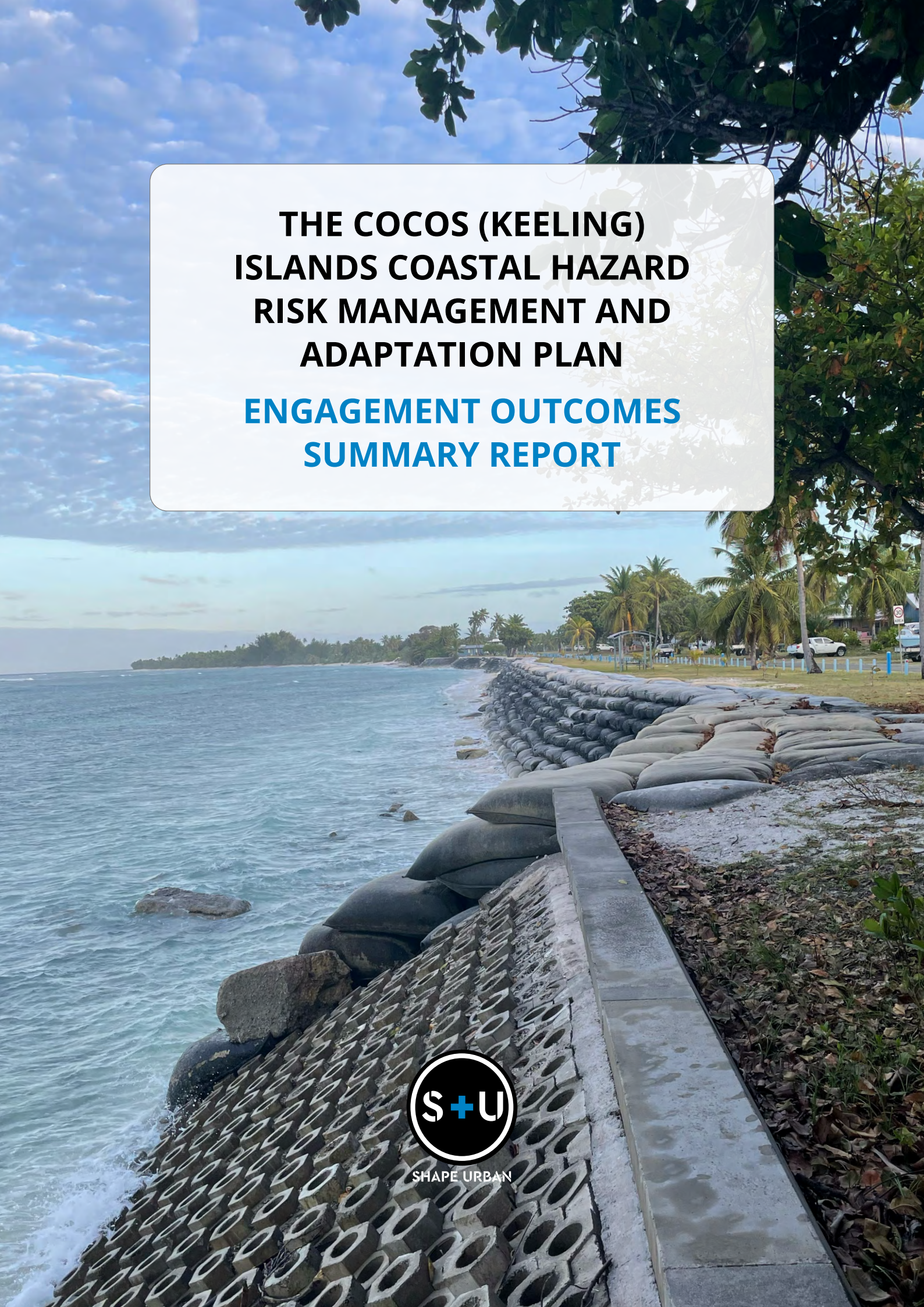


THE COCOS (KEELING) ISLANDS COASTAL HAZARD RISK MANAGEMENT AND ADAPTATION PLAN

ENGAGEMENT OUTCOMES SUMMARY REPORT

SHAPE URBAN

ACKNOWLEDGEMENT

This document has been prepared with the support of many people. Shape Urban and Wavelength wish to acknowledge the contributions of the CKI community and the support of the Australian Government and Department of Planning, Lands and Heritage in preparing this document.

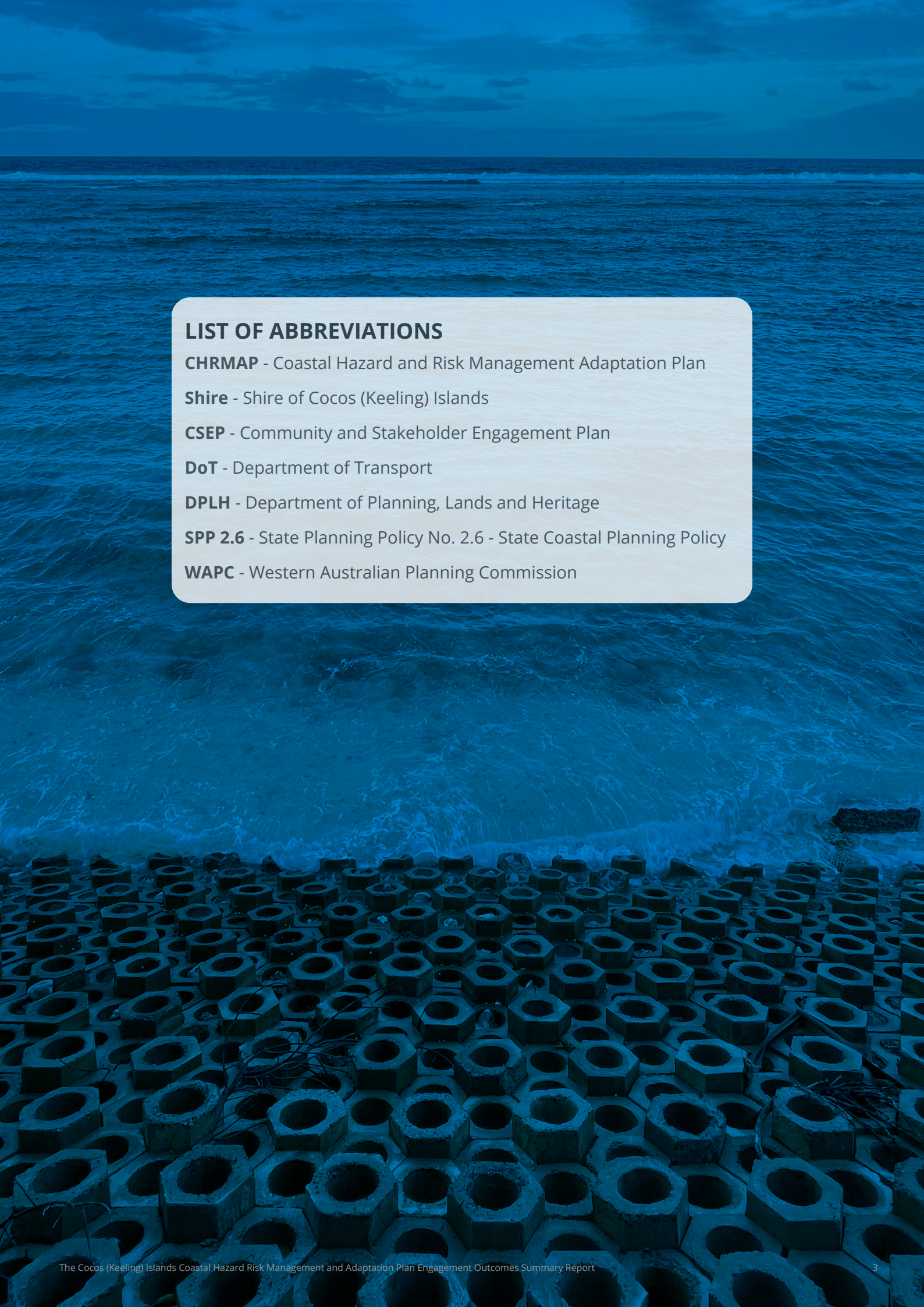
The project in the Indian Ocean Territories has been funded by the Australian Government through the Department of Infrastructure, Transport, Regional Development, Communications and the Arts, in partnership with the Western Australian Department of Planning, Lands and Heritage and the Shire of Cocos (Keeling) Islands.

Shape Urban acknowledges the Cocos Malay people who inhabit the land on which we have worked for this project. We recognise their cultural heritage, beliefs and relationship to the islands, and the importance of the islands to the Cocos Malay people today and into the future.

DOCUMENT TITLE

The Cocos (Keeling) Islands Coastal Hazard Risk Management and Adaptation Plan Engagement Outcomes Summary Report

NO.	AUTHOR	REVIEWED BY	DATE	APPROVALS
1	K Yang	A Kelderman	30/6/2023	Final (pre-advertising of draft CHRMAP)
2				



LIST OF ABBREVIATIONS

CHRMAP - Coastal Hazard and Risk Management Adaptation Plan

Shire - Shire of Cocos (Keeling) Islands

CSEP - Community and Stakeholder Engagement Plan

DoT - Department of Transport

DPLH - Department of Planning, Lands and Heritage

SPP 2.6 - State Planning Policy No. 2.6 - State Coastal Planning Policy

WAPC - Western Australian Planning Commission

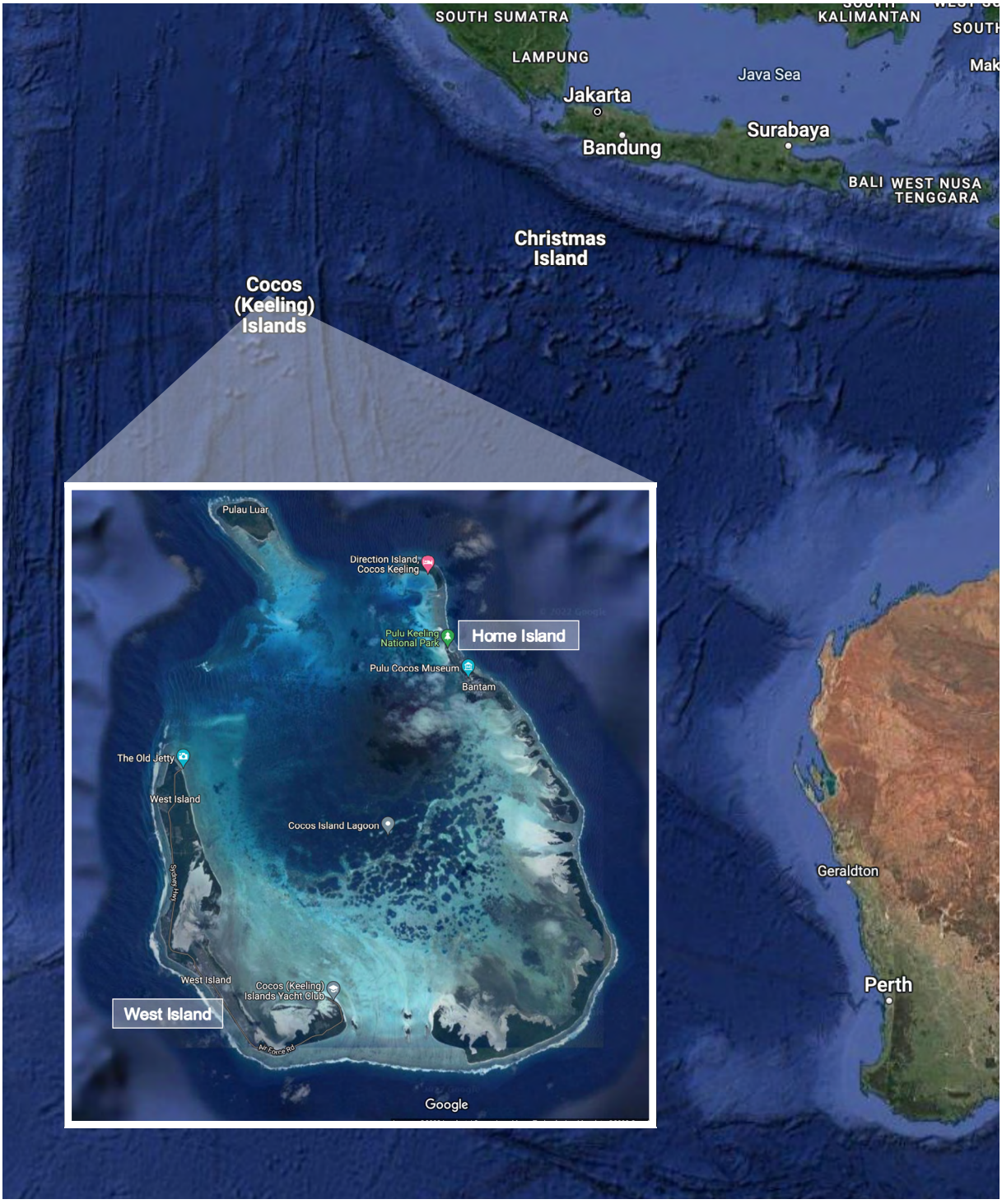


Figure 1 The Southern Keeling Islands showing West Island and Home Island (Google, 2022)

PROJECT BACKGROUND

The Cocos (Keeling) Islands (CKI) consists of two atolls made up of 27 coral islands. West Island and Home Island are in the South Keeling Islands and are inhabited by approximately 593 people (ABS, 2021). Figure 1 depicts a map of the CKI.

The Australian Government in collaboration with the Shire of CKI and the Western Australian Department of Planning, Lands and Heritage (DPLH) are undertaking coastal management planning for the CKI (refer Figure 2).

PHASE 1

The Australian Government commissioned the *Cocos (Keeling) Islands Coastal Vulnerability Study - Coastal Vulnerability Assessment Report* (Royal HaskoningDHV, 2021) (the CVA Report) which identifies the areas of West Island and Home Island at risk to the impacts of inundation and coastal erosion over a 100-year planning timeframe.

PHASE 2

This project progresses coastal planning; with the development of a *Coastal Hazard Risk Management Adaptation Plan* (**CHRMAP**) for CKI.

The CHRMAP for CKI will confirm that the consequence ratings of the CVA Report reflects community and stakeholder values. It will identify coastal erosion and inundation risks and challenges and proposed adaptation measures for Home Island and West Island.

The CHRMAP will also consider vulnerability and management for the other islands as part of the overall management response.

The CHRMAP will give decision makers, administrators and landowners on CKI a framework for sustainable coastal development into the future.



Figure 2 Project Phases for CKI Coastal Planning

CHRMAP STAGES & ENGAGEMENT APPROACH

A critical part of this project is the engagement with the local community and relevant stakeholders.

The engagement approach aligns with the framework of the Shire's strategic planning framework and the CHRMAP process in accordance with the Western Australian State Government's coastal planning policy framework - State Planning Policy No. 2.6 - State Coastal Planning Policy (SPP 2.6) and the CHRMAP Guidelines.

Engagement for the CHRMAP investigates the matters raised in previous engagement, and confirm or update risk assessments to reflect community and stakeholder values.

The project team has carried out stakeholder engagement throughout the CHRMAP stages. Figure 3 and Table 1 depict an overview of engagement approach in each of the CHRMAP stages to affirm the deliverables.

The outcomes of all engagement activities will inform the next steps of CHRMAP process.

The engagement activities and outcomes are detailed in the following reports:

- the *Provision Of Coastal Hazard Risk Management And Adaptation Planning In The Cocos (Keeling) Islands Engagement Outcomes Report* (Shape Urban, 2023a)
- *The Cocos (Keeling) Islands Coastal Hazard Risk Management and Adaptation Plan Stage 5 Engagement Outcomes Report* (Shape Urban, 2023b)

This report summarises the key outcomes of all the engagement activities undertaken in the CHRMAP stages to date.

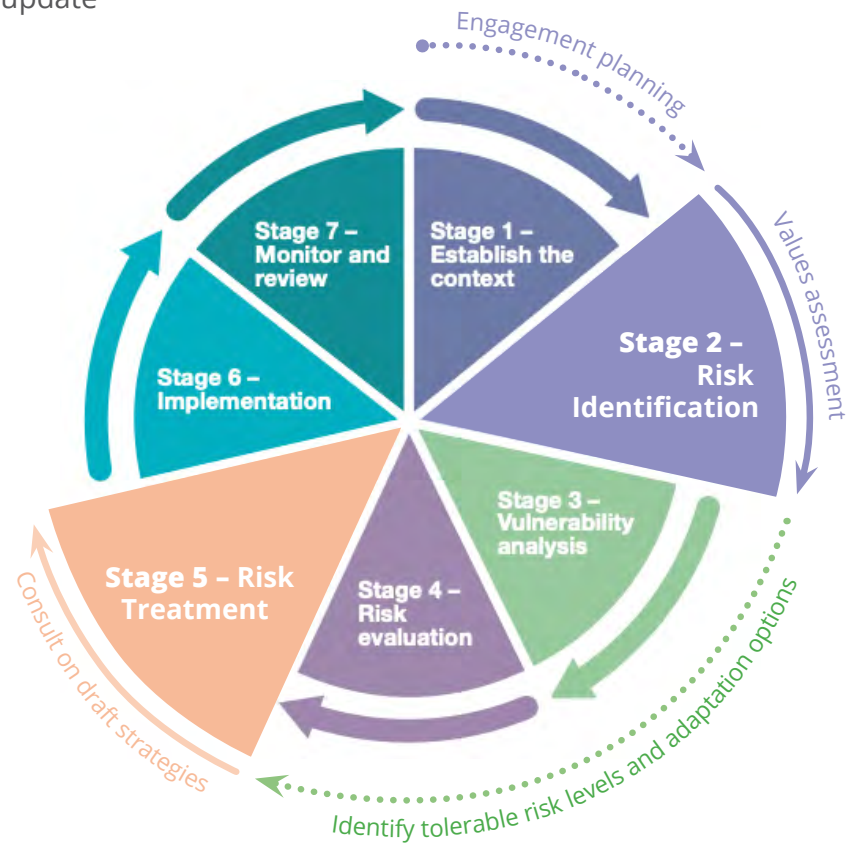


Figure 3 Engagement approaches in CHRMAP Stages adapted from the CHRMAP Guidelines (WAPC, 2019)

Table 1 Engagement in each of the CHRMAP stages

CHRMAP STAGE	DELIVERABLE	STAKEHOLDER/ AUDIENCE	ENGAGEMENT METHODS
Stage 1 – Establish the Context	• Develop Community & Stakeholders Engagement Plan	• Project Control Group • Australian Government	• Meetings
	• Build on information - informed values related to coastal assets	• Australian Government • State Government • Elected Members • Shire • CRG • Community groups incl Elders • Landowners • Businesses • General community • Schools • Service providers • Funding bodies • Other coastal stakeholders	• Shire webpage • Social Pinpoint (online platform - maps, asset points, surveys) • Introductory letter/ email • Preparation of supporting material (posters, infographics in English and Cocos Malay, reproduction of Coastal Vulnerability Assessment maps) • Social media - primarily Facebook • Stakeholder meetings in Perth and on-island • Workshops in Perth • On-island CRG workshops, information sessions and drop-in sessions • Meetings/ telephone calls - Perth • Open Day on-island • Elected Member briefings
Stage 2 – Risk Identification	• Updated list of coastal assets		
Stage 3 – Vulnerability Analysis	• Update risks, vulnerability and consequences		
Stage 4 – Risk Evaluation	• Consider tolerances and acceptance of risk in relation to values, assets and Australian Government needs		
Stage 5 – Risk Treatment	• Identify adaptation options and pathways for valued assets • Multicriteria analysis considering values, assets and needs • Cost benefit analysis of risk treatment options • Assess funding options		
Stage 6 – Implement-ation	• Prepare short term implementation plan • Identify long term pathways		
Stage 7 – Monitor and Review	• Develop monitoring plan	• Coastal managers (TBD)	• NA
CHRMAP Reporting and Adoption	• Integrate information into draft CHRMAP • Advertise draft CHRMAP • Finalisation and adoption of CHRMAP		

ENGAGEMENT OBJECTIVES

The engagement process was tailored to the unique local community needs on CKI, and to the decision making requirements of the Australian Government and State Government agencies with service delivery agreements (SDAs) with the Australian Government.

The overall objective of the engagement process is to facilitate an understanding of coastal hazards and risks, and to select appropriate risk management and adaptation strategies to respond to the identified coastal risks.

Specific engagement objectives are to:

- **Inform** the community and stakeholders about the extent of potential coastal hazards and the adaptation strategies available to respond to those hazards;
- **Explain** Australian, state and local governments' responsibilities and capacity to respond to potential coastal hazards, per the CKI governance framework;
- **Understand** community and stakeholder values along the coastlines; and
- Invite the community to bring their **local knowledge, expertise and lived experience** to the process and give them adequate opportunity to contribute in a way that suits their needs and circumstances.
- Ensure that the community and stakeholders' **advice and recommendations are incorporated into the decisions** to the maximum extent possible, and that this encourages a sense of community ownership for the CHRMAP
- The engagement will be **fair, equitable, transparent and honest**
- **Develop positive relationships** between all tiers of government and the community
- Gain an understanding of the community's preferred methods of **continued engagement** with local, state and Australian governments



COMMUNICATION METHODS

PROJECT WEBSITE

The Social Pinpoint engagement platform (Figure 4) was used as the primary location for all project information, including:

- background and links
- registrations of interest
- hazard maps
- an interactive mapping exercise,
- frequently asked questions (FAQs)
- common terms used

SOCIAL MEDIA

Social media, specifically the Shire's Facebook page and the Buy, Swap and Sell page, were used to promote the project and opportunities to be involved.

PUBLIC NOTICES

The Shire posted project launch posters/ information at the supermarket and other key locations on Home Island, at the ferry terminal and on the blackboard on West Island, and at its offices on both islands.

NEWSLETTER

Articles were published in "The Atoll" newsletter in English and Cocos Malay throughout the engagement process. The articles encouraged community members to learn, engage and contribute by visiting the project website.

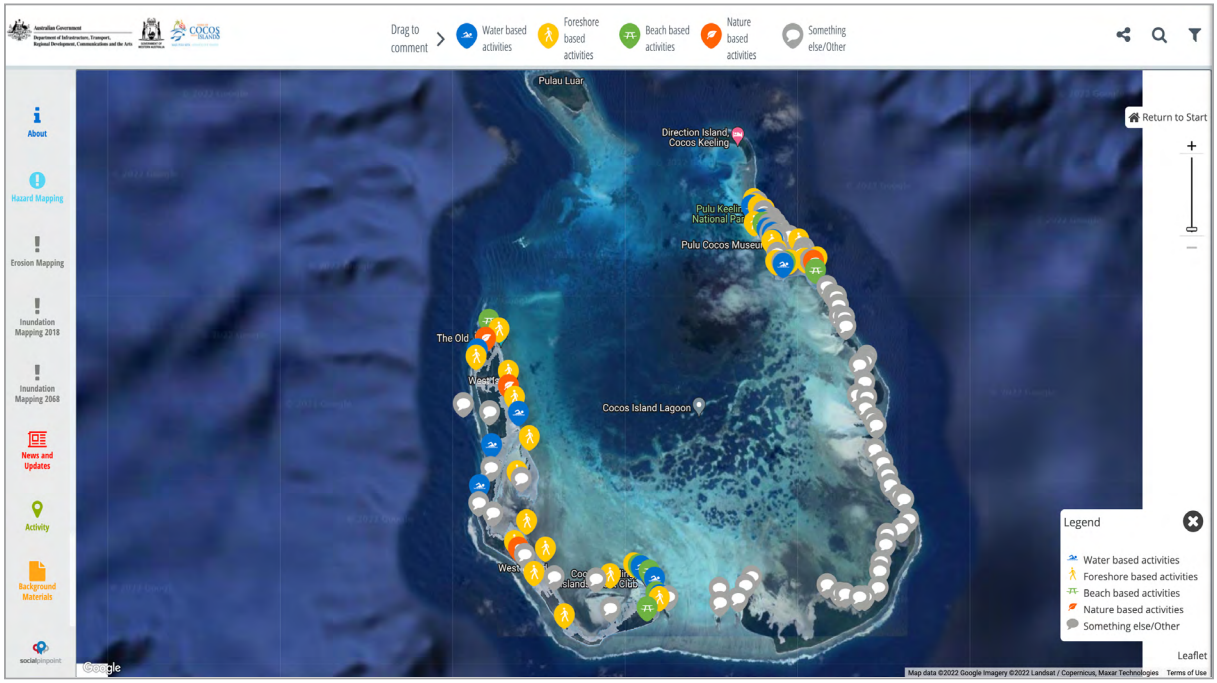


Figure 4 Project website and online interactive mapping tool

WORKSHOPS & SESSIONS

Project information and updates were communicated at the following workshops and sessions:

WORKSHOPS & SESSIONS	DATE	LOCATION
DITRDCA Workshop	23 Aug 2022	Perth
State Government & Key Stakeholders Workshop	24 Aug 2022	Perth
CRG Workshops	3 & 5 Sep 2022	CKI
Elders Workshops	11 & 14 Nov 2022	CKI
DITRDCA Meeting	14 Feb 2023	Perth
Home Island Sessions	22 & 27 Feb 2023	CKI
West Island Sessions	23 & 27 Feb 2023	CKI

DIRECT COMMUNICATION

The project team communicated directly with community members on-island to invite nominations for a community reference group (CRG), or to set up meetings.

The team also sent email invites to workshops for identified Australian and state government agency stakeholders.

MEETINGS

Individual meetings were undertaken on-island with community members and stakeholders as required or requested. The meetings provided the project team with the opportunity to share project information and get feedback on values and the viable potential risk treatment options.

OTHER

The manager of the Community Resource Centre on-island shared project communications materials provided by the project team with community members.

The Shire's project manager also engaged directly with community about the project and advised them of on-island engagement and how to register to be involved.

In addition to the workshops on-island, the project team also hosted 'drop in' information sessions on Home Island and West Island.

LANGUAGE

Translation services for both written and spoken content were tailored for engaging the culturally and linguistically diverse community effectively, including workshops and one-on-one meetings.

ENGAGEMENT ACTIVITIES

STAGE 2 - RISK IDENTIFICATION

The purpose of Stage 2 engagement was to raise awareness of the project, understand how assets are valued along the coastline, and introduce the viable potential risk treatment options to stakeholders.

BRIEFING

Participants were introduced to the CHRMAP project including:

- Vulnerability mapping in the CVA Report for assets of interest on both islands
- SPP2.6 and CHRMAP Guidelines and the coastal risk management
- Examples of adaption pathways, with trade offs for each
- Multi-criteria assessment (MCA) process
- the next steps, including on-island engagement and future updates

ENGAGEMENT TASKS

Participants were tasked to contribute to the identification of the following:

- Values and asset mapping (including missed or sacrificial assets)
- Asset prioritisation
- Open discussion on proposed solutions for the next 100 years

Full report: see Attachment A



Figure 5 Council staff and Youth Council participated in the value mapping activity.

STAGE 5 - RISK TREATMENT

The purpose of Stage 5 engagement is to discuss the proposed risk treatment options by the coastal engineer, including how the multi-criteria assessment were formulated and associated cost to each treatment options.

BRIEFING

Participants were provided updates to the CHRMAP project including:

- Community values and assets identified from the last engagement
- Whole-of-settlement approach
- Multi-criteria assessment (MCA) methodology and results
- Shortlisted adaptation options
- The indicative costing, funding and remit for each option
- the next steps, including the finalisation of CHRMAP

ENGAGEMENT TASKS

Participants were asked to contribute to the following:

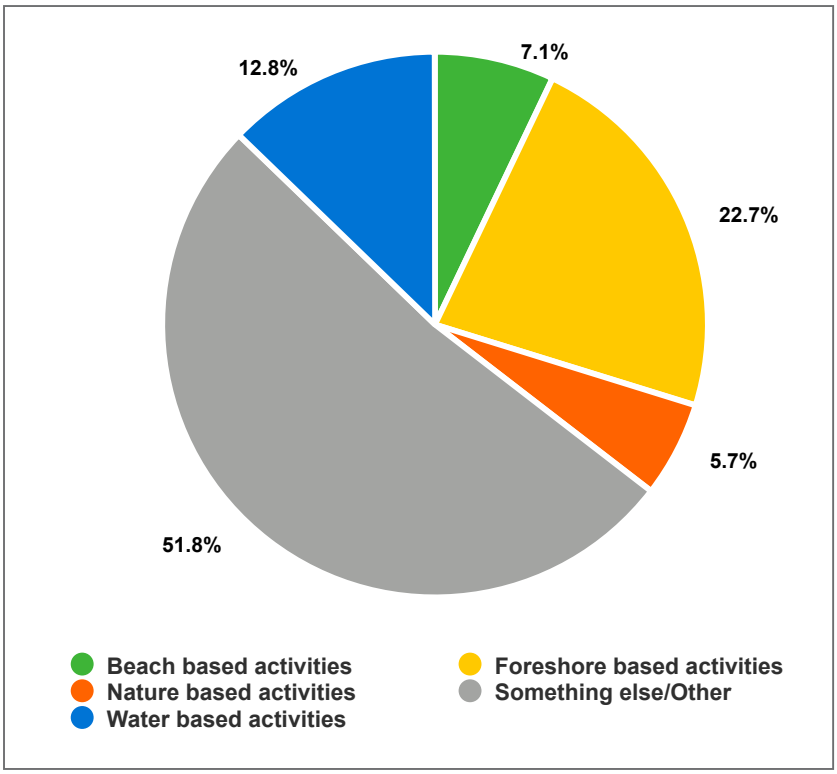
- MCA criteria
- Preferred short and long-term adaptation options
- Open discussion

Full report: see Attachment B



Figure 6 Project team presented the MCA methodology and results

COMMENT CATEGORY BREAKDOWN



WORD CLOUD

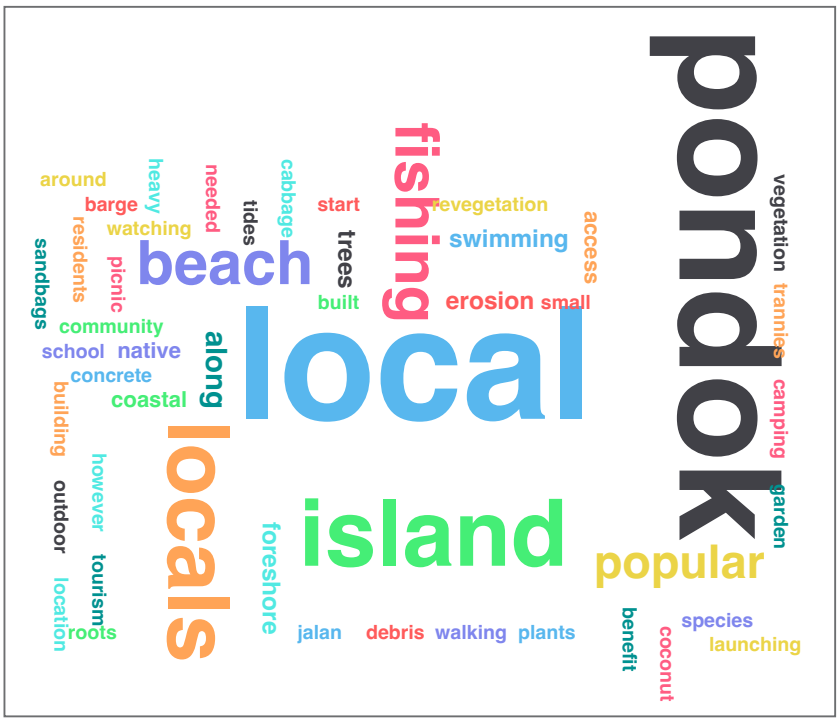


Figure 7 Result of the online engagement - value and asset mapping from 1 Jul 2022 to 28 Feb 2023

ENGAGEMENT KEY OUTCOMES

The following summarises key outcomes of all engagement activities under headings:

- Government and Key Stakeholders
- Prioritised Values and Assets
- Preferred Management Options
- Concerns

Detailed outcomes are available in the Attachment A and Attachment B in the end of this report.

GOVERNMENT AND KEY STAKEHOLDERS

Adaptation pathways will factor in the sustainability of the CKI community, with particular focus on the development of reasonable staged pathways.

Information gap regarding drainage and groundwater to be investigated, as this may impact on the suitability of adaptation options.

Assets at risk in the short term were also identified, such as the jetties and the medical clinic on West Island, which are assets of critical importance to living on the islands.

Full support for the development of a CHRMAP as a proactive Australian Government response to coastal risks and their management for the CKI community and stakeholders.

PRIORITISED VALUES & ASSETS

Recreation - The use of beach and foreshore areas for recreation, fishing, boat launching and recreational sporting activities are highly valued on both islands

Environment - The ocean, lagoon, views, landscapes, foreshore vegetation and protection of the natural environment and vegetation are highly valued

Amenities and infrastructure - The yacht, jukong and sailing clubs and other sporting/ recreation clubs are highly valued

Access - There is a strong desire for access along the coastal and lagoon foreshore areas, including for boat launching and access to other islands

Cultural and religious significance - the cemetery at Pulu Gangsa and the mosque on Home Island were raised as important assets, with comments raised by the Imam and Elders about the regular flooding experienced at the cemetery

Coastal process changes - The CKI community is concerned about the impacts of coastal change, with community members observing felled trees around the coastlines of the islands, sandbags that had been impacted and how much the coastlines on Home Island and West Island have changed over time.

Coastal management - The CKI community had a clear consensus on things being done to manage vulnerability risks (beyond making plans)

HOME ISLAND ASSETS & VALUE MAPPING

Figure 8 is the Home Island map collated all assets and values identified from the online mapping tool and engagement workshops. The map is also showing 2018, 2068 and 2118 erosion hazard lines and 2068 inundation hazard risk area.

PRIORITISED ASSETS

1. Pulu Gangsa Cemetery
2. Desalination pumps
3. Refuse stations
4. Potable water pump station
5. Waste water treatment plant
6. Fuel station
7. Power station
8. Oceania House
9. Mosque
10. Home Island Jetty

WATER BASED ACTIVITIES

1. Boogie boarding
2. Sandy Point picnic area
3. Swimming spot
4. Jukong and sailing club

BEACH BASED ACTIVITIES

1. Pondok Nek Jamil picnic spot
2. Pondok Abang viewing platform
3. Ujung Waru picnic area

FORESHORE BASED ACTIVITIES

1. Fishing/netting spot
2. Beach debris collection area
3. KampongBaru - Jukong launch area
4. Jalan Balok Mem - fitness use
5. Local boat ramp
6. Beach debris project - Pasir Nek Ayak

NATURE BASED ACTIVITIES

1. Bird watching area

SOMETHING ELSE/OTHER

1. Green waste and rubble site
2. Revegetation area
3. Tanah Tinggi - highest point on island
4. Large native calophyllum trees
5. Submerged breakwater
6. Reclaimed foreshore
7. Heritage listed area
8. Old Bungalow site - Copra Manager
9. Chicken and Garden Plots
10. Old Home Island School building
11. Local Pondok

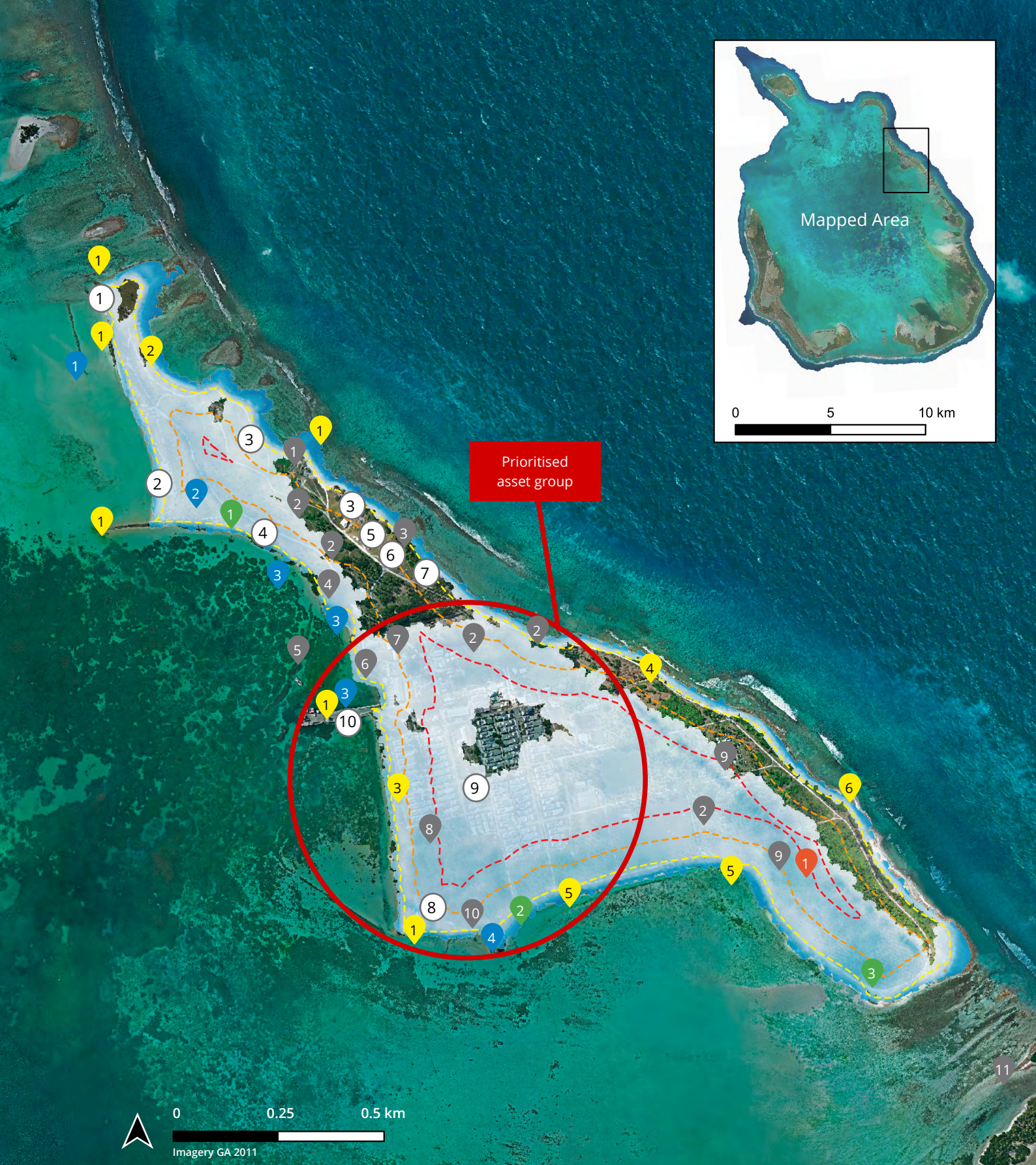


Figure 8 Asset and value mapping summary for Home Island

WEST ISLAND ASSETS & VALUE MAPPING

Figure 9 is the West Island map collated all assets and values identified from the online mapping tool and engagement workshops. The map is also showing 2018, 2068 and 2118 erosion hazard lines and 2068 inundation hazard risk area.

PRIORITISED ASSETS

1. Fuel station
2. Trannies beach reserve
3. Transmitter station
4. Rumah Baru jetty
5. Airfield storage
6. GA geomagnetic observatory
7. Bureau of Meteorology site
8. GA GNSS Mark
9. GA Seismic station
10. Communication array
11. Plaque
12. Substation
13. Access road
14. Scout Park reserve
15. Boat ramp
16. Yacht club
17. Pondok (shelter)
18. Runway

WATER BASED ACTIVITIES

1. Swimming spot
2. Local boat launch
3. Boat ramp
4. Surfing spot

BEACH BASED ACTIVITIES

1. Picnic area
2. Camping area
3. Cocos Islands Adventure Tours

FORESHORE BASED ACTIVITIES

1. Fishing/netting spot
2. Sunset viewing spot
3. Bicentennial track
4. Bob's Folly - old anchorage area
5. Shore walk
6. Small boat ramp

NATURE BASED ACTIVITIES

1. Bike and car track
2. Bird watching area
3. Massive fig tree
4. Beachcombing, turtle watching
5. Pulu Maria snorkeling spot

SOMETHING ELSE/OTHER

1. Big Barge Art Gallery
2. Red Claw Farm
3. Firewood collection (pemphis)
4. Iron wood trees

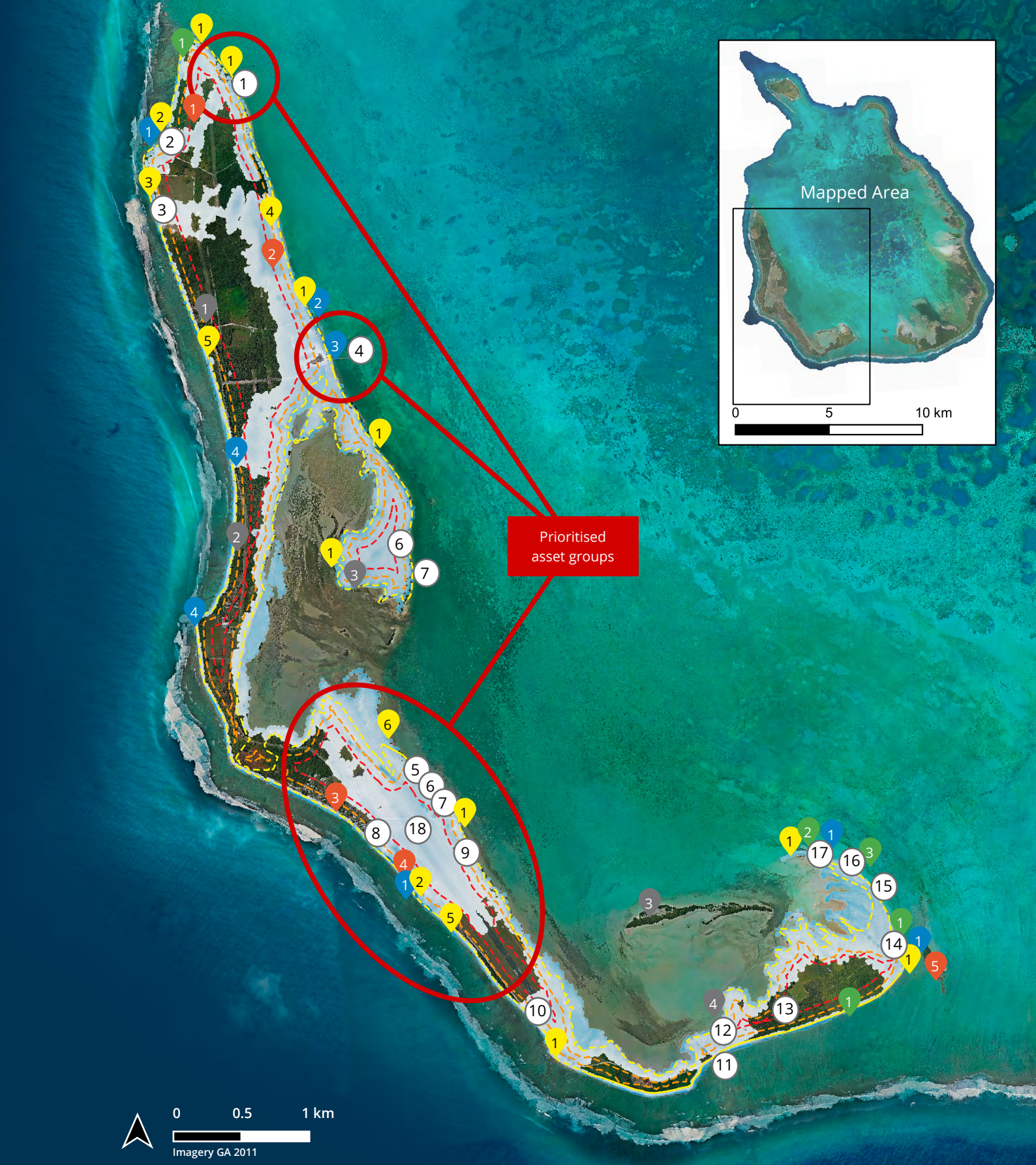


Figure 9 Asset and value mapping summary for West Island

PREFERRED MANAGEMENT OPTIONS

There was divergence of local preferences on management options for Home Island and West Island.

HOME ISLAND

Home Islanders prefer soft options including revegetation and education in the short-term, prioritising effective protection for the settlement area.

The community also continues to explore the retreat from islands options for the longer term.

There was an observation that people will adapt to the most applicable and safe options, for example, the community is adapting to the loss of pondoks (shelters) by camping instead.

WEST ISLAND

West Islanders prefer protection, adaptation and engineering options including sandbags and seawalls.

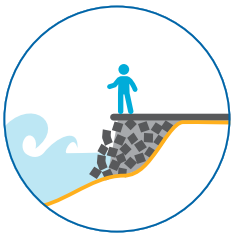
The community also wanted certainty and transparency to help them making long-term plans – whether to invest or retreat.

'PROTECTION' PREFERRED

Both island communities prioritised settlement protection, with keen interest for Seabee seawalls which are present on-island and which many long term locals helped to construct.

The CKI community has additional prioritisation of protection for the Yacht Club and Rumah Baru jetty areas on West Island.

PREFERRED SHORT-TERM OPTIONS



Seabee Sea wall



Monitor

CKI vulnerability to coastal inundation and erosion requires an unique timeframe of short term adaptation within next 5 to 10 years.

- "Avoid" and "Retreat" are not viable in the short term.
- "Protect" and "Accommodate" are possible for continued enjoyment until way of life substantially impacted

PREFERRED MEDIUM-TO-LONG TERM OPTIONS



With the accepted vulnerability modelling, it is challenging to maintain the short-term options of "Accommodate" and "Protect" due to the following factors:

- Groundwater impacts and regular flooding from rainfall events.
- High levees reduce visibility of the water, access to boat ramps, and doesn't stop land flooding.

Long-term options will be determined by the ongoing monitoring to decide the appropriate timing for "Reclaim and protect" or "Retreat from islands".

CONCERNS

GROUNDWATER & FLOODING

Increased frequency and severity of rainwater flooding, high ground water level and storm inundation has detrimentally affected the daily activities of the Home Island community.

FUNDING & OWNERSHIP

Funding for options are key consideration but the Home Island community thinks that they are not in the position to make the call as they do not own the houses or have a funding source.

The community is also likely to follow the lead of the Shire and the Commonwealth for retreat options as a collective.

INCREASED EROSION SEVERITY

Many changes along the coastlines have been observed by the community in both the short and long term periods, including the vegetation loss of Prison Island, and storm-exacerbated erosion near settlements.

RUNWAY UPGRADE

Both island communities are aware of the runway upgrade project and would like to have certainty about its ramification to the island's future, including its effect to local community and the change of coastal risks.

ENGAGEMENT EVALUATION

Increasing involvement of the community and their awareness of the project are observed over the engagement period from April 2022 to February 2023:

PROJECT WEBSITE	ENGAGEMENT PERIOD	VISITS	UNIQUE USERS
Cocos Strategic Community Plan	Apr - Jul 2022	185	57
CHRMAP Launch (Stage 2)	Jul - Nov 2022	844*	52
Post Visit 1 + 2	Nov - Dec 2022	256	95
CHRMAP Stage 5	Jan - Feb 2023	494	199
Total		**1,779**	**403**

IN PERSON ENGAGEMENT	PERSONS
Cocos Strategic Community Plan	57 (31 self-selected, 26 direct meetings)
CHRMAP **Launch** (Stage 2)	39 Stakeholders (including 2 Elders)
Post Visit 1 + 2	18-20* Elders
CHRMAP Stage 5	71 Stakeholders (including 7 Elders, 20 Seniors and 23 from schools)
Total	**~187**

The Community and Stakeholder Engagement Plan success measures:

MEASURE OF SUCCESS	TARGET	RESULTS
Number of people aware (impressions on social media, website visits, document downloads)	400	Achieved
Interested stakeholders (total number of people who contribute)	100	Achieved
Open rate on e-News / click throughs	30%	Achieved
Expressions of interest for workshops	>20	Achieved
Attendee diversity	Diversity of applicants allows at least three community profile ratios to be achieved (age, gender, land ownership, culture, geography categories)	Achieved

NEXT STEPS

The next phase of engagement will include formal public advertising of the Draft CHRMAP.

The Draft CHRMAP will include refinement of viable adaptation options, considering trade-offs resulting from each option.

Once finalised, the Shire will commence preparation of the Local Planning Strategy/ Scheme in conjunction with DPLH, which will duly be considered by the Assistant Minister for Regional Development and Territories, the Western Australian Planning Commission and the Minister for Regional Development and Territories.

ATTACHMENTS

Attachment A: The Cocos (Keeling) Islands Coastal Hazard Risk Management And Adaptation Plan Stage 2 Engagement Outcomes Report 25

Attachment B: The Cocos (Keeling) Islands Coastal Hazard Risk Management and Adaptation Plan Stage 5 Engagement Outcomes Report 26

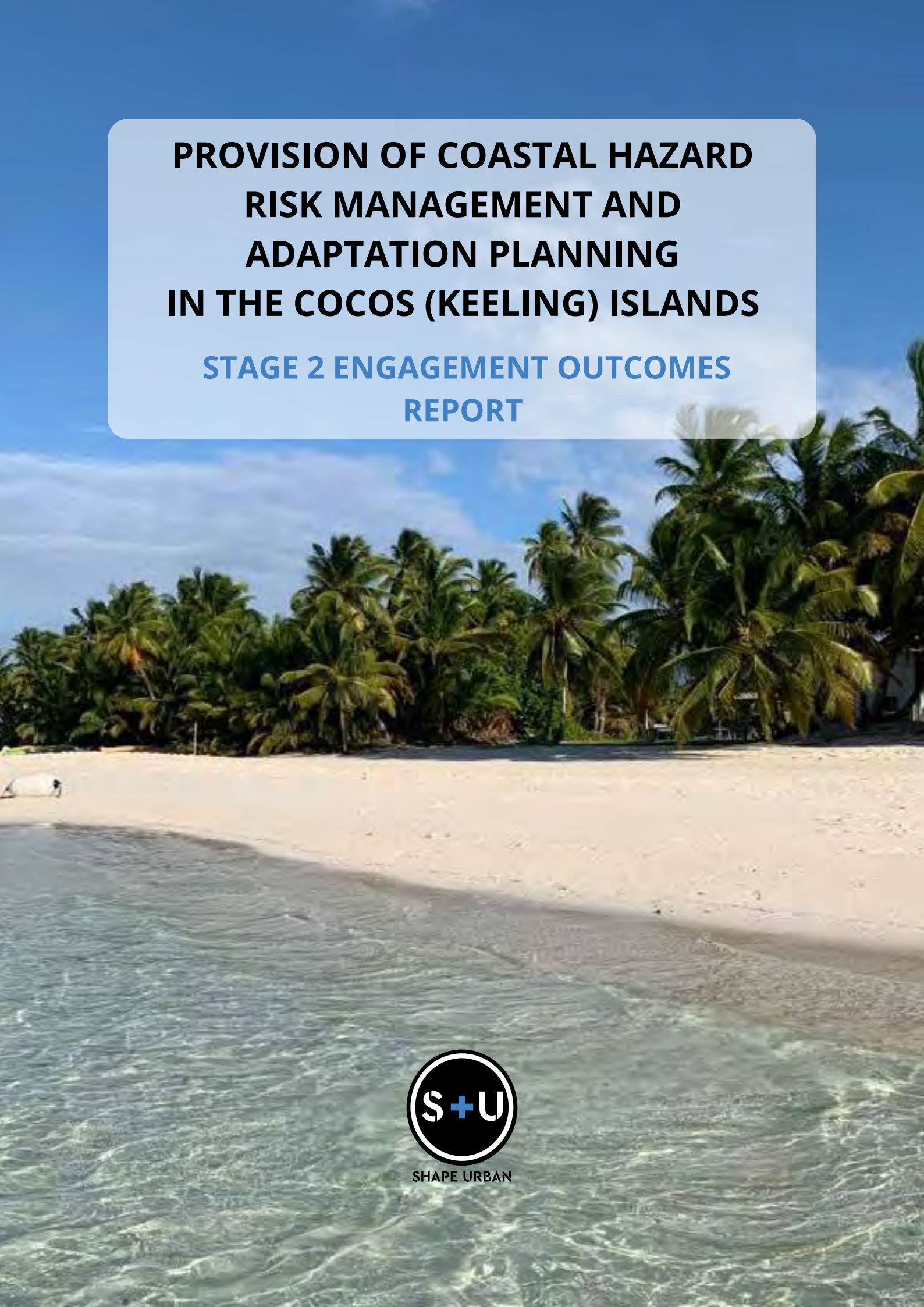
ATTACHMENT A

Attachment A: The Cocos (Keeling) Islands Coastal Hazard Risk Management And Adaptation Plan Stage 2 Engagement Outcomes Report

Use Hyperlink Here

PROVISION OF COASTAL HAZARD RISK MANAGEMENT AND ADAPTATION PLANNING IN THE COCOS (KEELING) ISLANDS

STAGE 2 ENGAGEMENT OUTCOMES REPORT



SHAPE URBAN

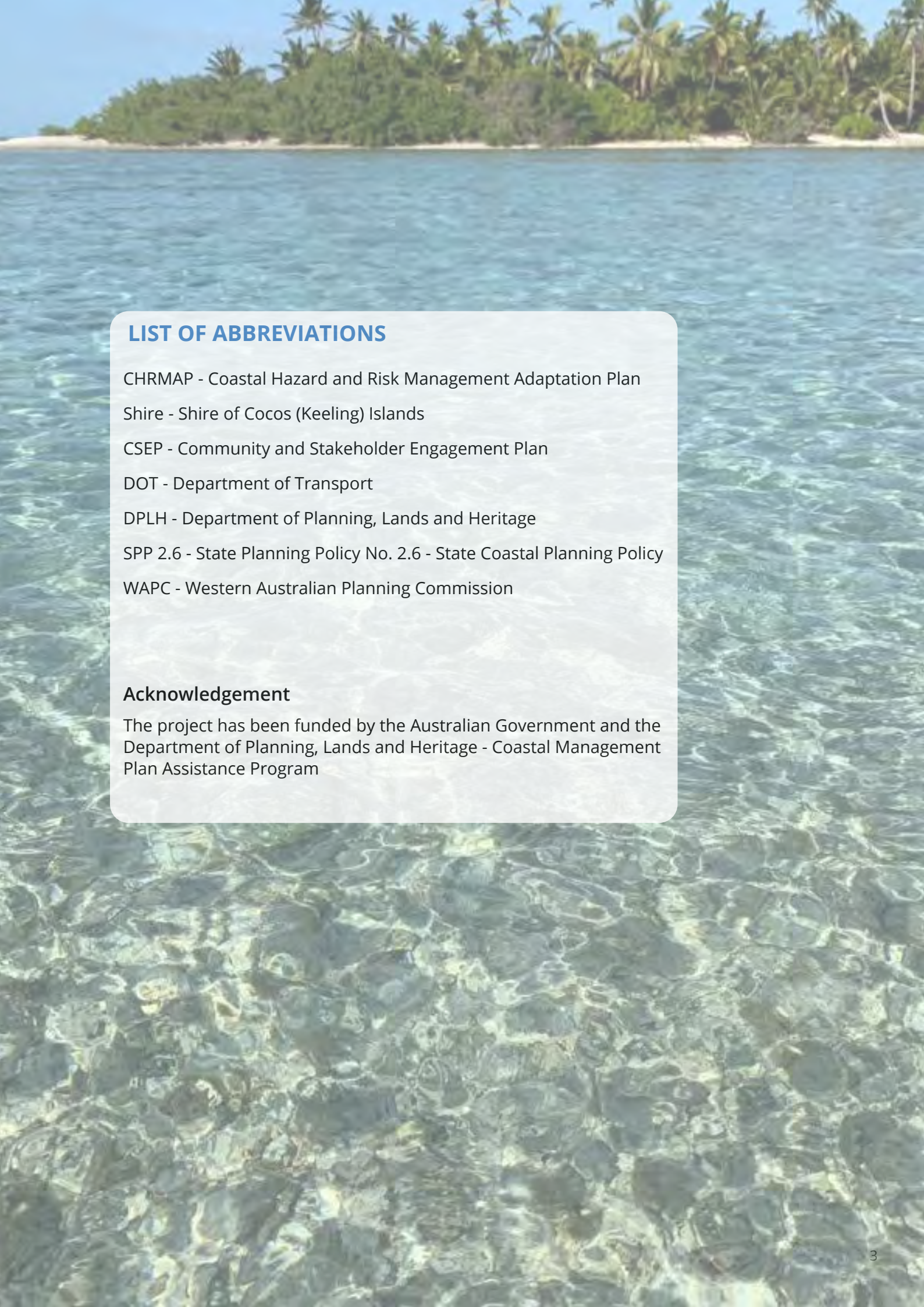
ACKNOWLDEGEMENT

This document has been prepared with the support of many people. Shape Urban and Wavelength wish to acknowledge the contributions of the CKI community and the support of the Australian Government and Department of Planning, Lands and Heritage in preparing this document.

DOCUMENT TITLE

Provision of Coastal Hazard Risk Management and Adaptation Planning in the Cocos (Keeling) Islands - Preliminary Engagement Summary

NO.	AUTHOR	REVIEWED BY	DATE	APPROVALS
1	A Chhabra	A Kelderman	2/2/23	Draft for Client



LIST OF ABBREVIATIONS

CHRMAP - Coastal Hazard and Risk Management Adaptation Plan

Shire - Shire of Cocos (Keeling) Islands

CSEP - Community and Stakeholder Engagement Plan

DOT - Department of Transport

DPLH - Department of Planning, Lands and Heritage

SPP 2.6 - State Planning Policy No. 2.6 - State Coastal Planning Policy

WAPC - Western Australian Planning Commission

Acknowledgement

The project has been funded by the Australian Government and the Department of Planning, Lands and Heritage - Coastal Management Plan Assistance Program

EXECUTIVE SUMMARY

The Australian Government in collaboration with the Shire of CKI and the Western Australian Department of Planning, Lands and Heritage (DPLH) are undertaking coastal management planning for the CKI.

The Coastal Hazard Risk Management Adaptation Plan (CHRMAP) for CKI will confirm the consequence ratings of the *Coastal Vulnerability Study - Coastal Vulnerability Assessment Report* (Haskoning Australia Pty Ltd, 2021) reflects the values of the community and stakeholders. It will identify coastal erosion and inundation risks and challenges, and propose adaptation measures for Home Island and West Island.

The CHRMAP will also consider vulnerability and management for the other islands as part of the overall management response.

The CHRMAP will give decision makers, administrators and landowners on CKI a framework for sustainable coastal development into the future.

A critical part of this project is the engagement with the local community and relevant stakeholders. Engagement for the CHRMAP will investigate the matters raised in previous engagement, and will confirm or update risk assessments to reflect community and stakeholder values.

Engagement activities will also investigate the coastal management matters raised in engagement for the development of the Shire's new Strategic Community Plan by Shape Urban consultants in May 2022.

Preliminary engagement

The preliminary stage of engagement ran from 19 July to 18 November 2022. Approximately 90 community members and stakeholders participated, with engagement activities comprising:

- Two Perth workshops on 23 and 24 August 2022;
- An online project page with an interactive mapping exercise and surveys for stakeholders to read up on the project and to register their interest in being kept in the loop or involved as part of the general Community Reference Group (CRG);
- Establishment of two CRGs on-island - a general one and a more specific Elders CRG.
- Two on-island engagement visits at the start of September 2022 and in November 2022 comprising CRG workshops, meetings, drop-in sessions and information sessions.

On-island and mainland stakeholders were also contacted via communication updates by email through this engagement period.

The key themes identified in this stage of engagement are:

Recreation - The use of beach and foreshore areas for recreation, fishing, boat launching and recreational sporting activities are highly valued on both islands

Environment - The ocean, lagoon, views, landscapes, foreshore vegetation and protection of the natural environment and vegetation are highly valued

Amenities and infrastructure - The yacht, jukong and sailing clubs and other sporting/ recreation clubs are highly valued

Access - There is a strong desire for access along the coastal and lagoon foreshore areas, including for boat launching and access to other islands

Cultural and religious significance - the cemetery at Pulu Gangsa and the mosque on Home Island were raised as important assets, with comments raised by the Imam and Elders about the regular flooding experienced at the cemetery

Coastal process changes - The CKI community is concerned about the impacts of coastal change, with community members observing felled trees around the coastlines of the islands, sandbags that had been impacted and how much the coastlines on Home Island and West Island have changed over time.

Coastal management - The CKI community had a clear consensus on things being done to manage vulnerability risks

There was divergence in preferences for management options to address the changes being experienced by people on Home Island and West Island. On Home Island, there was a preference for soft options including revegetation and education in the short-term, and initial conversations about the possibility of retreat in the longer term - these conversations will be continued in the next stage of engagement.

On West Island, there was a preference for protection, adaptation and engineering options including sandbags and seawalls.

Both island communities prioritised settlement protection, with additional prioritisation of protection of the Yacht Club and Rumah Baru jetty areas on West Island.

This report will be updated with the outcomes of additional engagement as the project progresses.



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S+U

1 INTRODUCTION

1.1 BACKGROUND

The Cocos (Keeling) Islands (CKI) consists of two atolls made up of 27 coral islands. West Island and Home Island are in the South Keeling Islands and are inhabited by approximately 544 people (ABS, 2016).

The Australian Government in collaboration with the Shire of CKI and the Western Australian Department of Planning, Lands and Heritage (DPLH) are undertaking coastal management planning for the CKI.

The Australian Government recently commissioned the *Cocos (Keeling) Islands Coastal Vulnerability Study - Coastal Vulnerability Assessment Report* (Haskoning Australia Pty Ltd, 2021) (the CVA Report) which identifies the areas of West Island and Home Island at risk to the impacts of inundation and coastal erosion over a 100-year planning timeframe.

This project progresses coastal planning; with the development of a Coastal Hazard Risk Management Adaptation Plan (CHRMAP) for CKI.

The CHRMAP for CKI will confirm the consequence ratings of the CVA Report reflects community and stakeholder values. It will identify coastal erosion and inundation risks and challenges and proposed adaptation measures for Home Island and West Island.

The CHRMAP will also consider vulnerability and management for the other islands as part of the overall management response. Figure 1 depicts a map of the CKI.

The CHRMAP will give decision makers, administrators and landowners on CKI a framework for sustainable coastal development into the future.

A critical part of this project is the engagement with the local community and relevant stakeholders.

Engagement for the CHRMAP will investigate the matters raised in previous engagement, and will confirm or update risk assessments to reflect community and stakeholder values.

Engagement activities will also investigate the coastal management matters raised in on-island engagement for the development of the Shire's new Strategic Community Plan by Shape Urban consultants in May 2022.

The preliminary stage of stakeholder engagement for the project (Stage 2 of the CHRMAP process - see Figure 2) has been shaped to raise awareness of the project, understand how the community values assets along the coastline, ensure that concerns and aspirations along the coastline are understood, and introduce the viable potential risk treatment options to the community.

This report details the online engagement, Perth workshops and on-island engagement undertaken in this preliminary engagement stage.

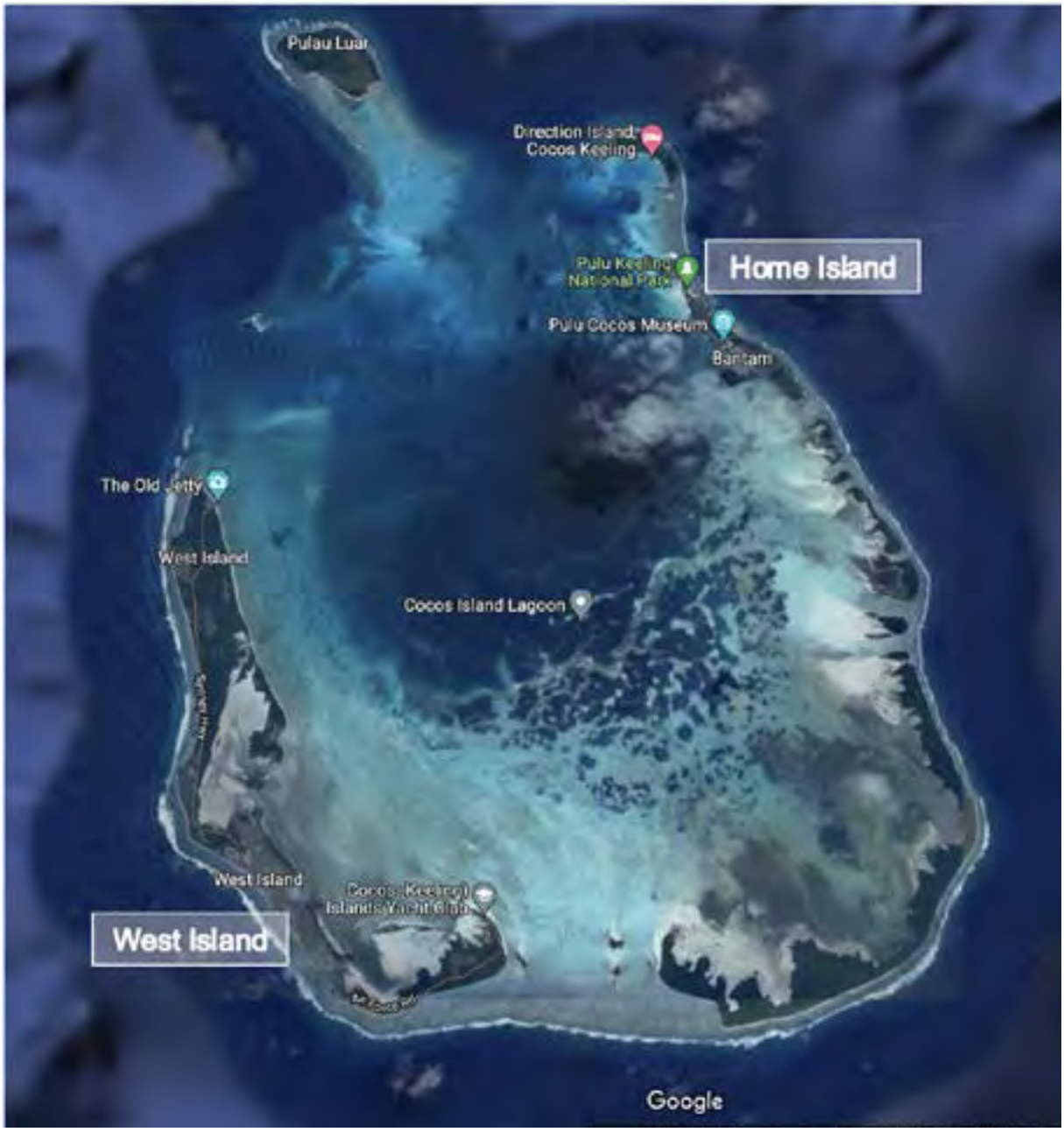


FIGURE 1 - THE SOUTHERN KEELING ISLANDS SHOWING WEST ISLAND AND HOME ISLAND (GOOGLE, 2022)

1.2 ENGAGEMENT PURPOSE

The objective of the engagement process is to facilitate engagement that is tailored to the unique local community needs on CKI, and to the decision making requirements of the Australian Government and State Government agencies with service delivery agreements (SDAs) with the Australian Government.

The overall objective of the engagement process is to facilitate an understanding of the coastal challenges, hazards and risks facing the islands, and to select appropriate adaptation strategies to respond to the risks.

More specific engagement objectives that will be used to measure success are to:

- Inform the community and stakeholders about the extent of potential coastal hazards and the adaptation strategies available to respond to those hazards;
- Explain Australian, state and local governments' responsibilities and capacity to respond to potential coastal hazards, per the CKI governance framework;
- Understand community and stakeholder values along the coastlines; and
- Invite the community to bring their local knowledge, expertise and lived experience to the process and give them adequate opportunity to contribute in a way that suits their needs and circumstances.

The engagement approach aligns with the framework of the Shire's strategic planning framework and the CHRMAP process.

This is in accordance with the Western Australian State Government's coastal planning policy framework - State Planning Policy No. 2.6 - State Coastal Planning Policy (SPP 2.6) and the CHRMAP Guidelines.

Table 1 depicts an overview of engagement in each of the CHRMAP stages.



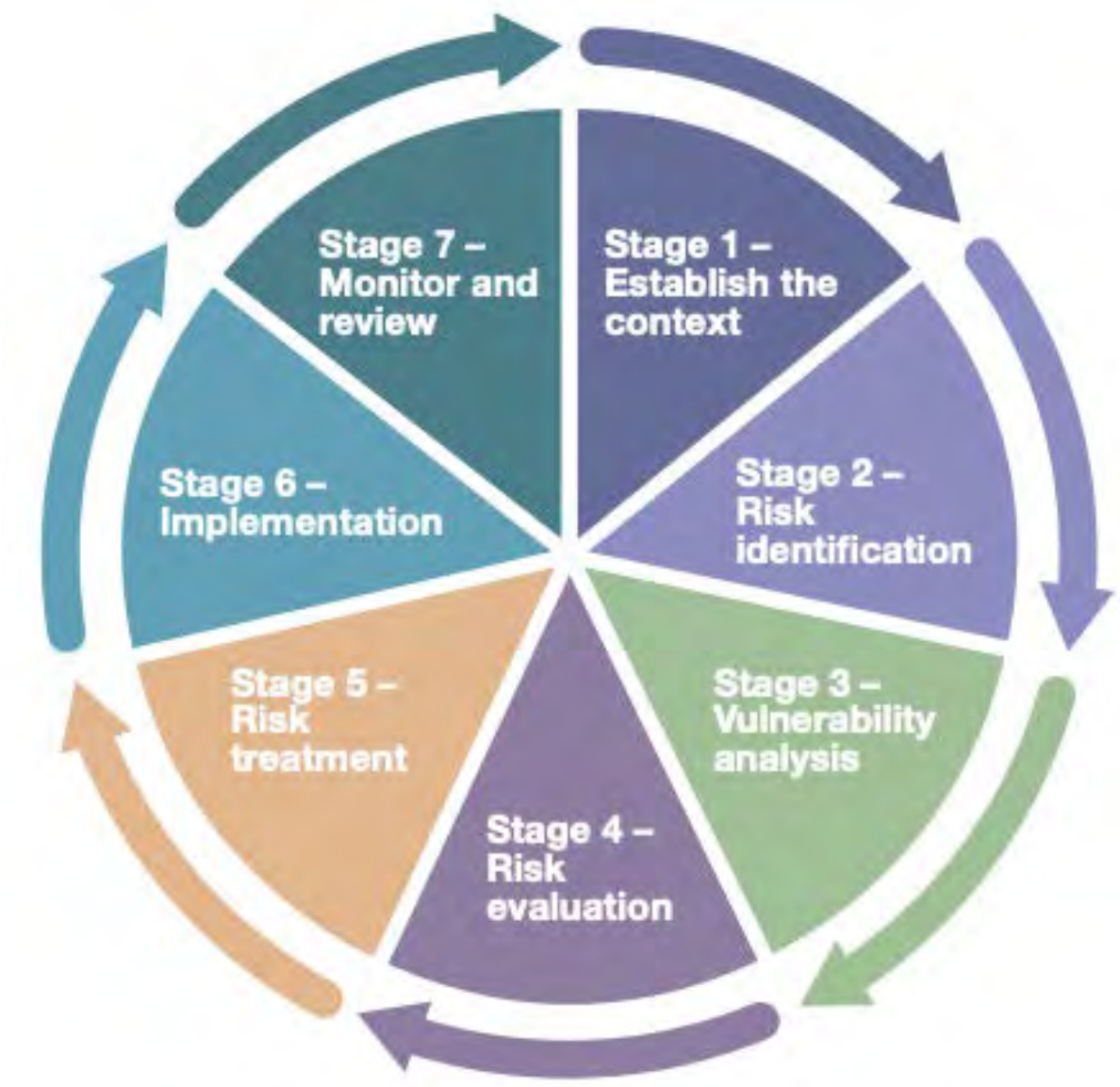


FIGURE 2 - CHRMAP STAGES PER THE CHRMAP GUIDELINES (WAPC, 2019)

TABLE 1 - ENGAGEMENT IN EACH OF THE CHRMAP STAGES

CHRMAP STAGE	DELIVERABLE	STAKEHOLDER/ AUDIENCE	ENGAGEMENT METHODS
1. Establish the Context	• Develop CSEP	• Project Control Group • Australian Government	• Meetings
	• Build on information - informed values related to coastal assets	• Australian Government • State Government • Elected Members • Shire • CRG • Community groups incl Elders • Landowners • Businesses • General community • Schools • Service providers • Funding bodies • Other coastal stakeholders	• Shire webpage • Social Pinpoint (online platform - maps, asset points, surveys) • Introductory letter/ email • Preparation of supporting material (posters, infographics in English and Cocos Malay, reproduction of Coastal Vulnerability Assessment maps) • Social media - primarily Facebook • Stakeholder meetings in Perth and on-island • Workshops in Perth • On-island CRG workshops, information sessions and drop-in sessions • Meetings/ telephone calls - Perth • Open Day on-island • Elected Member briefings
2. Risk Identification	• Updated list of coastal assets		
3. Vulnerability Analysis	• Update risks, vulnerability and consequences		
4. Risk Evaluation	• Consider tolerances and acceptance of risk in relation to values, assets and Australian Government needs		
5. Risk Treatment	• Identify adaptation options and pathways for valued assets • Multicriteria analysis considering values, assets and needs • Cost benefit analysis of risk treatment options • Assess funding options		
6. Implement-ation	• Prepare short term implementation plan • Identify long term pathways		
7. Monitor and Review	• Develop monitoring plan	• Coastal managers (TBD)	NA
CHRMAP Reporting and Adoption	• Integrate information into draft CHRMAP • Advertise draft CHRMAP • Finalisation and adoption of CHRMAP		

2 ENGAGEMENT ACTIVITIES

2.1 PRELIMINARY ENGAGEMENT

The purpose of Stage 2 engagement is to raise awareness of the project, understand how assets are valued along the coastline, and introduce the viable potential risk treatment options to stakeholders.

To do this, a number of engagement activities and opportunities were undertaken, including:

- Two workshops in Perth - the first for the Australian Government's Department of Infrastructure, Transport, Regional Development, Communications and the Arts (DITRDCA) and the second for other government agencies and key stakeholders



FIGURE 3 - ONLINE INTERACTIVE MAPPING TOOL

- On-island engagement comprising Community Reference Group (CRG) workshops, information sessions, ‘drop-in’ sessions and meetings on Home Island and West Island;
- Individual stakeholder meetings;
- Online project website; and
- Online interactive mapping tool.

3 COMMUNICATION METHODS

3.1 PROJECT WEBPAGE

The Social Pinpoint engagement platform was used as the primary location for all project information, including background information and links, registrations of interest, hazard mapping, an interactive mapping exercise, frequently asked questions (FAQs) and common terms used in the project.

3.2 DIRECT COMMUNICATION

The project team communicated directly with community members on-island on 17 and 18 August 2022 to invite nominations for a community reference group (CRG), or to set up meetings.

The team also sent email invites to workshops for identified Australian and state government agency stakeholders on 19 August 2022.

Note: The project team will communicate with DITRDCA in February 2023 to provide them with an update on stakeholder engagement on-island and the initial draft multi-criteria assessment results. This information will inform the next stage of workshops with Australian Government and state government stakeholders in February/ March 2023.

3.3 PUBLIC NOTICES

The Shire posted project launch posters/ information at the supermarket and other key locations on Home Island, at the ferry terminal and on the blackboard on West Island, and at its offices on both islands in the last week of August 2022.

3.4 WORKSHOPS

Project information was shared at the following workshops:

- Perth - DITRDCA workshop on 23 August 2022;
- Perth - state government and key stakeholder workshop on 24 August 2022;
- Two CRG workshops on-island on 3 and 5 September 2022; and
- Two Elders workshops on-island on 11 and 14 November 2022.

3.5 MEETINGS

Individual meetings were undertaken on-island with community member stakeholders as required or requested. The meetings provided the project team with the opportunity to share project information and get feedback on values and the viable potential risk treatment options.

3.6 SOCIAL MEDIA

Social media, specifically the Shire's Facebook page and the Buy, Swap and Sell page, were used to promote the project and opportunities to be involved.

Facebook posts:

- 31 Aug 2022 - Project launch and opportunities to get involved - 2 reactions, 1 comment and 1 share
- 1 Sept 2022 - Notification about on-island engagement sessions - 1 reaction, 2 comments, 1 share
- 2 Sept 2022 - Notification about upcoming on-island engagement activities and opportunities to get involved - 3 reactions, 1 comment, 1 share
- 2 Sept 2022 - Reminder about engagement activities - 1 share

3.7 NEWSPAPER

An article was published in "The Atoll" newsletter on 6 September 2022. The news article encouraged people to visit the project website to read more, get involved by sharing their values for how they use the coastline, see what the project team had been up to in their time on-island, look at the technical information available and do the interactive mapping activity.

3.8 OTHER

The manager of the Community Resource Centre on-island shared project communications materials provided by the project team with community members.

The Shire's project manager also engaged directly with community about the project and advised them of on-island engagement and how to register to be involved.

In addition to the workshops on-island, the project team also hosted 'drop in' information sessions on Home Island on 3 September 2022 and West Island on 5 September 2022 and met with community members on 11, 14 and 15 November 2022.



4 PRELIMINARY ENGAGEMENT OUTCOMES

4.1 ENGAGEMENT APPROACH

This preliminary engagement stage raised awareness of the project, defined assets (both tangible and things like swimming at the beach), sought feedback on coastal values, and introduced viable risk treatment options to stakeholders.

Importantly, stakeholders shared their coastal values and observations about coastal changes that they had experienced over time.

The project team shared trade-offs between options (pros and cons) in a meaningful and nuanced way. Stakeholders were invited to identify potential solutions and alternatives, and discuss feasible risk management and adaptation options.

Feedback was sought from stakeholders between 19 July 2022 to 18 November 2022, through the following methods.

- Perth engagement
- On-island engagement
- Online project website
- Online interactive mapping tool
- Individual stakeholder meetings.

Perth engagement comprised two workshops with the Australian Government (DITRDCA), state government agencies and other key stakeholders.

On-island engagement was originally planned around a general CRG program, 'drop in' information sessions, meetings with key stakeholders and incidental encounters with community members.

The CRG program involved the establishment of the group, sharing of background information, a CRG program comprising two workshops and a self-guided site visit, and conversations with CRG members. The project team directly communicated with on-island community members to seek nominations for the CRG, which numbered 23 representatives.

This included community figureheads, State and Australian government representatives and a mix of community members from Home Island and West Island who are landowners, renters and business owners. Youth and Elders were also asked to be on the CRG.

Unfortunately, due to COVID illness and other commitments, neither workshops had all 23 CRG members present. The project team had incidental interactions with a number of the apology CRG members.

A number of Elders on Home Island had contracted COVID while the project team was on-island. This meant that the planned Elders meeting did not progress and a separate Elders meeting was scheduled.

Members of the project team accordingly undertook a second on-island visit from 11 to 15 November 2022 to undertake an Elders CRG program comprising two workshops. The team also met with identified community leaders and community members who were previous apologies.

The details and outcomes of the completed engagement activities are summarised in this section of the report.

4.2 PERTH ENGAGEMENT

Two workshops were held in Perth; the first for the DITRDCA and the second for other government agencies and key stakeholders.

The first workshop was held on 23 August 2022. The second workshop was held on 24 August 2022. Both meetings provided stakeholders with the opportunity to attend online (via Microsoft Teams).

The workshop sessions introduced the project, provided stakeholders with the local context - coastal processes, hazards and risks on CKI, reviewed assets and values the project team had identified through literature reviews, introduced risk management approaches in accordance with SPP 2.6 and discussed viable potential risk treatment options.

The project team also discussed trade-offs that would need to be made for each of the options and provided the opportunity for stakeholders to identify additional assets/ values or ones that were sacrificial, and to discuss potential solutions and alternatives to valued activities.

The first workshop was one and a half hours long and the second workshop was two and a half hours long.

4.2.1 Workshop Format

The workshops commenced with project background, including previous studies undertaken, the project area scope - focused on Home Island and West Island but considering other islands, and the coastal processes occurring at each of these locations.

Participants were introduced to the vulnerability mapping established in the CVA Report over the 2018 and 2068 time periods, erosion and inundation vulnerabilities for each location and time period, and assets of interest on both islands that are affected.

A discussion followed including any missing assets and any assets considered sacrificial.

Participants were subsequently introduced to the WA coastal planning risk management / adaptation approaches and options outlined in SPP2.6 and the CHRMAP Guidelines, and the recommended approach to considering management options for the islands.

Examples of proposed options for various adaption approaches was presented to participants, with trade offs for each also discussed.

At the second workshop, participants were introduced to the multi-criteria assessment (MCA) process.

The workshops concluded with the project team advising participants of the next steps, including on-island engagement and future updates.

A copy of the workshop presentation is available in **Appendix A**.

Participants were also presented with project maps which are available in **Appendix B**.

4.2.2 Workshop Attendees

There were 12 workshop attendees at the first workshop, including four project team members and the DPLH project manager.

There were 23 workshop attendees at the second workshop, including three project team members and the DPLH project manager.

Attendees at the second workshop represented the following agencies:

- DPLH
- Department of Transport's coastal branch
- DITRDCA
- Department of Premier and Cabinet
- Department of Water and Environmental Regulation (DWER)
- DWER Environment Protection Authority services
- Water Corporation
- Department of Mines, Industry Regulation and Safety - Resource and Environmental Compliance division
- Department of Defence (Canberra)
- Fulton Hogan as Department of Defence's runway upgrade contractor
- TOLL Global Logistics
- Department of Education
- Department of Fire and Emergency Services
- Department of Finance

Both workshops had a combination of in-person and online attendance.

4.2.3 Workshop Outcomes

The workshops aimed to:

- Introduce the project and key vulnerability risks to stakeholder participants, in the context of asset ownership and management responsibility on the CKI;
- Initiate discussions about feasible management options and and how each of the options impact assets in the identified locations; and
- Explain the MCA process and criteria used to determine the most appropriate adaptation options;
- To provide stakeholders the opportunity to consider coastal processes in their planning and management capacities.

Workshop discussions comprised known assets and recent upgrades, missed or sacrificial assets and assets that are easily relocated.

Recent upgrades to Rumah Baruh and missing assets (bores on Home Island) were identified.

Participants advised they would provide additional feedback after the meeting regarding relevant information.

Workshops summary

Participants considered challenging issues such as retreat in the context of the islands.

It was noted that adaptation pathways should factor in the sustainability of the CKI community - this was confirmed, with particular focus on the development of reasonable staged pathways.

The lack of information regarding drainage and groundwater was also raised as an information gap to be investigated, as this may impact on the suitability of adapation options.

Assets at risk in the short term were also identified, such as the jetties and the medical clinic on West Island, which are assets of critical importance to living on the islands.

Notwithstanding the challenging coastal context, participants indicated full support for the development of a CHRMAP as a proactive Australian Government response to coastal risks and their management for the CKI community and stakeholders.



4.3 ON-ISLAND ENGAGEMENT - SEPTEMBER 2022

The September 2022 on-island engagement program included:

- The CRG program
- 'Drop in' spaces for the community
- Individual stakeholder meetings.

The project team engaged with:

- 14 CRG members
- 15 'drop-in' community members
- The Imam on Home Island
- 2 Elders on the Imam-guided walk
- 7 incidental community member meetings
- The Shire CEO and Shire Project Manager.

The on-island program is at Table 2. It includes dates, times, engagement activities and key comments.

CRG sessions were held on Home Island, with the remaining activities held on both Home Island and West Island to maximise opportunities for each of the island's communities to be involved.

Elders on Home Island were nominated to be part of the CRG and a separate meeting was scheduled with the Elders group, however a number of COVID cases resulted in cancellation. Members of the project team undertook a second Elders CRG program on-island in November 2022 (detailed in Section 4.4).

The September 2022 visit provided the project team with time to discuss issues and build awareness with community members.

A scheduled school activity was also cancelled due to COVID. Scheduled activities that had to be cancelled due to a COVID outbreak are identified in blue in Table 2.

The details and outcomes of the September 2022 on-island engagement activities are summarised in this section of the report.

TABLE 2 - ON-ISLAND ENGAGEMENT PROGRAM - SEPTEMBER 2022

DATE	LOCATION	ACTIVITY	NUMBERS / COMMENTS
Friday 2 September	West Island	Meeting with Shire	Introduced the project team and on-island activities and spoke about community concerns relating to coastal processes and management
		Site visit	West Island coastlines
		Incidental	The community member made his apologies for non-attendance at the CRG, but took some time to discuss the project with the project team
Saturday 3 September	Home Island	Drop-in information session	7 attendees
		CRG workshop session 1	11 attendees: • West Islanders x 4 • Home Islanders x 8 (including youth x 3)
Sunday 4 September	Both islands	CRG homework - site visit	At the end of the first workshop session, CRG members were given a task to visit the island coastlines and note assets and values along the coastline
Monday 5 September	Home Island	Elders meeting	Cancelled as a number of Elders were in isolation due to COVID
Monday 5 September	Home Island	Meeting	Meeting with the Island Imam
		Site tour	Home Island coastlines
		Meeting with Elders	Discussion with Elders
		CRG workshop session 2	9 attendees: • West Islanders x 5 • Home Islanders x 4 (youth at school)

TABLE 2 (CONT.) - ON-ISLAND ENGAGEMENT PROGRAM - SEPTEMBER 2022

DATE	LOCATION	ACTIVITY	NUMBERS / COMMENTS
	West Island	Drop-in information session	8 attendees
Tuesday 6 September	Home Island	Meeting with Shire	To close out on-island engagement and discuss key findings and next steps
Tuesday 6 September	Home Island	School meeting	Not possible due to COVID outbreak on Home Island
Tuesday 6 September	West Island	Meeting with youth from CRG	Met with 2 x students who attended CRG to wrap up CRG inputs (remaining student in isolation due to COVID)
		Meeting landowner	Meeting (requested by stakeholder)
		Meeting with Stakeholder	Meeting (requested by stakeholder)





4.3.1 Meeting with Shire

On arrival on-island, the project team met with the Shire to introduced the project in-person and share on-island activities.

4.3.2 'Drop in' Sessions

Session 1 - Home Island

The first 'drop in' session was held on Saturday 3 September 2022 from 10:30 to 11:30 at the Council Chambers on Home Island.

The session was attended by 7 community members including the landowner of Oceania House who observed the implications of inundation and erosion at that significant site.

Project maps and adaptation infographics were used for the session. The project maps are at **Appendix B** and the infographic is at **Appendix C**.

The project team spoke to attendees about the project, vulnerability mapping on the tables, coastal values and assets, and answered questions about the project, coastal processes and implications.

Session 2 - West Island

The second 'drop in' session was held on Monday 5 September 2022 from 4:30 to 5:30 at the function room at the Cocos Club on West Island.

The session was attended by 8 community members.

Project maps and adaptation infographics were used for the session, including values that CRG members had marked at the workshops - attendees were able to view and discuss these with the project team.

Attendees were provided information about implications of the vulnerability mapping on various values across the timeframes and likelihood of occurrence.

One stakeholder requested a follow-up meeting with the project team to discuss site specific impacts. This meeting occurred on Tuesday 6 September 2022.

4.3.3 CRG Workshops

Workshop 1

CRG workshop 1 was held on Saturday 3 September 2022 from 12:30 to 2:30 in the Council Chambers on Home Island.

The workshop was attended by 11 CRG members - four West Islanders and eight Home Islanders (including three youth).

The nominated Elders on the CRG were an apology due to COVID. Various other apologies were also made.

The CRG Workshop 1 presentation is at **Appendix D**

Workshop Format

The workshop commenced with the project background and the purpose for each CRG session. Workshop participants were provided with the project remit:

To prepare a CHRMAP that:

- *Identifies vulnerable public and private assets*
- *Recognises and preserves community values for current and future generations*
- *Informs community and decision makers*
- *Is required under West Australian State Planning Policy 2.6 – State Coastal Planning*

Members were advised that CHRMAPs are usually a plan for the next 100 years but that it is potentially more urgent on CKI.

CRG members were taken through a similar presentation to the Perth workshops, however with greater local context focus and identification of vulnerable assets on Home Island and West Island.

The MCA process and criteria used was then discussed. After this, participants undertook an asset/values mapping exercise.

Activity 1 - Values / Assets

Using the maps at Appendix B, CRG members were asked to identify 'things' (assets and values) in the coastal zones that are important to them, and if there were assets missing or sacrificial assets that were of no concern.

CRG members were given sticky dots for the exercise, with the following colour representations:

- Water based activities
- Beach based activities
- Foreshore based activities
- Nature based activities
- Something else / Other

Following this activity, there was a discussion about the coastal processes at work and values of the community.

Key observations were that:

- The CRG is well versed in the coastal processes and changes that are occurring in the CKI, with members noting sediment movement, overtopping of trees, island shape and geography changing and the resultant impacts on the community's ability to do the things they used to do.
- The CRG (and community, as represented by the CRG) wants to see action and something being done to manage vulnerability risks. Members noted that it was time for action, not 're-planning'.



CRG members were given task to complete over the weekend - to undertake a self-guided site visit of their island coastlines with maps and a worksheet and to note values and assets of interest or other interesting coastal observations.

The maps handed out for the homework activity are smaller versions of the maps at Appendix B. The homework worksheet is at **Appendix E**.

The project team asked members to bring their completed worksheets to the next CRG workshop, where their observations would be discussed.

Activity 2 - The next 100 years

Members were also provided with an worksheet activity titled '*What should we do over the next 100 years to 'solve' coastal issues*'.

At the end of the workshop, CRG members were asked to write down their ideas for solutions to the coastal issues.

The ideas worksheet is at **Appendix F**. It asks the above question at three different dates (Workshop 1, site visit/post Workshop 1 and Workshop 2).

At the end of Workshop 1, the solution suggestions were:

- More trees to "hold" the land together.
- Preservation
  - Saving important areas
  - Whole island/settlements
  - Tree planting
  - Natural erosion preservation methods
- Coastal protection
- Built infrastructure planning
- Last option for relocation program
- Rehabilitation process

For the second date, proposed solutions were:

- Housing development on stumps
- "Shifting" land / sand. Putting it back

At the end of Workshop 2, the proposed solutions were:

- Putting "blocks" along the coast to hold it together.
- Relocation (with the mainland and West Island queried as potential locations)

It should be noted that the above responses are from only a few members only who provided the feedback. The remaining CRG members did not complete this feedback.

Workshop 2

CRG workshop 2 was held on Monday 5 September 2022 from 12:30 to 3:00 in the cyclone shelter on Home Island.

The workshop was attended by nine CRG members - five West Islanders and four Home Islanders. Apologies included the three youth who were in school and members from both West and Home Island who had work commitments.

Workshop 2 was attended by two Elders, however others were apologies due to COVID.

The CRG Workshop 2 presentation is at **Appendix G**

Workshop Format

The workshop commenced with a reminder that the CHRMAP will be making recommendations for action.

CRG members were invited to share their weekend observations. Members noted felled trees around the coastlines of the islands, sandbags that had been impacted by weather and water conditions, and the changing coastlines on Home Island and West Island (erosion significance).

Discussions included:

Home Island

- Breach points at boat ramps - noting five boat ramps at the foreshore,one in the industrial area and one at the southern tip of the island
- The ocean side of Kampong Atas (the settlement) eroding, with many puddles - it was noted that the high water table contributes to this
- Kampong drainage - drain pipes from the kampong to the ocean been recently been opened up to aid drainage of kampong land

West Island

- The clinic location currently impacted by water and the seawall protecting it is also impacted - members noted the construction joint movement in the wall
- Trees near jetties falling in because of the lack of sand stabilisation
- Sandbags falling apart - have holes
- Old buildings falling in the water
- Severe erosion at the memorial site for a community member who had recently passed away, with water flow feeling like it could cut the island in half
- Scout Park moving away from the water's edge, with an observation of significant changes in this area

General

- Observations about the many changes along the coastlines observed by the community in both the short and long term periods
- The loss of seagrass - some community members suggested the increase in turtles as a reason for the loss, however others in the CRG opposed this view, advising that seagrass changes were caused by the dynamic nature of the coastline, storm events and coastal changes over time

Presentation - Adaptation Options

The project team presented viable risk management/ adaptation approaches for CKI - whole of settlement and individual asset treatment outside settlements (see Figure 4).

Settlements

CRG members were advised that for the settlements, adaptation will be required in the short term (next 5 to 10 years)

The project team advised that three feasible adaptation pathways had been identified for the settlements; protect, accommodate and no regrets.

The team also explained the options considered unsuitable in the CKI context:

- Avoid - there are already assets in place
- Retreat – Insufficient space / higher ground to retreat to (within island consideration)

The project team described the three feasible pathways, showed participants local examples of each (see Figure 5 for examples of protect structures on-island) and discussed the trade-offs for each adaptation type with participants.

Table 3 depicts each of the adaptation pathway options and MCA criteria trade-off considerations - the original slides are in the presentation at Appendix G.

The project team discussed hard options including seawalls and levees and soft options such as revegetation using grass.

The project team noted that use of hard options needed to be considered in terms of access, for example, sandbags around the yacht club would impact access from the road, and the levee option may have the effect of making access to other locations on the island more difficult.

Assets outside of Settlements

CRG members were advised that individual asset treatment outside of settlement require adaptation over a variety of timeframes, and can be responded to separately or in small groupings. See Figure 6 and Figure 7 for assets outside of the settlement.

Participants were advised that the options are:

- Avoid further development in known areas of risk;
- Opportunity to relocate some assets within property boundaries; or
- Alternate 'soft' protection options (revegetate, sand nourishment).



FIGURE 4 - OVERALL RISK MANAGEMENT APPROACH



FIGURE 5 - PROTECT ADAPTATION EXAMPLES

TABLE 3 - ADAPTATION OPTION TRADE-OFFS

ADAPTATION OPTION & MCA CRITERIA	BENEFITS	CONSTRAINTS
Seawall		
Effectiveness	• Ultimately provides last line of defence	• Cheaper design reduces effectiveness
Capital and Maintenance Costs		• Requires importing materials • Requires ongoing maintenance costs
Environmental		• Disruptions to local ecosystems • Loss of beach, vegetation • Can increase downdrift erosion
Social	• Provides assets protection	• Loss of ability to walk on beach, enjoy vistas • Visual impacts
Flexibility		• Once chosen, other options are off the table or very difficult to implement • Sets expectations assets will always be protected
Levee		
Effectiveness	• Provides last line of defence (flooding)	• Only address flood risk • Requires adequate spaces
Capital and Maintenance Costs		• Requires importing materials • Requires ongoing maintenance costs
Environmental	• Set back from shoreline, beach can still exist • Can tie into the natural environment	• Construction disrupts local ecosystems, vegetation
Social	• Provides asset protection (flooding)	• Visual impacts • Position could create feeling of disconnection
Flexibility		• Sets expectations assets will always be protected

TABLE 3 (CONT.) - ADAPTATION OPTION TRADE-OFFS

ADAPTATION OPTION & MCA CRITERIA	BENEFITS	CONSTRAINTS
Accommodate		
Effectiveness	• Highly effective for assets that can be raised	• Only address flood risk • Challenging for some assets
Capital and Maintenance Costs	• Undertake at end of asset design life	• Requires importing building materials • High costs to accommodate some infrastructure
Environmental	• Limited impacts • Beach can be maintained	
Social	• Provides protection (flooding)	• Requires considered planning to limit impact to residents • Daily impacts, residents accessing properties
Flexibility	• Highly flexible	
No Regrets trade-offs		
Effectiveness		• Only a interim measure
Capital and Maintenance Costs	• Lowest upfront costs	• Highest cost for repair of damage
Environmental	• Limited impacts	
Social		• Potential increased risk to lives during flood
Flexibility	• Highly flexible	

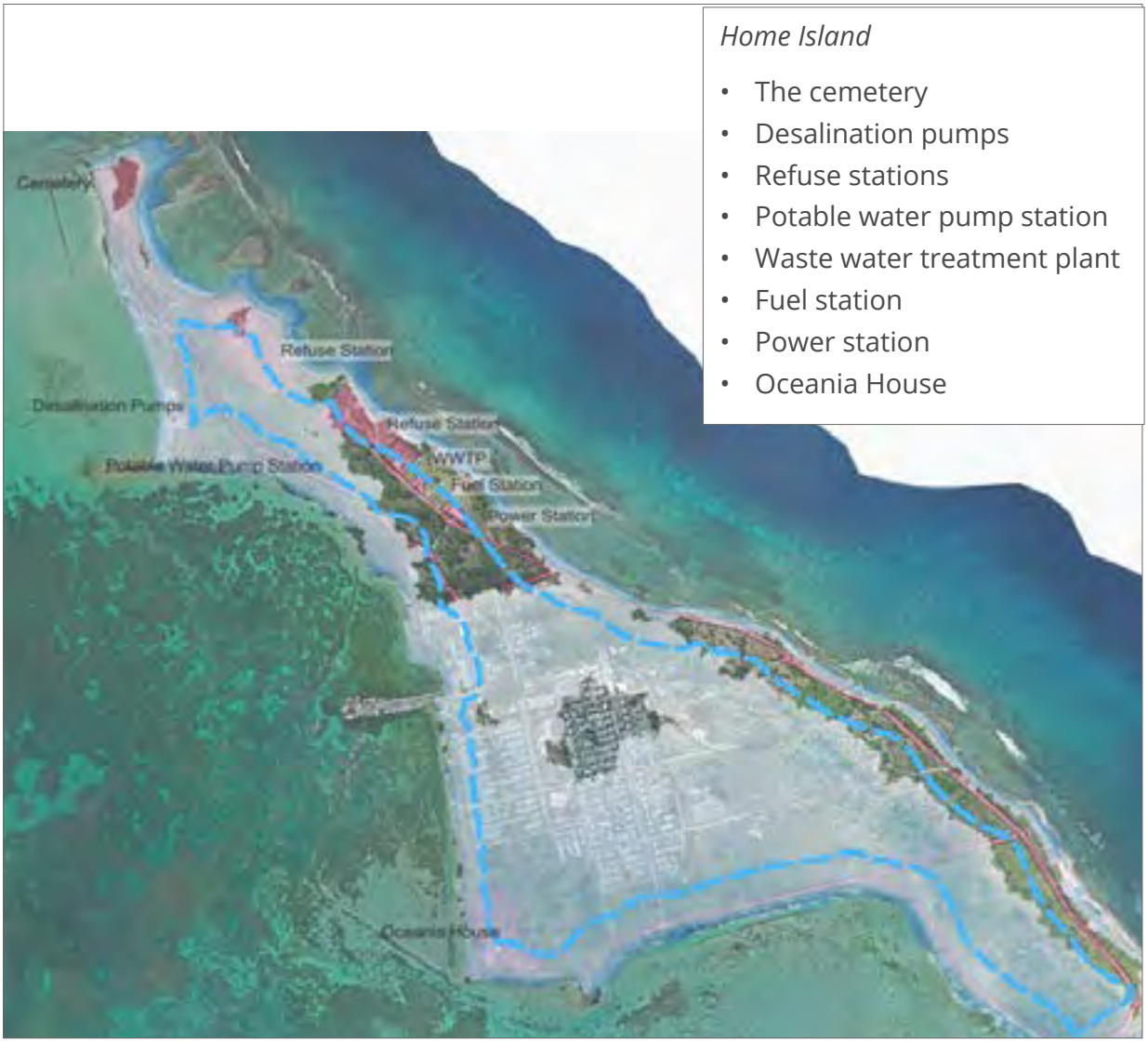


FIGURE 6 - INDIVIDUAL ASSETS OUTSIDE OF SETTLEMENT - HOME ISLAND



West Island

- Fuel station
- Trannies beach reserve
- Transmitter station
- Rumah Baru jetty
- Airfield storage
- GA geomagnetic observatory
- Bureau of Meteorology site
- GA GNSS Mark
- GA Seismic station
- Communication array
- Plaque
- Substation
- Access road
- Scout Park reserve
- Boat ramp
- Yacht club
- Pondok (shelter)

FIGURE 7 - INDIVIDUAL ASSETS OUTSIDE OF SETTLEMENT - WEST ISLAND

Long-term Options

Following this, the project team presented longer term implications (2118), noting that it will be challenging to maintain the accommodate and levee/ seawall protect pathways due to groundwater shoaling impacts, and the challenges of drainage outflowing to higher sea water levels.

The project team advised CRG members that feasible potential long-term options include:

- Retreat from islands
- Reclaim and protect.

Figure 8 depicts the slide presented to participants presenting an example of the reclaim and protect option, noting that it:

- Is technically feasible and promotes long term resilience
- Has substantial costs
- Requires an integrated planning, engineering and environmental approach.

The CRG asked the following questions during the workshop:

- What does extreme vulnerability mean?
- Is the Department of Defence going to pay for protection or other mitigation structures as part of its protection of assets?
- Who determines who pays for adaptation options?

The project team responded with a more detailed response regarding the 'who pays' question, as it is discussed in the CHRMAP guidelines. The team explained the beneficiary pays principle, but also that a realistic discussion of 'who pays' is required for funding requests.

The discussion about funding was followed up by a discussion about costing options for protect options and the funding allocations and limitations.

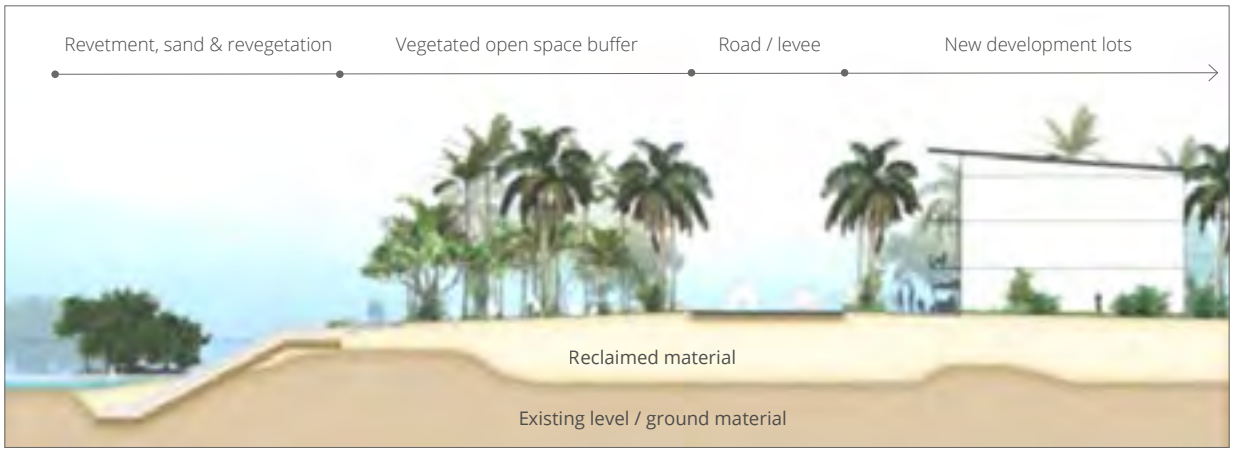


FIGURE 8 - RECLAIM AND PROTECT OPTION - THE KIRIBATI EXAMPLE

There was an observation that people will adapt to the most applicable and safe options, quoting island Pulu Maraya which has been 'cut in half' - the community is adapting to the loss of pondoks (shelters) by camping there now.

Activity - Asset / Value mapping in coastal hazard zones

Continuing on from the asset / value mapping exercise initiated in Workshop 1, CRG members were asked to:

- Consider what assets exist in the coastal zones;
- Reflecting on what they had heard so far, and the possible options, to consider assets in the coastal zones for both islands;
- Group assets where possible and sensible to do so;
- Prioritise groups;
- Identify things that could move; and
- Comment on options

CRG members continued the activity from Workshop 1 and identified their prioritised asset grouping locations (see maps at Figures 9 to 12). The maps used for the activity are 2018 and 2068 erosion and inundation vulnerability maps (part of map set at Appendix B)

Key CRG values, observations and management option preference discussions were:

- Maintaining beaches and access to the water - the use of levees would create complaints about access to the water
- Noting there is not much swimming at the back of Home Island
- Crayfishing - sometimes
- Let Sandy Point do its thing – accommodate for it
- Sandbag the sections close to settlement
- Plant trees
- Home Island - if options are too expensive CRG members expressed that they would probably look at retreat and noted that they are not really interested in living on West Island
- *"We can try as much as we want but the retreat is the last option"*
- Something to do to slow it down is relocating sand to where it is needed and then on to beaches (Sandy Point, Trannies beach) - this would save time and dollars in the short term

Other values discussed and mapped in the CRG workshops are:

Home Island:

- The inner lagoon - valued for dukong racing, community meets ups, swimming, foreshore activities
- Garden plots
- Waste management - inundation issues
- The cemetery
- Sandy Point Beach

West Island:

- North Point
- Trannies Beach including the gazebo
- Scout Park
- The Spot
- The Shack
- Big Barge
- Yacht Club
- Jetty Beach
- All leaseholds - north western side West Island south end - but it's very low

Other:

- Pulu Kambing - island in the atoll ring of islands
- Picnic areas
- Bird watching
- Tourism based sports
- All housing should have concrete walls
- Geobags are short term bandaids - they also increase & speed up erosion each end side of bags

Workshop summary

On Home Island, CRG members suggested softer options - for example revegetatlon near Oceania House, with the CRG suggesting the use of Kayu Dedap which has deep roots to hold sand and vegetation that takes water out of the ground.

CRG members suggested education programs about coastal processes on Home Island, and the prioritisation of protection of settlement-based assets (see Figures 10 and 11).

On West Island, CRG members selected protection, adaptation and engineering options to protect assets at the yacht club, Rumah Baru (jetty) and the main settlement. Members also wanted to replicate the concrete wall in lieu of geotextile sandbags around the settlement and the runway (see Figures 12 and 13).

A CRG member specifically referenced a tree on the oceanside of the settlement that they wanted to see protected from coastal processes (marked on Figure 12).

4.3.4 Meetings

Meeting and site tour with the Imam

The project team met with the islands' Imam on Monday 5 September at 8.30 on Home Island, followed by a site visit, in particular to the cemetery on Home Island.

The discussion referred to the cultural and religious significance of the cemetery at Pulu Gangsa, the burial site for Home Island residents, and noted that it used to be a separate island, with the strait closed off by the locals in the early 1900's.

Regular flooding was noted at the cemetery, with the implication of having to wait until flooding subsides for religious burial requirements linked to time and depth of burial sites.

During the site visit a number of community members noted that the settlement gets flooded regularly and water disburses slowly.

Elders also indicated they would prefer to be engaged separately and made a suggestion for an Elders CRG with appropriate translation support.

This Elders CRG was scheduled for November 2022, with membership coordinated by the Imam.

Meeting with Shire

A member of the project team met with the Shire to close out on-island engagement, present a summary of what was heard in the engagement on-island, and discuss next steps.

Meeting with Stakeholders

Two additional meetings with stakeholders were undertaken to discuss specific site management issues.

Both stakeholders recognised the challenges associated with coastal hazards and the impact these might have their own assets, and acknowledged the limitations that may need to be recognised in future planning.



FIGURE 9 - VALUES / ASSET MAPPING TASK - HOME ISLAND



FIGURE 10 - PRIORITISED ASSETGROUPS - HOME ISLAND 1

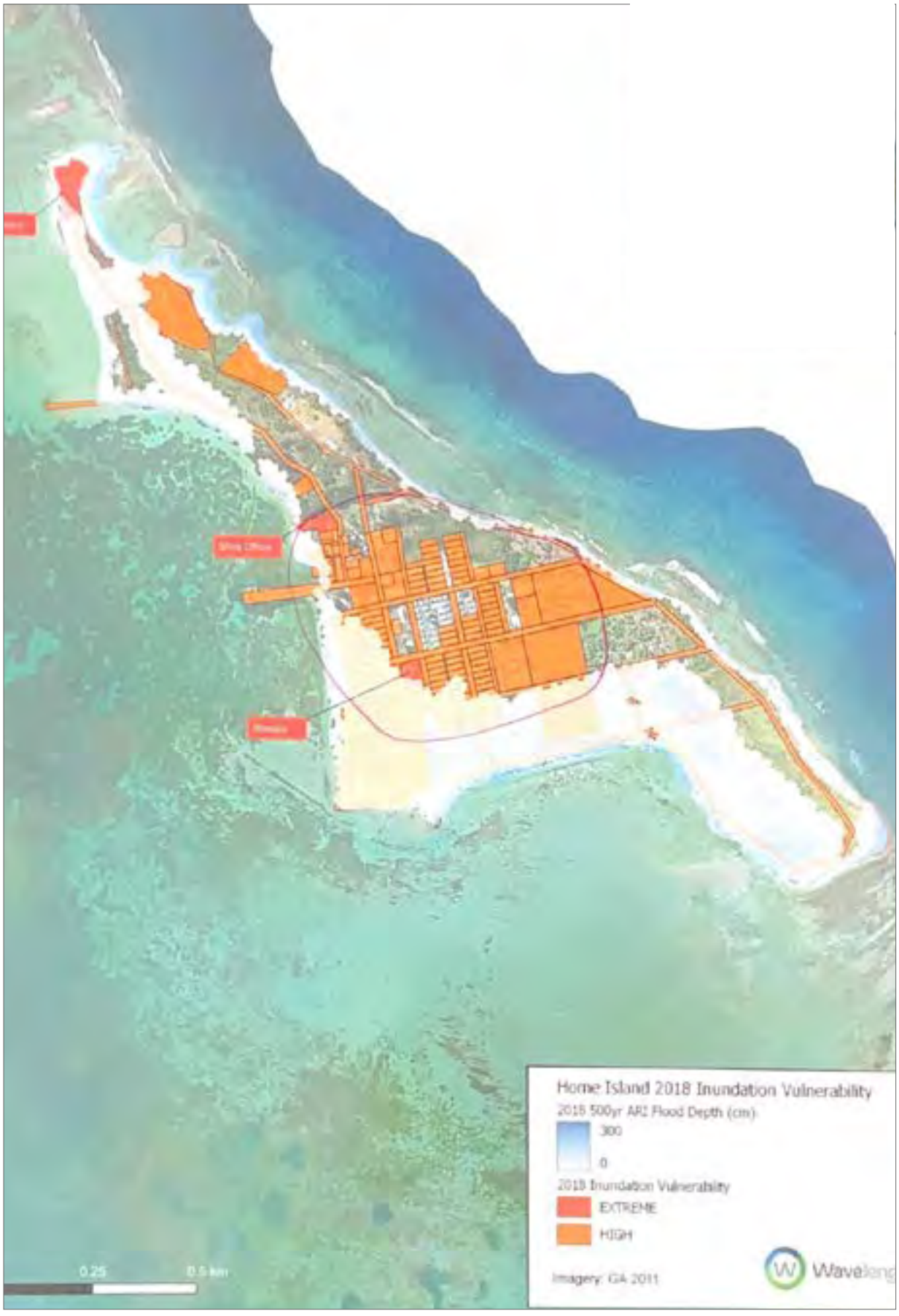


FIGURE 11 - PRIORITISED ASSET GROUPS - HOME ISLAND 2

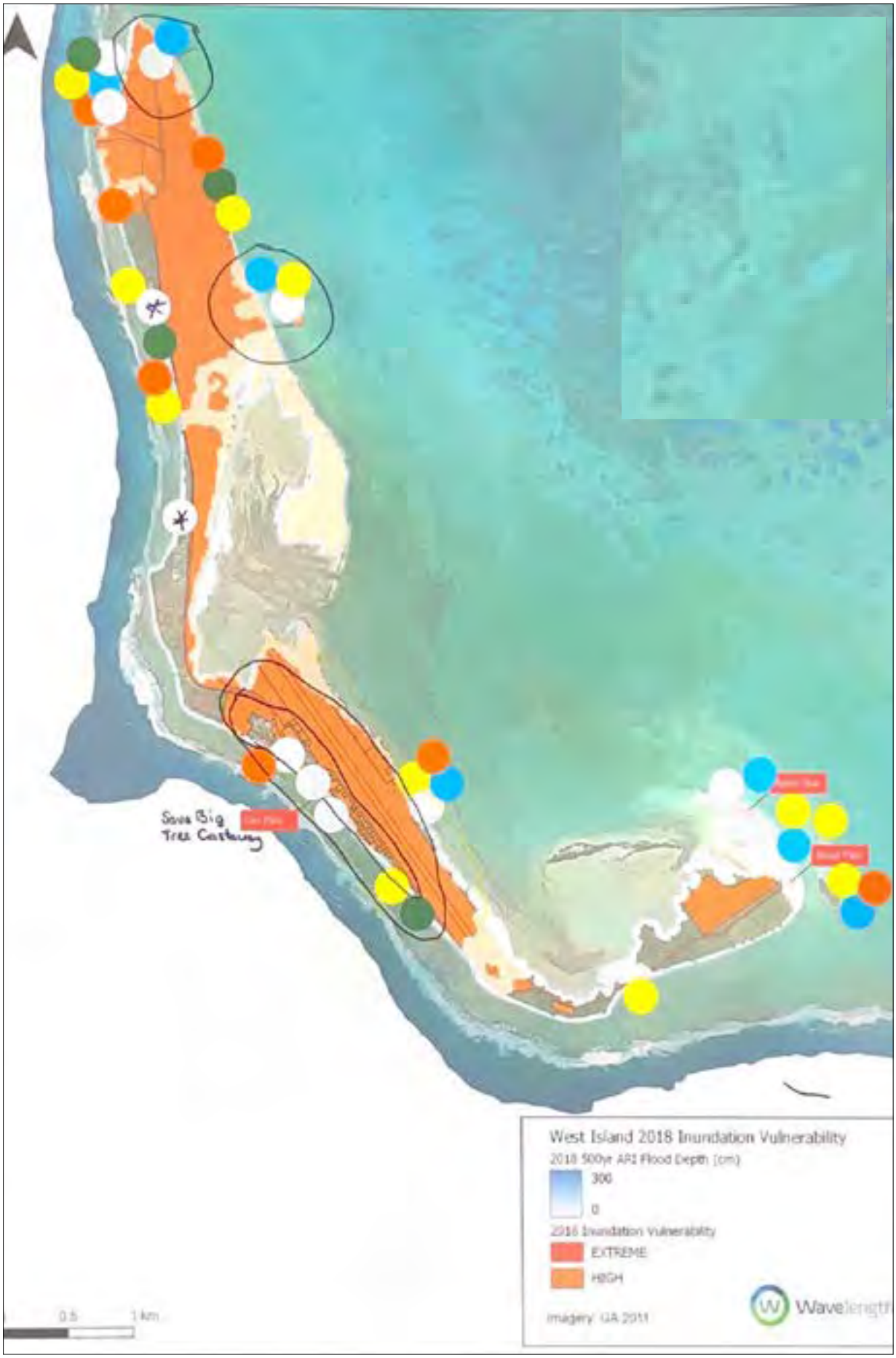


FIGURE 12 - VALUES / ASSET MAPPING & PRIORITISED ASSET GROUPS - WEST ISLAND



FIGURE 13 - PRIORITISED ASSETS - WEST ISLAND

4.4 ON-ISLAND ENGAGEMENT - NOVEMBER 2022

The November 2022 on-island engagement program included meeting with the Shire and the Elders CRG program.

The project team engaged with:

- 15 Elders at the first CRG session
- 18 Elders at the second CRG session
- The Imam
- The Shire

The Elders CRG sessions were held at the cyclone shelter on Home Island. The Imam supported the process through invitations and translation.

The Elders CRG program replicated the general CRG program undertaken in September 2022 (at Section 4.3). The November 2022 engagement provided members of the project team with time to discuss Elder-specific issues and build awareness with them.

There was also time for CRG members to communicate with the project team outside of the scheduled activities.

The details and outcomes of the November 2022 on-island engagement activities are summarised in this section of the report. Given the CRG program replicated the one undertaken in September 2022, a summary of discussions and outcomes from the two CRG sessions is at Section 4.4.1. Meetings are discussion in Section 4.4.2.

4.4.1 Elders CRG Sessions

Format of sessions

The first Elders CRG session was held on Friday 11 November 2022 from 4:15 to 5:00 in the cyclone shelter on Home Island. The session was attended by 15 Elders and the Imam.

The attendees were introduced to the project background before being provided a presentation on coastal processes, hazards and risks on CKI. They were invited to say what they thought should be done over the next 100 years to 'solve' coastal issues.

The second Elders CRG session was held on Monday 14 November 2022 from 1:00 to 3:00 at the cyclone shelter on Home Island. The session was attended by 18 Elders, and the Imam.

The second session provided a recap of the context for the project and presented, for discussion, the viable risk management (adaptation) options that work in the island atoll environment, what is possible to implement, the impacts of each type of option, longevity of each option and other impacts that my be indirect (for example other islands).

Attendees undertook the values mapping exercise undertaken by other groups and an open question and answer session followed.

The Elders CRG session presentations follow the original CRG in September 2022 (at Appendix D and Appendix G).

Key outcomes

The key outcomes from the Elders CRG sessions are detailed below. It should be noted that these outcomes are specific to Home Island.

Values:

- Cemetery – the Elders identified the cemetery as their highest valued asset
- Mosque - the mosque was also identified as an important value

Concerns:

- The jetty has changed the water
- The cemetery is being eroded
- Flooding of houses in the settlement - the project team noted that there was limited recognition of the difference in groundwater versus inundation flooding, however with some clarification this was better understood
- Highly concerned about water in buildings
- The front row of houses – House 56 and houses 25-28 flood in very basic rain
- Concern that management costs are expensive

Suggested approaches:

- Dredge from the lagoon/ other areas and bring to shore to add an additional 10 metres of land – nourish edges (it was, however, noted by another Elder said this was a risk)
- Sandbags do the job
- Dredge to lift land
- Build a barrier/ line to protect assets and services
- Dredge – example on Swan River to reclaim area
- Collect sand on Barge – from Prison Island
- Import sand/ dredge and fill sandbags
- Sand to increase the height of low lying areas
- Short term – upgrade drainage so houses don't flood
- It was noted that lifting homes seems possible
- Comfort in implementing planning controls for minimum finished floor levels for residential properties in the settlement.

Elders also queried when these approaches/ 'something' might happen.

General Comments:

- Costs should be borne by the Commonwealth or Shire
- Community have told us what they think – now it's up to scientists
- Community want the Minister to come and see how they are living – understand it
- Elders want the team to return and spend more time talking to different people on the islands, get more young people involved





4.5 ONLINE MAPPING TOOL OUTCOMES

The project engagement platform included an online mapping tool and a project interest registration survey. The platform attracted 946 visitors, 345 unique users, 125 comments and 3 registrations of interest.

Of the 125 comments pinned on the mapping tool, 44 relate to Home Island and 41 to West Island. The remaining 40 pins identify local pondoks (shelters) marked on the map (see Figure 14 for the marked up pondoks in grey - Something else/ Other).

Comments were created with the same five categories as used in the CRG workshops on-island. Summarised key values are:

- Picnic areas along the coastline on both islands
- Fishing areas on both islands
- Boat launching locations on both islands, with comments noting the inadequacy of their current states to service needs of community members
- The Jukong and sailing club on Home Island
- Swimming and snorkelling - with specific mention of the Yacht Club and Trannies Beach on West Island and the inner lagoon foreshore area on Home Island
- The need to manage the vegetation growing on-island, with a preference for natives to manage erosion and for aesthetic purposes
- Identification of revegetation areas on Home Island
- Identification of local vegetation species used by the community for firewood for ceremonies and cooking, and also as a potential option to hold sand
- Surfing at the Spot on West Island
- Cultural and religious significance of Pulu Gangsa - the cemetery

Other comments:

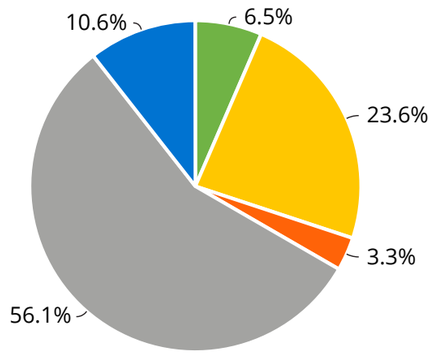
- Noted that tourism is 'talked up' but does not benefit most of the locals who are instead disadvantaged by it
- Identified pondoks on the other islands in the atoll ring

The full list of comments broken down into islands (Home Island and West Island) and categories is in Table 4 and Table 5.

Figure 14 depicts all mapped comments, breakdown of category comments and key words (via a word cloud). Figure 15 and 16 are zoomed into the key island settlements.



Comment Category Breakdown



Key Words

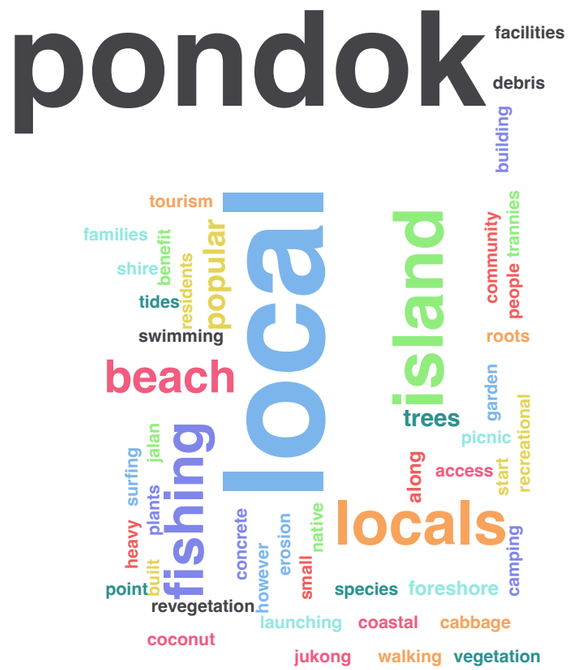


FIGURE 14 - ONLINE MAPPING TOOL COMMENTS, CATEGORY BREAKDOWN AND KEY WORDS



FIGURE 15 - ONLINE MAPPING TOOL - HOME ISLAND VALUE AND ASSETS MAPPING



FIGURE 16 - ONLINE MAPPING TOOL - WEST ISLAND VALUE AND ASSETS MAPPING

TABLE 4: HOME ISLAND COMMENTS ON MAPPING TOOL

HOME ISLAND COMMENTS
Water based activities
Jukong and sailing club. The foreshore area is most popular for launching jukongs and T2 catamarans. The community also uses this space for Market Days and recreational swimming with the family.
Swimming spot.
Local swimming beach
Pondok Nek Jamil also attracts the local residents for parties and BBQ's. The locals also fish here on high tides for targeted species such as bonesfish and silveries.
Sandy Point has been a very popular attraction beach quite recently. The Shire has built shelters, toilet facility, playground, beach wheelchair and ramp for easier access for people with disabilities. families often come her for weekend recreational swimming and picnics.
boogie boarding spot for locals.
Foreshore based activities
local fishing spot.
local fishing spot.
Boat launching area for the locals. This boat ramp is equipped with brick paving and kerbing.
Beach fishing and boat launching area for some locals. The large shady casuarina trees provide much needed shade protection from the elements.
Beach debris project collection area. Pasir Nek Ayak.
Kampong Baru is a very popular area for all Home Island residents. It is where the Jukong club launch and start their races. It has a number of small infrastructures such as bench seating and a shelter. There are six beat ramps along this foreshore.
fishing spot
jalan Balok mem a popular road for fitness enthusiasts.
Locals forage for drift timbers for projects along this stretch of beachline called Alor Charlie. You will find the most beach debris items on the beach.
fishing sport called Alor Charlie.
Beach Debris collection area.
local fishing spot.
fishing spot for the locals.
Netting spot for bonefish.

TABLE 4: HOME ISLAND COMMENTS ON MAPPING TOOL

HOME ISLAND COMMENTS
Beach based activities
Picnic area with shelter at Ujung Waru. Popular for locals when fishing or getting ready to prepare equipment for reef walking.
Pondok Nek jamil picnic spot.
Pondok Abang and ideal location to spot fish and to fish from. This small viewing platform was consutructed in 2006 by the Coastcare project.
Nature based activities
bird watching area. Area is subjected to inundation during heavy rainfalls.
Something else/Other
old Home Island school building.
Vegetable garden established by locals. they plant fruit trees and bananas. Area however is subjected to inundation and high salinity.
Revegetation area at the chicken and garden plot off Jalan Kipas and Jalan Kampong Atas.
old Bungalow site, former home of the Copra Manager.
Chicken and Garden Plots. The locals have established an area away from the community to raise free range chickens and grow bananas, pumpkin, tapioca and drinking coconuts.
Heritage building, carpentry workshops, blacksmith, offices, slipway and boat building area.
Reclaimed foreshore, built upon rubble from the old concrete homes.
Rehabilitation of native tree species at this site behind the container park. e.g box tree, callopylum, pisonia grandis and hernandia.
Heritage listed area.
Large native calophyllum trees that assist in beach stabilisation and act as buffer zones.
Boat storage area for the locals.
Revegetation of native trees.
Tanah Tinggi, lookout area, highest point on island.
Revegetation of native species.
revegetation area.
Cultural and religious significance is Pulu Gangsa , the burial site for all Home Island residents. Was once a separate island the strait that divided it was closed off by the locals in the early 1900's

TABLE 4: HOME ISLAND COMMENTS ON MAPPING TOOL

HOME ISLAND COMMENTS
Need to start thinking of restoring those cabbage bush and phempis along the coastline to stop erosion, as thise plants holds soil together and less clearing along coastal line for vegetation. Also the sand bags is good but as we built one area, it starts to eat somewhere else. As our island is so low, big tides and heavy rains are my main concern??? Landfill like what they did back in the days, eg infrontnof shire office?
REPLY TO ABOVE: Strategic planting of native vegetation can be used to help control erosion. the roots of coastal plants help to anchor the sand and ensure that it is not carried off in erosion.
In the past the breakwater was fully exposed at higher tides. This created a good buffer from wave surges from the north west.
Green waste site and rubble site.

TABLE 5: WEST ISLAND COMMENTS ON MAPPING TOOL

WEST ISLAND COMMENTS
Water based activities
Camping snorkelling swimming and boating from the south end
Boat ramp
Sheltered area for families to swim and picnic if they don't want to use the yacht club facilities.
Surfing at The Spot
Boat ramp facilities - although current state is inadequate to service needs of community members
Swim snorkel beach walks BBQs at Trannies Beach
Surfing spot for the locals.
Foreshore based activities
Fishing and crayfishing spot for locals.
fly fishing area
Walking along foreshore and living close to the foreshore
The island used to have many wood barbecues around the island and these have gradually been removed to the detriment of the island however bbq's as in national parks with a simple rounds concrete with swing over plate could be installed around the island increasing outdoor activities and eating.
small boat ramp
fishing spot
fishing spot
Popular fishing sport for locals.
fishing spot.
Bob's Folly...used to be an anchorage area
bicentennial track
fishing spot
Good fishing spot on a high tide for certain fish species.
Ujung Pasir is a popular beach fishing spot for the locals and also netting spot for mullet and goatfish.
Popular fishing spot for locals.

TABLE 5: WEST ISLAND COMMENTS ON MAPPING TOOL

WEST ISLAND COMMENTS
Beach based activities
Secret beach area away from other popular beach swimming and rec areas. The area is also a breeding spot for the Sooty Terns.
Scout Park popular area for picnics and outdoor entertainment. Some locals do launch their smaller boats from the beach here.
Cocos Islands Adventure Tours
Camping area.
Picnic area for locals.
Nature based activities
Massive fig tree
Bird watching area for visitors and locals.
Bike and car track.
Something else/Other
iron wood tree along the foreshore
Pulu Kambing has many pemphis bushes along the foreshore and locals use this for firewood for ceremonial and everyday cooking.
The services on the island are stretched due to tourism and not many jobs are created through tourism.
Firewood collecting. pemphis
Red Claw farm
Tourism is always talked up as being good for the island however I think most of the residents of the island don't benefit from tourism and indeed are disadvantaged from it. A very small portion of people on the island benefit from tourism being accommodation providers, tours and cafes however a lot of the accommodation providers don't live on the island and the profits go off island providing no benefit to the island.
The concrete wall behind government house seems to be the best prevention for erosion and has been standing for about 30 years with little or no maintenance. The temporary bagging of the island only has a short life and requires lots of maintenance so I feel that over a life of 30 years the concrete wall would be a more effective solution both in performance and cost. Access to the shoreline would require stairs as installed currently at the spot and trannies so I don't think this is an issue
REPLY TO ABOVE: The bags become slippery and also need stair access so I don't consider access with a concrete structure any worse than the bags.

TABLE 5: WEST ISLAND COMMENTS ON MAPPING TOOL

WEST ISLAND COMMENTS
Flight to and from the islands are now very difficult and expensive to obtain due to increased tourism and this is having an adverse affect on all islanders who have to book up to 12 months ahead to get flights.
The island has no had any management of what is growing on the island which is predominantly coconut trees, cabbage bush and consequently the native trees and bushes to the island are under stress and are not able to act in preventing coastal erosion. Coconut trees have very shallow roots and when they fall they make the ground unstable and increase erosion. Cabbage bush has many shallow roots but when allowed to grow uncontrolled as it has been it takes over and makes the shoreline unpleasant
The number of coconut trees growing on the island must be millions and with no management they provide no benefit to the island and alternative plants or reducing the numbers should be considered.



4.6 PRELIMINARY ENGAGEMENT SUMMARY

Approximately 90 community members and stakeholders participated in this stage of engagement.

The key themes identified during this stage are:

Recreation

- Use of beach and foreshore areas for walking, picnics, community get togethers is highly valued on both islands
- Fishing is highly valued on both islands
- Boat launching is highly valued by the two island communities
- Surfing, swimming and snorkelling spots are highly valued on both islands - specific mention of the Yacht Club and Trannies Beach on West Island and the inner lagoon foreshore area on Home Island

Environment

- The ocean, views, landscapes, foreshore vegetation are highly valued
- Protecting the foreshore vegetation and prioritising native revegetation / managing revegetation as a soft management option is supported
- Protection of trees that are being felled by water and weather conditions

Amenities and infrastructure

- The yacht, jukong and sailing clubs and other sporting/ recreation clubs are highly valued
- The jetties on both islands are highly valued, with comments about protecting these assets for private and between-island access a priority
- *A note about ongoing conversations about asset data on-island with government stakeholders (e.g. Water Corporation bores on both islands) - this includes sacrificial asset consideration*

Culture and heritage

- Cultural and religious significance of Pulu Gangsa - the cemetery on Home Island, with various comments about regular inundation experienced at this location
- The value of the mosque was also identified by Elders on Home Island

Management options

- Concern about the impacts of coastal change, with CKI community members observing felled trees around the coastlines of the islands, sandbags that had been impacted and how much the coastlines on Home Island and West Island had changed over time (erosion significance)
- Consensus on things being done to manage vulnerability risks - it is time for action, not ‘re-planning’
- Discussions about the longer term possibility of retreat as an option initiated with the community

- The community is well versed in the coastal processes and changes that are occurring in the CKI, with members noting sediment movement, overtopping of trees, island shapes changing and the according impacts on the community's ability to do the things they used to do
- Prioritisation of settlement protection on both islands, with additional prioritisation of protection of the Yacht Club and Rumah Baru jetty areas on West Island - noting access implications of protection structures
- Concern about the clinic location on West Island, with the seawall protecting it also a concern - community members noted a construction joint shift in the wall
- Island-based preferences for management options - soft options and retreat consideration on Home Island and protection, adaptation and engineering option consideration on West Island
- A desire for education programs about coastal processes on Home Island
- Queries from the community about funding and payment for management options and the timing for management responses/ actions
- Observations that the CKI community is adapting to coastal changes and will continue to do so, selecting the most applicable and safe options
- Consideration needs to be given to the breach points at boat ramps
- Drainage and water issues on-island are relatively unknown - one of the adaptation pathway recommendations may be to investigate drainage/ do a drainage study that investigates drain time and options for management into future

<u>Other comments:</u>

- Community members on-island discussed tourism in the context of its proposed benefit to the local community - with argument that most community members are disadvantaged by it
- Pondoks on the other islands were noted as values, with these marked on the map at Figure 14
- Kampong drainage on Home Island - drain pipes from the kampong to the ocean been recently been opened up to aid drainage of kampong land



6 NEXT STEPS

This report summarises the preliminary engagement undertaken with the CKI community and key stakeholders for Stage 2 of the CHRMAP process.

It includes:

- Two in-person workshops for Government and other key stakeholders in Perth;
- A September 2022 CRG program - two workshops;
- A November 2022 Elders CRG program - two sessions;
- Information sessions on-island;
- Incidental encounters with CKI community members;
- Targeted meetings on-island and in Perth;
- Online project website engagement;
- Online interactive mapping tool engagement; and
- Communications with stakeholders.

The community and stakeholder values collected so far will be used to inform the progression of adaptation options for the islands, through the multi-criteria assessment (MCA) process, and refinement of viable adaptation options, through further consideration of trade-offs resulting from each option.

Following internal assessment and refinement of viable potential adaptation options further, the project team will commence communication and engagement with the CKI community and stakeholders about the MCA process.

This report will be updated after the next stage of engagement with the CKI community and stakeholders.





7 ENGAGEMENT EVALUATION

**This section of the report will be updated following completion of the CHRMAP process.*

TABLE X - EVALUATION TARGETS

MEASURE OF SUCCESS	EVIDENCE
Number of people aware (impressions on social media, website visits, document downloads etc)	400
Interested stakeholders (total number of people who contribute)	100
Open rate on e-News / click throughs	30%
Expressions of interest for workshops	>20
Attendee profile at workshops	Diversity of applicants allows at least three community profile ratios to be achieved (age, gender, land ownership, culture, geography categories)
Workshop evaluations	65% satisfied or very satisfied
Outcomes reporting	All deliverables accepted by Australian Government and DPLH
Recommendations accepted by Australian Government and DPLH	>90%



APPENDICES

APPENDIX A: Perth Government Agency Workshop Presentations

APPENDIX B: 2016 and 2068 Vulnerability Mapping for Perth and On-island Engagement

APPENDIX C: Adaptation Infographic

APPENDIX D: CRG Workshop 1 Presentation

APPENDIX E: CRG Workshop 1 Homework Worksheet - Values / Assets

APPENDIX F: CRG Workshop 1 100 Years Solution Worksheet

APPENDIX G: CRG Workshop 2 Presentation

APPENDIX A

Perth Government Agency Workshop Presentations

Cocos (Keeling) Islands Coastal Hazard Risk Management and Adaptation Planning Project

Australian Government Department of Infrastructure, Transport, Regional Development, Communications and the Arts, in partnership with WA Department of Planning, Lands and Heritage, and Shire of Cocos Keeling Islands

August 2022

SHAPE URBAN

Why are we here today?

We are doing the Coastal Hazard Risk Management Adaptation Plan (CHRMAP) for Cocos (Keeling) Islands

We will explain what this is and how you are involved in the next few slides…

Introductions

Steering Group

Commonwealth Department of Infrastructure, Transport, Regional Development, Communications and the Arts

WA Department of Planning Lands and Heritage

Shire of Cocos (Keeling) Islands

Department of Transport (Coastal Infrastructure Branch)

Consultant Team

Shape Urban – Planning, Communications & Stakeholder Engagement

Wavelength – Coastal Planning and Engineering

FAR Lane – Economics/Cost Benefit

SHAPE URBAN

Your Team Today

Australian Government – Jeff Dzodz

Department of Planning, Lands and Heritage – Peter Wood, Ben Bassett

Consultant Team:

Shape Urban – Anna Kelderman, Anika Chhabra

Wavelength – Annabel Sandery

FAR Lane – Jason McFarlane

Introductions

Who are you?

What agency / section are you representing?

Why are you interested in / impacted by this project?

How this session will work

- Process/project
- Coastal processes, hazards and risks on CKI (context)
- Assets and values in Coastal Hazard Zones
- Risk management approaches/adaptation options available (viable)
- Multi criteria assessment – what are the criteria?
- Q&As through the session



What are we doing?

The Remit

The Cocos (Keeling) Islands are affected by coastal erosion and inundation, with vulnerability of use and development expected to increase in the future.

- Home Island and West Island coastlines are used and highly valued by the CKI community
- Important to understand how the coastlines are changing
- How to respond to these changes for sustainable coastal living for the CKI community into the future
- We will be making recommendations for action

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The Remit

So we are preparing a CHRMAP…

…a strategic document to *plan* for responding to *coastal hazard challenges…*

- Identify vulnerable public and private assets
- Recognise and preserve community values for current and future generations
- Inform community and decision makers
- Required under West Australian State Planning Policy 2.6 – State Coastal Planning

A plan for the next 100 years (but on CKI….?)

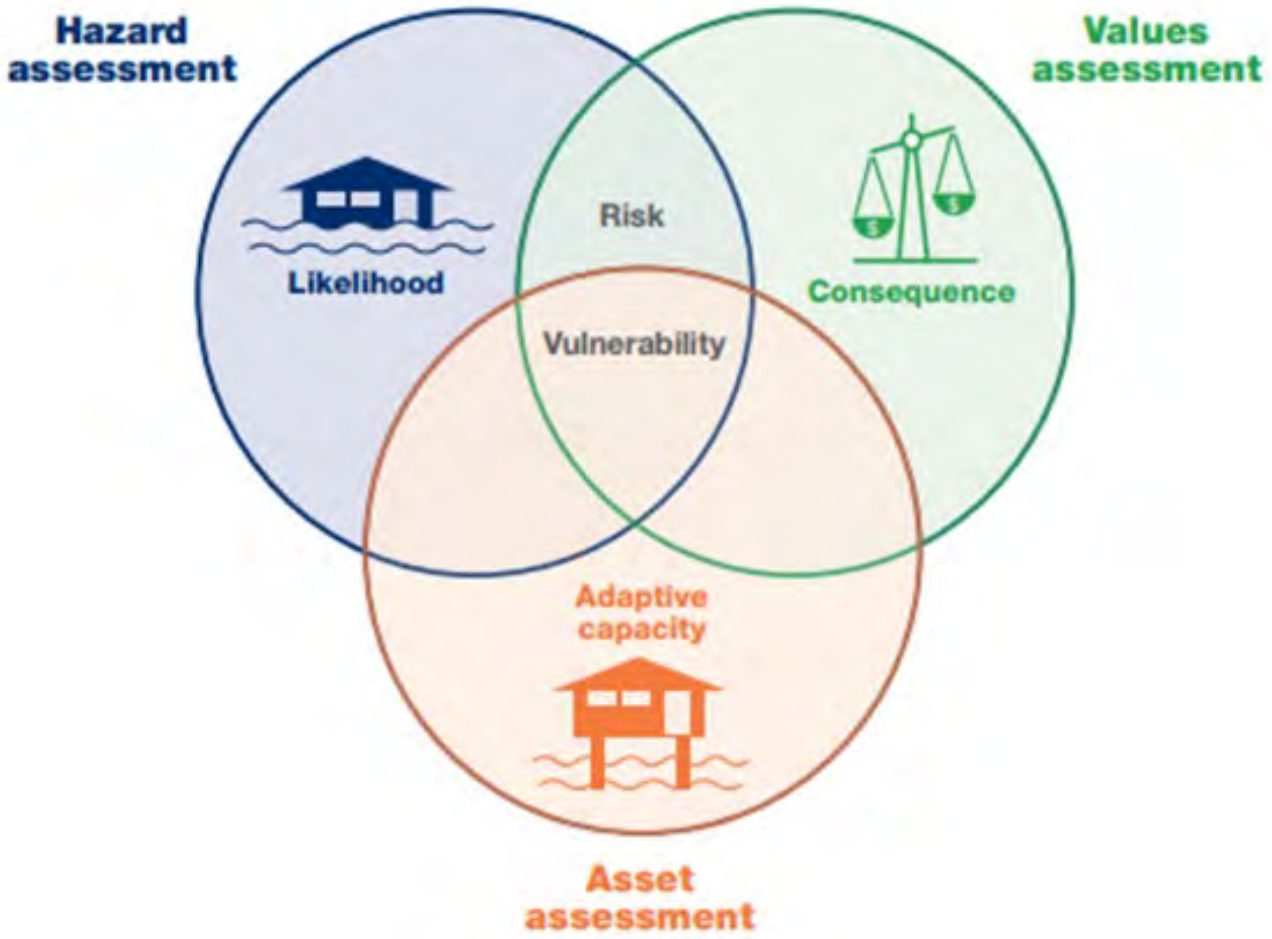
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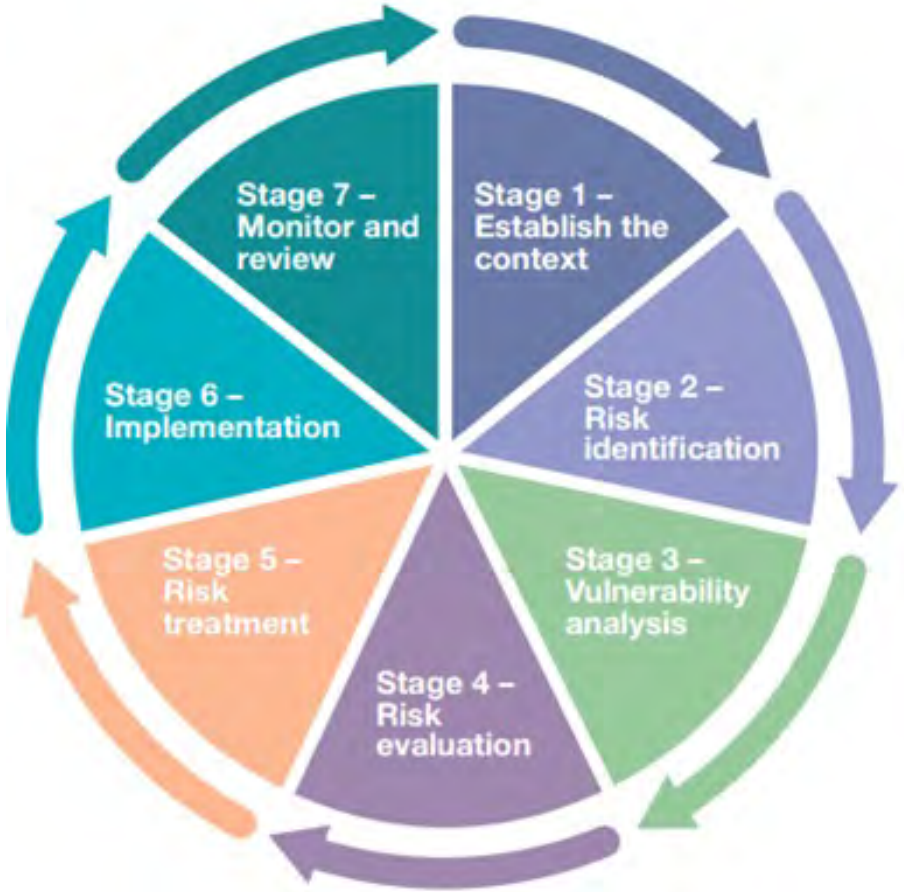
What a CHRMAP does

Predict the *risk* of **erosion** + **inundation** with sea level rise

- Looks at likelihood of exposure on an asset
- Looks at consequence of exposure on an asset (or sensitivity)

Then considers adaptability of the asset





SPP 2.6 + CHRMAP Guidelines - Process

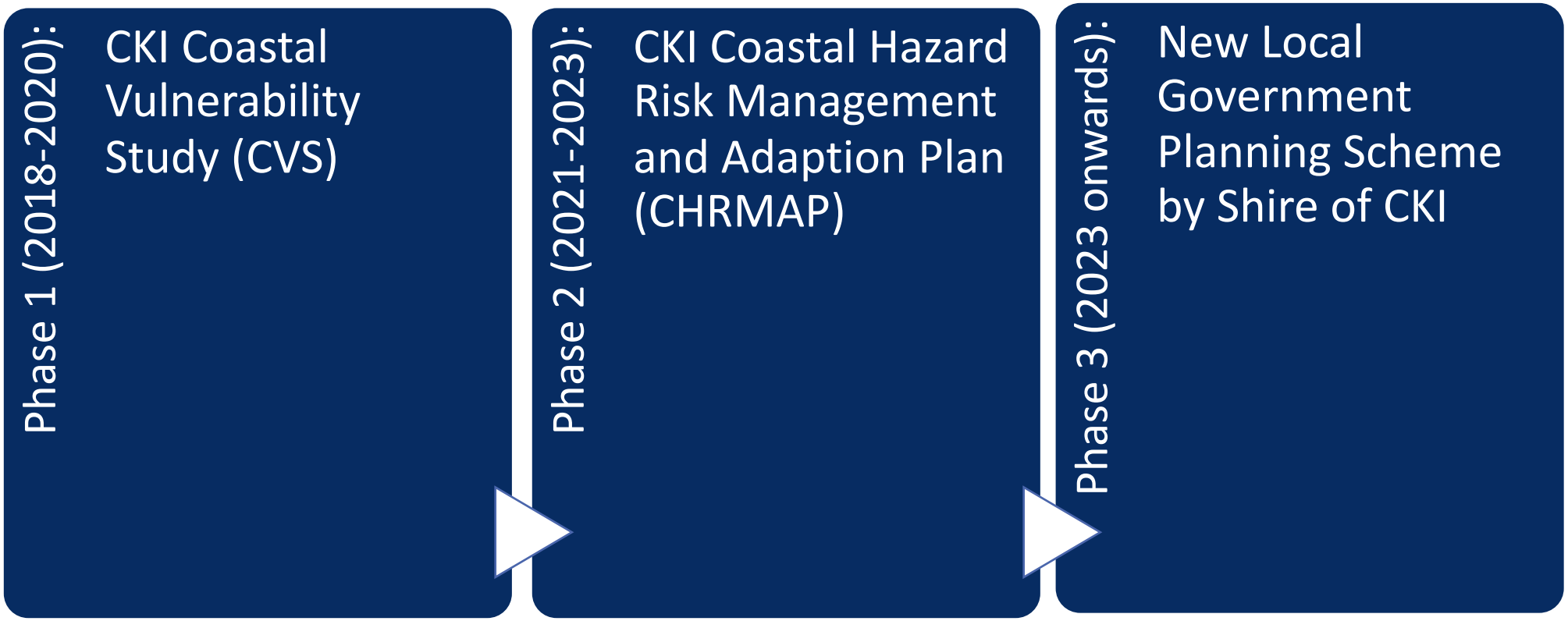
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Project Background

- DPLH - state-wide responsibility for the planning - provides support to the IOT under Service Delivery Arrangements (SDAs) with Commonwealth
- DPLH is responsible for delivering on State Planning Policy. In this case - *State Planning Policy 2.6 - State Coastal Planning Policy* - SPP 2.6
- SPP 2.6 looks at vulnerability of populations. Perhaps the most critical issue affecting the future sustainability of human settlement on CKI

Project Background (cont…)

- DPLH - *Cocos (Keeling) Islands Coastal Vulnerability Study* (Haskoning Australia PTY Ltd, 2021) identifies areas vulnerable over a 100-year planning timeframe
- This project is next step to deliver a ‘CHRMAP’
- Then deliver actions ($$)


Phase 1 (2018-2020):
CKI Coastal Vulnerability Study (CVS)
Phase 2 (2021-2023):
CKI Coastal Hazard Risk Management and Adaption Plan (CHRMAP)
Phase 3 (2023 onwards):
New Local Government Planning Scheme by Shire of CKI

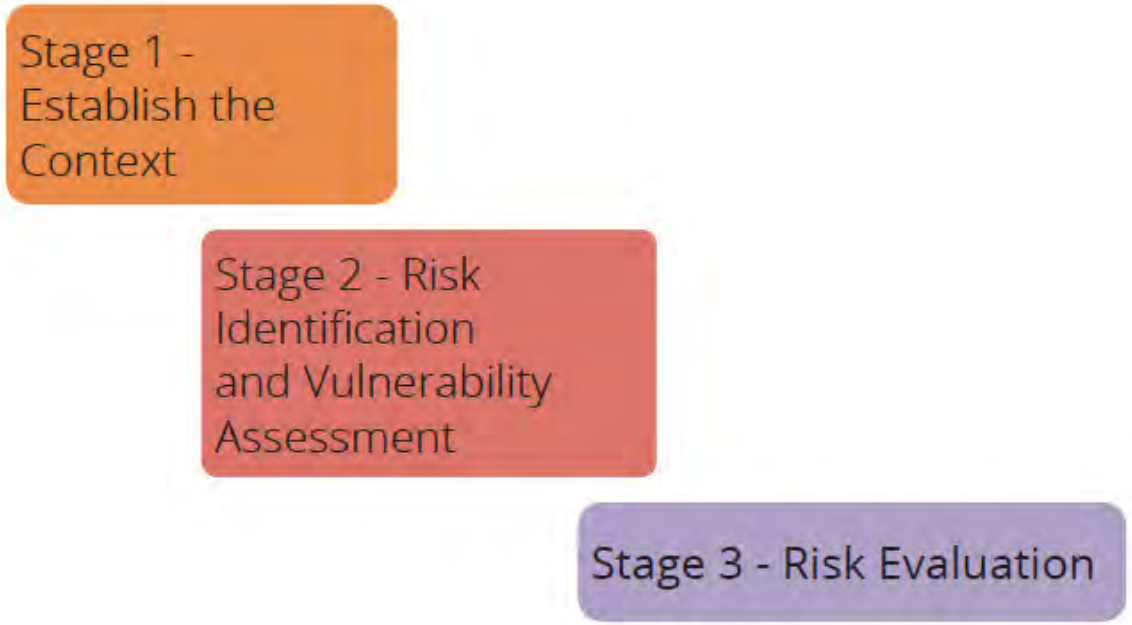
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How to complete it

Understanding the local environment and community values

Assessing how much things can cope with the impact of climate change

Identifying the risks (likelihood of an event occurring and the consequences of that event occurring)



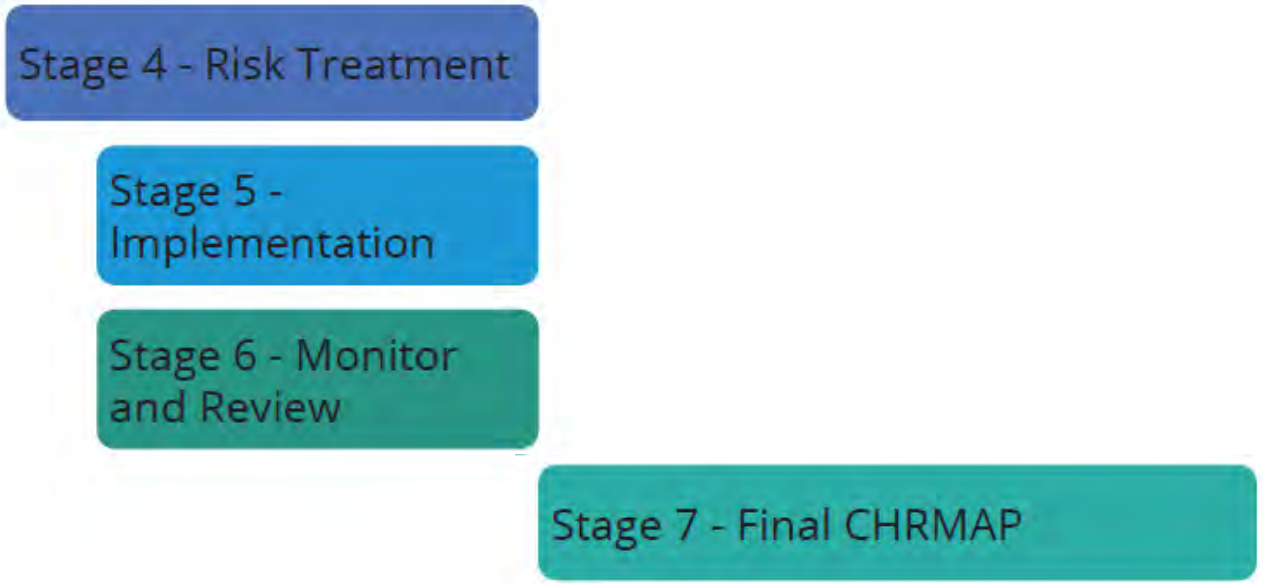
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How to complete it

Analysing the findings and evaluating the management *options** for each asset that is vulnerable

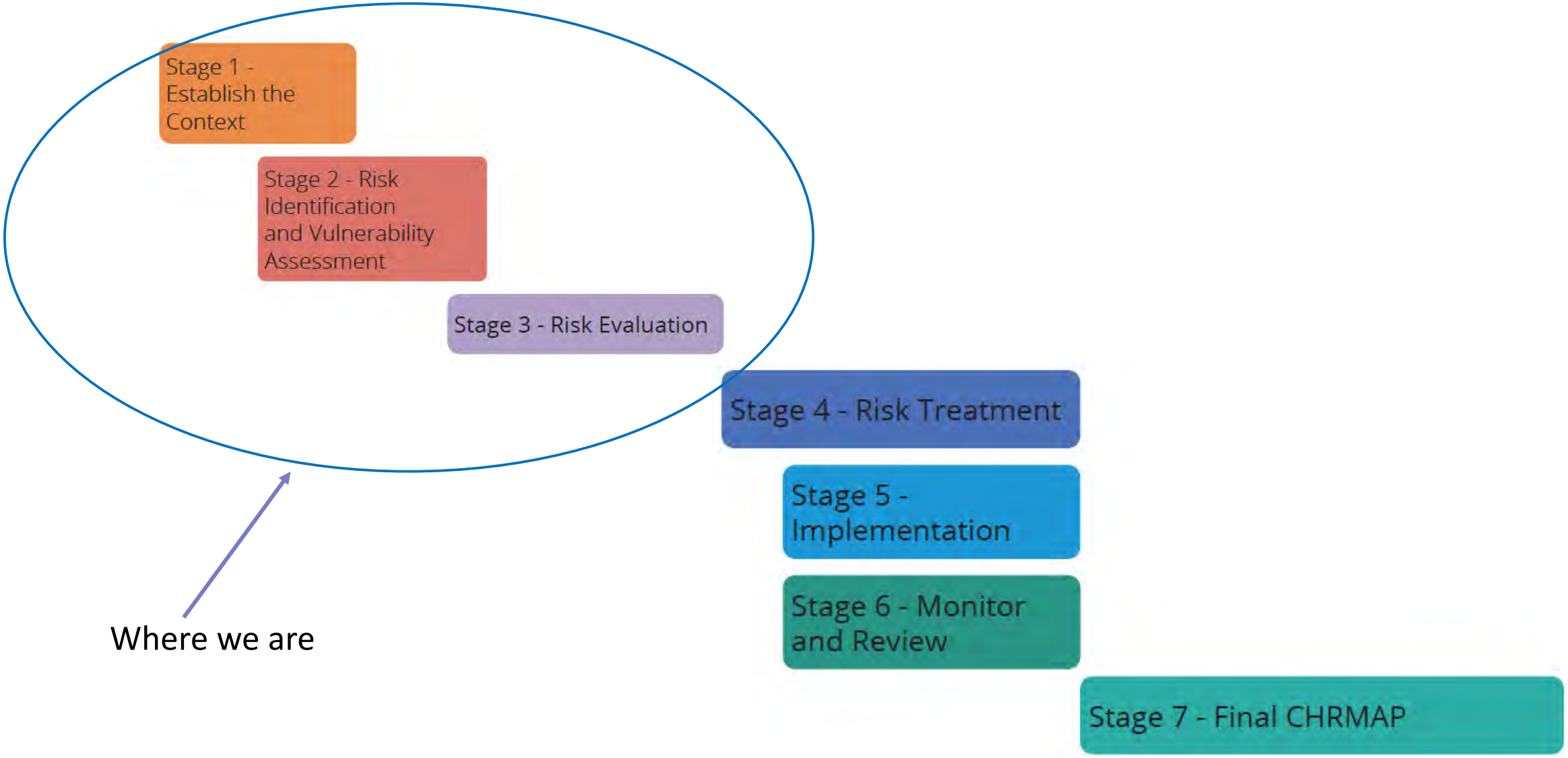
Identifying the adaptation *options** for each asset that is vulnerable

Identifying funding options, monitoring and review of frameworks



In the case of CKI – 'options' could be interesting – there may not be options for each asset, rather options for significant groups of assets

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Stage 1 - Establish the Context
Stage 2 - Risk Identification and Vulnerability Assessment
Stage 3 - Risk Evaluation
Stage 4 - Risk Treatment
Stage 5 - Implementation
Stage 6 - Monitor and Review
Stage 7 - Final CHRMAP
Where we are

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Other Studies

- Hydrographic surveys, long term wind data, long term tide data, topographic information, LiDAR, metocean data, CVS
- Climate Change Risk Assessment
- CKI Sand Management Strategy Numerical Modelling Report
- Crown Land Management Plan for IOT
- An assessment by BoM (2005) regarding cyclone activity in the region
- Physical Coastal Processes for Rumah Baru

(RHDHV, DoT, DoD, Maunsell, CZM, DA Lord & Associates, GHD, BoM…)

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What it all says (so far)

- The islands are one of the most vulnerable coastal types to Sea Level Rise (SLR)
- The CVS shows risks are already ‘High’ for multiple assets.

The studies don’t tell us what is *valuable* to the community, only what is *objectively* vulnerable



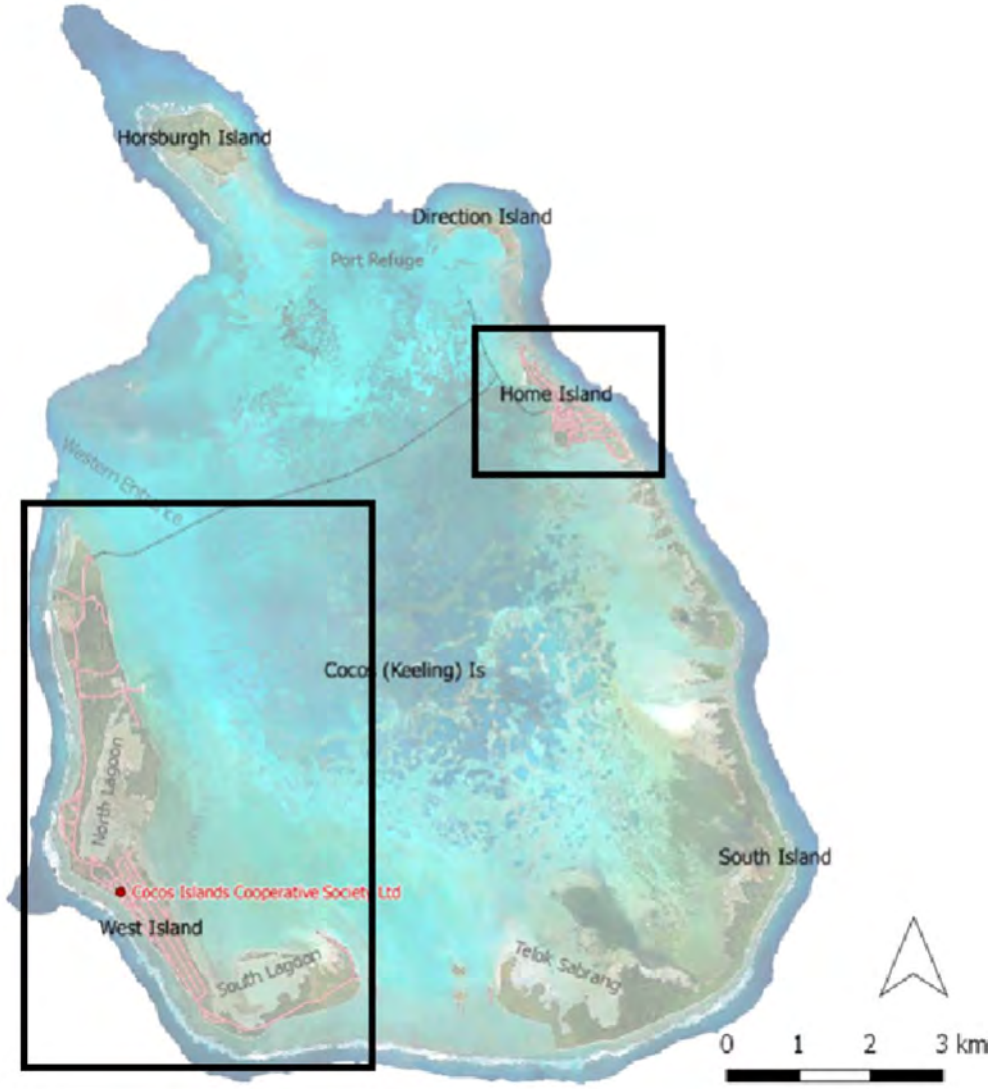
Island landforms and settlement

The shoreline around CKI can be divided into:

- ocean shores that occur around the perimeter of the atoll and face the open ocean; and
- lagoon shores that flank the lagoon

Fringing coral reef surrounds all the CKI lagoon

Two breaks in the reef at Port Refuge and Western Entrance

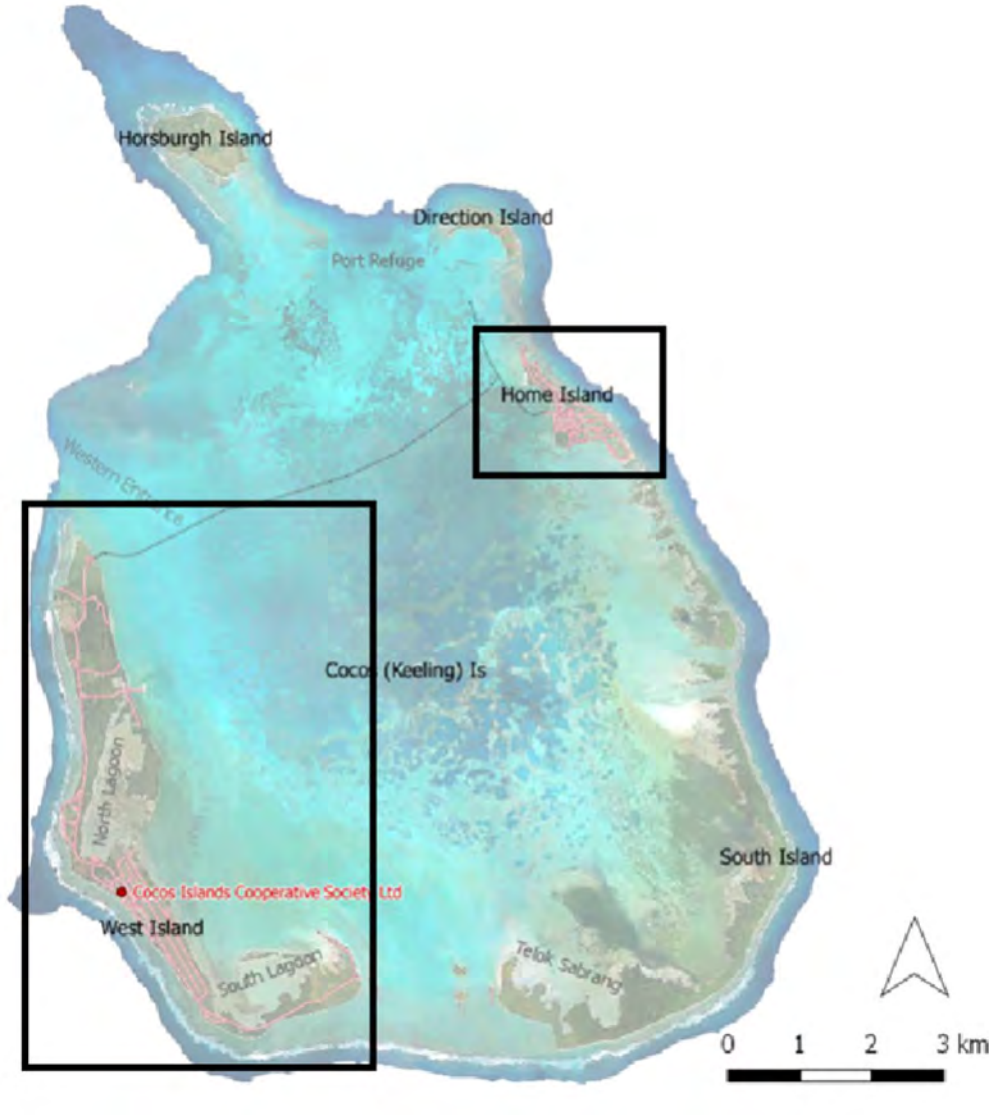


Home Island

Home Island is located on the eastern side of CKI.

Home Island is low lying and susceptible to coastal flooding, especially the foreshore adjacent to the lagoon.

Most shorelines on Home Island have been stable and infrastructure on the ocean coast is reasonably setback in most locations.



Home Island





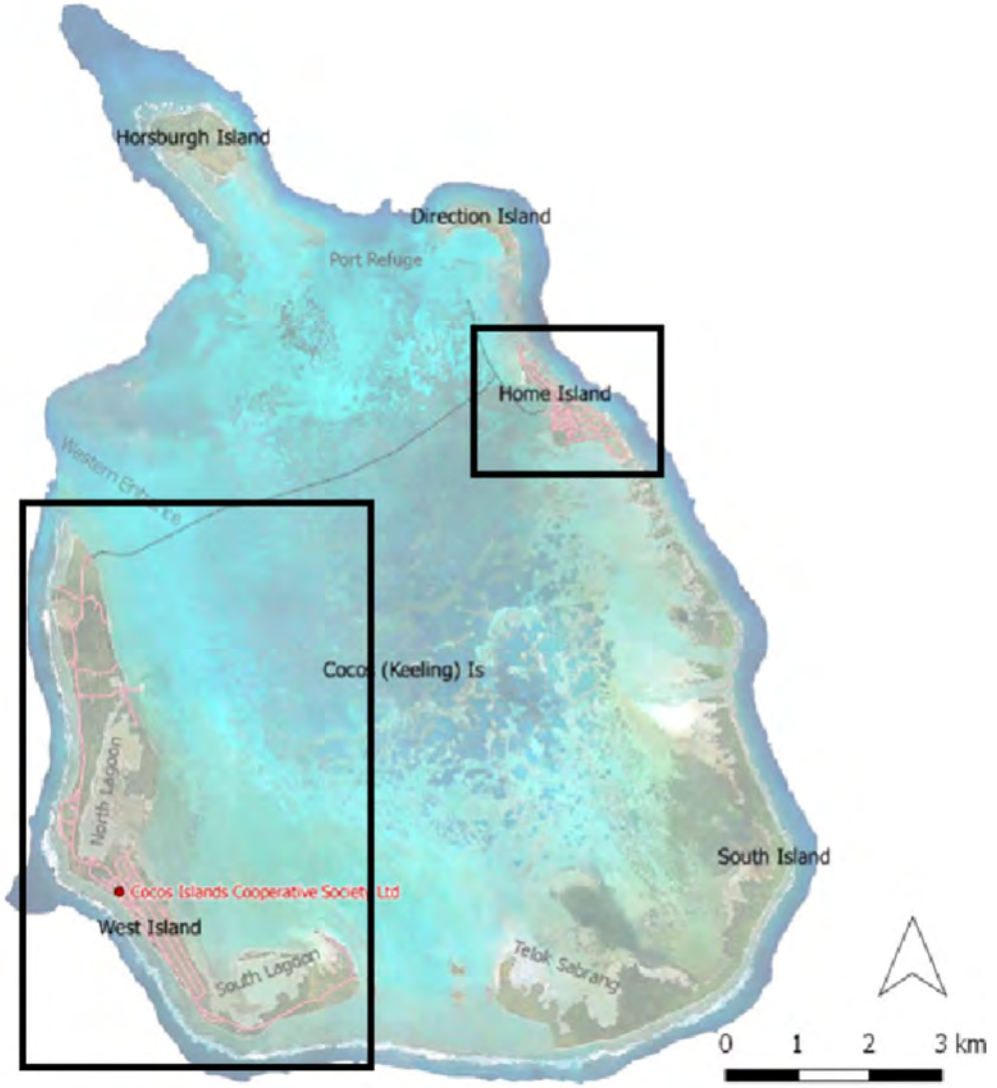
West Island

West Island - elongated shape with a sandy shoreline.

Development concentrated around the airport and West Island Settlement in the southern part of the island.

Development along the ocean coast has a very narrow foreshore buffer.

The island has a history of chronic erosion along the western ocean facing shore, requiring construction of multiple coastal structures since the 1970's to protect assets.



West Island





Cyclones and Waves

The region experiences tropical cyclones, typically 2-3 per year

Subsequently, extreme wave events occur, impacting both ocean facing sides

The local wave climate includes:

- **Local sea waves** produced by winds predominantly from the east
- **Swell waves** from storms in the Indian Ocean, predominantly from the south west

Tides and Currents

CKI typically has two high tides and two low tides per day

Mean sea level varies on a monthly timescale - sea level rise will also increase mean sea levels over time

Department of Transport recommends the following sea level rises be used for planning:

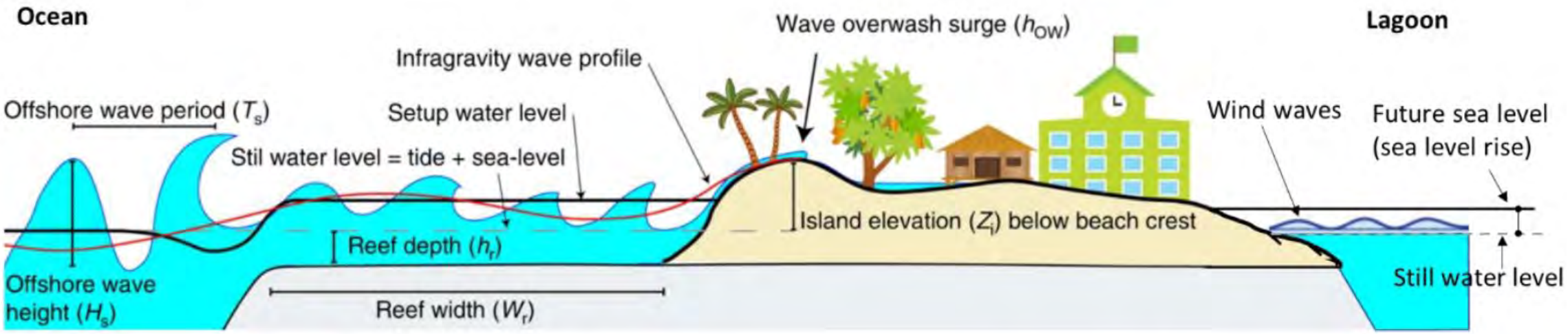
- 0.4m for a 50-year planning timeframe (i.e. 2068)
- 0.9m for a 100-year planning timeframe (2118)

Currents and circulation within the lagoon are driven by waves, wind and tides

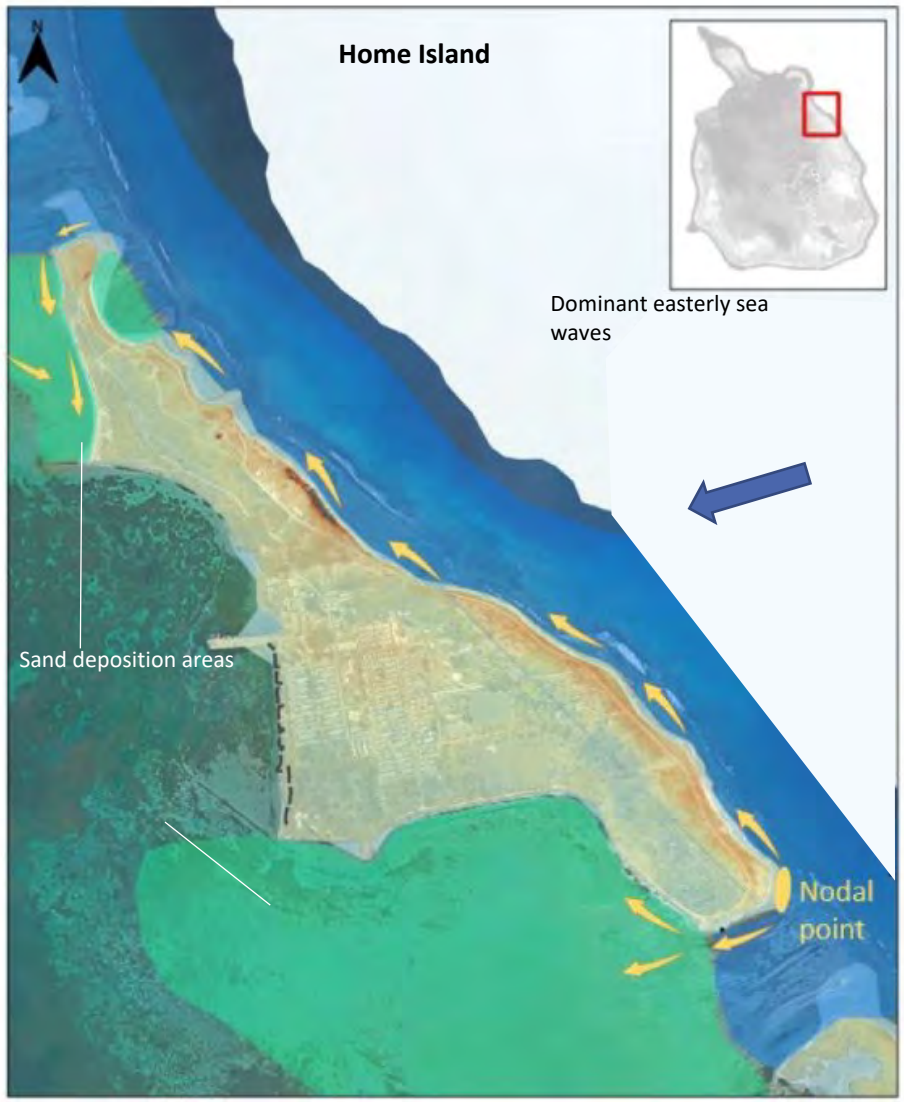
Coastal Inundation

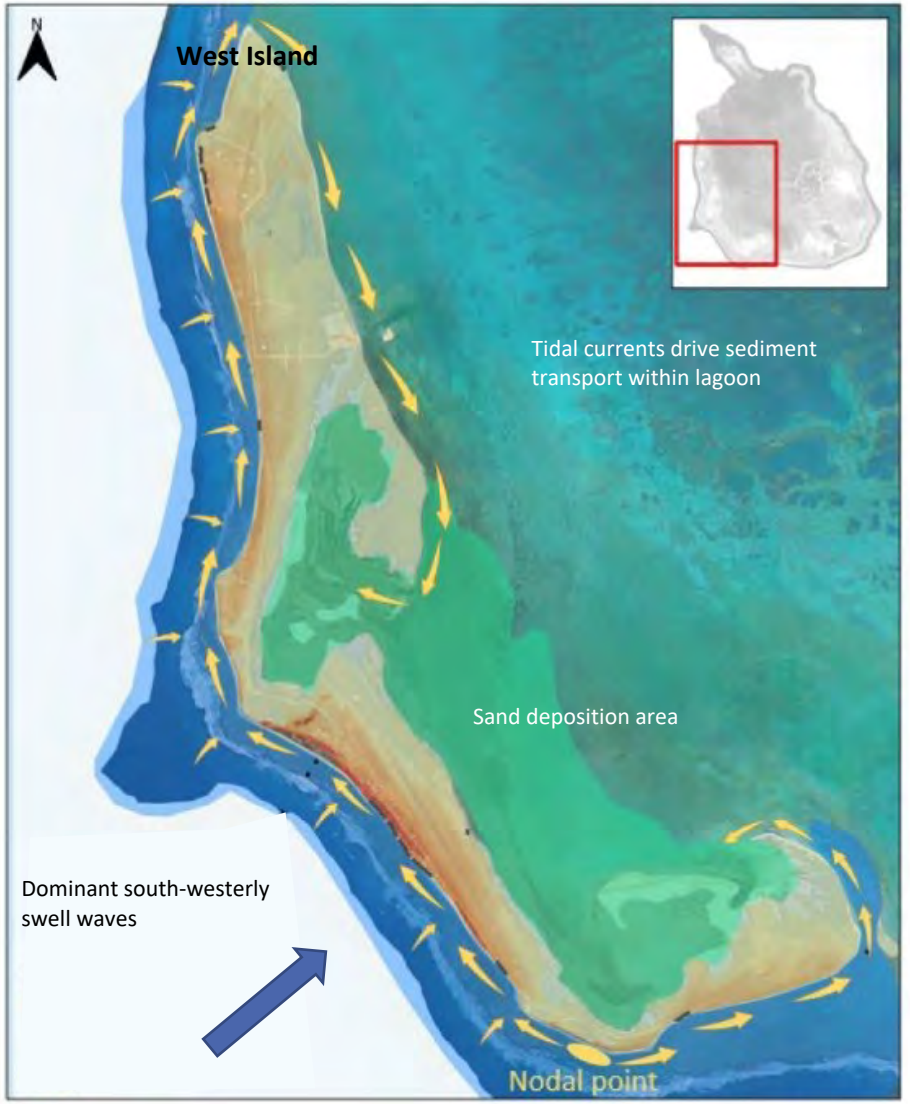
Lagoon side - extreme water levels driven by short term wind waves and cyclone events.

Ocean side - offshore waves travelling across the reef, causing wave setup and runup (i.e. elevated water levels and flooding).



Sand Movement and Erosion



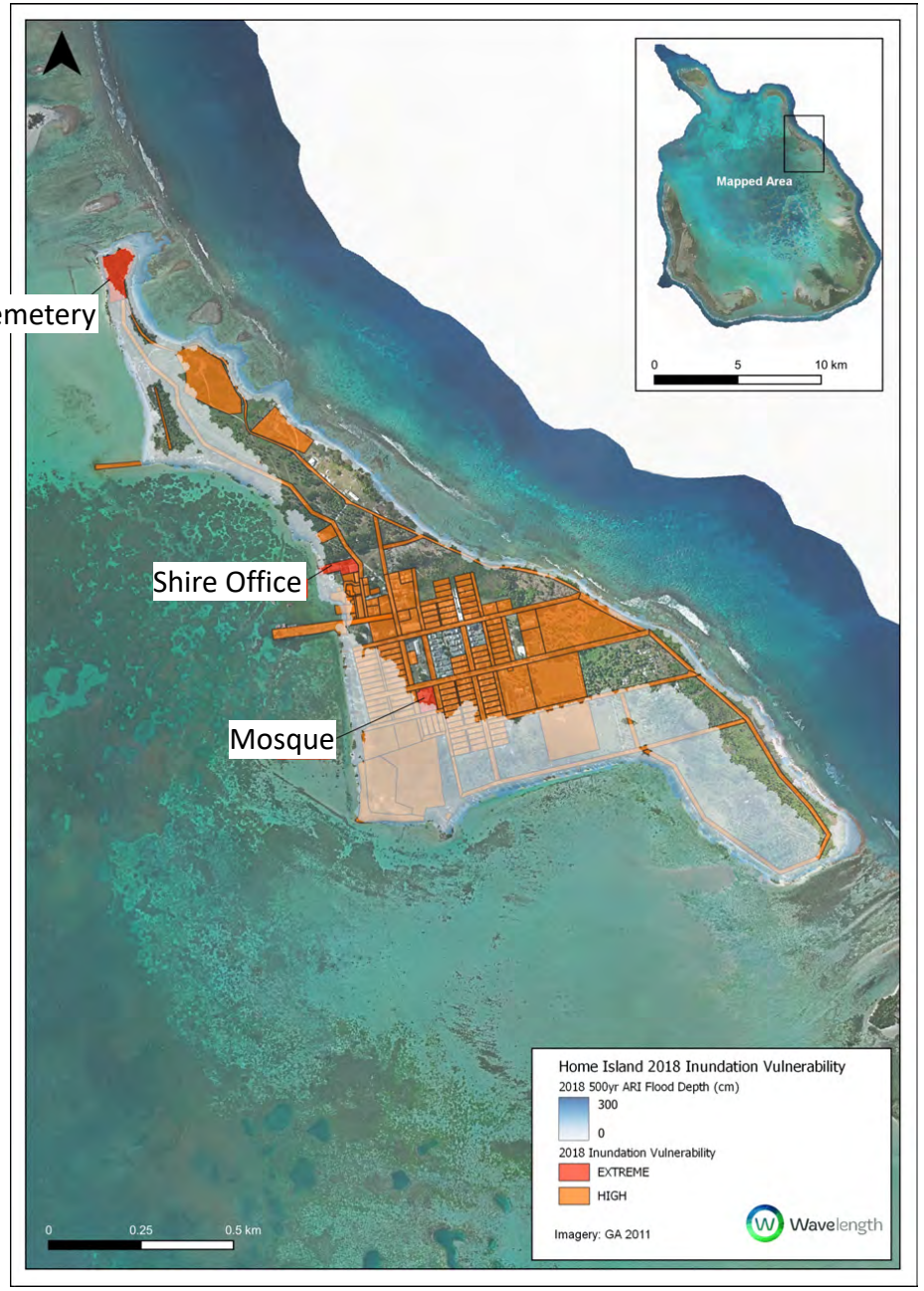


Assets and Values

Vulnerability Mapping for 2018 and 2068

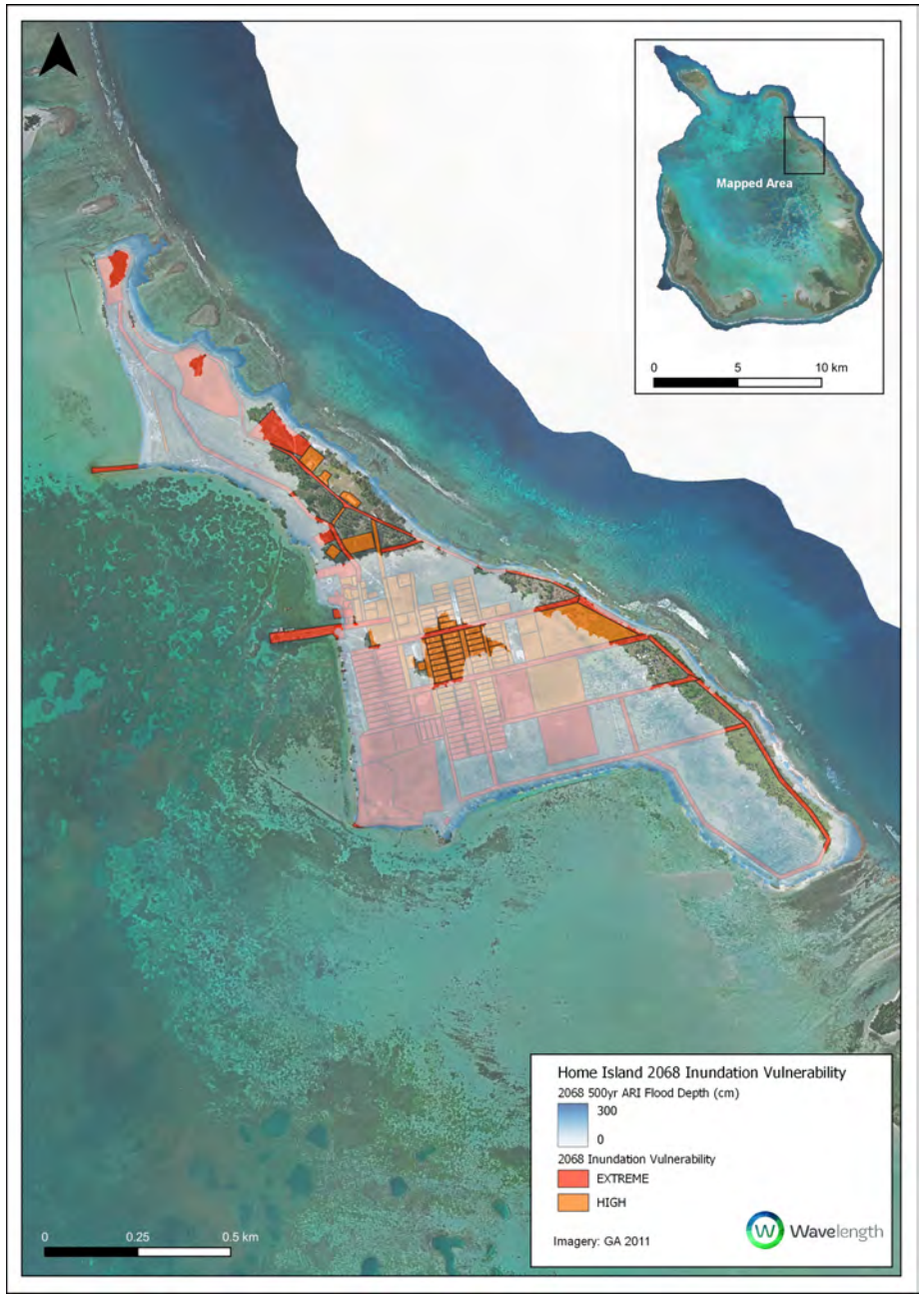
SHAPE URBAN

Home Island – Inundation Vulnerability 2018



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Home Island – Inundation Vulnerability 2068



SHAPE URBAN

Home Island – Erosion Vulnerability 2018



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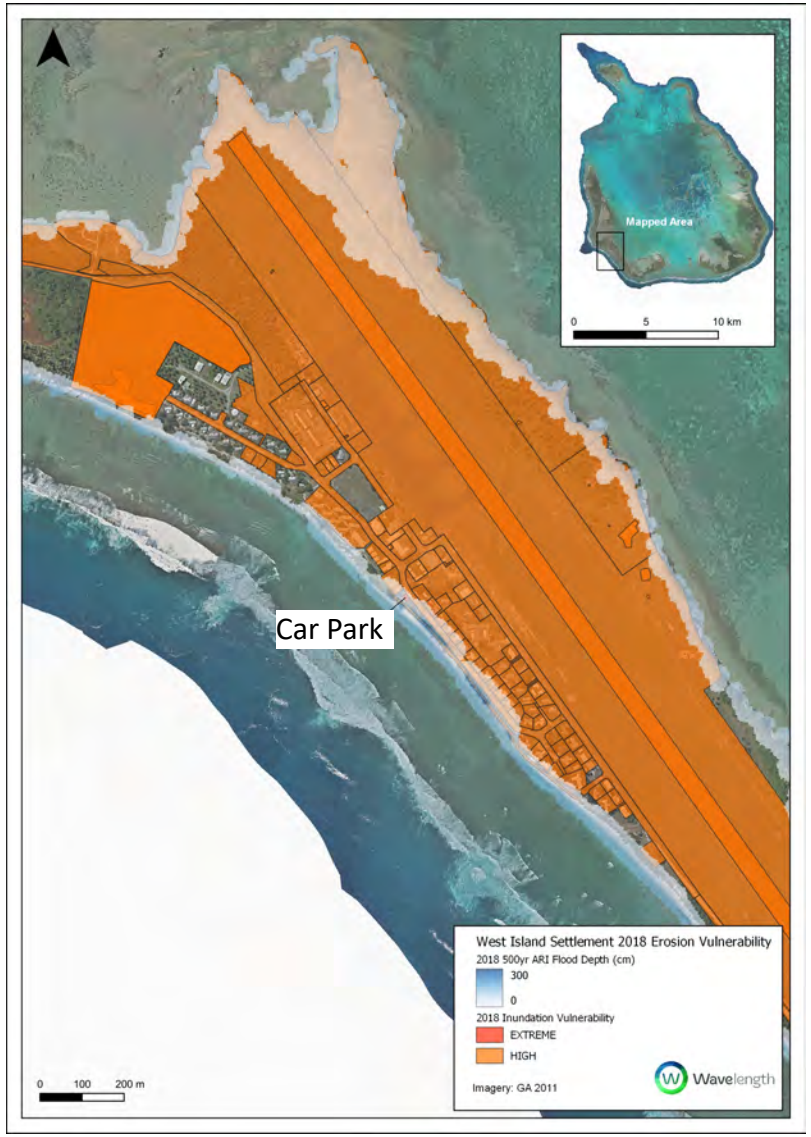
Home Island – Erosion Vulnerability 2068



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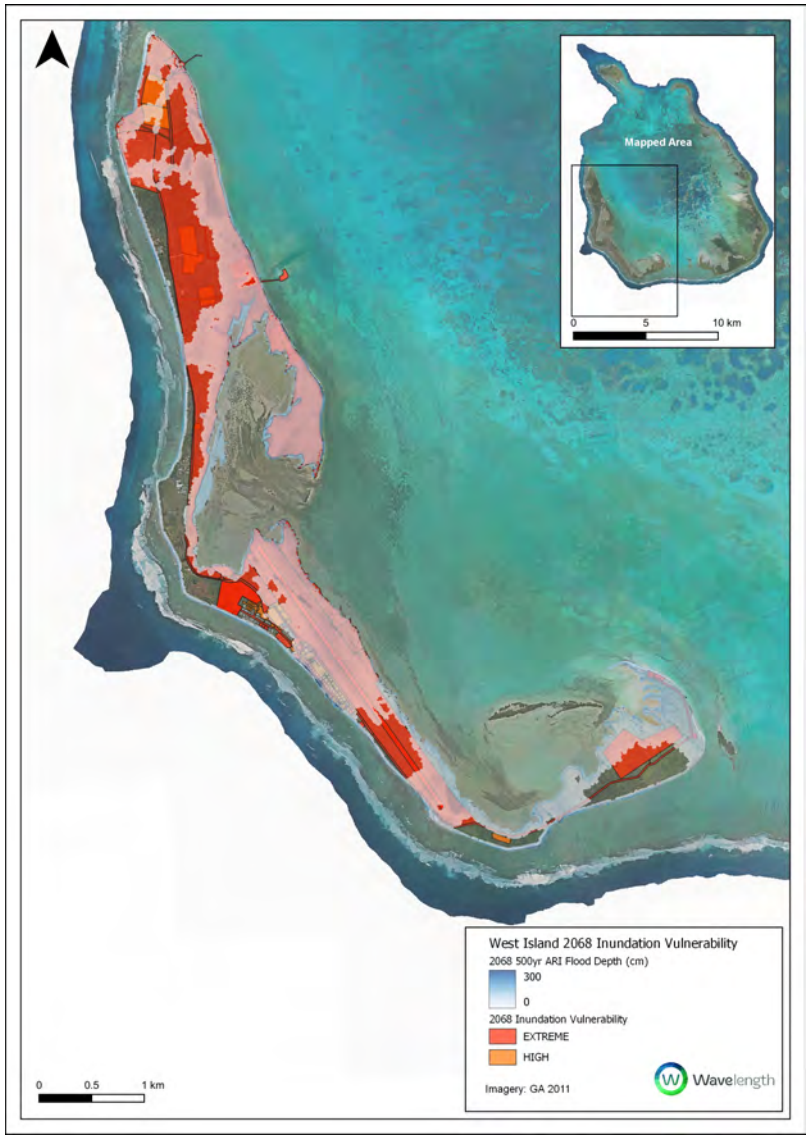
West Island – Inundation Vulnerability 2018

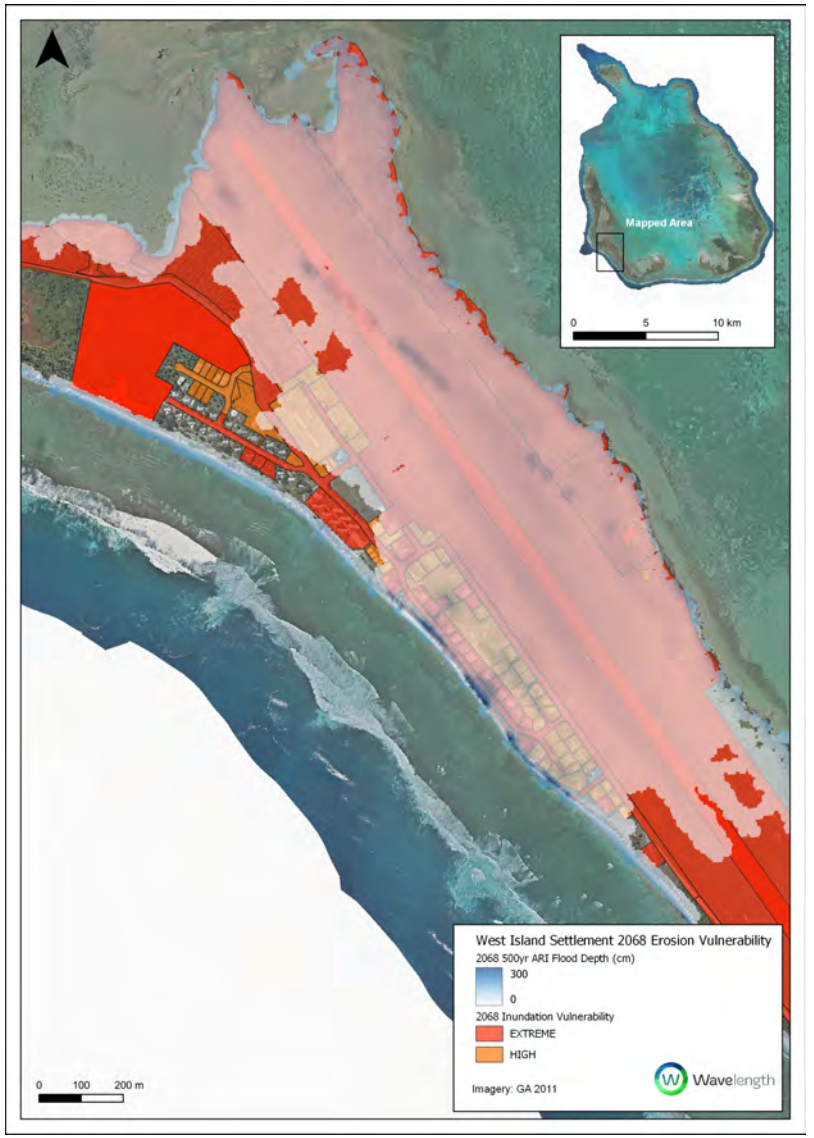




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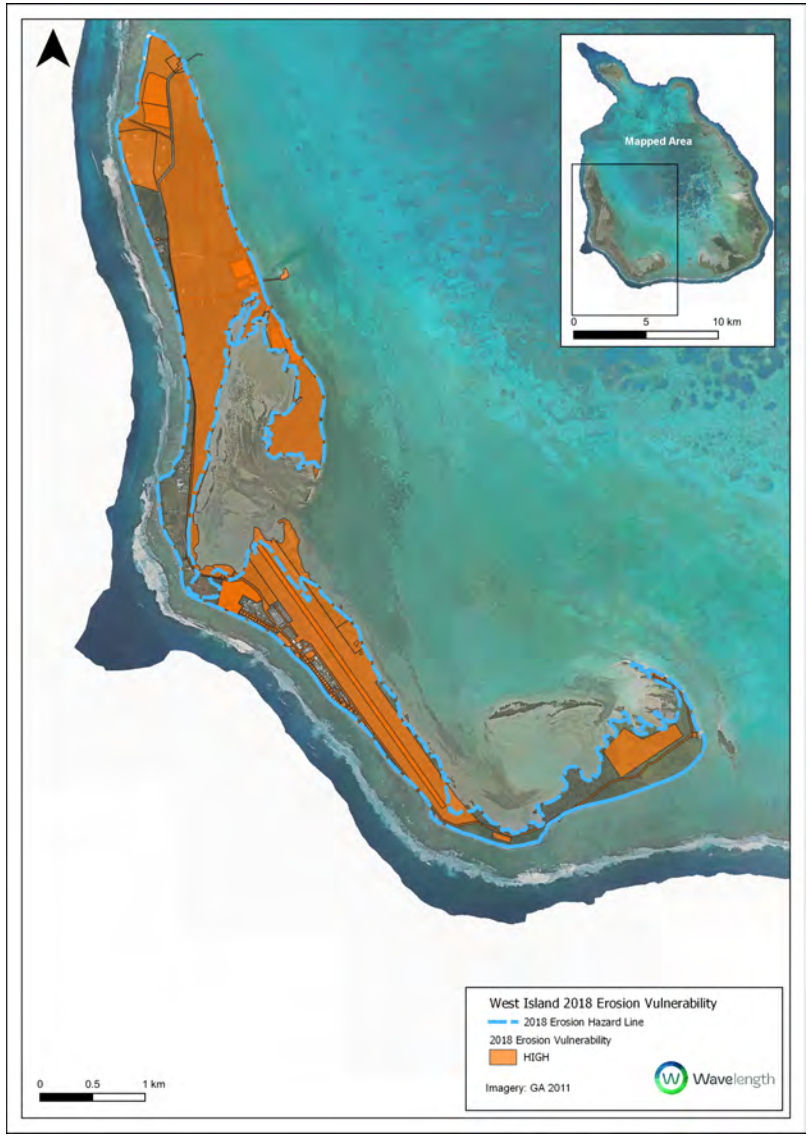
West Island – Inundation Vulnerability 2068

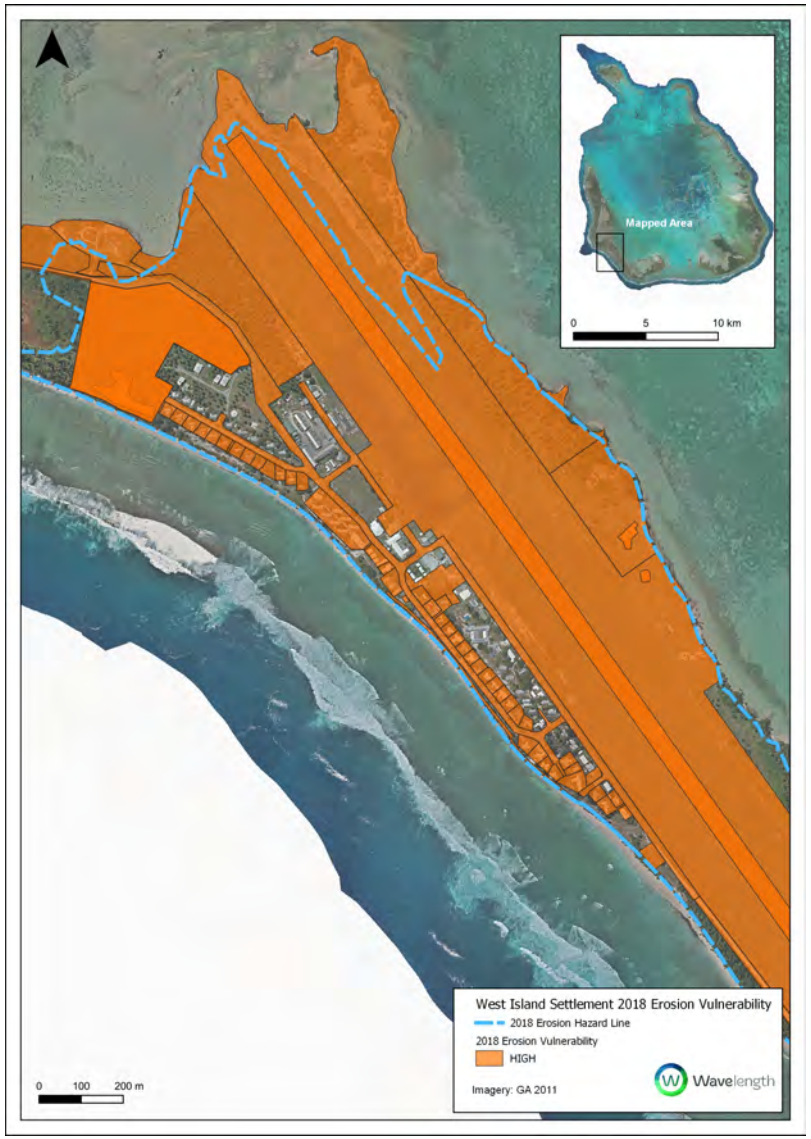




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West Island – Erosion Vulnerability 2018

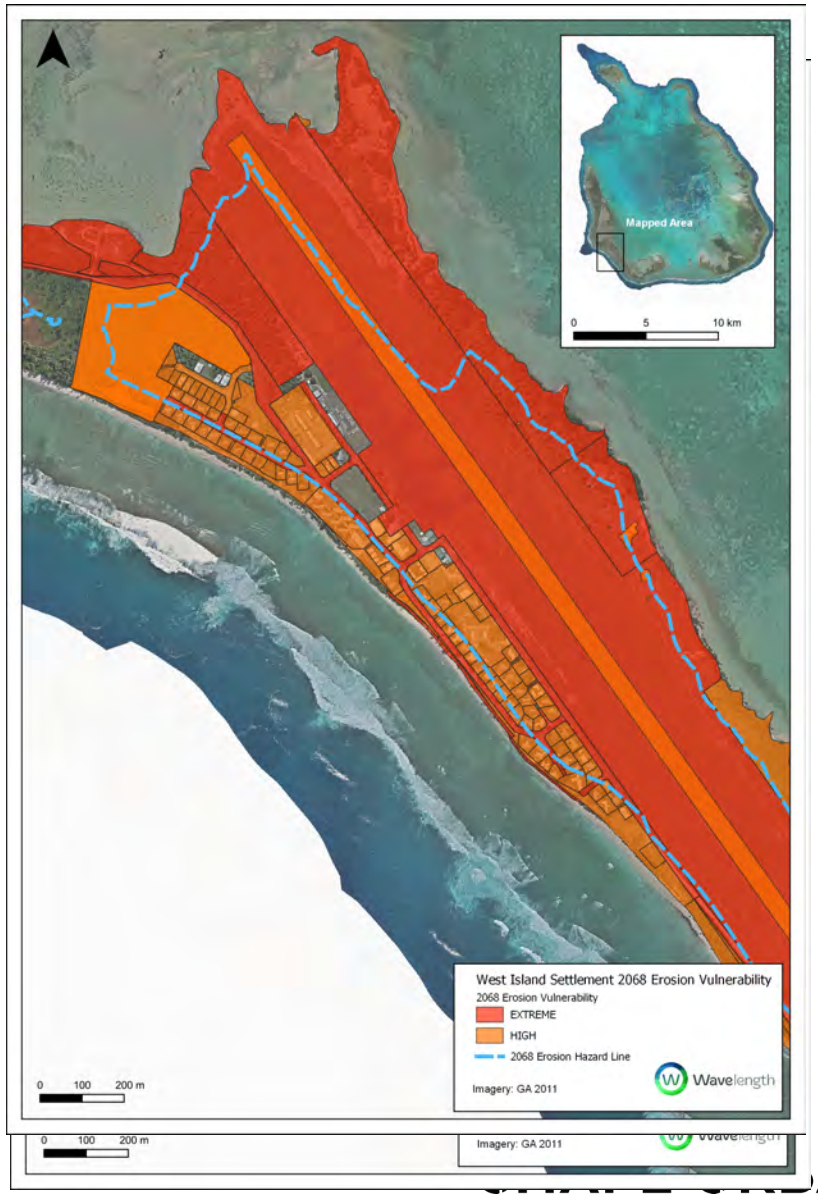




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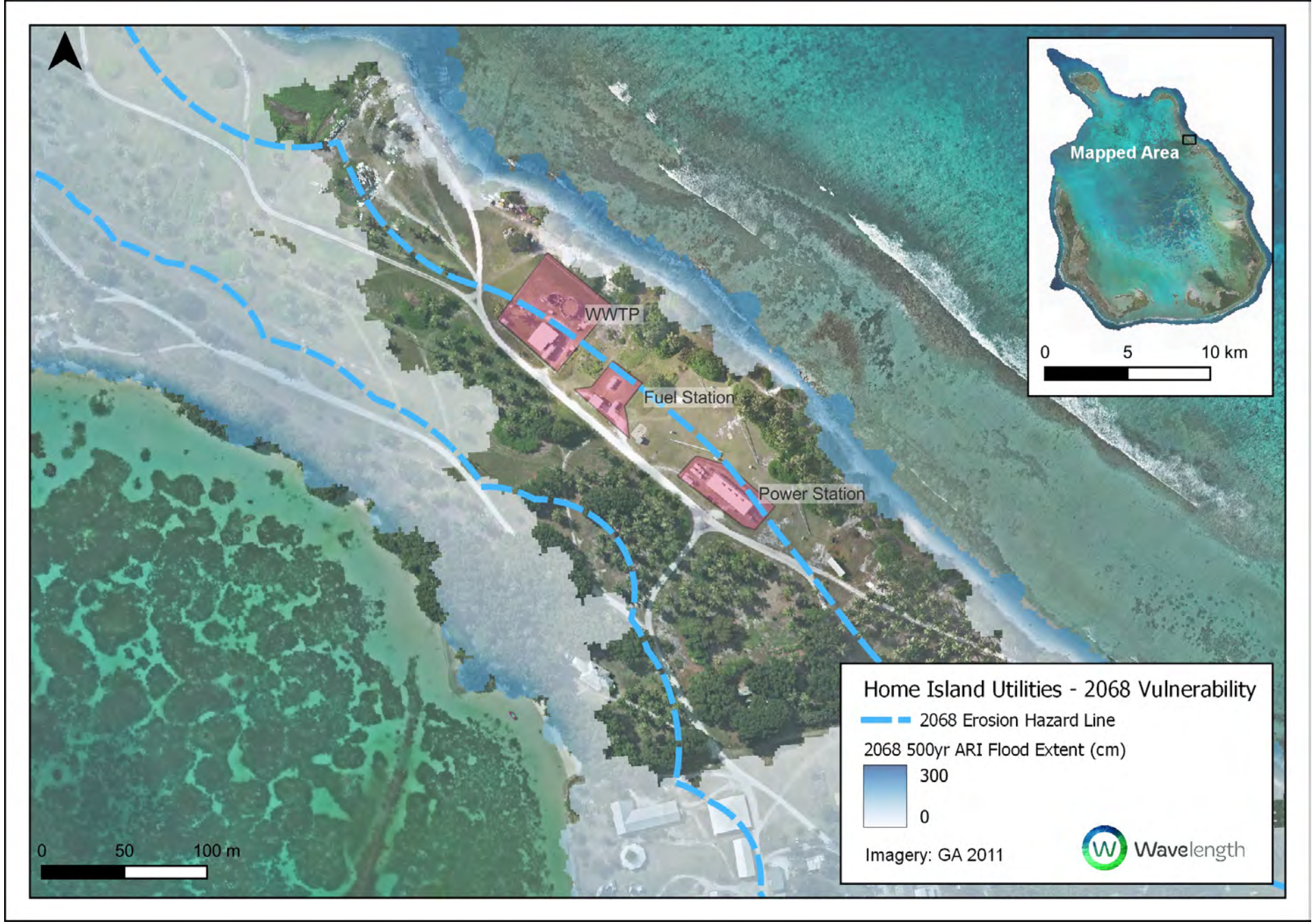
West Island – Erosion Vulnerability 2068

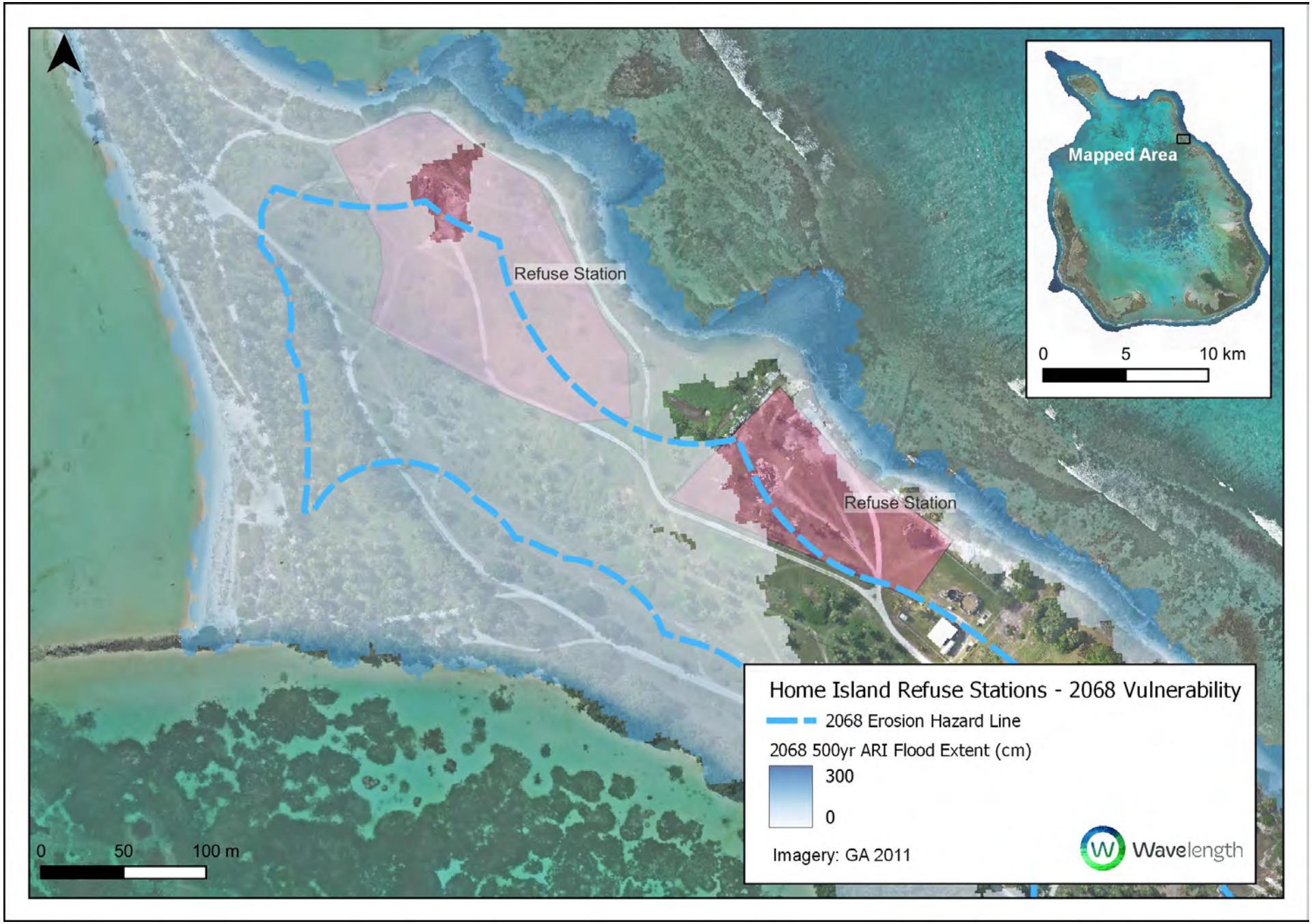




Assets of interest
…a closer look…

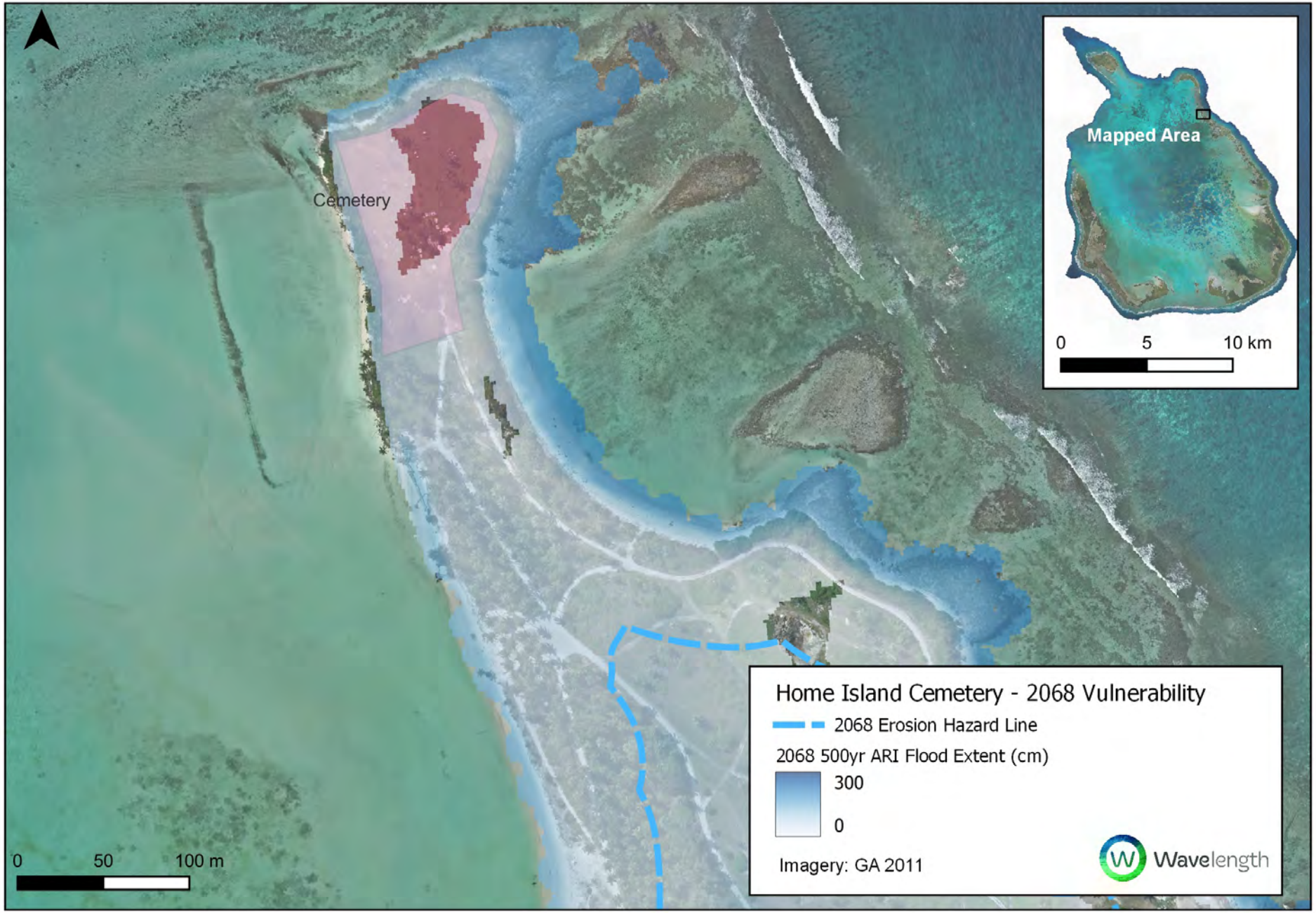
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WWTP
Fuel Station
Power Station
Mapped Area
0
5
10 km
0
50
100 m
Home Island Utilities - 2068 Vulnerability
2068 Erosion Hazard Line
2068 500yr ARI Flood Extent (cm)
300
0
Imagery: GA 2011
Wavelength

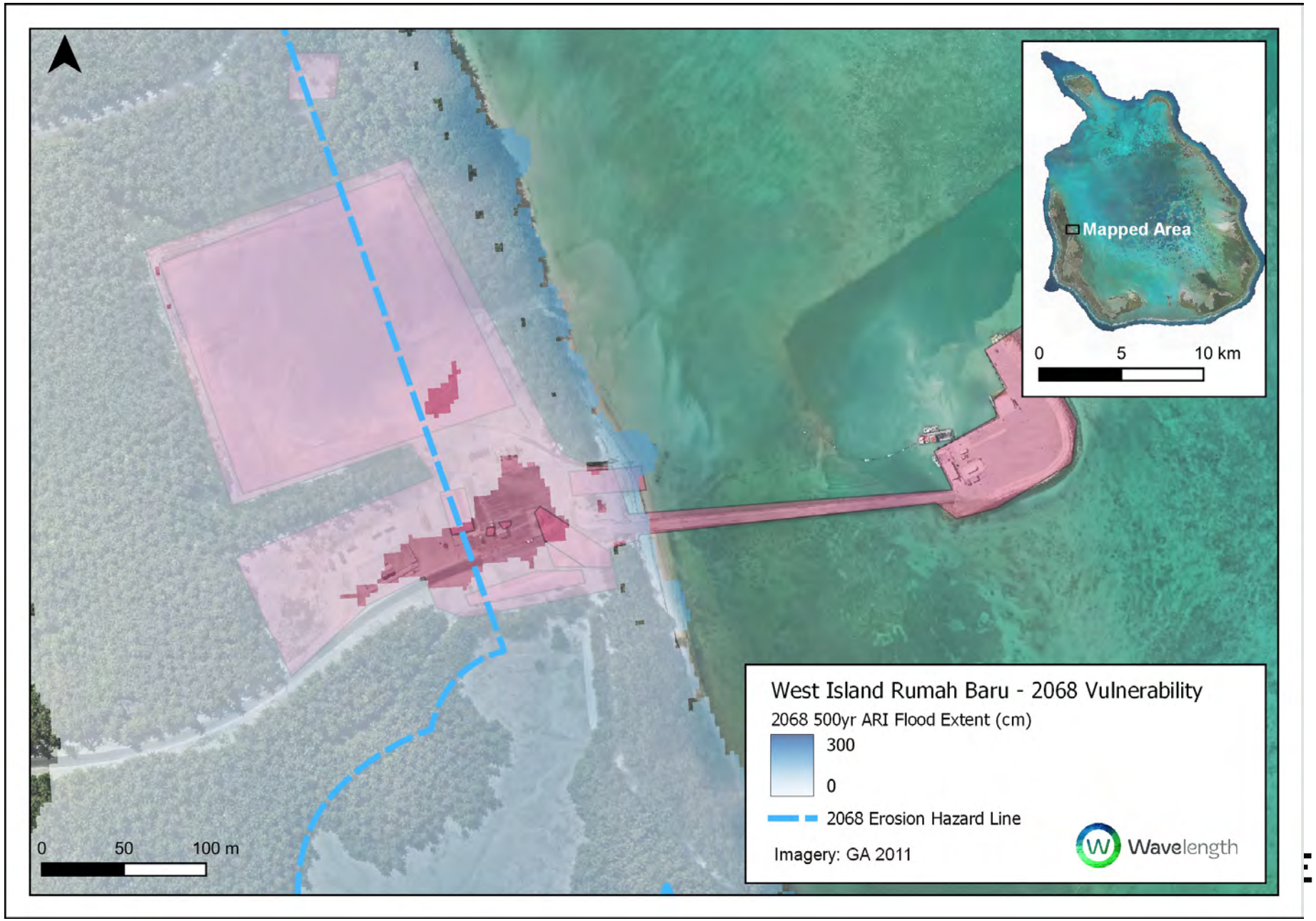

Refuse Station
Refuse Station
Mapped Area
0
5
10 km
0
50
100 m
Home Island Refuse Stations - 2068 Vulnerability
2068 Erosion Hazard Line
2068 500yr ARI Flood Extent (cm)
300
0
Imagery: GA 2011
Wavelength


Mapped Area
0 5 10 km
Home Island Oceania House - 2068 Vulnerability
2068 Erosion Hazard Line
2068 500yr ARI Flood Extent (cm)
300
0
Imagery: GA 2011
Wavelength
0 50 100 m

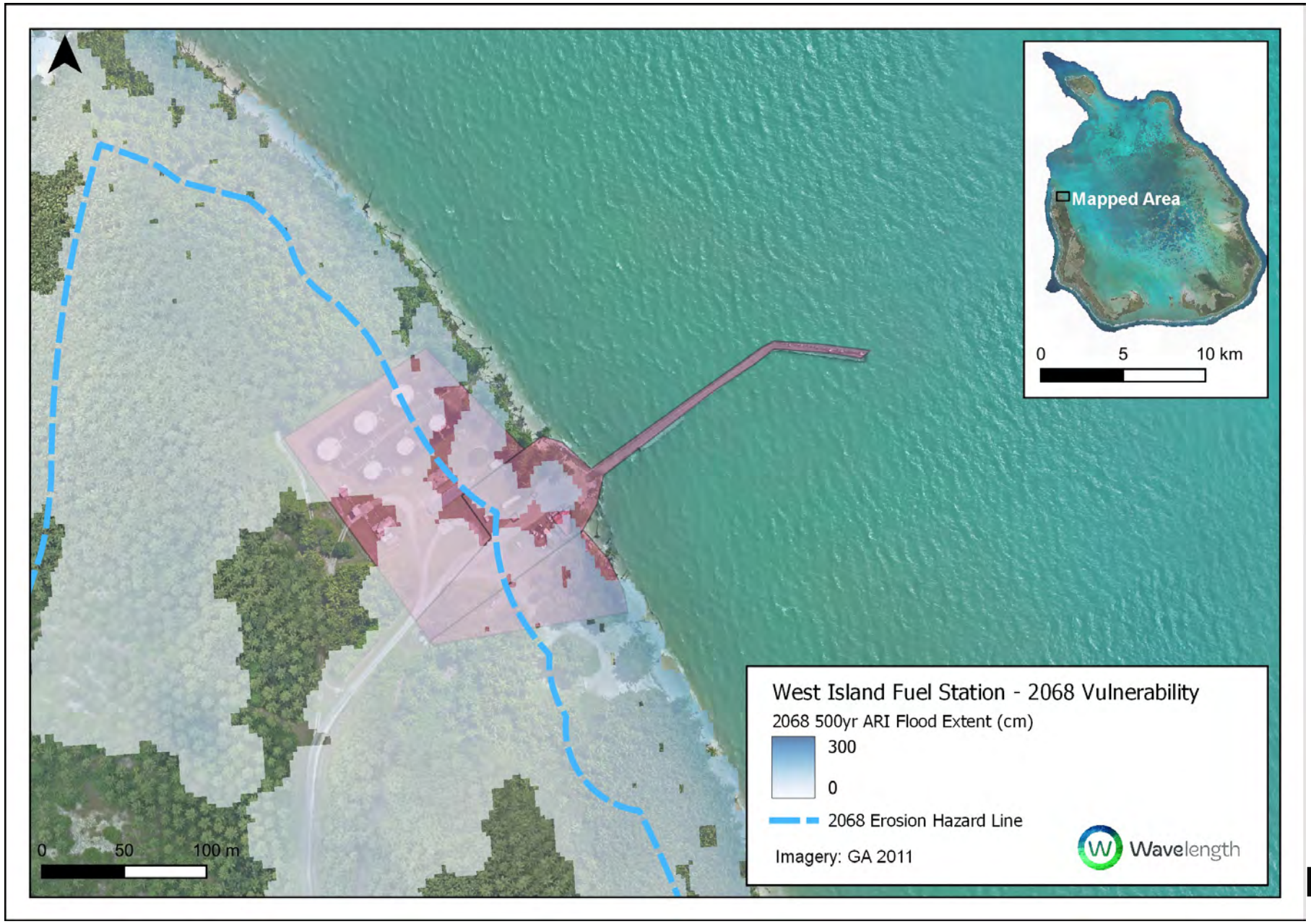
E URBAN


Cemetery
Mapped Area
0
5
10 km
0
50
100 m
Home Island Cemetery - 2068 Vulnerability
2068 Erosion Hazard Line
2068 500yr ARI Flood Extent (cm)
300
0
Imagery: GA 2011
Wavelength

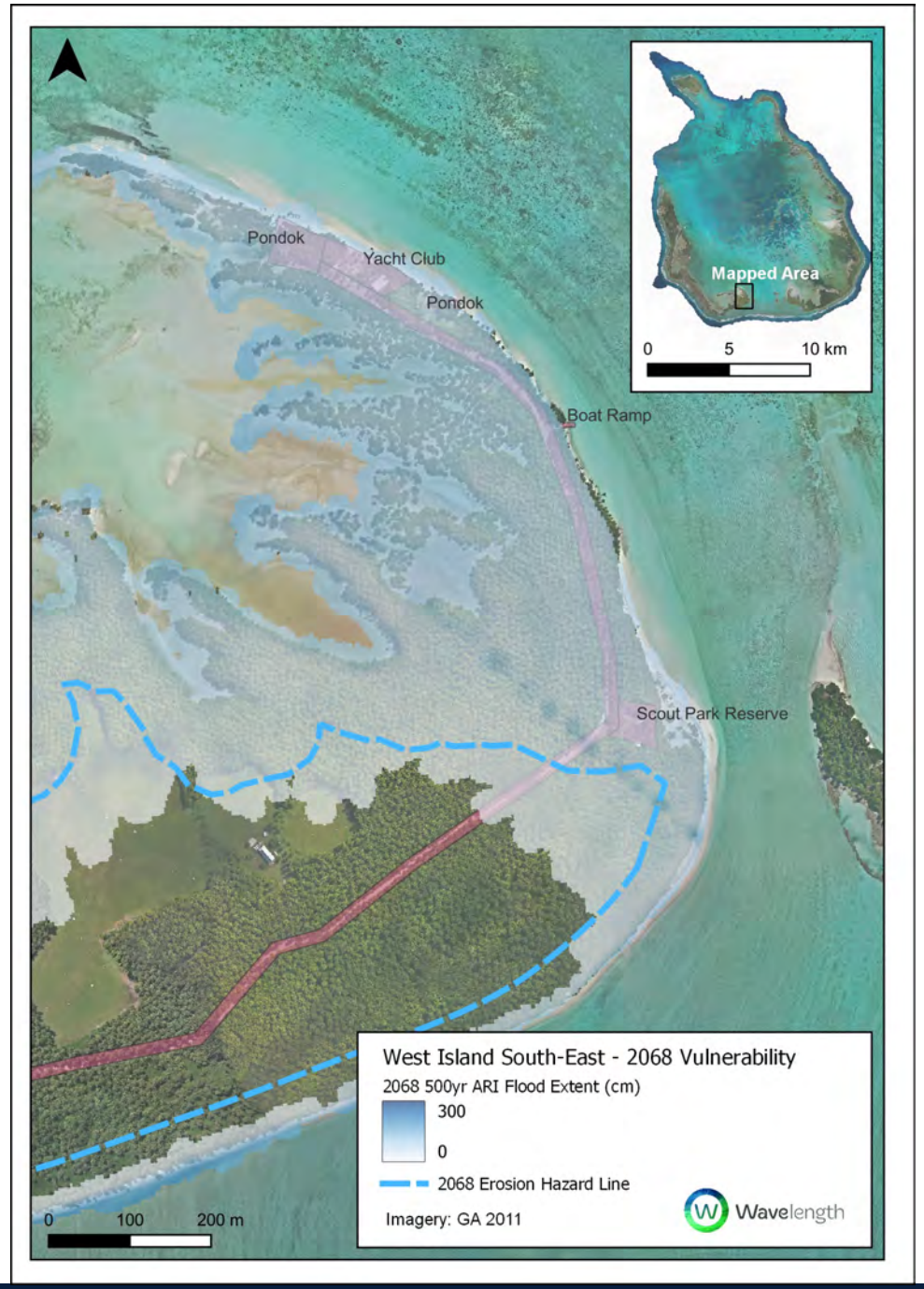

Mapped Area
0
5
10 km
Home Island Outer Road - 2068 Vulnerability
2068 Erosion Hazard Line
2068 500yr ARI Flood Extent (cm)
300
0
Imagery: GA 2011
Wavelength
0
50
100 m


Mapped Area
0 5 10 km
West Island Rumah Baru - 2068 Vulnerability
2068 500yr ARI Flood Extent (cm)
300
0
2068 Erosion Hazard Line
Imagery: GA 2011
Wavelength
0 50 100 m

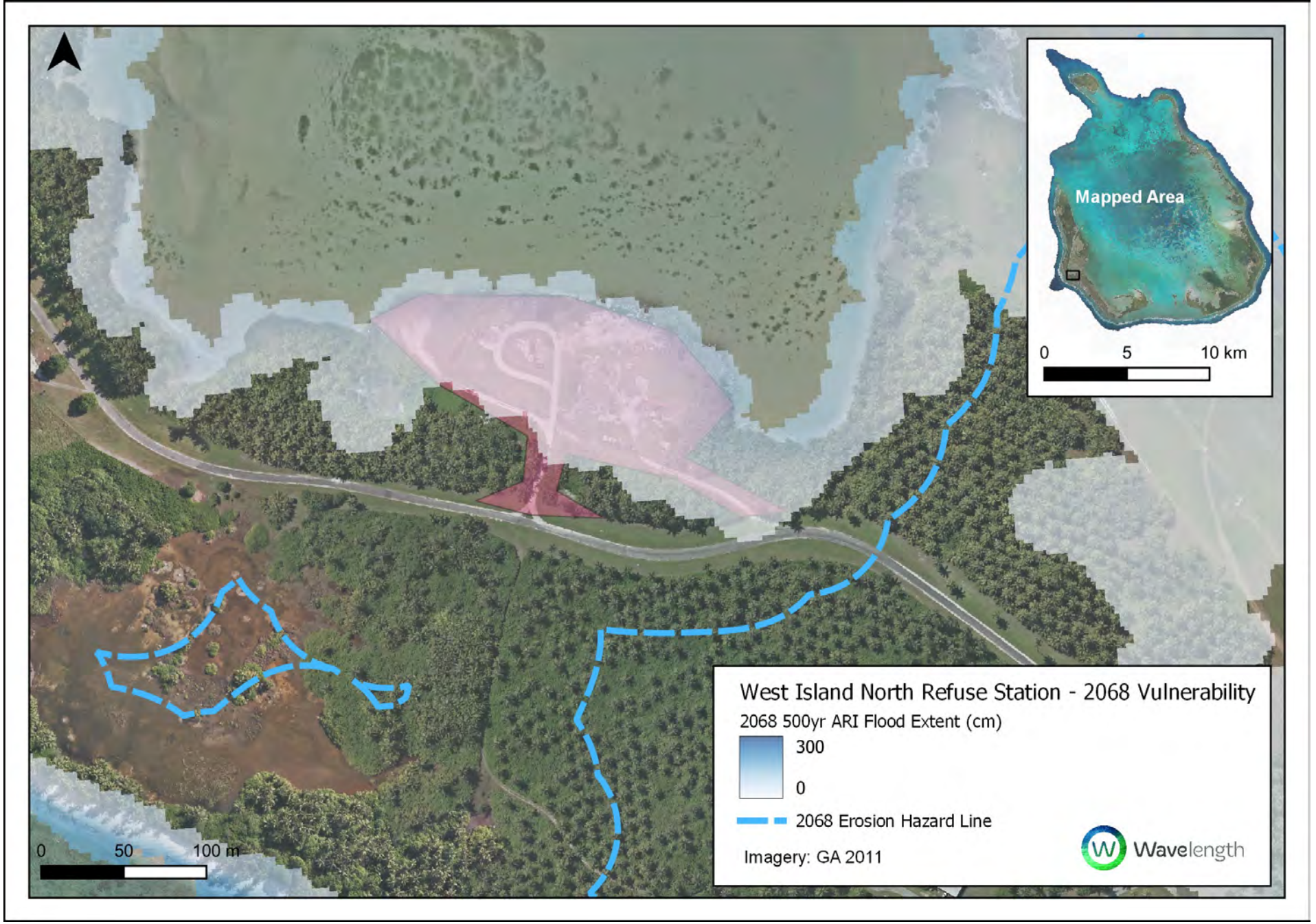
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Mapped Area
0 5 10 km
West Island Fuel Station - 2068 Vulnerability
2068 500yr ARI Flood Extent (cm)
300
0
2068 Erosion Hazard Line
Imagery: GA 2011
Wavelength
0 50 100 m

E URBAN


Pondok
Yacht Club
Pondok
Boat Ramp
Scout Park Reserve
Mapped Area
0
5
10 km
0
100
200 m
West Island South-East - 2068 Vulnerability
2068 500yr ARI Flood Extent (cm)
300
0
2068 Erosion Hazard Line
Imagery: GA 2011
Wavelength

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Mapped Area
0
5
10 km
West Island North Refuse Station - 2068 Vulnerability
2068 500yr ARI Flood Extent (cm)
300
0
2068 Erosion Hazard Line
Imagery: GA 2011
Wavelength
0
50
100 m

Discussion…

Any assets or values missing?

Any sacrificial assets we can dismiss?

Asset / Values Mapping in Coastal Hazard Zones

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Asset / Values Mapping in Coastal Hazard Zones

What assets exist in the coastal zones?

- Review maps
- What assets do you own/have responsibility for in the marked ‘Coastal zone’?
- Any missing assets in the marked ‘Coastal zone’?
- Prioritise assets – are there any sacrificial assets we can dismiss?

Discuss

Risk Management / Adaptation Approaches

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Adaptation Options (per WA SPP 2.6)



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Adaptation Options



Avoid – Options which aim to eliminate the risk of coastal hazards by avoiding development



Managed Retreat – Options which progressive retreat / relocate development



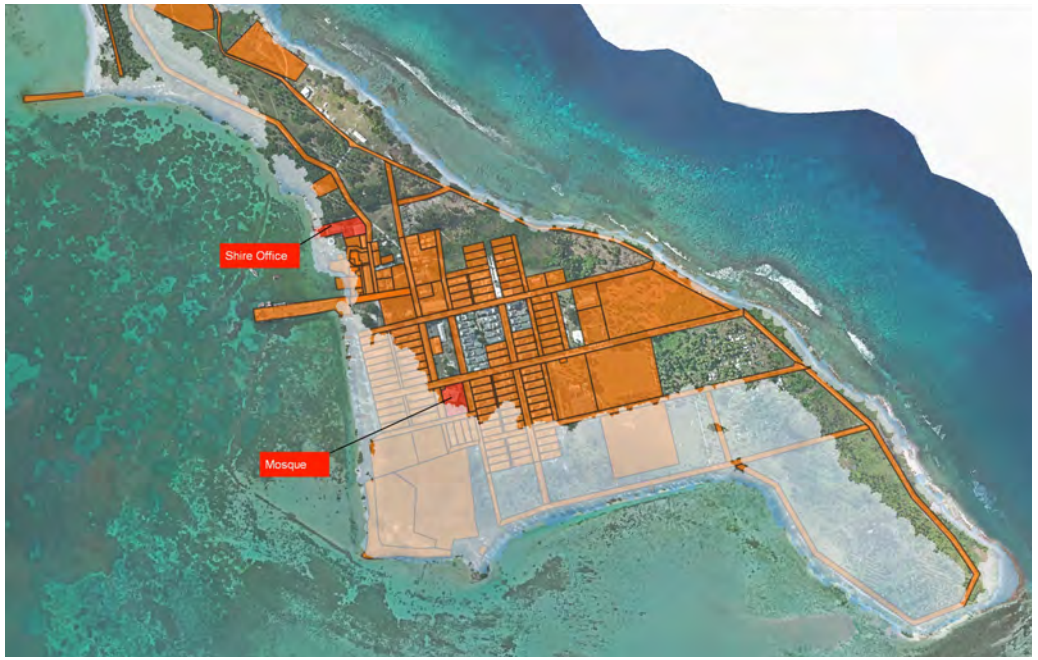
Accommodation – Options which seek to enhance assets to cope with the temporary impacts



Protection – Options which seek to artificially protect the coast

Approach

- Whole of Settlement (with airport on West Island)
- Individual asset treatment outside Settlements



Home Island



West Island

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Approach – Settlement

- Adaptation required in short term, next 5 to 10 years
- Three adaptation pathways identified:
    1. Protect
    2. Accommodate
    3. No regrets
- Unfeasible options:
    - Avoid – assets already in place
    - Retreat – Insufficient space / higher ground to retreat to (within island consideration)

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Protect

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Protect Trade Offs

- Seawalls are already established, relatively straightforward option
- Set levees back from beach allows shoreline to erode maintaining beaches outside of settlement
- Likely loss of beach at Jalan Pantai and West Island settlement
- Potential to create a disconnection from island through construction of levee
- Consideration needed for connections at roads and other infrastructure
- Requires sourcing materials including sand, clays or fine sand as a core material

Accommodate

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Replace and upgrade properties and buildings at end of design life



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Accommodate Trade Offs

- Existing connections at roads and other infrastructure can be maintained
- Shoreline beaches outside of settlement maintained
- Potential daily impact on residents accessing properties
- Requires importing material and building products
- Replacing assets at end of design life would reduce costs
- High cost to replace new properties and assets

No Regrets

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Accepting properties and assets are at increased risk

Establish emergency plans and emergency shelter for Settlement

Undertake event-based monitoring

Audit of protection structures (determine effectiveness and future protection potential)

No Regrets Trade Offs

- Less daily impact compared to other pathways
- Low costs
- Reduced impact on environment
- Potential increased risk to lives during flood
- Potential high reputational risk

Outside of Settlement – Home Island example:

Utilities, Refuse Stations, desalination pumps, multiple roads
short term monitor
medium term relocate within lot at end of life

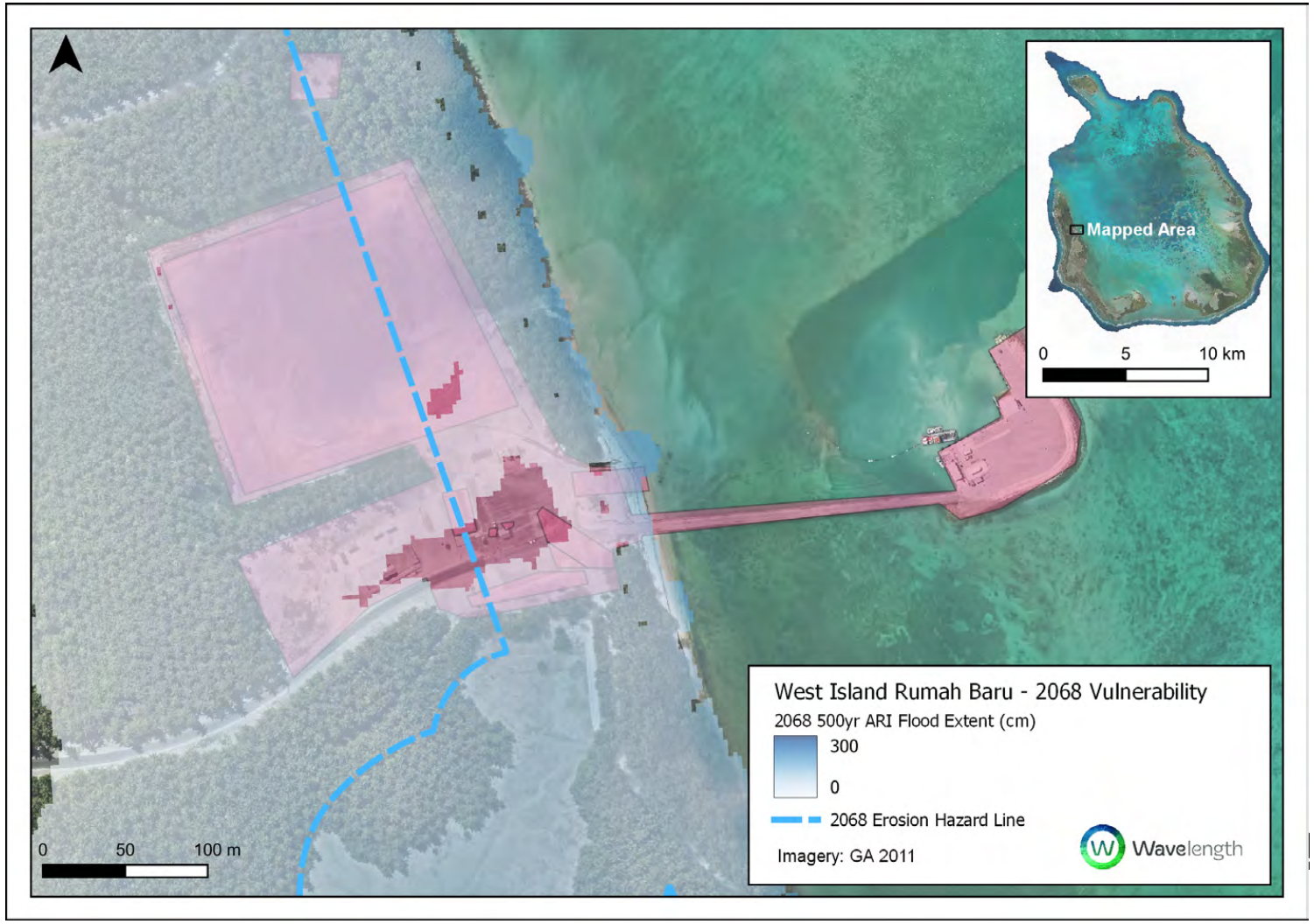
Historic Oceania House
short term monitor
medium term protect or no regrets

Dry Dock and Patricks Port
short term monitor
medium term upgrade dry dock and buildings to higher level at end of design life

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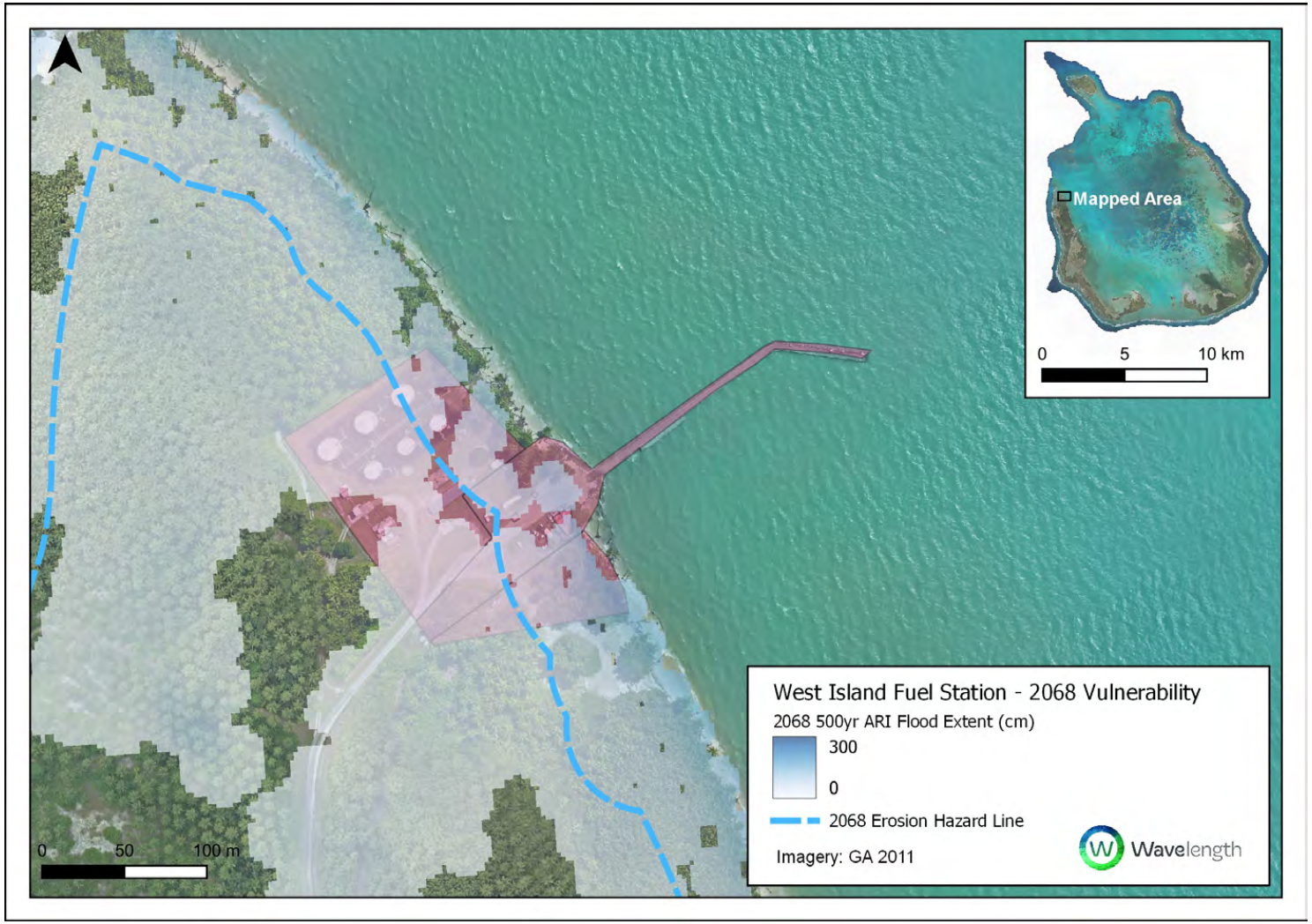
Outside of Settlement – West Island example

Rumah Baruh precinct



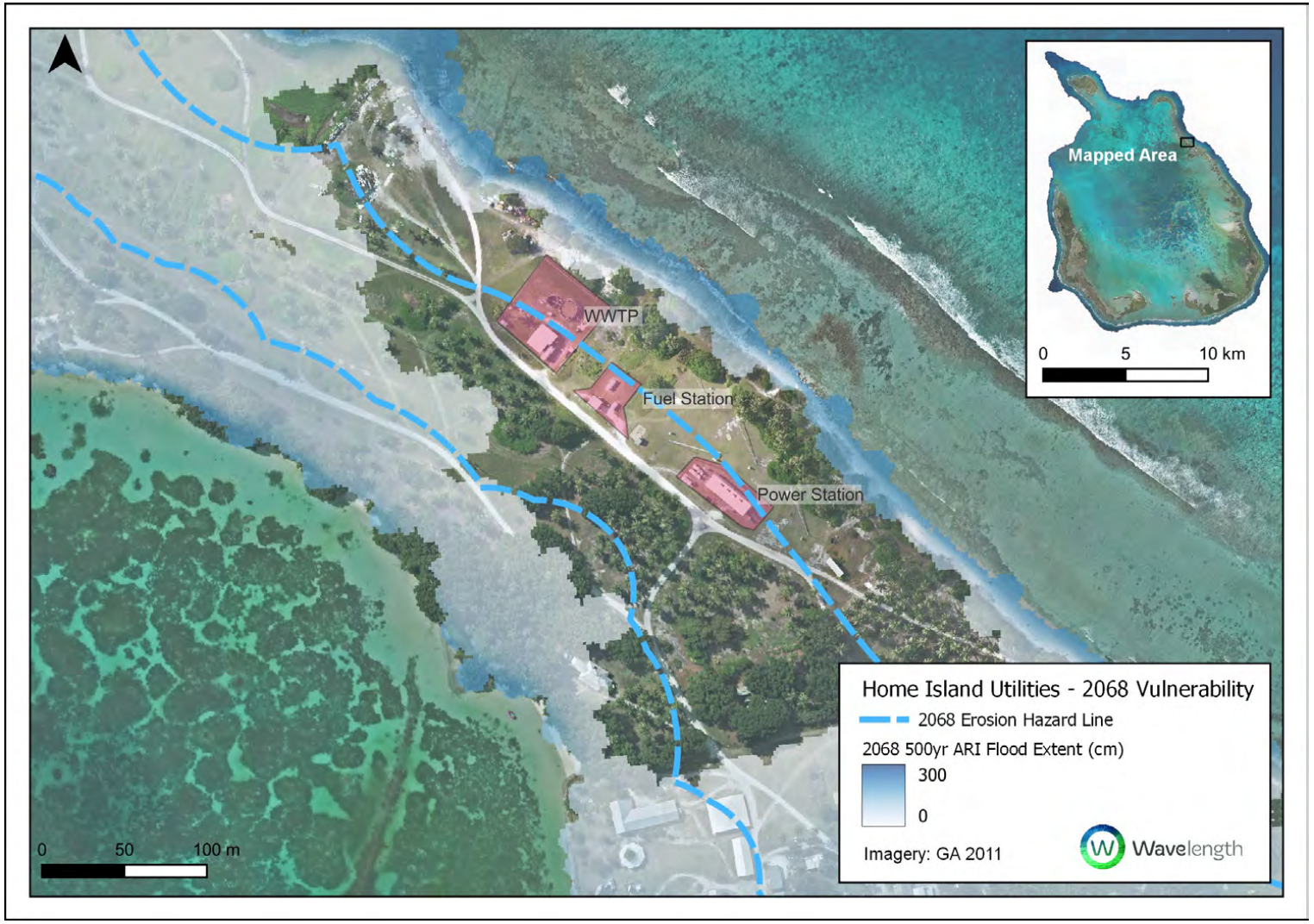
Outside of Settlement – West Island example:

Fuel Station and
Jetty precinct



Outside of Settlement – Home Island example

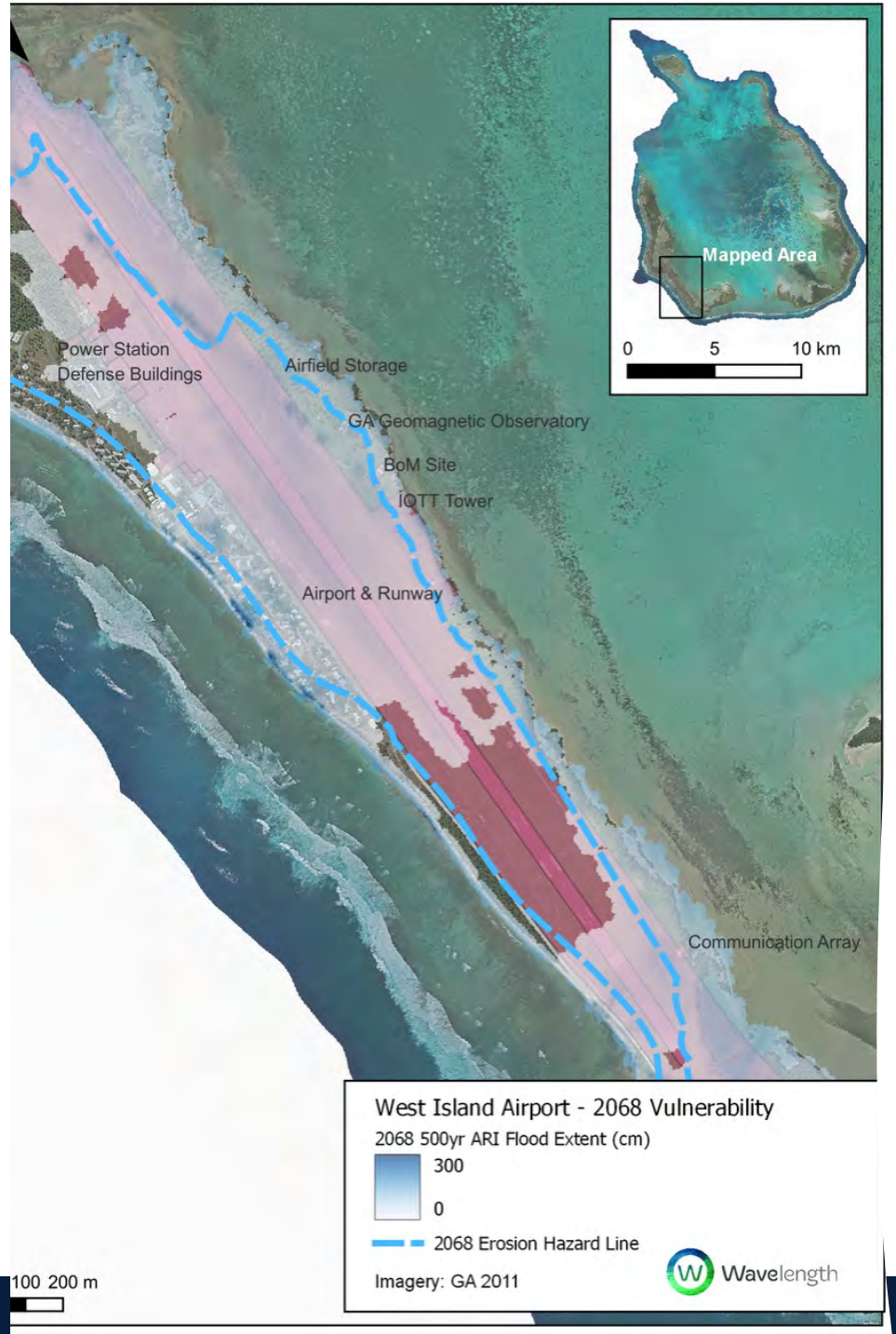
Utilities



Outside of Settlement – West Island examples:

Short to Medium Term:

- Monitor shoreline erosion
- Relocate landward
  and upgrade at end of design life



Longer Term (2118)

Towards end of century, it will be challenging to maintain protect pathways:

- Groundwater shoaling impacts
- Levees would make it difficult to stop terrestrial flooding, as drainage outflows will be backed up more frequently by higher tides and storm water levels
- High levees would also be difficult to access other locations on islands

Potential long-term options include:

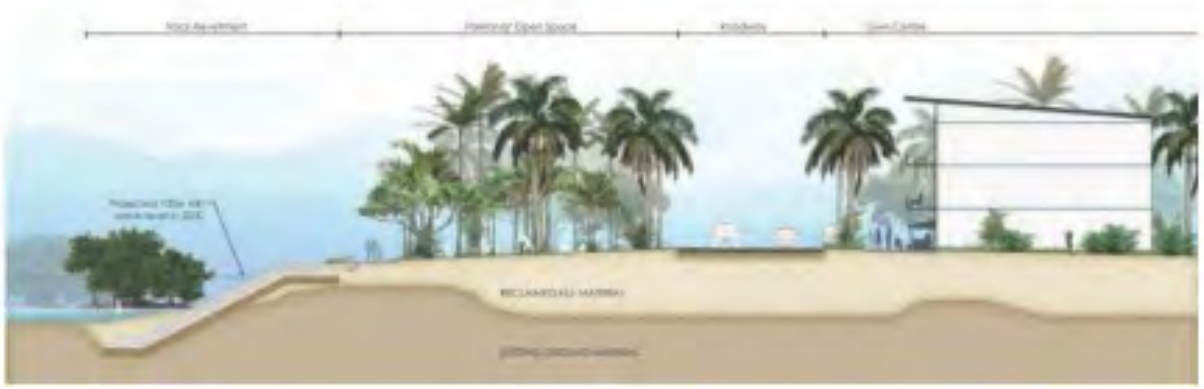
1. Retreat from islands
2. Reclaim and protect

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Reclaim and Protect

Sand is sourced and pumped properties and assets are raised…

- Technically feasible and promotes long term resilience
- Substantial costs
- Requires integrated planning, engineering and environmental approach



Example : Kiribati raise 300-hectare area of land 2 – 5 m above the highest measured sea level.

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Q & A

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Multi-Criteria Assessment

Criteria

- Options go through multi-criteria assessment
- Criteria are identified for how we might assess adaptation options
- Relatively standard across state

Capital Costs

How much it costs us to build something up front (in todays' $)

Maintenance Costs

How much it costs us to keep maintaining something over 100 years (in todays' $)

Environmental Impact

Damage/loss of beach, vegetation, seagrass, fauna habitat

Erosion in adjacent areas

Social Impact - Property

Property is affected and may be lost or damaged

May have restriction placed on use

Collective Kampong on HI / linear settlement on WI affected

Social Impact - Communal

Loss of ability to walk on beach, enjoy vistas

Loss of park land, footpaths

Loss of assets such as cafes, club spaces (e.g. Yacht Club), etc

Reversibility

Once chosen, other options are off the table or very difficult to implement

Sets expectation/ties decision makers and future community to the decision/costs

Effectiveness

Short term options suitable for minor protection

Untested / unclear how effective

Well tested and understood – works to reduce risk

Next Steps…



APPENDIX B

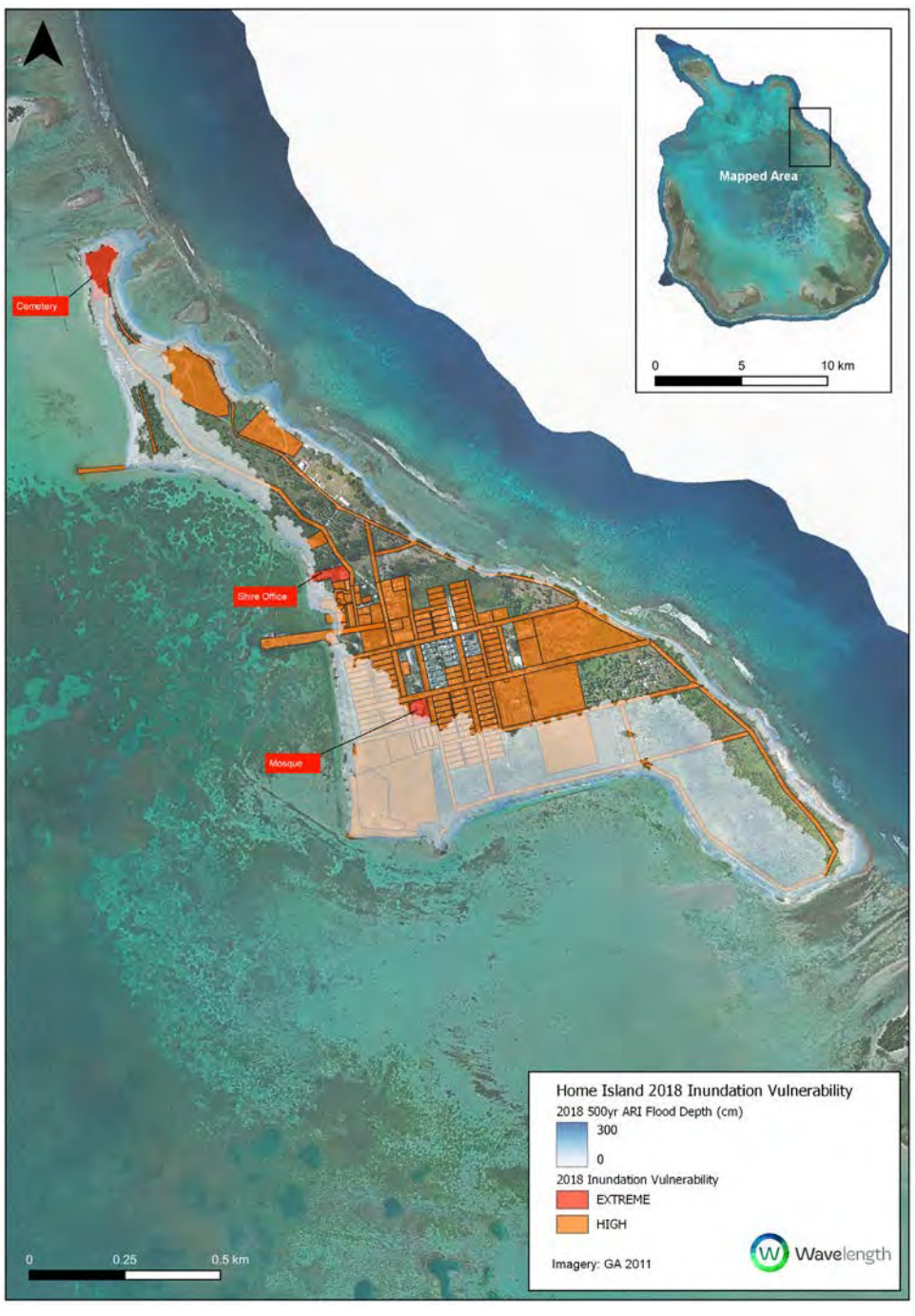
2016 and 2068 Vulnerability Mapping for Perth and On-island Engagement



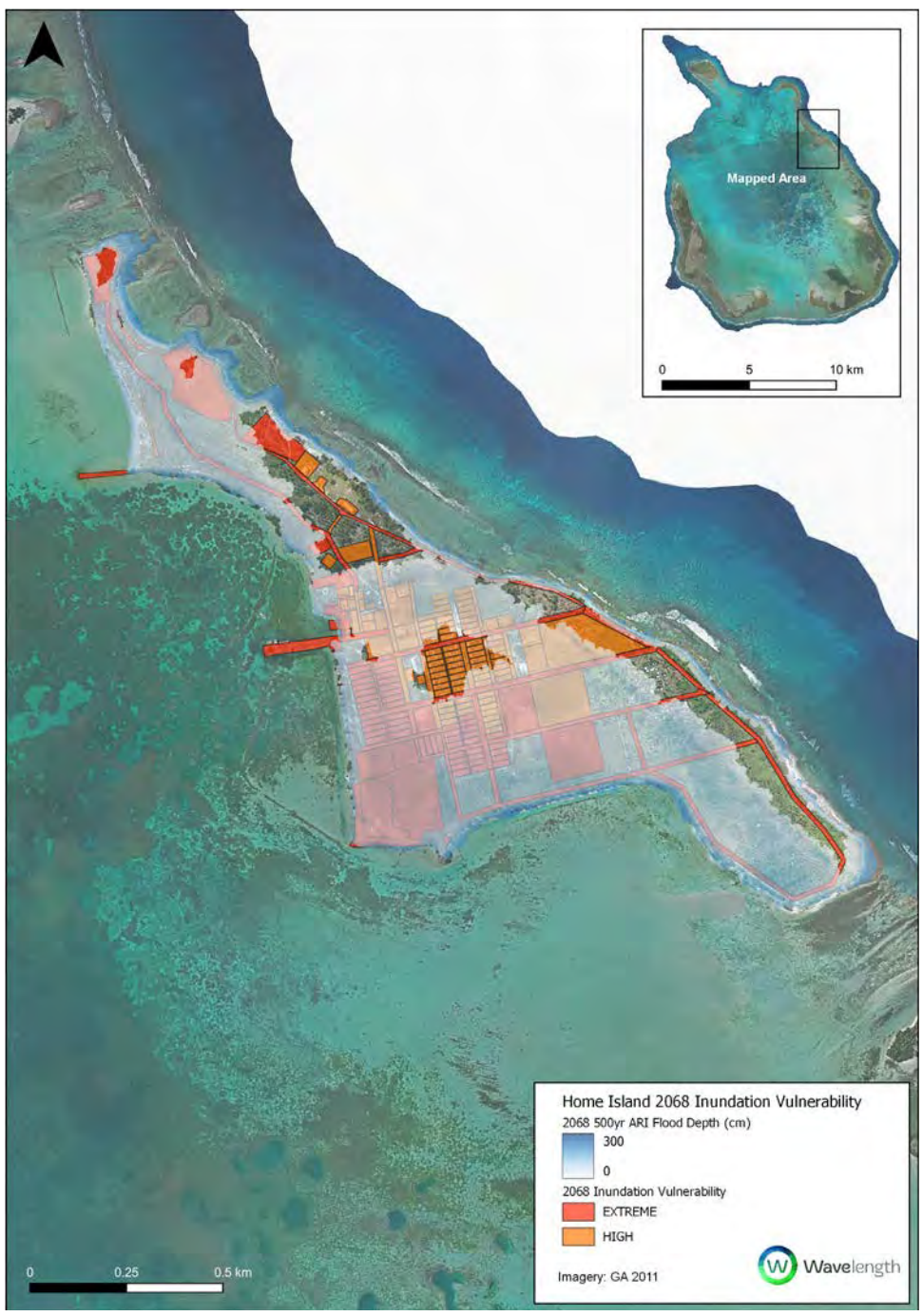
Home Island (1) - 2018 Erosion Vulnerability



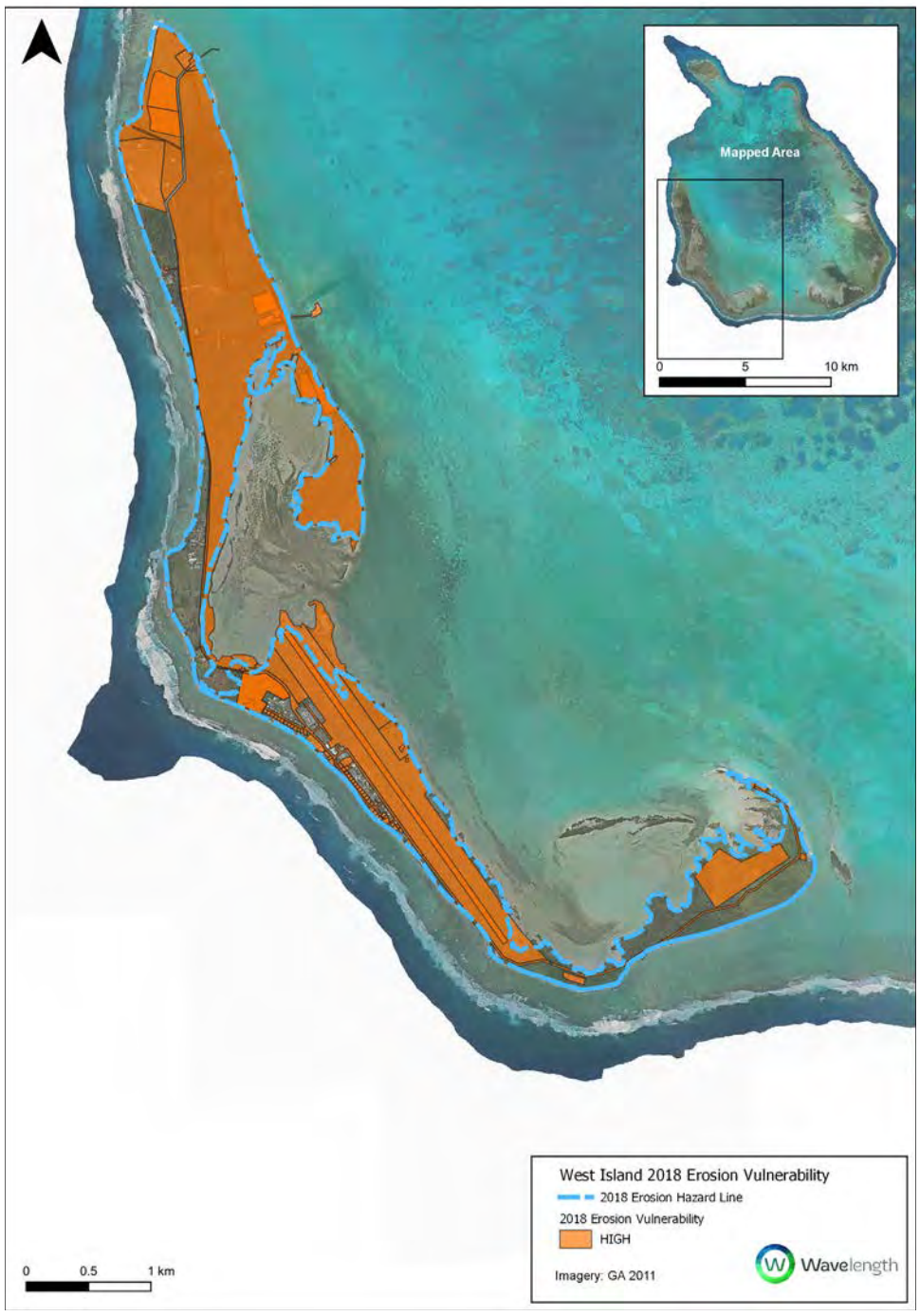
Home Island (2) - 2068 Erosion Vulnerability



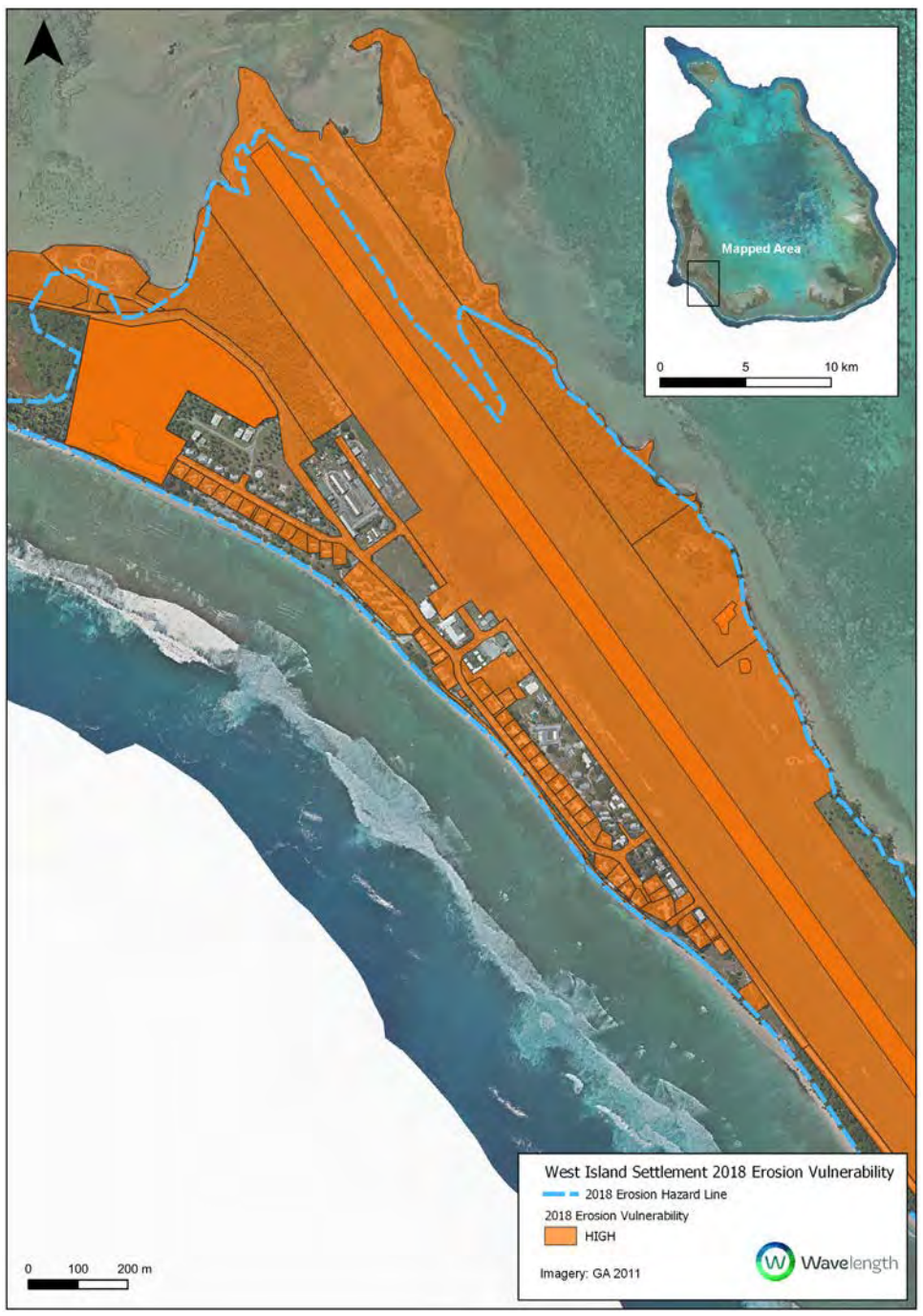
Home Island (3) - 2018 Inundation Vulnerability



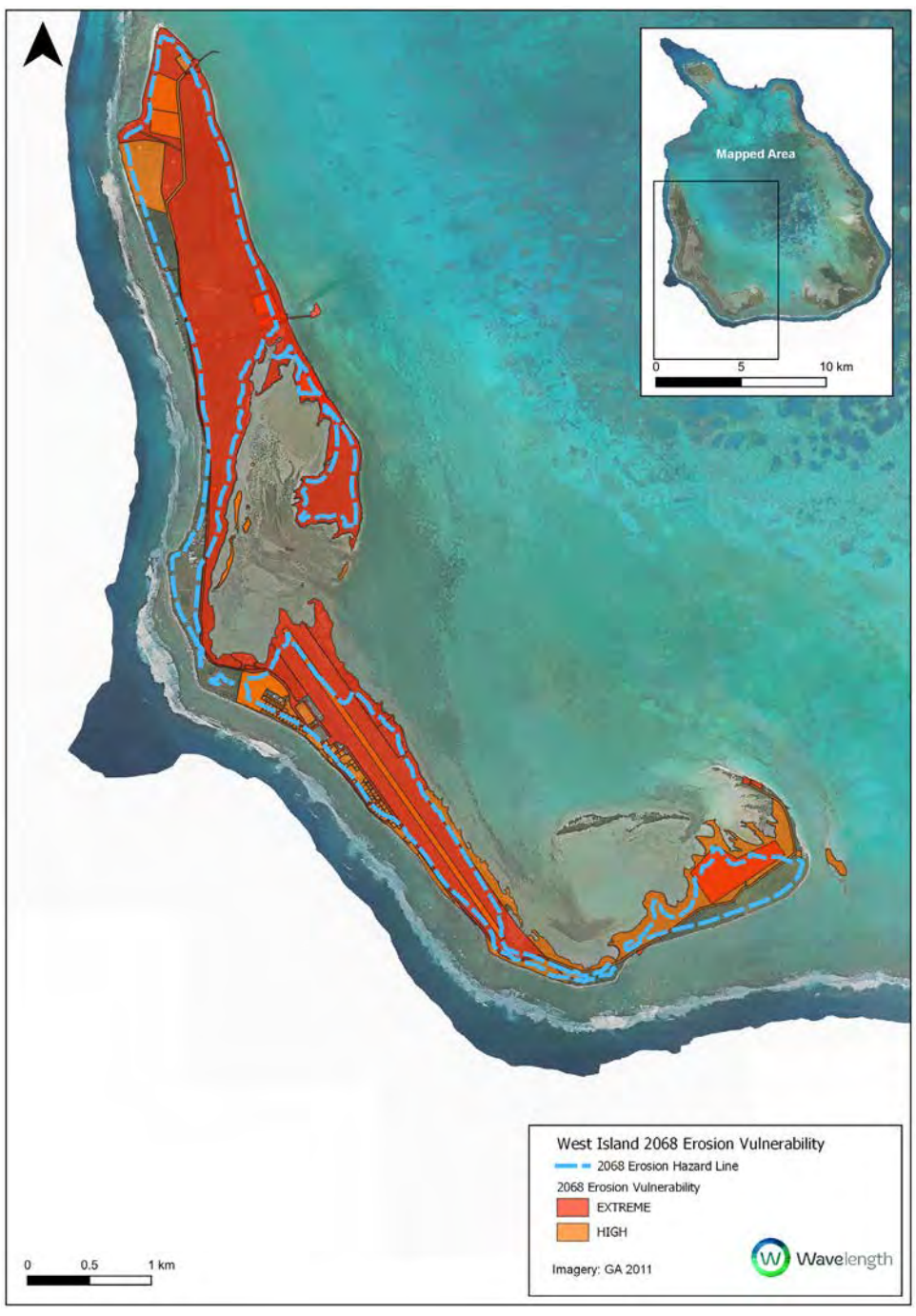
Home Island (4) - 2068 Inundation Vulnerability



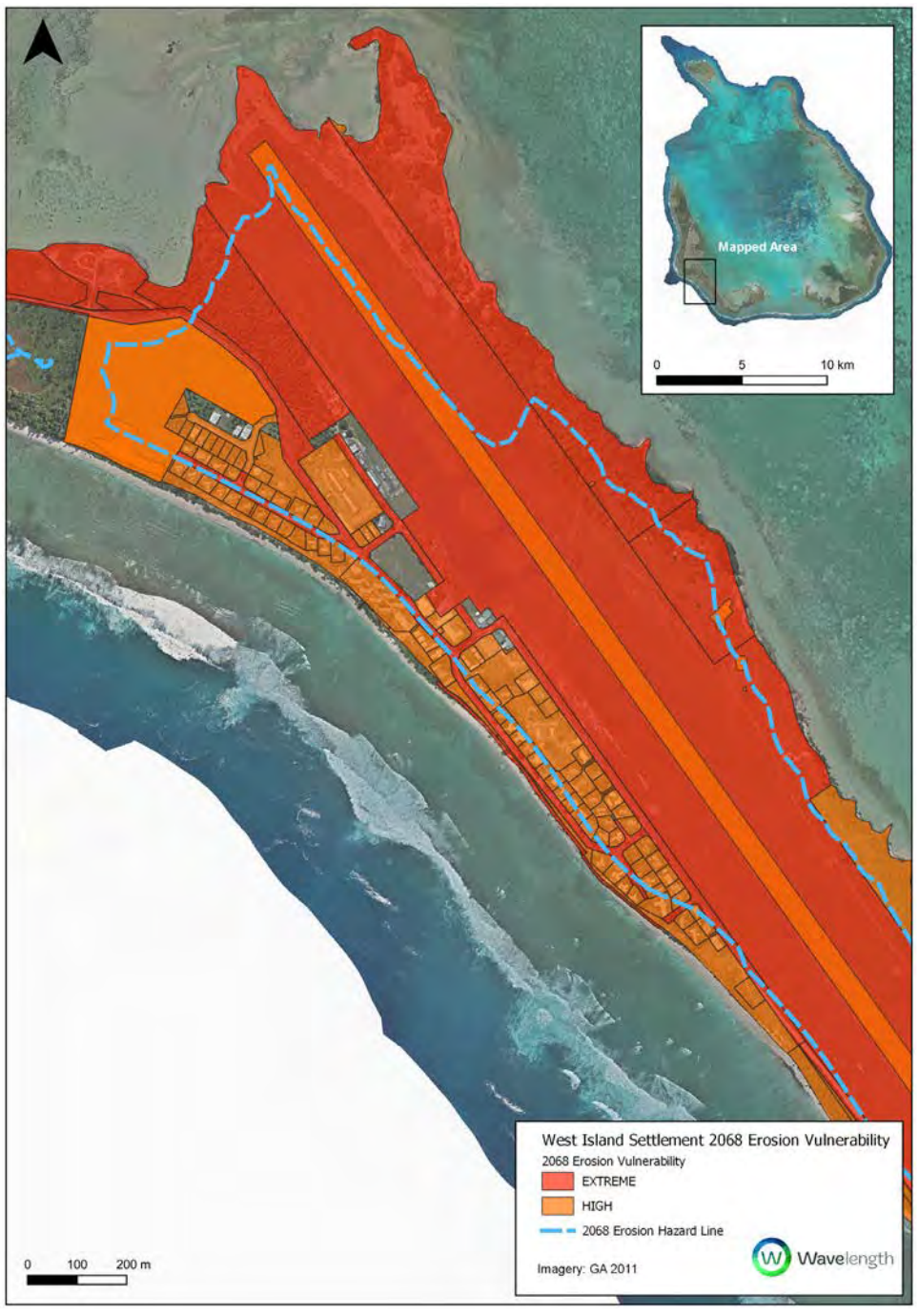
West Island (5) - 2018 Erosion Vulnerability



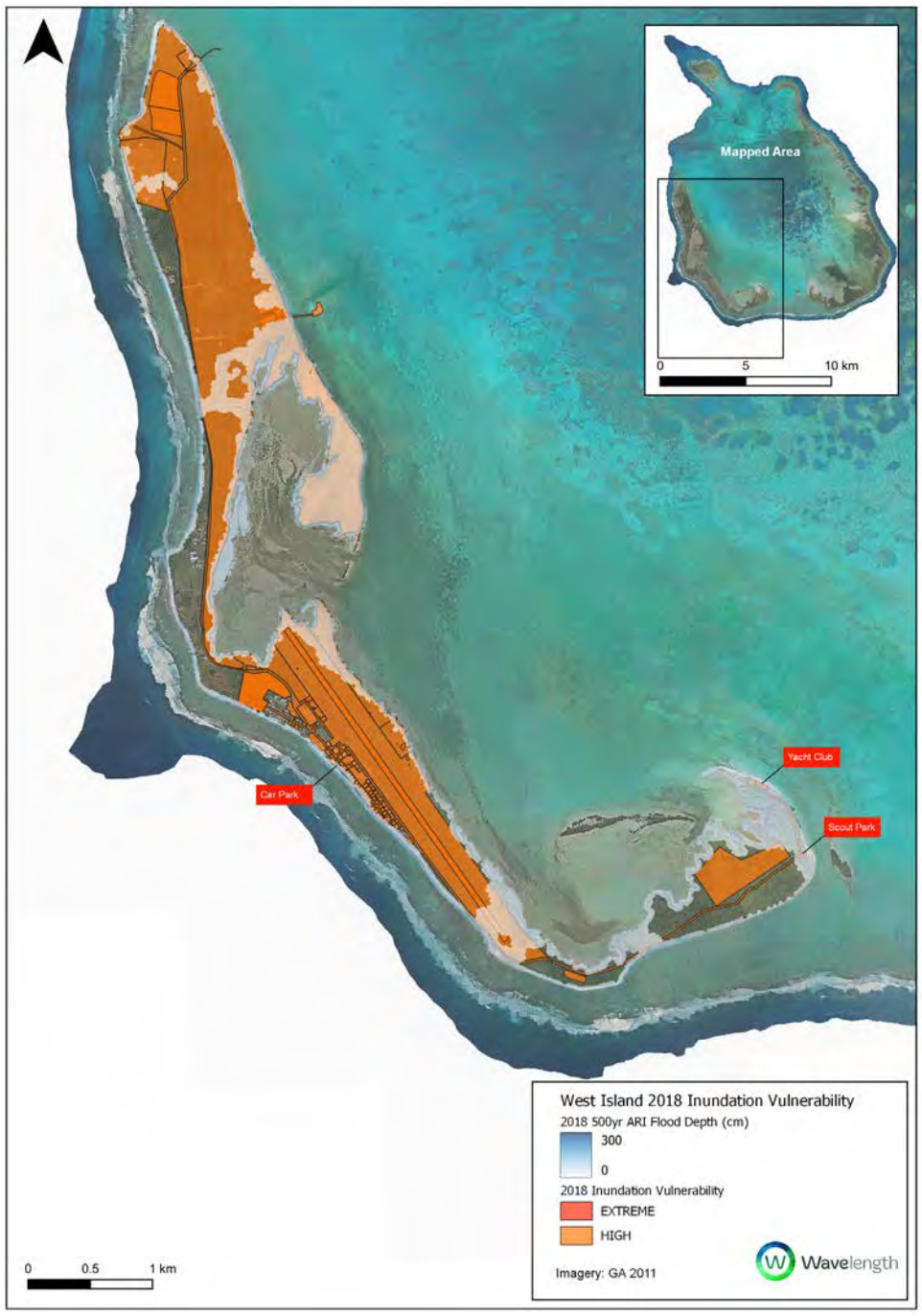
West Island Settlement (6) - 2018 Erosion Vulnerability



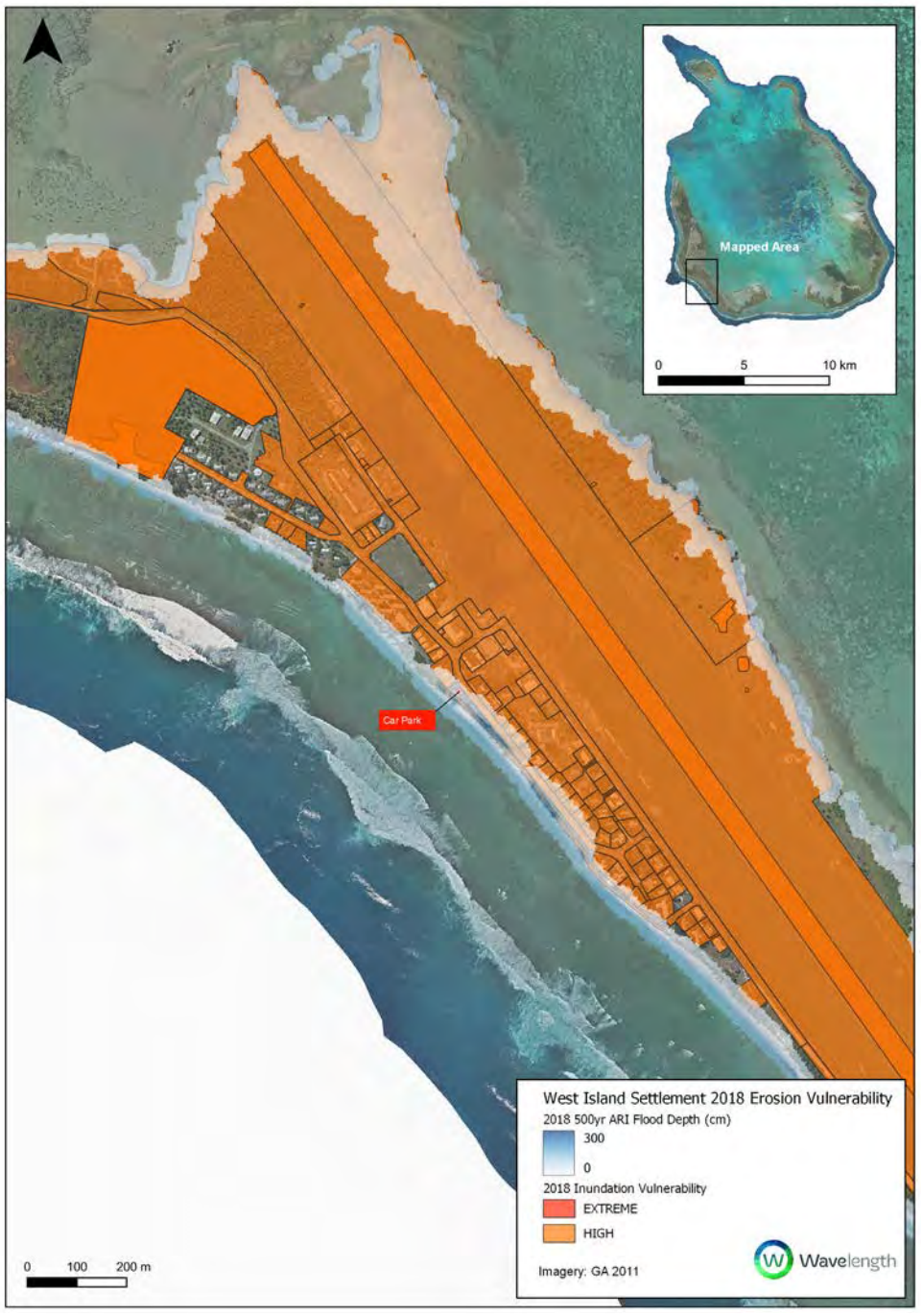
West Island (7) - 2068 Erosion Vulnerability



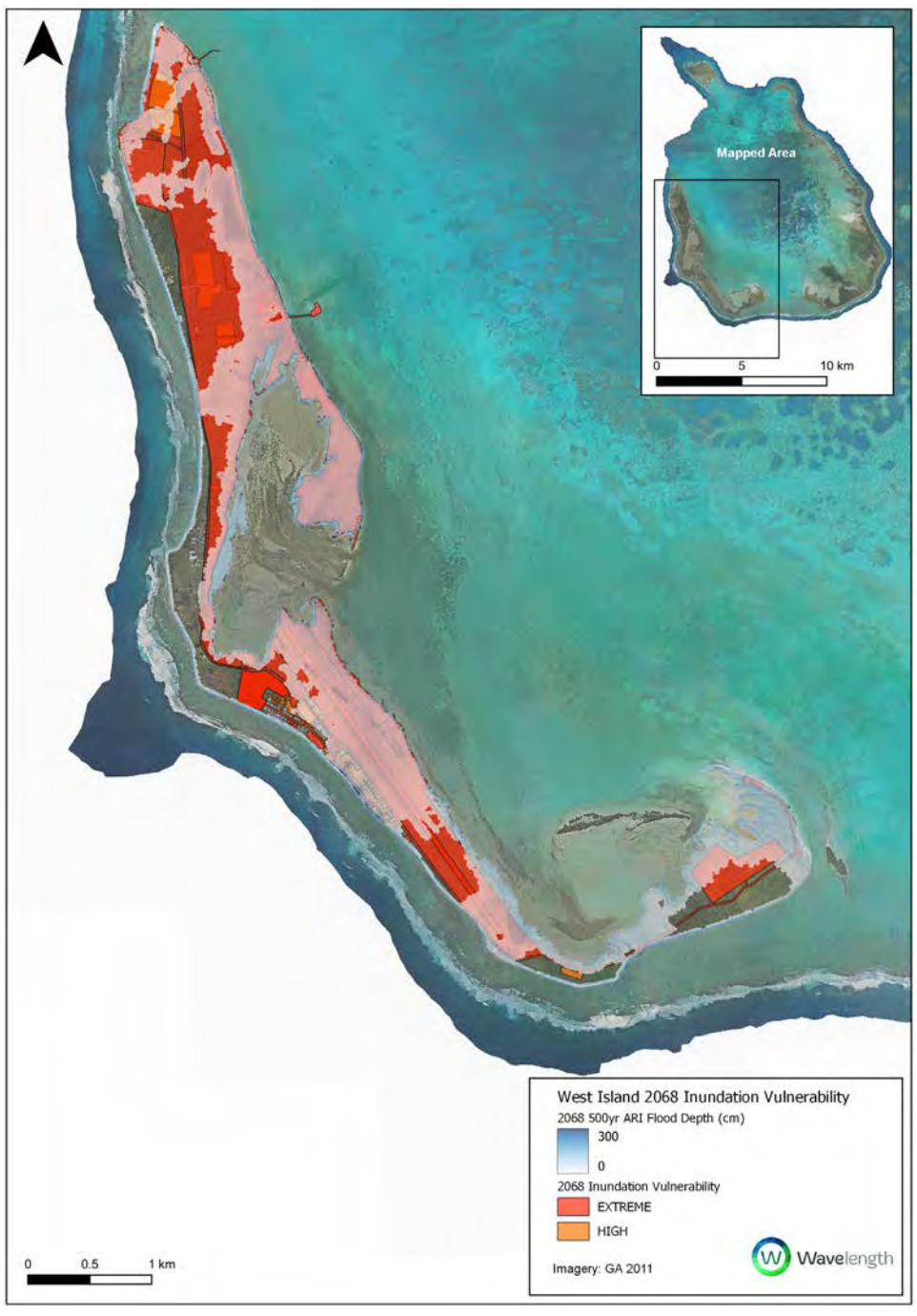
West Island Settlement (8) - 2068 Erosion Vulnerability



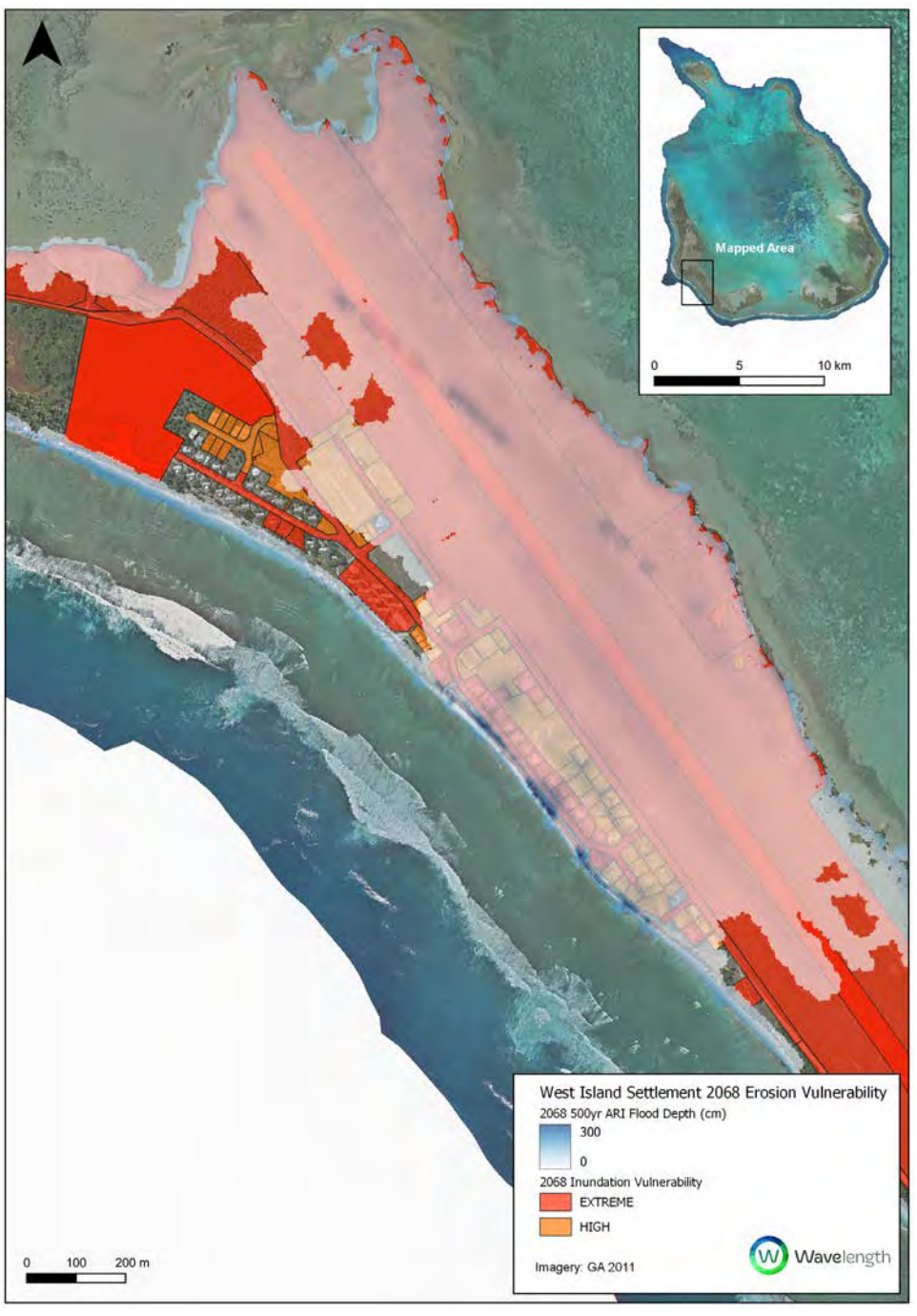
West Island (9) - 2018 Inundation Vulnerability



West Island Settlement (10) - 2018 Inundation Vulnerability



West Island (11) - 2068 Inundation Vulnerability

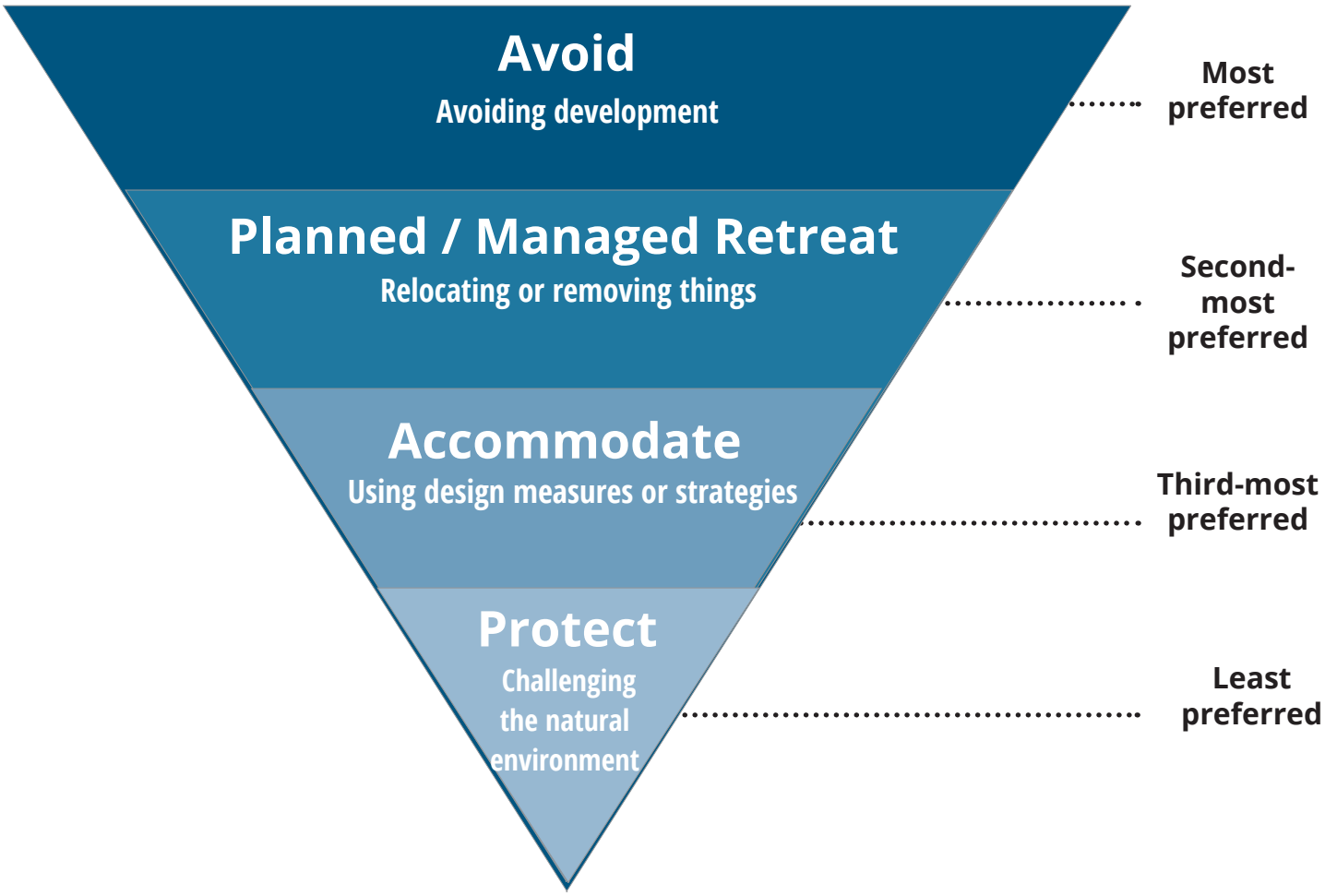


West Island Settlement (12) - 2068 Inundation Vulnerability

APPENDIX C

Adaptation Infographic

COASTAL ADAPTATION OPTIONS



We need to understand coastal hazards and risks so we can continue to use and enjoy the coast.

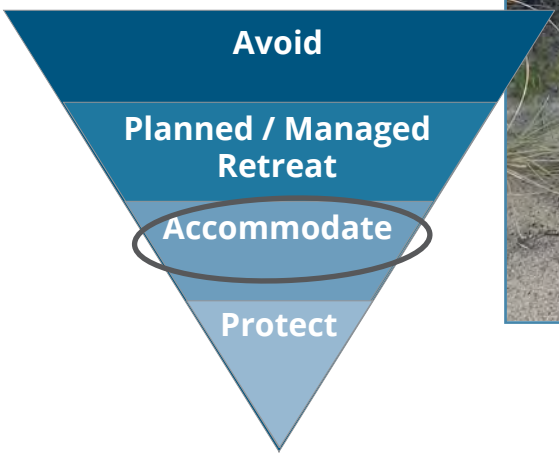
Once we understand the coastal hazards and risks, we can determine the best way to respond.

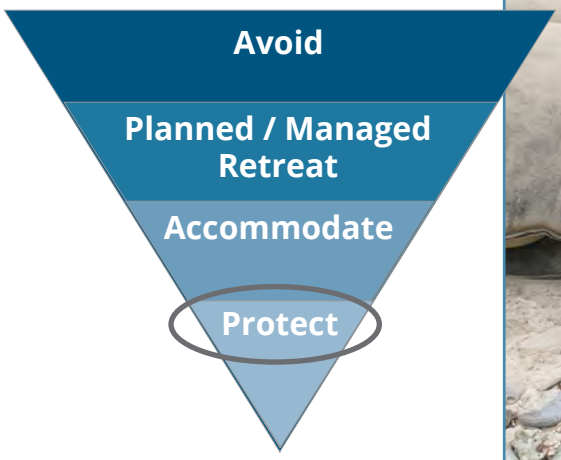
The response options are also known as **coastal adaptation options**.


WARNING
UNSTABLE DUNES KEEP OFF


Avoid
Planned / Managed Retreat
Accommodate
Protect

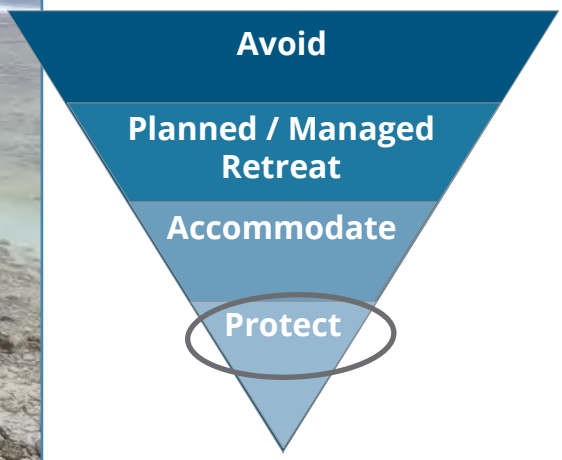


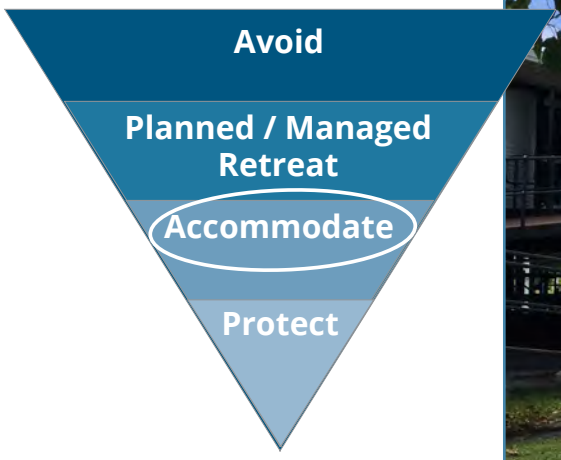

Avoid
Planned / Managed Retreat
Accommodate
Protect


Avoid
Planned / Managed Retreat
Accommodate
Protect






Avoid
Planned / Managed Retreat
Accommodate
Protect


Avoid
Planned / Managed Retreat
Accommodate
Protect


HYUNDAI

APPENDIX D

CRG Workshop 1 Presentation



Cocos (Keeling) Islands Coastal Hazard Risk Management and Adaptation Planning Project – Community Reference Group

Australian Government Department of Infrastructure, Transport, Regional Development, Communications and the Arts, in partnership with WA Department of Planning, Lands and Heritage, and Shire of Cocos Keeling Islands

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Why are we here today?

We are doing the **Coastal Hazard** Risk Management Adaptation Plan (CHRMAP) for Cocos (Keeling) Islands

We will explain what this is and how you are involved in the next few slides…

Who is running the project

Steering Group

Commonwealth Department of Infrastructure, Transport, Regional Development, Communications and the Arts

WA Department of Planning Lands and Heritage

Shire of Cocos (Keeling) Islands

Department of Transport (Coastal Infrastructure Branch)

Consultant Team

Shape Urban – Planning, Communications & Stakeholder Engagement

Wavelength – Coastal Planning and Engineering

FAR Lane – Economics/Cost Benefit

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How this session will work

- Process/project
- Coastal processes, hazards and risks on CKI (context)
- Multi criteria assessment – what are the criteria?
- Assets and values in Coastal Hazard Zones

Workshop 2 on Monday will look at:

- *Important assets and locations*
- *Typical risk management approaches and options available (viable)*
- *Ideas and suggestions*

Q&As through both sessions



What are we doing?

The Remit

The Cocos (Keeling) Islands are affected by coastal erosion and inundation, with vulnerability of use and development expected to increase in the future.

- Home Island and West Island coastlines are used and highly valued by the CKI community
- Important to understand how the coastlines are changing
- How to respond to these changes for sustainable coastal living for the CKI community into the future
- We will be making recommendations for action

The Remit

So we are preparing a CHRMAP…

…a strategic document to *plan* for responding to *coastal hazard challenges…*

- Identify vulnerable public and private assets
- Recognise and preserve community values for current and future generations
- Inform community and decision makers
- Required under West Australian State Planning Policy 2.6 – State Coastal Planning

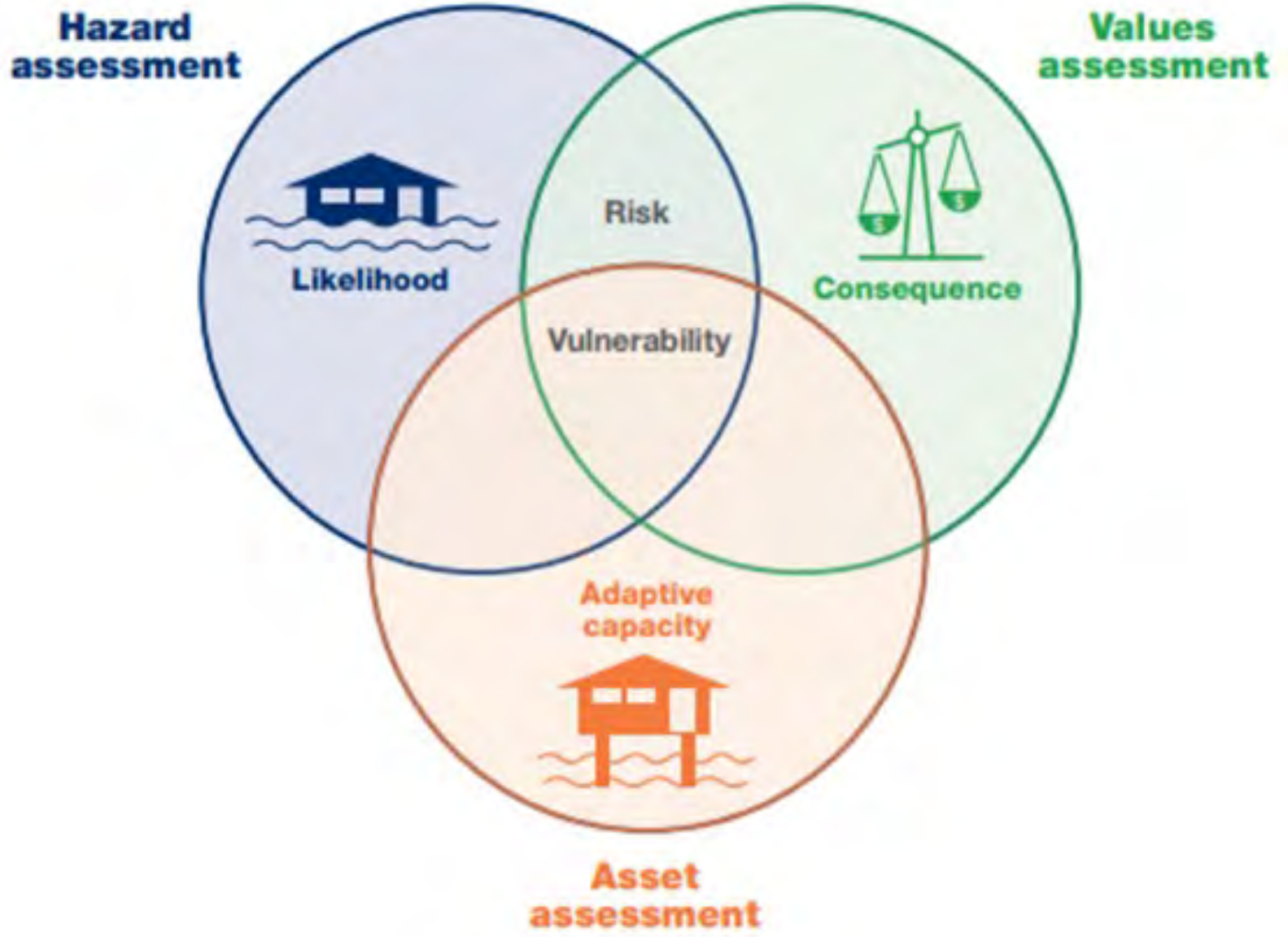
A plan for the next 100 years…. But more urgent here than 'normal'…

What a CHRMAP does

Predict the *risk* of **erosion** + **inundation** with sea level rise

- Looks at likelihood of exposure on an asset
- Looks at consequence of exposure on an asset (or sensitivity)

Then considers adaptability of the asset



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Project Background

- DPLH - state-wide responsibility for the planning - provides support to the IOT under Service Delivery Arrangements (SDAs) with Commonwealth
- DPLH is responsible for delivering on State Planning Policy. In this case - *State Planning Policy 2.6 - State Coastal Planning Policy* - SPP 2.6
- SPP 2.6 looks at vulnerability of populations. Perhaps the most critical issue affecting the future sustainability of human settlement on CKI

Project Background (cont…)

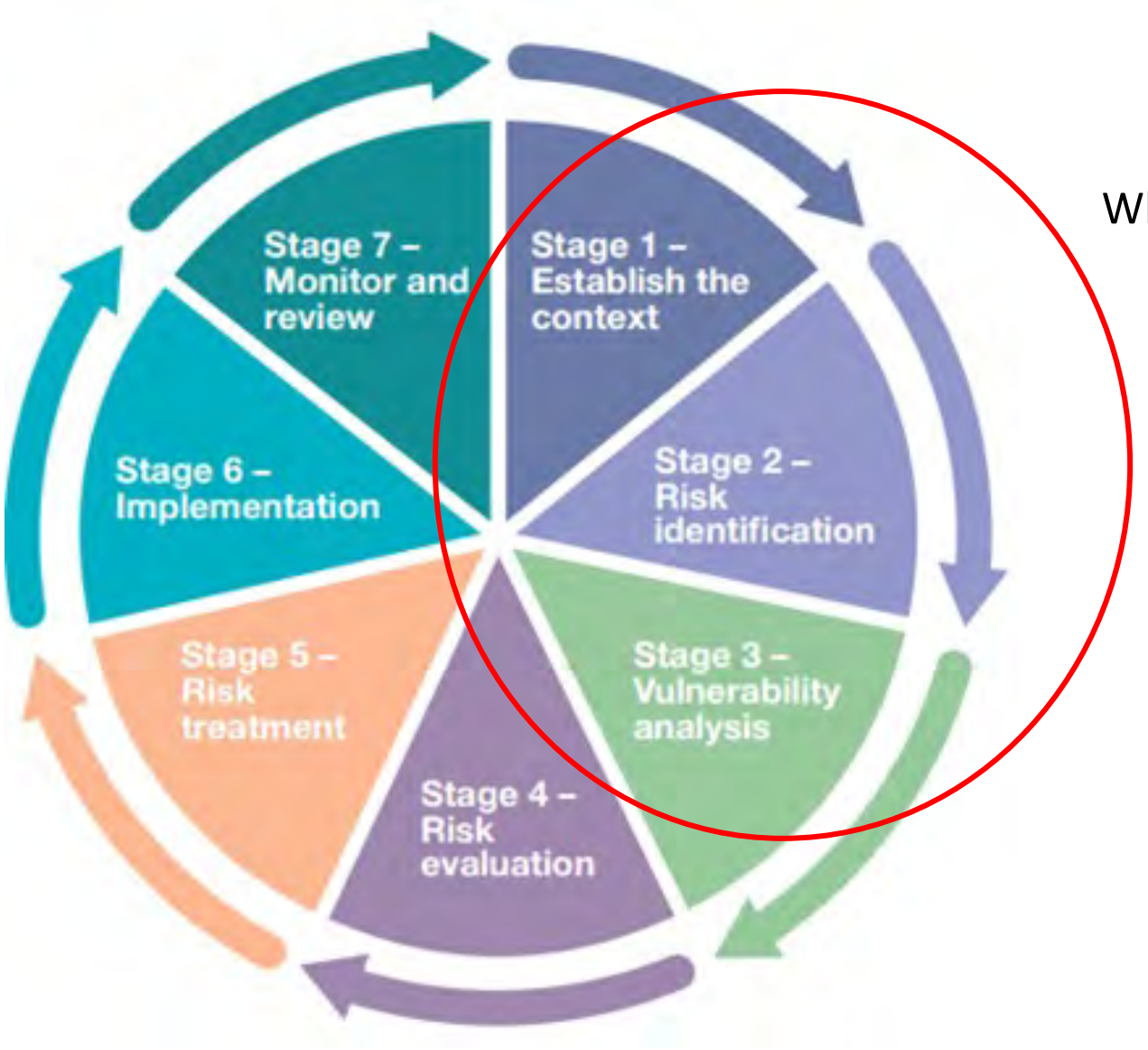
- DPLH - *Cocos (Keeling) Islands Coastal Vulnerability Study* (Haskoning Australia PTY Ltd, 2021) identified areas vulnerable over a 100-year planning timeframe
- This project is next step to deliver this ‘CHRMAP’
- Then deliver actions ($$)

Phase 1 (2018-2020): CKI Coastal Vulnerability Study (CVS)

Phase 2 (2021-2023): CKI Coastal Hazard Risk Management and Adaption Plan (CHRMAP)

Phase 3 (2023 onwards): New Local Government Planning Scheme by Shire of CKI

How to complete it



Where we are

SPP 2.6 + CHRMAP Guidelines - Process

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Other Completed and Supporting Studies

- Hydrographic surveys, long term wind data, long term tide data, topographic information, LiDAR, metocean data, CVS
- Climate Change Risk Assessment
- CKI Sand Management Strategy Numerical Modelling Report
- Crown Land Management Plan for IOT
- An assessment by BoM (2005) regarding cyclone activity in the region
- Physical Coastal Processes for Rumah Baru

(RHDHV, DoT, DoD, Maunsell, CZM, DA Lord & Associates, GHD, BoM…)

What it all says (so far)

- The islands are one of the most vulnerable coastal types to Sea Level Rise (SLR)
- The CVS shows risks are already ‘High’ for multiple assets.

The studies don’t tell us what is *valuable* to YOU, only what is *objectively* vulnerable



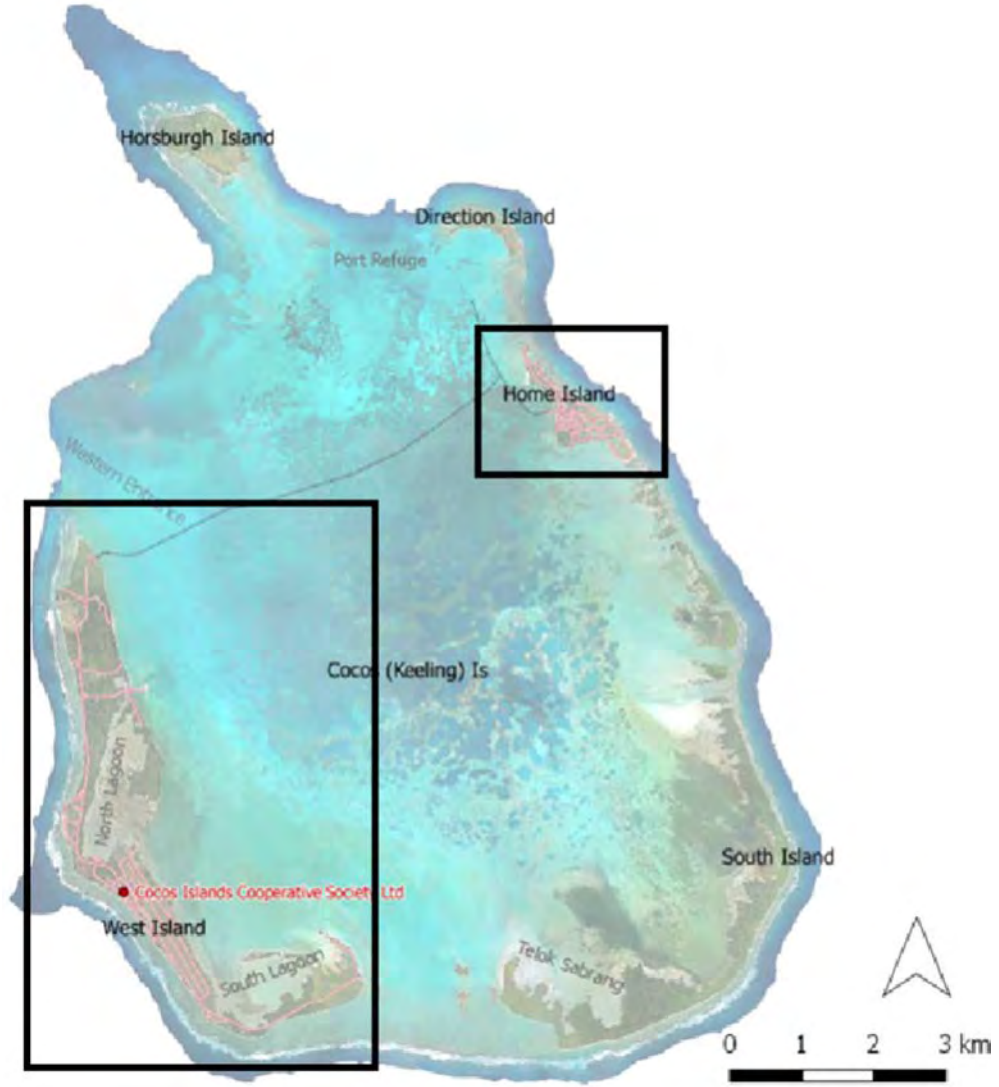
Island landforms and settlement

The shoreline around CKI can be divided into:

- ocean shores that occur around the perimeter of the atoll and face the open ocean; and
- lagoon shores that flank the lagoon

Fringing coral reef surrounds all the CKI lagoon

Two breaks in the reef at Port Refuge and Western Entrance



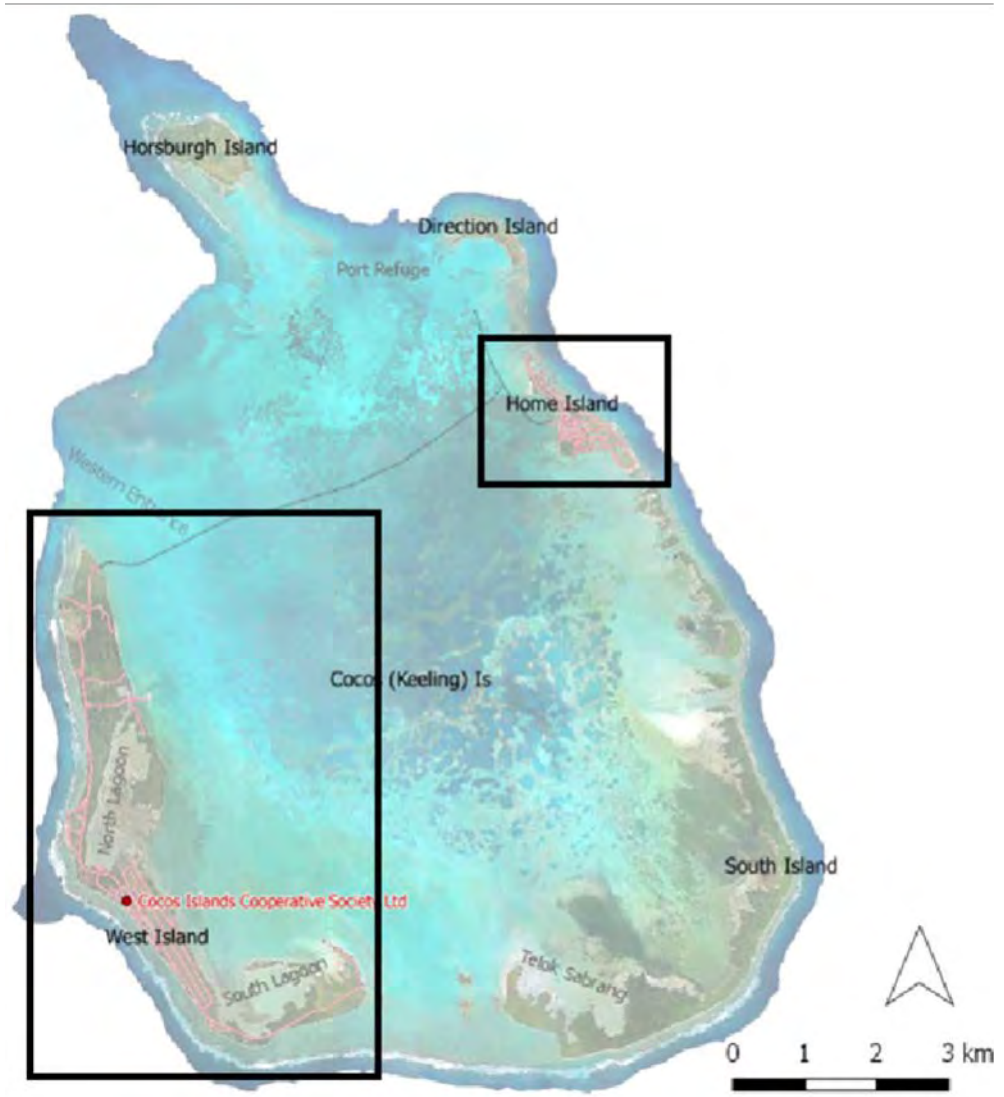
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Home Island

Home Island is located on the eastern side of CKI.

Home Island is low lying and susceptible to coastal flooding, especially the foreshore adjacent to the lagoon.

Most shorelines on Home Island have been stable and infrastructure on the ocean coast is reasonably setback in most locations.



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Home Island





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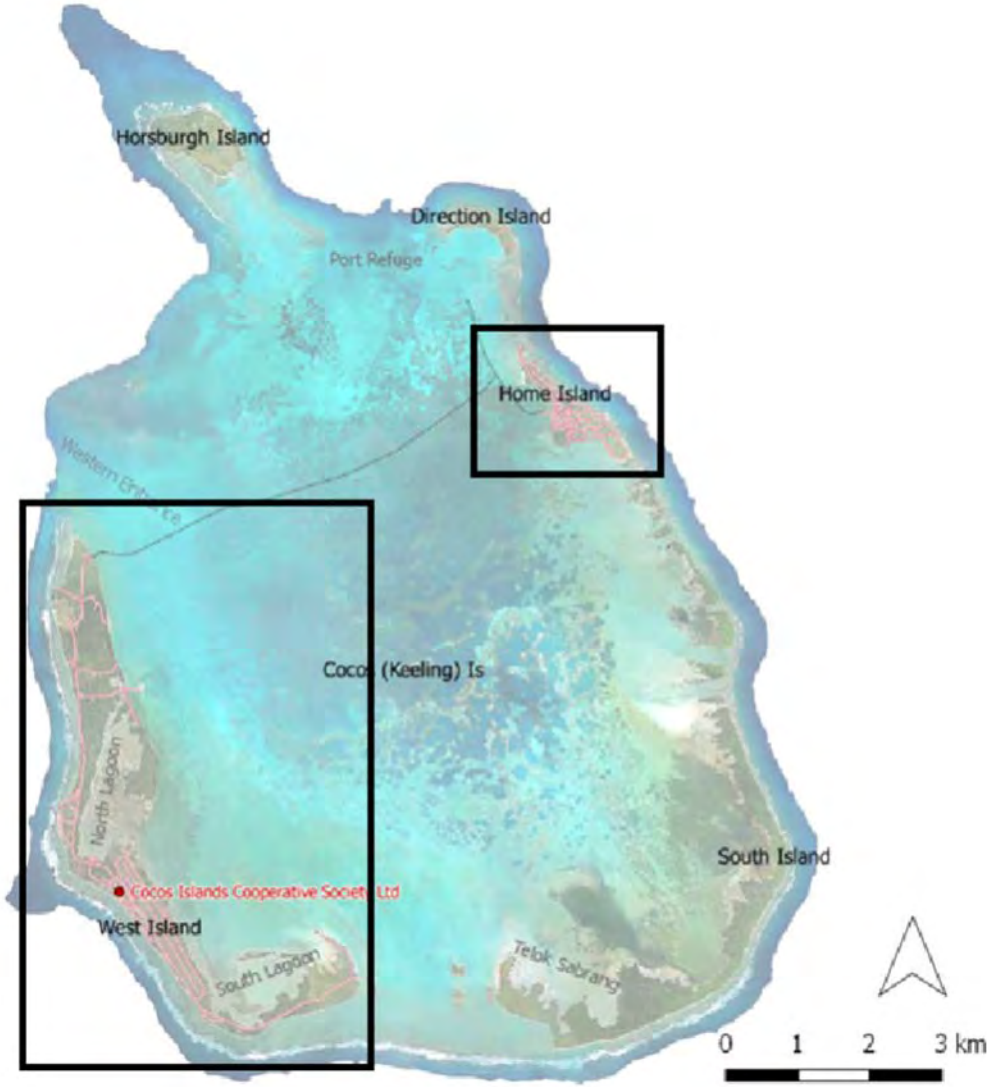
West Island

West Island - elongated shape with a sandy shoreline.

Development concentrated around the airport and West Island Settlement in the southern part of the island.

Development along the ocean coast has a very narrow foreshore buffer.

The island has a history of chronic erosion along the western ocean facing shore, requiring construction of multiple coastal structures since the 1970's to protect assets.



West Island





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Cyclones and Waves

The region experiences tropical cyclones, typically 2-3 per year

Subsequently, extreme wave events occur, impacting both ocean facing sides

The local wave climate includes:

- **Local sea waves** produced by winds predominantly from the east
- **Swell waves** from storms in the Indian Ocean, predominantly from the south west

Tides and Currents

CKI typically has two high tides and two low tides per day

Mean sea level varies on a monthly timescale - sea level rise will also increase mean sea levels over time

Department of Transport recommends the following sea level rises be used for planning:

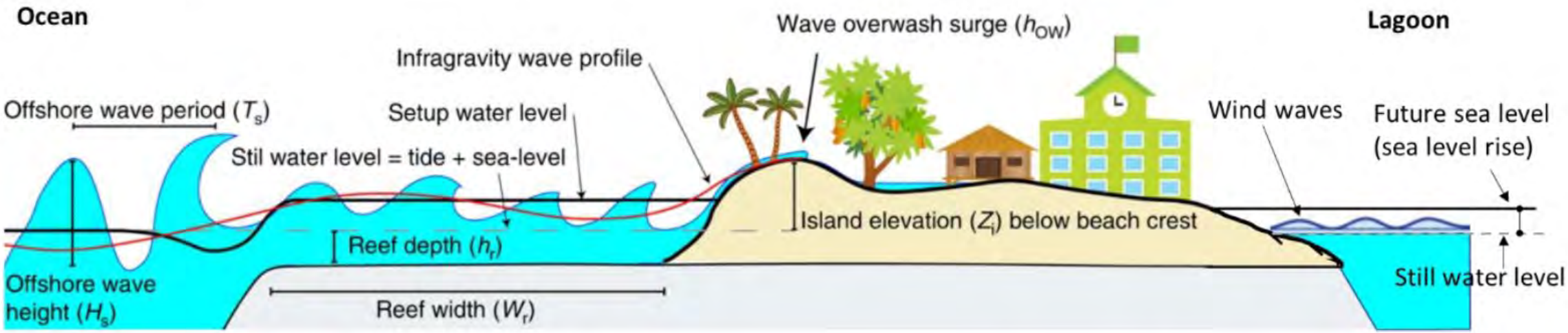
- 0.4m for a 50-year planning timeframe (i.e. 2068)
- 0.9m for a 100-year planning timeframe (2118)

Currents and circulation within the lagoon are driven by waves, wind and tides

Coastal Inundation

Lagoon side - extreme water levels driven by short term wind waves and cyclone events.

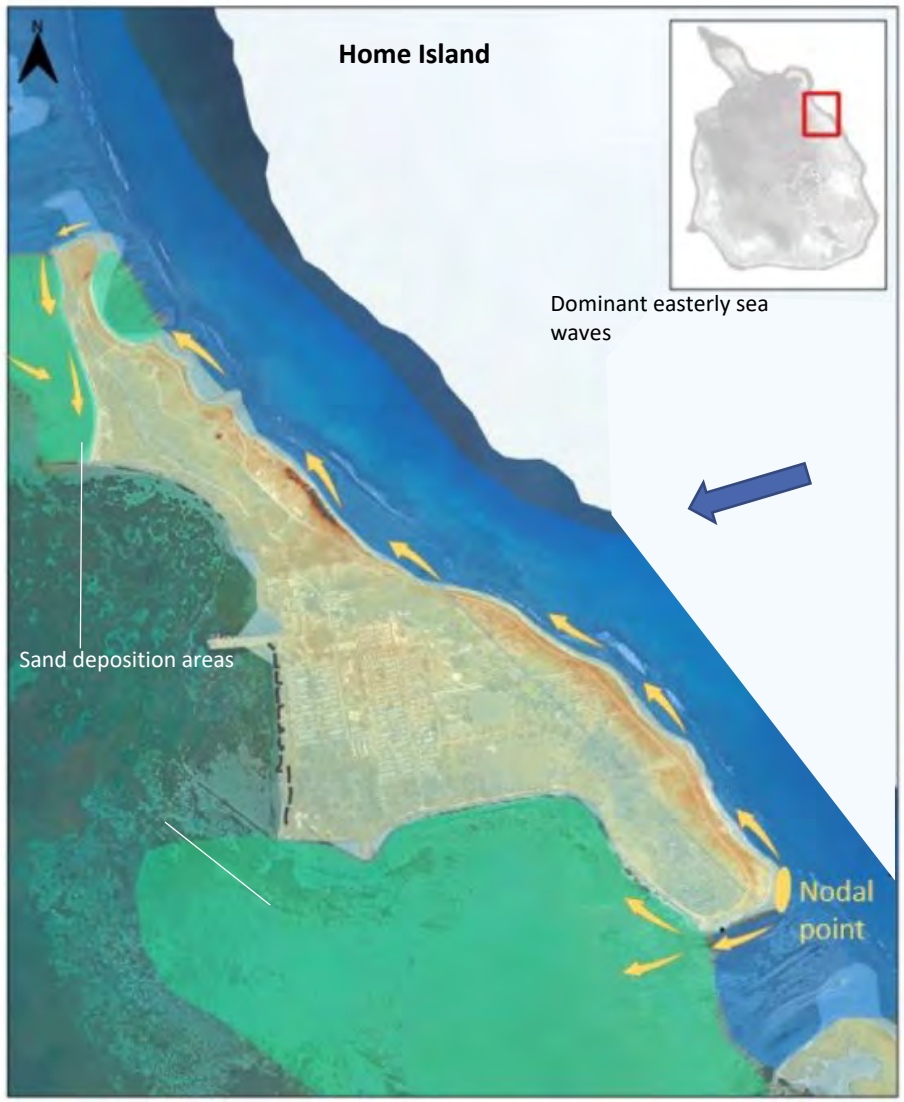
Ocean side - offshore waves travelling across the reef, causing wave setup and runup (i.e. elevated water levels and flooding).

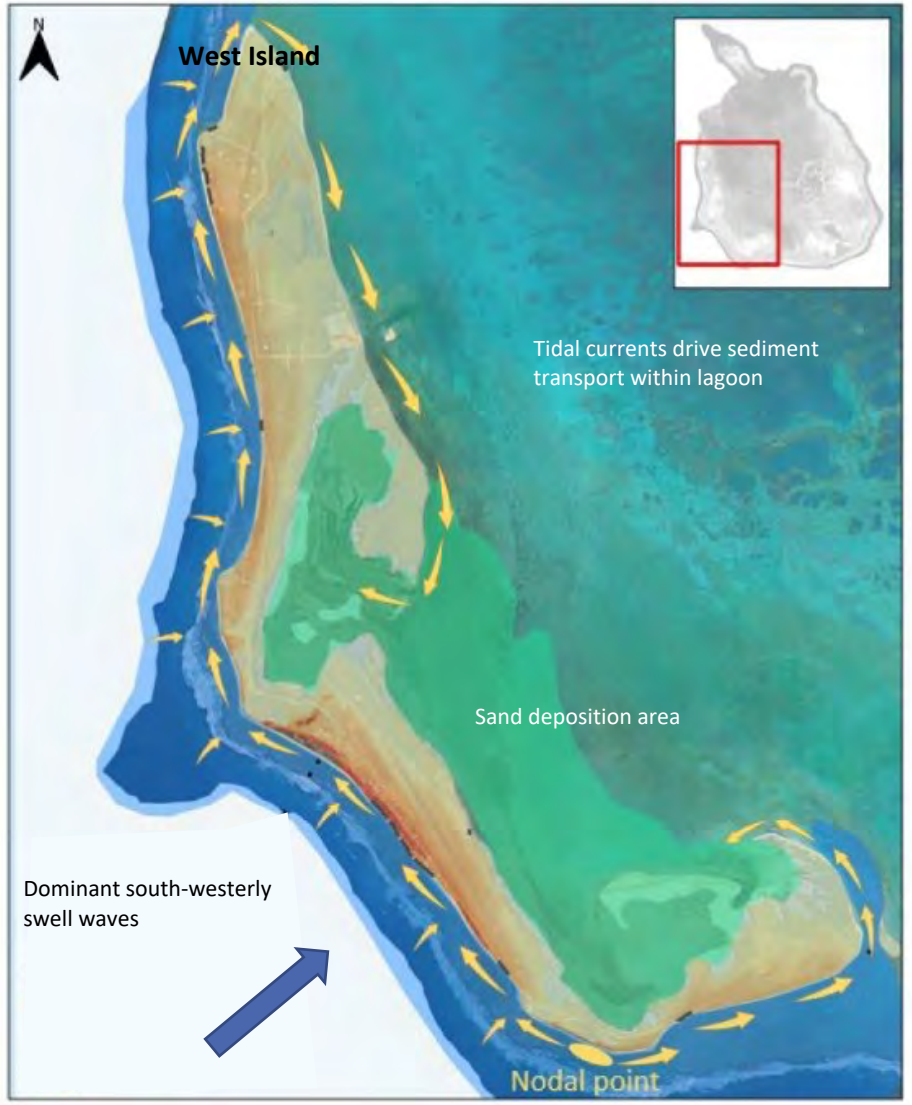


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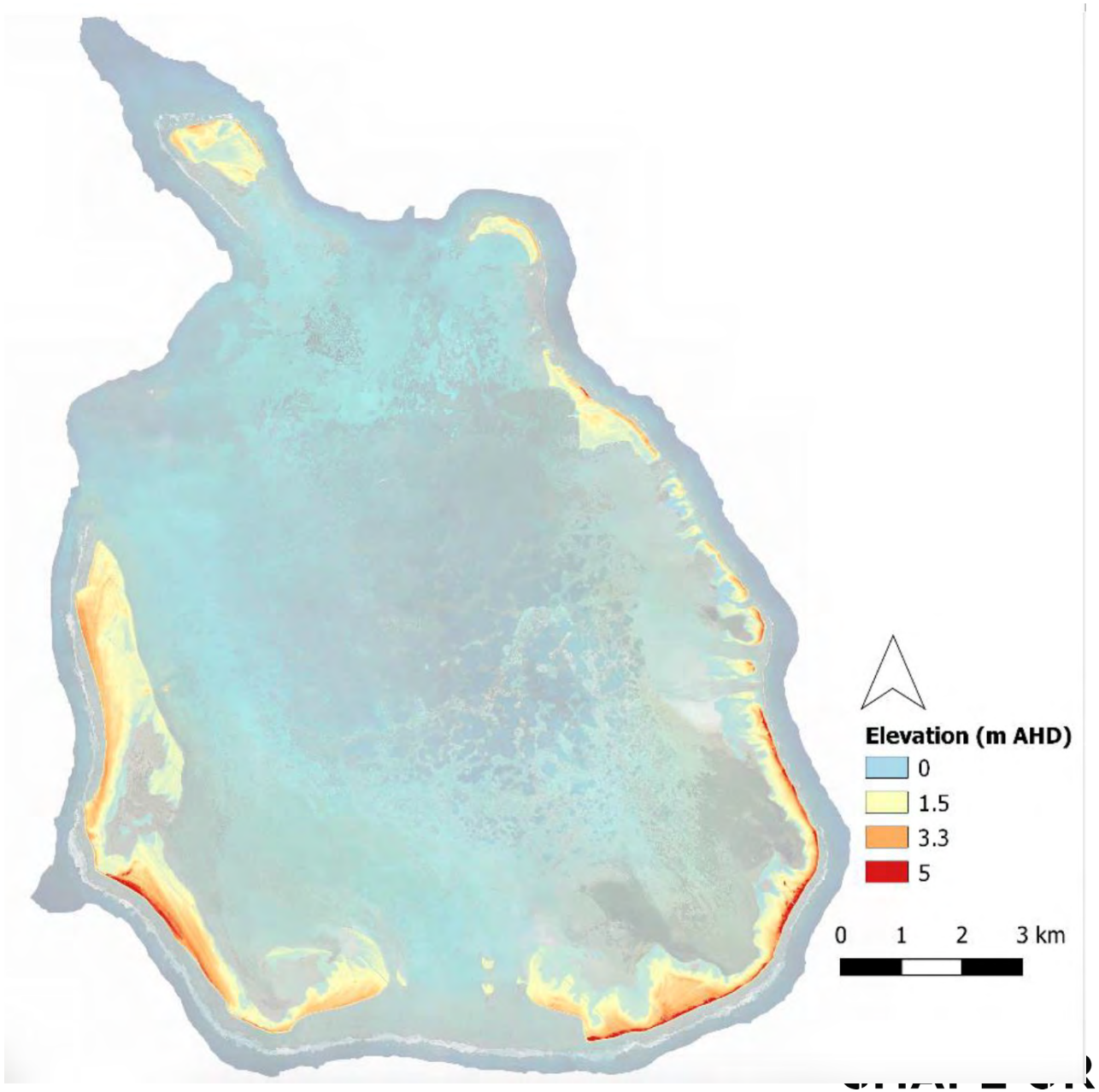
Wavelength

Sand Movement and Erosion





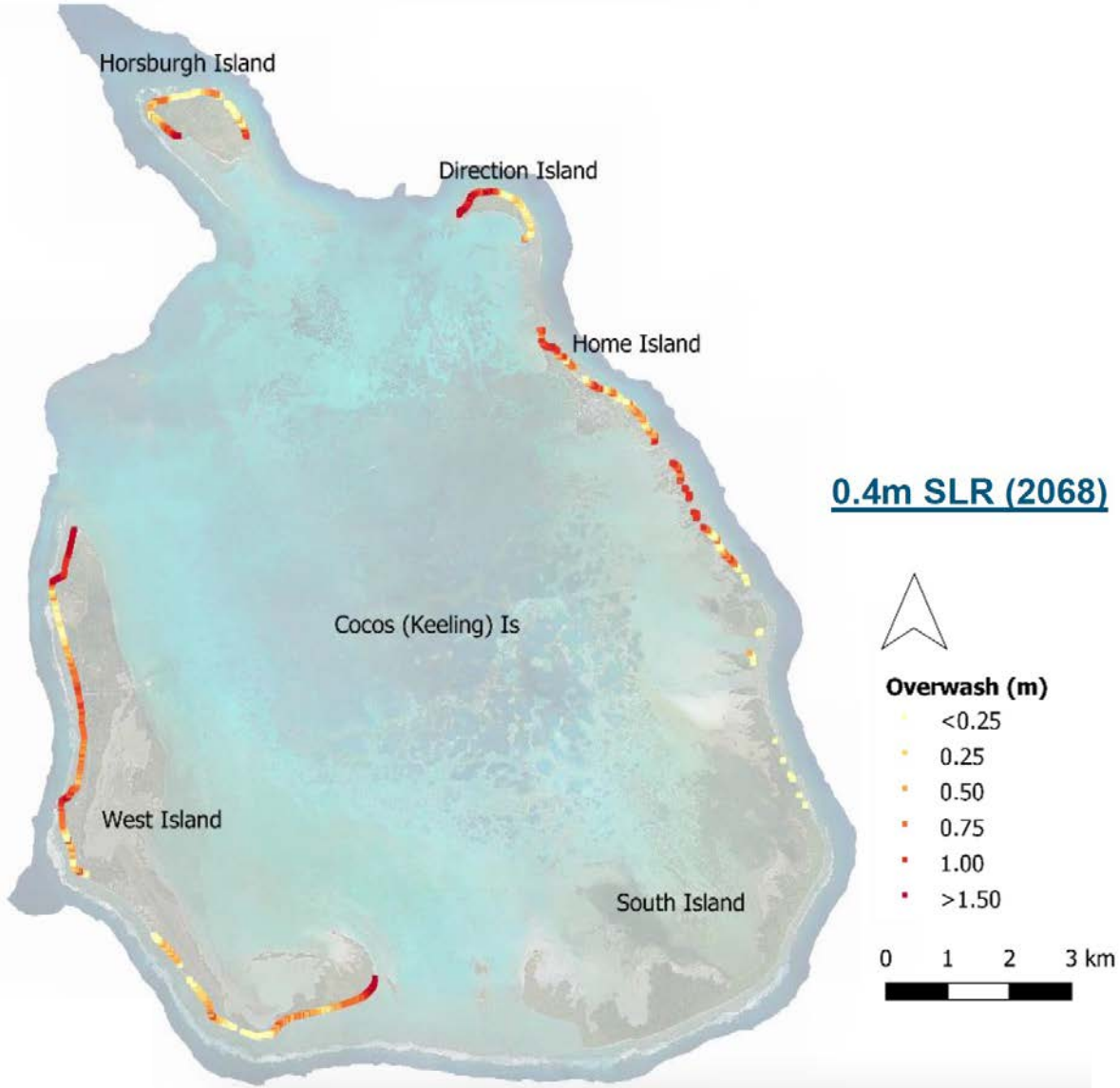
Elevation

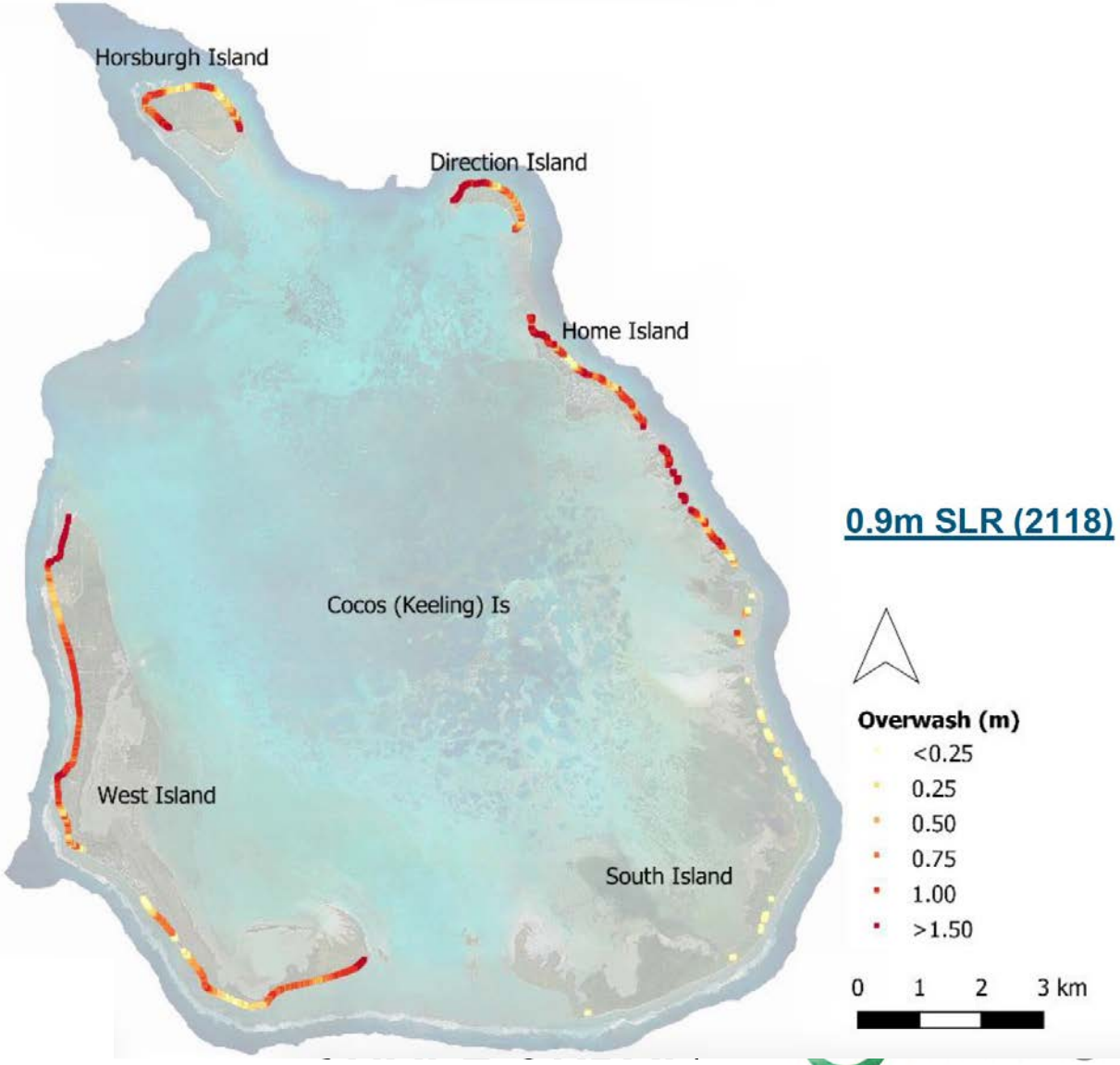


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Overtopping





Q & A

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Vulnerability Mapping for 2018 and 2068

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Home Island – Inundation Vulnerability 2018

Cemetery

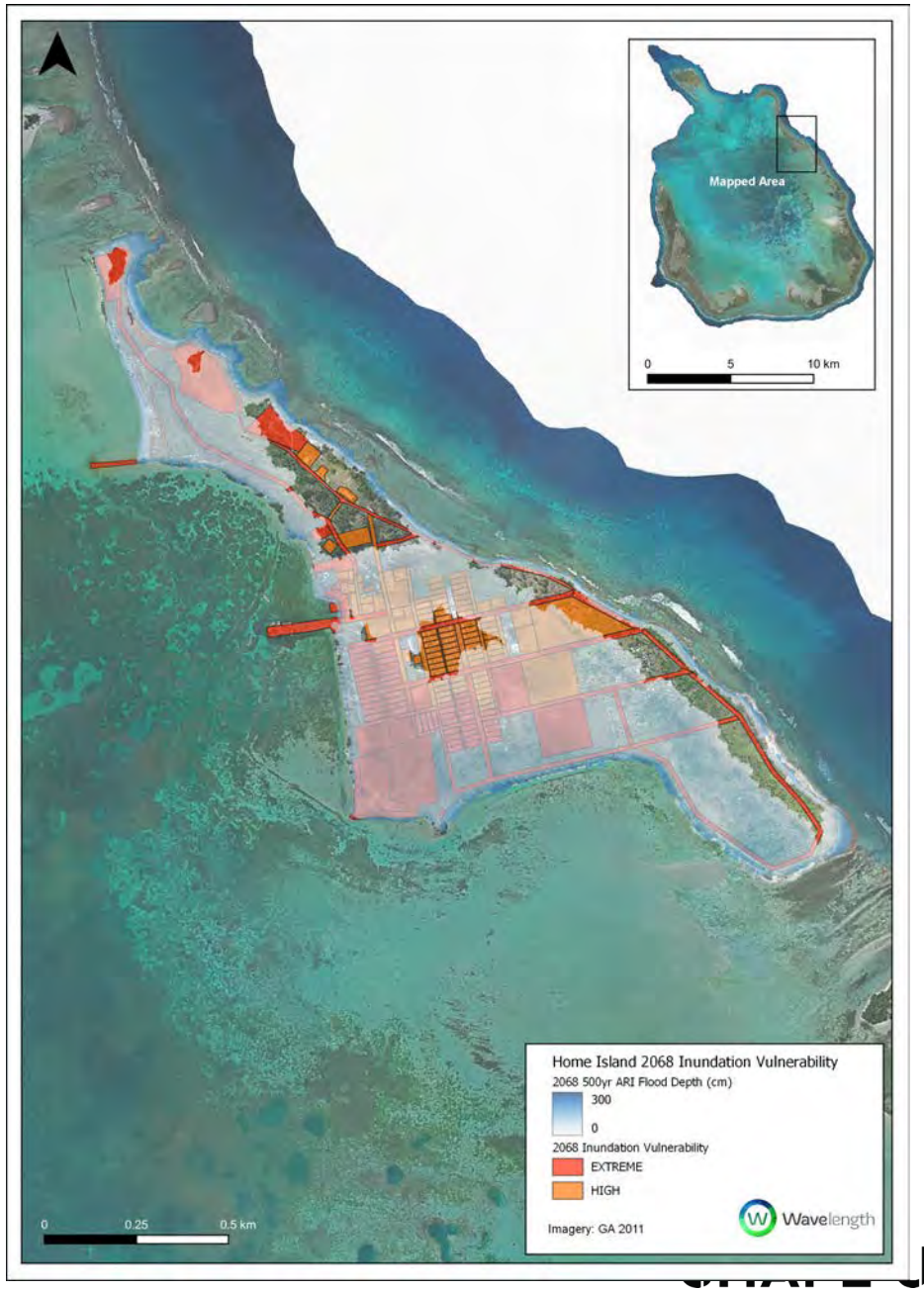
Shire Office

Mosque

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Home Island – Inundation Vulnerability 2068



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Wavelength

Home Island – Erosion Vulnerability 2018



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Wavelength

Home Island – Erosion Vulnerability 2068

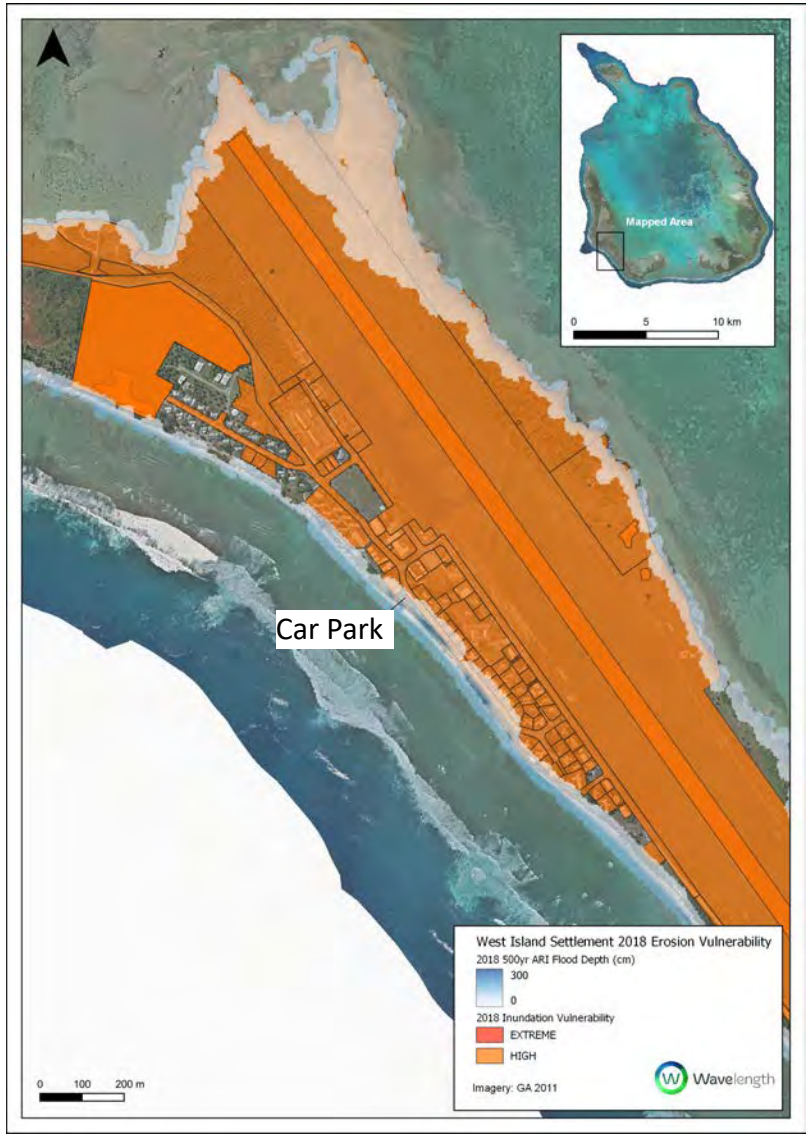


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West Island – Inundation Vulnerability 2018

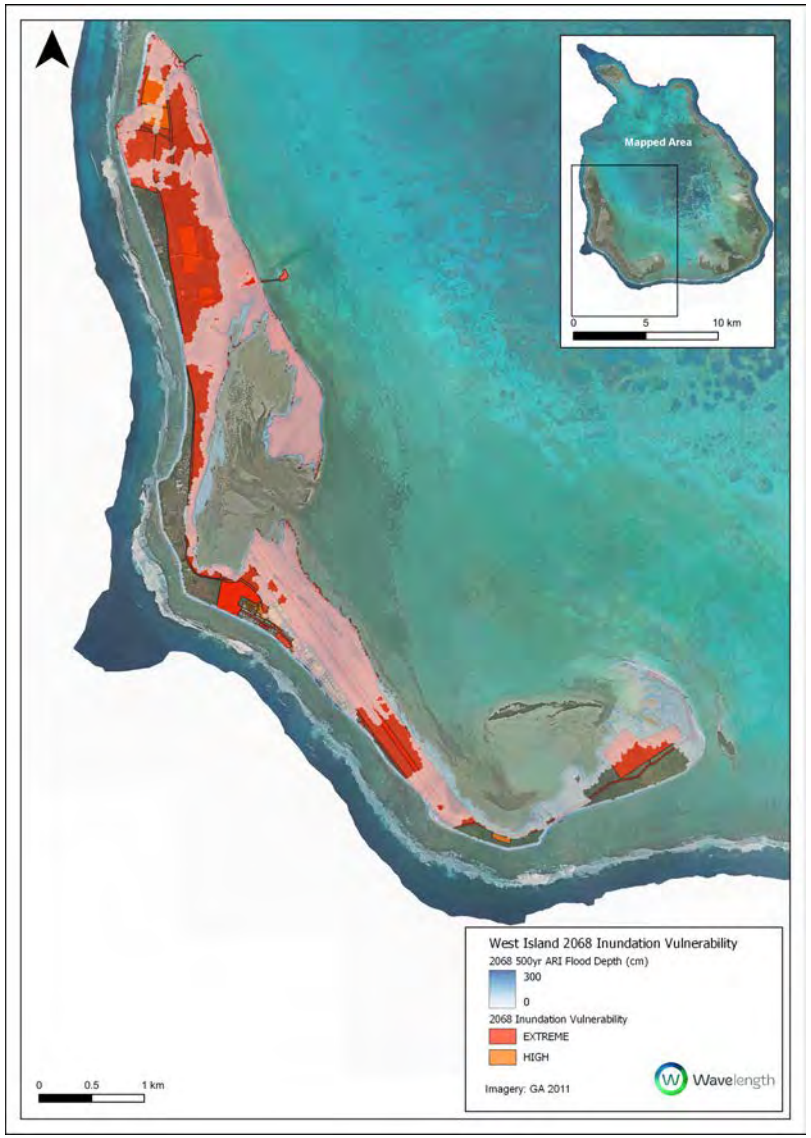


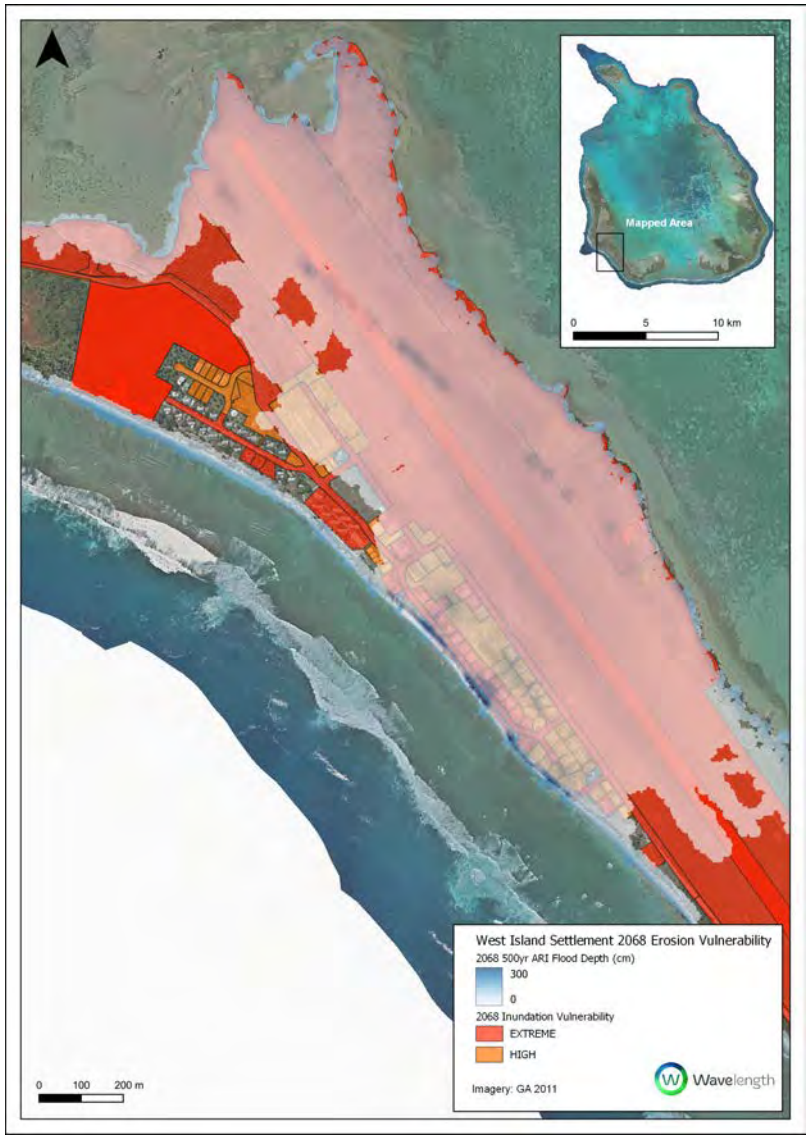


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West Island – Inundation Vulnerability 2068

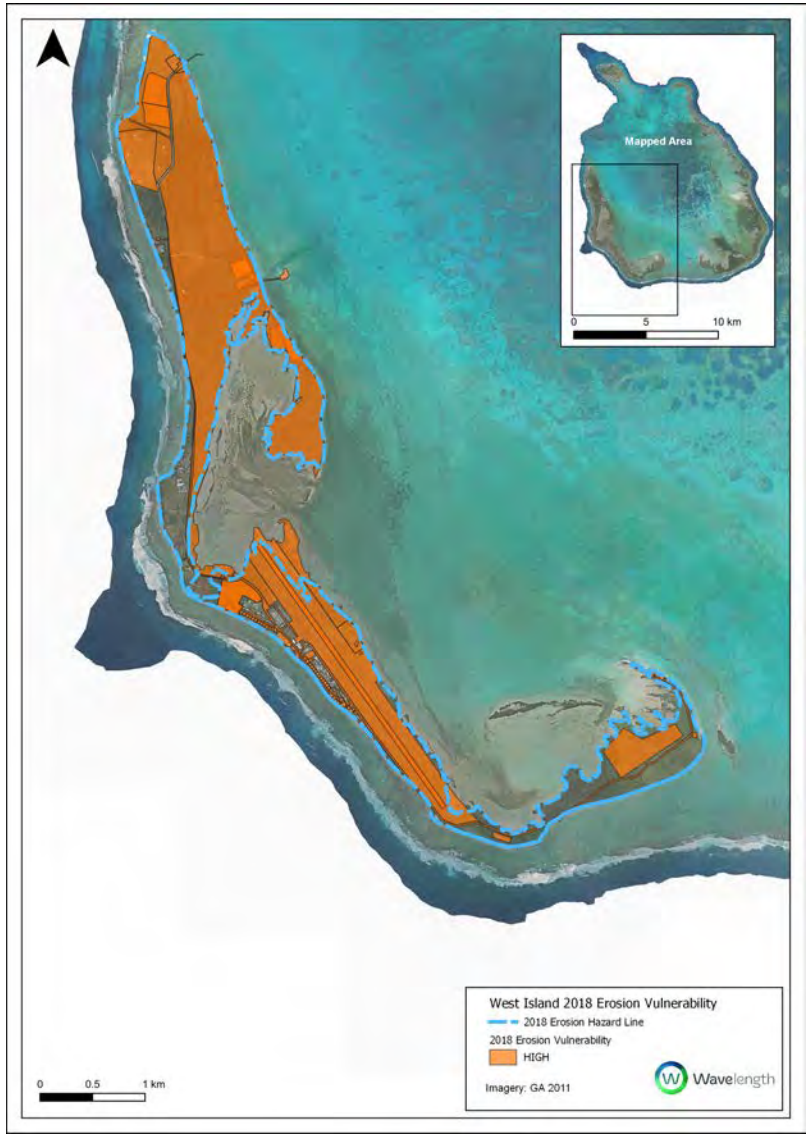




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West Island – Erosion Vulnerability 2018

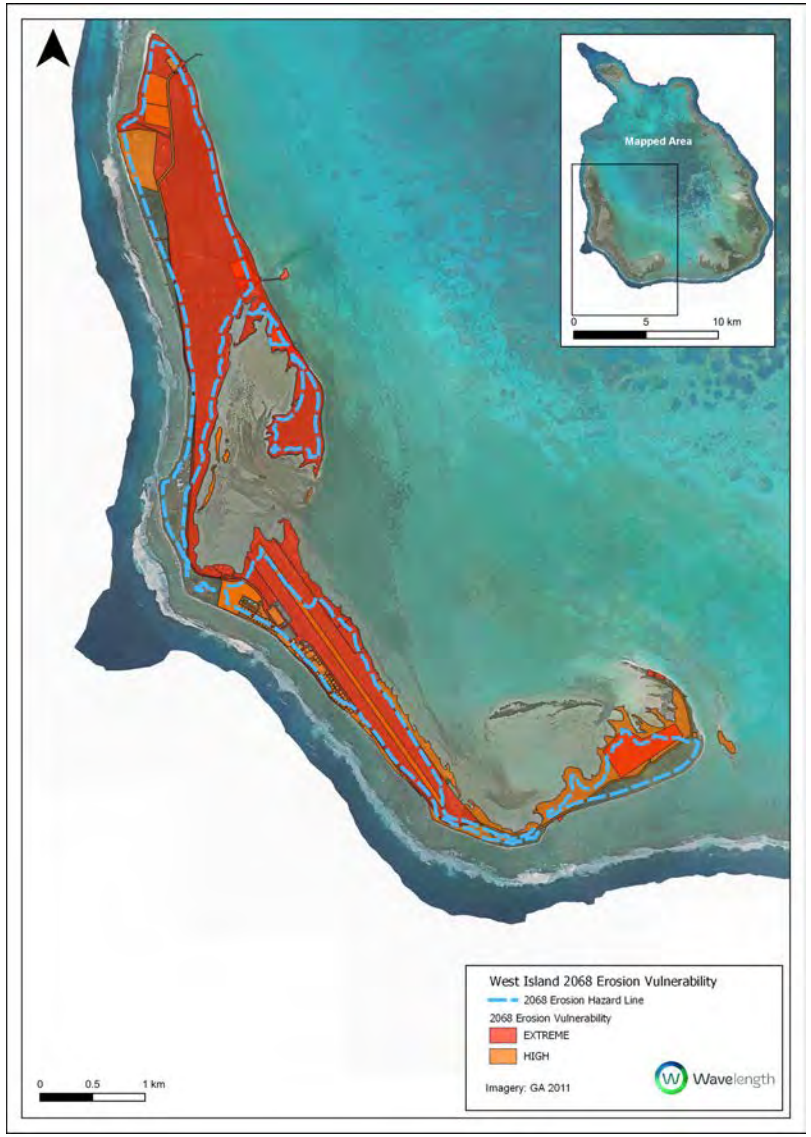


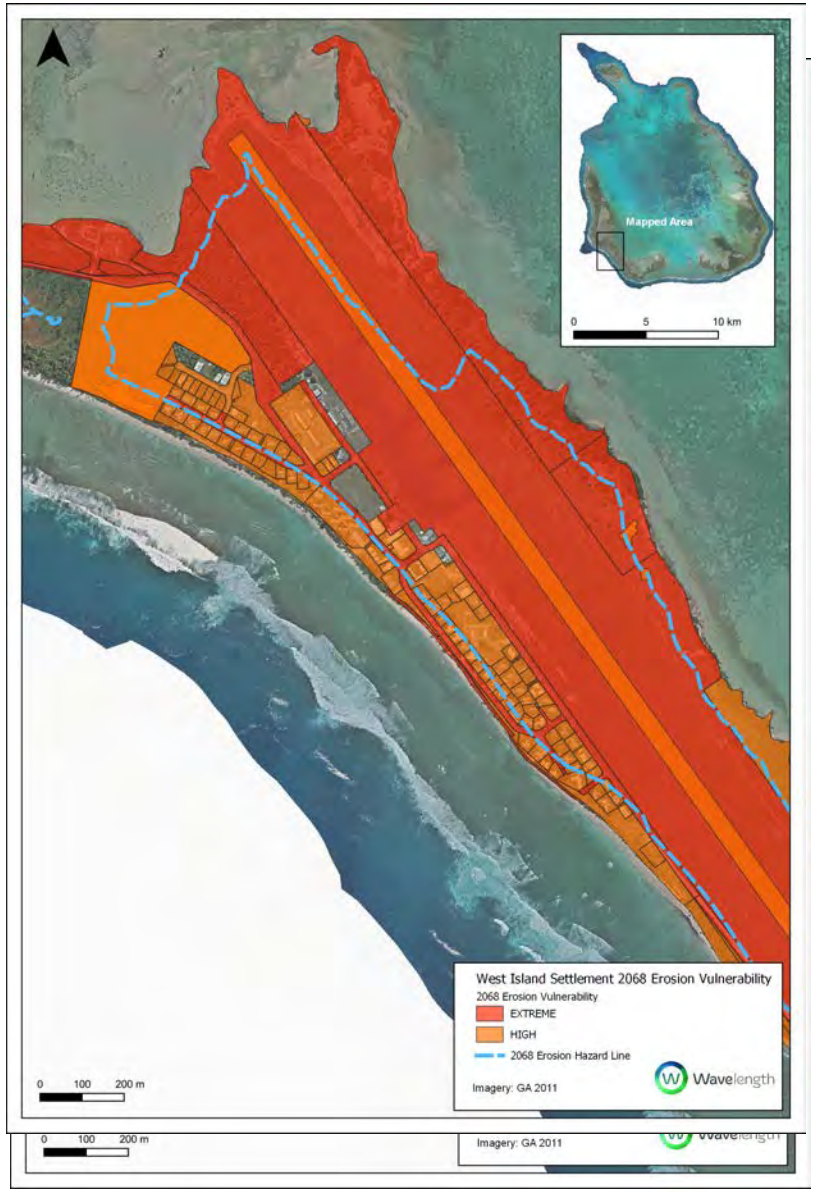


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West Island – Erosion Vulnerability 2068





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Q & A

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Risk Management / Adaptation Approaches

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Adaptation Options (per WA SPP 2.6)



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Adaptation Options



Avoid – Options which aim to eliminate the risk of coastal hazards by avoiding development



Managed Retreat – Options which progressive retreat / relocate development



Accommodation – Options which seek to enhance assets to cope with the temporary impacts



Protection – Options which seek to artificially protect the coast

1. Development does not occur unless:
   a) the development is located, designed, and constructed to withstand coastal hazard impacts; or
   b) the development is temporary, readily relocatable, or able to be demolished and removed; or
   c) the development can mitigate the risks to people and property to an acceptable or tolerable level based on the scientific information available at the time of application.

2. Design responses are not to have a detrimental impact on the amenity of neighbouring land or the amenity of the locality generally. This includes adversely impacting storm surge inundation levels on adjoining properties.

7. Any development approval is to be conditioned requiring all structures be removed at the cost of the proponent once the current risk of erosion poses a risk to a development or structure, as defined by the following triggers:
   a) Where a public road is no longer available or able to provide legal access to the property.
   b) When water, sewage or electricity to the lot is no longer available as they have been removed/ decommissioned by the relevant authority due to coastal hazards.
   c) Where structural integrity of the building has been compromised.

8. Any development approval shall (by a condition) require the following notifications to be placed on the Certificate of Title, pursuant to Section 70A of the Transfer of Land Act 1893, or lease documentation:
   VULNERABLE COASTAL AREA - This lot is located in an area likely to be subject to coastal erosion and/or inundation over the 100-planning timeframe (2110).

9. Any development with an estimated cost above $250,000 shall require an independent assessment by a coastal engineer to certify the suitability of the proposed development or await the finalisation of the Shire's CHRMAP and specific measures to be taken or not taken for the subject land parcel(s).





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Multi-Criteria Assessment

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Criteria

- Options go through multi-criteria assessment
- Criteria are identified for how we might assess adaptation options
- Relatively standard across state

Capital Costs

How much it costs us to build something up front (in todays' $)

Maintenance Costs

How much it costs us to keep maintaining something over 100 years (in todays' $)

Environmental Impact

Damage/loss of beach, vegetation, seagrass, fauna habitat

Erosion in adjacent areas

Social Impact - Property

Property is affected and may be lost or damaged

May have restriction placed on use

Collective Kampong on HI / linear settlement on WI affected

Social Impact - Communal

Loss of ability to walk on beach, enjoy vistas

Loss of park land, footpaths

Loss of assets such as cafes, club spaces (e.g. Yacht Club), etc

Flexibility

Once chosen, other options are off the table or very difficult to implement

Sets expectation/ties decision makers and future community to the decision/costs

Effectiveness

Short term options suitable for minor protection

Untested / unclear how effective

Well tested and understood – works to reduce risk

Activity - Asset / Values Mapping in Coastal Hazard Zones

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Asset / Values Mapping in Coastal Hazard Zones

What ‘things’ (assets) exist in the coastal zones that are important to you?

- Look over the maps
- Mark assets that are important
- Any assets that we might not know about?
- Consider – are there any sacrificial assets we don’t need to worry about



Takeaway – Self-Guided Site Visit

- Take the maps and pages
- Talk to friends and neighbours
- See what else you can add
- Bring it back Monday – we will discuss observations

https://getinvolved.mysocialpinpoint.com.au/your-coastal-plan-cki

One last thing

– next year…

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APPENDIX E

CRG Workshop 1 Homework Worksheet - Values / Assets

CRG WORKSHOP - VALUES AND ASSETS MAPPING TASK

NAME: A. HOSIE

Water based activities	Beach based activities	Foreshore based	Comments (e.g. "we like to swim at this beach")
• TRAINING	• KITE BEACH	• JETTY BEACH	
• SCOUT PARK	• GOLFING TRAINING	• GARDEN PLOT	
• SPOT	• SCOUT PARK	• WATER	
• SHACK	• PUBLIC SEATING		
• BIG BEACH	• NORTH POINT		
• END OF YACHT CLUB	• SAILING POINT		
• YACHT CLUB	• PICNIC AREA		
• END OF JETTY	•		
• INNER LAGOON	•		

CRG WORKSHOP - VALUES AND ASSETS MAPPING TASK

NAME:

Nature based activities	Something else / Other	Comments (e.g. "we like to swim at this beach")
• BIRD WATCHING	• CHRISTMAS	
	• FLY FISHING	
	• TRADITIONAL BATHING SPOTS.	

CRG WORKSHOP - VALUES AND ASSETS MAPPING TASK

NAME: Narelle.

Water based activities

Beach based activities

Foreshore based

What's important to me on cocos.

Comments

(e.g. "we like to swim at this beach")

Solution

All housing - Concrete walls

Western WI side north of settlement

All leaseholds - north western side WI

South end - but its very low

Geo bags are short term bandaids they also increase + speed up erosion each end side of bags

APPENDIX F

CRG Workshop 1 100 Years Solution Worksheet

CRG WORKSHOP - WHAT SHOULD WE DO OVER THE NEXT 100 YEARS TO 'SOLVE' COASTAL ISSUES?

NAME: A. HAQUE.

1 DATE: 03.09.2022	2 DATE:	3 DATE:
· COASTAL PROTECTION	· HOUSING DEVELOPMENT ON STILTS.	
· BUILT INFRASTRUCTURE PLANNING	·	
· LAST OPTION FOR RELOCATION PROGRAM		
· REHABILITATION PROJECTS.		

next 100 years.

CRG WORKSHOP - WHAT SHOULD WE DO OVER THE NEXT 100 YEARS TO 'SOLVE' COASTAL ISSUES?

NAME:

1 DATE: Preservation	2 DATE:	3 DATE: Relocation
-Saving important areas. - Whole Islands/settlements. -Tree planting Natural erosion prevention methods.		-Mainland - WI?

CRG WORKSHOP - WHAT SHOULD WE DO OVER THE NEXT 100 YEARS TO 'SOLVE' COASTAL ISSUES?

NAME:

1 DATE:	2 DATE:	3 DATE:
* More trees to "hold" the land together.	* "Shifting?" land/ sand. Putting it back.	* Putting "blocks" along the coast. to hold it together.

APPENDIX G

CRG Workshop 2 Presentation



Cocos (Keeling) Islands Coastal Hazard Risk Management and Adaptation Planning Project – Community Reference Group

Australian Government Department of Infrastructure, Transport, Regional Development, Communications and the Arts, in partnership with WA Department of Planning, Lands and Heritage, and Shire of Cocos Keeling Islands

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Why are we here today?

We are doing the **Coastal Hazard** Risk Management Adaptation Plan (CHRMAP) for Cocos (Keeling) Islands

We will explain what this is and how you are involved in the next few slides…

What are we doing?

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The Remit

The Cocos (Keeling) Islands are affected by coastal erosion and inundation, with vulnerability of use and development expected to increase in the future.

- Home Island and West Island coastlines are used and highly valued by the CKI community
- Important to understand how the coastlines are changing
- How to respond to these changes for sustainable coastal living for the CKI community into the future
- We will be making recommendations for action

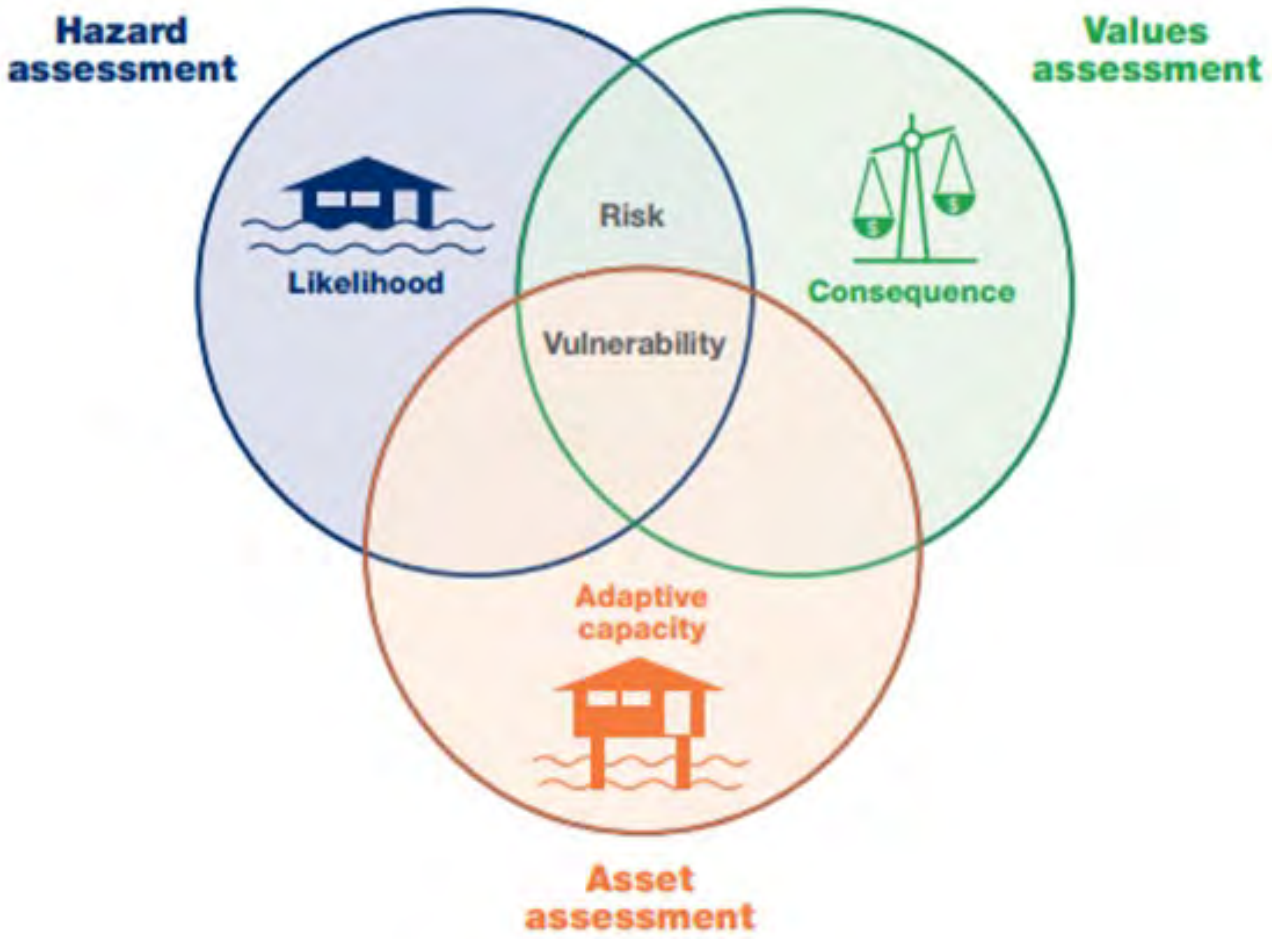
The Remit

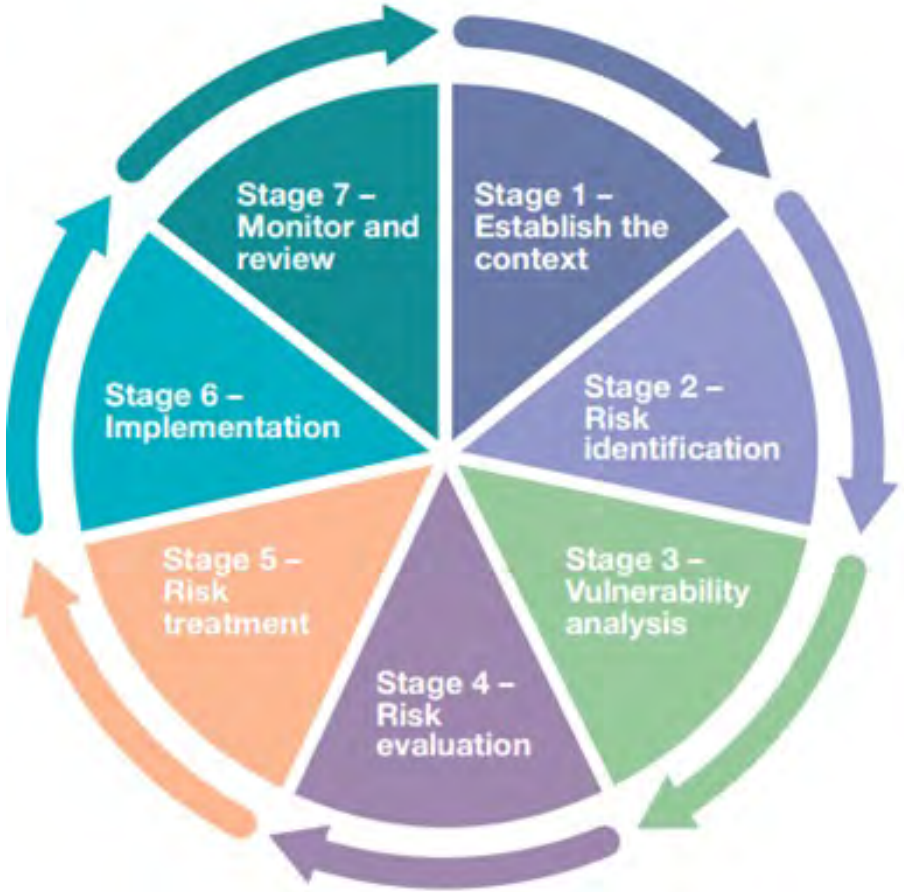
So we are preparing a CHRMAP…

…a strategic document to *plan* for responding to *coastal hazard challenges…*

- Identify vulnerable public and private assets
- Recognise and preserve community values for current and future generations
- Inform community and decision makers
- Required under West Australian State Planning Policy 2.6 – State Coastal Planning

A plan for the next 100 years…. But more urgent here than 'normal'…





SPP 2.6 + CHRMAP Guidelines - Process

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Project Background (cont…)

- DPLH - *Cocos (Keeling) Islands Coastal Vulnerability Study* (Haskoning Australia PTY Ltd, 2021) identified areas vulnerable over a 100-year planning timeframe
- This project is next step to deliver this ‘CHRMAP’
- Then deliver actions ($$)

Phase 1 (2018-2020): CKI Coastal Vulnerability Study (CVS)

Phase 2 (2021-2023): CKI Coastal Hazard Risk Management and Adaption Plan (CHRMAP)

Phase 3 (2023 onwards): New Local Government Planning Scheme by Shire of CKI

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Risk Management / Adaptation Approaches

Approach

1. Whole of settlement
2. Individual asset treatment outside settlements



Home Island



West Island

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Approach – Settlement

- Adaptation required in short term, next 5 to 10 years
- Three adaptation pathways identified:
    1. Protect
    2. Accommodate
    3. No regrets
- Unfeasible options:
    - Avoid – assets already in place
    - Retreat – Insufficient space / higher ground to retreat to (within island consideration)

Protect examples



geotextile sand container (GSC) seawall



concrete seawall

Seawalls

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Seawall trade offs

Criteria	Benefits	Constraints
Effectiveness	• Ultimately provides last line of defence	• Cheaper design reduces effectiveness
Capital and Maintenance Costs		• Requires importing materials • Requires ongoing maintenance costs
Environmental Impacts		• Disruptions to local ecosystems • Loss of beach, vegetation • Can increase downdrift erosion
Social Impacts	• Provides assets protection	• Loss of ability to walk on beach, enjoy vistas • Visual impacts
Flexibility		• Once chosen, other options are off the table or very difficult to implement • Sets expectations assets will always be protected

Protect







Levees and road raising

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Levee trade offs

Criteria	Benefits	Constraints
Effectiveness	• Provides last line of defence (flooding)	• Only address flood risk • Requires adequate spaces
Capital and Maintenance Costs		• Requires importing materials • Requires ongoing maintenance costs
Environmental Impacts	• Set back from shoreline, beach can still exist • Can tie into the natural environment	• Construction disrupts local ecosystems, vegetation
Social Impacts	• Provides asset protection (flooding)	• Visual impacts • Position could create feeling of disconnection
Flexibility		• Sets expectations assets will always be protected

Accommodate example

Replace and upgrade properties and buildings at end of design life



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Accommodate trade offs

Criteria	Benefits	Constraints
Effectiveness	• Highly effective for assets that can be raised	• Only address flood risk • Challenging for some assets
Capital and Maintenance Costs	• Undertake at end of asset design life	• Requires importing building materials • High costs to accommodate some infrastructure
Environmental Impacts	• Limited impacts • Beach can be maintained	
Social Impacts	• Provides protection (flooding)	• Requires considered planning to limit impact to residents • Daily impacts, residents accessing properties
Flexibility	• Highly flexible	

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No Regrets

Accepting properties and assets are at increased risk

Establish emergency plans and emergency shelter for Settlement





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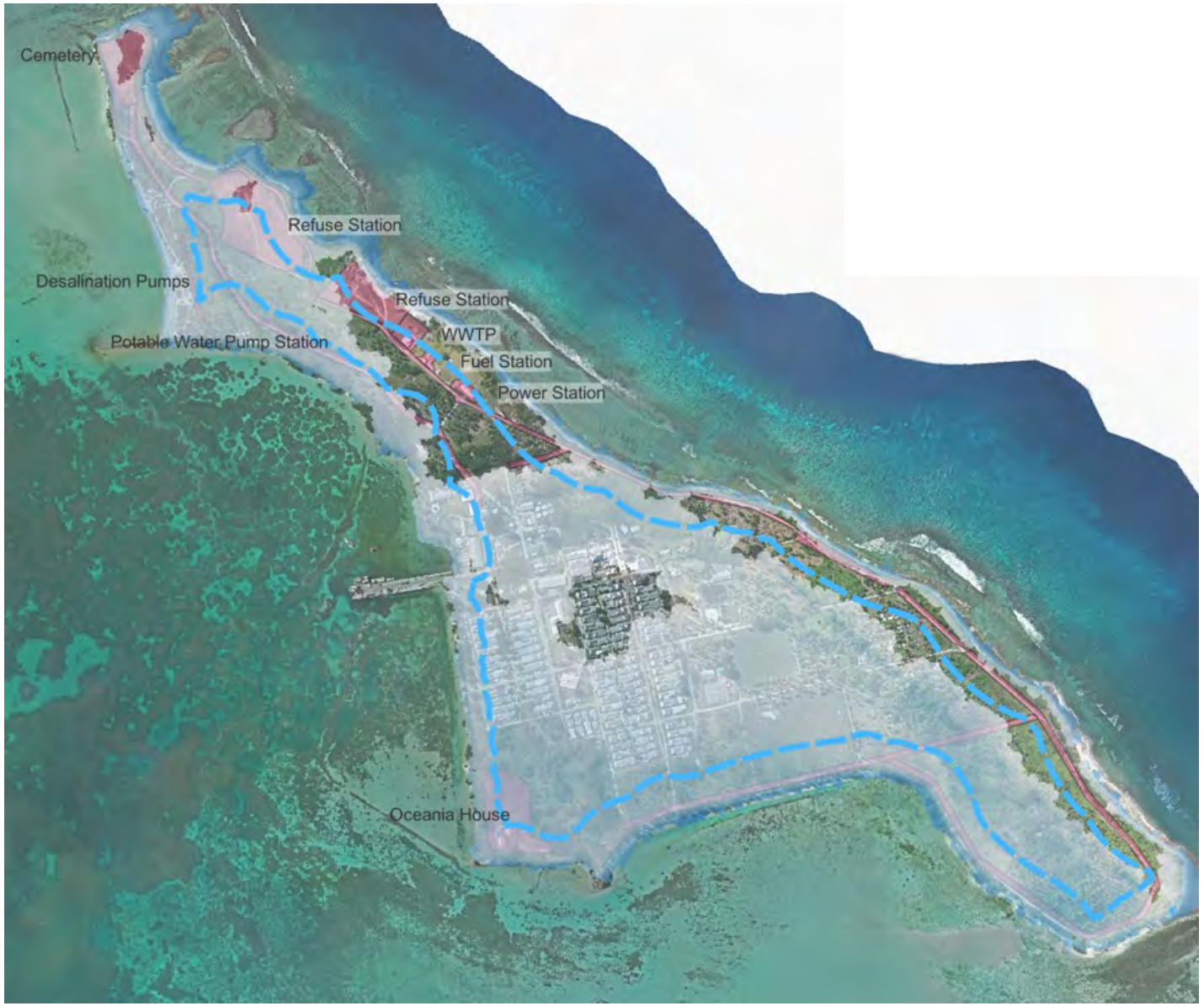
Wavelength

No Regrets trade offs

Criteria	Benefits	Constraints
Effectiveness		• Only a interim measure
Capital and Maintenance Costs	• Lowest upfront costs	• Highest cost for repair of damage
Environmental Impacts	• Limited impacts	
Social Impacts		• Potential increased risk to lives during flood
Flexibility	• Highly flexible	

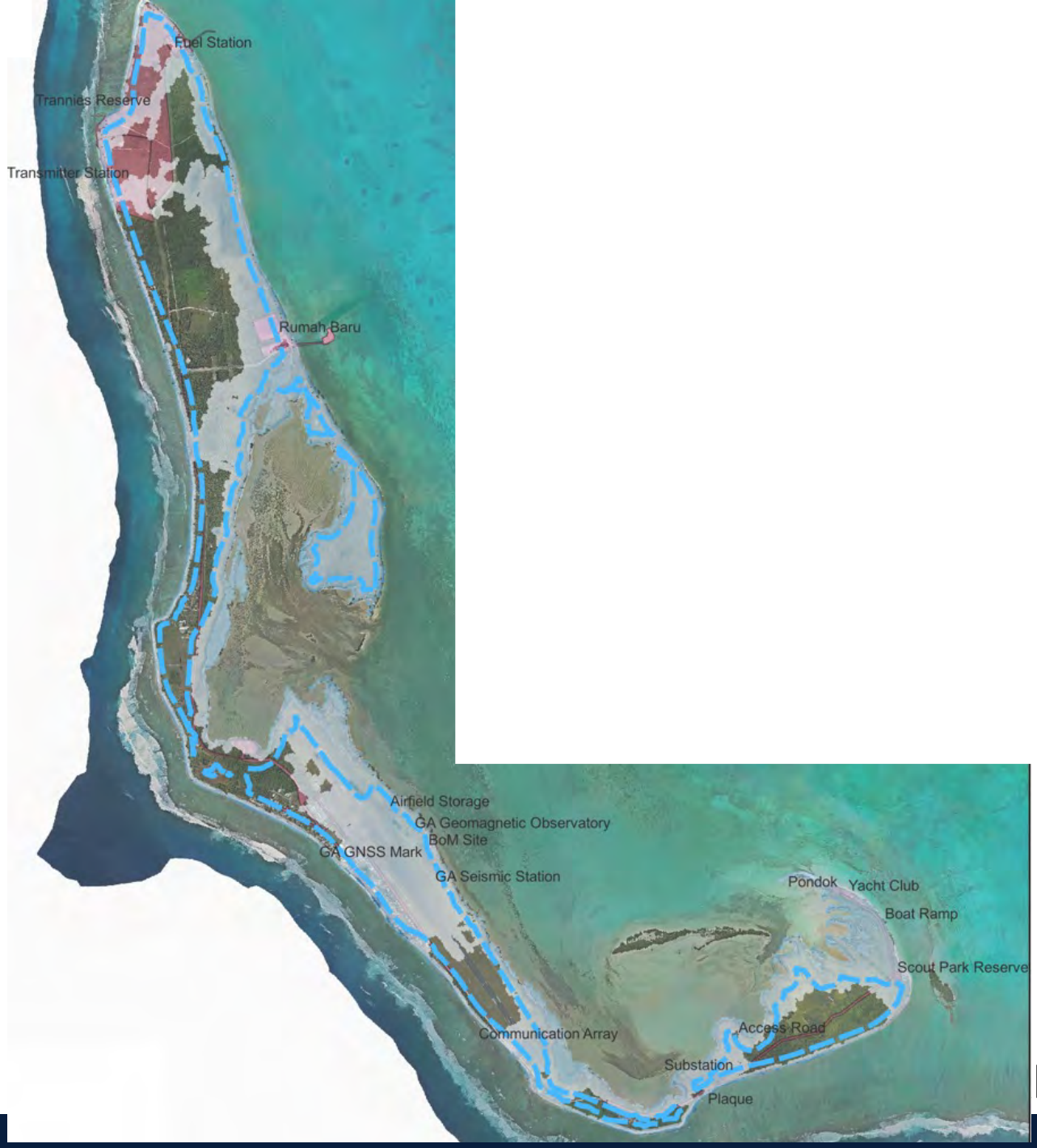
Assets outside of settlement

- Avoid further development in known areas of risk
- Opportunity to relocate some assets within property boundaries
- Alternate ‘soft’ protection options (revegetate, sand nourishment)



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BAN

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Longer Term (2118)

Towards end of century, it will be challenging to maintain the pathways:

- Groundwater shoaling impacts
- Levees would make it difficult to stop terrestrial flooding, as drainage outflows will be backed up more frequently by higher tides and storm water levels
- High levees would also be difficult to access other locations on islands

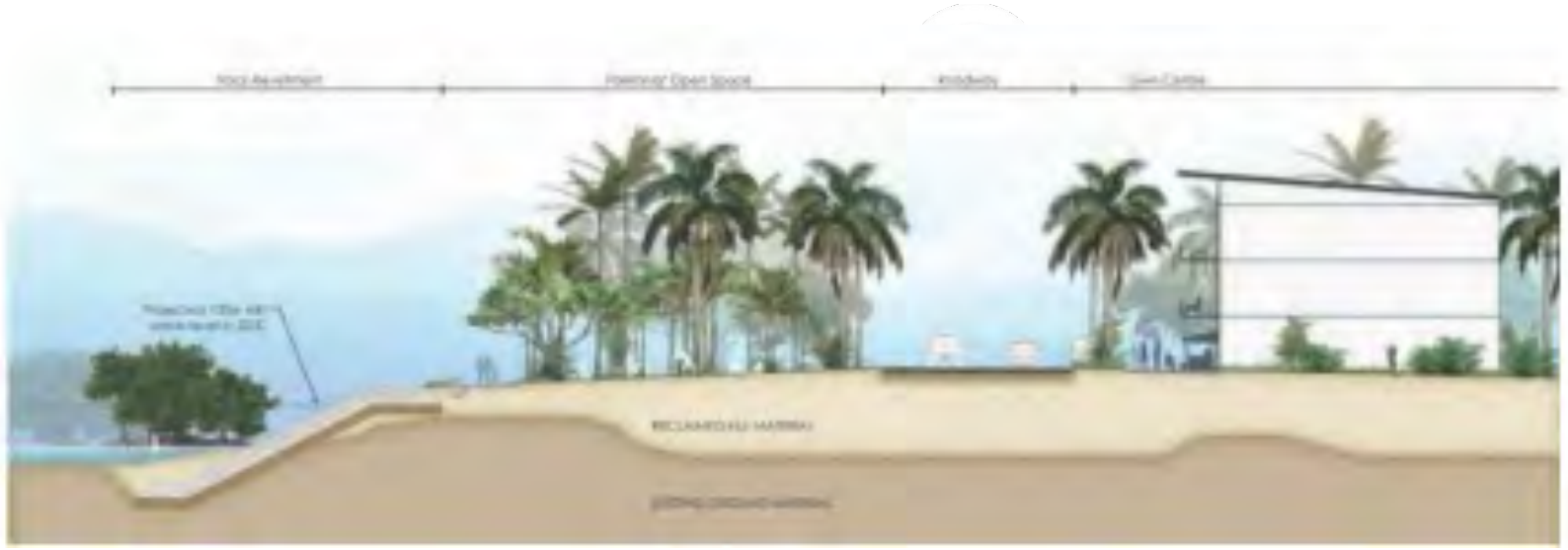
Potential long-term options include:

1. Retreat from islands
2. Reclaim and protect

Reclaim and protect

Sand is sourced and pumped, properties and assets are raised

- Technically feasible and promotes long term resilience
- Substantial costs
- Requires integrated planning, engineering and environmental approach



Example : Kiribati raise 300-hectare area of land 2 – 5 m above the highest measured sea level.

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Activity - Asset / Values Mapping in Coastal Hazard Zones

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Asset / Values Mapping in Coastal Hazard Zones

What assets exist in the coastal zones?

- Considering all that you have heard – and the possible options – consider assets
- Group where possible and sensible to do so
- ID things that *could* move
- Prioritise groups
- Comment on options

What next for the project

- This phase finishes October 9
- Options and ideas will be considered with the values identified
- Return in March with options to discuss in more detail – short, medium, long term
- Finalise CHRMAP throughout 2023 and then start actioning
- *Shire of CKI commence Local Planning Strategy/Scheme in conjunction with DPLH*
- *Assistant Minister for Regional Development and Territories considers*
- *WAPC endorsement*



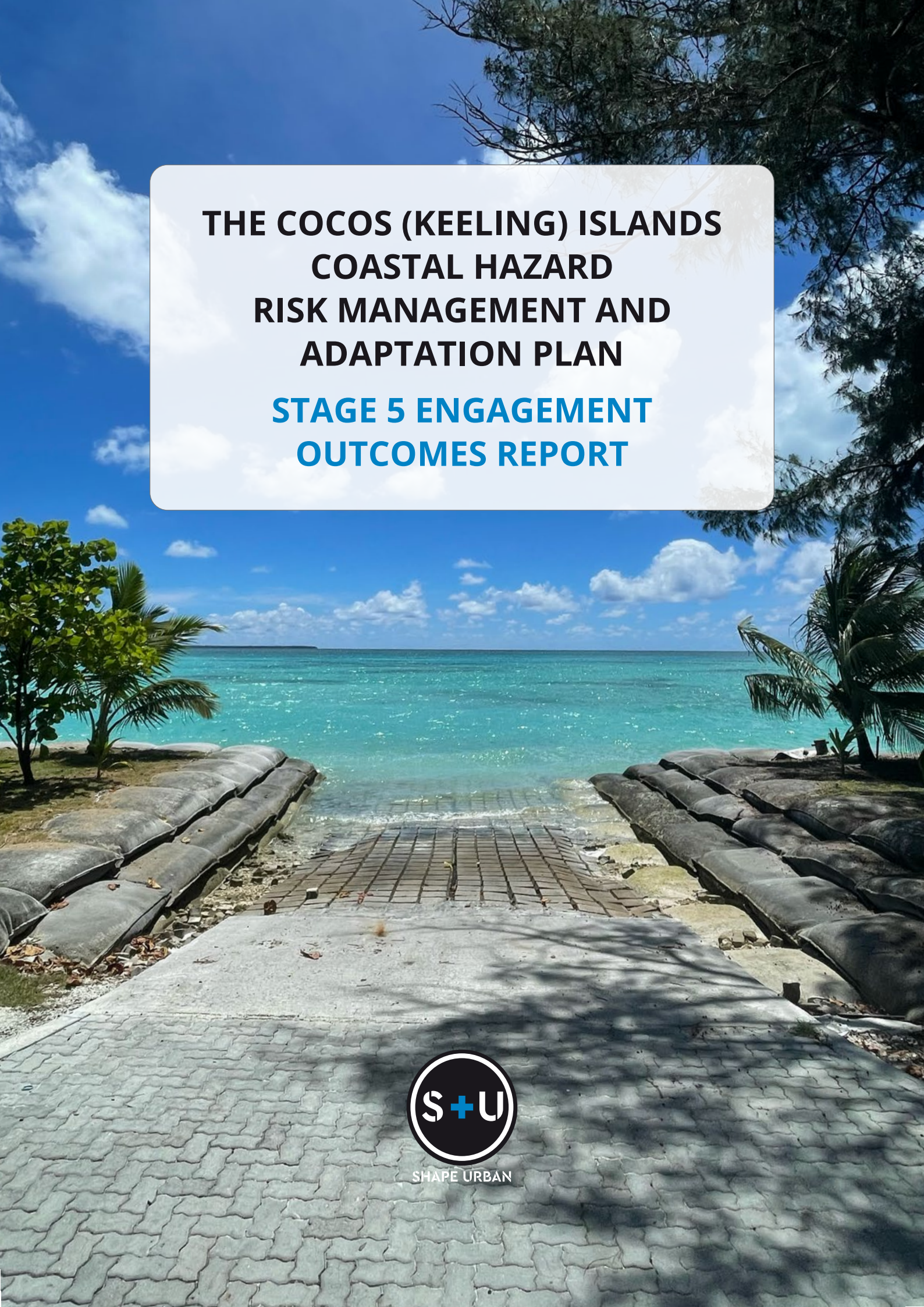
ATTACHMENT B

Attachment B: The Cocos (Keeling) Islands Coastal Hazard Risk Management and Adaptation Plan Stage 5 Engagement Outcomes Report

Use Hyperlink Here

THE COCOS (KEELING) ISLANDS COASTAL HAZARD RISK MANAGEMENT AND ADAPTATION PLAN

STAGE 5 ENGAGEMENT OUTCOMES REPORT



SHAPE URBAN

ACKNOWLDEGEMENT

This document has been prepared with the support of many people. Shape Urban and Wavelength wish to acknowledge the contributions of the CKI community and the support of the Australian Government and Department of Planning, Lands and Heritage in preparing this document.

The project in the Australian Indian Ocean Territories has been funded by the Australian Government through the Department of Infrastructure, Transport, Regional Development, Communications.

DOCUMENT TITLE

The Cocos (Keeling) Islands Coastal Hazard Risk Management and Adaptation Plan
Stage 5 Engagement Outcomes Report

NO.	AUTHOR	REVIEWED BY	DATE	APPROVALS
1	K Yang		31/3/2023	Internal Draft
2	K Yang	Anna Kelderman	15/5/2023	Draft for Client
3	K Yang	Anna Kelderman	10/6/2024	Final



LIST OF ABBREVIATIONS

CHRMAP - Coastal Hazard and Risk Management and Adaptation Plan

CKI - Cocos (Keeling) Islands

CSEP - Community and Stakeholder Engagement Plan

DITRDCA - Australian Government Department of Infrastructure, Transport, Regional Development, Communications and the Arts

DoT - Western Australian Department of Transport

DPLH - Western Australian Department of Planning, Lands and Heritage

SPP 2.6 - State Planning Policy No. 2.6 - State Coastal Planning Policy

The Shire - Shire of Cocos (Keeling) Islands

WAPC - Western Australian Planning Commission

EXECUTIVE SUMMARY

The Australian Government in collaboration with the *Shire of Cocos (Keeling) Islands* (The Shire) and the *Western Australian Department of Planning, Lands and Heritage* (DPLH) is developing a *Coastal Hazard Risk Management Adaptation Plan* (CHRMAP) for *Cocos (Keeling) Islands* (CKI).

A critical part of this project is the engagement with the local community and relevant stakeholders.

This report details the Stage 5 engagement of the CHRMAP process undertaken in February 2023, which provides the project team with a confirmation of community values and the Community Panel members' preferred management options for the four coastal towns overall for both the short to medium term and long term.

Engagement for this stage comprised Community Panel sessions and stakeholder meetings, with information communicated via the Social Pinpoint website, the Shire's Facebook page and the Atoll newsletter, and by direct letters and email contact.

Stage 5 comprises the MCA and cost benefit analysis (CBA) of the identified risk management and adaptation options, informed by the coastal values and discussions about potential adaptation options in Stage 2 engagement.

This stage involves engagement activities with stakeholders in Perth and the CKI community on-island.

The project team met with DITRDC in Perth to re-test the project team's internal MCA and resultant adaptation options, and discuss the implications of the options for stakeholders.

The project team then undertook on-island engagement including meetings and engagement sessions on both Home Island and West Island, involving Elders, Seniors and community members. The project team also observed the increased engagement across the CKI community in the coastal planning.

The project team also undertook site visits and a school presentation during the on-island trip. The site visits also revealed increased vulnerability of CKI to inundation and erosion.

The engagement provided the community with the opportunity to learn about the Multi Criteria Assessment (MCA) process, criteria and scoring, and to review and confirm proposed scores from technical experts.

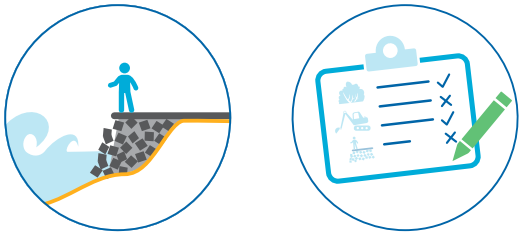
It also allowed community members to recognise that each of the proposed adaptation options in the State Planning Policy 2.6 - State Coastal Planning Policy (SPP 2.6) hierarchy has pros and cons, and that selection comprises a complex comparison of benefit, cost, who pays, how options impact established community values and the negative consequences of various options e.g. the maintenance frequencies and effectiveness of seawalls and scouring at the terminus of different seawalls.

The community confirmed values, feedback and shared information, and preferred short to medium and long term management option preferences will help refine the adaptation pathways to be outlined in the CHRMAP.

All engagement comments and feedbacks affirmed the community values and assets identified from Stage 2 engagement.

The following summarises the preferred short and medium-to-long term options by the community and stakeholders.

PREFERRED SHORT-TERM OPTIONS



Seabee Sea wall | Monitor

CKI vulnerability to coastal inundation and erosion requires an unique timeframe of short term adaptation within next 5 to 10 years.

- "Avoid" and "Retreat" are not viable.
- "Protect" and "Accommodate" are possible for continued enjoyment until way of life substantially impacted

Community members on Home Island, in particular, expressed that enjoyment is regularly impacted and is already intolerable around flooding events. The option for "retreat from islands" as short-term option was not excluded by residents.

PREFERRED MEDIUM-TO-LONG TERM OPTIONS



With the accepted vulnerability modelling, it is challenging to maintain the short-term options of "Accommodate" and "Protect" with the additional factors:

- Groundwater impacts
- High levees – visibility, access to boat ramps, doesn't stop land flooding

Long-term options will be determined by the ongoing monitoring to decide the appropriate timing for "Reclaim and protect" or "Retreat from islands".

The next step will be the submission of the draft CHRMAP to the Australian Government for endorsement of advertising, where the community will be able to provide further feedback on the information and recommendations contained within the CHRMAP report.

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1 INTRODUCTION

1.1 BACKGROUND

The Australian Government in collaboration with the *Shire of Cocos (Keeling) Islands* (The Shire) and the *Western Australian Department of Planning, Lands and Heritage* (DPLH) is developing a *Coastal Hazard Risk Management Adaptation Plan* (CHRMAP) for *Cocos (Keeling) Islands* (CKI).

A critical part of this project is the engagement with the local community and relevant stakeholders.

The engagement approach is in accordance with the Western Australian State Government's coastal planning policy framework - *State Planning Policy No. 2.6 - State Coastal Planning Policy* (SPP 2.6) and the CHRMAP Guidelines (Figure 1).

The preliminary stakeholder engagement (Stage 2 of the CHRMAP Guidelines) has been shaped to raise awareness of the project, understand how the community values assets along the coastline, ensure that concerns and aspirations along the coastline are understood, and introduce the viable potential risk treatment options to the community.

Detailed outcome of stage 2 engagement can be found in the *Provision Of Coastal Hazard Risk Management And Adaptation Planning In The Cocos (Keeling) Islands Engagement Outcomes Report* (Shape Urban, 2023a).

1.2 PROJECT PHASES

After the Stage 2 engagement, the project team has progress into the following CHRMAP development stages:

Stage 3 Vulnerability Analysis: Identifying assets and existing controls, understanding community values and developing a vulnerability assessment

Stage 4 Risk Evaluation & Stage 5 Risk Treatment: Completing a Multi Criteria Assessment and then considering the cost benefit of options.

With the findings from the above, the project team presented and discussed the risk treatment options with stakeholders and community.

This report details the **Stage 5 engagement outcomes**.

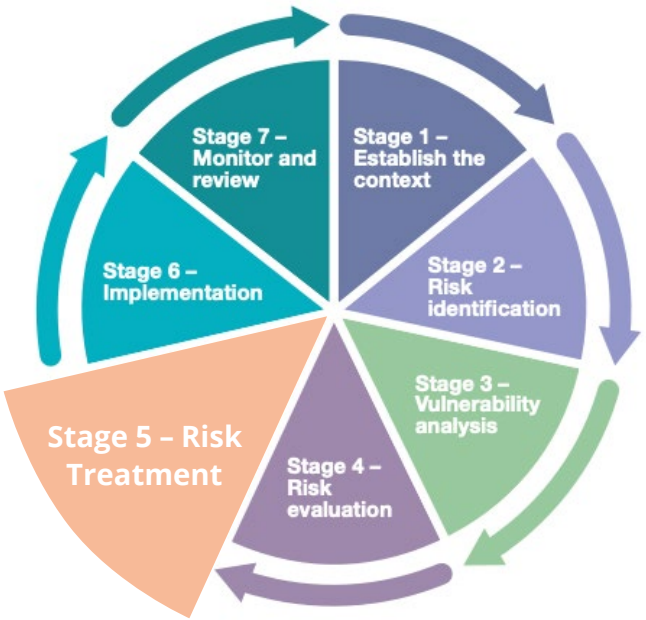


Figure 1 CHRMAP Stages per the CHRMAP Guidelines (WAPC, 2019)

1.3 ENGAGEMENT PURPOSE

The purpose of Stage 5 engagement was to discuss proposed risk treatment options, including how the Multi Criteria Assessment (MCA) was formulated, and approximate cost per treatment option.

The stakeholders and community were asked for their opinions and preferences on the proposed treatment options.

1.4 COMMUNICATION METHODS

Various communication channels were used to communicate the Stage 5 engagement.

1.4.1 Project webpage

An update was posted on the Social Pinpoint engagement platform – the primary communication gateway for the CHRMAP project, to inform about the return of the project team with detailed agenda and sessions available (Figure 2).

1.4.2 Social media

The Shire's Facebook page were used to promote the project and opportunities to be involved.

- 14 Feb 2023 - Project update and and opportunities to get involved - 2 reactions and 1 share
- 20 Feb 2023 - Project update and and opportunities to get involved - 6 reactions, 3 comment and 2 share

1.4.3 Newspaper

Articles in English and Cocos Malay were published in "The Atoll" newsletter on 27 January and 10 February 2023.

The news articles informed about actions taken after the previous engagement and announcing scheduled on-island sessions for the project team visit from 21-28 February 2023.

1.4.4 Direct Emails

Email announcement about the engagement was sent directly to the stakeholders and community members who registered their contact details from previous engagement.

1.4.5 Meetings

Government stakeholders were briefed on the project and consulted on the content.

Individual meetings were undertaken on-island with community member stakeholders as requested.

The meetings provided the project team with the opportunity to share project updates and get feedback on proposed risk treatment options.

1.4.6 Youth

A classroom presentation was organised with the help of a year 7/8 Humanties and Social Sciences (HASS) teacher at Cocos Islands District High School during the on-island visit on 28 February 2023.

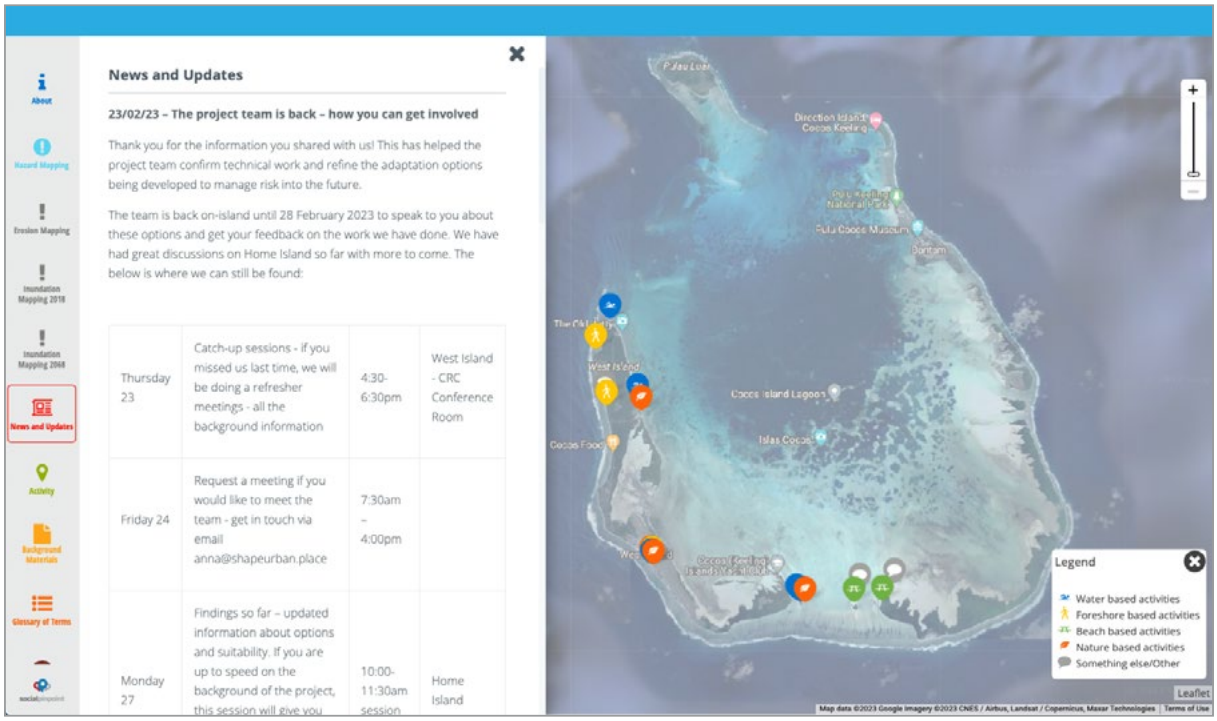


Figure 2 Online project website with interactive mapping tool

2 ENGAGEMENT OUTCOMES

2.1 ENGAGEMENT ACTIVITIES

A number of engagement activities and opportunities were undertaken, including:

- One meeting in Perth - for the Australian Government's Department of Infrastructure, Transport, Regional Development, Communications and the Arts (DITRDCA);
- On-island engagement comprising Community Reference Group (CRG) catch-up sessions and 'drop-in' sessions on Home Island and West Island;
- Individual stakeholder meetings;
- One school presentation for the year 7/8 HASS class at Cocos Islands District High School; and
- Project website (Figure 2) details the engagement opportunities and project updates.

2.2 DITRDCA MEETING

On 14 February 2023. the project team met with the DITRDCA officials and Indian Ocean Territories Administration to provide a project update on the following agenda:

- The CHRMAP purpose and process
- Recap Coastal processes, hazards and risk on CKI
- Present feedbacks to engagement
- Recap options and present MCA and costs (including Q & A throughout)
- Discussion - presentation material, risks identified and relevant

See Appendix A for the DITRDCA meeting presentation slides.

2.2.1 Meeting Notes

- The Government fully supports the CHRMAP project, seeking the preference of community; the final CHRMAP is required to be approved by the Minister for the Territories.
- The community is well aware of the threat as over the years, many experts have proposed solutions but no action being taken
- Noting that there are limited land ownership on CKI, where most assets are owned by the Trust, managed by the Shire.
- The coming engagement should be presented by comparing options cost estimates in cost brackets.
- A broad categories in money value will be useful for testing with tangible number.
- All parties agreed to present the potential adaptation options using indicative cost brackets alongside the viability matrix:



- The airstrip runway upgrade announcement by Australian Defence Force has assumed impact on the expectation and outcomes from the CHRMAP process.
- Drainage and water management is a known planning gap to be investigated.

2.3 ON-ISLAND ENGAGEMENT

The project team engaged with 71 stakeholders and community members during the on-island visit:

- 20 Seniors reference group members
- 7 Elders group members
- 1 General 'drop in'
- 16 West Island community members
- 4 Stakeholders
- 17 Students
- 5 teaching staff
- 1 Incidental community member meetings

The Project Team On-Island comprised:

- Anna Kelderman, Keyon Yang (Shape Urban – engagement consultant)
- Annabel Sandery (Wavelength – coastal engineer)
- Peter Wood, Ben Bassett – DPLH
- Thomas Battcher – Environmental Officer, The Shire

2 sessions were held on Home Island, where Elders and Seniors participated, and one session on West Island, to re-engage with those who had previously attended workshops.

The remaining activities were held on both Home Island and West Island to maximise opportunities for each of the island's stakeholders and communities to get involved.

Table 1 details the scheduled program held from 21-28 February 2023 where the project team visited the on-island stakeholders and community.

The February 2023 on-island engagement program included:

- HI Session 1 - Seniors
- HI Session 2 - Elders
- HI Session 3 - Community Drop-in
- HI Session 4 - Community General
- WI Community Catch-up Session
- WI Community Session
- Site visits
- School presentation
- Meetings

The February 2023 visit provided the project team with time to discuss the risk assessment methodology and potential adaptation pathways with community members.

The community members and stakeholders provided observations and updates on recent incidents in settlements and around the atoll.

A school presentation and discussion at the Cocos Islands District High School was organised for a year 7/8 HASS class on 28 February 2023.

The details and outcomes of the February 2022 on-island engagement activities are summarised in this section of the report:

- 2.3.1 Session Presentation
- 2.4.1 Home Island Engagement Outcomes
- 2.4.2 West Island Engagement Outcomes
- 2.4.3 School Presentation Outcomes

Table 1 On-island engagement program - February 2023

DATE	ACTIVITY	LOCATION	PERSONS	NOTES
Wednesday 22 Feb 2023	HI Session 1 - Seniors Group	Cyclone Shelter	20	Findings, possible options and suitability
	Site Visit	Home Island	1	Project team visit Home Island coastal sites
	HI Session 2 - Elders Group	Cyclone Shelter	7	Findings, possible options and suitability
Thursday 23 Feb 2023	Site Visit	Atoll	1	Project team boat charter to islands
	WI Catch-up session	CRC Conference Room	10	CHRMAP Project briefing
Monday 27 Feb 2023	Meeting with the Shire	The Shire Office	2	Shire Officers
	HI Session 4 - General	Cyclone Shelter	1	Findings, possible options and suitability
	Meeting on Request	Home Island	1	Shire Officer
	WI Session	CRC Conference Room	12	Findings, possible options and suitability
Tuesday 28 Feb 2023	School Presentation	Cocos Islands District High School	23	CHRMAP Project briefing
	Meeting on Request	West Island, various	0	None requested



Image 1 Stage 2 Engagement workshop at the Shire Office

2.3.1 Session Presentation

The community and stakeholders were presented the MCA process during the on-island engagement in February 2023. This section details the information communicated.

Interactions with the stakeholders and communities were focussed on their own interests, and as such presentation materials differed slightly. However, all materials are comprised in the On-island Engagement Presentation at Appendix B.

2.3.2 Report Back

The community and stakeholder values collected from Stage 2 CHRMAP processes was presented back to the stakeholders and community, as follows:

HIGHLY VALUED ASSETS / VALUES

- Recreation - Use of beach and foreshore areas for recreation, fishing, boat launching and sporting activities (both islands)
- Environment - Ocean, lagoon, views, landscapes, foreshore vegetation and protection of the natural environment
- Amenities and infrastructure – Yacht, jukong and sailing clubs
- Access along the coastal and lagoon foreshore areas - boat launching, access to other islands
- Cemetery at Pulu Gangsa and mosque on Home Island

COASTAL PROCESS CONCERNS

- The impacts of coastal change
- Felled trees around the coastlines of both islands
- Sandbags that have been impacted
- How much the coastlines on Home Island and West Island have changed over time

PREFERRED COASTAL MANAGEMENT

- Soft options – (re)vegetation, education, conversations about possibility of retreat in the long term
- Protection and adaptation – sandbags, seawalls
- Prioritising settlement protection on both islands
- Additional protection of the Yacht Club and Rumah Baru jetty areas (West Island)



Image 2 Boat launching



Image 3 Access to beach over sandbags



Image 4 Jukong racing



Image 5 Pulu Gangsa Cemetery



Image 6 Home Island jetty



Image 7 Impact of coastal process



Image 8 Mosque, Home Island



Image 9 Sandbags that have been impacted

2.3.3 Multi Criteria Assessment

The information collected from the Stage 2 CHRMAP processes were used to inform the progression of adaptation options for the islands, through a Multi Criteria Assessment (MCA) process. The preliminary MCA evaluation is at Appendix C.

Following internal assessment and refinement of viable potential adaptation options, the project team was able to engage with the CKI community and stakeholders about the MCA process and preliminary scores.

MCA PROCESS

STEP 1 Assessment of adaptation options (general) for advancement to MCA
STEP 2a Assessment of inundation options for advancement to MCA
STEP 2b Assessment of erosion options for advancement to MCA
STEP 3 MCA assessment using criteria developed (+ weighting)
STEP 4 Costing

ADAPTATION PATHWAYS

Pre-screening of possible adaptation pathways looked at feasibility and effectiveness. The project team ruled out the unfeasible possible options with reasons:

Avoid - Rejected	
	Options which aim to eliminate the risk of coastal hazards by avoiding development • Assets already in place
Retreat - Rejected	
	Options which progressive retreat / relocate development • Insufficient space / higher ground to retreat to (within island consideration)

POSSIBLE ADAPTATION OPTIONS CONSIDERED

The possible adaptation pathways are considered against the following:

- Both Erosion / Inundation vulnerability independently
- Approaches (whole of settlements vs individual asset)
- Short term and long term options

APPROACHES

The shortlisted adaptation options are based on the following three approaches:

- Home Island whole of settlement (Figure 3)
- West Island whole of settlement (Figure 4)
- Individual asset treatment outside of settlements



Figure 3 Home Island whole of settlement

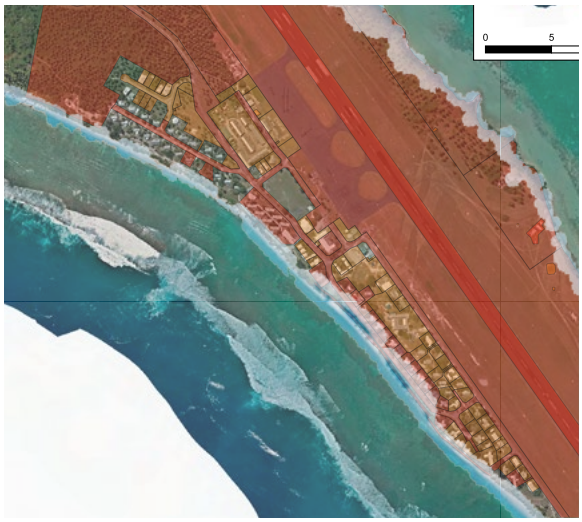


Figure 4 West Island whole of settlement

SHORT TERM OPTIONS

Based on the above, the project team presented the adaptation required in short term, where three adaptation pathways were identified:

Protect	Accommo-date	No Regrets
		

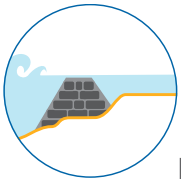
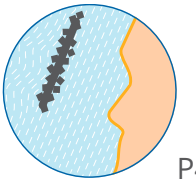
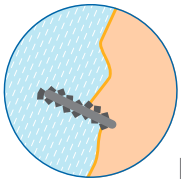
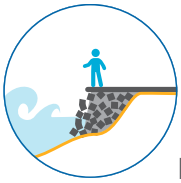
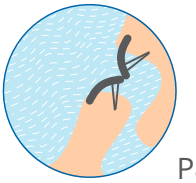
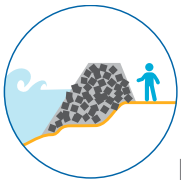
LONG TERM OPTIONS (2118)

Towards end of century, it will be challenging to maintain the accommodate and protect pathways. Potential long-term possible options include:

Retreat from islands	Reclaim and protect
	

All shortlisted adaptation options are then screened for feasibility and effectiveness as shown in the example below (Table 2); only the feasible or effective advance to MCA.

Table 2 Pre-screening - adaptation options for short-term erosion at within Settlement

ACCOMMODATE	Possible options which seek to enhance assets to cope with the temporary impacts			
	 AC1 Structural - Design assets to withstand hazards	 AC2 Maintain and enhance beach system	 AC3 Maintain and enhance dune system	 AC4 Maintain and enhance reef system
	Proceed to MCA	Shorlist for Quick Wins	Shorlist for Quick Wins	Shorlist for Quick Wins
PROTECT	Possible options which seek to artificially protect the coast			
	 P1 Beach Nourishment - Massive Campaign	 P2 Beach Nourishment - On-going campaigns	 P3 Offshore structures - Artificial reefs/shoals	 P4 Offshore structures - Detached breakwaters/ headlands
	Rejected	Proceed to MCA	Rejected	Rejected
	 P5 Groynes	 P6 Geotextile Sand Container (GSC) seawalls	 P7 SeaBee concrete seawalls	 P8 Storm surge barrier
	Rejected	Proceed to MCA	Proceed to MCA	Rejected
	 P9 Levees	 P10 Land reclamation		
	Proceed to MCA	Rejected		
NO REGRETS	Monitor and assess risk treatment option prior to implementation			
	 NR1 Monitoring	 NR2 Protection Structure Audit	 NR3 Notification on Title	 NR4 Emergency Evacuation Plans
	Shorlist for Quick Wins	Shorlist for Quick Wins	Shorlist for Quick Wins	Shorlist for Quick Wins

MCA CRITERIA

The following describes the eight criteria utilised by the project team for the MCA:

Implementation	How easy is the option to implement? Can it be made on the island using readily available, local resources?
Environmental impact	How significant are the environmental impacts?
Social impact (property)	How significant are the impacts on properties?
Social impact (way of life)	How significant are the impacts on daily life?
Economic impact	How significant are the impacts on businesses and the local economy?
Flexibility	Is the option reversible/ adaptable in the future?
Effectiveness	How effective is the solution at mitigating erosion and inundation risks?
Financial	How much does the option cost?

MCA SCORING

With each adaptation option, the project team used a scoring matrix against the eight criteria above.

Table 3 details the scoring matrix for each criteria.

Image 10 The project team explaining the MCA process in the Elders CRG session.



Table 3 MCA Scoring Matrix

MULTI CRITERIA ASSESMENT - KEY CRITERIA & SCORING										
Scoring		Implementation	Environmental Impact	Social Impact (Property)	Social Impact (Way of Life)	Economic Impact	Flexibility	Effectiveness	Financial	Overall Consideration
5	**Insignificant impacts OR Very low risk**	Abundant and sustainable source of material on island	Preserves and repairs	0 houses lost Does not affect property access	Does not affect any community values and/ or improves access	No loss of existing businesses	Easily reversible or adaptable	Effective, long term mitigation	<$5 million	Excellent performance - no impacts on criterion
4	**Minor impacts OR Low risk**	A significant portion of material available on island	Maintains status quo	1-10 houses lost	Minor impact to community values and/or access		Reversible or adaptable	Effective, mid-term mitigation	$5 to $15 million	Good performance - minor short term impacts on criterion
3	**Moderate impacts OR Medium Risk**	Some material available on island	May result in impact and damage	11-19 houses lost Minor impact to property access	Loss of access to some community assets that doesn't effect overall intrinsic community value	Protects or maintains as long as possible	Reversible or adaptable but with some cost	Effective, short term mitigation	$15 - $30 million	Sound performance - manageable short-term adverse impacts on criterion
2	**Major impacts OR High risk**	Only a small portion of material available on island, majority of material needs to be imported	Likely to result in impact and damage	20-40 houses lost	Loss of access to certain assets		Difficult to reverse or adapt	Limited effectiveness	$30-$50 million	Poor performance - short-term adverse impacts on criterion, not easily managed
1	**Severe impacts OR Very high risk**	No material on island, all materials need to be imported	Will result in impact and damage	>40 houses lost Major impact to property access	Will definitely affect key values of area	Loss of existing businesses	Irreversible or unadaptable	Ineffective and/ or suitable only for minor events	>$50 million	Very Poor Performance - long term adverse major impacts on criterion, not easily managed

MCA CRITERIA WEIGHTING

Table 4 shows how weighting is applied to each MCA criteria to result in a well-considered adaptation option. Figure 5 shows the resulting weighting being applied to MCA for the possible adaptation options.

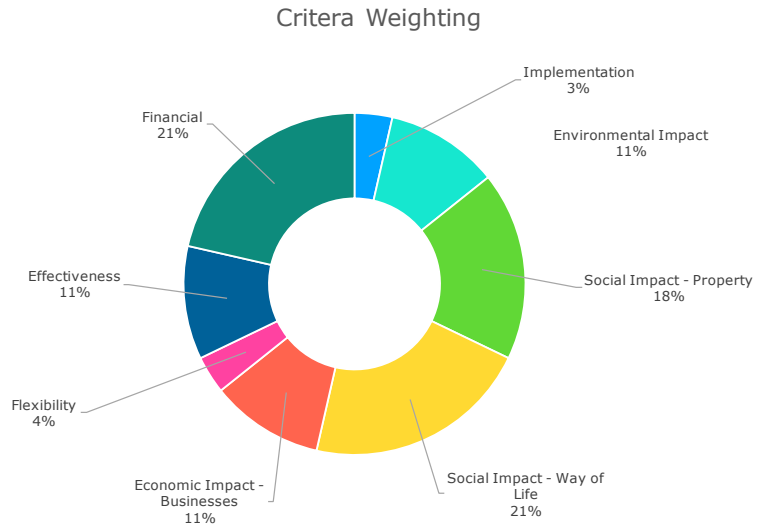


Figure 5 Multi Criteria Assessment Weighting

Table 4 Criteria factor weighting

		CRITERIA B							
		Implement-ation	Environmen-tal Impact	Social Impact (Property)	Social Impact (Way of Life)	Economic Impact (Businesses)	Flexibility	Effectiveness	Financial
CRITERIA A	Implementation								
	Environmental Impact	A							
	Social Impact (Property)	A	A						
	Social Impact (Way of Life)	A	A	A					
	Economic Impact (Businesses)	A	B	B	B				
	Flexibility	B	B	B	B	A			
	Effectiveness	A	A	B	B	B	A		
	Financial	A	A	A	A	B	A	A	



2.3.4 MCA Result and Options Summary

After presenting the MCA process, the project team opened discussion on the options.

Handouts of detailed analysis were provided at the engagement session.

The options presented are mainly focused on the Home Island Settlement and West Island Settlement, including the associated cost approximations.

The following shows the summary of the presented.

ASSETS OUTSIDE OF SETTLEMENT

- Avoid further activity in known areas of risk
- Opportunity to relocate within property boundaries
- Accommodate – very expensive for a single asset
- Protect – very expensive for a single asset
- Revegetate, sand nourishment



HOME ISLAND SETTLEMENT

Home Island settlement area is at threat of inundation in increased frequency. By emphasizing the need to preserve the important social value of the community, especially the daily interaction with the water, the MCA result for Home Island Settlement recommended short-term option AC1 - Structural design that would withstand hazards (refer Table 5) with the highest weighted score.

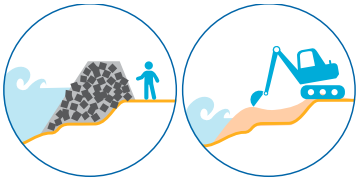
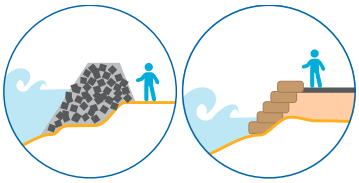
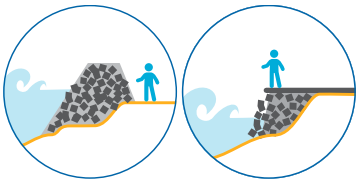
The short-term options assume that Retreat is not a feasible option for the community as they see possibility for continued enjoyment until their way of life is substantially impacted. While medium-to-long-term options are presented to indicate subsequent implications.

WEST ISLAND SETTLEMENT

West Island settlement area is at threat of severe erosion, while many of the important public and private infrastructure and assets are at risk. The MCA result for West Island Settlement recommended short-term option P9+P7 - Levees with Concrete SeaBee Seawalls (refer Table 6).

The short-term options assume that Retreat is not a feasible option that the community sees possibility for continued enjoyment until way of life substantially impacted. While medium-to-long-term options are presented to indicate subsequential costing involved.

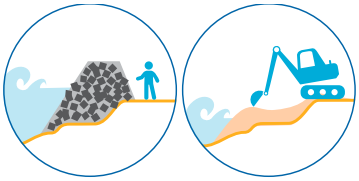
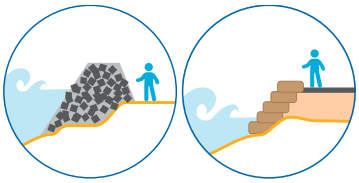
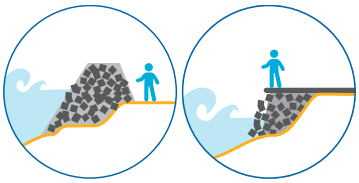
Table 5 Result of the MCA for Home Island Settlement Adaptation Options

HOME ISLAND SETTLEMENT – SHORT TERM			WEIGHTED SCORE	SHORT
Accommodate				
	AC1 Structural - Design assets to withstand hazards	This option would involve constructing properties on stilts to accommodate inundation.	60	$ < $100 mil
Protect				
	P9+P2 Levees with on-going nourishment	This option would involve construction of a levee to protect against inundation and on-going nourishment to counter erosion	55	$ < $50 mil
	P9+P6 Levees with GSC Seawalls	This option would involve construction of a combined levee and GSC seawall structure to counter inundation and erosion	54	$ < $20 mil
	P9+P7 Levees with Concrete SeaBee Seawalls	This option would involve construction of a combined levee and concrete seabee seawall structure to counter inundation and erosion	52	$ < $20 mil

HOME ISLAND SETTLEMENT – MEDIUM - LONG TERM	SHORT		LONG TERM
Reclamation on HI Settlement - Following AC1 short term option	$ < $100 mil	+	$ $100 mil +
Reclamation on HI Settlement - Following Protect short term option (P9 + P7)	$ < $20 mil	+	$ $100 mil +
Retreat to WI - New Settlement near Rumah Baru	-	+	$ $100 mil +

Note: P9 + P2 (levees + nourishment) and P9 + P6 (levees + GSC seawalls) not costed for long term

Table 6 Result of the MCA for West Island Settlement Adaptation Options

WEST ISLAND SETTLEMENT – SHORT TERM			WEIGHTED SCORE	SHORT
Accommodate				
	AC1 Structural - Design assets to withstand hazards	This option would involve constructing properties on stilts to accommodate inundation.	43	$ < $100 mil
Protect				
	P9+P2 Levees with on-going nourishment	This option would involve construction of a levee to protect against inundation and on-going nourishment to counter erosion	51	$ < $100 mil
	P9+P6 Levees with GSC Seawalls	This option would involve construction of a combined levee and GSC seawall structure to counter inundation and erosion	54	$ < $50 mil
	P9+P7 Levees with Concrete SeaBee Seawalls	This option would involve construction of a combined levee and concrete seabee seawall structure to counter inundation and erosion	54	$ < $50 mil

WEST ISLAND SETTLEMENT – MEDIUM - LONG TERM	SHORT		LONG TERM
Protect with Seabee seawalls - following AC1 short term option	$ < $100 mil	+	$ < $100 mil
Protect with Seabee seawalls - following Protect with Seabee seawalls short term option	$ < $50 mil	+	$ < $100 mil
Reclaim Land and protect with Seabee seawalls - following AC1 short term option	$ < $100 mil	+	$ $100 mil +
Reclaim Land and protect with Seabee seawalls - following Protect short term option	$ < $50 mil	+	$ $100 mil +

2.4 ENGAGEMENT SUMMARY

Approximately 71 community members and stakeholders participated in this stage of engagement, including 7 Elders, 20 Seniors and 23 from the school).

The project team provided time for questions and open discussion to the room for all engagement activities. In particular, the discussion focused on the following:

1. Did we get it about right?

2. If not, what would you change and why?

3. If you added a criteria, how would you score that?

The stakeholders and communities' feedback and responses are presented in following sections:

- 2.4.1 Home Island Engagement Outcomes
- 2.4.2 West Island Engagement Outcomes
- 2.4.3 School Presentation Outcomes
- 2.4.4 Preferred Short-Term Options
- 2.4.5 Preferred Medium-to-Long Term Options

Image 11 The project team explaining the MCA process at the West Island session.





Image 12 Engagement session on Home Island

2.4.1 Home Island Engagement Outcomes

The following collates all the feedback and comments from the stakeholders and the community regarding engagement for Home Island coastal adaptation management.

SEAWALL

- a Preference for "protect" measure – sandbags, seawall, revegetation for the immediate action, with a general preference for seabee seawall
- Queries about longevity and design of walls
- Some concern about seawalls impacting way of life
- Preference for seabee seawall due to less maintenance, noting current rate of repair requires extensive maintenance
- The seawall may not be the best option but the best to be chosen

LEVEES

- How high, and could it include steps

DREDGING

- Query if dredging is feasible option
- The dredger material has been used for maintaining the unsealed roads on the island.

RETREAT

- "Retreat" to mainland is considered
- Concern with relocation due to significant historical memories, including copra industry for the elders/ seniors
- Strong desire to be interned on their home island.
- Several stakeholders noted a cost that would support retreat
- Noting that community would stick together
- Buyback scheme has been discussed among the community

RECLAMATION/ACCOMMODATE

- Concern that fill and reclaim is too expensive
- Recognising that the height of the HI cyclone centre is the height of the WI cyclone centre

GENERAL

- Better to focus on the short-term solutions; prefer the long-term option, but limited money to make it possible

URGENCY

- Request to convey the message that "One day of rain" houses are already flooded and the matter is urgent
- Desire to see action on the ground
- Query about who will pay

COMMUNITY SENTIMENT

- Community keen to know what roles they can play
- Suggestion that the Australian Government has responsibility for the community
- Love for the island and wish to protect it as much as possible
- Noted that historically many islanders were disinterested about the coastal issues and Sea Level Rise, but recent times have seen change of attitude
- Generally, elders and seniors would prefer not to leave the island, but not all expressed the same
- A number of participants suggested they will never left the island for religious reason
- Many islanders have strong ties to Malaysia/Singapore with relatives across different countries

FUTURE PROOF

- The community will have to adapt and the local government will have to ensure the next build will be resilient to the anticipated change

FAIRNESS

- Would like the Australian Government to consider the old people and the future of the younger generations
- Would love to protect the islands for the future generation when choosing the long-term solutions
- West Island seems to get more response (building sandbags)

FUNDING

- Rates not feasible
- The community does not understood the cost liability
- Observation that big solutions are a lot of money, preference to make gradual expenses in shorter term
- Query about funding from the WA Government

LAND TRUST AGREEMENT

- Land Trust Agreement recommendation that project team review
- Community feels out of control with regard to decision making as the Shire/ Australian Government owns their homes
- Queries about current Australian Government spending on the island
- Queries about implications of Cocos Malay born versus new migrants

ECONOMIC DEVELOPMENT

- Community interested in further promotion of the island including land-based agriculture
- Would like to establish local seawall construction (sandbag/sea wall concrete precast)
- Concerns about waste management

COSTING

- The community have thought a lot about the cost involved, but unsure about the best way forward

BUILDING MATERIALS

- Query about sand source
- Concern about the freight costs making material accessible

RUNWAY UPGRADE

- Comments that the runway upgrade project adds to complication of the issue
- Project adding to ancillary facilities – quarantine, etc.
- Query about defence investment timeframes – 50 years? 100 years?
- Concern that the defence base would make the island a target

PULU GANGSA CEMETERY

- Concern that the erosion near the cemetery is happening quickly, desire to use sandbags to protect the cemetery
- The terminal scour of the sandbags with short length of the placement

OUTSIDE OF SETTLEMENT

- Preference that all identified assets be protected, but also the rest of the island including the pondok's
- Suspicion that the old concrete seawall on Pulu Gangsa may have accelerated the sand loss on Prison Island
- Concern about potential loss of South Island
- Pondoks are considered personal property - many have lost almost all beach area

RECENT FLOODING VS GROUND WATER

- Flooding happens often (three times this year). Toilet blocking is a problem that follows
- Pumping takes several days to remedy the situation
- Concern about loss of drains to take water away from the rain into the ocean
- Ground water has changed since the desalination plant operational and suspect this exacerbates the ground water levels
- Query is the ground water going to keep rising
- Refer Figure 66 for photos submission of inundation following rain events from the stakeholders and communities on Home Island



Figure 6 A collage of photos submission from stakeholders and communities shows flooding on Home Island during rain events (Nov 2022 & Mar 2023)















Image 13 Engagement session on West Island

2.4.2 West Island Engagement Outcomes

The following collates all the feedback and comments from the stakeholders and the community regarding engagement for West Island coastal adaptation management.

MODELLING

- Prefer to see an earlier timeframe than 2068 as the need for action urgent
- Query about science of 0.9m Sea Level Rise, and reliability of models

GEOLOGY & COASTAL PROCESS

- Query coral rocks under the sand
- Query what causes the extreme event

SAND NOURISHMENT

- Sand nourishment – recognition it doesn't work

LEVEES

- High levees - Access to the boat ramp is already a problem without a levee
- Query where will it go

RETREAT

- If 'retreat' is a reality, how should the community continue investing in the islands
- Have considered abandoning South Island

URGENCY

- Query why there is a delay in getting the project finish
- Query how similar this situation is to mainland Australia experiences
- Query when decisions will be made

PLANNING CONTROL

- Query why when the problem was identified long ago and no new development was meant to occur; why were more houses built

TRANSPARENCY [INFORMATION]

- Would like to see information available about the risk available from the Shire
- Query whether there will be an “expiry” date that the settlement will be deemed habitable
- Concern that communication will reduce when the project is in decision making phase (currently happy with communication)

RUNWAY UPGRADE

- If the runway upgrade project is going ahead, hopefully community is also protected; Government to look at protecting assets for everyone to enjoy
- Concern about the runway behaving as a sort of a levee and impact on existing leases
- Query if the defence force considers similar issues
- Query if the policy applies to the Runway upgrade project

COMMUNITY SENTIMENT

- Concern that there is no support

COSTING

- Concern that long term is billions of dollars

BUILDING MATERIALS

- Suggest the use of the crushed coral from the dredging at the jetty
- Logistics of getting material to island is difficult (remoteness and cost)



Image 14 School presentation at Cocos Islands District High School

2.4.3 School Presentation Outcomes

A CHRMAP project presentation was held at the Cocos Islands District High School (see Appendix D for presentation slides).

The following comprises a summary of queries raised by students during the interactive session.

PROJECT OVERVIEW

- Students noted that a coastal hazard is erosion, marine debris and flooding

COASTAL PROCESS + SEA LEVEL RISE

- Students identified that the island is the asset (not individual assets)
- Students recognised that storm damage to the sandy beach is happening more often
- Students queried what the Cocos Island will look like in 100 years and how to deal with inundation
- Students asked a number of questions about sandbags versus seawalls; how durable, how strong and how much maintenance required. Students also queried if continuous sandbagging would result in other impacts (e.g. Prison Island)
- Students asked why sea levels are rising
- Students queried if it is possible to help the coral get bigger
- Students queried what would happen if the islands (South Island etc) were joined to protect the lagoon

GENERAL QUESTIONS

- Query if the erosion will cause the southern end of WI to separate
- Query erosion on North Keeling - inland lagoon student visit and fresh water inlet observation.
- Students queried if it was suitable to leave sunken sandbags

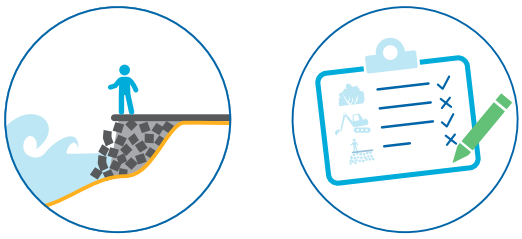


Image 15 Artwork at Cocos Islands District High School



Image 16 Playground at Cocos Islands District High School with an toy excavator

2.4.4 Preferred Short-Term Options



Seabee Sea wall Monitor

- Adaptation required in short term, next 5 to 10 years
- Short term: avoid and retreat not viable, protect and accommodate possible for continued enjoyment until way of life substantially impacted
- Community members on Home Island, in particular, expressed that enjoyment is regularly impacted and is already intolerable around flooding events

2.4.5 Preferred Medium-to-Long Term Options



Reclaim/Protect Retreat

- Challenging to maintain accommodate and protect:
  - Groundwater impacts
  - High levees – visibility, access to boat ramps, doesn't stop land flooding
- Reclaim and protect / Retreat from islands

2.4.6 Overall Observations

- Increasing engagement across community
- 40-60 years old community members still need to be engaged
- Short term desire to maintain lifestyle – plan lowest cost, highest impact mitigation
- Community expressed relative support for medium term changes – accommodate, planning rules
- Community expressed desire for certainty – even if that means certainty about retreat
- The runway project is considered to be security for the island - clear intent needs to be communicated
- The Trust land negotiations are complex but are interwoven with expectations for adaptation pathways



2.5 SITE VISITS

The project team has been shown several sites on the islands by stakeholders and communities during the engagement period. This section documents the project team's observations and notes during the site visits.

2.5.1 Home Island

- Tree planting has overall good success rate
- Evidence of established tree being eroded away on the immediate foreshore
- Planting has positive feedback from locals. Seniors and elders are helping with propagation. Locals are keen with protection (soft approach)
- Some trees are dying from sea water inundation
- Mangroves can be propagated
- Erosion happens fastest on the lagoon side. The ocean side is less so but still happening
- Sandbar forming on the north end of the island used for concrete in some projects.





Image 18 Successful propagation of bay-cedar but at threat of acute beach erosion



Image 17 The Shire nursery



Image 19 Lagoon side beach erosion severely affected by recent storm event

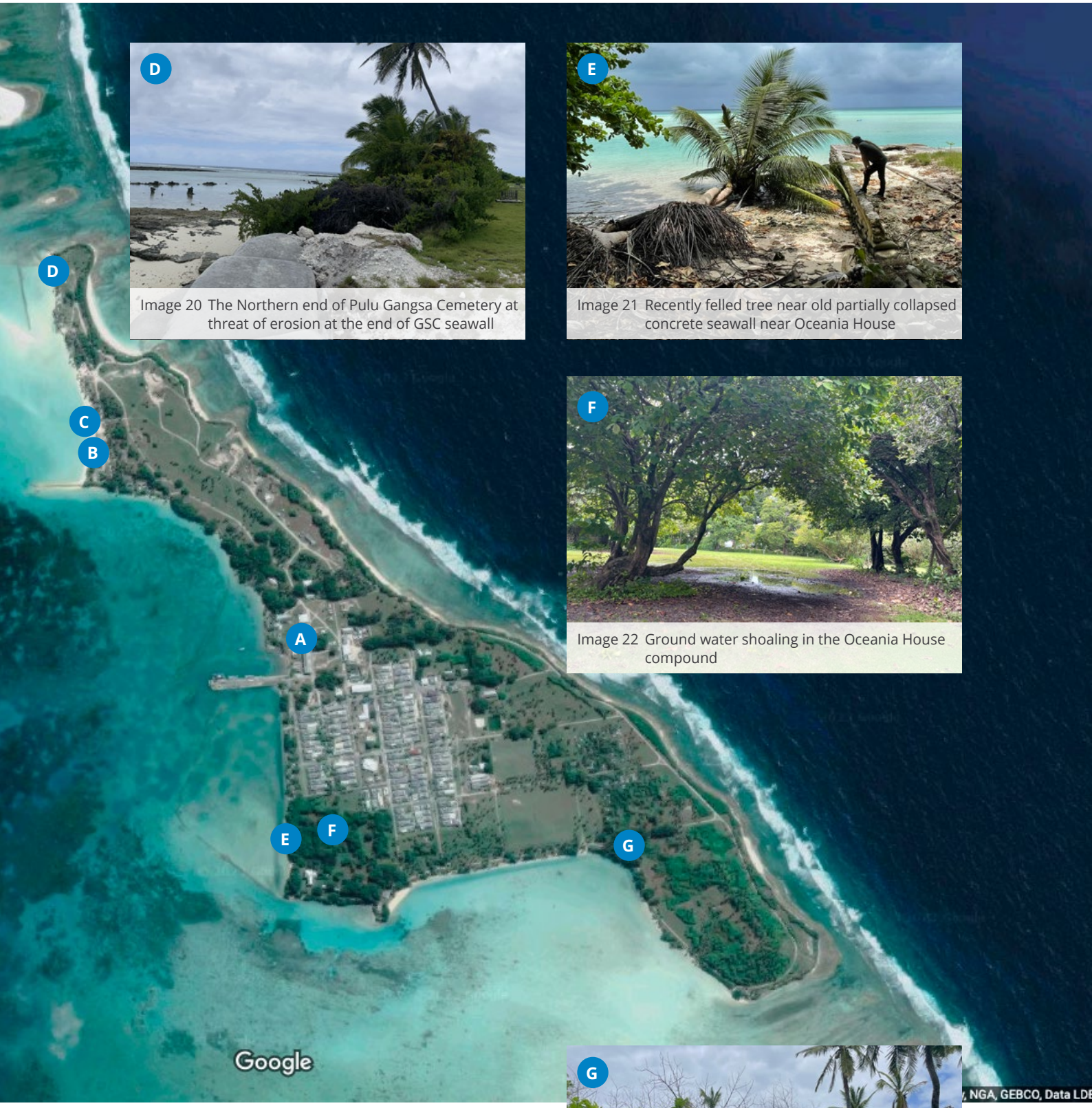


Image 20 The Northern end of Pulu Gangsa Cemetery at threat of erosion at the end of GSC seawall

Image 21 Recently felled tree near old partially collapsed concrete seawall near Oceania House

Image 22 Ground water shoaling in the Oceania House compound



Image 23 Dying trees after sea water inundation near Kampung Atas

2.5.2 West Island

- Severe erosion near the Cocos Beach Motel
- Reopening of the The Barge Art Centre receives good patronage and is much loved
- Part of Sydney Highway GSC seawall near Rumah Baru suffered storm damage, which is under repair
- Many parts of the GSC seawall near the West Island settlement show signs of repair
- The southern end of the seabee seawall near the Government House shows scouring

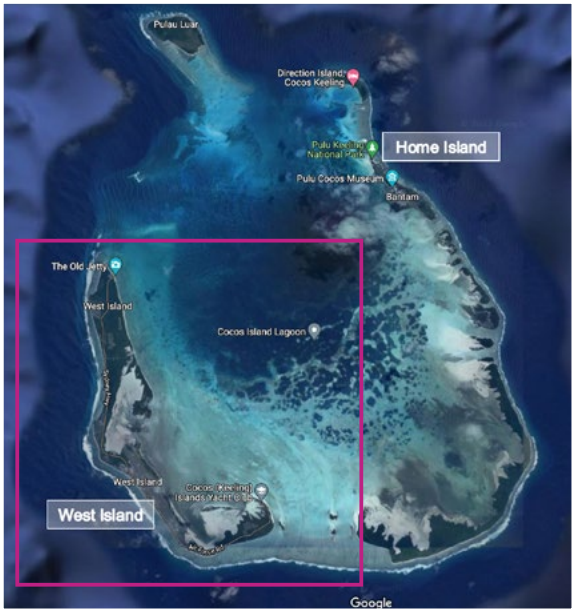




Image 25 Access bridge over the GSC seawall to the beach at the Trannies Beach



Image 24 Severe erosion near Cocos Beach Motel has commenced the GSC seawall installation.



Image 26 The Big Barge Art Centre



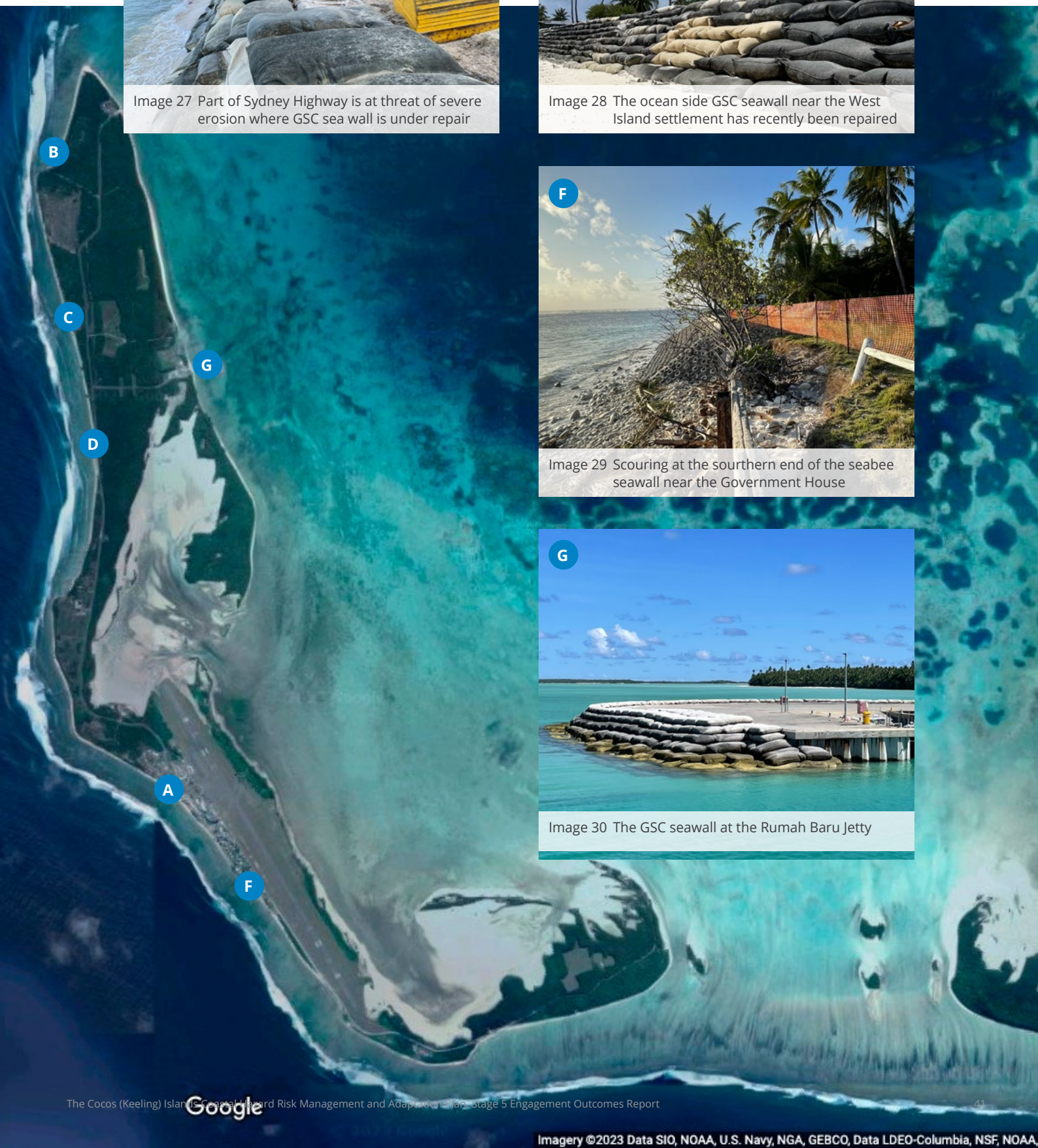
Image 27 Part of Sydney Highway is at threat of severe erosion where GSC sea wall is under repair

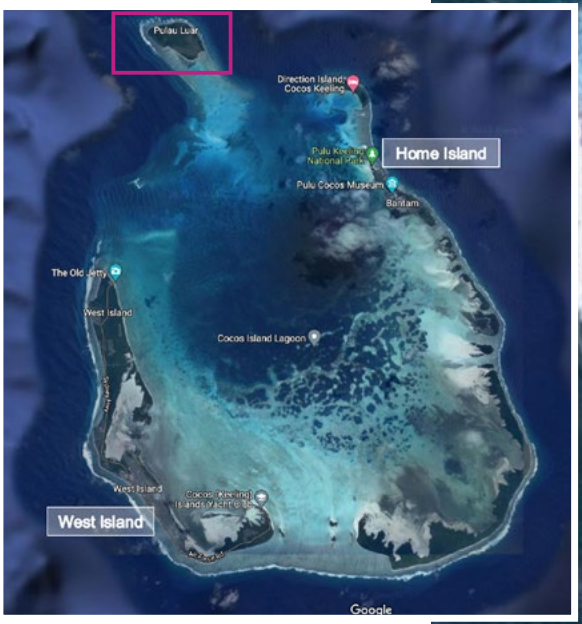


Image 28 The ocean side GSC seawall near the West Island settlement has recently been repaired

Image 29 Scouring at the sourthern end of the seabee seawall near the Government House

Image 30 The GSC seawall at the Rumah Baru Jetty





2.5.3 Horsburgh Island (Pulu Luar)

- Biggest physical change in the coastal environment observed (anecdotal)
- South Eastern erosion has intensified, resulted in sand deposition on the adjacent beach on its West (A to D on map)
- Turtle nesting
- Ship wreck on island
- Western side used to be able to drive a boat around, now far too shallow
- Pondok looks to be in reasonable condition



Image 32 Turtle nesting site



Image 31 Western side sand build-up



Image 36 Six Inch Guns (1996). Source: Australian Heritage database: Place ID 105222

Image 34 The collapsed Six Inch Guns (2023)

Image 35 Pondok on Horsburgh Island



Image 33 Local pondok at threat of beach erosion on the Eastern side



2.5.4 Burial Island (Pulu Belan Madar)

- Atoll side accreting, ocean facing side eroding
- Tree roots exposed on ocean side
- Guide spoke of burial site exposure under trees on the ocean side
- Pondok looks to be in reasonable condition
- Remnants of old jetty
- Adjacent atoll with derelict shelter/ pondok and concrete tank (B)
- Concerns about the implication of losing the southern atolls to erosion for the lagoon.

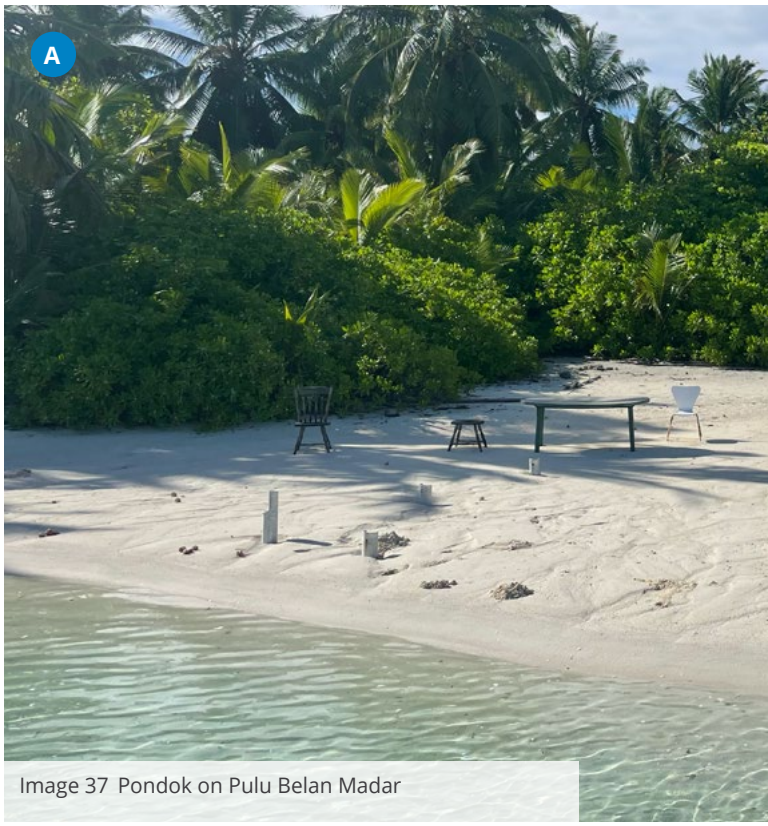


Image 37 Pondok on Pulu Belan Madar



Image 38 Coconut treets with exposed roots on Pulu Maria



Image 39 Pondok on Pulu Maria





Image 40 The project team undertook a site visit where the guide shared personal observations of changes to the atoll over 20 years

2.6 ONLINE MAPPING TOOL OUTCOMES

The project engagement platform consists of an online mapping tool and a project interest registration survey. The platform was opened 1 July 2022 to 30 November 2022 for Stage 2 engagement.

The platform was kept active for the community to find project updates.

As of 28 February 2023, the platform attracted 1,821 visits, 636 unique users, 146 comments and 5 registrations of interest. Of the 146 comments pinned on the mapping tool, 21 new comments were added by 2 unique users in February 2023.

Figure 7 depicts all mapped comments by categories and Table 7 for a full list of additional comments).

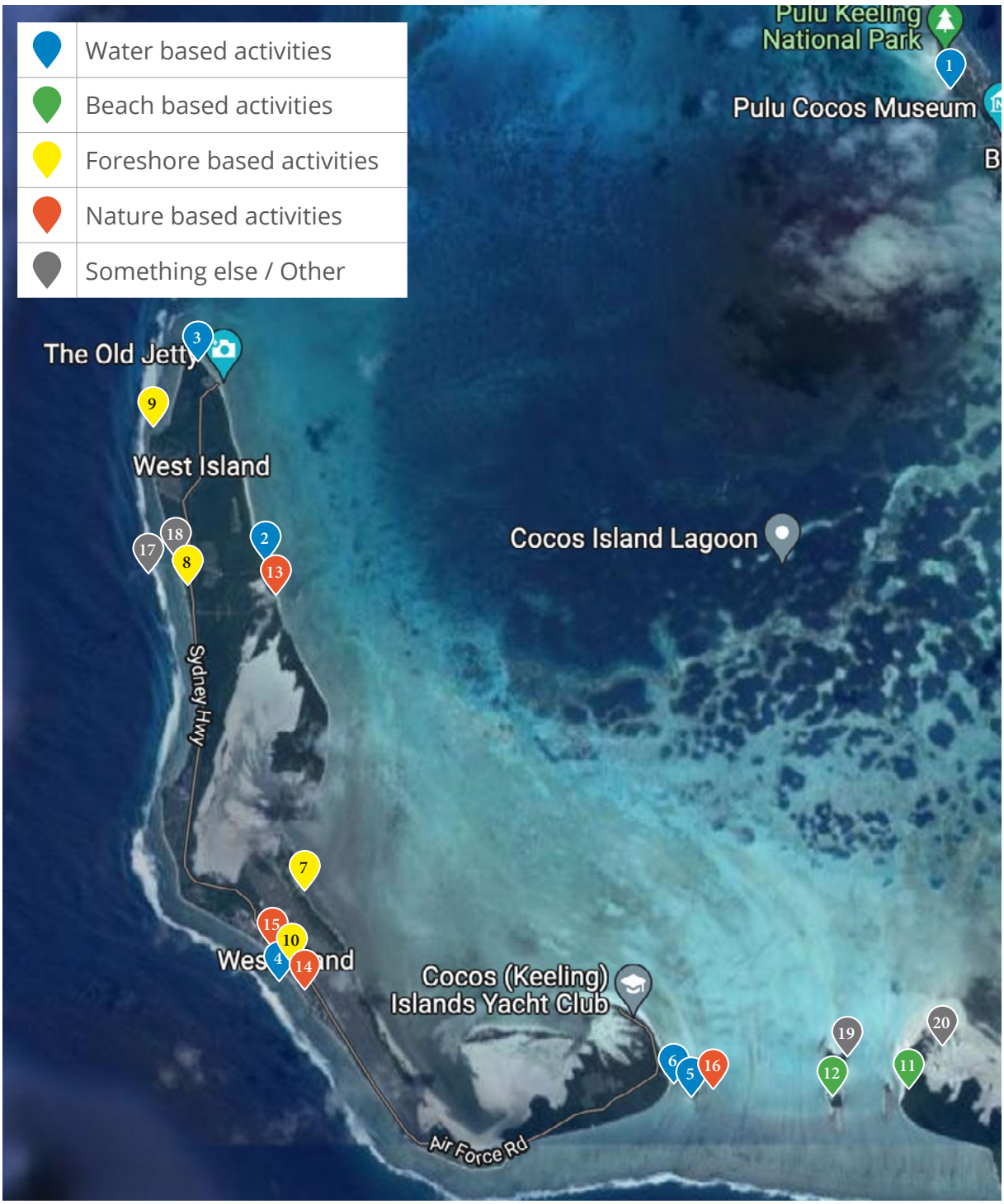


Figure 7 Value and Assets Mapping - Additional Comment on West Island

Table 7 Additional West island Comments on Mapping Tool

FEBRUARY 2023 COMMENTS	
	Water based activities
1	This is also where the school swimming lessons are conducted for younger children.
2	unofficial locals boat ramp on private property - needed because the public boat ramp at Rumah baru is inadequate.
3	fishing spot
4	Swimming in the dynamited sandy patches, local children kayak and play in these waters
5	Snorkeling at Pulu Maria
6	Wading across to Pulu Maria at certain tides
	Foreshore based activities
7	Is there really a small boat ramp at this location? Why may access it?
8	Walking along the shore north from the settlement up to the Big Barge
9	watching sunsets at Trannies Beach - popular with tourists and locals alike. Public toilets and playground
10	Watching sunsets from the top of the sandbags.
	Beach based activities
11	South Island picnic / camping spot very popular with locals
12	Pulu Belan Madar - popular picnic spot for locals
	Nature based activities
13	"I lived and breed on the island went to west island high school in the eighties then went to study on the mainland and came back to work at the coop involved with the stevedoring when the barge “Biar Berjaya” used to unload containers at the old jetty location. The coast line on Cocos is a living creatures that i learned from the white beach sand will moved around constantly depending on the current wind and sea movement. This is the same with Rumah Baru beach where they have issues with the ramp"
14	Enjoyment of coastal views from the sandbags. However native coastal fringing vegetation is needed to be restored along the grassed foreshore reserve strip to slow erosion and prevailing winds from storm fronts.
15	Beachcombing, watching turtles feeding on sea grass, exploring rock pools and shallows on low tide, watching reef sharks. Safe pedestrian access to the sand is needed as the sandbags are slippery and steep - numerous injuries occur from falls down them.
16	Encountering beautiful reef teeming with life, sharks, turtles, tropical fish
	Something else/Other
17	I agree, it seems like most of the tourist dollar goes straight off the island because the business owners don't live here. Very few local benefits are seen and the infrastructure here doesn't even adequately service the locals, let alone support additional visitors.
18	The Big Barge Art Centre - restored wooden barge housing art gallery, community art workshops, outdoor cinema, cafe in beautiful jungle location with beach access and enjoyment of coastal views. Very popular with tourists and locals, alike.
19	Conservation of translocated population of Christmas Island blue tailed skink
20	Conservation value of tidal mud flats as refuge for migratory birds

3 NEXT STEPS

This phase of engagement and the CHRMAP process finishes in March 2023.

With the refinement of viable adaptation options, considering trade-offs resulting from each option, the project team will then make adjustment to the engagement outcomes to finalise a well-considered CHRMAP for CKI.

The CHRMAP is expected to be finalised by August/September 2023, with the following actions:

- The Shire will then commence Local Planning Strategy/ Scheme in conjunction with DPLH
- Assistant Minister for Regional Development and Territories considers
- WAPC endorsement
- Minister for Regional Development and Territories Endorsement



Figure 8 Project Phases for CKI Coastal Planning

REFERENCES

Shape Urban (2023a), *Provision Of Coastal Hazard Risk Management And Adaptation Planning In The Cocos (Keeling) Islands Engagement Outcomes Report*

APPENDICES

Appendix A: Perth DITRDCA Meeting Presentations 51

Appendix B: On-Island Engagement Presentation – Master 52

Appendix C: Multi Criteria Assessment Details 53

Appendix D: School CHRMAP Presentation 54

APPENDIX A

Appendix A: Perth DITRDCA Meeting Presentations



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Department of Infrastructure, Transport, Regional Development, Communications and the Arts

Welcome

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Australian Government
Department of Infrastructure, Transport, Regional Development, Communications and the Arts

Acknowledgement

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Introductions

Steering Group

Commonwealth Department of Infrastructure, Transport, Regional Development, Communications and the Arts

WA Department of Planning Lands and Heritage

Shire of Cocos (Keeling) Islands

Department of Transport (Coastal Infrastructure Branch)

Consultant Team

Shape Urban – Planning, Communications & Stakeholder Engagement

Wavelength – Coastal Planning and Engineering

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The Team

Australian Government – Brent Ritchie, Jeff Dzodz

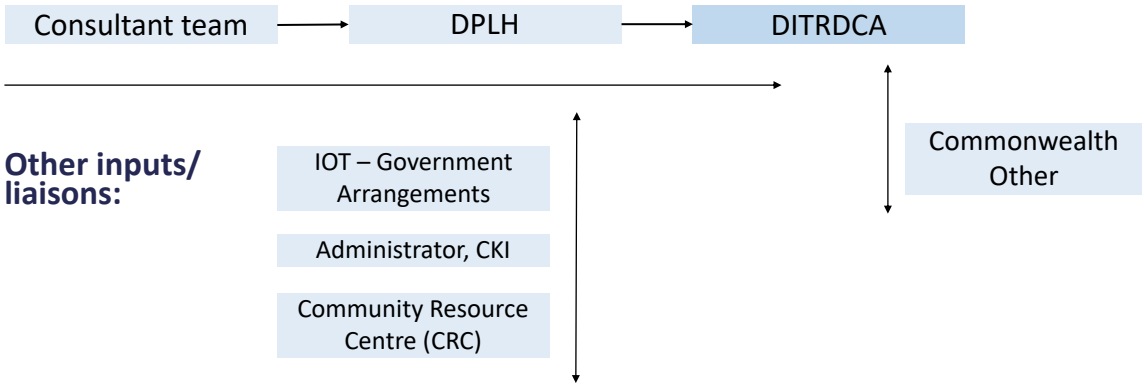
Department of Planning, Lands and Heritage – Peter Wood, Ben Bassett

Consultant Team:

Shape Urban – Anna Kelderman, Anika Chhabra

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Relationships



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How this session will work

- Process/project recap
- Coastal processes, hazards and risks on CKI (context)
- What we heard - assets and values
- Risk management approaches / adaptation options available (viable)
- Multi criteria assessment (MCA) process
- Findings and what this means going forward
- Q&As through the session

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What are we doing?

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The Remit

The Cocos (Keeling) Islands are affected by coastal erosion and inundation, with vulnerability of use and development expected to increase in the future.

- Home Island and West Island coastlines are used and highly valued by the CKI community
- Important to understand how the coastlines are changing
- How to respond to these changes for sustainable coastal living for the CKI community into the future
- We will be making **recommendations for action**

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The Remit

Preparing a CHRMAP…

…a strategic document to *plan* for responding to *coastal hazard challenges…*

- Identify vulnerable public and private assets
- Recognise and preserve community values for current and future generations
- Inform community and decision makers
- Required under West Australian State Planning Policy 2.6 – State Coastal Planning

A plan for the next 100 years (but on CKI….?)

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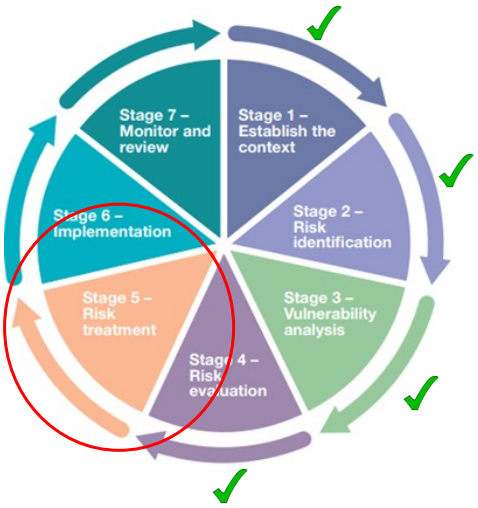
What a CHRMAP does

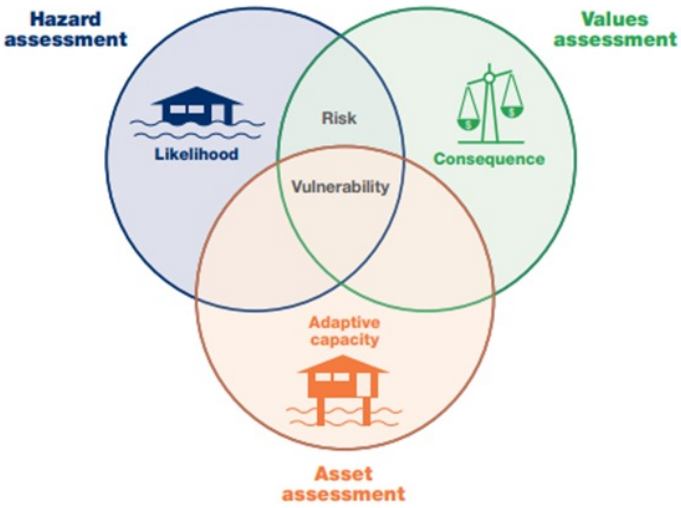
Predict the *risk* of **erosion** + **inundation** with sea level rise

- Looks at likelihood of exposure on an asset
- Looks at consequence of exposure on an asset (or sensitivity)

Then considers adaptability of the asset

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SPP 2.6 + CHRMAP Guidelines - Process

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Project Phases

Phase 1 (2018-2020)
CKI Coastal Vulnerability Study (CVS)

Phase 2 (2021-2023)
CKI Coastal Hazard Risk Management and Adaption Plan (CHRMAP)

Phase 3 (2023 onwards)
New Local Government Planning Scheme by Shire of CKI

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Project Background

- DPLH - state-wide responsibility for the planning - provides support to the IOT under Service Delivery Arrangements (SDAs) with Commonwealth
- DPLH is responsible for delivering on State Planning Policy. In this case - *State Planning Policy 2.6 - State Coastal Planning Policy* - SPP 2.6 which looks at the vulnerability of populations
- DPLH - *Cocos (Keeling) Islands Coastal Vulnerability Study* (Haskoning Australia PTY Ltd, 2021) identifies areas vulnerable over a 100-year planning timeframe
- This project is next step to deliver a 'CHRMAP'
- Then deliver actions ($$)

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Other Studies

- Hydrographic surveys, long term wind data, long term tide data, topographic information, LiDAR, metocean data, CVS
- Climate Change Risk Assessment
- CKI Sand Management Strategy Numerical Modelling Report
- Crown Land Management Plan for IOT
- An assessment by BoM (2005) regarding cyclone activity in the region
- Physical Coastal Processes for Rumah Baru

(RHDHV, DoT, DoD, Maunsell, CZM, DA Lord & Associates, GHD, BoM…)

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What it all says

- The islands are one of the most vulnerable coastal types to Sea Level Rise (SLR)
- Risks are already 'High' for multiple assets.

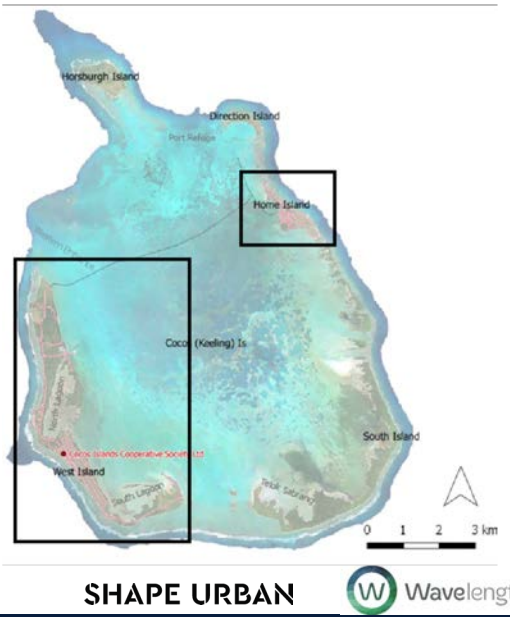


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Home Island

Susceptible to coastal flooding (inundation), especially the foreshore adjacent to the lagoon.

Most shorelines have been stable and infrastructure on the ocean coast is reasonably setback in most locations.

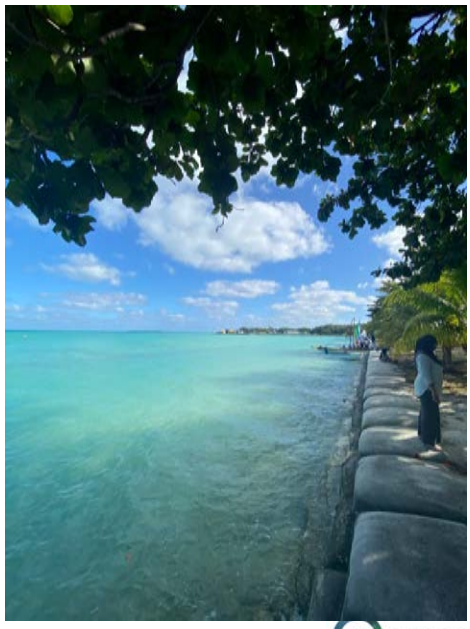


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Home Island





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Home Island – Nov 22



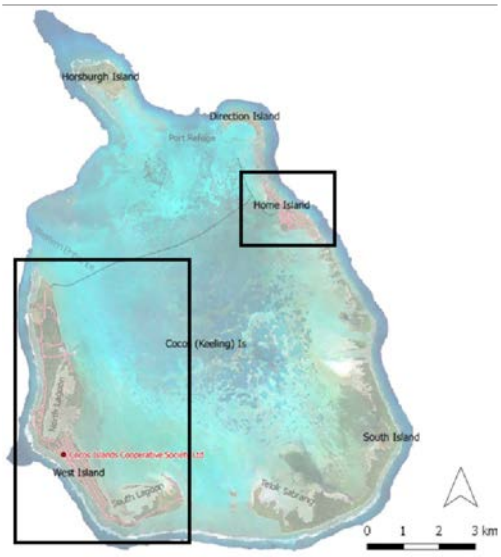


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West Island

History of chronic erosion along the western ocean facing shore, requiring construction of multiple coastal structures since the 1970's to protect assets.



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West Island





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West Island





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Coastal Inundation

Lagoon side - extreme water levels driven by short term wind waves and cyclone events.

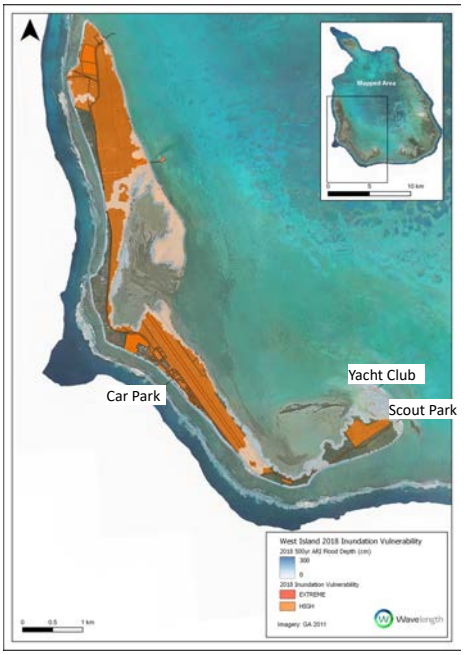
Ocean side - offshore waves travelling across the reef, causing wave setup and runup (i.e. elevated water levels and flooding).

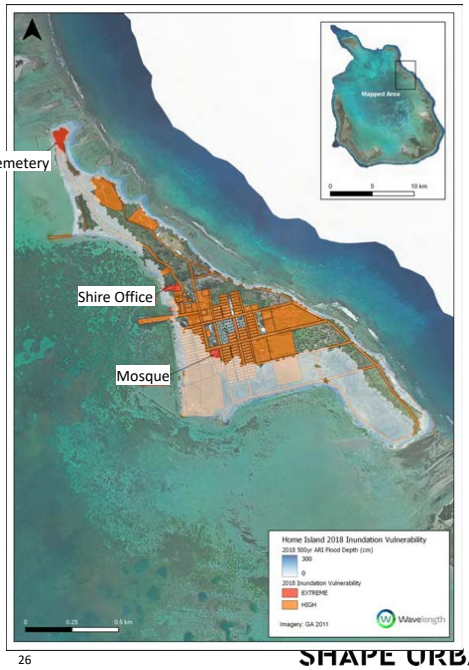


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Vulnerability Mapping for 2018 and 2068

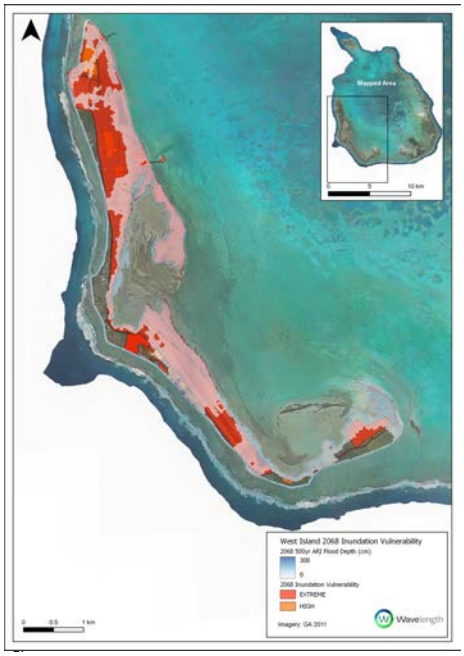
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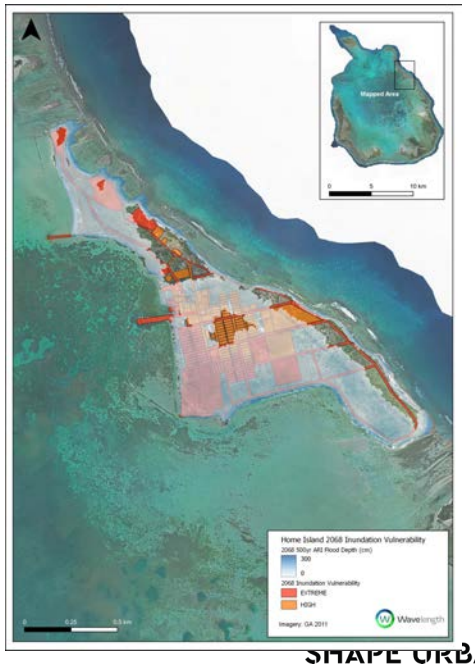




Inundation Vulnerability 2018

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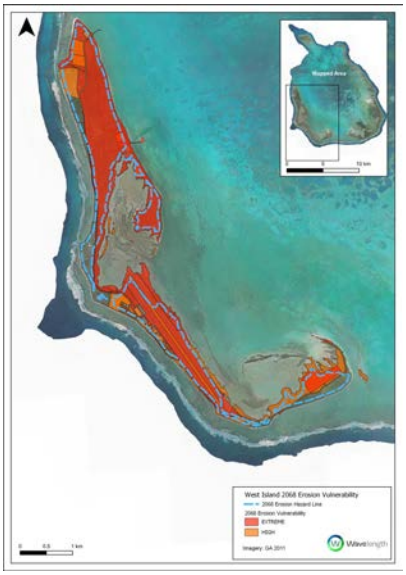


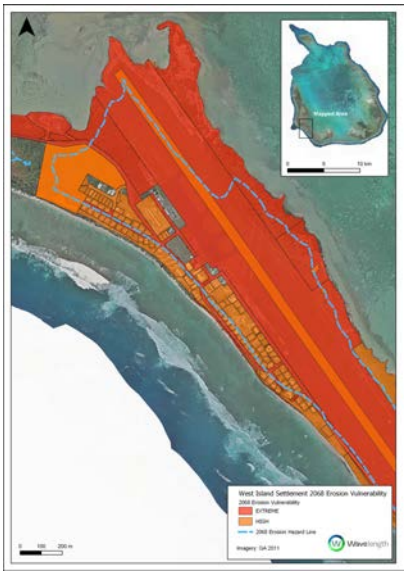


Inundation Vulnerability 2068

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Erosion 2068

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Risk Management / Adaptation Approaches

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Possible adaptation options (per WA SPP 2.6)



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Possible adaptation options



Avoid – options which aim to eliminate the risk of coastal hazards by avoiding development



Planned/ Managed Retreat – options which progressive retreat / relocate development

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Possible adaptation options



Accommodate – possible options which seek to enhance assets to cope with the temporary impacts

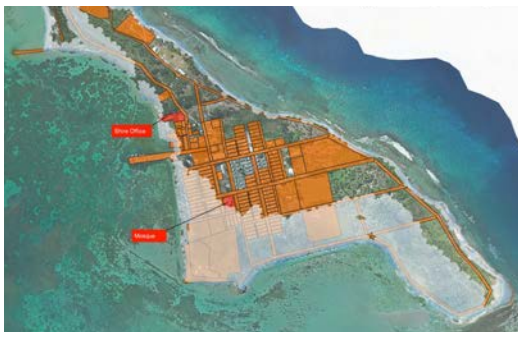


Protect – possible options which seek to artificially protect the coast

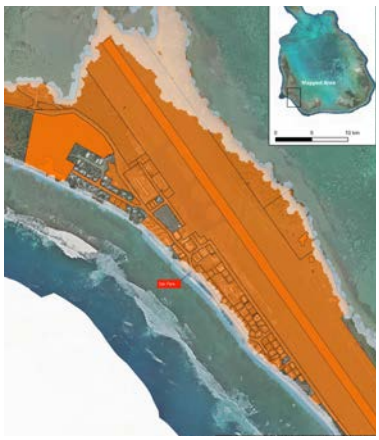
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Approach

1. Whole of settlement
2. Individual asset treatment outside settlements



Home Island



West Island

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Approach – Settlement

- Adaptation required in short term, next 5 to 10 years
- Three adaptation pathways identified:
  - Protect
  - Accommodate
  - No regrets
- Unfeasible possible options:
  - Avoid – assets already in place
  - Retreat – Insufficient space / higher ground to retreat to (within island consideration)

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Approach – Assets outside of settlement

- Avoid further development in known areas of risk
- Opportunity to relocate some assets within property boundaries
- Alternate 'soft' protection possible options (revegetate, sand nourishment)

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Protect examples



geotextile sand container (GSC) seawall

Seawalls

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concrete seawall

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Protect



Levees and road raising

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Accommodate example

Replace and upgrade properties and buildings at end of design life



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No Regrets

Accepting properties and assets are at increased risk

Establish emergency plans and emergency shelter for Settlement





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Longer Term (2118)

Towards end of century, it will be challenging to maintain the accommodate and protect pathways:

- Groundwater shoaling impacts
- Levees would make it difficult to stop terrestrial flooding, as drainage outflows will be backed up more frequently by higher tides and storm water levels
- High levees would also be difficult to access other locations on islands

Potential long-term possible options include:

- Retreat from islands
- Reclaim and protect

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Reclaim and protect

Sand is sourced and pumped, properties and assets are raised

- Technically feasible and promotes long term resilience
- Substantial costs
- Requires integrated planning, engineering and environmental approach



Example : Kiribati raise 300-hectare area of land 2 – 5 m above the highest measured sea level.

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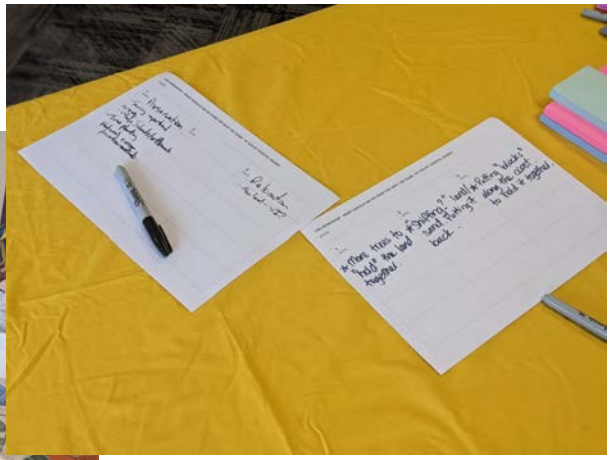
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What we heard – Assets and Values

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What we heard…





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Highly valued assets / values

- Recreation - Use of beach and foreshore areas for recreation, fishing, boat launching and sporting activities (both islands)
- Environment - Ocean, lagoon, views, landscapes, foreshore vegetation and protection of the natural environment
- Amenities and infrastructure – Yacht, jukong and sailing clubs
- Access along the coastal and lagoon foreshore areas - boat launching, access to other islands
- Cemetery at Pulu Gangsa and mosque on Home Island

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Access to water e.g. boat launching

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Recreation e.g. dukong racing, sailing

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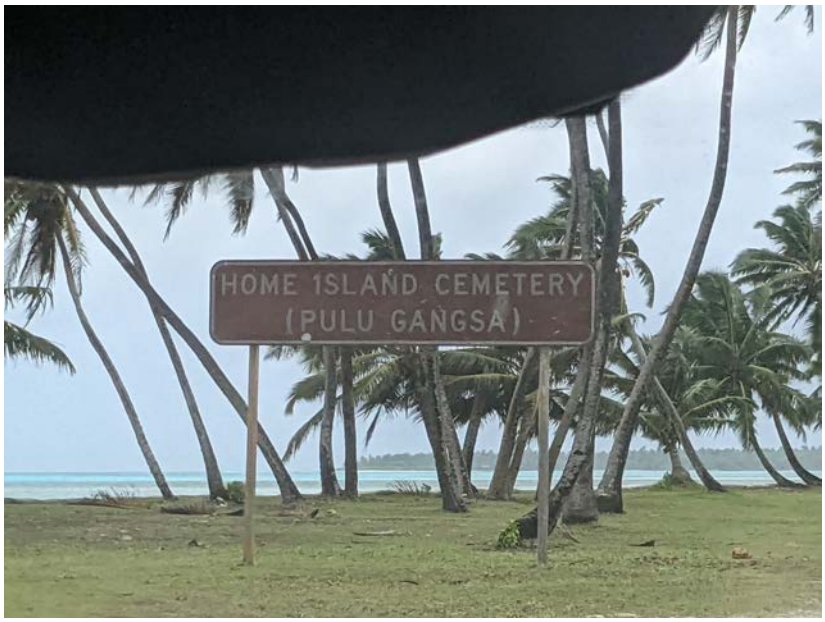
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Jetty areas

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Pulu Gangsa (cemetery)

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What else?





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What else?

- Coastal process changes – concerned about:
  - the impacts of coastal change
  - felled trees around the coastlines of both islands
  - sandbags that have been impacted
  - how much the coastlines on Home Island and West Island have changed over time
- Coastal management – action critical – '*get on with it*'

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What else?





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Management-wise, we heard…

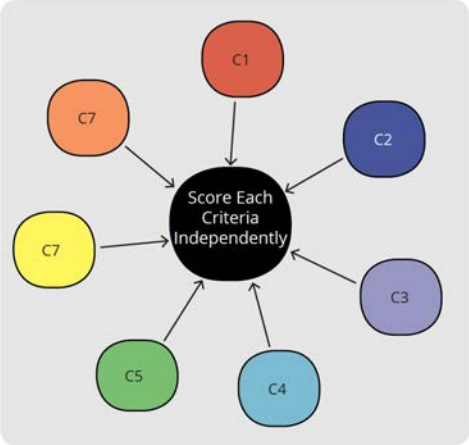
- Community wanted to see:
  - Soft options – (re)vegetation, education, conversations about possibility of retreat in the long term
  - Protection and adaptation – sandbags, seawalls
  - Prioritising settlement protection on both islands
  - Additional protection of the Yacht Club and Rumah Baru jetty areas (West Island)

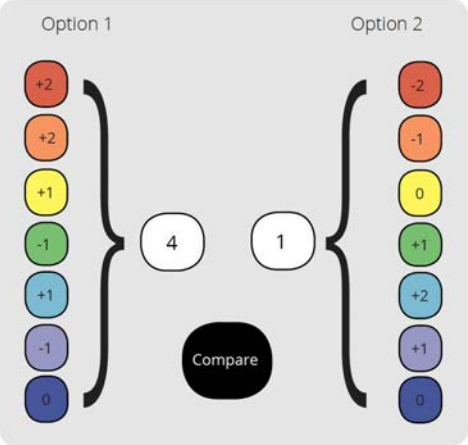
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Multi-Criteria Assessment

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Multi-Criteria Assessment





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Multi-Criteria Assessment (MCA)
(Short term)

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MCA steps

1 Assessment of adaptation options (general) for advancement to MCA

2a. Assessment of inundation options for advancement to MCA

2b. Assessment of erosion options for advancement to MCA

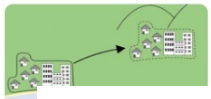
3 MCA assessment using criteria developed (+ weightings)

4 Options costs

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1 Assess all adaptation options

1.0 Pre-Screening - Settlement Wide Adaptation Pathways				West Island - Settlement Inundation - Present Day High Vulnerability of Assets Erosion - Present Day High Vulnerability of Assets	
Adaptation Type	Description	Diagram	Scenario	Feasibility- Reduce erosion and inundation risks to Settlement?	Advance to specific options assessment
Avoid	Locating assets in areas that will not be vulnerable to coastal hazards.	New	Short Term	Not feasible at present or into future as existing assets currently at High risk of erosion and inundation.	Rejected
Planned/Managed Retreat	Planned or managed retreat for existing development involves relocating or sacrificing infrastructure, both public assets and private property. This pathway also includes prevention of further development in risk areas		Short Term	Not feasible for whole of Settlement, including airport, as insufficient high ground outside Settlement. Potentially feasible for individual assets within Settlement but not whole of Settlement.	Rejected
Accommodate	The accommodate risk treatment option aims to utilise design and management strategies which render the risks as tolerable/acceptable. Design and management strategies may include a mix of structural or non-structural approaches, including modifications to buildings, enhancing the natural environment and policy updates	Need to find similar figures from GHD report for other options	Short Term	Partially effective Structural options can be used to reduce inundation risk and will be partially effective against erosion. Non-structural options, such as enhancing the natural environment, can help to reduce erosion risk	Shortlist pathway for specific options assessment
Protect	Protect risk treatment options aim to protect assets from damage resulting from erosion and recession and storm surge inundation. Common hard protection structures include seawalls; groynes; offshore breakwaters and artificial headlands; and soft protection measures such as beach nourishment.	Need to find similar figures from GHD report for other options	Short Term	Different protect options effective at managing erosion and inundation risk	Shortlist pathway for specific options assessment

2a Assess all options - inundation

2.0 Pre-Screening - Adaptation Options						West Island - Settlement Inundation - Present Day High Vulnerability of Assets			
Adaptation Type	ID	Method	Description	Benefits	Adverse Impacts	Effectiveness - Reduce inundation risks to property and people?	Environmental Fatal Flaw	Social Fatal Flaw	Advance to MCA
Protect			impacts of storm events. May have a negative impact on the adjoining shoreline.						
	P5	Groynes	Shore perpendicular structures which extend into the water. Range of construction materials (incl. rock, concrete, steel sheet pile, timber, geotextile sand filled tubes/bags). Aim to trap sand moving along the coast and retain a natural buffer to assist in absorbing the impacts of storm events. May have a negative impact on the adjoining shoreline.			Not effective at countering inundation.	-		Rejected
	P6	Geotextile Sand Container (GSC) seawalls	Involves construction of a GSC seawall usually along an entire section of shoreline. Seawalls stop both cross-shore and longshore erosion.		Loss of beach in front of seawall Downdrift / end scour erosion	Not effective at countering inundation. Must be used in conjunction with suitable Protect option	-		Rejected
	P7	Seabee concrete seawalls	Involves construction of a Seabee concrete unit seawall usually along an entire section of shoreline. Seawalls stop both cross-shore and longshore erosion.		Loss of beach in front of seawall Downdrift / end scour erosion	Not effective at countering inundation. Must be used in conjunction with suitable Protect option	-		Rejected
	P8	Storm surge barrier	Artificial barrier designed to be closed during a storm event to prevent high ocean water levels entering an estuary or inlet. May have a negative visual impact.			Not suitable for this location, as open coastline	-		Rejected
	P9	Levees	Involves construction of a levee usually along an entire section of shoreline. Levees can prevent coastal inundation of low-lying areas			Effective at countering inundation	Nil	Nil	Proceed to short-term MCA
	P10	Land raising and/or reclamation	Involves raising or reclaiming low-lying land to prevent inundation. This option is usually completed in conjunction with levees and/or seawalls.			Effective at countering inundation	Nil	Significant disruption to local communities in short term. Should be considered as a longer term option to manage groundwater shoaling and inundation risk	Rejected
	NR1	Monitoring	This option involves long term baseline monitoring and event based monitoring following storm erosion events			Partially effective Won't stop erosion and inundation risk to existing assets but can be used as a policy measure to monitor risk over time			Shortlist option for Quick Wins
	NR2	Protection Structure Audit	This option involves undertaking an audit of existing protection structures to determine their current condition, effectiveness and future protection potential			Partially effective Won't stop erosion and inundation risk to existing assets but can be used as a policy measure to help clarify risk			Shortlist option for Quick Wins

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2b Assess all options - erosion

2.0 Pre-Screening - Adaptation Options						West Island - Settlement Erosion - Present Day High Vulnerability of Assets			
Adaptation Type	ID	Method	Description	Benefits	Adverse Impacts	Effectiveness - Reduce erosion risks to property and people?	Environmental Fatal Flaw	Social Fatal Flaw	Advance to MCA
Protect	P2	Beach Nourishment - On-going campaigns	Placement of smaller volumes of sand on the beach, dunes or nearshore at more frequent intervals. May be undertaken pre/post storm event. Requires available sources of compatible sand. Aims to restore or enhance the beach profile to provide a natural buffer to absorb the impacts of storm events.			Effective at countering erosion	Nil	Nil	Proceed to short-term MCA Combine with levee (Protect option)
	P3	Offshore structures - Artificial reefs/shoals	Larger submerged structures, placed further off-shore, which aim to dampen wave energy similar to natural reefs and reduce the impacts of storm events. Typical construction materials are rock, concrete, or geotextile sand filled tubes. May have a negative impact on the adjoining shoreline.	Improved benthic habitat		Not effective at countering cross-shore erosion. Will cause erosion downdrift settlement (MU1B)	-		Rejected
	P4	Offshore structures - Detached breakwaters/headlands	Large structures, visible above the waterline placed some distance off-shore. Typical construction materials are rock or geotextile sand filled tubes. In comparison to option P2, typically require significantly more construction materials. Aims to stop/redirect incoming waves to capture/retain sand at the beach and improve the capacity of the beach system to absorb the impacts of storm events. May have a negative impact on the adjoining shoreline.			Not effective at countering cross-shore erosion. Will cause erosion downdrift settlement (MU1B)	-		Rejected
	P5	Groynes	Shore perpendicular structures which extend into the water. Range of construction materials (incl. rock, concrete, steel sheet pile, timber, geotextile sand filled tubes/bags). Aim to trap sand moving along the coast and retain a natural buffer to assist in absorbing the impacts of storm events. May have a negative impact on the adjoining shoreline.			Not effective at countering cross-shore erosion. Will cause erosion downdrift settlement (MU1B)	-		Rejected
	P6	Geotextile Sand Container (GSC) seawalls	Involves construction of a seawall usually along an entire section of shoreline. Areas setback from erosion risk can be protected from inundation with a levee		Loss of beach in front of seawall	Effectiv and long			

3 Key criteria and scoring

3.0 - Multi Criteria Assesment - Key Criteria & Scoring

	Category	Implementation	Environmental Impact	Social Impact - Property	Social Impact - Way of Life	Economic Impact - Businesses	Flexibility	Effectiveness	Financial
	Description	How easy is the option to implement on a small island (i.e. can it be made on the island using readily available, local resources)?	How significant are the environmental impacts?	How significant are the impacts on properties?	How significant are the impacts on daily life?	How significant are the impacts on businesses and the local economy?	Is the option reversible / adaptable in the future?	How effective is the solution at mitigating erosion and inundation risks?	How much does the option cost?
	Goals	- Implementation timeframe - Local use of products - Logistics and delays to import material - Maintenance of option into future - Carbon miles -Re-use of existing material	- Amenity and public health (noise, dust, noise, odours) impacts - distance to sensitive receptors - Scale of disturbance to marine habitat, water quality vulnerable/ protected species - Scale of disruption to commercial fisheries	- Residential property losses - Property access	- Impact on community values - Impact on access to important social and cultural areas (i.e. beach access, boat launching, views etc) - Scale and duration of disturbance to community areas/ activities	- Impact on existing businesses	- Reversibility of option - Adaptable to unforeseen changes in climate conditions - Alignment with potential long term adaptation pathways, including reclamation with seawalls	- Effectiveness against erosion - Effectiveness against inundation	-Combined capital and maintenance costs -Potential for external funding sources
5	Insignificant impacts OR Very low risk	Abundant and sustainable source of material on island	Preserves and repairs	0 houses lost Does not affect property access	Does not affect any community values and/or improves access	No loss of existing businesses	Easily reversible or adaptable	Effective, long term mitigation	<$5 million
4	Minor impacts OR Low risk	A significant portion of material available on island	Maintains status quo	1-10 houses lost	Minor impact to community values and/or access		Reversible or adaptable	Effective, mid-term mitigation	$5 to $15 million
3	Moderate impacts OR Medium Risk	Some material available on island	May result in impact and damage	11-19 houses lost Minor impact to property access	Loss of access to some community assets that doesn't effect overall intrinsic community value	Protects or maintains as long as possible	Reversible or adaptable but with some cost	Effective, short term mitigation	$15 - $30 million
2	Major impacts OR High risk	Only a small portion of material available on island, majority of material needs to be imported	Likely to result in impact and damage	20-40 houses lost	Loss of access to certain assets		Difficult to reverse or adapt	Limited effectiveness	$30-$50 million
1	Severe impacts OR Very high risk	No material on island, all materials need to be imported	Will result in impact and damage	>40 houses lost Major impact to property access	Will definitely affect key values of area	Loss of existing businesses	Irreversible or unadaptable	Ineffective and/or suitable only for minor events	>$50 million

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MCA criteria

- **Implementation** – how easy is the option to implement? Can it be made on the island using readily available, local resources?
- **Environmental impact** - how significant are the environmental impacts?
- ***Social impact – property*** *- how significant are the impacts on properties?*
- **Social impact – way of life** - how significant are the impacts on daily life?

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MCA criteria (cont.)

- **Economic impact** - how significant are the impacts on businesses and the local economy?
- **Flexibility** - is the option reversible/ adaptable in the future?
- **Effectiveness** - How effective is the solution at mitigating erosion and inundation risks?
- **Financial** – how much does the option cost?

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West Island - possible options (screened)

Adaptation Type	ID	Name	Description	NPV
Accommodate	AC1	Structural - Design assets to withstand hazards	This option would involve constructing properties on stilts to accommodate inundation.	<$100 million
Protect	P9 + P2	Levees with on-going nourishment	This option would involve construction of a levee to protect against inundation and on-going nourishment to counter erosion	<$100 million
	P9 + P6	Levees with GSC Seawalls	This option would involve construction of a combined levee and GSC seawall structure to counter inundation and erosion	<$50 million
	P9 + P7	Levees with Concrete SeaBee Seawalls	This option would involve construction of a combined levee and concrete seabee seawall structure to counter inundation and erosion	<$50 million

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West Island – unweighted score

Name	Implementation	Environmental Impact	Social Impact - Property	Social Impact - Way of Life	Economic Impact - Businesses	Flexibility	Effectiveness	Financial	Unweighted Score
Structural - Design assets to withstand hazards	1	4	2	5	1	4	2	1	20
Levees with on-going nourishment	2	2	5	3	5	5	3	1	26
Levees with GSC Seawalls	5	3	5	2	5	3	3	2	28
Levees with Concrete SeaBee Seawalls	4	3	5	2	5	2	4	2	27

5	Insignificant impacts OR Very low risk
4	Minor impacts OR Low risk
3	Moderate impacts OR Medium Risk
2	Major impacts OR High risk
1	Severe impacts OR Very high risk

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West Island – option costs

Long term

Protect with Seabee seawalls - following AC1 short term option	<$100 million
Protect with Seabee seawalls - following Protect with Seabee seawalls short term option	<$100 million
Reclaim Land and protect with Seabee seawalls - following AC1 short term option	<$500 million
Reclaim Land and protect with Seabee seawalls - following Protect short term option	<$500 million

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Home Island - possible options (screened)

Adaptation Type	ID	Name	Description	NPV
Accommodate	AC1	Structural - Design assets to withstand hazards	This option would involve constructing properties on stilts to accommodate inundation.	<$100 million
Protect	P9 + P2	Levees with on-going nourishment	This option would involve construction of a levee to protect against inundation and on-going nourishment to counter erosion	<$50 million
	P9 + P6	Levees with GSC Seawalls	This option would involve construction of a combined levee and GSC seawall structure to counter inundation and erosion	<$20 million
	P9 + P7	Levees with Concrete SeaBee Seawalls	This option would involve construction of a combined levee and concrete seabee seawall structure to counter inundation and erosion	<$20 million

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Home Island – unweighted score

Name	Implementation	Environmental Impact	Social Impact - Property	Social Impact - Way of Life	Economic Impact - Businesses	Flexibility	Effectiveness	Financial	Unweighted Score
Structural - Design assets to withstand hazards	1	4	4	5	5	4	4	1	28
Levees with on-going nourishment	2	2	5	3	5	5	3	2	27
Levees with GSC Seawalls	5	3	5	1	5	3	3	3	28
Levees with Concrete SeaBee Seawalls	4	3	5	1	5	2	3	3	26

5	Insignificant impacts OR Very low risk
4	Minor impacts OR Low risk
3	Moderate impacts OR Medium Risk
2	Major impacts OR High risk
1	Severe impacts OR Very high risk

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Home Island – option costs

Long term

Reclamation on HI Settlement - Following AC1 short term option	<$500 million
Reclamation on HI Settlement - Following Protect short term option (P9 + P7)	>$500 million
Retreat to WI - New Settlement near Rumah Baru	<$500 million

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Discussion – Presentation / Risks

- Presenting all options
- Presenting options – HI
- Presenting options – WI

NB – most of the options are well understood by the community

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What next for the project

- This phase finishes in March
- We will finalise CHRMAP in July-August 2023 and then start actioning
- *Shire of CKI commence Local Planning Strategy/ Scheme in conjunction with DPLH*
- *Assistant Minister for Regional Development and Territories considers*
- *WAPC endorsement*

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Australian Government

Department of Infrastructure, Transport,
Regional Development, Communications and the Arts

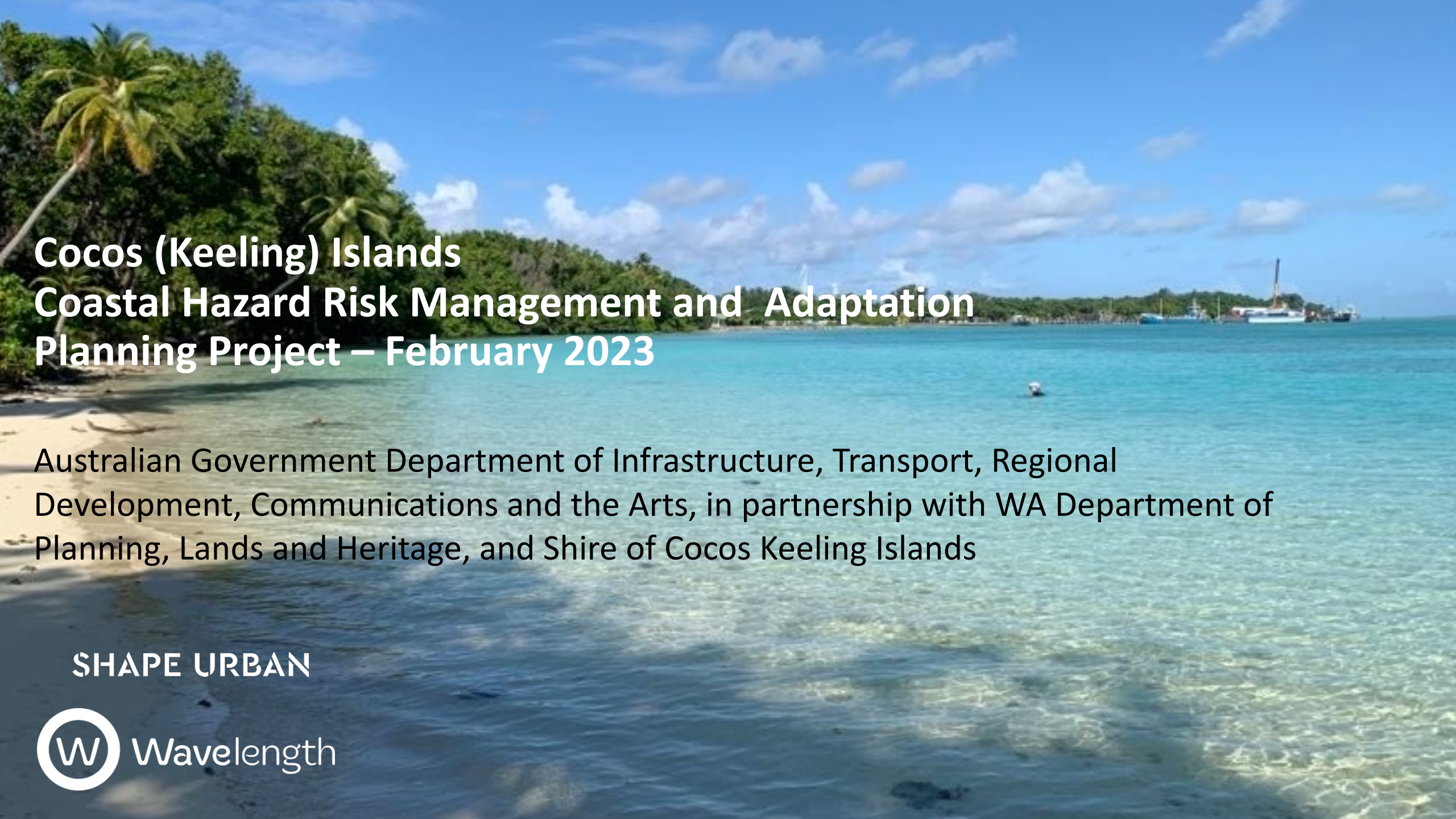
Thank You

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APPENDIX B

Appendix B: On-Island Engagement Presentation – Master



Cocos (Keeling) Islands Coastal Hazard Risk Management and Adaptation Planning Project – February 2023

Australian Government Department of Infrastructure, Transport, Regional Development, Communications and the Arts, in partnership with WA Department of Planning, Lands and Heritage, and Shire of Cocos Keeling Islands

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Department of Infrastructure, Transport,
Regional Development, Communications and the Arts

Welcome

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Regional Development, Communications and the Arts

Acknowledgement

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Who's who

Steering Group

Commonwealth Department of Infrastructure, Transport, Regional Development, Communications and the Arts

WA Department of Planning Lands and Heritage

Shire of Cocos (Keeling) Islands

Department of Transport (Coastal Infrastructure Branch)

Consultant Team

Shape Urban – Planning, Communications & Stakeholder Engagement

Wavelength – Coastal Planning and Engineering

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The Team

Department of Planning, Lands and Heritage – Peter Wood, Ben Bassett

Shape Urban – Anna Kelderman, Keyon Yang

Wavelength – Annabel Sandrey

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How this session will work

- Process/project recap
- Coastal processes, hazards and risks on CKI (context)
- What we heard - assets and values
- Risk management approaches / adaptation options available (viable)
- Multi criteria assessment (MCA) process
- Findings and what this means going forward
- Q&As through the session



What are we doing?

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The Remit

The Cocos (Keeling) Islands are affected by coastal erosion and inundation, with vulnerability of use and development expected to increase in the future.

- Home Island and West Island coastlines are used and highly valued by the CKI community
- Important to understand how the coastlines are changing
- How to respond to these changes for sustainable coastal living for the CKI community into the future
- We will be making **recommendations for action**

The Remit

Preparing a CHRMAP…

…a strategic document to *plan* for responding to *coastal hazard challenges…*

- Identify vulnerable public and private assets
- Recognise and preserve community values for current and future generations
- Inform community and decision makers
- Required under West Australian State Planning Policy 2.6 – State Coastal Planning

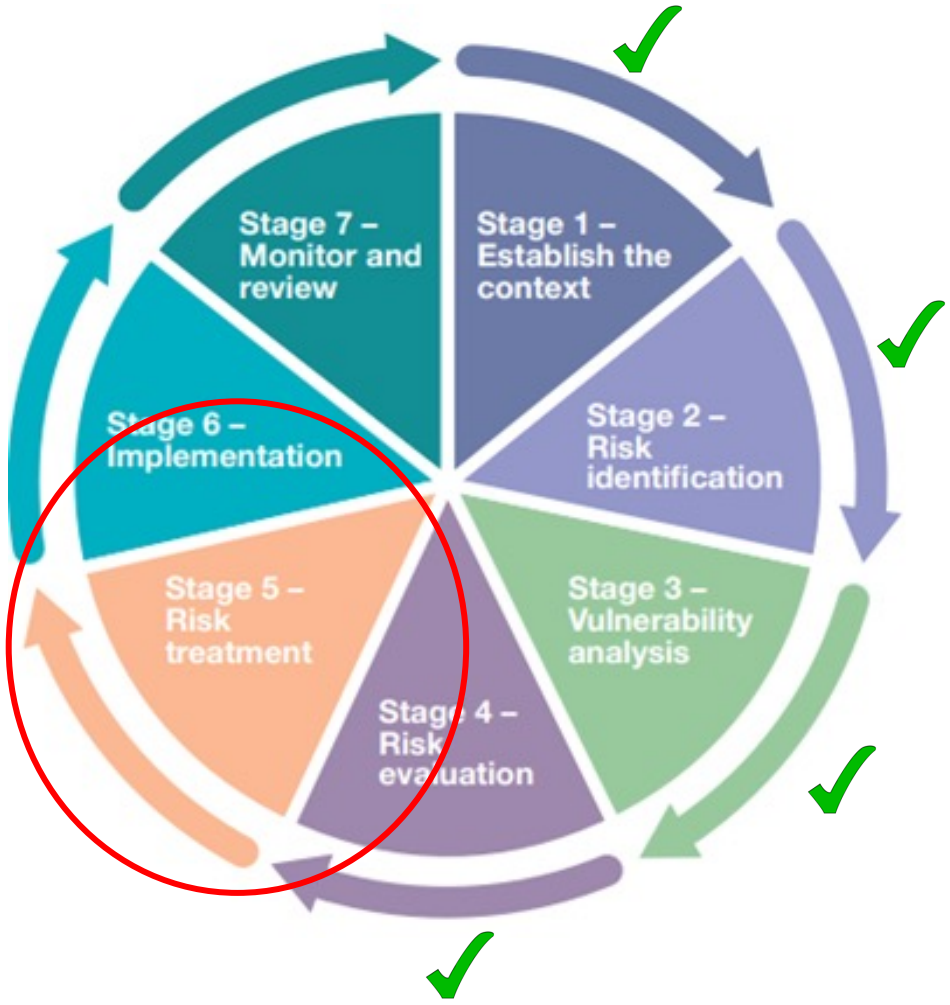
A plan for the next 100 years (but on CKI….?)

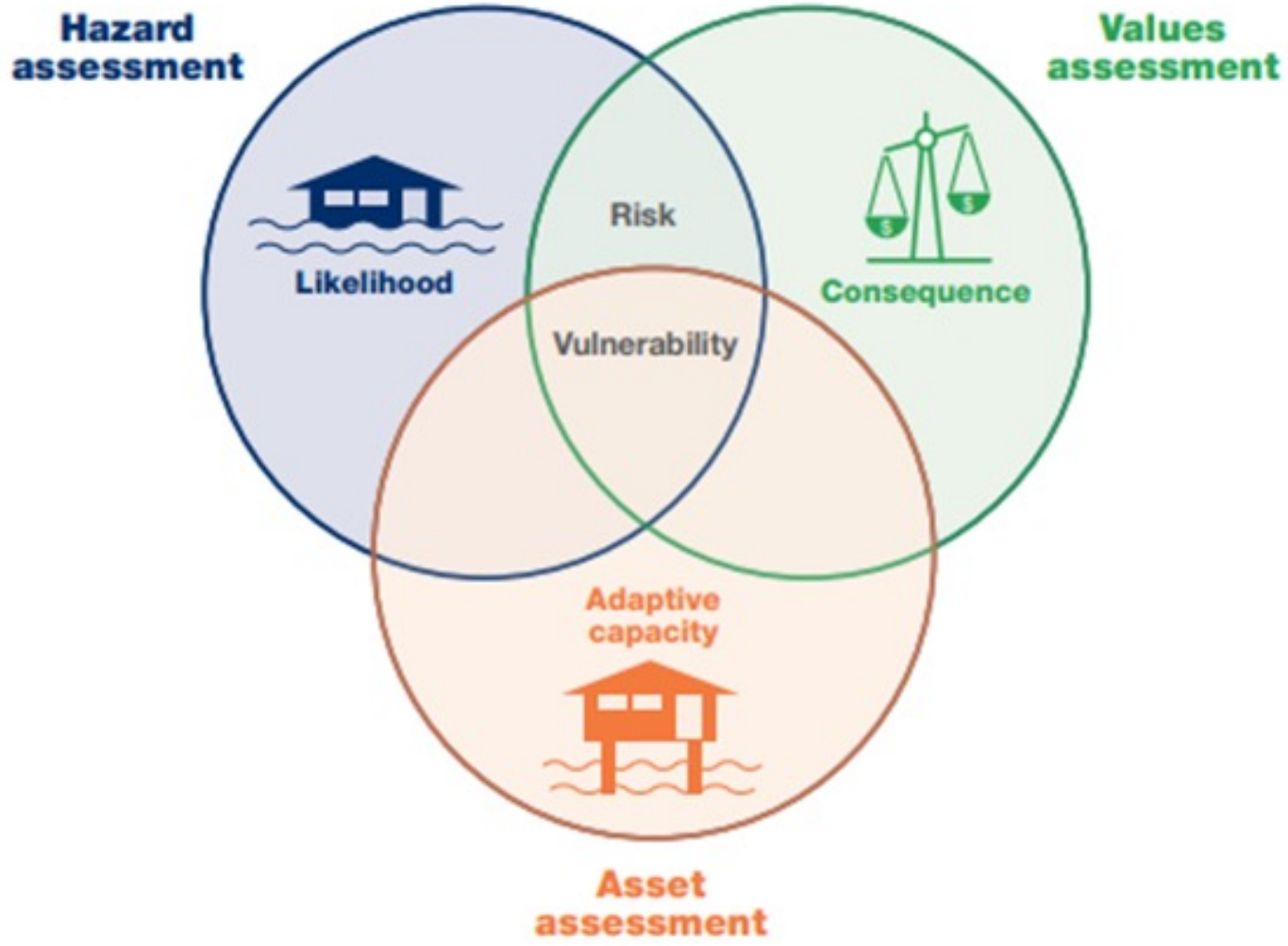
What a CHRMAP does

Predict the *risk* of **erosion** + **inundation** with sea level rise

- Looks at likelihood of exposure on an asset
- Looks at consequence of exposure on an asset (or sensitivity)

Then considers adaptability of the asset





SPP 2.6 + CHRMAP Guidelines - Process

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Project Phases

Phase 1 (2018-2020)

CKI Coastal Vulnerability Study (CVS)

Phase 2 (2021-2023)

CKI Coastal Hazard Risk Management and Adaption Plan (CHRMAP)

Phase 3 (2023 onwards)

New Local Government Planning Scheme by Shire of CKI

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Project Background

- DPLH - state-wide responsibility for the planning - provides support to the IOT under Service Delivery Arrangements (SDAs) with Commonwealth
- DPLH is responsible for delivering on State Planning Policy. In this case - *State Planning Policy 2.6 - State Coastal Planning Policy* - SPP 2.6 which looks at the vulnerability of populations
- DPLH - *Cocos (Keeling) Islands Coastal Vulnerability Study* (Haskoning Australia PTY Ltd, 2021) identifies areas vulnerable over a 100-year planning timeframe
- This project is next step to deliver a 'CHRMAP'
- Then deliver actions ($$)

Other Studies

- Hydrographic surveys, long term wind data, long term tide data, topographic information, LiDAR, metocean data, CVS
- Climate Change Risk Assessment
- CKI Sand Management Strategy Numerical Modelling Report
- Crown Land Management Plan for IOT
- An assessment by BoM (2005) regarding cyclone activity in the region
- Physical Coastal Processes for Rumah Baru

(RHDHV, DoT, DoD, Maunsell, CZM, DA Lord & Associates, GHD, BoM…)

What it all says

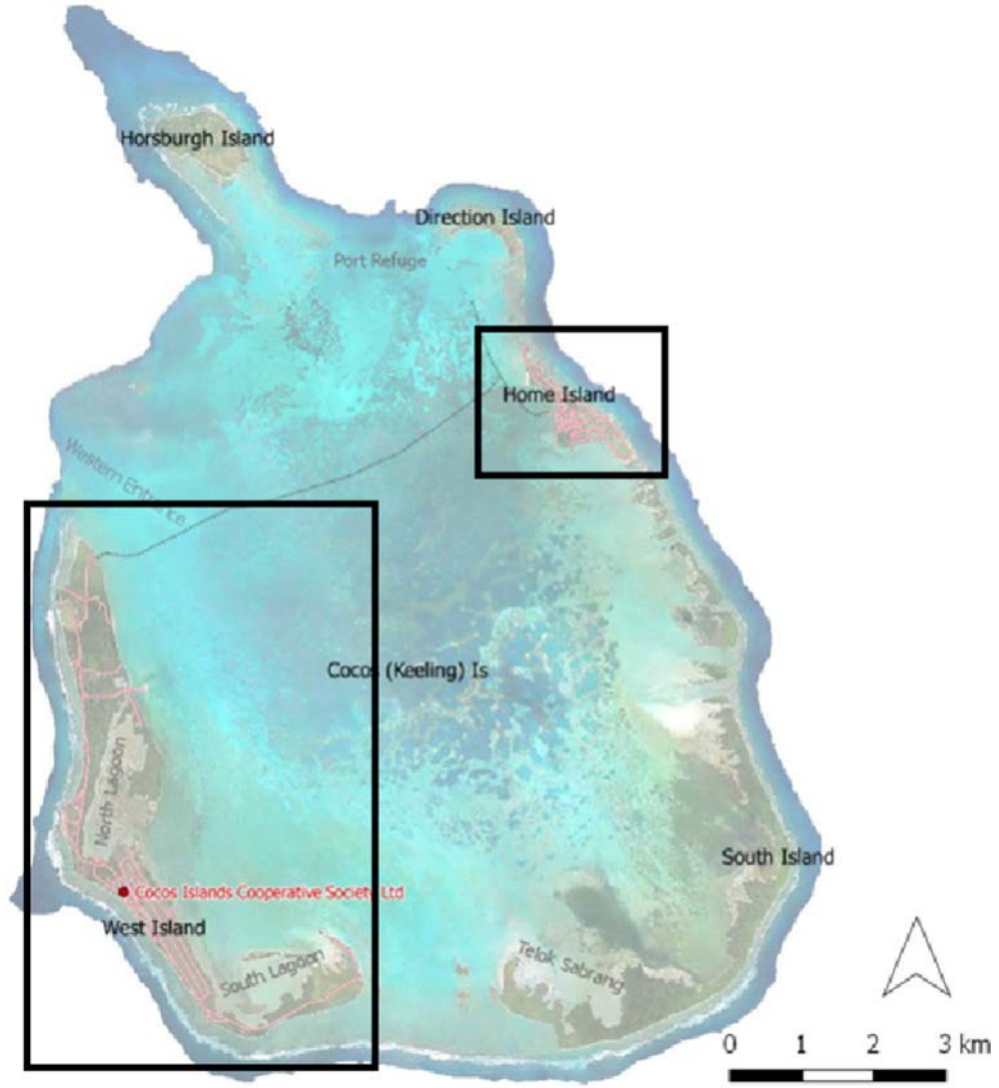
- The islands are one of the most vulnerable coastal types to Sea Level Rise (SLR)
- Risks are already ‘High’ for multiple assets.



Home Island

Susceptible to coastal flooding (inundation), especially the foreshore adjacent to the lagoon.

Most shorelines have been stable and infrastructure on the ocean coast is reasonably setback in most locations.



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Home Island





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Home Island – Nov 22



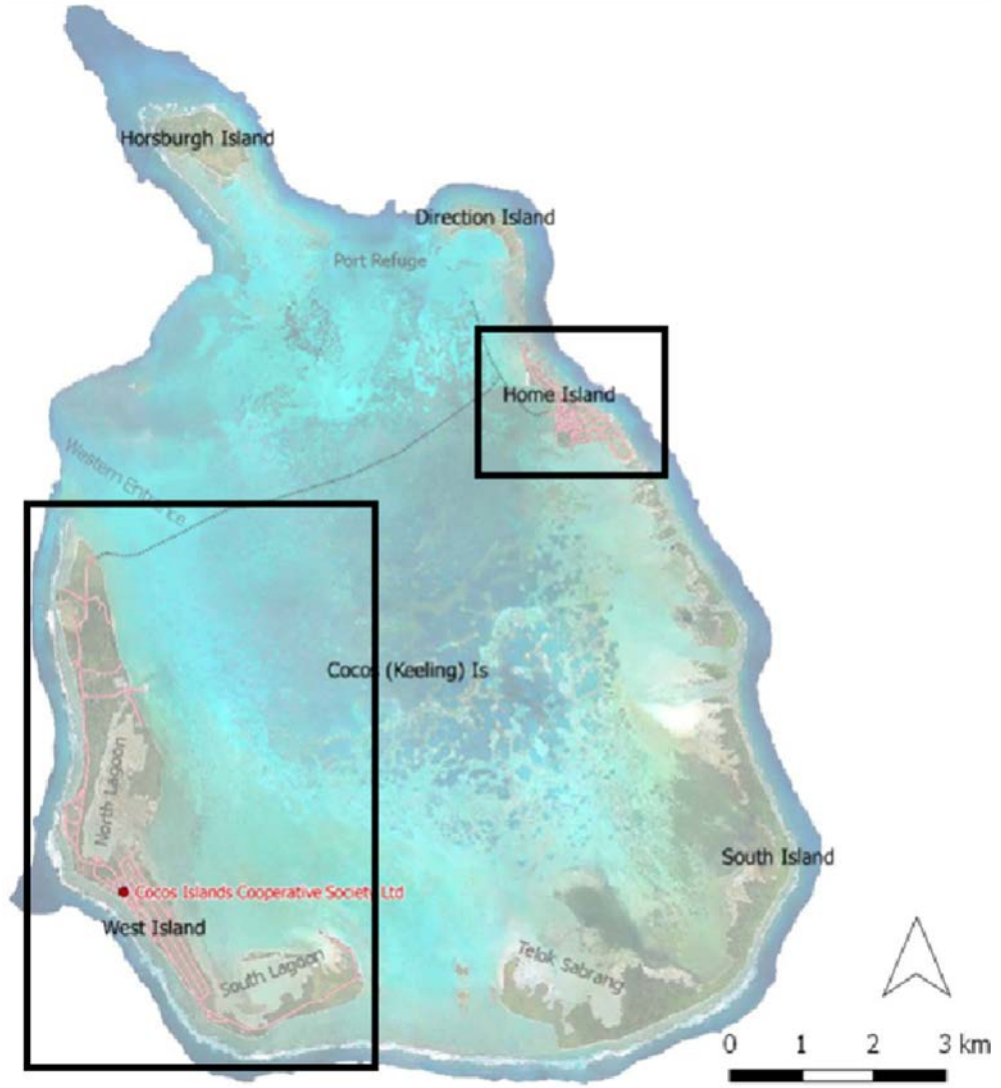


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West Island

History of chronic erosion along the western ocean facing shore, requiring construction of multiple coastal structures since the 1970's to protect assets.



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West Island





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West Island





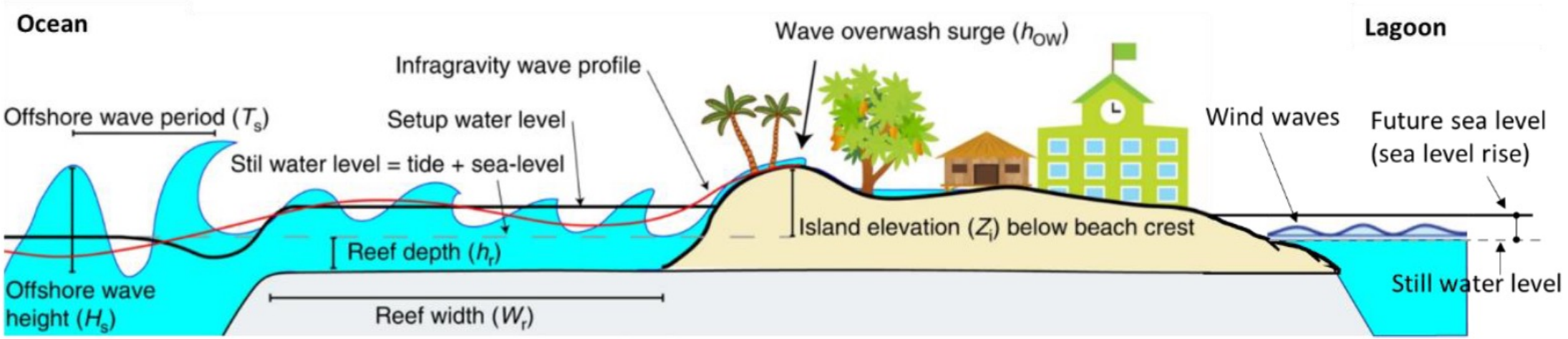
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Coastal Inundation

Lagoon side - extreme water levels driven by short term wind waves and cyclone events.

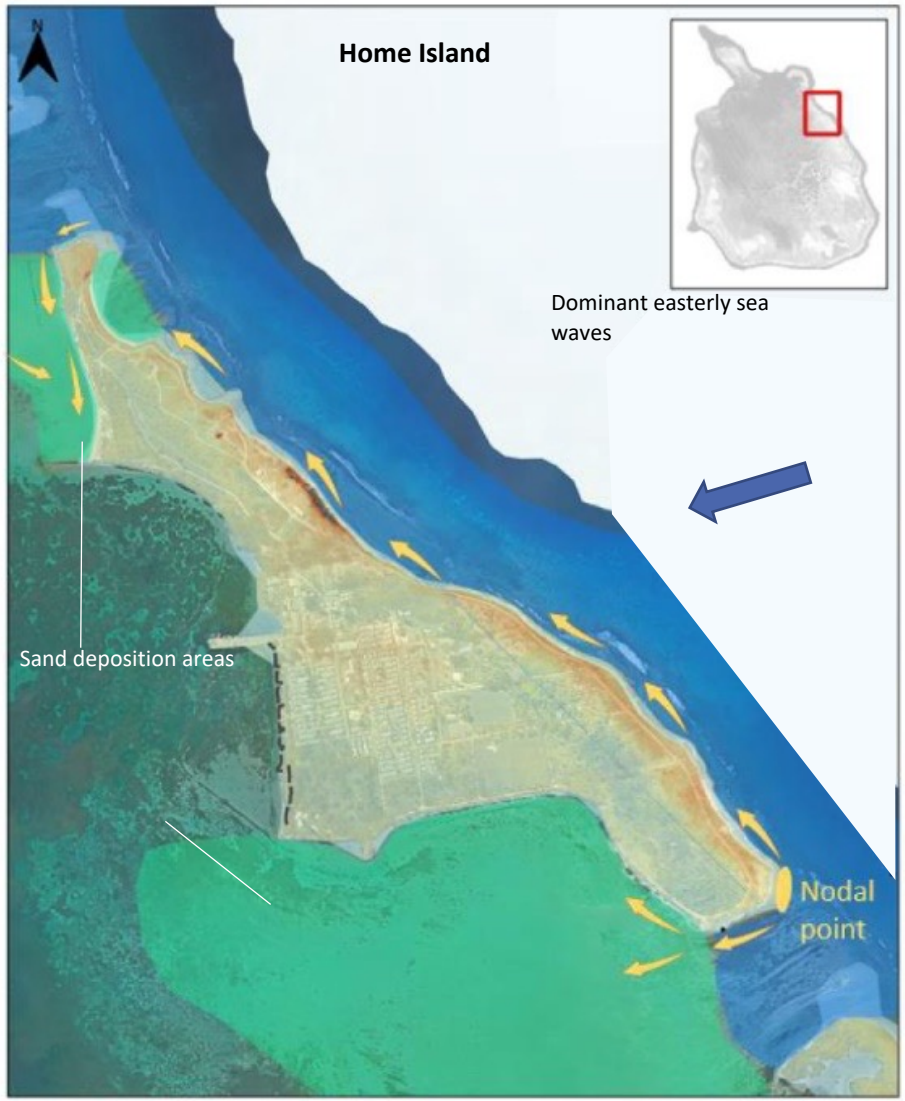
Ocean side - offshore waves travelling across the reef, causing wave setup and runup (i.e. elevated water levels and flooding).

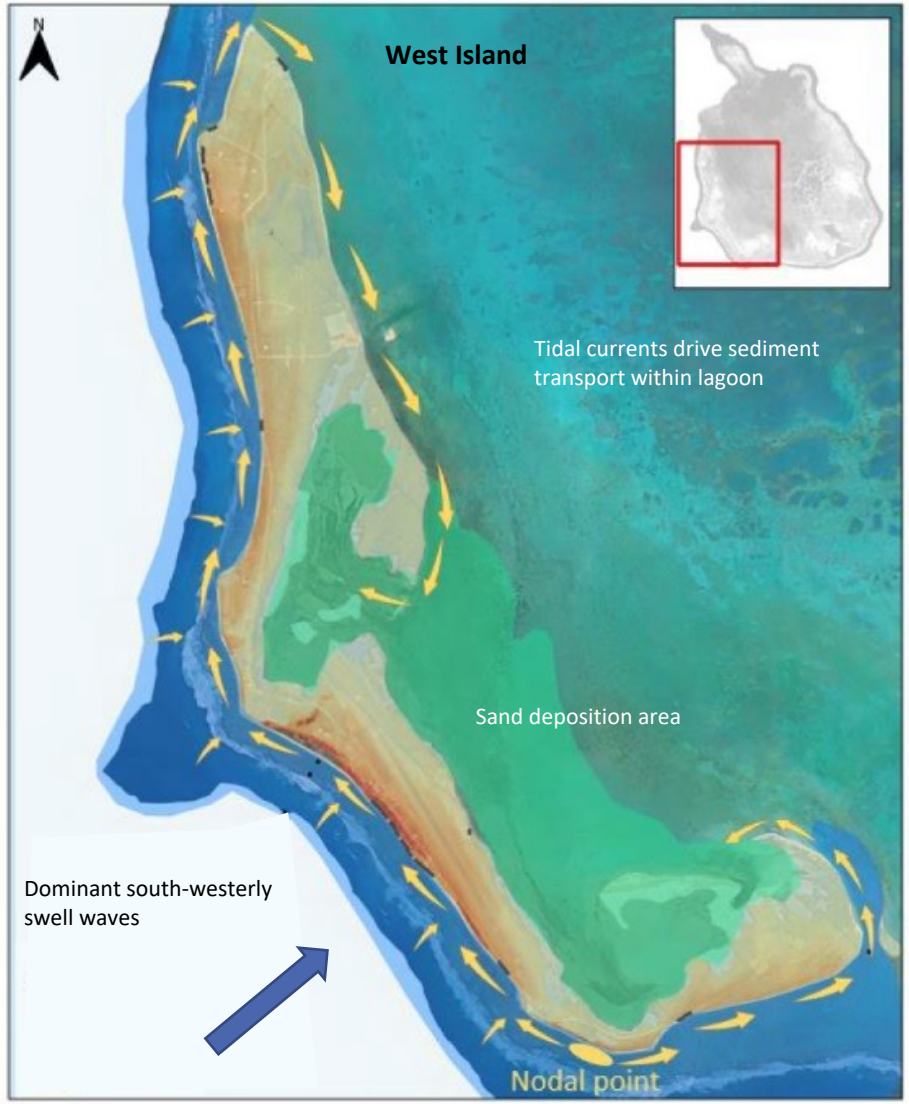


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Sand Movement and Erosion



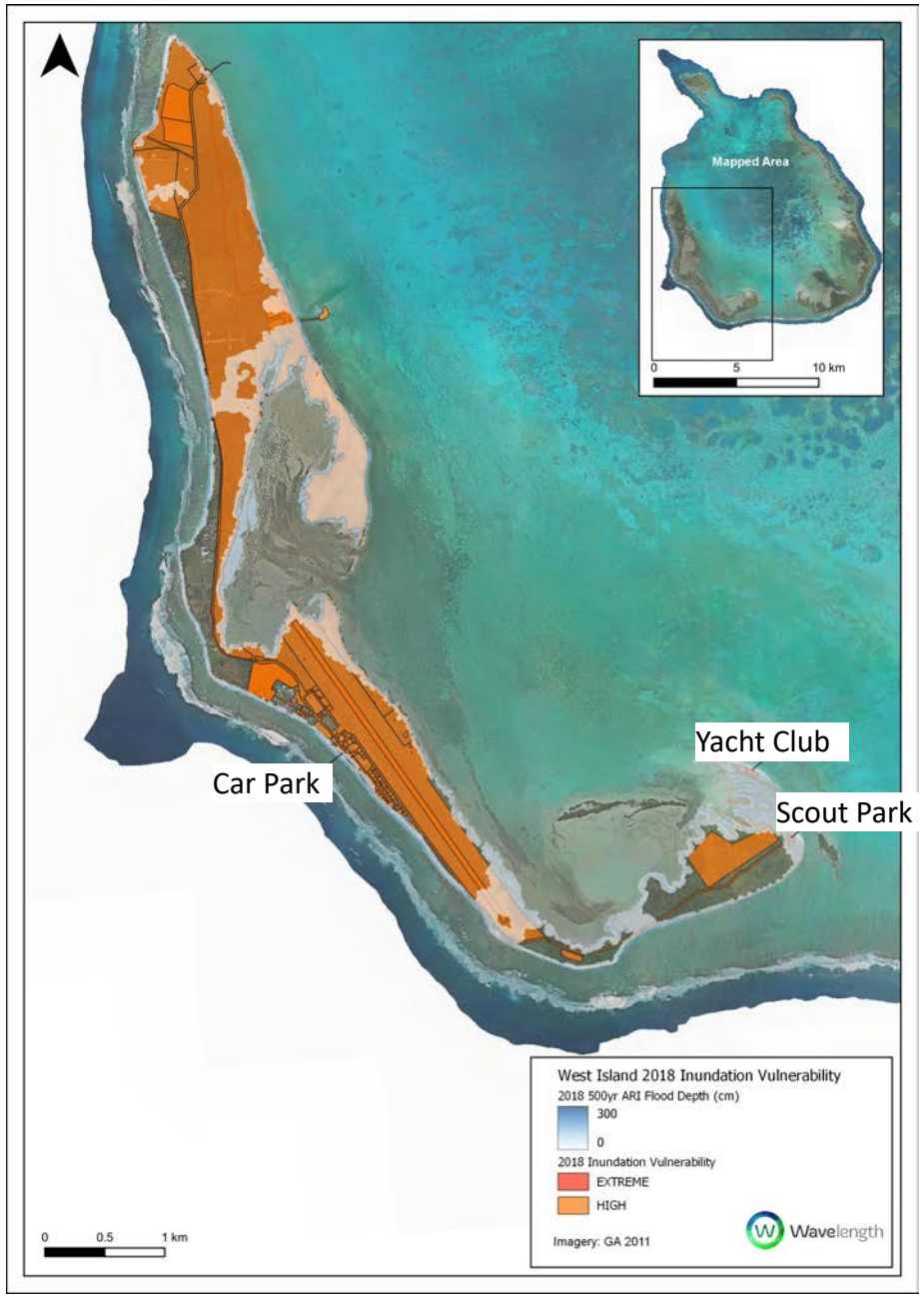


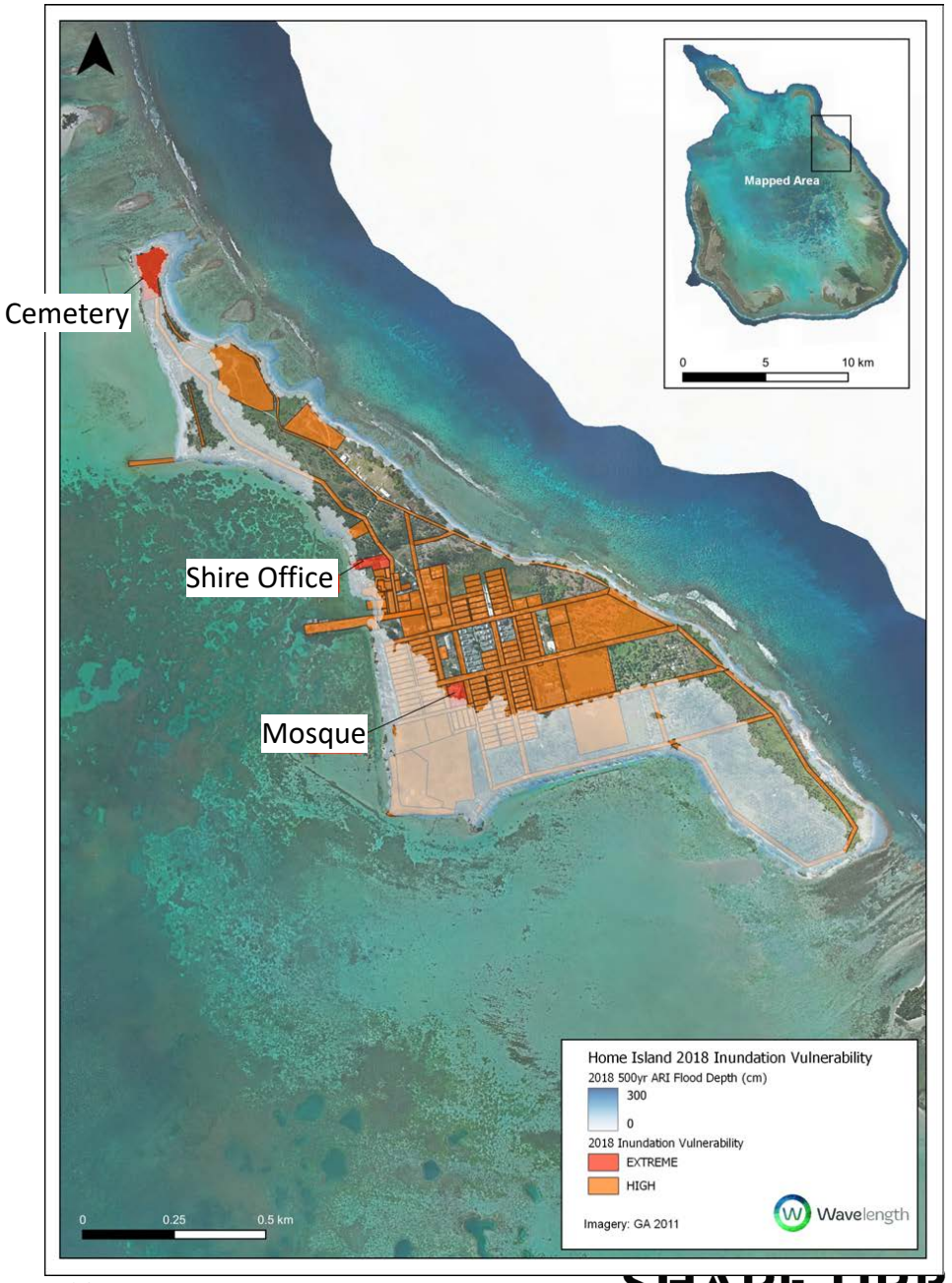
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Vulnerability Mapping for 2018 and 2068

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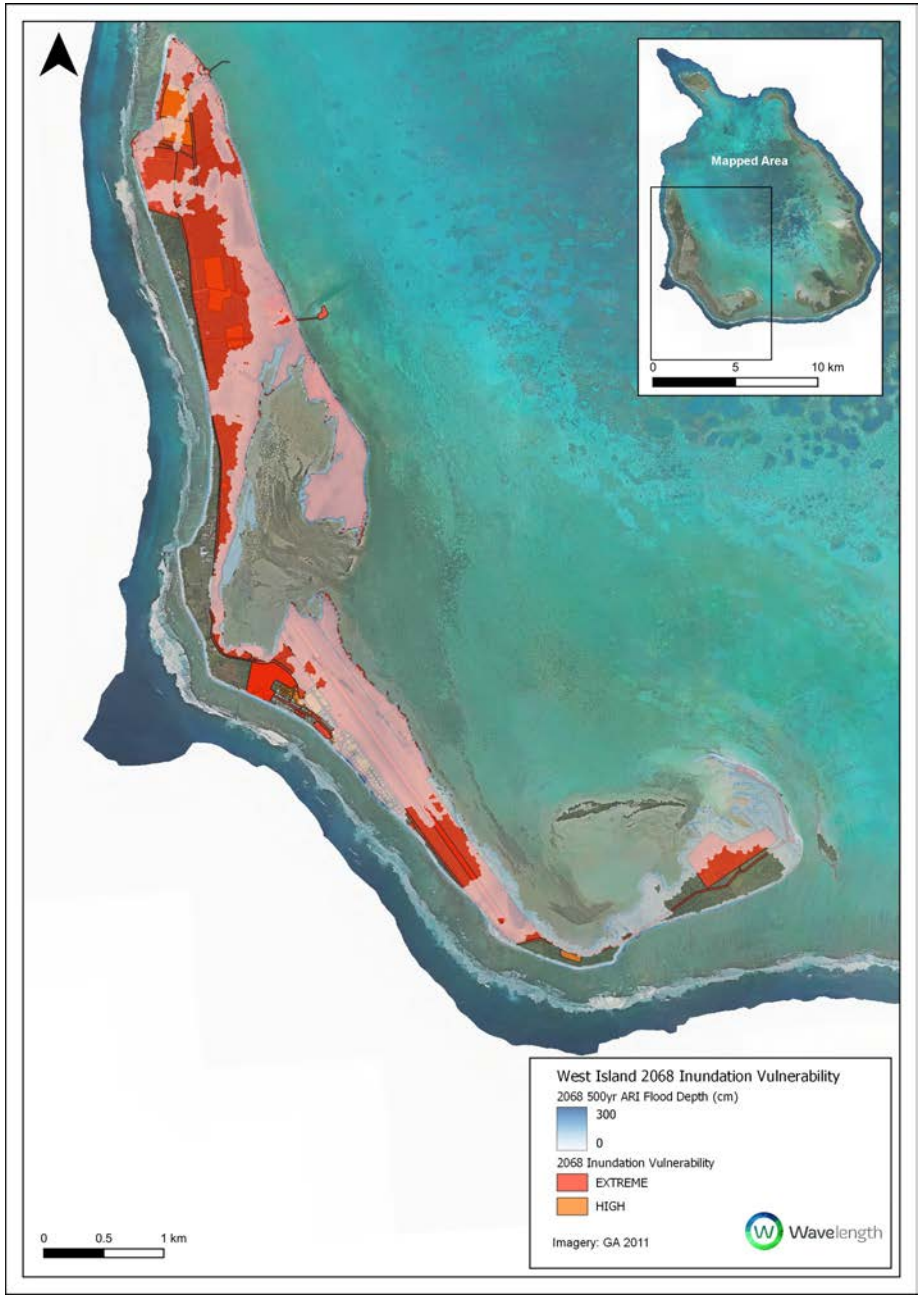


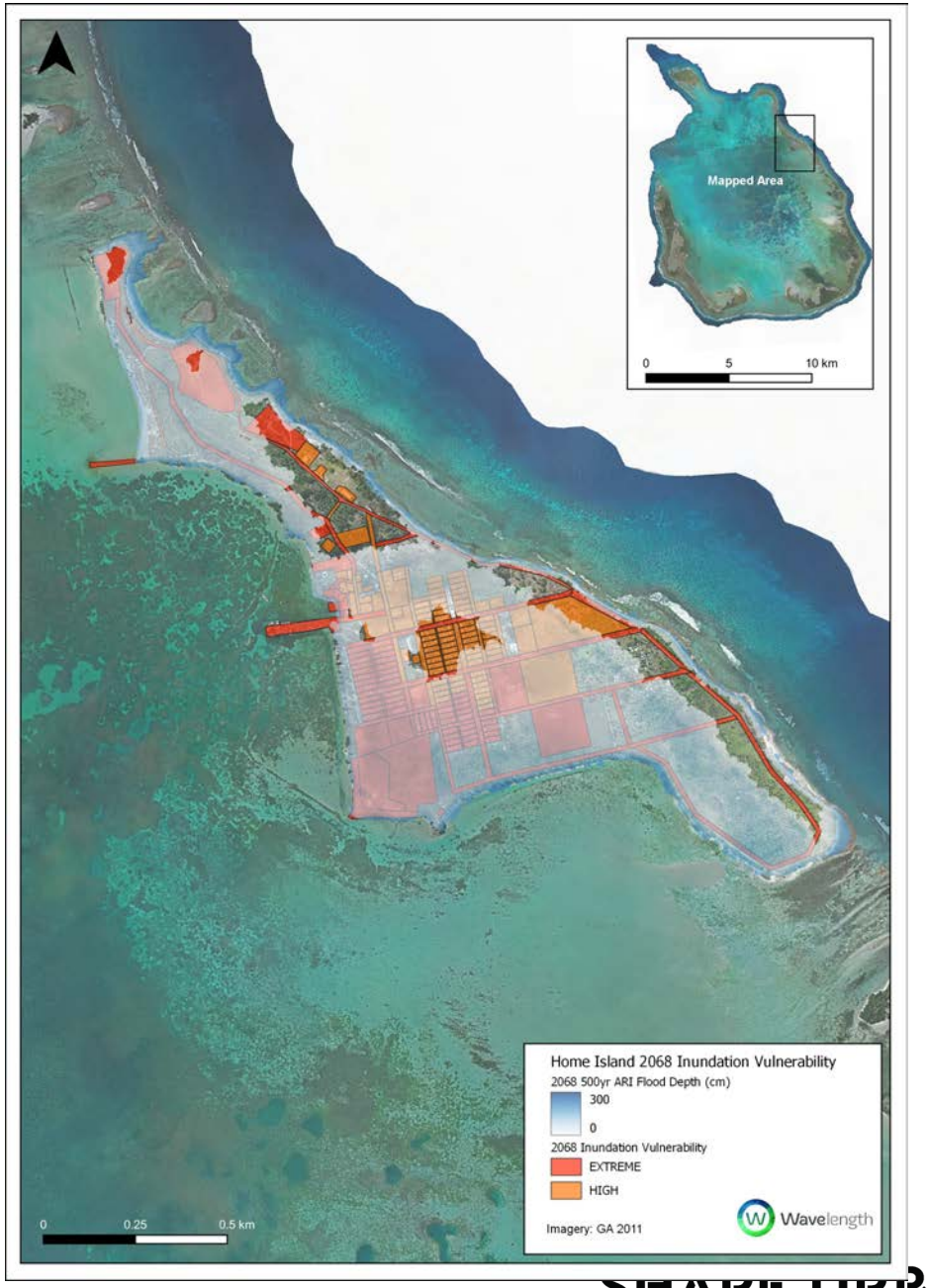


Inundation Vulnerability 2018

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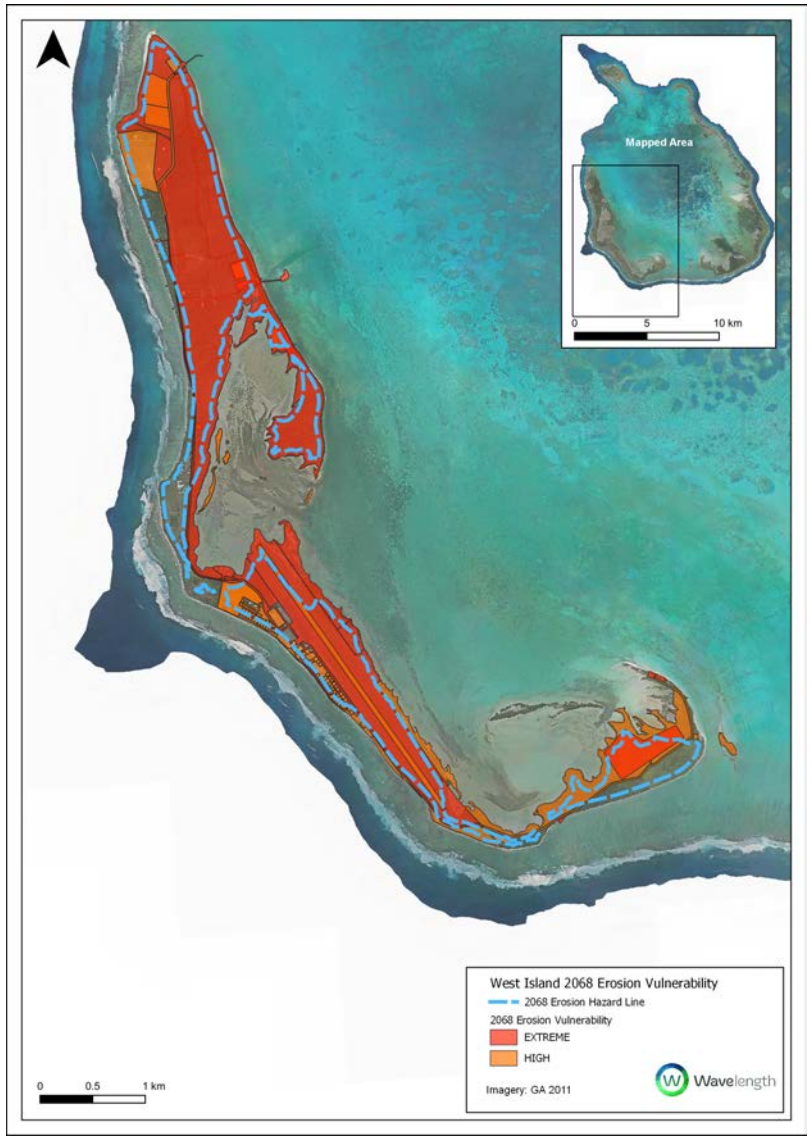


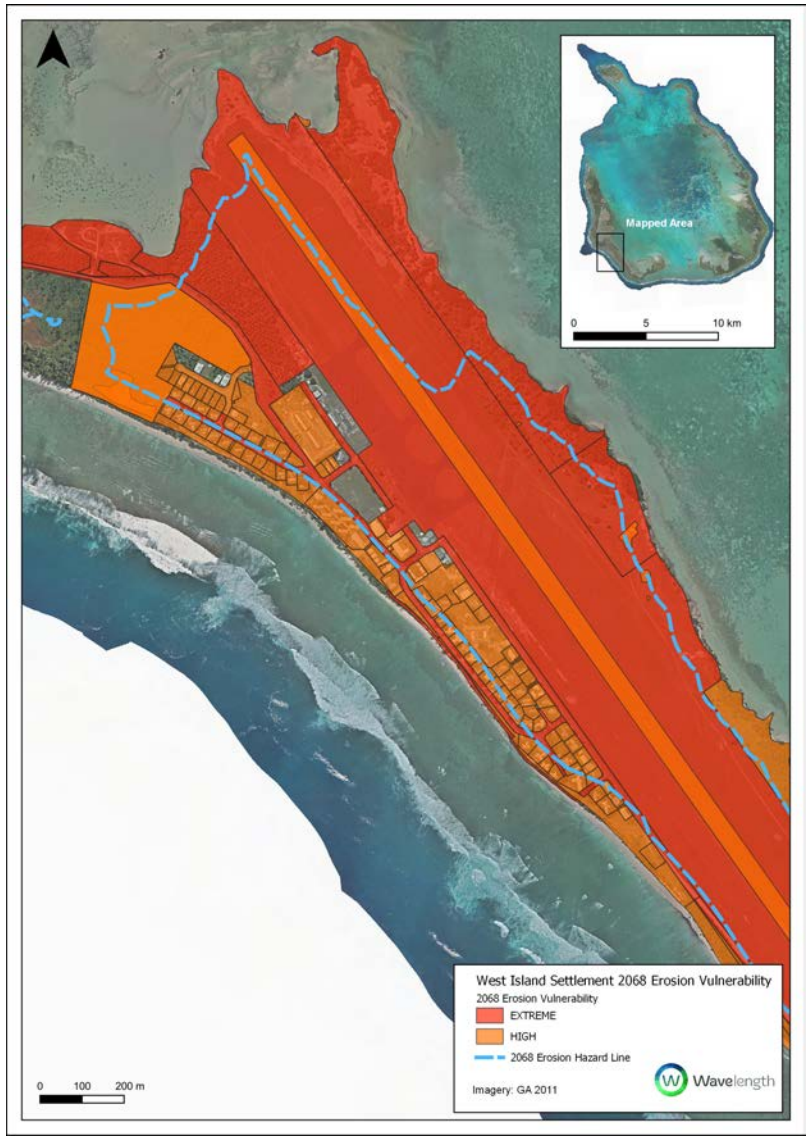


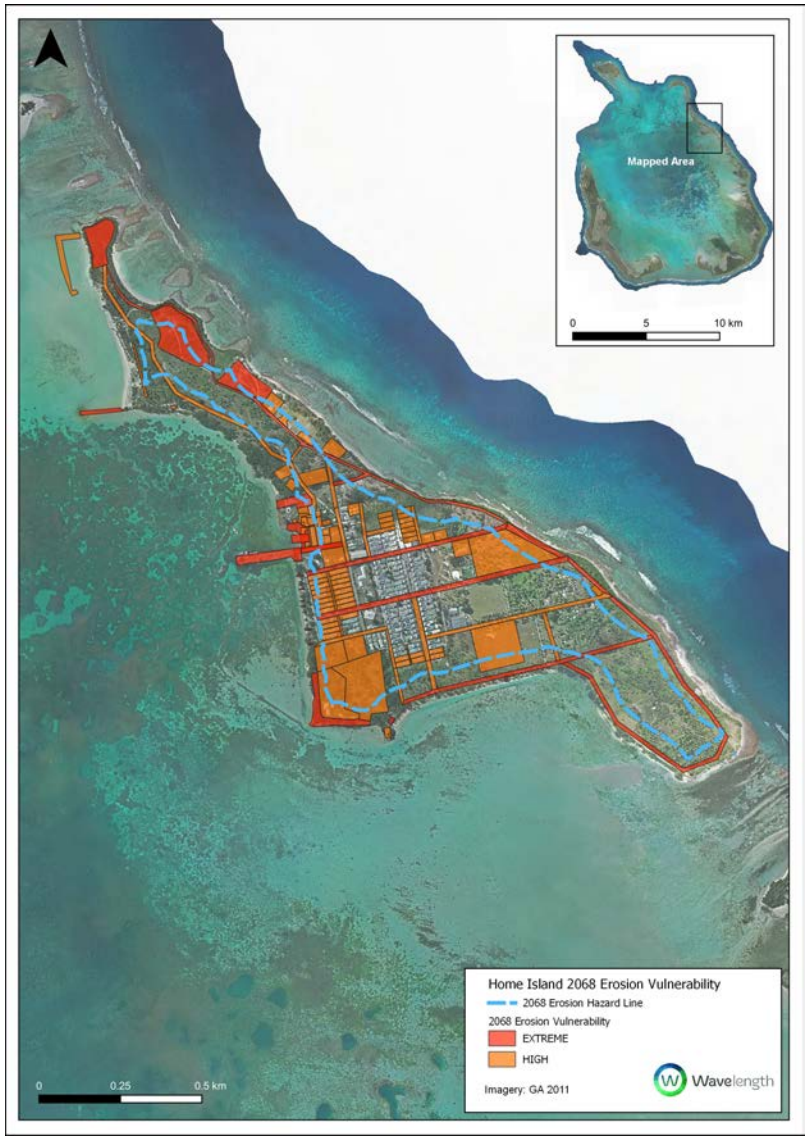
Inundation Vulnerability 2068

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Erosion 2068

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Risk Management / Adaptation Approaches

Possible adaptation options (per WA SPP 2.6)



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Possible adaptation options



Avoid – options which aim to eliminate the risk of coastal hazards by avoiding development



Planned/ Managed Retreat – options which progressive retreat / relocate development

Possible adaptation options



Accommodate – possible options which seek to enhance assets to cope with the temporary impacts



Protect – possible options which seek to artificially protect the coast

Approach

1. Whole of settlement
2. Individual asset treatment outside settlements



Home Island



West Island

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Approach – Settlement

- Adaptation required in short term, next 5 to 10 years
- Three adaptation pathways identified:
  - Protect
  - Accommodate
  - No regrets
- Unfeasible possible options:
  - Avoid – assets already in place
  - Retreat – Insufficient space / higher ground to retreat to (within island consideration)

Approach – Assets outside of settlement

- Avoid further development in known areas of risk
- Opportunity to relocate some assets within property boundaries
- Alternate ‘soft’ protection possible options (revegetate, sand nourishment)

Protect examples



geotextile sand container (GSC) seawall



concrete seawall

Seawalls

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Protect







Levees and road raising

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Seawall trade offs

Criteria	Benefits	Constraints
Effectiveness	• Ultimately provides last line of defence	• Cheaper design reduces effectiveness
Capital and Maintenance Costs		• Requires importing materials • Requires ongoing maintenance costs
Environmental Impacts		• Disruptions to local ecosystems • Loss of beach, vegetation • Can increase downdrift erosion
Social Impacts	• Provides assets protection	• Loss of ability to walk on beach, enjoy vistas • Visual impacts
Flexibility		• Once chosen, other possible options are off the table or very difficult to implement • Sets expectations assets will always be protected

Levee trade offs

Criteria	Benefits	Constraints
Effectiveness	• Provides last line of defence (flooding)	• Only address flood risk • Requires adequate spaces
Capital and Maintenance Costs		• Requires importing materials • Requires ongoing maintenance costs
Environmental Impacts	• Set back from shoreline, beach can still exist • Can tie into the natural environment	• Construction disrupts local ecosystems, vegetation
Social Impacts	• Provides asset protection (flooding)	• Visual impacts • Position could create feeling of disconnection
Flexibility		• Sets expectations assets will always be protected

Accommodate example

Replace and upgrade properties and buildings at end of design life



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Accommodate trade offs

Criteria	Benefits	Constraints
Effectiveness	• Highly effective for assets that can be raised	• Only address flood risk • Challenging for some assets
Capital and Maintenance Costs	• Undertake at end of asset design life	• Requires importing building materials • High costs to accommodate some infrastructure
Environmental Impacts	• Limited impacts • Beach can be maintained	
Social Impacts	• Provides protection (flooding)	• Requires considered planning to limit impact to residents • Daily impacts, residents accessing properties
Flexibility	• Highly flexible	

No Regrets

Accepting properties and assets are at increased risk

Establish emergency plans and emergency shelter for Settlement





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No Regrets trade offs

Criteria	Benefits	Constraints
Effectiveness		• Only a interim measure
Capital and Maintenance Costs	• Lowest upfront costs	• Highest cost for repair of damage
Environmental Impacts	• Limited impacts	
Social Impacts		• Potential increased risk to lives during flood
Flexibility	• Highly flexible	

Longer Term (2118)

Towards end of century, it will be challenging to maintain the accommodate and protect pathways:

- Groundwater shoaling impacts
- Levees would make it difficult to stop terrestrial flooding, as drainage outflows will be backed up more frequently by higher tides and storm water levels
- High levees would also be difficult to access other locations on islands

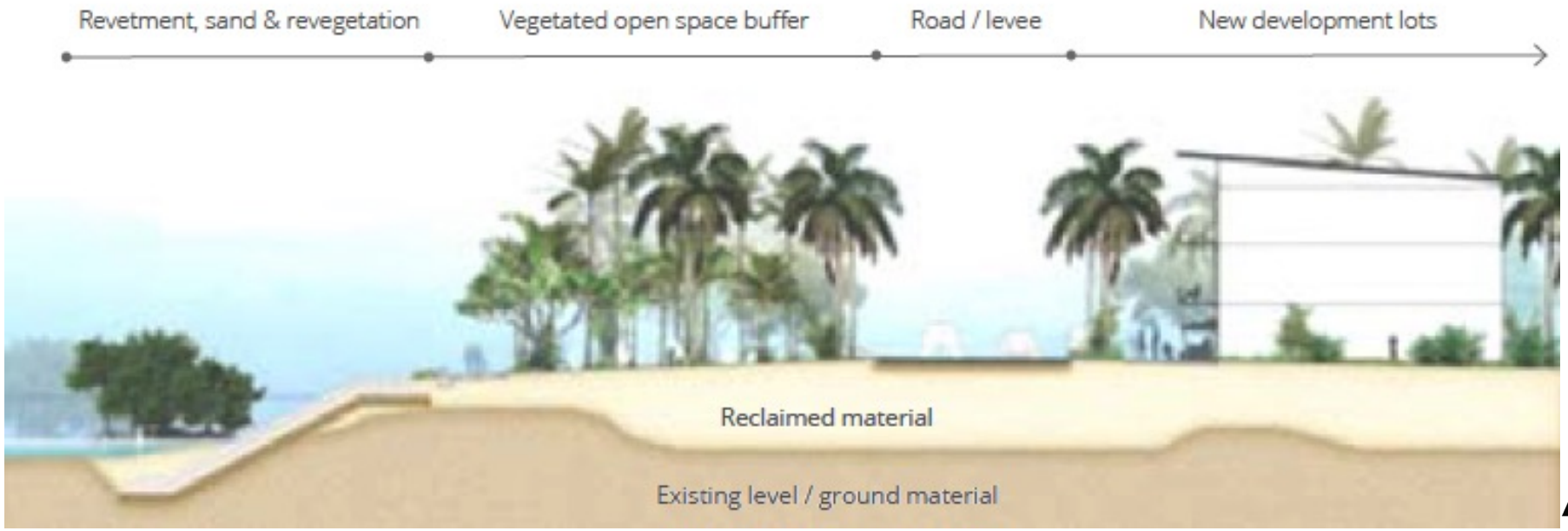
Potential long-term possible options include:

- Retreat from islands
- Reclaim and protect

Reclaim and protect

Sand is sourced and pumped, properties and assets are raised

- Technically feasible and promotes long term resilience
- Substantial costs
- Requires integrated planning, engineering and environmental approach



Example : Kiribati raise 300-hectare area of land 2 – 5 m above the highest measured sea level.

Q & A

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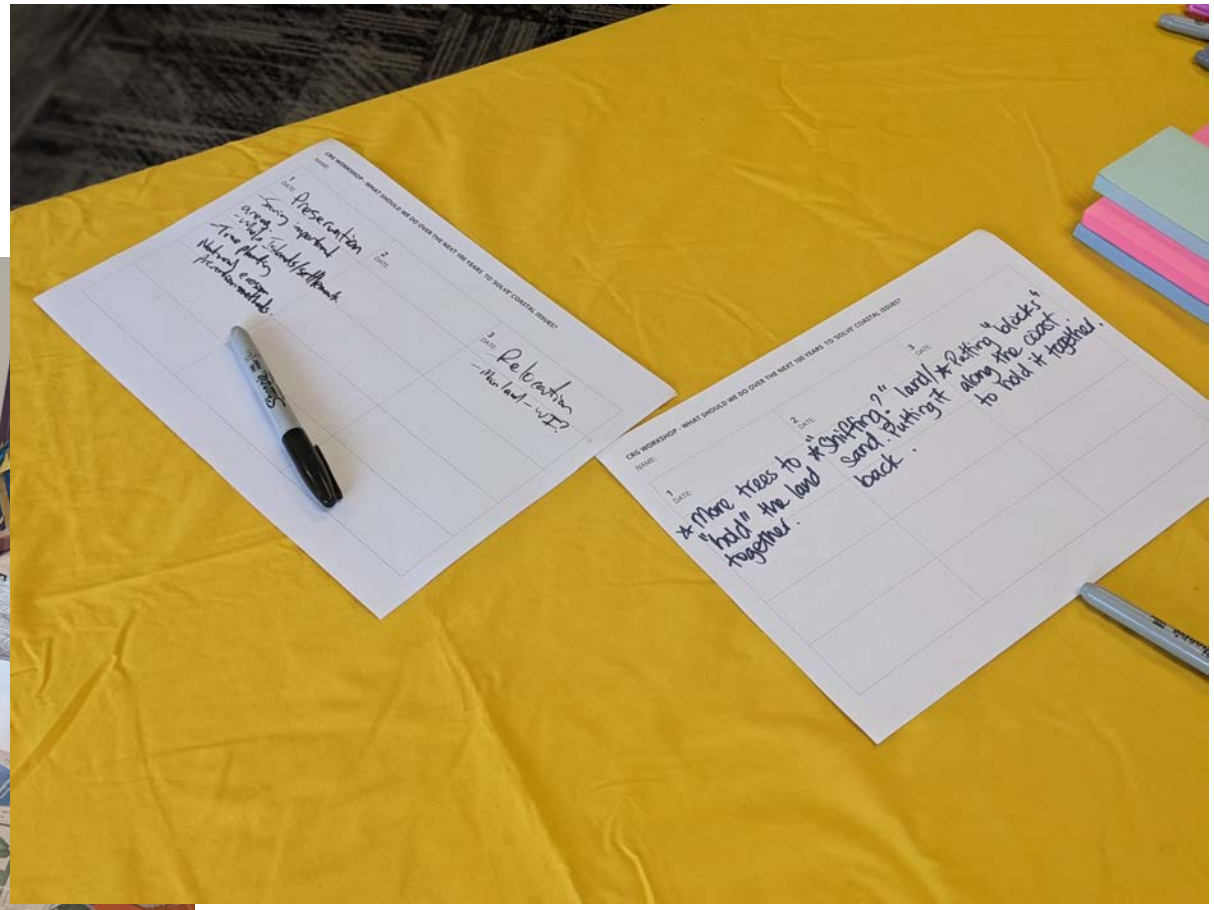
What we heard – Assets and Values

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What we heard...





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Highly valued assets / values

- Recreation - Use of beach and foreshore areas for recreation, fishing, boat launching and sporting activities (both islands)
- Environment - Ocean, lagoon, views, landscapes, foreshore vegetation and protection of the natural environment
- Amenities and infrastructure – Yacht, jukong and sailing clubs
- Access along the coastal and lagoon foreshore areas - boat launching, access to other islands
- Cemetery at Pulu Gangsa and mosque on Home Island



Access to water e.g. boat launching

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Recreation e.g. dukong racing, sailing

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Jetty areas

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Pulu Gangsa (cemetery)

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What else?





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What else?

- Coastal process changes – concerned about:
  - the impacts of coastal change
  - felled trees around the coastlines of both islands
  - sandbags that have been impacted
  - how much the coastlines on Home Island and West Island have changed over time
- Coastal management – action critical – *'get on with it'*

What else?





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Management-wise, we heard…

- Community wanted to see:
  - Soft options – (re)vegetation, education, conversations about possibility of retreat in the long term
  - Protection and adaptation – sandbags, seawalls
  - Prioritising settlement protection on both islands
  - Additional protection of the Yacht Club and Rumah Baru jetty areas (West Island)

To note…

1. Development does not occur unless:
   a) the development is located, designed, and constructed to withstand coastal hazard impacts; or
   b) the development is temporary, readily relocatable, or able to be demolished and removed; or
   c) the development can mitigate the risks to people and property to an acceptable or tolerable level based on the scientific information available at the time of application.

2. Design responses are not to have a detrimental impact on the amenity of neighbouring land or the amenity of the locality generally. This includes adversely impacting storm surge inundation levels on adjoining properties.

7. Any development approval is to be conditioned requiring all structures be removed at the cost of the proponent once the current risk of erosion poses a risk to a development or structure, as defined by the following triggers:
   a) Where a public road is no longer available or able to provide legal access to the property.
   b) When water, sewage or electricity to the lot is no longer available as they have been removed/ decommissioned by the relevant authority due to coastal hazards.
   c) Where structural integrity of the building has been compromised.

8. Any development approval shall (by a condition) require the following notifications to be placed on the Certificate of Title, pursuant to Section 70A of the Transfer of Land Act 1893, or lease documentation:
   VULNERABLE COASTAL AREA - This lot is located in an area likely to be subject to coastal erosion and/or inundation over the 100-planning timeframe (2110).

9. Any development with an estimated cost above $250,000 shall require an independent assessment by a coastal engineer to certify the suitability of the proposed development or await the finalisation of the Shire's CHRMAP and specific measures to be taken or not taken for the subject land parcel(s).

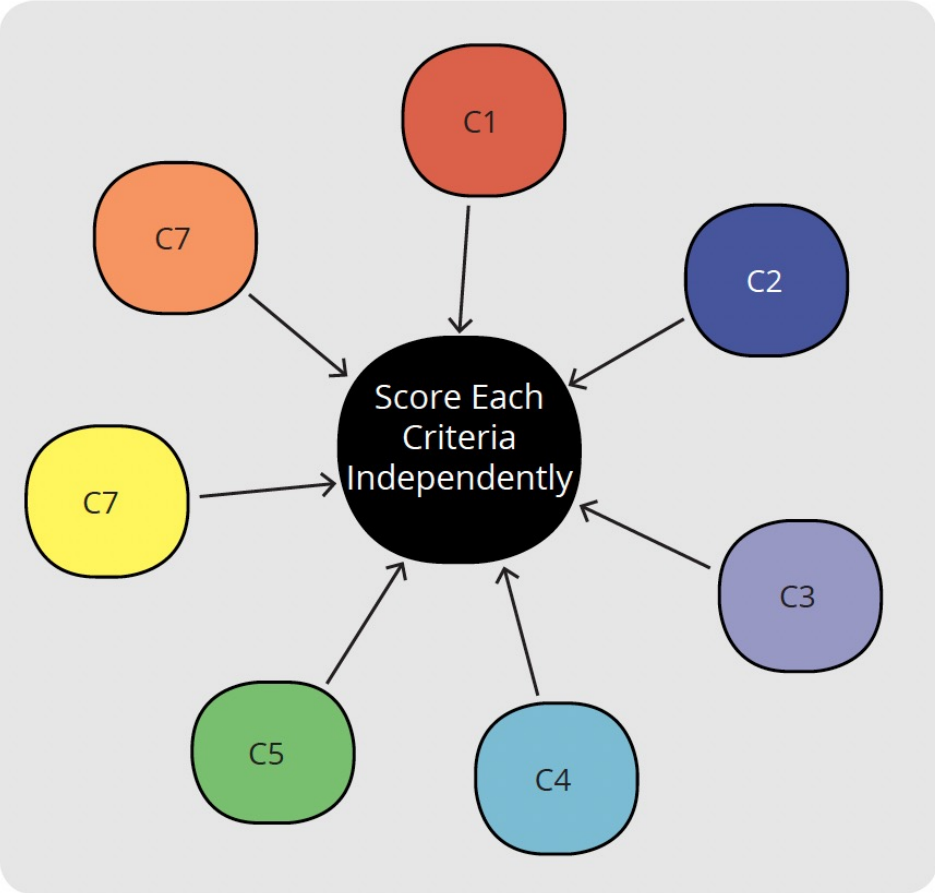
Q & A

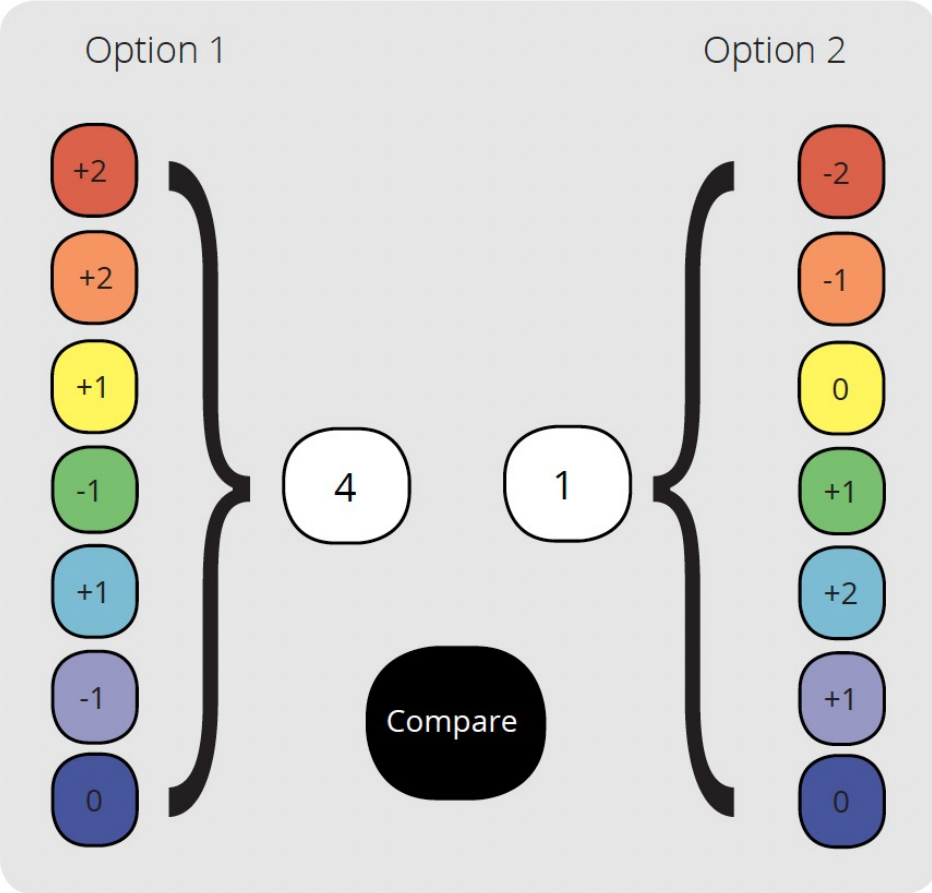
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Multi-Criteria Assessment

Multi-Criteria Assessment





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MCA criteria

- **Implementation** – how easy is the option to implement? Can it be made on the island using readily available, local resources?
- **Environmental impact** - how significant are the environmental impacts?
- ***Social impact – property*** *- how significant are the impacts on properties?*
- **Social impact – way of life** - how significant are the impacts on daily life?

MCA criteria (cont.)

- **Economic impact** - how significant are the impacts on businesses and the local economy?
- **Flexibility** - is the option reversible/ adaptable in the future?
- **Effectiveness** - How effective is the solution at mitigating erosion and inundation risks?
- **Financial** – how much does the option cost?

Multi-Criteria Assessment (MCA)

MCA steps

1 Assessment of adaptation options (general) for advancement to MCA

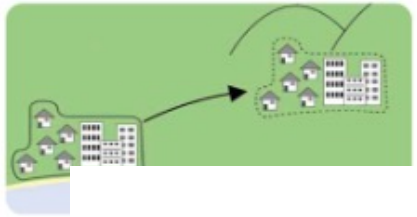
2a. Assessment of inundation options for advancement to MCA

2b. Assessment of erosion options for advancement to MCA

3 MCA assessment using criteria developed (+ weightings)

4 Options costs

1 Assess all adaptation options

1.0 Pre-Screening - Settlement Wide Adaptation Pathways				West Island - Settlement Inundation - Present Day High Vulnerability of Assets Erosion - Present Day High Vulnerability of Assets	
Adaptation Type	Description	Diagram	Scenario	Feasibility- Reduce erosion and inundation risks to Settlement?	Advance to specific options assessment
Avoid	Locating assets in areas that will not be vulnerable to coastal hazards.	Nee	Short Term	Not feasible at present or into future as existing assets currently at High risk of erosion and inundation.	Rejected
Planned/Managed Retreat	Planned or managed retreat for existing development involves relocating or sacrificing infrastructure, both public assets and private property. This pathway also includes prevention of further development in risk areas		Short Term	Not feasible for whole of Settlement, including airport, as insufficient high ground outside Settlement. Potentially feasible for individual assets within Settlement but not whole of Settlement.	Rejected
Accommodate	The accommodate risk treatment option aims to utilise design and management strategies which render the risks as tolerable/acceptable. Design and management strategies may include a mix of structural or non-structural approaches, including modifications to buildings, enhancing the natural environment and policy updates	Need to find similar figures from GHD report for other options	Short Term	Partially effective Structural options can be used to reduce inundation risk and will be partially effective against erosion. Non-structural options, such as enhancing the natural environment, can help to reduce erosion risk	Shortlist pathway for specific options assessment
Protect	Protect risk treatment options aim to protect assets from damage resulting from erosion and recession and storm surge inundation. Common hard protection structures include seawalls; groynes; offshore breakwaters and artificial headlands; and soft protection measures such as beach nourishment.	Need to find similar figures from GHD report for other options	Short Term	Different protect options effective at managing erosion and inundation risk	Shortlist pathway for specific options assessment

2a Assess all options - inundation

2.0 Pre-Screening - Adaptation Options						West Island - Settlement Inundation - Present Day High Vulnerability of Assets			
Adaptation Type	ID	Method	Description	Benefits	Adverse Impacts	Effectiveness - Reduce inundation risks to property and people?	Environmental Fatal Flaw	Social Fatal Flaw	Advance to MCA
Protect			impacts of storm events. May have a negative impact on the adjoining shoreline.						
	P5	Groynes	Shore perpendicular structures which extend into the water. Range of construction materials (incl. rock, concrete, steel sheet pile, timber, geotextile sand filled tubes/bags). Aim to trap sand moving along the coast and retain a natural buffer to assist in absorbing the impacts of storm events. May have a negative impact on the adjoining shoreline.			Not effective at countering inundation.	-		Rejected
	P6	Geotextile Sand Container (GSC) seawalls	Involves construction of a GSC seawall usually along an entire section of shoreline. Seawalls stop both cross-shore and longshore erosion.		Loss of beach in front of seawall Downdrift / end scour erosion	Not effective at countering inundation. Must be used in conjunction with suitable Protect option	-		Rejected
	P7	SeaBee concrete seawalls	Involves construction of a Seabee concrete unit seawall usually along an entire section of shoreline. Seawalls stop both cross-shore and longshore erosion.		Loss of beach in front of seawall Downdrift / end scour erosion	Not effective at countering inundation. Must be used in conjunction with suitable Protect option	-		Rejected
	P8	Storm surge barrier	Artificial barrier designed to be closed during a storm event to prevent high ocean water levels entering an estuary or inlet. May have a negative visual impact.			Not suitable for this location, as open coastline	-		Rejected
	P9	Levees	Involves construction of a levee usually along an entire section of shoreline. Levees can prevent coastal inundation of low-lying areas			Effective at countering inundation	Nil	Nil	Proceed to short-term MCA
	P10	Land raising and/or reclamation	Involves raising or reclaiming low-lying land to prevent inundation. This option is usually completed in conjunction with levees and/or seawalls.			Effective at countering inundation	Nil	Significant disruption to local communities in short term. Should be considered as a longer term option to manage groundwater shoaling and inundation risk	Rejected
	NR1	Monitoring	This option involves long term baseline monitoring and event based monitoring following storm erosion events			Partially effective Won't stop erosion and inundation risk to existing assets but can be used as a policy measure to monitor risk over time			Shortlist option for Quick Wins
	NR2	Protection Structure Audit	This option involves undertaking an audit of existing protection structures to determine their current condition, effectiveness and future protection potential			Partially effective Won't stop erosion and inundation risk to existing assets but can be used as a policy measure to help clarify risk			Shortlist option for Quick Wins

Adaptation Options Available; Inundation – the full list

Using the handout of the list of options and the comments we have provided…

1. Do you have any questions / concerns with things we have made ‘red’?
2. Do you have any other comments to add, e.g. reasons why the option might be less or more suitable, more socially acceptable, other?

2b Assess all options - erosion

2.0 Pre-Screening - Adaptation Options						West Island - Settlement Erosion - Present Day High Vulnerability of Assets			
Adaptation Type	ID	Method	Description	Benefits	Adverse Impacts	Effectiveness - Reduce erosion risks to property and people?	Environmental Fatal Flaw	Social Fatal Flaw	Advance to MCA
Protect	P2	Beach Nourishment - On-going campaigns	Placement of smaller volumes of sand on the beach, dunes or nearshore at more frequent intervals. May be undertaken pre/post storm event. Requires available sources of compatible sand. Aims to restore or enhance the beach profile to provide a natural buffer to absorb the impacts of storm events.			Effective at countering erosion	Nil	Nil	Proceed to short-term MCA Combine with levee (Protect option)
	P3	Offshore structures - Artificial reefs/shoals	Larger submerged structures, placed further off-shore, which aim to dampen wave energy similar to natural reefs and reduce the impacts of storm events. Typical construction materials are rock, concrete, or geotextile sand filled tubes. May have a negative impact on the adjoining shoreline.	Improved benthic habitat		Not effective at countering cross-shore erosion. Will cause erosion downdrift settlement (MU1B)	-		Rejected
	P4	Offshore structures - Detached breakwaters/headlands	Large structures, visible above the waterline placed some distance off-shore. Typical construction materials are rock or geotextile sand filled tubes. In comparison to option P2, typically require significantly more construction materials. Aims to stop/redirect incoming waves to capture/retain sand at the beach and improve the capacity of the beach system to absorb the impacts of storm events. May have a negative impact on the adjoining shoreline.			Not effective at countering cross-shore erosion. Will cause erosion downdrift settlement (MU1B)	-		Rejected
	P5	Groynes	Shore perpendicular structures which extend into the water. Range of construction materials (incl. rock, concrete, steel sheet pile, timber, geotextile sand filled tubes/bags). Aim to trap sand moving along the coast and retain a natural buffer to assist in absorbing the impacts of storm events. May have a negative impact on the adjoining shoreline.			Not effective at countering cross-shore erosion. Will cause erosion downdrift settlement (MU1B)	-		Rejected
	P6	Geotextile Sand Container (GSC) seawalls	Involves construction of a seawall usually along an entire section of shoreline. Areas setback from erosion risk can be protected from inundation with a levee		Loss of beach in front of seawall	Effective at countering cross-shore and longshore erosion			Proceed to short-term MCA Combine with levee (Protect option)

Adaptation Options Available; Erosion – the full list

Using the handout of the list of options and the comments we have provided…

1. Do you have any questions / concerns with things we have made ‘red’?
2. Do you have any other comments to add, e.g. reasons why the option might be less or more suitable, more socially acceptable, other?

3 MCA

1. Screened options -> criteria assessment -> unweighted scores ->
2. Weight the scores ->
3. Cost the final possible options…

3 Key criteria and scoring

3.0 - Multi Criteria Assesment - Key Criteria & Scoring									
	Category	Implementation	Environmental Impact	Social Impact - Property	Social Impact - Way of Life	Economic Impact - Businesses	Flexibility	Effectiveness	Financial
	Description	How easy is the option to implement on a small island (i.e. can it be made on the island using readily available, local resources)?	How significant are the environmental impacts?	How significant are the impacts on properties?	How significant are the impacts on daily life?	How significant are the impacts on businesses and the local economy?	Is the option reversible / adaptable in the future?	How effective is the solution at mitigating erosion and inundation risks?	How much does the option cost?
	Goals	- Implementation timeframe - Local use of products - Logistics and delays to import material - Maintenance of option into future - Carbon miles -Re-use of existing material	- Amenity and public health (noise, dust, noise, odours) impacts - distance to sensitive receptors - Scale of disturbance to marine habitat, water quality vulnerable/ protected species - Scale of disruption to commercial fisheries	- Residential property losses - Property access	- Impact on community values - Impact on access to important social and cultural areas (i.e. beach access, boat launching, views etc) - Scale and duration of disturbance to community areas/ activities	- Impact on existing businesses	- Reversibility of option - Adaptable to unforeseen changes in climate conditions - Alginment with potential long term adaptation pathways, including reclamation with seawalls	- Effectiveness against erosion - Effectiveness against inundation	-Combined capital and maintenance costs -Potential for external funding sources
5	Insignificant impacts OR Very low risk	Abundant and sustainable source of material on island	Preserves and repairs	0 houses lost Does not affect property access	Does not affect any community values and/or improves access	No loss of existing businesses	Easily reversible or adaptable	Effective, long term mitigation	<$5 million
4	Minor impacts OR Low risk	A significant portion of material available on island	Maintains status quo	1-10 houses lost	Minor impact to community values and/or access		Reversible or adaptable	Effective, mid-term mitigation	$5 to $15 million
3	Moderate impacts OR Medium Risk	Some material available on island	May result in impact and damage	11-19 houses lost Minor impact to property access	Loss of access to some community assets that doesn't effect overall intrinsic community value	Protects or maintains as long as possible	Reversible or adaptable but with some cost	Effective, short term mitigation	$15 - $30 million
2	Major impacts OR High risk	Only a small portion of material available on island, majority of material needs to be imported	Likely to result in impact and damage	20-40 houses lost	Loss of access to certain assets		Difficult to reverse or adapt	Limited effectiveness	$30-$50 million
1	Severe impacts OR Very high risk	No material on island, all materials need to be imported	Will result in impact and damage	>40 houses lost Major impact to property access	Will definitely affect key values of area	Loss of existing businesses	Irreversible or unadaptable	Ineffective and/or suitable only for minor events	>$50 million

3 Key criteria and scoring

Using the handout and the criteria we have suggested…

1. Did we get it about right?
2. If not, what would you change and why?
3. Any other comments or criteria we may have missed?

3 Criteria weighting

3.1 - Multi Criteria Assesment - Factor Weighting

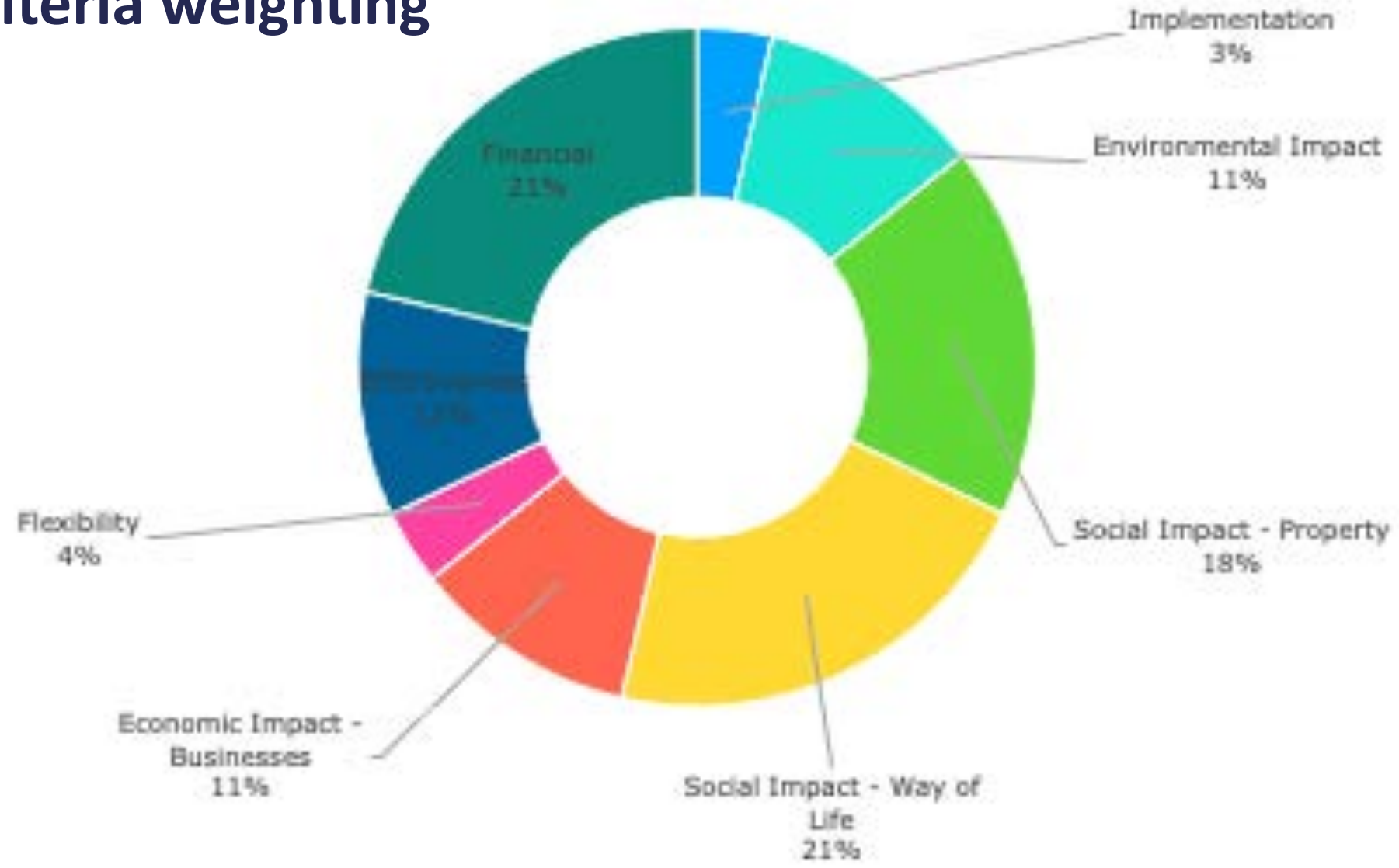
Criteria A	Criteria B: Implementation	Environmental Impact	Social Impact - Property	Social Impact - Way of Life	Economic Impact - Businesses	Flexibility	Effectiveness	Financial
Implementation								
Environmental Impact	A							
Social Impact - Property	A	A						
Social Impact - Way of Life	A	A	A					
Economic Impact - Businesses	A	B	B	B				
Flexibility	B	B	B	B	A			
Effectiveness	A	A	B	B	B	A		
Financial	A	A	A	A	B	A	A	

Count	Weighting
1	3.6%
3	10.7%
5	17.9%
6	21.4%
3	10.7%
1	3.6%
3	10.7%
6	21.4%
	100%

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3 Criteria weighting



3 Criteria Weighting

Using the handout and the weighting we have suggested…

1. Did we get it about right?
2. If not, what would you change and why?
3. If you added a criteria, how would you weight that compared to the others?



West Island MCA

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West Island - possible options (screened)

Adaptation Type	ID	Name	Description
Accommodate	AC1	Structural - Design assets to withstand hazards	This option would involve constructing properties on stilts to accommodate inundation.
Protect	P9 + P2	Levees with on-going nourishment	This option would involve construction of a levee to protect against inundation and on-going nourishment to counter erosion
	P9 + P6	Levees with GSC Seawalls	This option would involve construction of a combined levee and GSC seawall structure to counter inundation and erosion
	P9 + P7	Levees with Concrete SeaBee Seawalls	This option would involve construction of a combined levee and concrete seabee seawall structure to counter inundation and erosion

NPV



West Island – unweighted score

Name	Implementation	Environmental Impact	Social Impact - Property	Social Impact - Way of Life	Economic Impact - Businesses	Flexibility	Effectiveness	Financial	Unweighted Score
Structural - Design assets to withstand hazards	1	4	2	5	1	4	2	1	20
Levees with on-going nourishment	2	2	5	3	5	5	3	1	26
Levees with GSC Seawalls	5	3	5	2	5	3	3	2	28
Levees with Concrete SeaBee Seawalls	4	3	5	2	5	2	4	2	27

5	Insignificant impacts OR Very low risk
4	Minor impacts OR Low risk
3	Moderate impacts OR Medium Risk
2	Major impacts OR High risk
1	Severe impacts OR Very high risk

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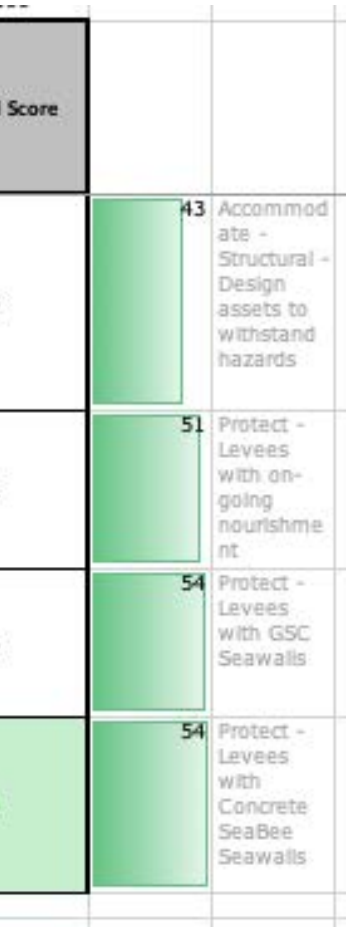
West Island Scoring - Discussion

Using the handout and the scores we have suggested…

1. Did we get it about right?
2. If not, what would you change and why?
3. If you added a criteria, how would you score that?

West Island – weighted score

Name	Implementation	Environmental Impact	Social Impact - Property	Social Impact - Way of Life	Economic Impact - Businesses	Flexibility	Effectiveness	Financial	Weighted Score
Structural - Design assets to withstand hazards	1	7	6	18	2	2	4	4	43
Levees with on-going nourishment	1	4	15	11	9	3	5	4	51
Levees with GSC Seawalls	3	5	15	7	9	2	5	7	54
Levees with Concrete SeaBee Seawalls	2	5	15	7	9	1	7	7	54



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West Island – option costs

Long term

	NPV	LONG TERM
Protect with Seabee seawalls - following AC1 short term option	$	+ $
Protect with Seabee seawalls - following Protect with Seabee seawalls short term option	$	+ $
Reclaim Land and protect with Seabee seawalls - following AC1 short term option	$	+ $
Reclaim Land and protect with Seabee seawalls - following Protect short term option	$	+ $

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Q and A

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Home Island MCA

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Home Island - possible options (screened)

Adaptation Type	ID	Name	Description	NPV
Accommodate	AC1	Structural - Design assets to withstand hazards	This option would involve constructing properties on stilts to accommodate inundation.	
Protect	P9 + P2	Levees with on-going nourishment	This option would involve construction of a levee to protect against inundation and on-going nourishment to counter erosion	
	P9 + P6	Levees with GSC Seawalls	This option would involve construction of a combined levee and GSC seawall structure to counter inundation and erosion	
	P9 + P7	Levees with Concrete SeaBee Seawalls	This option would involve construction of a combined levee and concrete seabee seawall structure to counter inundation and erosion	

Home Island – unweighted score

Name	Implementation	Environmental Impact	Social Impact - Property	Social Impact - Way of Life	Economic Impact - Businesses	Flexibility	Effectiveness	Financial	Unweighted Score
Structural - Design assets to withstand hazards	1	4	4	5	5	4	4	1	28
Levees with on-going nourishment	2	2	5	3	5	5	3	2	27
Levees with GSC Seawalls	5	3	5	1	5	3	3	3	28
Levees with Concrete SeaBee Seawalls	4	3	5	1	5	2	3	3	26

5	Insignificant impacts OR Very low risk
4	Minor impacts OR Low risk
3	Moderate impacts OR Medium Risk
2	Major impacts OR High risk
1	Severe impacts OR Very high risk

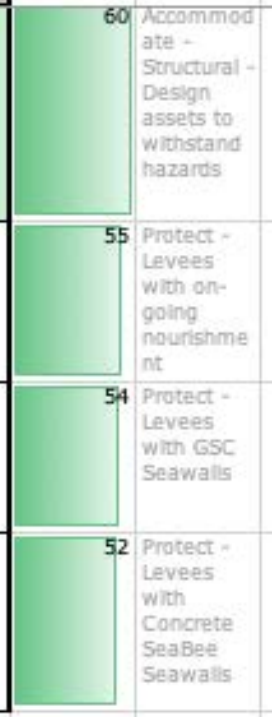
Home Island Scoring - Discussion

Using the handout and the scores we have suggested…

1. Did we get it about right?
2. If not, what would you change and why?
3. If you added a criteria, how would you score that?

Home Island – weighted score

Name	Implementation	Environmental Impact	Social Impact - Property	Social Impact - Way of Life	Economic Impact - Businesses	Flexibility	Effectiveness	Financial	Weighted Score
Structural - Design assets to withstand hazards	1	7	12	18	9	2	7	4	60
Levees with on-going nourishment	1	4	15	11	9	3	5	7	55
Levees with GSC Seawalls	3	5	15	4	9	2	5	11	54
Levees with Concrete SeaBee Seawalls	2	5	15	4	9	1	5	11	52



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Home Island – option costs

Long term

	NPV	LONG TERM
Reclamation on HI Settlement - Following AC1 short term option	$	+ $
Reclamation on HI Settlement - Following Protect short term option (P9 + P7)	$	+ $
Retreat to WI - New Settlement near Rumah Baru	-	+ $

Note: P9 + P2 (levees + nourishment) and P9 + P6 (levees + GSC seawalls) not costed long term



Q and A

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What next for the project

- This phase finishes in March
- We will finalise CHRMAP in August/September 2023
- *Shire of CKI commence Local Planning Strategy/ Scheme in conjunction with DPLH*
- *Assistant Minister for Regional Development and Territories considers*
- *WAPC endorsement*
- *Minister for Regional Development and Territories Endorsement*





Australian Government

Department of Infrastructure, Transport,
Regional Development, Communications and the Arts

Thank You

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APPENDIX C

Appendix C: Multi Criteria Assessment Details

Project: Shape Urban - Cocos Islands CHRMAP
Title: Home Island Settlement
By: Wavelength
Revision: A

Document Short Term HI Settlement MCA
Date: 22/03/23

1.0 Pre-Screening - Settlement Wide Adaptation Pathways (Short Term)

Home Island - Settlement
Inundation - Present Day High to Extreme Vulnerability of Assets
Erosion - Present Day High to Extreme Vulnerability of Assets

Adaptation Type	Description	Diagram	Scenario	Feasibility- Reduce erosion and inundation risks to Settlement?	Advance to specific options assessment
Avoid	Locating assets in areas that will not be vulnerable to coastal hazards.		Short Term	Not feasible at present or into future as existing assets currently at High risk of erosion and inundation.	Rejected
Planned/Managed Retreat	Planned or managed retreat for existing development involves relocating or sacrificing infrastructure, both public assets and private property. This pathway also includes prevention of further development in risk areas		Short Term	Not feasible for whole of Settlement, as insufficient high ground outside Settlement. Potentially feasible for individual assets within Settlement but not whole of Settlement.	Rejected
Accommodate	The accommodate risk treatment option aims to utilise design and management strategies which render the risks as tolerable/acceptable. Design and management strategies may include a mix of structural or non-structural approaches, including modifications to buildings, enhancing the natural environment and policy updates		Short Term	Partially effective Structural options can be used to reduce inundation risk and will be partially effective against erosion. Non-structural options, such as enhancing the natural environment, can help to reduce erosion risk	Shortlist pathway for specific options assessment
Protect	Protect risk treatment options aim to protect assets from damage resulting from erosion and recession and storm surge inundation. Common hard protection structures include seawalls; groynes; offshore breakwaters and artificial headlands; and soft protection measures such as beach nourishment.		Short Term	Different protect options effective at managing erosion and inundation risk	Shortlist pathway for specific options assessment
No Regrets	The no regrets risk treatment options cover the period while a range of assessments and works are required to determine a preferred risk treatment option, prior to implementing specific asset risk management measures.		Short Term	Partially effective Won't stop erosion and inundation risk to existing assets but can be used while preferred risk treatment options are implemented	Shortlist pathway for specific options assessment
Do Nothing	Assumes all levels of risk are accepted, and assumes that there is no change in existing planning controls, and no actions are implemented (i.e. no controls are implemented to treat known coastal risks).		Short Term	Not feasible for whole of Settlement, including properties and airport	Rejected

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2.0 Pre-Screening - Adaptation Options (Inundation)

Home Island - Settlement

Inundation - Present Day High to Extreme Vulnerability of Assets

Adaptation Type	ID	Method	Description	Benefits	Adverse Impacts	Effectiveness - Reduce inundation risks to property and people?	Environmental Fatal Flaw	Social Fatal Flaw	Advance to MCA
Accommodate	AC1	Structural - Design assets to withstand hazards	Where avoiding or relocating an asset is not an option, design of assets to withstand the impact of erosion and inundation. This would involve constructing properties on stilts to accommodate inundation.			Effective against inundation	Nil	Nil	Proceed to short-term MCA
	AC2	Maintain and enhance beach system	Beach scraping or back passing to move sand from accreting areas to eroding areas. Preserves or enhances the beach's ability to absorb the impacts of storm events and/or assists in post storm recovery. Aims to increase the resilience of the natural beach system			Not effective at countering inundation	-		Rejected
	AC3	Maintain and enhance dune system	Dune management, including management of access tracks, control of dune blowouts, revegetation, sand fencing. Preserves and enhances the dune's ability to absorb the impacts of storm events and provide a source of sand for beach recovery. Aims to increase the resilience of the natural beach and dune system.			Not effective at countering inundation	-		Rejected
	AC4	Maintain and enhance reef system	Reef management including reef restoration, no-anchorage areas and marine parks Preserves and enhances the reefs ability to absorb the impacts of storm events and provide a source of sand for beahc recovery. Aims to increase the resilience of the reef system			Not effective at countering inundation	-		Rejected
Protect	P1	Beach Nourishment - Massive Campaign	Placement of large volumes of sand on the beach, dunes or nearshore. May be undertaken pre/post storm event. Requires available sources of compatible sand. Aims to restore or enhance the beach profile to provide a natural buffer to absorb the impacts of storm events.	Maintains beaches	Smothering of corals Impact at source site	Not effective at countering inundation High dune systems are not a natural feature of atolls, so a naturally stable dune system could not be formed. Storm surge would overtop nourishment causing inundation.	-		Rejected
	P2	Beach Nourishment - On-going campaigns	Placement of smaller volumes of sand on the beach, dunes or nearshore at more frequent intervals. May be undertaken pre/post storm event. Requires available sources of compatible sand. Aims to restore or enhance the beach profile to provide a natural buffer to absorb the impacts of storm events.			Not effective at countering inundation High dune systems are not a natural feature of atolls, so a naturally stable dune system could not be formed. Storm surge would overtop nourishment causing inundation.	-		Rejected
	P3	Offshore structures - Artificial reefs/shoals	Larger submerged structures, placed further off-shore, which aim to dampen wave energy similar to natural reefs and reduce the impacts of storm events. Typical construction materials are rock, concrete, or geotextile sand filled tubes. May have a negative impact on the adjoining shoreline.	Improvde benthic habitat		Not effective at countering inundation.	-		Rejected
	P4	Offshore structures - Detached breakwaters/headlands	Large structures, visible above the waterline placed some distance off-shore. Typical construction materials are rock or geotextile sand filled tubes. In comparison to option P2, typically require significantly more construction materials. Aims to stop/redirect incoming waves to capture/retain sand at the beach and improve the capacity of the beach system to absorb the impacts of storm events. May have a negative impact on the adjoining shoreline.			Not effective at countering inundation.	-		Rejected
	P5	Groynes	Shore perpendicular structures which extend into the water. Range of construction materials (incl. rock, concrete, steel sheet pile, timber, geotextile sand filled tubes/bags). Aim to trap sand moving along the coast and retain a natural buffer to assist in absorbing the impacts of storm events. May have a negative impact on the adjoining shoreline.			Not effective at countering inundation.	-		Rejected
	P6	Geotextile Sand Container (GSC) seawalls	Involves construction of a GSC seawall usually along an entire section of shoreline. Seawalls stop both cross-shore and longshore erosion.		Loss of beach in front of seawall Downdrift / end scour erosion	Not effective at countering inundation. Must be used in conjunction with suitable Protect option	-		Rejected
	P7	SeaBee concrete seawalls	Involves construction of a Seabee concrete unit seawall usually along an entire section of shoreline. Seawalls stop both cross-shore and longshore erosion.		Loss of beach in front of seawall Downdrift / end scour erosion	Not effective at countering inundation. Must be used in conjunction with suitable Protect option	-		Rejected
	P8	Storm surge barrier	Artificial barrier designed to be closed during a storm event to prevent high ocean water levels entering an estuary or inlet. May have a negative visual impact.			Not suitable for this location, as open coastline	-		Rejected
	P9	Levees	Involves construction of a levee usually along an entire section of shoreline. Levees can prevent coastal inundation of low-lying areas			Effective at countering inundation	Nil	Nil	Proceed to short-term MCA
	P10	Land raising and/or reclamation	Involves raising or reclaiming low-lying land to prevent inundation. This option is usually completed in conjunction with levees and/or seawalls.			Effective at countering inundation	Nil	Significant disruption to local communities in short term. Should be considered as a longer term option to manage groundwater shoaling and inundation risk	Rejected
No Regrets	NR1	Monitoring	This option involves long term baseline monitoring and event based monitoring following storm erosion events			Partially effective Won't stop erosion and inundation risk to existing assets but can be used as a policy measure to monitor risk over time	Nil	Nil	Shortlist option for Quick Wins
	NR2	Protection Structure Audit	This option involves undertaking an audit of existing protection structures to determine their current condition, effectiveness and future protection potential			Partially effective Won't stop erosion and inundation risk to existing assets but can be used as a policy measure to help clarify risk	Nil	Nil	Shortlist option for Quick Wins
	NR3	Notification on Title	Indicates to current and future land owners that an asset is likely to be affected by coastal erosion and/or inundation over the planning timeframe. Helps current and future owners make informed decision about level of risk they are/may be willing to accept, and that risk management is likely to be required at some stage within the planning timeframe			Partially effective Won't stop erosion and inundation risk to existing assets but can be used as a policy measure to manage owner understanding of risk	Nil	Nil	Shortlist option for Quick Wins
	NR4	Emergency Evacuation Plans	Where existing assets may be affected by inundation and are not already identified in an existing emergency evacuation mangement plan. Such plans are important in manging the safety of community and stakeholders.			Partially effective Won't stop erosion and inundation risk to existing assets but can be used to help protect lives	Nil	Nil	Shortlist option for Quick Wins

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2.0 Pre-Screening - Adaptation Options (Erosion)

Home Island - Settlement

Erosion - Present Day High to Extreme Vulnerability of Assets

Adaptation Type	ID	Method	Description	Benefits	Adverse Impacts	Effectiveness - Reduce erosion risks to property and people?	Environmental Fatal Flaw	Social Fatal Flaw	Advance to MCA
Accommodate	AC1	Structural - Design assets to withstand hazards	Where avoiding or relocating an asset is not an option, design of assets to withstand the impact of erosion and inundation. This would involve constructing properties on stilts to accommodate minor erosion			Partially effective Constructing houses on stilts can accommodate some minor erosion but piles will be undercut by erosion and access roads will be cut-off	Nil	Nil	Proceed to short-term MCA
	AC2	Maintain and enhance beach system	Beach scraping or back passing to move sand from accreting areas to eroding areas. Preserves or enhances the beach's ability to absorb the impacts of storm events and/or assists in post storm recovery. Aims to increase the resilience of the natural beach system			Partially effective Won't stop erosion risk to existing assets but can be used to maintain beach widths in key locations (such as a public beach area) and reduce erosion risk in conjunction with seawalls.	Nil	Nil	Shortlist option for Quick Wins
	AC3	Maintain and enhance dune system	Dune management, including management of access tracks, control of dune blowouts, revegetation, sand fencing. Preserves and enhances the dune's ability to absorb the impacts of storm events and provide a source of sand for beach recovery. Aims to increase the resilience of the natural beach and dune system.			Partially effective Won't stop erosion risk to existing assets but can be used to maintain beach widths in key locations (such as a public beach area) and reduce erosion risk in conjunction with seawalls.	Nil	Nil	Shortlist option for Quick Wins
	AC4	Maintain and enhance reef system	Reef management including reef restoration, no-anchorage areas and marine parks Preserves and enhances the reefs ability to absorb the impacts of storm events and provide a source of sand for beahc recovery. Aims to increase the resilience of the reef system			Partially effective Won't stop erosion risk to existing assets but can be used to maintain beach widths in key locations (such as a public beach area) and reduce erosion risk in conjunction with seawalls.	Nil	Nil	Shortlist option for Quick Wins
Protect	P1	Beach Nourishment - Massive Campaign	Placement of large volumes of sand on the beach, dunes or nearshore. May be undertaken pre/post storm event. Requires available sources of compatible sand. Aims to restore or enhance the beach profile to provide a natural buffer to absorb the impacts of storm events.	Maintains beaches	Smothering of corals Impact at source site	Effective at countering erosion	Smothering of nearshore coral reef flats of significant concern with large nourishment volumes.	-	Rejected
	P2	Beach Nourishment - On-going campaigns	Placement of smaller volumes of sand on the beach, dunes or nearshore at more frequent intervals. May be undertaken pre/post storm event. Requires available sources of compatible sand. Aims to restore or enhance the beach profile to provide a natural buffer to absorb the impacts of storm events.			Effective at countering erosion	Nil	Nil	Proceed to short-term MCA Combine with levee (Protect option)
	P3	Offshore structures - Artificial reefs/shoals	Larger submerged structures, placed further off-shore, which aim to dampen wave energy similar to natural reefs and reduce the impacts of storm events. Typical construction materials are rock, concrete, or geotextile sand filled tubes. May have a negative impact on the adjoining shoreline.	Improved benthic habitat		Not effective at countering cross-shore erosion. Will cause erosion downdrift settlement (MU1B)	-		Rejected
	P4	Offshore structures - Detached breakwaters/headlands	Large structures, visible above the waterline placed some distance off-shore. Typical construction materials are rock or geotextile sand filled tubes. In comparison to option P2, typically require significantly more construction materials. Aims to stop/redirect incoming waves to capture/retain sand at the beach and improve the capacity of the beach system to absorb the impacts of storm events. May have a negative impact on the adjoining shoreline.			Not effective at countering cross-shore erosion. Will cause erosion downdrift settlement (MU1B)	-		Rejected
	P5	Groynes	Shore perpendicular structures which extend into the water. Range of construction materials (incl. rock, concrete, steel sheet pile, timber, geotextile sand filled tubes/bags). Aim to trap sand moving along the coast and retain a natural buffer to assist in absorbing the impacts of storm events. May have a negative impact on the adjoining shoreline.			Not effective at countering cross-shore erosion. Will cause erosion downdrift settlement (MU1B)	-		Rejected
	P6	Geotextile Sand Container (GSC) seawalls	Involves construction of a seawall usually along an entire section of shoreline. Areas setback from erosion risk can be protected from inundation with a levee		Loss of beach in front of seawall	Effective at countering cross-shore and longshore erosion	Nil	Nil	Proceed to short-term MCA Combine with levee (Protect option)
	P7	SeaBee concrete seawalls	Involves construction of a seawall usually along an entire section of shoreline. Areas setback from erosion risk can be protected from inundation with a levee		Loss of beach in front of seawall	Effective at countering cross-shore and longshore erosion	Nil	Nil	Proceed to short-term MCA Combine with levee (Protect option)
	P8	Storm surge barrier	Artificial barrier designed to be closed during a storm event to prevent high ocean water levels entering an estuary or inlet. May have a negative visual impact.			Not effective at countering erosion	-		Rejected
	P9	Levees	Involves construction of a levee usually along an entire section of shoreline. Levees can prevent coastal inundation of low-lying areas			Not effective at countering erosion	-		Rejected
	P10	Land reclamation	Involves raising or reclaiming low-lying land to prevent inundation. This option is usually completed in conjunction with levees and/or seawalls.			Not effective at countering erosion	-		Rejected
No Regrets	NR1	Monitoring	This option involves long term baseline monitoring and event based monitoring following storm erosion events			Partially effective Won't stop erosion and inundation risk to existing assets but can be used as a policy measure to monitor risk over time	Nil	Nil	Shortlist option for Quick Wins
	NR2	Protection Structure Audit	This option involves undertaking an audit of existing protection structures to determine their current condition, effectiveness and future protection potential			Partially effective Won't stop erosion and inundation risk to existing assets but can be used as a policy measure to help clarify risk	Nil	Nil	Shortlist option for Quick Wins
	NR3	Notification on Title	Indicates to current and future land owners that an asset is likely to be affected by coastal erosion and/or inundation over the planning timeframe. Helps current and future owners make informed decision about level of risk they are/may be willing to accept, and that risk management is likely to be required at some stage within the planning timeframe			Partially effective Won't stop erosion and inundation risk to existing assets but can be used as a policy measure to manage owner understanding of risk	Nil	Nil	Shortlist option for Quick Wins
	NR4	Emergency Evacuation Plans	Where existing assets may be affected by inundation and are not already identified in an existing emergency evacuation mangement plan. Such plans are important in manging the safety of community and stakeholders.			Partially effective Won't stop erosion and inundation risk to existing assets but can be used to help protect lives	Nil	Nil	Shortlist option for Quick Wins

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3.0 - Multi Criteria Assesment - Key Criteria & Scoring

	Category	Implementation	Environmental Impact	Social Impact - Property	Social Impact - Way of Life	Economic Impact - Businesses	Flexibility	Effectiveness	Financial	
	Description	How easy is the option to implement on a small island (i.e. can it be made on the island using readily available, local resources)?	How significant are the environmental impacts?	How significant are the impacts on properties?	How significant are the impacts on daily life?	How significant are the impacts on businesses and the local economy?	Is the option reversible / adaptable in the future?	How effective is the solution at mitigating erosion and inundation risks?	How much does the option cost?	
	Goals	- Implementation timeframe - Local use of products - Logistics and delays to import material - Maintenance of option into future - Carbon miles -Re-use of existing material	- Amenity and public health (noise, dust, noise, odours) impacts - distance to sensitive receptors - Scale of disturbance to marine habitat, water quality vulnerable/ protected species - Scale of disruption to commercial fisheries	- Residential property losses - Property access	- Impact on community values - Impact on access to important social and cultural areas (i.e. beach access, boat launching, views etc) - Scale and duration of disturbance to community areas/ activities	- Impact on existing businesses	- Reversibility of option - Adaptable to unforeseen changes in climate conditions - Alginment with potential long term adaptation pathways, including reclamation with seawalls	- Effectiveness against erosion - Effectiveness against inundation	-Combined capital and maintenance costs -Potential for external funding sources	
5	**Insignificant impacts OR Very low risk**	Abundant and sustainable source of material on island	Preserves and repairs	0 houses lost Does not affect property access	Does not affect any community values and/or improves access	No loss of existing businesses	Easily reversible or adaptable	Effective, long term mitigation	<$5 million	Excellent performance - no impacts on criterion
4	**Minor impacts OR Low risk**	A significant portion of material available on island	Maintains status quo	1-10 houses lost	Minor impact to community values and/or access		Reversible or adaptable	Effective, mid-term mitigation	$5 to $15 million	Good performance - minor short term impacts on criterion
3	**Moderate impacts OR Medium Risk**	Some material available on island	May result in impact and damage	11-19 houses lost Minor impact to property access	Loss of access to some community assets that doesn't effect overall intrinsic community value	Protects or maintains as long as possible	Reversible or adaptable but with some cost	Effective, short term mitigation	$15 - $30 million	Sound performance - manageable short-term adverse impacts on criterion
2	**Major impacts OR High risk**	Only a small portion of material available on island, majority of material needs to be imported	Likely to result in impact and damage	20-40 houses lost	Loss of access to certain assets		Difficult to reverse or adapt	Limited effectiveness	$30-$50 million	Poor performance - short-term adverse impacts on criterion, not easily managed
1	**Severe impacts OR Very high risk**	No material on island, all materials need to be imported	Will result in impact and damage	>40 houses lost Major impact to property access	Will definitely affect key values of area	Loss of existing businesses	Irreversible or unadaptable	Ineffective and/or suitable only for minor events	>$50 million	Very Poor Performance - long term adverse major impacts on criterion, not easily managed

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3.2 - Multi Criteria Assesment - Short Term

Max 40

Adaptation Type	ID	Name	Description	Implementation	Environmental Impact	Social Impact - Property	Social Impact - Way of Life	Economic Impact - Businesses	Flexibility	Effectiveness	Implementation	Environmental Impact	Social Impact - Property	Social Impact - Way of Life	Economic Impact - Businesses	Flexibility	Effectiveness	Financial	Unweighted Score
Accommodate	PMR2	**Structural - Design assets to withstand hazards**	This option would involve constructing properties on stilts to accommodate inundation.	Difficult implementation, as each house and structure has to be replaced Significant import of material to the island	Maintains status quo. Impact is restricted to property footprint. Allows shoreline to continue to erode	High impact - potential loss of multiple properties (approximately 30) due to erosion Daily impact to residents accessing properties, as stairs are required for stilted housing		High impact - potential loss of Cocos Island Beach Resort with on-going erosion	Difficult to reverse or adapt, as houses built on stilts can't be easily raised.	Partially effective in medium term Raising houses on stilts is effective at countering inundation in medium term but not effective at countering erosion Option would have to be combined with a protect pathway (nouirishment or seawall option) to increase erosion effectiveness	1	4	4	5	1	2	4	1	**22**
Protect	P9 + P2	**Levees with on-going nourishment**	This option would involve construction of a levee to protect against inundation and on-going nourishment to counter erosion	Moderate implementation difficulty, with on-going resources required to implement Nourishment uses locally available sand Levee requires import of clay core material or Geotextile Clay Layer	Will impact on environment at nourishment source site and placement site Maintains some beach width	Insignificant impacts	Loss of access to some community values, as levee separates community from Settlement beaches and views Nourishment maintains beach widths	Low impact - no businesses lost	Nourishment is reversible or flexible, allowing different pathways to be implemented as required	Effective short term adaptation option Requires on-going nourishment and sand sources are finite Not effective in long term given potential groundwater shoaling behind levees	2	2	5	3	5	5	3	2	**27**
	P9 + P6	**Levees with GSC Seawalls**	This option would involve construction of a combined levee and GSC seawall structure to counter inundation and erosion	Relatively straightforward implementation, using previously implemented GSC seawalls Containers need to be imported but uses locally available sand Levee requires import of clay core material or Geotextile Clay Layer	Likely to impact beaches in front and adjacent to seawall	Insignificant impacts	Will definitely affect key values of area, as levee separates community from Settlement beaches and views Seawalls cause erosion of Settlement beaches	Low impact - no businesses lost	Seawalls are reversible or adaptable but with some cost. This could includes raised crests or additional bag layers	Effective short term adaptation option GSC seawalls are considered less robust than concrete SeaBee seawalls Not effective in long term given potential groundwater shoaling behind levees	5	3	5	1	5	3	3	5	**30**
	P9 + P7	**Levees with Concrete SeaBee Seawalls**	This option would involve construction of a combined levee and concrete seabee seawall structure to counter inundation and erosion	Moderate implementation difficulty, using Seabee seawall units that need to be imported Levee requires import of clay core material or Geotextile Clay Layer	Likely to impact beaches in front and adjacent to seawall	Insignificant impacts	Will definitely affect key values of area, as levee separates community from Settlement beaches and views Seawalls cause erosion of Settlement beaches	Low impact - no businesses lost	Seabee seawalls are difficult to reverse or adapt. The crest could be raised but additional concrete layers could not be added	Effective medium term adaptation option Not effective in long term given potential groundwater shoaling behind levees	4	3	5	1	5	2	4	4	**28**

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Adaptation Option Costings

				Option Name	PMR2 Accommodate - Raise properties on stilts					P9 + P2 Protect - Levees with Nourishment					P9 + P6 Protect - Levees with GSC Seawalls					P9 + P7 Protect - Levees with concrete Seabee				
					Capital Costs		Repair Costs		Sand Volumes	Capital Costs		Repair Costs		Sand Volumes	Capital Costs		Repair Costs		Sand Volumes	Capital Costs		Repair Costs		Sand Volumes
Timeframe		$	Unit		Qty	Subtotal	Qty	Subtotal		Qty	Subtotal	Qty	Subtotal		Qty	Subtotal	Qty	Subtotal		Qty	Subtotal	Qty	Subtotal	
Present Day	Approvals & Monitoring	$ 50,000	/unit		1	$ 50,000				3	$ 150,000				1	$ 50,000				1	$ 50,000			
	Mobilisation Civil/Structural	$ 100,000	/unit		2	$ 200,000				5	$ 500,000				1	$ 100,000				1	$ 100,000			
	Protect - Upgrade GSC Seawall - 1 additional crest layer	$ 2,100	/m			$ -			-		$ -			-	0	$ -			-		$ -			-
	Protect - Upgrade Seabee Seawall - 1m higher	$ 3,400	/m			$ -					$ -					$ -					$ -			
	Protect - New GSC Seawall	$ 14,000	/m			$ -			-		$ -			-	0	$ -			-		$ -			-
	Protect - New Seabee Seawall	$ 17,000	/m			$ -					$ -					$ -					$ -			
	Protect - New 1m high levee	$ 3,000	/m			$ -			-		$ -			-		$ -			-		$ -			-
	Protect - New 1.5m high levee	$ 6,000	/m			$ -			-	500	$ 3,000,000			3,500	500	$ 3,000,000			3,500	500	$ 3,000,000			3,500
	Protect - Nourishment	$ 1,024	/m per year			$ -			-		$ -			-		$ -			-		$ -			-
	Accommodate - Raise road 1m and asphalt	$ 2,800	/m			$ -			-	220	$ 616,000			770	220	$ 616,000			770	220	$ 616,000			770
	Accommodate - Asphalt new road	$ 2,200	/m		0	$ -					$ -					$ -					$ -			
	Accommodate - New stilted house	$ 822,500	/unit		46	$ 37,835,000					$ -					$ -					$ -			
	Accommodate - Large Building (commercial or public)	$ 2,467,500	/unit		1	$ 2,467,500					$ -					$ -					$ -			
	Accommodate - Raise stilted house 0.5m	$ 100,000	/unit			$ -					$ -					$ -					$ -			
	Project Management 10%																							
	Approvals and monitoring (10-15%																							
	Contingency	20%	item			$ 8,110,500					$ 853,200					$ 753,200					$ 753,200			
	Repairs						1%					0%					5%					2%		
			Total			**$ 48,663,000**		**$ 486,630**	-		**$ 5,119,200**		**$ -**	4,270		**$ 4,519,200**		**$ -**	4,270		**$ 4,519,200**		**$ 120,400**	4,270
2030	Approvals & Monitoring	$ 50,000	/unit		1	$ 50,000				3	$ 150,000				1	$ 50,000				1	$ 50,000			
	Mobilisation Civil/Structural	$ 100,000	/unit		2	$ 200,000				5	$ 500,000				1	$ 100,000				1	$ 100,000			
	Protect - Upgrade GSC Seawall - 1 additional crest layer	$ 2,100	/m			$ -			-		$ -			-	0	$ -			-		$ -			-
	Protect - Upgrade Seabee Seawall - 1m higher	$ 3,400	/m			$ -					$ -					$ -					$ -			
	Protect - New GSC Seawall	$ 14,000	/m			$ -			-		$ -			-	430	$ 6,020,000			6,543		$ -			-
	Protect - New Seabee Seawall	$ 17,000	/m			$ -					$ -					$ -				430	$ 7,310,000			
	Protect - New 1m high levee	$ 3,000	/m			$ -			-		$ -			-		$ -			-		$ -			-
	Protect - New 1.5m high levee	$ 6,000	/m			$ -			-	400	$ 2,400,000			2,800	400	$ 2,400,000			2,800	400	$ 2,400,000			2,800
	Protect - Nourishment	$ 1,690	/m per year			$ -			-	270	$ 456,192			1,728		$ -			-		$ -			-
	Accommodate - Raise road 1m and asphalt	$ 2,800	/m		850	$ 2,380,000			2,975	0	$ -			-		$ -			-		$ -			-
	Accommodate - Asphalt new road	$ 2,200	/m			$ -					$ -					$ -					$ -			
	Accommodate - New stilted house	$ 822,500	/unit		10	$ 8,225,000					$ -					$ -					$ -			
	Accommodate - Large Building (commercial or public)	$ 2,500,000	/unit		4	$ 10,000,000					$ -					$ -					$ -			
	Accommodate - Raise stilted house 0.5m	$ 100,000	/unit			$ -					$ -					$ -					$ -			
	Contingency	20%	item			$ 4,171,000					$ 701,238					$ 1,714,000					$ 1,972,000			
							1%					0%					5%					2%		
			Total			**$ 25,026,000**		**$ 250,260**	2,975		**$ 4,207,430**		**$ -**	4,528		**$ 10,284,000**		**$ 301,000**	9,343		**$ 11,832,000**		**$ 120,400**	2,800
2040	Approvals & Monitoring	$ 50,000	/unit			$ -				3	$ 150,000					$ -					$ -			
	Mobilisation Civil/Structural	$ 100,000	/unit			$ -				5	$ 500,000					$ -					$ -			
	Protect - Upgrade GSC Seawall - 1 additional crest layer	$ 2,100	/m			$ -			-		$ -			-	0	$ -			-		$ -			-
	Protect - Upgrade Seabee Seawall - 1m higher	$ 3,400	/m			$ -					$ -					$ -					$ -			
	Protect - New GSC Seawall	$ 14,000	/m			$ -			-		$ -			-	0	$ -			-		$ -			-
	Protect - New Seabee Seawall	$ 17,000	/m			$ -					$ -					$ -					$ -			
	Protect - New 1m high levee	$ 3,000	/m			$ -			-		$ -			-		$ -			-		$ -			-
	Protect - New 1.5m high levee	$ 6,000	/m			$ -			-	0	$ -			-	0	$ -			-		$ -			-
	Protect - Nourishment	$ 1,690	/m per year			$ -			-	270	$ 456,192			1,728		$ -			-		$ -			-
	Accommodate - Raise road 1m and asphalt	$ 2,800	/m			$ -			-		$ -			-		$ -			-		$ -			-
	Accommodate - Asphalt new road	$ 2,200	/m			$ -					$ -					$ -					$ -			
	Accommodate - New stilted house	$ 822,500	/unit			$ -					$ -					$ -					$ -			
	Accommodate - Large Building (commercial or public)	$ 2,500,000	/unit			$ -										$ -					$ -			
	Accommodate - Raise stilted house 0.5m	$ 100,000	/unit			$ -					$ -					$ -					$ -			
	Contingency	20%	item			$ -					$ 221,238					$ -								
							1%					0%					5%					2%		
			Total			**$ -**		**$ -**	-		**$ 1,327,430**		**$ -**	1,728		**$ -**		**$ 301,000**	-		**$ -**		**$ 120,400**	-
2050	Approvals & Monitoring	$ 50,000	/unit		1	$ 50,000				3	$ 150,000				1	$ 50,000				1	$ 50,000			
	Mobilisation Civil/Structural	$ 100,000	/unit		2	$ 200,000				5	$ 500,000				1	$ 100,000				1	$ 100,000			
	Protect - Upgrade GSC Seawall - 1 additional crest layer	$ 2,100	/m			$ -			-		$ -			-	430	$ 903,000			935		$ -			-
	Protect - Upgrade Seabee Seawall - 1m higher	$ 3,400	/m			$ -					$ -					$ -					$ -			
	Protect - New GSC Seawall	$ 14,000	/m			$ -			-		$ -			-	430	$ 6,020,000			6,543		$ -			-
	Protect - New Seabee Seawall	$ 17,000	/m			$ -					$ -					$ -					$ -			
	Protect - New 1m high levee	$ 3,000	/m			$ -			-		$ -			-		$ -			-		$ -			-
	Protect - New 1.5m high levee	$ 6,000	/m			$ -			-	230	$ 1,380,000			1,610	230	$ 1,380,000			1,610	230	$ 1,380,000			1,610
	Protect - Nourishment	$ 1,690	/m per year			$ -			-	270	$ 456,192			1,728		$ -			-		$ -			-
	Accommodate - Raise road 1m and asphalt	$ 2,800	/m		370	$ 1,036,000			1,295		$ -			-		$ -			-		$ -			-
	Accommodate - Asphalt new road	$ 2,200	/m			$ -					$ -					$ -					$ -			
	Accommodate - New stilted house	$ 822,500	/unit		38	$ 31,255,000					$ -					$ -					$ -			
	Accommodate - Large Building (commercial or public)	$ 2,500,000	/unit		2	$ 5,000,000					$ -					$ -					$ -			
	Accommodate - Raise stilted house 0.5m	$ 100,000	/unit			$ -					$ -					$ -					$ -			
	Contingency	20%	item			$ 7,508,200					$ 497,238					$ 1,690,600					$ 306,000			
							1%					0%					5%					2%		
			Total			**$ 45,049,200**		**$ 450,492**	1,295		**$ 2,983,430**		**$ -**	3,338		**$ 10,143,600**		**$ 301,000**	9,088		**$ 1,836,000**		**$ 120,400**	1,610
2060	Approvals & Monitoring	$ 50,000	/unit			$ -				3	$ 150,000				1	$ 50,000				1	$ 50,000			
	Mobilisation Civil/Structural	$ 100,000	/unit			$ -				5	$ 500,000				1	$ 100,000				1	$ 100,000			
	Protect - Upgrade GSC Seawall - 1 additional crest layer	$ 2,100	/m			$ -			-		$ -			-	0	$ -			-		$ -			-
	Protect - Upgrade Seabee Seawall - 1m higher	$ 3,400	/m			$ -					$ -					$ -				430	$ 1,462,000			
	Protect - New GSC Seawall	$ 14,000	/m			$ -			-		$ -			-	330	$ 4,620,000			5,022		$ -			-
	Protect - New Seabee Seawall	$ 17,000	/m			$ -					$ -					$ -				760	$ 12,920,000			
	Protect - New 1m high levee	$ 3,000	/m			$ -			-		$ -			-		$ -			-		$ -			-
	Protect - New 1.5m high levee	$ 6,000	/m			$ -			-	560	$ 3,360,000			3,920	560	$ 3,360,000			3,920	560	$ 3,360,000			3,920
	Protect - Nourishment	$ 1,690	/m per year			$ -			-	600	$ 1,013,760			3,840		$ -			-		$ -			-
	Accommodate - Raise road 1m and asphalt	$ 2,800	/m			$ -			-		$ -			-		$ -			-		$ -			-
	Accommodate - Asphalt new road	$ 2,200	/m			$ -					$ -					$ -					$ -			
	Accommodate - New stilted house	$ 822,500	/unit		0	$ -					$ -					$ -					$ -			
	Accommodate - Large Building (commercial or public)	$ 2,500,000	/unit			$ -					$ -					$ -					$ -			
	Accommodate - Raise stilted house 0.5m	$ 100,000	/unit			$ -					$ -					$ -					$ -			
	Contingency	20%	item			$ -					$ 1,004,752					$ 1,626,000					$ 3,578,400			
							1%					0%					5%					2%		
			Total			**$ -**		**$ -**	-		**$ 6,028,512**		**$ -**	7,760		**$ 9,756,000**		**$ 532,000**	8,942		**$ 21,470,400**		**$ 212,800**	3,920

NPV Calcs

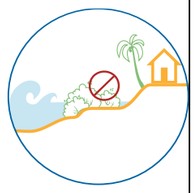
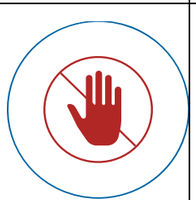
	Total NPV	$ 76,286,747		$ 1,756,673	4270	$ 16,209,509		$ -	165522	$ 15,263,768		$ 479,196	31,643		$ 15,976,944		$ 297,608	12,600						
	Average cost per year	$ 1,658,408		$ 38,189		$ 352,381		$ -		$ 331,821		$ 10,417			$ 347,325		$ 6,470							
	Sand Volume Total																							

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1.0 Pre-Screening - Settlement Wide Adaptation Pathways

West Island - Settlement
Inundation - Present Day High Vulnerability of Assets
Erosion - Present Day High Vulnerability of Assets

Adaptation Type	Description	Diagram	Scenario	Feasibility- Reduce erosion and inundation risks to Settlement?	Advance to specific options assessment
Avoid	Locating assets in areas that will not be vulnerable to coastal hazards.		Short Term	Not feasible at present or into future as existing assets currently at High risk of erosion and inundation.	Rejected
Planned/Managed Retreat	Planned or managed retreat for existing development involves relocating or sacrificing infrastructure, both public assets and private property. This pathway also includes prevention of further development in risk areas		Short Term	Not feasible for whole of Settlement, including airport, as insufficient high ground outside Settlement. Potentially feasible for individual assets within Settlement but not whole of Settlement.	Rejected
Accommodate	The accommodate risk treatment option aims to utilise design and management strategies which render the risks as tolerable/acceptable. Design and management strategies may include a mix of structural or non-structural approaches, including modifications to buildings, enhancing the natural environment and policy updates		Short Term	Partially effective Structural options can be used to reduce inundation risk and will be partially effective against erosion. Non-structural options, such as enhancing the natural environment, can help to reduce erosion risk	Shortlist pathway for specific options assessment
Protect	Protect risk treatment options aim to protect assets from damage resulting from erosion and recession and storm surge inundation. Common hard protection structures include seawalls; groynes; offshore breakwaters and artificial headlands; and soft protection measures such as beach nourishment.		Short Term	Different protect options effective at managing erosion and inundation risk	Shortlist pathway for specific options assessment
No Regrets	The no regrets risk treatment options cover the period while a range of assessments and works are required to determine a preferred risk treatment option, prior to implementing specific asset risk management measures.		Short Term	Partially effective Won't stop erosion and inundation risk to existing assets but can be used while preferred risk treatment options are implemented	Shortlist pathway for specific options assessment
Do Nothing	Assumes all levels of risk are accepted, and assumes that there is no change in existing planning controls, and no actions are implemented (i.e. no controls are implemented to treat known coastal risks).		Short Term	Not feasible for whole of Settlement, including properties and airport	Rejected

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2.0 Pre-Screening - Adaptation Options (Inundation)

West Island - Settlement
Inundation - Present Day High Vulnerability of Assets

Adaptation Type	ID	Method	Description	Benefits	Adverse Impacts	Effectiveness - Reduce inundation risks to property and people?	Environmental Fatal Flaw	Social Fatal Flaw	Advance to MCA
Accommodate	AC1	Structural - Design assets to withstand hazards	Where avoiding or relocating an asset is not an option, design of assets to withstand the impact of erosion and inundation. This would involve constructing properties on stilts to accommodate inundation.			Effective against inundation	Nil	Nil	Proceed to short-term MCA
	AC2	Maintain and enhance beach system	Beach scraping or back passing to move sand from accreting areas to eroding areas. Preserves or enhances the beach's ability to absorb the impacts of storm events and/or assists in post storm recovery. Aims to increase the resilience of the natural beach system			Not effective at countering inundation	-		Rejected
	AC3	Maintain and enhance dune system	Dune management, including management of access tracks, control of dune blowouts, revegetation, sand fencing. Preserves and enhances the dune's ability to absorb the impacts of storm events and provide a source of sand for beach recovery. Aims to increase the resilience of the natural beach and dune system.			Not effective at countering inundation	-		Rejected
	AC4	Maintain and enhance reef system	Reef management including reef restoration, no-anchorage areas and marine parks Preserves and enhances the reefs ability to absorb the impacts of storm events and provide a source of sand for beahc recovery. Aims to increase the resilience of the reef system			Not effective at countering inundation	-		Rejected
Protect	P1	Beach Nourishment - Massive Campaign	Placement of large volumes of sand on the beach, dunes or nearshore. May be undertaken pre/post storm event. Requires available sources of compatible sand. Aims to restore or enhance the beach profile to provide a natural buffer to absorb the impacts of storm events.	Maintains beaches	Smothering of corals Impact at source site	Not effective at countering inundation High dune systems are not a natural feature of atolls, so a naturally stable dune system could not be formed. Storm surge would overtop nourishment causing inundation.	-		Rejected
	P2	Beach Nourishment - On-going campaigns	Placement of smaller volumes of sand on the beach, dunes or nearshore at more frequent intervals. May be undertaken pre/post storm event. Requires available sources of compatible sand. Aims to restore or enhance the beach profile to provide a natural buffer to absorb the impacts of storm events.			Not effective at countering inundation High dune systems are not a natural feature of atolls, so a naturally stable dune system could not be formed. Storm surge would overtop nourishment causing inundation.	-		Rejected
	P3	Offshore structures - Artificial reefs/shoals	Larger submerged structures, placed further off-shore, which aim to dampen wave energy similar to natural reefs and reduce the impacts of storm events. Typical construction materials are rock, concrete, or geotextile sand filled tubes. May have a negative impact on the adjoining shoreline.	Improvde benthic habitat		Not effective at countering inundation.	-		Rejected
	P4	Offshore structures - Detached breakwaters/headlands	Large structures, visible above the waterline placed some distance off-shore. Typical construction materials are rock or geotextile sand filled tubes. In comparison to option P2, typically require significantly more construction materials. Aims to stop/redirect incoming waves to capture/retain sand at the beach and improve the capacity of the beach system to absorb the impacts of storm events. May have a negative impact on the adjoining shoreline.			Not effective at countering inundation.	-		Rejected
	P5	Groynes	Shore perpendicular structures which extend into the water. Range of construction materials (incl. rock, concrete, steel sheet pile, timber, geotextile sand filled tubes/bags). Aim to trap sand moving along the coast and retain a natural buffer to assist in absorbing the impacts of storm events. May have a negative impact on the adjoining shoreline.			Not effective at countering inundation.	-		Rejected
	P6	Geotextile Sand Container (GSC) seawalls	Involves construction of a GSC seawall usually along an entire section of shoreline. Seawalls stop both cross-shore and longshore erosion.		Loss of beach in front of seawall Downdrift / end scour erosion	Not effective at countering inundation. Must be used in conjunction with suitable Protect option	-		Rejected
	P7	SeaBee concrete seawalls	Involves construction of a Seabee concrete unit seawall usually along an entire section of shoreline. Seawalls stop both cross-shore and longshore erosion.		Loss of beach in front of seawall Downdrift / end scour erosion	Not effective at countering inundation. Must be used in conjunction with suitable Protect option	-		Rejected
	P8	Storm surge barrier	Artificial barrier designed to be closed during a storm event to prevent high ocean water levels entering an estuary or inlet. May have a negative visual impact.			Not suitable for this location, as open coastline	-		Rejected
	P9	Levees	Involves construction of a levee usually along an entire section of shoreline. Levees can prevent coastal inundation of low-lying areas			Effective at countering inundation	Nil	Nil	Proceed to short-term MCA
	P10	Land raising and/or reclamation	Involves raising or reclaiming low-lying land to prevent inundation. This option is usually completed in conjunction with levees and/or seawalls.			Effective at countering inundation	Nil	Significant disruption to local communities in short term. Should be considered as a longer term option to manage groundwater shoaling and inundation risk	Rejected
No Regrets	NR1	Monitoring	This option involves long term baseline monitoring and event based monitoring following storm erosion events			Partially effective Won't stop erosion and inundation risk to existing assets but can be used as a policy measure to monitor risk over time			Shortlist option for Quick Wins
	NR2	Protection Structure Audit	This option involves undertaking an audit of existing protection structures to determine their current condition, effectiveness and future protection potential			Partially effective Won't stop erosion and inundation risk to existing assets but can be used as a policy measure to help clarify risk			Shortlist option for Quick Wins
	NR3	Notification on Title	Indicates to current and future land owners that an asset is likely to be affected by coastal erosion and/or inundation over the planning timeframe. Helps current and future owners make informed decision about level of risk they are/may be willing to accept, and that risk management is likely to be required at some stage within the planning timeframe			Partially effective Won't stop erosion and inundation risk to existing assets but can be used as a policy measure to manage owner understanding of risk			Shortlist option for Quick Wins
	NR4	Emergency Evacuation Plans	Where existing assets may be affected by inundation and are not already identified in an existing emergency evacuation mangement plan. Such plans are important in manging the safety of community and stakeholders.			Partially effective Won't stop erosion and inundation risk to existing assets but can be used to help protect lives			Shortlist option for Quick Wins

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2.0 Pre-Screening - Adaptation Options (Erosion)

West Island - Settlement

Erosion - Present Day High Vulnerability of Assets

Adaptation Type	ID	Method	Description	Benefits	Adverse Impacts	Effectiveness - Reduce erosion risks to property and people?	Environmental Fatal Flaw	Social Fatal Flaw	Advance to MCA
Accommodate	AC1	Structural - Design assets to withstand hazards	Where avoiding or relocating an asset is not an option, design of assets to withstand the impact of erosion and inundation. This would involve constructing properties on stilts to accommodate minor erosion			Partially effective Constructing houses on stilts can accommodate some minor erosion but piles will be undercut by erosion and access roads will be cut-off	Nil	Nil	Proceed to short-term MCA
	AC2	Maintain and enhance beach system	Beach scraping or back passing to move sand from accreting areas to eroding areas. Preserves or enhances the beach's ability to absorb the impacts of storm events and/or assists in post storm recovery. Aims to increase the resilience of the natural beach system			Partially effective Won't stop erosion risk to existing assets but can be used to maintain beach widths in key locations (such as a public beach area) and reduce erosion risk in conjunction with seawalls.	Nil	Nil	Shortlist option for Quick Wins
	AC3	Maintain and enhance dune system	Dune management, including management of access tracks, control of dune blowouts, revegetation, sand fencing. Preserves and enhances the dune's ability to absorb the impacts of storm events and provide a source of sand for beach recovery. Aims to increase the resilience of the natural beach and dune system.			Partially effective Won't stop erosion risk to existing assets but can be used to maintain beach widths in key locations (such as a public beach area) and reduce erosion risk in conjunction with seawalls.	Nil	Nil	Shortlist option for Quick Wins
	AC4	Maintain and enhance reef system	Reef management including reef restoration, no-anchorage areas and marine parks Preserves and enhances the reefs ability to absorb the impacts of storm events and provide a source of sand for beahc recovery. Aims to increase the resilience of the reef system			Partially effective Won't stop erosion risk to existing assets but can be used to maintain beach widths in key locations (such as a public beach area) and reduce erosion risk in conjunction with seawalls.	Nil	Nil	Shortlist option for Quick Wins
Protect	P1	Beach Nourishment - Massive Campaign	Placement of large volumes of sand on the beach, dunes or nearshore. May be undertaken pre/post storm event. Requires available sources of compatible sand. Aims to restore or enhance the beach profile to provide a natural buffer to absorb the impacts of storm events.	Maintains beaches	Smothering of corals Impact at source site	Effective at countering erosion	Smothering of nearshore coral reef flats of significant concern with large nourishment volumes.	-	Rejected
	P2	Beach Nourishment - On-going campaigns	Placement of smaller volumes of sand on the beach, dunes or nearshore at more frequent intervals. May be undertaken pre/post storm event. Requires available sources of compatible sand. Aims to restore or enhance the beach profile to provide a natural buffer to absorb the impacts of storm events.			Effective at countering erosion	Nil	Nil	Proceed to short-term MCA Combine with levee (Protect option)
	P3	Offshore structures - Artificial reefs/shoals	Larger submerged structures, placed further off-shore, which aim to dampen wave energy similar to natural reefs and reduce the impacts of storm events. Typical construction materials are rock, concrete, or geotextile sand filled tubes. May have a negative impact on the adjoining shoreline.	Improved benthic habitat		Not effective at countering cross-shore erosion. Will cause erosion downdrift settlement (MU1B)	-		Rejected
	P4	Offshore structures - Detached breakwaters/headlands	Large structures, visible above the waterline placed some distance off-shore. Typical construction materials are rock or geotextile sand filled tubes. In comparison to option P2, typically require significantly more construction materials. Aims to stop/redirect incoming waves to capture/retain sand at the beach and improve the capacity of the beach system to absorb the impacts of storm events. May have a negative impact on the adjoining shoreline.			Not effective at countering cross-shore erosion. Will cause erosion downdrift settlement (MU1B)	-		Rejected
	P5	Groynes	Shore perpendicular structures which extend into the water. Range of construction materials (incl. rock, concrete, steel sheet pile, timber, geotextile sand filled tubes/bags). Aim to trap sand moving along the coast and retain a natural buffer to assist in absorbing the impacts of storm events. May have a negative impact on the adjoining shoreline.			Not effective at countering cross-shore erosion. Will cause erosion downdrift settlement (MU1B)	-		Rejected
	P6	Geotextile Sand Container (GSC) seawalls	Involves construction of a seawall usually along an entire section of shoreline. Areas setback from erosion risk can be protected from inundation with a levee		Loss of beach in front of seawall	Effective at countering cross-shore and longshore erosion			Proceed to short-term MCA Combine with levee (Protect option)
	P7	SeaBee concrete seawalls	Involves construction of a seawall usually along an entire section of shoreline. Areas setback from erosion risk can be protected from inundation with a levee		Loss of beach in front of seawall	Effective at countering cross-shore and longshore erosion			Proceed to short-term MCA Combine with levee (Protect option)
	P8	Storm surge barrier	Artificial barrier designed to be closed during a storm event to prevent high ocean water levels entering an estuary or inlet. May have a negative visual impact.			Not effective at countering erosion			Rejected
	P9	Levees	Involves construction of a levee usually along an entire section of shoreline. Levees can prevent coastal inundation of low-lying areas			Not effective at countering erosion	-		Rejected
	P10	Land reclamation	Involves raising or reclaiming low-lying land to prevent inundation. This option is usually completed in conjunction with levees and/or seawalls.			Not effective at countering erosion	-		Rejected
No Regrets	NR1	Monitoring	This option involves long term baseline monitoring and event based monitoring following storm erosion events			Partially effective Won't stop erosion and inundation risk to existing assets but can be used as a policy measure to monitor risk over time			Shortlist option for Quick Wins
	NR2	Protection Structure Audit	This option involves undertaking an audit of existing protection structures to determine their current condition, effectiveness and future protection potential			Partially effective Won't stop erosion and inundation risk to existing assets but can be used as a policy measure to help clarify risk			Shortlist option for Quick Wins
	NR3	Notification on Title	Indicates to current and future land owners that an asset is likely to be affected by coastal erosion and/or inundation over the planning timeframe. Helps current and future owners make informed decision about level of risk they are/may be willing to accept, and that risk management is likely to be required at some stage within the planning timeframe			Partially effective Won't stop erosion and inundation risk to existing assets but can be used as a policy measure to manage owner understanding of risk			Shortlist option for Quick Wins
	NR4	Emergency Evacuation Plans	Where existing assets may be affected by inundation and are not already identified in an existing emergency evacuation mangement plan. Such plans are important in manging the safety of community and stakeholders.			Partially effective Won't stop erosion and inundation risk to existing assets but can be used to help protect lives			Shortlist option for Quick Wins

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3.0 - Multi Criteria Assesment - Key Criteria & Scoring

	Category	Implementation	Environmental Impact	Social Impact - Property	Social Impact - Way of Life	Economic Impact - Businesses	Flexibility	Effectiveness	Financial	
	Description	How easy is the option to implement on a small island (i.e. can it be made on the island using readily available, local resources)?	How significant are the environmental impacts?	How significant are the impacts on properties?	How significant are the impacts on daily life?	How significant are the impacts on businesses and the local economy?	Is the option reversible / adaptable in the future?	How effective is the solution at mitigating erosion and inundation risks?	How much does the option cost?	
	Goals	- Implementation timeframe - Local use of products - Logistics and delays to import material - Maintenance of option into future - Carbon miles -Re-use of existing material	- Amenity and public health (noise, dust, noise, odours) impacts - distance to sensitive receptors - Scale of disturbance to marine habitat, water quality vulnerable/ protected species - Scale of disruption to commercial fisheries	- Residential property losses - Property access	- Impact on community values - Impact on access to important social and cultural areas (i.e. beach access, boat launching, views etc) - Scale and duration of disturbance to community areas/ activities	- Impact on existing businesses	- Reversibility of option - Adaptable to unforeseen changes in climate conditions - Alginment with potential long term adaptation pathways, including reclamation with seawalls	- Effectiveness against erosion - Effectiveness against inundation	-Combined capital and maintenance costs -Potential for external funding sources	
5	**Insignificant impacts OR Very low risk**	Abundant and sustainable source of material on island	Preserves and repairs	0 houses lost Does not affect property access	Does not affect any community values and/or improves access	No loss of existing businesses	Easily reversible or adaptable	Effective, long term mitigation	<$5 million	Excellent performance - no impacts on criterion
4	**Minor impacts OR Low risk**	A significant portion of material available on island	Maintains status quo	1-10 houses lost	Minor impact to community values and/or access		Reversible or adaptable	Effective, mid-term mitigation	$5 to $15 million	Good performance - minor short term impacts on criterion
3	**Moderate impacts OR Medium Risk**	Some material available on island	May result in impact and damage	11-19 houses lost Minor impact to property access	Loss of access to some community assets that doesn't effect overall intrinsic community value	Protects or maintains as long as possible	Reversible or adaptable but with some cost	Effective, short term mitigation	$15 - $30 million	Sound performance - manageable short-term adverse impacts on criterion
2	**Major impacts OR High risk**	Only a small portion of material available on island, majority of material needs to be imported	Likely to result in impact and damage	20-40 houses lost	Loss of access to certain assets		Difficult to reverse or adapt	Limited effectiveness	$30-$50 million	Poor performance - short-term adverse impacts on criterion, not easily managed
1	**Severe impacts OR Very high risk**	No material on island, all materials need to be imported	Will result in impact and damage	>40 houses lost Major impact to property access	Will definitely affect key values of area	Loss of existing businesses	Irreversible or unadaptable	Ineffective and/or suitable only for minor events	>$50 million	Very Poor Performance - long term adverse major impacts on criterion, not easily managed

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3.2 - Multi Criteria Assesment - Short Term

Max 40

Adaptation Type	ID	Name	Description	Implementation	Environmental Impact	Social Impact - Property	Social Impact - Way of Life	Economic Impact - Businesses	Flexibility	Effectiveness	Implementation	Environmental Impact	Social Impact - Property	Social Impact - Way of Life	Economic Impact - Businesses	Flexibility	Effectiveness	Financial	Unweighted Score
Accommodate	AC1	**Structural - Design assets to withstand hazards**	This option would involve constructing properties on stilts to accommodate inundation.	Difficult implementation, as each house and structure has to be replaced Significant import of material to the island	Maintains status quo. Impact is restricted to property footprint. Allows shoreline to continue to erode	High impact - potential loss of multiple properties (approximately 30) due to erosion Daily impact to residents accessing properties, as stairs are required for stilted housing		High impact - potential loss of Cocos Island Beach Resort with on-going erosion	Houses built on stilts can be raised in future if built as kit homes that can be dismantled and lifted with cranes	Partially effective in medium term Raising houses on stilts is effective at countering inundation in medium term but not effective at countering erosion Option would have to be combined with a protect pathway (nouirishment or seawall option) to increase erosion effectiveness	1	4	2	5	1	4	2	1	**20**
Protect	P9 + P2	**Levees with on-going nourishment**	This option would involve construction of a levee to protect against inundation and on-going nourishment to counter erosion	Moderate implementation difficulty, with on-going resources required to implement Nourishment uses locally available sand Levee requires import of clay core material or Geotextile Clay Layer	Will impact on environment at nourishment source site and placement site Maintains some beach width	Insignificant impacts	Loss of access to some community values, as levee separates community from Settlement beaches and views Nourishment maintains beach widths	Low impact - no businesses lost	Nourishment is reversible or flexible, allowing different pathways to be implemented as required	Effective short term adaptation option Requires on-going nourishment and sand sources are finite Not effective in long term given potential groundwater shoaling behind levees	2	2	5	3	5	5	3	1	**26**
	P9 + P6	**Levees with GSC Seawalls**	This option would involve construction of a combined levee and GSC seawall structure to counter inundation and erosion	Relatively straightforward implementation, using previously implemented GSC seawalls Containers need to be imported but uses locally available sand Levee requires import of clay core material or Geotextile Clay Layer	Likely to impact beaches in front and adjacent to seawall	Insignificant impacts	Loss of access to certain assets, as levee separates community from Settlement beaches and views Seawalls cause erosion of Settlement beaches	Low impact - no businesses lost	Seawalls are reversible or adaptable but with some cost. This could includes raised crests or additional bag layers	Effective short term adaptation option GSC seawalls are considered less robust than concrete SeaBee seawalls Not effective in long term given potential groundwater shoaling behind levees	5	3	5	2	5	3	3	2	**28**
	P9 + P7	**Levees with Concrete SeaBee Seawalls**	This option would involve construction of a combined levee and concrete seabee seawall structure to counter inundation and erosion	Moderate implementation difficulty, using Seabee seawall units that need to be imported Levee requires import of clay core material or Geotextile Clay Layer	Likely to impact beaches in front and adjacent to seawall	Insignificant impacts	Loss of access to certain assets, as levee separates community from Settlement beaches and views Seawalls cause erosion of Settlement beaches	Low impact - no businesses lost	Seabee seawalls are difficult to reverse or adapt. The crest could be raised but additional concrete layers could not be added	Effective medium term adaptation option Not effective in long term given potential groundwater shoaling behind levees	4	3	5	2	5	2	4	2	**27**

Wavelength

Project: Shape Urban - Cocos Islands CHRMAP
Title: West Island Settlement
By: Wavelength
Revision: A

Document: Short Term WI Settlement MCA
Date: 22/03/23

Adaptation Option Costings - West Island Short to Medium Term

				Option	AC1					P9 + P2					P9 + P6					P9 + P7				
				Name	Accommodate					Levees with nourishment					Levees with GSC Seawalls					Levees with Concrete Seabee Seawalls				
					Capital Costs		Seawall Repair Costs		Sand Volumes	Capital Costs		Seawall Repair Costs		Sand Volumes	Capital Costs		Seawall Repair Costs		Sand Volumes	Capital Costs		Seawall Repair Costs		Sand Volumes
Timeframe		$	Unit		Qty	Subtotal	Seawall Length (m)	Subtotal		Qty	Subtotal	Seawall Length (m)	Subtotal		Qty	Subtotal	Seawall Length (m)	Subtotal		Qty	Subtotal	Seawall Length (m)	Subtotal	
Present Day	Mobilisation Civil/Structural	$ 100,000	/unit		2	$ 200,000				5	$ 500,000				1	$ 100,000				1	$ 100,000			
	Protect - Upgrade GSC Seawall - 1 additional crest layer	$ 2,100	/m			$ -			-		$ -			-	0	$ -			-		$ -			-
	Protect - Upgrade Seabee Seawall - raise crest height 1m	$ 3,400	/m			$ -					$ -					$ -				0	$ -			
	Protect - New GSC Seawall	$ 14,000	/m			$ -			-		$ -			-	1130	$ 15,820,000			17,196		$ -			-
	Protect - New Seabee Seawall	$ 17,000	/m			$ -					$ -					$ -				1130	$ 19,210,000			-
	Protect - New 1m high levee	$ 3,000	/m			$ -			-		$ -			-		$ -			-		$ -			-
	Protect - New 1.5m high levee	$ 5,000	/m			$ -			-	900	$ 4,500,000			6,300	900	$ 4,500,000			6,300	900	$ 4,500,000			6,300
	Protect - Nourishment	$ 1,404	/m per year			$ -			-	1070	$ 1,501,852			13,653		$ -			-		$ -			-
	Accommodate - Raise road 1m and asphalt	$ 2,600	/m			$ -			-		$ -			-		$ -			-		$ -			-
	Accommodate - Asphalt new road	$ 2,200	/m		470	$ 1,034,000					$ -					$ -					$ -			-
	Accommodate - New stilted house	$ 900,000	/unit		56	$ 50,400,000					$ -					$ -					$ -			-
	Accommodate - Large Building (commercial or public)	$ 2,700,000	/unit		11	$ 29,700,000					$ -					$ -					$ -			-
	Accommodate - Raise stilted house 0.5m	$ 100,000	/unit			$ -					$ -					$ -					$ -			-
	Project Management	5%	item			$ 4,066,700					$ 325,093					$ 1,021,000					$ 1,190,500			
	Approvals and monitoring - general	5%	item			$ 4,066,700					$ 325,093					$ 1,021,000					$ 1,190,500			
	PM and approvals - nourishment	10%	item			$ -					$ 150,185					$ -					$ -			
	Contingency	20%	item			$ 16,266,800					$ 1,300,370					$ 4,084,000					$ 4,762,000			
	Repairs	specific to option	item				0%					0%					5%					2%		
			Total			$ 105,734,200		$ -	-		$ 8,602,593		$ -	19,953		$ 26,546,000	1240	$ 868,000	23,496		$ 30,953,000	1240	$ 421,600	6,300
2030	Mobilisation Civil/Structural	$ 100,000	/unit			$ -				5	$ 500,000				1	$ 100,000				1	$ 100,000			
	Mobilisation TSHD	$ 4,500,000	/unit			$ -					$ -					$ -					$ -			
	Protect - Upgrade GSC Seawall - 1 additional crest layer	$ 2,100	/m			$ -			-		$ -			-	0	$ -			-		$ -			-
	Protect - Upgrade Seabee Seawall - raise crest height 1m	$ 3,400	/m			$ -					$ -					$ -				0	$ -			
	Protect - New GSC Seawall	$ 14,000	/m			$ -			-		$ -			-	660	$ 9,240,000			10,043		$ -			-
	Protect - New Seabee Seawall	$ 17,000	/m			$ -					$ -					$ -				660	$ 11,220,000			-
	Protect - New 1m high levee	$ 3,000	/m			$ -			-		$ -			-		$ -			-		$ -			-
	Protect - New 1.5m high levee	$ 5,000	/m			$ -			-	0	$ -			-	0	$ -			-	0	$ -			-
	Protect - Nourishment	$ 1,597	/m per year			$ -			-	1730	$ 2,763,156			22,075		$ -			-		$ -			-
	Accommodate - Raise road 1m and asphalt	$ 2,600	/m			$ -			-		$ -			-		$ -			-		$ -			-
	Accommodate - Asphalt new road	$ 2,200	/m			$ -					$ -					$ -					$ -			-
	Accommodate - New stilted house	$ 900,000	/unit			$ -					$ -					$ -					$ -			-
	Accommodate - Large Building (commercial or public)	$ 2,700,000	/unit			$ -					$ -										$ -			
	Accommodate - Raise stilted house 0.5m	$ 100,000	/unit			$ -					$ -					$ -					$ -			
	Project Management	5%	item			$ -					$ 138,158					$ 462,000					$ 561,000			
	Approvals and monitoring - general	5%	item			$ -					$ 138,158					$ 462,000					$ 561,000			
	PM and approvals - nourishment	10%	item			$ -					$ 276,316					$ -					$ -			
	Contingency	20%	item			$ -					$ 652,631					$ 1,868,000					$ 2,264,000			
	Repairs	specific to option	item				0%					0%					5%					2%		
			Total			$ -		$ -	-		$ 4,468,418		$ -	22,075		$ 12,132,000	1240	$ 868,000	10,043		$ 14,706,000	1240	$ 421,600	-
2040	Mobilisation Civil/Structural	$ 100,000	/unit			$ -				5	$ 500,000				1	$ 100,000					$ -			
	Mobilisation TSHD	$ 4,500,000	/unit			$ -					$ -					$ -					$ -			
	Protect - Upgrade GSC Seawall - 1 additional crest layer	$ 2,100	/m			$ -			-		$ -			-	720	$ 1,512,000			1,565		$ -			-
	Protect - Upgrade Seabee Seawall - raise crest height 1m	$ 3,400	/m			$ -					$ -					$ -				0	$ -			
	Protect - New GSC Seawall	$ 14,000	/m			$ -			-		$ -			-	1180	$ 16,520,000			17,957		$ -			-
	Protect - New Seabee Seawall	$ 17,000	/m			$ -					$ -					$ -				0	$ -			
	Protect - New 1m high levee	$ 3,000	/m			$ -			-		$ -			-		$ -			-		$ -			-
	Protect - New 1.5m high levee	$ 5,000	/m			$ -			-	0	$ -			-	0	$ -			-	0	$ -			-
	Protect - Nourishment	$ 1,597	/m per year			$ -			-	1730	$ 2,763,156			22,075		$ -			-		$ -			-
	Accommodate - Raise road 1m and asphalt	$ 2,600	/m			$ -			-		$ -			-		$ -			-		$ -			-
	Accommodate - Asphalt new road	$ 2,200	/m			$ -					$ -					$ -					$ -			
	Accommodate - New stilted house	$ 900,000	/unit			$ -					$ -					$ -					$ -			
	Accommodate - Large Building (commercial or public)	$ 2,700,000	/unit			$ -					$ -										$ -			
	Accommodate - Raise stilted house 0.5m	$ 100,000	/unit			$ -					$ -					$ -					$ -			
	Project Management	5%	item			$ -					$ 138,158					$ 901,600					$ -			
	Approvals and monitoring - general	5%	item			$ -					$ 138,158					$ 901,600					$ -			
	PM and approvals - nourishment	10%	item			$ -					$ 276,316					$ -					$ -			
	Contingency	20%	item			$ -					$ 652,631					$ 3,626,400					$ -			
	Repairs	specific to option	item				0%					0%					5%					2%		
			Total			$ -		$ -	-		$ 4,468,418		$ -	22,075		$ 23,561,600	1240	$ 868,000	19,522		$ -	1240	$ 421,600	-
2050	Mobilisation Civil/Structural	$ 100,000	/unit			$ -				5	$ 500,000				1	$ 100,000				1	$ 100,000			
	Mobilisation TSHD	$ 4,500,000	/unit			$ -					$ -					$ -					$ -			
	Protect - Upgrade GSC Seawall - 1 additional crest layer	$ 2,100	/m			$ -			-		$ -			-	660	$ 1,386,000			1,435		$ -			-
	Protect - Upgrade Seabee Seawall - raise crest height 1m	$ 3,400	/m			$ -					$ -					$ -				1110	$ 3,774,000			
	Protect - New GSC Seawall	$ 14,000	/m			$ -			-		$ -			-	660	$ 9,240,000			10,043		$ -			-
	Protect - New Seabee Seawall	$ 17,000	/m			$ -					$ -					$ -				1130	$ 19,210,000			
	Protect - New 1m high levee	$ 3,000	/m			$ -			-		$ -			-		$ -			-		$ -			-
	Protect - New 1.5m high levee	$ 5,000	/m			$ -			-	0	$ -			-	0	$ -			-	0	$ -			-
	Protect - Nourishment	$ 1,597	/m per year			$ -			-	1730	$ 2,763,156			22,075		$ -			-		$ -			-
	Accommodate - Raise road 1m and asphalt	$ 2,600	/m			$ -			-		$ -			-		$ -			-		$ -			-
	Accommodate - Asphalt new road	$ 2,200	/m			$ -					$ -					$ -					$ -			
	Accommodate - New stilted house	$ 900,000	/unit			$ -					$ -					$ -					$ -			
	Accommodate - Large Building (commercial or public)	$ 2,700,000	/unit			$ -					$ -										$ -			
	Accommodate - Raise stilted house 0.5m	$ 100,000	/unit			$ -					$ -					$ -					$ -			
	Project Management	5%	item			$ -					$ 138,158					$ 531,300					$ 1,149,200			
	Approvals and monitoring - general	5%	item			$ -					$ 138,158					$ 531,300					$ 1,149,200			
	PM and approvals - nourishment	10%	item			$ -					$ 276,316					$ -					$ -			
	Contingency	20%	item			$ -					$ 652,631					$ 2,145,200					$ 4,616,800			
	Repairs	specific to option	item				0%					0%					5%					2%		
			Total			$ -		$ -	-		$ 4,468,418		$ -	22,075		$ 13,933,800	1240	$ 868,000	11,478		$ 29,999,200	1240	$ 421,600	-
2060	Mobilisation Civil/Structural	$ 100,000	/unit		2	$ 200,000				5	$ 500,000				1	$ 100,000				1	$ 100,000			
	Mobilisation TSHD	$ 4,500,000	/unit			$ -					$ -					$ -					$ -			
	Protect - Upgrade GSC Seawall - 1 additional crest layer	$ 2,100	/m			$ -			-		$ -			-	1110	$ 2,331,000			2,413		$ -			-
	Protect - Upgrade Seabee Seawall - raise crest height 1m	$ 3,400	/m			$ -					$ -					$ -				660	$ 2,244,000			
	Protect - New GSC Seawall	$ 14,000	/m			$ -			-		$ -			-	1180	$ 16,520,000			17,957		$ -			-
	Protect - New Seabee Seawall	$ 17,000	/m			$ -					$ -					$ -				720	$ 12,240,000			
	Protect - New 1m high levee	$ 3,000	/m			$ -			-		$ -			-		$ -			-		$ -			-
	Protect - New 1.5m high levee	$ 5,000	/m			$ -			-	0	$ -			-	0	$ -			-	0	$ -			-
	Protect - Nourishment	$ 1,597	/m per year			$ -			-	1730	$ 2,763,156			22,075		$ -			-		$ -			-
	Accommodate - Raise road 1m and asphalt	$ 2,600	/m			$ -			-		$ -			-		$ -			-		$ -			-
	Accommodate - Asphalt new road	$ 2,200	/m			$ -					$ -					$ -					$ -			
	Accommodate - New stilted house	$ 900,000	/unit		3	$ 2,700,000					$ -					$ -					$ -			
	Accommodate - Large Building (commercial or public)	$ 2,700,000	/unit			$ -					$ -					$ -					$ -			
	Accommodate - Raise stilted house 0.5m	$ 100,000	/unit			$ -					$ -					$ -					$ -			
	Project Management	5%	item			$ 135,000					$ 138,158					$ 942,550					$ 724,200			
	Approvals and monitoring - general	5%	item			$ 135,000					$ 138,158					$ 942,550					$ 724,200			
	PM and approvals - nourishment	10%	item			$ -					$ 276,316					$ -					$ -			
	Contingency	20%	item			$ 580,000					$ 652,631					$ 3,790,200					$ 2,916,800			
	Repairs	specific to option	item				0%					0%					5%					2%		
			Total			$ 3,750,000		$ -	-		$ 4,468,418		$ -	22,075		$ 24,626,300	1240	$ 868,000	20,370		$ 18,949,200	1240	$ 421,600	-

APPENDIX D

Appendix D: School CHRMAP Presentation



Cocos (Keeling) Islands Coastal Hazard Risk Management and Adaptation Planning Project – Community Reference Group

Australian Government Department of Infrastructure, Transport, Regional Development, Communications and the Arts, in partnership with WA Department of Planning, Lands and Heritage, and Shire of Cocos Keeling Islands

SHAPE URBAN

Wavelength

COASTAL PLANNING – WHAT IS IT, WHY, HOW

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Why are we here?

We are doing the **Coastal Hazard Risk Management Adaptation Plan** (CHRMAP) for Cocos (Keeling) Islands

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COASTAL HAZARDS



Coastal hazard challenges

The key challenges on the coast are **erosion** and **inundation**





Predicted Sea Level Rise will increase both!

SHAPE URBAN

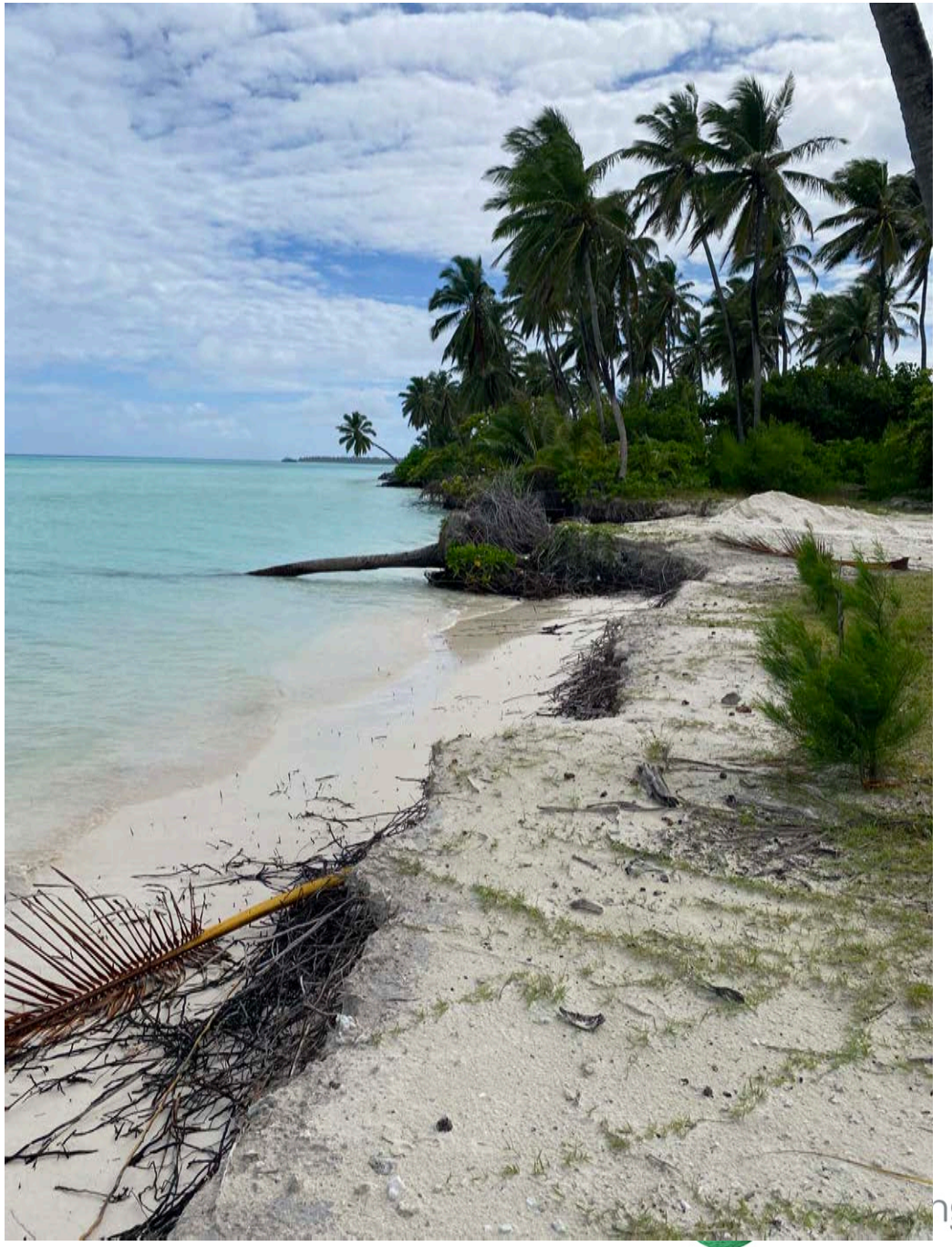
Wavelength

What’s a coastal hazard?

The Cocos (Keeling) Islands are affected by coastal erosion and inundation

Erosion is when the beach starts ‘disappearing’;

- Gradually from natural movement of sand
- Fast after big storms and cyclones or high tides



What’s a coastal hazard?

The Cocos (Keeling) Islands are affected by coastal erosion and inundation

Inundation is when the sea rises up above the edge of the land and starts to flood the ground;

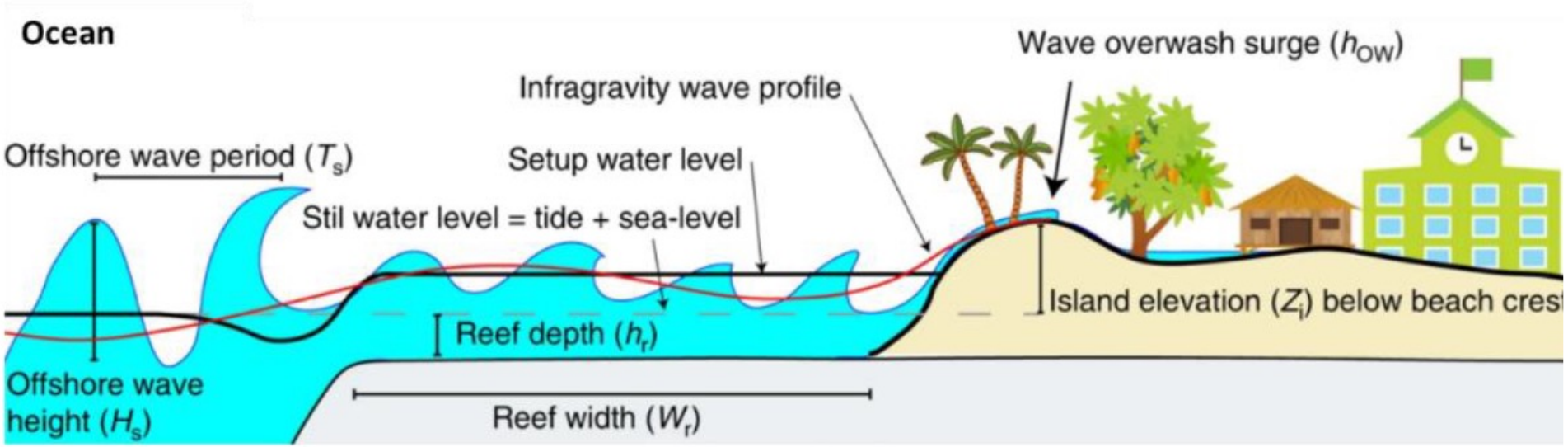
- During times of high tides, sometimes with storms as well
- Over time as sea level rises



Coastal Inundation

Lagoon side - extreme water levels driven by short term wind waves and cyclone events.

Ocean side - offshore waves travelling across the reef, causing wave setup and runup (i.e. elevated water levels and flooding).



Sea Level Rise - Predictions

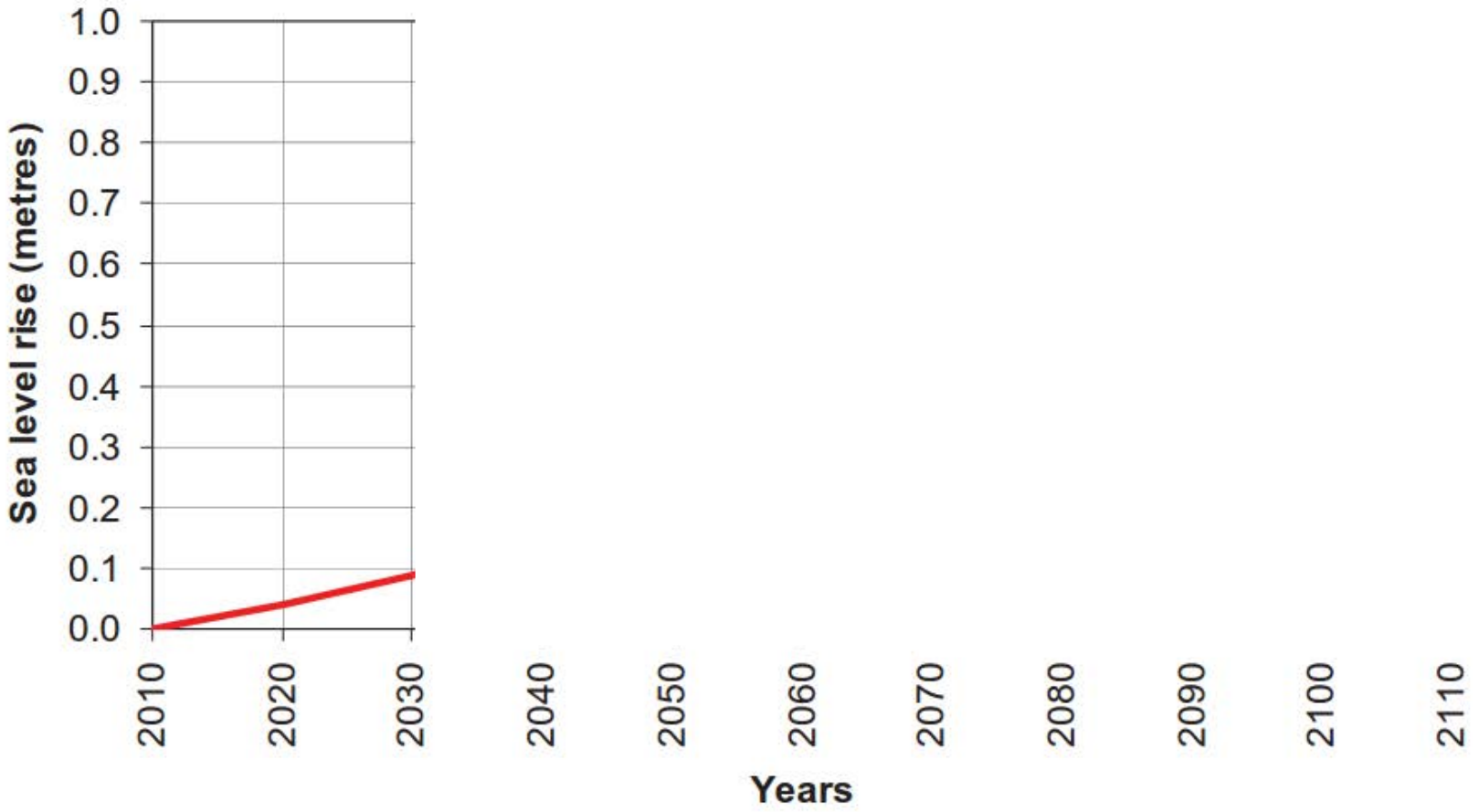
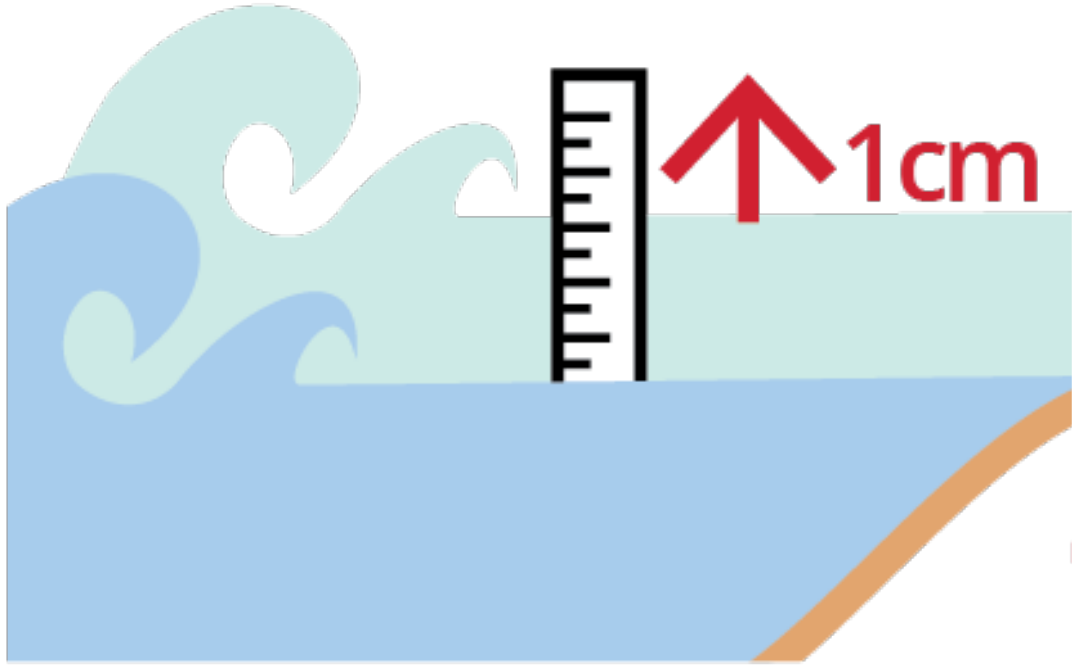


Figure 16 - Recommended allowance for sea level rise in coastal planning for WA (red line SRES scenario A1FI 95th percentile after Hunter (2009), normalised to 2010, blue line continuation of scenario to 2010)

Wavelength

Sea Level Rise – why it matters



What a CHRMAP does

Predict the *risk* of **erosion** + **inundation** with sea level rise

- Looks at likelihood of exposure on an asset
- Looks at consequence of exposure on an asset (or sensitivity)

Then considers adaptability of the asset

What about Cocos Keeling?

The Cocos (Keeling) Islands are affected by coastal erosion and inundation

- Coastlines are used and highly valued
- Need to understand how the coastlines are changing
- How to respond for sustainable living for CKI community into the future
- We will be making **recommendations for action**

Project Background

- DPLH - *Cocos (Keeling) Islands Coastal Vulnerability Study* (Haskoning Australia PTY Ltd, 2021) identified areas vulnerable over a 100-year planning timeframe
- This project is next step to deliver this ‘CHRMAP’
- Then deliver actions ($$)

What we know

- The islands are one of the most vulnerable coastal types to Sea Level Rise (SLR)
- The Coastal Vulnerability Study shows risks are already ‘High’ for multiple assets.

The studies don’t tell us what is *valuable* to YOU, only what is *objectively* vulnerable



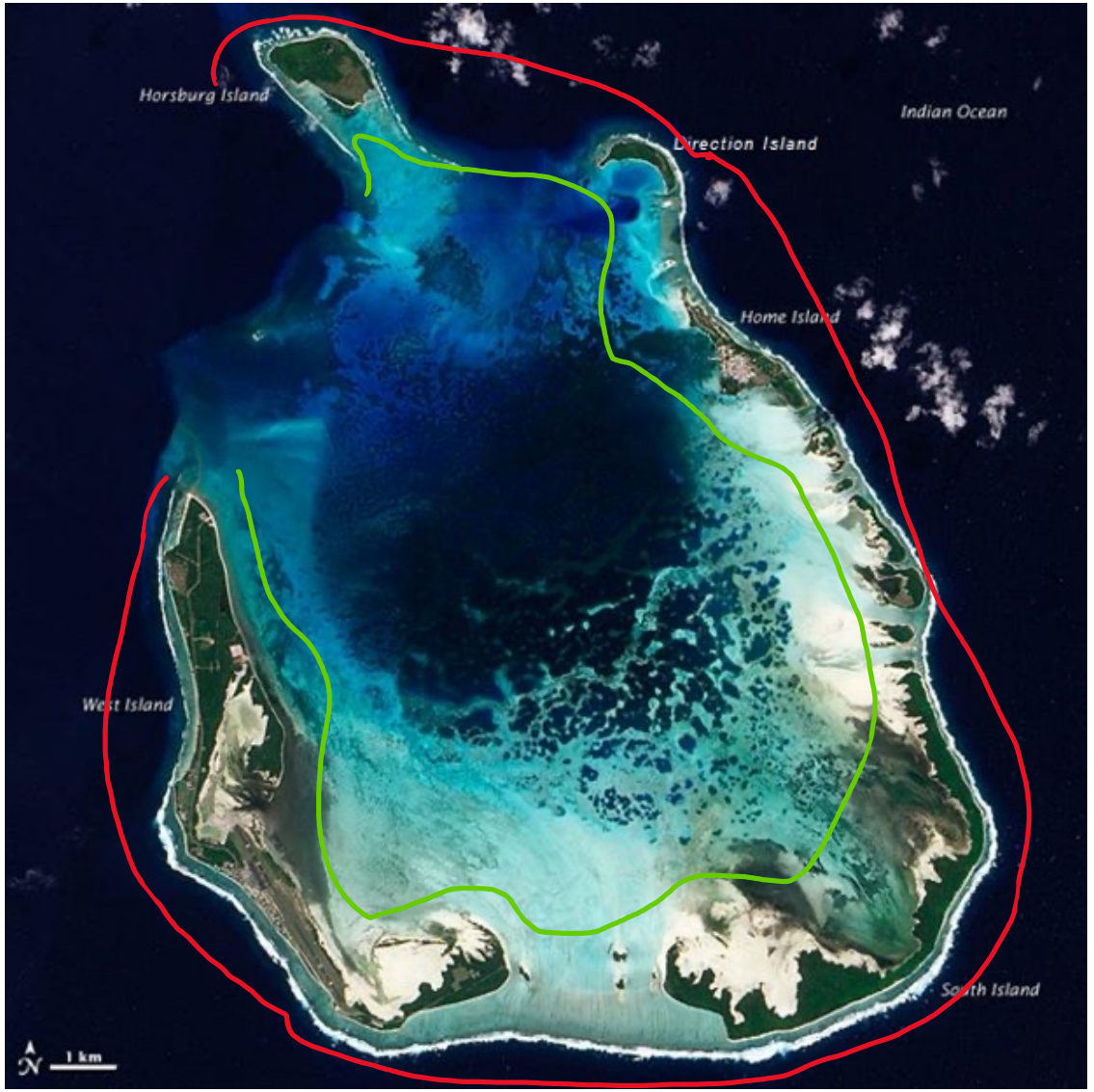
Island landforms and settlement

The shoreline around CKI can be divided into:

- ocean shores that occur around the perimeter of the atoll and face the open ocean; and
- lagoon shores that flank the lagoon

Fringing coral reef surrounds all the CKI lagoon

Two breaks in the reef at Port Refuge and Western Entrance



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West Island

Elongated shape with a sandy shoreline

Development along the ocean coast has a very narrow foreshore buffer

The island has a history of chronic erosion along the western ocean facing shore

Construction of multiple coastal structures since the 1970's



West Island





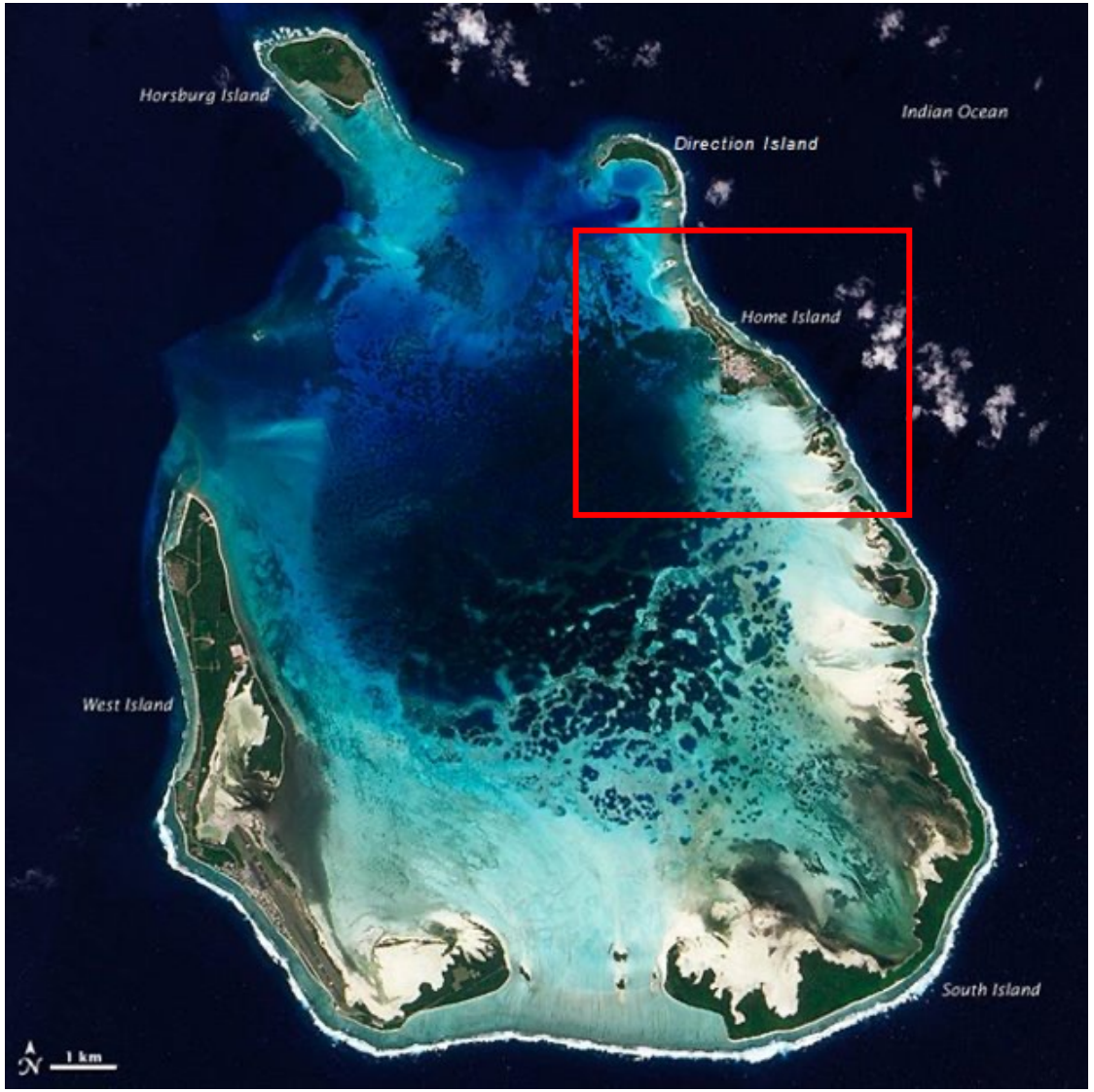
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Home Island

Low lying and susceptible to coastal flooding, especially the foreshore adjacent to the lagoon

Most shorelines on Home Island have been stable and infrastructure on the ocean coast is reasonably setback in most locations



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Home Island





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Cyclones and Waves

The region experiences tropical cyclones, typically 2-3 per year

Subsequently, extreme wave events occur, impacting both ocean facing sides

The local wave climate includes:

- **Local sea waves** produced by winds predominantly from the east
- **Swell waves** from storms in the Indian Ocean, predominantly from the south west

Tides and Currents

CKI typically has two high tides and two low tides per day

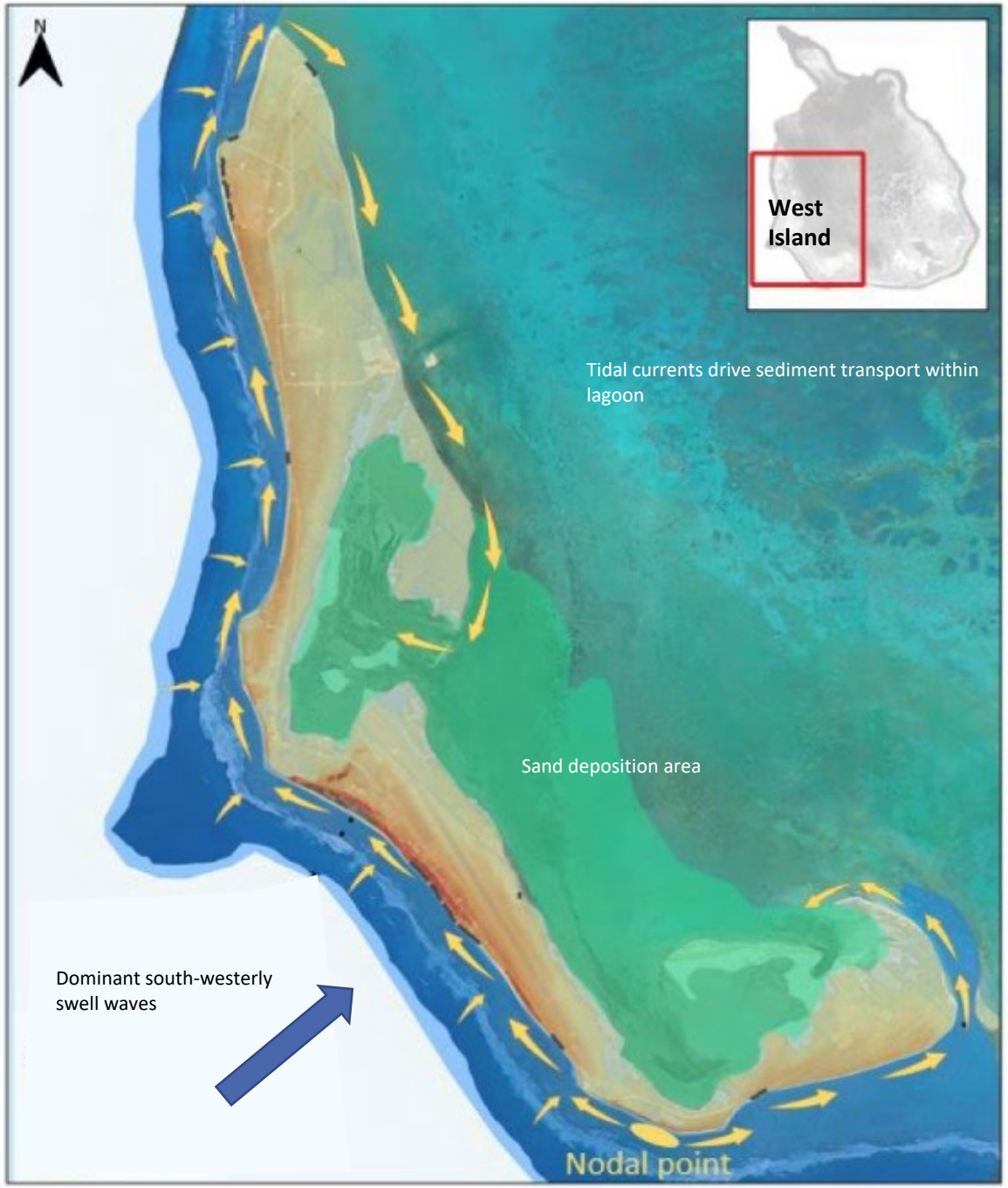
Mean sea level varies on a monthly timescale - sea level rise will also increase mean sea levels over time

Department of Transport recommends the following sea level rises be used for planning:

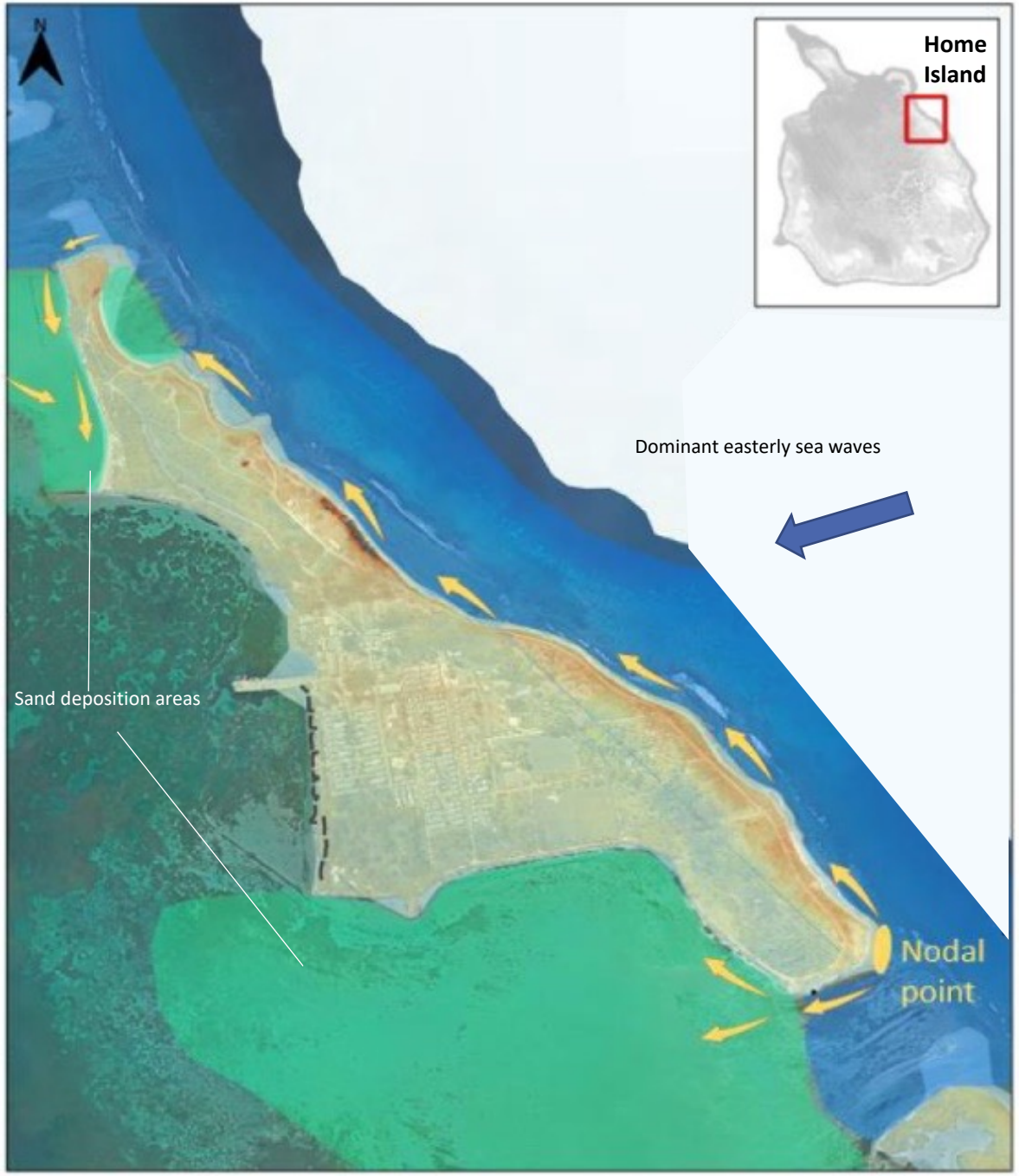
- 0.4m for a 50-year planning timeframe (i.e. 2068)
- 0.9m for a 100-year planning timeframe (2118)

Currents and circulation within the lagoon are driven by waves, wind and tides

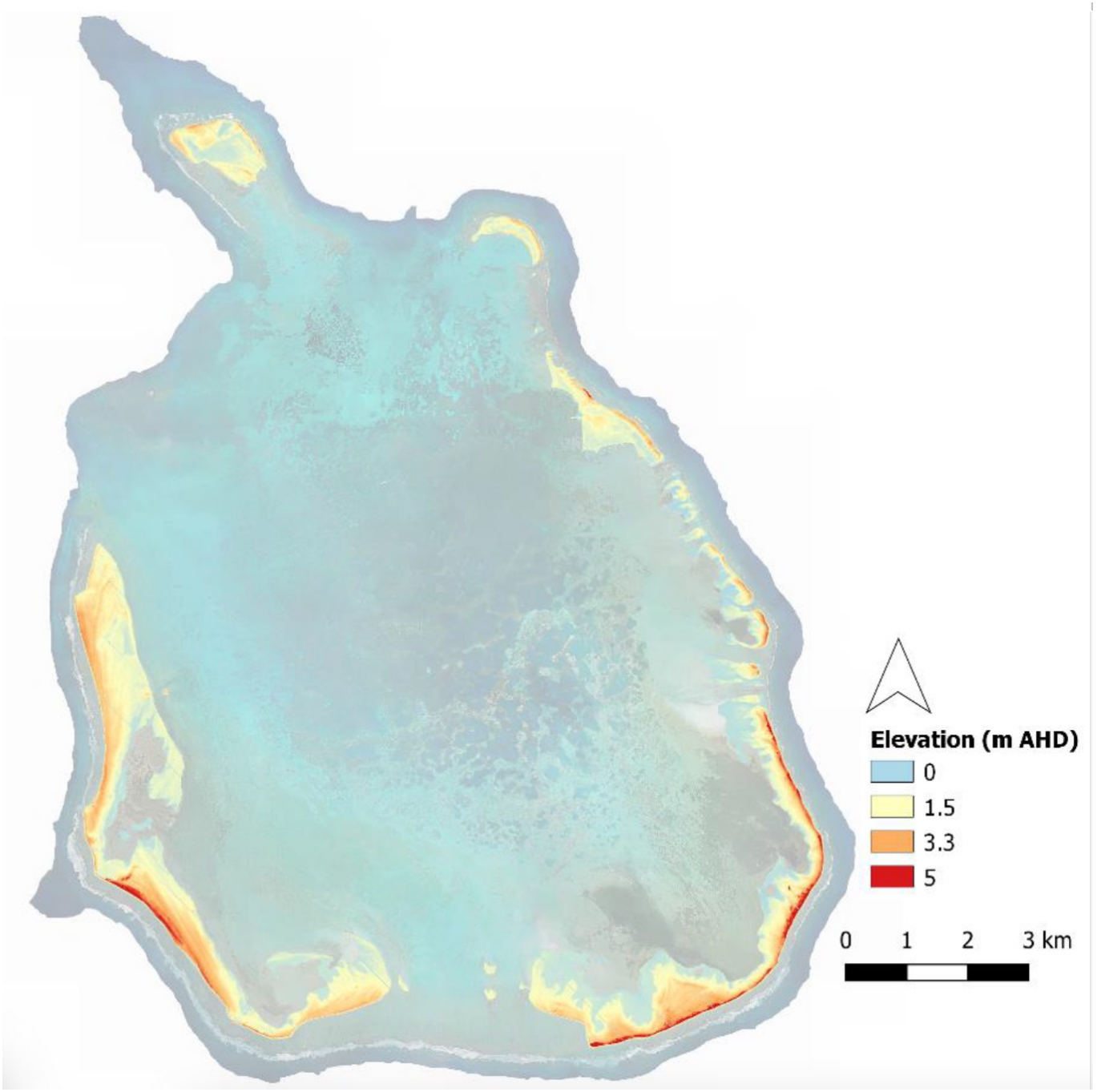
Sand Movement and Erosion



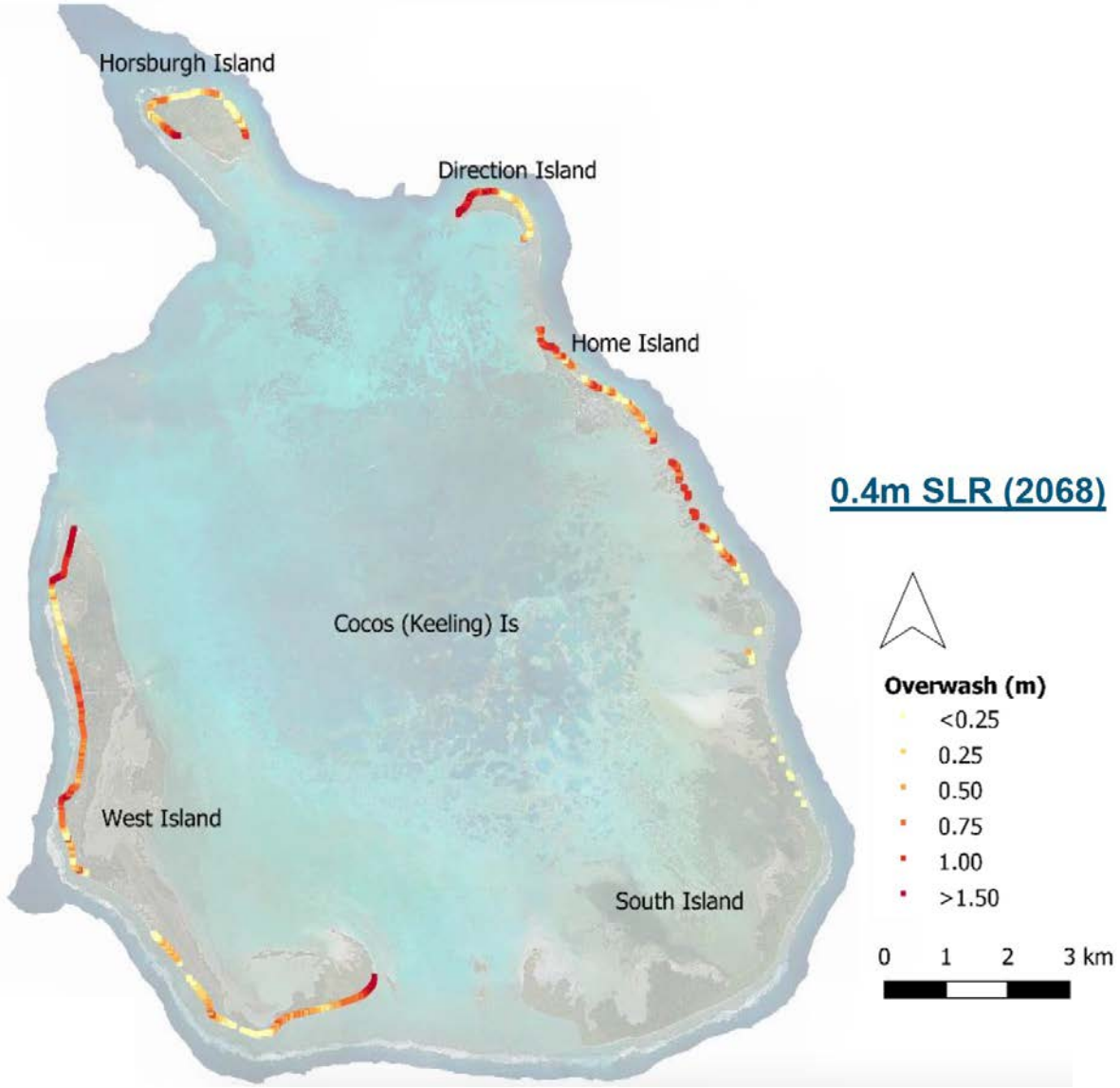
Sand Movement and Erosion

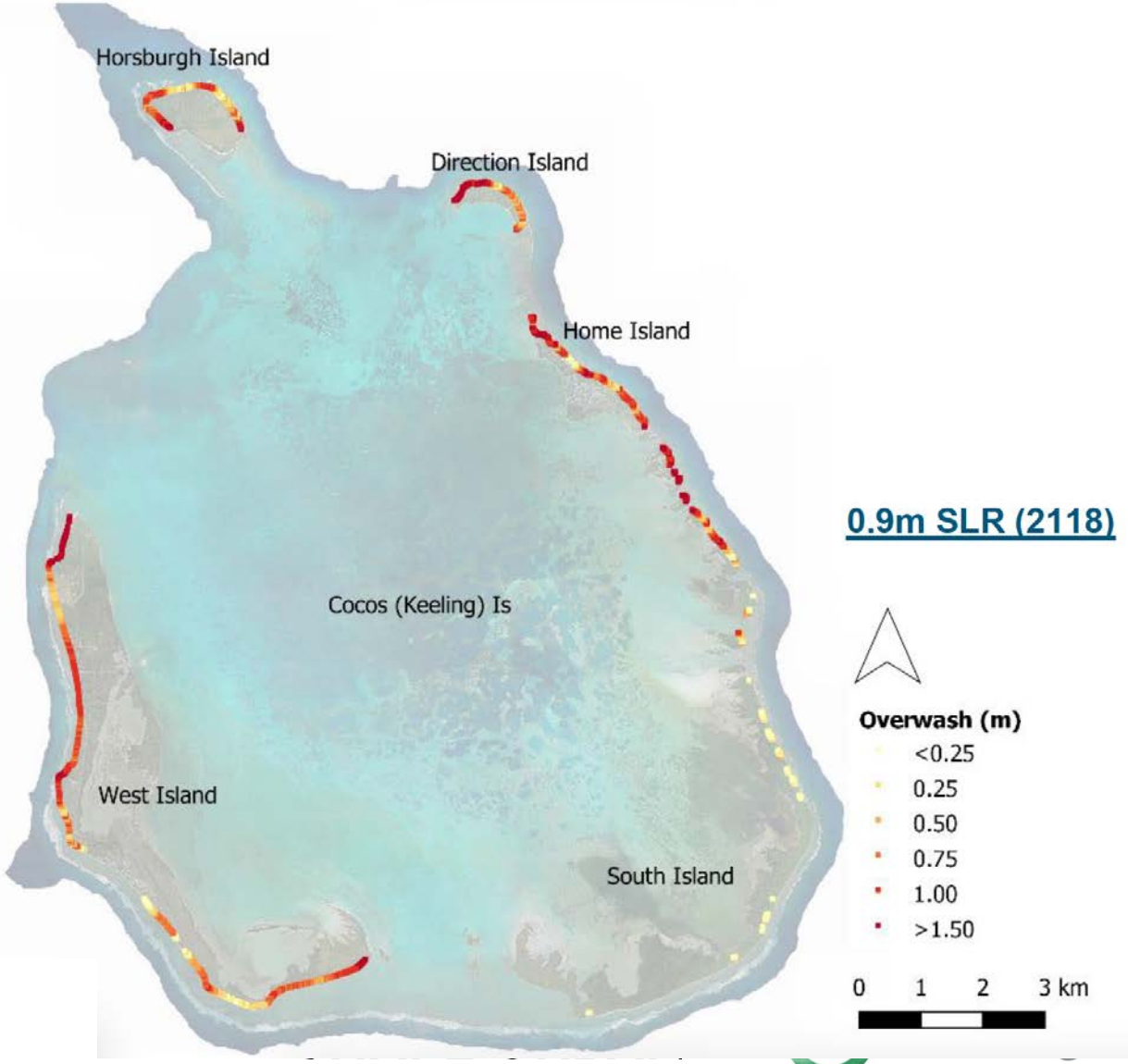


Elevation



Overtopping





Q & A

SHAPE URBAN

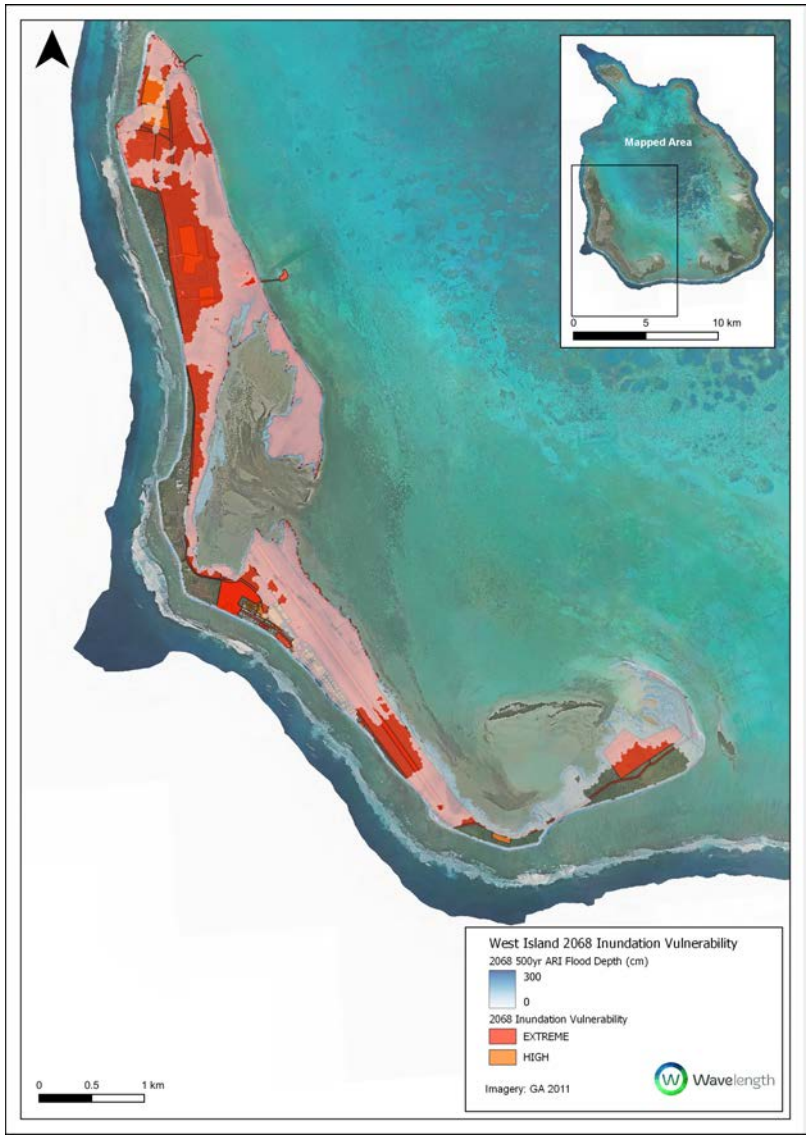
Wavelength

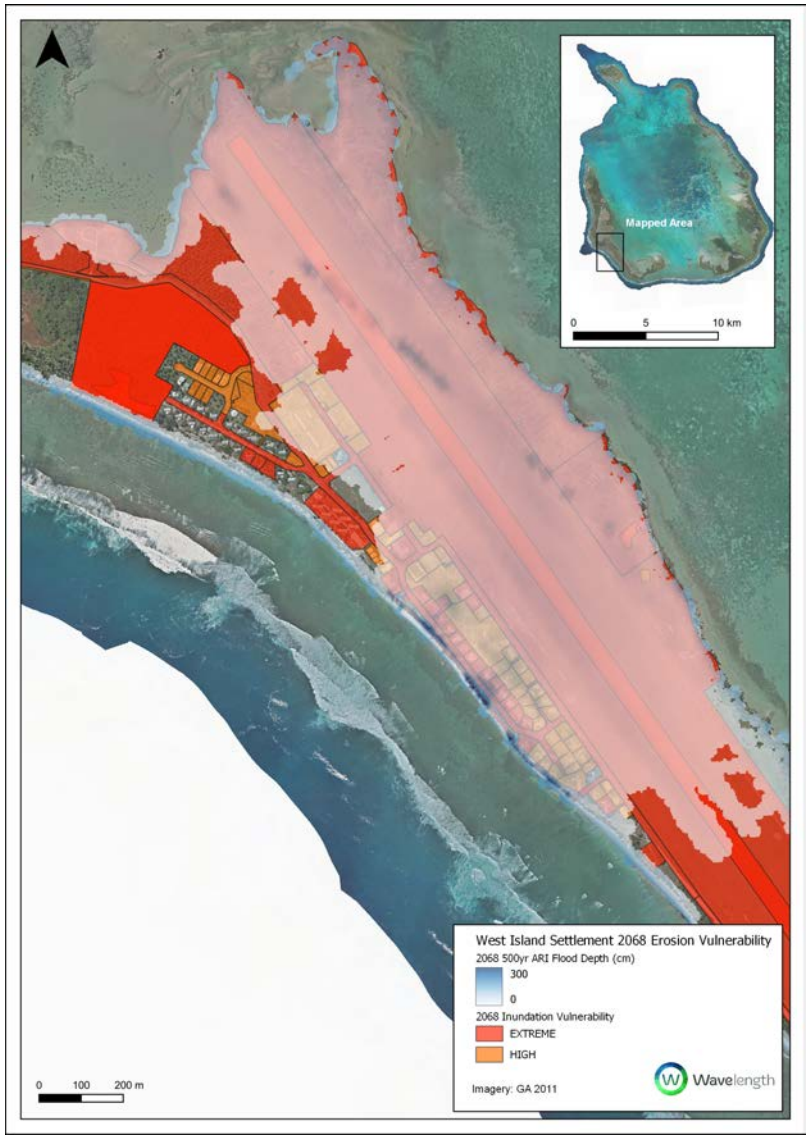
Vulnerability Mapping for 2018 and 2068

SHAPE URBAN

Wavelength

West Island – Inundation Vulnerability 2068

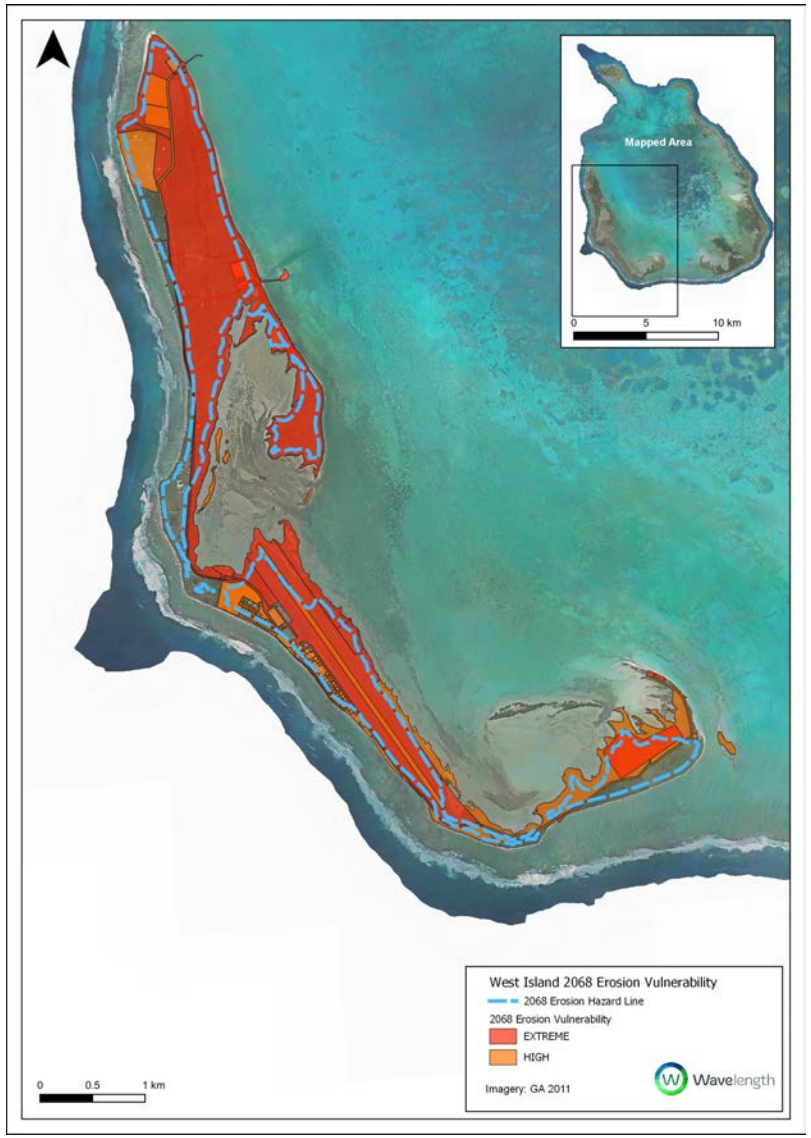


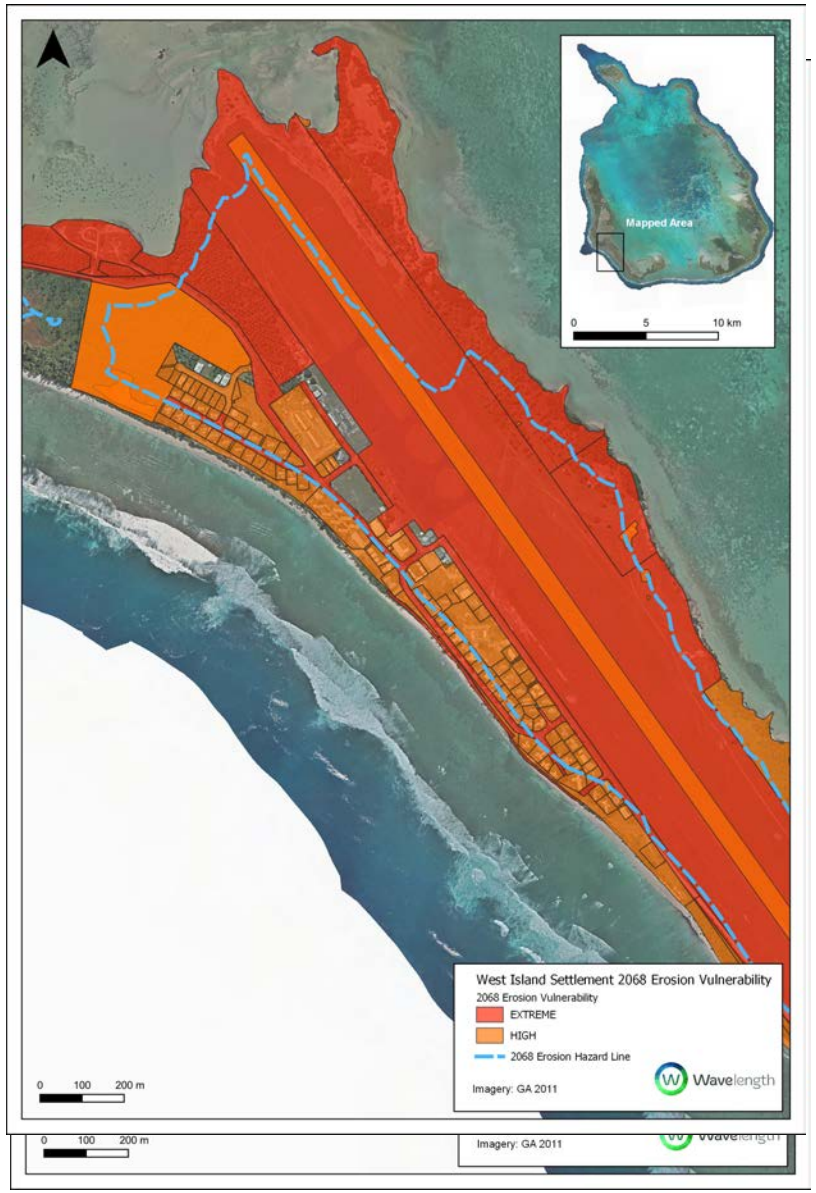


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Wavelength

West Island – Erosion Vulnerability 2068

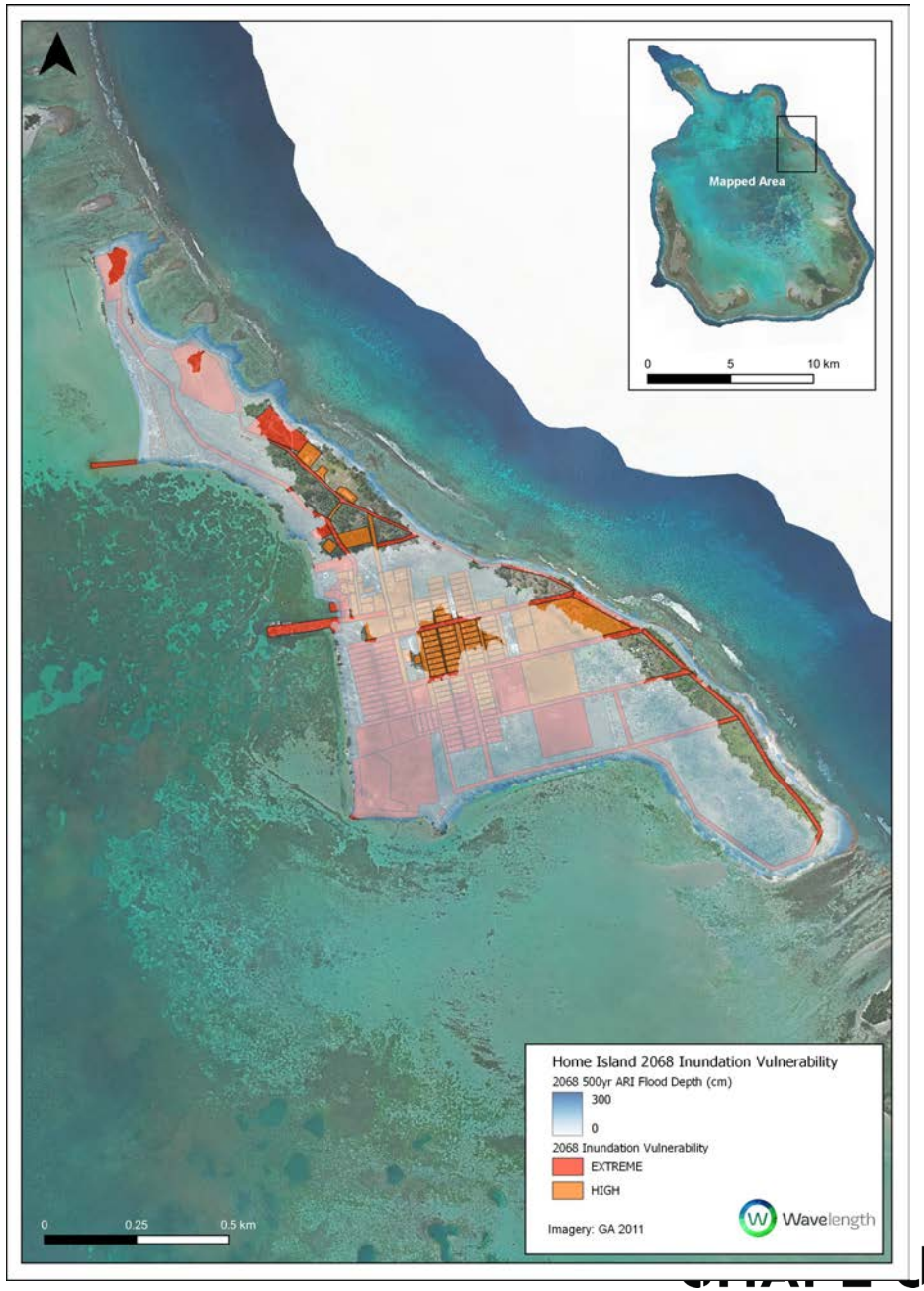




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Wavelength

Home Island – Inundation Vulnerability 2068



URBAN

Wavelength

Home Island – Erosion Vulnerability 2068



URBAN

Wavelength

Q & A

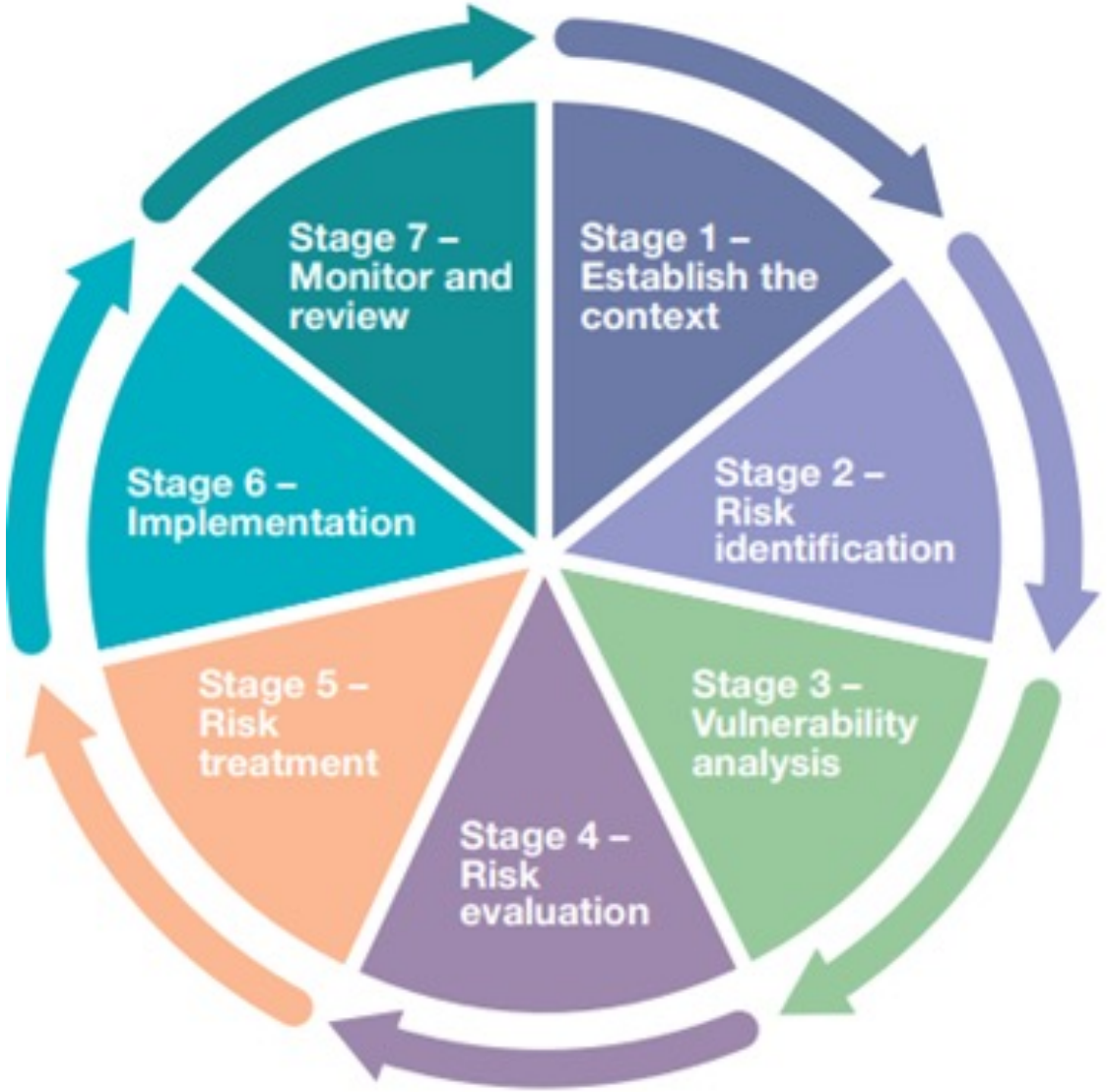
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Wavelength


ADAPTATION
PLANNING

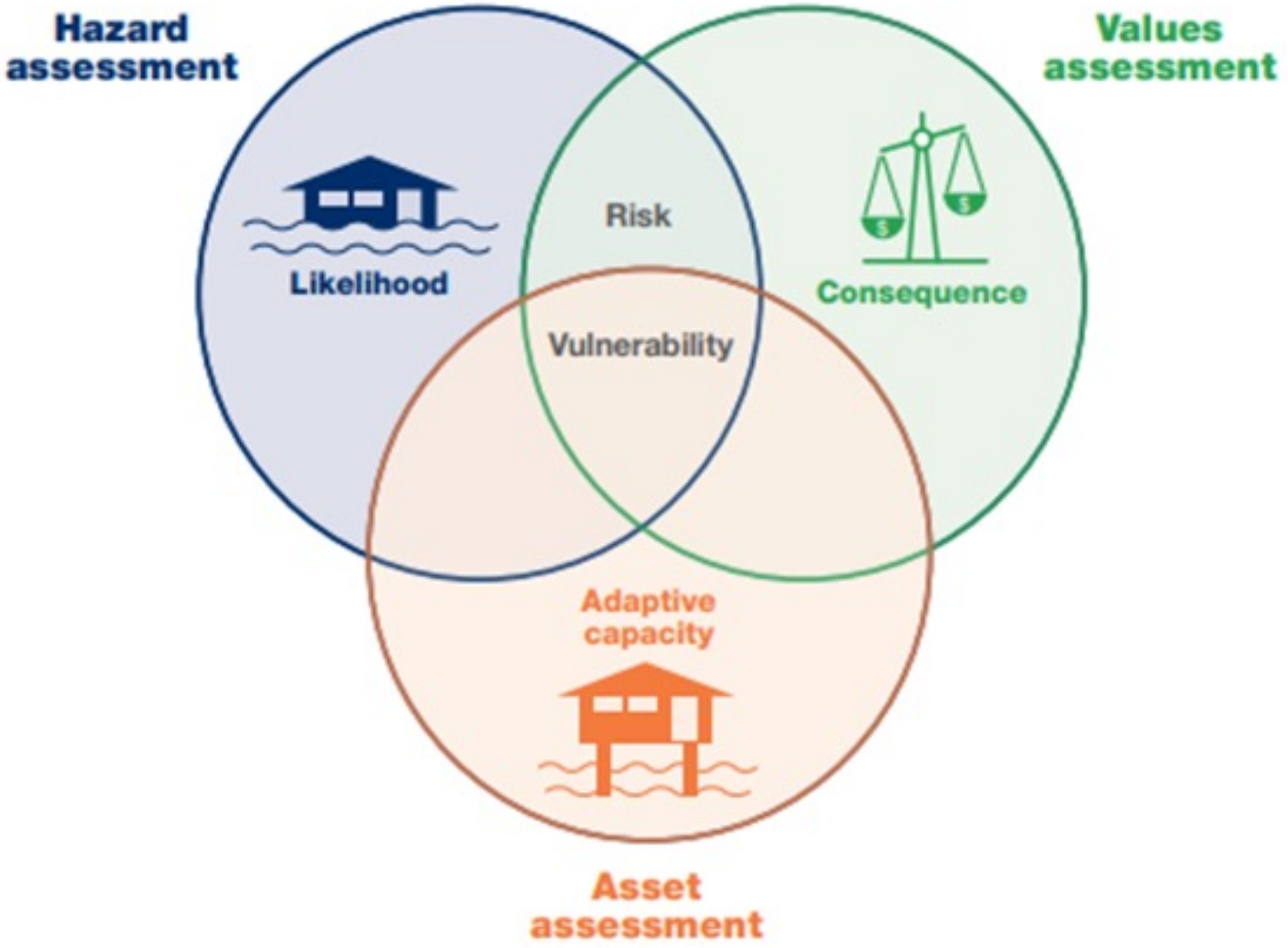
How to complete it

SPP 2.6 + CHRMAP Guidelines - Process



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Wavelength



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Possible adaptation options



Avoid – options which aim to eliminate the risk of coastal hazards by avoiding development



Planned/ Managed Retreat – options which progressive retreat / relocate development

Possible adaptation options



Accommodate – possible options which seek to enhance assets to cope with the temporary impacts



Protect – possible options which seek to artificially protect the coast

Accommodate – lift levels

Replace and upgrade properties and buildings at end of design life



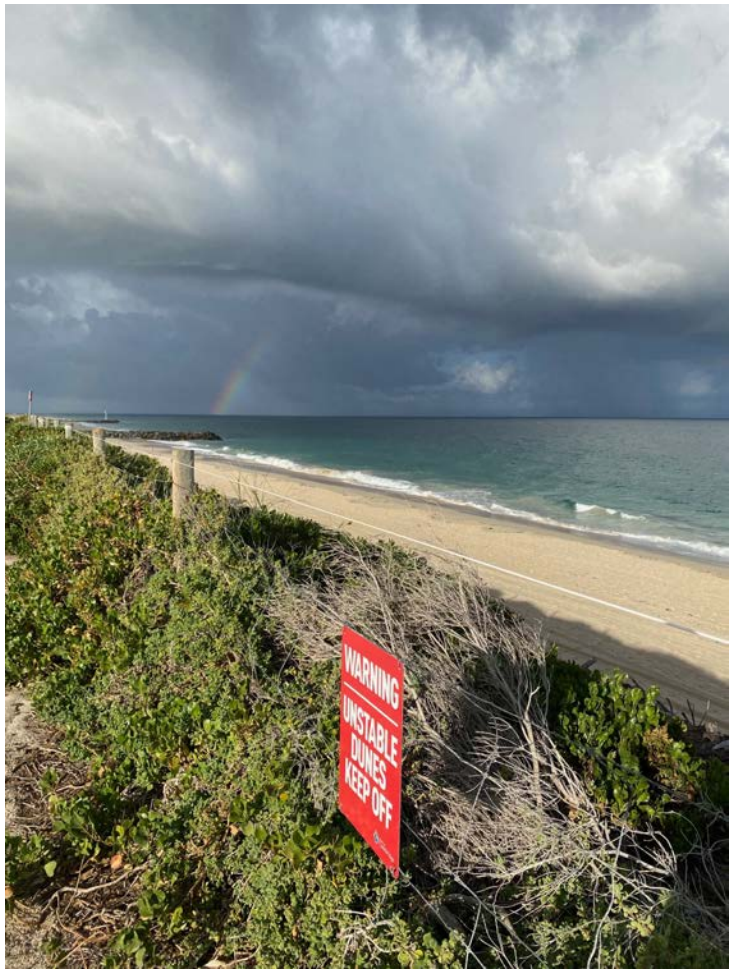
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Accommodate – Monitoring and re-vegetation

Citizen monitoring, planting, soft protect







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Protect examples



geotextile sand container (GSC) seawall



concrete seawall

Seawalls

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Protect







Levees and road raising

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Protect

Offshore breakwaters and groynes





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Thank You

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