managers and asset owners certainty that the preferred adaptation options can be implemented in a timely manner
2050	All	Avoid	Reduce intensity of future development
2050	All	Planned Transition	Relocate important infrastructure
2050	All	Protect	Riverbank protection to protect public assets

**subject to further detailed investigations and consultation*

Present Day to 2050:
- Avoid, development setbacks/planning controls
- Adapt, build redundancy into road network

2050 to 2100:
- Planned transition, retreat if risks become intolerable

General approach for Mary River Foreshore areas to maintain public assets
- Planned transition, monitor and relocate assets if risks become intolerable or asset reaches the end of its useful life
- Adapt, build redundancy into road network
- Protect, build resilience maintain/refurbish existing riverbank protection

General approach for Maaroom Foreshore to maintain public assets

Present Day to 2050:
- Adapt and Protect, build resilience
- Enhance natural ecosystems

2050 to 2100:
- Planned transition, retreat and relocate important infrastructure

Present Day to 2050:
- Adapt and Protect, build resilience, maintain boat ramp and jetty
- Avoid, coastal building lines/development setbacks/planning controls
- Adapt, build redundancy into road network

River Heads
Boat Ramps
Maryborough Hervey Bay Rd
Aldershot
Island Plantation Rd
Boat Ramps
Island Plantation Rd
Aubinville STP
Queens Park
Jetties
Beaver Rock Rd
Beaver Rock Rd
Beaver Rock Rd
Maryborough
Boardwalk
Boat Ramps
Bruce Hwy
Prickett Aquatic Area
Tiger St
Jetties
Tinana
Jetties
Boat Ramps
Maaroom
Jetties
Owanyilla

LEGEND

Cadastral Boundaries

Risk Rating

Extreme
High
Low/Medium

Title:

Risks and Potential Adaptation Options
2100 Erosion and Permanent Inundation due to Sea Level Rise

Figure:

Rev: **A**

N

0 3 6km

Approx. Scale

BMT
www.bmt.org

Filepath: I:\B23628_i_jgc_FCRC_CHAS_Phase3to8_mpb\DRG\20200929_Assets_ExtremeHigh_Risk\COA_365_201023_Zone6_2100_SLR_ExtremeHighRisk.WOR

4.7 Management Zone 7 – K'gari (Fraser Island) & Great Sandy Strait Islands

K'gari (Fraser Island) is not a focus of the Coastal Futures project since it is managed differently to other coastal areas, and through other projects and processes. The reasons for this locality not being a key area of interest for this study include:

- The $QCoast_{2100}$ program is focussed on coastal hazards and adaptation planning, particularly for built or Council-controlled assets and areas;
- Whilst parts of the eastern coastline of K'gari are likely to be subject to some erosion and storm tide hazards out to 2100, the Fraser Island communities are generally located behind significant dunes or are protected by rocky outcrops and therefore the risks associated with coastal hazards are generally low;
- Whilst some foreshore parks are Council-controlled, K'gari is set within a National Park. This means its management structure is complex and direct intervention to manage coastal hazard risks is unlikely to be supported, other than to relocate potentially vulnerable built assets; and
- There are several other projects and processes in place to manage the natural values associated with K'gari.

As a result, potentially vulnerable assets have been identified but coastal hazard adaptation planning for K'gari has not been completed. A summary of the risk assessment outcomes is provided below.

4.7.1 Risk Assessment Summary

K'gari land parcels at high risk of impact from sea level rise are mainly zoned environmental management and conservation. Unzoned land parcels associated with the Wangoolba barge landing and a transmitter station site are at high to extreme risk from erosion under all climates and at extreme risk from sea level rise under all climates.

The key assets and values at high or extreme risk identified by the Phase 5 risk assessment are:

- Wangoolba Barge Landing: present day high risk from erosion, extreme risk from sea level rise by 2050
- Transmitter Station: present day high risk from erosion, extreme risk from sea level rise by 2050
- Kingfisher Bay Ferry Landing: present day extreme risk from erosion
- Beaches used as roads: high risk from sea level rise by 2050
- North White Cliffs: present day extreme risk from erosion, high risk from sea level rise by 2050, high risk from storm tide by 2100.

5 Conclusion

The assessment of adaptation options for the Fraser Coast mainland coastline has identified that for many locations, existing development is to be protected through a combination of hard and soft engineering responses. Hard infrastructure is generally recommended where the precedence has already been set and these structures are already in place.

For most localities a mixture of adaptation responses at any given time may be appropriate, particularly under the no regrets options, where these actions can be implemented to improve resilience and/or respond to minor shoreline erosion impacts. At each locality, several adaptation options have not been considered suitable for mitigating coastal hazard risks and therefore are not considered further as part of the Coastal Futures project. In some cases, these options may have other benefits to the community and therefore could be implemented to achieve other objectives.

As discussed in Section 2.3, the Coastal Futures project promotes an adaptation pathways approach that supports flexibility by allowing options to be adapted to changing circumstances (e.g. new knowledge) or as a result of the uncertainty surrounding the timing and extent of coastal hazards. Once an adaptation approach is implemented the selected options are used until they no longer deliver the intended outcomes and a trigger point (threshold) is reached, at which time another option or suite of options is required.

Trigger points can also be used in locations where hazards are not yet occurring but are likely to occur in the future. This approach effectively defers action until an identified point or event in the future (such as a distance from an erosion escarpment or a frequency of inundation or water level) whereby the appropriate action should then be implemented. Planning controls, “no regrets” actions and preliminary investigations should still be undertaken to effectively reduce the scale and cost of risk treatment required in the future, and monitoring is essential so that the emerging triggers for action are recognised. Barnes et al. (2017) provide examples of trigger-based coastal management strategies implemented in Queensland (Appendix E).

Beach nourishment and beach scraping have been identified as potential options at several localities throughout the study area. These actions help to protect land-based assets, maintains the social and recreational values of the beach, and can delay the need for hard engineering structures such as seawalls. Currently there is no permitted sand source to support regional beach nourishment activities, and beach scraping is also limited by environmental constraints at many localities. Council has recently commenced an investigation that seeks to identify a sand source from within the Great Sandy Strait Marine Park (Dayman Spit). For the Coastal Futures project, it has been assumed that a viable beach nourishment sand source for the Esplanade beaches can be established.

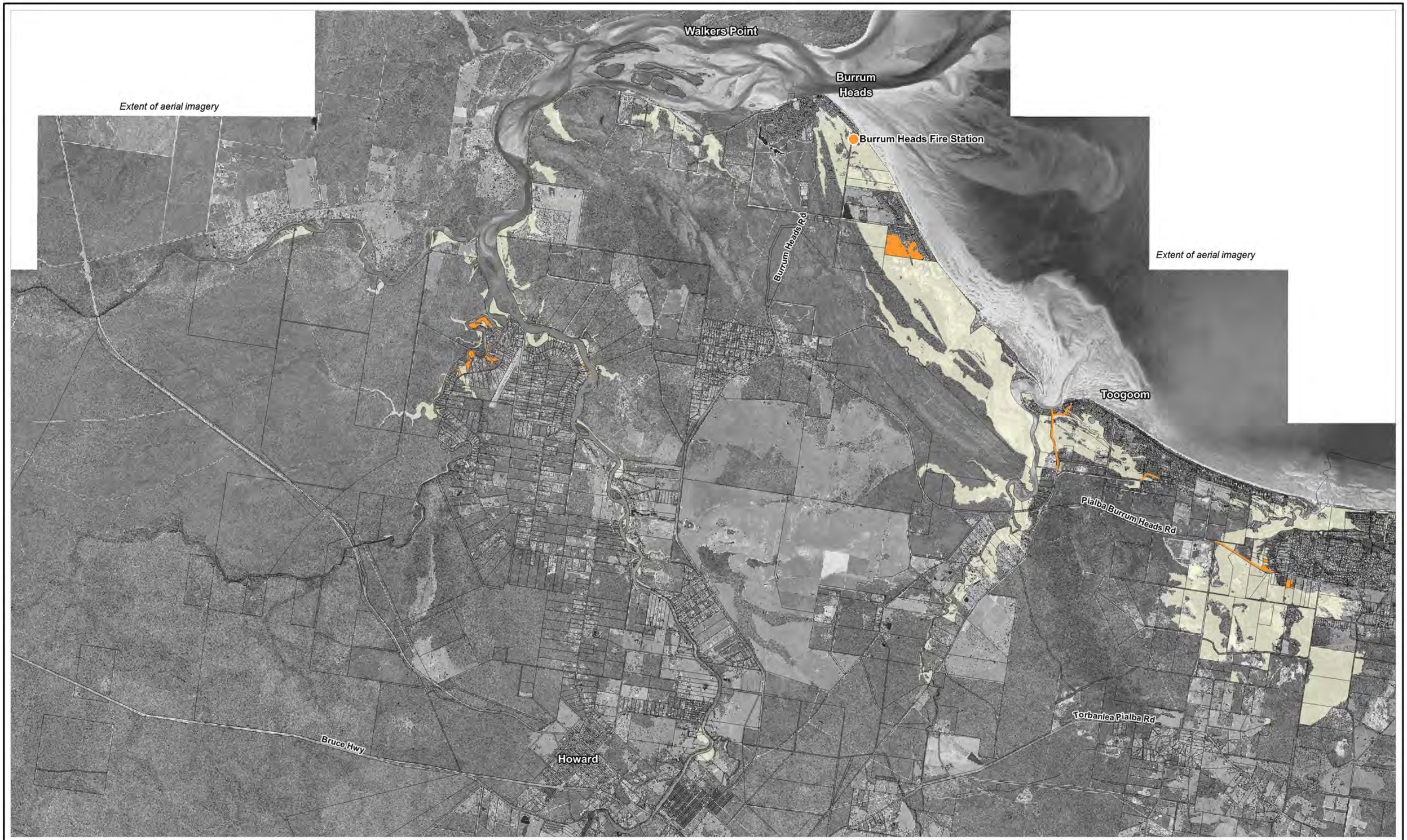
Socio-economic analysis is needed to refine the preferred adaptation responses and pathways and is the focus of Phase 7 of the project. A quantitative Cost Benefit Analysis (CBA) analysis is possible for the Eli Waters to Urangan coastline (Zone 3). At other locations, there is insufficient data for a quantitative CBA and therefore a qualitative socio-economic analysis will be undertaken. This is especially the case for the Great Sandy Strait townships and communities adjacent to estuaries. In some locations the impacts associated with catchment rainfall and flooding need to be integrated into the consideration of specific adaptation responses.

6 References

Ethos Urban (2019) Coastal Futures Phase 3 & 4 Engagement Summary.

Ethos Urban (2020) Coastal Futures Phase 5 & 6 Engagement Summary.

Appendix A Coastal Hazard Risk Mapping



LEGEND

Cadastral Boundaries

Risk Rating

- Extreme
- High
- Low/Medium

Title:

Risks - Present Day Storm Tide

Figure: **A-1**

Rev: **A**

N

0 2 4km

Approx. scale

BMT

www.bmt.org

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Walkers Point
Ross St
Riverview Dr
Burrum Heads
Extent of aerial imagery
Burrum Heads Rd
Burrum Heads Fire Station
Ivor Dr
Orchid Dr
Burrum Heads Rd
Extent of aerial imagery
Boat Ramp
Toogoom
Pialba Burrum Heads Rd
Torbanlea Pialba Rd
Bruce Hwy
Howard

LEGEND

Cadastral Boundaries

Risk Rating

Extreme
High
Low/Medium

Title:
Risks - 2050 Storm Tide

Figure: **A-2**

Rev: **A**

N

0 2 4km

Approx. scale

BMT
www.bmt.org

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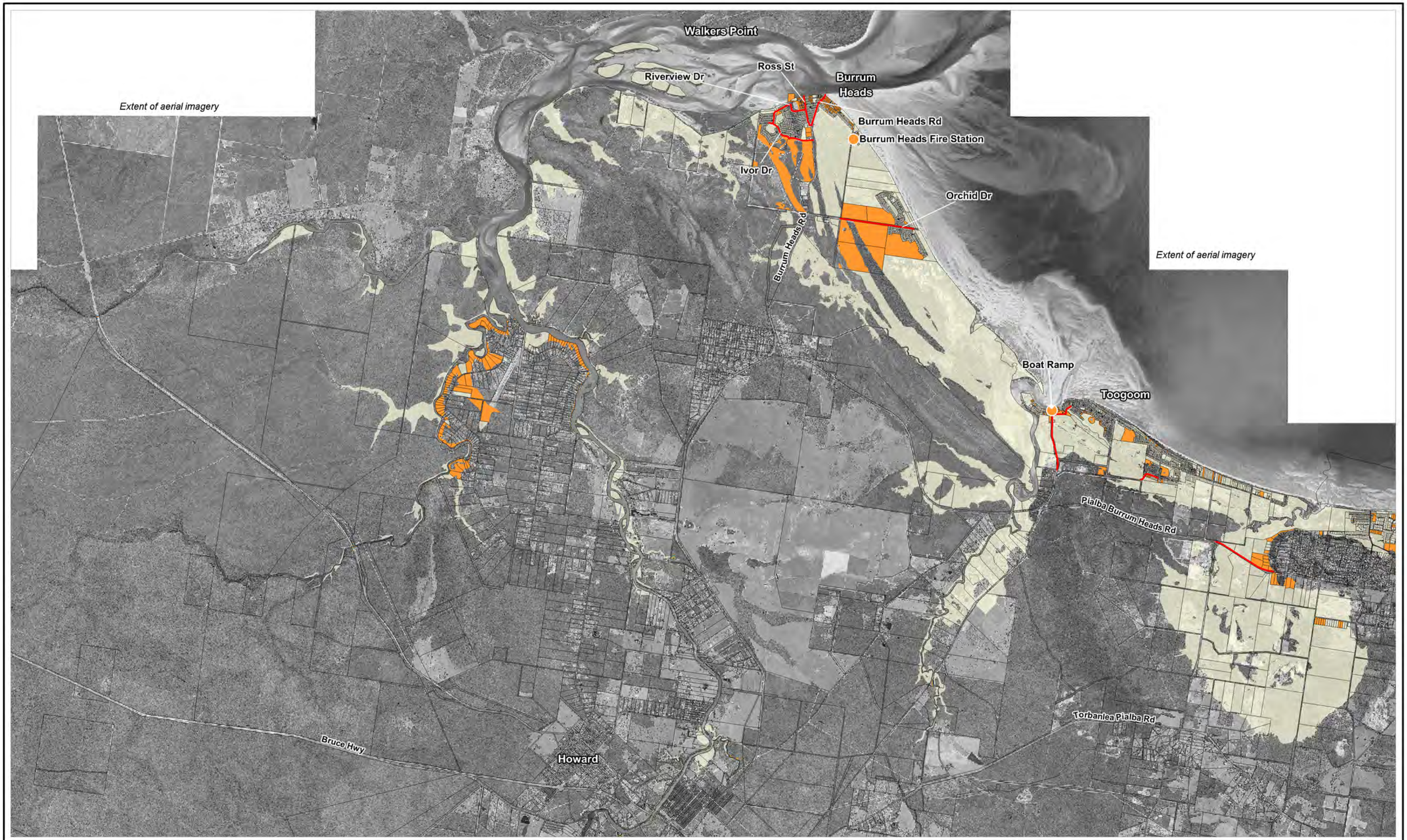


LEGEND

Cadastral Boundaries

Risk Rating

- Extreme
- High
- Low/Medium

Title:

Risks - 2100 Storm Tide

Figure: **A-3**

Rev: **A**

N

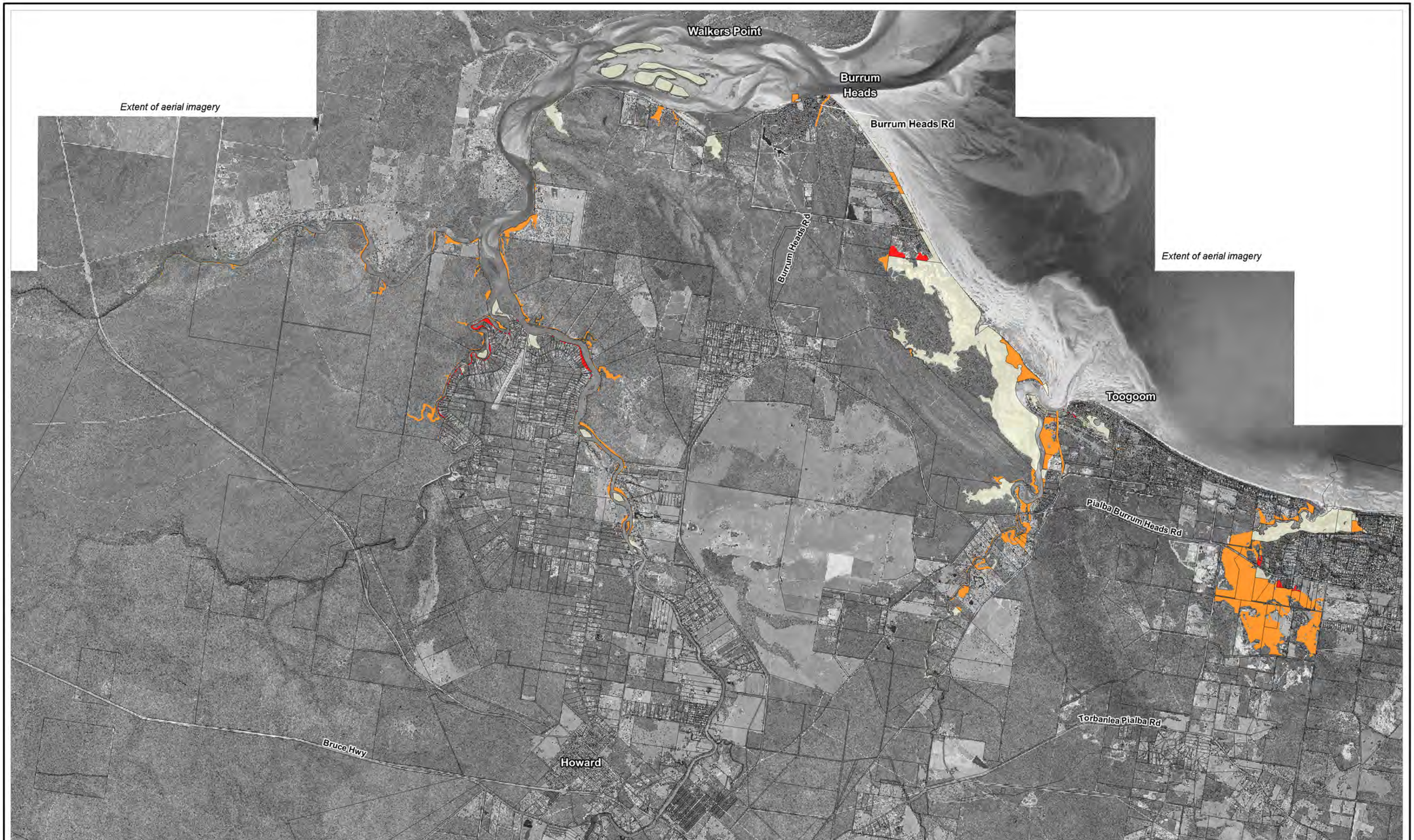
0 2 4km

Approx. scale

BMT

www.bmt.org

Filepath: I:\B23628_i_jgc_FCRC_CHAS_Phase3to8_mpb\DRG\20200929_Assets_ExtremeHigh_Risk\COA_338_200929_Zone1_2100_STI_ExtremeHighRisk.WOR



LEGEND

Cadastral Boundaries

Risk Rating

Extreme

High

Low/Medium

Title:

Risks - Present Day Erosion and Permanent Inundation due to Sea Level Rise

Figure: **A-4**

Rev: **A**

N

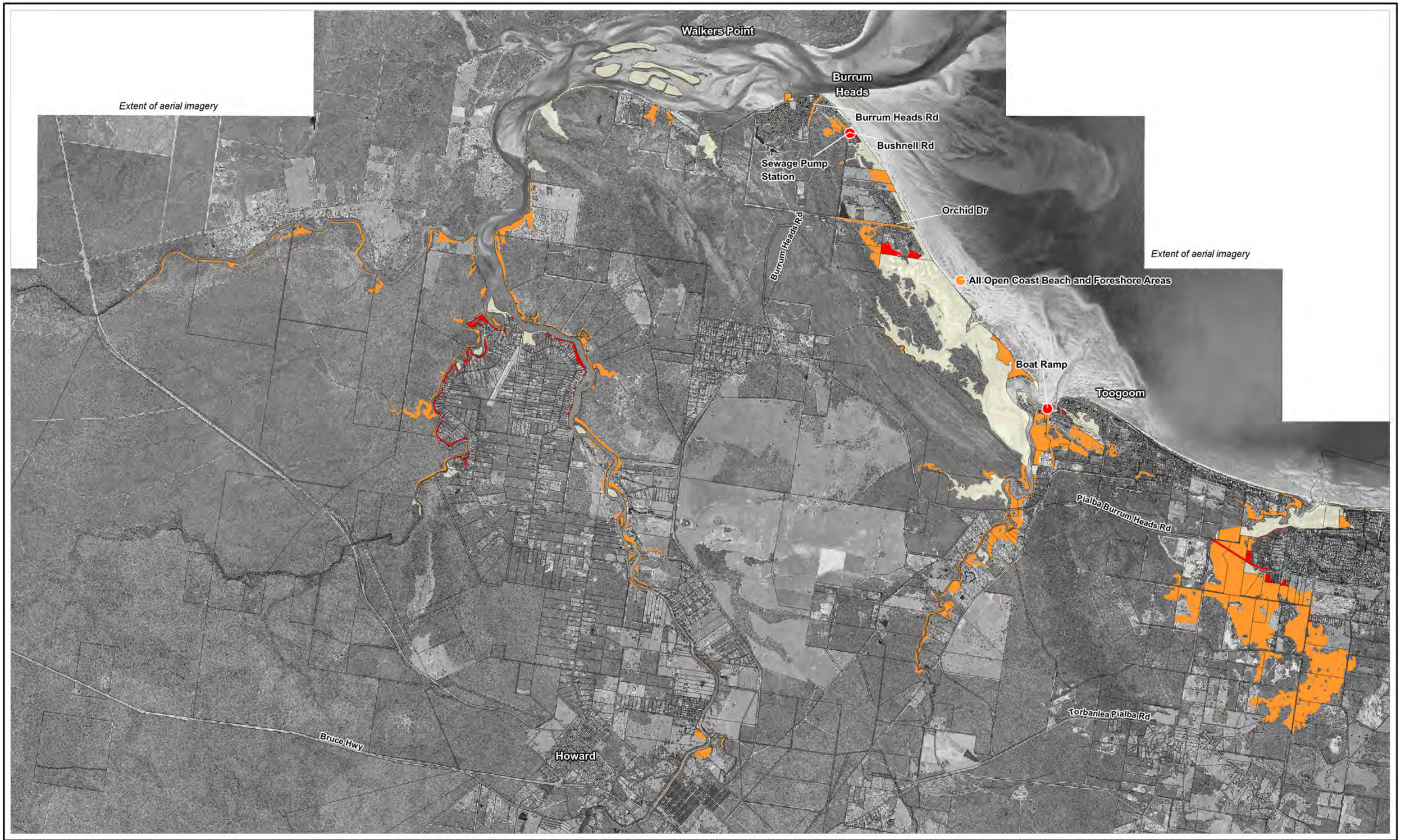
0 2 4km

Approx. scale

BMT

www.bmt.org

Filepath: I:\B23628_i_jgc_FCRC_CHAS_Phase3to8_mpb\DRG\20200929_Assets_ExtremeHigh_Risk\COA_339_200929_Zone1_PresentDay_SLR_ExtremeHighRisk.WOR



LEGEND

Cadastral Boundaries

Risk Rating

- Extreme
- High
- Low/Medium

Title:

Risks - 2050 Erosion and Permanent Inundation due to Sea Level Rise

Figure: **A-5**

Rev: **A**

N

0 2 4km

Approx. scale

BMT

www.bmt.org

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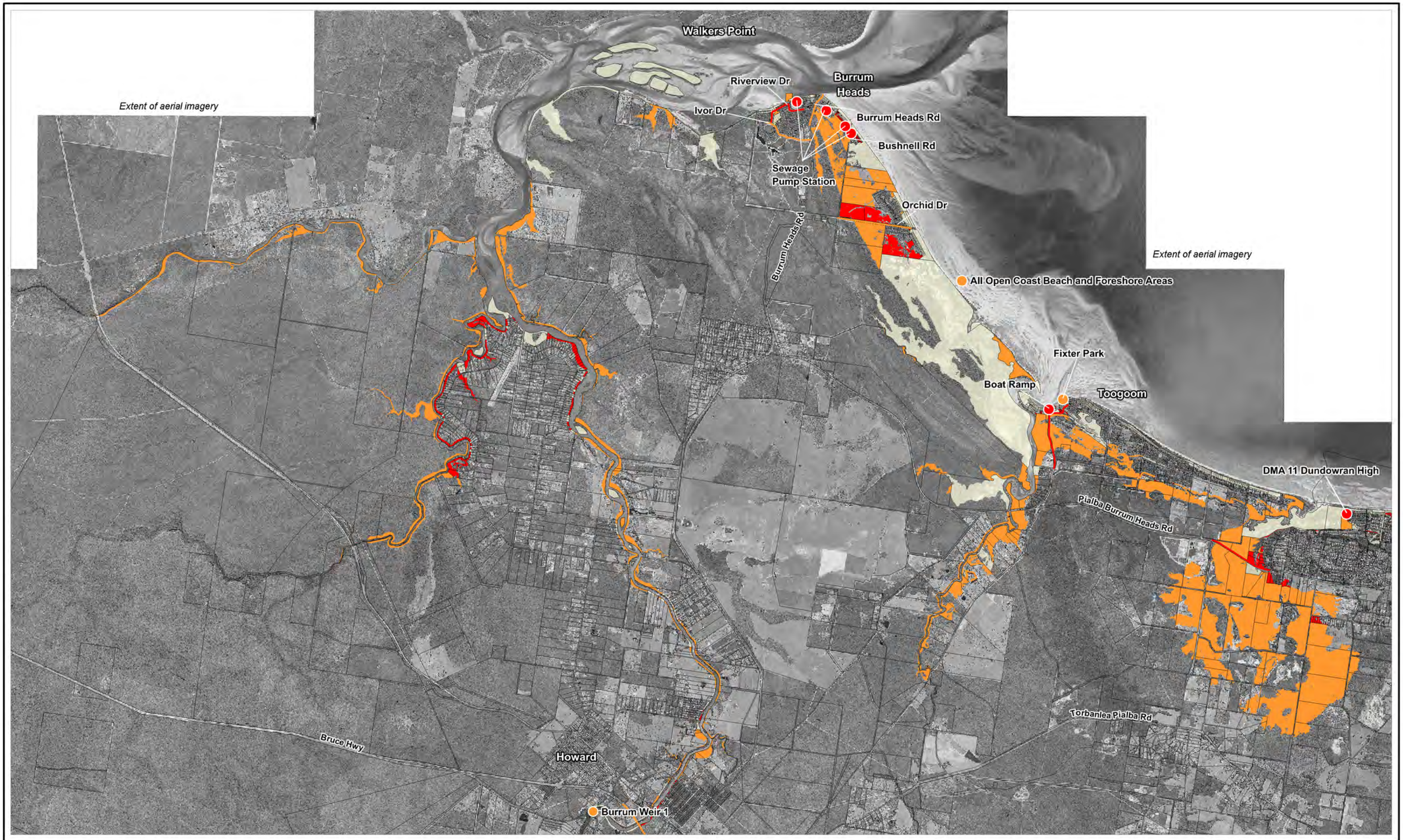

LEGEND

Cadastral Boundaries

Risk Rating

- Extreme
- High
- Low/Medium

Title:

Risks - 2100 Erosion and Permanent Inundation due to Sea Level Rise

Figure: **A-6**

Rev: **A**

N

0 2 4km

Approx. scale

BMT

www.bmt.org

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Extent of aerial imagery

Esplanade
North St
Martin St
Pialba
Serenity Dr
Boat Harbour Dr
Hervey Bay
Urraween Rd
Nikenbah
Boundary Rd
Esplanade
Pier St
Dayman St
Urangan Boat Harbour
Urangan Boat Harbour Ramps
Pulgul St
Booral Rd

Risk Rating

- Extreme
- High
- Low/Medium

Title:

Risks - Present Day Storm Tide

Figure: **A-7**

Rev: **A**

N

0 1 2km

Approx. Scale

BMT

www.bmt.org

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Risk Rating

- Extreme
- High
- Low/Medium

Title:

Risks - 2050 Storm Tide

Figure: **A-8**

Rev: **A**

N

0 1 2km

Approx. Scale

BMT

www.bmt.org

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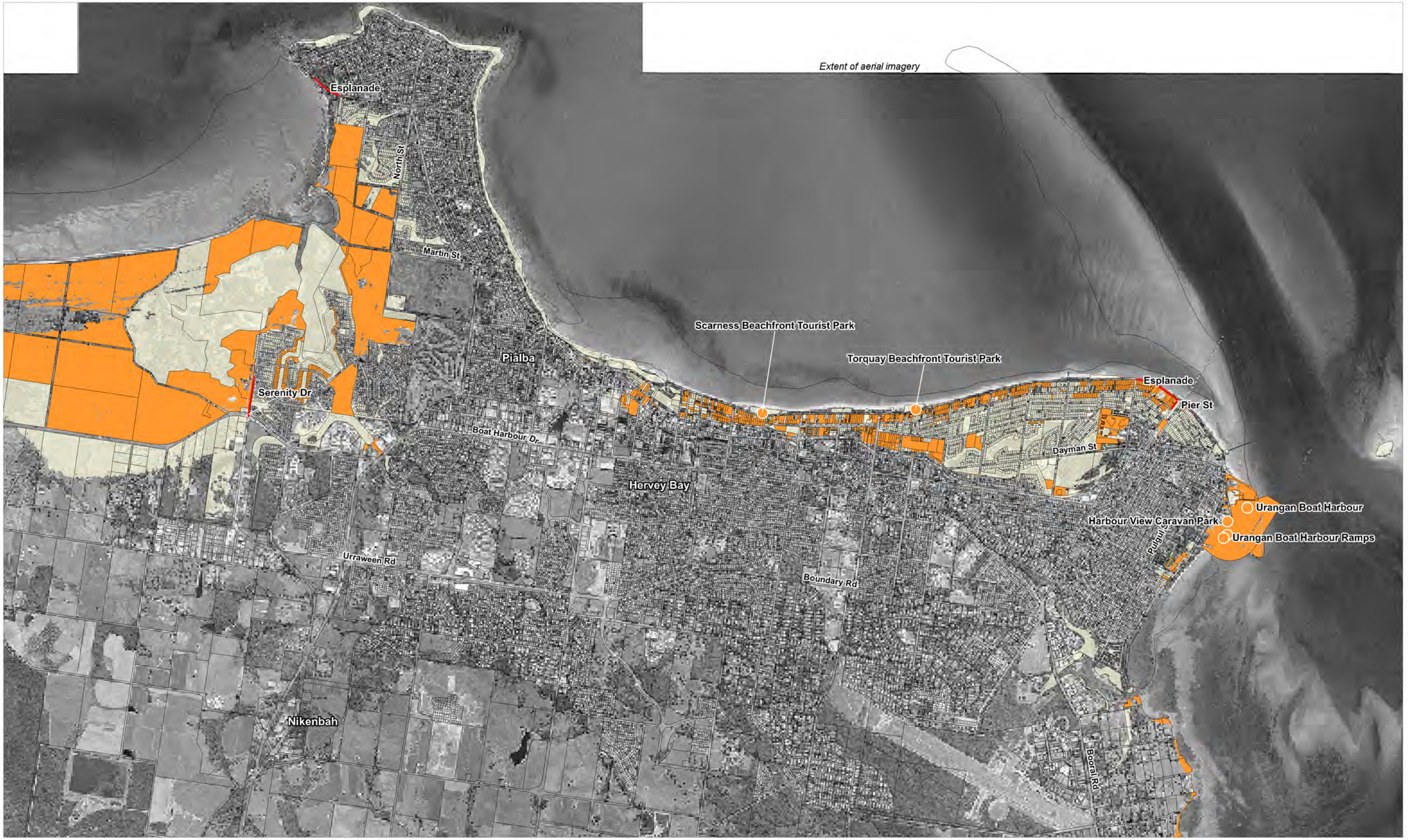

LEGEND

Cadastral Boundaries

Risk Rating

- Extreme
- High
- Low/Medium

Title:

Risks - 2100 Storm Tide

Figure: **A-9**

Rev: **A**

N

0 1 2km

Approx. Scale

BMT

www.bmt.org

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Extent of aerial imagery

North St

Martin St

Wetside Water Education Park

Pialba

Boat Harbour Dr

Hervey Bay

Dayman St

Urraween Rd

Boundary Rd

Nikenbah

Urangan Boat Harbour

Urangan Boat Harbour Ramps

Pulgul St

Boorai Rd

LEGEND

Cadastral Boundaries

Risk Rating

Extreme

High

Low/Medium

Title:

Risks - Present Day Erosion and Permanent Inundation due to Sea Level Rise

Figure: **A-10**

Rev: **A**

N

0 1 2km

Approx. Scale

BMT

www.bmt.org

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Extent of aerial imagery

Esplanade

North St

Martin St

Wetside Water Education Park

All Open Coast Beach and Foreshore Areas

Pialba

Jetty

Jetty

Pier

Boat Harbour Dr

Dayman St

Hervey Bay

Urangan Boat Harbour

Urangan Boat Harbour Ramps

Pulgul St

Urraween Rd

Boundary Rd

Nikenbah

Booral Rd

LEGEND

Cadastral Boundaries

Risk Rating

Extreme

High

Low/Medium

Title:

Risks - 2050 Erosion and Permanent Inundation due to Sea Level Rise

Figure: **A-11**

Rev: **A**

N

0 1 2km

Approx. Scale

BMT

www.bmt.org

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Extent of aerial imagery

Esplanade
North St
Martin St
Sewage Pump Station
Wetside Water Education Park
Sewage Pump Station
Pialba
Pialba Oval
Serenity Dr
Boat Harbour Dr
Jetty
Jetty
All Open Coast Beach and Foreshore Areas
Esplanade
Pier
Pier St
Dayman St
Dayman Park and Surrounds
Hervey Bay
Urraween Rd
Boundary Rd
Urangan Boat Harbour
Urangan Boat Harbour Ramps
Pulgul St
Pulgul Waste Water Treatment Plant
Boorai Rd
Nikenbah

LEGEND

Cadastral Boundaries

Risk Rating

- Extreme
- High
- Low/Medium

Title:

Risks - 2100 Erosion and Permanent Inundation due to Sea Level Rise

Figure: **A-12**

Rev: **A**

N

0 1 2km

Approx. Scale

BMT
www.bmt.org

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Toogoom

Lorikeet Av

Toogoom Rd

O'Regan Creek Rd

Pialba Burrum Heads Rd

Pialba Burrum Heads Rd

Extent of aerial imagery

Serenity Dr

Torbanlea Pialba Rd

Nikenbah

Risk Rating

- Extreme
- High
- Low/Medium

Title:

Risks - Present Day Storm Tide

Figure: **A-13**

Rev: **A**

N

0 1 2km

Approx.Scale

BMT

www.bmt.org

Filepath: I:\B23628_i_jgc_FCRC_CHAS_Phase3to8_mpb\DRG\20200929_Assets_ExtremeHigh_Risk\COA_348_201112_Zone_2_PresentDay_STI_ExtremeHighRisk.WOR

Toogoom Boat Ramp
Toogoom
Lorikeet Av
Toogoom Rd
O'Regan Creek Rd
Pialba Burrum Heads Rd
Pialba Burrum Heads Rd
Extent of aerial imagery
Serenity Dr
Torbanlea Pialba Rd
Nikenbah

LEGEND

Cadastral Boundaries

Risk Rating

Extreme
High
Low/Medium

Title:
Risks - 2050 Storm Tide

Figure: A-14

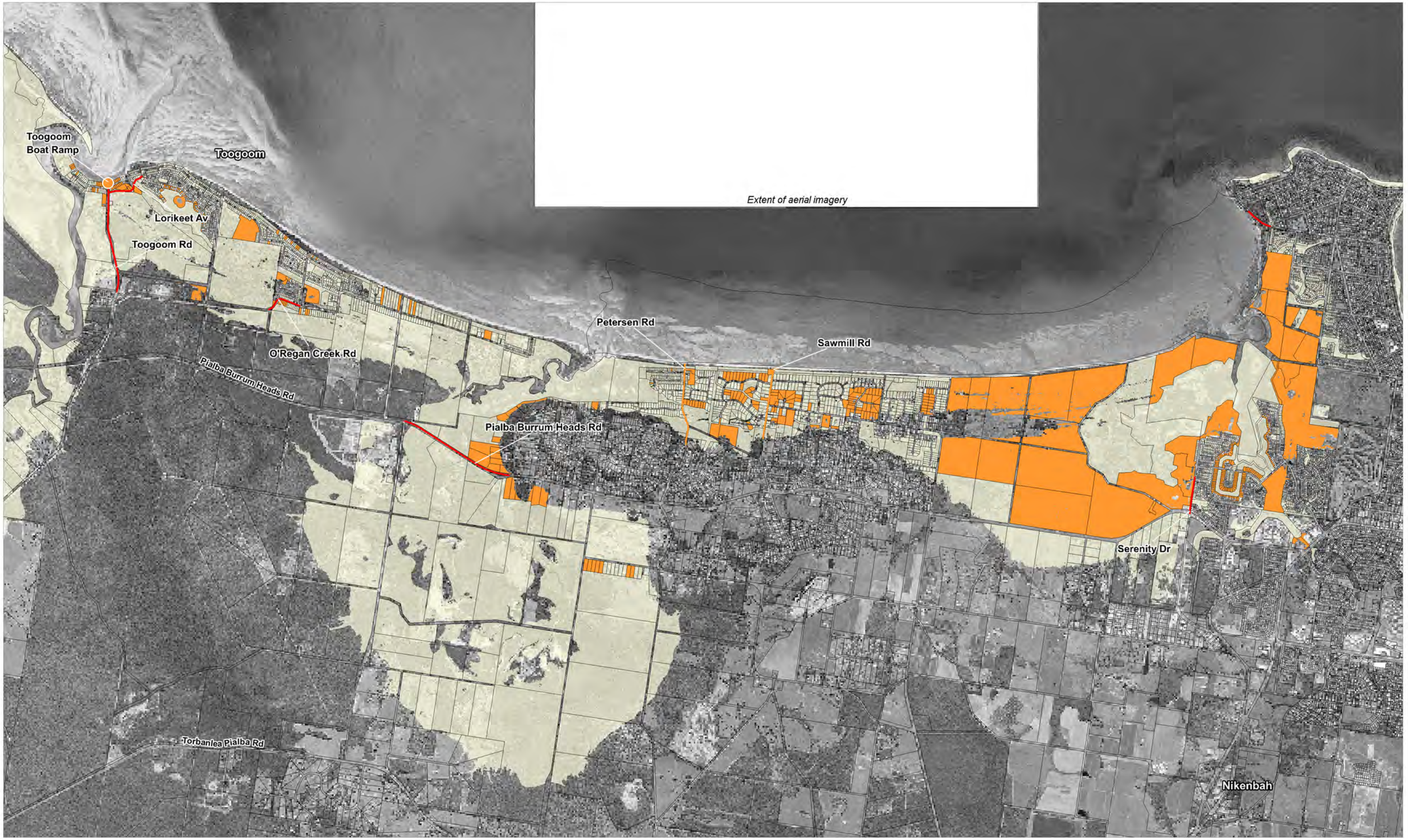
Rev: A

N

0 1 2km
Approx.Scale

BMT
www.bmt.org

Filepath: I:\B23628_i_jgc_FCRC_CHAS_Phase3to8_mpb\DRG\20200929_Assets_ExtremeHigh_Risk\COA_349_201112_Zone_2_2050_STI_ExtremeHighRisk.WOR



LEGEND

Cadastral Boundaries

Risk Rating

Extreme

High

Low/Medium

Title:

Risks - 2100 Storm Tide

Figure: **A-15**

Rev: **A**

N

0 1 2km

Approx.Scale

BMT

www.bmt.org

Filepath: I:\B23628_i_jgc_FCRC_CHAS_Phase3to8_mpb\DRG\20200929_Assets_ExtremeHigh_Risk\COA_350_201112_Zone_2_2100_STI_ExtremeHighRisk.WOR

Toogoom

Toogoom Rd

Plalba Burrum Heads Rd

Torbanlea Plalba Rd

Nikenbah

Extent of aerial imagery

LEGEND

Cadastral Boundaries

Risk Rating

Extreme

High

Low/Medium

Title:

Risks - Present Day Erosion and Permanent Inundation due to Sea Level Rise

Figure: **A-16**

Rev: **A**

N

0 1 2km

Approx.Scale

BMT

www.bmt.org

Filepath: I:\B23628_i_jgc_FCRC_CHAS_Phase3to8_mpb\DRG\20200929_Assets_ExtremeHigh_Risk\COA_351_201112_Zone_2_PresentDay_SLR_ExtremeHighRisk.WOR

Toogoom Boat Ramp

Toogoom

Extent of aerial imagery

Toogoom Rd

Pialba Burrum Heads Rd

Pialba Burrum Heads Rd

Torbanlea Pialba Rd

Nikenbah

LEGEND

Cadastral Boundaries

Risk Rating

Extreme

High

Low/Medium

Title:

Risks - 2050 Erosion and Permanent Inundation due to Sea Level Rise

Figure: **A-17**

Rev: **A**

N

0 1 2km

Approx.Scale

BMT

www.bmt.org

Filepath: I:\B23628_i_jgc_FCRC_CHAS_Phase3to8_mpb\DRG\20200929_Assets_ExtremeHigh_Risk\COA_352_201112_Zone_2_2050_SLR_ExtremeHighRisk.WOR

Fixter Park
Toogoom Boat Ramp
Toogoom
Lorikeet Av
Toogoom Rd
O'Regan Creek Rd
Pialba Burrum Heads Rd
Pialba Burrum Heads Rd
Torbanlea Pialba Rd
Nikenbah

Extent of aerial imagery

LEGEND

Cadastral Boundaries

Risk Rating

Extreme
High
Low/Medium

Title:

Risks - 2100 Erosion and Permanent Inundation due to Sea Level Rise

Figure: **A-18**

Rev: **A**

N

0 1 2km

Approx.Scale

BMT
www.bmt.org

Filepath: I:\B23628_i_jgc_FCRC_CHAS_Phase3to8_mpb\DRG\20200929_Assets_ExtremeHigh_Risk\COA_353_201023_Zone2_2100_SLR_ExtremeHighRisk.WOR

Risk Rating

- Extreme
- High
- Low/Medium

Title:

Risks - Present Day Storm Tide

Figure: **A-19**

Rev: **A**

N

0 2 4km

Approx. scale

BMT

www.bmt.org

Filepath: I:\B23628_i_jgc_FCRC_CHAS_Phase3to8_mpb\DRG\20200929_Assets_ExtremeHigh_Risk\COA_354_201116_Zone_4_PresentDay_STI_ExtremeHighRisk.WOR

LEGEND

Cadastral Boundaries

Risk Rating

Extreme

High

Low/Medium

Title:

Risks - 2050 Storm Tide

Figure: **A-20**

Rev: **A**

N

0 2 4km

Approx. scale

BMT

www.bmt.org

Filepath: I:\B23628_i_jgc_FCRC_CHAS_Phase3to8_mpb\DRG\20200929_Assets_ExtremeHigh_Risk\COA_355_201116_Zone_4_2050_STI_ExtremeHighRisk.WOR

LEGEND

Cadastral Boundaries

Risk Rating

Extreme

High

Low/Medium

Title:

Risks - 2100 Storm Tide

Figure: **A-21**

Rev: **A**

N

0 2 4km

Approx. scale

BMT

www.bmt.org

Filepath: I:\B23628_i_jgc_FCRC_CHAS_Phase3to8_mpb\DRG\20200929_Assets_ExtremeHigh_Risk\COA_356_201112_Zone_4_2100_STI_ExtremeHighRisk.WOR

Extent of aerial imagery

Maryborough Hervey Bay Rd

River Heads

LEGEND

Cadastral Boundaries

Risk Rating

- Extreme
- High
- Low/Medium

Title:

Risks - Present Day Erosion and Permanent Inundation due to Sea Level Rise

Figure: **A-22**

Rev: **A**

N

0 2 4km

Approx. scale

BMT

www.bmt.org

Filepath: I:\B23628_i_jgc_FCRC_CHAS_Phase3to8_mpb\DRG\20200929_Assets_ExtremeHigh_Risk\COA_357_201116_Zone_4_PresentDay_SLR_ExtremeHighRisk.WOR

Booral Rd

Effluent Reuse Facility
Vanderwolf

Extent of aerial imagery

Maryborough Hervey Bay Rd

River Heads

Boat Ramps

LEGEND

Cadastral Boundaries

Risk Rating

Extreme

High

Low/Medium

Title:

Risks - 2050 Erosion and Permanent Inundation due to Sea Level Rise

Figure: **A-23**

Rev: **A**

N

0 2 4km

Approx. scale

BMT

www.bmt.org

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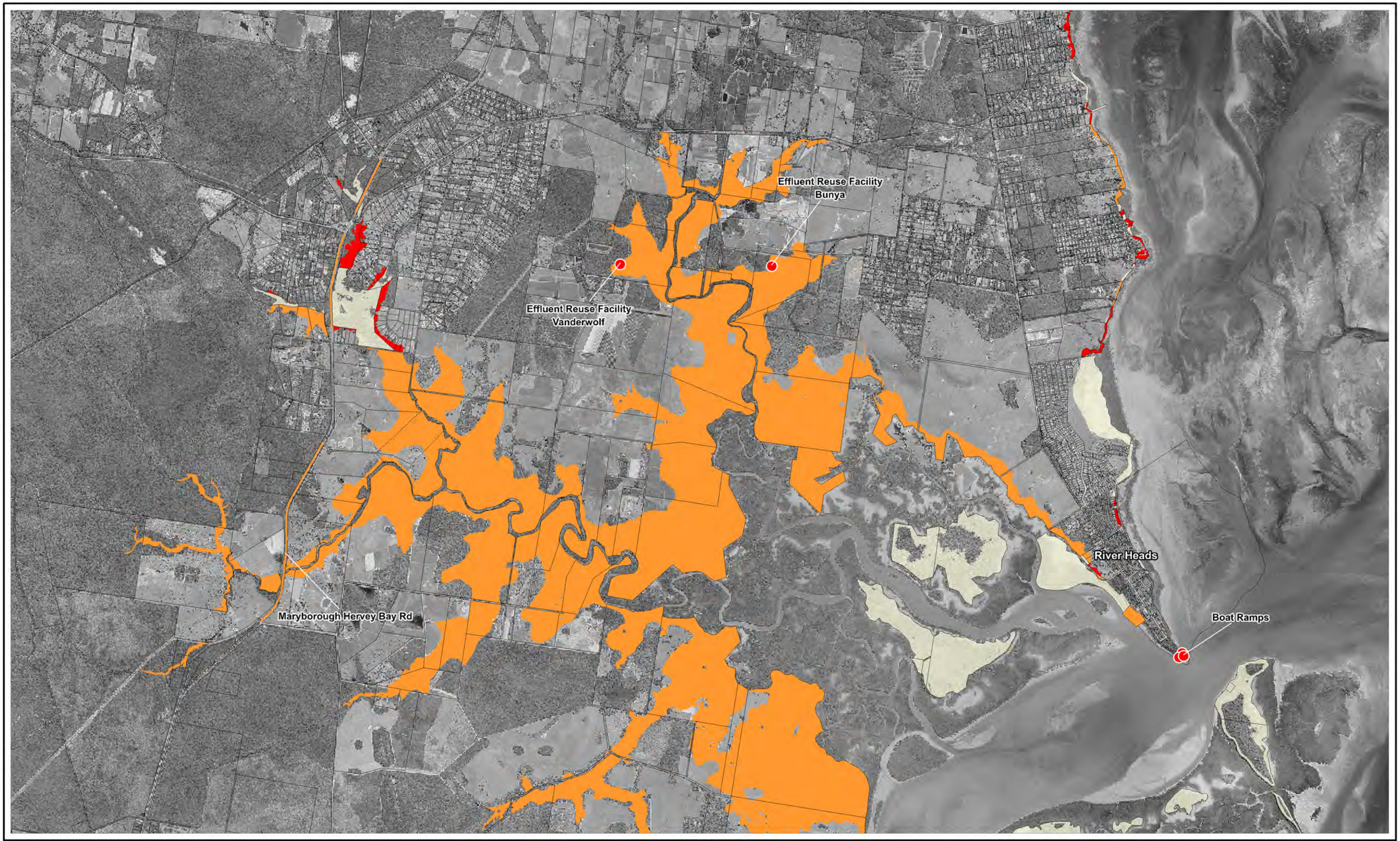

LEGEND

Cadastral Boundaries

Risk Rating

- Extreme
- High
- Low/Medium

Title:

Risks - 2100 Erosion and Permanent Inundation due to Sea Level Rise

Figure: **A-24**

Rev: **A**

N

0 2 4km

Approx. scale

BMT

www.bmt.org

Filepath: I:\B23628_i_jgc_FCRC_CHAS_Phase3to8_mpb\DRG\20200929_Assets_ExtremeHigh_Risk\COA_359_201023_Zone4_2100_SLR_ExtremeHighRisk.WOR

Risk Rating

- Extreme
- High
- Low/Medium

Title:

Risks - Present Day Storm Tide

Figure: **A-25**

Rev: **A**

N

0 3 6km

Approx. Scale

BMT

www.bmt.org

Filepath: I:\B23628_i_jgc_FCRC_CHAS_Phase3to8_mpb\DRG\20200929_Assets_ExtremeHigh_Risk\COA_360_201116_Zone_6_PresentDay_STI_ExtremeHighRisk.WOR

LEGEND

Cadastral Boundaries

Risk Rating

- Extreme
- High
- Low/Medium

Title:

Risks - 2050 Storm Tide

Figure: **A-26**

Rev: **A**

N

0 3 6km

Approx. Scale

BMT

www.bmt.org

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LEGEND

Cadastral Boundaries

Risk Rating

- Extreme
- High
- Low/Medium

Title:

Risks - 2100 Storm Tide

Figure: **A-27**

Rev: **A**

N

0 3 6km

Approx. Scale

BMT

www.bmt.org

Filepath: I:\B23628_i_jgc_FCRC_CHAS_Phase3to8_mpb\DRG\20200929_Assets_ExtremeHigh_Risk\COA_362_201116_Zone_6_2100_STI_ExtremeHighRisk.WOR

River Heads
Maryborough Hervey Bay Rd
Aldershot
Aubinville STP
Beaver Rock Rd
Beaver Rock Rd
Maryborough
Bruce Hwy
Tiger St
Tinana
Maaroom
Owanyilla

LEGEND

Cadastral Boundaries

Risk Rating

Extreme
High
Low/Medium

Title:

Risks - Present Day Erosion and Permanent Inundation due to Sea Level Rise

Figure: **A-28**

Rev: **A**

N

0 3 6km

Approx. Scale

BMT
www.bmt.org

Filepath: I:\B23628_i_jgc_FCRC_CHAS_Phase3to8_mpb\DRG\20200929_Assets_ExtremeHigh_Risk\COA_363_201116_Zone_6_PresentDay_SLR_ExtremeHighRisk.WOR

River Heads
Boat Ramps
Maryborough Hervey Bay Rd
Aldershot
Island Plantation Rd
Boat Ramps
Island Plantation Rd
Aubinville STP
Jetties
Beaver Rock Rd
Beaver Rock Rd
Maryborough
Bruce Hwy
Boat Ramps
Tiger St
Boat Ramps
Jetties
Tinana
Jetties
Maaroom
Jetties
Owanyilla

LEGEND

Cadastral Boundaries

Risk Rating

Extreme

High

Low/Medium

Title:

Risks - 2050 Erosion and Permanent Inundation due to Sea Level Rise

Figure: A-29

Rev: A

N

0 3 6km

Approx. Scale

BMT

www.bmt.org

Filepath: I:\B23628_i_jgc_FCRC_CHAS_Phase3to8_mpb\DRG\20200929_Assets_ExtremeHigh_Risk\COA_364_201116_Zone_6_2050_SLR_ExtremeHighRisk.WOR

River Heads
Boat Ramps
Maryborough Hervey Bay Rd
Aldershot
Island Plantation Rd
Boat Ramps
Island Plantation Rd
Aubinville STP
Queens Park
Jetties
Beaver Rock Rd
Beaver Rock Rd
Beaver Rock Rd
Maryborough
Boardwalk
Boat Ramps
Bruce Hwy
Prickett Aquatic Area
Tiger St
Jetties
Tinana
Jetties
Boat Ramps
Maaroom
Jetties
Owanyilla

LEGEND

Cadastral Boundaries

Risk Rating

- Extreme
- High
- Low/Medium

Title:

Risks - 2100 Erosion and Permanent Inundation due to Sea Level Rise

Figure: **A-30**

Rev: **A**

N

0 3 6km

Approx. Scale

BMT
www.bmt.org

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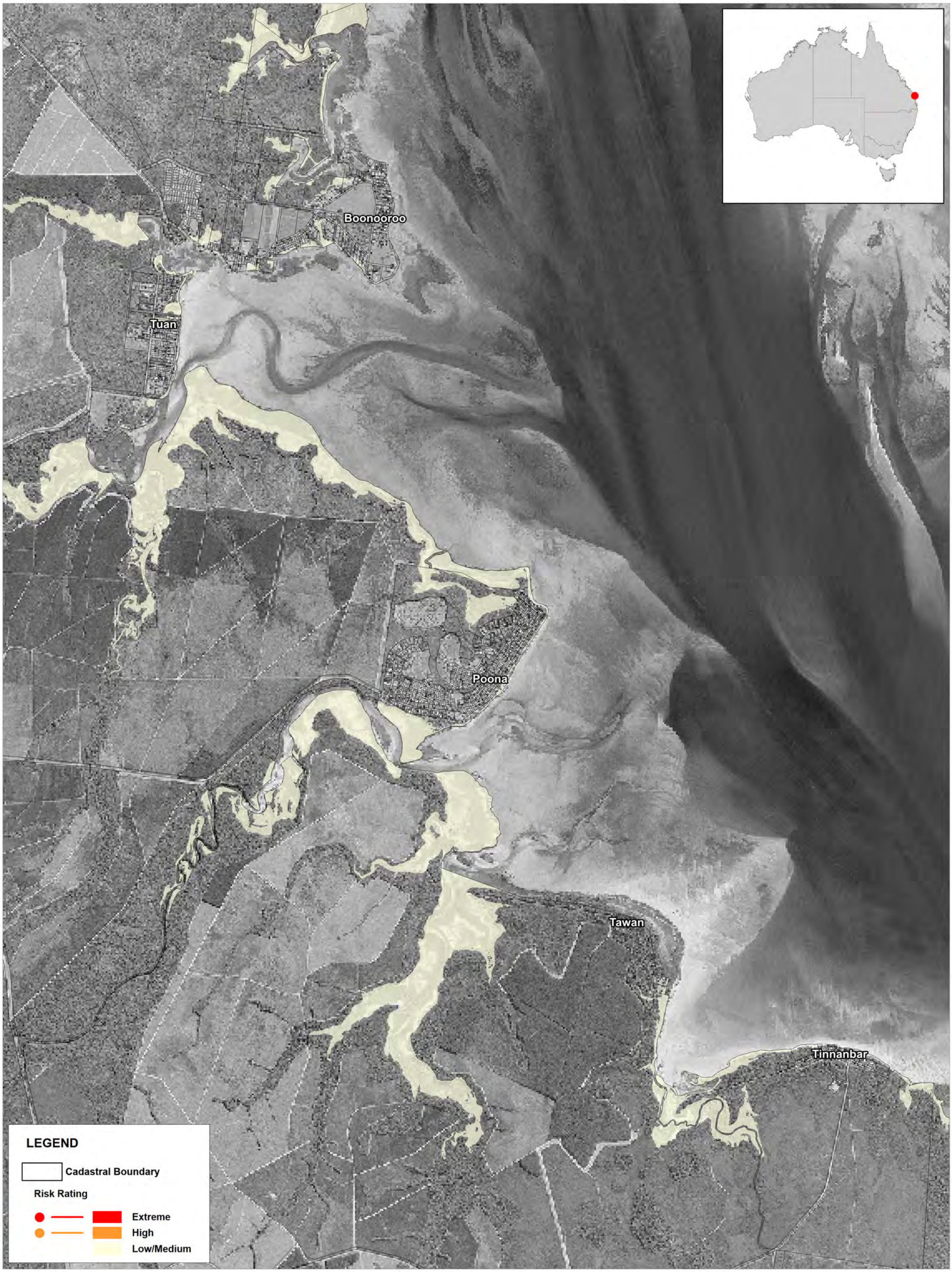

Title:

Risks - Present Day Storm Tide

Figure: **A-31**

Rev: **A**

N

0 4 8km

Approx. Scale

BMT
www.bmt.org

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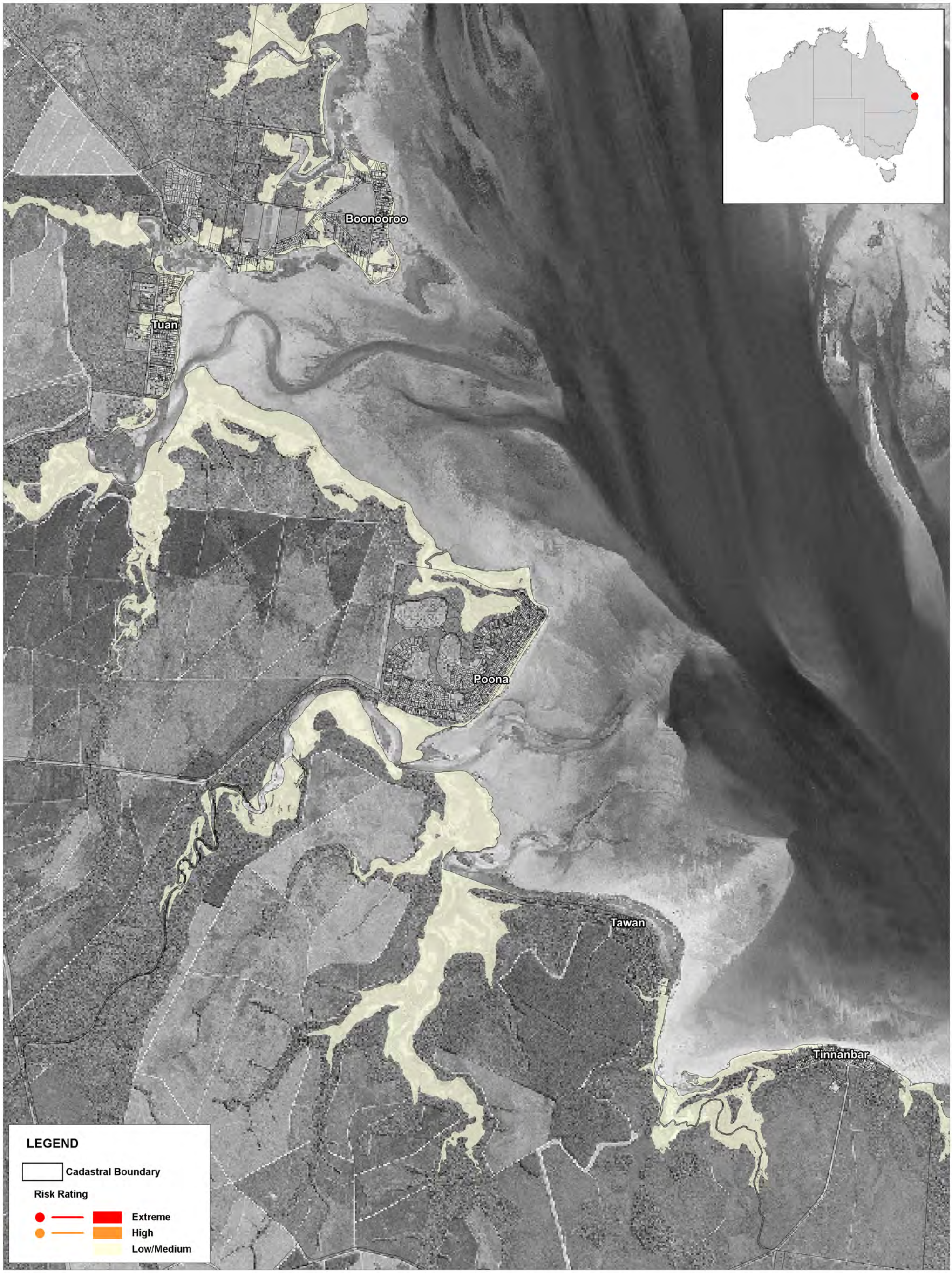

Title:

Risks - 2050 Storm Tide

Figure: **A-32**

Rev: **A**

N

0 4 8km

Approx. Scale

BMT
www.bmt.org

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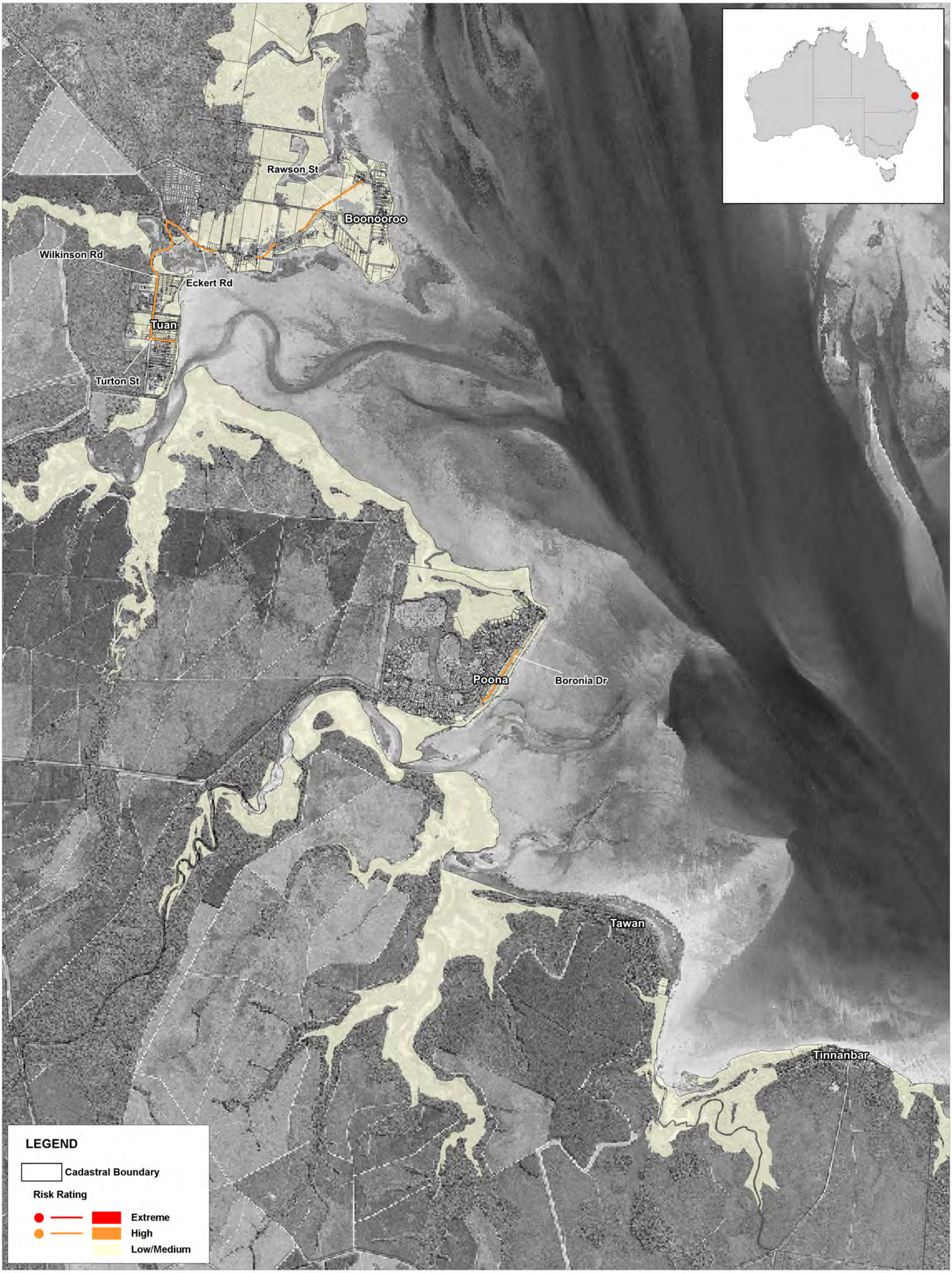


Title:

Risks - 2100 Storm Tide

Figure: **A-33**

Rev: **A**

BMT endeavours to ensure that the information provided in this map is correct at the time of publication. BMT does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

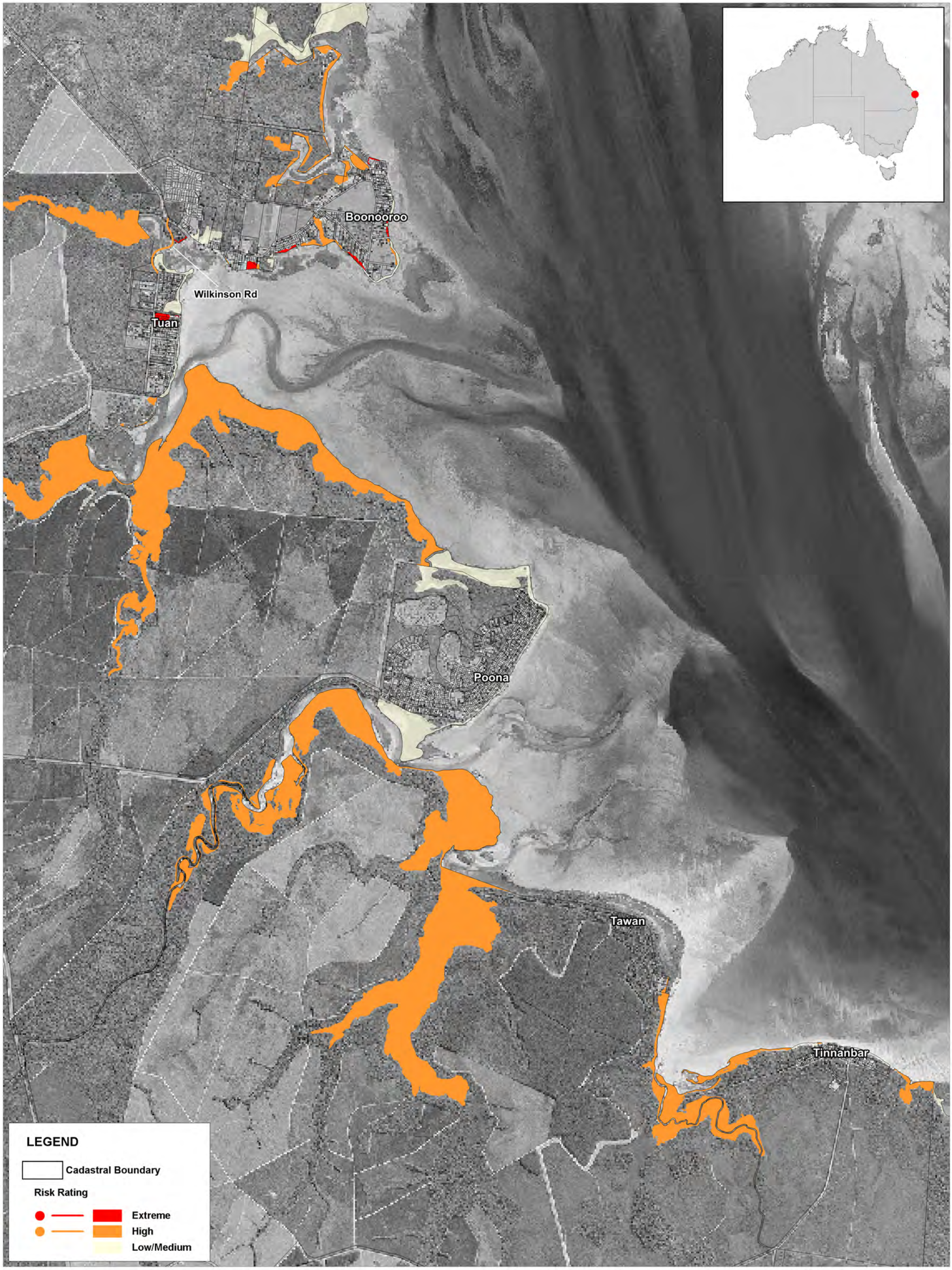
N

0 4 8km

Approx. Scale

BMT
www.bmt.org

Filepath: I:\B23628_i_jgc_FCRC_CHAS_Phase3to8_mpb\DRG\20200929_Assets_ExtremeHigh_Risk\COA_368_201116_Zone_5_2100_STI_ExtremeHighRisk.WOR



Title:

Risks - Present Day Erosion and Permanent Inundation due to Sea Level Rise

Figure: **A-34**

Rev: **A**

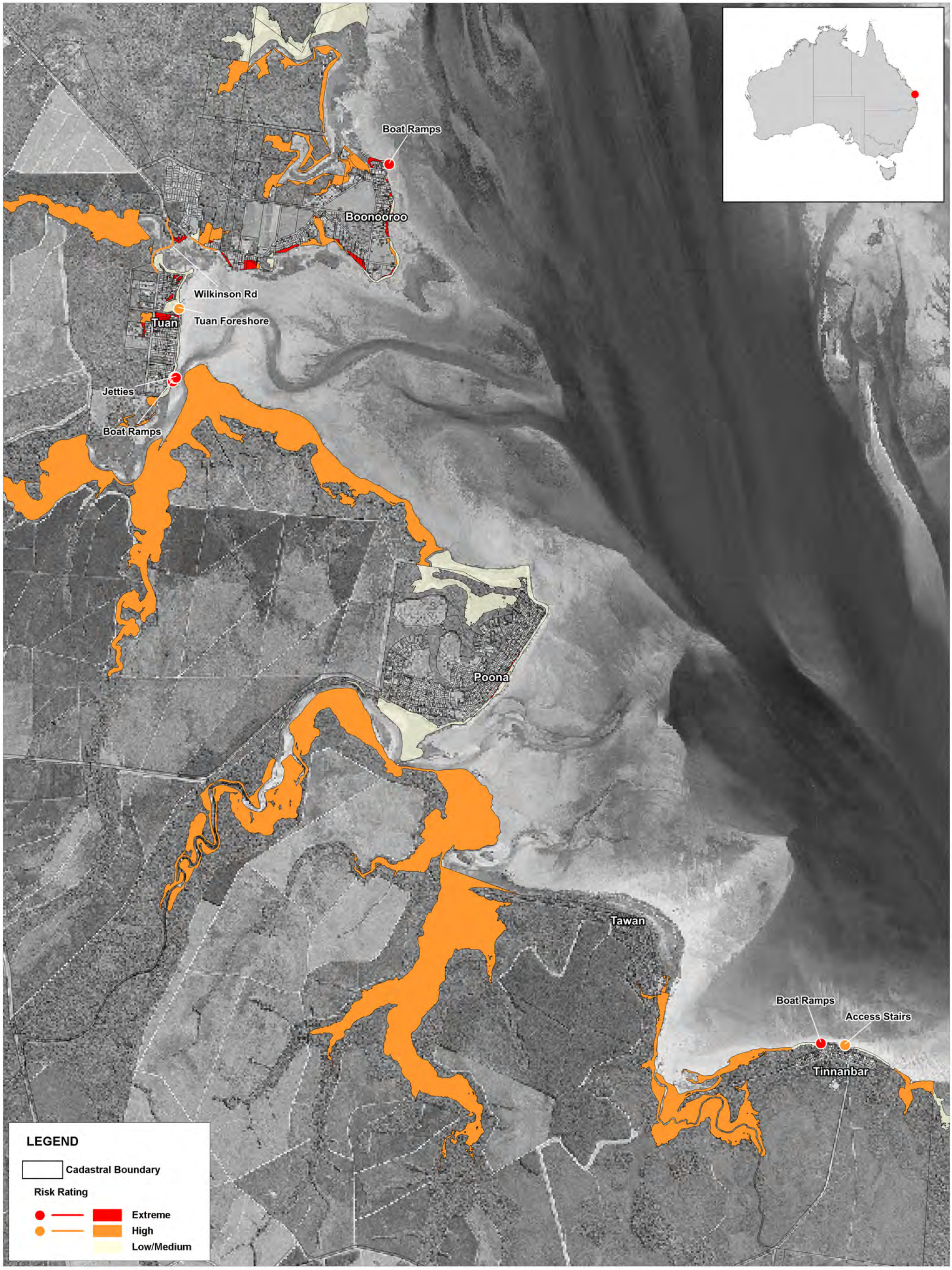
N

0 4 8km

Approx. Scale

BMT
www.bmt.org

Filepath: I:\B23628_i_jgc_FCRC_CHAS_Phase3to8_mpb\DRG\20200929_Assets_ExtremeHigh_Risk\COA_369_201116_Zone_5_PresentDay_SLR_ExtremeHighRisk.WOR



Title:

Risks - 2050 Erosion and Permanent Inundation due to Sea Level Rise

Figure: A-35

Rev: A

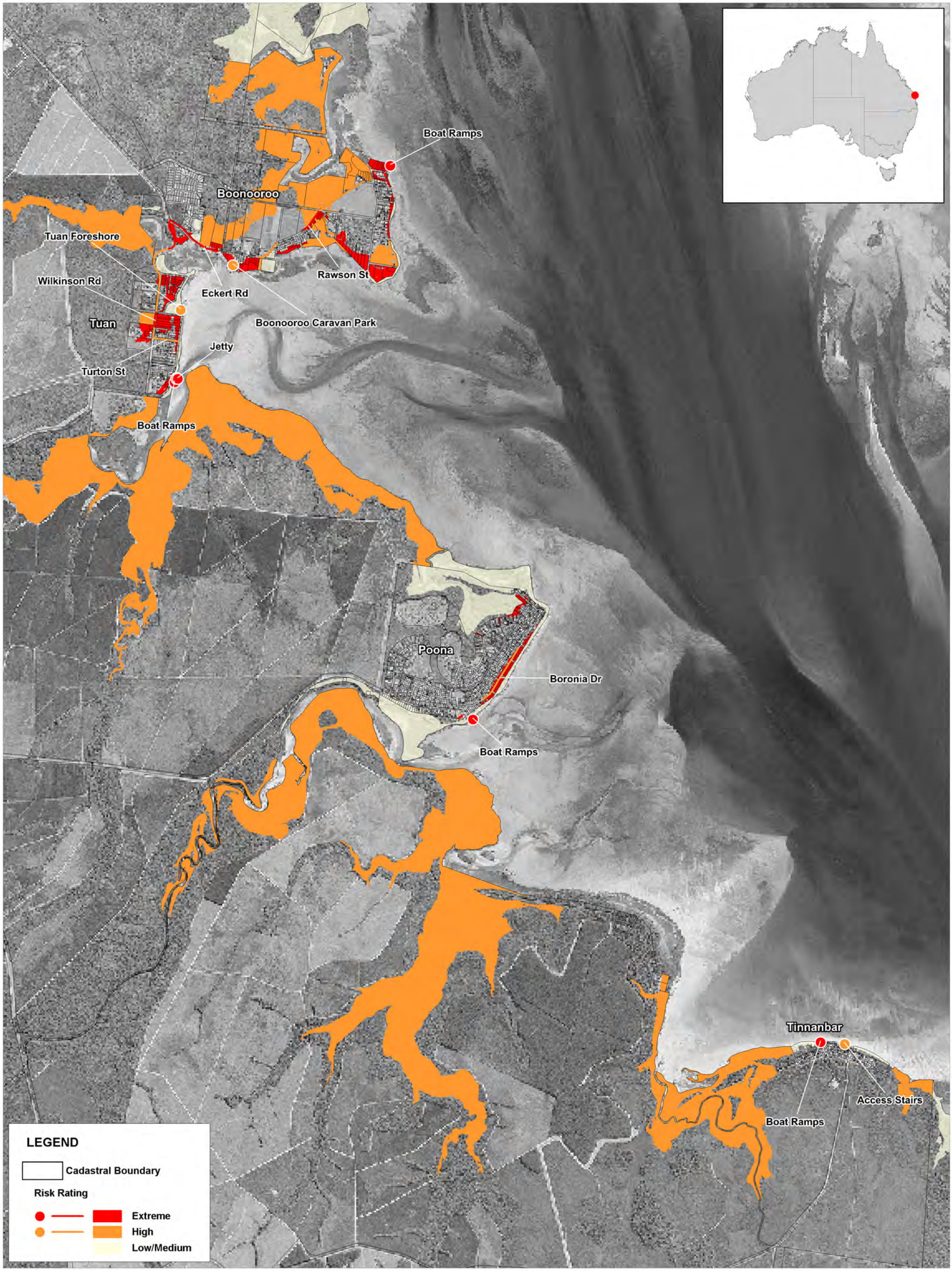
N

0 4 8km

Approx. Scale

BMT
www.bmt.org

Filepath: I:\B23628_i_jgc_FCRC_CHAS_Phase3to8_mpb\DRG\20200929_Assets_ExtremeHigh_Risk\COA_370_201116_Zone_5_2050_SLR_ExtremeHighRisk.WOR



Title:

Risks - 2100 Erosion and Permanent Inundation due to Sea Level Rise

Figure: **A-36**

Rev: **A**

N

0 4 8km

Approx. Scale

BMT
www.bmt.org

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Appendix B Adaptation Options Compendium

Fraser Coast Coastal Hazard Adaptation Strategy (CHAS)

Coastal Futures: Planning Our Changing Coastline

Phase 6 – Adaptation Options Compendium

www.qcoast2100.com.au

1 Introduction

1.1 Background Information

Fraser Coast Regional Council (FCRC) has commenced studies to support preparation of a Coastal Hazard Adaptation Strategy (CHAS) under the QCoast$_{2100}$ program, known locally as the *Coastal Futures: Planning Our Changing Coastline* project. The project has already identified potential risks to the community, assets and values associated with coastal hazards, specifically:

- Temporary flooding of coastal areas due to storm tide;
- Temporary or permanent loss of land due to coastal erosion; and
- Permanent loss of land due to coastal erosion and sea level rise.

1.2 QCoast$_{2100}$ Program

The QCoast$_{2100}$ program has been designed to assist Queensland coastal councils with funding and technical support to progress the preparation of plans and strategies to address climate change related coastal hazard risks. Governed by a Board comprising members from the Local Government Associated of Queensland (LGAQ), Department of Environment and Science (DES) and Department of Local Government, Racing and Multicultural Affairs (DLGRMA), the program is intended to guide decision-making across key areas of local government planning and operations, including:

- Corporate and operational planning and financial planning;
- Land use planning and development assessment;
- Infrastructure planning and management including roads, stormwater and foreshores;
- Asset management and planning including nature conservation, recreation, cultural heritage values and other public amenities;
- Community planning; and
- Emergency management.

The QCoast$_{2100}$ Minimum Standards & Guidelines (MS&G) (DEHP, 2016) provide guidance to local government on preparing a CHAS. The guidelines set minimum requirements that are to be included in a CHAS, as well as providing information on leading practices to facilitate continuous improvement.

The minimum standards set a benchmark for undertaking such studies in Queensland so that coastal hazard adaptation decision-making is approached in a consistent and systematic manner. The MS&G are structured to address the key phases of a CHAS which are illustrated in Figure 1-1. This compendium has been prepared as part of *Phase 6 – identify potential adaptation options*.

1.3 Purpose of the Compendium

This Adaptation Options Compendium provides summaries of potential options to manage coastal hazard risks to the year 2100.

Many of the options have already been implemented by FCRC or are part of routine activities at some localities.

Figure 1-1 QCoast$_{2100}$ Phases (DEHP, 2016)

Other options may represent a significant change to the present-day approach to managing coastal hazard risks. These options will need further consideration through socio-economic analysis (Phase 7 of the project) to determine if they're suitable for Fraser Coast localities.

In some cases, an option presented here will be determined unsuitable and will not be considered further as part of the current project.

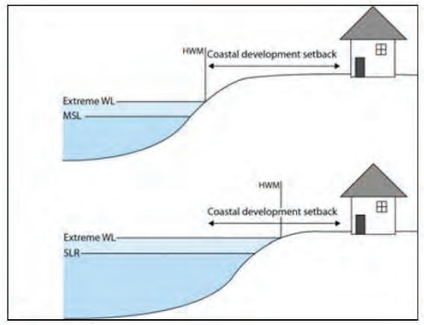
The Compendium describes almost 50 unique options for managing coastal hazard risks. No single option can eliminate the risk and most localities will require a suite of actions to be sequenced over time. Any future options or actions identified as part of the *Coastal Futures* project will need further consideration before implementation. New technologies or approaches to managing coastal hazards risk may also need to be considered in the future.

A preliminary assessment of each option in terms of the 'Period of Effectiveness' and 'Capital Cost' has been made. A simple traffic light colour code system has been applied, whereby:

- Green indicates long term effectiveness or low cost
- Yellow indicates medium term effectiveness or medium cost
- Red indicates short term effectiveness or high cost

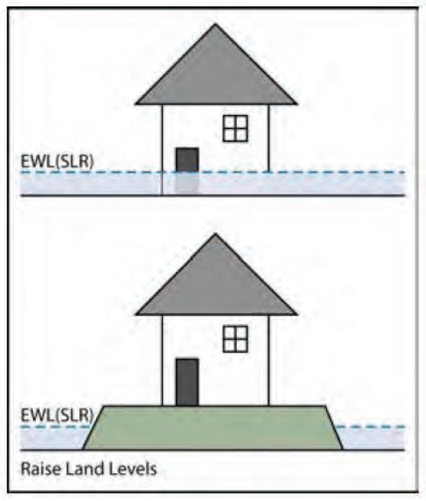
Following this approach options that are effective in the long term and low cost are preferred over those with a shorter period of effectiveness and higher cost. It is noted that this preliminary assessment is indicative and won't be representative across all localities and scenarios.

'Period of Effectives' colour code	Short term	Medium term	Long term
'Capital Cost' colour code	Low	Medium	High

Adaptation Option	Adaptation Option Description	Adaptation Option Type	Relevant hazards			Period of Effectiveness	Drawbacks	Benefits	Capital Cost
			Erosion	Storm Tide Inundation	Sea Level Rise				
Avoid									
Community infrastructure planning and management	Avoid locating new important community infrastructure with a long design life in hazard areas. Progressively relocate replacement infrastructure footprint landward over time. Consider opportunities associated with the design life of assets and relocate assets once they are due for replacement.	Planning	✓	✓	✓	Long term	Potential impediment to economic growth and to accommodating population growth. Capital costs may be substantially increased.	Reduces exposure to future risk. Relocating infrastructure can help influence decisions to relocate other services and assets (often non-council) away from hazard areas. Opportunity for Council to lead by example by avoiding hazard areas.	Varies depending on infrastructure interdependencies and land availability
Coastal building lines / development setbacks	Maintain, review and/or implement coastal development building lines to avoid the placement of permanent assets in the hazard area.  *Note: HWM = high water mark; SLR = sea level rise; MSL = mean sea level* **Figure 2 Coastal Development Setbacks**[1]	Planning	✓	✓	✓	Medium - Long term	Reduced area within property boundary for development potential. Existing landowners expect to be able to place infrastructure within the full building envelope.	Minimal cost to public. Prolonged life of development. Reduces risk profile of properties within the hazard area. Can be applied to all hazards, but most commonly to erosion.	Low, but impacts on land values will vary depending on existing land values and length of shoreline. May be in the order of tens of thousands of dollars for some open coast properties

[1] Griffith University Centre for Coastal Management and GHD Pty Ltd (2012) Coastal hazard adaptation options – A compendium for Queensland coastal councils.

Adaptation Option	Adaptation Option Description	Adaptation Option Type	Relevant hazards			Period of Effectiveness	Drawbacks	Benefits	Capital Cost
			Erosion	Storm Tide Inundation	Sea Level Rise				
Reduce intensity of future development	Implement risk appropriate land use policy and development provisions to maintain/not increase existing risk and future exposure in the coastal hazard area, for example: • change zoning to less intensive uses to avoid future exposure and allow risk appropriate land uses to occur such as open space or conservation • reduce density to maintain/not increase exposure to risk. Consider minimum habitable floor levels to manage risk to property in areas of tolerable risk. Includes partial zoning changes of lots. Covers greenfield and infill development.	Planning	✓	✓	✓	Medium - Long term	Potential impediment to economic growth and to accommodating population growth. Existing land values may reduce. Existing owners would have an investment-backed expectation to be able to develop land. Implementation may require a planning scheme amendment. Risk of landowners not being supportive. May impact on land supply.	Maintains current risk profile by not allowing inappropriate development in current or future hazard areas where the risks are intolerable. Allows risk responsive land use and development that is appropriate for the location and level of risk in the coastal hazard area. Creates / improves buffer between the coastline and other landward development. Reduces exposure to future risk. Reduces long-term exposure to legal and financial risks. Risk of potential compensation to landowners from adverse planning scheme changes can be avoided through the Feasible Alternative Assessment Reporting (FAAR) process. Can be used to signal a clear policy intent to transition land use over time. Provides greater certainty for development and community expectations when zoning and provisions are risk appropriate. Getting the land use strategy right minimises reliance on emergency evacuation as the sole measure to mitigate risk to life and, avoids putting additional burden on existing emergency management resources. Can be applied to all coastal hazards.	Varies depending on land values and length of shoreline. May be in the order of millions of dollars for some open coast properties

Adaptation Option	Adaptation Option Description	Adaptation Option Type	Relevant hazards			Period of Effectiveness	Drawbacks	Benefits	Capital Cost
			Erosion	Storm Tide Inundation	Sea Level Rise				
Raise land levels	Manually change land levels on low-lying sites within inundation hazard zones to allow new assets to be located above hazard levels. Often associated with greenfield development or in association with seawall construction  *Note: EWL = extreme water level; SLR = sea level rise* **Figure 3 Raised land levels[1]**	Engineering and Planning	×	✓	✓	Medium - Long term	Large costs on the developer/owner to import fill Potential isolation, drainage, erosion and landscape issues with neighbouring lands May locally increase flood levels or adversely impact on the natural environment. Protection measures can fail and require maintenance over time Unsuitable for existing highly urbanised areas Unsuitable for existing highly urbanised areas and can result in issues with pedestrian connectivity, impacts on streetscape and character	Works can avoid exposure to current and future risks. May increase property values.	Varies depending on location, $20 - $35/m^2 per m raised
Retreat or Planned Transition									
Maintain status quo (no changes to present management approach)	Accept loss of land or assets affected by a hazard event on unprotected shorelines (i.e. once affected, assets or land is not replaced). Allow dunes to recede without intervention, potentially leading to damage of public or private infrastructure Maintain existing structures as per current management arrangements	Ecosystem Management / Engineering	✓	✓	✓	Ongoing	Does not reduce risk exposure	No increase in costs	Existing costs are variable. No change in cost

Adaptation Option	Adaptation Option Description	Adaptation Option Type	Relevant hazards			Period of Effectiveness	Drawbacks	Benefits	Capital Cost
			Erosion	Storm Tide Inundation	Sea Level Rise				
Relocate important infrastructure	Relocate important public or community assets to a new location outside of the hazard zone  **Figure 4 Mungo Brush Road relocation overview, Myall Lakes National Park NSW[2]**	Planning / Engineering	✓	✓	✓	Medium - Long Term	Requires suitable alternative locations for the infrastructure Development approvals may be required to facilitate relocation and establishment Substantial additional costs or impacts may be incurred depending on the availability/ characteristics of the alternative site	The coastline and sandy beaches are retained because they can recede naturally Assets are not subject to ongoing impacts and retrofitting/rebuild costs Where possible timing can be aligned to coincide with planned asset renewal Reduces exposure to future risk	Varies depending on asset type and scale. May be in the millions of dollars
Land buy back (no lease back)	High risk private properties are bought at market prices, built infrastructure is demolished and land is used for coastal management purposes (e.g. open space (or similar))	Planning	✓	✓	✓	Long Term	The public (Council/State Govt) must fund full purchase price up-front Coastal property can be very expensive, particularly those with ocean views, large land parcels/houses, apartment blocks etc. Some community members may consider it unfair to spend public funds on private property (including the perception that the public funds are being used to "bail out" wealthy property owners) May require planning scheme changes to signal clear intent that land use will be transitioning over time because of coastal hazard risks May inadvertently increase the market value of remaining properties due to increased rarity Many freehold coastal landowners will not voluntarily accept the arrangement and will prefer to protect freehold land	Private property owners are adequately compensated The public retains a functional beach and gains public land in the medium term Prevents upgrading or intensification of site assets Creates a buffer between the coastline and other landward development once infrastructure is removed Reduces exposure to future risk	Varies depending on market values. May be in the millions for beachfront properties in some locations

[2]NSW Department of Planning, Industry and Environment (2019) Relocating Mungo Brush Road Myall Lakes National Park, accessed 14 April 2020, https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Topics/Parks-reserves-and-protected-areas/M-R/myall-lakes-national-park-mungo-brush-road-construction-overview-map-2019-february-photo.jpg?la=en&h=59%25&w=100%25&hash=720E537051AB3250234DDA777DCEE25176988320

Adaptation Option	Adaptation Option Description	Adaptation Option Type	Relevant hazards			Period of Effectiveness	Drawbacks	Benefits	Capital Cost
			Erosion	Storm Tide Inundation	Sea Level Rise				
Land buy back with lease back opportunity	High risk private properties are bought at market prices, then rented out until hazard impacts are imminent (years). When hazard is imminent, built infrastructure is demolished and land is used for coastal management purposes (e.g. open space (or similar))	Planning	✓	✓	✓	Medium - Long Term	Many freehold coastal landowners will not voluntarily accept the arrangement and will prefer to protect freehold land Very costly for coastal properties with high property values Some community members may consider it unfair to spend public funds on private property (including the perception that the public funds are being used to "bail out" wealthy property owners) May inadvertently increase the market value of remaining properties due to increased rarity Council / State government must commit to mortgage arrangements May require planning scheme changes to signal clear intent that land use will be transitioning over time because of coastal hazard risks.	Lease back provides some funding back to contribute towards the purchase costs, or reduces initial purchase cost if lease back is for nominal amount Provides flexibility to allow occupation of the site for as long as it is safe to do so Private property owners are adequately compensated Reduces exposure to future risk The public retains a functional beach and gains public land in the medium term Prevents upgrading or intensification of site assets Creates a buffer between the coastline and other landward development once infrastructure is removed	Varies depending on market values. May be in the millions for beachfront properties

Adaptation Option	Adaptation Option Description	Adaptation Option Type	Relevant hazards			Period of Effectiveness	Drawbacks	Benefits	Capital Cost
			Erosion	Storm Tide Inundation	Sea Level Rise				
Partial land buy-back	Partial acquisition of privately held freehold land to accommodate coastal management options and be designated as public land	Planning	✓	✓	✓	Medium - Long Term	The public (Council/State Govt) must fund purchase price up-front Unsuited to small, densely developed land parcels. Most suited to large properties adjoined on both sides by public land Some community members may consider it unfair to spend public funds on private property (including the perception that the public funds are being used to "bail out" wealthy property owners) May inadvertently increase the market value of remaining properties due to increased rarity May require planning scheme changes to signal clear intent that land use will be transitioning over time because of coastal hazard risks. Property owners may not accept changes to development provisions that may prevent or limit development potential. Many freehold coastal landowners will not voluntarily accept the arrangement and will prefer to protect freehold land	Property owners retain visual amenity and access to the coastline Reduces exposure to future risk Considerably less expensive than purchasing entire land parcel Improves continuity of public land (and public access) along the shoreline Private property owners are adequately compensated The public retains a functional beach and gains public land in the medium term Prevents upgrading or intensification of site assets in hazard area Creates a buffer between the coastline and remainder of site once infrastructure is removed	Varies depending on market values. May be in the millions for beachfront properties

Adaptation Option	Adaptation Option Description	Adaptation Option Type	Relevant hazards			Period of Effectiveness	Drawbacks	Benefits	Capital Cost
			Erosion	Storm Tide Inundation	Sea Level Rise				
Land swap	Exchange high risk private land holdings for replacement public land out of the hazard area. Built infrastructure is demolished on acquired parcels and land is used for coastal management purposes (e.g. open space or similar land use)	Planning	✓	✓	✓	Long Term	Assumes that an available and suitable location exists (difficult in intensively developed coastal areas or those with high levels of visual amenity or conservation values) Expensive for areas with high land values – difficult to provide a nearby substitute location with similar value Alternative land may need to be purchased if existing suitable land is not already in public ownership Landowners are unlikely to accept alternative locations without considerable incentives or compensation Some community members may consider it unfair to spend public funds on private property (including the perception that the public is "bailing out" wealthy property owners) May inadvertently increase the market value of remaining properties due to increased rarity Requires coordinated government response and intervention to be successful Many freehold coastal landowners will not voluntarily accept the arrangement and will prefer to protect freehold land May require planning scheme changes to signal clear intent that land use will be transitioning over time because of coastal hazard risks.	Supports property owners to stay in general area and retains sense of community Reduces exposure to future risk The public retains a functional beach and gains public land in the medium term Creates a buffer between the coastline and other landward development once infrastructure is removed	Varies depending on market values

Adaptation Option	Adaptation Option Description	Adaptation Option Type	Relevant hazards			Period of Effectiveness	Drawbacks	Benefits	Capital Cost
			Erosion	Storm Tide Inundation	Sea Level Rise				
Rolling easement	Property boundary is based on a distance to the shoreline, and therefore will move landward as the shoreline does	Planning	✓	✓	✓	Medium Term until hazard becomes immediate and frequent	There is currently no legal mechanism to introduce this style of land title (for existing land parcels or new subdivisions). Private property owners bear the cost of lost land / assets Many freehold coastal landowners will not voluntarily accept the arrangement and will prefer to protect freehold land	Coastline is retained because it can recede naturally Property owners are aware of lifespan of development, therefore no need for compensation resulting in a lower cost to the public Prevents upgrading or intensification of site assets in hazard area Maintains a buffer between the coastline and remainder of site once infrastructure is removed	Varies depending on market values
Trigger related development approvals	Development approvals are lawful until a nominated hazard trigger is reached, e.g. the shoreline comes within a defined distance of the property or infrastructure and the structure or asset needs to be moved further landward or removed from the site entirely. Conditions can also be imposed that trigger a series of certain actions to occur, e.g. Owner commences design of seawall once the shoreline comes within a defined distance. Owner then constructs the seawall once shoreline is within a defined distance.	Planning	✓	×	✓	Medium Term until hazard becomes immediate and frequent	May be difficult to implement for redevelopments where owners have an expectation to have the same rights for a new building as they had with the old building It is possible under the current planning system for applicants to modify the development approval or conditions of approval to have such conditions removed or amended	Coastline is retained because it can recede naturally Well-suited to approvals for infrastructure with a limited lifespan Property owners are aware of lifespan of development approval at the outset, therefore no need for compensation resulting in no cost to the public Prevents upgrading or intensification of site assets in hazard area Maintains a buffer between the coastline and remainder of site once infrastructure is removed	Nil

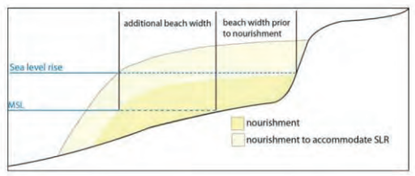
Adaptation Option	Adaptation Option Description	Adaptation Option Type	Relevant hazards			Period of Effectiveness	Drawbacks	Benefits	Capital Cost
			Erosion	Storm Tide Inundation	Sea Level Rise				
Build community resilience									
Community education and consultation	Build acceptance and resilience for coastal risk management in the community by providing ongoing information on coastal hazards, risks, monitoring and implementation of actions Actively look for ways to involve the community in coastal, wetland and natural system management Increase signage and activities which help the community and visitors to understand more about climate change, its impacts and solutions  Figure 5 Coastal Futures Project stakeholder engagement, Scarness, November 2019	Community / Education	✓	✓	✓	Ongoing	Requires targeted information and involvement opportunities presented in a way that can be readily understood and embraced by the community	Increases community understanding of hazards and risks and encourages community involvement in mitigation implementation	Costs vary depending on scope of education and consultation undertaken

Adaptation Option	Adaptation Option Description	Adaptation Option Type	Relevant hazards			Period of Effectiveness	Drawbacks	Benefits	Capital Cost
			Erosion	Storm Tide Inundation	Sea Level Rise				
Monitoring	Undertake monitoring to determine when risk approaches unacceptable levels and management triggers are reached Monitoring may include: • beach condition, profile and recession rates • mangrove extents recession rates • dune vegetation extents, dune stability • habitat health, connectivity and availability • bathymetric changes (shoaling, scour, channel migration) Involve community where appropriate  Figure 6 CoastSnap photo point Stockton Beach NSW[3]	Data collection / Community / Education	✓	✓	✓	Ongoing	Data collection program needs to be well designed and will need to be implemented over a prolonged time period to allow for monitoring of management triggers Data collection program may be costly depending on type of data collected Requires targeted information and involvement opportunities presented in a way that can be readily understood and embraced by the community	There are opportunities to share costs between state and local governments depending on the type of monitoring (and assessment of monitoring outputs) Monitoring undertaken for purposes other than coastal hazards may also be able to be used to inform coastal management assessments Supports timely implementation of mitigation responses, reducing costs and facilitating risk appropriate uses for as long as possible (pathways approach) Increases community understanding of hazards and risks and encourages community involvement	Varies depending on data type, community involvement and scale
Geotechnical investigation & detailed erosion studies	Undertake detailed geotechnical investigations to determine the erosion potential within foreshore area (requires physical examination down to -2m AHD or below) and likely geotechnical stability of foreshore if the fronting beach or primary dune becomes completely eroded	Data collection	✓	×	×	Ongoing	Investigations and studies may be costly depending on nature and extent	Improves confidence in hazard area interpretation Reduces broader costs of adaptation if geotechnical controls reduce hazard exposure	Varies depending on data sought and scale

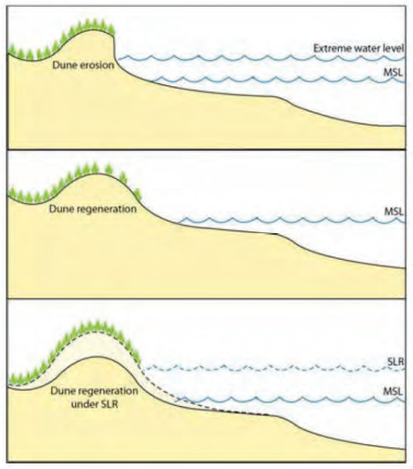
[3]NSW Department of Planning, Industry and Environment (2019) CoastSnap beach monitoring, Accessed 14 April 2020. https://www.environment.nsw.gov.au/research-and-publications/your-research/citizen-science/digital-projects/coastsnap

Adaptation Option	Adaptation Option Description	Adaptation Option Type	Relevant hazards			Period of Effectiveness	Drawbacks	Benefits	Capital Cost
			Erosion	Storm Tide Inundation	Sea Level Rise				
Enhance coastline or habitat resilience									
Beach scraping	Manual pushing of a thin (less than 200mm thick) layer of sand from the beach face towards the upper beach to reinforce the dune or reduce risks associated with erosion scarps (such as vertical drops at beach access points). Scraping should only occur above mean sea level, and preferably above the level of high tide.  **Figure 7 Beach Scraping, New Brighton Beach, Byron Shire[4]**	Engineering (Soft)	✓	×	×	Short Term	Unsuitable for locations where there is minimal sand on the beach face Does not prevent erosion but provides a sacrificial buffer for when erosion does occur Needs to be monitored and repeated on an as needs basis – ongoing costs can be hard to predict and plan for, as timing depends on event frequency	Assists to create an erosion buffer and reduce storm damage to landward coastal assets Largely retains beach safety, amenity and access for recreational purposes Relatively inexpensive, can be done using local earthmoving equipment Can be implemented broadly or at localised locations such as at beach access points Can be mobilised quickly, enabling rapid response to manage risks following erosion	$50 to $60 per m beach length

[4] Dowsett,C.(2017) New Brighton beach scraping, Byron Shire Council. Snapshot for CoastAdapt, National Climate Change Adaptation Research Facility, Gold Coast, accessed 14 April 2020. *https://coastadapt.com.au/sites/default/files/case_studies/SS63_Beach%20Scraping%20New%20Brighton.pdf*

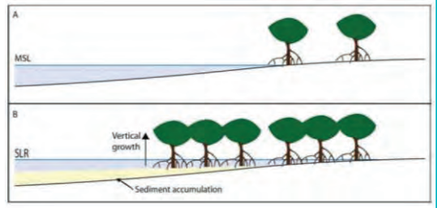
Adaptation Option	Adaptation Option Description	Adaptation Option Type	Relevant hazards			Period of Effectiveness	Drawbacks	Benefits	Capital Cost
			Erosion	Storm Tide Inundation	Sea Level Rise				
Small-scale beach nourishment (up to 100,000 m³)	Manual placement of sand on the beach using either nearshore, estuarine or land-based sand sources to top up the beach and dune system  **Figure 8 Beach Nourishment, Maroochydore[5]**  **Figure 9 Typical beach nourishment cross-section[1]**	Engineering (Soft)	✓	×	×	Short Term	Does not prevent erosion but provides a sacrificial buffer for when erosion does occur Nourishment design influences longevity of benefits as material can be rapidly lost during single storm events, and more slowly lost over time if there is a deficit in sand supply Needs to be monitored and repeated on an ongoing basis – ongoing costs can be hard to predict and plan for, as timing depends on event frequency Sets a community expectation that the beach will always be retained	Assists to create an erosion buffer and reduce storm damage to landward coastal assets Largely retains beach amenity and access for recreational purposes Effectiveness can be increased when teamed with other measures to limit sand loss from the beach, such as groynes Nourishment that widens beaches and raises beach elevations can also assist in reducing inundation impacts on landward areas	Nearshore or estuarine sources may be as little as $30/m³

[5] Photo courtesy of Matthew Barnes, taken in 2013

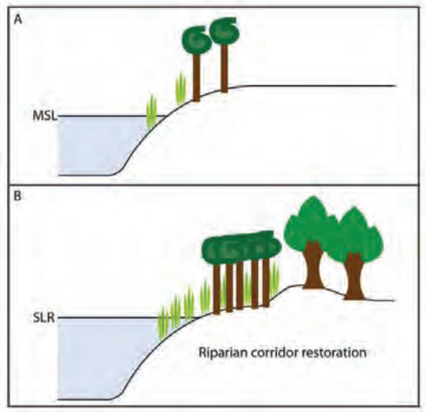
Adaptation Option	Adaptation Option Description	Adaptation Option Type	Relevant hazards			Period of Effectiveness	Drawbacks	Benefits	Capital Cost
			Erosion	Storm Tide Inundation	Sea Level Rise				
Dune restoration / augmentation	Increase the crest height or functional integrity of existing dunes through the addition of imported sand from offshore / inactive sand sources. Implement vegetation works to stabilise placed sand (aligned with dune restoration)  **Figure 10 Typical dune constructions and regeneration cross-section[1]**	Engineering (Soft)	✓	✓	✓	Short - Medium Term	Sourcing suitable or sufficient sand may be problematic and costly In heavily populated areas an increase in dune height may affect residential view lines and be opposed by the local community Dune and associated vegetation will still be exposed to damage during storm events Initial revegetation works may be vulnerable to vandalism or trees may be unlawfully lopped/damaged to maintain views. Effectiveness may reduce over time due to increasing frequency of coastal hazard impacts	Provides a natural solution Can be used to restore degraded dunes Supports opportunities to control pedestrian movements to minimise future damage Once established requires the same level of maintenance as similar existing natural dune areas Provides opportunity to involve community partnerships to undertake the revegetation works and monitoring, e.g. Traditional Owners Rangers, residents, environment groups etc.	Sand supply and placement, offshore sand source - $54 to $72/m^3 Revegetation and management over 5 year life, incl weed and vermin control, monitoring, $2200/ha
Dune construction	Reinstatement or artificial construction of new dunes using imported sand from offshore / inactive sand sources. Dunes are positioned at the back of the beach and vegetated to restore natural coastal hazard protection (aligned with dune restoration)	Engineering (Soft)	✓	✓	✓	Medium Term	Sourcing suitable or sufficient sand may be problematic and costly In heavily populated areas any impacts on view lines may be opposed by the local community Initial revegetation works may be vulnerable to vandalism Windblown sand may cause nuisance issues until vegetation establishes Will require periodic maintenance and sand top ups depending on local sediment transport Effectiveness may reduce over time due to increasing frequency of coastal hazard impacts	Provides a natural looking solution Increases coastal habitat and may improve visual amenity Once established requires the same level of maintenance as similar existing natural dune areas	Sand supply and placement, offshore sand source - $54 to $72/m^3 Revegetation and management over 5 year life, incl weed and vermin control, monitoring, $2200/ha

Adaptation Option	Adaptation Option Description	Adaptation Option Type	Relevant hazards			Period of Effectiveness	Drawbacks	Benefits	Capital Cost
			Erosion	Storm Tide Inundation	Sea Level Rise				
Active dune and habitat management including vegetation planting and management	Continue to implement and support natural dune processes through dune care / habitat management programs, including consolidation of informal beach access Fencing of dune management areas until habitat re-established and to encourage natural dune building processes  **Figure 11 Vegetation planting at Kemp Beach, Rosslyn[6]**	Ecosystem management	✓	✓	✓	Short Term	May be cost effective in short term, but dunes don't provide an engineering solution to a chronic erosion or a receding coastline over the long term (dunes will erode) Significant reinstatement works may be required after major damage occurs to maintain protective functionality	In short term, provides a store of sand to buffer from storms and reduce risk of erosion Intact dune systems can limit inland inundation penetration on the open coast Provides complementary ecological and amenity benefits Supports maintenance and enhancement of natural values expressed by stakeholders. Vegetated dunes are cooler than non-vegetated dunes Can form part of other long term or interim solutions (e.g. stabilising nourished sands) and increases the time available for major decision making Relatively low cost in areas where erosion is not chronic Provides an opportunity to educate and involve the community in managing risks and undertaking monitoring	Varies, may be in the order of thousands of dollars annually depending on condition
Land management to support habitat migration	Actively encourage temporary, low impact uses and/or habitat maintenance on land fringing coastal habitats to support progressive habitat migration. This may also include assisted colonisation to enable distribution shifts of important species	Ecosystem management	✓	✓	✓	Medium - Long Term	Short term community opposition by people whose activities may be affected May need changes to land use planning policy and development provisions to help implement	Long term viability of habitat and wildlife corridors Long term habitat availability for community and visitors who appreciate natural values.	Varies depending on location and use of adjoining land

[6] Livingstone Shire Council (2019) *Yeppoon State High School Planting at Kemp Beach*, Accessed 14 April 2020. https://www.livingstone.qld.gov.au/images/CivicAlerts/5/Yeppoon-State-High-School-Planting-at-Kemp-Beach-1.gif

Adaptation Option	Adaptation Option Description	Adaptation Option Type	Relevant hazards			Period of Effectiveness	Drawbacks	Benefits	Capital Cost
			Erosion	Storm Tide Inundation	Sea Level Rise				
Freshwater and saltwater wetland restoration	Actively restore degraded wetlands to improve natural hazard management function. Planting of wetland vegetation enables sediment to accumulate. It may, depending on the scale, reduce the impact of storm tide inundation through water flow attenuation and assist with adapting to SLR  **Figure 12 Typical cross-section before and after restoration[1]** *Note: MSL=mean sea level; SLR=sea level rise*  **Figure 13 Mangrove rehabilitation works on the Shoalhaven Rover, south coast of NSW[7]**	Ecosystem management	×	✓	✓	Short - Medium Term	Costs vary, but depending on scale, can be substantial May have other environmental impacts where existing vegetation/ecological values occur	Maintain significant values expressed by stakeholders including Traditional Owners May assist with attenuating inundation Provides co-benefits of ecological improvements and carbon sequestration Provides an opportunity to educate and involve the community in monitoring and managing wetlands Carbon sequestration potential may provide an avenue to attract investment.	Varies depending on condition and scale. May be in the tens of thousands of dollars
Establish buffers around wetlands	Establishing buffers around wetlands enables them to migrate landward as sea-levels rise and reduce potential for coastal squeeze	Planning and ecosystem management	×	×	✓	Short Term	May require rezoning and/or land purchase	Supports long term viability of important community assets Complementary benefits include retention of fish habitat, carbon sequestration potential and flood mitigation	Varies depending on land values and adjoining land uses

[7]NSW Department of Primary Industries (2008) Primefact 746: Mangroves. Accessed 14 April 2020 http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0020/236234/mangroves.pdf

Adaptation Option	Adaptation Option Description	Adaptation Option Type	Relevant hazards			Period of Effectiveness	Drawbacks	Benefits	Capital Cost
			Erosion	Storm Tide Inundation	Sea Level Rise				
Green belts and riparian corridors	Rows of trees and other native habitat, preferably riparian Plant riparian buffers along estuary foreshores  **Figure 14 Typical riparian corridor cross section before and after restoration[1]**	Ecosystem management	✓	✓	×	Short - Medium Term	Cost varies depending on scale Could cause issues with nearby residents who may lose water views.	Establishes a buffer devoid of built assets to accommodate wave action and erosion, and attenuate storm tide inundation Increases the stability of estuary banks at creek mouths to reduce the likelihood of erosion Added benefits of provision of shade and animal/fish habitat Creates shading and heat management Carbon sequestration Increases ecological connectivity and wildlife movement	Revegetation and management over 5 year life, incl weed and vermin control, monitoring, $2200/ha
Reduce extents of hard surfaces	Reduction in the coverage of impenetrable surfaces to increase infiltration and decrease runoff	Planning and ecosystem management	✓	✓	✓	Medium Term	Cost varies depending on scale Difficult to implement in highly developed areas	Reduce runoff and therefore localised erosion Has additional risk mitigation potential such as reducing flood risk Can improve water quality Planning scheme can incorporate water sensitive urban design provisions for new development	Varies depending on nature of hard surface coverage
Adapt or accommodate									
Allow foreshore recession	Accept erosion of the foreshore at some locations that are less critical from a tourism / community / asset perspective	Ecosystem management	✓	×	×	Long Term	Private landholders are not compensated for the loss of land or property The community may lose public facilities or land temporarily or permanently Ongoing replacement costs for low-cost, easily replaced infrastructure Criticism from some parts of the community over the loss of minor assets and lack of intervention	Particularly suitable for park land and low-cost facilities (e.g. access ways, walkways) Establishes community expectations about highly valued infrastructure from a broad community perspective Supports risk-appropriate usage of hazard area	No to low cost

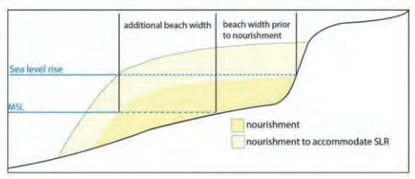
Adaptation Option	Adaptation Option Description	Adaptation Option Type	Relevant hazards			Period of Effectiveness	Drawbacks	Benefits	Capital Cost
			Erosion	Storm Tide Inundation	Sea Level Rise				
Emergency management planning (e.g. alternative route provision)	Accept inundation impacts where suitable alternative infrastructure exists to service community needs during / following an event	Emergency response	×	✓	✓	Medium - Long Term	Infrastructure is still exposed to inundation hazards, with resultant repair/maintenance costs There may be minor inconvenience to a small number of directly affected private properties Relies on existing alternative infrastructure availability	Alternative infrastructure is in place to meet community needs (i.e. redundancy is built into the system) Overwhelming majority of community is able to continue to function while any assets are impacted or being repaired	No cost
Emergency management response	Monitoring and warning systems including evacuation strategies and community engagement	Emergency response and Planning	✓	✓	✓	Short - Medium Term	Initial capital outlay for new systems and processes Requires continuing investment in coordination and education that must be trialled and updated Implementation is in conjunction with other strategies Emergency evacuation response should not be relied upon as the sole measure for mitigating risk to life for new development New development in higher risk areas creates an additional burden on existing emergency management capabilities and resources	If effective, can reduce or eliminate risk of loss of life Pre-warning and education can help to minimise loss of property	Cost varies depending on scale
Insurance	Taking out insurance coverage of Council assets in current and future hazard areas	Planning	✓	✓	✓	Short Term (or as long as can be insured)	Premiums will increase over time with increasing numbers of claims or areas may become uninsurable Risk that insurance definitions do not cover event that causes damage (e.g. 'storm' compared with a 'flood') Will still need to be done in conjunction with other strategies	If able to be insured, assets can be re-built as a result of claims or payout can fund the relocation landward or redesign	Varies depending on asset and risk exposure
Development master planning	Master planning or structure planning of new developments to avoid placing any vulnerable uses within the hazard extent	Planning	✓	✓	✓	Medium - Long Term	Site coverage may not be able to be used as initially intended by developer Potential impediment to form of accommodating population growth Existing owners would have an investment-backed expectation to be able to develop land to achieve a certain return	Reduces exposure to future risk Opportunity to maintain or enhance natural ecological function of hazard area Supports risk-appropriate usage of hazard area Provides greater certainty for community and development expectations	Minimal, as should be done as part of good practice development planning

Adaptation Option	Adaptation Option Description	Adaptation Option Type	Relevant hazards			Period of Effectiveness	Drawbacks	Benefits	Capital Cost
			Erosion	Storm Tide Inundation	Sea Level Rise				
Build redundancy into network systems	Provide alternative connections to network assets (such as sewer, water, roads etc) at high risk locations to minimise impacts on asset interdependency	Engineering	✓	✓	✓	Medium - Long Term	Existing infrastructure is still exposed to inundation hazards, with resultant repair/maintenance costs There may be minor inconvenience to a small number of directly affected private properties	New alternative infrastructure is in place to meet community needs (i.e. redundancy is built in to the system) Overwhelming majority of community is able to continue to function while any assets are impacted or being repaired Supports staging of relocation of critical infrastructure as infrastructure with high risk exposure may eventually be able to be removed	Cost varies depending on scale and asset type
Manual creek mouth management to protect public assets	Actively limit creek mouth meandering into dune areas seaward of critical public infrastructure. Requires active monitoring for implementation  **Figure 15 Currimundi Lake entrance management, Sunshine Coast, December 2019**	Engineering / Ecosystem management	✓	×	×	Short Term	Requires active management and interference May affect local waterway ecology Will require statutory approvals Erosion from high creek flows during major flooding can still occur	Reduces localised risks from wave erosion reaching the dune Supports natural growth and stabilisation of dunes May benefit water quality and discourage breeding of pest species (e.g. biting midge) by increasing flushing of waterway	Low if easily accessible
Manual creek mouth management to protect private assets	Actively limit creek mouth meandering into dune areas seaward of private assets. Requires active monitoring for implementation	Engineering / Ecosystem management	✓	×	×	Short Term	Requires active management and interference May affect local waterway ecology Will require statutory approvals May attract criticism that public funds are being used to protect private assets Erosion from high creek flows during major flooding can still occur	Reduces localised risks from wave erosion reaching the dune Supports natural growth and stabilisation of dunes May benefit water quality and discourage breeding of pest species (e.g. biting midge) by increasing flushing of waterway	Low if easily accessible

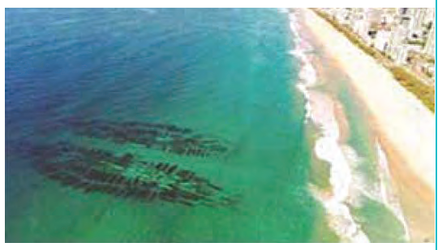
Adaptation Option	Adaptation Option Description	Adaptation Option Type	Relevant hazards			Period of Effectiveness	Drawbacks	Benefits	Capital Cost
			Erosion	Storm Tide Inundation	Sea Level Rise				
Hazard resilient design for new/ upgraded public infrastructure	Where new or replacement public infrastructure is necessary within the hazard extent and the risk is deemed 'tolerable', infrastructure is designed to accommodate temporary inundation, be sacrificial or be relocatable. Includes setting or amending floor levels  **Figure 16 Flood resilient toilet, Lismore NSW[8]**	Planning / Engineering	✓	✓	✓	Ongoing	May increase construction costs in hazard areas Relies on availability of replacement infrastructure (if sacrificial), nearby receiving space and resources to relocate (if relocatable) Design may not be able to fully reduce risk and may be expensive (i.e. retreat or accept damage may be a cheaper option)	Reduces exposure to future risk Design modification can support an extended life for the asset Relocatable or sacrificial designs are well-suited to infrastructure with a short design life Effective in the short to medium term to accommodate storm-tide and SLR; effectiveness dependent upon design parameters, hazard categories and overall risk Encourages innovative design practices Greatest benefits when new builds or renovations are occurring	Varies depending on infrastructure type and construction costs

[8] Modus Australia n.d. *Toilet building for busy flood prone city centre accessed 14 April 2020.* https://www.modusaustralia.com.au/projects/toilet-building-for-busy-flood-prone-city-centre

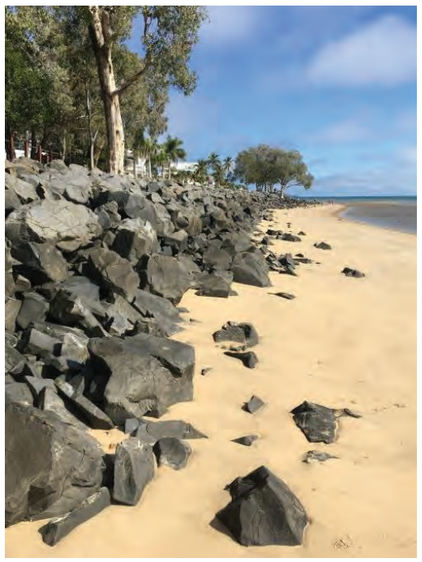
Adaptation Option	Adaptation Option Description	Adaptation Option Type	Relevant hazards			Period of Effectiveness	Drawbacks	Benefits	Capital Cost
			Erosion	Storm Tide Inundation	Sea Level Rise				
Hazard resilient design for new/ upgraded private infrastructure	Where new or replacement private built assets are proposed within the hazard extent, infrastructure is designed to accommodate temporary inundation, be sacrificial or be relocatable. Includes setting or amending floor levels	Planning / Engineering	✓	✓	✓	Ongoing	May increase construction costs in hazard areas Design may not be able to fully reduce risk and may be expensive (i.e. retreat or accept damage may be a cheaper option) Sacrificial or relocatable designs unlikely to be palatable to owners for dwellings or major infrastructure Relies on availability of replacement infrastructure (if sacrificial), nearby receiving space and resources to relocate (if relocatable) May place restrictions on future development for existing owners Transfer of ownership may change the owner attitude to acceptability Issues for ongoing access if the built assets are isolated as a result of hazard impacts on surrounding land	No cost to public Reduces exposure to future risk Opportunity to educate community on future hazards Design modification can support an extended life for the asset Relocatable or sacrificial designs are well-suited to infrastructure with a short design life Effective in the short to medium term to accommodate storm-tide and SLR; effectiveness dependent upon design parameters and overall level of risk i.e.: may not be appropriate in higher risk areas or where the depth of inundation is high Encourages innovative design practices Greatest benefits when new builds or renovations are occurring Supports progressive increase in resilience throughout hazard areas	Varies depending on infrastructure type and construction costs
Contaminated site management	Identify contaminated sites that are within hazard zones to establish clean-up procedures or implement options that reduce exposure	Planning	✓	✓	✓	Ongoing	Potential local contamination during clean-up May be costly depending on contaminants and volumes	Reduces the risk of harm to waterway and human health Reduced litigation risk	Varies depending on site specific contaminants and volumes
Urban design	Increase tidal inundation management capacity using water sensitive urban design including onsite detention	Planning	×	✓	✓	Ongoing	Needs supporting policy Likely to be problematic for coincident flooding and tidal inundation	Can reduce the penetration of tidal inundation onto private property	Varies depending on site

Adaptation Option	Adaptation Option Description	Adaptation Option Type	Relevant hazards			Period of Effectiveness	Drawbacks	Benefits	Capital Cost
			Erosion	Storm Tide Inundation	Sea Level Rise				
Floating development	Allow structures to move with changing water levels  **Figure 17 Floating restaurant, Lakes Entrance**	Planning	×	✓	✓	Ongoing	Only effective in areas not subjected to wave action	Manages the uncertainty of sea levels	Varies depending on infrastructure type and construction costs
Protect									
Large-scale beach nourishment (greater than 100,000 m^3)	Manual placement of sand on the beach using marine source (offshore inactive preferred)  **Figure 18 Beach Nourishment, Woorim, Bribie Island[9]**  **Figure 19 Typical beach nourishment cross-section[1]**	Engineering (Soft)	✓	×	×	Medium-Long Term	Can be very expensive, particularly when a suitable and economical sand source is not located close to the placement site Does not prevent erosion but provides a sacrificial buffer for when erosion does occur Nourishment design influences longevity of benefits as material can be rapidly lost during single storm events, and more slowly lost over time if there is a deficit in sand supply Sets a community expectation that the beach will always be retained	Assists to create an erosion buffer and reduce storm damage to landward coastal assets Largely retains beach amenity and access for recreational purposes Effectiveness can be increased when teamed with other measures to limit sand loss from the beach, such as groynes Nourishment that widens beaches and raises beach elevations can also assist in reducing inundation impacts on landward areas	Offshore sand source and delivery could be up to $45 to $60/m^3

[9] Webb, T., 2016: Engineering solutions for coastal infrastructure. CoastAdapt Information Manual 7, National Climate Change Adaptation Research Facility, Gold Coast.

Adaptation Option	Adaptation Option Description	Adaptation Option Type	Relevant hazards			Period of Effectiveness	Drawbacks	Benefits	Capital Cost
			Erosion	Storm Tide Inundation	Sea Level Rise				
Artificial reef	Construction of a submerged offshore structure designed to reduce the energy of waves approaching the adjacent coastline  **Figure 20 Narrowneck artificial reef, Gold Coast[1]**	Engineering	✓	×	×	Medium Term	Very expensive to build and maintain ($ millions) Effectiveness reduced as sea levels rise, allowing waves to pass without being attenuated May reduce sediment transport supply to adjacent downdrift beaches Will only impact on a short section of shoreline	Effectiveness can be increased when teamed with other measures to increase beach width such as beach nourishment Supports beach widening and retention of a natural beach environment by slowing sediment transport along the adjacent shoreline Appropriate design may increase surfing opportunities Creates calmer wave environment for recreational uses such as swimming May locally increase biodiversity of marine species by increasing habitat Can increase recreational amenity (fishing opportunities)	Expensive, $10 to $20 million+ depending on size and location
Groyne and artificial headlands	Construction of an artificial barrier perpendicular to the beach to trap and hold beach sediments  **Figure 21 Short rock groyne at Bramston Beach[10]**	Engineering	✓	×	×	Medium - Long Term	Can be expensive to build ($ millions) if groynes are built into the surf zone or estuary. Require ongoing maintenance Loss of beach amenity from natural conditions - numerous groynes may be required along a beach to be effective Erosion effects at end of groyne field due to interrupted sediments not reaching downdrift areas Unlikely to be effective for long term sea level rise (groynes don't increase sediment budget for beach) Do not assist with storm tide inundation	Effectiveness can be increased when teamed with other measures to increase beach width such as beach nourishment Retains a sandy beach in current position In some scenarios, can provide recreational amenity (fishing) Can be used as a temporary measure if constructed using geobags or similar	From $2000 to $5000/m length, subject to groyne height and materials used. Artificial headlands are more expensive

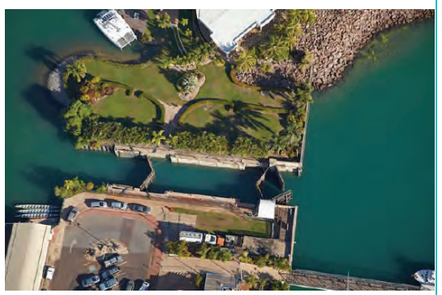
[10] Image from Queensland Globe, Accessed 13 September 2018 https://qldglobe.information.qld.gov.au/

Adaptation Option	Adaptation Option Description	Adaptation Option Type	Relevant hazards			Period of Effectiveness	Drawbacks	Benefits	Capital Cost
			Erosion	Storm Tide Inundation	Sea Level Rise				
Seawall to protect public assets	Protect public assets by constructing major protection works seaward of valued community infrastructure. Typically constructed from rock or concrete along the dune line parallel to the beach  **Figure 22 Rock Revetment Seawall, The Esplanade, Hervey Bay**	Engineering (Hard)	✓	×	✓	Medium - Long Term	Expensive capital outlay (can be $ millions depending on site) plus ongoing maintenance after storm events to maintain integrity Existing seawalls may need to be re-designed or augmented to account for sea level rise Beach lowering immediately seaward of the wall will occur at seawall sites experiencing chronic long-term erosion, resulting in no high tide beach and a loss of recreational and visual amenity Government protection of private property can be controversial and evoke equity issues Accelerated erosion can occur at the ends of seawalls. Wall ideally should be built as contiguous lengths/major segments along the beach but can be staged for future risks Can have significant negative impacts on landscape character and loss of access and beach amenity. 'Ugly' seawalls that dominate or don't blend with the landscape or result in loss of sandy beaches may not support community values.	Holds shoreline in current position (i.e. the land behind the beach is protected, often at the expense of the beach) The crest height of a seawall may also be sufficient to locally protect against sea level rise on the ocean frontage, but may not be high enough to limit storm tide inundation Alternative materials such as geobags may be suited to locations with smaller wave climates where a structure with a shorter design life is desired Provides opportunity for seawalls to be designed to 'look good' and have multiple design objectives beyond only their engineering function. Seawalls that 'blend with the landscape' and character of a place and allow public access, provide better urban design and public realm outcomes	$2000 to $5000/m length, subject to seawall height and proximity to suitable materials

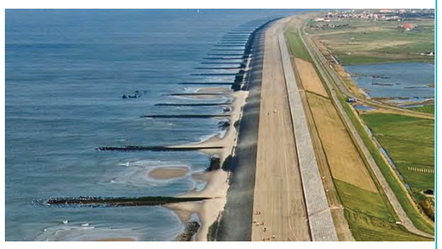
Adaptation Option	Adaptation Option Description	Adaptation Option Type	Relevant hazards			Period of Effectiveness	Drawbacks	Benefits	Capital Cost
			Erosion	Storm Tide Inundation	Sea Level Rise				
Scour protection to protect public assets	Protect public assets by constructing low-level protection works along waterways to protect valued community infrastructure  **Figure 23 Scour protection at public boat ramp and stormwater drain outlet, Poona**	Engineering	✓	×	✓	Medium - Long Term	Costs vary, but depending on scale, may be substantial May have adverse environmental impacts where high ecological values occur, especially during construction Design will need to integrate with other measures for flood protection	Works can employ a variety of materials, including softer materials such as coir logs or vegetative solutions etc. Softer materials or low-key works may be able to be implemented by community groups. Crest level may also be sufficient to locally protect against sea level rise inundation, but may not be high enough to limit storm tide inundation	$50 to $250/m^2, subject to access restrictions and materials used

Adaptation Option	Adaptation Option Description	Adaptation Option Type	Relevant hazards			Period of Effectiveness	Drawbacks	Benefits	Capital Cost
			Erosion	Storm Tide Inundation	Sea Level Rise				
Seawall / scour protection on private land to protect private assets	Allow private asset owners to construct major or low-level protection works to protect private assets  **Figure 24 Scour protection Sunshine Coast**[11]	Engineering / Planning	✓	×	×	Medium Term	Expensive capital outlay in isolation, savings can be made when private property owners combine resources to fund (economies of scale) All owners may not maintain seawalls to the approved design standard, particularly following ownership changes Private asset owners often seek to construct individual walls rather than protecting a longer section of coastline, leading to discontinuous standards of protection and alignment. Erosion is accelerated on unprotected properties Many private properties have already built close to seaward property boundaries and there is often insufficient space to fully or partially contain a suitably designed seawall on the private property, or space to undertake seawall maintenance Beach lowering immediately seaward of the wall will occur at seawall sites experiencing chronic long-term erosion, resulting in no high tide beach and a loss of recreational and visual amenity. This can sever access along the beach on public land Crest height to accommodate wave overtopping can sometimes obscure sea views from natural ground level Protection works can impact on beach amenity and adversely impact on natural coastal environment values, processes and functions	Holds shoreline in current position (i.e. the land behind the beach is protected, often at the expense of the beach) The broader community does not fund the capital or maintenance costs of protecting private property There is no exclusive use of public land for private benefit Design criteria can vary depending on owner's willingness to pay The planning scheme can provide clear policy direction for where new private asset protection works are supported, or not envisaged. Development provisions can be included to achieve consistency in design outcomes and criteria	As for scour protection and seawalls for public assets

[11] Sunshine Coast Council (2014) Resident's handbook: Artificial waterways. Accessed 14 April 2020 https://assets.website-files.com/5cf9d1a3e1b6580b4593f70d/5d003b9d11b2dbf534012a0b_Sunshine%20Coast%20Artificial%20Waterways%20Handbook.pdf

Adaptation Option	Adaptation Option Description	Adaptation Option Type	Relevant hazards			Period of Effectiveness	Drawbacks	Benefits	Capital Cost
			Erosion	Storm Tide Inundation	Sea Level Rise				
Tidal barrage / gates / surge barriers	Construction of a physical barrier across a waterway to prevent elevated water levels from penetrating into upstream areas. Can be designed to be movable to optimise water level and water quality management  **Figure 25 Noosa Waters lock and weir system[12]**  **Figure 26 Tidal lock, Cullen Bay Marina, Darwin, NT[1]**	Engineering	×	✓	✓	Long Term	Very high capital and maintenance costs Often requires ancillary structures and works to maintain effectiveness (e.g. training walls to affix the gates to and a sand bypassing system if placed close to a river mouth) Can adversely impact on riverine flooding extents if storm tide is coincident with flood peaks	Allows natural riverine and coastal functions including navigation to continue while barrier is not in operation (i.e. when the gates are closed) Can assist in reducing the impacts of storm tide inundation and sea level rise by being deployed only when elevated water levels are expected Assists with disaster management	Expensive. Can be in the millions of dollars depending on the width and depth of barrier required

[12] Sunshine Coast Daily (2014) *Noosa residents could finally get their canal repair wish*, accessed 14 April 2020 https://www.sunshinecoastdaily.com.au/news/canal-residents-get-a-windfall/2493319/

Adaptation Option	Adaptation Option Description	Adaptation Option Type	Relevant hazards			Period of Effectiveness	Drawbacks	Benefits	Capital Cost
			Erosion	Storm Tide Inundation	Sea Level Rise				
Levees / dykes	Construction of a permanent, physical barrier on land to prevent inundation of landward areas  **Figure 27 Dyke at Petten, the Netherlands**[13]	Engineering and Planning	×	✓	✓	Medium Term	Expensive capital outlay (can be $ millions depending on site) plus ongoing maintenance after storm events to maintain integrity Existing levees may need to be re-designed or augmented to account for sea level rise One breach of the levee can render the entire system redundant Crest height to accommodate inundation levels can sometimes obscure sea views from natural ground level Once a levee is overtopped, the water is trapped behind levee (cannot drain back into the sea / estuary) unless there is a pumping system Implementation can be challenging due to the potential involvement of multiple landowners Implications of stormwater management or coincident flooding need to be considered to avoid worsening of inundation	Prevent flooding (estuarine and riverine) into landward areas Can be used to formalise open space and public access along a shoreline Most effective along estuaries where wave action is minimal	Can be expensive depending on exposure to wave action and required height above ground level. $5000 to $10 million /m length for rock structures. $600/m for low earthen bunds
Tide flaps and valves on stormwater pipe network	Installation of valves or tide flaps on the existing stormwater network to permit one-way flow only and avoid penetration of salt water upstream into the pipe network  **Figure 28 Duckbill Valve**[14]	Engineering	×	✓	✓	Short - Medium Term	Flow control devices need to be installed on all affected outlets in the area to avoid provide broad immunity from inundation Flow control device cost depends on device type, size of pipe, accessibility and difficulty to retrofit Does not prevent inundation overtopping local land levels and entering the stormwater network upstream of the flow control device Effectiveness depends on device type, hydraulic head in system, sensitivity to sedimentation levels etc.	Highly suited to retrofitting in existing developed areas Able to provide a localised solution anywhere within the network	Varies depending on pipe size and mechanism type, from hundreds to tens of thousands of dollars

[13] Dutch Water Sector (2013) *Boskalis and Van Oord to reinforce coastline by creating beach in front of sea dike, the Netherlands*, accessed 14 April 2020, https://www.dutchwatersector.com/news/boskalis-and-van-oord-to-reinforce-coastline-by-creating-beach-in-front-of-sea-dike-the
[14] Measurit Technologies Ltd (2020) *Tideflex check valves are free draining* Accessed 14 April 2020 https://www.measurit.com/tideflex-benefits/tideflex-valves-are-free-draining

Appendix C Locality Factsheets

Burrum Heads

01

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Our life ring – how we can respond

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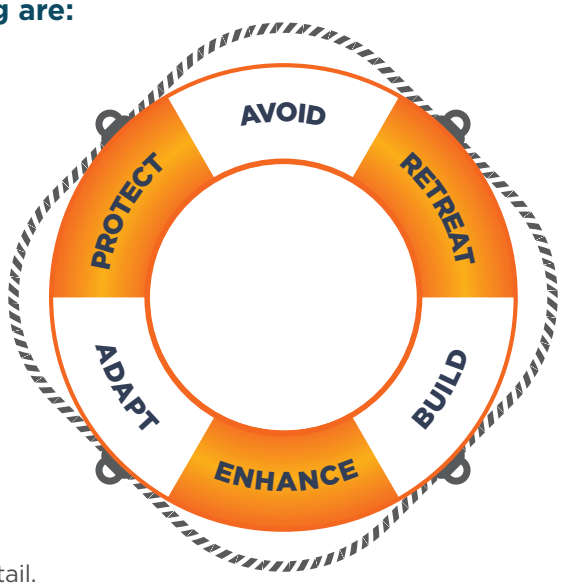
05. **Adapt** existing and future buildings, structures and infrastructure to be able to accommodate coastal changes – building things 'higher and stronger', evacuation planning.
06. **Protect/defend** priority shorelines, localities and infrastructure through the use of beach nourishment, seawalls, levees, groynes or other structures.



A fact sheet on adaptation options explains each of these in greater detail.

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Will it be financially sustainable? Adaptation can be expensive, and we can't protect the whole coastline. We need to focus on low cost solutions wherever we can, and prioritise where and when we invest in high cost shoreline protection.

How can we protect what we love and value? Protecting our coastline should align with what we value.

How can we maximise the benefits? When we invest in coastal hazard adaptation, we want to make sure that we maximise community benefits for the region as a whole.

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COASTAL FUTURES
Planning Our Changing Coastline

Burrum Heads

01

Our coastal values

Burrum Heads is loved by many in the region for its small village feel. The beach and foreshore are highly valued for fishing, walking, relaxing and family holidays. The National Park, bushland and river system and their associated habitats are important to many people.

Our vulnerabilities

When we spoke with community representatives from Burrum Heads, we heard that impacts from coastal hazards could result in:

- Inundation of Burrum Heads Road meaning more repair costs, and possibly community isolation during events.
- Damage to coastal infrastructure like seawalls and boat ramps.
- Damage to the sewerage treatment plant, meaning more repair costs and possible environmental impacts.
- Loss of the foreshore areas and impacts to the National Park.

Our opportunities

Some of the adaptation options suggested by community representatives and key stakeholders for the Burrum Heads townships in the future include:

No new development in any vulnerable areas to **avoid** increasing exposure.

Short to long term, low cost.

Accommodate hazards through changes to building design and subsidising adaptive design.

Medium term, medium to high cost.

Protect through maintaining existing seawall structures.

Medium term, medium to high cost.

Retreat by relocating vulnerable houses and businesses – this may involve land resumption and transitioning land to open space.

Medium to long term, medium to high cost.

HAVE YOUR SAY!

We'd like to hear from you...

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Dundowran and Craignish

02

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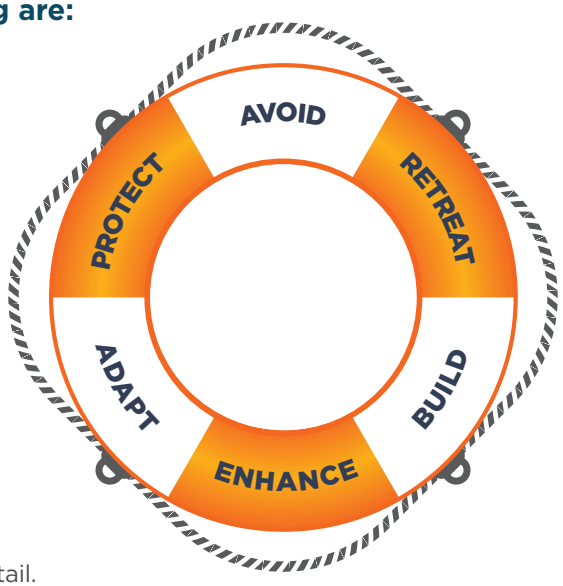

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COASTAL FUTURES
Planning Our Changing Coastline

Dundowran and Craignish

02

Our coastal values

Dundowran and Craignish communities value their coastal setting – for dog walking, fishing and horse riding. The natural environment is also valued; from coastal dunes to foreshore vegetation, as well as the Mungomery Vine Forest Reserve and the mouth of Regan's Creek.

Our vulnerabilities

Community representatives from Dundowran and Craignish identified that coastal hazards impacts could result in:

- Damage to housing or property loss, particularly around Craignish and O'Regan's Creek.
- Impacts on wetlands, mangroves and the endangered ecosystem of Dundowran Beach.
- Loss of vegetated buffer areas, including impact to the Mungomery Vine Forest Reserve, and wildlife habitat.

Our opportunities

Some of the adaptation options suggested by community representatives and key stakeholders for Dundowran and Craignish include:

Build community resilience through an awareness program about long-term coastal hazard impacts, and by monitoring coastal changes.

Short term, low cost.

No new development in highly vulnerable areas to **avoid** increasing exposure.

Short to long term, low cost.

Protect foreshores through targeted dune rehabilitation, stabilization and management.

Short to medium term, low cost.

Retreat at-risk infrastructure and plan for relocation/redesign of roads.

Medium to long term, medium to high cost.

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COASTAL FUTURES
Planning Our Changing Coastline

Great Sandy Strait Townships

03

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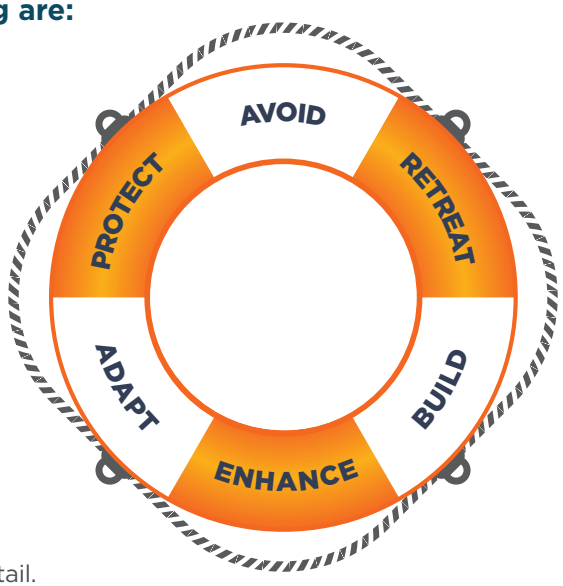

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COASTAL FUTURES
Planning Our Changing Coastline

Great Sandy Strait Townships

03

Our coastal values

In the Great Sandy Strait townships of Maaroom, Boonooroo, Tuan, Poona and Tinnanbar, there is a strong community connection to the ocean – for fishing, boating, views and sea air. Coastal mangroves, wetlands and threatened species are also highly valued.

Our vulnerabilities

Community representatives from the Great Sandy Straits identified that coastal hazards impacts could result in:

- Damage and temporary disruption to roads, stormwater and on-site effluent. This would have cost implications and result in community isolation during events.
- Losing areas of the foreshore which would reduce amenity, impact fishing access and increase repair/maintenance costs of infrastructure like playgrounds and paths.
- Habitat damage to coastal wetlands and mangroves which would impact endangered species and the ecological functioning of the area.

Our opportunities

Some of the adaptation options suggested by the community and key stakeholders for Great Sandy Strait townships include:

Protect foreshores in each community through targeted dune restoration/ mangrove replanting in partnership with the community.

Short to medium term, low to medium cost.

Better **accommodate** hazards by investigating increased buffer widths, and consider reducing roads to one way loops (Tuan/Tinnanbar).

Medium term, medium cost.

Retreat at-risk infrastructure and plan for its relocation (e.g. Tuan playground; Maaroom bench seats; Poona toilet block; Tinnanbar foreshore fencing).

Short to long term, medium to high cost.

Limit development in at risk areas to **avoid** increasing exposure.

Short to long term, low cost.

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COASTAL FUTURES
Planning Our Changing Coastline

Hervey Bay Esplanade

04

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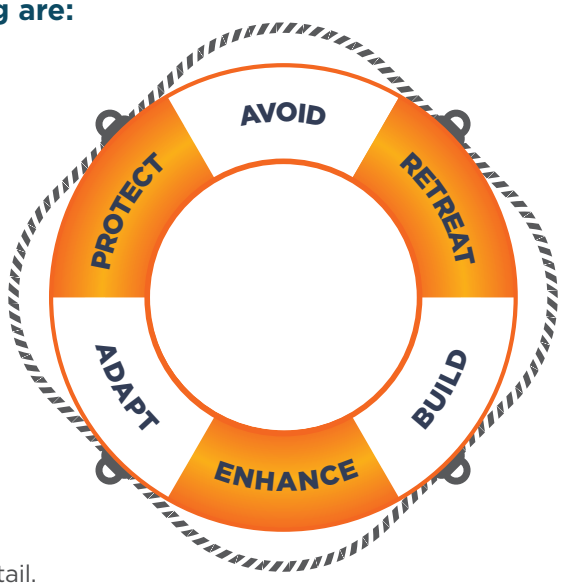

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COASTAL FUTURES
Planning Our Changing Coastline

Hervey Bay Esplanade

04

Our coastal values

The Hervey Bay Esplanade is loved by residents and visitors alike. Extending from Point Vernon to Urangan, the Esplanade is one of the most popular areas in the region for recreation, swimming, shopping, dining out, events and tourist accommodation. Residents and visitors highly value the sheltered beaches, parks and bike paths along the Esplanade as well as the Pier and Torquay Park precinct.

Our vulnerabilities

Community representatives from Point Vernon to Urangan identified that coastal hazards impacts could result in:

- Impacts to key infrastructure like the Point Vernon Sewer Treatment, Wetside Water Park, Seafront Oval or the Urangan or Scarness piers which may result in high repair/relocation costs or pollution.
- Damage to housing and businesses and loss of property.
- Impacts to Great Sandy Marine Park, and flora (vegetation and seagrass) and fauna (turtles, dugong, fish nurseries) generally that are important to local tourism and recreation.
- Impacts on esplanade beaches which are highly valued for tourism and local recreation.

Our opportunities

Some of the adaptation options suggested by the community and key stakeholders for the Hervey Bay Esplanade include:

Protect foreshores through targeted beach nourishment, dune restoration and stabilisation programs, in partnership with the community, and by formalising beach access points.

Short to long term, low to medium cost.

Limiting development by amending land use controls and design requirements to **avoid** increasing exposure.

Short to long term, low cost.

Accommodate hazards through changes to building design and subsidising adaptive design.

Medium term, medium to high cost.

Retreat by relocating vulnerable houses and businesses – potentially through land acquisition.

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COASTAL FUTURES
Planning Our Changing Coastline

Mary River

05

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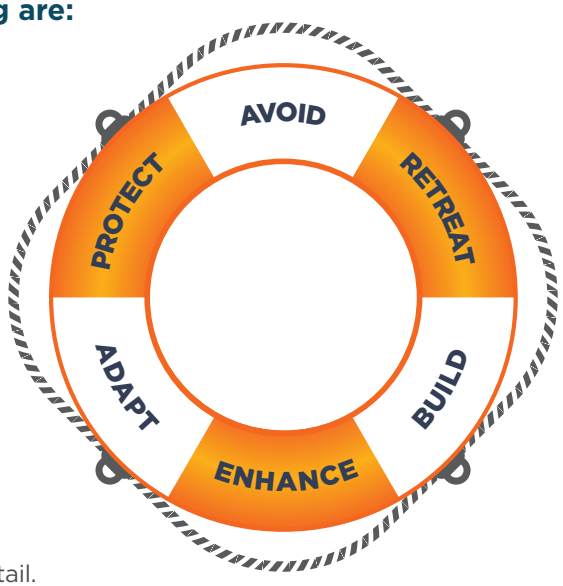

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COASTAL FUTURES
Planning Our Changing Coastline

Mary River

05

Our coastal values

The Mary River is highly valued for its relaxed sense of place and the range of recreational opportunities it provides. The river system itself is navigable and well managed, its popular among residents and visitors for boating and fishing. The parkland surrounding the river is also valued as an area for recreation, events and markets, and places to stay and eat.

Our vulnerabilities

Community representatives from Mary River identified that coastal hazards impacts could result in:

- Business interruption caused by flooding from storm tide inundation.
- Damage and disruption to key infrastructure such as roads, bridges, water mains and sewer.

Our opportunities

Some of the adaptation options suggested by the community and key stakeholders for Mary River include:

Accommodate hazards through raising road access or exploring alternative access routes.

Medium term, medium to high cost.

Protect through maintaining existing erosion protection structures.

Medium term, medium to high cost.

No new development in any vulnerable areas to **avoid** increasing exposure.

Short to long term, low cost.

Retreat by relocating vulnerable houses and businesses – potentially through land acquisition.

Medium to long term, medium to high cost.

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Please complete the survey for any locality of interest to you via https://frasercoast.engagementhub.com.au/coastal-futures-planning-our-changing-coastline.
The survey will close at 11:55pm on Sunday 26 July 2020.

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COASTAL FUTURES
Planning Our Changing Coastline

River Heads and Booral

06

The Coastal Futures: Planning Our Changing Coastline project is all about getting ready for the short, medium and long-term impacts of coastal hazards.

We are working to develop a strategy to plan for, protect, or mitigate the impacts of coastal hazards on:

- **Community infrastructure** - like boat ramps, walking paths and playgrounds.
- **Environmental features** – like dunes, wetlands and trees.
- **Built assets** – like businesses, homes, tourist accommodation, roads and services pipes.
- **Indigenous and cultural assets**.

The last time we consulted with you was to understand what places and aspects of the coast you value most. Since then the team have undertaken further technical work and met with a range of stakeholders to better understand the projected impacts of coastal hazards to the Fraser Coast coastline and how we might respond to them.

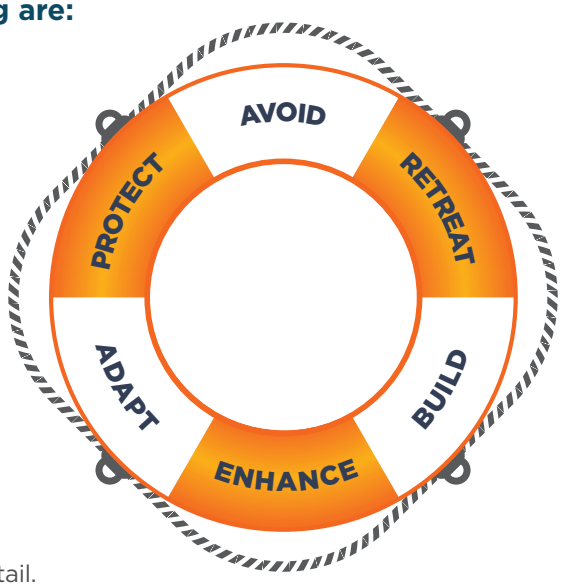
Now we are seeking to explore what types of adaptation responses you think are acceptable, to help inform the development of the draft Coastal Futures strategy.

Our life ring – how we can respond

Each of the coastal localities in the Fraser Coast region is different and will need its own strategy for the future. Uniting all the localities is the Coastal Futures life ring that will inform our approach to coastal hazard adaptation.

The six guiding strategies of the Coastal Futures life ring are:

01. **Avoid** building new things in hazard areas.
02. **Retreat** existing buildings and infrastructure out of high-risk areas over time.
03. **Build community resilience** through education and community awareness measures.
04. **Enhance coastline resilience** by protecting and/or reinstating natural coastal ecosystems – like stabilising dunes, or revegetating mangroves.
05. **Adapt** existing and future buildings, structures and infrastructure to be able to accommodate coastal changes – building things 'higher and stronger', evacuation planning.
06. **Protect/defend** priority shorelines, localities and infrastructure through the use of beach nourishment, seawalls, levees, groynes or other structures.



A fact sheet on adaptation options explains each of these in greater detail.

When we are considering these options for each locality, we need to think about:

Will it be financially sustainable? Adaptation can be expensive, and we can't protect the whole coastline. We need to focus on low cost solutions wherever we can, and prioritise where and when we invest in high cost shoreline protection.

How can we protect what we love and value? Protecting our coastline should align with what we value.

How can we maximise the benefits? When we invest in coastal hazard adaptation, we want to make sure that we maximise community benefits for the region as a whole.

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COASTAL FUTURES
Planning Our Changing Coastline

River Heads and Booral

06

Our coastal values

River Heads and Booral are highly valued for their natural features including migratory bird resting sites, wetlands (feeding wader birds), fish habitat and mangroves and the environmental reserve (remnant vine forest). Residents and visitors alike value beach and foreshore areas for recreation, picnicking, boating, and fishing. River Heads is also important as the launch point to Fraser Island.

Our vulnerabilities

Community representatives from River Heads and Booral identified that coastal hazards impacts could result in:

- Damage to transport infrastructure to and from Fraser Island, impacting the tourism industry.
- Loss of habitat for vulnerable and significant species along coastal conservation land and wetlands.
- Damage to housing and businesses, including the Queensland Aquaculture Factory, and potential property loss in some areas.

Our opportunities

Some of the adaptation options suggested by community representatives and key stakeholders for River Heads and Booral include:

No new development in any vulnerable areas to **avoid** increasing exposure.

Short to long term, low cost.

Protect foreshores and wildlife habitats by maintaining and increasing existing buffer areas and revegetating foreshore areas.

Short to medium term, low to medium cost.

Protect the environmental values of Fraser Island by capping tourist visitation numbers.

Short to medium term, low to medium cost.

Redesigning and upgrading boat ramps and car parks to better **accommodate** coastal hazards

Medium term, medium to high cost.

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COASTAL FUTURES
Planning Our Changing Coastline

Toogoom

07

The Coastal Futures: Planning Our Changing Coastline project is all about getting ready for the short, medium and long-term impacts of coastal hazards.

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- **Community infrastructure** - like boat ramps, walking paths and playgrounds.
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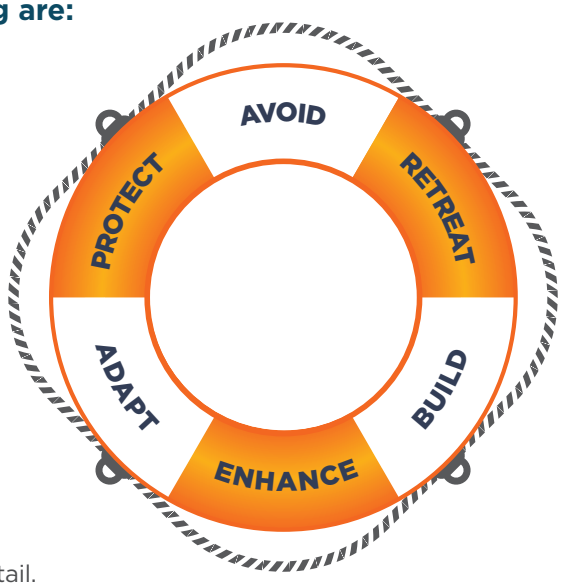

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How can we maximise the benefits? When we invest in coastal hazard adaptation, we want to make sure that we maximise community benefits for the region as a whole.

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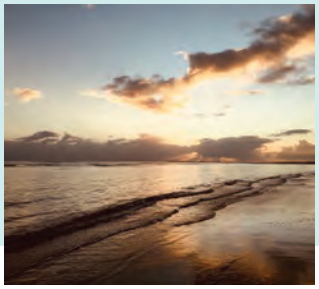
COASTAL FUTURES
Planning Our Changing Coastline

Toogoom

07

Our coastal values

Toogoom is highly valued and visited by many in the region. The beach, Beelbi Creek and Fixter Park foreshore are popular for recreation, boating, paddling and bird watching. Residents and visitors value the quiet, natural areas, and also the range of places to stay and eat.



Our vulnerabilities

Community representatives from Toogoom identified that coastal hazards impacts could result in:

- Inundation and damage to local roads which may result in increased repair costs and limited access for residents and visitors
- Damage or limited access to Fixter Park
- The operation of sewer pump stations and water infrastructure, this could also result in environmental impacts
- Damage to or loss of seafront houses, businesses, and the seawalls protecting these properties

Our opportunities

Some of the adaptation options suggested by the community and key stakeholders for Toogoom include:

Build community resilience through an awareness program about long term coastal hazard impacts, and better monitoring coastal changes.

Short term, low cost.

No new development in highly vulnerable areas to **avoid** increasing exposure.

Short to long term, low cost.

Retreat at-risk infrastructure and plan for relocation/redesign of roads, sewerage treatment plant and other assets.

Mediumto long term, medium to high cost.

Retreat existing vulnerable houses and businesses – this could involve land resumption – planning early for greater setbacks.

Short term, medium to high cost.

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COASTAL FUTURES
Planning Our Changing Coastline

Appendix D MCA Results

MCA Results

Table D-1 Burrum Heads MCA Results

Response Type	Action	Is the option technically effective at reducing risks regardless of timescale?	Does the option provide multiple or other benefits?	Proceed to next level of assessment?	Cost	Weighted Economic Impact	Environmental Impact	Weighted Environmental Impact	Social Impact	Weighted Social Impact	Reversible / Adaptable	Weighted reversible/ Adaptable	Effectiveness	Weighted Effectiveness	Approvability	Weighted Approvability	Timing	Weighted Timing	Unweighted Total Score (Go = >4, Slow = -4 to >4, Stop = 41)	Weighted Score	Rank	ACTION STATUS
Natural ecosystem strengthening	Active dune and habitat management	Yes	Yes	Yes	2	0.8	2	0.2	2	0.2	2	0.2	1	0.15	2	0.2	-2	-0.1	9	1.65	1	GO
Accommodate	Development master planning	Yes	Yes	Yes	2	0.8	2	0.2	2	0.2	1	0.1	1	0.15	0	0	0	0	8	1.45	2	GO
Natural ecosystem strengthening	Dune restoration / augmentation	Yes	Yes	Yes	2	0.8	0	0	2	0.2	2	0.2	1	0.15	2	0.2	-2	-0.1	7	1.45	3	GO
Natural ecosystem strengthening	Green belts and riparian corridors	Yes	Yes	Yes	2	0.8	2	0.2	1	0.1	1	0.1	1	0.15	1	0.1	-1	-0.05	7	1.4	4	GO
Accommodate	Emergency management response	No	Yes	Yes	2	0.8	0	0	-1	-0.1	2	0.2	2	0.3	2	0.2	-2	-0.1	5	1.3	5	GO
Accommodate	Hazard resilient design for new/upgraded private infrastructure	Yes	No	Yes	2	0.8	1	0.1	0	0	1	0.1	1	0.15	1	0.1	1	0.05	7	1.3	5	GO
Build community resilience / complementary measures	Community Education and Consultation	Yes	No	Yes	2	0.8	0	0	1	0.1	1	0.1	0	0	2	0.2	0	0	6	1.2	7	GO
Natural ecosystem strengthening	Establish buffers around wetlands	Yes	Yes	Yes	1	0.4	2	0.2	2	0.2	2	0.2	1	0.15	1	0.1	-1	-0.05	8	1.2	7	GO
Natural ecosystem strengthening	Land management to support habitat migration	Yes	Yes	Yes	1	0.4	2	0.2	2	0.2	2	0.2	1	0.15	1	0.1	-1	-0.05	8	1.2	7	GO
Natural ecosystem strengthening	Wetland restoration	Yes	Yes	Yes	1	0.4	2	0.2	2	0.2	2	0.2	1	0.15	1	0.1	-1	-0.05	8	1.2	7	GO
Protect	Tide flaps/valves on stormwater network	Yes	No	Yes	2	0.8	0	0	0	0	1	0.1	1	0.15	1	0.1	0	0	5	1.15	11	GO
Accommodate	Hazard resilient design for new/upgraded public infrastructure	Yes	Yes	Yes	1	0.4	1	0.1	2	0.2	1	0.1	1	0.15	1	0.1	1	0.05	8	1.1	12	GO
Build community resilience / complementary measures	Monitoring	Yes	No	Yes	2	0.8	0	0	1	0.1	0	0	0	0	2	0.2	-1	-0.05	4	1.05	13	GO
Accommodate	Insurance	No	Yes	Yes	1	0.4	0	0	0	0	1	0.1	2	0.3	2	0.2	0	0	6	1	14	SLOW
Accommodate	Allow foreshore recession	Yes	No	Yes	2	0.8	2	0.2	-1	-0.1	-1	-0.1	0	0	2	0.2	-1	-0.05	3	0.95	15	SLOW
Natural ecosystem strengthening	Beach scraping	Yes	Yes	Yes	2	0.8	-1	-0.1	1	0.1	1	0.1	0	0	1	0.1	-2	-0.1	2	0.9	16	SLOW
Natural ecosystem strengthening	Small-scale beach nourishment	Yes	Yes	Yes	1	0.4	-1	-0.1	1	0.1	2	0.2	1	0.15	1	0.1	-1	-0.05	4	0.8	17	SLOW
Planned Transition	Maintain status quo (no changes to present management approach)	Yes	No	Yes	2	0.8	-1	-0.1	-1	-0.1	0	0	0	0	2	0.2	0	0	2	0.8	17	SLOW
Build community resilience / complementary measures	Geotechnical Investigation & Detailed Erosion Study	Yes	No	Yes	1	0.4	0	0	0	0	0	0	0	0	2	0.2	0	0	3	0.6	19	SLOW
Avoid	Community Infrastructure Management	Yes	No	Yes	0	0	0	0	1	0.1	0	0	2	0.3	1	0.1	2	0.1	6	0.6	20	SLOW
Avoid	Coastal building lines / development setbacks	Yes	No	Yes	1	0.4	0	0	0	0	0	0	0	0	1	0.1	0	0	2	0.5	21	SLOW
Accommodate	Urban design	Yes	Yes	Yes	0	0	1	0.1	1	0.1	0	0	0	0	2	0.2	0	0	4	0.4	22	SLOW
Protect	Groyne and artificial headlands	Yes	No	Yes	0	0	0	0	1	0.1	0	0	1	0.15	0	0	1	0.05	3	0.3	23	SLOW
Avoid	Reduce intensity of future development	Yes	No	Yes	0	0	1	0.1	-1	-0.1	1	0.1	1	0.15	-1	-0.1	1	0.05	2	0.2	24	SLOW
Planned Transition	Trigger related development approvals	Yes	No	Yes	0	0	0	0	0	0	0	0	1	0.15	0	0	1	0.05	2	0.2	24	SLOW
Protect	Seawall/scour protection on private land to protect private assets	Yes	No	Yes	0	0	0	0	0	0	0	0	1	0.15	0	0	1	0.05	2	0.2	24	SLOW
Planned Transition	Land buy back with lease back opportunity	Yes	No	Yes	-1	-0.4	1	0.1	-1	-0.2	1	0.1	2	0.3	2	0.2	1	0.05	4	0.15	27	SLOW
Planned Transition	Relocate important infrastructure	Yes	No	Yes	-1	-0.4	0	0	0	0	0	0	2	0.3	1	0.1	2	0.1	4	0.1	28	SLOW
Avoid	Raise land levels	Yes	No	Yes	0	0	0	0	0	0	-2	-0.2	1	0.15	1	0.1	0	0	0	0.05	29	SLOW
Planned Transition	Land buy back (no lease back)	Yes	No	Yes	-1	-0.4	0	0	-1	-0.1	1	0.1	2	0.3	0	0	2	0.1	3	0	30	SLOW
Planned Transition	Land swap	Yes	Yes	Yes	-1	-0.4	0	0	-1	-0.1	1	0.1	2	0.3	0	0	2	0.1	3	0	30	SLOW
Protect	Seawall/scour protection to protect public assets	Yes	No	Yes	-1	-0.4	0	0	-1	-0.1	1	0.1	1	0.15	1	0.1	2	0.1	3	-0.05	43	SLOW
Planned Transition	Partial land buy-back	Yes	No	Yes	-1	-0.4	1	0.1	-1	-0.1	1	0.1	1	0.15	0	0	1	0.05	2	-0.1	44	SLOW
Protect	Large-scale beach nourishment	Yes	Yes	Yes	-1	-0.4	-1	-0.1	2	0.2	2	0.2	0	0	-1	-0.1	1	0.05	2	-0.15	45	SLOW
Accommodate	Build redundancy into network systems	Yes	Yes	Yes	-2	-0.8	0	0	1	0.1	0	0	2	0.3	0	0	2	0.1	3	-0.3	46	SLOW
Accommodate	Contaminated site management	No	No	No	No known contaminated sites														0	30	STOP
Accommodate	Emergency management planning (e.g. alternative route provision)	No	No	No	Not considered at this time but should be reviewed as part of future evacuation planning studies														0	30	STOP
Accommodate	Floating development (residential)	No	No	No	Not considered suitable for mitigating coastal hazard risks														0	30	STOP
Accommodate	Manual Creek Mouth Management to Protect Private Assets	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality														0	30	STOP
Accommodate	Manual Creek Mouth Management to Protect Public Assets	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality														0	30	STOP
Natural ecosystem strengthening	Dune construction	No	No	No	Limited opportunity for this action; preference to restore/maintain existing dune system														0	30	STOP
Natural ecosystem strengthening	Reduce extents of hard surfaces	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality; this action may provide other benefits (e.g. heat reduction)														0	30	STOP
Planned Transition	Rolling easement	No	No	No	Limited to no opportunity to implement at this location														0	30	STOP
Protect	Artificial reef	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality; this action may provide other benefits (e.g. fish habitat)														0	30	STOP
Protect	Levees / dykes	No	No	No	Likely to impact catchment flooding, not considered further at this time														0	30	STOP
Protect	Tidal barrage / gates / surge barriers	No	No	No	Tidal control of the Burrum River not consider viable at this time														0	30	STOP

MCA Results

Table D-2 Toogoom MCA Results

Response Type	Action	Is the option technically effective at reducing risks regardless of timescale?	Does the option provide multiple or other benefits?	Proceed to next level of assessment?	Cost	Weighted Economic Impact	Environmental Impact	Weighted Environmental Impact	Social Impact	Weighted Social Impact	Reversible / Adaptable	Weighted reversible/ Adaptable	Effectiveness	Weighted Effectiveness	Approvability	Weighted Approvability	Timing	Weighted Timing	Unweighted Total Score (Go = >4, Slow = -4 to >4, Stop = 41)	Weighted Score	Rank	ACTION STATUS
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Accommodate	Development master planning	Yes	Yes	Yes	2	0.8	2	0.2	2	0.2	1	0.1	1	0.15	0	0	0	0	8	1.45	2	GO
Natural ecosystem strengthening	Dune restoration / augmentation	Yes	Yes	Yes	2	0.8	0	0	2	0.2	2	0.2	1	0.15	2	0.2	-2	-0.1	7	1.45	3	GO
Natural ecosystem strengthening	Green belts and riparian corridors	Yes	Yes	Yes	2	0.8	2	0.2	1	0.1	1	0.1	1	0.15	1	0.1	-1	-0.05	7	1.4	4	GO
Accommodate	Emergency management response	No	Yes	Yes	2	0.8	0	0	-1	-0.1	2	0.2	2	0.3	2	0.2	-2	-0.1	5	1.3	5	GO
Accommodate	Hazard resilient design for new/upgraded private infrastructure	Yes	No	Yes	2	0.8	1	0.1	0	0	1	0.1	1	0.15	1	0.1	1	0.05	7	1.3	5	GO
Build community resilience / complementary measures	Community Education and Consultation	Yes	No	Yes	2	0.8	0	0	1	0.1	1	0.1	0	0	2	0.2	0	0	6	1.2	7	GO
Natural ecosystem strengthening	Establish buffers around wetlands	Yes	Yes	Yes	1	0.4	2	0.2	2	0.2	2	0.2	1	0.15	1	0.1	-1	-0.05	8	1.2	7	GO
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Protect	Tide flaps/valves on stormwater network	Yes	No	Yes	2	0.8	0	0	0	0	1	0.1	1	0.15	1	0.1	0	0	5	1.15	11	GO
Accommodate	Hazard resilient design for new/upgraded public infrastructure	Yes	No	Yes	1	0.4	1	0.1	2	0.2	1	0.1	1	0.15	1	0.1	1	0.05	8	1.1	12	GO
Build community resilience / complementary measures	Monitoring	Yes	No	Yes	2	0.8	0	0	1	0.1	0	0	0	0	2	0.2	-1	-0.05	4	1.05	13	GO
Accommodate	Emergency management planning (e.g. alternative route provision)	Yes	No	Yes	2	0.8	1	0.1	-2	-0.2	1	0.1	1	0.15	0	0	1	0.05	4	1	14	SLOW
Accommodate	Insurance	No	Yes	Yes	1	0.4	0	0	0	0	1	0.1	2	0.3	2	0.2	0	0	6	1	14	SLOW
Accommodate	Allow foreshore recession	Yes	No	Yes	2	0.8	2	0.2	-1	-0.1	-1	-0.1	0	0	2	0.2	-1	-0.05	3	0.95	16	SLOW
Natural ecosystem strengthening	Beach scraping	Yes	No	Yes	2	0.8	-1	-0.1	1	0.1	1	0.1	0	0	1	0.1	-2	-0.1	2	0.9	17	SLOW
Planned Transition	Maintain status quo (no changes to present management approach)	Yes	No	Yes	2	0.8	-1	-0.1	-1	-0.1	0	0	0	0	2	0.2	0	0	2	0.8	18	SLOW
Build community resilience / complementary measures	Geotechnical Investigation & Detailed Erosion Study	Yes	No	Yes	1	0.4	0	0	0	0	0	0	0	0	2	0.2	0	0	3	0.6	19	SLOW
Avoid	Community Infrastructure Management	Yes	No	Yes	0	0	0	0	1	0.1	0	0	2	0.3	1	0.1	2	0.1	6	0.6	20	SLOW
Avoid	Coastal building lines / development setbacks	Yes	No	Yes	1	0.4	0	0	0	0	0	0	0	0	1	0.1	0	0	2	0.5	21	SLOW
Accommodate	Urban design	Yes	Yes	Yes	0	0	1	0.1	1	0.1	0	0	0	0	2	0.2	0	0	4	0.4	22	SLOW
Avoid	Reduce intensity of future development	Yes	No	Yes	0	0	1	0.1	-1	-0.1	1	0.1	1	0.15	-1	-0.1	1	0.05	2	0.2	23	SLOW
Planned Transition	Trigger related development approvals	Yes	No	Yes	0	0	0	0	0	0	0	0	1	0.15	0	0	1	0.05	2	0.2	23	SLOW
Protect	Seawall/scour protection to protect private assets	Yes	No	Yes	0	0	0	0	0	0	0	0	1	0.15	0	0	1	0.05	2	0.2	23	SLOW
Planned Transition	Land buy back with lease back opportunity	Yes	No	Yes	-1	-0.4	1	0.1	-2	-0.2	1	0.1	2	0.3	2	0.2	1	0.05	4	0.15	26	SLOW
Planned Transition	Relocate important infrastructure	Yes	No	Yes	-1	-0.4	0	0	0	0	0	0	2	0.3	1	0.1	2	0.1	4	0.1	27	SLOW
Avoid	Raise land levels	Yes	No	Yes	0	0	0	0	0	0	-2	-0.2	1	0.15	1	0.1	0	0	0	0.05	28	SLOW
Planned Transition	Land buy back (no lease back)	Yes	No	Yes	-1	-0.4	0	0	-1	-0.1	1	0.1	2	0.3	0	0	2	0.1	3	0	29	SLOW
Planned Transition	Land swap	Yes	Yes	Yes	-1	-0.4	0	0	-1	-0.1	1	0.1	2	0.3	0	0	2	0.1	3	0	29	SLOW
Protect	Seawall/scour protection to protect public assets	Yes	No	Yes	-1	-0.4	0	0	-1	-0.1	1	0.1	1	0.15	1	0.1	2	0.1	3	-0.05	43	SLOW
Planned Transition	Partial land buy-back	Yes	No	Yes	-1	-0.4	1	0.1	-1	-0.1	1	0.1	1	0.15	0	0	1	0.05	2	-0.1	44	SLOW
Protect	Large-scale beach nourishment	Yes	Yes	Yes	-1	-0.4	-1	-0.1	2	0.2	2	0.2	0	0	-1	-0.1	1	0.05	2	-0.15	45	SLOW
Accommodate	Build redundancy into network systems	Yes	Yes	Yes	-2	-0.8	0	0	1	0.1	0	0	2	0.3	0	0	2	0.1	3	-0.3	46	SLOW
Accommodate	Contaminated site management	No	No	No	No known contaminated sites															0	29	STOP
Accommodate	Floating development (residential)	No	No	No	Not considered suitable for mitigating coastal hazard risks															0	29	STOP
Accommodate	Manual Creek Mouth Management to Protect Private Assets	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	29	STOP
Accommodate	Manual Creek Mouth Management to Protect Public Assets	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	29	STOP
Natural ecosystem strengthening	Dune construction	No	No	No	Limited opportunity for this action; preference to restore/maintain existing dune system															0	29	STOP
Natural ecosystem strengthening	Reduce extents of hard surfaces	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality; this action may provide other benefits (e.g. heat reduction)															0	29	STOP
Natural ecosystem strengthening	Small-scale beach nourishment	No	No	No	Small-scale beach nourishment unlikely to provide tangible benefit due to the extent of beach compartment															0	29	STOP
Planned Transition	Rolling easement	No	No	No	Limited to no opportunity to implement at this location															0	29	STOP
Protect	Artificial reef	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality; this action may provide other benefits (e.g. fish habitat)															0	29	STOP
Protect	Groyne and artificial headlands	No	No	No	To be reconsidered if large scale beach nourishment is planned															0	29	STOP
Protect	Levees / dykes	No	No	No	Likely to impact catchment flooding, not considered further at this time															0	29	STOP
Protect	Tidal barrage / gates / surge barriers	No	No	No	Tidal control of Beelbi and O'Regan Creeks not considered viable at this time															0	29	STOP

MCA Results

Table D-3 Dundowran Beach & Eli Waters MCA Results

Response Type	Action	Is the option technically effective at reducing risks regardless of timescale?	Does the option provide multiple or other benefits?	Proceed to next level of assessment?	Cost	Weighted Economic Impact	Environmental Impact	Weighted Environmental Impact	Social Impact	Weighted Social Impact	Reversible / Adaptable	Weighted reversible/ Adaptable	Effectiveness	Weighted Effectiveness	Approvability	Weighted Approvability	Timing	Weighted Timing	Unweighted Total Score (Go = >4, Slow = -4 to >4, Stop = 41)	Weighted Score	Rank	ACTION STATUS
Natural ecosystem strengthening	Active dune and habitat management	Yes	Yes	Yes	2	0.8	2	0.2	2	0.2	2	0.2	1	0.15	2	0.2	-2	-0.1	9	1.65	1	GO
Accommodate	Development master planning	Yes	No	Yes	2	0.8	2	0.2	2	0.2	1	0.1	1	0.15	0	0	0	0	8	1.45	2	GO
Natural ecosystem strengthening	Dune restoration / augmentation	Yes	Yes	Yes	2	0.8	0	0	2	0.2	2	0.2	1	0.15	2	0.2	-2	-0.1	7	1.45	3	GO
Natural ecosystem strengthening	Green belts and riparian corridors	Yes	Yes	Yes	2	0.8	2	0.2	1	0.1	1	0.1	1	0.15	1	0.1	-1	-0.05	7	1.4	4	GO
Accommodate	Emergency management response	Yes	No	Yes	2	0.8	0	0	-1	-0.1	2	0.2	2	0.3	2	0.2	-2	-0.1	5	1.3	5	GO
Accommodate	Hazard resilient design for new/upgraded private infrastructure	Yes	No	Yes	2	0.8	1	0.1	0	0	1	0.1	1	0.15	1	0.1	1	0.05	7	1.3	5	GO
Build community resilience / complementary measures	Community Education and Consultation	Yes	No	Yes	2	0.8	0	0	1	0.1	1	0.1	0	0	2	0.2	0	0	6	1.2	7	GO
Natural ecosystem strengthening	Establish buffers around wetlands	Yes	Yes	Yes	1	0.4	2	0.2	2	0.2	2	0.2	1	0.15	1	0.1	-1	-0.05	8	1.2	7	GO
Natural ecosystem strengthening	Land management to support habitat migration	Yes	Yes	Yes	1	0.4	2	0.2	2	0.2	2	0.2	1	0.15	1	0.1	-1	-0.05	8	1.2	7	GO
Natural ecosystem strengthening	Wetland restoration	Yes	Yes	Yes	1	0.4	2	0.2	2	0.2	2	0.2	1	0.15	1	0.1	-1	-0.05	8	1.2	7	GO
Accommodate	Hazard resilient design for new/upgraded public infrastructure	Yes	No	Yes	1	0.4	1	0.1	2	0.2	1	0.1	1	0.15	1	0.1	1	0.05	8	1.1	11	GO
Build community resilience / complementary measures	Monitoring	Yes	No	Yes	2	0.8	0	0	1	0.1	0	0	0	0	2	0.2	-1	-0.05	4	1.05	12	GO
Accommodate	Insurance	No	Yes	Yes	1	0.4	0	0	0	0	1	0.1	2	0.3	2	0.2	0	0	6	1	13	SLOW
Protect	Tide flaps/valves on stormwater network	Yes	No	Yes	2	0.8	0	0	0	0	1	0.1	0	0	1	0.1	0	0	4	1	13	SLOW
Accommodate	Allow foreshore recession	Yes	No	Yes	2	0.8	2	0.2	-1	-0.1	-1	-0.1	0	0	2	0.2	-1	-0.05	3	0.95	15	SLOW
Natural ecosystem strengthening	Beach scraping	Yes	No	Yes	2	0.8	-1	-0.1	1	0.1	1	0.1	0	0	1	0.1	-2	-0.1	2	0.9	16	SLOW
Planned Transition	Maintain status quo (no changes to present management approach)	Yes	No	Yes	2	0.8	-1	-0.1	-1	-0.1	0	0	0	0	2	0.2	0	0	2	0.8	17	SLOW
Build community resilience / complementary measures	Geotechnical Investigation & Detailed Erosion Study	Yes	No	Yes	1	0.4	0	0	0	0	0	0	0	0	2	0.2	0	0	3	0.6	18	SLOW
Avoid	Community Infrastructure Management	Yes	No	Yes	0	0	0	0	1	0.1	0	0	2	0.3	1	0.1	2	0.1	6	0.6	19	SLOW
Avoid	Coastal building lines / development setbacks	Yes	No	Yes	1	0.4	0	0	0	0	0	0	0	0	1	0.1	0	0	2	0.5	20	SLOW
Accommodate	Urban design	Yes	Yes	Yes	0	0	1	0.1	1	0.1	0	0	0	0	2	0.2	0	0	4	0.4	21	SLOW
Avoid	Reduce intensity of future development	Yes	No	Yes	0	0	1	0.1	-1	-0.1	1	0.1	1	0.15	-1	-0.1	1	0.05	2	0.2	22	SLOW
Planned Transition	Trigger related development approvals	Yes	No	Yes	0	0	0	0	0	0	0	0	1	0.15	0	0	1	0.05	2	0.2	22	SLOW
Protect	Seawall/scour protection to protect private assets	Yes	No	Yes	0	0	0	0	0	0	0	0	1	0.15	0	0	1	0.05	2	0.2	22	SLOW
Planned Transition	Land buy back with lease back opportunity	Yes	No	Yes	-1	-0.4	1	0.1	-2	-0.2	1	0.1	2	0.3	2	0.2	1	0.05	4	0.15	25	SLOW
Planned Transition	Relocate important infrastructure	Yes	No	Yes	-1	-0.4	0	0	0	0	0	0	2	0.3	1	0.1	2	0.1	4	0.1	26	SLOW
Avoid	Raise land levels	Yes	No	Yes	0	0	0	0	0	0	-2	-0.2	1	0.15	1	0.1	0	0	0	0.05	27	SLOW
Planned Transition	Land buy back (no lease back)	Yes	No	Yes	-1	-0.4	0	0	-1	-0.1	1	0.1	2	0.3	0	0	2	0.1	3	0	28	SLOW
Planned Transition	Land swap	Yes	Yes	Yes	-1	-0.4	0	0	-1	-0.1	1	0.1	2	0.3	0	0	2	0.1	3	0	28	SLOW
Planned Transition	Partial land buy-back	Yes	No	Yes	-1	-0.4	1	0.1	-1	-0.1	1	0.1	1	0.15	0	0	1	0.05	2	-0.1	44	SLOW
Protect	Large-scale beach nourishment	Yes	Yes	Yes	-1	-0.4	-1	-0.1	2	0.2	2	0.2	0	0	-1	-0.1	1	0.05	2	-0.15	45	SLOW
Accommodate	Build redundancy into network systems	Yes	Yes	Yes	-2	-0.8	0	0	1	0.1	0	0	2	0.3	0	0	2	0.1	3	-0.3	46	SLOW
Accommodate	Contaminated site management	No	No	No	No known contaminated sites															0	28	STOP
Accommodate	Emergency management planning (e.g. alternative route provision)	No	No	No	Not considered at this time but should be reviewed as part of future evacuation planning studies															0	28	STOP
Accommodate	Floating development (residential)	No	No	No	Not considered suitable for mitigating coastal hazard risks															0	28	STOP
Accommodate	Manual Creek Mouth Management to Protect Private Assets	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	28	STOP
Accommodate	Manual Creek Mouth Management to Protect Public Assets	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	28	STOP
Natural ecosystem strengthening	Dune construction	No	No	No	Limited opportunity for this action; preference to restore/maintain existing dune system															0	28	STOP
Natural ecosystem strengthening	Reduce extents of hard surfaces	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality; this action may provide other benefits (e.g. heat reduction)															0	28	STOP
Natural ecosystem strengthening	Small-scale beach nourishment	No	No	No	Small-scale beach nourishment unlikely to provide tangible benefit due to the extent of beach compartment															0	28	STOP
Planned Transition	Rolling easement	No	No	No	Limited to no opportunity to implement at this location															0	28	STOP
Protect	Artificial reef	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality; this action may provide other benefits (e.g. fish habitat)															0	28	STOP
Protect	Groyne and artificial headlands	No	No	No	To be reconsidered if large scale beach nourishment is planned															0	28	STOP
Protect	Levees / dykes	No	No	No	Likely to impact catchment flooding, not considered further at this time															0	28	STOP
Protect	Seawall/scour protection to protect public assets	No	No	No	No major public assets at risk; preference to transition minor assets rather than protect															0	28	STOP
Protect	Tidal barrage / gates / surge barriers	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	28	STOP

MCA Results

Table D-4 MCA Results Point Vernon

Response Type	Action	Is the option technically effective at reducing risks regardless of timescale?	Does the option provide multiple or other benefits?	Proceed to next level of assessment?	Cost	Weighted Economic Impact	Environmental Impact	Weighted Environmental Impact	Social Impact	Weighted Social Impact	Reversible / Adaptable	Weighted reversible/ Adaptable	Effectiveness	Weighted Effectiveness	Approvability	Weighted Approvability	Timing	Weighted Timing	Unweighted Total Score (Go = >4, Slow = -4 to >4, Stop = 41)	Weighted Score	Rank	ACTION STATUS
Natural ecosystem strengthening	Active dune and habitat management	Yes	Yes	Yes	2	0.8	2	0.2	2	0.2	2	0.2	1	0.15	2	0.2	-2	-0.1	9	1.65	1	GO
Accommodate	Development master planning	No	Yes	Yes	2	0.8	2	0.2	2	0.2	1	0.1	1	0.15	0	0	0	0	8	1.45	2	GO
Natural ecosystem strengthening	Green belts and riparian corridors	Yes	Yes	Yes	2	0.8	2	0.2	1	0.1	1	0.1	1	0.15	1	0.1	-1	-0.05	7	1.4	4	GO
Accommodate	Emergency management response	No	Yes	Yes	2	0.8	0	0	-1	-0.1	2	0.2	2	0.3	2	0.2	-2	-0.1	5	1.3	4	GO
Accommodate	Hazard resilient design for new/upgraded private infrastructure	Yes	No	Yes	2	0.8	1	0.1	0	0	1	0.1	1	0.15	1	0.1	1	0.05	7	1.3	5	GO
Build community resilience / complementary measures	Community Education and Consultation	Yes	No	Yes	2	0.8	0	0	1	0.1	1	0.1	0	0	2	0.2	0	0	6	1.2	6	GO
Natural ecosystem strengthening	Establish buffers around wetlands	Yes	Yes	Yes	1	0.4	2	0.2	2	0.2	2	0.2	1	0.15	1	0.1	-1	-0.05	8	1.2	7	GO
Natural ecosystem strengthening	Land management to support habitat migration	Yes	Yes	Yes	1	0.4	2	0.2	2	0.2	2	0.2	1	0.15	1	0.1	-1	-0.05	8	1.2	7	GO
Natural ecosystem strengthening	Wetland restoration	Yes	Yes	Yes	1	0.4	2	0.2	2	0.2	2	0.2	1	0.15	1	0.1	-1	-0.05	8	1.2	6	GO
Accommodate	Hazard resilient design for new/upgraded public infrastructure	Yes	No	Yes	1	0.4	1	0.1	2	0.2	1	0.1	1	0.15	1	0.1	1	0.05	8	1.1	11	GO
Build community resilience / complementary measures	Monitoring	Yes	No	Yes	2	0.8	0	0	1	0.1	0	0	0	0	2	0.2	-1	-0.05	4	1.05	11	GO
Accommodate	Insurance	No	Yes	Yes	1	0.4	0	0	0	0	1	0.1	2	0.3	2	0.2	0	0	6	1	12	SLOW
Protect	Tide flaps/valves on stormwater network	Yes	No	Yes	2	0.8	0	0	0	0	1	0.1	0	0	1	0.1	0	0	4	1	12	SLOW
Accommodate	Allow foreshore recession	Yes	No	Yes	2	0.8	2	0.2	-1	-0.1	-1	-0.1	0	0	2	0.2	-1	-0.05	3	0.95	14	SLOW
Natural ecosystem strengthening	Beach scraping	Yes	No	Yes	2	0.8	-1	-0.1	1	0.1	1	0.1	0	0	1	0.1	-2	-0.1	2	0.9	15	SLOW
Natural ecosystem strengthening	Small-scale beach nourishment	Yes	Yes	Yes	1	0.4	-1	-0.1	1	0.1	2	0.2	1	0.15	1	0.1	-1	-0.05	4	0.8	16	SLOW
Planned Transition	Maintain status quo (no changes to present management approach)	Yes	No	Yes	2	0.8	-1	-0.1	-1	-0.1	0	0	0	0	2	0.2	0	0	2	0.8	16	SLOW
Build community resilience / complementary measures	Geotechnical Investigation & Detailed Erosion Study	Yes	No	Yes	1	0.4	0	0	0	0	0	0	0	0	2	0.2	0	0	3	0.6	18	SLOW
Avoid	Community Infrastructure Management	Yes	No	Yes	0	0	0	0	1	0.1	0	0	2	0.3	1	0.1	2	0.1	6	0.6	19	SLOW
Avoid	Coastal building lines / development setbacks	Yes	No	Yes	1	0.4	0	0	0	0	0	0	0	0	1	0.1	0	0	2	0.5	20	SLOW
Avoid	Reduce intensity of future development	Yes	No	Yes	0	0	1	0.1	-1	-0.1	1	0.1	1	0.15	-1	-0.1	1	0.05	2	0.2	21	SLOW
Planned Transition	Trigger related development approvals	Yes	No	Yes	0	0	0	0	0	0	0	0	1	0.15	0	0	1	0.05	2	0.2	21	SLOW
Planned Transition	Land buy back with lease back opportunity	Yes	No	Yes	-1	-0.4	1	0.1	-2	-0.2	1	0.1	2	0.3	2	0.2	1	0.05	4	0.15	23	SLOW
Planned Transition	Relocate important infrastructure	Yes	No	Yes	-1	-0.4	0	0	0	0	0	0	2	0.3	1	0.1	2	0.1	4	0.1	24	SLOW
Avoid	Raise land levels	Yes	No	Yes	0	0	0	0	0	0	-2	-0.2	1	0.15	1	0.1	0	0	0	0.05	25	SLOW
Planned Transition	Land buy back (no lease back)	Yes	No	Yes	-1	-0.4	0	0	-1	-0.1	1	0.1	2	0.3	0	0	2	0.1	3	0	26	SLOW
Planned Transition	Land swap	Yes	Yes	Yes	-1	-0.4	0	0	-1	-0.1	1	0.1	2	0.3	0	0	2	0.1	3	0	26	SLOW
Planned Transition	Partial land buy-back	Yes	No	Yes	-1	-0.4	1	0.1	-1	-0.1	1	0.1	1	0.15	0	0	1	0.05	2	-0.1	45	SLOW
Accommodate	Build redundancy into network systems	Yes	Yes	Yes	-2	-0.8	0	0	1	0.1	0	0	2	0.3	0	0	2	0.1	3	-0.3	46	SLOW
Accommodate	Contaminated site management	No	No	No	No known contaminated sites															0	26	STOP
Accommodate	Emergency management planning (e.g. alternative route provision)	No	No	No	Not considered at this time but should be reviewed as part of future evacuation planning studies															0	26	STOP
Accommodate	Floating development (residential)	No	No	No	Not considered suitable for mitigating coastal hazard risks															0	26	STOP
Accommodate	Manual Creek Mouth Management to Protect Private Assets	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	26	STOP
Accommodate	Manual Creek Mouth Management to Protect Public Assets	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	26	STOP
Accommodate	Urban design	No	No	No	Not considered in detail as part of the CHAS; to be considered as part of future master planning (for example)															0	26	STOP
Natural ecosystem strengthening	Dune construction	No	No	No	Limited opportunity for this action; preference to restore/maintain existing dune system															0	26	STOP
Natural ecosystem strengthening	Dune restoration / augmentation	No	No	No	Limited to no opportunity to implement at this location due to local intertidal geology															0	26	STOP
Natural ecosystem strengthening	Reduce extents of hard surfaces	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality; this action may provide other benefits (e.g. heat reduction)															0	26	STOP
Planned Transition	Rolling easement	No	No	No	Limited to no opportunity to implement at this location															0	26	STOP
Protect	Artificial reef	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality; this action may provide other benefits (e.g. fish habitat)															0	26	STOP
Protect	Groyne and artificial headlands	No	No	No	Limited to no opportunity to implement at this location due to local intertidal geology															0	26	STOP
Protect	Large-scale beach nourishment	No	No	No	Limited opportunities due to local intertidal geology															0	26	STOP
Protect	Levees / dykes	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	26	STOP
Protect	Seawall/scour protection to protect private assets	No	No	No	Private assets generally outside of the coastal erosion hazard area															0	26	STOP
Protect	Seawall/scour protection to protect public assets	No	No	No	No major public assets at risk; preference to transition minor assets rather than protect															0	26	STOP
Protect	Tidal barrage / gates / surge barriers	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	26	STOP

MCA Results

Table D-5 MCA Results Pialba

Response Type	Action	Is the option technically effective at reducing risks regardless of timescale?	Does the option provide multiple or other benefits?	Proceed to next level of assessment?	Cost	Weighted Economic Impact	Environmental Impact	Weighted Environmental Impact	Social Impact	Weighted Social Impact	Reversible / Adaptable	Weighted reversible/ Adaptable	Effectiveness	Weighted Effectiveness	Approvability	Weighted Approvability	Timing	Weighted Timing	Unweighted Total Score (Go = >4, Slow = -4 to >4, Stop = 41)	Weighted Score	Rank	ACTION STATUS
Natural ecosystem strengthening	Active dune and habitat management	Yes	Yes	Yes	2	0.8	2	0.2	2	0.2	2	0.2	1	0.15	2	0.2	-2	-0.1	9	1.65	1	GO
Accommodate	Development master planning	Yes	Yes	Yes	2	0.8	2	0.2	2	0.2	1	0.1	1	0.15	0	0	0	0	8	1.45	2	GO
Natural ecosystem strengthening	Dune restoration / augmentation	Yes	No	Yes	2	0.8	0	0	2	0.2	2	0.2	1	0.15	2	0.2	-2	-0.1	7	1.45	3	GO
Accommodate	Emergency management response	No	Yes	Yes	2	0.8	0	0	-1	-0.1	2	0.2	2	0.3	2	0.2	-2	-0.1	5	1.3	4	GO
Accommodate	Hazard resilient design for new/upgraded private infrastructure	Yes	No	Yes	2	0.8	1	0.1	0	0	1	0.1	1	0.15	1	0.1	1	0.05	7	1.3	4	GO
Build community resilience / complementary measures	Community Education and Consultation	Yes	No	Yes	2	0.8	0	0	1	0.1	1	0.1	0	0	2	0.2	0	0	6	1.2	6	GO
Natural ecosystem strengthening	Wetland restoration	Yes	Yes	Yes	1	0.4	2	0.2	2	0.2	2	0.2	1	0.15	1	0.1	-1	-0.05	8	1.2	6	GO
Protect	Tide flaps/valves on stormwater network	Yes	No	Yes	2	0.8	0	0	0	0	1	0.1	1	0.15	1	0.1	0	0	5	1.15	8	GO
Natural ecosystem strengthening	Beach scraping	Yes	No	Yes	2	0.8	-1	-0.1	1	0.1	2	0.2	1	0.15	1	0.1	-2	-0.1	4	1.15	9	GO
Accommodate	Hazard resilient design for new/upgraded public infrastructure	Yes	No	Yes	1	0.4	1	0.1	2	0.2	1	0.1	1	0.15	1	0.1	1	0.05	8	1.1	10	GO
Build community resilience / complementary measures	Monitoring	Yes	No	Yes	2	0.8	0	0	1	0.1	0	0	0	0	2	0.2	-1	-0.05	4	1.05	11	GO
Accommodate	Insurance	No	Yes	Yes	1	0.4	0	0	0	0	1	0.1	2	0.3	2	0.2	0	0	6	1	12	SLOW
Planned Transition	Maintain status quo (no changes to present management approach)	Yes	No	Yes	2	0.8	0	0	-1	-0.1	0	0	0	0	2	0.2	0	0	3	0.9	13	SLOW
Accommodate	Manual Creek Mouth Management to Protect Public Assets	Yes	No	Yes	2	0.8	-1	-0.1	0	0	2	0.2	0	0	0	0	-2	-0.1	1	0.8	14	SLOW
Natural ecosystem strengthening	Small-scale beach nourishment	Yes	No	Yes	1	0.4	-1	-0.1	1	0.1	2	0.2	1	0.15	1	0.1	-1	-0.05	4	0.8	15	SLOW
Build community resilience / complementary measures	Geotechnical Investigation & Detailed Erosion Study	Yes	No	Yes	1	0.4	0	0	0	0	0	0	0	0	2	0.2	0	0	3	0.6	16	SLOW
Avoid	Community Infrastructure Management	Yes	No	Yes	0	0	0	0	2	0.2	1	0.1	1	0.15	1	0.1	0	0	5	0.55	17	SLOW
Avoid	Coastal building lines / development setbacks	Yes	No	Yes	1	0.4	0	0	0	0	0	0	0	0	1	0.1	0	0	2	0.5	18	SLOW
Accommodate	Allow foreshore recession	Yes	No	Yes	1	0.4	1	0.1	-2	-0.2	-2	-0.2	2	0.3	0	0	0	0	0	0.4	19	SLOW
Protect	Groyne and artificial headlands	Yes	No	Yes	0	0	0	0	1	0.1	0	0	1	0.15	0	0	1	0.05	3	0.3	20	SLOW
Avoid	Reduce intensity of future development	Yes	No	Yes	0	0	1	0.1	-1	-0.1	1	0.1	1	0.15	-1	-0.1	1	0.05	2	0.2	21	SLOW
Planned Transition	Trigger related development approvals	Yes	No	Yes	0	0	0	0	0	0	0	0	1	0.15	0	0	1	0.05	2	0.2	21	SLOW
Planned Transition	Land buy back with lease back opportunity	Yes	No	Yes	-1	-0.4	1	0.1	-2	-0.2	1	0.1	2	0.3	2	0.2	1	0.05	4	0.15	23	SLOW
Planned Transition	Relocate important infrastructure	Yes	No	Yes	-1	-0.4	0	0	0	0	0	0	2	0.3	1	0.1	2	0.1	4	0.1	24	SLOW
Avoid	Raise land levels	Yes	No	Yes	0	0	0	0	0	0	-2	-0.2	1	0.15	1	0.1	0	0	0	0.05	25	SLOW
Accommodate	Contaminated site management	Yes	Yes	Yes	-1	-0.4	1	0.1	1	0.1	0	0	1	0.15	0	0	1	0.05	3	0	26	SLOW
Planned Transition	Land buy back (no lease back)	Yes	No	Yes	-1	-0.4	0	0	-1	-0.1	1	0.1	2	0.3	0	0	2	0.1	3	0	26	SLOW
Planned Transition	Land swap	Yes	Yes	Yes	-1	-0.4	0	0	-1	-0.1	1	0.1	2	0.3	0	0	2	0.1	3	0	26	SLOW
Protect	Seawall/scour protection to protect public assets	Yes	No	Yes	-1	-0.4	0	0	-1	-0.1	1	0.1	1	0.15	1	0.1	2	0.1	3	-0.05	42	SLOW
Planned Transition	Partial land buy-back	Yes	No	Yes	-1	-0.4	1	0.1	-1	-0.1	1	0.1	1	0.15	0	0	1	0.05	2	-0.1	43	SLOW
Protect	Large-scale beach nourishment	Yes	No	Yes	-1	-0.4	-1	-0.1	2	0.2	2	0.2	0	0	-1	-0.1	1	0.05	2	-0.15	44	SLOW
Protect	Tidal barrage / gates / surge barriers	Yes	No	Yes	-1	-0.4	-1	-0.1	0	0	1	0.1	1	0.15	-1	-0.1	1	0.05	0	-0.3	45	SLOW
Accommodate	Build redundancy into network systems	Yes	No	Yes	-2	-0.8	0	0	1	0.1	0	0	2	0.3	0	0	2	0.1	3	-0.3	46	SLOW
Accommodate	Emergency management planning (e.g. alternative route provision)	No	No	No	Not considered at this time but should be reviewed as part of future evacuation planning studies															0	26	STOP
Accommodate	Floating development (residential)	No	No	No	Not considered suitable for mitigating coastal hazard risks															0	26	STOP
Accommodate	Manual Creek Mouth Management to Protect Private Assets	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	26	STOP
Accommodate	Urban design	No	No	No	Not considered in detail as part of the CHAS; to be considered as part of future master planning (for example)															0	26	STOP
Natural ecosystem strengthening	Dune construction	No	No	No	Limited opportunity for this action; preference to restore/maintain existing dune system															0	26	STOP
Natural ecosystem strengthening	Establish buffers around wetlands	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	26	STOP
Natural ecosystem strengthening	Green belts and riparian corridors	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	26	STOP
Natural ecosystem strengthening	Land management to support habitat migration	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	26	STOP
Natural ecosystem strengthening	Reduce extents of hard surfaces	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality; this action may provide other benefits (e.g. heat reduction)															0	26	STOP
Planned Transition	Rolling easement	No	No	No	Limited to no opportunity to implement at this location															0	26	STOP
Protect	Artificial reef	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality; this action may provide other benefits (e.g. fish habitat)															0	26	STOP
Protect	Levees / dykes	No	No	No	Likely to impact catchment flooding, not considered further at this time															0	26	STOP
Protect	Seawall/scour protection to protect private assets	No	No	No	Generally not relevant to location; seaward public assets including the Esplanade likely to be protected															0	26	STOP

MCA Results

Table D-6 MCA Results Scarness

Response Type	Action	Is the option technically effective at reducing risks regardless of timescale?	Does the option provide multiple or other benefits?	Proceed to next level of assessment?	Cost	Weighted Economic Impact	Environmental Impact	Weighted Environmental Impact	Social Impact	Weighted Social Impact	Reversible / Adaptable	Weighted reversible/ Adaptable	Effectiveness	Weighted Effectiveness	Approvability	Weighted Approvability	Timing	Weighted Timing	Unweighted Total Score (Go = >4, Slow = -4 to >4, Stop = 41)	Weighted Score	Rank	ACTION STATUS
Natural ecosystem strengthening	Active dune and habitat management	Yes	Yes	Yes	2	0.8	2	0.2	2	0.2	2	0.2	1	0.15	2	0.2	-2	-0.1	9	1.65	1	GO
Accommodate	Development master planning	Yes	Yes	Yes	2	0.8	2	0.2	2	0.2	1	0.1	1	0.15	0	0	0	0	8	1.45	2	GO
Natural ecosystem strengthening	Dune restoration / augmentation	Yes	No	Yes	2	0.8	0	0	2	0.2	2	0.2	1	0.15	2	0.2	-2	-0.1	7	1.45	3	GO
Accommodate	Emergency management response	No	Yes	Yes	2	0.8	0	0	-1	-0.1	2	0.2	2	0.3	2	0.2	-2	-0.1	5	1.3	4	GO
Accommodate	Hazard resilient design for new/upgraded private infrastructure	Yes	No	Yes	2	0.8	1	0.1	0	0	1	0.1	1	0.15	1	0.1	1	0.05	7	1.3	4	GO
Build community resilience / complementary measures	Community Education and Consultation	Yes	No	Yes	2	0.8	0	0	1	0.1	1	0.1	0	0	2	0.2	0	0	6	1.2	6	GO
Natural ecosystem strengthening	Wetland restoration	Yes	Yes	Yes	1	0.4	2	0.2	2	0.2	2	0.2	1	0.15	1	0.1	-1	-0.05	8	1.2	6	GO
Protect	Tide flaps/valves on stormwater network	Yes	No	Yes	2	0.8	0	0	0	0	1	0.1	1	0.15	1	0.1	0	0	5	1.15	8	GO
Natural ecosystem strengthening	Beach scraping	Yes	No	Yes	2	0.8	-1	-0.1	1	0.1	2	0.2	1	0.15	1	0.1	-2	-0.1	4	1.15	9	GO
Accommodate	Hazard resilient design for new/upgraded public infrastructure	Yes	No	Yes	1	0.4	1	0.1	2	0.2	1	0.1	1	0.15	1	0.1	1	0.05	8	1.1	10	GO
Build community resilience / complementary measures	Monitoring	Yes	No	Yes	2	0.8	0	0	1	0.1	0	0	0	0	2	0.2	-1	-0.05	4	1.05	11	GO
Accommodate	Insurance	No	Yes	Yes	1	0.4	0	0	0	0	1	0.1	2	0.3	2	0.2	0	0	6	1	12	SLOW
Planned Transition	Maintain status quo (no changes to present management approach)	Yes	No	Yes	2	0.8	0	0	-1	-0.1	0	0	0	0	2	0.2	0	0	3	0.9	13	SLOW
Natural ecosystem strengthening	Small-scale beach nourishment	Yes	No	Yes	1	0.4	-1	-0.1	1	0.1	2	0.2	1	0.15	1	0.1	-1	-0.05	4	0.8	14	SLOW
Build community resilience / complementary measures	Geotechnical Investigation & Detailed Erosion Study	Yes	No	Yes	1	0.4	0	0	0	0	0	0	0	0	2	0.2	0	0	3	0.6	15	SLOW
Avoid	Community Infrastructure Management	Yes	No	Yes	0	0	0	0	2	0.2	1	0.1	1	0.15	1	0.1	0	0	5	0.55	16	SLOW
Avoid	Coastal building lines / development setbacks	Yes	No	Yes	1	0.4	0	0	0	0	0	0	0	0	1	0.1	0	0	2	0.5	17	SLOW
Accommodate	Allow foreshore recession	Yes	No	Yes	1	0.4	1	0.1	-2	-0.2	-2	-0.2	2	0.3	0	0	0	0	0	0.4	18	SLOW
Protect	Groyne and artificial headlands	Yes	No	Yes	0	0	0	0	1	0.1	0	0	1	0.15	0	0	1	0.05	3	0.3	19	SLOW
Avoid	Reduce intensity of future development	Yes	No	Yes	0	0	1	0.1	-1	-0.1	1	0.1	1	0.15	-1	-0.1	1	0.05	2	0.2	21	SLOW
Planned Transition	Trigger related development approvals	Yes	No	Yes	0	0	0	0	0	0	0	0	1	0.15	0	0	1	0.05	2	0.2	20	SLOW
Planned Transition	Land buy back with lease back opportunity	Yes	No	Yes	-1	-0.4	1	0.1	-2	-0.2	1	0.1	2	0.3	2	0.2	1	0.05	4	0.15	23	SLOW
Planned Transition	Relocate important infrastructure	Yes	No	Yes	-1	-0.4	0	0	0	0	0	0	2	0.3	1	0.1	2	0.1	4	0.1	23	SLOW
Avoid	Raise land levels	Yes	No	Yes	0	0	0	0	0	0	-2	-0.2	1	0.15	1	0.1	0	0	0	0.05	25	SLOW
Planned Transition	Land buy back (no lease back)	Yes	No	Yes	-1	-0.4	0	0	-1	-0.1	1	0.1	2	0.3	0	0	2	0.1	3	0	26	SLOW
Planned Transition	Land swap	Yes	Yes	Yes	-1	-0.4	0	0	-1	-0.1	1	0.1	2	0.3	0	0	2	0.1	3	0	25	SLOW
Protect	Seawall/scour protection to protect public assets	Yes	No	Yes	-1	-0.4	0	0	-1	-0.1	1	0.1	1	0.15	1	0.1	2	0.1	3	-0.05	43	SLOW
Planned Transition	Partial land buy-back	Yes	No	Yes	-1	-0.4	1	0.1	-1	-0.1	1	0.1	1	0.15	0	0	1	0.05	2	-0.1	44	SLOW
Protect	Large-scale beach nourishment	Yes	No	Yes	-1	-0.4	-1	-0.1	2	0.2	2	0.2	0	0	-1	-0.1	1	0.05	2	-0.15	45	SLOW
Accommodate	Build redundancy into network systems	Yes	No	Yes	-2	-0.8	0	0	1	0.1	0	0	2	0.3	0	0	2	0.1	3	-0.3	46	SLOW
Accommodate	Contaminated site management	No	No	No	No known contaminated sites															0	25	STOP
Accommodate	Emergency management planning (e.g. alternative route provision)	No	No	No	Not considered at this time but should be reviewed as part of future evacuation planning studies															0	25	STOP
Accommodate	Floating development (residential)	No	No	No	Not considered suitable for mitigating coastal hazard risks															0	25	STOP
Accommodate	Manual Creek Mouth Management to Protect Private Assets	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	25	STOP
Accommodate	Manual Creek Mouth Management to Protect Public Assets	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	25	STOP
Accommodate	Urban design	No	No	No	Not considered in detail as part of the CHAS; to be considered as part of future master planning (for example)															0	25	STOP
Natural ecosystem strengthening	Dune construction	No	No	No	Limited opportunity for this action; preference to restore/maintain existing dune system															0	25	STOP
Natural ecosystem strengthening	Establish buffers around wetlands	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	25	STOP
Natural ecosystem strengthening	Green belts and riparian corridors	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	25	STOP
Natural ecosystem strengthening	Land management to support habitat migration	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	25	STOP
Natural ecosystem strengthening	Reduce extents of hard surfaces	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality; this action may provide other benefits (e.g. heat reduction)															0	25	STOP
Planned Transition	Rolling easement	No	No	No	Limited to no opportunity to implement at this location															0	25	STOP
Protect	Artificial reef	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality; this action may provide other benefits (e.g. fish habitat)															0	25	STOP
Protect	Levees / dykes	No	No	No	Likely to impact catchment flooding, not considered further at this time															0	25	STOP
Protect	Seawall/scour protection to protect private assets	No	No	No	Generally not relevant to location; seaward public assets including the Esplanade likely to be protected															0	25	STOP
Protect	Tidal barrage / gates / surge barriers	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	25	STOP

MCA Results

Table D-7 MCA Results Torquay

Response Type	Action	Is the option technically effective at reducing risks regardless of timescale?	Does the option provide multiple or other benefits?	Proceed to next level of assessment?	Cost	Weighted Economic Impact	Environmental Impact	Weighted Environmental Impact	Social Impact	Weighted Social Impact	Reversible / Adaptable	Weighted reversible/ Adaptable	Effectiveness	Weighted Effectiveness	Approvability	Weighted Approvability	Timing	Weighted Timing	Unweighted Total Score (Go = >4, Slow = -4 to >4, Stop = ≤1)	Weighted Score	Rank	ACTION STATUS
Natural ecosystem strengthening	Active dune and habitat management	Yes	Yes	Yes	2	0.8	2	0.2	2	0.2	2	0.2	1	0.15	2	0.2	-2	-0.1	9	1.65	1	GO
Accommodate	Development master planning	Yes	Yes	Yes	2	0.8	2	0.2	2	0.2	1	0.1	1	0.15	0	0	0	0	8	1.45	2	GO
Natural ecosystem strengthening	Dune restoration / augmentation	Yes	No	Yes	2	0.8	0	0	2	0.2	2	0.2	1	0.15	2	0.2	-2	-0.1	7	1.45	3	GO
Accommodate	Emergency management response	No	Yes	Yes	2	0.8	0	0	-1	-0.1	2	0.2	2	0.3	2	0.2	-2	-0.1	5	1.3	4	GO
Accommodate	Hazard resilient design for new/upgraded private infrastructure	Yes	No	Yes	2	0.8	1	0.1	0	0	1	0.1	1	0.15	1	0.1	1	0.05	7	1.3	4	GO
Build community resilience / complementary measures	Community Education and Consultation	Yes	No	Yes	2	0.8	0	0	1	0.1	1	0.1	0	0	2	0.2	0	0	6	1.2	6	GO
Natural ecosystem strengthening	Wetland restoration	Yes	Yes	Yes	1	0.4	2	0.2	2	0.2	2	0.2	1	0.15	1	0.1	-1	-0.05	8	1.2	6	GO
Protect	Tide flaps/valves on stormwater network	Yes	No	Yes	2	0.8	0	0	0	0	1	0.1	1	0.15	1	0.1	0	0	5	1.15	8	GO
Natural ecosystem strengthening	Beach scraping	Yes	No	Yes	2	0.8	-1	-0.1	1	0.1	2	0.2	1	0.15	1	0.1	-2	-0.1	4	1.15	9	GO
Accommodate	Hazard resilient design for new/upgraded public infrastructure	Yes	No	Yes	1	0.4	1	0.1	2	0.2	1	0.1	1	0.15	1	0.1	1	0.05	8	1.1	10	GO
Build community resilience / complementary measures	Monitoring	Yes	No	Yes	2	0.8	0	0	1	0.1	0	0	0	0	2	0.2	-1	-0.05	4	1.05	11	GO
Accommodate	Insurance	No	Yes	Yes	1	0.4	0	0	0	0	1	0.1	2	0.3	2	0.2	0	0	6	1	12	SLOW
Planned Transition	Maintain status quo (no changes to present management approach)	Yes	No	Yes	2	0.8	0	0	-1	-0.1	0	0	0	0	2	0.2	0	0	3	0.9	13	SLOW
Natural ecosystem strengthening	Small-scale beach nourishment	Yes	No	Yes	1	0.4	-1	-0.1	1	0.1	2	0.2	1	0.15	1	0.1	-1	-0.05	4	0.8	14	SLOW
Build community resilience / complementary measures	Geotechnical Investigation & Detailed Erosion Study	Yes	No	Yes	1	0.4	0	0	0	0	0	0	0	0	2	0.2	0	0	3	0.6	15	SLOW
Avoid	Community Infrastructure Management	Yes	No	Yes	0	0	0	0	2	0.2	1	0.1	1	0.15	1	0.1	0	0	5	0.55	16	SLOW
Avoid	Coastal building lines / development setbacks	Yes	No	Yes	1	0.4	0	0	0	0	0	0	0	0	1	0.1	0	0	2	0.5	17	SLOW
Accommodate	Allow foreshore recession	Yes	No	Yes	1	0.4	1	0.1	-2	-0.2	-2	-0.2	2	0.3	0	0	0	0	0	0.4	18	SLOW
Protect	Groyne and artificial headlands	Yes	No	Yes	0	0	0	0	1	0.1	0	0	1	0.15	0	0	1	0.05	3	0.3	19	SLOW
Avoid	Reduce intensity of future development	Yes	No	Yes	0	0	1	0.1	-1	-0.1	1	0.1	1	0.15	-1	-0.1	1	0.05	2	0.2	21	SLOW
Planned Transition	Trigger related development approvals	Yes	No	Yes	0	0	0	0	0	0	0	0	1	0.15	0	0	1	0.05	2	0.2	20	SLOW
Planned Transition	Land buy back with lease back opportunity	Yes	No	Yes	-1	-0.4	1	0.1	-2	-0.2	1	0.1	2	0.3	2	0.2	1	0.05	4	0.15	23	SLOW
Planned Transition	Relocate important infrastructure	Yes	No	Yes	-1	-0.4	0	0	0	0	0	0	2	0.3	1	0.1	2	0.1	4	0.1	23	SLOW
Avoid	Raise land levels	Yes	No	Yes	0	0	0	0	0	0	-2	-0.2	1	0.15	1	0.1	0	0	0	0.05	25	SLOW
Planned Transition	Land buy back (no lease back)	Yes	No	Yes	-1	-0.4	0	0	-1	-0.1	1	0.1	2	0.3	0	0	2	0.1	3	0	26	SLOW
Planned Transition	Land swap	Yes	Yes	Yes	-1	-0.4	0	0	-1	-0.1	1	0.1	2	0.3	0	0	2	0.1	3	0	25	SLOW
Protect	Seawall/scour protection to protect public assets	Yes	No	Yes	-1	-0.4	0	0	-1	-0.1	1	0.1	1	0.15	1	0.1	2	0.1	3	-0.05	43	SLOW
Planned Transition	Partial land buy-back	Yes	No	Yes	-1	-0.4	1	0.1	-1	-0.1	1	0.1	1	0.15	0	0	1	0.05	2	-0.1	44	SLOW
Protect	Large-scale beach nourishment	Yes	No	Yes	-1	-0.4	-1	-0.1	2	0.2	2	0.2	0	0	-1	-0.1	1	0.05	2	-0.15	45	SLOW
Accommodate	Build redundancy into network systems	Yes	No	Yes	-2	-0.8	0	0	1	0.1	0	0	2	0.3	0	0	2	0.1	3	-0.3	46	SLOW
Accommodate	Contaminated site management	No	No	No	No known contaminated sites															0	25	STOP
Accommodate	Emergency management planning (e.g. alternative route provision)	No	No	No	Not considered at this time but should be reviewed as part of future evacuation planning studies															0	25	STOP
Accommodate	Floating development (residential)	No	No	No	Not considered suitable for mitigating coastal hazard risks															0	25	STOP
Accommodate	Manual Creek Mouth Management to Protect Private Assets	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	25	STOP
Accommodate	Manual Creek Mouth Management to Protect Public Assets	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	25	STOP
Accommodate	Urban design	No	No	No	Not considered in detail as part of the CHAS; to be considered as part of future master planning (for example)															0	25	STOP
Natural ecosystem strengthening	Dune construction	No	No	No	Limited opportunity for this action; preference to restore/maintain existing dune system															0	25	STOP
Natural ecosystem strengthening	Establish buffers around wetlands	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	25	STOP
Natural ecosystem strengthening	Green belts and riparian corridors	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	25	STOP
Natural ecosystem strengthening	Land management to support habitat migration	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	25	STOP
Natural ecosystem strengthening	Reduce extents of hard surfaces	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality; this action may provide other benefits (e.g. heat reduction)															0	25	STOP
Planned Transition	Rolling easement	No	No	No	Limited to no opportunity to implement at this location															0	25	STOP
Protect	Artificial reef	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality; this action may provide other benefits (e.g. fish habitat)															0	25	STOP
Protect	Levees / dykes	No	No	No	Likely to impact catchment flooding, not considered further at this time															0	25	STOP
Protect	Seawall/scour protection to protect private assets	No	No	No	Generally not relevant to location; seaward public assets including the Esplanade likely to be protected															0	25	STOP
Protect	Tidal barrage / gates / surge barriers	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	25	STOP

MCA Results

Table D-8 MCA Results Urangan

Response Type	Action	Is the option technically effective at reducing risks regardless of timescale?	Does the option provide multiple or other benefits?	Proceed to next level of assessment?	Cost	Weighted Economic Impact	Environmental Impact	Weighted Environmental Impact	Social Impact	Weighted Social Impact	Reversible / Adaptable	Weighted reversible/ Adaptable	Effectiveness	Weighted Effectiveness	Approvability	Weighted Approvability	Timing	Weighted Timing	Unweighted Total Score (Go = >4, Slow = -4 to >4, Stop = 41)	Weighted Score	Rank	ACTION STATUS
Natural ecosystem strengthening	Active dune and habitat management	Yes	Yes	Yes	2	0.8	2	0.2	2	0.2	2	0.2	1	0.15	2	0.2	-2	-0.1	9	1.65	1	GO
Accommodate	Development master planning	No	Yes	Yes	2	0.8	2	0.2	2	0.2	1	0.1	1	0.15	0	0	0	0	8	1.45	2	GO
Accommodate	Emergency management response	No	Yes	Yes	2	0.8	0	0	-1	-0.1	2	0.2	2	0.3	2	0.2	-2	-0.1	5	1.3	3	GO
Accommodate	Hazard resilient design for new/upgraded private infrastructure	Yes	Yes	Yes	2	0.8	1	0.1	0	0	1	0.1	1	0.15	1	0.1	1	0.05	7	1.3	3	GO
Build community resilience / complementary measures	Community Education and Consultation	Yes	Yes	Yes	2	0.8	0	0	1	0.1	1	0.1	0	0	2	0.2	0	0	6	1.2	5	GO
Natural ecosystem strengthening	Wetland restoration	Yes	Yes	Yes	1	0.4	2	0.2	2	0.2	2	0.2	1	0.15	1	0.1	-1	-0.05	8	1.2	5	GO
Protect	Tide flaps/valves on stormwater network	Yes	No	Yes	2	0.8	0	0	0	0	1	0.1	1	0.15	1	0.1	0	0	5	1.15	7	GO
Natural ecosystem strengthening	Beach scraping	Yes	Yes	Yes	2	0.8	-1	-0.1	1	0.1	2	0.2	1	0.15	1	0.1	-2	-0.1	4	1.15	8	GO
Accommodate	Hazard resilient design for new/upgraded public infrastructure	Yes	Yes	Yes	1	0.4	1	0.1	2	0.2	1	0.1	1	0.15	1	0.1	1	0.05	8	1.1	9	GO
Build community resilience / complementary measures	Monitoring	No	Yes	Yes	2	0.8	0	0	1	0.1	0	0	0	0	2	0.2	-1	-0.05	4	1.05	10	GO
Accommodate	Insurance	No	Yes	Yes	1	0.4	0	0	0	0	1	0.1	2	0.3	2	0.2	0	0	6	1	11	SLOW
Planned Transition	Maintain status quo (no changes to present management approach)	Yes	No	Yes	2	0.8	0	0	-1	-0.1	0	0	0	0	2	0.2	0	0	3	0.9	12	SLOW
Accommodate	Manual Creek Mouth Management to Protect Public Assets	Yes	No	Yes	2	0.8	-1	-0.1	0	0	2	0.2	0	0	0	0	-2	-0.1	1	0.8	13	SLOW
Natural ecosystem strengthening	Small-scale beach nourishment	Yes	Yes	Yes	1	0.4	-1	-0.1	1	0.1	2	0.2	1	0.15	1	0.1	-1	-0.05	4	0.8	14	SLOW
Build community resilience / complementary measures	Geotechnical Investigation & Detailed Erosion Study	No	Yes	Yes	1	0.4	0	0	0	0	0	0	0	0	2	0.2	0	0	3	0.6	15	SLOW
Avoid	Community Infrastructure Management	Yes	No	Yes	0	0	0	0	2	0.2	1	0.1	1	0.15	1	0.1	0	0	5	0.55	16	SLOW
Avoid	Coastal building lines / development setbacks	Yes	No	Yes	1	0.4	0	0	0	0	0	0	0	0	1	0.1	0	0	2	0.5	17	SLOW
Accommodate	Allow foreshore recession	Yes	No	Yes	1	0.4	1	0.1	-2	-0.2	-2	-0.2	2	0.3	0	0	0	0	0	0.4	18	SLOW
Protect	Groyne and artificial headlands	Yes	No	Yes	0	0	0	0	1	0.1	0	0	1	0.15	0	0	1	0.05	3	0.3	19	SLOW
Avoid	Reduce intensity of future development	Yes	No	Yes	0	0	1	0.1	-1	-0.1	1	0.1	1	0.15	-1	-0.1	1	0.05	2	0.2	21	SLOW
Planned Transition	Trigger related development approvals	Yes	No	Yes	0	0	0	0	0	0	0	0	1	0.15	0	0	1	0.05	2	0.2	20	SLOW
Planned Transition	Land buy back with lease back opportunity	Yes	No	Yes	-1	-0.4	1	0.1	-2	-0.2	1	0.1	2	0.3	2	0.2	1	0.05	4	0.15	23	SLOW
Planned Transition	Relocate important infrastructure	Yes	No	Yes	-1	-0.4	0	0	0	0	0	0	2	0.3	1	0.1	2	0.1	4	0.1	23	SLOW
Avoid	Raise land levels	Yes	No	Yes	0	0	0	0	0	0	-2	-0.2	1	0.15	1	0.1	0	0	0	0.05	25	SLOW
Planned Transition	Land buy back (no lease back)	Yes	No	Yes	-1	-0.4	0	0	-1	-0.1	1	0.1	2	0.3	0	0	2	0.1	3	0	26	SLOW
Planned Transition	Land swap	Yes	Yes	Yes	-1	-0.4	0	0	-1	-0.1	1	0.1	2	0.3	0	0	2	0.1	3	0	25	SLOW
Protect	Seawall/scour protection to protect public assets	Yes	No	Yes	-1	-0.4	0	0	-1	-0.1	1	0.1	1	0.15	1	0.1	2	0.1	3	-0.05	43	SLOW
Planned Transition	Partial land buy-back	Yes	No	Yes	-1	-0.4	1	0.1	-1	-0.1	1	0.1	1	0.15	0	0	1	0.05	2	-0.1	44	SLOW
Protect	Large-scale beach nourishment	Yes	Yes	Yes	-1	-0.4	-1	-0.1	2	0.2	2	0.2	0	0	-1	-0.1	1	0.05	2	-0.15	45	SLOW
Accommodate	Build redundancy into network systems	Yes	Yes	Yes	-2	-0.8	0	0	1	0.1	0	0	2	0.3	0	0	2	0.1	3	-0.3	46	SLOW
Accommodate	Contaminated site management	No	No	No	No known contaminated sites															0	25	STOP
Accommodate	Emergency management planning (e.g. alternative route provision)	No	No	No	Not considered at this time but should be reviewed as part of future evacuation planning studies															0	25	STOP
Accommodate	Floating development (residential)	No	No	No	Not considered suitable for mitigating coastal hazard risks															0	25	STOP
Accommodate	Manual Creek Mouth Management to Protect Private Assets	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	25	STOP
Accommodate	Urban design	No	No	No	Not considered in detail as part of the CHAS; to be considered as part of future master planning (for example)															0	25	STOP
Natural ecosystem strengthening	Dune construction	No	No	No	Limited opportunity for this action; preference to restore/maintain existing foreshore areas															0	25	STOP
Natural ecosystem strengthening	Dune restoration / augmentation	No	No	No	Limited to no opportunity to implement at this location due to existing seawall and harbour															0	25	STOP
Natural ecosystem strengthening	Establish buffers around wetlands	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	25	STOP
Natural ecosystem strengthening	Green belts and riparian corridors	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	25	STOP
Natural ecosystem strengthening	Land management to support habitat migration	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	25	STOP
Natural ecosystem strengthening	Reduce extents of hard surfaces	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality; this action may provide other benefits (e.g. heat reduction)															0	25	STOP
Planned Transition	Rolling easement	No	No	No	Limited to no opportunity to implement at this location															0	25	STOP
Protect	Artificial reef	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality; this action may provide other benefits (e.g. fish habitat)															0	25	STOP
Protect	Levees / dykes	No	No	No	Likely to impact catchment flooding, not considered further at this time															0	25	STOP
Protect	Seawall/scour protection to protect private assets	No	No	No	Generally not relevant to location; seaward public assets including the Esplanade likely to be protected															0	25	STOP
Protect	Tidal barrage / gates / surge barriers	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	25	STOP

MCA Results

Table D-9 MCA Results River Heads

Response Type	Action	Is the option technically effective at reducing risks regardless of timescale?	Does the option provide multiple or other benefits?	Proceed to next level of assessment?	Cost	Weighted Economic Impact	Environmental Impact	Weighted Environmental Impact	Social Impact	Weighted Social Impact	Reversible / Adaptable	Weighted reversible/ Adaptable	Effectiveness	Weighted Effectiveness	Approvability	Weighted Approvability	Timing	Weighted Timing	Unweighted Total Score (Go = >4, Slow = -4 to >4, Stop = 41)	Weighted Score	Rank	ACTION STATUS
Natural ecosystem strengthening	Active dune and habitat management	Yes	Yes	Yes	2	0.8	2	0.2	2	0.2	2	0.2	1	0.15	2	0.2	-2	-0.1	9	1.65	1	GO
Accommodate	Development master planning	No	Yes	Yes	2	0.8	2	0.2	2	0.2	1	0.1	1	0.15	0	0	0	0	8	1.45	2	GO
Natural ecosystem strengthening	Green belts and riparian corridors	Yes	Yes	Yes	2	0.8	2	0.2	1	0.1	1	0.1	1	0.15	1	0.1	-1	-0.05	7	1.4	3	GO
Accommodate	Hazard resilient design for new/upgraded private infrastructure	Yes	Yes	Yes	2	0.8	1	0.1	0	0	1	0.1	1	0.15	1	0.1	1	0.05	7	1.3	4	GO
Accommodate	Emergency management response	No	Yes	Yes	2	0.8	0	0	-1	-0.1	2	0.2	2	0.3	2	0.2	-2	-0.1	5	1.3	4	GO
Build community resilience / complementary measures	Community Education and Consultation	Yes	No	Yes	2	0.8	0	0	1	0.1	1	0.1	0	0	2	0.2	0	0	6	1.2	6	GO
Natural ecosystem strengthening	Land management to support habitat migration	Yes	No	Yes	1	0.4	2	0.2	2	0.2	2	0.2	1	0.15	1	0.1	-1	-0.05	8	1.2	6	GO
Natural ecosystem strengthening	Wetland restoration	Yes	Yes	Yes	1	0.4	2	0.2	2	0.2	2	0.2	1	0.15	1	0.1	-1	-0.05	8	1.2	6	GO
Natural ecosystem strengthening	Establish buffers around wetlands	Yes	No	Yes	1	0.4	2	0.2	2	0.2	2	0.2	1	0.15	1	0.1	-1	-0.05	8	1.2	6	GO
Accommodate	Hazard resilient design for new/upgraded public infrastructure	Yes	No	Yes	1	0.4	1	0.1	2	0.2	1	0.1	1	0.15	1	0.1	1	0.05	8	1.1	10	GO
Build community resilience / complementary measures	Monitoring	Yes	No	Yes	2	0.8	0	0	1	0.1	0	0	0	0	2	0.2	-1	-0.05	4	1.05	11	GO
Accommodate	Insurance	No	Yes	Yes	1	0.4	0	0	0	0	1	0.1	2	0.3	2	0.2	0	0	6	1	12	SLOW
Accommodate	Allow foreshore recession	Yes	No	Yes	2	0.8	2	0.2	-1	-0.1	-1	-0.1	0	0	2	0.2	-1	-0.05	3	0.95	13	SLOW
Planned Transition	Maintain status quo (no changes to present management approach)	Yes	No	Yes	2	0.8	-1	-0.1	-1	-0.1	0	0	0	0	2	0.2	0	0	2	0.8	14	SLOW
Build community resilience / complementary measures	Geotechnical Investigation & Detailed Erosion Study	Yes	No	Yes	1	0.4	0	0	0	0	0	0	0	0	2	0.2	0	0	3	0.6	15	SLOW
Avoid	Community Infrastructure Management	Yes	No	Yes	0	0	0	0	1	0.1	0	0	2	0.3	1	0.1	2	0.1	6	0.6	16	SLOW
Avoid	Coastal building lines / development setbacks	Yes	No	Yes	1	0.4	0	0	0	0	0	0	0	0	1	0.1	0	0	2	0.5	17	SLOW
Avoid	Reduce intensity of future development	Yes	No	Yes	0	0	1	0.1	-1	-0.1	1	0.1	1	0.15	-1	-0.1	1	0.05	2	0.2	21	SLOW
Planned Transition	Trigger related development approvals	Yes	No	Yes	0	0	0	0	0	0	0	0	1	0.15	0	0	1	0.05	2	0.2	18	SLOW
Planned Transition	Relocate important infrastructure	Yes	No	Yes	-1	-0.4	0	0	0	0	0	0	2	0.3	1	0.1	2	0.1	4	0.1	20	SLOW
Avoid	Raise land levels	Yes	No	Yes	0	0	0	0	0	0	-2	-0.2	1	0.15	1	0.1	0	0	0	0.05	21	SLOW
Accommodate	Build redundancy into network systems	Yes	Yes	Yes	-2	-0.8	0	0	1	0.1	0	0	2	0.3	0	0	2	0.1	3	-0.3	46	SLOW
Accommodate	Contaminated site management	No	No	No	No known contaminated sites															0	22	STOP
Accommodate	Emergency management planning (e.g. alternative route provision)	No	No	No	Not considered at this time but should be reviewed as part of future evacuation planning studies															0	22	STOP
Accommodate	Floating development (residential)	No	No	No	Not considered suitable for mitigating coastal hazard risks															0	22	STOP
Accommodate	Manual Creek Mouth Management to Protect Private Assets	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	22	STOP
Accommodate	Manual Creek Mouth Management to Protect Public Assets	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	22	STOP
Accommodate	Urban design	No	No	No	Not considered in detail as part of the CHAS; to be considered as part of future master planning (for example)															0	22	STOP
Natural ecosystem strengthening	Beach scraping	No	No	No	Limited to no opportunity to implement at this location due to local intertidal geology															0	22	STOP
Natural ecosystem strengthening	Dune construction	No	No	No	Not considered suitable at this location, no existing dune habitat; preference to restore maintain existing habitats															0	22	STOP
Natural ecosystem strengthening	Dune restoration / augmentation	No	No	No	Limited to no opportunity to implement at this location due to local intertidal geology															0	22	STOP
Natural ecosystem strengthening	Reduce extents of hard surfaces	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality; this action may provide other benefits (e.g. heat reduction)															0	22	STOP
Natural ecosystem strengthening	Small-scale beach nourishment	No	No	No	Limited opportunities due to local intertidal geology															0	22	STOP
Planned Transition	Land buy back (no lease back)	No	No	No	Private assets generally outside of the coastal erosion hazard area															0	22	STOP
Planned Transition	Land buy back with lease back opportunity	No	No	No	Private assets generally outside of the coastal erosion hazard area															0	22	STOP
Planned Transition	Land swap	No	No	No	Private assets generally outside of the coastal erosion hazard area															0	22	STOP
Planned Transition	Partial land buy-back	No	No	No	Private assets generally outside of the coastal erosion hazard area															0	22	STOP
Planned Transition	Rolling easement	No	No	No	Limited to no opportunity to implement at this location															0	22	STOP
Protect	Artificial reef	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality; this action may provide other benefits (e.g. fish habitat)															0	22	STOP
Protect	Groyne and artificial headlands	No	No	No	Limited to no opportunity to implement at this location due to local intertidal geology															0	22	STOP
Protect	Large-scale beach nourishment	No	No	No	Limited opportunities due to local intertidal geology															0	22	STOP
Protect	Levees / dykes	No	No	No	Likely to impact catchment flooding, not considered further at this time															0	22	STOP
Protect	Seawall/scour protection to protect private assets	No	No	No	Private assets generally outside of the coastal erosion hazard area															0	22	STOP
Protect	Seawall/scour protection to protect public assets	No	No	No	No major public assets at risk; preference to transition minor assets rather than protect															0	22	STOP
Protect	Tidal barrage / gates / surge barriers	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	22	STOP
Protect	Tide flaps/valves on stormwater network	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	22	STOP

MCA Results

Table D-10 MCA Results Maaroom

Response Type	Action	Is the option technically effective at reducing risks regardless of timescale?	Does the option provide multiple or other benefits?	Proceed to next level of assessment?	Cost	Weighted Economic Impact	Environmental Impact	Weighted Environmental Impact	Social Impact	Weighted Social Impact	Reversible / Adaptable	Weighted reversible/ Adaptable	Effectiveness	Weighted Effectiveness	Approvability	Weighted Approvability	Timing	Weighted Timing	Unweighted Total Score (Go = >4, Slow = -4 to >4, Stop = 41)	Weighted Score	Rank	ACTION STATUS
Natural ecosystem strengthening	Active dune and habitat management	Yes	Yes	Yes	2	0.8	2	0.2	2	0.2	2	0.2	1	0.15	2	0.2	-2	-0.1	9	1.65	1	GO
Accommodate	Development master planning	Yes	Yes	Yes	2	0.8	2	0.2	2	0.2	1	0.1	1	0.15	0	0	0	0	8	1.45	2	GO
Natural ecosystem strengthening	Green belts and riparian corridors	Yes	Yes	Yes	2	0.8	2	0.2	1	0.1	1	0.1	1	0.15	1	0.1	-1	-0.05	7	1.4	3	GO
Accommodate	Emergency management response	No	Yes	Yes	2	0.8	0	0	-1	-0.1	2	0.2	2	0.3	2	0.2	-2	-0.1	5	1.3	4	GO
Accommodate	Hazard resilient design for new/upgraded private infrastructure	Yes	No	Yes	2	0.8	1	0.1	0	0	1	0.1	1	0.15	1	0.1	1	0.05	7	1.3	4	GO
Build community resilience / complementary measures	Community Education and Consultation	Yes	No	Yes	2	0.8	0	0	1	0.1	1	0.1	0	0	2	0.2	0	0	6	1.2	6	GO
Natural ecosystem strengthening	Establish buffers around wetlands	Yes	Yes	Yes	1	0.4	2	0.2	2	0.2	2	0.2	1	0.15	1	0.1	-1	-0.05	8	1.2	6	GO
Natural ecosystem strengthening	Land management to support habitat migration	Yes	Yes	Yes	1	0.4	2	0.2	2	0.2	2	0.2	1	0.15	1	0.1	-1	-0.05	8	1.2	6	GO
Natural ecosystem strengthening	Wetland restoration	Yes	Yes	Yes	1	0.4	2	0.2	2	0.2	2	0.2	1	0.15	1	0.1	-1	-0.05	8	1.2	6	GO
Accommodate	Hazard resilient design for new/upgraded public infrastructure	Yes	No	Yes	1	0.4	1	0.1	2	0.2	1	0.1	1	0.15	1	0.1	1	0.05	8	1.1	10	GO
Build community resilience / complementary measures	Monitoring	Yes	No	Yes	2	0.8	0	0	1	0.1	0	0	0	0	2	0.2	-1	-0.05	4	1.05	11	GO
Accommodate	Emergency management planning (e.g. alternative route provision)	Yes	No	Yes	2	0.8	1	0.1	-2	-0.2	1	0.1	1	0.15	0	0	1	0.05	4	1	12	SLOW
Accommodate	Insurance	No	Yes	Yes	1	0.4	0	0	0	0	1	0.1	2	0.3	2	0.2	0	0	6	1	12	SLOW
Protect	Tide flaps/valves on stormwater network	Yes	No	Yes	2	0.8	0	0	0	0	1	0.1	0	0	1	0.1	0	0	4	1	12	SLOW
Accommodate	Allow foreshore recession	Yes	No	Yes	2	0.8	2	0.2	-1	-0.1	-1	-0.1	0	0	2	0.2	-1	-0.05	3	0.95	15	SLOW
Planned Transition	Maintain status quo (no changes to present management approach)	Yes	No	Yes	2	0.8	-1	-0.1	-1	-0.1	0	0	0	0	2	0.2	0	0	2	0.8	16	SLOW
Build community resilience / complementary measures	Geotechnical Investigation & Detailed Erosion Study	Yes	No	Yes	1	0.4	0	0	0	0	0	0	0	0	2	0.2	0	0	3	0.6	17	SLOW
Avoid	Community Infrastructure Management	Yes	No	Yes	0	0	0	0	1	0.1	0	0	2	0.3	1	0.1	2	0.1	6	0.6	18	SLOW
Avoid	Coastal building lines / development setbacks	Yes	No	Yes	1	0.4	0	0	0	0	0	0	0	0	1	0.1	0	0	2	0.5	19	SLOW
Avoid	Reduce intensity of future development	Yes	No	Yes	0	0	1	0.1	-1	-0.1	1	0.1	1	0.15	-1	-0.1	1	0.05	2	0.2	20	SLOW
Planned Transition	Trigger related development approvals	Yes	No	Yes	0	0	0	0	0	0	0	0	1	0.15	0	0	1	0.05	2	0.2	20	SLOW
Protect	Seawall/scour protection to protect private assets	Yes	No	Yes	0	0	0	0	0	0	0	0	1	0.15	0	0	1	0.05	2	0.2	20	SLOW
Planned Transition	Land buy back with lease back opportunity	Yes	No	Yes	-1	-0.4	1	0.1	-2	-0.2	1	0.1	2	0.3	2	0.2	1	0.05	4	0.15	23	SLOW
Planned Transition	Relocate important infrastructure	Yes	No	Yes	-1	-0.4	0	0	0	0	0	0	2	0.3	1	0.1	2	0.1	4	0.1	24	SLOW
Avoid	Raise land levels	Yes	No	Yes	0	0	0	0	0	0	-2	-0.2	1	0.15	1	0.1	0	0	0	0.05	25	SLOW
Planned Transition	Land buy back (no lease back)	Yes	No	Yes	-1	-0.4	0	0	-1	-0.1	1	0.1	2	0.3	0	0	2	0.1	3	0	26	SLOW
Planned Transition	Land swap	Yes	Yes	Yes	-1	-0.4	0	0	-1	-0.1	1	0.1	2	0.3	0	0	2	0.1	3	0	26	SLOW
Protect	Seawall/scour protection to protect public assets	Yes	No	Yes	-1	-0.4	0	0	-1	-0.1	1	0.1	1	0.15	1	0.1	2	0.1	3	-0.05	44	SLOW
Planned Transition	Partial land buy-back	Yes	No	Yes	-1	-0.4	1	0.1	-1	-0.1	1	0.1	1	0.15	0	0	1	0.05	2	-0.1	45	SLOW
Accommodate	Build redundancy into network systems	Yes	No	Yes	-2	-0.8	0	0	1	0.1	0	0	2	0.3	0	0	2	0.1	3	-0.3	46	SLOW
Accommodate	Contaminated site management	No	No	No	No known contaminated sites															0	26	STOP
Accommodate	Floating development (residential)	No	No	No	Not considered suitable for mitigating coastal hazard risks															0	26	STOP
Accommodate	Manual Creek Mouth Management to Protect Private Assets	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	26	STOP
Accommodate	Manual Creek Mouth Management to Protect Public Assets	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	26	STOP
Accommodate	Urban design	No	No	No	Not considered in detail as part of the CHAS; to be considered as part of future master planning (for example)															0	26	STOP
Natural ecosystem strengthening	Beach scraping	No	No	No	Limited to no opportunity to implement at this location; no viable sand source and environmental constraints															0	26	STOP
Natural ecosystem strengthening	Dune construction	No	No	No	Not considered suitable at this location, no existing dune habitat; preference to restore maintain existing habitats															0	26	STOP
Natural ecosystem strengthening	Dune restoration / augmentation	No	No	No	Not considered suitable at this location, no existing dune habitat; preference to restore maintain existing habitats															0	26	STOP
Natural ecosystem strengthening	Reduce extents of hard surfaces	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality; this action may provide other benefits (e.g. heat reduction)															0	26	STOP
Natural ecosystem strengthening	Small-scale beach nourishment	No	No	No	Limited to no opportunity to implement at this location; no viable sand source and environmental constraints															0	26	STOP
Planned Transition	Rolling easement	No	No	No	Limited to no opportunity to implement at this location															0	26	STOP
Protect	Artificial reef	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality; this action may provide other benefits (e.g. fish habitat)															0	26	STOP
Protect	Groyne and artificial headlands	No	No	No	Limited to no opportunity to implement at this location; longshore sand transport assumed too low to be effective															0	26	STOP
Protect	Large-scale beach nourishment	No	No	No	Limited to no opportunity to implement at this location; no viable sand source and environmental constraints															0	26	STOP
Protect	Levees / dykes	No	No	No	Likely to impact catchment flooding, not considered further at this time															0	26	STOP
Protect	Tidal barrage / gates / surge barriers	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	26	STOP

MCA Results

Table D-11 MCA Results Boonooroo

Response Type	Action	Is the option technically effective at reducing risks regardless of timescale?	Does the option provide multiple or other benefits?	Proceed to next level of assessment?	Cost	Weighted Economic Impact	Environmental Impact	Weighted Environmental Impact	Social Impact	Weighted Social Impact	Reversible / Adaptable	Weighted reversible/ Adaptable	Effectiveness	Weighted Effectiveness	Approvability	Weighted Approvability	Timing	Weighted Timing	Unweighted Total Score (Go = >4, Slow = -4 to >4, Stop = 41)	Weighted Score	Rank	ACTION STATUS
Natural ecosystem strengthening	Active dune and habitat management	Yes	Yes	Yes	2	0.8	2	0.2	2	0.2	2	0.2	1	0.15	2	0.2	-2	-0.1	9	1.65	1	GO
Accommodate	Development master planning	Yes	Yes	Yes	2	0.8	2	0.2	2	0.2	1	0.1	1	0.15	0	0	0	0	8	1.45	2	GO
Natural ecosystem strengthening	Green belts and riparian corridors	Yes	Yes	Yes	2	0.8	2	0.2	1	0.1	1	0.1	1	0.15	1	0.1	-1	-0.05	7	1.4	3	GO
Accommodate	Emergency management response	No	Yes	Yes	2	0.8	0	0	-1	-0.1	2	0.2	2	0.3	2	0.2	-2	-0.1	5	1.3	4	GO
Accommodate	Hazard resilient design for new/upgraded private infrastructure	Yes	No	Yes	2	0.8	1	0.1	0	0	1	0.1	1	0.15	1	0.1	1	0.05	7	1.3	4	GO
Build community resilience / complementary measures	Community Education and Consultation	Yes	No	Yes	2	0.8	0	0	1	0.1	1	0.1	0	0	2	0.2	0	0	6	1.2	6	GO
Natural ecosystem strengthening	Establish buffers around wetlands	Yes	Yes	Yes	1	0.4	2	0.2	2	0.2	2	0.2	1	0.15	1	0.1	-1	-0.05	8	1.2	6	GO
Natural ecosystem strengthening	Land management to support habitat migration	Yes	Yes	Yes	1	0.4	2	0.2	2	0.2	2	0.2	1	0.15	1	0.1	-1	-0.05	8	1.2	6	GO
Natural ecosystem strengthening	Wetland restoration	Yes	Yes	Yes	1	0.4	2	0.2	2	0.2	2	0.2	1	0.15	1	0.1	-1	-0.05	8	1.2	6	GO
Accommodate	Hazard resilient design for new/upgraded public infrastructure	Yes	No	Yes	1	0.4	1	0.1	2	0.2	1	0.1	1	0.15	1	0.1	1	0.05	8	1.1	10	GO
Build community resilience / complementary measures	Monitoring	Yes	No	Yes	2	0.8	0	0	1	0.1	0	0	0	0	2	0.2	-1	-0.05	4	1.05	11	GO
Accommodate	Emergency management planning (e.g. alternative route provision)	Yes	No	Yes	2	0.8	1	0.1	-2	-0.2	1	0.1	1	0.15	0	0	1	0.05	4	1	12	SLOW
Accommodate	Insurance	No	Yes	Yes	1	0.4	0	0	0	0	1	0.1	2	0.3	2	0.2	0	0	6	1	12	SLOW
Protect	Tide flaps/valves on stormwater network	Yes	No	Yes	2	0.8	0	0	0	0	1	0.1	0	0	1	0.1	0	0	4	1	12	SLOW
Accommodate	Allow foreshore recession	Yes	No	Yes	2	0.8	2	0.2	-1	-0.1	-1	-0.1	0	0	2	0.2	-1	-0.05	3	0.95	15	SLOW
Planned Transition	Maintain status quo (no changes to present management approach)	Yes	No	Yes	2	0.8	-1	-0.1	-1	-0.1	0	0	0	0	2	0.2	0	0	2	0.8	16	SLOW
Build community resilience / complementary measures	Geotechnical Investigation & Detailed Erosion Study	Yes	No	Yes	1	0.4	0	0	0	0	0	0	0	0	2	0.2	0	0	3	0.6	17	SLOW
Avoid	Community Infrastructure Management	Yes	No	Yes	0	0	0	0	1	0.1	0	0	2	0.3	1	0.1	2	0.1	6	0.6	18	SLOW
Avoid	Coastal building lines / development setbacks	Yes	No	Yes	1	0.4	0	0	0	0	0	0	0	0	1	0.1	0	0	2	0.5	19	SLOW
Avoid	Reduce intensity of future development	Yes	No	Yes	0	0	1	0.1	-1	-0.1	1	0.1	1	0.15	-1	-0.1	1	0.05	2	0.2	20	SLOW
Planned Transition	Trigger related development approvals	Yes	No	Yes	0	0	0	0	0	0	0	0	1	0.15	0	0	1	0.05	2	0.2	20	SLOW
Protect	Seawall/scour protection to protect private assets	Yes	No	Yes	0	0	0	0	0	0	0	0	1	0.15	0	0	1	0.05	2	0.2	20	SLOW
Planned Transition	Land buy back with lease back opportunity	Yes	No	Yes	-1	-0.4	1	0.1	-2	-0.2	1	0.1	2	0.3	2	0.2	1	0.05	4	0.15	23	SLOW
Planned Transition	Relocate important infrastructure	Yes	No	Yes	-1	-0.4	0	0	0	0	0	0	2	0.3	1	0.1	2	0.1	4	0.1	24	SLOW
Avoid	Raise land levels	Yes	No	Yes	0	0	0	0	0	0	-2	-0.2	1	0.15	1	0.1	0	0	0	0.05	25	SLOW
Planned Transition	Land buy back (no lease back)	Yes	No	Yes	-1	-0.4	0	0	-1	-0.1	1	0.1	2	0.3	0	0	2	0.1	3	0	26	SLOW
Planned Transition	Land swap	Yes	Yes	Yes	-1	-0.4	0	0	-1	-0.1	1	0.1	2	0.3	0	0	2	0.1	3	0	26	SLOW
Planned Transition	Partial land buy-back	Yes	No	Yes	-1	-0.4	0	0	-1	-0.1	1	0.1	2	0.3	0	0	2	0.1	3	0	26	SLOW
Accommodate	Build redundancy into network systems	Yes	No	Yes	-2	-0.8	0	0	1	0.1	0	0	2	0.3	0	0	2	0.1	3	-0.3	46	SLOW
Accommodate	Contaminated site management	No	No	No	No known contaminated sites															0	26	STOP
Accommodate	Floating development (residential)	No	No	No	Not considered suitable for mitigating coastal hazard risks															0	26	STOP
Accommodate	Manual Creek Mouth Management to Protect Private Assets	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	26	STOP
Accommodate	Manual Creek Mouth Management to Protect Public Assets	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	26	STOP
Accommodate	Urban design	No	No	No	Not considered in detail as part of the CHAS; to be considered as part of future master planning (for example)															0	26	STOP
Natural ecosystem strengthening	Beach scraping	No	No	No	Limited to no opportunity to implement at this location; no viable sand source and environmental constraints															0	26	STOP
Natural ecosystem strengthening	Dune construction	No	No	No	Not considered suitable at this location, no existing dune habitat; preference to restore maintain existing habitats															0	26	STOP
Natural ecosystem strengthening	Dune restoration / augmentation	No	No	No	Not considered suitable at this location, no existing dune habitat; preference to restore maintain existing habitats															0	26	STOP
Natural ecosystem strengthening	Reduce extents of hard surfaces	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality; this action may provide other benefits (e.g. heat reduction)															0	26	STOP
Natural ecosystem strengthening	Small-scale beach nourishment	No	No	No	Limited to no opportunity to implement at this location; no viable sand source and environmental constraints															0	26	STOP
Planned Transition	Rolling easement	No	No	No	Limited to no opportunity to implement at this location															0	26	STOP
Protect	Artificial reef	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality; this action may provide other benefits (e.g. fish habitat)															0	26	STOP
Protect	Groyne and artificial headlands	No	No	No	Limited to no opportunity to implement at this location; longshore sand transport assumed too low to be effective															0	26	STOP
Protect	Large-scale beach nourishment	No	No	No	Limited to no opportunity to implement at this location; no viable sand source and environmental constraints															0	26	STOP
Protect	Levees / dykes	No	No	No	Likely to impact catchment flooding, not considered further at this time															0	26	STOP
Protect	Seawall/scour protection to protect public assets	No	No	No	No major public assets at risk; preference to transition minor assets rather than protect															0	26	STOP
Protect	Tidal barrage / gates / surge barriers	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	26	STOP

MCA Results

Table D-12 MCA Results Tuan

Response Type	Action	Is the option technically effective at reducing risks regardless of timescale?	Does the option provide multiple or other benefits?	Proceed to next level of assessment?	Cost	Weighted Economic Impact	Environmental Impact	Weighted Environmental Impact	Social Impact	Weighted Social Impact	Reversible / Adaptable	Weighted reversible/ Adaptable	Effectiveness	Weighted Effectiveness	Approvability	Weighted Approvability	Timing	Weighted Timing	Unweighted Total Score (Go = >4, Slow = -4 to >4, Stop = 41)	Weighted Score	Rank	ACTION STATUS
Natural ecosystem strengthening	Active dune and habitat management	Yes	Yes	Yes	2	0.8	2	0.2	2	0.2	2	0.2	1	0.15	2	0.2	-2	-0.1	9	1.65	1	GO
Accommodate	Development master planning	Yes	Yes	Yes	2	0.8	2	0.2	2	0.2	1	0.1	1	0.15	0	0	0	0	8	1.45	2	GO
Natural ecosystem strengthening	Green belts and riparian corridors	Yes	Yes	Yes	2	0.8	2	0.2	1	0.1	1	0.1	1	0.15	1	0.1	-1	-0.05	7	1.4	3	GO
Accommodate	Emergency management response	No	Yes	Yes	2	0.8	0	0	-1	-0.1	2	0.2	2	0.3	2	0.2	-2	-0.1	5	1.3	4	GO
Accommodate	Hazard resilient design for new/upgraded private infrastructure	Yes	No	Yes	2	0.8	1	0.1	0	0	1	0.1	1	0.15	1	0.1	1	0.05	7	1.3	4	GO
Build community resilience / complementary measures	Community Education and Consultation	Yes	No	Yes	2	0.8	0	0	1	0.1	1	0.1	0	0	2	0.2	0	0	6	1.2	6	GO
Natural ecosystem strengthening	Establish buffers around wetlands	Yes	Yes	Yes	1	0.4	2	0.2	2	0.2	2	0.2	1	0.15	1	0.1	-1	-0.05	8	1.2	6	GO
Natural ecosystem strengthening	Land management to support habitat migration	Yes	Yes	Yes	1	0.4	2	0.2	2	0.2	2	0.2	1	0.15	1	0.1	-1	-0.05	8	1.2	6	GO
Natural ecosystem strengthening	Wetland restoration	Yes	Yes	Yes	1	0.4	2	0.2	2	0.2	2	0.2	1	0.15	1	0.1	-1	-0.05	8	1.2	6	GO
Accommodate	Hazard resilient design for new/upgraded public infrastructure	Yes	No	Yes	1	0.4	1	0.1	2	0.2	1	0.1	1	0.15	1	0.1	1	0.05	8	1.1	10	GO
Build community resilience / complementary measures	Monitoring	Yes	No	Yes	2	0.8	0	0	1	0.1	0	0	0	0	2	0.2	-1	-0.05	4	1.05	11	GO
Accommodate	Emergency management planning (e.g. alternative route provision)	Yes	No	Yes	2	0.8	1	0.1	-2	-0.2	1	0.1	1	0.15	0	0	1	0.05	4	1	12	SLOW
Accommodate	Insurance	No	Yes	Yes	1	0.4	0	0	0	0	1	0.1	2	0.3	2	0.2	0	0	6	1	12	SLOW
Protect	Tide flaps/valves on stormwater network	Yes	No	Yes	2	0.8	0	0	0	0	1	0.1	0	0	1	0.1	0	0	4	1	12	SLOW
Accommodate	Allow foreshore recession	Yes	No	Yes	2	0.8	2	0.2	-1	-0.1	-1	-0.1	0	0	2	0.2	-1	-0.05	3	0.95	15	SLOW
Planned Transition	Maintain status quo (no changes to present management approach)	Yes	No	Yes	2	0.8	-1	-0.1	-1	-0.1	0	0	0	0	2	0.2	0	0	2	0.8	16	SLOW
Build community resilience / complementary measures	Geotechnical Investigation & Detailed Erosion Study	Yes	No	Yes	1	0.4	0	0	0	0	0	0	0	0	2	0.2	0	0	3	0.6	17	SLOW
Avoid	Community Infrastructure Management	Yes	No	Yes	0	0	0	0	1	0.1	0	0	2	0.3	1	0.1	2	0.1	6	0.6	18	SLOW
Avoid	Coastal building lines / development setbacks	Yes	No	Yes	1	0.4	0	0	0	0	0	0	0	0	1	0.1	0	0	2	0.5	19	SLOW
Avoid	Reduce intensity of future development	Yes	No	Yes	0	0	1	0.1	-1	-0.1	1	0.1	1	0.15	-1	-0.1	1	0.05	2	0.2	20	SLOW
Planned Transition	Trigger related development approvals	Yes	No	Yes	0	0	0	0	0	0	0	0	1	0.15	0	0	1	0.05	2	0.2	20	SLOW
Protect	Seawall/scour protection to protect private assets	Yes	No	Yes	0	0	0	0	0	0	0	0	1	0.15	0	0	1	0.05	2	0.2	20	SLOW
Planned Transition	Land buy back with lease back opportunity	Yes	No	Yes	-1	-0.4	1	0.1	-2	-0.2	1	0.1	2	0.3	2	0.2	1	0.05	4	0.15	23	SLOW
Planned Transition	Relocate important infrastructure	Yes	No	Yes	-1	-0.4	0	0	0	0	0	0	2	0.3	1	0.1	2	0.1	4	0.1	24	SLOW
Avoid	Raise land levels	Yes	No	Yes	0	0	0	0	0	0	-2	-0.2	1	0.15	1	0.1	0	0	0	0.05	25	SLOW
Planned Transition	Land buy back (no lease back)	Yes	No	Yes	-1	-0.4	0	0	-1	-0.1	1	0.1	2	0.3	0	0	2	0.1	3	0	26	SLOW
Planned Transition	Land swap	Yes	Yes	Yes	-1	-0.4	0	0	-1	-0.1	1	0.1	2	0.3	0	0	2	0.1	3	0	26	SLOW
Planned Transition	Partial land buy-back	Yes	No	Yes	-1	-0.4	0	0	-1	-0.1	1	0.1	2	0.3	0	0	2	0.1	3	0	26	SLOW
Protect	Seawall/scour protection to protect public assets	Yes	No	Yes	-1	-0.4	0	0	-1	-0.1	1	0.1	1	0.15	1	0.1	2	0.1	3	-0.05	45	SLOW
Accommodate	Build redundancy into network systems	Yes	No	Yes	-2	-0.8	0	0	1	0.1	0	0	2	0.3	0	0	2	0.1	3	-0.3	46	SLOW
Accommodate	Contaminated site management	No	No	No	No known contaminated sites															0	26	STOP
Accommodate	Floating development (residential)	No	No	No	Not considered suitable for mitigating coastal hazard risks															0	26	STOP
Accommodate	Manual Creek Mouth Management to Protect Private Assets	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	26	STOP
Accommodate	Manual Creek Mouth Management to Protect Public Assets	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	26	STOP
Accommodate	Urban design	No	No	No	Not considered in detail as part of the CHAS; to be considered as part of future master planning (for example)															0	26	STOP
Natural ecosystem strengthening	Beach scraping	No	No	No	Limited to no opportunity to implement at this location; no viable sand source and environmental constraints															0	26	STOP
Natural ecosystem strengthening	Dune construction	No	No	No	Not considered suitable at this location, no existing dune habitat; preference to restore maintain existing habitats															0	26	STOP
Natural ecosystem strengthening	Dune restoration / augmentation	No	No	No	Not considered suitable at this location, no existing dune habitat; preference to restore maintain existing habitats															0	26	STOP
Natural ecosystem strengthening	Reduce extents of hard surfaces	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality; this action may provide other benefits (e.g. heat reduction)															0	26	STOP
Natural ecosystem strengthening	Small-scale beach nourishment	No	No	No	Limited to no opportunity to implement at this location; no viable sand source and environmental constraints															0	26	STOP
Planned Transition	Rolling easement	No	No	No	Limited to no opportunity to implement at this location															0	26	STOP
Protect	Artificial reef	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality; this action may provide other benefits (e.g. fish habitat)															0	26	STOP
Protect	Groyne and artificial headlands	No	No	No	Limited to no opportunity to implement at this location; longshore sand transport assumed too low to be effective															0	26	STOP
Protect	Large-scale beach nourishment	No	No	No	Limited to no opportunity to implement at this location; no viable sand source and environmental constraints															0	26	STOP
Protect	Levees / dykes	No	No	No	Likely to impact catchment flooding, not considered further at this time															0	26	STOP
Protect	Tidal barrage / gates / surge barriers	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	26	STOP

MCA Results

Table D-13 MCA Results Poona

Response Type	Action	Is the option technically effective at reducing risks regardless of timescale?	Does the option provide multiple or other benefits?	Proceed to next level of assessment?	Cost	Weighted Economic Impact	Environmental Impact	Weighted Environmental Impact	Social Impact	Weighted Social Impact	Reversible / Adaptable	Weighted reversible/ Adaptable	Effectiveness	Weighted Effectiveness	Approvability	Weighted Approvability	Timing	Weighted Timing	Unweighted Total Score (Go = >4, Slow = -4 to >4, Stop = 41)	Weighted Score	Rank	ACTION STATUS
Natural ecosystem strengthening	Active dune and habitat management	Yes	Yes	Yes	2	0.8	2	0.2	2	0.2	2	0.2	1	0.15	2	0.2	-2	-0.1	9	1.65	1	GO
Accommodate	Development master planning	Yes	Yes	Yes	2	0.8	2	0.2	2	0.2	1	0.1	1	0.15	0	0	0	0	8	1.45	2	GO
Natural ecosystem strengthening	Green belts and riparian corridors	Yes	Yes	Yes	2	0.8	2	0.2	1	0.1	1	0.1	1	0.15	1	0.1	-1	-0.05	7	1.4	3	GO
Accommodate	Emergency management response	No	Yes	Yes	2	0.8	0	0	-1	-0.1	2	0.2	2	0.3	2	0.2	-2	-0.1	5	1.3	4	GO
Accommodate	Hazard resilient design for new/upgraded private infrastructure	Yes	No	Yes	2	0.8	1	0.1	0	0	1	0.1	1	0.15	1	0.1	1	0.05	7	1.3	4	GO
Build community resilience / complementary measures	Community Education and Consultation	Yes	No	Yes	2	0.8	0	0	1	0.1	1	0.1	0	0	2	0.2	0	0	6	1.2	6	GO
Natural ecosystem strengthening	Establish buffers around wetlands	Yes	No	Yes	1	0.4	2	0.2	2	0.2	2	0.2	1	0.15	1	0.1	-1	-0.05	8	1.2	6	GO
Natural ecosystem strengthening	Land management to support habitat migration	Yes	No	Yes	1	0.4	2	0.2	2	0.2	2	0.2	1	0.15	1	0.1	-1	-0.05	8	1.2	6	GO
Natural ecosystem strengthening	Wetland restoration	Yes	No	Yes	1	0.4	2	0.2	2	0.2	2	0.2	1	0.15	1	0.1	-1	-0.05	8	1.2	6	GO
Accommodate	Hazard resilient design for new/upgraded public infrastructure	Yes	No	Yes	1	0.4	1	0.1	2	0.2	1	0.1	1	0.15	1	0.1	1	0.05	8	1.1	10	GO
Build community resilience / complementary measures	Monitoring	Yes	No	Yes	2	0.8	0	0	1	0.1	0	0	0	0	2	0.2	-1	-0.05	4	1.05	11	GO
Accommodate	Emergency management planning (e.g. alternative route provision)	Yes	No	Yes	2	0.8	1	0.1	-2	-0.2	1	0.1	1	0.15	0	0	1	0.05	4	1	12	SLOW
Accommodate	Insurance	No	Yes	Yes	1	0.4	0	0	0	0	1	0.1	2	0.3	2	0.2	0	0	6	1	12	SLOW
Protect	Tide flaps/valves on stormwater network	Yes	No	Yes	2	0.8	0	0	0	0	1	0.1	0	0	1	0.1	0	0	4	1	12	SLOW
Accommodate	Allow foreshore recession	Yes	No	Yes	2	0.8	2	0.2	-1	-0.1	-1	-0.1	0	0	2	0.2	-1	-0.05	3	0.95	15	SLOW
Planned Transition	Maintain status quo (no changes to present management approach)	Yes	No	Yes	2	0.8	-1	-0.1	-1	-0.1	0	0	0	0	2	0.2	0	0	2	0.8	16	SLOW
Build community resilience / complementary measures	Geotechnical Investigation & Detailed Erosion Study	Yes	No	Yes	1	0.4	0	0	0	0	0	0	0	0	2	0.2	0	0	3	0.6	17	SLOW
Avoid	Community Infrastructure Management	Yes	No	Yes	0	0	0	0	1	0.1	0	0	2	0.3	1	0.1	2	0.1	6	0.6	18	SLOW
Avoid	Coastal building lines / development setbacks	Yes	No	Yes	1	0.4	0	0	0	0	0	0	0	0	1	0.1	0	0	2	0.5	19	SLOW
Protect	Groyne and artificial headlands	Yes	No	Yes	0	0	0	0	1	0.1	0	0	1	0.15	0	0	1	0.05	3	0.3	20	SLOW
Avoid	Reduce intensity of future development	Yes	No	Yes	0	0	1	0.1	-1	-0.1	1	0.1	1	0.15	-1	-0.1	1	0.05	2	0.2	21	SLOW
Planned Transition	Trigger related development approvals	Yes	No	Yes	0	0	0	0	0	0	0	0	1	0.15	0	0	1	0.05	2	0.2	21	SLOW
Protect	Seawall/scour protection to protect private assets	Yes	No	Yes	0	0	0	0	0	0	0	0	1	0.15	0	0	1	0.05	2	0.2	21	SLOW
Planned Transition	Land buy back with lease back opportunity	Yes	No	Yes	-1	-0.4	1	0.1	-2	-0.2	1	0.1	2	0.3	2	0.2	1	0.05	4	0.15	24	SLOW
Planned Transition	Relocate important infrastructure	Yes	No	Yes	-1	-0.4	0	0	0	0	0	0	2	0.3	1	0.1	2	0.1	4	0.1	25	SLOW
Avoid	Raise land levels	Yes	No	Yes	0	0	0	0	0	0	-2	-0.2	1	0.15	1	0.1	0	0	0	0.05	26	SLOW
Planned Transition	Land buy back (no lease back)	Yes	No	Yes	-1	-0.4	0	0	-1	-0.1	1	0.1	2	0.3	0	0	2	0.1	3	0	27	SLOW
Planned Transition	Land swap	Yes	Yes	Yes	-1	-0.4	0	0	-1	-0.1	1	0.1	2	0.3	0	0	2	0.1	3	0	27	SLOW
Planned Transition	Partial land buy-back	Yes	No	Yes	-1	-0.4	0	0	-1	-0.1	1	0.1	2	0.3	0	0	2	0.1	3	0	27	SLOW
Protect	Seawall/scour protection to protect public assets	Yes	No	Yes	-1	-0.4	0	0	-1	-0.1	1	0.1	1	0.15	1	0.1	2	0.1	3	-0.05	46	SLOW
Accommodate	Build redundancy into network systems	No	No	No	Network systems managed as part of ongoing asset maintenance and renewal															0	27	STOP
Accommodate	Contaminated site management	No	No	No	No known contaminated sites															0	27	STOP
Accommodate	Floating development (residential)	No	No	No	Not considered suitable for mitigating coastal hazard risks															0	27	STOP
Accommodate	Manual Creek Mouth Management to Protect Private Assets	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	27	STOP
Accommodate	Manual Creek Mouth Management to Protect Public Assets	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	27	STOP
Accommodate	Urban design	No	No	No	Not considered in detail as part of the CHAS; to be considered as part of future master planning (for example)															0	27	STOP
Natural ecosystem strengthening	Beach scraping	No	No	No	Limited to no opportunity to implement at this location; no viable sand source and environmental constraints															0	27	STOP
Natural ecosystem strengthening	Dune construction	No	No	No	Not considered suitable at this location, no existing dune habitat; preference to restore maintain existing habitats															0	27	STOP
Natural ecosystem strengthening	Dune restoration / augmentation	No	No	No	Not considered suitable at this location, no existing dune habitat; preference to restore maintain existing habitats															0	27	STOP
Natural ecosystem strengthening	Reduce extents of hard surfaces	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality; this action may provide other benefits (e.g. heat reduction)															0	27	STOP
Natural ecosystem strengthening	Small-scale beach nourishment	No	No	No	Limited to no opportunity to implement at this location; no viable sand source and environmental constraints															0	27	STOP
Planned Transition	Rolling easement	No	No	No	Limited to no opportunity to implement at this location															0	27	STOP
Protect	Artificial reef	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality; this action may provide other benefits (e.g. fish habitat)															0	27	STOP
Protect	Large-scale beach nourishment	No	No	No	Limited to no opportunity to implement at this location; no viable sand source and environmental constraints															0	27	STOP
Protect	Levees / dykes	No	No	No	Likely to impact catchment flooding, not considered further at this time															0	27	STOP
Protect	Tidal barrage / gates / surge barriers	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	27	STOP

MCA Results

Table D-14 Tinnanbar MCA Results

Response Type	Action	Is the option technically effective at reducing risks regardless of timescale?	Does the option provide multiple or other benefits?	Proceed to next level of assessment?	Cost	Weighted Economic Impact	Environmental Impact	Weighted Environmental Impact	Social Impact	Weighted Social Impact	Reversible / Adaptable	Weighted reversible/ Adaptable	Effectiveness	Weighted Effectiveness	Approvability	Weighted Approvability	Timing	Weighted Timing	Unweighted Total Score (Go = >4, Slow = -4 to >4, Stop = 41)	Weighted Score	Rank	ACTION STATUS
Natural ecosystem strengthening	Active dune and habitat management	Yes	No	Yes	2	0.8	2	0.2	2	0.2	2	0.2	1	0.15	2	0.2	-2	-0.1	9	1.65	1	GO
Accommodate	Development master planning	Yes	Yes	Yes	2	0.8	2	0.2	2	0.2	1	0.1	1	0.15	0	0	0	0	8	1.45	2	GO
Accommodate	Emergency management response	No	Yes	Yes	2	0.8	0	0	-1	-0.1	2	0.2	2	0.3	2	0.2	-2	-0.1	5	1.3	3	GO
Accommodate	Hazard resilient design for new/upgraded private infrastructure	Yes	No	Yes	2	0.8	1	0.1	0	0	1	0.1	1	0.15	1	0.1	1	0.05	7	1.3	3	GO
Build community resilience / complementary measures	Community Education and Consultation	Yes	No	Yes	2	0.8	0	0	1	0.1	1	0.1	0	0	2	0.2	0	0	6	1.2	5	GO
Natural ecosystem strengthening	Wetland restoration	Yes	No	Yes	1	0.4	2	0.2	2	0.2	2	0.2	1	0.15	1	0.1	-1	-0.05	8	1.2	5	GO
Accommodate	Hazard resilient design for new/upgraded public infrastructure	Yes	No	Yes	1	0.4	1	0.1	2	0.2	1	0.1	1	0.15	1	0.1	1	0.05	8	1.1	7	GO
Build community resilience / complementary measures	Monitoring	Yes	No	Yes	2	0.8	0	0	1	0.1	0	0	0	0	2	0.2	-1	-0.05	4	1.05	8	GO
Accommodate	Insurance	No	Yes	Yes	1	0.4	0	0	0	0	1	0.1	2	0.3	2	0.2	0	0	6	1	9	SLOW
Protect	Tide flaps/valves on stormwater network	Yes	No	Yes	2	0.8	0	0	0	0	1	0.1	0	0	1	0.1	0	0	4	1	9	SLOW
Accommodate	Allow foreshore recession	Yes	No	Yes	2	0.8	2	0.2	-1	-0.1	-1	-0.1	0	0	2	0.2	-1	-0.05	3	0.95	11	SLOW
Planned Transition	Maintain status quo (no changes to present management approach)	Yes	No	Yes	2	0.8	-1	-0.1	-1	-0.1	0	0	0	0	2	0.2	0	0	2	0.8	12	SLOW
Build community resilience / complementary measures	Geotechnical Investigation & Detailed Erosion Study	Yes	No	Yes	1	0.4	0	0	0	0	0	0	0	0	2	0.2	0	0	3	0.6	13	SLOW
Avoid	Community Infrastructure Management	Yes	No	Yes	0	0	0	0	1	0.1	0	0	2	0.3	1	0.1	2	0.1	6	0.6	14	SLOW
Avoid	Coastal building lines / development setbacks	Yes	No	Yes	1	0.4	0	0	0	0	0	0	0	0	1	0.1	0	0	2	0.5	15	SLOW
Avoid	Reduce intensity of future development	Yes	No	Yes	0	0	1	0.1	-1	-0.1	1	0.1	1	0.15	-1	-0.1	1	0.05	2	0.2	21	SLOW
Planned Transition	Trigger related development approvals	Yes	No	Yes	0	0	0	0	0	0	0	0	1	0.15	0	0	1	0.05	2	0.2	16	SLOW
Planned Transition	Relocate important infrastructure	Yes	No	Yes	-1	-0.4	0	0	0	0	0	0	2	0.3	1	0.1	2	0.1	4	0.1	18	SLOW
Avoid	Raise land levels	Yes	No	Yes	0	0	0	0	0	0	-2	-0.2	1	0.15	1	0.1	0	0	0	0.05	26	SLOW
Protect	Seawall/scour protection to protect public assets	Yes	No	Yes	-1	-0.4	0	0	-1	-0.1	1	0.1	1	0.15	1	0.1	2	0.1	3	-0.05	46	SLOW
Accommodate	Build redundancy into network systems	No	No	No	Network systems managed as part of ongoing asset maintenance and renewal															0	20	STOP
Accommodate	Contaminated site management	No	No	No	No known contaminated sites															0	20	STOP
Accommodate	Emergency management planning (e.g. alternative route provision)	No	No	No	Not considered at this time but should be reviewed as part of future evacuation planning studies															0	20	STOP
Accommodate	Floating development (residential)	No	No	No	Not considered suitable for mitigating coastal hazard risks															0	20	STOP
Accommodate	Manual Creek Mouth Management to Protect Private Assets	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	20	STOP
Accommodate	Manual Creek Mouth Management to Protect Public Assets	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	20	STOP
Accommodate	Urban design	No	No	No	Not considered in detail as part of the CHAS; to be considered as part of future master planning (for example)															0	20	STOP
Natural ecosystem strengthening	Beach scraping	No	No	No	Limited to no opportunity to implement at this location; no viable sand source and environmental constraints															0	20	STOP
Natural ecosystem strengthening	Dune construction	No	No	No	Not considered suitable at this location, no existing dune habitat; preference to restore maintain existing habitats															0	20	STOP
Natural ecosystem strengthening	Dune restoration / augmentation	No	No	No	Not considered suitable at this location, no existing dune habitat; preference to restore maintain existing habitats															0	20	STOP
Natural ecosystem strengthening	Establish buffers around wetlands	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality; this action may provide other benefits (e.g. environmental)															0	20	STOP
Natural ecosystem strengthening	Green belts and riparian corridors	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality; this action may provide other benefits (e.g. environmental)															0	20	STOP
Natural ecosystem strengthening	Land management to support habitat migration	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality; this action may provide other benefits (e.g. environmental)															0	20	STOP
Natural ecosystem strengthening	Reduce extents of hard surfaces	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality; this action may provide other benefits (e.g. heat reduction)															0	20	STOP
Natural ecosystem strengthening	Small-scale beach nourishment	No	No	No	Limited to no opportunity to implement at this location; no viable sand source and environmental constraints															0	20	STOP
Planned Transition	Land buy back (no lease back)	No	No	No	Private assets generally outside of the coastal erosion hazard area															0	20	STOP
Planned Transition	Land buy back with lease back opportunity	No	No	No	Private assets generally outside of the coastal erosion hazard area															0	20	STOP
Planned Transition	Land swap	No	No	No	Private assets generally outside of the coastal erosion hazard area															0	20	STOP
Planned Transition	Partial land buy-back	No	No	No	Private assets generally outside of the coastal erosion hazard area															0	20	STOP
Planned Transition	Rolling easement	No	No	No	Limited to no opportunity to implement at this location															0	20	STOP
Protect	Artificial reef	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality; this action may provide other benefits (e.g. fish habitat)															0	20	STOP
Protect	Groyne and artificial headlands	No	No	No	Limited to no opportunity to implement at this location; longshore sand transport assumed too low to be effective															0	20	STOP
Protect	Large-scale beach nourishment	No	No	No	Limited to no opportunity to implement at this location; no viable sand source and environmental constraints															0	20	STOP
Protect	Levees / dykes	No	No	No	Likely to impact catchment flooding, not considered further at this time															0	20	STOP
Protect	Seawall/scour protection to protect private assets	No	No	No	Private assets generally outside of the coastal erosion hazard area															0	20	STOP
Protect	Tidal barrage / gates / surge barriers	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	20	STOP

MCA Results

Table D-15 Mary River MCA Results

Response Type	Action	Is the option technically effective at reducing risks regardless of timescale?	Does the option provide multiple or other benefits?	Proceed to next level of assessment?	Cost	Weighted Economic Impact	Environmental Impact	Weighted Environmental Impact	Social Impact	Weighted Social Impact	Reversible / Adaptable	Weighted reversible/ Adaptable	Effectiveness	Weighted Effectiveness	Approvability	Weighted Approvability	Timing	Weighted Timing	Unweighted Total Score (Go = >4, Slow = -4 to >4, Stop = 41)	Weighted Score	Rank	ACTION STATUS
Natural ecosystem strengthening	Active dune and habitat management	Yes	No	Yes	2	0.8	2	0.2	2	0.2	2	0.2	1	0.15	2	0.2	-2	-0.1	9	1.65	1	GO
Accommodate	Development master planning	Yes	Yes	Yes	2	0.8	2	0.2	2	0.2	1	0.1	1	0.15	0	0	0	0	8	1.45	2	GO
Natural ecosystem strengthening	Green belts and riparian corridors	Yes	Yes	Yes	2	0.8	2	0.2	1	0.1	1	0.1	1	0.15	1	0.1	-1	-0.05	7	1.4	3	GO
Accommodate	Emergency management response	No	Yes	Yes	2	0.8	0	0	-1	-0.1	2	0.2	2	0.3	2	0.2	-2	-0.1	5	1.3	4	GO
Accommodate	Hazard resilient design for new/upgraded private infrastructure	Yes	No	Yes	2	0.8	1	0.1	0	0	1	0.1	1	0.15	1	0.1	1	0.05	7	1.3	4	GO
Build community resilience / complementary measures	Community Education and Consultation	Yes	No	Yes	2	0.8	0	0	1	0.1	1	0.1	0	0	2	0.2	0	0	6	1.2	6	GO
Natural ecosystem strengthening	Establish buffers around wetlands	Yes	No	Yes	1	0.4	2	0.2	2	0.2	2	0.2	1	0.15	1	0.1	-1	-0.05	8	1.2	6	GO
Natural ecosystem strengthening	Land management to support habitat migration	Yes	No	Yes	1	0.4	2	0.2	2	0.2	2	0.2	1	0.15	1	0.1	-1	-0.05	8	1.2	6	GO
Natural ecosystem strengthening	Wetland restoration	Yes	No	Yes	1	0.4	2	0.2	2	0.2	2	0.2	1	0.15	1	0.1	-1	-0.05	8	1.2	6	GO
Accommodate	Hazard resilient design for new/upgraded public infrastructure	Yes	No	Yes	1	0.4	1	0.1	2	0.2	1	0.1	1	0.15	1	0.1	1	0.05	8	1.1	10	GO
Build community resilience / complementary measures	Monitoring	Yes	No	Yes	2	0.8	0	0	1	0.1	0	0	0	0	2	0.2	-1	-0.05	4	1.05	11	GO
Accommodate	Insurance	No	Yes	Yes	1	0.4	0	0	0	0	1	0.1	2	0.3	2	0.2	0	0	6	1	12	SLOW
Protect	Tide flaps/valves on stormwater network	Yes	No	Yes	2	0.8	0	0	0	0	1	0.1	0	0	1	0.1	0	0	4	1	12	SLOW
Accommodate	Allow foreshore recession	Yes	No	Yes	2	0.8	2	0.2	-1	-0.1	-1	-0.1	0	0	2	0.2	-1	-0.05	3	0.95	14	SLOW
Planned Transition	Maintain status quo (no changes to present management approach)	Yes	No	Yes	2	0.8	-1	-0.1	-1	-0.1	0	0	0	0	2	0.2	0	0	2	0.8	15	SLOW
Build community resilience / complementary measures	Geotechnical Investigation & Detailed Erosion Study	Yes	No	Yes	1	0.4	0	0	0	0	0	0	0	0	2	0.2	0	0	3	0.6	16	SLOW
Avoid	Community Infrastructure Management	Yes	No	Yes	0	0	0	0	1	0.1	0	0	2	0.3	1	0.1	2	0.1	6	0.6	17	SLOW
Avoid	Coastal building lines / development setbacks	Yes	No	Yes	1	0.4	0	0	0	0	0	0	0	0	1	0.1	0	0	2	0.5	18	SLOW
Planned Transition	Relocate important infrastructure	Yes	No	Yes	-1	-0.4	0	0	0	0	0	0	2	0.3	1	0.1	2	0.1	4	0.1	18	SLOW
Planned Transition	Trigger related development approvals	Yes	No	Yes	0	0	0	0	0	0	0	0	1	0.15	0	0	1	0.05	2	0.2	19	SLOW
Avoid	Reduce intensity of future development	Yes	No	Yes	0	0	1	0.1	-1	-0.1	1	0.1	1	0.15	-1	-0.1	1	0.05	2	0.2	21	SLOW
Protect	Seawall/scour protection to protect private assets	Yes	No	Yes		0		0		0		0		0		0		0	0	0	23	SLOW
Avoid	Raise land levels	Yes	No	Yes	0	0	0	0	0	0	-2	-0.2	1	0.15	1	0.1	0	0	0	0.05	25	SLOW
Protect	Seawall/scour protection to protect public assets	Yes	No	Yes	-1	-0.4	0	0	-1	-0.1	1	0.1	1	0.15	1	0.1	2	0.1	3	-0.05	45	SLOW
Accommodate	Build redundancy into network systems	Yes	Yes	Yes	-2	-0.8	0	0	1	0.1	0	0	2	0.3	0	0	2	0.1	3	-0.3	46	SLOW
Planned Transition	Partial land buy-back	No	No	No	Private assets generally outside of the coastal erosion hazard area															0	20	STOP
Accommodate	Urban design	No	No	No	Not considered in detail as part of the CHAS; to be considered as part of future master planning (for example)															0	23	STOP
Accommodate	Contaminated site management	No	No	No	No known contaminated sites															0	23	STOP
Accommodate	Emergency management planning (e.g. alternative route provision)	No	No	No	Not considered at this time but should be reviewed as part of future evacuation planning studies															0	23	STOP
Accommodate	Floating development (residential)	No	No	No	Not considered suitable for mitigating coastal hazard risks															0	23	STOP
Accommodate	Manual Creek Mouth Management to Protect Private Assets	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	23	STOP
Accommodate	Manual Creek Mouth Management to Protect Public Assets	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	23	STOP
Natural ecosystem strengthening	Beach scraping	No	No	No	Limited to no opportunity to implement at this location; no viable sand source and existing environmental constraints															0	23	STOP
Natural ecosystem strengthening	Dune construction	No	No	No	Not considered suitable at this location, no existing dune habitat; preference to restore maintain existing habitats															0	23	STOP
Natural ecosystem strengthening	Dune restoration / augmentation	No	No	No	Not considered suitable at this location, no existing dune habitat; preference to restore maintain existing habitats															0	23	STOP
Natural ecosystem strengthening	Reduce extents of hard surfaces	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality; this action may provide other benefits (e.g. heat reduction)															0	23	STOP
Natural ecosystem strengthening	Small-scale beach nourishment	No	No	No	Generally not viable for riverbank locations															0	23	STOP
Planned Transition	Land buy back (no lease back)	No	No	No	Private assets generally outside of the coastal erosion hazard area															0	23	STOP
Planned Transition	Land buy back with lease back opportunity	No	No	No	Private assets generally outside of the coastal erosion hazard area															0	23	STOP
Planned Transition	Land swap	No	No	No	Private assets generally outside of the coastal erosion hazard area															0	23	STOP
Planned Transition	Rolling easement	No	No	No	Limited to no opportunity to implement at this location															0	23	STOP
Protect	Artificial reef	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality; this action may provide other benefits (e.g. fish habitat)															0	23	STOP
Protect	Groyne and artificial headlands	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	23	STOP
Protect	Large-scale beach nourishment	No	No	No	Generally not viable for riverbank locations															0	23	STOP
Protect	Levees / dykes	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	23	STOP
Protect	Tidal barrage / gates / surge barriers	No	No	No	Not considered suitable for mitigating coastal hazard risks at this locality															0	23	STOP

Appendix E Trigger-Based Coastal Management Strategies

Implementation of Trigger-Based Coastal Management Strategies

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Abstract
An approach to adaptive, trigger-based coastal management is presented. The approach draws on traditional coastal and waterway management options coupled with novel applications of existing approvals mechanisms. This approach is risk-based, following adaptive management concepts that are already used in environmental management, but with specific application to decision-making for coastal assets. The approach utilises 'triggers', identified through best practice coastal science and engineering, as the basis for adapting management actions over short or extended planning horizons. The approach is underpinned by a framework that seeks development approvals for preferred 'outcomes' rather than a 'discrete' program of works. The trigger-based approach gives greater flexibility to decision-makers in responding to immediate and/or emerging hazards without the need for approval amendments, while providing certainty to regulatory agencies that relevant planning and environmental interests will be met. While the approach can be built into a traditionally 'static' approvals framework, there is significant opportunity for further development of this system to better align with the risks and uncertainty posed by coastal hazards and climate change.

Keywords: coastal management, waterways, coastal hazard adaptation, climate change

1. Introduction

Best-practice management strategies for developed coastlines seek to meet the needs of competing interests. Often the most cost effective means for protecting land based assets can cause undesirable impacts to the natural, social, cultural and economic values of the coastal zone.

The specific requirements and intended outcomes of coastal hazard and planning studies are generally set by State and Territory policy and/or guideline documents. Common across all jurisdictions is an increasing need for coastal hazard management plans or adaptation strategies. Such plans typically need to include ways to identify and interpret changing risk profiles over time and also accommodate uncertainty with regard to the appropriate timing of the preferred risk mitigation measures. In many cases the risk profile is misunderstood which leads to poor outcomes when there is a failure to intervene or when inappropriate 'solutions' are adopted. The level of uncertainty typically increases with the length of planning period, particularly in light of future challenges associated with climate change including more frequent coastal inundation and/or severe shoreline erosion events.

Across much of Australia there are important built and natural assets at risk from coastal hazards. These include roads, caravan parks, foreshores and open space, residential and commercial development, and popular local beaches. However, while the potential hazards and risks are understood in a general sense, the realisation of impacts is subject to significant uncertainty. The difficulty presented to coastal management decision-makers is that while proposed management actions need to account for current and future coastal hazards, the timing and nature of these effects often cannot be known in any detail at the development assessment stage.

The development approvals (DAs) framework has been designed to commit a particular development at a particular point in time. This typically 'static' system, when utilised in the traditional way, is fundamentally inconsistent with the intent of adaptation planning. Coastal management decision-makers need the flexibility to either progressively adapt or rapidly respond to changing circumstances under a single approvals framework, while still providing certainty to State, Territory and Federal regulators that all relevant environmental and planning interests will be met.

Using Queensland examples, this paper presents a unique approach that has sought to introduce adaptive coastal management into the existing legislative context in order to give greater confidence to decision-makers and proponents in the face of uncertainty.

1.1 Legislative Context in Queensland

Unallocated State Land (USL) adjacent to tidal waters in Queensland is often dedicated as an esplanade or reserve which is managed by Local government. This land use provides access to the general public and can create a buffer between land-based assets and natural processes which helps to manage the uncertainty and risk associated with coastal hazards. However, in many urban coastal areas there has been extensive allocation of land to the high water mark for both public and private purposes. At these locations the potential exposure to coastal hazards is generally managed by the land owners or those permitted to occupy the land.

The system for DAs in Queensland is largely static and allows applicants to commence construction of operational works, including tidal works, within a 2 year period. This includes the system for DAs under both the integrated development assessment system (IDAS) of the *Sustainable Planning Act 2009* and the environmental authority system under the *Environmental Protection Act 1994*. Longer-term strategic and adaptive planning is typically managed outside of the DA system (with the exception of preliminary approvals for master planned areas). DAs are then used only to implement the outcomes of this planning.

There are two inherent risks associated with this current system when considering coastal management and climate change adaptation:

1) As only DAs are able to 'lock in' development outcomes, longer-term planning activities do not give proponents or decision-makers certainty in terms of the development and implementation of management strategies necessary to mitigate risks; and
2) As impacts in the coastal environment, especially those associated with storm events, can occur extremely rapidly, this process often undermines a proponent's ability to respond appropriately and in a timely manner.

For example, consider a strip of beachfront houses or public foreshore area. Planning studies undertaken for the area shows changes in shoreline erosion patterns as a result of sea level rise are likely to cause impact to land-based assets. However, the impact is not certain and may not eventuate for another 20 years. Utilising the traditional DA approach, no approval will be sought to manage this impact until a time when it is more likely to eventuate. However, this then creates a risk to the management authority or proponent as the uncertainty associated with the timing and nature of impact realisation means that their DA may be too early or too late. In addition, changes in the policy climate may diminish the chances of achieving a DA. Alternatively, if a long-term DA is sought at early stages, it may no longer be relevant by the time the impact eventuates due to changes in the local built and/or natural context. All of these factors introduce uncertainty that long-term planning outcomes will actually be met.

2. Methodology

2.1 A Trigger-Based Approach to Coastal Management

In light of the challenges associated with adaptive coastal management planning, BMT WBM has pioneered an approach through the existing DA system in Queensland. The development of this approach has come through a combination of project work for Sunshine Coast and Gold Coast beaches and waterways, and the adoption of the 'risk continuum' framework described in [1].

The risk continuum approach was originally established to deal with uncertainty associated with climate change adaptation and planning. However, the approach has also been readily accepted and integrated into best practice within the context of contemporary coastal management. The risk continuum acknowledges uncertainty in the success of management actions and relies on ongoing monitoring and performance criteria to trigger changes in approach in order to achieve an overarching objective. This same approach has also been adopted in the context of DAs for new coastal development.

Acknowledging the long-term planning outcome required for a particular coastal asset or infrastructure, a monitoring and management framework is established, with triggers for implementation actions necessary to achieve the planning outcome. This entire framework is then approved within a DA, thus providing the certainty required for the coastal manager or proponent while allowing necessary flexibility to adjust the management approach in response to a severe event and/or adaptation to emerging hazards.

The key elements to this DA approach are as follows:

- Conceptual planning outcome to be achieved;
- Interim implementation actions linked to triggers;
- Monitoring actions to verify when triggers are reached; and
- Extended 'sunset clause'.

These elements can all be introduced into an application for a Development Permit, Preliminary Approval or Environmental Authority which is then approved for the development.

In the example provided above, this may involve a DA seeking to develop a seawall to protect the beachfront houses. Rather than developing the seawall design in detail, however, the DA would set triggers for when seawall design should commence, with further triggers for when building works can actually begin.

The key to this adaptive management approach is the identification of triggers and a commitment to monitoring in order to identify a changing risk profile. The risk continuum, illustrated in Figure 1, provides a conceptual approach for identifying relevant triggers to achieve a particular planning outcome.

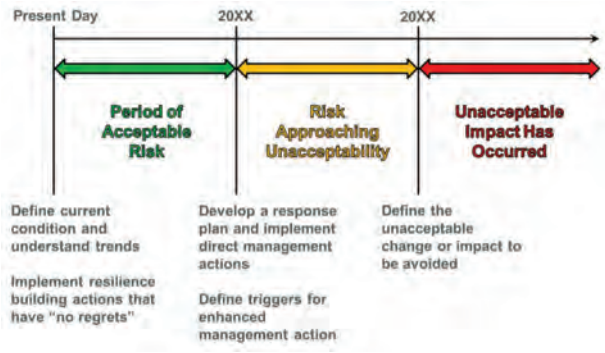

Figure 1 Actions along the Risk Continuum (adapted from [1])

Within this approach, it is important to define the point of unacceptable impact, i.e. the point at which the relevant planning outcome has failed or can no longer be achieved. Working back from this point allows identification of one or more triggers for enhanced management action and implementation to avoid reaching the unacceptable impact. In many cases, separate triggers may be required for different aspects of implementation, such as phases for management plans, detailed design, and actual construction.

The definition of a trigger needs to be linked to a monitoring element so that a decision-maker or proponent can verify when a trigger has been met. Most triggers, such as width of shoreline erosion buffers, an increase in mean sea level, or the occurrence of particular design storm events, can easily be adopted in the coastal environment based on existing monitoring programs typically undertaken by Local or State governments. It should be recognised that complicated and/or intensive monitoring programs are difficult to implement and maintain overtime. In the case of a new beachfront development (for example), there may be little incentive for a proponent to commit to site-specific monitoring for the life of the development.

Depending upon the nature of the management approach or development, interim actions linked to triggers may require the reinvolvement of decision-making bodies. For example, compliance assessment processes under the *Sustainable Planning Act 2009* provide an avenue for decision-makers to be involved with post-approval processes to ensure that development activities meet the original planning outcomes that were approved.

3. Results

3.1 Case Study 1: Maroochydore Beach

The beach unit, consisting of 1.7 km of sandy coastline between Alexandra Headland and the Maroochy River mouth, has historically been identified as a key area for long-term management planning for the Sunshine Coast Council. Over the years, various management options have been proposed for this area through shoreline erosion management plans (SEMPs) and other technical studies (e.g. [2]). The importance of coastal management in this area relates to a number of Local and State government assets, in particular the Aerodrome Road/Alexandra Parade state controlled road corridor, and social and economic values attributed to the beach itself.

Since 2013 beach nourishment has been used to mitigate the risk to land based assets and maintain beach values. The shoreline management works involve dredging marine sand from the Maroochy River mouth (immediately north of the beach) and relocating the material to the beach via a slurry pipeline. Access to suitable sand for beach nourishment within the lower Maroochy River is limited by a declared fish habitat area and the potential to impact listed threatened and migratory shorebird species. These environmental constraints restrict the sand borrow area and timing of dredging. The beach condition before and after the initial beach nourishment campaign is shown in Figure 2.

Figure 2 Maroochydore Beach before (top) and after (bottom) a 125,000 m^3 beach nourishment campaign, September 2013 (photos courtesy of Birdon Pty Ltd)

Despite the apparent success of the ongoing beach nourishment program (three campaigns were completed between 2013 and 2016), it was recognised that this action alone would not necessarily protect land based assets from a design storm erosion event. Furthermore, the sustainability of this management approach over a longer-term planning horizon was questioned due to limited sand reserves and the expectation of increased erosion pressure associated with sea level rise. Instead, it was acknowledged that a terminal structure (a rock revetment seawall) may eventually be required.

In managing this area, Council identified both (1) the uncertainty associated with determining when (if at all) impacts to the land-based assets would eventuate, and (2) the potential need to rapidly respond to changing circumstances. In particular, it was acknowledged that a significant storm event could rapidly cause the existing erosion buffer to narrow to an unacceptable width. However, the development of a detailed seawall design was not considered appropriate in present circumstances, before the extent of future erosion impacts could be fully understood.

In order to provide certainty for long-term management in this area, an application for a DA for an adaptive management approach was prepared. Utilising the risk continuum framework, the 'unacceptable impact' was defined as the loss of key land-based assets to coastal erosion. To mitigate these risks a rock revetment was required (at an uncertain time in the future), which would be constructed on a consistent alignment along a 1.7 km stretch of coastline. This represented the overall planning outcome to be achieved, with triggers then set for the design and construction of the seawall. A conceptual model of the expected change in risk profile over time and overall management strategy is illustrated in Figure 3.

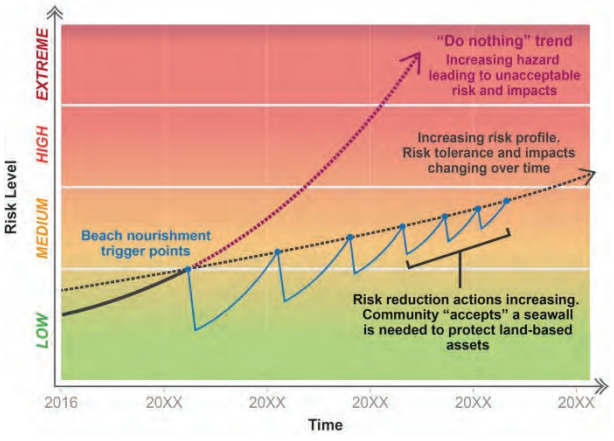

Figure 3 Maroochydore Beach changing risk profile over time and risk mitigation management strategy

In this context, the key features of the development application were:

- Single seawall alignment and preferred footprint across the beach unit, with clearly stated planning outcomes to be achieved;
- Trigger levels for three smaller management units, based on erosion buffer between the crest of the frontal dune and the edge of assets;
- Currency period up to 2050;
- Annual fees to be introduced only once development triggers were met; and
- Requirement for submission of detailed design information and construction environmental management plan (EMP) to Queensland Department of Environment and Heritage Protection (EHP) for compliance assessment prior to commencement of construction.

Triggers were set based on the erosion buffer required for assets which was informed by numerical modelling of design event erosion volumes. It was determined that once assets were within the area of immediate erosion risk from a design storm event, construction would be required to prevent damage to land based assets. This buffer width can easily be monitored through aerial photography and/or on-ground surveys undertaken by Council, in order to verify when revetment detailed design and ultimately construction works are required. Approval was received for this application in 2015.

3.2 Case Study 2: Gold Coast Waterways

The Gold Coast Waterways Authority (GCWA) and City of Gold Coast are responsible for maintaining safe, navigable access across the tidal waterway network of the region which includes the Broadwater and adjacent tidal river systems.

Shoaling sand across the network requires regular maintenance dredging; leading to the need to not only control the environmental impacts of dredging but also to determine appropriate placement solutions.

Dredging and placement activities within Gold Coast waterways are regulated under a broad suite of State legislation and policies including the *Sustainable Planning Act 2009*, *Coastal Protection and Management Act 1995*, *Marine Parks Act 2004 and Fisheries Act 1994*.

In recognition of the need for a long term and adaptive approach, the GWCA, with the assistance of BMT WBM, developed a Sand Management Plan (SMP) and Environmental Management Framework (EMF) for how these activities will be investigated, carried out and monitored.

The SMP concept outlines a strategic approach to the management of sand resources to maintain navigational access of the Gold Coast's waterways. The objectives of this more strategic approach to waterway management are as follows:

- To work with nature in terms of recognising natural channel migration and shoaling behaviour of the waterways and undertake an adaptive management approach to dredging and material placement over time;
- To reduce administrative burden on the GCWA, City of Gold Coast and regulatory agencies related to approvals for routine dredging and placement activities particularly where such activities have a low environmental risk and/or the potential environmental impacts from operations are well understood (e.g. have been monitored and shown to not be causing impacts in previous operations);
- To provide longer term certainty to where and how sand dredging and placement will be managed whilst providing flexibility to the GCWA for how it procures and manages the dredging programme over time (noting a parallel process is in place to procure a long term dredge contractor for the works); and
- To recognise and implement sustainable and adaptive management practices for dredging and material placement through development of clear environmental commitments and performance requirements including a strategic whole-of-study area approach to mitigation, monitoring, and research that is overseen by an Agency Steering Committee (ASC) and Scientific Advisory Committee (SAC).

The SMP/EMF was given effect in late 2015/early 2016 by a series of statutory approvals obtained from State Government and Council. These strategic approvals permitted dredging and placement activities over a much longer term period (up to twenty years) across the network subject to agreed assessment processes and performance requirements.

This was achieved in part by the EMF setting out 'trigger areas' for each waterway and anchorage zone within the Gold Coast waterway network based on the relative environmental risk of dredging activities within them and the suitability of the dredged material from the waterway for beach nourishment or placement into the active coastal system.

A map showing the trigger areas is provided in Figure 4.

Under the EMF, green trigger areas are characterised by one or more the following criteria:

1) Impacts from dredging or placement activities are well understood and have been observed or monitored in the past; and
2) Mitigation and monitoring measures are more routine and can be replicated from previous experience.

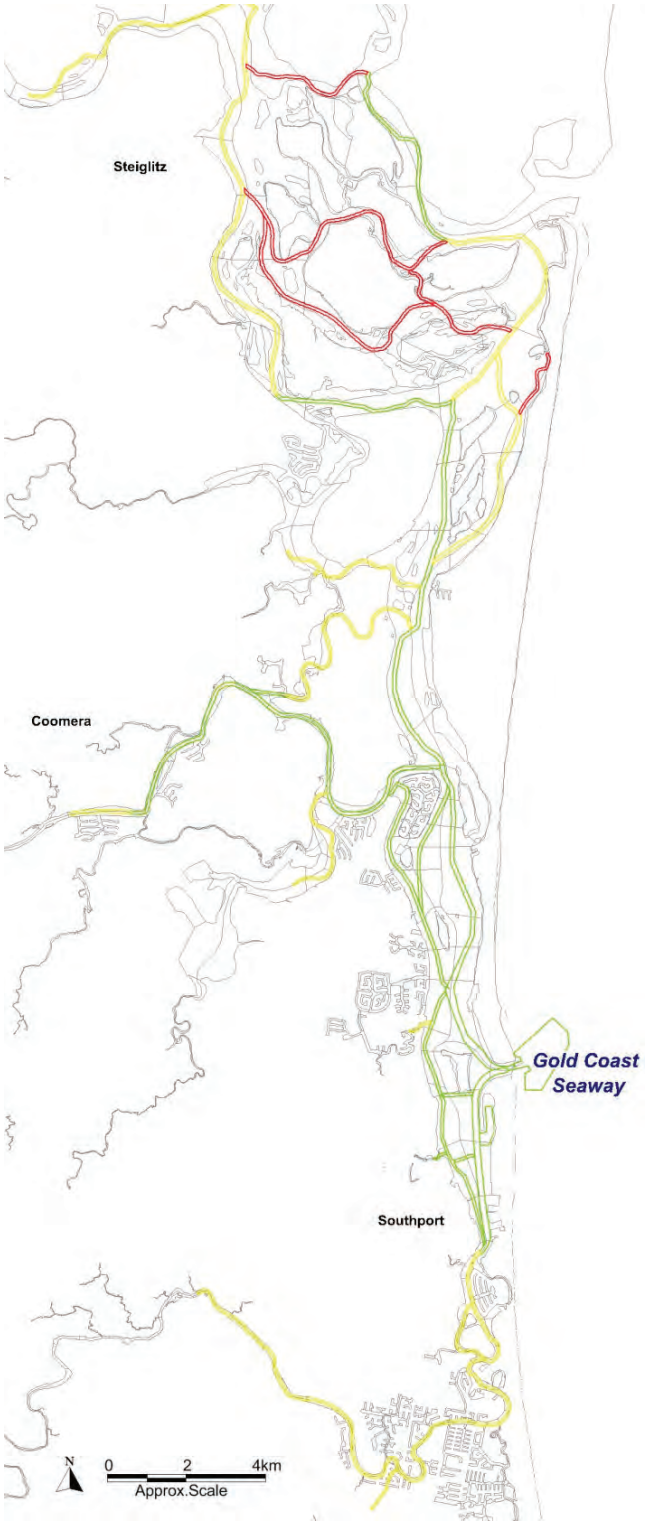

Figure 4 Gold Coast waterways EMF green, yellow and red trigger areas

In these lower risk 'green trigger' areas, the GCWA will be responsible for preparing plans of work, engineering drawings (where relevant), and will undertake basic survey and monitoring activities, such as pre-work surveys of in-channel seagrass disturbance and visual monitoring of dredge plumes. Works in these waterways are subject to standard environmental management procedures and performance requirements.

In general the 'yellow trigger' waterways are those where the GCWA needs to undertake additional investigations, including the preparation of water quality monitoring and compliance plans, prior to undertaking dredging and placement activities. These investigations must be presented to and discussed with the ASC and require a level of subsequent approval (compliance assessment) prior to being undertaken.

Yellow trigger areas are characterised by one or more of the following criteria:

1) Contain or are adjacent to sensitive receptors such as marine park and/or and fish habitat area;
2) Involves sediments that have been identified as having higher silt and fine fractions or a risk of contamination (i.e. sediments unlikely to be suitable for beach nourishment);
3) Is an area where there is insufficient information about environmental risks and the values of sensitive receptors, such that additional baseline information needs to be collected.

Over time, waterways that are currently defined as 'yellow trigger' waterways may be able to be downgraded to 'green trigger' areas based on confirmation of suitable sediment quality, or where monitoring demonstrates that impacts upon sensitive receptors from dredging and placement can be avoided or minimised to acceptable levels.

Provision is also made in the EMF for some waterways in the network to be considered 'red trigger' level. The intent of red trigger areas is to identify those waterways, anchorages and access points where responsible agencies have expressed a view that the level of environmental constraints is believed to be high based on likely resource values, potential disturbance and/or relative user demand for access, thereby requiring a higher level of consideration with respect to alteration of trigger levels.

Conversion of red trigger level waterways to a yellow trigger level is possible, subject to further planning investigations.

The trigger-based and adaptive approach to management of dredging and placement activities across the Gold Coast Waterways has been innovative and challenging for the existing DA system to accommodate.

However, while implementation is in its early stages, both the proponents (the GCWA and City of Gold Coast) and agencies have been working effectively together as part of the ASC process and a number of projects have been progressed under the new system.
The system will deliver greater certainty over time as more assessments are undertaken; noting sufficient checks and balances have been developed to ensure high environmental standards are maintained. The integration of approvals into a single framework also promotes consistency of environmental conditions and standards as well as reducing the administrative burden of permitting each activity by multiple agencies.

4. Discussion

The above case studies and consideration of coastal adaptation planning in general indicates the potential need for an alternative approvals approach. While the case studies demonstrate that adaptive management can be built into the current approvals framework in Queensland, there is significant opportunity for further development of this system to better align with the risks posed by coastal hazards.

There are three key elements considered necessary to an approvals framework that promotes adaptive management:

1) Approval of a long-term outcome rather than structure and/or program of works;
2) Development of a monitoring framework with triggers for management and compliance actions; and
3) Ongoing regulatory agency support in managing activities to meet the approved outcome.

A proposed alternative approvals framework to support coastal management and coastal hazard adaption is illustrated in Figure 5.

In approving an outcome rather than set works, greater flexibility is provided to proponents to respond to immediate conditions without the need for approval amendments. This flexibility needs to be balanced with ongoing regulatory agency liaison and technical advice in order to ensure State, Territory and Federal interests are always being met. Importantly, this promotes greater collaboration between these two principle stakeholders in order to achieve best practice outcomes.

This approvals framework requires a shift in the nature of planning and assessment effort. Pre-

approval phases require technical assessments in order to identify perceived risk within the agreed planning horizon, in order to establish an overall adaptation outcome. Detailed assessments (including detailed design) to meet regulatory requirements would in turn be undertaken in a post-approvals phase, based on the results of monitoring and consultation. This differs from the current approach where technical work is front-loaded despite initial assessments often not reflecting conditions at the time of implementation.

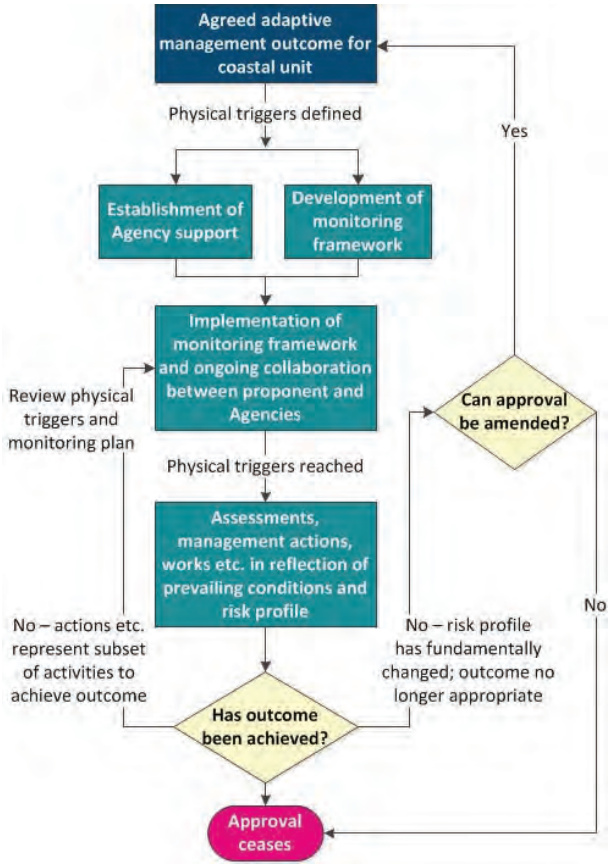

Figure 5 Proposed alternative approvals framework

Regulatory agency collaboration and monitoring would also link to a 'feedback' mechanism that allows for ongoing assessment of the relevance of the agreed outcome. Where the outcome is no longer considered appropriate for the coastal unit, the approval would require amendment or suspension. This ensures that fundamental changes in the risk profile for a coastal unit or asset that otherwise invalidates the initial approved 'outcomes' are captured and responded to.

5. Summary

An adaptive approach to coastal management provides certainty to decision-makers and proponents while allowing for development to appropriately respond to both immediate and emerging threats. The existing DA framework in place in Queensland is already being used to implement this approach successfully on the Sunshine Coast and within the Gold Coast waterways network. The future application in other areas is also apparent given the wide-reaching impacts of climate change across the coastal zone.

While the case studies demonstrate that adaptive management can be built into a traditionally 'static' approvals framework, there is significant opportunity for further development of this system to better align with the risks and uncertainty posed by coastal hazards and climate change.

6. Acknowledgements

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7. References

[1] Fisk, G. and Kay, R. (2010). Dealing with uncertainty in climate change adaptation planning and developing triggers for future action. Climate Change 2010: Practical Responses to Climate Change, 554-563.

[2] Shoreline Erosion Management Plan (2014), Sunshine Coast Council, Caloundra. https://www.sunshinecoast.qld.gov.au/en/Environment/Rivers-and-Coast/Coastal-Management/Shoreline-Erosion-Management-Plan

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