NSW National Parks and Wildlife Service

Coastal hazard response plan

Woody Head campground, Bundjalung National Park

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Acknowledgement of Country

Department of Climate Change, Energy, the Environment and Water acknowledges the Traditional Custodians of the lands where we work and live.

We pay our respects to Elders past, present and emerging.

This resource may contain images or names of deceased persons in photographs or historical content.

Artist and designer Nikita Ridgeway from Aboriginal design agency – Boss Lady Creative Designs, created the People and Community symbol.

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AEP	annual exceedance probability
BCA	benefit–cost analysis
BCR	benefit–cost ratio
EEC	Endangered Ecological Community
ENSO	El Niño–Southern Oscillation
EP	exceedance probability
CMP	coastal management program
CHRP	coastal hazard response plan
CVC	Clarence Valley Council
HHWSS	high high-water solstice springs (tide)
MCA	multi-criteria analysis
NPWS	National Parks and Wildlife Service
SEPP	state environmental planning policy
SSP	shared socio-economic pathway
TOC	total outturn costs

Executive summary

Woody Head campground within Bundjalung National Park is a significant feature within the National Parks and Wildlife Service (NPWS) coastal reserve system. The value of the campground is related to the scenic beauty of the natural landscape, recreational opportunities, visitor usage, and historic and cultural heritage. Woody Head includes sites of spiritual significance and contemporary importance to the Yaegl people as well as some of the few remaining examples of European heritage in the Bundjalung National Park. The high levels of biodiversity in the area reflect climatic conditions that support a diverse range of subtropical coastal communities.

The Woody Head campground precinct has experienced significant coastal erosion and recession. NPWS has made significant investment in facilities and coastal protection works at Woody Head. A seawall and artificial dune were constructed to provide protection against beach erosion and shoreline recession. The aim of these works was to protect the campground while a phased retreat program from the eroding section of the campground was formulated and carried out.

At present, there is significant coastline recession occurring along Woody Bay north-west of the seawall. 'End effects' are occurring downdrift of the seawall, leading to increased erosion at the north-western end of the wall. Combined, these effects are currently reducing the extent of the sandy beach, impacting pedestrian access to the beach and contributing to vegetation loss in this area. This is likely to damage the campground entrance road and campground assets and services (e.g. electricity and sewerage). Risks to safety and amenity associated with beach access and falling trees along Woody Bay are also impacting the site.

This coastal hazard response plan (CHRP) considers the predicted impacts of beach erosion, recession and inundation on the campground. The plan assesses the suitability of potential options for managing the predicted extent of the coastal hazards in the short, medium and long term.

A community reference group was established for the development of the CHRP, consisting of Aboriginal representatives, community representatives, site users, state government agencies, Clarence Valley Council (CVC) and other interest groups. The key considerations in the development of this plan are:

- a desire to maintain the facilities at Woody Head campground and the surrounding reserve areas for as long as economically and practically viable
- future management approaches should accommodate natural coastal processes
- artificial intervention should be limited.

The recommended management approach involves **adaptive management**, including extension of the existing seawall, beach nourishment and long-term planned retreat. Extension of the current seawall by approximately 80 m with sand nourishment will restore the end effect area and create a usable beach.

The long-term recommended management approach is to implement strategic planned retreat of the campground and associated assets. This approach recognises that coastal processes will impact the natural landscape and intervention will not stop 'nature taking its course'. The adaptive management approach will be implemented to address risks and maintain functionality and safety of the campground for as long as viable. Planning for the long-term retreat of campground assets should be commenced in consultation with stakeholders to appropriately manage the risk to the natural environment and cultural heritage.

1. Introduction

The New South Wales coastal zone contains natural, cultural and socioeconomic values of regional, state and national significance. Approximately half of the coastline is managed within reserves by the National Parks and Wildlife Service (NPWS) under the *National Parks and Wildlife Act 1974.*

Woody Head campground in Bundjalung National Park is a significant site and landscape feature within the NPWS coastal reserve system. The Woody Head campground precinct has experienced significant coastal erosion and Woody Bay beach has receded over time (an event known as 'recession'). There is a risk of further impact, particularly with the expected influence of climate change.

The study area for this coastal hazard response plan (CHRP) incorporates the Woody Head campground, operational facilities, NPWS land and assets and the surrounding areas as shown in **Figure 17**, **Appendix A**. The coastline and estuary in the study area is the traditional land of the Yaegl people. The study area is highly valued in terms of biodiversity, Aboriginal and European cultural heritage and is a popular recreation area. The Woody Head campground attracts thousands of visitors each year and is valued by the local community who use its beach, foreshore and surrounding natural areas for a range of recreational activities. Commercial fishing operations also rely on the infrastructure and facilities within the campground.

NPWS has managed erosion through dune nourishment and a seawall; however, recession risks to Woody Head campground and Woody Bay beach remain. There is an expectation from the community that the facilities at this precinct will be maintained as long as possible.

This CHRP considers the risks of coastal hazards to natural, built and cultural assets and values within the Woody Head campground. This response plan presents measures to respond to erosion, recession and inundation over the short, medium and long term. Detailed coastal hazard studies, an assessment and comparison of management options and stakeholder engagement have informed the development of this response plan. The aim is to balance the expectations and values of NPWS, the local community, traditional owners and visitors with the future safety and viability of the campground in the face of current and future coastal hazards.

2. Legislative and planning context

The principal legislation guiding the management of NSW national parks and reserves is the *National Parks and Wildlife Act 1974*. The *Coastal Management Act 2016* and *State Environmental Planning Policy (Resilience and Hazards) 2021* (Resilience and Hazards SEPP) establish the strategic framework for management of coastal issues in New South Wales.

The NPWS undertakes coastal planning and management consistent with:

- the NSW Government's coastal management framework
- NPWS statutory land management responsibilities, as defined under the *National Parks and Wildlife Act 1974*.

The *Broadwater National Park, Bundjalung National Park and Iluka Nature Reserve plan of management* (NPWS, 1997) outlines how the national park will be managed.

This response plan aligns with the requirement for sustainable coastal management and objectives of the *Coastal Management Act 2016* that are consistent with the conservation objectives of the *National Parks and Wildlife Act 1974.* This coastal hazard response plan will contribute to better alignment of NPWS, other NSW government agencies and Clarence Valley Council (CVC) coastal management and planning activities for Woody Head.

Development controls relating to coastal management are prescribed in the *Environmental Planning and Assessment Act 1979*, the Resilience and Hazards SEPP and the *State Environmental Planning Policy (Transport and Infrastructure) 2021*. A detailed assessment of regulatory requirements and potential planning pathways for implementation of the CHRP is provided in Hydrosphere Consulting (2023).

3. Project background

The study area is part of the Bundjalung National Park and is located within the Clarence Valley local government area. The majority of the coastline north of the Clarence River entrance at Iluka is managed as national park/reserve. Recognising the extensive area of the coastal zone under management, NPWS is collaborating with CVC in the development of the coastal management program for the Clarence Valley coastline and estuaries (the Clarence Valley Coastline CMP).

A scoping study was completed in March 2021 as the stage 1 of development of the Clarence Valley Open Coast CMP (Hydrosphere Consulting, 2021). This identified the need for detailed assessment of coastal hazards within the study area due to the high risk of continuing coastal erosion and recession and the lack of contemporary understanding of coastal hazards at that time. Stage 2 of the CMP development involved probabilistic modelling of coastal erosion/recession and tidal/coastal inundation for various likelihoods, planning horizons and climate scenarios has been (refer **Section 5.3** and **Appendix C**). The coastal hazard mapping resulting from this modelling provides robust and contemporary information on the current and future risks that have been considered in the development of this CHRP.

This CHRP aligns with Stage 3 of the Clarence Valley Coastline CMP, which will develop strategies and identify coastal management actions within the NPWS estate. NPWS intends to incorporate the outcomes of this plan as actions in the CMP (Stage 4) to ensure a coordinated management approach for the Clarence Valley coastline.

This plan is consistent with the relevant components of the *NSW coastal management manual* (NSW Environment and Heritage, 2018a; 2018b), which guides the preparation of CMPs.

4. The study area

4.1 Campground location and layout

NPWS acquired the Woody Head campground site in 1982. Maps of the study area including land ownership and management are shown in **Appendix A**. The study area includes the Woody Head campground and surrounding areas, entrance roads, tracks and facilities. The future management of the Woody Head campground site and facilities (**Appendix A**, **Figure 18**) is the focus of this plan.

The campground is in the Iluka precinct of Bundjalung National Park and is accessed via Iluka Road and Woody Head Road (both owned by CVC). Woody Bay is located west of the Woody Head campground and is enclosed by Woody Head to its east and a tombolo to the west, between Shark Bay/Ten Mile Beach and Woody Bay. The campground includes unpowered campsites and hard-roofed accommodation (cabins, cottages and houses), with a sandy beach, rock platform and shallow reefs.

Services at the site include electricity, solar panel, water supply, waste facilities, sewerage, fire management, stormwater, security and safety assets, pedestrian and vehicle access and recreational assets (e.g. picnic and BBQ facilities).

The site is surrounded by littoral rainforest to the south/south-west and the beach of Woody Bay and the Pacific Ocean to the north (**Photo 1 and Photo 2**, **Figure 17** and **Figure 19** in **Appendix A**).

Vehicle use on beaches adjoining Bundjalung National Park in the study area is restricted to the southern half of Ten Mile Beach between Black Rocks and Shark Bay, with vehicle access at Shark Bay. A boat ramp within the campground allows ocean access, including for licensed commercial fishers (**Photo 3**). A hut and road access near the boat ramp are managed by Clarence River Fishermen's Co-Operative Limited, which holds a Permissive Occupancy.

Multiple authorities are responsible for infrastructure and public use (NPWS, CVC, Essential Energy and various state government agencies), which will require a coordinated approach to site management.

Photo 1 **Aerial view of Woody Head campground and rocky reefs (looking south, June 2022)**

Photo 2 **Campground and picnic areas (June 2022)**

Photo 3 **Woody Head boat ramp (June 2022)**

4.2 Aboriginal cultural heritage and historic heritage

The Yaegl people are the traditional owners and custodians of Yaegl Country, which encompasses the study area. The coastal areas continue to play a significant role in the daily lives of the Yaegl people, providing an abundance of natural resources for survival, a location for ceremonial rituals and a deep social, cultural and spiritual connection. Numerous significant sites, areas and landscapes are located along the coastline. The Yaegl people's ongoing use of and relationship to Country is recognised through the successful native title determination over lands and coastal waters along the coastline (NCD2017/003 – Yaegl People #2 Part B). The native title determination covers areas of Crown land within the lower Clarence Valley from Shark Bay in the north to Wooli in the south, including areas of Bundjalung National Park and parts of the study area (**Appendix A**, **Figure 17**).

Bundjalung National Park has a long history of 'shared' Aboriginal and European use, occupation and association. The Hammond family cottage is one of the few remaining examples of European heritage in the Bundjalung National Park. The cottage was built in 1923 by Henry Robert Hammond from timber cut from the Woody Head 'scrub', which at that time was leased by Henry Hammond. The cottage has been moved a short distance from its original site opposite the present campground kiosk and is now situated at the base of Woody Head headland (**Appendix A, Figure 18**). Swamp House and Forest House are the family homes of Henry Hammond's sons which have been relocated to the area at the entrance to the campground (**Appendix A, Figure 18**). The fishing hut adjacent to the boat ramp was constructed under Permissive Occupancy granted by the former Lands Department prior to the creation of Bundjalung National Park (**Appendix A, Figure 18**).

4.3 Biodiversity

Bundjalung National Park is part of a major conservation system covering much of the sub-tropical coast of northern New South Wales and is part of the Gondwana Rainforests of Australia World Heritage area. The high levels of biodiversity in the study area reflect the diverse vegetation communities and climatic conditions supporting temperate species and sub-tropical and coastal communities (**Appendix A, Figure 19**), including Endangered Ecological Communities (Far North Sands Tuckeroo–Banksia Littoral Rainforest, Northern Sands Tuckeroo–Banksia Forest and Northern Estuarine Paperbark Sedge Forest). This variation in vegetation communities supports a diverse range of species, including wet and dry heathland communities, hind-dune swamps of sedges and rushes, swamp sclerophyll forest along marshes and waterways, areas of open eucalypt woodland and forest and small areas of sub-tropical littoral rainforest, as well as reptiles, birds and mammals and both migratory and resident shorebirds and bats. A range of coastal landforms and related biological features featured in the study area demonstrate important aspects of the evolution of the extensive Pleistocene sand plain and dunal system of northern New South Wales (NPWS, 1997).

5. Development of the response plan

5.1 Stakeholder engagement

A community reference group was established for this project to assist in the development of the coastal hazard response plan. The group consisted of:

- campground users
- representatives from Iluka Ratepayers Association
- Clarence Valley Council
- Department of Climate Change, Energy, Environment and Water (the department)
- Department of Primary Industries (DPI – Fisheries)
- Yaegl Traditional Owners' Aboriginal Corporation (a Registered Native Title Body Corporate)
- Iluka Fishing Co-operative
- Iluka Landcare and Dune Care
- Iluka Fishing Club.

Three meetings were held with the community reference group.

- Meeting 1 (June 2022) – introduction to the project, presentation of information on coastal hazards and asset risks, determine community objectives and gather information
- Meeting 2 (September 2022) – presented management options, obtained input into options and discussed management plan components
- Meeting 3 (November 2022) – presented management options, obtained input into options and discussed management plan components.

Separate meetings were held in September 2022 and May 2023 with the Yaegl Traditional Owners' Corporation to present the project scope and additional context.

The department's Marine, Coast, Estuaries and Flood team provided a technical review of the management options and recommendations during the development of this plan.

5.2 Key values, issues and considerations

5.2.1 Values

The Woody Head campground is valued for its:

- scenic beauty
- recreational opportunities
- natural landscape
- historic heritage
- significant cultural heritage value.

5.2.2 Objectives

Broadwater National Park, Bundjalung National Park and Iluka Nature Reserve plan of management (NPWS, 1997) outlines the following management objectives:

- the conservation of wildlife

- the encouragement of scientific and educational inquiry into environmental features and processes, prehistoric and historic features and park use patterns
- the maintenance of natural processes as far as is possible
- the preservation of Aboriginal sites and historic features
- the protection and preservation of scenic and natural features
- the provision of appropriate recreation opportunities.

No operations may be undertaken within the national park and the nature reserve except in accordance with the plan of management. The plan of management considers the protection of the Woody Head Camping Area from coastal erosion, subject to environmental and economic considerations.

The key considerations in the development of the CHRP are:

- artificial intervention should be limited so that the scenic beauty and natural landscape of the area are not substantially compromised
- future management and protection measures should be sympathetic to natural coastal processes and should not result in an increase in coastal hazards
- the community and NPWS have a desire to maintain the facilities at Woody Head campground and the surrounding reserve areas for as long as it is economically and practically viable.

The NPWS also has objectives for the ongoing management of the Woody Head campground. These include:

- acknowledgement of the cultural heritage values and facilitation of the use and access to the area by native title holders
- maintenance of the economic viability of the campground
- maintenance of the surrounding beaches, foreshore and reserve areas to support the visitor experience
- preservation of habitat and ecosystem services in the surrounding area
- preservation of scenic amenity
- provision of opportunities for appreciation, understanding and enjoyment of the area
- a safe and enjoyable visitor (camping and day use) experience
- safe and functional access to the campground for all services (water, electricity, telecommunications and wastewater) and by road for vehicles.

The *Coastal Management Act 2016* provides for the integrated management of the coastal environment of New South Wales consistent with the principles of ecologically sustainable development, for the social, cultural and economic wellbeing of the people of the state. A key objective of this plan is to promote and achieve the objects of the NSW coastal management framework. Section 3 of the Act states that its objectives are:

> (a) to protect and enhance natural coastal processes and coastal environmental values including natural character, scenic value, biological diversity and ecosystem integrity and resilience, and
>
> (b) to support the social and cultural values of the coastal zone and maintain public access, amenity, use and safety, and
>
> (c) to acknowledge Aboriginal peoples' spiritual, social, customary and economic use of the coastal zone, and
>
> (d) to recognise the coastal zone as a vital economic zone and to support sustainable coastal economies, and

(e) to facilitate ecologically sustainable development in the coastal zone and promote sustainable land use planning decision-making, and

(f) to mitigate current and future risks from coastal hazards, taking into account the effects of climate change, and

(g) to recognise that the local and regional scale effects of coastal processes, and the inherently ambulatory and dynamic nature of the shoreline, may result in the loss of coastal land to the sea (including estuaries and other arms of the sea), and to manage coastal use and development accordingly, and

(h) to promote integrated and coordinated coastal planning, management and reporting, and

(i) to encourage and promote plans and strategies to improve the resilience of coastal assets to the impacts of an uncertain climate future including impacts of extreme storm events, and

(j) to ensure co-ordination of the policies and activities of government and public authorities relating to the coastal zone and to facilitate the proper integration of their management activities, and

(k) to support public participation in coastal management and planning and greater public awareness, education and understanding of coastal processes and management actions, and

(l) to facilitate the identification of land in the coastal zone for acquisition by public or local authorities in order to promote the protection, enhancement, maintenance and restoration of the environment of the coastal zone, and

(m) to support the objects of the *Marine Estate Management Act 2014*.

5.2.3 Considerations in the development of the CHRP

The key considerations in the development of the CHRP are:

- artificial intervention should be limited so that the scenic beauty and natural landscape of the area are not substantially compromised
- future management and protection measures should be sympathetic to natural coastal processes and should not result in an increase in coastal hazards
- the community and NPWS have a desire to maintain the facilities at Woody Head campground and the surrounding reserve areas for as long as it is economically and practically viable.

5.3 Coastal hazards

Coastal processes at Woody Head have been studied extensively over the last 40 years and are outlined in the CMP scoping study (Hydrosphere Consulting, 2021) and summarised below. This plan addresses the current and future coastal hazards of tidal and coastal inundation, beach erosion and coastal recession.

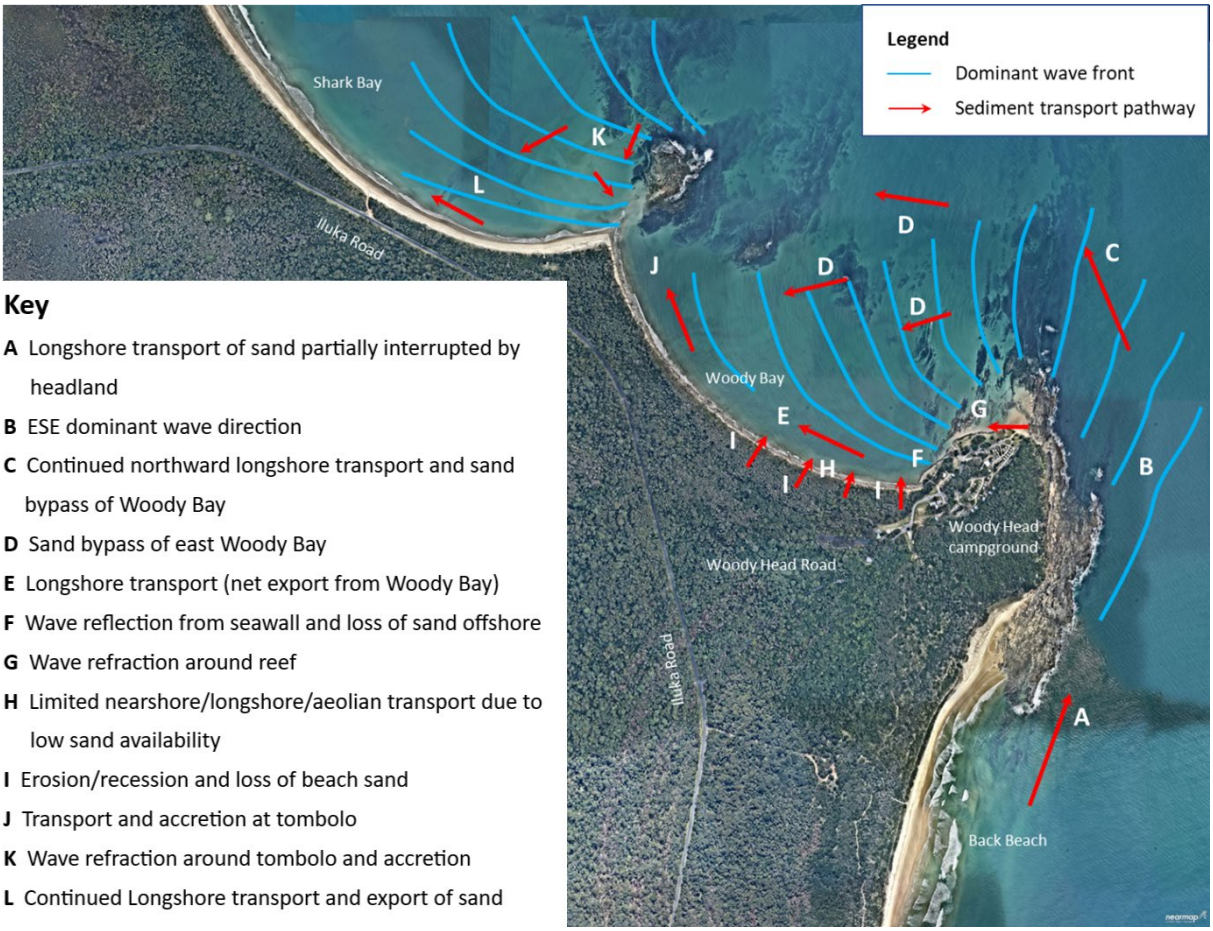
5.3.1 Coastal processes

The ocean conditions and wave climate – that is, the distribution of wave characteristics averaged over a period of time and for a particular location – along the coastline are influenced by short-term weather and longer-term climatic conditions. Coastal processes and influences on coastal processes occurring along the Clarence Valley coastline include the following (Hydrosphere Consulting, 2021).

- **Wind.** Morning winds are typically light and from the west with stronger winds from the south occasionally. Afternoon winds are typified by stronger north-east and south-east winds. Winds influence aeolian transport of sand and local wave conditions.

- **Wave direction.** The dominant swell direction along the Clarence Valley coastline is from the east to south-east. There is a seasonal trend in wave direction with swells predominantly east-southeast during summer, shifting further south in autumn with dominant south-east to south-southeast during winter. North-easterly winds can influence wave direction in the spring, but the predominant direction is still south-east. In summer, the largest swells come from the south-southeast with a small portion of larger swells from the east.
- **Wave height.** Wave heights peak between March and April. Periodic weather events can result in large wave conditions that impact on shorelines.
- **Sediment movement.** The Clarence Valley coastline is a longshore drift coastline, which means that waves move sediments (such as sand, pebbles and shells) parallel to the coastline. Overall sediment movement (in a northerly direction) is influenced by the predominant south-easterly swell. Longshore drift occurs within and between sediment compartments. There are other localised sediment movements, including on- and offshore movements under different conditions.
- **Weather patterns.** The El Niño Southern Oscillation (ENSO) is responsible for influencing weather patterns on the east coast and consequently is a major driver of wave climate and associated coastal processes and conditions. The ENSO drives the El Niño/La Niña weather phases. Typically, El Niño events are associated with reduced storminess, weaker easterly trade winds and a generally more southerly wave climate. La Niña events are associated with the opposite – increased storminess, stronger trade winds and a more easterly wave.

The tidal influences and wave climate along the Clarence Valley coastline have formed multiple crenulated embayments such as at Woody Head **(Figure 1**). Sand is supplied to the beaches by longshore drift, with sand pulses around headlands a key mechanism for the longshore transport. Large migratory updrift rips are generated that erode the beach and transport sand to the north through sand waves. The bedrock reef (tombolo) extending offshore to the north of Woody Head is believed to act as a barrier to sand deposition in Woody Bay and this, combined with the dominant north-easterly wave direction, is responsible for the recession experienced in the bay (Hydrosphere Consulting, 2021).



Key

A Longshore transport of sand partially interrupted by headland

B ESE dominant wave direction

C Continued northward longshore transport and sand bypass of Woody Bay

D Sand bypass of east Woody Bay

E Longshore transport (net export from Woody Bay)

F Wave reflection from seawall and loss of sand offshore

G Wave refraction around reef

H Limited nearshore/longshore/aeolian transport due to low sand availability

I Erosion/recession and loss of beach sand

J Transport and accretion at tombolo

K Wave refraction around tombolo and accretion

L Continued Longshore transport and export of sand

Figure 1 Coastal processes at Woody Bay

Beach erosion and shoreline recession are a significant concern at Woody Head/Woody Bay. The historical evolution of the shoreline and modifications to the campground, including construction of coastal protection works, are illustrated in the historical aerial photographs included in **Appendix B**. The aerial photograph from 1958 shows substantial sand accretion at the western end of Woody Bay with a wide tombolo. Later photographs show significant recession of Woody Bay.

The receding shoreline is likely to impact the reserve campground and the Woody Head access roads, as well as affecting safety and amenity associated with beach access. Shoreline recession further west along Woody Bay and Shark Bay is likely to also impact Iluka Road.

NPWS is seeking to address the current and future coastal hazards impacting the Woody Head campground precinct in this CHRP.

5.3.2 Current coastal management

Shoreline recession at Woody Bay is resulting in risk to natural, cultural and built assets vulnerable to coastal hazards. NPWS has made significant investment in facilities and coastal protection works at Woody Head.

A seawall was constructed along the shoreline of the Woody Head campground by NPWS (**Figure 2**) to provide protection against beach erosion and shoreline recession. The section east of the boat ramp is an older seawall founded on bedrock (constructed in the late 1980s and 1999). The section to the west of the boat ramp was constructed from 2006 and built progressively west from the boat ramp in several sections (**Photo 4** and **Photo 5**). The aim

of these works was to protect the campground amenities while a phased retreat program from the eroding section of the campground was formulated and carried out. Upgrades to the seawall were implemented following recommendations of a structural assessment (Water Technology, 2018).

An artificial dune was constructed at Woody Bay in 2004. The dune is approximately 100 m in length, 25 m wide and 2.5 m in height and has been revegetated with local dune species (**Figure 2**). The purpose of this dune was to limit wave overtopping and coastal inundation of low-lying areas of the campground and provide protection to the facilities from foreshore erosion.

These works were seen as a management option to permit the natural processes to proceed, while affording protection to the main areas of the campground. The north-western 'node' of the campground was relinquished at the time of the dune construction. Part of the management strategy was to allow for the natural realignment of the front of the dune while subsequently building up the back to allow the dune to move further landward. However, the location of the amenities block and sewer pumping station behind the eroded section of the dune has prevented dune replenishment occurring (DECCW, 2012). Instead, the seawall fronting the dune has been progressively extended as required to provide protection for the site (Hydrosphere Consulting, 2021). The existing seawall is maintained by NPWS and will continue to require maintenance and/or upgrade for all management options into the future.

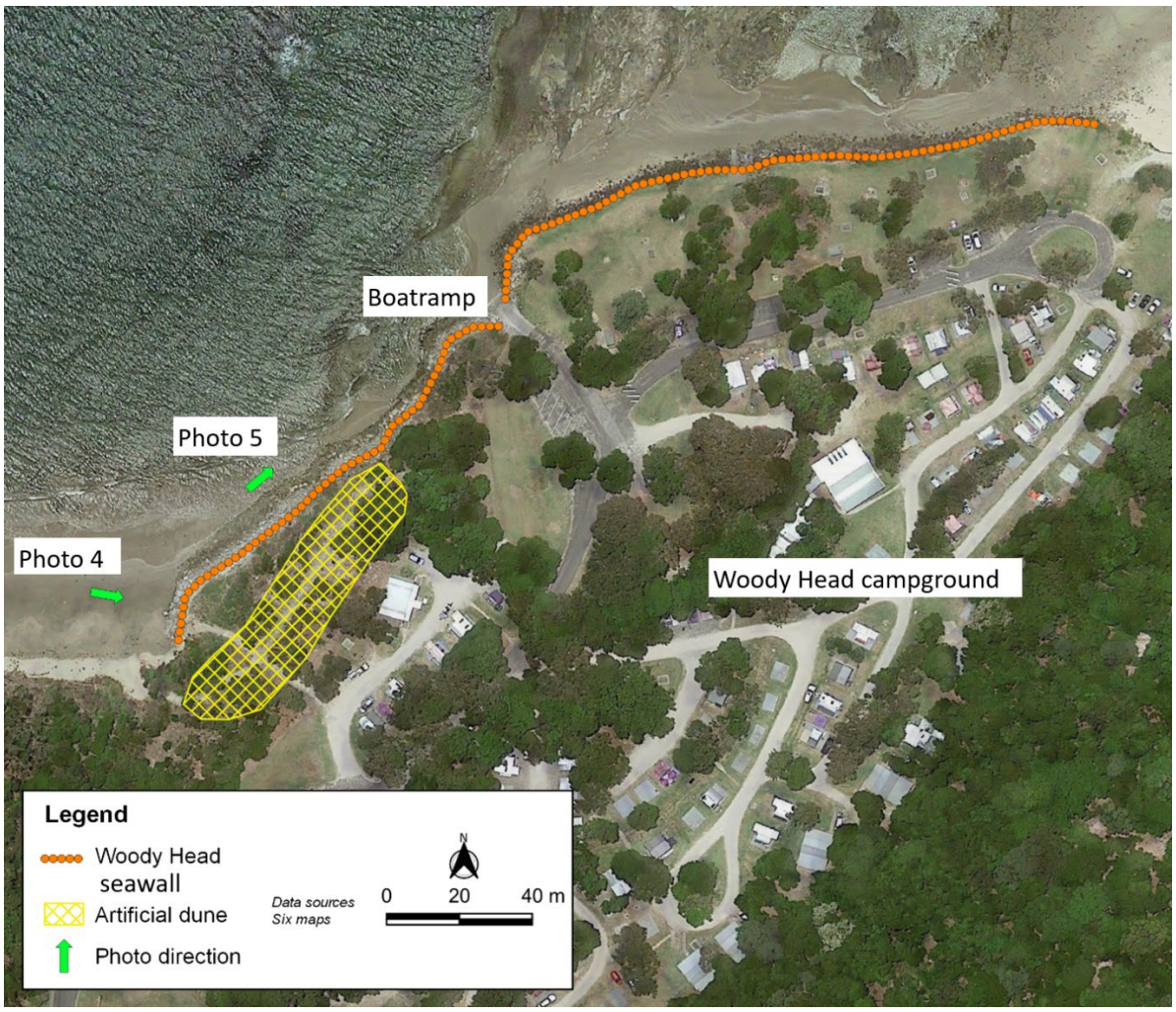


Figure 2 Location of seawall and artificial dune at Woody Head

Photo 4 Seawall at Woody Head – photo locations indicated in Figure 2 (July 2020)

Photo 5 Seawall at Woody Head – photo locations indicated in Figure 2 (July 2020)

5.3.3 Coastal hazard assessments

Coastal hazard assessments and associated maps (JBP, 2022; JBP, 2023) were prepared to support Stage 2 of the development of the Clarence Valley Open Coast CMP. Coastal hazard mapping is provided in **Appendix C**. The coastal hazard assessment considers the hazards of coastal erosion, recession and inundation as defined by NSW Environment and Heritage (2019a).

Beach erosion refers to the removal of beach materials by wave action, tidal currents, littoral currents or wind. It is usually associated with storms or with elevated water levels and can occur on the open coast and in estuaries. Beach erosion events are often combined with a beach recovery phase in which sediment moves back onshore to rebuild the beach and dunes. The total amount of sediment (the 'sediment budget') is maintained in a sediment compartment (**Figure 3**).

Shoreline recession refers to continuing landward movement of the shoreline or a net landward movement of the shoreline over a specified time.

Tidal inundation refers to the flooding of land by tidal action under normal weather conditions. Tidal inundation may include shorter-term incursion of seawater onto low-lying land during an elevated water level event such as a 'king' tide or more permanent inundation due to land subsidence, changes in tidal range or sea level rise. Any changes in mean sea level will directly affect the extent and severity of tidal inundation hazards.

Coastal inundation related to storm events refers to the temporary flooding of a portion of land within the coastal zone, which is generally related to storm events. Coastal inundation occurs when a combination of marine and atmospheric processes raises ocean water levels above normal elevations and inundates low-lying areas or overtop dunes, structures and barriers. Coastal inundation is often associated with storms resulting in elevated still water levels (storm surge), wave set-up, wave run-up and over-wash flows.

The coastal hazard assessments considered a number of scenarios for each of 3 categories of hazard – tidal inundation, coastal inundation, and beach erosion and shoreline recession – that would result from a combination of 3 factors: timeframe, event frequency and future climate scenario.

Coastal hazards have been defined in terms of an event frequency based on terminology used in flood management planning (Geoscience Australia, 2019). The term **exceedance probability** (EP) means the probability that a particular even will be exceeded in a given period.

- For inundation, the event frequency is the probability that a particular inundation event will be exceeded in a given year, that is, the annual EP (AEP).
- For erosion and recession, hazard projections are a combination of short- and long-term probabilistic components, so scenarios are described in terms of likely EP. For a given planning time horizon, erosion/recession maps indicate the probability (e.g. 1%) that the hazard extent will be exceeded.

The future climate scenarios were drawn from the Intergovernmental Panel on Climate Change (IPCC) categories of shared socio-economic pathways (SSPs), which consider how socio-economic factors may change over the next century, including potential changes to population, economic growth, education, urbanisation and the rate of technological development (IPCC, 2023). The assessment scenarios included allowances for sea level rise based on 2 SSPs, namely SSP2 and SSP5.

- SSP2 represents a pathway on which global social, economic and technological trends do not shift markedly from historical patterns. It considers intermediate greenhouse gas emissions, with carbon dioxide (CO_2) emissions maintaining current levels until 2050 and then falling, but not reaching net zero by 2100.

- SSP5 represents the highest level of fossil fuel use, food demand, energy use and greenhouse gas emissions. It includes very high greenhouse gas emissions, with CO_2 emissions tripling by 2075. However, it also includes a socio-economic pathway with competitive markets, innovation and participatory societies able to produce rapid technological progress to achieve sustainable development over the long term (IPCC, 2023).

CVC commissioned a climate risk assessment which considers that SSP2 is more likely than SSP5 (Risk Frontiers, 2021).

Table 1 shows the 64 scenarios considered in the coastal hazard assessments, in the following combinations:

- 8 tidal inundation scenarios, based on a high high-water solstice springs (HHWSS) tide, for:
  - 4 timeframes (2023, 2043, 2073 and 2123)
  - an AEP of more than one per year (very frequent)
  - 2 future climate scenarios (SPP2 and SPP5)
- 24 coastal inundation scenarios, based on extreme sea level rise, for the same 4 timeframes and same 2 future climate scenarios, but with 3 event frequencies:
  - 10% AEP (frequent to very rare)
  - 2% AEP (rare)
  - 1% AEP (rare to very rare)
- 32 beach erosion and shoreline recession scenarios for the same 4 timeframes and same 2 future climate scenarios, but with 4 event frequencies:
  - 50% AEP (frequent)
  - 10% AEP
  - 2% AEP
  - 1% AEP.

Table 1 Coastal hazard assessment scenarios*

Hazard	Planning timeframes	Event frequency*	Future climate scenarios
Tidal inundation (HHWSS tide)	Present day (2023) +20 years (2043) +50 years (2073) +100 years (2123)	> 1 per year	SSP2 SSP5
Coastal inundation (extreme sea level rise)	Present day (2023) +20 years (2043) +50 years (2073) +100 years (2123)	10% AEP 2% AEP 1% AEP	SSP2 SSP5
Beach erosion and shoreline recession	Present day (2023) +20 years (2043) +50 years (2073) +100 years (2123)	50% EP 10% EP 2% EP 1% EP	SSP2 SSP5

AEP = annual exceedance probability; EP = exceedance probability; HHWSS = high high-water solstice spring; SSP = shared socio-economic pathway, as defined by the Intergovernmental Panel on Climate Change (2023).

* Event frequency values are defined as: > 1 = very frequent; 50% = frequent; 10% = frequent to rare; 2% = rare; 1% = rare to very rare.

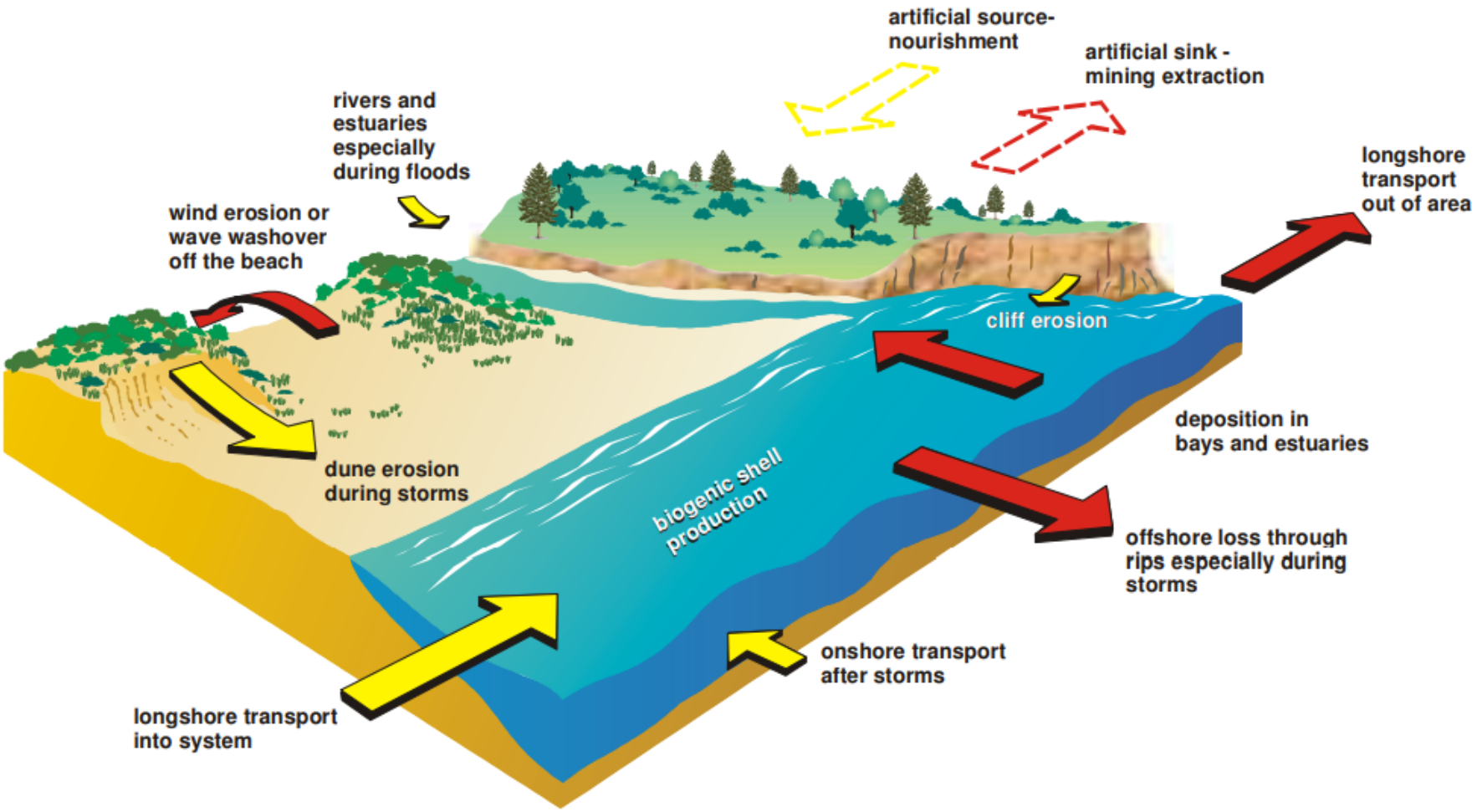


Figure 3 Components of the coastal sediment budget

Source: NSW Department of Land and Water Conservation (2001).

Tidal and coastal inundation

Coastal inundation is generally related to storm events, including trapped ocean waves and tsunamis, and occurs when a combination of marine and atmospheric processes raises ocean water levels above normal elevations and inundates low-lying areas or overtops dunes, structures and barriers (**Figure 4**).

The detailed assessment of tidal and coastal inundation undertaken for Woody Head (JBP, 2022) provides information on the likelihood of occurrence and the extent of inundation over time. Tidal and coastal inundation hazard mapping has been produced for the Sandon River and coastline areas using hydrodynamic modelling and spatial projection methods. Each time horizon includes tidal inundation mapping based on the HHWSS (termed as very frequent and occurring more than once each year) tide and coastal inundation (extreme storm events), shown in **Table 1**.

Periodic tidal inundation is predicted to impact on the national park north of the Clarence River, with inundation extents increasing over time towards Iluka Road at Shark Bay. More frequent river inundation of management trails and the NPWS depot is expected over the next 20 years. Storm surge ocean levels are predicted to overtop the existing seawall by 2123 and impact the northern parts of the campground, including campsites and access roads. The inundation extents for the campground and surrounding areas for the present day and for 20, 50 and 100 years in the future, based on predicted changes to sea level under IPCC scenario SSP2, are shown in **Appendix C.**

While the inundation from the ocean could extend into the campground areas, including the boat ramp and picnic areas in the northern sections, the risk of inundation within the campground areas is limited and is not a focus of this plan.

Heavy rainfall, including floods in February and March 2022, has resulted in Iluka Road and Woody Head Road being flooded and impassable in some sections. This is a result of surface drainage deficiencies rather than tidal/coastal inundation and was common along much of the east coast due to the severe weather event. Heavy rains experienced in early 2022 resulted in increased surface runoff to the beach and caused a breakout through the dune between the campground entrance road and the seawall (**Photo 6**). The path of this surface water runoff allows waves to penetrate the rainforest vegetation, damage dune vegetation and increase dune erosion.

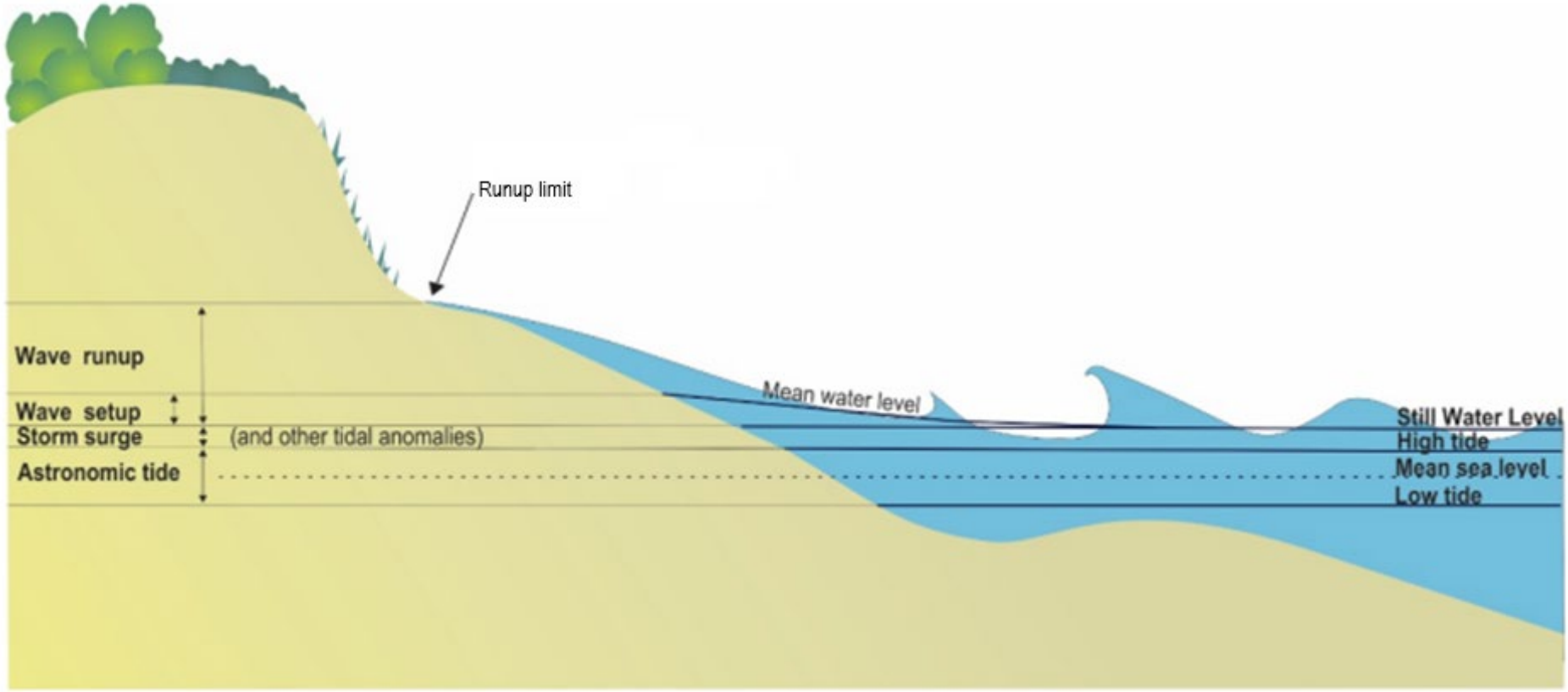


Figure 4 Elevated water levels on the open coast

Source: Office of Environment and Heritage, 2019a.

Photo 6 Surface water breakout to beach (November 2022)

Beach erosion and shoreline recession

Changes in the distribution of sediment between the nearshore, alongshore, beach face, fore dune and estuaries are considered in the assessment of potential beach erosion. Short-term fluctuations of the shoreline are often quite dramatic and may mask long-term accretion or recession, which occurs at much slower rates (**Figure 5**).

As shoreline recession occurs, the beach fluctuation zone is translated landward (**Figure 5**). Whether long-term recession occurs depends primarily on the state of the sediment budget for a particular part of the coast. Coastal sediment compartments can gain and/or lose sediment from several sources. If the losses persistently exceed the gains, the depositional shorelines within that compartment will recede.

During a storm, sand is removed from the upper beach and dune profile and deposited below the intertidal zone to form a storm bar. The sand is not lost from the system and does not contribute to recession. Unlike long-term recession and recession as a result of sea level rise, storm erosion is temporary, with the beach and dune usually accreting following the storm event – although this may take weeks to years, or even decades.

At present, there is significant coastline recession occurring along Woody Bay north-west of the seawall, resulting in collapse of trees and reduced sandy beach (**Photo 7** and **Photo 8**).

Seawall end effects are also occurring downdrift of the seawall with increased erosion at the north-western end. This is impacting pedestrian access to Woody Bay beach and the vegetation in this area (**Photo 9** and **Photo 10** and **Photo 11**). The natural processes instigating the longshore movement of sand on the Woody Bay foreshore cause sand to be transported away from the end of the seawall. The seawall effectively ‘fixes’ the shoreline in place, restricting the longshore movement that would normally replace sand. Seawalls tend

to reflect wave energy more strongly than a beach, which leads to offshore transport of sand from the toe of the wall. This sand is then more readily transferred by longshore drift and rip currents. While local sand transport processes are moving sand downdrift at the end of the seawall, there is no natural supply of sand to compensate for the loss. The net effect is that the foreshore immediately downdrift of the seawall erodes (Water Technology, 2018).

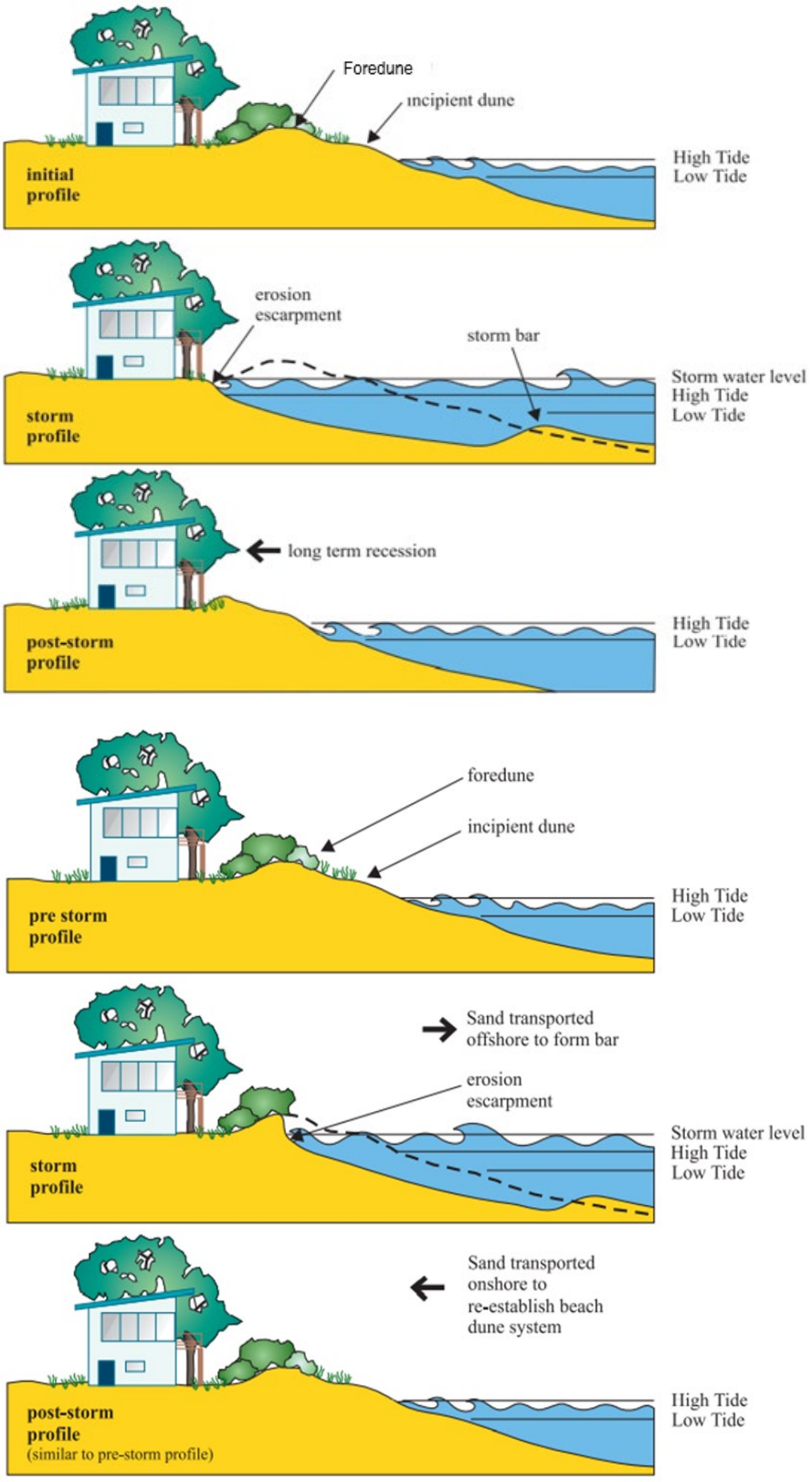


Figure 5 **(Top) Beach erosion/accretion cycle with no permanent sand loss or shoreline retreat (Bottom) Long-term beach recession – landward displacement due to permanent sand loss**

Source: NSW Department of Land and Water Conservation (2001).

Photo 7 Woody Bay shoreline recession impacting littoral rainforest – looking west from seawall (June 2022)

Photo 8 Woody Bay shoreline recession aerial view showing seawall and impacts on vegetation (June 2022)

Photo 9 **Woody Bay seawall end effects (June 2022)**

Photo 10 **End effect erosion at the western end of the seawall in 2016. Source: Nearmap, 28 May 2016**

Photo 11 End effect erosion at the western end of the seawall in 2022. Source: Nearmap, 11 September 2022

The detailed assessment of beach erosion and recession (JBP, 2023) provides information on the likelihood of beach erosion/shoreline recession over time. Erosion and recession assessments were undertaken for each planning horizon, event frequency and climate pathway (**Table 1**) and considered 5 factors:

1. historic recession rate
2. future variability in wave climate
3. potential sea level rise impacts
4. storm (event-based) erosion
5. other site-specific geomorphological features.

The future extent of erosion and shoreline recession will depend on the occurrence and severity of storms, future variability in wave climate and impacts due to sea level rise.

In the detailed assessment of beach erosion and recession (JBP, 2023), historic recession was measured as the landward movement of the shoreline (lineal metres). The mean historic recession rate for the section of Woody Bay adjacent to the camping ground is 2.89 m/year. Projected storm erosion and recession as a result of sea level rise was measured as the volume of sand lost from each metre along the length of the of beachfront (in cubic metres (m^3) per metre). The mean historic recession rate for the section of Woody Bay adjacent to the camping ground is 2.89 m/year. Event-based erosion in Woody Bay adjacent to the campground may be 104 m^3/m for the 1% AEP event.

Sea level rise impacts are expected to increase the rate of erosion. Over 2043, 2073 and 2123 timeframes, the additional erosion in Woody Bay adjacent to the camping ground may be 59 m^3/m, 168 m^3/m and 295 m^3/m respectively (50th percentile values for a SSP2 climate scenario).

Any volume of sand lost that is not included in above estimates (e.g. tombolo loss, as discussed below) would result in further landward recession of the shoreline.

All erosion/recession scenarios have been formulated using differing assumptions and may not represent all the potential changes as the coastline may continue to evolve in an

unforeseeable way. These scenarios provide guidance for strategic planning and risk management.

JBP (2023) includes an additional hazard component for the zone of reduced foundation capacity, which is an area of instability for building purposes behind the eroded beach scarp. During an extreme storm event, the potential landward instability zone for the beach at the eastern end of Woody Bay may extend inland by an additional 5.9 m (1% AEP).

JBP (2023) provides maps over different time horizons (reproduced in **Appendix C**) which combine the upper values of the long-term recession rate, sea level rise impacts and an extreme storm (exceedance probability, EP). Without the existing protection works (seawall and artificial dune), it is estimated the shoreline would have receded an additional 29 m by 2023 (based on a 10% EP event). The assessment also suggests that the entrance road is currently at risk of erosion if a storm event (at least a 10% EP) were to occur. Over the next 20 years increasing sea levels mean that more frequent storm events (e.g. 50% EP) will present an increasing risk to the entrance road.

JBP (2023) also estimated the volumes of sand expected to be lost from Woody Head west of the existing seawall (beach block 2) due to shoreline recession, extreme storm bite and sea level rise erosion under various scenarios (**Table 2**). Over the next 20 years, approximately 40,000 m^3 of sand loss is predicted (i.e. 2,000 m^3/year) due to shoreline recession alone. The total sand loss by 2043 is predicted to be between 81,000 m^3 and 100,000 m^3 (or 4,000 to 5,000 m^3/year). The average rate of total sand loss over the next 100 years to 2123 is predicted to be at least 4,100 m^3/year.

Table 2 Sand lost due to erosion and shoreline recession at Woody Head (beach block 2)

Scenario	Sand loss		
	2043	2073	2123
Historic recession rate	2.89 m/year		
Historic recession	38,400 m^3	110,300 m^3	254,300 m^3
Seawall end effects	1,000 m^3	18,500 m^3	34,600 m^3
Total volume (recession and end effects)	**39,400 m^3**	**128,800 m^3**	**288,900 m^3**
Extreme storm bite – 10% EP (single storm)	3,900 m^3		
Extreme storm bite – 2% EP (single storm)	4,500 m^3		
Extreme storm bite – 1% EP (single storm)	4,700 m^3		
Extreme storm bite – 10% EP (scaled) [1]	9,900 m^3		
Extreme storm bite – 2% EP (scaled) [1]	11,500 m^3		
Extreme storm bite – 1% EP (scaled) [1]	12,000 m^3		
Sea level rise erosion – 10% EP	32,200 m^3	70,500 m^3	111,200 m^3
Sea level rise erosion – 2% EP	38,200 m^3	76,600 m^3	119,600 m^3
Sea level rise erosion – 1% EP	48,400 m^3	78,100 m^3	121,700 m^3
Total volume (recession, end effects, extreme storm bite and sea level rise erosion)			
10% EP	**81,500 m^3**	**209,200 m^3**	**410,000 m^3**
2% EP	**89,100 m^3**	**216,900 m^3**	**420,000 m^3**
1% EP	**99,800 m^3**	**218,900 m^3**	**422,600 m^3**

The volume lost due to extreme storm bite has been scaled to account for multiple events, clustering of storms and other localised factors. Source: JBP, 2023.

Tombolo

The tombolo between Woody Bay and Shark Bay (**Photo 12**) is an important morphological feature that separates the beaches and is responsible for the crenulated shape of the shoreline. The refraction of waves around the island results in wave convergence and sand deposition to form the tombolo. The tombolo is not considered to have high stability due to its geometric shape and island characteristics. These characteristics indicate it is on the lower threshold for salient tombolo development.

Continued erosion of the flanking beaches indicates there will be less sand available to maintain the integrity of the tombolo. Loss of the connecting tombolo would influence wave, current and sand transport patterns for this section of coastline. Due to the potential long-term shoreline recession and climate change impacts, the coastal hazard assessment predicts that the tombolo may be breached, causing a realignment of the current shoreline

planform (JBP, 2023). This realignment would cause significant additional beach retreat at the tombolo site and could have broader ramifications for the Woody Bay and Shark Bay shorelines. A realignment may result in more severe and faster shoreline recession, with significant impacts on Iluka Road and this part of the reserve.

Nevertheless, there is inherent uncertainty in the predicted tombolo impacts due to climate change and the future shoreline alignment. The extent of intervention required to mitigate possible tombolo impacts is expected to be significant and the options in this report do not address this risk.

Ongoing monitoring and reassessment of coastal hazards is recommended.

Photo 12 Tombolo between Woody Bay and Shark Bay (looking east, June 2022)

Vulnerability to erosion/recession

Figure 6 shows the risk of erosion/recession affecting campground assets.

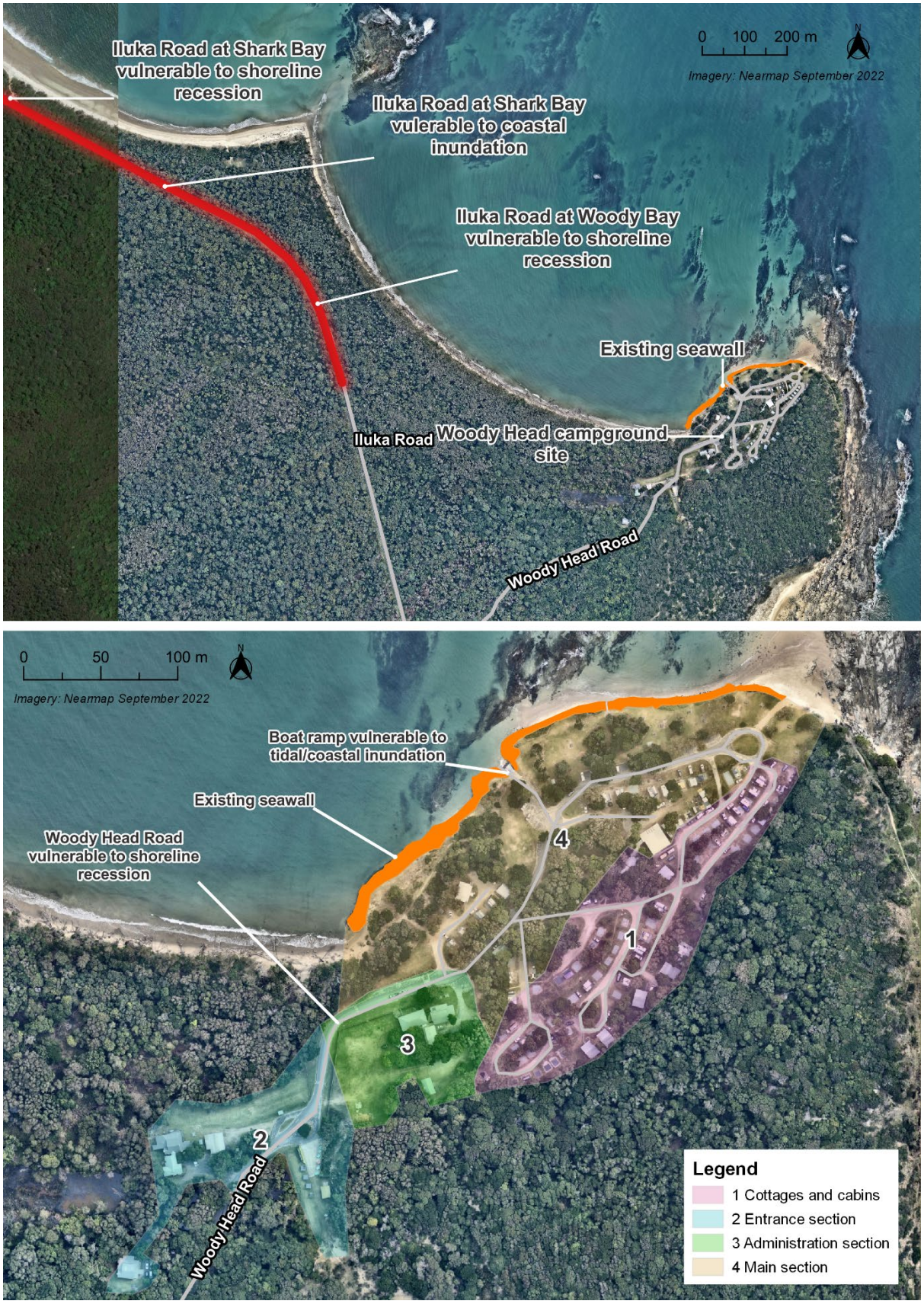


Figure 6 Campground sections and assets vulnerable to coastal hazards

5.4 Development and assessment of management options

5.4.1 Strategic management approaches

This plan takes the strategic approach adopted in the *Coastal management manual* (NSW Environment and Heritage 2019b), with options examined to address identified risks. Opportunities are considered to manage any unacceptable risks, adaptation pathways over time are developed and potential actions evaluated.

The potential strategic risk management approaches are:

- **alert** – coastal management actions that seek to 'watch and wait' such as monitoring change and setting thresholds, 'low regret' responses and research to improve knowledge
- **avoid future impact** – proactive land use planning with campground development only in low-risk locations. There is limited scope for future campground development so the focus is on infrastructure modifications in low-risk locations
- **active intervention** – includes coastal management actions that seek to protect assets or accommodate change, while maintaining current systems and values
- **planning for change** – includes planning to relocate or redevelop assets to consider the dynamic and ambulatory nature of the shoreline. This may be timed to commence as opportunities arise or when thresholds of exposure, impact and risk are exceeded
- **emergency response** – includes actions to address residual risk in emergency situations.

Coastal processes will continue to impact the natural landscape over time and artificial intervention may not be able to stop 'nature taking its course'. It is likely that the campground will become unviable at some point in the future due to coastal hazards. Despite this, there is inherent uncertainty with the coastal hazard projections; consequently, the extent and timing of impacts need to be acknowledged in the selection of management options. The timeframe for which the campground can remain in operation may be extended by prudent and adaptive management.

5.4.2 Preliminary assessment of feasibility

A preliminary assessment of potential management options and their feasibility was undertaken considering the following factors:

- consistency with management objectives outlined in Section 5.2, including:
  - meeting the management objectives for the campground
  - promoting and achieving the objects of the NSW coastal management framework
  - consistency with legislation and NPWS management plans
- the wider context and potential impacts, including:
  - environmental impacts (positive or negative) impacts on the natural and built environment, considering environmental and sustainability objectives
  - social impacts, considering usability, access to the coastline, safety, aesthetics, recreational values, visitation, commercial activities etc.
  - cultural heritage values – positive or negative impacts to heritage values, including native title considerations
  - economic considerations such as anticipated costs (including initial and ongoing costs) and predicted benefits (e.g. campground income)

- feasibility of coastal management actions, determined by effectiveness, technical viability, confidence in performance, constructability and legal and approval risks
- viability of implementation as determined by availability of resources and expected commitment.

The results of the preliminary feasibility assessment are provided in **Table 6** (**Appendix D**). The potentially feasible management options are further described in the following sections and assessed for suitability in **Table 6** (**Appendix D**).

5.4.3 Potentially feasible management options

Option 1 – Planned retreat

Depending on the erosion and recession experienced over time, there may be a need to decommission and relocate parts of the campground facilities as the shoreline recedes.

Although the cottages and cabins section of the campground in the south-west (**Figure 7**) is the least vulnerable to coastal hazards, there is limited capacity to relocate other facilities to this area.

Relocating the campground to a new site could be undertaken if a suitable site is found. Mibanbah – Black Rocks campground is the only other campground in Bundjalung National Park but has fewer facilities and more low-key camping than Woody Head. It would be difficult to replicate a campground that capitalises on the natural assets at Woody Head – large headland, rock platform, sheltered bay and lagoon area, north-westerly views across water, cultural heritage, historic heritage and recreational assets (>60,000 m^2 of campground with >100 campsites/cabins and boat launching facilities). Alternative sites would provide a different camping experience compared to the unique values at the current site.

Alternative sites within the existing NPWS reserve estate (Bundjalung National Park and Iluka Nature Reserve) within 500 m of the existing shoreline have been considered to determine whether relocating the campground is feasible. To maximise the use of existing infrastructure and minimise disturbance and impact, sites with or near existing road access were considered. Sites within existing mapped coastal wetland areas or other low-lying areas prone to flooding or future coastal inundation were considered unsuitable.

The Woody Head area has high cultural heritage significance and native title extends along the coastline (**Figure 17** in **Appendix A)**. Any future relocation options would be considered in consultation with the Yaegl traditional owners. Detailed investigation into any potentially viable sites would need to be undertaken.

Figure 9 shows the constraints and potential new locations for the campground from Evans Head in the north to the Clarence River in the south. All areas north of Woody Head are unsuitable due to extensive wetland areas and the risk of future flooding and inundation. In addition, there is already an established campground at Mibanbah – Black Rocks and there are no suitable locations north of Black Rocks outside the Evans Head Air Weapons Range.

Potentially suitable sites between Woody Head and Iluka are shown in **Figure 8** and **Photo 13, Photo 14** and **Photo 15**. These sites consist of small picnic areas along the coastline (Back Beach and Frasers Reef) and at Middle Bluff and Iluka Bluff, each with existing non-flush toilets. These sites are near Woody Head Road and Iluka and are partially cleared.

The site at Middle Bluff has a large, cleared area, potentially allows ocean views and is protected from southerly winds. This area was disturbed through historic sand mining and much of the vegetation is regrowth. Access to this site would be via the Frasers Reef access road, which would need to be extended to the bluff site. A boat launching facility may be feasible at this site. Significant revegetation works that have been undertaken at Middle Bluff by NPWS would be compromised by development of a campground in this area.

The existing picnic areas at Frasers Reef and Back Beach are currently popular day use areas, particularly during summer, with existing access roads and walking tracks to the beach.

Iluka Bluff, accessed by Bluff Road, is close to the Iluka village and is a high day use area. Extensive revegetation has been undertaken in the area which is surrounded by littoral rainforest (Iluka Nature Reserve), resulting in limited potential for site expansion.

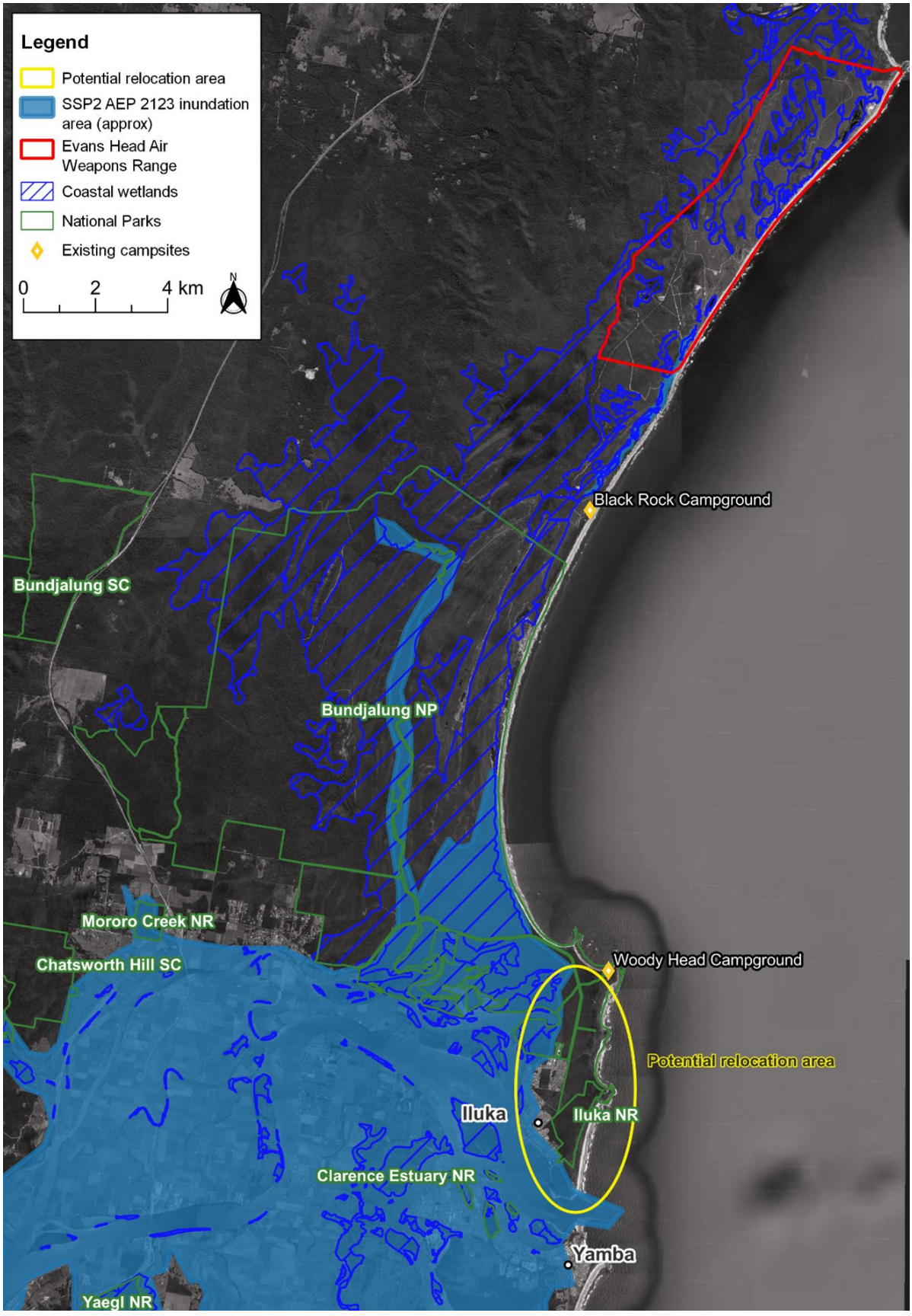


Figure 7 Land use constraints and potential campground relocation area

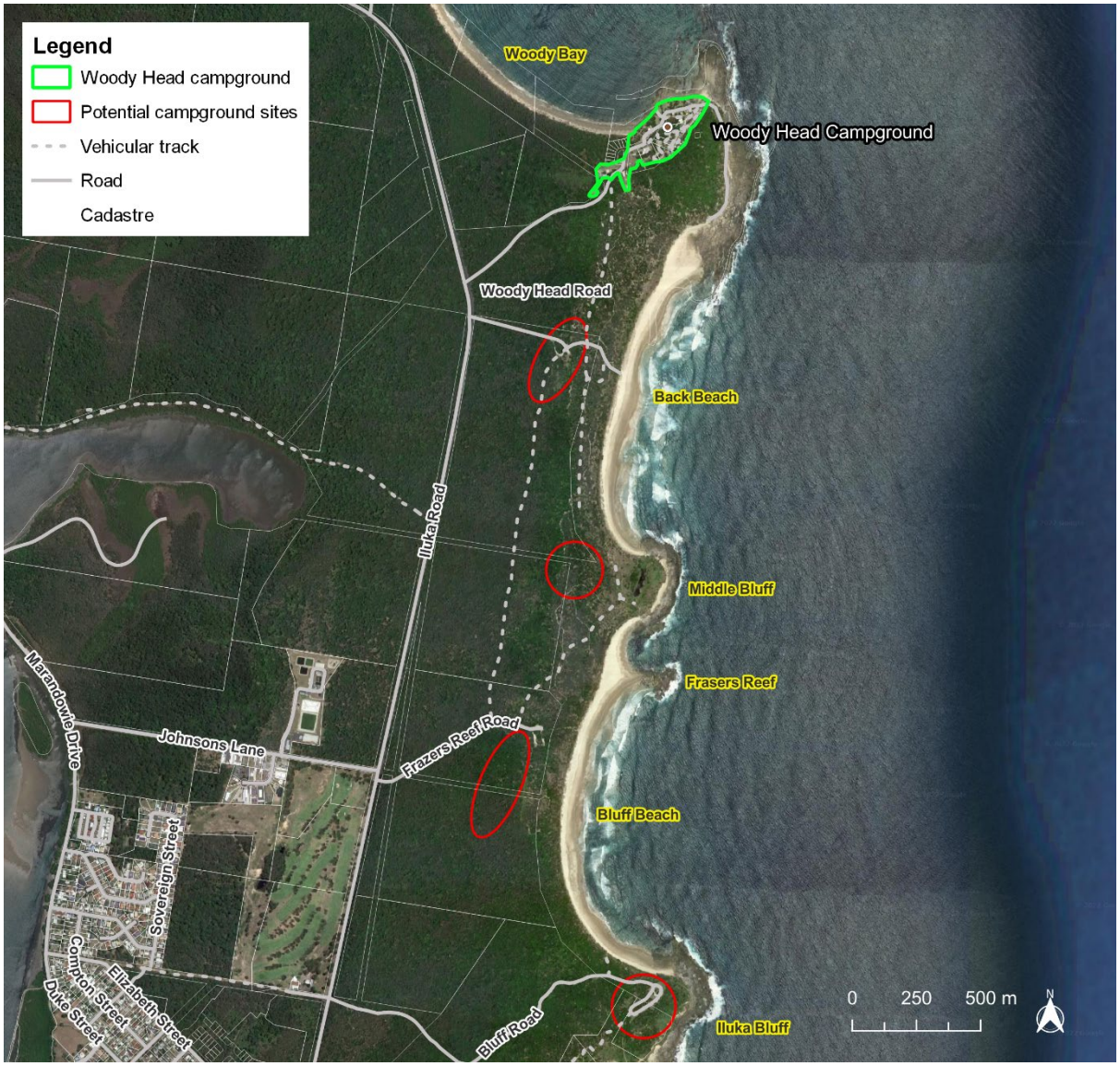


Figure 8 Potential campground relocation areas

Photo 13 Back Beach picnic areas (November 2022)

Photo 14 Bluff Beach picnic areas (November 2022)

Photo 15 Iluka Bluff picnic areas (November 2022)

Over time, the viable area of Woody Head campground is expected to reduce as a result of increasing sea levels and impacts from beach erosion. Shoreline recession is expected to impact the campground access road and associated services by 2030. Without protection, a staged retreat from the site would be required by this time.

Detailed planning for retreat would need to consider:

- future management may involve the transition of the campground to an infrequently used day use area accessed by 4WD, boat or on foot only, without power, water and sewerage services
- potential relocation of heritage listed items
- restrictions on access to the boat ramp and potential alternative boat ramp locations.

Significant consultation and coordination of strategic retreat planning and implementation will be required.

While undertaking planning for future retreat, an adaptive management approach can be taken to maintain natural and recreational values at the campground in the short to medium term. By using coastal protection works to protect against erosion and recession, NPWS can maintain the natural and recreational values in the short term.

Option 2 – Modification to Woody Head (Entrance) Road

Option 2A – Rock revetment to protect Woody Head (Entrance) Road

This option involves protecting Woody Head Road (e.g. with a rock revetment) when the shoreline recession and end effect erosion begins to impact the entrance road, utilities and infrastructure. This option allows the shoreline to recede until key assets are at immediate risk.

Option 2A (**Figure 10**) involves protection of the access road once the shoreline has receded to a certain distance (e.g. 15 m) from the road, allowing sufficient time to construct protection works such as a rock revetment. End effect erosion would occur at the western end of such a revetment and would eventually impact buildings in this area (Swamp House and the old depot). Modelling indicates that this is a present-day risk under a 10% EP (frequent to rare) erosion event scenario. The risk that an event could impact the road and therefore trigger this option could occur at any time.

Option 2A would require significant investment to protect the road and would still involve the loss of at least 50 m of the foreshore reserve areas and the mapped endangered ecological community.

Option 2B – Relocation of Woody Head (Entrance) Road combined with rock revetment

Option 2B (**Figure 9**) involves relocating the access road southward, away from the recession hazard zone once the shoreline has receded to a certain distance (e.g. 15 m) from the existing road in this section. Rock revetment as in option 2A would also be required to protect the relocated road, ideally in a similar location to the existing road to provide protection to the administration area and limit further recession.

If the road is relocated without the protection of the seawall, the shoreline is expected to advance to the ultimate location of the road and eventually damage/undermine the road, necessitating further relocation of the road and/or reconstruction. This option could be staged, with the road relocated initially, allowing natural recession processes to occur, and a seawall constructed later in a location closer to the relocated road. A disadvantage of the staged approach is that the expected timeframe to retreat the site would be reduced as the shoreline would recede unhindered until the protective seawall is built. This would be associated with a significant reduction in amenity and the desire to protect the campground at this time may be reduced.

Services within the entrance road (sewerage, electricity and communications) would also need to be relocated.

The trigger for implementation of this option could occur at any time.

Options 2A and 2B would not protect the foreshore vegetation and wider reserve areas to the west from recession and inundation, but they would allow continued road access and utilities (e.g. water, sewerage, power supply) to the campground.

The capacity of the campground would not change but reserve areas between the new access road and shoreline would be inaccessible. There is likely to be a reduction in scenic amenity, with the loss of Woody Bay shoreline and increased erosion visible from the campground entrance.

Adaptive management, including retreat of the site, would still be required in the long term with continued shoreline recession.

Relocating Woody Head Road to the south should be considered if other management measures cannot be implemented in the timeframe necessary to protect the road.

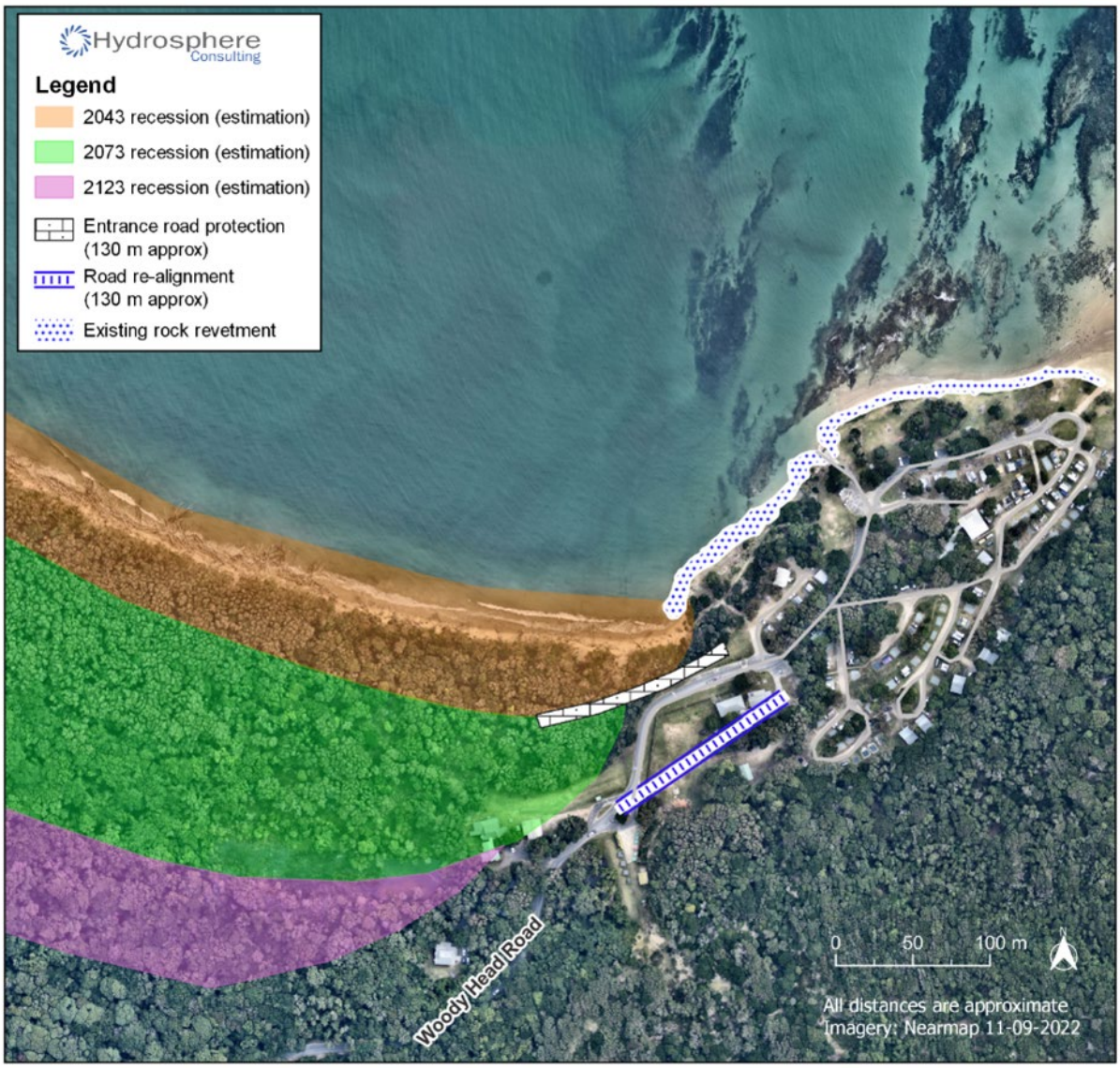


Figure 9 Option 2A – rock revetment to protect Woody Head (Entrance) Road and option 2B – relocation of Woody Head (Entrance) Road combined with rock revetment

Note: Recession only, not considering future variability in wave climate, storm erosion, impacts of sea level rise or stability of the tombolo.

Option 3 – Coastal protection works – shoreline protection

Previous studies (MHL, 2000; DECCW, 2012; Water Technology, 2018) have considered coastal protection works along Woody Bay. Additional coastal protection works were not recommended due to the long lengths of shoreline requiring protection and the need to manage the end effect, which may be exacerbated by any structures. Instead, planning for adaptive management of the campground facilities was recommended.

Protection options have been reconsidered for this CHRP with the key aim of protecting the campground entrance road and the area of reserve that would be impacted first by any ongoing recession. This is consistent with the objective of cost-effectively extending the life of the campground through the protection of essential infrastructure.

Shoreline protection options include:

- Option 3A – extension of existing seawall
- Option 3B – groyne/s
- Option 3C – offshore breakwater/s
- Option 3D – sand nourishment.

Similarly to option 2, these options would not protect the majority of the foreshore vegetation and wider reserve areas further to the west from recession and inundation. Shoreline areas nearest to the campground would be maintained along with continued road access and utilities for the campground. The scenic amenity of this area of the campground would be maintained with the creation of a small 'pocket' beach at the eastern end of Woody Bay.

Option 3A – Extension of existing seawall

This option involves the extension of the current seawall by an additional 80 m parallel to the existing beach to provide additional protection for the campground and access road.

The existing rock seawall would be extended along Woody Bay to protect the entrance and administration sections of the campground which are at present-day risk of shoreline recession. Extending the seawall offers protection to the adjacent eroded shoreline; however, end effect erosion would still occur at the new seawall extension (**Figure 10**). The 80 m extension is expected to move this end effect area westward sufficiently to reduce the risk to campground infrastructure. Initial and ongoing sand nourishment of the end effect area would assist in providing protection to this area and enhancing the amenity value.

The proposed seawall extension is unlikely to impact the tombolo due to its distance from the tombolo and the addition of sand to the system through nourishment (Hydrosphere Consulting, 2023).

A seawall extension and beach nourishment, combined with enhanced seating and/or picnic areas in this part of the campground, would also provide increased amenity value and enhance the user experience. Shoreline vegetation immediately south of the new seawall would also be protected allowing an opportunity to address erosion associated with high overland stormwater flows.

While this area is expected to experience a continued high rate of sand loss, extending the seawall will reduce the rate of erosion in this immediate location. Sand nourishment will increase amenity for campground users, allow stabilisation and revegetation and offset sand loss further to the west. A potential source of sand has been identified within the campground site. The Viability Report (Hydrosphere Consulting, 2023) has confirmed there is sufficient sand supply (15,250 m^3) for sand nourishment campaigns for up to 25 years.

Based on the coastal hazard assessments, the seawall extension is expected to provide protection to the campground access road until at least 2050. The assets along the access road, including Swamp House, Bunk House and the old depot, are expected to be protected until 2045. Ongoing sand nourishment would extend the longevity of this option further (refer option 3D).

This option is cost-effective, meets the project objectives to extend the life of the campground while protecting existing values as far as possible, and is also consistent with the site's current coastal management approach.

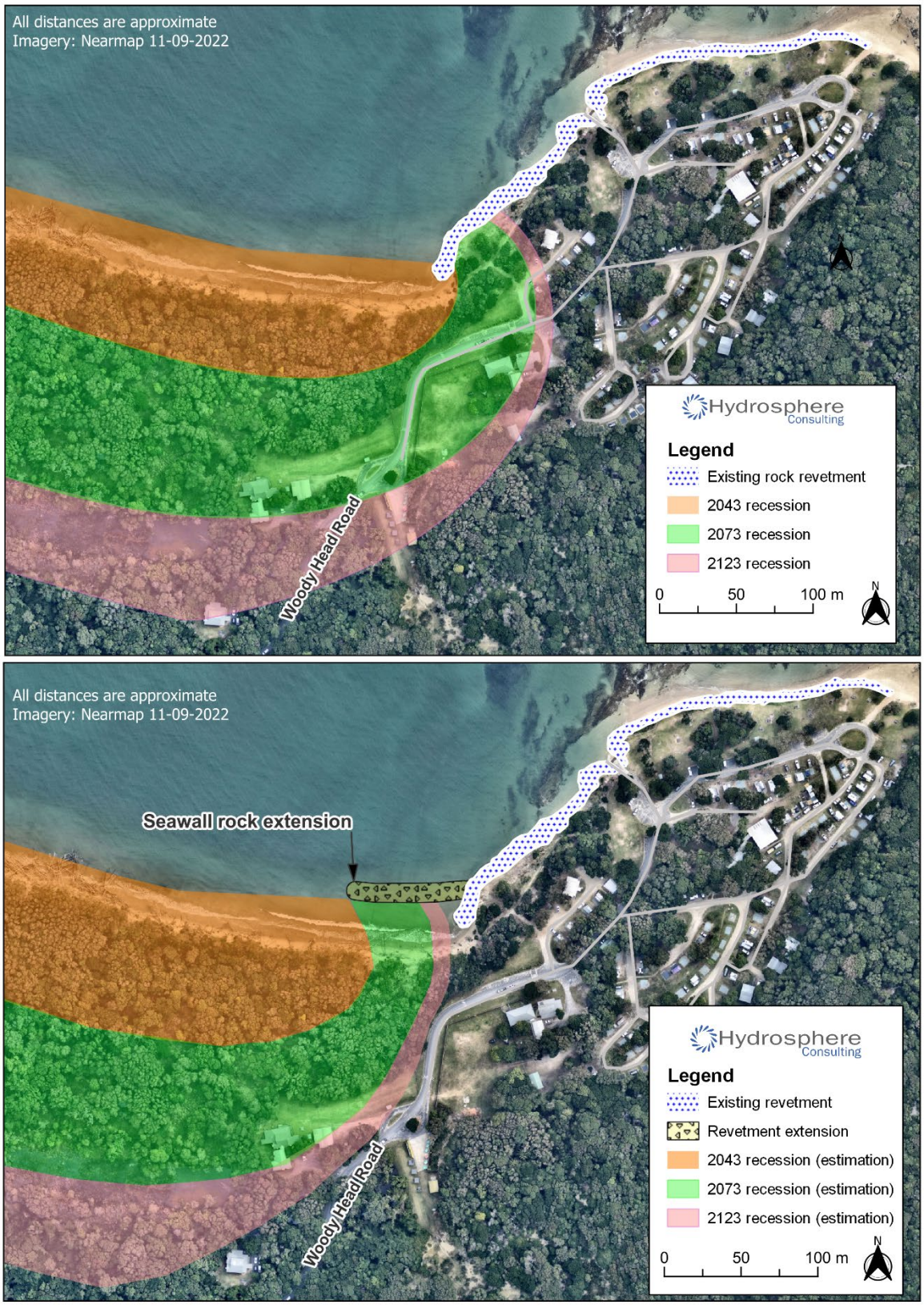


Figure 10 **Predicted extents of recession (based on historical rates) and end effect erosion with (top) existing seawall and (bottom) option 3A – extension of seawall with recession and end effect erosion shifted west along Woody Bay**

Option 3B – Groyne/s and Option 3C – Offshore breakwater/s

Hard engineering structures were considered by MHL (2000) but were not recommended due to high costs and likely changes to the character of the beach.

This CHRP has reconsidered several other protection options to assess their current suitability.

A series of groynes along Woody Bay would trap and reduce the sand losses, realign sand to form pocket beaches and effectively change the nature of the beach system (**Figure 11**). Recreational beach and foreshore areas would be expanded, although longshore access over the groyne structures would be required.

Offshore artificial reefs would also change the character of the foreshore by 'sheltering' the shoreline and trapping sand behind the breakwaters. Breakwaters and artificial reefs can be constructed as a rocky extension of the existing foreshore and are more natural in appearance than groynes but are still visually obtrusive (**Figure 12**).

Groynes and offshore breakwater options are not considered suitable for beaches with sand deficit such as Woody Bay and would require ongoing nourishment. This is because the structures are designed to intersect the longshore sand transport and therefore rely on a continual sand supply to supplement the reconstructed beach. As there is limited sediment bypassing at Woody Bay, sand would need to be introduced to the system through nourishment. In addition, any sand trapped to the east (i.e. updrift) of the structure would be prevented from reaching the western, downdrift part of the beach and would contribute to downdrift erosion. A single groyne near the campground may be feasible with beach nourishment (as an alternative to the seawall extension) and may provide recreational benefits through the creation of a pocket beach. Erosion and shoreline recession would still occur downdrift of the groyne structure. Multiple groynes would be required to protect the length of Woody Bay.

These options provide a 'buffer' to erosion hazards and do not provide protection.

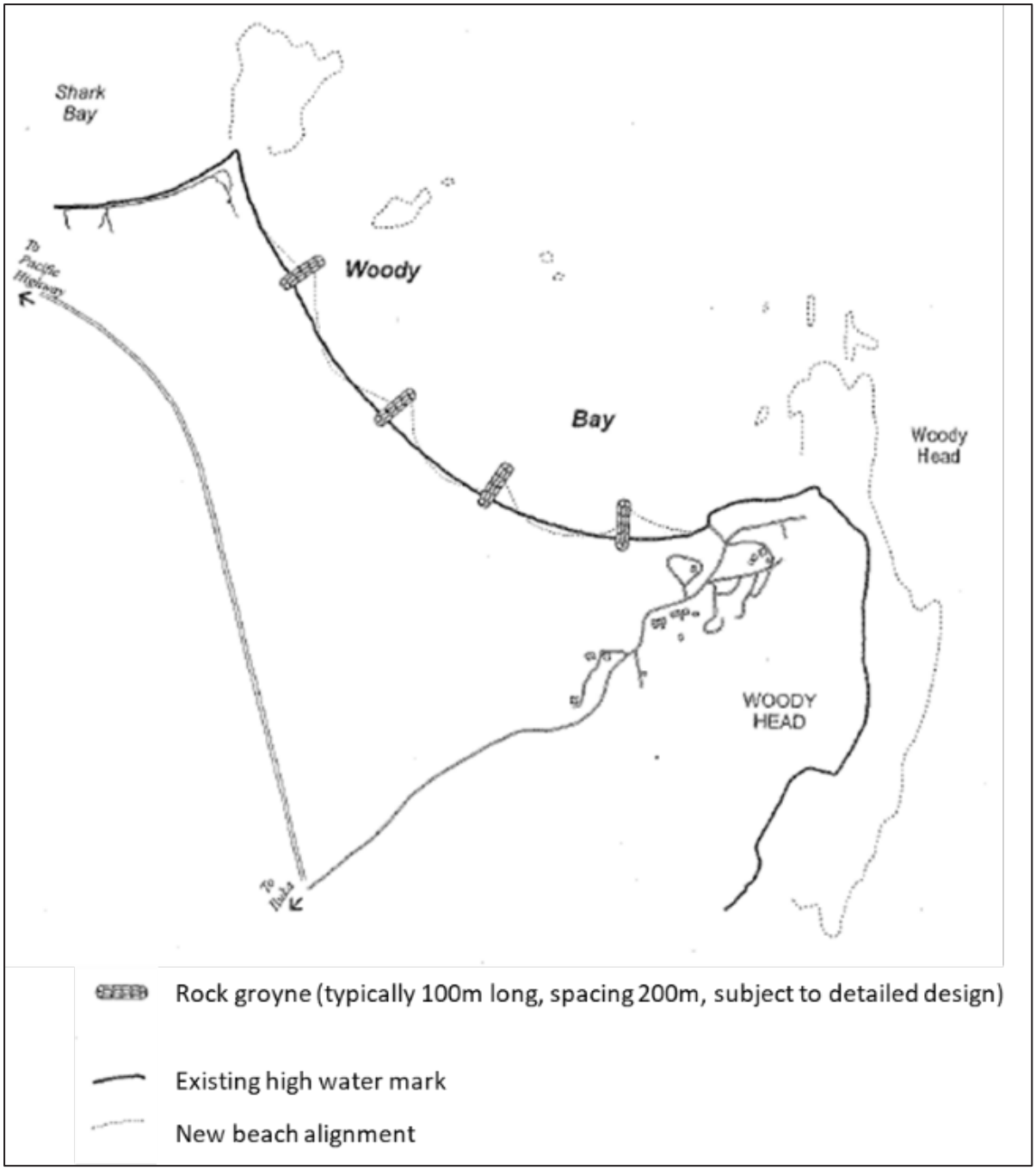


Figure 11 Groyne concept plan

Source: MHL, 2000.

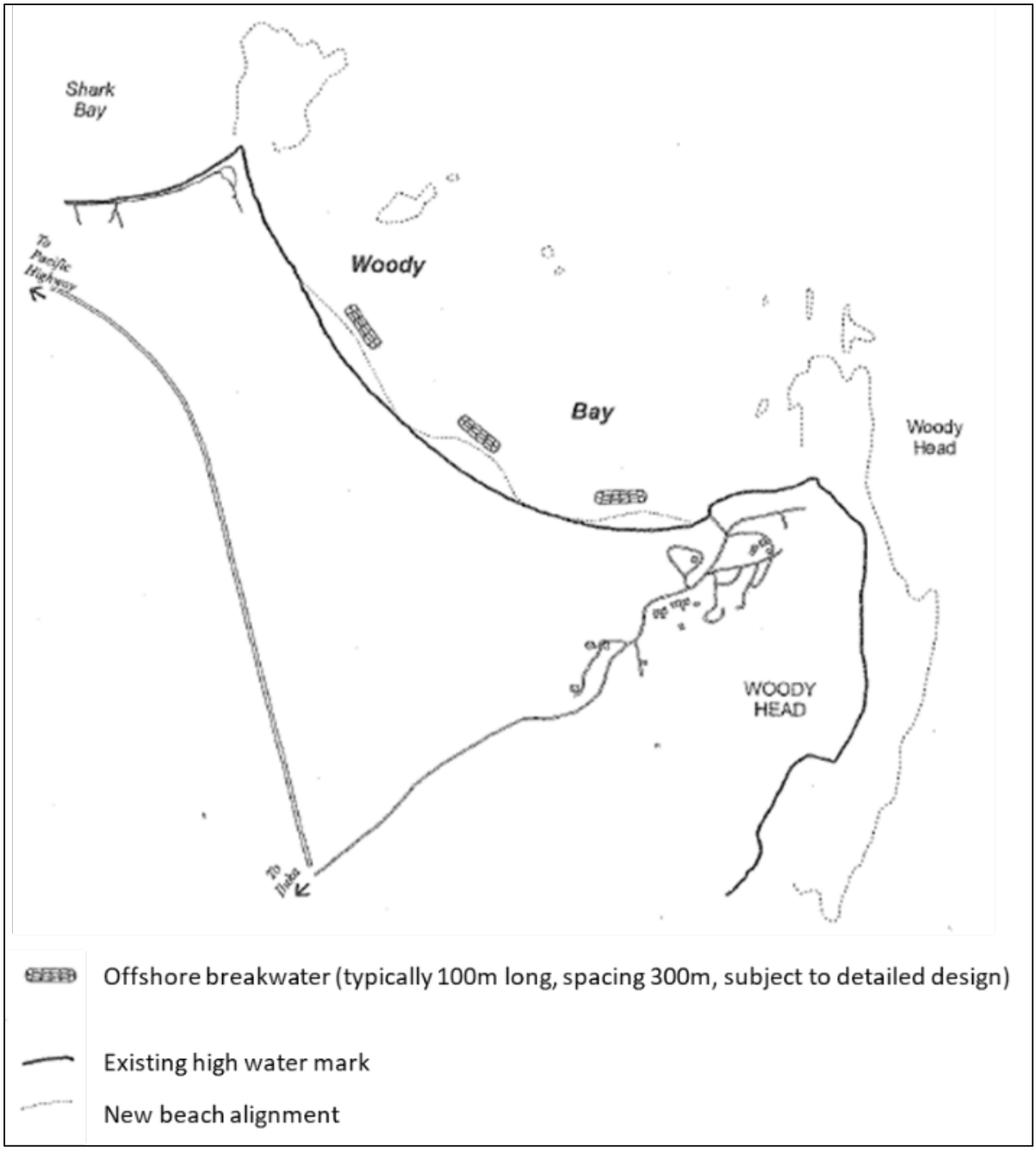


Figure 12 Offshore breakwater/reef concept plan

Source: MHL, 2000.

Option 3D – Sand nourishment

Sand nourishment involves importing sand to a beach from an external source. Sand nourishment can be used to bolster sand supplies and return lost sand to a beach. The intention is to import sufficient sand to replace lost sand on an ongoing basis and buffer against future anticipated losses. Sand nourishment can improve or maintain beach amenity and recreational use. However, it does not protect against erosion. This option will only provide a 'buffer' to erosion hazards. Sand would need to be 'replaced' at regular periods and following significant erosion events.

Estimated quantities required for sand nourishment are:

- initial restoration of existing end effect area: 1,000 m^3

- extension of artificial dune landward of seawall extension (initial infill for new beach embayment as part of option 3A): 7,150 m^3
- maintaining existing coastline position (Woody Bay) without seawall: 12,000 to 15,000 m^3 per year.

Sand nourishment options for Woody Bay are as follows.

- Targeted beach nourishment to manage end effect erosion and beach amenity.
- Beach nourishment in front of the seawall to maintain beach frontage, improve amenity and provide connection to the Woody Bay beach. A high rate of sand loss due to end effect erosion is still expected, but this option would be beneficial if it can be achieved cost-effectively or opportunistically.
- Larger and wider-scale sand nourishment to reduce recession of the bay to the west may prolong the life of the tombolo and reduce visual and safety impact from fallen trees. This option is not cost-effective due to the large volumes of sand required and environmental impact and has not been considered further.

It is important that imported sand matches or has similar characteristics (i.e. grain size, texture, angularity and composition) to the existing sand at Woody Bay. A sand sourcing study was undertaken to investigate potential sand sources and methods of nourishment (Hydrosphere Consulting, 2023).

Commercially available sand from terrestrial sand quarries is a potential source of sand for nourishment but is likely to be viable for small volumes only. Apart from the high costs, the constraints and potential issues with using commercially available sand at Woody Head include:

- reliability and availability of the supply into the future – sand characteristics may change with extraction areas. Some quarry extraction licences may expire, or sand sources may become exhausted
- sustainability – quarry sand is a finite resource that is generally considered to be in short supply. Using the resource for sand nourishment will put extra pressure on the resource
- truck movements – the impact of the truck movements required to deliver the sand will be significant, putting extra pressure on Iluka Road and Woody Head Road and negatively impacting amenities in the area
- site access – there is currently no direct access to the nourishment site for trucks. Sand would need to be temporarily stockpiled and moved to site by earth-moving equipment.

Sand dunes within the vicinity of Woody Head provide a potential source of sand for nourishment. Depending on the site the sand could be excavated and transported to the site by truck or front-end loader along the beach or local roads. Constraints and potential issues with using local sand sources include:

- potential negative impacts on Aboriginal cultural heritage sites and values
- potential coastal hazard consequences of removing the material from the source location
- negative environmental impacts of removing sand from the source site and from the significant movement of machinery along beaches
- available volumes are likely to be limited and therefore this is not a long-term sand source.

Sand used to build the artificial dune was sourced from the Iluka Back Beach hind dunes behind the campground (pers. comm. J. Kennedy, NPWS) (**Photo 16**, refer 1958 aerial photo in **Appendix B**). This site may have fewer constraints and provide an ongoing source of sand for nourishment.

Photo 16 Potential sand source – Woody Bay/Back Beach hind dune (November 2022)

Offshore sand sources are expected to have similar constraints to the terrestrial sources and are also highly costly; for this reason they have not been considered further.

There are frequent requests from the marine industry to dredge the Clarence River bar to improve safety and navigation. Using the potentially large volumes of sand from such dredging as a sand source for Woody Bay would be a beneficial re-use of the material. The entrance bar is located approximately 9 km to the south of Woody Head at Yamba/Iluka. This option would involve dredging sand from the Clarence River bar and transporting the material to Woody Bay. This is considered an ‘opportunistic’ option.

Dredging the Clarence River bar and placing sand on local beaches such as Woody Bay should be considered holistically as part of the CVC Open Coast CMP for navigational improvements as well as beach nourishment.

Option 4 – Protect Iluka Road

Iluka Road at the Shark Bay picnic area and the 4WD access at the western end of Woody Bay are vulnerable to shoreline recession. This impact is potentially accelerated by the instability of the tombolo. Any engineering works to increase the stability of the tombolo and maintain the shoreline position in this area would be extensive and would detract from the natural values of the area. They would also only address the risk to Iluka Road in this area, not the risks to the campground access road.

Significant and constant volumes of sand would be required to nourish both Woody Bay and Shark Bay to prevent further recession, and significant impacts are associated with sourcing such high volumes of sand (see discussion of sand nourishment option under option 3D, above).

Over the longer term, Iluka Road is also at risk of inundation from the Clarence River as sea levels rise and the river expands into the reserve areas west of the campground.

Iluka Road is managed by CVC and options to manage recession in this area will be considered by the council as part of the Clarence Valley Open Coast CMP development. This option is not considered further in this response plan, as it focuses on NPWS responsibilities for management of the campground. NPWS will continue to liaise with CVC regarding the management of Iluka Road.

The Woody Head campground relies on council roads and reserve access roads that are vulnerable to coastal hazards. The council roads are outside NPWS control.

While some intervention actions may provide protection over the short term, the scale of the predicted hazards in this area of the coast limits the economic and practical viability of long-term protection options. Any attempts to protect large sections of foreshore – and therefore Iluka Road – from further recession will require significant expenditure and will have an adverse effect on natural beach processes.

Despite the existing coastal protection works (seawall and artificial sand dune), the campground is under threat from coastal hazards and the risks will increase over time. A combination of strategic management approaches will need to be implemented over time as circumstances change and thresholds are reached. An adaptive management approach (**Section 6.1**) will be required to address these risks and maintain functionality and safety of the campground for as long as viable.

Summary of options

The Woody Head campground access road is at significant risk from erosion and recession, and the campground will be required to retreat in the long term. The management options assessed as being potentially feasible are summarised in **Table 3**.

Table 3 Management options for Woody Head campground

Option type	Option number	Description
Planned retreat	1	Develop timing and impact thresholds for the removal of assets within 5 years.
Protect and retreat planning	2A	Rock revetment to protect Woody Head (Entrance) Road (130 m length)
	2B	Relocation of Woody Head (Entrance) Road combined with rock revetment (130 m)
	3A + 3D	Adaptive management: Seawall extension (80 m) plus sand nourishment
Buffer and retreat planning	3B	Buffer erosion using groynes (3 150 m each)
	3C	Buffer erosion using offshore breakwaters (100 m)
	3D	Buffer erosion using sand nourishment

The effectiveness of each option is summarised in **Table 4**. Modifications to Woody Head Road (option 2) will protect the road, but result in the losses of access, use and vegetation at Woody Bay. Coastal protection works options 3B to 3D provide a buffer against erosion and recession only, with protection effectiveness and timeframes uncertain. Extending the existing seawall (option 3A) with ongoing sand nourishment (option 3D) would facilitate an adaptive approach to address risks and maintain functionality and safety of the campground, until long-term retreat of campground assets (option 1) becomes essential.

Table 4 Effectiveness of management options for each campground section

Section	Coastal hazard	Options that enable natural processes (no protection)	Erosion buffer options	Protection options against erosion/recession	Protection options against inundation	Comments
Iluka Road	Beach erosion/shoreline recession expected to impact Iluka Road by 2043 (1% EP) and earlier if a more severe event is experienced. Coastal inundation from Clarence River expected to impact road by 2123.	1, 2A, 2B, 3A, 3B, 3C, 3D	Nil	Nil	Nil	–
1 – Cottages/cabins	Lowest risk area, slightly elevated and protected by existing seawall. Potentially isolated if beach erosion/shoreline recession of Woody Bay and Back Beach advances through other sections over the long term.	1, 2A, 2B, 3A, 3B, 3C, 3D	Nil	Nil	Nil	Limited impact until entrance road is compromised
2 – Entrance section	Beach erosion/shoreline recession expected to impact this section from 2043.	1, 2A, 2B	3B, 3C, 3D	3A	nil	2A, 3A –-Shift existing end effect erosion further west.
3 – Administration section	Beach erosion/shoreline recession expected to impact this section by 2043.	1, 2B	3B, 3C, 3D	2A, 3A	Nil	2A, 3A – Shift existing end effect erosion further west.
4 – Main campground section	Currently protected by existing seawall. Coastal inundation from ocean expected to impact main campground area by 2123. Infrequent inundation of boat ramp at present during high tides, increasing over time.	1	Nil	Nil	Nil	No protection required, but access impacted

Location of sections are shown on the map in Figure 7.

5.4.4 Assessment of management options

Qualitative assessment

Options 1 to 3, which were assessed as being potentially feasible (**Section 5.4.3**) were evaluated through a comparison of benefits and costs (**Table 6**, **Appendix D**). A qualitative assessment of environmental, social and cultural factors was undertaken to consider the key aspects of each option.

Multi-criteria analysis

The NPWS assessed the range of potential management options using a multi-criteria analysis (MCA). The MCA was based on Infrastructure Australia (2021) methodology and is designed to support an analysis of coastal management options within the NSW national park estate.

The NPWS has previously identified planned retreat (option 1) as the long-term option. The planned retreat option includes the development of a retreat strategy, including identification of triggers and thresholds for retreat actions. Planning for retreat is included in all management options.

The planned retreat option is a stand-alone management option that will immediately decommission the campground. The adaptive management approach combines planning for long-term retreat of campground infrastructure and assets with extending the seawall and sand nourishment to protect in the medium to long term.

Three primary criteria form the basis of the multi-criteria assessment:

- environmental and cultural considerations
- recreational considerations
- financial considerations.

Each primary criterion has numerous indicators (sub-criteria) that represent the key values identified from stakeholder consultation in 2022 and 2023. Some indicators are specific (e.g. heritage items) while others relate to multiple park values (e.g. avoid damage to watercourses and waterbodies relates to environmental, cultural and recreational values). No weighting was applied to indicators and criteria. Details of how the criteria and indicators were applied in the MCA to arrive at the rankings are provided in **Appendix D**.

The results of the MCA are shown in Table 5.

Table 5 Results of multi-criteria analysis of the management options for Woody Head campground

Option type	Option number	Option description	MCA ranking
Planned retreat	1	Develop timing and impact thresholds for the removal of assets	6
Buffer & retreat planning	3B	Groyne (150 m length)	5
	3C	Offshore breakwaters (100 m length)	NA
	3D	Sand nourishment	4
Protect & retreat planning	2A	Entrance road protection (130 m length)	3
	2B	Relocate Woody Head Road (130 m length) combined with rock revetment	2
	3A	Seawall extension (80 m length) and sand nourishment	1

Option 1 ranked 6, reflecting the loss of recreational value if the campground was no longer accessible.

Option 3B ranked 5, reflecting the possible impact on natural coastal processes, visual amenity, uncertainty of protection and high construction costs. Option 3C was deemed not feasible due to the high uncertainty of protection.

Option 3D ranked 4, reflecting the option only provides a buffer to erosion, and the reduced campground lifespan due to large volumes of sand required.

Option 2A and 2B ranked 3 and 2 respectively, reflecting increased longevity of the campground, but reduced recreational and environmental values as the shoreline would erode adjacent to the rock revetment leaving no beach or vegetation.

The adaptive approach (option 3A+3D) received the highest overall score (66%) and ranked 1. Combined, these options protect the campground for 25 years (2050), protecting the recreational and environmental values through the creation of a pocket beach and revegetation of the back dune. Planning for long-term retreat will still need to occur.

Recommendation

Based on the MCA, the recommended management option for Woody Head campground is the **adaptive management approach** (option 3A + 1) including seawall extension (80 m) with sand nourishment and long-term planned retreat.

6. Recommended management approach

6.1 Adaptive management

The recommended option for the management of Woody Head campground is an adaptive management approach including long-term strategic retreat of campground infrastructure and assets combined with an extension of the seawall and sand nourishment.

The recommended measures are sympathetic to natural coastal processes and aim to balance the natural and recreational values of this area. Further detailed assessments will be required to implement the recommended option. Any short-term actions will need to be compatible with the long-term adaptive management strategy. Emergency response is a key component of the long-term adaptive management strategy.

Table 6 and **Table 7** detail the key risks, strategic response and recommended management approach for present and future scenarios. **Table 8** lists the suggested timing and costs for each of the required implementation actions – planned retreat, seawall extension and sand nourishment – as described below.

6.1.1 Planned retreat

Due to the high risk of erosion and shoreline recession and resulting impacts on Iluka Road and Woody Head Road, planned retreat is the recommended long-term solution for Woody Head campground.

The timing of planned retreat will depend largely on:

- council's plans for Iluka Road
- protection provided to the campground access road
- the actual future rate of erosion/recession experienced
- the impacts of erosion and inundation on accessibility, safety and the visitor experience.

The suggested long-term response (i.e. beyond 2050) to the predicted shoreline recession and inundation is the strategic retreat of all amenities from this site. Coastal hazard risk thresholds and triggers for response will need to be developed to determine when retreat actions are required.

A plan for the retreat of campground assets, infrastructure and heritage items needs to be developed in consultation with stakeholders. A coordinated approach between council, NPWS and other asset owners (e.g. Essential Energy) will be required.

6.1.2 Seawall extension and beach nourishment

To restore the end effect area and maintain the south-eastern corner of Woody Bay beach, it is recommended that the seawall be extended by approximately 80 m to the west with ongoing sand nourishment from the hind dune borrow site. Refer to **Figure 13**, **Figure 14** and **Figure 15** below (from Hydrosphere Consulting, 2023) for further detail.

This measure provides increased medium-term protection of the entrance road and core campground assets while recognising long-term threats and the need to respond to the changing coastal environment.

The seawall extension and beach, combined with enhanced seating and/or picnic areas, would provide increased amenity value and enhance the user experience. Shoreline vegetation immediately south of the existing seawall would be protected, providing an opportunity to address erosion associated with overland stormwater flows during extreme

events. This option meets the project objectives of extending the life of the campground while protecting existing values as far as possible and is consistent with the current site's coastal management approach.

Ongoing maintenance of the existing and extended seawall will be required.

A detailed assessment of the recommended management option and further detail on the design and construction are provided in Hydrosphere Consulting, 2023.

A concept design, construction methodology, approvals pathway and cost estimate are provided in Hydrosphere Consulting, 2023.

6.1.3 Emergency response

Emergency response measures for the Woody Head campground will be addressed in the Coastal Zone Emergency Action Subplan as part of the Clarence Valley Open Coast CMP.

6.1.4 Clarence Valley Council CMP

Adaptive management actions are recommended for inclusion in the Clarence Valley Council CMP.

Liaison with the Clarence Valley Council on the long-term management of Iluka Road and access to Woody Head campground is recommended.

Table 6 Potential adaptive management actions for each strategic response stage to present day (2023) risks

Key risks	Strategic responses	Potential actions for the adaptive management approach
Northern campground areas, boat ramp and beach areas are periodically and temporarily inaccessible due to inundation with higher tides and storm surge. Recession of Woody Bay shoreline and end effects of the existing seawall are affecting vegetation, cultural heritage, beach access and public safety although there is limited current risk to built assets. Infrequent inundation of campground access roads and erosion of Woody Bay beach occurs near the beach access path with heavy rainfall.	Alert	• Development of a coastal hazard monitoring plan and monitoring of the extent and impacts of coastal hazards • Development of cultural heritage management plans • Periodic re-assessment of long-term coastal hazards as additional information becomes available • Assessment and maintenance of existing seawall as required • Ongoing maintenance of beach and campground areas in response to coastal hazards • Engagement with traditional owners • Consider undertaking campground user surveys/engagement • Consider undertaking community awareness/education.
	Avoid future impact	• Maintain existing campground facilities with limited expansion.
	Active intervention	• Design, approvals and construction of the western extension of the existing seawall (approximately 80 m) • Initial sand nourishment to restore the end effect area • Ongoing sand nourishment of Woody Bay beach to maintain the end effect area and the current coastline position as opportunities arise and as identified in sand sourcing study • Relocation of Woody Head Road as an alternative approach if required prior to seawall construction.
	Planning for change	• Investigate options for relocation of the campground • Retreat planning – develop actions and triggers to remove assets required to protect natural and cultural heritage values • Consultation and engagement with stakeholders in planning for change.
	Emergency response	• Preparation and implementation of emergency response measures for the campground to respond to coastal hazards.

Table 7 Potential adaptive management actions for each strategic response stage to future (2043 and beyond) risks

Key risks	Strategic responses	Potential actions for the adaptive management approach
Increased erosion/recession and extent and frequency of ocean inundation expected resulting in more frequent impacts on access roads, boat ramp and campground areas with predicted wave overtopping of parts of the seawall. Longer duration of inaccessible beach and rock platform north of the campground. Seawater inundation of campground areas with more severe storm tides. Frequently inaccessible beach and rock platform.	Alert	• Continue revegetation and dune restoration maintenance as required • Periodic re-assessment of long-term coastal hazards as additional information becomes available • Assessment and maintenance of seawall as required • Ongoing monitoring of the extent and impacts of coastal hazards • Ongoing maintenance of beach and campground areas in response to coastal hazards • Engagement with traditional owners • Consider undertaking campground user surveys/engagement • Consider undertaking community awareness and education of coastal hazards
	Avoid future impact	• Maintain campground assets to preserve natural and recreational values until planned retreat triggers have been met • Maintain existing campground facilities with limited expansion or upgrade.
	Active intervention	• Ongoing sand nourishment of Woody Bay beach to maintain the end effect area and the current coastline position.
	Planning for change	• Design and approvals for an alternative campground site if a viable site is found • Implement retreat actions required to protect natural and cultural heritage values once planned retreat triggers have been met.
	Emergency response	• Implement emergency response measures as required.

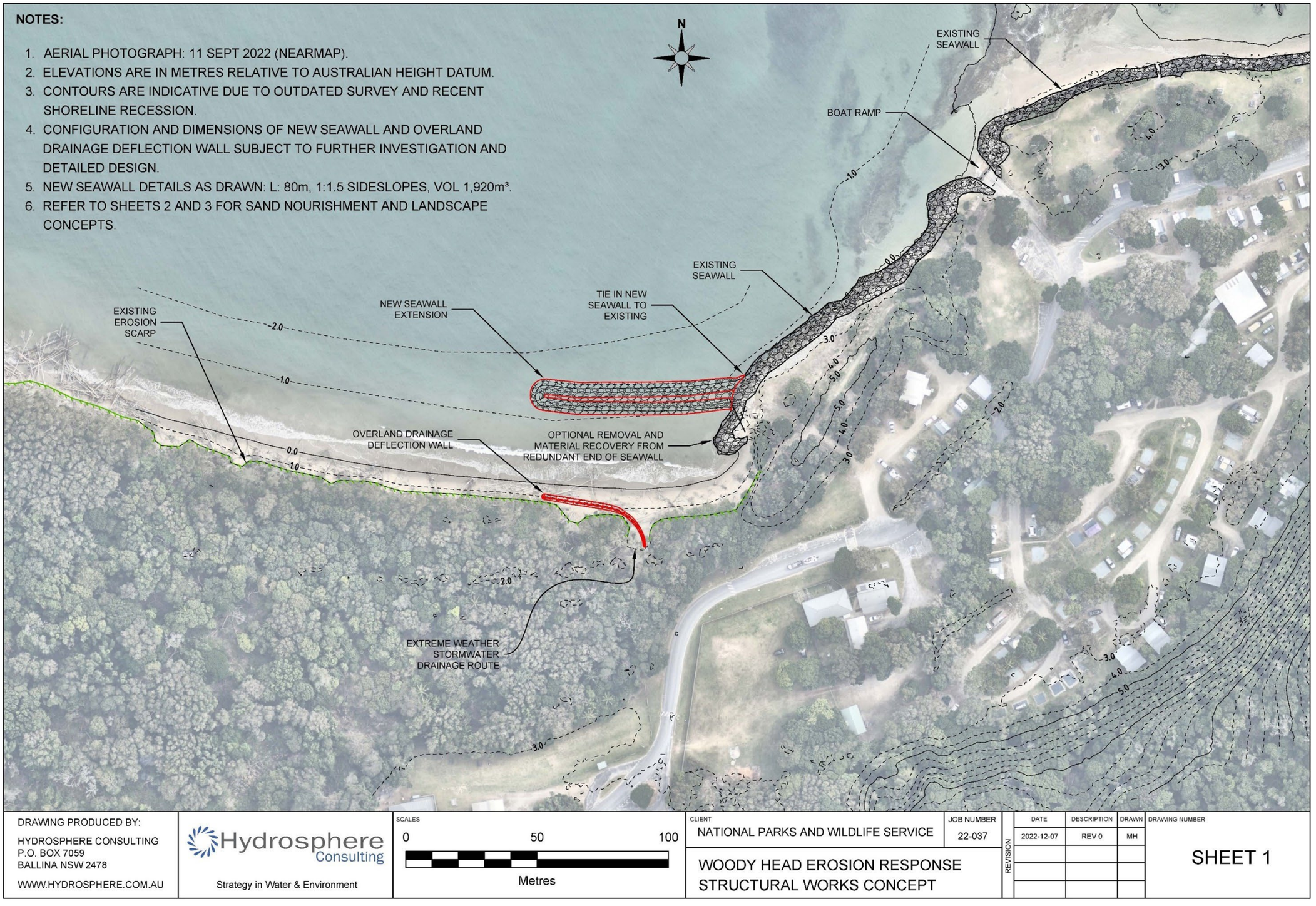


Figure 13 Seawall extension

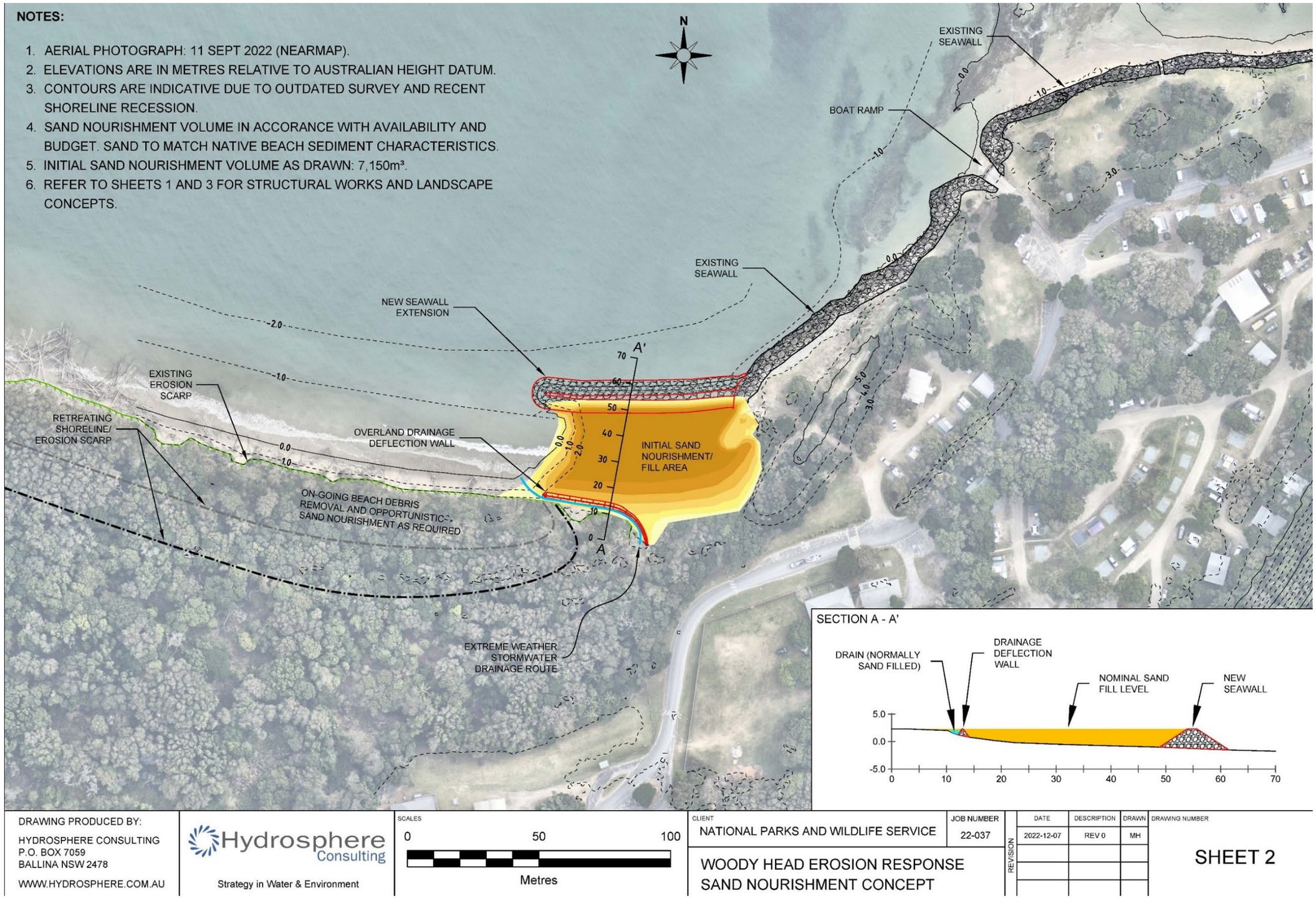


Figure 14 Sand nourishment

Figure 15 Revegetation

Table 8 Woody Head coastal hazard response plan – cost estimates for adaptive management implementation actions over 10 years

No.	Recommended actions	Description	Estimate 10-year cost (2023 $)	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
1	**Planning**												
1a	Coastal hazard monitoring	Develop a coastal hazard monitoring plan including ongoing inspection and monitoring requirements and responses	**60,000**	15,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
1b	Coastal hazard assessment	Periodic review of coastal hazard assessment and mapping (align with CMP)	**30,000**	0	0	0	0	0	0	0	0	0	30,000
1c	Campground user surveys	Determine user satisfaction with campground facilities and management response	**20,000**	0	0	0	0	10,000	0	0	0	0	10,000
1d	Community awareness/education	Update education/interpretive signage with latest information and management response	**20,000**	10,000	0	0	0	0	10,000	0	0	0	0
1e	Aboriginal heritage	Investigate Aboriginal heritage protection requirements	**60,000**	60,000	0	0	0	0	0	0	0	0	0
1f	European heritage	Investigate European heritage protection requirements for historic heritage sites	**60,000**	0	0	0	0	0	0	30,000	30,000	0	0
2	**Implementation**												
2a	Design and approvals	Detailed design and approvals (refer Hydrosphere Consulting, 2023)	**235,000**	235,000	0	0	0	0	0	0	0	0	0
2b	Seawall construction[1]	Extend seawall by 80 m to west along Woody Bay	**1,142,000**	0	1,142,000	0	0	0	0	0	0	0	0
2c	Initial sand nourishment	Creation of a pocket beach and restoration of end effect area using sand from the hind-dune area	**200,000**	0	200,000	0	0	0	0	0	0	0	0
2d	Site restoration	Site rehabilitation, revegetation and restoration of beach access	**100,000**	0	100,000	0	0	0	0	0	0	0	0
2e	Campground relocation investigations	Investigation potential campground relocation options	**100,000**	0	0	0	0	0	0	0	0	50,000	50,000
2f	Retreat planning	Develop strategic plan including actions and triggers. Engage with Yaegl traditional owners to develop ongoing management requirements. Develop strategic retreat planning actions with stakeholders. Monitor satisfaction with management response.	**100,000**	0	0	0	0	0	0	0	0	0	100,000
3	**Maintenance**												
3a	Seawall and beach maintenance	Maintenance of revegetation area and weed management	**95,000**	5,000	5,000	5,000	5,000	5,000	50,000	5,000	5,000	5,000	5,000
3b	Repeat sand nourishment	Beach nourishment using sand from the hind-dune area	**200,000**	0	0	0	0	0	0	200,000	0	0	0
Totals			**2,422,000**	**325,000**	**1,452,000**	**10,000**	**10,000**	**20,000**	**65,000**	**240,000**	**40,000**	**60,000**	**200,000**

To accommodate the risk of constructing a pocket beach and seawall in the surf zone with potential soft sediments, an additional 30% construction risk contingency has been added to the initial concept estimate from the *Assessment of viability* report (Hydrosphere Consulting, 2023). Initial sand nourishment and construction of the seawall (2a–2d) is estimated to be $1.677 million.

6.2 Ongoing strategic planning

Ongoing strategic planning is required to support the adaptive management approach including:

- monitoring
- re-assessment
- stakeholder engagement
- community awareness and education
- emergency planning.

Specific actions that contribute to management of environmental impacts and cultural heritage through preparedness and responsible coastal management in a dynamic environment are set out below. These actions may be resource-intensive once assets and values are at imminent risk.

- **Early warning systems and preparedness**. The state of the beach and campground area and forecast ocean and weather conditions need monitoring for triggers to initiate emergency response measures. Monitoring requirements and response measures are recommended.
- **Monitoring of beach profile**. Change in the beach profile – such as the position of the shoreline and condition of sand-trap fencing – should be monitored regularly and following coastal events. Triggers for intervention should be identified as part of a trigger-based planning approach.
- **Monitoring campground use and visitor satisfaction** Monitoring of visitor numbers and surveys of campground users and visitors as to their satisfaction with access and amenity are recommended.
- **Monitoring safety and ease of access**. Periodic monitoring and event-based monitoring (e.g. following large tides or swell) of the condition of the boat ramp and of access for vehicles, 4WD vehicles and pedestrians is recommended.
- **Review of coastal hazard assessments**. Coastal hazard assessments need to be updated with further knowledge of climate change impacts to assess the effectiveness of the management approach. As part of the CMP implementation stage, review of coastal hazards and of management approach is recommended every 10 years. More frequent review may be required if coastal hazards are more severe than predicted.
- **Community awareness and education programs**. Interpretive and educational signage at the campground should be updated and added to, with input from the Yaegl people as traditional custodians, to provide information on campground values, coastal hazards and the management approach.

7. References

Ball J, Babister M, Nathan R, Week M, Weimann E, Retallick M, Testoni I (eds) (2019) The Australian rainfall and runoff: a guide to flood estimation 2019, Geoscience Australia, Canberra.

DCS Spatial Services (2023) *Clip & ship*, https://maps.six.nsw.gov.au/clipnship.html, accessed August 2023.

DECCW (NSW Department of Environment, Climate Change and Water) (2012) *Woody Head coastal hazard review.*

DLWC (NSW Department of Land and Water Conservation) (2001) C*oastal dune management: A manual of coastal dune management and rehabilitation techniques*, Coastal Unit, DLWC, Newcastle.

DPIE (NSW Department of Planning, Industry and Environment) (2020) *Economic values of parks report, recreational use value, Bundjalung National Park,* NPWS Economic Values - Power BI, accessed April 2024.

Goodwin ID, Stables MA and Olley JM (2005) *Wave climate, sand budget and shoreline alignment evolution of the Iluka-Woody Bay sand barrier, northern New South Wales, Australia, since 3000 yr BP*. Marine Geology 226 (2006) 127–144.

Hydrosphere Consulting (2021) *Clarence Valley coastline and estuaries coastal management program stage 1: Scoping study.*

Hydrosphere Consulting (2023) *Woody Head campground seawall extension – assessment of viability,* September 2023.

Infrastructure Australia (2021) Guide to multi-criteria analysis, accessed July 2021.

IPCC (Intergovernmental Panel on Climate Change) (2023) Sixth assessment report, accessed October 2023.

JBP (2022) Clarence coastline tidal and coastal inundation hazard mapping*,* Clarence Valley Council, accessed 20 June 2022.

—— (2023) Clarence coastline beach erosion and recession hazard assessment, Clarence Valley Council*,* accessed 22 September 2023.

MHL (2000) *Woody Head erosion mitigation coastal processes, hazard definition, management study and management plan.*

National Native Title Tribunal (2023) Native title determinations, Sharing and Enabling Environmental Data Portal, accessed 18 September 2023.

NPWS (1997) Broadwater National Park Bundjalung National Park and Iluka Nature Reserve plan of management.

NSW Environment and Heritage (2018a) Our future on the coast, NSW coastal management manual part A: introduction and mandatory requirements for a coastal management program.

—— (2018b) Our future on the coast, NSW coastal management manual part B: stage 1 – identify the scope of a coastal management program.

—— (2019a) Our future on the coast, NSW coastal management manual part B: stage 2 – determine risks, vulnerabilities and opportunities.

—— (2019b) Our future on the coast, NSW coastal management manual part B: stage 3 – identify and evaluate options.

Risk Frontiers (2021) *Physical climate risk assessment – coastal flood and sea level rise, supplementary report S6*, Clarence Valley Council.

Water Technology (2018) *Preliminary assessment Woody Head seawall and Woody Bay erosion*, NSW National Parks & Wildlife Service.

Appendix A: Maps

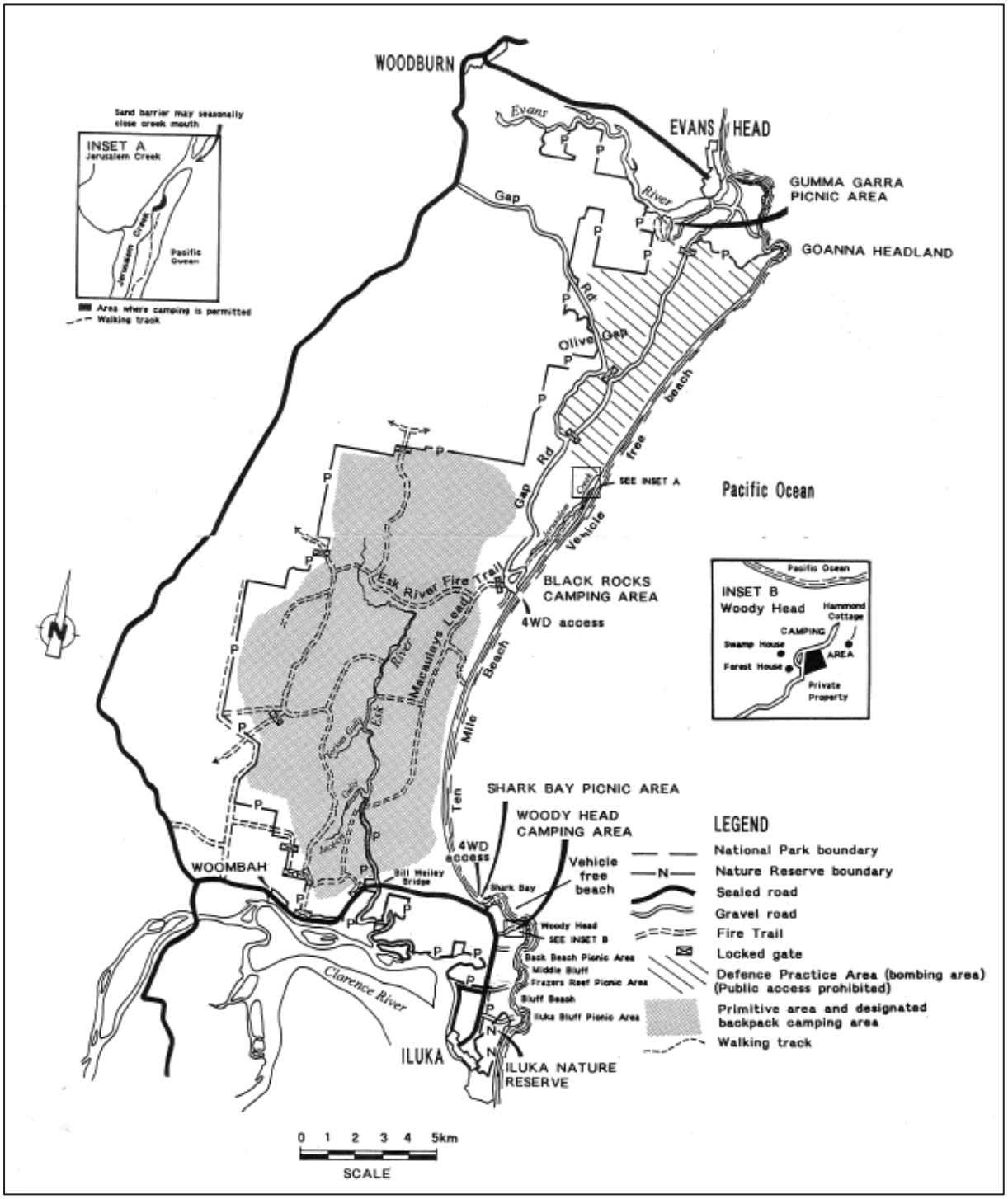
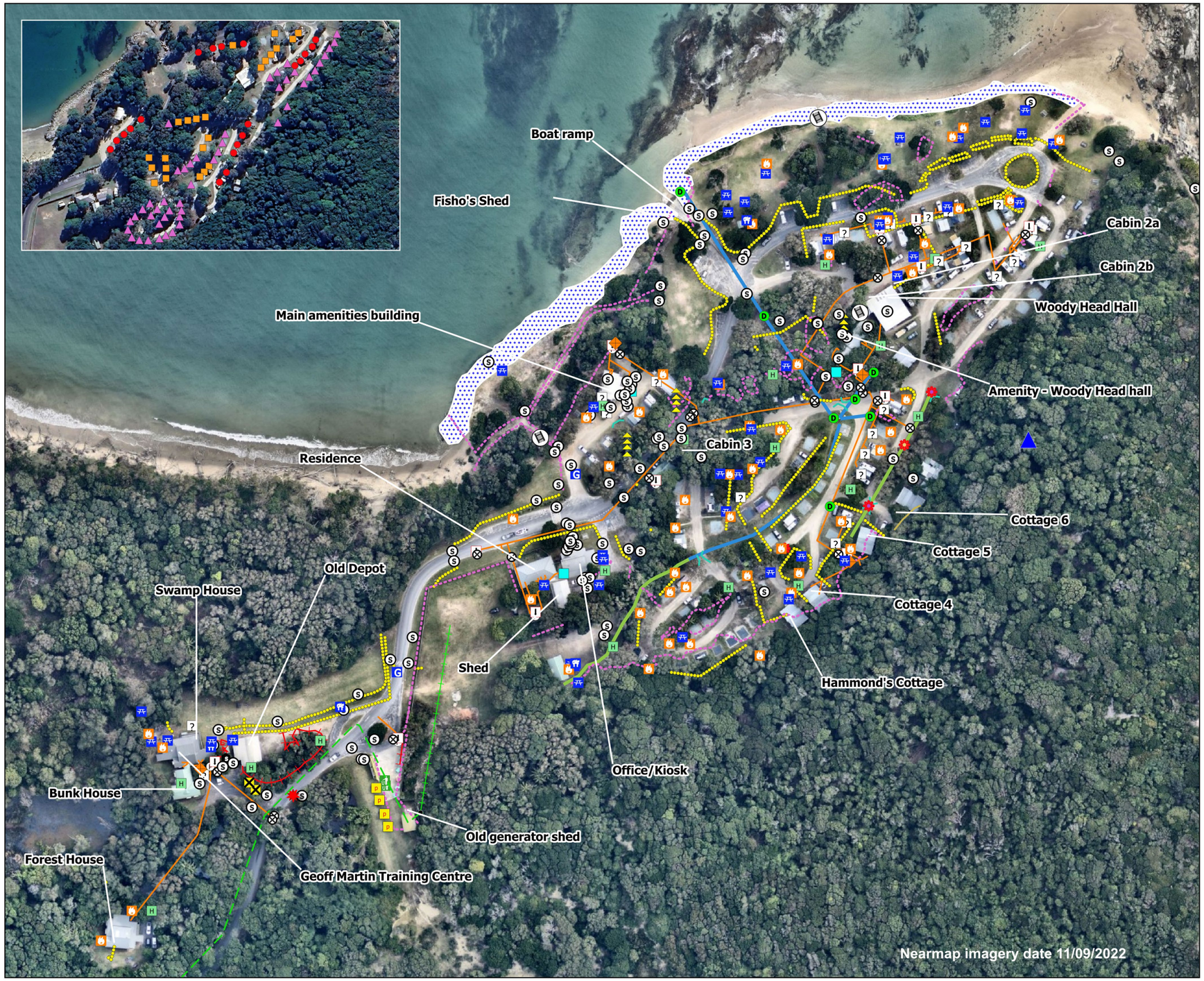


Figure 16 Bundjalung National Park

Source: NPWS (1997) Broadwater National Park Bundjalung National Park and Iluka Nature Reserve plan of management.

Figure 17 **Study area – land ownership and management**

Source: DCS Spatial Services 2023, National Native Title Tribunal 2023.



Hydrosphere Consulting

Legend

- Power-pole
- Underground powerline
- Overhead powerline
- Solar panels
- Rock revetment
- Reservoir (CVC)
- BBQ/Fireplace
- Picnic Table
- Shelter
- Waste/Recycling Stn
- Stairs
- Visitor monitoring
- Sign
- Culvert
- Pedestrian Crossing
- Elevated walkway
- Septic tank
- Grease Trap
- Hydrant
- Inspection Pit
- Meter
- Outdoor Shower
- Pump
- Tap
- Stormwater drain
- Gate
- Valves
- Fence/handrail
- Bollard
- Edging
- Retaining Wall
- Roadside Barrier
- Closed Stormwater Drn
- Open Stormwater Drn
- Sewer pipe

Inset

- Caravan,Tent,Trailer sites
- Tent sites
- Trailer, Tent sites

N

0 30 60 m

Figure 18 Woody Head campground site

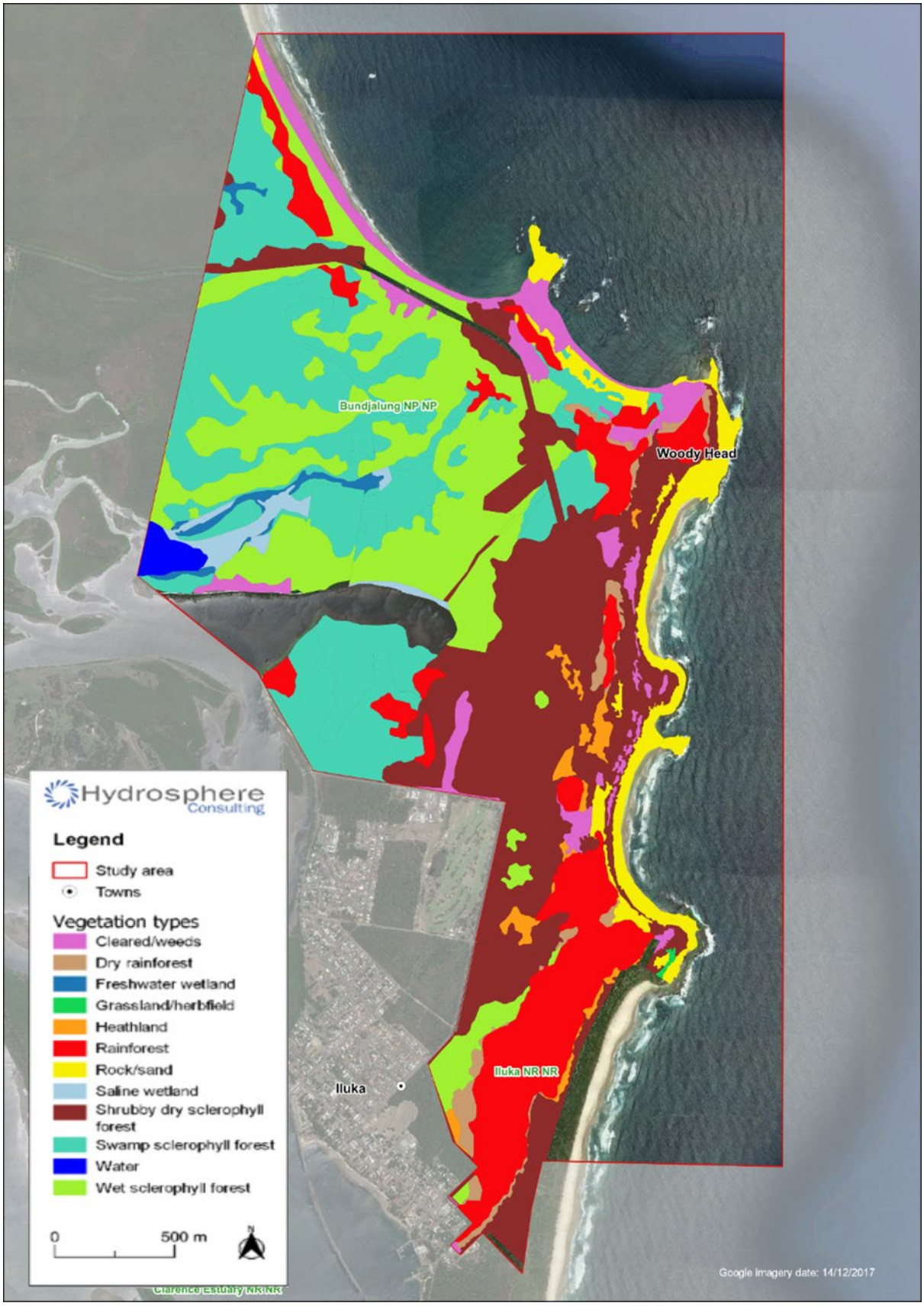


Figure 19 Study area – vegetation types

Source: CRAFTI Upper North East Floristics dataset, SEED mapping.

Appendix B: Historical aerial photographs

Source: 1958–1998: *Historical Imagery Viewer* Historical Imagery (nsw.gov.au)

Source: 2006–2011: Google Earth

Source: 2016–2022: Nearmap

Photo 17 **1958 – showing sand accretion at the western end of Woody Bay and the tombolo, north of the campground site and south of Iluka Bluff**

Photo 18 1980 – expanded area of vegetation at the western end of Woody Bay dune

Photo 19 **1989 – prior to construction of the seawall and artificial dune at western node campsite in the 1990s**

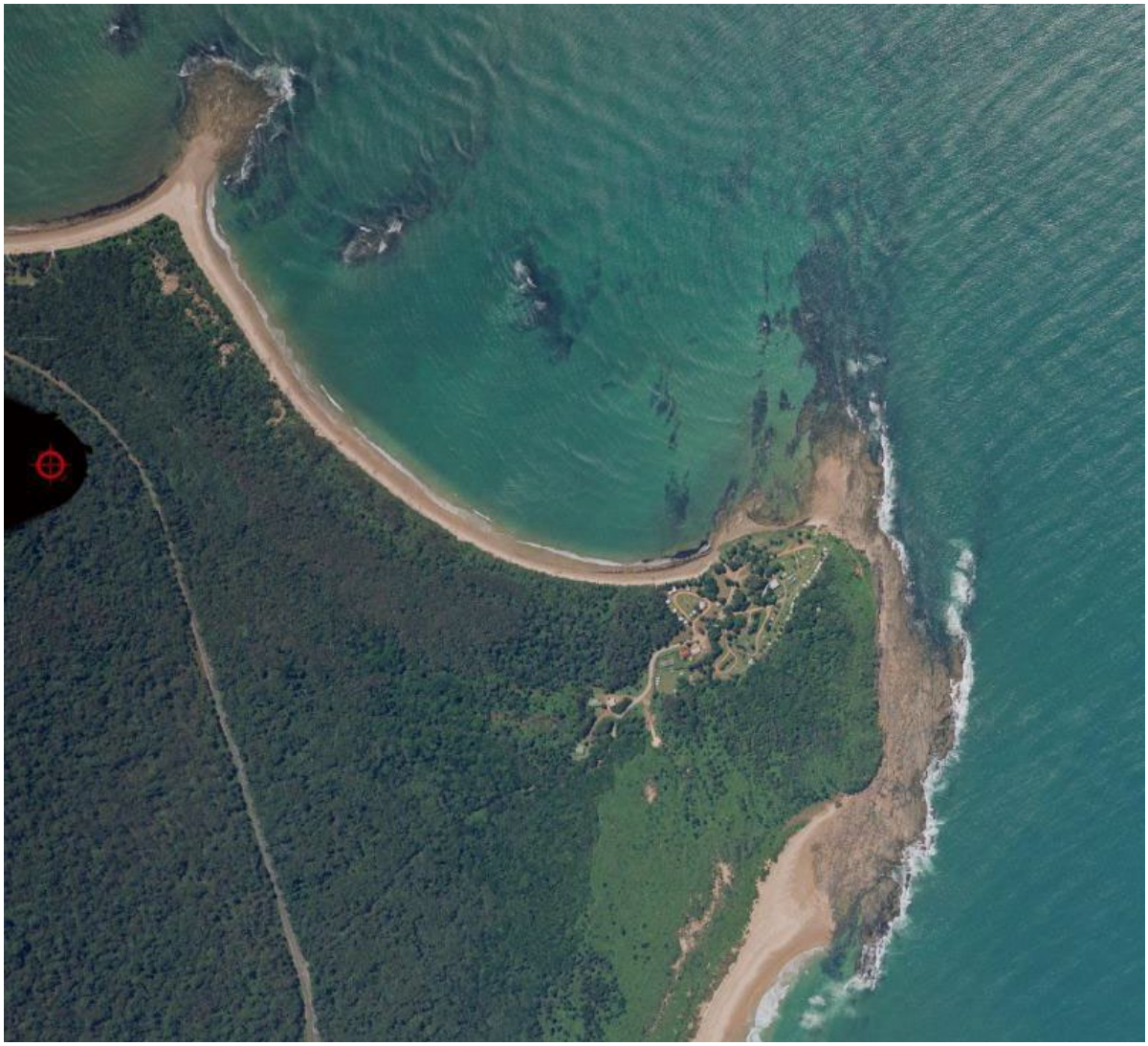


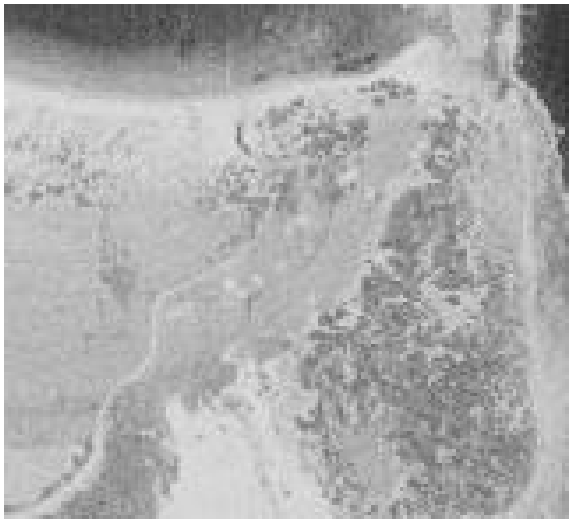
Photo 20 1998 – eastern end of seawall constructed

Photo 21 **July 2006 – showing clearing for construction of artificial dune (western extent of Woody Bay is not included in the aerial photograph)**

Photo 22 February 2011 – vegetation extended across artificial dune, seawall end effects are evident

Photo 23 May 2016 – visible beach recession and seawall end effects

Photo 24 September 2022 – visible beach recession and increasing seawall end effects



1958

1980

1989

1998

June 2006

February 2011

May 2016 August 2018 September 2022

Figure 20 Changes in Woody Head campground site since 1958

Appendix C: Coastal hazard mapping

Detailed coastal hazard assessments and mapping are provided in JBP (2022, 2023). Additional mapping is also available to view and download on the Clarence Valley Council website:

- Clarence Valley coastline and estuaries plans and studies

Appendix C is available as 2 separate PDFs:

Appendix C Clarence River (Woody Bay and Iluka) inundation mapping:

- Clarence River (Woody Bay and Iluka) inundation extents – present day (2023)
- Clarence River (Woody Bay and Iluka) inundation extents – 2043 SSP2
- Clarence River (Woody Bay and Iluka) inundation extents – 2073 SSP2
- Clarence River (Woody Bay and Iluka) inundation extents – 2123 SSP2

Appendix C Clarence River (Woody Bay and Iluka) erosion mapping:

- Erosion and recession zones – present day (2023): Woody Head campground
- Erosion and recession zones – SSP2 – 2043: Woody Head campground
- Erosion and recession zones – SSP2 – 2073: Woody Head campground
- Erosion and recession zones – SSP2 – 2123: Woody Head campground

Appendix D: Assessment of potential management options

Section 1: Preliminary assessment of feasibility

The preliminary assessment and feasibility of potential management options for each strategic management approach (alert, avoid, active intervention, planning for change and emergency response) are provided in **Table 9**.

A comparison of the benefits and costs associated with the feasible options involving active intervention or planning for change is provided in **Table 10**.

Table 9 Preliminary assessment of potential coastal hazard responses

Potential response	Expected outcomes	Management objectives	Environmental context	Social context	Cultural heritage values	Costs	Benefits	Feasibility	Viability	Comments on feasibility
Alert (low regrets)										
Enhance sand dune and beach through sand nourishment	Build up beach profile artificially to slow down recession.	Protects the cultural heritage and amenity values of the campground and improves safety, beach accessibility and the visitor experience and will prolong the life of the campground while a feasible source of sand is available. .	Impacts at sand source and placement site require assessment but are expected to be minor with best practice controls.	Temporary impacts during nourishment phase but improved access, safety and aesthetic appeal over the longer-term.	Impacts at sand source and placement site require assessment and consultation with traditional custodians. Can provide protection to cultural heritage sites within the nourishment area. No impact on European heritage values.	Moderate – significant volumes required to maintain the coastline position and alignment as well as ongoing maintenance and replenishment as sand is lost to natural erosion processes.	Slows the rate of recession and impacts of erosion with sufficient nourishment volumes although unlikely to be effective against major storm events – provides a buffer only.	Limited sand available in intertidal area within Woody Bay and Shark Bay or active beach system. Potential dredging from other marine areas and placement on Woody Bay beach or importing sand of suitable composition from local quarry.	Ongoing commitment to renourishment is. to be required.	Beach nourishment is recommended to improve amenity and dune stability but is unlikely to be effective in mitigating erosion over the long term without coastal protection works. Beach nourishment should be combined with other measures to improve success and enhance amenity. Woody Bay is unsuitable for beach scraping due to the deficit of sand on the lower beach.
Enhance foreshore vegetation	Rehabilitation of littoral rainforest areas west of seawall to provide additional protection against wave impact and surface water runoff.	Assists with the preservation of local habitat and improves the visitor experience.	Contributes to enhanced biodiversity values.	Contributes to enhanced social values (visual amenity, visitor experience).	Contributes to management of cultural heritage impacts through restoration activities.	Low – requires ongoing maintenance.	Slows the rate of recession and impacts of erosion although unlikely to be effective against major storm events – provides a buffer only.	Feasible – limited constraints.	Ongoing commitment to maintenance is required.	Unlikely to be successful over the long term without additional measures e.g. sand nourishment. Littoral rainforest is not resilient to wave impact and salt exposure. Coastal vegetation could be established to provide a protective buffer for any littoral rainforest as part of a sand nourishment or coastal protection measures. Rehabilitation of littoral rainforest areas should be combined with other measures to enhance amenity.
Management of existing seawall end effects through sand nourishment, regrading and revegetation	Rehabilitate end effect areas to maintain access to Woody Bay beach and restore areas of erosion.	Protects the cultural heritage and amenity values of the campground and improves safety, beach accessibility and the visitor experience and will prolong the life of the campground while a feasible source of sand is available.	Limits impacts biodiversity values.	Contributes to enhanced social values (visual amenity, visitor experience).	Limits impacts to cultural heritage.	Moderate – requires ongoing maintenance.	Slows the rate of erosion although unlikely to be effective against major storm events.	Feasible if sand source is identified.	Ongoing commitment to maintenance is required.	Likely to require repeated nourishment campaigns particularly if implemented in isolation of additional coastal protection works. Sand nourishment, regrading and revegetation should be combined with other measures to enhance amenity.
Manage 4WD and pedestrian beach access	Restore beach access through regrading and removal of debris in	Protects the amenity values of the campground and improves safety, beach	No impacts.	Contributes to enhanced social values (safety, access to the	Unlikely to impact cultural heritage values if current footprint is maintained.	Moderate – requires ongoing maintenance.	Maintains safety and accessibility.	As shoreline changes over time, existing access may not be viable and alternative	Ongoing commitment to maintenance is required.	Likely to be required in response to monitoring of safety/access.

Potential response	Expected outcomes	Management objectives	Environmental context	Social context	Cultural heritage values	Costs	Benefits	Feasibility	Viability	Comments on feasibility
	response to erosion and inundation.	accessibility and the visitor experience.		coastline, visitor experience).				locations or approaches may be required.		
Manage offshore boat access	Restore offshore boat access in response to erosion and inundation.	Protects the amenity values of the campground and improves safety, beach accessibility and the visitor experience.	Requires assessment but are expected to be minor with best practice controls.	Contributes to enhanced social values (safety, access to the coastline for commercial activities).	Requires assessment and consultation with traditional custodians.	Low–Moderate (depending on design, related infrastructure e.g. access roads and location).	Ongoing offshore boat access for commercial activities.	Feasible locations may not be available in this part of the reserve due to ongoing recession and inundation.	Minimal resources and commitment required over the short term. Long-term viability will depend on coastal hazards impact.	Offshore boat access should be maintained if safe and suitable access can be provided in this location. Relocation options may be required over the longer term.
Manage risks to public safety due to dangerous/fallen trees	Fallen trees along Woody Bay beach are periodically removed to facilitate safe longshore beach access. Dangerous trees (at risk of falling) are identified and managed as required.	Protects the amenity values of the campground and improves safety, beach accessibility and the visitor experience.	Impacts require assessment but are expected to be minor with best practice controls.	Contributes to enhanced social values (safety, access to the coastline, visitor experience).	Unlikely to impact cultural heritage values.	Low – requires ongoing maintenance.	Safe beach access is provided. Repositioning fallen trees can assist in the formation and retention of windblown sand into the foredune system although unlikely to offset the scale of the natural coastal processes and the effect on the littoral transport regime.	Feasible if safe access to the beach is available.	Ongoing commitment to maintenance is required.	**Recommended** – Removal of fallen trees prior to peak visitor periods and following significant coastal events to reinstate viable beach areas and facilitate longshore pedestrian access. Monitoring of vegetation should be undertaken.
Protect First Nations cultural values/sites	Management decisions consider impacts on cultural heritage values and management approaches preferred by traditional custodians.	Protects the cultural heritage values of the campground.	Impacts require assessment but are expected to be acceptable with best practice controls.	Contributes to enhanced social values (visitor experience).	Expected to enhance Aboriginal cultural heritage values through collaboration and development of integrated management approaches.	Low for consultation activities.	Enhanced collaboration with First Nations and development of culturally sensitive management approaches.	It is expected that feasible options can be developed.	Requires ongoing commitment from all stakeholders.	**Recommended** – Ongoing liaison with Yaegl traditional owners to identify values, areas at risk and potential management approaches
Protect European cultural values/sites	Relocation or modification of cultural sites in high-risk areas.	Protects the cultural heritage values of the campground.	Impacts require assessment but are expected to be acceptable with best practice controls.	Unlikely to impact social values.	Expected to enhance European cultural heritage values through preservation.	Potentially Moderate–High.	Local European cultural heritage values are preserved.	Over the longer timeframes, relocation of sites is expected to be required as campground is unlikely to be viable. Further assessment of alternative sites is required.	Ongoing commitment to maintenance and/or relocation is likely to be required.	**Recommended** – Cultural heritage management plans should be prepared for heritage sites to adequately plan for protection of sites and potential relocation/removal as part of retreat of campground.
Protect significant vegetation	Survey of littoral rainforest areas along Woody Bay/Shark Bay to identify management requirements.	Assists with the preservation of local habitat and ecosystem services.	Contributes to enhanced biodiversity values.	Contributes to enhanced social values (visitor experience, aesthetics).	Expected to enhance European cultural heritage values through preservation.	Low–Moderate depending on management requirements.	Biodiversity values are preserved.	Feasible protection options may be identified although the condition and extent of the local vegetation communities are vulnerable to coastal hazards.	Ongoing commitment is likely to be required.	**Recommended –** Vegetation survey and identification of feasible management options (transplanting, seed collection and propagation, revegetation).

Potential response	Expected outcomes	Management objectives	Environmental context	Social context	Cultural heritage values	Costs	Benefits	Feasibility	Viability	Comments on feasibility
Avoid future impact										
Identify areas where campground redevelopment is not acceptable	Future risk campground areas identified.	Assists in providing a safe and enjoyable visitor (camping and day use) experience and maintaining the economic viability of the campground.	Unlikely to impact environmental values.	Increasing social impacts (loss of usability) as adaptive management is implemented.	Unlikely to impact cultural heritage values.	Low – however, campground revenue would be reduced with reduced capacity.	Contributes to adaptive management approach and facilitates safe use of the campground.	Feasible	Minimal resources and commitment required.	There is limited potential for campground development and therefore this option would not provide significant beneficial outcomes.
Relocate existing campground infrastructure to low-risk areas	Future risk campground areas identify and lower risk areas for campground reconfiguration.	Assists in providing a safe and enjoyable visitor (camping and day use) experience and maintaining the economic viability of the campground.	Unlikely to impact environmental values.	Increasing social impacts (loss usability) as adaptive management is implemented.	Unlikely to impact cultural heritage values.	Variable – campground revenue would be reduced with reduced capacity. High cost for relocation of essential assets such as amenities buildings, roads and services.	Contributes to adaptive management approach and facilitates safe use of the campground.	Limited low-risk areas available. Likely to be viable for relocatable assets e.g. cabins, tent sites. May result in reduced campground capacity.	Minimal resources and commitment required.	There is limited potential for campground development and therefore this option would not provide significant beneficial outcomes.
Identify design standards for assets in areas where coastal risks are anticipated to change over time	Raised floor levels above inundation depth for new campground infrastructure. Limited application for erosion risks.	Assists in providing a safe and enjoyable visitor (camping and day use) experience and maintaining the economic viability of the campground.	Unlikely to impact environmental values.	Contributes to enhanced social values (visitor experience, recreational values, access).	Unlikely to impact cultural heritage values.	Potentially Moderate–High.	Contributes to longer-term viability of campground although access to campground will continue to be an issue periodically. Not considered to be beneficial in isolation of coastal protection works.	Unlikely to be feasible over the longer term due to increasing risks.	Ongoing commitment is required.	There is limited potential for campground development and therefore this option would not provide significant beneficial outcomes.
Active intervention										
Modifications to campground access road (Woody Head Road)	Relocation or modification (raising, drainage, armouring) of Woody Head Road.	Assists in providing a safe and enjoyable visitor (camping and day use) experience and maintaining the economic viability of the campground.	Impacts require assessment but are expected to be minor with best practice controls.	Contributes to enhanced social values (visitor experience, recreational values, access).	Impacts require assessment and consultation with traditional custodians.	Moderate–High	Contributes to longer-term viability of campground.	Expected to be feasible subject to design.	Ongoing resources and commitment are required.	**Consider** – Relocation of the access road may be considered if significant erosion occurs before coastal protection works are constructed.
Modifications to Iluka Road	Relocation or modification (raising, drainage, armouring) of Iluka Road.	Maintenance of vehicular access is consistent for the short term if benefits can be demonstrated. Major infrastructure development within the reserve is unlikely to align with risks and impacts on reserve values.	Potential high impacts on biodiversity values.	Contributes to enhanced social values (visitor experience, recreational values, access) once implemented. Minor impacts on social values are expected during construction.	Potential impacts on cultural heritage values.	High	Contributes to longer-term viability of campground.	Limited due to: Long lengths of potentially impacted roads. Limited opportunity for relocation of roads within reserve areas due to potential impacts on reserve values.	Iluka Road is managed by council.	**Recommended** – Collaboration with council on management of Iluka Road.
Hard protection structures extended further in the embayment	Placement of non-erodible materials to reduce the extent and impact of erosion and realign the foreshore (e.g. extension of	Consistent for the short-term as it contributes to ongoing viability of the campground although artificial	Some potential impacts on biodiversity values.	Contributes to enhanced social values (visitor experience, recreational	Potential impacts on cultural heritage values.	High	Contributes to short-term viability of campground.	Can limit landward recession and protect areas close to the beach.	Ongoing resources and commitment are required.	**Recommended** – Extension of the seawall to provide protection to the campground access road.

Potential response	Expected outcomes	Management objectives	Environmental context	Social context	Cultural heritage values	Costs	Benefits	Feasibility	Viability	Comments on feasibility
	seawall along Woody Bay, groynes, offshore breakwaters and artificial headlands).	intervention may compromise natural values of the reserve. NPWS considers that hard engineering options should only be a last resort to protect key assets.		values, access) once implemented. Minor impacts on social values are expected during construction.						
Beach nourishment to replace sand lost to erosion and recession	Beach nourishment along shoreline to mitigate shoreline recession.	Protects the cultural heritage and amenity values of the campground and improves safety, beach accessibility and the visitor experience and will prolong the life of the campground while a feasible source of sand is available.	Potential impacts on biodiversity values.	Contributes to enhanced social values (visitor experience, recreational values, access).	Potential impacts on cultural heritage values.	Moderate	Contributes to short-term viability of campground.	Can limit landward recession and protect areas close to the beach.	Ongoing resources and commitment are likely to be required.	This may provide a buffer to target assets and extend the viability of the campground, but significant sand volumes are expected to be required.
Planning for change										
Update plan of management	Update plan of management to incorporate coastal hazard information and response actions.	Consistent (Section 73B and 79A of the *National Parks and Wildlife Act 1974*).	No impacts	No impacts	No impacts	Low	Consistent with legislative requirements and best practice management.	Feasible	NPWS resources and commitment are likely to be required.	**Recommended** – The plan of management should be updated with the adopted coastal hazard response measures.
Coastal management program	Integrate the coastal hazard response actions into the CVC CMP.	Consistent with Coastal Management Framework.	No impacts	No impacts	No impacts	Low	Consistent with integrated coastal management approach.	Feasible. NPWS collaborated with CVC on Stage 1 and 2 of CMP development. The preparation of this response plan is consistent with Stage 3 of the Clarence Valley Coastline CMP development.	NPWS resources and commitment are required.	**Recommended** – Incorporating the adopted coastal hazard response measures in the CMP will formalise the management approach and contribute to an integrated coastal management approach for the Clarence Valley coastline.
Identify alternative sites for campground	Campground relocated to low-risk area.	Consistent with Coastal Management Framework. Assists in providing a safe and enjoyable visitor (camping and day use) experience.	Potential impacts on biodiversity values.	Contributes to enhanced social values (visitor experience, recreational values, access) although potentially reduced visitor experience in alternative location.	Potential impacts on cultural heritage values.	Moderate–high (depending on location and infrastructure requirements).	Provides an alternative for future loss of campground facility.	Limited suitable land available within national park.	Ongoing resources and commitment are required.	**Consider** – Relocating the campground to a new site could be undertaken if a suitable site is found.
Adaptive management	As risks increase over time, the campground facilities are withdrawn, allowing natural	Consistent with current coastal management strategy. Management objectives may not	Ongoing maintenance of remaining reserve areas would be required to protect biodiversity values as far as possible.	Loss of social values	Ongoing maintenance of remaining reserve areas would be required to protect cultural heritage	Low–Moderate for relocation activities, significant reduction in reserve revenue.	Acknowledges impacts of natural processes, eliminates need for ongoing investment	Feasible.	Ongoing resources and commitment are likely to be required.	**Recommended** – Due to the high risk of erosion and shoreline recession impacting Iluka Road and campground access

Potential response	Expected outcomes	Management objectives	Environmental context	Social context	Cultural heritage values	Costs	Benefits	Feasibility	Viability	Comments on feasibility
	processes to proceed unhindered.	be achievable over the long-term if coastal hazards occur as predicted.			values as far as possible.		in coastal protection works.			roads, planned retreat is likely to be required. The timing may depend on council's plans for Iluka Road, protection provided to the campground access road, the actual future rate of erosion/recession and inundation on accessibility.
Emergency response										
Emergency management plan	Emergency response measures identified.	May be required to provide safe and functional access to the campground.	No impacts	No impacts	No impacts	Low	Provides for appropriate management in response to impacts of natural processes.	Feasible	Ongoing resources and commitment are required.	**Recommended** – Preparation of an emergency response plan (potentially prepared by CVC through the Clarence Valley Open Coast CMP). The plan will outline the roles and responsibilities of all public authorities in response to emergencies immediately preceding or during periods of coastal emergencies.

Table 10 Comparison of benefits and costs associated with the potentially feasible options involving active intervention or planning for change

Option	Description	Environmental	Social	Cultural	NPV 50-year benefits ($)[1,3]	NPV 50-year costs ($)[2,3]	BCR	Recommendation
1 – Planned retreat	Immediate retreat planning and retreat within 2 years.	Allows natural coastal processes to continue which would result in the loss of shoreline vegetation west of the existing seawall (swamp sclerophyll forest and rainforest).	Closure of the campground would result in loss of valued recreational opportunities and offshore access for commercial fishers. As the shoreline recedes, the amenity value of Woody Bay beach, and the campground and therefore visitation, are expected to reduce.	European and Aboriginal cultural heritage within the campground and shoreline areas would be impacted.	$11,937,879	$13,167,916	0.91	**Not recommended (short term**) – This option is not recommended in isolation in the short - term. Other short-term cost-effective options have been identified. NB: This option is recommended in the long-term.
2A – Rock revetment to protect Woody Head (Entrance) Road	Construct a rock revetment (approximately 130 m) to protect the entrance road once shoreline recedes to the road.	Shoreline vegetation west of the existing seawall would be lost to erosion. End effect erosion would occur impacting additional vegetation and campground infrastructure. Temporary construction-related impacts.	As the shoreline recedes, the amenity value of the Woody Bay beach and the campground, and therefore visitation, are expected to reduce.	European and Aboriginal cultural heritage within the shoreline areas would be impacted.	$34,807,511	$17,252,987	2.02	**Not recommended** – This option does not protect as much foreshore or buildings as option 3.
2B – Relocation of Woody Head (Entrance) Road combined with rock revetment[4]	Move road further south once shoreline recedes to the road.	Additional shoreline vegetation west of the existing seawall (swamp sclerophyll forest and rainforest) would be lost to erosion. Temporary construction-related impacts.	As the shoreline recedes, the amenity value of the Woody Bay beach and the campground, and therefore visitation, are expected to reduce.	European and Aboriginal cultural heritage within the shoreline areas would be directly impacted.	$34,807,511	$17,673,548	1.97	**Not recommended** – this option does not protect as much foreshore or buildings as option 3.
3A – Extend existing seawall[5]	Extend seawall west by approximately 80 m with initial sand nourishment to restore end effect area and create a landward beach.	Shoreline vegetation west of the existing seawall (swamp sclerophyll forest and rainforest) would be protected. End effect erosion would occur further west along Woody Bay although immediate risks to the eastern section of the road would be avoided. The proposed seawall extension is unlikely to impact the tombolo due to its distance from the tombolo and the addition of sand to the system through nourishment. Temporary construction-related impacts.	The sand nourishment would result in increased beach amenity. The amenity value of the Woody Bay beach and the campground in this area would be protected. Ongoing sand nourishment would be required to maintain end effect area.	European and Aboriginal cultural heritage within the shoreline areas and entrance section of the campground would be protected.	$34,807,511	17,136,458	2.03	**Recommended** – this option meets the project objectives to extend the life of the campground while protecting existing values as much as possible. The management approach is consistent with the current site's coastal management approach.
3B – Groyne	Construct 3 groynes ~150 m long with initial sand nourishment to restore end effect area and create updrift beach.	Shoreline vegetation west of the existing seawall would be protected if shoreline can be maintained with sand nourishment. Erosion would continue to occur downdrift of the groynes. Temporary construction-related impacts.	The sand nourishment would result in increased beach amenity, but the amenity value of the Woody Bay beach would rely on frequent sand nourishment in the seawall end effect area as well as downdrift of the groynes.	European and Aboriginal cultural heritage within the shoreline areas and entrance section of the campground would be protected.	$34,807,511	$18,186,248	1.91	**Not recommended** – this option meets the project objectives to extend the life of the campground while protecting existing values as much as possible. However, there is uncertainty regarding the final configuration of the beach within the embayment. Groynes are ineffective where longshore transport with limited sediment supply exists (such as at Woody Bay). Groynes do not offer any advantages over option 3A.

Option	Description	Environmental	Social	Cultural	NPV 50-year benefits ($)[1,3]	NPV 50-year costs ($)[2,3]	BCR	Recommendation
3C – Offshore breakwater	Construct offshore breakwater ~100 m long with initial sand nourishment along shoreline to restore end effect area and create landward beach.	Shoreline vegetation west of the existing seawall would be protected if shoreline can be maintained with sand nourishment. Sand nourishment and dune management are required in areas with a sand deficit. Temporary construction-related impacts.	The sand nourishment would result in increased beach amenity, but the amenity value of the Woody Bay beach would rely on frequent sand nourishment in the seawall end effect area as well as landward of the breakwater.	European and Aboriginal cultural heritage within the shoreline areas and entrance section of the campground would be protected.	Not costed	Not costed	Not costed	Level of protection too uncertain to undertake cost analysis. **Not recommended** – the breakwater would need to be designed to allow access for marine vessels which is likely to reduce the certainty of success. Sand nourishment would be required to maintain a usable beach. An offshore breakwater does not offer any advantages over option 3A.
3D – Sand nourishment	Import sand to restore eroded areas and protect the shoreline. The feasibility of various sources should be considered with local sources likely to be viable for smaller volumes along with opportunistic placement of sand from dredging of the Clarence River bar potentially suitable for larger volumes.	Environmental impacts of the sand sourcing and placement would need to be assessed. Shoreline vegetation landward of nourishment areas would be protected. Temporary construction-related impacts.	The sand nourishment would result in increased beach amenity, but the amenity value would rely on frequent sand nourishment in the seawall end effect area as well as along the shoreline.	Cultural heritage impacts of the sand sourcing and placement would need to be assessed. European and Aboriginal cultural heritage within the shoreline areas and entrance section of the campground would be protected.	$29,323,500	$16,274,042	1.80	**Recommended** – Restoration of the end effect area would enhance the amenity of Woody Bay beach and limit further recession near the entrance road. However, sand nourishment would need to be ongoing (e.g. every 2 years). Sand nourishment without the protection of a seawall provides reduced certainty of erosion mitigation success.

BCR = benefit-cost ratio; NPV = net present value.

1. Benefits assumptions include campground annual income of $1,000,000 (average income for 8 years to June 2023, excluding 2019–20 which was impacted by COVID-19 and bushfires); park annual recreational value of $1,901,040 (DPIE, 2020); Woody Bay beach annual natural asset value (Existence, bequest, option to use in the future (EBO) value) of $292,342 for option 1, 3A, 3B and 3D and EBO value for option 2A and 2B of $234,553 (NSW Department of Climate Change, Energy, the Environment and Water, based on preliminary research results).
2. Costs assumptions include planning cost of $220,000 for option 1, $430,000 for option 2A, 2B, 3A and 3C, and $320,000 for option 3D; implementation and maintenance costs of $60,000 for option 1, $2.5M for option 2A, $3M for option 2B, $2.6M for option 3A, $3.8M for option 3B and $2.4M for option 3D; campground operational cost of $985,000 p.a.; and retreat planning and decommission cost of $12.5M .
3. Retreat assumptions are year 5 (2029) for option 1, year 18 (2042) for option 3D and year 26 (2050) for option 2A, 2B, 3A, 3B and 3C.
4. Relocation of Woody Head Road was considered in a separate study with a cost estimate of $450,000.
5. To accommodate the risk of constructing a pocket beach and seawall in the surf zone with potential soft sediments, an additional 30% construction risk contingency has been added to the initial concept estimate from the Assessment of Viability report (Hydrosphere Consulting, 2023). Initial sand nourishment and construction of the seawall is estimated to be $1.677 million.

Section 2: Multi-criteria analysis

Table 11 describes the indicators for each of the 3 criteria in the multi-criteria analysis (MCA).

Table 11 Description of criteria and associated indicators in the multi-criteria analysis

Criterion	Indicators
Environmental and cultural considerations	Protect Aboriginal cultural heritage
	Protect historic heritage
	Allow natural coastal processes
	Protect threatened flora species and ecological communities
	Protect fauna species
	Protect flora species
	Maintain habitat connectivity
	Avoid damaging watercourses and waterbodies
	Avoid damage to marine wildlife
Visitor enjoyment and safety considerations	Protect recreational values of fishing (land-based)
	Protect recreational values of camping
	Protect beach values for recreational activities
	Protect or enhance nature-based activities (e.g. birdwatching)
	Maintain access for boating (powered)
	Maintain access for boating (unpowered)
	Protect/maintain road access to campground
	Protect access to beach
	Maintain access to river
	Community support for option (gauged from community workshops)
	Protect visual amenity value
Financial considerations	Provide a cost-effective management option (benefit–cost ratio)
	Maintain viability of campground lifespan
	Provide a viable management option considering NPWS budget (i.e. the ability to pay/fund)

NPWS = NSW National Parks and Wildlife Service

Environmental/cultural and recreational indicators scoring

For environmental and cultural criterion and recreational criterion, each indicator is given a score out of 10 as shown in **Table 12**. Scores from 1 to 4 indicate a negative consequence and scores from 6 to 10 indicate a positive consequence. A score of 5 indicates a neutral consequence.

Table 12 MCA score for individual indicators

MCA measure	MCA score	Description	Example
Very strong positive	10	Very strong impact on indicator, long-term improvement	Large increase of listed species habitat
Strong positive	9	Strong impact, long-term improvement	Increase in habitat size (not large)
Medium Positive	8	Medium positive impact	Medium-term habitat improvement
Slight positive	7	Slight positive impact	Allows natural processes to occur
Very slight positive	6	Minimal positive impact	Buries and preserves cultural heritage in short-term
Neutral (no impacts)	5	No positive or negative impact	Retreat does not directly disturb tangible cultural items, so there is no negative impact; however, it does not protect so there is no positive impact.
Very slight negative	4	Very slight negative impact, short term	Road works impact result in slight impact to cultural heritage related to construction activities
Slight negative	3	Slight negative impact (usually short term)	Raising road causes minor impact to visual amenity
Medium negative	2	Medium negative impact, medium-term	Building seawall on nesting shorebird habitat
Strong negative	1	Strong negative impact, long-term	New road footprint clearing native vegetation
Very strong negative	0	Very strong irreversible (permanent) negative impact	Seawalls built on nesting shorebird habitat or clearing endangered ecological communities

Financial indicator scoring

The financial considerations criterion of the MCA adopts option cost estimates from the CHRP.

Benefit–cost ratio values from **Table 10** were used to produce a 'normalised' score out of 10 – that is, the highest benefit–cost ratio received the highest score of 10. These are calculated scores and not a subjective assessment. The costs and benefits assessed in the BCR are outlined below.

The costs for each option include:

- all components to deliver the option, including planning and design, environmental approvals, stakeholder engagement, procurement and construction
- retreat planning costs including investigation, planning, decommission and lost asset costs. The timeframe in which these costs are incurred differs for each option.
- ongoing or maintenance costs including beach maintenance (e.g. clean up of debris) and existing seawall maintenance, ongoing sand nourishment costs (if applicable) and ongoing campground operational costs.

The benefits include:

- park recreational value (2018 data) from the NPWS Economic values dashboard, Bundjalung National Park recreational value (DPIE, 2020)
- Woody Bay beach annual natural asset value (Existence, bequest, option to use in the future (EBO) value)
- campground revenue.

Campground lifespan is an estimated measure of the benefit (in years) from the management option. This benefit is assigned a score from 0 to 10 based on the description in **Table 13**.

Table 13 Campground lifespan indicator score

Score	Description
0	Option does not alter lifespan on campground
5	Option has a moderate impact on lifespan
10	Maximum increase in lifespan for selected options

Financial viability refers to the ability of NPWS to pay or fund the option. These scores are based on historical budget allocations and the likely funding to be available. Historically, the NPWS receives modest funding for coastal protection works and this funding reality is reflected in the scores detailed **Table 14**. The lower the funding range of the option, the higher the financial viability score.

Table 14 Financial viability score for funding ranges of management options

Funding range ($m)	Financial viability score – ability to pay/fund option
0–0.89	**10**
0.9–1.9	**8**
2.0–4.9	**5**
5.0–9.9	**3**
10.0 +	**0**

Assumptions

The options were developed using high-level conceptual designs and available information, rather than detailed scoping and data. Assumptions have been made to reflect the high-level nature of the options. Details of the assumptions are detailed in full in Section 5.4 of the CHRP.

Final scores

A total score out of 10 is calculated for each primary criteria by averaging the respective indicators (see **Table 3**). The final overall score for the management option is calculated by adding all 3 primary criteria scores out of 10 to produce an overall score out of 30.

The final score calculation for each option is:

Criterion 1 (x/10) + Criterion 2 (y/10) + Criterion 3 (z/10) = Total (T/30)