

# Appendix D

**Appendix D Excerpts of Cocos (Keeling) Islands Master Plan showing opportunities affected by coastal hazards**

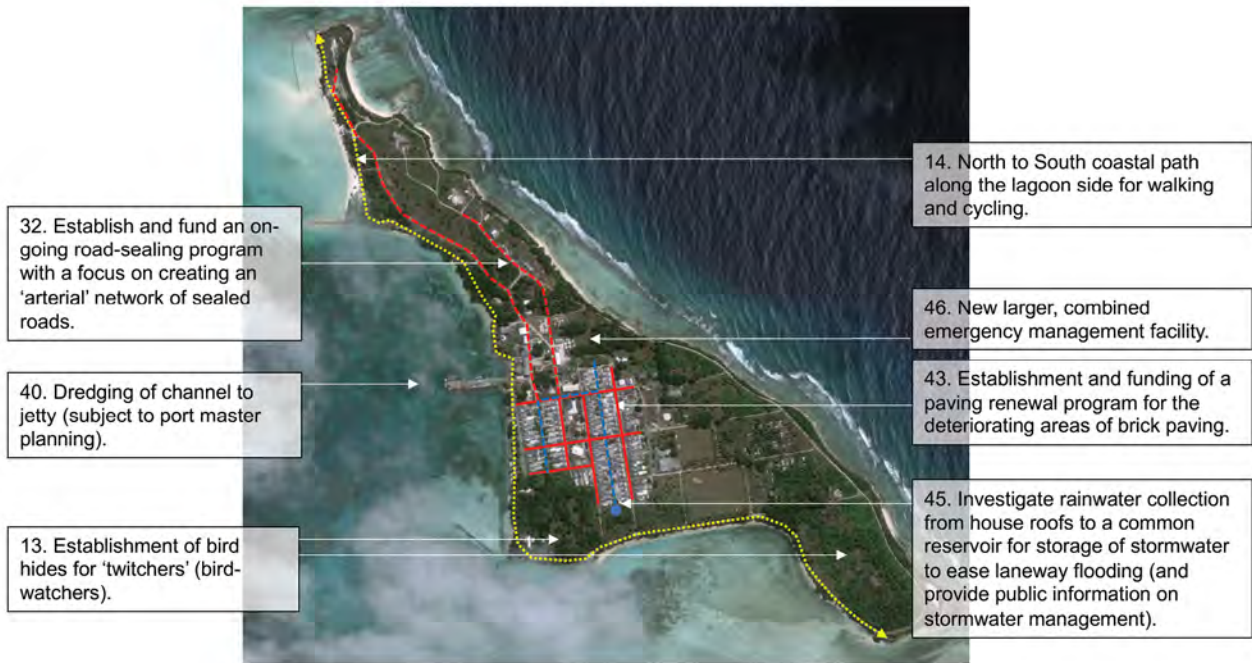


Figure 82: CKI Master Plan Home Island opportunities 1



Figure 83: CKI Master Plan Home Island opportunities 2

Table 44: CKI Master Plan projects

MASTER PLAN PROJECT NUMBER	PROJECT OPPORTUNITY
<b>Home Island</b>	
32	Establish and fund an on-going road-sealing program with a focus on creating an 'arterial' network of sealed roads
40	Dredging of channel to jetty (subject to port master planning)
13	Establishment of bird hides for 'twitchers' (bird-watchers)
14	North to South coastal path along the lagoon side for walking and cycling
46	New larger, combined emergency management facility
43	Establishment and funding of a paving renewal program for the deteriorating areas of brick paving
45	Investigate rainwater collection from house roofs to a common reservoir for storage of stormwater to ease laneway flooding (and provide public information on stormwater management)
37	Protect and establish interpretive material for the cemetery and investigate land availability for cemetery expansion.
15	Prioritisation of Turtle Beach/Sandy Point for facility upgrades (shelters, BBQs, lighting, water, toilets, etc) and disabled access
26a	Alternative location for an in-water playground off the foreshore

Table 44: CKI Master Plan projects (continued)

MASTER PLAN PROJECT NUMBER	PROJECT OPPORTUNITY
27	Establishment of an overwater Pondok with glass floor for viewing lagoon life
30	Establishment of a secure compound/shed for rented boat storage
47	Retain some unsealed tracks/ add new ones for off-road cycling (BMX)
22	Reconfiguration of the waste centre to avoid ocean impact, and inclusion of recycling and composting
20	Establishment of an energy precinct – solar farm, and reconfiguring power station'
21	Expansion/consolidation of the industrial precinct and establish a small business precinct as an interface with the Kampong
44	Establishment of a Mens' Shed
33	Refurbishment and reuse of the old heritage depot (subject to port master planning)
25	Business incubation spaces – potentially reuse the old gym
41	More shade on the jetty
36	Establish a wash-down and fish cleaning area at key boat ramps, initially at south end of the foreshore
34	Establishment of a botanic garden and nursery in the Oceania grounds
35	Investigate options for public ownership and uses of the Oceania (big house) building to secure the long-term heritage value
36a	Alternative location for washdown and fish cleaning area
18	Construction of housing on existing vacant lots
24	If a resort is developed on DI, construction of staff housing on Home Island specifically for local staff
17	Relocation of sports facilities to free up more land in the settlement for additional lots for future housing. New housing to focus on smaller dwellings to reduce overcrowding in existing homes
39	Rationalisation of the plot area with an improved path network
23	Expansion of the plot area for food production
16	Establishment of a consolidated sporting precinct at the Oval by relocating the tennis/ volleyball and other possible recreation activities such as trampoline, skate park (pump track) etc
26	Establishment of an in-water playground off the foreshore
38	Upgrade of foreshore adjacent to the Shire office – removal of old debris

Table 44: CKI Master Plan projects (continued)

MASTER PLAN PROJECT NUMBER	PROJECT OPPORTUNITY
19	Reconfiguration of the retail precinct/settlement core to create a focal space and better sense of arrival, with a visitor/interpretive centre visible from the jetty
42	Use of under-utilised play group space as a day care centre or creche
31	Establish self-storage units
29	Reflooring and use of the community centre undercroft as temporary event space (markets etc)
28	Use of the community centre steps as an occasional outdoor theatre/ performance space
<b>Core 'welcome' area of kampong</b>	North-South walking/ cycling track
	New park at the end of jetty created by retaining the tree and relocating the existing road to the north
	Avenue of trees leading from the jetty
	Visitors information Pondok
	AI fresco desk on the most visible corner, looking out to the parks and lagoons
	Upgrade of park nearest jetty with more trees
	Secure boat storage area with potential business tenancies facing the new park
	New shop facing new park
<b>West Island</b>	
48	Plan for a series of activity nodes along the island with each one a walkable/cyclable distance to the next
54	Establishment of a series of camping spots, or eco-tents for hire, along the Island, associated with planting of native vegetation
13	Establishment of bird hides at strategic locations to support the 'twitcher' (bird watcher) tourism market
52	Widen and reseal the main road (Sydney Highway) to the new jetty
74	Create an 'off-road' adventure track which could double as an access to currently remote areas of the island
50	Establishment of a walking and cycling coastal path along the ocean side (an extension of the
51	Establish a dedicated pedestrian/cycle path along the Sydney Highway corridor between the settlement and the new jetty and, ultimately, the old jetty
63	Encouragement for a resort development at the northern end of the island.

Table 44: CKI Master Plan projects (continued)

MASTER PLAN PROJECT NUMBER	PROJECT OPPORTUNITY
49	Establishment of a 50m ocean pool north of 'Trannies' beach
58	Better use/ expansion of the around the freshwater lake. horticultural precinct, including an area for individual allotments
65	Establishment of a small boat marina for 'wet' boat storage and boat ramp by digging out existing building material and connecting to the lagoon
57	Establishment of a solar farm near existing sub-station, and augment with private rooftop solar as a 'virtual solar power station
64	Establishment of a new fishing jetty and interpretative platform at the old jetty and retaining the old jetty as a (non-accessible) heritage element in the landscape
53	Prioritisation of 'Trannies' for facility upgrades (shelters, BBQs, lighting, water, toilets, etc) and disabled access
55	Establishment of a coastal path and possible camping spots along the lagoon beach (between the two jetties), with a spur around the freshwater lake
71	Establish a better boat ramp that could double as a breakwater for the small boat marina, potentially with a ramp on either side
66	Review the layout of the new jetty to improve access and facilities at the end of the Jetty e.g. shelter, toilets, cafe etc.(subject to ports masterplan)
<b>Small boat harbour near the new jetty</b>	New harbour formed by excavating dredged material that could be used for other construction purposes
	Sheltered boat ramp in harbour
	Improved turnaround and trailer parking
	Access channel dredged
	Twin boat ramps alongside breakwater to boat harbour
	Shane's coffee shop at the end of the jetty
56	Use of the Q station for new workers' accommodation for the runway upgrade that can then be a legacy that provides future rental housing
72	Reconfiguration of the waste station to allow a tree screen along the edge of the lagoon
73	Establishment of self-storage units
68	Establishment of a skate park (pump track) as part of the
67	Provide better access and signage to the existing boat ramp north of the Meteorological station
69	Plan for expansion of the industrial/ commercial area for future business

Table 44: CKI Master Plan projects (continued)

MASTER PLAN PROJECT NUMBER	PROJECT OPPORTUNITY
70	Establishment of a Men's/Women's Shed
59	Upgrade of the road from the southern end of the runway to the water sports area at the south end of the island – and raise as a 'causeway' at vulnerable locations
62	Establishment of a 'Sunset Promenade' – downgrading William Keeling to a shared space, planting trees, lighting, and low plants/rocks in front of the sand bags
61	Reconfiguration of the arrival area outside the airport with an attractive space, public toilets and seating, including making better use of, and providing direct access to, the club as awaiting area
60	Establishment of a community and recreation precinct around the school (day care, gym, etc) and integrated existing facilities (tennis courts)

# Appendix E

## Appendix E Multi Criteria Analysis for Home Island and West Island Settlement Areas' Adaptation Options

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

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 beach 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 - Ongoing 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.	Improve 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/will 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 management plan. Such plans are important in managing 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

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 beach 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 management plan. Such plans are important in managing 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

### 3.0 - Multi Criteria Assessment - 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	<ul style="list-style-type: none"> <li>- Implementation timeframe</li> <li>- Local use of products</li> <li>- Logistics and delays to import material</li> <li>- Maintenance of option into future</li> <li>- Carbon miles</li> <li>- Re-use of existing material</li> </ul>	<ul style="list-style-type: none"> <li>- Amenity and public health (noise, dust, noise, odours) impacts</li> <li>- distance to sensitive receptors</li> <li>- Scale of disturbance to marine habitat, water quality vulnerable/protected species</li> <li>- Scale of disruption to commercial fisheries</li> </ul>	<ul style="list-style-type: none"> <li>- Residential property losses</li> <li>- Property access</li> </ul>	<ul style="list-style-type: none"> <li>- Impact on community values</li> <li>- Impact on access to important social and cultural areas (i.e. beach access, boat launching, views etc)</li> <li>- Scale and duration of disturbance to community areas/ activities</li> </ul>	<ul style="list-style-type: none"> <li>- Impact on existing businesses</li> </ul>	<ul style="list-style-type: none"> <li>- Reversibility of option</li> <li>- Adaptable to unforeseen changes in climate conditions</li> <li>- Alginment with potential long term adaptation pathways, including reclamation with seawalls</li> </ul>	<ul style="list-style-type: none"> <li>- Effectiveness against erosion</li> <li>- Effectiveness against inundation</li> </ul>	<ul style="list-style-type: none"> <li>- Combined capital and maintenance costs</li> <li>- Potential for external funding sources</li> </ul>	
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

3.2 - Multi Criteria Assessment - Short Term

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 (nourishment 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 include 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



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

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 beach 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.	Improve 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/will 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 management plan. Such plans are important in managing 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

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 beach 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/will 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 management plan. Such plans are important in managing 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

### 3.0 - Multi Criteria Assessment - 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?	
<b>Goals</b>	<ul style="list-style-type: none"> <li>- Implementation timeframe</li> <li>- Local use of products</li> <li>- Logistics and delays to import material</li> <li>- Maintenance of option into future</li> <li>- Carbon miles</li> <li>- Re-use of existing material</li> </ul>	<ul style="list-style-type: none"> <li>- Amenity and public health (noise, dust, noise, odours) impacts - distance to sensitive receptors</li> <li>- Scale of disturbance to marine habitat, water quality vulnerable/ protected species</li> <li>- Scale of disruption to commercial fisheries</li> </ul>	<ul style="list-style-type: none"> <li>- Residential property losses</li> <li>- Property access</li> </ul>	<ul style="list-style-type: none"> <li>- Impact on community values</li> <li>- Impact on access to important social and cultural areas (i.e. beach access, boat launching, views etc)</li> <li>- Scale and duration of disturbance to community areas/ activities</li> </ul>	<ul style="list-style-type: none"> <li>- Impact on existing businesses</li> </ul>	<ul style="list-style-type: none"> <li>- Reversibility of option</li> <li>- Adaptable to unforeseen changes in climate conditions</li> <li>- Alignment with potential long term adaptation pathways, including reclamation with seawalls</li> </ul>	<ul style="list-style-type: none"> <li>- Effectiveness against erosion</li> <li>- Effectiveness against inundation</li> </ul>	<ul style="list-style-type: none"> <li>- Combined capital and maintenance costs</li> <li>- Potential for external funding sources</li> </ul>	
<b>5</b> 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
<b>4</b> 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
<b>3</b> 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
<b>2</b> 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
<b>1</b> 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

3.2 - Multi Criteria Assessment - Short Term

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 houses 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 (nourishment 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 include 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

Adaptation Option Costings - West Island Short to Medium Term

Timeframe	Option Name	AC1 Accommodate				P9 + P2 Levees with nourishment				P9 + P6 Levees with GSC Seawalls				P9 + P7 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		
		\$	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			
	Mobilisation TSHD	\$ 4,500,000	/unit		\$ -				\$ -				\$ -				\$ -			
	Protect - Upgrade GSC Seawall - 1 additional crest layer	\$ 2,100	/m		\$ -				\$ -				0	\$ -			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		\$ -				\$ -				\$ -				\$ -			
	Protect - Nourishment	\$ 1,404	/m per year		\$ -			900	\$ 4,500,000			6,300	\$ 4,500,000			6,300	\$ 4,500,000		6,300	
	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				\$ 4,742,000			
	Repairs	specific to option	Item		\$ -				\$ -				\$ -				\$ -			
		<b>Total</b>				\$ 105,794,200				\$ 8,602,593			19,953	\$ 26,546,000	1240	\$ 848,000	23,496	\$ 30,953,000	1240	\$ 421,600
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		\$ -				\$ -				\$ -				\$ -			
	Protect - Upgrade Seabee Seawall - raise crest height 1m	\$ 3,400	/m		\$ -				\$ -				\$ -				\$ -			
	Protect - New GSC Seawall	\$ 14,000	/m		\$ -				\$ -			640	\$ 9,240,000			10,043	\$ -			
	Protect - New Seabee Seawall	\$ 17,000	/m		\$ -				\$ -				\$ -			640	\$ 11,220,000			
	Protect - New 1m high levee	\$ 3,000	/m		\$ -				\$ -				\$ -				\$ -			
	Protect - New 1.5m high levee	\$ 5,000	/m		\$ -				\$ -				\$ -				\$ -			
	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		\$ -				\$ -				\$ -				\$ -			
		<b>Total</b>				\$ -			\$ 4,468,418			22,075	\$ 12,132,000	1240	\$ 848,000	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		\$ -				\$ -				\$ -				\$ -			
	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		\$ -				\$ -				\$ -				\$ -			
		<b>Total</b>				\$ -			\$ 4,468,418			22,075	\$ 23,561,600	1240	\$ 848,000	19,522	\$ 29,999,200	1240	\$ 421,600	
2050	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		\$ -				\$ -			640	\$ 1,384,000			1,435	\$ -			
	Protect - Upgrade Seabee Seawall - raise crest height 1m	\$ 3,400	/m		\$ -				\$ -				\$ -			1110	\$ 3,774,000			
	Protect - New GSC Seawall	\$ 14,000	/m		\$ -				\$ -			640	\$ 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		\$ -				\$ -				\$ -				\$ -			
	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		\$ -				\$ -				\$ -				\$ -			
		<b>Total</b>				\$ -			\$ 4,468,418			22,075	\$ 13,933,800	1240	\$ 848,000	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		\$ -				\$ -											

# Appendix F

## Appendix F Cost Benefit Analysis

Anna Kelderman  
Director  
Shape Urban  
20/663 Newcastle Street  
Leederville 6007

24 August 2023

**RE: COCOS (KEELING) ISLANDS – ADVICE ON COST BENEFIT ANALYSIS**

Dear Anna

Thank you for the opportunity to provide advice on the potential for a Cost Benefit Analysis on potential interventions to address sea level rise on the Cocos (Keeling) Islands (CKI).

As part of the CHRMAP report for CKI, a benefit distribution analysis was undertaken to ascertain the economic value of community assets and infrastructure at risk of coastal erosion and inundation. This analysis examined the magnitude of value that would be affected, as well as how this value was distributed across land and asset owners.

A subsequent step within a CHRMAP analysis is to also undertake cost-benefit analysis (CBA), which assists in the decision of when is the best time to implement various measures, as well as which interventions against sea level rise (protect, accommodate, retreat, etc) provide the greatest benefit relative to costs. This analysis involves forecasting future cash flows associated with each measure (both the cost of implementing a measure, and the flow of future benefits) and discounting based on an assumed time period. An extract of the RFQ regarding the CBA is attached below.

As CKI is a small island community under immediate threat of coastal erosion and inundation, the CHRMAP has developed the view that the best time to implement the required interventions to combat the threat for the majority of assets is the present. Noting this, MCA analysis was conducted, with those assets receiving a positive score proceeding for CBA analysis. The MCA determined that only two assets exist with positive scores where a CBA may inform timing of interventions. These assets are:

- The cemetery on Home Island, which potentially could have levees and reclamation proposed either now or towards 2035-40. However, there is little value conducting a CBA before a Cultural Heritage Assessment is complete.
- Sydney Highway, which requires relocation somewhere between now and 2030. Given the immediacy of the need for interventions, there is also little need for a CBA.

Two critical pieces of infrastructure that support CKI's community and economy are the fuel jetty which handles all fuel entering CKI, and Rumah Baru jetty which acts as CKI's port facility and is vital to all freight and logistics entering the islands (excluding fuel). Maintaining both these facilities against sea level rise is critical to maintaining the existence of the CKI community, as well as the runway and other infrastructure. This work will be required well in advance of 2068, and is likely to require short term intervention as well as longer term maintenance. A CBA is therefore not required to analyse investment timing for these assets.

Noting the above, it is therefore suggested that conducting a CBA would add minimal value to the overall analysis.

Yours Sincerely



Jason McFarlane  
Managing Director

## Attachment – RFQ Extract – Task 9 Cost Benefit Analysis

For this project, it is recognised that a typical Benefit Distribution Analysis (BDA) is unlikely to influence recommendations, as members of the community and asset owners are likely to benefit from adaptation options, almost equally.

Similarly, cost benefit analysis for this project is likely to need to be applied to grouping of assets comparative to the adaptation options. This is because nearly all assets and community values are likely to be significantly affected in a do-nothing scenario.

Notwithstanding this broader consideration, adaptation options receiving a positive score in the MCA will proceed to the CBA. The CBA will use the estimated dollar value of lost assets at each timeframe using a combination of write-off losses and annual average damage estimates.

This will be used to support the comparative evaluation of options and implementation trigger points. Providing a transparent analysis of adaptation option costs and potential benefits allows all stakeholders to understand what can be realistically implemented, tempered with the reality of available funding. The following steps will be followed:

- Review the existing population and consider potential population growth over the 100 year timeframe should current trends continue
- Estimate losses of land, infrastructure and assets, including lost income from lease land, based on available hazard mapping
- Assign damage values to all land, infrastructure and assets lost to erosion/inundation
- Cost adaptation options
- Estimate each management options performance in mitigating damages. Any damages avoided will be estimated as a financial benefits
- Convert whole lifecycle costs and benefits to a present day value (this applies an adjustment because things happening sooner should be considered more important)
- Calculate the benefit/costs for each management option to determine the extent to which the financial benefits (i.e. damages avoided) outweigh costs.

# Appendix G

## Appendix G Benefit Distribution Analysis

# **COASTAL MANAGEMENT STRATEGY - BENEFIT DISTRIBUTION ANALYSIS**

## **SHIRE OF COCOS (KEELING) ISLANDS**

**February 2024**



**FAR lane**

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## 1 RELIANCE AND DISCLAIMER

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The professional analysis and advice in this report has been prepared by Delta Echo Pty Ltd trading as FAR Lane for the exclusive use of the party or parties to whom it is addressed (the addressee) and for the purposes specified in it. This report is supplied in good faith and reflects the knowledge, expertise, and experience of the consultants involved. FAR Lane accepts no responsibility whatsoever for any loss occasioned by any person acting or refraining from action as a result of reliance on the report, other than the addressee.

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Delta Echo Pty Ltd T/A FAR Lane

ABN 47 609 529 928

## 2 EXECUTIVE SUMMARY

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### Background

This report provides a Benefit Distribution Analysis (BDA) for the Cocos Keeling Islands (CKI) Coastal Hazard Risk Management Adaptation Plan (CHRMAP) 2024.

The coastal hazards of erosion and inundation, combined with rising sea levels, are impacting the safety and existence of coastal communities around the globe. CKI consists of low-lying islands that are already being impacted by these coastal hazards. CKI's two populated islands, Home Island and West Island, are considered in detail in this report. CKI's unpopulated islands are also considered for loss of public amenity.

Where coastal hazards are deemed a risk to a community, a range of interventions may occur to mitigate this risk. These includes consideration of options to avoid impacts, retreat, accommodate or to protect.

When investment is made in interventions, different individuals, enterprises or groups may experience different levels of benefit. This report systematically estimates benefits to different parties as the result of interventions in CKI.

West Island's and Home Island's risk of inundation and erosion is so great that potential interventions other than relocation have been assessed as cost prohibitive and will likely be ineffective against the combination of erosion and inundation. As such, this report makes the assumption that the CKI communities will eventually be relocated.

For completeness, FAR Lane has estimated the value of benefits that would be affected by coastal hazards in CKI by 2068. These benefits are based on the estimated maximum costs of relocating and incorporating the entire CKI community into an alternative location in Western Australia (WA). The beneficiaries are agencies and community members who:

- Do not have to unsustainably invest in the home that is not economically feasible to sustain (the CKI).
- Can avoid the physical and economic costs of considerable trauma from ongoing disasters due to coastal hazards.
- Avoid the ongoing costs for defending the islands from coastal erosion and inundation.

The BDA in this report is therefore developed to:

- Elicit a shared understanding of which parties will benefit from coastal hazard interventions.
- Ensure a broad understanding is developed by capturing a range of benefits from different perspectives.
- Inform any future decision-making relating to funding contributions for interventions (noting that a cost distribution analysis is out of scope for this report).

## Methodology

The BDA quantifies the estimated proportional benefit accruing to relevant groups of asset holders against a do-nothing base case, thereby informing future structures for robust and fair cost allocations in the future. The BDA takes a broad view of the benefits resulting from coastal management interventions, including consideration of benefits to landowners, tenants, agencies, interest groups, and the community as a whole.

For this work, benefit is defined as “the continued existence and operation of an asset, at its existing full functionality, landholding, service, or economic/commercial outcome as at the time of the BDA”. A key assumption is that coastal management interventions will result in beneficiaries continuing to enjoy these benefits in perpetuity.

For the purposes of this BDA, essential services infrastructure is defined as infrastructure without which a settlement would not sustainably exist on CKI. Examples of essential services infrastructure includes infrastructure for water, wastewater, telecommunications, fuel, power and ports (particularly important given CKI imports most of its food and all fuel by sea).

Maintaining this infrastructure against coastal hazards is essential to maintaining the existence of the CKI community and adjacent activities. Given the essential nature of this infrastructure and the community’s reliance on it, this infrastructure is not included in the BDA as the benefit accrues equally to all community members. However, for completeness, it is estimated total value of essential services infrastructure on CKI is \$1.5 billion, noting this figure is provided by the Australian Government.

Non-essential infrastructure (distinct to essential services infrastructure) is considered within this BDA as a community on CKI could arguably continue to exist without it. Note that non-essential infrastructure is not considered with Net Present Value calculations, but instead is presented in current values of built form to represent indicative costs of relocating the infrastructure.

It is important to note that CKI is unusual in that there is very little privately held land. Instead, the islands comprise of Crown Land, and land held by the Cocos (Keeling) Islands Lands Trust (Trust) of which the Shire of CKI is the administrator and Trustee. The majority of residents are renters in houses owned by the Trust. Therefore, while much of the benefit is noted as preserved for private dwellings, most of this benefit ultimately flows to the Trust.

## Summary of findings

A summary of all owner and community benefit that will be impacted by coastal hazards at CKI is at Table 1. All calculations are based on the assumption that interventions to mitigate the impact of erosion and inundation would successfully protect the assets.

Table 1 - Summary of economic Net Present Value in CKI that will be impacted by erosion and inundation

Beneficiary / community benefit	Net Present Value	Percentage of total benefit
Private Dwellings	\$87,021,600	45.8%
Private Commercial Properties	\$37,185,729	19.6%
Environmental Amenity	\$9,355,068	4.9%
Public Sector Revenue - rates	\$5,773,262	3.0%
Economic Activity - wages	\$50,628,977	26.7%
<b>Total</b>	<b>\$189,964,636</b>	<b>100.0%</b>

Source: FAR Lane, 2023.

The analysis indicates that:

- The economic Net Present Value of assets included in the BDA, that will potentially be impacted by coastal hazards in CKI by 2068 is approximately \$190 million.
- Should any protection be proposed to mitigate the risk of coastal hazards, 65.4% of the Net Present Value benefit of providing coastal hazard adaptation would be apportioned to private interests (including the Trust), with private dwellings (predominantly owned by the Trust) and lost economic activity from lost wages constituting the highest preserved values.

As noted above, non-essential infrastructure is not considered with Net Present Value calculations but instead is presented in current values of built form to represent indicative costs of relocating the infrastructure. Noting this, the approximate total value of replacement of non-essential infrastructure in CKI is \$78.9 million (2023 dollars). None of the value of the non-essential infrastructure would go to private beneficiaries.

The essential services infrastructure is \$1.5 billion for the entirety of CKI.

In summary, supporting economic Net Present Value of \$190 million in CKI is:

- \$78.9 million in non-essential infrastructure in CKI.
- \$1.5 billion of essential services infrastructure across all CKI.

Short term interventions are possible to extend the enjoyment of CKI's coastal lifestyle but are likely to be sacrificial in the long term, and any planning should be cognisant of this. Notwithstanding, should any protection be proposed to mitigate the risk of flooding, 65.4% of the economic Net Present Value of providing coastal hazard adaptation would be apportioned to private interests (including the Trust), who, under the beneficiary pays principal outlined in State Planning Policy 2.6, should be obliged to contribute to protection measures.

Given the extreme likelihood of erosion and inundation, the community of CKI will likely need to be relocated in the medium term. In the case of retreat, no intervention is being proposed that assures "the continued existence and operation of an asset, at its existing full functionality, landholding, service, or economic/commercial outcome as at the time of the BDA". Therefore, caution should be used in consideration of a BDA as sole means of considering the preserved benefits of CKI.

### 3 INTRODUCTION

This report is intended as an attachment to the Cocos Keeling Islands (CKI) Coastal Hazard Risk Management Adaptation Plan 2023 (Shape Urban, 2024). Some key background is included here for completeness. Please note this section draws heavily on Shape Urban, 2024.

#### 3.1 BACKGROUND AND PROJECT SCOPE

The coastal hazards of erosion and inundation, combined with rising sea levels, are impacting the safety and existence of coastal communities around the globe. Coastal flooding and long-term shoreline recession risk making parts of many coastal communities untenable in the longer term unless action is taken.

CKI comprises several islands which face unique challenges in managing coastal hazards and sea level rise, due to being low lying with sandy shorelines and narrow foreshore buffers and chronic erosion along the ocean-facing shores. The CHRMAP process considers how best to mitigate these effects and allow for informed decisions regarding land use and development in its coastal areas.

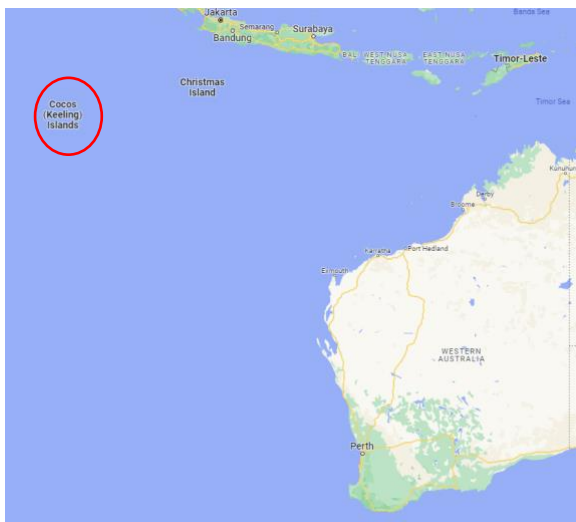
Where coastal hazards are deemed a risk to a given community, a range of interventions may be considered to mitigate this risk. These includes consideration of options to ‘avoid’ impact, ‘retreat’, ‘accommodate’ or to ‘protect’. CKI already has experience in this space, with the sandbags already installed to slow the coastal erosion process on West Island (protect).

When investment is made in interventions, different people or groups may experience different levels of benefit. This report develops a Benefit Distribution Analysis (BDA) to systematically estimate benefits to different parties as the result of interventions.

#### 3.2 STUDY AREA – COCOS (KEELING) ISLANDS

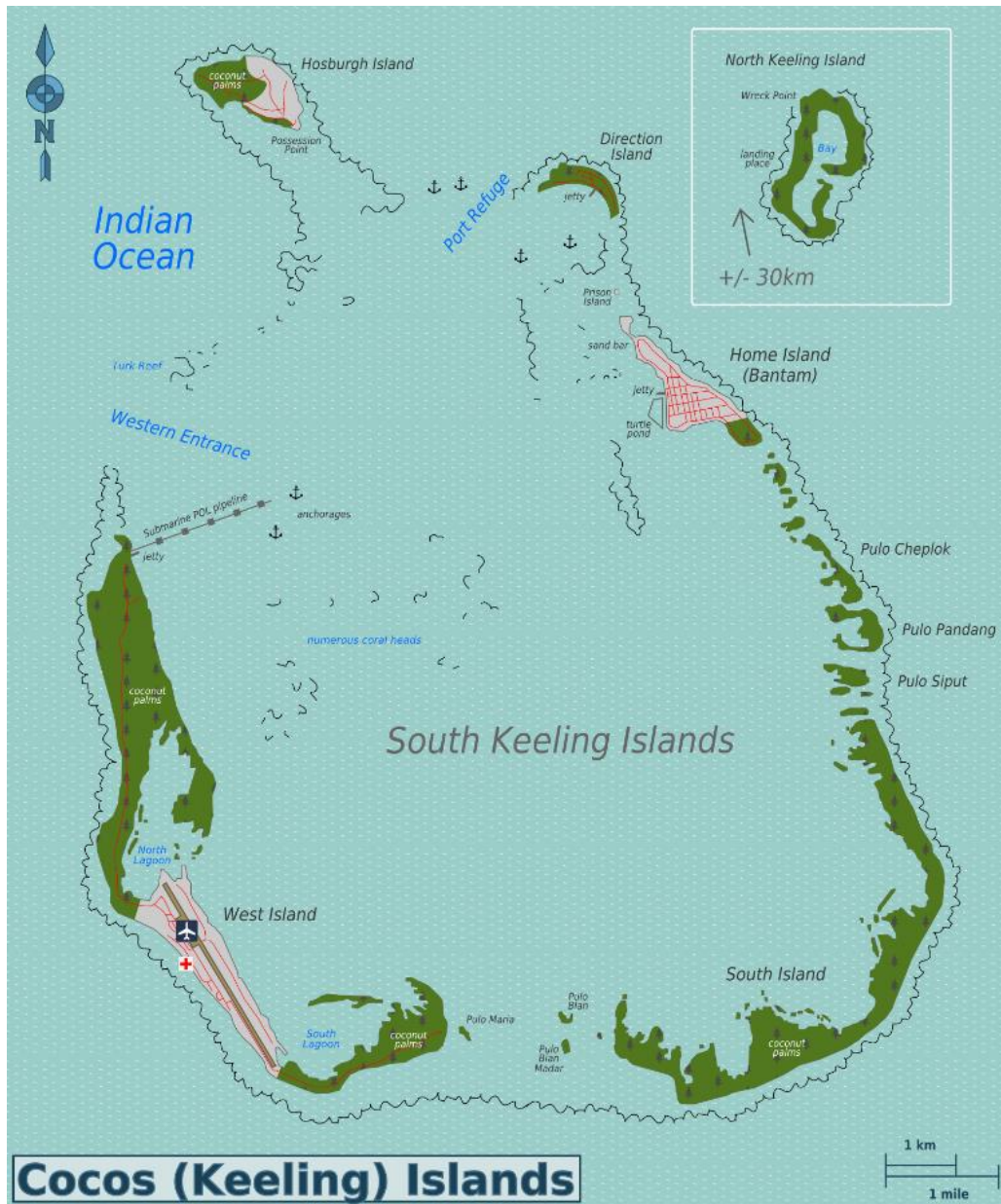
CKI are located in the Indian Ocean to the north west of Western Australia, and south west of Java (Figure 1). CKI consists of many islands surrounding a lagoon, all of which are low lying with a maximum height above mean sea level of eight metres. The only populated islands are Home Island and West Islands, which are the subject of this CHRMAP. A map of CKI is at Figure 2, with maps of West Island and Home Island respectively at Figure 3 and Figure 4.

Figure 1 - Map of Cocos (Keeling) Islands and Western Australia



Source: Google Maps, 2023.

Figure 2 - Map of Cocos (Keeling) Islands



Source: Wikimedia Commons, 2023.

West Island is the largest island in the CKI group (Figure 3). Development is primarily concentrated around the airport and West Island Settlement located in the southern region of the island. The island has a history of persistent erosion along its western ocean-facing shore, prompting the construction of coastal protection structures since the 1970s to address ongoing concerns regarding beach erosion. Over the past decade, instances of erosion and coastal flooding have been recorded during storm events, including two significant storm events occurring in 2013/2014 that threatened the island's already limited road infrastructure.

Home Island, which hosts the main population settlement, is situated on the eastern side of CKI (Figure 4). Home Island is also prone to coastal flooding, but from the lagoon-side rather

than open ocean. As a result, over the past decade three seawalls have been constructed along the lagoon-facing beaches. Infrastructure is reasonably well set back in most areas, and most shorelines have remained stable.

Figure 3 - Map of West Island



Source: Australian Government and Department of Primary Industries and Regional Development, 2019.

Figure 4 - Map of Home Island



Source: Australian Government and Department of Primary Industries and Regional Development, 2019.

South Island, Direction Island, Pulu Laur (Horsburgh Island) and some other smaller islands are all uninhabited and contain limited infrastructure, noting that numerous pondoks (traditional fishing huts) are scattered throughout the islands.

### 3.3 POLICY CONTEXT

CKI is a Territory of Australia that falls under jurisdiction of the Australian Government. However, legislative powers are applied as Western Australian laws as per *The Cocos (Keeling) Islands Act 1955*. The Government of Western Australia provides a range of services to CKI under formal agreements with the Australian Government. The Shire of CKI (Shire) operates under the same legislation as all local governments on mainland Australia.

The Western Australian Planning Commission (WAPC) has carriage of Western Australia's (and therefore CKI's) governing policy for coastal management via State Planning Policy No. 2.6 - State Coastal Planning Policy (SPP 2.6; 2013a). To guide land use and development decision making in coastal zones, SPP 2.6 recommends management authorities develop a Coastal Hazard Risk Management and Adaptation Plan in accordance with WAPC's Coastal Hazard Risk Management and Adaptation Planning Guidelines (2019).

SPP 2.6 includes aims to establish coastal foreshore reserves that provide allowance for the protection, conservation and enhancement of coastal values across the state. This process includes identifying existential or intolerable risks to communities and other stakeholders, and developing suitable mitigation approaches that align with SPP 2.6.

### 3.4 PREVIOUS STUDIES

In 2019 the Australian Government, DPLH and the Shire commenced a CHRMAP for CKI, with the Cocos (Keeling) Islands Coastal Vulnerability Study - Coastal Vulnerability Assessment Report (the CVA Report) (RHDHV, March 2021) developed for Home Island and West Island.

As per of SPP 2.6 and CHRMAP guidelines, the CVA identified coastal hazard risks, and the vulnerability of built and natural assets. The CVA found that CKI's coastline is exposed and vulnerable to erosion and inundation. This situation is likely to worsen over time as sea levels rise, potentially impacting critical infrastructure including housing, roads, and tourism assets.

## 4 OVERVIEW OF POTENTIAL COASTAL HAZARD IMPACT ON CKI

This section contains a high-level summary of CKI's potential vulnerability from erosion and inundation. As stated in the CHRMAP (Shape Urban, 2023), these vulnerabilities are measured against the following benchmarks:

- Vertical sea level rise of 0.4m for 50-year planning timeframes (2068)
- Vertical sea level rise of 0.9m for 100-year planning timeframes (2118).

Detailed assessments can be found in Shape Urban 2023.

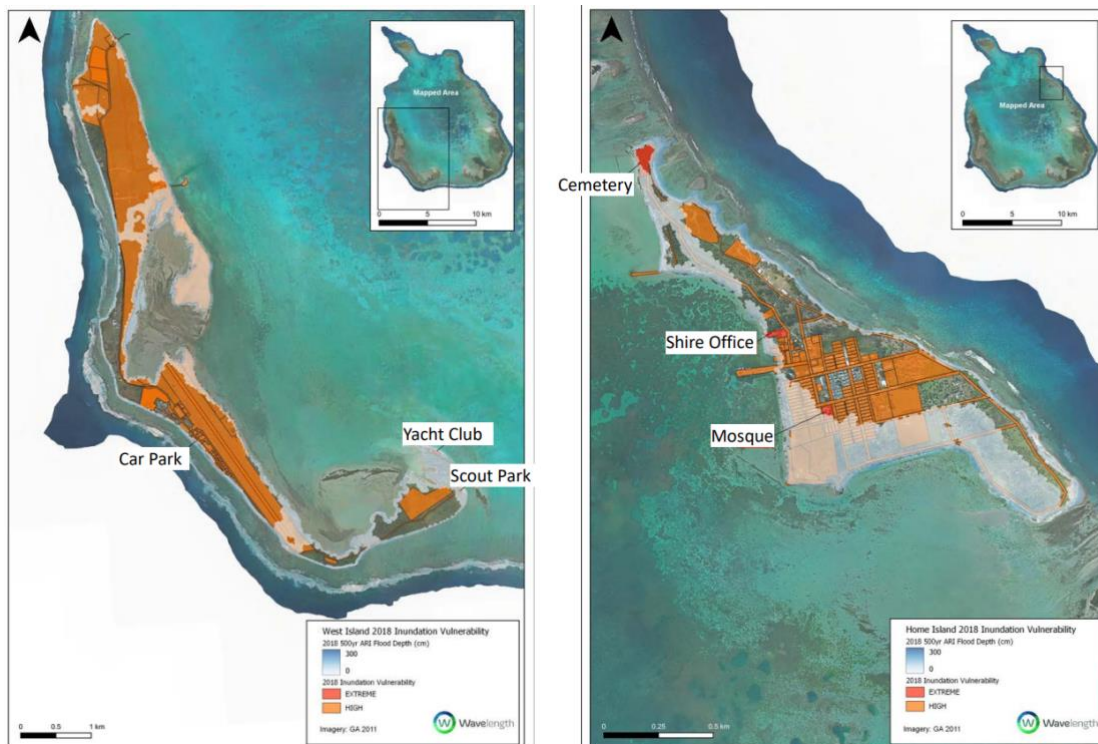
The considered impacts are:

- **Inundation** - Storm surges and increased mean sea levels will create flooding in areas adjacent to shorelines. The risk zone is measured based on 500-year average return interval (ARI) storms, combined with 100 years of sea level rise.
- **Erosion** – Coastlines composed primarily of loose sediment (such as beaches) recede until a new equilibrium shoreline is found further inland. This report considers predicted erosion levels at 2068.

Inundation vulnerability is shown at Figure 5 for 2018, and Figure 6 for 2068. Erosion risk is shown for 2068 at Figure 7 and

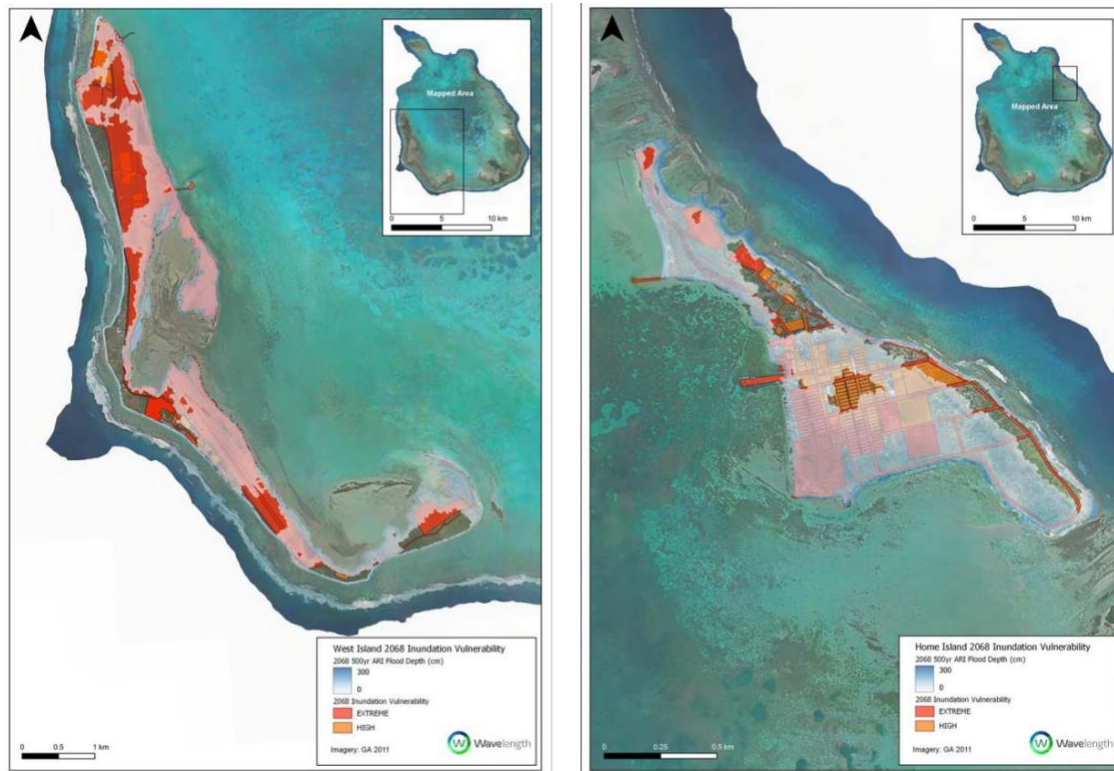
Figure 8.

Figure 5 - Inundation vulnerability for West Island (left) and Home Island, 2018



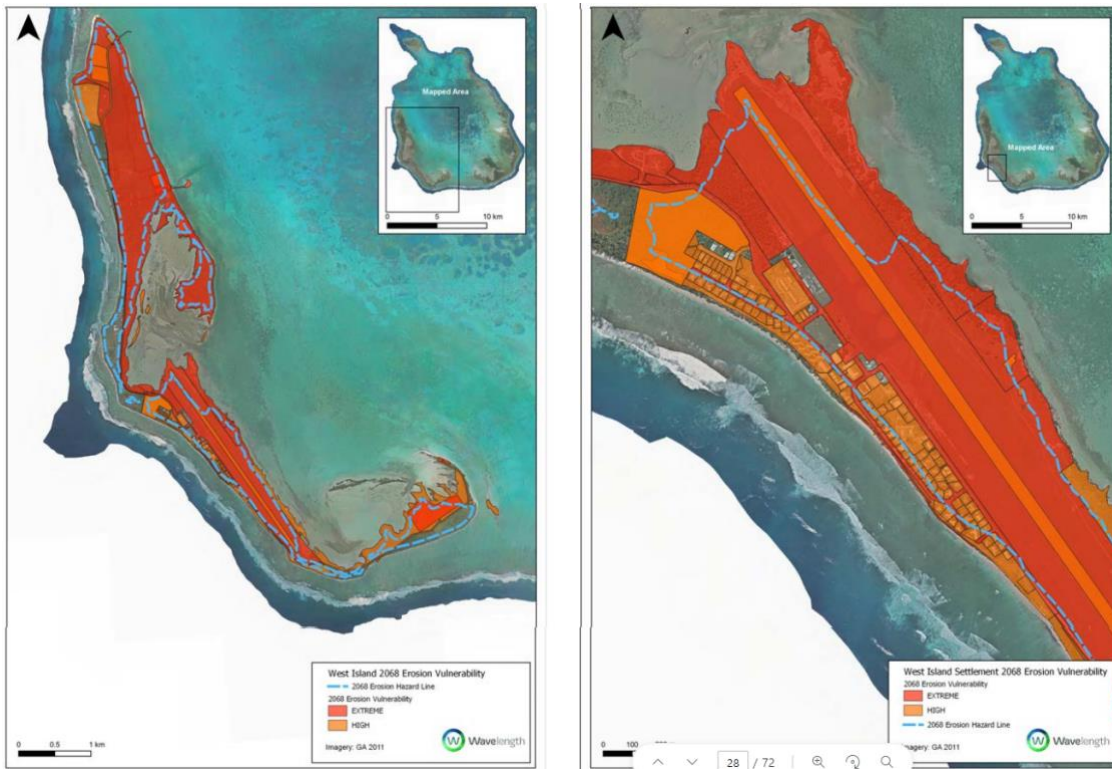
Source: Shape Urban, 2024.

Figure 6 - Inundation risk for West Island (left) and Home Island, 2068



Source: Shape Urban, 2024.

Figure 7 – Erosion risk for West Island, and West Island settlement, 2068



Source: Shape Urban, 2024.

Figure 8 - Erosion risk for Home Island, 2068



Source: Shape Urban, 2024.

The analysis indicates:

- Both West Island and Home Island are already at high risk of inundation.
- By 2068, almost all of West Island will be at extreme risk of inundation, and almost all of Home Island will be at either high or extreme risk of inundation.
- By 2068, all of West Island will be at high or extreme risk of erosion (including the settlement), while significant parts of Home Island will be at high or extreme risk of erosion.

These findings are summarised at Table 2.

Table 2 - Summary of CKI inundation and erosion risk

Island	Inundation risk - 2018	Inundation risk - 2068	Erosion risk – 2018	Erosion risk- 2068
West Island	High	Extreme	n/a	Extreme/High
Home Island	High	Extreme/High	n/a	Extreme/High

Source: Shape Urban, 2023.

## 5 METHODOLOGY OVERVIEW

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As noted in Section 4, both West Island's and Home Island's risk of inundation and erosion is so great that potential interventions other than relocation will be cost prohibitive and will likely be ineffective against the combination of erosion and inundation. Given this, this report makes the assumption that the community will eventually be relocated.

Notwithstanding this, for completeness FAR Lane has estimated the value of benefits that would be impacted by coastal hazards in CKI by 2068 (see Section 6). These benefits are based on the maximum costs of relocating and incorporating the entire CKI community into an alternative location in WA that is safe from coastal hazards. The beneficiaries are community members who:

- Do not have to unsustainably invest in a location that is not economically feasible to sustain (i.e. the CKI).
- Can avoid considerable trauma from ongoing disasters due to coastal hazards.
- Avoid the ongoing costs for defending the islands from coastal erosion and inundation.

Assumptions include:

- Preserved benefits include costs for property value, infrastructure (services and built form), and community benefits.
- Costs do not include land, or efficiencies gained from moving the CKI community to a better serviced location.
- Environmental amenity is captured on the assumption that the community will be provided with the same level of amenity when relocated.

Methodology for these calculations is below. All calculations assume that interventions to mitigate the impact of erosion and inundation successfully protect the assets.

### Background to Benefit Distribution Analysis (BDA)

Typically, a BDA is developed to:

- Develop a shared understanding of who will benefit from coastal hazard interventions (existing and future).
- Ensure a broad understanding is developed by capturing a range of benefits from different perspectives.
- Inform future decision-making relating to funding contributions for interventions.

The report breaks down the communities into "management units" which allows for the required level of detail for assessment under the BDA (see section 8.2). The BDA captures and, where possible, quantifies relevant proportional benefits associated with existing and proposed protection works identified in the CHRMAP at the management unit level. This includes objective and/or subjective capture of benefits related to, but not limited to:

- Avoided loss of assets and/or asset value.

- Retention of opportunities for business activities and earning of wages.
- Retention for options for alternative asset utilisation in the future.
- Retention of critical infrastructure.
- Avoided travel costs.
- Avoided clean-up costs.
- Retention of amenity.

The BDA quantifies the estimated proportional benefit accruing to relevant groups of asset holders against a do-nothing base case, informing future structures for robust and fair cost allocations in the future. Cost distribution modelling is out of scope for this report and is therefore not considered.

The BDA takes a broad view of the benefits resulting from CMS interventions, including consideration of benefits to landowners, tenants, agencies, interest groups, and the community as a whole.

For this work, benefit is defined as “the continued existence and operation of an asset, at its existing full functionality, landholding, service, or economic/commercial outcome as at the time of the BDA”. A key assumption is that beneficiaries will continue to enjoy these benefits in perpetuity.

### **Essential services infrastructure**

Essential services infrastructure is infrastructure without which a settlement could not sustainably exist on CKI. Examples of essential services infrastructure includes infrastructure for water, wastewater, power, fuel, telecommunications, and ports services (particularly important given CKI imports most of its food and all fuel by sea).

Maintaining this infrastructure against coastal hazards is critical to maintaining the existence of the CKI community and adjacent activities. Given the critical nature of this infrastructure and the community’s reliance on it, this infrastructure is not included in the BDA as the benefit accrues equally to all community members.

For completeness, aggregated asset values for Home Island and West Island are included in this report based on figures provided by the Australian Government.

It should also be noted that maintaining this infrastructure will be required well in advance of 2068, and is likely to require short term intervention as well as longer term maintenance.

### **Apportioning benefit**

The methodology for apportioning benefit is:

1. Profile relevant benefits against the CHRMAPs for:
  - Owner benefits
  - Community benefits.

2. Calculate total benefit retention/realisation for all owners and users, including public and private landowners; service/utility providers; commercial operators; community groups; and local, state and federal governments.
3. Allocate overall benefit at the unit management level.

It is important to note that CKI is unusual in that there is very little privately held land. Instead, the islands comprise of Crown Land, and land held by the Cocos (Keeling) Islands Lands Trust of which the Shire is the administrator and Trustee. The majority of residents are renters in houses owned by the Trust. Therefore, while much of the benefit is noted as preserved for private dwellings, most of this benefit ultimately flows to the Trust.

Methodology for calculating the value of benefit for each type of beneficiary is at Table 3. Please note that a glossary of definitions can be found at section 10.

Table 3 - Methodology summary table for calculating value of benefit

Benefit type	Value of benefit – calculation methodology
Private dwellings	Net Present Value of annual Gross Rental Value
Private commercial assets	Net Present Value of annual Gross Rental Value
Environmental amenity	Net Present Value of foregone amenity
Public sector revenue - rates	Net Present Value of foregone Shire rates
Economic activity	Net Present Value of indirect and induced economic impact of foregone wages on CKI
Infrastructure value	Cost of replacement based on current values

Source: FAR Lane, 2023.

A discount rate of four percent was used for Net Present Value calculations for private dwellings, private commercial assets, and community amenity. This social discount rate was selected to reflect the multigenerational nature of interventions and impacts being considered.

A discount rate of seven percent was used for Net Present Value calculations for public sector revenues and economic activity (the economic impact of indirect and induced wages). This rate was selected to reflect that wages and public sector revenues are not accruing in a multi-generational way but instead are accruing to given individuals/households at a given point in time.

The direct economic impact from wages is assumed to accrue to individuals/households, while indirect and induced accrues to the local economy. For this reason, only the impact from indirect and induced wages are considered in the BDA.

## Infrastructure

Infrastructure considered in this report (excluding essential services infrastructure) includes:

- Public assets - estimated value of built form for items such as roads, and amenities such as sports facilities, schools, and museums.

Infrastructure is not considered with Net Present Value calculations because:

- Infrastructure can, in many cases, generate revenues which are utilised in future infrastructure upgrades.
- The infrastructure is specifically provided to support other assets such as residential and commercial assets.

A full methodology can be found in section 8.

## 6 KEY FINDINGS – BENEFIT DISTRIBUTION ANALYSIS BASED ON PROPOSED INTERVENTIONS

As noted in section 4, CKI’s risks from coastal hazards include:

### Inundation risk:

- Both West Island and Home Island are already at high risk of inundation.
- By 2068, almost all of both West Island will be at extreme risk of inundation, and almost all of Home Island will be at either high or extreme risk of inundation.

### Erosion risk:

- By 2068, all of West Island will be at high or extreme risk of erosion (including the settlement), while significant parts of Home Island will be at high risk of erosion, with other parts at extreme risk.

Both West Island’s and Home Island’s risk of inundation and erosion is so great that potential interventions other than relocation will be cost prohibitive and will likely be ineffective against the combination of erosion and inundation. Given this, this report makes the assumption that the community will eventually be relocated.

Below is a breakdown of the BDA for CKI by management unit. Please note that detailed calculations and breakdowns of management units can be found at section 9.

### 6.1 REPLACEMENT OF ESSENTIAL SERVICES INFRASTRUCTURE

Aggregated asset values for essential services infrastructure for Home Island and West Island in this report have been provided by the Australian Government (noting that figures have only been provided as aggregated and not by management unit). These values indicate the approximate total value of replacement (in 2023 dollars) of essential services infrastructure is:

- \$0.5 billion for Home Island.
- \$1 billion for West Island.

### 6.2 HOME ISLAND OVERVIEW

A summary of all owner and community benefit that will be impacted by coastal hazards at Home Island is at Table 4. Note that Home Island contains only a single management unit, meaning the entire island is considered in this section.

Table 4 - Summary of economic NPV in Home Island impacted by coastal hazards by 2068

Beneficiary	Net PV of Benefit	% of Total Benefit
Private Dwellings	\$49,542,000	53.7%
Private Commercial	\$10,141,563	11.0%
Environmental Amenity	\$470,560	0.5%
Public Sector Revenue	\$3,286,758	3.6%
Economic Activity - Wages	\$28,830,874	31.2%
Total	\$92,271,754	100.0%

Source: FAR Lane, 2023.

The analysis indicates that:

- The economic Net Present Value that will potentially be lost to coastal hazards in Home Island by 2068 is approximately \$92.2 million.
- Should any protection be proposed to mitigate the risk of coastal hazards, 64.7% of the Net Present Value benefit of providing coastal hazard adaptation would be apportioned to private interests (including the Trust).

The approximate total value of replacement of non-essential infrastructure in Home Island, representing indicative costs of relocating the infrastructure, is \$42.8 million (2023 dollars). None of the value of non-essential infrastructure would go to private beneficiaries.

Note that, as per section 6.1, the value of essential services infrastructure on Home Island is \$0.5 billion.

In summary, supporting economic Net Present Value of \$92.2 million in Home Island is:

- \$42.8 million of non-essential infrastructure.
- \$0.5 billion of essential services infrastructure.

### 6.3 WEST ISLAND SETTLEMENT OVERVIEW

A summary of all owner and community benefit that will be impacted by coastal hazards at West Island Settlement is at Table 5.

Table 5 – Summary of economic Net Present Value in West Island Settlement that will be impacted by coastal hazards by 2068

Beneficiary	PV of Benefit	% of Total Benefit
Private Dwellings	\$37,479,600	42%
Private Commercial	\$26,368,063	30%
Environmental Amenity	\$1,629,118	2%
Public Sector Revenue	\$2,486,504	3%
Economic Activity – Wages	\$21,357,737	24%
Total	\$89,321,021	100%

Source: FAR Lane, 2023.

The analysis indicates that:

- The economic Net Present Value that will potentially be lost to coastal hazards in West Island Settlement by 2068 is approximately \$89.3 million.
- Should any protection be proposed to mitigate the risk of coastal hazards, 71.5% of the Net Present Value benefit of providing coastal hazard adaptation would be apportioned to private interests (including the Trust).

The approximate total value of replacement of non-essential infrastructure in West Island Settlement, representing indicative costs of relocating the infrastructure, is \$23.8 million (2023 dollars). None of the value of non-essential infrastructure would go to private beneficiaries.

Note that, as per section 6.1, the essential services infrastructure in the West Island Settlement management unit is included in an aggregated figure of \$1 billion for the entirety of West Island.

In summary, supporting economic Net Present Value of \$89.3 million in West Island Settlement is:

- \$23.8 million in non-essential infrastructure in the West Island Settlement management unit.
- \$1 billion of essential services infrastructure across all of West Island.

#### 6.4 WEST ISLAND NORTH OVERVIEW

Summary of all owner and community benefit that will be impacted by coastal hazards at West Island North is at Table 6.

Table 6 - Summary of economic Net Present Value in West Island North that will be impacted by coastal hazards by 2068

Beneficiary	PV of Benefit	% of Total Benefit
Dwellings	\$0	0%
Private Commercial	\$676,104	27%
Environmental Amenity	\$1,404,989	56%
Public Sector Revenue	\$0	0%
Economic Activity - Wages	\$440,366	17%
Total	\$2,521,458	100%

Source: FAR Lane, 2023.

The analysis indicates that:

- The economic Net Present Value that will potentially be lost to coastal hazards in West Island North by 2068 is approximately \$2.5 million.
- Should any protection be proposed to mitigate the risk of coastal hazards, 26.8% of the Net Present Value benefit of providing coastal hazard adaptation would be apportioned to private interests (including the Trust).

The approximate total value of replacement of non-essential infrastructure in West Island North, representing indicative costs of relocating the infrastructure, is \$7.3 million (2023 dollars). None of the value of non-essential infrastructure would go to private beneficiaries.

Note that, as per section 6.1, the essential services infrastructure in the West Island North management unit is included in an aggregated figure of \$1 billion for the entirety of West Island.

In summary, supporting economic Net Present Value of \$2.5 million in West Island North is:

- \$7.3 million in non-essential infrastructure in the West Island North management unit.
- \$1 billion of essential services infrastructure across all of West Island.

### 6.5 WEST ISLAND SOUTH OVERVIEW

A summary of all owner and community benefit that will be impacted by coastal hazards at West Island South is at Table 7.

Table 7 – Summary of economic Present Value in West Island South that will be impacted by coastal hazards by 2068

Beneficiary	PV of Benefit	% of Total Benefit
Dwellings	\$0	0%
Private Commercial	\$0	0%
Environmental Amenity	\$780,549	100%
Public Sector Revenue	\$0	0%
Economic Activity – Wages	\$0	0%
Total	\$780,549	100%

Source: FAR Lane, 2023.

The analysis indicates that:

- The economic Net Present Value that will potentially be lost to coastal hazards in West Island South by 2068 is approximately \$0.78 million.
- Should any protection be proposed to mitigate the risk of coastal hazards, none of the Present Value benefit of providing coastal hazard adaptation would be apportioned to private interests (including the Trust).

The approximate total value of replacement of non-essential infrastructure in West Island South, representing indicative costs of relocating the infrastructure, is \$5 million (2023 dollars). None of the value of non-essential infrastructure would go to private beneficiaries.

Note that, as per section 6.1, the essential services infrastructure in the West Island South management unit is included in an aggregated figure of \$1 billion for the entirety of West Island.

In summary, supporting economic Net Present Value of \$0.78 million in West Island South is:

- \$5 million in non-essential infrastructure in the West Island Settlement management unit.
- \$1 billion of essential services infrastructure across all of West Island.

### 6.6 OTHER ISLANDS – OVERVIEW

This section examines CKI's unpopulated islands which are considered for loss of public amenity, as they contain many sites used for by CKI's residents for recreation, including fishing and sightseeing. Islands considered are South Island, Direction Island, and Pulu Laur (Other Islands).

Note that no other benefits are considered as these islands are unpopulated and do not contain infrastructure or properties, with the exception of numerous pondoks (traditional fishing huts) scattered throughout the islands which are assumed to have no determinable value.

A summary of community benefit that will be impacted by coastal hazards for Other Islands is described at Table 35.

Table 8 – Community benefit for Other Islands by 2068

Item	Net Present Value	% of Total Benefit
Environmental Amenity	\$5,069,853	100%

Source: FAR Lane, 2023.

The analysis indicates that the Net Present Value of the preserved community benefits on all other islands is approximately \$5 million, none of which would be apportioned to private interests.

## 6.7 SUMMARY

A summary of the NPV of all owner and community benefit that will be impacted by coastal hazards in CKI is at Table 9. All calculations assume that interventions to mitigate the impact of erosion and inundation successfully protect the assets.

Table 9 – Summary of economic Net Present Value in CKI that will be impacted by coastal hazards by 2068

Beneficiary / Community Benefit	Value of Benefit	Percentage of Total Benefit
Private Dwellings	\$87,021,600	45.8%
Private Commercial	\$37,185,729	19.6%
Environmental Amenity	\$9,355,068	4.9%
Public Sector Revenue – Rates	\$5,773,262	3.0%
Economic Activity – Wages	\$50,628,977	26.7%
Total	\$189,964,636	100.0%

Source: FAR Lane, 2023.

The analysis indicates that:

- The economic Net Present Value that will potentially be lost to coastal hazards in CKI by 2068 is approximately \$190 million.
- Should any protection be proposed to mitigate the risk of coastal hazards, 65.4% of the Net Present Value benefit of providing coastal hazard adaptation would be apportioned to private interests (including the Trust), with private dwellings (predominantly owned by the Trust) and lost economic activity from lost wages constituting the highest preserved values.

The approximate total value of replacement of non-essential infrastructure in CKI, representing indicative costs of relocating the infrastructure, is \$78.9 million (2023 dollars). None of the value of non-essential infrastructure would go to private beneficiaries.

The essential services infrastructure is \$1.5 billion for the entirety of CKI.

In summary, supporting economic Net Present Value of \$190 million in CKI is:

- \$78.9 million in non-essential infrastructure in CKI.

- \$1.5 billion of essential services infrastructure across CKI.

As noted above, CKI is unusual in that there is very little privately held land. Instead, the islands comprise of Crown Land, and land held by the Cocos (Keeling) Islands Lands Trust of which the Shire is the administrator and Trustee. The majority of residents are renters in houses owned by the Trust. Therefore, while much of the benefit is noted as preserved for private dwellings, most of this benefit ultimately flows to the Trust.

Short term interventions are possible to extend the enjoyment of CKI's coastal lifestyle but are likely to be sacrificial in the long term, and any planning should be cognisant of this. Notwithstanding, should any protection be proposed to mitigate the risk of flooding, 65.4% of the economic Net Present Value of providing coastal hazard adaptation would be apportioned to private interests (including the Trust), who, under the beneficiary pays principal outlined in State Planning Policy 2.6, should be obliged to contribute to protection measures.

Given the extreme likelihood of erosion and inundation, the community of CKI will likely need to be relocated in the medium term. In the case of retreat, no intervention is being proposed that assures "the continued existence and operation of an asset, at its existing full functionality, landholding, service, or economic/commercial outcome as at the time of the BDA". Therefore caution should be used in consideration of a BDA as sole means of considering the preserved benefits of CKI.

## 7 CONCLUSION

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This report provides a Benefit Distribution Analysis (BDA) for the Cocos Keeling Islands (CKI) Coastal Hazard Risk Management Adaptation Plan 2023.

Both West Island's and Home Island's risk of inundation and erosion is so great that potential interventions over the long term other than relocation will be cost prohibitive and will likely be ineffective against the combination of erosion and inundation. Notwithstanding this, for completeness FAR Lane has estimated the value of benefits that would be impacted by coastal hazards in CKI by 2068.

The BDA quantifies the estimated proportional benefit accruing to relevant groups of asset holders against a do-nothing base case, thereby informing potential future structures for robust and fair cost allocations in the future. The BDA takes a broad view of the benefits resulting from coastal management interventions, including consideration of benefits to landowners, tenants, agencies, interest groups, and the community as a whole.

The analysis indicates supporting economic Net Present Value of \$190 million in CKI is:

- \$78.9 million in non-essential infrastructure in CKI.
- \$1.5 billion of essential services infrastructure across all CKI.

## 8 DETAILED METHODOLOGY

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### 8.1 METHODOLOGY OVERVIEW

#### Background to benefit distribution analysis

The benefit distribution analysis (BDA) in this report is developed to:

- Develop a shared understanding of who will benefit from coastal hazard interventions (existing and future).
- Ensure a broad understanding is developed by capturing a range of benefits from different perspectives.
- Inform future decision-making relating to funding contributions for interventions.

The BDA quantifies the estimated proportional benefit accruing to relevant groups of asset holders against a do-nothing base case, informing future structures for robust and fair cost allocations in the future. Cost distribution modelling is out of scope for this report and is therefore not considered.

The BDA takes a broad view of the benefits resulting from CMS interventions, including consideration of benefits to landowners, tenants, agencies, interest groups, and the community as a whole.

For this work, benefit is defined as “the continued existence and operation of an asset, at its existing full functionality, landholding, service, or economic/commercial outcome as at the time of the BDA”. A key assumption is that, for the purposes of the analysis, beneficiaries will continue to enjoy these benefits in perpetuity.

#### Essential services infrastructure

Essential services infrastructure is infrastructure without which a settlement could not sustainably exist on CKI. Examples of essential services infrastructure includes infrastructure for water, wastewater, power, fuel, telecommunications, and ports services (particularly important given CKI imports most of its food and all fuel by sea).

Maintaining this infrastructure against coastal hazards is critical to maintaining the existence of the CKI community and adjacent activities. Given the critical nature of this infrastructure and the community’s reliance on it, this infrastructure is not included in the BDA as the benefit accrues equally to all community members.

For completeness, aggregated asset values for Home Island and West Island are included in this report. These values are based on aggregated insurance values provided by the Australian Government.

It should also be noted that maintaining this infrastructure will be required well in advance of 2068, and is likely to require short term intervention as well as longer term maintenance.

#### Apportioning benefit

Methodology for apportioning benefit is:

1. Profile logical groupings of management units based on logical groupings of adjoining residential/commercial sites.
2. Profile relevant benefits against the CHRMAPs for:
  - Owner benefits
  - Community benefits.
3. Calculate total benefit retention/realisation for all owner users, including landowners; service/utility providers; commercial operators; local, state and federal governments; and the community.
4. Allocate overall benefit at the unit management level.

Methodology for calculating the value of benefit for each type of beneficiary is at Table 10, and is detailed below. Please note that a glossary of definitions can be found at Section 10.

Table 10 – Methodology summary table for calculating value of benefit

Benefit Type	Value of Benefit – Calculation Methodology
Private Dwellings	Net Present Value of Gross Rental Value
Private Commercial Assets	Net Present Value of Gross Rental Value
Environmental Amenity	Net Present Value of foregone amenity
Public Sector Revenue - Rates	Net Present Value of foregone Shire rates
Economic Activity - Wages	Net Present Value of indirect and induced economic impact of foregone wages on CKI
Infrastructure Value	Cost of replacement based on current values

Source: FAR Lane, 2023.

Net Present Value considers the lifetime of streams of costs and benefits expressed in constant real dollars. The below equation displays how to calculate the net present value of a cash flow existing in perpetuity:<sup>1</sup>

$$\text{Net Present Value} = \frac{\text{Net Annual Cash Flow}}{\text{Discount Rate}}$$

A discount rate of four percent was used for Net Present Value calculations for private dwellings, private commercial assets, and community amenity<sup>2</sup>. This social discount rate was selected to reflect the multigenerational nature of interventions and impacts being considered.

A discount rate of seven percent was used for Net Present Value calculations for public sector revenues and economic activity. This rate was selected to reflect that wages and public

<sup>1</sup> Assumption: Constant discount rate and cash flows hold in perpetuity.

<sup>2</sup> CSIRO, Estimating Coastal Values using multi-criteria and valuation methods, 2018, p.59.

sector revenues are not accruing in a multi-generational way but instead are accruing to given individuals/households at a given point in time.

The direct economic impact from wages is assumed to accrue to individuals/households, while indirect and induced accrues to the local economy. For this reason, only the impact from indirect and induced wages are considered in the BDA.

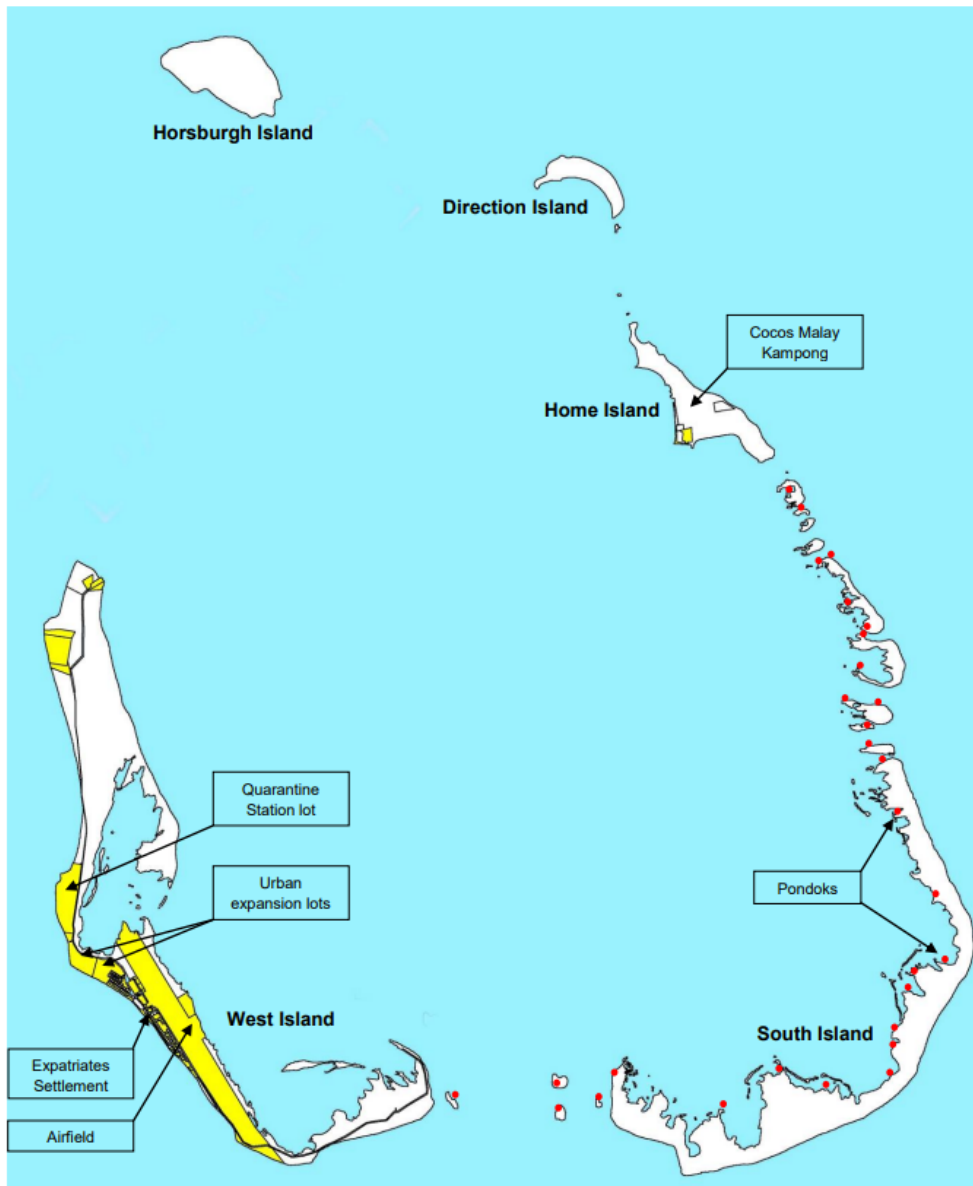
## 8.2 GEOGRAPHICAL DEFINITIONS – MANAGEMENT UNITS

The report breaks down CKI's coastal communities into "management units" which allows for the required level of detail for assessment under the BDA (see section 4). The BDA captures, and where possible, quantifies proportional benefits associated with existing and proposed protection works identified in the CHRMAP at the management unit level. This includes objective and/or subjective capture of benefits related to, but not limited to:

- Avoided loss of assets and/or asset value.
- Retention of opportunities for business activities and earning of wages.
- Retention for options for alternative asset utilisation in the future.
- Retention of critical infrastructure.
- Avoided travel costs.
- Avoided clean-up costs.
- Retention of amenity.

CKI is unusual in that there is very little privately held land. Instead, the islands comprise of Crown Land, and land held by the Cocos (Keeling) Islands Lands Trust of which the Shire is the administrator and Trustee (Figure 9). The majority of residents are renters in houses owned by the Trust.

Figure 9 – Map of land ownership on CKI



Source: Calmy Planning & Design, 2015.

#### Map Legend

- a) Crown land is shown in yellow.
- b) Freehold land held by the Land Trust since 1984 is shown in white.
- c) Freehold land held privately are residential lots all located within the Expatriates Settlement.
- d) The red dots shown depict the location of the Cocos Malay Pondoks.

Noting the breakdown into Crown land and Trust-owned land noted above, a list of management units is at Table 11.

Table 11 – Breakdown of CKI management units

Management unit	Area	Comment
Home Island	All of Home Island.	Treated as single units as any intervention (protect, retreat) impacts the settlement holistically and benefits everyone.
West Island Settlement	The main population centre on West Island located immediately west of the airport.	
West Island South	All land area south of airport runway.	For private commercial property (leased from the Trust), any preserved benefit will accrue solely to the owners.  Also considered for its environmental amenity benefits.
West Island North	All land area north of Rumah Baru jetty. Includes Big Barge art gallery and Wild Coconut discovery centre.	
Other Islands	South Island, Direction Island, Pulau Laur.	Unpopulated islands, only environmental amenity benefits considered.

Source: FAR Lane, 2023.

### 8.3 CALCULATING BENEFITS FOR PRIVATE DWELLINGS AND PRIVATE COMMERCIAL ASSETS

Methodology for calculating the benefit value of preserving residential and commercial property in perpetuity is at Table 12.

Table 12 – Methodology for calculating benefit for residential and commercial property

Steps	Data source
1. Define value units based on median gross rental values for CKI	Shire of CKI statutory budget 2022/23
2. Calculate number of properties	ABS Census 2021
3. Calculate total gross rental value of value unit, as an annual cash flow	n/a
4. Convert into a PV at an assumed discount rate of 4%	Assumption – see section 8.1

Source: FAR Lane, 2023.

Assumptions:

- Continuation of usability (utility) of property and assets for the same uses.
- Cash flow exists in perpetuity.
- Cost of maintaining land asset at present value of GRV is nominal and therefore not accounted for in the model.

#### 8.4 CALCULATING COMMUNITY BENEFIT

Methodology for calculating the benefit value of preserving community benefit in perpetuity is at Table 13.

Table 13 – Methodology for calculating community benefit

Community benefit type	Analysis	Methodology
Environmental Amenity	Loss of access/use of islands' undeveloped landmass	Benchmarked amenity calculation based on areas of non-developed land, <sup>3</sup> at a discount rate of 4%
Public Sector Revenues – Rates	Foregone LGA rates revenue	Average Shire of CKI rate payment applied to each residential property <sup>4</sup> at a discount rate of 7%
Economic Activity – Wages	Total loss of indirect and induced economic impact from wages on CKI	The number of jobs, multiplied by the median household income, <sup>5</sup> minus direct impact <sup>6</sup> , at a discount rate of 7%.

Source: FAR Lane, 2023.

Assumptions:

- Continuation of community activities, access to services and amenity, rate revenues, jobs.

#### 8.5 CALCULATING BENEFITS TO INFRASTRUCTURE OWNERS

Infrastructure considered in this report includes:

- Road infrastructure.
- Estimated cost of replacement for built form of public infrastructure, such as schools and sporting facilities.

Methodology for calculating the benefit value of preserving service infrastructure is at Figure 10.

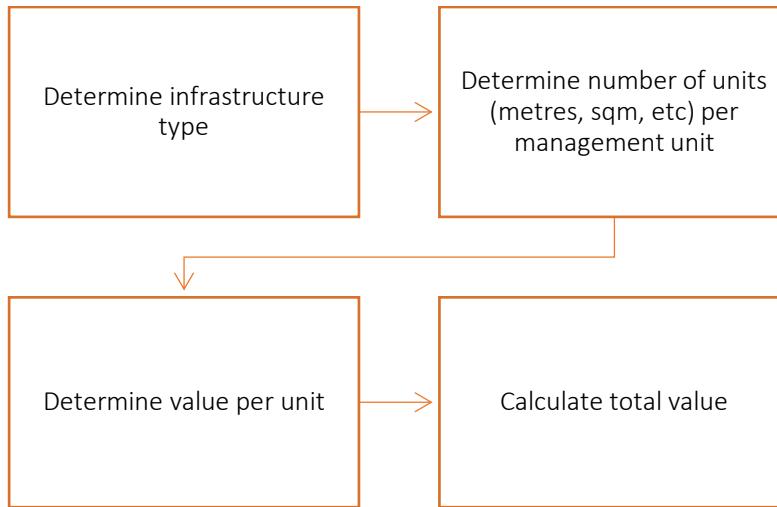
<sup>3</sup> CSIRO, Estimating Coastal Values using multi-criteria and valuation methods, 2018, p.59. Land areas calculated by FAR lane, 2023.

<sup>4</sup> Shire of CKI Adopted Budget 2022-23.

<sup>5</sup> ABS Census 2021.

<sup>6</sup> A multiplier of 1.4 was used to determine total impact, leaving a multiplier of 0.4 for indirect and induced impact. Source: NSW Department of Treasury, Aus Input-Output Employment Multipliers, February 2022.

Figure 10 – Methodology for calculating service infrastructure benefit



Source: FAR Lane, 2022.

The value per unit of service infrastructure types is described at Table 14. Note these costs do not include project management, design, site remediation and preparation, and other associated costs.

Table 14 – Value per unit of road infrastructure

Infrastructure type	Value/unit <sup>7</sup>
Road - Sealed	\$2,200 per sqm
Road – Gravel (sqm)	\$1,406 per sqm

Source: FAR Lane, 2022.

Benefit value of preserving built form for infrastructure is calculated by area using the estimated values described at Table 15. Note these costs do not include project management, design, site remediation and preparation, and other associated costs.

Table 15 – Value per unit of built form infrastructure

Infrastructure type	Value/unit <sup>8</sup>
Individual House, brick veneer	\$1,750 per sqm
Group Practice Surgery	\$2,125 per sqm

Source: FAR Lane, 2022.

Infrastructure is not considered with Net Present Value calculations because:

- Infrastructure can, in many cases, generate revenues which are utilised in future infrastructure upgrades.
- The infrastructure is specifically provided to support other assets such as residential and commercial assets.

<sup>7</sup> Wavelength, Cocos (Keeling) Islands CHRMAP, 2023.

<sup>8</sup> All per unit infrastructure values obtained from Rawlinsons Construction Cost Guide, 2022. All values are indexed at the highest listed rate for regional WA (160%) to reflect the additional expense for constructing infrastructure on CKI.

Assumptions:

- Continued operations/ performance of infrastructure.

### 8.6 LIMITATIONS OF APPROACH

Limitations of the above approach are at Table 16.

Table 16 – Limitations of approach

Assumption/limitation	Comment
Assumes status quo in perpetuity is desirable/beneficial.	Consideration of appropriate nature of the status quo is out of scope of this report.
Assumes protection in perpetuity.	Assumes interventions will be replaced when required to ensure assets remain protected.
Assumes equivalent benefit across all assets within a defined management unit.	Value units have been specifically selected based on similarity of gross rental value and/or community usage type.
Does not account for comparative sunk cost incurred by different stakeholders.	Due to the long timeframes involved calculating the BDA (50+ years), there is no mechanism available to determine the nature of any development costs that may improve the land value for each block over such a period.
Does not account for comparative opportunities for due diligence by different stakeholders i.e. recent lessees of landholdings should be more aware of risks than those purchasing 30-years ago.	Due to the long timeframes involved calculating the BDA (50+ years), and the current interventions already in place, it is a reasonable assumption that any new lessees will be aware of the effects of rising sea level on the Shire.
Does not dictate cost distributions – further processes need to be developed.	Out of scope of this report.

Source: FAR Lane, 2023.

## 9 DETAILED BENEFICIARY ANALYSIS BY MANAGEMENT UNIT

As noted in section 4, CKI's risks from coastal hazards include:

### Inundation risk:

- Both West Island and Home Island are already at high risk of inundation.
- By 2068, almost all of both West Island will be at extreme risk of inundation, and almost all of Home Island will be at either high or extreme risk of inundation.

### Erosion risk:

- By 2068, all of West Island will be at high or extreme risk of erosion (including the settlement), while significant parts of Home Island will be at high risk of erosion, with other parts at extreme risk.

Both West Island's and Home Island's risk of inundation and erosion is so great that potential interventions other than relocation will be cost prohibitive and will likely be ineffective against the combination of erosion and inundation. Given this, this report makes the assumption that the community will eventually be relocated.

Notwithstanding this, FAR Lane has estimated below the value that would be impacted. All calculations are based on the assumption that interventions to mitigate the impact of erosion and inundation successfully protect the assets. Full methodology and data sources can be found from sections 8.3 to 8.5

As noted in section 5, aggregated asset values for essential services infrastructure for Home Island and West Island in this report have been provided by the Australian Government based on insurance values (noting that values have only been provided as aggregated and not by management unit). These values indicate the approximate total value of replacement (in 2024 dollars) of essential services infrastructure is:

- \$500 million for Home Island.
- \$1 billion for West Island.

### 9.1 DETAILED BENEFICIARY ANALYSIS – HOME ISLAND

Economic value for property on Home Island has been considered based on the mean GRV within the Shire of CKI. Property benefits for Home Island are described at Table 17.

Table 17 – Property benefits for Home Island that will be impacted by coastal hazards

Type	Total Properties	Per unit value	Total (Annual)	NPV (4% discount rate)
Dwellings	115	\$17,232	\$1,981,680	\$49,542,000
Commercial	15	\$27,044	\$405,663	\$10,141,563
Total			\$2,387,343	\$59,683,563

Source: FAR Lane, 2023.

The analysis indicates that NPV of the preserved benefits for properties on Home Island is approximately \$59.6 million.

Community benefits for Home Island are described at Table 18.

Table 18 – Community benefit in Home Island

Item	Units	Total CKI Households	Per unit value	Annual Value	NPV	NPV discount rate
Wages	131	-	\$38,532	\$2,018,161	\$28,830,874	7%
Environmental Amenity	63	202	\$36.80	-	\$470,560	4%
Public Sector Revenue	-	115	\$2,001	\$230,073	\$3,286,758	7%
<b>Total</b>					\$32,588,192	

Source: FAR Lane, 2023.

The analysis indicates that the NPV of the preserved community benefits on Home Island is approximately \$32.6 million.

### Infrastructure

Cost of replacement for road infrastructure on Home Island is described at Table 19.

Table 19 – Cost of replacement for road infrastructure on Home Island that will be impacted by coastal hazards

Utility Type	Area Impacted (sqm)	Per unit value (\$)	Replacement Value (\$2023)
Road – Sealed	4,400	2,200	\$9,680,000
Road – Gravel	15,330	1,406	\$21,553,980
<b>Totals</b>			\$31,233,980

Source: FAR Lane, 2023.

The analysis indicates the estimated cost of replacement for road infrastructure on Home Island at approximately \$31.2 million.

Indicative cost of replacement for built form public infrastructure on Home Island is described at Table 20. Note these costs do not include project management, design, site remediation and preparation, and other associated costs.

Table 20 – Cost of replacement for built form public infrastructure on Home Island that will be impacted by coastal hazards

Infrastructure Item – Built Form	Estimated Value of Built Form (\$2023)
Mosque	\$612,500
Doctor's centre	\$1,104,469
Museum	\$693,000
Police station	\$577,500
School	\$5,250,000
Oval	\$1,732,500
Tennis Courts	\$123,420
Yacht Club	\$70,455

Boat Yard	\$1,398,705
Total	\$11,562,549

Source: FAR Lane, 2023.

The analysis indicates the cost of replacement for built form public infrastructure on Home Island is approximately \$11.6 million.

Aggregating costs of replacement for road infrastructure and public infrastructure on Home Island gives a total of \$42.8 million (\$2023).

Please also note that values for the following built form infrastructure has been captured separately in calculations for private commercial properties:

- Shire office.
- Supermarket.

### Summary – Home Island

Summary of all owner and community benefit that will be impacted by coastal hazards at Home Island is at Table 21.

Table 21 - Summary of economic NPV in Home Island that will be impacted by coastal hazards

Beneficiary	NPV of Benefit	% of Total Benefit
Dwellings	\$49,542,000	53.7%
Private Commercial	\$10,141,563	11.0%
Environmental Amenity	\$470,560	0.5%
Public Sector Revenue	\$3,286,758	3.6%
Economic Activity – wages	\$28,830,874	31.2%
Total	\$92,271,754	100.0%

Source: FAR Lane, 2023.

The analysis indicates that:

- The economic Net Present Value that will potentially be lost to coastal hazards in Home Island by 2068 is approximately \$92.2 million.
- Should any protection be proposed to mitigate the risk of coastal hazards, 64.7% of the Net Present Value benefit of providing coastal hazard adaptation would be apportioned to private interests (including the Trust).

The approximate total value of replacement of non-essential infrastructure in Home Island Settlement, representing indicative costs of relocating the infrastructure, is \$42.8 million (2023 dollars). None of the value of non-essential infrastructure would go to private beneficiaries.

Note that, as per section 6.1, the value of essential services infrastructure on Home Island is \$0.5 billion.

In summary, supporting economic Net Present Value of \$92.2 million in Home Island is:

- \$42.8 million of non-essential infrastructure.
- \$0.5 billion of essential services infrastructure.

## 9.2 DETAILED BENEFICIARY ANALYSIS – WEST ISLAND SETTLEMENT

Economic value for property on Home Island has been considered based on the mean GRV within the Shire of CKI. Property benefits for West Island Settlement are described at Table 22.

Table 22 – Property benefits for West Island Settlement that will be impacted by coastal hazards

Type	Total Properties	Per unit value	Total (Annual)	NPV (4% discount rate)
Dwellings	87	\$17,232	\$1,499,184	\$37,479,600
Commercial	39	\$27,044	\$1,054,723	\$26,368,063
Total			\$2,553,907	\$63,847,663

Source: FAR Lane, 2023.

The analysis indicates that NPV of the preserved benefits for properties on West Island Settlement is approximately \$63.8 million.

Community benefits for West Island Settlement are described at Table 23.

Table 23 – Community benefit in West Island Settlement

Item	Units	Total CKI Households	Per unit value	Annual Value	NPV	NPV discount rate
Wages	97	-	\$38,532	\$1,495,042	\$21,357,737	7%
Environmental Amenity	219 ha	202	\$36.80	-	\$1,629,118	4%
Public Sector Revenue	-	87	\$2,001	\$174,055.26	\$2,486,504	7%
Total					\$25,473,359	

Source: FAR Lane, 2023.

The analysis indicates that the NPV of the preserved community benefits on West Island Settlement is approximately \$25.5 million.

### Infrastructure

Cost of replacement for road infrastructure on West Island Settlement is described at Table 24.

Table 24 – Cost of replacement for road infrastructure in West Island Settlement that will be impacted by coastal hazards

Utility Type	Unit quantity	Per unit value (\$)	Total
Road – Sealed (sqm)	7,125	\$2,200	\$15,675,000
Road - Gravel (sqm)	1,181	\$1,406	\$1,660,486
Total			\$17,335,486

Source: FAR Lane, 2023.

The analysis indicates the estimated cost of replacement for road infrastructure for West Island Settlement at approximately \$32.5 million.

Indicative cost of replacement for built form public infrastructure is described at Table 25. Note these costs do not include project management, design, site remediation and preparation, and other associated costs.

Table 25 – Cost of replacement for built form public infrastructure on West Island Settlement that will be impacted by coastal hazards

Infrastructure Item	Estimated Value of Built Form
School	\$4,900,000
Medical centre	\$1,577,813
Total	\$6,477,813

Source: FAR Lane, 2023.

The analysis indicates the cost of replacement for built form infrastructure on West Island Settlement is approximately \$6.5 million.

Please also note that values for the following built form infrastructure has been captured in calculations for private commercial properties:

- Golf course.
- Settlement facilities.
- Transmitter station.

Aggregating costs of replacement for service and built form infrastructure gives a total of approximately \$23.8 million.

Summary of all owner and community benefit that will be impacted by coastal hazards at West Island Settlement is at Table 26.

Table 26 - Summary of economic value in West Island Settlement that will be impacted by coastal hazards

Beneficiary	NPV of Benefit	% of Total Benefit
Private Dwellings	\$37,479,600	42%
Private Commercial	\$26,368,063	30%
Environmental Amenity	\$1,629,118	2%
Public Sector Revenue	\$2,486,504	3%
Economic Activity - wages	\$21,357,737	24%
Total	\$89,321,021	100%

Source: FAR Lane, 2023.

The analysis indicates that:

- The economic Net Present Value that will potentially be lost to coastal hazards in West Island Settlement by 2068 is approximately \$89.3 million.
- Should any protection be proposed to mitigate the risk of coastal hazards, 71.5% of the Net Present Value benefit of providing coastal hazard adaptation would be apportioned to private interests (including the Trust).

The approximate total value of replacement of non-essential infrastructure in West Island Settlement, representing indicative costs of relocating the infrastructure, is \$23.8 million (2023 dollars). None of the value of non-essential infrastructure would go to private beneficiaries.

Note that, as per section 6.1, the essential services infrastructure in the West Island Settlement management unit is included in an aggregated figure of \$1 billion for the entirety of West Island.

In summary, supporting economic Net Present Value of \$89.3 million in West Island Settlement is:

- \$23.8 million in non-essential infrastructure in the West Island Settlement management unit.
- \$1 billion of essential services infrastructure across all of West Island.

### 9.3 DETAILED BENEFICIARY ANALYSIS – WEST ISLAND NORTH

West Island North contains no dwellings but one commercial property, the Big Barge art gallery. Economic value for property on West Island North has been considered based on the mean GRV within the Shire of CKI. Property benefits for West Island North are described at Table 27.

Table 27 – Property benefits for West Island North that will be impacted by coastal hazards

Type	Total Properties	Per unit value	Total (Annual)	NPV (4% discount rate)
Commercial	1	\$27,044	\$27,044	\$676,104

Source: FAR Lane, 2023.

The analysis indicates that NPV of the preserved benefits for properties on West Island North is approximately \$676,000.

Community benefits for West Island North are described at Table 28. Wages have been calculated the assumption that Big Barge has two FTE staff.

Table 28 – Community benefit in West Island North

Item	Units	Total CKI Households	Per unit value	Annual Value	NPV	NPV discount rate
Wages	2	-	\$38,532	\$30,825.60	\$440,366	7%
Environmental Amenity –	189 ha	202	\$36.80	\$1,404,989	\$1,404,989	4%
Total					\$1,845,354	

Source: FAR Lane, 2023.

The analysis indicates that the NPV of the preserved community benefits on West Island North is \$1.85 million.

### Infrastructure

Cost of replacement for road infrastructure on West Island North is at Table 29.

Table 29 – Cost of replacement for road infrastructure value in West Island North that will be impacted by coastal hazards

Utility Type	Unit quantity	Per unit value (\$)	Total
Road - Sealed (sqm)	3,330	\$2,200	\$7,326,000

Source: FAR Lane, 2023.

The analysis indicates the estimated cost of replacement for road infrastructure on West Island North at approximately \$7.3 million.

West Island North has no built form public infrastructure, therefore the cost of replacement is zero.

As noted above, values for the following built form infrastructure has been captured in calculations for private commercial properties:

- Big Barge Art Gallery.

Aggregating costs of replacement for service and built form infrastructure gives a total of approximately \$7.3 million.

Summary of all owner and community benefit that will be impacted by coastal hazards at West Island North is at Table 30.

Table 30 – Summary of economic Net Present Value in West Island North that will be impacted by coastal hazards

Beneficiary	NPV of Benefit	% of Total Benefit
Dwellings	-	0.0%
Private Commercial	\$676,104	26.8%
Environmental Amenity	\$1,404,989	55.7%
Public Sector Revenue	-	0.0%
Economic Activity - wages	\$440,366	17.5%
Total	\$2,521,458	100%

Source: FAR Lane, 2023.

The analysis indicates that:

- The economic Net Present Value that will potentially be lost to coastal hazards in West Island North by 2068 is approximately \$2.5 million.
- Should any protection be proposed to mitigate the risk of coastal hazards, 26.8% of the Net Present Value benefit of providing coastal hazard adaptation would be apportioned to private interests (including the Trust).

The approximate total value of replacement of non-essential infrastructure in West Island North, representing indicative costs of relocating the infrastructure, is \$7.3 million (2023 dollars). None of the value of non-essential infrastructure would go to private beneficiaries.

Note that, as per section 6.1, the essential services infrastructure in the West Island North management unit is included in an aggregated figure of \$1 billion for the entirety of West Island.

In summary, supporting economic Net Present Value of \$2.5 million in West Island North is:

- \$7.3 million in non-essential infrastructure in the West Island North management unit.
- \$1 billion of essential services infrastructure across all of West Island.

#### 9.4 DETAILED BENEFICIARY ANALYSIS – WEST ISLAND SOUTH

No dwellings or commercial properties exist within West Island South. Therefore the preserved benefit for property for this management unit is zero.

Community benefits for West Island South are described at Table 31.

Table 31 – Community benefit in West Island South

Item	Units	Total CKI Households	Per unit value	NPV	NPV discount rate
Environmental Amenity –	105	202	\$36.80	\$780,549	4%

Source: FAR Lane, 2023.

The analysis indicates that the NPV of the preserved community benefits on West Island South is approximately \$780,000.

#### Infrastructure

Cost of replacement for road infrastructure on West Island South is at Table 32.

Table 32 – Cost of replacement for road infrastructure in West Island South that will be impacted by coastal hazards

Utility Type	Unit quantity	Per unit value (\$)	Total
Road – Gravel (sqm)	3,470	\$1,406	\$4,878,820

Source: FAR Lane, 2023.

The analysis indicates the estimated cost of replacement for current costed service infrastructure on West Island South at approximately \$4.8 million.

Indicative cost of replacement for built form public infrastructure is described at Table 33. Note these costs do not include project management, design, site remediation and preparation, and other associated costs.

Table 33 – Cost of replacement for built form public infrastructure on West Island South that will be impacted by coastal hazards

Infrastructure Item	Estimated Value of Built Form
Yacht club	\$118,264

Source: FAR Lane, 2023.

The analysis indicates the cost of replacement for built form infrastructure on West Island Settlement is approximately \$0.1 million.

Aggregating costs of replacement for service and built form infrastructure gives a total of approximately \$5 million.

Summary of all owner and community benefit that will be impacted by coastal hazards at West Island South is at Table 34.

Table 34 - Summary of economic Net Present Value in West Island South that will be impacted by coastal hazards

Beneficiary	PV of Benefit	% of Total Benefit
Dwellings	-	0%
Private Commercial	-	0%
Environmental Amenity	\$780,549	100%
Public Sector Revenue	-	0%
Economic Activity - wages	-	0%
Total	\$780,549	100%

Source: FAR Lane, 2023.

The analysis indicates that:

- The economic Net Present Value that will potentially be lost to coastal hazards in West Island South by 2068 is approximately \$0.78 million.
- Should any protection be proposed to mitigate the risk of coastal hazards, none of the Net Present Value benefit of providing coastal hazard adaptation would be apportioned to private interests (including the Trust).

The approximate total value of replacement of non-essential infrastructure in West Island South, representing indicative costs of relocating the infrastructure, is \$5 million (2023 dollars). None of the value of non-essential infrastructure would go to private beneficiaries.

Note that, as per section 6.1, the essential services infrastructure in the West Island South management unit is included in an aggregated figure of \$1 billion for the entirety of West Island.

In summary, supporting economic Net Present Value of \$0.78 million in West Island South is:

- \$5 million in non-essential infrastructure in the West Island Settlement management unit.

- \$1 billion of essential services infrastructure across all of West Island.

### 9.5 DETAILED BENEFICIARY ANALYSIS – OTHER ISLANDS

This section examines CKI's unpopulated islands are considered for loss of public amenity, as they contain many sites used for by CKI's residents for recreation, including fishing and sightseeing. Islands considered are South Island, Direction Island, and Pulau Laur.

Note that no other benefits are considered as the islands are unpopulated and do not contain infrastructure or properties, with the exception of numerous pondoks (traditional fishing huts) scattered throughout the islands which are assumed to have no determinable value.

Table 35 – Community benefit, all other islands

Item	Total Hectares	Environment Hectares	NPV per Household	Total CKI Households	NPV	NPV discount rate
Environmental Amenity	682	682	\$25,098	202	\$5,069,853	4%

Source: FAR Lane, 2023.

The analysis indicates that the PV of the preserved community benefits on all other islands is approximately \$5 million, none of which would be apportioned to private interests.

## 10 GLOSSARY OF KEY TERMS AND ACRONYMS

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Amenity - an asset, facility or place that is a desirable or useful feature of a given area, which individuals find value in having access to. Includes natural environments such as beaches, waterways or parklands.

Benefit Distribution Analysis – a method of systematically estimating benefits to different parties from an action.

Benefit - the continued existence and operation of an asset, at its existing full functionality, landholding, service, or economic/commercial outcome as at the time of the BDA.

CHRMAP - Coastal Hazard Risk Management and Adaptation Plan.

Commercial benefit – benefit that sustains a commercial return from an intervention that preserves a business location.

Community amenity – see amenity.

Economic activity – wages generated by workers on CKI.

Erosion - Coastlines composed primarily of loose sediment (such as beaches) recede until a new equilibrium shoreline is found further inland. This report considers predicted erosion levels at 2068.

GRV – Gross Rental Value. The value expected to be gained from renting a property to a tenant/lessee.

Infrastructure – as defined in section 8.5.

Intervention – a deliberate action to avoid coastal hazards to townships that are deemed a risk to a community. Includes consideration of options to ‘avoid’ impact, ‘retreat’, ‘accommodate’ or to ‘protect’. CKI already has experience in this space, with construction of seawalls to mitigate the immediate effects of erosion (protect).

Inundation - Storm surges and increased mean sea levels will create flooding in areas adjacent to shorelines. The risk zone is measured based on 500-year average return interval (ARI) storms, combined with 100 years of sea level rise.

Management unit – a sub-unit of a community which allows for the required level of detail for assessment under the BDA (see section 8.2).

Net Present Value in perpetuity – difference in present value of cash inflows and present value of cash outflows, that will exist in perpetuity.

Private dwelling benefit – benefit value from an intervention that protects a private dwelling.

## 11 APPENDIX A – LIST OF INFRASTRUCTURE

A list of all road infrastructure on CKI by management unit is at Table 36.

Table 36 – Table of all road infrastructure by management unit

Management Unit	Asset	Value (\$2023)
Home Island	Roads - Sealed	\$9,680,000
Home Island	Road - Gravel	\$21,553,980
West Island - North	Roads - Sealed	\$7,326,000
West Island - Settlement	Roads - Sealed	\$15,675,000
West Island - Settlement	Road - Gravel	\$1,660,486
West Island - South	Road - Gravel	\$4,878,820
Total		\$60,774,286

Source: FAR Lane, 2023.

A list of all non-essential infrastructure built form on CKI by management unit is at Table 37.

Table 37 – Table of all public infrastructure built form by management unit

Management Unit	Asset - built form	Value of built form (\$2023)
Home Island	Mosque	\$612,500
Home Island	Doctor's centre	\$1,104,469
Home Island	Museum	\$693,000
Home Island	Police	\$577,500
Home Island	School	\$5,250,000
Home Island	Oval	\$1,732,500
Home Island	Tennis Courts	\$123,420
Home Island	Yacht Club	\$70,455
Home Island	Boat Yard	\$1,398,705
West Island - Settlement	School	\$4,900,000
West Island - Settlement	Medical Centre	\$1,577,813
West Island - South	Yacht Club	\$118,264
Total		\$18,158,625

Source: FAR Lane, 2023.

A list of essential services infrastructure by management unit is at Table 38. Note that values are not included, as aggregated asset values for essential services infrastructure for Home Island and West Island in this report have been provided by the Australian Government based on insurance values. These values indicate the approximate total value of replacement (in 2023 dollars) of essential services infrastructure is:

- \$0.5 billion for Home Island.
- \$1 billion for West Island.

Table 38 – Table of essential services infrastructure by management unit

Management Unit	Asset
Home Island	Desalination Pumps
Home Island	Water Pump
Home Island	Waste Water Treatment
Home Island	Fuel Facilities
Home Island	Power
Home Island	Jetty
Home Island	Cyclone Shelter
Home Island	Water Pipes
Home Island	Sewerage
Home Island	Underground cables
West Island - North	Fuel Station/Depot
West Island - North	Rumah Baru Jetty/Infrastructure
West Island - North	Port Office
West Island - North	Underground cables
West Island - North	Communication cables
West Island - Settlement	Transmitter Station
West Island - Settlement	Waste Water Treatment
West Island - Settlement	Water Storage Tank
West Island - Settlement	BoM facility
West Island - Settlement	Seismic Station
West Island - Settlement	Power Station
West Island - Settlement	Water Pipes
West Island - Settlement	Sewerage
West Island - Settlement	Underground cables
West Island - Settlement	Communication Cables
West Island - Settlement	Airport and Related Infrastructure
West Island - South	Underground cables
West Island - South	Communication cables

Source: FAR Lane, 2023.