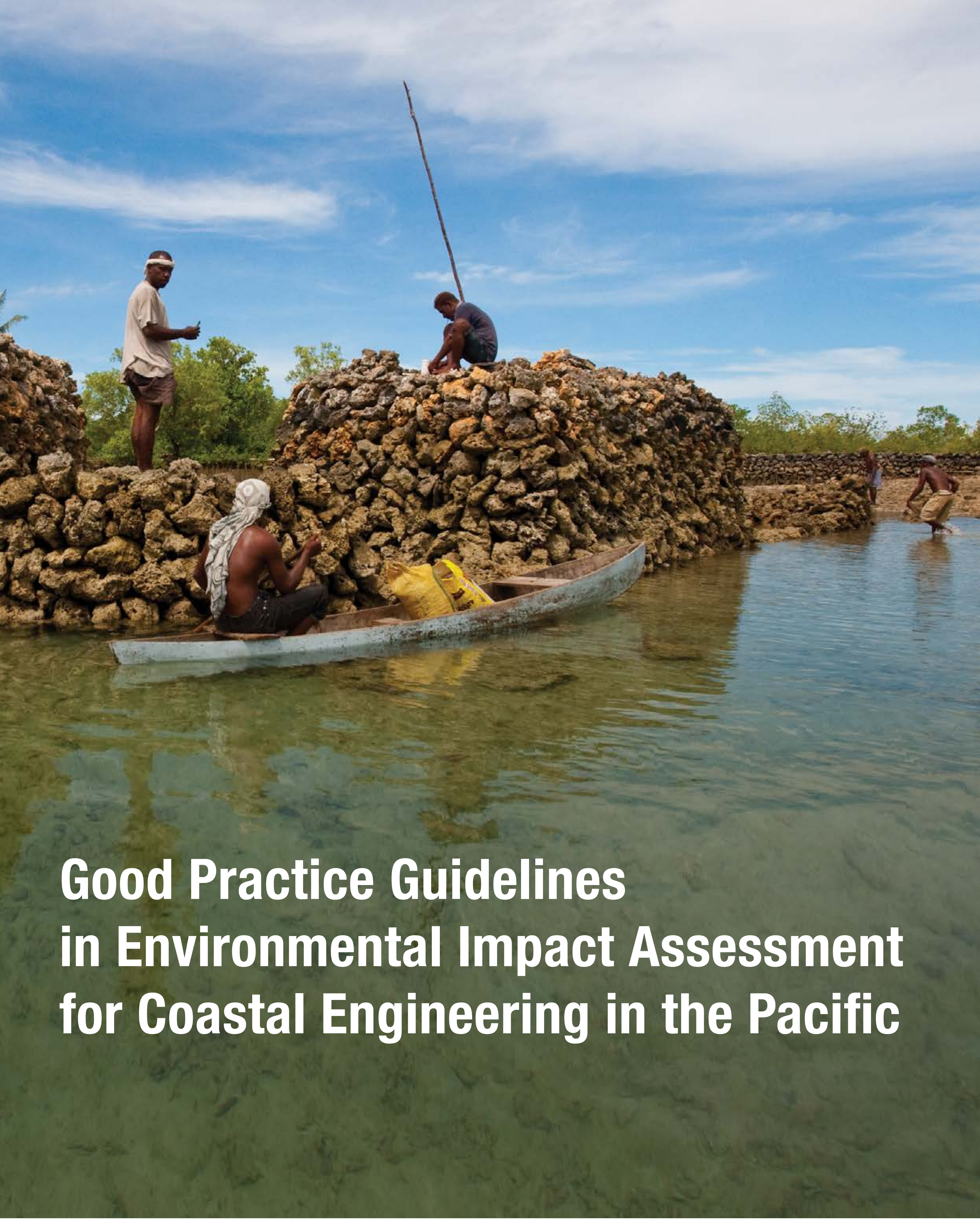

Good Practice Guidelines in Environmental Impact Assessment for Coastal Engineering in the Pacific

SPREP
Secretariat of the Pacific Regional Environment Programme

acp
An initiative of the Organisation of African, Caribbean and Pacific States funded by the European Union

ACP MEAs 3

UN environment programme
50 1972-2022

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This publication provides general guidance on the environmental impact assessment (EIA) process. It is designed to be tested and revised over time based on experiences in Pacific Island countries and territories, and the development and progression of EIA in the region. For specific direction and guidance SPREP member countries should refer to their national legislation and relevant Multilateral Environmental Agreements and/or consult with an EIA specialist.

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Our vision:

A resilient Pacific environment sustaining our livelihoods and natural heritage in harmony with our cultures.

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Acknowledgement

The development and publication of this Guidance Note followed an extensive consultation process involving SPREP staff, SPREP member countries, regional and national experts, and partner agencies, culminating in the approval of the Guidelines by the SPREP Executive Board meeting in 2022. The development – which started in October 2021 and concluded in November 2022 – was spearheaded by the SPREP Environment Monitoring and Governance Programme and was made possible with funding contribution through the EU funded ACPMEA3 project as well as the Australian and New Zealand Governments. A special thank you is expressed to government personnel who assisted with testing and validating sections of the document, and who shared their own EIA knowledge and experiences during EIA training workshops. We sincerely acknowledge the assistance, ideas and input provided by all contributors.

Thank you, Merci, Meitaki Maata, Vinaka Vakalevu, Dhanyewaad, Kalahngan, Kinisou chapur, Māuruuru, Ko rab'a, Kommooltata, Tubwa Kor, Ngā mihi, Fakaue Lahi, Ke kmal mesaul, Fakafetai lahi lele, Fa'afetai lava, Fakafetai lasi, Malo 'Aupito, Tangkiu tumas, Malo tou ofa.

DG Foreword

The Secretariat of the Pacific Regional Environment Programme (SPREP) has a long history of leading and promoting EIA capacity building across Pacific island countries and territories. For more than 30 years, SPREP has supported EIA awareness raising and training programmes in member countries, as well as the publication of EIA guidelines and manuals. As the pace of development and urbanisation intensifies in our islands, the need for effective EIA processes has become more vital.

This Good Practice in Environmental Impact Assessment for Coastal Engineering in the Pacific (Guidance Note) represents a sector specific version of SPREP's regional EIA Guidelines, first published in 1993 and updated in 2016. They deliver on SPREP's Strategic Plan 2017–2026 and other regional frameworks such as the 2050 Strategy for a Blue Pacific Continent. With the challenges presented by climate change (including the increased frequency of extreme weather events, drought, floods, coastal erosion, inundation, salinisation, coral bleaching, changing fish migratory paths, and more) and the vulnerability of Pacific islands, building resilience and adaptation has become a necessity for the survival of communities across the Pacific. Sea level rise remains a reality and a threat to Pacific Island communities. Many projects in the region include elements of coastal engineering from simple seawalls and sand mining to dredging and port construction as well as ecosystem-based adaptation projects for coastal protection. Such projects are necessary and will need to be assessed appropriately.

This Guidance Note aims to assist the implementation of national EIA legal requirements and promote best practice in EIA processes for coastal engineering projects in the Pacific. It complements other forms of SPREP EIA assistance such as the development and review of EIA legislation, delivery of in-country EIA training workshops, and provision of technical advice for different stages of EIA. The Guidance Note will be subject to further revision as EIA thinking and processes advance.

SPREP acknowledges the financial support from the European Union-funded ACP MEAs project delivered through the United Nations Environment Programme (UNEP), and from the Australian and New Zealand Governments. SPREP is also thankful for technical input from partners such as the New Zealand Association for Impact Assessment (NZAIA), Pacific Community (SPC), World Bank, Asian Development Bank and University of the South Pacific. In addition, SPREP member countries are greatly acknowledged, for providing feedback on earlier drafts and sharing local insights during EIA training workshops which informed this Guidance Note.

It is my hope that this Guidance Note will foster stronger and improved EIA practices and complement the ongoing capacity-building efforts of SPREP and partner agencies in the region.

Mr Sefanaia Nawadra
Director General,
SPREP

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Glossary

Area of influence: the area affected by a development project, which is beyond the project footprint. It may be upstream and/or downstream of the project site and include the wider catchment, watershed, coastal/ocean zone, airshed or buffer zones; an off-site resettlement zone; and areas that are culturally significant or used for livelihood activities. The area of influence is determined by a project's resource requirements and the nature and magnitude of its impacts, and it may vary across different development phases of a project.

Baseline: a description of the pre-development or current environmental, economic, social, and cultural conditions of a project's defined area of influence for factors specific to that assessment. In assessing the 'do-nothing' (no development) scenario, an impact assessment should consider how the pre-development baseline would evolve without the project.

Biota: the plant and animal life found in specific regions at specific times.

Climate change: long-term changes in climate conditions, i.e., changes in the mean and/or the variability of a property of climate, such as precipitation, temperature or wind force. These changes persist for an extended period, typically a decade or longer. Climate change can influence and alter the scale, scope, frequency and intensity of disaster risks.

Coastal development: any physical development that occurs in the coastal environment or coastal zone (see below). Entire islands may be in the coastal zone, especially if they are small low-lying or atolls.

Coastal zone: the area from the edge of the upland forest out to the reef edge. Entire islands may be in the coastal zone, especially if they are small low-lying islands and atolls.

Convention on Biological Diversity (or Biodiversity Convention): is a multilateral treaty for the conservation of biological diversity and sustainable use of its components. Signatories to the Convention, which include Pacific island countries and territories along with Australia, France, New Zealand, United Kingdom and the United States of America, are required to implement procedures relating to environmental impact assessment.

Cumulative impacts: changes in the environment resulting from the combined, incremental effects of past, present and future human activities; environmental change (e.g., climate change); and physical events. Physical events can be of natural or human origin and may include extreme weather events and natural or human-induced disasters.

Disaster: severe, adverse disruption to the normal functioning of a community, society or ecosystem due to hazardous events interacting with vulnerable social and/or ecological conditions. Can cause widespread human, material, economic and/or environmental losses.

Ecosystem-based management: an integrated, holistic approach to achieving environmental, social and economic goals across "ridge-to-reef" or "whole-of-island" areas, typically combining land-use and development planning with environmental protection and production needs.

Environment: encompasses natural and biophysical, social (people, culture, health, heritage, amenity) and economic aspects, and the relationships between these different aspects.

Environmental hazard: an event or action that has the potential to cause significant impacts on a community, society or ecosystem. Environmental hazards can be natural (e.g., cyclone, flood, earthquake, tsunami, volcanic eruption, drought, landslide), human-induced (e.g., oil spill) or technological (e.g., infrastructure failure) in origin. They are not impacts (or disasters) in themselves but have the potential to cause them.

Environmental impact assessment (EIA): a process for identifying and managing a development or project's potential impacts on the environment, and the potential impacts of the environment on a development. Refer to SPREP (2016) Strengthening environmental impact assessment: guidelines for Pacific Island countries and territories.

Environmental impact assessment report (EIA report) or environmental impact statement (EIS): the document prepared by or on behalf of the development proponent as part of the EIA process, which details the project type, its timeframe and scale, likely impacts and impact significance, proposed impact mitigation measures (for negative impacts) and optimisation measures (for positive impacts), and monitoring requirements.

Environmental monitoring and management plan (EMMP): a project specific plan that describes all mitigation measures and monitoring and reporting actions to be undertaken by the project proponent. An EMMP should include a schedule and assign responsibility to particular personnel (or roles) for undertaking mitigation measures and monitoring and reporting on a project's environmental performance to regulatory authorities.

Environmental Safeguards Officer: or Specialist, or Environmental Management Officer, are all terms for project specific technical staff engaged by the project proponent and responsible for monitoring and managing the environmental performance of a development. They can be direct employees of the proponent or independent consultants engaged to conduct the work. These officers are not to be confused with government regulator's Environment Officers who have the authority to conduct site audits, change approval conditions and issue infringement notices.

Environmental, social and cultural assets: tangible and intangible assets that are valued and enjoyed by residents and visitors to the Pacific. Examples of 'environmental assets' include areas of particular ecological significance, national parks, community reserves, protected areas, forests, mangroves, seagrass beds, coral reefs, beaches, cliffs, blowholes, rivers, waterfalls, streams, wetlands, freshwater springs, waterholes, as well as plants and animals (especially species that are native, endemic or threatened). Examples of 'social assets' include land and other resources that customary owners have given their approval to share with local community groups and networks, tourists, and local businesses, as well as local knowledge, community facilities, utilities and transport. Examples of 'cultural assets' include cultural heritage sites and environments, physical structures, historical places, cultural knowledge and practices, museums and collections, art and live performances.

Geographic Information Systems (GIS): are used to spatially analyse environmental, social, economic and engineering datasets to help identify development risks, impacts and opportunities, and assess different development options. GIS can produce informative visual materials (e.g., maps) to support stakeholder communication throughout the entire EIA process.

Groyne: a shore protection solid structure built perpendicular to the coast (or river), over the beach to reduce longshore drift and trap sediments.

Hydrodynamic modelling: is the study of fluids in motion. Many forces can be responsible for fluid motion, either acting alone or in combination with each other. In a coastal engineering context, these forces are typically generated by tides, winds and waves, together with topographic gradients and the meeting of bodies of water, such as oceans, rivers and wastewater outlets.

Impact: a negative or positive change as a result of an action, activity or event. Refers to the impact of a project on the environment, as well as the impact of the environment on a project due to an environmental hazard or change. Examples of negative impacts include degradation of ecosystem services, loss of life or injury, property or infrastructure damage, and social unrest. Examples of positive impacts include environmental recovery and restoration, increased food security, property or infrastructure improvements, and increased local job opportunities.

Intertidal zone: is the area where the ocean meets the land between high (MHWS) and low (MLWS) tides. During the tidal cycle this zone is intermittently wet and dry, providing habitat for many marine and coastal foraging organisms. It may consist of mudflats, mangroves, sandy shore, rock platforms, rock pools or combinations of these. The subtidal zone is seawards of the intertidal zone and always covered by seawater.

Mitigation: measures or actions taken by a project proponent to address the impacts identified through the EIA process. Mitigation measures should follow the impact mitigation hierarchy and be detailed in an EMMP.

Mitigation hierarchy: in order of preference, is

- avoid negative impacts;
- minimise negative impacts that cannot be avoided;
- rehabilitate or remedy negative impacts that cannot be minimised; and
- offset (or compensate for) negative impacts that cannot be remedied.

Morphology or geomorphology: refers to the shape of and processes associated with landforms on the surface of the earth.

Morphological modelling: refers to the study of the interaction and adjustment of the seafloor or coastal topography and hydrodynamic processes (or forces), involving the motion of sediment.

Nature-based solutions: learn from and mimic the strategies found in nature to solve human design challenges. They encompass habitat creation (e.g., wetland creation) and translocation (e.g., coral gardens).

Noumea Convention: The Convention for the Protection of Natural Resources and Environment of the South Pacific Region and its Protocols obliges Parties to endeavour to take all appropriate measures to prevent, reduce and control pollution from any source and to ensure sound environmental management and development of natural resources, using the best practicable means at their disposal and in accordance with their capabilities (see also the Convention on Biological Diversity).

Project footprint: the land and/or ocean area occupied by project buildings, facilities, infrastructure or activities.

Proponent: an individual, company or government ministry/department/agency planning to undertake a development or project.

Residual effects: those effects (or impacts) that are predicted to remain once mitigation has been implemented.

Resilience: the ability of a community or system (human and/or natural) to sustain itself, to respond to and recover from extreme events and disturbances, or to use extreme events and disturbances as an opportunity for renewal and positive transformation.

Sensitive receiver: people, organisms or places that have increased sensitivity or exposure to emissions or contaminants due to their age and health (schools and hospitals), status (endangered species), proximity to the contamination source or the area they inhabit (endangered habitat and significant cultural sites).

Stakeholder: any person, organisation, institution or business who has interests in, or is affected by, a development or project issue or activity, including local community members and customary land/resource owners.

Strategic environmental assessment: a higher-level assessment process that can be used to: (1) prepare a strategic development or resource use plan for a defined land and/or ocean area, (2) examine the potential environmental impacts associated with the implementation of government policies, plans and programmes, (3) produce general environmental management policies or design guidelines for different classes/types of development. See SPREP (2020) Strategic Environmental Assessment: Guidelines for PICT.

Sustainable development: is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It has three interdependent and mutually reinforcing pillars - economic development, social development, and environmental protection.

Vulnerability: the sensitivity of a development, human community or ecosystem to damage and loss resulting from a hazardous event or disturbance.

Abbreviations

ADB	Asian Development Bank
ADCP	acoustic Doppler current profiler
CBD	Convention on Biological Diversity
CLO	community liaison officer
dB	decibels
EIA	environmental impact assessment
EIS	environmental impact statement
EMMP	environmental monitoring and management plan
ERP	emergency response plan
FRDP	Framework for Resilient Development in the Pacific 2017–2030
GIS	geographic information system
GRM	grievance redress mechanism
HIV/AIDS	human immunodeficiency virus/acquired immunodeficiency syndrome
IUCN	International Union for Nature Conservation
LiDAR	light detection and ranging remote sensing system
MEA	multilateral environmental agreement
MCA	multi criteria analysis
MHWS	mean high water spring tides
MLWS	mean low water spring tides
MSL	mean sea level
NGOs	non-governmental organisations
PPE	protective personal equipment
RMI	Republic of Marshall Islands
ROV	remotely operated vehicles
SDG	United Nations Sustainable Development Goals
SEA	strategic environmental assessment
SIA	social impact assessment
SIDS	small island developing states
SPREP	Secretariat of the Pacific Regional Environment Programme
SSC	suspended sediment concentration
STI	sexually transmitted infection
ToR	terms of reference
TSS	total suspended solids
UXO	unexploded ordnance (typically associated with World War II)

1 Introduction

1.1 Guidance on EIA

Environmental impact assessment (EIA) is a process that is used to assess and manage individual development projects. It aims to maximise positive benefits and minimise negative impacts for local communities and their environment. Stakeholder engagement and local knowledge is fundamental to good EIA. When implemented correctly, EIA can help to support the achievement of green growth targets, climate change resilience, and the United Nations Sustainable Development Goals (SDGs)[1].

The SPREP Strategic Plan 2017-2026 recognises that the people and environment of the Pacific benefit from commitment to and best practice in environmental governance. Good environmental governance is supported by regulation and a structured process for the environmental assessment of development, as well as the mitigation of adverse effects, monitoring and appropriate environmental management. Each one is dependent on the other and benefits from thorough but straightforward guidance.

The Strengthening environmental impact assessment: guidelines for Pacific Island countries and territories (SPREP 2016), Environmental impact assessment: guidelines for coastal tourism development in Pacific Island countries and territories (SPREP 2018) and Strategic environmental assessment: guidelines for Pacific Island countries and territories (SPREP 2020), have facilitated improvements in EIA processes, its management and awareness. They have built capacity in environmental assessment, but the broad descriptions provided are limited regarding the specific assessment of coastal development and adaptation projects, and in the design of associated mitigation and management measures. With the challenges presented by climate change (including the increased frequency of extreme weather events, drought, floods, coastal erosion and inundation, salinisation, coral bleaching, changing fish migratory paths, and more) and the vulnerability of Pacific island countries and territories to global economic fluctuations and the accumulation of waste in the oceans, such projects will only become more important and need to be assessed appropriately.

SPREP (2016) provides guidance on the general EIA process (Figure 1) by:

- Emphasising the importance of assessing the potential impacts of development on the environment and the potential impacts of the environment on development, especially impacts related to climate change and disasters.
- Emphasising the importance of effective stakeholder engagement throughout the EIA process.
- Emphasising the importance of designing suitable mitigation measures informed and tailored by the EIA process.
- Providing a clear overview of the process and a set of toolkits that includes templates and checklists for EIA screening, scoping, reporting, environmental monitoring and management planning, review and risk assessment.
- Providing information on the type of baseline studies that are required to support certain investigations and the forms of assessment that are appropriate (or can be applied, for example, where there is a lack of resources) in different circumstances.
- Introducing the concept of strategic environmental assessment (SEA), an approach that provides context for EIA by identifying what forms of development are environmentally sound and appropriate; pinpointing locations where developments are/are not permissible; stipulating desired types and characteristics of developments; and identifying broad environmental management measures that are advocated at a wider scale than project-specific EIA.
- Setting out considerations and recommendations for effective EIA in the Pacific.
- Providing guidance to Pacific island countries should they wish to develop their own national EIA guidelines.
- Linking the EIA process to multilateral environmental agreements (MEAs).

1 THE 17 GOALS | Sustainable Development (un.org)

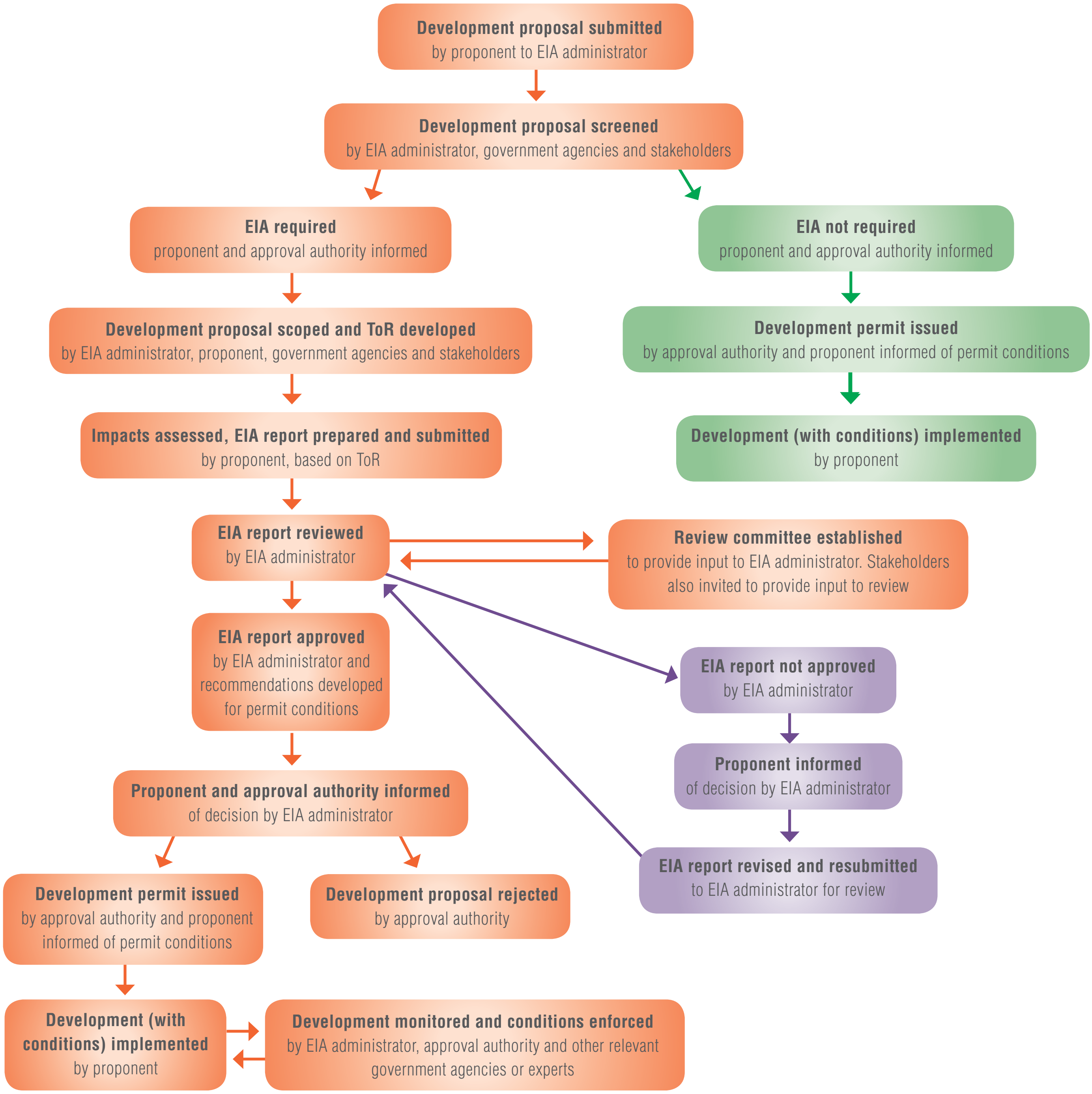


Figure 1: EIA process (SPREP 2016)

The general approach to impact assessment advocated is consistent across the SPREP guidance documents (including this document) and the SPREP core priority areas – of climate change resilience, island and ocean ecosystems, effective waste management and pollution control, and environmental governance – are evident.

Tip – EIA in the Pacific

All Pacific island countries now have legislation in place that provides substantive provisions for EIA application. However, due to constant advances in technology and new development types, countries continually need to improve their use of the tool, particularly in terms of the need to assess and address the social impacts of development and the impacts a changing environment may have on development. This is often complicated by gaps in staffing numbers and experience, and financial and technical resource constraints within governments and their agencies. Hence, the value of the SPREP Environmental Assessment Guidelines.

But note that EIA requirements can change based on traditional governance structures and should always be checked at both a national and island/island group level. For example, the Cook Islands Environment Act 2003 does not apply on the remote island of Nassau (or on two other Cook Islands) because the island has a traditional leader in place, with a higher status than the Government, and is governed by traditional rule. Hence the EIA undertaken for their Harbour improvement took the form of an 'Environment Report' (not an EIA under the 2003 Act).

A coastal road in American Samoa. Credit: SPTO & Jonathan Irish

1.2 This Guidance Note

1.2.1 Background

Across the Pacific, SPREP has been promoting the use of EIA, delivering EIA capacity-building and advancing global practice relating to environmental assessment for more than 25 years. While the SPREP (2016) and SPREP (2018) Environmental Assessment Guidelines provide a detailed overview of EIA and offer practical tips and tools to support government officers managing the EIA process, they do not provide practical details on how to assess and mitigate impacts from specific developments, including the many projects in the Pacific that entail coastal engineering.

Coastal environments in the Pacific are ecologically diverse, and in many instances cover entire islands from the reef to the ridgetop, with natural processes interacting across these zones. Coastal zones are integral to island life supporting a variety of livelihoods and cultural practices. In addition, coastal zones provide critical defences against weather events like storms, cyclones, flooding and erosion. SPREP recognises the importance of EIA for responsible planning and management of coastal development, to help ensure that the development does not degrade these vital coastal areas, and that coastal development makes a positive impact to Pacific island countries and territories.

Given this, SPREP determined that guidance on good practice in EIA – scoping, data collection, impact assessment, mitigation, and monitoring and management – for coastal development, adaptation and engineering projects would be valuable and this Guidance Note was born in line with Objective 4.1 of SPREP's Strategic Plan 2017–2026[2]. It is an addendum to the existing strengthening EIA guidelines (SPREP 2016) and a companion document to the EIA guidance for coastal tourism development (SPREP 2018) and SEA guidelines (SPREP 2020). This Guidance Note does not alter the established EIA process (shown in Figure 1), rather it builds upon it, with a specific coastal engineering, adaptation, and management focus. It provides specific examples, approaches and mitigation measures relevant to the coastal environment. The guidance provided herein is designed to support Pacific island governments in meeting their obligations to undertake, require and review EIAs for coastal development, in line with relevant MEAs, including the Noumea Convention and Convention on Biological Diversity.

2 To "Strengthen national sustainable development planning and implementation systems including through use of Environmental Impact Assessments, Strategic Environmental Assessments, and spatial planning".

1.2.2 Aims and Targets

The aims of this Guidance Note are to:

1. Complement and build upon the existing SPREP Environmental Assessment Guidelines (SPREP 2016, SPREP 2018 and SPREP 2020).
2. Increase awareness and understanding of the EIA process in the Pacific.
3. Promote good practice in EIA for coastal engineering projects.
4. Encourage government agencies and project proponents to comply with national EIA regulatory frameworks and, in the absence of these, to follow regional EIA guidance.
5. Support sustainable and resilient coastal development that protects environmental, social and cultural assets.

This Guidance Note, alongside the other SPREP Environmental Assessment Guidelines, are intended for:

- Government officers who are responsible for managing or providing input into the EIA process.
- SPREP members.
- Marine businesses and operators, both small and large.
- National marine and coastal development associations.
- Customary and private land and resource owners.
- Members of civil society organisations and local community groups who have an interest in coastal development and EIA.

2 Coastal Systems and Engineering

2.1 Coastal Systems

Coastal areas, or systems, are among the most dynamic parts of the earth's surface. The land and the sea rarely meet at a constant boundary. The shoreline migrates daily with the tide, changes seasonally, and varies over longer timescales as the coast and seabed erodes or accretes, or as sea level changes. Coastal landforms are shaped and reshaped by winds, waves and currents, which in turn vary through time. The coast is the interface between the energy of the sea and the resistance of the land (John, Brew and Cottle 2017). While there are rocky cliffs that will take the full force of a storm without apparently suffering much damage, in most places the energy is absorbed by a beach and/or a reef. Sandbars, spits and even reefs can be moved, damaged, or created by extreme events. Rapid changes to coastlines after extreme events such as tsunamis, cyclones or even flooding and king tides can be dramatic and long lasting. These changes to the coastline and coastal processes can have severe impacts to existing habitats, businesses and those residing in the coastal zones.

Coastal systems take many forms, including wide beach backed by dunes, narrow beaches or barrier beaches behind which coastal wetlands and marshes can accumulate. Muddy shorelines are common along the banks of estuaries and sheltered tidal embayments, which may also be characterised by seagrass meadows. Left alone, coastal systems will change over time, often seasonally, with beaches and sand bars either building out where sediment accumulates or moving landward as sediment moves offshore or along the shore. All these systems depend on a supply of sediment, which can be interrupted by activities such as coastal protection works and dredging.

Figure 2 shows an idealised high elevation Pacific island, with a typical coastal system and ecosystem features; including coastal lowland vegetation, the beach or coastal strand, tidal pools, coastal wetlands, an estuary, seagrass and mudflats, a coastal lagoon, deep water channels and coral reefs. As set out above, these coastal environments are productive and diverse. More than 80% of Pacific islanders live in or near coastal areas and draw from them for their livelihood and lifestyles (Marto, Papageorgiou and Klyuev 2017). There is a very high degree of economic and cultural dependence on the natural environment. Coral reefs, for example, support approximately 25% of all marine life, including over 4,000 species of fish, by providing valuable spawning, nursery, refuge and feeding areas for large varieties of organisms (SPREP 2009). They also play vital roles as natural breakwaters, minimising wave impacts, flooding and erosion, during storms, cyclones and tsunamis.

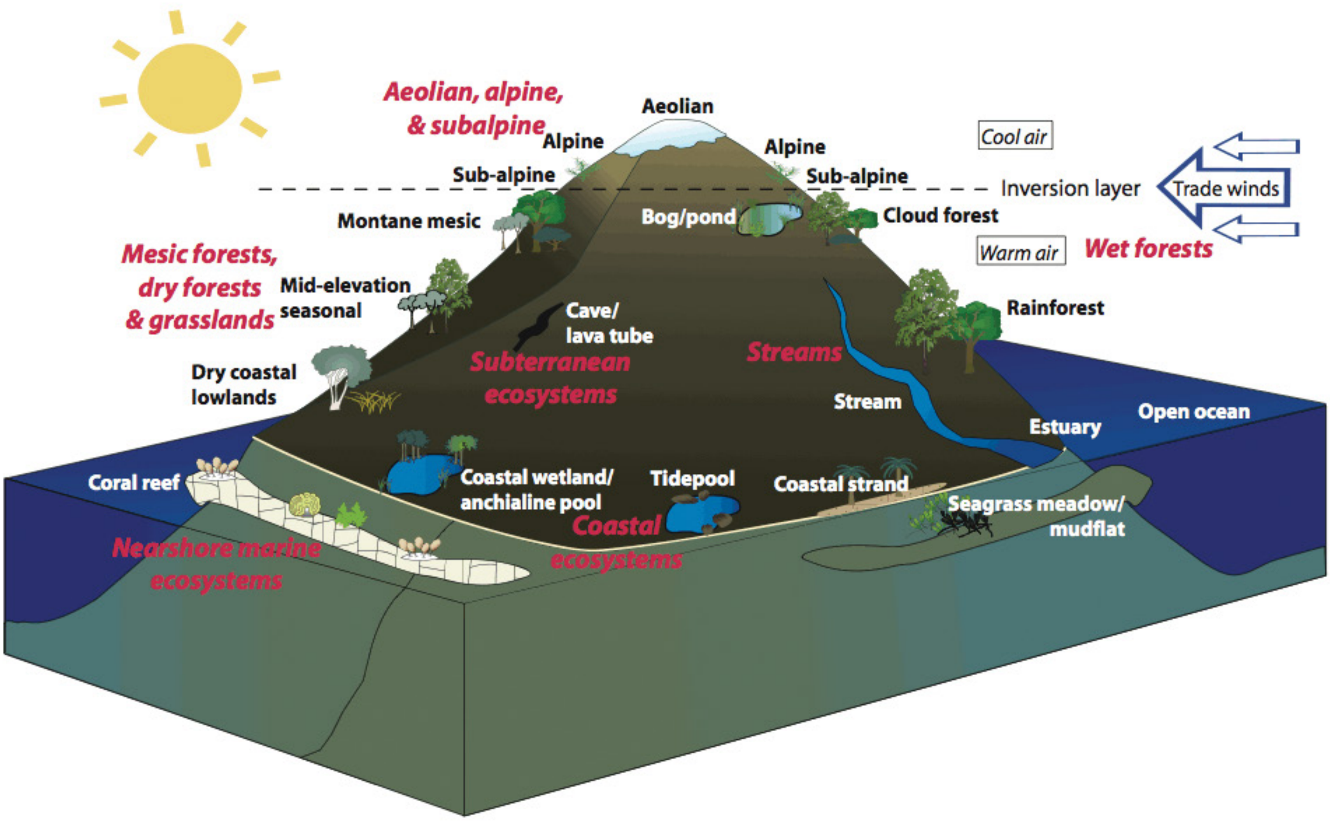


Figure 2: Idealised high elevation Pacific island showing a typical coastal system and ecosystem zonation based on the Pacific Island Network's six key ecosystem groups (Stephens and Daniel 2006).

The variety of processes, landforms, geology and substrates that characterise coastal systems, along with the influence of humans, create a wide range of complex ecosystems that provide highly valued environments. This value has led to the coast being subjected to many different pressures and, consequently, its management is often complex due to the need to balance potentially conflicting requirements, such as meeting the demands for access to other islands and resources (including education and health care), of tourism and development, to protect vulnerable assets from flooding and erosion, and to protect important cultural, physical (geomorphological) and ecological systems. These challenges are enhanced in the Pacific due to the small size of many islands and their remoteness.

An additional and pressing issue facing coastal areas is climate change. For the period 2011 to 2100, the Pacific Climate Change Science Program of Australia projections (Australian Bureau of Meteorology and CSIRO 2011) indicate that the following are projected to continually increase:

- Surface air temperatures and sea temperatures.
- Annual and seasonal mean rainfall.
- The intensity and frequency of extreme heat days and rainfall days.
- Ocean acidification.
- Mean sea level.
- Coral bleaching.

By contrast, in the south-east Pacific Ocean basin (towards South America), the frequency of tropical cyclones and incidents of drought may decrease.

Sea level rise is a factor which is becoming increasingly more relevant to the assessment of coastal engineering projects in the Pacific and there is a lack of design standards related to sea level rise in the region. This can lead to the inconsistent application of sea level rise predictions across different projects and, in turn, over or under designed infrastructure. The recently published Guidance for managing sea level rise infrastructure risk in Pacific Island countries (Pacific Region Infrastructure Facility 2022) provides advice that allows adaptive strategies to be included in the design of infrastructure and coastal engineering projects that will allow for development to respond to changing levels of sea level rise.

Coastal engineering projects need to take account of climate change predictions, and be informed by EIA, to determine their suitability (which will be location specific) and reduce any adverse effects. This will require information on the existing physical (geology, morphology, and hydrology), ecological (terrestrial and marine) and human (societal and cultural) environment and modelling, or other forms of prediction, of the consequences of the works. This Guidance Note will assist readers in determining what types of studies are likely to be required to support EIA for the types of projects described below, as well as the impacts that could arise and the mitigation measures that may be appropriate.

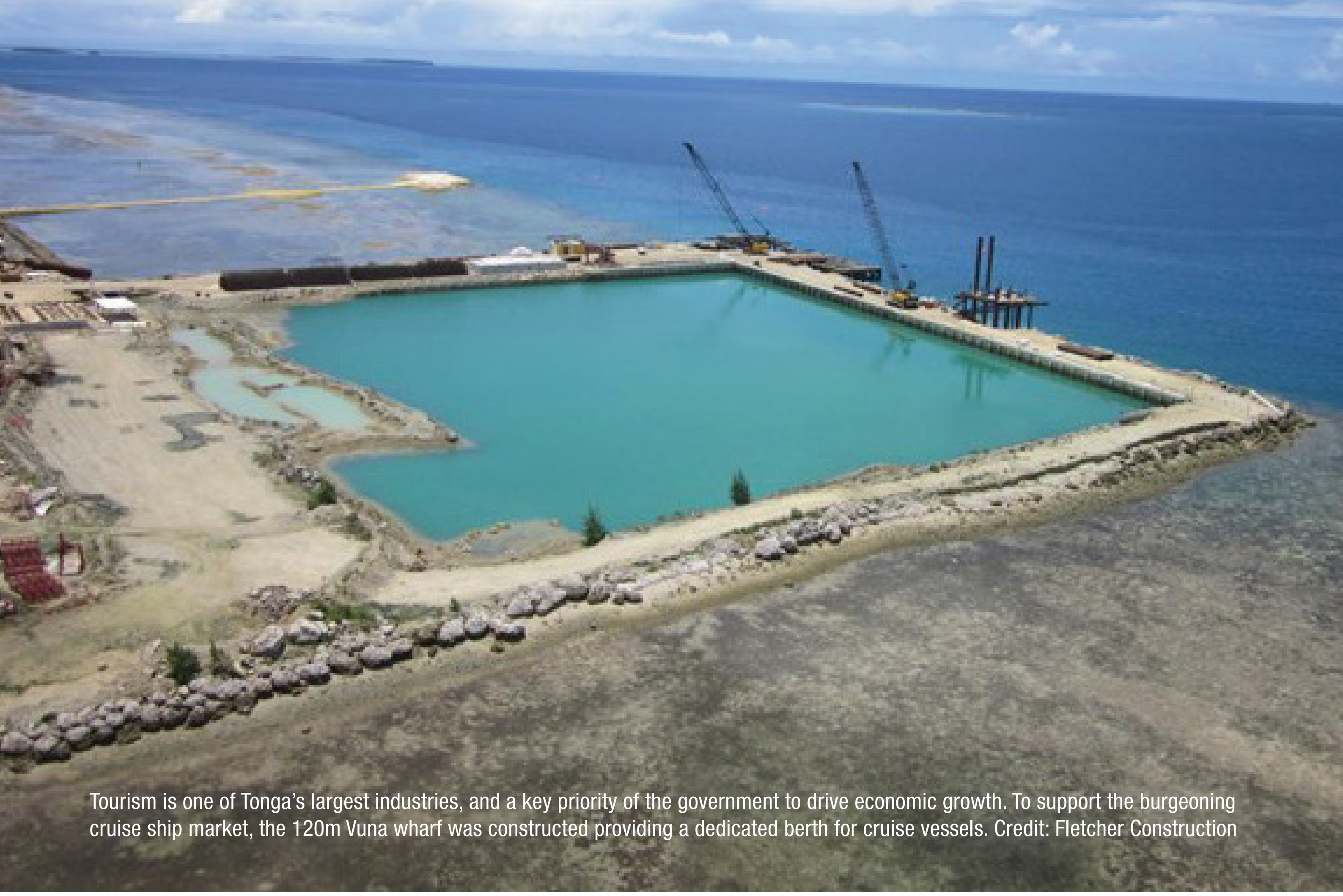
2.2 Coastal Engineering Projects

For ease, 'coastal engineering' is used herein as a catch all for coastal engineering, coastal management, and coastal adaptation projects. Coastal engineering involves the planning, design, construction and maintenance of works aimed at protecting or adapting shorelines, reclaiming land from the sea, countering subsidence, facilitating navigation and providing marine facilities, and ecosystem enhancement and restoration. Broad categories of coastal engineering activities and projects typical of the Pacific region are described below. However, this is not a complete list of all possible project types. Given the ever-evolving nature of development and industry it is possible that new types of developments may emerge in the future, but this document should still support the reader in identifying appropriate studies to assess these new development types and impact mitigation measures.

2.2.1 Dredging and excavation

Dredging typically involves removing sediment (sand, silt and mud) from below water to create the required depth for the safe navigation of vessels or to collect material (e.g., sand) as a resource. Excavation typically involves removing rock or coral platforms to achieve the required depth for safe navigation or to enable the construction of a jetty or harbour. Dredging and excavation are a common part of coastal development projects in the Pacific due to the communities' reliance on marine transport and the requirement to provide access for vessels to land though coralline platforms and table reefs.

Dredging projects are often coupled with land reclamation projects because they provide a cheap, accessible source of land raising material (which can provide real benefit in low lying areas). Hence, they provide strong benefits associated with safe access to marine transport and construction material. In doing so, however, they remove part of the marine environment (often the reef platform) and can cause siltation without good management (see Example below). By contrast, the impact of mining beach sand for construction purposes on Pacific islands has significantly affected coastal processes and their coastal environments. Consequently, in most Pacific island countries and territories, the removal of beach gravel and sand is now restricted. In Tuvalu, the Foreshore and Land Reclamation Act 2008 states that no person shall remove from the foreshore any sand, gravel, reef mud, coral or other like substances without having first obtained a license for that purpose from the Kaupule in whose area of authority such foreshore lies, and licenses will only be provided for personal use (e.g., house building).



Tourism is one of Tonga's largest industries, and a key priority of the government to drive economic growth. To support the burgeoning cruise ship market, the 120m Vuna wharf was constructed providing a dedicated berth for cruise vessels. Credit: Fletcher Construction

Good Practice Example – Small Boat Harbour, Nui

Dredging associated with the construction of a small boat harbour in Nui, Tuvalu (to be constructed between 2022-24), will include the removal of sand and rock from the bottom of the channel and the removal of solid coralline rock from the side walls, to create a turning basin within the reef platform. The proposed channel has been aligned to maximise its overlay with the existing channel to minimise the dredging requirements of the project and reduce its environmental impact.

The length of the existing channel will not change but the last 300m from the mouth will be enlarged to be a minimum of 20m and up to 40m wide in the turning basin and at its mouth to allow for safer access for small passenger vessels/work boats.

The channel will be dredged to a maximum depth of -3.30m below mean sea level (MSL) at its mouth, with two steps up to a level of -2.5m below MSL in the turning basin. These depths have been determined based on the tidal variation within the channel to ensure there is sufficient under keel clearance for the workboats at mean low water spring tides (MLWS).

The dredging will be carried out by 40- or 50-ton excavators using a hydraulic rock breaker and bucket attachments for the removal of the reef material, rather than the use of a grinder/suction head due to the marginal economics of mobilising such equipment for a remote island. Dredging from the reef platform would be limited to low tidal conditions, which would limit the plume, whereas dredging from a floating barge could occur for longer periods.

2.2.2 Reclamation

Reclamation can involve raising the seabed or intertidal zone below the high-water mark above the high-water mark (i.e., claiming land from the sea) by depositing solid material that creates land on top of previously marine or coastal environment. The placement of such material typically needs to be contained by piled walls, rock armour or rock baskets/bags. Many Pacific islands are constrained by lack of available land, meaning that reclamation is often viewed as an option to alleviate this.

It can also be undertaken inland in swamps, wetlands or riverine areas to provide more agricultural land or land for housing. The latter is often undertaken by individuals or private developers and, while providing more productive land, can enhance flooding risks to both the reclaimed and adjacent areas (by restricting the extent and function of the flood plain) if it is not properly planned and assessed.

In addition, reclamation - or more accurately land raising - may be undertaken as an adaptation response to sea level rise (as an alternative to or in conjunction with seawalls). This has occurred in the Solomon Islands (Honiara), Kiribati (Tarawa), Tuvalu (Funafuti), Fiji and Samoa. The Temaiku land and urban development project in South Tarawa, Kiribati (see Figure 3) aimed to provide protection from inundation by raising approximately 330ha of land, 2m above the highest measured sea level. Due to its scale, this project is high risk and involved extensive stakeholder consultation, engineering design, ecological assessment and social impact assessment (Jacobs 2018). A project of this scale and complexity has never been attempted in the Pacific islands and would come with many challenges ranging from but not limited to engineering, social impacts, resource limitations and access.

Figure 3: Concept image, Temaiku Land and Urban Development, Kiribati (Jacobs 2018)

2.2.3 Port or harbour

A port or harbour is an essential node in a supply chain. Most Pacific island countries or territories have one major port that serves as its international hub for imports and exports and is of critical importance, representing a vital link to other regions. Many other islands have harbours (via which larger vessels can access the shore) from which people, goods and services are transhipped between islands. This includes the movement of people for essential health care, education, and social and cultural events. Some islands have neither but instead have jetties or boat ramps that provide access to smaller work boats (discussed below). Ports and harbours typically include fully enclosed (walled), reclaimed areas and piled structures. Both harbours and jetties are also often referred to generically as 'wharfs' (and ports and harbours typically include wharfs).

While ports and harbours provide critical access to goods and services, they will result in the loss of some natural habitat, can disrupt sediment transport and be focal points for waste entering the sea and the transfer of invasive species.

2.2.4 Jetty or boat ramp

By contrast to a port or harbour, jetties and boat ramps are smaller structures suited to smaller vessels that are typically used in locations where access to deep water is limited and the cost of constructing and maintaining a harbour is not warranted. These structures are often used to load work boats or barges to transfer goods to or from larger vessels moored offshore. They also provide local access to transport and for subsistence fishing and recreation. Many Pacific islands have piled jetties leading to deeper water, but many others simply have boat ramps (which may be concrete structures or flexi mats pinned to the seabed), and some only have beach landing points.

Jetties and boat ramps also provide critical access to goods and services, and can cause habitat loss and the disruption of sediment transport, but this tends to be on a much smaller scale than ports and harbours.


Apia harbour. Credit: Stuart Chape

Point of Interest – Maritime Infrastructure in Tonga

Due to Tonga's relative isolation, spatial dispersion over a large area of the South Pacific and dependence on imports, international, regional and internal transport links are crucial. But in 2021 28% of its islands either had no wharfs or wharfs with significant damage that cannot be used; 22% of its islands had wharfs that are significantly damaged but still functional (although not safe); and 22% of its islands had wharfs that have moderate damage, which impacts their function (ADB 2021). In 2022 the region suffered additional, as yet unquantified, damage to its maritime infrastructure as a result of a volcanic eruption and subsequent tsunami. Significant investment in wharf and jetty infrastructure is required but presents Tonga with the opportunity to build back better through appropriate planning and assessment.

2.2.5 Breakwater

A breakwater is a coastal structure (usually a rock and rubble mound structure) typically projecting from land into the sea that, when designed correctly, can shelter vessels and the shoreline from waves and currents, and prevent siltation of navigation channels. Such breakwaters are often associated with marine facilities such as harbours or jetties, where they provide protection against wave attack. Offshore breakwaters (detached from the shore) can also provide shoreline protection (see Figure 4). If they are not well designed, however, they can deflect wave energy to adjacent areas, potentially increasing rates of erosion and/or siltation, leading to the need for remedial work.

2.2.6 Seawalls, groynes and other erosion protection measures

Hard structures are frequently constructed in an attempt to prevent erosion of coastal landscapes and infrastructure and mitigate the risks to populations and economic activities. Coastal structures are most often built using materials that do not usually form naturally, such as concrete, large armour stone, steel (steel baskets and rock), or timber. They are designed to be relatively permanent (typically with a 50-year design life) and are spatially fixed within an otherwise dynamic coastal zone; the consequence of which will often be the loss of the beach over time.

Figure 4 shows a range of options for coastal protection from softer, living shorelines to harder structures. However, it is not comprehensive and other options, such as groynes and artificial reefs (or reef restoration), are available and discussed below.

Seawalls are onshore structures with the principal function of preventing erosion or alleviating overtopping and flooding of the land and the structures behind due to storm surges and waves. Seawalls are built parallel to the shoreline as reinforcement. Quite often, seawalls are used to protect roads, houses, commercial areas and vulnerable infrastructure seaward of the natural beach profile. They are also regularly used at larger ports to protect onshore dock warehouse facilities and stabilise the seaward edge of reclaimed land. Seawalls range from vertical face structures (such as gravity concrete walls, tied walls using steel or concrete piling, and stone-filled cribwork) to sloping structures with typical surfaces being reinforced concrete slabs, concrete armour units, stone rubble or 'sandcrete' (a form of concrete). That is, they often introduce foreign material to the beach and remove existing habitats. In some cases, they can be buried (or planted) and take the form of backstop walls.

Throughout the Pacific there are varying scales of seawalls ranging from ad-hoc structures protecting local areas, to engineered rock or sandbag walls, through to large coastal protection works and associated infilling designed to protect or reclaim large areas (see Figure 4). In Aonobuaka, Kiribati, a technique has been adopted, called te buibui, which involves the construction of a structure from local materials, including branches, palm fronds and coconut fibre string (Figure 5). The structure is placed parallel to the beach where the erosion is occurring. The structure then dissipates wave energy and captures sediment, which halts erosion and can allow beaches and dunes to re-establish. This type of protection has a lower risk because its scale is small and it uses natural construction materials (SPREP 2015). However, it is less effective in providing protection from storm events (which can remove any trapped sand) and will not provide protection against sea level rise.

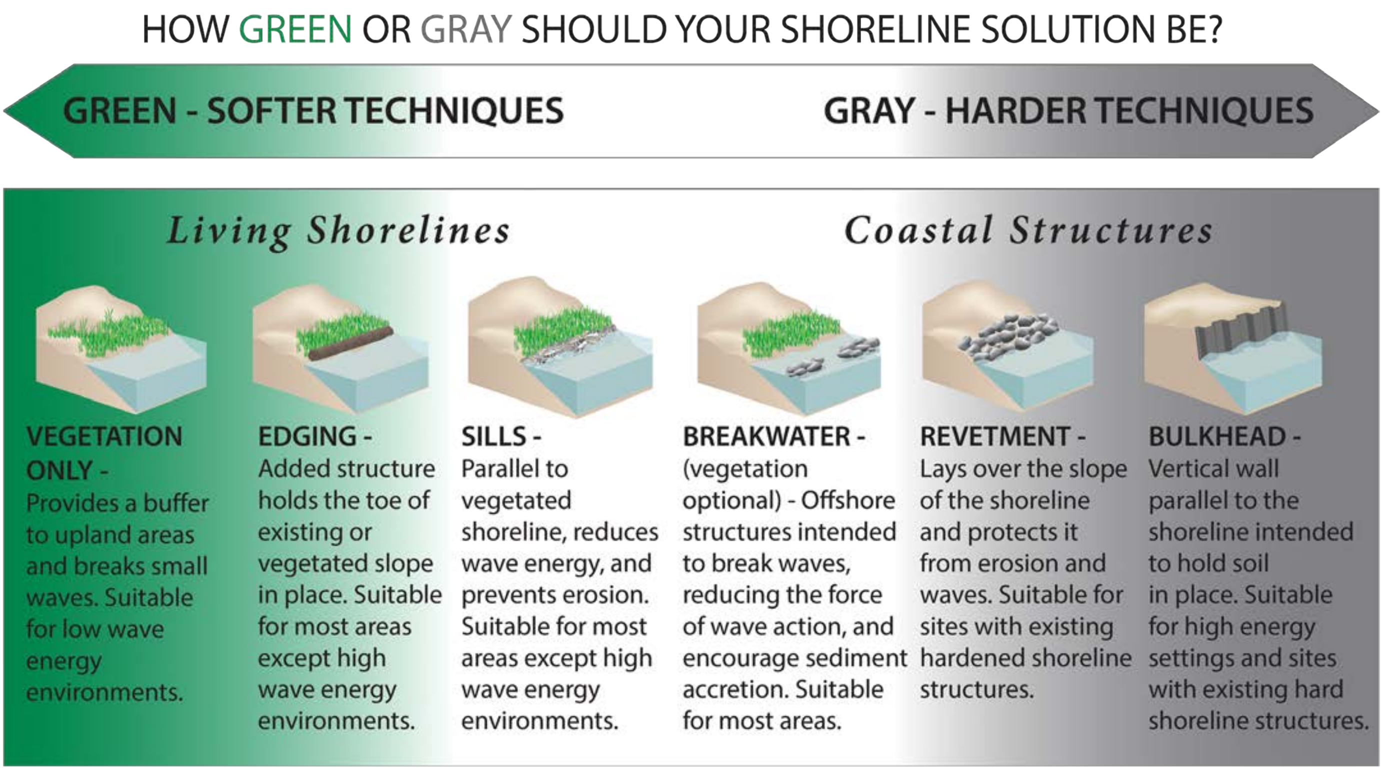


Figure 4: Green ('soft') and Gray ('hard') coast protection options (MfE 2017)

Figure 5: Te buibui structure in Abaiang, Kiribati (SPREP 2015)

Alternatively semi-permanent engineered seawalls, such as the seawall in Tarawa, Kiribati shown in Figure 6, are common. While these seawalls provide good protection from erosion to the location they protect, they can cause erosion in areas adjacent to the seawall, so-called ‘end effects’ (SPREP 2015).

Figure 6: A hard seawall in Tarawa, Kiribati (SPREP 2015)

Groynes are typically narrow structures built perpendicular to the shore (as in Figure 7) to stabilise a stretch of beach against erosion due to a net longshore loss of beach material (i.e., the movement of sediment along, up or down, the shoreline). Groynes work only when longshore transport occurs. The effect of a single groyne is the build-up of sand on the side from which the sediment is moving (up current) and erosion on the down current side; both effects can extend some distance from the structure. Hence, as for seawalls, groynes can assist in beach building where they are placed but will limit the amount of sand able to reach areas beyond them, and this can result in erosion.

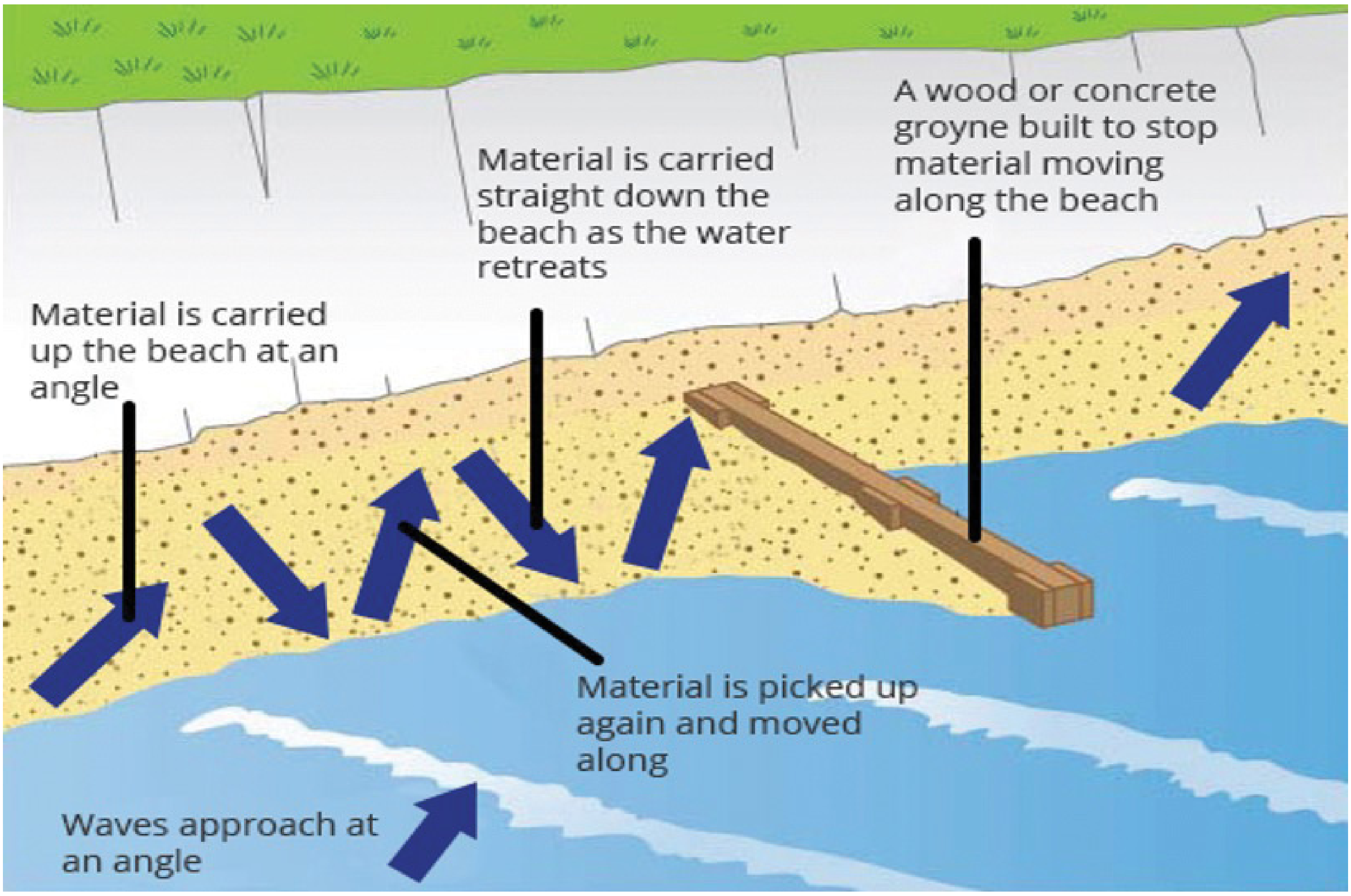


Figure 7: Illustration of the effects of groynes on beaches (Welsh Joint Education Committee 2018)

Offshore breakwaters are often small, relatively short, breakwaters that are not attached to the shore, with the principal function of reducing wave energy and beach erosion. They are built parallel to the shore just seaward of the shoreline in shallow water depths, using solid concrete structures, piles of stone/concrete blocks, or rubble mounds. Multiple detached breakwaters spaced along the shoreline can provide protection to substantial shoreline frontages. However, again, they cause the loss of natural habitats in their footprint and can restrict sediment movement onshore.

Soft engineering includes engineering approaches to set back and stabilise dunes and planting in a geotextile matrix or similar (see Figure 8); and focusses on retaining natural defences (through dune management, maintenance of sediment supply, maintaining healthy foreshore vegetation and wetlands, managing access and so on). This approach may involve buried seawalls, which are covered with sand or soils and planted, to resemble a natural dune system.

Figure 8: Geotextile matrix used for slope stabilisation (Source: https://www.okorder.com/p/hdpe-geocell-with-ce-certificate-for-road-construction_1031785.html)

2.2.7 Beach Nourishment

Beach nourishment, or beach filling, is the practice of adding sand or sediment to beaches to combat erosion and increase beach width. Often referred to as a "soft armouring" technique, it is viewed as a superior alternative to hard armouring, as long as the supply of sediment can be maintained. With sea level rise and storms threatening to erode sandy beaches, it is likely that nourishment will become more prevalent, especially in those locations where the existence of a sandy beach is a financial resource (e.g., at beach resorts). However, this approach will be limited in the Pacific by the availability (or lack of availability) of sand. Beach nourishment would require the import of fill or sand mining from the subtidal area. Both of which present challenges relating to managing the impacts on the area being nourished and the area being mined. Any such works would need to comply with relevant national and local legislation and follow a robust EIA process, to ensure that the nourishment is undertaken sustainably.

Beach nourishment should only be undertaken where the coastal processes are such that the placed sand is likely to remain in place for a reasonable length of time. This will require a good understanding of hydrodynamic processes that characterise the site.

2.2.8 Nature-based solutions

In the context of coastal engineering projects in the Pacific, nature-based solutions can take the form of constructed wetlands, seagrass restoration, coral gardens, reef restoration, artificial reefs and planted mangrove forests. These projects can be undertaken as standalone projects or undertaken in conjunction with other measures or works to increase the potential benefits (i.e., coral planting in conjunction with an artificial reef or offshore breakwater).

Natural wetlands and seagrass beds support significant biodiversity and particularly fish, which are often impacted by coastal developments. Constructed wetlands are frequently designed to restore natural wetland habitats and ecosystems but can serve other purposes, often related to water or sewage filtration and treatment (as alternatives to more industrial processes).

Coral gardening is a method of growing translocated coral polyps to help restore reefs. Sometimes called coral farming, this gardening method involves taking small coral fragments or "cuttings" and growing them in safe locations (coral nurseries) until they are large enough to be transplanted either back to restore damaged areas or into new areas to expand existing reefs. Coral nurseries can be ocean based, where the coral pieces are attached to steel structures, or use aquaculture style facilities to cultivate corals in tanks. Coral nurseries require regular monitoring and maintenance to ensure corals are not succumbing to disease and to identify the most suitable varieties for transplanting (Shaver et al. 2020).

An artificial reef is a human-made underwater structure that closely approaches or extends above the surface of the water. These reefs provide excellent habitats for marine life and are often built specifically for this purpose. In addition, reefs can protect nearby beaches from erosion.

If such measures are proposed as part of a mitigation strategy for a coastal engineering project, they must be supported by a long-term management programme and expert knowledge from specialists such as coastal engineers, hydrodynamic modellers, ecologists (coral specialists) and geotechnical engineers.

The Seagrass Restoration Guidelines for Kiribati (SPREP 2020) discuss the methods for such works. However, whether the proposal involves restoring seagrass beds, mangrove forests or wetlands, the considerations are similar. In brief, the proponent should consider:

- Site selection and habitat suitability - environmental conditions suited to the growth of the selected species.
- If there are suitable donor sites to populate the restoration area.
- Community participation - using local knowledge of the species and what is needed for it to thrive.
- Scale - larger areas are more likely to succeed than small areas.
- Is it feasible to attempt the restoration?

As a step on from nature-based solutions, ecosystem-based management is an integrated 'ridge-to-reef' or 'whole of island' approach for achieving environmental, social and economic goals. It aims to combine land use and development planning with environmental protection and production needs. An ecosystem-based management approach could be particularly useful for guiding coastal development in the Pacific islands because it recognises the physical and biological linkages between land and sea, encourages the use of scientific knowledge in combination with traditional and local knowledge, promotes coordination across all government and non-government agencies who manage different aspects of the coastal zone, and encourages the use of participatory approaches with local stakeholders to achieve increased climate resilience, healthier ecosystems, enhanced natural resource management and improved livelihoods.

2.2.9 Outfalls, moored structures and shoreline connections

Outfalls or discharge points are used to discharge wastewater into a water body. They are a necessary part of wastewater management and the avoidance of disease. A properly designed and operated outfall effectively dilutes the discharged wastewater which, in turn, causes a reduction in the concentration of contaminants (Tate, Scaturro and Cathers 2016). Poorly designed and located outfalls can cause erosion of beaches or riverbanks and reduce water quality as a result of ineffective dilution or recirculation.

Moored structures are typically floating structures (such as offshore platforms) that are attached to the seabed by lines and anchors. The lines need to be of sufficient length so the structure can move with the tide and currents of the location. Moored structures include navigational aids and mooring buoys, through to ship platforms, refuelling stations, and wind turbines. Such structures are fundamental to safe navigation (for example) but if the anchors are not located with care and the lines are too long, they can damage marine habitats and corals.

Maritime activities often require a connection to the shoreline, these connections can be for securing a vessel or can be a pipeline to transfer fuel, dredged material, or water and wastewater from land to ships or from ships to land. Again, they can damage marine habitats if they are poorly located.

2.2.10 Aquaculture

Aquaculture is the farming of aquatic organisms such as fish, shellfish and plants (e.g., seaweed). The term aquaculture refers to the cultivation of both marine and freshwater species and can range from land-based to open-ocean production. The three main types of aquaculture are:

- Land based pond systems - where stock is contained in a series of interconnected ponds on land, with wastewater being exchanged between ponds by pumping.
- Open net pens - where stock is contained in open floating nets that are anchored in natural bodies of water and wastewater is exchanged freely through the net.
- Recirculating systems - where stock is contained in ponds or tanks, often indoors, where the water exchange is strictly controlled by pumping.

Aquaculture in the Pacific currently consists of mostly pond aquaculture, with fish such as tilapia, carp and milkfish being grown in ponds in Fiji, Kiribati and Nauru. Less common is the open pen type aquaculture, however, this is being undertaken in the Republic of the Marshall Islands (RMI), where giant clams, seaweed and pearl oysters are grown in this manner, and sea cucumbers are produced in Fiji in open cages. Finally, there are hatcheries for prawns in Fiji, giant clams in the Cook Islands and a trout hatchery in Papua New Guinea that use recirculating systems (Subasinghe 2017).

Aquaculture can provide a good source of income and food, but water quality can be problematic if the farms are not located in environments that are well flushed and water exchange is not maintained. In addition, the stock cultivated should always be endemic.

Honiara Fishing Village, Solomon Islands. Credit: Stuart Chape

3 Supporting Studies

3.1 Introduction

To assess the environmental effects of coastal engineering projects, site investigations or studies are required to characterise the physical environment, identify sensitive receptors and quantify potential impacts. Typical studies required as part of the assessment of predicted changes to the coastal environment are discussed below.

A guide such as this cannot provide specific details of the level of investigation or detail required by a specific project, but it is important to be proportionate in determining survey requirements. For instance, where an effect is expected to be limited, the surveys commissioned can be higher level, whereas if an effect is expected to be significant detailed modelling (e.g., dredged plume modelling) may be required. Section 5.2 on Scoping provides further details on selecting appropriate types of investigations. A good first step is a desktop study of available evidence to determine the requirements (or not) for further investigation, supported by consultation with local stakeholders. Traditional and local knowledge can be particularly important in the Pacific, where recorded data may be limited.

Example – Ebeye Seawall

Below is an example of the types of information that were required and their sources from a seawall project in Ebeye in RMI. While this table is not an exhaustive list it is a good indication of the types of information required for a project of this nature. It should not be used as a check list for other projects, which will have their own unique requirements.

EIA parameter (topic)	Source of information
Physical Environment	
Geological Resources – soils, sands, reef flat, freshwater lens	Field studies (geotechnical survey); published data on 'borrow pits' (aggregate extraction sites)
Coastal Processes – waves, water levels, tides and erosion/ sediment transport	Desktop studies; site observations; numerical modelling
Bathymetry (the seabed) and Topography (on land)	Hydrographic field survey (seabed); LiDAR data (land)
Wind and Temperature	Sourced from closest weather station
Natural Hazards – cyclones, tsunamis, volcanic activity and earthquakes	Desktop studies
Climate Change – sea level rise, rainfall, cyclonic intensity	Desktop studies; Pacific Climate Change Science Program of Australia – RMI
Noise	Baseline noise sampling during site investigations
Air Quality (dust)	Baseline dust sampling during site investigations
Biological Environment	
Terrestrial Ecology – flora, fauna and land use	Aerial imagery; CBD Reports (RMIEPA); ecological survey
Marine Ecology – coral reef health, fish/reptile/mammal assemblage, intertidal reef flat, marine ecosystem services	LiDAR imagery; ecological survey; coral reef mapping; State of Environment Report (SPREP)
Protected Areas – nationally protected, community managed and area uses	Pacific Islands Protected Area portal – SPREP; local government databases
Vulnerable and Endangered Species – endemic, rare and valuable species	IUCN Red List; CBD Reports; State of Environment Report (SPREP)
Invasive and Alien Species	National Biodiversity Strategy and Action Plan; National Invasive Species Action Plan; stakeholder engagement

Social Environment	
Landownership and Land Use	Stakeholder consultation; land records, lease records, land agency; satellite imagery
Demographics and Education	Census data; key informant interviews
Health and medical services and facilities	Desktop studies; key informant interviews; focus groups
Gender	Gender and Development Office consultation; focus group
Economy and Employment	Census data; informant interviews/focus groups; ADB reports
Cultural Resources	Desktop studies; consultation with traditional leaders
Vulnerable Persons – youth, elderly, disable persons	Desktop study; focus groups discussions, Census data, other Government or NGO reports on demographics
Infrastructure and Utilities	Development Project Reports; Development Plans; key informant interviews

Table 1: EIA parameters and data sources for the Ebeye seawall, RMI

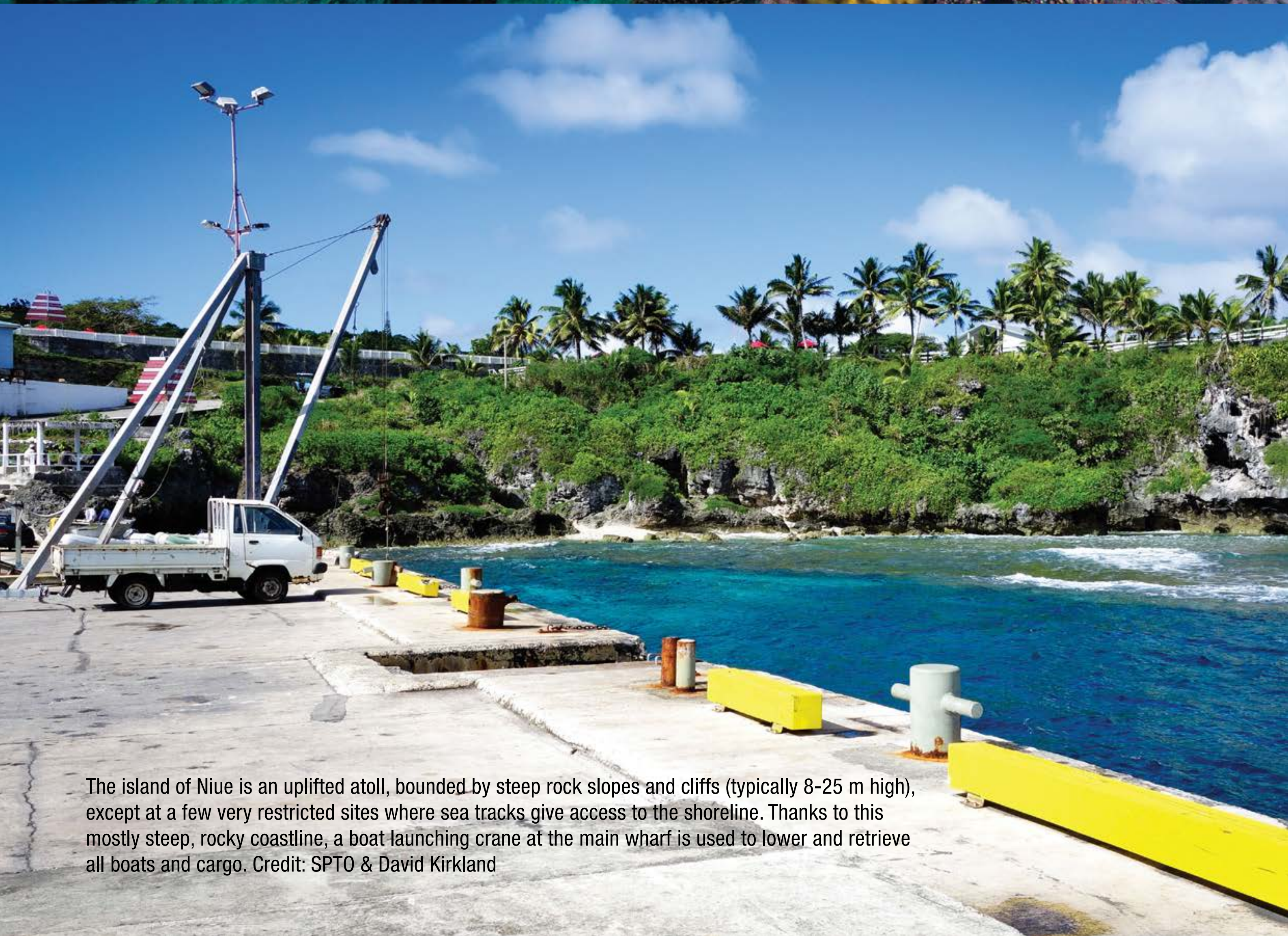
EIAs can be costly and time consuming. All too often the data collected from the investigations is specific to the project and stands alone. This is a lost opportunity to build national environmental datasets and compare any monitoring outputs required for the project against existing datasets. Where feasible and/or appropriate, the use of standardised data collection methods and presentation formats should be encouraged, so that the same level of rigour applies across all developments.

When scoping the studies required for an EIA, early discussion between the project team and the regulators should identify what data collection standards should be applied, as well as the preferred presentation and metadata fields required to accompany data reports. The benefits of this are that project proponents can then compare their findings with any baseline data held by the regulators and the regulators can set more appropriate and practical monitoring requirements as conditions for consent. Better data alignment will make it easier for regulators to interpret and benefit from the EIA data collection.

Proponents should also be encouraged to present EIA data in a spatial format (using a GIS), to assist with understanding the physical location and extent of a development, and the scope and scale of impacts. Where datasets are novel and or greatly enhance the national environmental database or data collection methodologies, this could be applied as an intellectual offset or capacity building technology transfer.

Tip – Planning in EIA

As part of scoping EIA investigations and field studies, planning is essential. Both to account for the requirements of the project locations and logistics, and to seek opportunities to couple investigations to minimise mobilisation costs and save on time. For example, due to the costs and logistics associated with deploying vessels, marine ecological, hydrographic and oceanographic surveys can be grouped together. It is important that the right data collection methodology is specified and the work carried out by suitably qualified experts.



The island of Niue is an uplifted atoll, bounded by steep rock slopes and cliffs (typically 8-25 m high), except at a few very restricted sites where sea tracks give access to the shoreline. Thanks to this mostly steep, rocky coastline, a boat launching crane at the main wharf is used to lower and retrieve all boats and cargo. Credit: SPTO & David Kirkland

3.2 Physical Resources

As for most EIAs, an EIA for a coastal engineering project will begin with a description of the physical resources of the study area, including its geology, topography, hydrography, reefs, and soils. In the Pacific, it is also relevant to consider seismic and volcanic activity. Of equal importance will be metocean and hydrodynamic conditions (coastal processes – waves, currents and tides), and climate (including rainfall, temperature, storms, tropical cyclones)/climate change – sea level rise but also increased storminess, increased intensity and frequency of rainfall and heat, and incidence of drought.

The subsections below focus on those studies that are specific to coastal engineering projects and do not necessarily cover standard studies (such as topographic surveys, using everything from LiDAR data to infield verification via smartphones, and tape surveys at key locations) that are covered in other guidance documents.

3.2.1 Hydrographic survey

A hydrographic survey maps the terrain of the sea floor (bathymetry) by determining the depth of an overlying water body. Hydrographic surveys are used for a range of applications in coastal engineering projects, including estimating sediment volumes during dredging, charting and ship navigation, and understanding nearshore/offshore coastal processes.

Hydrographic surveys may include the following:

- A survey plan to define the extent of the data to be collected.
- Physical field survey by an appropriately qualified surveyor.
- Data analysis and reporting.
- Data outputs that may include 2D and/or 3D mapping as well as data files for GIS input.

Tip – Hydrographic Survey Methods

A variety of methods can be employed to determine horizontal location and vertical depth, however, global positioning systems (GPS), using differential or real time kinematic (RTK) corrections via an electronic single beam or multibeam echosounder, are the most common method for collecting hydrographic data. But a weighted line and a survey tape can also be used.

Multibeam echosounders transmit sound signals and analyse the return signal that has bounced off the seafloor or other objects. Multibeam sonars emit sound waves from directly beneath a ship's hull to produce fan-shaped coverage of the seafloor. These systems measure and record the time for the signal to travel from the transmitter to the seafloor and back to the receiver. Multibeam surveys are among some of the most expensive survey methods but provide the clearest picture. It is the quickest collection method for large areas; however, it requires specialist equipment and deployment, along with more processing time than other methods. Given the remoteness of many Pacific islands, this method may only be feasible for larger projects.

With **single beam echosounders** the sound is transmitted straight down in a focused beam, typically a 3-20° cone. This yields a single depth measurement from somewhere inside the 'beam'. Taken in a continuous string, a single beam echosounder produces a seafloor profile. Single beam echosounder do not record the average depth within the area of the beam on the seafloor. Rather the first sound return for each "ping" provides the depth. Therefore, the shallowest depth within the cone is recorded. In areas with a rough seafloor and/or large relief, this means that the "least depth" within the cone of transmitted sound is recorded, which can reduce accuracy. Single beam surveys are the most cost-effective way to obtain a survey of an area. These surveys can be collected and processed quickly when the equipment is available.

Leadline surveys have a long history in the maritime sector. This kind of manual survey has been replaced by echo sounding for the most part, due to the improvements in data collection speed, accuracy and point density. Leadline surveys will generally require a boat, a surveyor's tape to measure range along a station, a weighted line marked to measure depth and an accurate tide gauge. Leadline surveys are a good alternative in situations when the equipment and resources do not allow for an echo sound survey or the area to be surveyed is small.

3.2.2 Geotechnical Investigation

The purpose of a geotechnical investigation is to understand the ground conditions below a development site. This will generally aim to understand the properties and distribution of geological units within the area for use in engineering design, construction or infrastructure planning. Essentially these studies help to identify the porosity and stability of soils, potential compaction or sinking rates, which are especially relevant to reclamation projects and flood prone areas. A geotechnical survey should identify contaminated soils and groundwater sources and discuss potential effects on groundwater. A significant data gap in the Pacific relates to the depths, volumes and risks to aquifers on which many islands (particularly atolls) rely.

A geotechnical investigation may include the following:

- Desk study: a review of available information and data prior to an on-site investigation.
- On-site investigations: including drilling, test pitting, in-situ testing etc.
- Laboratory testing: testing samples recovered from on-site investigations.
- Factual reporting: geotechnical logs, laboratory results and investigation methodologies.
- Interpretive reporting: reporting containing interpretation of the investigation results (e.g., design parameters, geotechnical construction advice, and geological cross sections).

The requirements for a geotechnical investigation will differ depending on the design requirements of a project, site conditions, available information, and site constraints. Generally, for small scale projects, on-site geotechnical investigations are not required to inform an EIA (desk study information is typically sufficient) but further detail can be informative. For large excavation or dredging projects and large coastal structures, on site geotechnical studies will be necessary.

Note – Unexploded Ordinance

Many Pacific islands have legacy hazards because they were exposed to explosives from opposing forces during World War II (WWII), either as bases for operations or scenes of battles. For example, Tuvalu was used as a staging base for US aerial attacks in the Battle of Tarawa in Kiribati. Bomber bases were established on Funafuti, Nanumea and Nukufetau, being the only islands big enough to accommodate them. Funafuti, Nanumea and Nui were bombed and UXOs are regularly found.

Consequently, there is a risk of unexploded ordinance (UXO) being present on many Pacific islands. In Tuvalu the Department of Environment requests that UXO clearance is undertaken for projects where a risk of UXO may occur. This risk should be investigated, in the first instance, through a historical desktop study of military activities. **If a risk of UXO being present in a project works area is determined, site clearance by a specialist is required before any ground penetrating activates are undertaken.** Even where a UXO risk to a project is not identified, the contractor should take appropriate precautions and include a plan for chance finds and UXO identification and disposal in their risk assessment.

3.2.3 Metocean assessment (meteorology, tides and waves)

Metocean refers to the study of meteorology and physical oceanography. In a coastal engineering context, these studies are primarily used to measure and assess wind, wave, tides, storm tides and climatic conditions that may influence a particular area and/or project.

A metocean study can be incorporated at various stages of coastal engineering projects but is typically undertaken in the early stages of a project to assist with defining design criteria, ranging in complexity from simply understanding the broad metocean conditions to providing detailed assessment of specific conditions (e.g., strength of cyclones, tidal influence, storm surge impact, etc.).

Metocean assessments should aim to include the following five key steps:

1. Project definition (i.e., scope, objectives).
2. Collection and analysis of field data or data from established suitable global models (e.g., WaveWatch III). For larger projects (such as ports) the collection of field data (e.g., via acoustic Doppler current profilers (ADCPs) or other current profiling techniques) is recommended over desktop data, particularly as many Pacific islands are highly dynamic.
3. Development of a 'conceptual' site model (assessing all influencing parameters).
4. Model selection, development, and calibration/uncertainty analysis.
5. Assessment of model predictions and outcomes to inform project design.

Metocean information on wind, waves, tides is required to inform EIA of coastal engineering projects, but existing information is often available and sufficient. Typically of more importance is hydrodynamic modelling, which requires metocean inputs, to predict the influence of any new structure in the coastal zone on coastal processes and, from this, on sedimentary process, water quality, ecology, etc.

3.2.4 Coastal process modelling – hydrodynamic and morphodynamic

Hydrodynamic modelling is the study of fluids in motion. Many forces can be responsible for fluid motion, either acting alone or in combination with each other. In a coastal engineering context, these forces are typically generated by tides, winds and waves, together with topographic gradients and bodies of water meeting, such as oceans, rivers, wastewater outlets, etc. Coastal morphodynamic (or geomorphodynamic) modelling refers to the study of the interaction and adjustment of the seafloor or coastal topography and hydrodynamic processes (or forces), involving the motion of sediment. Seabed features and structures will be impacted directly by hydrodynamic motion generated by these forces, which in turn will affect the fluids behaviour and hydrodynamic and morphodynamic processes (sediment transport).

The placement of physical structures in the marine environment (such as a breakwater) or changes to the depth profile (through actions such as dredging) can change the hydrodynamic forces in a location and adjacent areas (such as the direction and strength of a tidal current). This does not mean that an impact will occur, but if that change affects water quality or sedimentary processes (such that erosion or the deposition of sediments occurs) or results in the trapping of debris and waste, then an impact may arise (typically on local ecology).

Coastal process modelling facilitates the understanding and quantification of these complex interactions and enables the development of effective coastal infrastructure. It is fundamental to coastal engineering EIA and typically includes the five steps set out above for metocean assessment. Hydrodynamic modelling requires information on the local bathymetry and waves, tides, currents, etc. to be effective. Modelled outputs will only be as good as the data they are built upon, and Pacific islands will benefit from good data collection and model development. But, again, the effort invested in such should be proportionate to the effects predicted. For a major port development or vertical seawall, a detailed hydrodynamic model and sediment transport assessment should be undertaken. For a jetty or boat ramp, or soft engineering solution, a conceptual coastal process model may be sufficient (see Figure 9).

Tip – Standards in Modelling

To determine the suitability of a model, reference can be made to best practice documents or standards from other jurisdictions where suitable guidance is not available locally. A good example of this is the QWMN Good Modelling Practice Principles document produced by the Queensland Government Department of Environment and Science (2018).

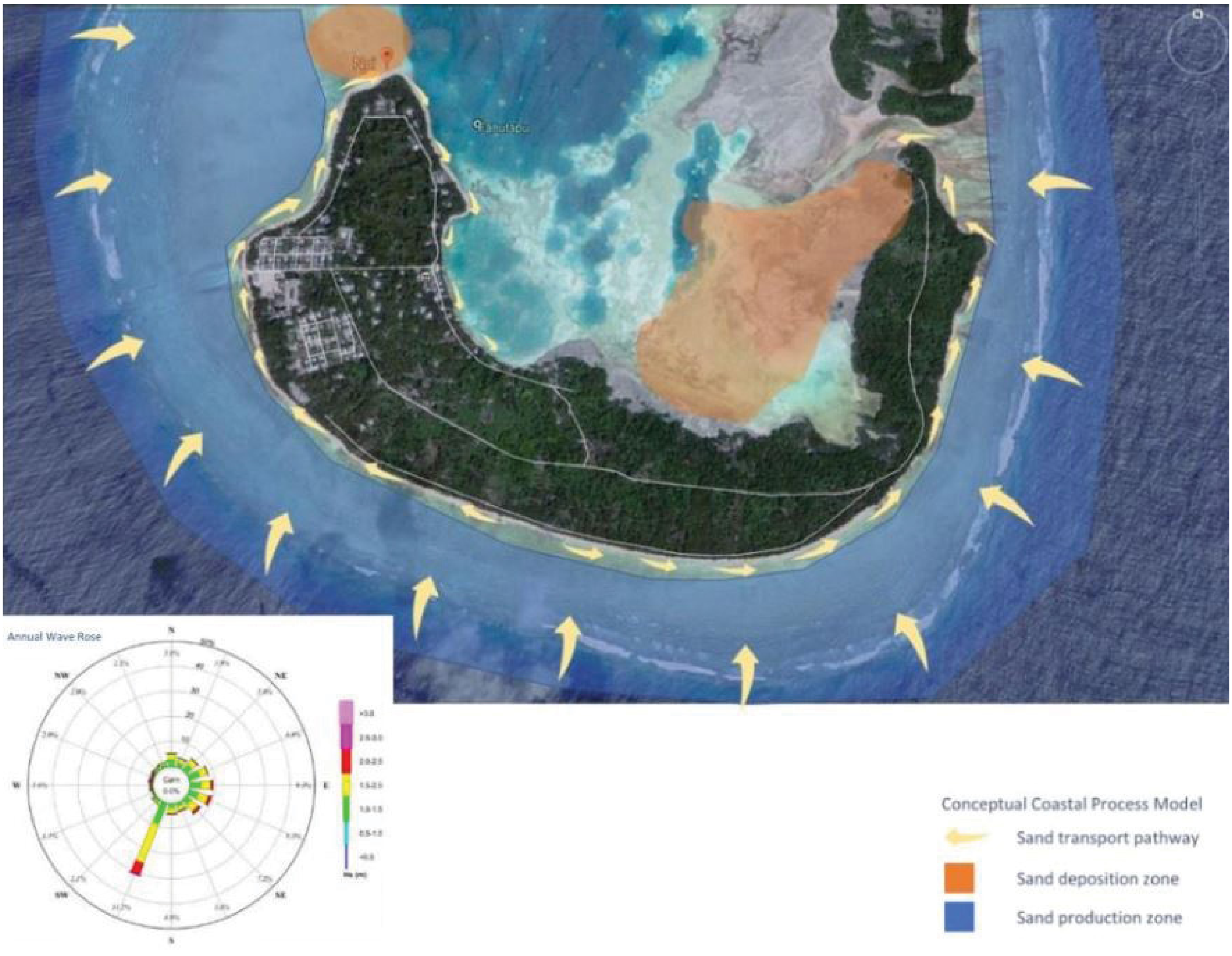


Figure 9: Conceptual coastal process model of Nui's southern coast, Tuvalu

3.2.5 Water and sediment quality monitoring and modelling

The purpose of water and sediment quality monitoring is to provide data on the health of water bodies and facilitate the effective management of catchments, water resources and the environment. Fundamentally, monitoring consists of a systematic and planned series of measurements or observations that are appropriately analysed and reported, to generate information and knowledge about a water body.

As a general approach, a water and/or sediment quality monitoring study may include the following:

- Setting objectives, including defining water quality objectives for construction and operational phases of a project (e.g., suspended sediment levels in a defined area are not to exceed 10% of the range of the levels typically encountered in the water body for a defined time).
- Establishing the parameters (e.g., total suspended solids (TSS) or faecal indicator bacteria, Enterococci) and locations to be monitored (i.e., vis-à-vis sensitive receptors).
- Field sampling (of the baseline, during and post works conditions). There are two main types of sampling:
    - Grab sampling: which is a one-off sample that is representative of a single location at one point in time. Simple handheld grab samplers can be used to take samples from the seabed, beaches and mudflats. Sediment corers are often used to sample the organisms that live on or just below the seabed, while displaying the structure of the sediment.
    - Composite sampling: which is multiple samples at regular intervals, usually over a 24-hour period, to represent an average over a period of time. Such sampling can be supported by telemetry capable data loggers (for remote operation). Data loggers range from simple standalone recording devices (see Figure 10) to internet-capable remote terminals.
    - For water quality, both use bottles (typically with stoppers at either end) to take samples at a desired water depth (e.g., Niskin bottles).
- Laboratory and data analysis.
- Reporting and modelling (if relevant).

Modelling water quality can be a useful tool in predicting and presenting the position and momentum of possible pollutants in a water body and can inform EIA where this is a significant risk.

Tip – Portable devices for remote locations

A Secchi disk is a simple tool which can be used to measure water clarity. It is a 20 centimetre diameter, black and white disk attached to a rod, rope or chain. Centimetre intervals are marked on the rod, rope or chain. To obtain a measurement, the disk is lowered into the water while observing the depth at which it the disc is no longer visible. This process is undertaken twice, and the measurement is the average of the two observations.

Secchi discs can be useful where projects are in remote locations, as they are cheap, highly portable and are able to be used by people without specialised training. Conversely, they also have some drawbacks, including the fact that they cannot be used in shallow water, that the results can be skewed dependant on the vision of the person recording and that low light and waves can impact the reading (Toivanen, Koponen, Kotovirta, Moliner , and Chengyuan 2013).

Figure 10: Example of a pressure sensor installation to monitor water levels in Nui, Tuvalu

3.3 Biological Resources

3.3.1 Survey and assessment

Ecological survey and assessment will facilitate the identification, prediction and evaluation of potential ecological impacts resulting from a project. The assessment should seek to protect and conserve the ecological value within and surrounding the project site. Generally, its content will be defined based on the environment potentially impacted and the type and scale of the project. The following should be included:

- Desk based assessment of available data.
- Baseline ecological survey – the scope of which will vary dependent on the identification of sensitive and/or important habitats and species (about which more may need to be known).
- Identification of sensitive ecological receptors. This should include relevant migratory species (birds, turtles, cetaceans) and consider migration patterns and seasonal changes in species distribution. It should also consider invasive species.
- Evaluation of the significance of potential impacts on these sensitive receptors and their behaviours.
- Recommendations for mitigation measures and monitoring (if applicable).

3.3.2 Marine ecological survey

For coastal engineering projects in the Pacific islands, a marine ecological survey of the beach, reef platform, reef edge, reef crest and reef slope is likely to be essential. That is, it should cover the project footprint and area of influence (based on the coastal process and water quality assessment). This could include offshore mooring sites. Such surveys will need to be undertaken through a combination of walking, wading, snorkelling and diving (depending on conditions). A towed underwater video approach (via a boat) may be used where sea conditions are rough. Underwater remotely operated vehicles (ROVs), which are essentially an underwater drone, can also be used to gather data.

Underwater camera traps (both baited and unbaited) are another method of passively collecting marine ecological data. This method is a no harm sampling approach, in that marine life does not need to be handled as part of this process.

Where access is challenging, remote sensing techniques may be able to used. Recent advances in satellite technology and increased access to drones, has meant that remote sensing has become viable for ecological surveys. Satellite imagery can be used to identify broad habitat types and land uses, while drones can provide even greater resolution and can gather information on individual species. Drones can also be used to survey areas using infrared cameras, that can pick up the heat signal of warm-blooded animals (Andrew, Wulder and Nelson 2014).

The focus of a marine survey should be on the benthic substrate and species (and in particular corals), fish, macroalgae, invertebrates and (in some cases) cetaceans, and threatened and protected species.

3.3.3 Terrestrial ecological survey

A terrestrial habitat survey is also likely to be required, dependent on the scope of the project, and should typically focus on the identification of threatened habitats and species – flora, fauna and avifauna (or biota). These surveys should identify, for example, turtle and bird nesting, roosting and feeding sites (particularly wetlands). Local knowledge can be very important in this regard. Ecological surveys should also identify the presence of invasive species to establish a baseline condition for the site.

There are many types of ecological survey that could be applicable to coastal engineering projects in the Pacific. These include:

- Desktop studies: initial research to gather background data on the area and establish if there are any records of protected or notable species, or any internationally or nationally designated protected sites nearby. This can determine the scale and nature of further work required.
- Targeted field surveys: involve targeted surveys for species that the desktop study identified as being likely on site, without doing a full field study as described below. For example, a targeted field study may involve camera trapping at night for specific bat species. Targeted surveys should be undertaken by relevant specialists.
- Habitat surveys: involve a site visit, during which an ecologist will undertake a walkover of the study area to identify and record all species of flora and fauna present, to enable the classification and mapping of habitat types. The habitat survey may be extended, as necessary, to determine the presence of protected or notable species. Ecologists will also look for evidence of species inhabiting or feeding in the area and may specify exclusion zones around nesting sites or periods in which certain works should not occur (e.g., during periods of fish spawning or breeding).

3.4 Socio-economic Resources

3.4.1 Context

In the Pacific, population, education, health and health infrastructure; livelihoods, subsistence and incomes; land tender, ownership and use; transport, energy, water supply/sanitation and waste management infrastructure; and cultural resources (particularly grave sites at the coast) are all relevant and information should be obtained on each of these (particularly land ownership and property boundaries). Such information can be obtained from government census data and land title records, as well as international donor reports on demographics. Non-Governmental Organisations (NGOs) and Civil Society Organisations (CSOs) can also be good sources of information on demographics and equity issues.

In addition, each island typically has its own governance structure and expectations regarding gender and respect, that need to be understood in the development of social impact mitigation strategies.

3.4.2 Heritage, or cultural, assessment

The purpose of a heritage impact assessment is to identify and evaluate the potential impacts of a proposed development on the cultural significance of a place. Typically, a heritage impact assessment builds on the work of an assessment of significance and should take account of any policies aimed at conserving the heritage or cultural value in the future.

In line with standard EIA methods, heritage assessment follows a process of:

- understanding the environment through observations and data collection;
- analysis of available information and classification of significance;
- identification and evaluation of potential impacts; and,
- recommending mitigation measures.

3.4.3 Air quality and noise assessment

Although coastal engineering projects may affect air quality and the noise environment of Pacific islands, baseline air quality and noise surveys are generally not warranted where air quality is expected to be very good and noise levels limited (i.e., the baseline is easy to quantify). This is not to say that the effects of dust and noise will not be significant, rather that time and money spent monitoring baseline levels will often not be warranted. Mitigation measures are discussed in the following chapter.

The assessment of changes in air quality and noise requires a good understanding of the works proposed and their likely emissions (during both construction and operation), and prediction of the expected area over which the emissions will have an influence (and their strength or significance with distance). This can be achieved through modelling.

Example – Assessment to determine siting of dusty plant

In Nui, Tuvalu, a boat harbour is proposed to be constructed adjacent to the main village. Given the proximity of the works to the village, the potential was evident for adjacent residents to be affected by a degradation of air quality and dust. So, an air quality assessment was undertaken with the objective of determining where the construction plant should be located to minimise the effects of dust and particulates (PM10). The study area was defined as human receptors within 350m of the site and 50m of the haul route and ecological receptors within 50m of the site/haul route. The predicted inputs were demolition; earthworks; crushing, concrete batching and stockpiling; and track-out activities. The location of highly sensitive receptors was determined relative to predicted dispersion/predominant wind direction. Based on this it was recommended that the crusher was not located to the north of the village, as winds would be more likely to disperse dust and particulates across the village.

4 Typical Impacts and Mitigation Strategies

Coastal engineering projects have the potential to generate a range of impacts, the significance of which need to be assessed through the EIA process. As detailed in Section 2.2, there are several different forms of coastal engineering that are relevant to this guide, including excavation and dredging, reclamation, breakwaters, seawalls, groynes, beach nourishment, planting and stabilisation, creation/adaptation of waterways and wetlands, coral gardens and so on. However, many of these activities have the same potential effects, so the approach adopted here aims to link activities to potential outcomes and then consider those outcomes (or impacts) and possible mitigation measures.

When proposing mitigation, the mitigation hierarchy should be considered. This states that mitigation should be approached in the following ways, in order of preference:

1. **Avoid** negative impacts, for example, siting development to not encroach on significant habitats.
2. Where they cannot be avoided, minimise the negative impact, for example, designing a breakwater to occupy the minimum footprint possible while meeting applicable design standards in order to minimise the impact on benthic habitats.
3. Rehabilitate or remedy residual negative impacts, for example, replanting vegetation in an area that has been cleared.
4. Offset impacts where they cannot be remedied, for example, planting mangroves in an area away from the site, where the works mean that the site no longer provides suitable habitat for mangroves.

4.1 Changes to Coastal Processes

This includes changes to hydrodynamic (waves, tides, and currents) and morphodynamic (sediment transport) processes. Such changes can have direct effects on coastal features (geomorphology, e.g., beaches) and indirect effects on water quality and ecology, which may cause significant impacts if coastal engineering works are inappropriately designed, or could provide significant benefits. Impacts on water quality and habitats are touched on here but are covered in Sections 4.2 and 4.3.

The prediction of effects on coastal processes, like the design of coastal infrastructure, needs to take account of the implications of projected future climate change parameters for the Pacific.

4.1.1 Activities and potential effects

Development activities that have the potential to affect coastal processes include, but are not necessarily limited to:

- Engineering activities that directly alter the morphology of the coastal zone, resulting in changes to sediment sources or sinks (and the loss or gain of habitats), such as -
  - reclamation/excavation of the coastline
  - capital and maintenance dredging (and dredged material disposal)
  - the creation of shipping/boat channels
  - beach nourishment (sand bypassing).
- Associated impacts may include -
  - interruption of longshore sediment transport
  - changes in erosion/deposition patterns, and coastal features
  - collapse of an exposed beach profile due to erosion during construction (prior to restoration)
  - loss or dispersion of excavated material stockpile on the beach
  - changes in the structure of marine habitats and communities (see Section 4.3).

Point of interest – Longshore drift

Longshore drift is the movement of sediment along the coastline and is a key coastal process. This movement of sediment is a result of the surf zone currents created by waves and the predominant wave direction. Typically, waves break at an angle to the shoreline (forming oblique waves) and the sediment is moved along the beach in the surf zone. The direction the sediment moves in depends on the dominant wave direction (Gold Coast City Council 2016). This process is shown in Figure 11.

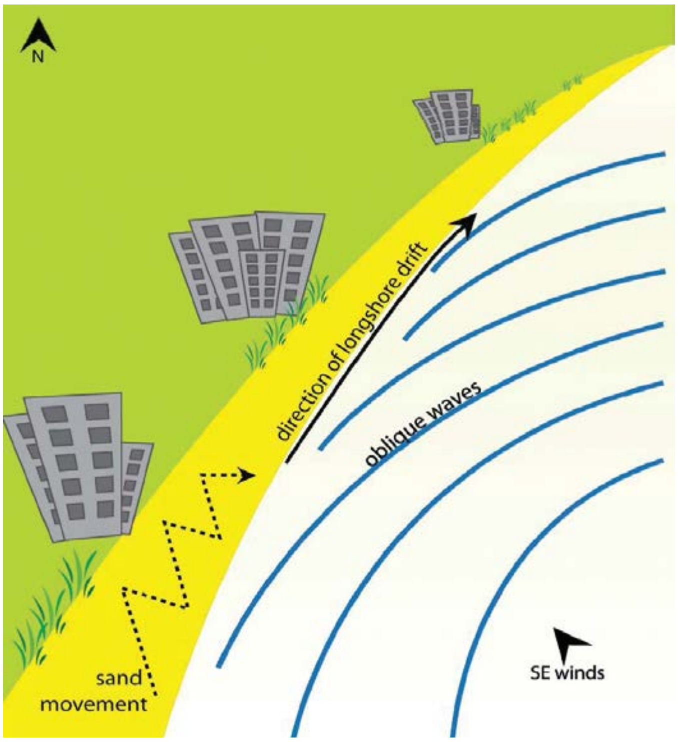


Figure 11: How longshore drift is created (Gold Coast City Council 2016)

- Infrastructure that alters wave energy and tidal currents, such as -
  - » breakwaters, seawalls, or revetment walls (rock armour)
  - » wharfs, jetties, boat ramps or marinas
  - » reclaimed areas.
- Associated impacts may include -
  - » effects on navigation
  - » interruption of longshore sediment transport
  - » changes in erosion/deposition patterns (e.g., increased rates of erosion or erosion of new areas due to changes in flow or wave regimes), and coastal features
  - » changes in the structure of marine communities.
- Infrastructure or engineering activities that interrupt tidal flows/currents or causes a reduction in water exchange, such as -
  - » marina or harbour water bodies
  - » canal developments
  - » alteration of river mouths or deltas.
- Associated impacts may include -
  - » changes in water quality
  - » deposition of sediments (due to reduced flows)
  - » retention of nutrients and other contaminants, with effects on benthic habitats
  - » saltwater intrusion or coastal inundation
  - » build-up of debris and waste
  - » impeding access to upstream habitats for fish or eels.

4.1.2 Mitigation strategies

To mitigate the effects of a project on coastal processes a project proponent may employ the following mitigation strategies:

- Careful site selection and design of the development layout should minimise effects on coastal processes, particularly sediment transport, and provide for climate resilience. Key to the development of such a design is numerical modelling of the predicted effects and testing alternatives; leading to the selection of a preferred project option, which minimises physical impacts and consequential biological impacts.
- Careful planning of works such that only short, excavated sections are exposed at one time and the works completed between periods of high tide or, if sufficiently above high tide mark, before any advancing weather system approaches the island (i.e., minimising the period that excavated areas are left unprotected). All excavated material to be immediately removed to a designated storage area. No excavated material to remain within the intertidal zone, on the beach or reef flat, between tides.
- Minimising the clearing or undercutting of any vegetation along the shoreline of a project site and/or incorporating nature-based solutions (or where necessary a retaining wall) into the design.
- Clear identification of a designated beach access route, to minimise damage.
- Pre and post work hydrographic surveys to ensure that currents, water depths and sediment transport regimes are unaffected or within the modelled parameters, linked to a management response should noncompliance be determined.

- Timing works to ensure that they do not occur at times that may lead to greater impacts, e.g., during bad weather and in the cyclone season.
- Beach nourishment or sand bypassing (e.g., routing sand around an obstacle, by pumping or trucking, that is stopping sand moving along the beach) may itself be a mitigation measure if sediment transport is interrupted.

Example – Multi-criteria analysis

To provide protection against wave induced erosion and flooding due to King tides and storm surge, 10 seawall concepts were initially developed for the Ebeye Coast Protection project in RMI. The top four concepts were then shortlisted through a multi-criteria analysis (MCA) process on which key stakeholder and community feedback was sought. MCA is a form of appraisal that compares alternatives by considering several different variables, such as cost, technical viability, social acceptability, sustainability, and social and environmental impacts (i.e., both quantitative and qualitative criteria). The shortlisted options are to be assessed against four weighted categories as follows:

- Engineering viability – 35%
- Affordability – 20%
- Social implications – 30%
- Environmental implications – 15%.

The MCA process adopted allowed for options that were not viable (e.g., impacts on critical habitats) to be ruled out early and for greater focus on suitable options.

The Sigatoka Sand Dunes National Park in Fiji. Hinterland erosion and traditional coastal dune development have created this sand dune ecosystem. The dunes are thousands of years old and the park serves as an archeological place as well with various discoveries. Credit: Stuart Chape

4.2 Changes to Marine Water and Sediment Quality

The term 'environmental quality' refers to the level of contaminants in water, sediments, or biota, or to changes in the physical or chemical properties of water and sediments relative to a natural state.

The waters of the Pacific marine environment, and the biota they support, are highly valued by the community for active and passive recreational opportunities and because they provide economic value by supporting subsistence and commercial fishing, aquaculture, and tourism. Coastal engineering projects can lead to a lowering of environmental quality.

4.2.1 Potential impacts

The different types of impacts associated with a reduction in marine water and sediment quality include:

- direct toxicity due to the release of natural or synthetic chemicals;
- concentration of contaminants in organisms to toxic levels;
- deficiencies (e.g., reduced oxygen);
- physical effects (e.g., increased light attenuation/turbidity);
- bio-stimulation effects (e.g., algal blooms); and
- exposure to viruses or bacteria that can have human health impacts (e.g., faecal coliforms).

The coastal engineering and development activities that have the potential to impact on marine water and sediment quality include, but are not necessarily limited to:

- Dredging (excavation) and dredged material disposal can increase turbidity, suspended sediment concentrations and sediment deposition rates, alter the physical characteristics of adjacent sediments, mobilise contaminants contained within the sediments, and reduce water clarity and light over quite large areas. All of which can have significant consequences for corals, invertebrates, fish and shellfish and marine mammals.

Tip – Sediment characterisation

Prior to dredged material being placed back into the environment as spoil or as fill, investigations need to be undertaken to ensure that it is suitable for the receiving location. In the case of beach nourishment, the grain size and distribution should be compared to that of the receiving environment to ensure that the composition of the receiving environment will not be changed. It is also important to ensure that dredged material is not contaminated.

Before a decision is made on where dredged materials are to be placed, they should be analysed for contamination (such as pesticides, herbicides, oil, industrial chemicals, heavy metals, and sewerage). The results of that analysis should be then compared against relevant local standards. Where local standards are not available guidance from other jurisdictions can be used, such as the Australian Government's National Assessment Guidelines for Dredging (2009). Once it is understood what levels of contamination the dredged material contains a decision can be made regarding the placement location and the required management measures and monitoring programme.

- The placement (or dumping) of rocks and other material for the construction of breakwaters, groynes, and rock walls, can increase turbidity and reduce water clarity and light availability, with effects on biota.
- Discharges, such as wastewater discharges, can release chemicals to the environment, change the physical and/or chemical characteristics of the receiving waters, enrich receiving water and sediment with nutrients, or release disease causing bacteria or viruses. Nutrient enrichment triggers phytoplankton algal blooms in acute and chronic situations, along with supporting macroalgal growth and favours invasive species.
- Ports, marinas and harbours generally contain higher levels of contaminants than other areas due to the presence of anti-foulants on vessels, corrosion inhibitors, and other chemicals in an environment with reduced water exchange and flushing. Therefore, any works within these locations can release these chemicals, with the effects detailed above and in Section 4.3.

- Unplanned releases of chemicals, hydrocarbons or other contaminants associated with activities such as the transfer and storage of bulk shipping commodities, construction activities (including excavators and other plant working in the marine or coastal environment, and concrete pours), and accidental collisions or ship groundings. Generally, if a site and construction plant are well managed and maintained, these have a low probability of occurrence but, if they do occur, the consequences for marine environmental quality can be severe.
- Aquaculture which, without proper water circulation and management, can lead to the concentration of contaminants in the stock and proliferation of disease.

4.2.2 Mitigation strategies

To mitigate the potential impacts of a project on marine environmental quality a proponent may employ the following mitigation strategies:

- Careful site selection and design of the development layout can minimise impacts on marine environmental quality. That is, impacts can be minimised by identifying, and avoiding, areas that contain potential contaminants (sites of historical spills or industrial use).
- The development of a Dredging Plan, often informed by a hydrodynamic and sediment transport model to assess the dispersion of fine sediment plumes associated with the proposed dredging. It is notable, however, that such plume modelling will often overestimate the dredging production rates that are achievable on remote Pacific islands working with excavators limited to low tidal conditions (see Section 5.2). As such, plume modelling is usually reserved for large projects with dredge volumes upwards of 100,000 cubic metres or for when the works may impact sensitive habitats or species. Sediment type is also an important factor, as coarse material is likely to generate much less of a plume than fine material, as the coarser sediment is heavier and will settle out of water far faster than fine sediments. A Dredging Plan may -
    - Limit dredging to lower tidal conditions.
    - Preclude dredging (or in-water work more generally) during bad weather.
    - Specify monitoring requirements (e.g., images of plume movements, details of sea conditions and wind and, if of sufficient concern, measurements of suspended sediment levels) and response protocols (e.g., if the responsible Environment Officer considers the plume density or extent to be at a level that could be having a detrimental effect on coral on the reef crest, then the dredging should be adapted to reduce the plume density or extent; which may involve reducing dredging intensity).
- Careful management of in-situ concrete pours to avoid spills and egress into the water body. Mass concrete pours undertaken on a reef platform must be undertaken in calm, low tide conditions, with the area of works temporarily bunded (see Figure 12 and Figure 13). Such activities should be monitored by the Environment Officer and any spills cleared immediately.

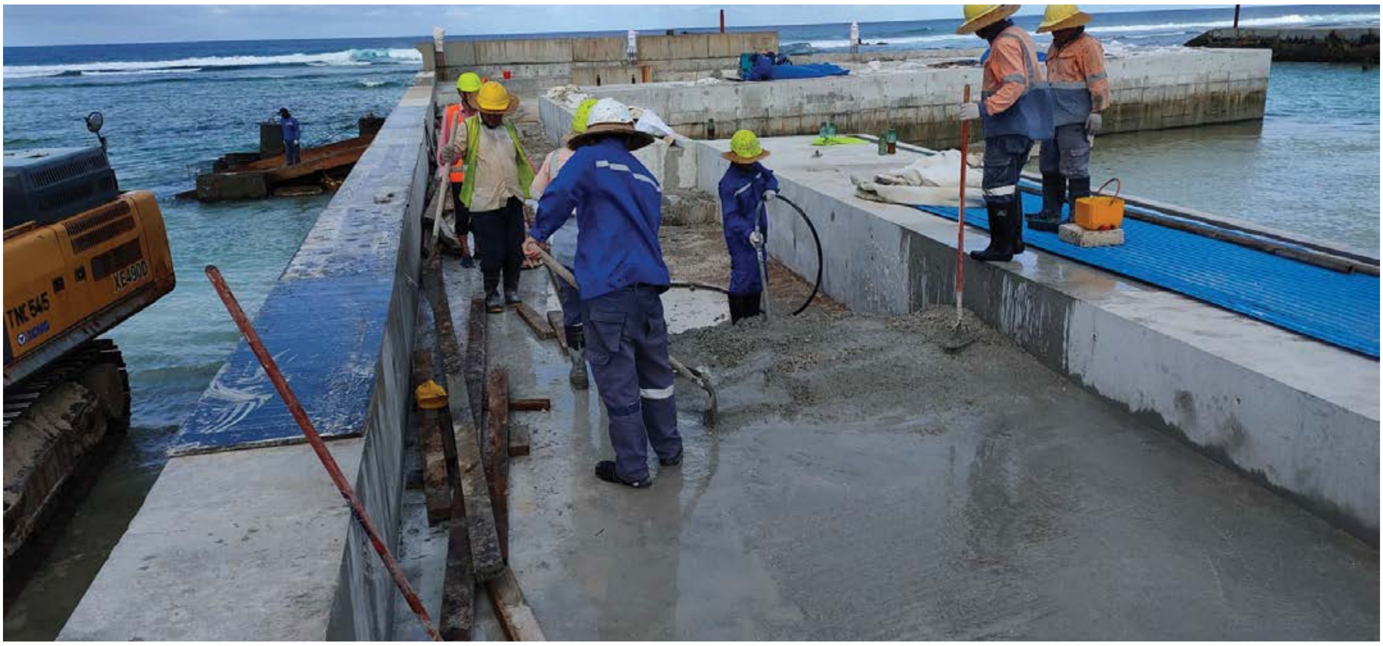


Figure 12: Example of working in low tide conditions and bunding in Nukulaelae, Tuvalu

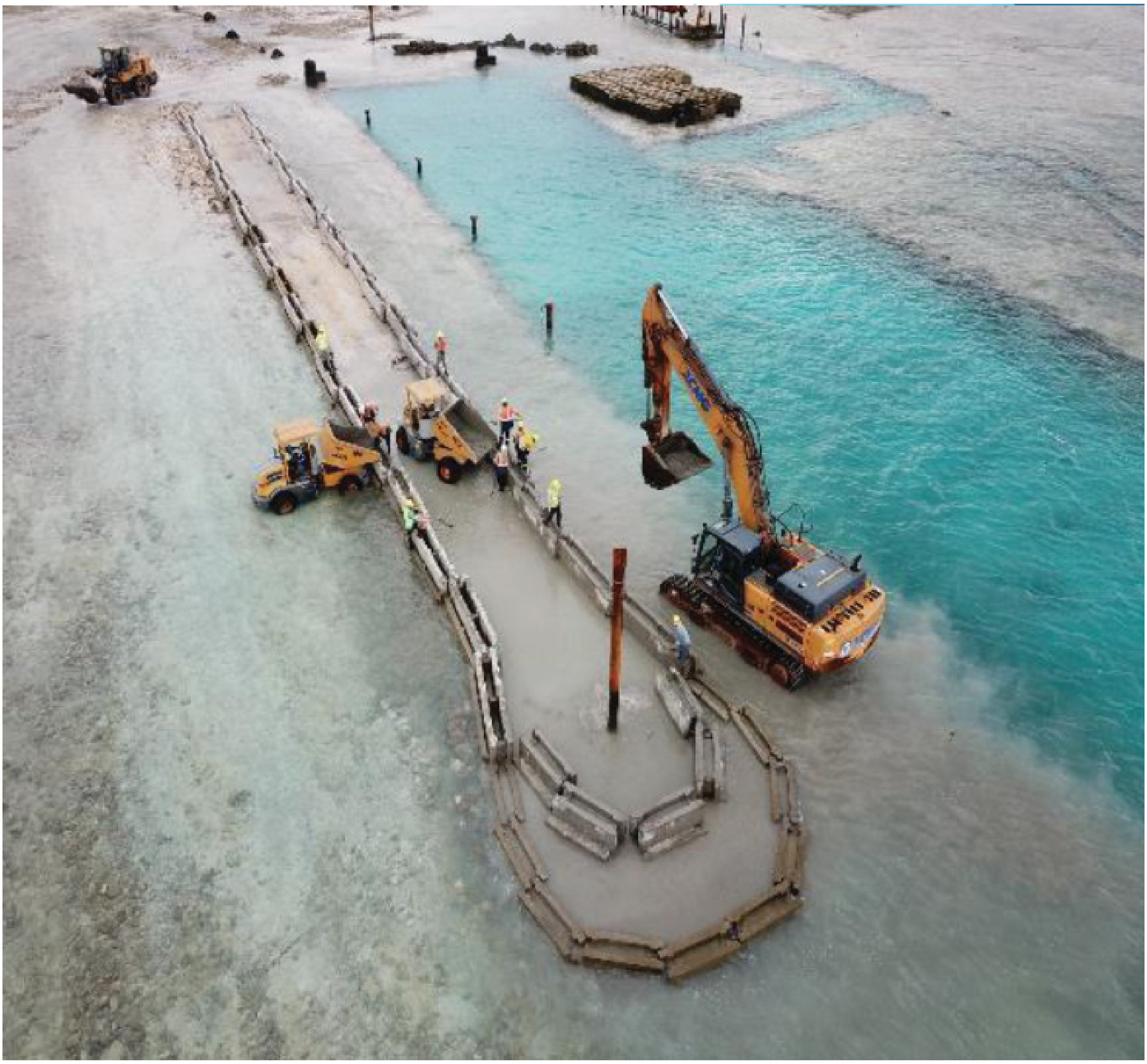


Figure 13: Another example of working in low tide conditions and bunding in Nukulaelae, Tuvalu

- An environmental monitoring and management plan (EMMP) that focuses on the key threats posed by the project to marine environmental quality and the pathways by which those threats could cause environmental protection to be compromised. Specifically, the EMMP should include -
  - Measures to minimise sediment release (in the appropriate circumstances, i.e., where currents are low, this may include silt curtains; see Figure 14).
  - Measures to ensure the release of contaminants from construction activities, such as concrete pours, and from plant or other construction equipment does not enter the water, e.g., ensuring that all equipment to be used below the highwater mark is in sound mechanical condition and free of any leaks of any fluid. Pre-start inspections should always be carried out and recorded. Plant should also only be operated by certified and experienced operators.
  - An immediate response protocol and management strategy is prepared in case unexpected contamination is uncovered during construction.
- A Spill Response Plan. This will often be a subplan forming part of the EMMP.

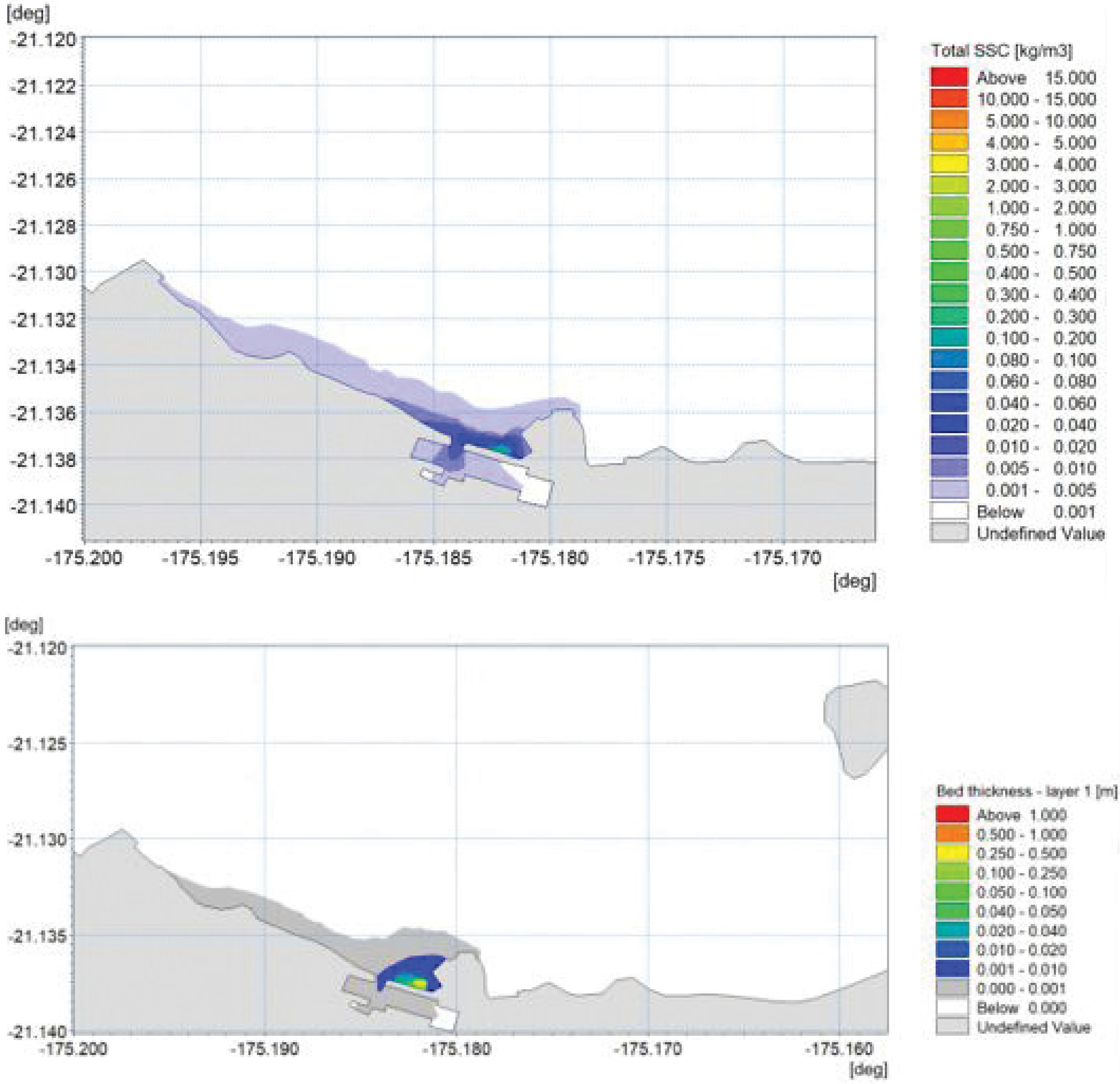


Figure 14: (a) Maximum surface total suspended solids (one-month simulation) without a silt curtain and (b) sediment deposition thickness (two-month simulation) with a silt curtain, Nukulaelae Port, Tuvalu

4.3 Benthic Communities and Habitats

Benthic communities are biological communities that live in or on the seabed. These communities typically contain light-dependent taxa such as algae, seagrass, mangroves and corals, which obtain energy primarily from photosynthesis and/or animals, such as molluscs, sponges and worms, that obtain their energy by consuming other organisms or organic matter. Benthic habitats are the seabed substrates that benthic communities grow on or in. They can range from unconsolidated sand to hard substrates such as limestone, igneous rock or coral reefs, and occur either singly or in combination.

Benthic communities and habitats play an important role in maintaining marine ecosystems and associated ecological services. Benthic communities are important for the maintenance of biodiversity through provision of diverse habitat, refuge, and food. Some of these habitats are vital nursery areas for various marine fauna species and may also provide essential food resources for large marine mammals, such as dugongs and turtles. Benthic primary producer habitats form the foundation of marine food webs which, in turn, support productive and economically important fisheries. They are also capable of dissipating wave and current energy, which helps protect shorelines and coastal infrastructure.

4.3.1 Potential impacts

Impacts on benthic communities and habitats can be both direct (e.g., dredging or reclamation of habitat), which are often irreversible, or indirect (e.g., shading or smothering), which may be reversible once the pressure is removed (e.g., in dredged channels, macroalgae communities, sponges, ascidians (sea squirts), other invertebrates and even corals may re-establish (or establish) in time). Impacts from most development activities include both direct and indirect impacts to varying degrees and almost all significant marine and coastal development proposals will result in some loss of important benthic communities and/or habitat.

The development activities that have the potential to impact on benthic communities and habitats include, but are not necessarily limited to[3]:

- Dredging and excavation, both through the direct take of benthic habitat and indirectly through increased turbidity (suspended sediments that reduce light availability for photosynthesis) and sedimentation, and the potential mobilisation of contaminants contained within the sediments.
- Placement of rocks and other material (including concrete blocks and sheet piles) for the construction of infrastructure such as harbours, breakwaters, groynes, bridges and rock walls, which destroys benthic habitat and has the potential to indirectly impact adjacent benthic communities and habitats through increased turbidity and by altering wave and current energy patterns. Piled structures (such as jetties) are less likely to have such indirect effects but will cause habitat loss in the footprint of the piles and shading.
- Construction of barriers to tidal movement (e.g., harbour and seawalls, berms, causeways) can potentially change the hydrodynamics and flushing of estuaries and embayments, causing mortality of benthic communities and loss of habitat through changes in inundation patterns and salinity.
- Wastewater discharges (domestic wastewater, industrial waste, cooling water and tail-water from onshore dredge spoil disposal) all have the potential to affect the quality of water, sediment and biota in the vicinity of the discharge and impact on the health of benthic communities or, in extreme cases, cause the mortality of benthic communities.
- The activities of marine vessels and construction plant and equipment (spills are covered in Section 4.2).
- Land-based construction works. In the absence of proper sediment and erosion controls heavy rainfall or wind may result in sediment being mobilised and transported to the ocean.

In assessing the direct loss of benthic communities and habitats, important factors to consider are percentage coverage (i.e., what proportion of the affected area contains habitats of interest), the unique attributes of the habitats and communities they support (are they rare, endangered or threatened), protected status, and potential for recovery (if any). Vulnerability (or sensitivity) to the predicted effect and ability to recover are important considerations related to indirect effects.

4.3.2 Mitigation strategies

To mitigate the impacts of a project on benthic communities and habitats a proponent may employ the following mitigation strategies:

- Careful site selection and design will minimise impacts to benthic communities at the site by identifying, and avoiding, areas that contain sensitive receptors, such as important ecological communities (e.g., corals). This may require some adjustments to the siting and orientation of aspects of the project at the planning stage. The design should meet its objectives, while at the same time minimising its footprint vis-à-vis benthic communities.
- Where relevant, projects should be timed to avoid key periods for sensitive receptors (e.g., breeding periods). For example, activities that increase turbidity should be timed to avoid important flowering and growth stages for marine plants.
- Working corridors and areas, e.g., on the reef platform, should be minimised and defined, and the movement of construction vehicles limited to these areas (see Figure 15). Designated anchoring zones (avoiding corals) should be defined.

3 Marine sea cage aquaculture can also directly impact on benthic communities and habitats through anchoring systems or shading by the cages. Indirect impacts can result from the deposition of organic waste and other contaminants causing changes in environmental quality.

Figure 15: Use of working corridors and containment areas in Nukulaelae, Tuvalu

- This detail should be set out in a site-specific Method Statement for the proposed works that clearly identifies the viability of the approach proposed and how impacts will be avoided or minimised (e.g., the use of a floating platform to excavate across the reef crest rather than a temporary bund).
- An EMMP that includes -
  - Monitoring to ensure the impacts to benthic communities are limited to those deemed acceptable, for example water quality monitoring to minimise the impacts to benthic communities outside the footprint of the works and surveying to determine if the works, workboats, etc. are avoiding identified significant communities.
  - Standard, best practice erosion and sediment controls for land-based construction (e.g., appropriate drainage around stockpiles and containment bund for hydrocarbons), including appropriate management plans for any specific contaminants (if present).
- Where impacts cannot be mitigated, compensatory measures may be explored, such as -
  - Relocation of communities, such as corals or seagrass, to other unaffected areas.
  - Restoration of habitats upon completion of the construction phase (if site conditions remain suitable post-construction), e.g., coral or seagrass replanting. Such initiatives need to be supported by relevant experience and over time, often after the projects works have been completed.

Tip – Consider alternative approaches

Traditional high order blasting can be extremely damaging to coral colonies, affecting fish populations and coastal communities. Hence, the use of explosives is largely prohibited in the Pacific islands. But coral pinnacles and rock heads on the reef crest can be difficult to remove using a barge or excavator due to the wave climate. An alternative approach is 'deflagration' - low order detonation, where the active material is burnt and expands without exploding. Vibration, noise and an air pressure blast will occur, but their levels and duration will be significantly lower and shorter, and the spread of the residual material will be less as compared to traditional blasting.

Deflagration has been used in Port Kembla, Australia, and Vanuatu (to remove dead coral heads) and is proposed for use in Tuvalu.

Issues relevant to the use of deflagration include geotechnical information (rock strength); bathymetry; the quantity of material to be removed; and access to the site. The cartridges need to be drilled into the coral layer, so consideration needs to be given to how the drilling will be undertaken (e.g., are expert divers available and diving conditions safe?) and the need and means to remove the broken coral.

To calculate the impact of such an approach, percentage coral coverage needs to be considered (which is typically higher on the reef slope and crest as compared to the reef edge and flat).

4.4 Marine Fauna and Avifauna

Marine fauna are highly diverse and range in size from microscopic zooplankton to the blue whale. Marine fauna that live their entire life in the ocean include sharks, whales, dolphins, dugongs, sea snakes, most fish, crustaceans and plankton. Marine fauna that either leaves or enters the ocean for breeding or resting purposes, includes turtles, seals and sea lions, penguins, and crabs. While animals such as sponges and corals that are attached to the seabed are also marine fauna, they are typically considered to be part of benthic communities and habitats.

Marine avifauna are seabirds, which are considered in parallel with marine fauna below.

4.4.1 Potential impacts

Development activities that have the potential to have an impact on marine fauna and avifauna (birds) include, but are not necessarily limited to:

- Activities that change the characteristics of the marine and coastal environment, including -
  - Dredging, excavation and the placement of rock, through increases in turbidity and the mobilisation of contaminants (if any) located within the sediment.
  - Construction of harbours, breakwaters, causeways, walls and other marine infrastructure that has the potential to change marine currents and other coastal processes.
  - Ports, harbours and marinas that effect water quality within confined water bodies and its exchange with the broader marine and coastal environment.
  - Outflows and discharges from construction sites (including accidental discharges), commercial and industrial development and aquaculture operations.
- Activities that cause underwater noise, including from pile driving, rock dumping, dredging, vessel movements and seismic exploration. Underwater noise can negatively impact marine fauna through physical injury or causing physiological effects/avoidance behaviour (albeit the latter will generally be intermittent, short term and localised).
- Infrastructure lighting. Inappropriate lighting either at the shore or on vessels that can alter feeding and migratory behaviours of fish, sea birds and turtles, e.g., turtle behaviour during the nesting season.
- Vessel movements during construction and the operation of ports, harbours and jetties have the potential to injure or kill marine fauna, through collisions, or may result in avoidance behaviour. Marine turtles and cetaceans (whales and dolphins) are particularly susceptible to harm from vessel strike.
- The import of plant, equipment, and materials for construction, which has the potential to introduce invasive marine species (such as the crown of thorns starfish Acanthaster plancii and Brown macroalgae Sargassum spp.) or disease through insufficient biosecurity (cleaning and inspection of marine plant and equipment) and ballast water exchange.
- High volume seawater intakes (e.g., desalination and cooling water intakes) can entrain or trap adult and juvenile marine fauna as well as large numbers of planktonic larvae and result in mortality.

Tip – Other guidance material

As discussed above, underwater piling can have negative impacts on marine life, in particular cetaceans. A useful document to understand the impacts and potential mitigation measures is the Underwater Piling Noise Guidelines prepared by the Government of South Australia (Department of Planning, Transport and Infrastructure, 2012) These are currently under review and being updated with latest guidance due to be released here https://www.dit.sa.gov.au/documents/EHTM .

Similarly, for light impacts, reference can be made to the National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds prepared by the Commonwealth of Australia (2020).

Coastal environments in the Pacific are home to a diverse range of coastal fauna and flora which play a significant ecological role in the functioning of coastal and oceanic habitats and are also recognised as being a fundamental element of Pacific Islanders' culture and heritage.

4.4.2 Mitigation strategies

To mitigate the impacts of a project on marine fauna a proponent may employ the following mitigation strategies:

- Careful site selection and design. Impacts can be minimised by identifying, and avoiding, areas that support sensitive receptors, such as feeding and nesting grounds for marine fauna.
- Project phasing to avoid key times for sensitive receptors. For example, activities that restrict fish passage should be avoided during migration and spawning seasons.
- Marine 'go slow' zones around construction sites to reduce the risk of boat strike and reduce noise related effects.
- An EMMP that includes -
  - » Equipment maintenance to ensure good working order and the use of proper sound controls where appropriate and practical (e.g., mufflers, propeller shrouds and tuned propellers and drive shafts).
  - » Monitoring to ensure the impacts to marine fauna are limited to those deemed acceptable (see Section 4.3.2), that sound-generating equipment is switched off when not in use, and that appropriate weed and pest control measures are in place.
  - » Measures to support any marine fauna or avifauna that are trapped or injured by the works.
  - » Thorough biosecurity measures (such as phytosanitary certificates issued in the country of origin prior to shipment of plant and aggregate) and compliance checks to ensure pest species, both marine and terrestrial, are not introduced by the works. This should include restrictions on ballast water discharge within 5km of the coast (with confirmation via logbooks).
  - » Education for skippers of construction barges and workboats on how best to avoid boat strikes, what to do during vessel interactions with marine fauna and reporting of boat strikes or fauna interactions.
  - » The minimisation and shielding of lighting, and use of directional lighting (while meeting health and safety requirements).
- Where impacts cannot be mitigated, compensatory measures may be explored, such as -
  - » Relocation of communities or individuals, to other, unaffected areas.
  - » Restoration of habitats upon completion of the construction phase (if site conditions are still suitable), e.g., mangrove seagrass replanting.

Example – Identification and protection of sensitive species

A consent condition for the Work Boat Harbour project in Niutao, Tuvalu, is that any coconut crabs, Birgus latro (a locally important species and food source) living in the vegetated parts of the beach need to be relocated (in conjunction with the local Conservation Officer) prior to clearance of the vegetation, and information on size, gender, number, and location needs to be provided to the Department of Environment. This is to be achieved via an immediate pre-works survey to identify coconut crab habitats (and active sea bird nesting sites).

For active sea bird nesting sites, a buffer is to be established between construction activities and the nest to minimise noise and disturbance and should be in effect until the nest is no longer active. The buffer should be as large as it can be and at least 10m. The Contractor shall not destroy nests, eggs, or nest sites, including trees.

4.5 Changes to Terrestrial Water and Sediment Quality

Although not the central focus of this guide, changes to terrestrial water and sediment quality can arise due to coastal engineering projects and affect the coastal environment.

4.5.1 Potential impacts

Development activities associated with coastal engineering projects that have the potential to impact on terrestrial environmental quality include, but are not necessarily limited to:

- clearing of deep-rooted remnant native vegetation in areas prone to salinity and erosion (see Section 4.1);
- waste rock and tailings (dredged arising) disposal;
- disturbance to acid sulphate soils and land use practices with the potential to cause soil contamination; and,
- production of construction waste.

The management of construction waste from maritime projects can have a significant environmental impact on small remote island communities. There is generally very little ability or infrastructure to effectively manage solid waste. While waste pits are used, there are potential problems associated with leachate entering groundwater, which is often already subject to degradation.

Hydrocarbons (fuel, lubricants) and marine paints and solvents stored, dispensed and used during construction works by vehicles, plant and equipment pose a potential hazard to the marine environment, as well as the subsurface freshwater lens on the island if leakage or spillage occur. Large quantities of hydrocarbons are often required to be stored on remote islands for the duration of coastal development projects, due to the logistical challenges and the long supply line. Hence, extreme care is required to ensure there are no accidental spills and proper storage.

Because of space and resource constraints, dredged material often needs to be stockpiled on island for harbour and/or seawall projects, ahead of crushing and its use in the structure. If such stockpiles are not properly managed, impacts on soils, vegetation and water quality can occur.

4.5.2 Mitigation

To mitigate the impacts of a coastal engineering project on terrestrial (and consequently marine) environmental quality, a proponent may employ the following mitigation strategies:

- Careful site selection and design, e.g., avoiding areas that contain potential contaminants or sensitive receivers. Additionally, the project should be staged to avoid large areas of excavation being exposed at the same time, to minimise the potential for erosion.
- A requirement for all hydrocarbons to be stored either on the supply ship, barge or in a dedicated land-based facility. The proposed location of the shed should be selected in conjunction with the island elders to ensure it does not impact any houses or water supplies.
- A requirement for all inorganic and solid waste generated by the construction (including waste hydrocarbons, steel, formwork hoses, tires, etc.) to be removed from the island environment. There may be some limited exceptions, for example, where surplus concrete or aggregate can be used for the construction of community facilities. Exceptions such as these will need to be agreed with the island elders in advance.
- Agreement on the location of any material stockpiles with the island elders in advance and ensuring that they are stored in bunded areas or in a controlled and well-managed manner.
- Installation of on-site toilet facilities (including separate, secure facilities for women) with an appropriate self-contained sewage tank.
- Composting of all green and organic wastes generated by the contractor to assist soil improvement for communal food crops or use as pig food.
- An EMMP that focuses on the key threats posed by the project to terrestrial environmental quality and the pathways by which those threats could cause environmental protection outcomes to be compromised. Specifically, the EMMP should include -
  - » Comprehensive site induction for all personnel involved in the project, with specific attention on, e.g., the sensitive atoll or reef environment and waste/spill management.
  - » All personnel involved in handling dangerous goods to be trained and inducted in the handling, emergency procedures and storage requirements for different types of substances.
  - » Measures to ensure contaminants released from plant or other construction activities do not enter any water bodies. Including:
    - where fuel is stored on land, it will be stored in dedicated areas in sealed tanks placed within a concrete bund that has 110% of the capacity of the drums for storage
    - storage areas to be located at least 50m away from the marine environment and fully secured and locked when not in use
    - smaller volumes of hazardous substances to be contained within a metal storage locker within the storage shed
    - quantities of marine paint to be limited to no more than two litres at any one time contained within a larger volume drip tray
    - lined pits to separate oil and water to be installed near any workshop or maintenance shed to prevent leaching of hydrocarbons into the water table
    - vehicles and machinery to be refuelled by authorized and trained personnel only in designated areas and not over water; drip trays to be used during refuelling or servicing
  - » Spill kits to be available in all land and sea works areas.
  - » A protocol for dealing with unexpected contamination if uncovered during construction.
  - » A Waste and Spoil Management Plan and a Spill Response Plan (procedures for cleaning up and reporting accidental spills).

4.6 Terrestrial Flora

Groupings of different flora (vegetation) are patterned across the landscape in response to environmental conditions. A decline in the extent and condition of vegetation may precede the loss of its species and provide an indicator of the (poor) health of other elements of the environment. Further, terrestrial habitats can be important for some coastal species (such as land crabs, insects, birds and reptiles). As such, although they are not a central focus of this guide, impacts on terrestrial vegetation due to coastal engineering projects are briefly discussed below.

4.6.1 Potential impacts

The degree of disturbance and the biology of the vegetation involved will determine the severity of direct impacts on flora. The most severe will be the permanent alteration of substrate and habitat (such as building a road, a passenger building or removing the landform upon which a species occurs), while some flora may readily recover from temporary clearing. Many coastal engineering projects will involve the removal of vegetation for the construction camp, laydown and storage areas, with the loss of protective ground cover, habitat and shade.

Indirect impacts on flora include, but are not necessarily limited to:

- fragmentation or isolation of populations/occurrences;
- effects on the habitat that supports it;
- effects on other species with important ecological functions, e.g., pollinators, seed dispersal vectors, essential symbiotic fungi;
- introduction or promotion of weeds and/or disease, and temporary impacts such as fire;
- altered hydrology, including an increase or decrease of the groundwater level and alteration of surface water flow.

4.6.2 Mitigation strategies

To mitigate the impacts of a project on terrestrial flora a proponent may employ the following mitigation strategies:

- Careful site selection and design, avoiding areas that contain sensitive receptors. Formerly cleared land should be selected preferentially, where suitable, for supporting infrastructure. Buildings and/or shelters should not be located closer than 20m to the foreshore.
- Large single trees should be retained where practicable to provide shade and amenity value. However, individual trees should not be retained where they are exposed to the influence of winds, impacting their stability, where the root plate is damaged during site preparation or where they are affected by disease. Trees to be retained should be clearly marked.
- An EMMP that includes monitoring to ensure the impacts are limited to those identified at the design stage, for example tree protection plans to ensure retained trees/ vegetation are not impacted by construction activities nearby, causing issues such as root die back and compaction of the drip zone.
- Where impacts cannot be mitigated, compensatory measures may be explored, such as relocation of communities (endangered plants) to other unaffected areas and restoration of habitats upon completion of the construction phase (if site conditions remain suitable post-construction).

4.7 Effects on Air Quality

Air quality is the chemical, physical, biological and aesthetic characteristics of air. Maintaining good air quality and minimising emissions protects human health and amenity, as well as the broader environment.

4.7.1 Potential impacts

Coastal engineering projects have a limited ability (by contrast to power and industrial projects) to adversely influence air quality. In general, any effects will be limited to dust and exhaust emissions in the construction phase, generated by construction machinery, excavation and material disposal, pile driving, vehicles, and mobile generators, as well as crushing dredged material for aggregate and concrete batching plants.

4.7.2 Mitigation strategies

To mitigate the impacts of a project on air quality a proponent may employ the following mitigation strategies:

- Careful site selection and design to avoid the proximity of certain activities (e.g., crushing and batching) to areas that contain sensitive receptors, such as important habitats or population centres. In the case of ports, green port initiatives to reduce emissions could be specified in the design.
- An EMMP that includes provisions for -
  - » The use of fully maintained vehicles and diesel equipment that have been certified as compliant with local air quality legislation prior to transhipment to the project site.
  - » Avoiding idling of vehicles when not in use and unnecessary operation of equipment.
  - » Dust control through
    - spraying haul routes and excavation areas, strictly using rain or seawater
    - imposing a speed limit of 15 mph on surfaced and 10 mph on unsurfaced haul roads
    - limiting or suspending excavation and other dust producing activities during periods of strong onshore winds when working adjacent to village buildings and houses
    - covering and bunding stockpiled materials where feasible (e.g., using mulches)
    - ensuring bulk cement and other fine powder materials are delivered in enclosed tankers and stored in silos with suitable emission control systems to prevent escape of material and overfilling during delivery
    - considering the erection of screens around dusty activities.

» Recording and resolving all dust and air quality complaints and exceptional incidents.

» Undertaking daily inspections of nearby receptors to monitor dust when activities with a high potential to produce dust are being undertaken, with cleaning to be provided if necessary.

Point of interest – Apia Green Port

The 'vision' for Apia Green Port in Samoa has two parts:

- to optimise energy efficiency, adopt environmentally sustainable practices and develop in a sustainable manner; and,
- to be operationally efficient, safe and resilient to future climate change and commercial challenges.

Its priorities are to:

- measure and reduce annual use of electric power and diesel; and,
- measure and improve waste and wastewater management (from vessels and on the yard), reuse/recycling, and water use.

4.8 Noise Effects

Noise pollution is unwanted or excessive sound that can have impacts on human health, wildlife, and environmental quality.

4.8.1 Potential impacts

British Standards set 'reasonable' daytime, night-time, and evening/weekend noise thresholds as 65 dB, 45 dB and 55 dB respectively. Noise pollution will arise due to the construction of coastal engineering projects, e.g., handling rock for seawalls, piling for jetties, dredging and hydraulic rock breaking (around 78 dB at 10m), crushing (around 82 dB at 10m), concrete batching, water and fuel pumps, generators (around 61 dB at 10m) and site vehicles. The operation of some facilities, such as ports, can also lead to operational noise, particularly in generally quiet (low noise) Pacific environments. However, for coastal engineering projects, noise effects are largely associated with the construction phase.

Exposure to excessive or prolonged noise has been shown to cause a range of human health problems, ranging from stress and fatigue from lack of sleep, poor concentration, productivity losses, and communication difficulties, to more serious issues such as cardiovascular disease, cognitive impairment, tinnitus, and hearing loss.

Noise pollution also has a negative impact on wildlife by reducing habitat quality, increasing stress levels, and masking other sounds. Chronic noise exposure is especially disruptive for species that rely on sound for communication or hunting. For example, bird species that rely on vocal communication, bats and owls, and prey species that rely on noise to detect predators may have decreased patterns of foraging, reducing growth and survivability. Bird species and nocturnal animals haven been shown to avoid areas with noise pollution. Reductions in bird populations and foraging activities can, in turn, negatively impact seed dispersion, affecting ecosystem services and diversity. Underwater noise can also impact marine species, as discussed in Section 4.4

4.8.2 Mitigation strategies

To mitigate the noise impacts of a project a proponent may employ the following mitigation strategies:

- Careful site selection and design to minimise noise impacts (as for air quality).
- Screening noisy activities where the noise impact is predicted to be significant and this is viable (e.g., it may be possible to screen a crusher or batching plant but, typically, it will not be possible to screen excavation activities).
- Time works to avoid sensitive periods, such as night-time[4], Sundays, cultural events, and fauna migrations.
- An EMMP that includes provisions for -
  - » Managing noise by ensuring that high noise generating activities are undertaken during daylight hours and not undertaken during known peak migration times for sensitive species that use the site.
  - » Establishing buffer zones around sensitive habitats and other receptors.
  - » Appropriate staff training to avoid unnecessary noise emissions (unnecessary revving of engines, avoiding reversing, driving within the speed limit, shutting down equipment between use, reporting and repairing defective equipment).
  - » The use of modern, quiet construction equipment, in accordance with guidance, and proper maintenance/ regular inspection. Refer to the Underwater Piling

4 For land based works, generally this will be possible, but working at night may not be able to be avoided (without significantly extending the duration of the construction phase) for works that are tidally constrained.

Noise Guidelines (Department of Planning, Transport and Infrastructure, 2012) for detailed advice on this issue.
    - Liaison with the island leaders to minimise disruption to church services, schools, health clinics and other sensitive receptors.
    - Undertaking noise monitoring to ensure applicable noise standards are met. This may be informal monitoring through a grievance redress mechanism (GRM).

4.9 Other Societal or Community Effects

Tropical small island nations in the Pacific and other parts of the world are facing increasing social and ecological change resulting from development, population growth, and climate-related changes. These are affecting the livelihoods and survival of coastal communities. Although most coastal engineering projects are designed to improve conditions on the islands (i.e., provide essential transportation infrastructure and coastal defences), they also have the potential to cause harm.

4.9.1 Potential impacts

Activities associated with coastal engineering projects that have the potential to affect communities include, but are not limited to:

- Activities that disturb the ground in a way that may impact sites of cultural and heritage significance.
- Activities that may impact amenity by -
    - Generating noise or vibration in proximity to sensitive premises (see Section 4.8).
    - Generating dust (see Section 4.7).
    - Increasing traffic and nuisance.
- Activities that may impact aesthetic values, such as -
    - large scale quarry or mining activities
    - major tourism or other developments in or adjacent to natural areas.
- Construction projects that involve an influx of foreign and non-local workers to remote communities, which introduces risks associated with cultural insensitivity, child protection and communicable diseases, including sexually transmitted infections (STIs) and COVID-19. Communicable diseases common in Pacific islands include chlamydia, syphilis and hepatitis B. HIV/AIDS is also prevalent.
- Activities that have hygiene and sanitation impacts through use of the island's water supply, potentially causing water shortages, and an absence of proper disposal procedures for water and wastewater used by workers and/or for construction activities (see Sections 5.2 and 5.5). Potable and fresh water is a scarce commodity on many outer islands, where groundwater is known to be increasing in salinity.
- Activities that have a health and safety risk. Construction on remote islands carries significant risk to construction workers and the community if it is not appropriately managed. Relatively minor injuries may have life threatening consequences due to the difficulty of getting access to appropriate and timely medical treatment.
- Dredging activities that may cause Ciguatera – a foodborne illness caused by eating certain reef fish whose flesh is contaminated with a toxin made by dinoflagellates, such as Gambierdiscus toxicus. These dinoflagellates adhere to coral, algae and seaweed, where they are eaten by herbivorous fish which in turn are eaten by larger carnivorous fish. Exacerbation of the effects of Ciguatera outbreaks have been linked to reef blasting in Tuvalu (Niutao in 1989 and Nui in 1988).

4.9.2 Mitigation strategies

To mitigate the societal impacts of a project a proponent should employ the following mitigation strategies:

- Careful site selection and design to minimise adverse effects and maximise benefits to the community. Suitable sites for the works and construction compounds should be approved by the village elders to ensure these are not on or near any heritage sites, areas of cultural significance or result in any damage or removal of indigenous vegetation of high ecological or social value.
- Timing works to avoid sensitive periods of the year, such as cultural events.
- The development of a chance (or unexpected) finds protocol should, for example, identify graves, cultural and heritage objects or artifacts (or UXO) during the works. For activities that may occur in areas where cultural resources could be present, procedures should be specified for identifying and avoiding impacts on cultural property, including:
    - Consultation with the village elders and community to identify known and possible sites linked to project activities.
    - Cessation of work should a site of possible cultural significance be found, until the significance of the "find" has been determined by the appropriate authorities and local inhabitants, and until fitting treatment of the site has been determined and carried out.
- Buffer zones or other management arrangements should be established to avoid damage to cultural resources, such as sacred forests and graveyards. Local communities/

custodians to which these areas belong will identify their presence (and should be consulted during the EIA process to this end) and should determine access procedures and should not be excluded from accessing these areas.

- Contractor self-sufficiency in the collection, supply and storage of all fresh and potable water to be used in the construction camp and for the works may require a desalination plant).
- A set of protocols (a 'code of conduct') should also be established and agreed upon with the island elders to determine the social and cultural parameters for working on the island. These protocols should form part of the contractual obligations of the contractor. Measures to mitigate any concerns should then be addressed in discussions with the island elders and through public consultation prior to any mobilisation.
- All project employees, local and non-local, should be trained and inducted prior to the commencement of any work on core principles, including health and safety, gender and cultural awareness, the prevention of sexual abuse, exploitation, and harassment, child protection, core labour standards, and the agreed code of conduct. Education and training in STI, HIV/AIDS and COVID-19 awareness and prevention is an important health risk mitigation factor for both community members and project workers.
- Site induction should also make construction personnel aware of the locations and importance of areas of cultural importance, and it should be made clear that such areas are always to be avoided.
- The employment of a local community liaison officer (CLO) by the contractor will facilitate productive communication between the community and the contractor.
- Efforts to hire local people, including women and disadvantaged individuals, for unskilled and semi-skilled activities and labour; with at least minimum wage requirements to be met.
- For Ciguatera:
  - » Risk assessment to determine if there is a need to test for dinoflagellates in fish tissues.
  - » Removal of extracted materials from the reef surface quickly to reduce the likelihood of algae bloom.
  - » Establishing a register to document any cases of Ciguatera brought to the attention of medical staff for a period of six months before, during, and six months after construction.
  - » Reporting any cases to the appropriate authorities so that safeguards can be put in place (e.g., a notice to advise against consumption of herbivorous reef fish until further testing has occurred and/or sufficient time has passed).
- An EMMP that includes -
  - » Relevant community protocols and a Community Liaison Plan. This should include regular meetings with the island elders and for the distribution of information (includes notices) on the scope and schedule of construction, and on activities that could cause nuisance.
  - » The 'code of conduct' to be agreed with local leaders and included in employment contracts. The contractor will need to ensure that worker actions outside the work site are controlled and that community rules are observed. This is likely to cover appropriate behavior around local men, women and children, restrictions on alcohol consumption, restrictions on fishing, the implementation of awareness programmes, the implementation of the GRM and handling of complaints, the approach to hiring local labor, and implementation of a community Health and Safety Plan (HSP).
  - » Security to be provided at the work site, such that there is a prohibition on unauthorised people (especially children) entering.
  - » An active GRM, supported by the CLO. The community must be aware of the GRM and how to access it and the CLO.
  - » A HSP (appropriate to the nature and scope of the works) to include details of -
    - Strict controls on access to the works site, patrolled by trained security, preventing children and locals from accessing the site and dangerous machinery.
    - Advisory and warning signage to be secured on fences, gates and sign boards, and provided in both the language of the islanders and the main nationality of the workers and repeated in English. The works site is to be fenced.
    - The location and response times to emergency hospital services (the provision of care is best met by having a qualified medical doctor in the construction team).
    - An emergency response plan (ERP) emergency medevac plan, with lines of responsibility for action.
    - Relevant and suitable protective personal equipment (PPE).
    - Management procedures for the use of shared roads (including maintaining access to the coast, vehicle numbers and speed restrictions, which can also help mitigate noise and dust levels as well as traffic impacts).

The information provided above is not exhaustive and will not have covered all potential impacts arising from coastal engineering projects in the Pacific. It is, however, indicative of the types of effects and impacts that can arise, and the mitigation measures and strategies that can be adopted.

Coral reef in Niue. Credit: SPTO and Jonathan Irish

5 Effective EIA of Coastal Engineering Projects

Key recommendations for effective EIA of coastal engineering projects are provided in this section. These recommendations are intended to guide government officers, project proponents and other key stakeholders on good EIA practices, as a basis for good planning decisions. This does not repeat the detailed information included in SPREP (2016), which provides a detailed overview of the phases of the EIA process (as per Figure 1), but instead highlights aspects of particular importance in the context of coastal development projects. For information on the general EIA process, please refer to Strengthening environmental impact assessment: guidelines for Pacific island countries and territories (SPREP 2016).

5.1 Stakeholder Engagement

As emphasised in SPREP (2016), good stakeholder and public consultation is crucial for a successful EIA process and requires a considered and continuous approach. It should be fully integrated throughout the EIA process, to identify sites of importance, identify risks and hazards, and design appropriate solutions. The approach taken to stakeholder engagement must also account for the cultural norms and hierarchy of the location where the project is taking place. There are strict protocols in the Pacific islands for engaging with traditional landowners and leaders and, in some locations, the ruling of the town council takes precedence over national law.

The Pacific is characterised by extensive customary ownership and direct linkages between community livelihoods, subsistence lifestyles, natural resource conditions and sustainable development. Within this context, an effective EIA process must be participatory, engaging the local community and customary land/resource owners likely to be affected by a development, as well as other relevant stakeholders, such as provincial or local government authorities, businesses, relevant NGOs and CSOs (such as the Red Cross and environmental groups), and women's, men's, youth and church groups.

Stakeholder engagement should reflect a project's level of risk and its anticipated impacts, and it should be designed to ensure communities have an opportunity to learn about, and participate in, decision-making processes and the activities that will affect them. This should support the acceptance of a development in the community. Effective stakeholder engagement should meet four objectives, to:

- familiarise stakeholders with the project planning and approval process
- get input on potential perceived or actual project impacts
- get feedback on the project design and proposed impact mitigation measures
- build and maintain constructive relationships and trust between all parties.

Typically, engagement with the local community, land/resource owners and other stakeholders is a requirement under EIA legislation. This is often supported by national guidelines that outline appropriate methods and timeframes for engagement and consultation, and that provide recommendations for ensuring adequate participation by, and representation of, affected communities. Techniques for stakeholder engagement are covered in SPREP (2020) and guidance produced by donor organisations such as the World Bank.

5.2 Scoping and Terms of Reference

Scoping is the process of identifying the issues to be addressed in EIA and the level of detail to which an issue is to be examined. Scoping is a fundamental early stage of the EIA process that enables the resources available to be focussed on the key issues, saving time and money. The key issues that should be considered with respect to coastal studies include:

- The predicted extent of the impact area, e.g., in relation to marine ecology (habitats and species). This will be strongly influenced by the extent of alterations to coastal processes and water quality.
- Identifying potentially significant impacts that require detailed assessment and insignificant impacts that do not (i.e., topics that can be 'scoped out').
- The adequacy of existing baseline data and scope for further studies, should they be deemed necessary.
- The approach to be taken to coastal process modelling studies, should any be required.
- The methods to be adopted for assessing the magnitude and significance of effects/impacts (including potentially cumulative and residual effects).

The focus of this stage should be on 'scoping in' those issues that could be potentially significant given the nature and extent of the development and 'scoping out' those that will not. For those issues scoped in, it is also important to closely define to what extent the subject needs to be examined (rather than simply examining all elements of it) and to design the survey and assessment work to be undertaken based on this. Section 3 herein provides guidance on the type of surveys and studies that may be relevant to the coastal engineering project. This should then be verified and agreed with the relevant stakeholders and used to define the terms of reference (ToR) for the EIA. Tool 2 in SPREP (2016) provides a ToR template to assist EIA officers and proponents.

The required scope of an EIA will be largely determined by the value, importance and sensitivity of the biological and social environment (the impact receptors) and the nature of the project (its characteristics, scale and area of influence). In general, coastal impact assessments should adopt a phased approach to baseline surveys characterising the environment, which can be set out and agreed in the scoping phase. It is essential that EIA investigations are proportionate and phased baseline investigations can inform this by first determining (often based on desktop review) if any features of interest, value, etc., are present (as detailed in Section 3). This should then inform the scope of further work required.

Effective scoping must be undertaken in relation to the specific context and requirements of the project in question, taking into account the considered views of all stakeholders. Scoping should never be just a matter of looking at similar projects or locations and specifying the same study types. While experience may assist in understanding likely types of studies, a "one size fits all" approach cannot be taken. If it is, it can lead to unnecessary studies being undertaken or necessary studies being missed. Suitably qualified and experienced persons should exercise judgement.

This can save significant time and costs in data collection, report preparation and design/construction. For example, for some (but not all) consent applications for works in the marine environment, many landside issues (transport, air quality, noise, etc.) can be scoped out if there are no direct connections to the project or the extent of any effects will be insignificant.

Example – Defining modelling requirements based on project details

Due to the remoteness of Tuvalu's outer islands, mobilisation of large dredging plant is impractical. The approach proposed for dredging for a series of small boat harbours was, therefore, for an excavator working from the reef flat to use a rock hammer to break the platform and remove the loose material to a bucket and, from there, into trucks. In Nukulaelae, it was quickly discovered that the use of this approach was limited by the tidal depth across the reef platform and swell conditions, resulting in an effective operation time of around 3-4 hours per low tide cycle. Hence for Nui, where the works entail widening the existing channel (to minimise the works footprint) characterised by rapid water discharge, it was determined that the EIA investigations did not need to include plume modelling. Rather, a dredging plan is to be prepared and approved, and visual plume monitoring is to be undertaken (should any concerns be raised, the approach will be adapted).

5.3 Monitoring, Management and Enforcement

An Environmental Monitoring and Management Plan (EMMP) is a site or project specific plan developed to ensure that appropriate environmental management practices are identified and implemented during the various stages of a project, including pre-construction, construction, operation, decommissioning, closure and post-closure. It is a legal requirement for EIA approval under most Pacific island EIA legislation.

An EMMP should:

- describe all mitigation measures required to address the identified impacts of the project;
- identify responsibilities and timeframes;
- include performance objectives and targets; and,
- outline a monitoring and reporting schedule to assess the effectiveness of the mitigation measures.

Consequently, the EIA process does not end once an approval is issued; as development approvals/environmental licences are contingent on conditions set by the regulator, which often refer directly to the mitigation measures identified in the EIA and/or specific conditions set by the regulator to be implemented through the EMMP. Therefore, the need for environmental monitoring and management in line with the EIA continues for the life of the project. To this end an EMMP is a working document that should be periodically reviewed and amended throughout the life of the project to reflect changing environmental conditions and developments in good environmental management.

The EIA administrator must ensure that a project proponent prepares, implements, monitors and reports on the effectiveness of the project EMMP [5]. They have an important role in overseeing the EMMP and coordinating independent monitoring (which may be delivered by members of the local community) to ensure mitigation measures are being effectively implemented and development conditions are complied with. The EIA administrator will need to use enforcement provisions under relevant legislation if the proponent fails to apply mitigation measures, if mitigation measures are not working well, if environmental impacts occur, or if development conditions are breached.

Several government agencies may need to be involved in managing and monitoring a coastal development, which means it is important for the EIA administrator to establish clear guidelines regarding who is responsible for different areas of monitoring, when the monitoring should be undertaken, how compliance will be determined, how enforcement should be carried out, and ensure that contracts associated with the works capture these arrangements.

It is recommended that a project's EMMP includes a requirement for all environmental data gathered for the EIA to be provided to the Country's EIA administrator. This data should then be stored and managed as an information asset. Ideally, data from coastal

5 Further detail is provided in SPREP (2018) (see Appendix 2, Section 10).

engineering EIA baseline and monitoring studies should be provided to the national environment agency on a regular, periodic basis so it can be stored in a national database. Data storage must allow for easy retrieval and analysis of information, and for the integration of data across project sites, where feasible, to support State of the Environment and MEA reporting, and the identification of cumulative impacts.

An EMMP Toolkit for coastal engineering projects is annexed to this guidance note.

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ANNEX

EMMP toolkit for coastal engineering projects in the Pacific

SPREP Secretariat of the Pacific Regional Environment Programme

An initiative of the Organisation of African, Caribbean and Pacific States funded by the European Union

ACP MEAs 3

UN environment programme 50 1972-2022

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The coral atoll of Ouvéa in Loyalty Islands, New Caledonia. Credit: SPTO & David Kirkland

1 Introduction

1.1 An EMMP Toolkit

This document has been prepared for government agencies and other project stakeholders to use as a 'toolkit' for the development of Environmental Monitoring and Management Plans (EMMPs)[1] for coastal engineering projects in the Pacific. Project specific EMMPs are generally required as a step to attaining approval to start work and form part of the approval conditions and environmental licences or permits for project operations. EMMPs typically follow from an environmental impact assessment (EIA), with the objective of implementing and ensuring their mitigation, monitoring and management actions. EMMPs should provide a consistent approach to managing and minimising environmental impacts throughout a project's life.

A common criticism of EIAs relates to poor implementation of environmental controls once approvals have been obtained. The production of an EMMP is an effective way of ensuring that EIA and consent requirements are met, and good environmental practice is conducted and constant.

The EMMP Toolkit's primary function is to set out the requirements for, and a coherent and consistent approach to, EMMP development and review. This should assist in achieving full and proper implementation of EIA commitments (enhancing the effectiveness of EIA) and best practice in environmental management during a project's or a development programme's lifetime.

1.2 Related Documents – Living Documents

An EMMP generally constitutes a single component of a project's environmental management documentation. As such, EMMPs should be integrated into, and consistent with, existing environmental documentation. This includes National Environmental Management Strategies, policies, legislation, standards as well as any project specific EIAs or wider strategic environmental assessments (SEAs) and associated technical reports. This may also include environmental management system (EMS) a proponent's organisation may have in place.

An EMS is a means for an organisation or entity to find, monitor, and manage environmental risks arising from their activities. A focus is to maintain ongoing environmental compliance with relevant local, regional and national legislation and conventions, particularly regarding resource management and pollution avoidance.

EMMPs should also be consistent with project design and associated activities and be tailored for the specific EIA. Ideally, aspects from each process should influence the other – EMMPs should not be an off the shelf set of standard operating procedures since each project is novel with its own set of approval conditions, environmental settings and therefore monitoring and management requirements. Importantly, an EMMP should be a "living" document, that is developed as project changes are observed. This may be in the design phase but may also be during implementation if, for example, environmental parameters change, for instance seasonal climatic changes, unexpected outcomes arise, such as discovery or chance finds of cultural heritage (which requires a different management approach) or monitoring capacity improves (i.e., new technology is available that can streamline monitoring, e.g., remote underwater cameras vs SCUBA divers). This is particularly important for coastal and marine projects, where the environment is typically dynamic.

1 Often also referred to as Environmental Management Plans (EMPs).

2 Core Requirements

2.1 Project Specific, Ensuring Compliance

EMMPs should be developed for a specific project and site (should not be generic) and, as a minimum, ensure the following:

- Compliance with:
  - the islands or territories environmental legislation
  - any project consent (license or permits) or consent conditions
  - the mitigation and monitoring requirements included in the project EIA.
- Proper risk management.
- Use of good practice management techniques.
- Documentation of environmental management actions throughout a project's life.

EMMPs should consider the pre-construction, construction, operation, and decommissioning phases of a project. In some cases, separate EMMPs may be prepared for the construction phase (CEMP) and the operation phase (OEMP). A CEMP is often required of the contractor that is going to construct a project; and an OEMP (or EMS) of the body that is going to operate the facility once built (e.g., a harbour operator). Such documents typically follow from the overarching project EMMP that (as above) also needs to consider the actions that should be taken before any works begin (the preconstruction phase) and either (or both) at the end of construction or the end of operation (if the facility has a foreseeable end of life). CEMPs and OMEPs should be specifically designed to ensure that contractors and operators met their environmental responsibilities.

Tip - Pre-construction EMMP actions

Pre-construction EMMP actions may include:

- Update to reflect any design changes and ensure climate change adaptation.
- Confirmation of land ownership arrangements and permission to access the site.
- Pre-works species surveys and translocation.
- Provision of a dredging method statement.
- Provision of phytosanitary certificates for any materials and plant to be imported.
- Community engagement and agreement to a code of conduct.
- Health and safety plan sign-off, inclusive of emergency response procedures, and pre-works training.
- Establishment of a grievance redress mechanism.
- Establishment of a chance finds procedure.

A poorly planned foreshore development. Credit: SPREP

2.2 Core Content

An EMMP should clearly define a project's or programme's environmental management and mitigation measures, based on the activity and/or impact they are associated with, and their means of implementation. That is, set out the required action, name the individual or organisation with responsibility for taking the action, record the approach to monitoring delivery, including frequency/ when and responsibility (see Table 1).

Project activity	Predicted impact	Management/Mitigation measure		Monitoring	
		Action	Responsibility	Approach & Timing	Responsibility
Excavation	Sediment laden runoff leaving site	Install sediment fences	Site Manager	• Daily visual inspection of sediment fences to ensure they are installed correctly and capable of retaining sediment on site. • Visual inspection of sediment fences during rain events to ensure no sediment is washed from site	Site Manager

Table 1: Example responsibility matrix

2.3 Preparation, Certification and Approval

Primary responsibility for EMMP development lies with the project's or programme's proponent. This includes obtaining the required certification and/or approval. Typically, during construction, the EMMP becomes the contractual responsibly of a contractor for preparation and/or implementation. However, this does not remove the proponent's responsibility for execution of approvals or conditions or ensuring sound environmental management and controls.

Generally, those government departments with responsibility for overseeing a project (and environment departments in particular) should be consulted on the content of the EMMP during the preparation phase (especially if certain environmental impacts or control measures have not been adequately detailed in the EIA phase). Within several Pacific island countries and territories, it is a legal requirement for proponents to engage with the regulators in developing an EMMP prior to the EIA being approved (e.g., the Solomon Islands). However, the absence of a legal requirement should not limit regulators in other jurisdictions from being consulted on the development of EMMPs, especially when it forms part of the EIA approval. It is in the proponents best interest to have a refined EMMP specific to the project needs, focusing on defined effects, clarifications and removing the need for unnecessary or redundant monitoring requirements that may result from off the shelf management plans. Project approvals may stipulate that an EMMP needs certification before construction/operation commences and early consultation should ease this process and reduce costly expenses or delays.

As part of the EIA process and development of the EMMP, any stakeholders affected directly or with vested interest in the project should be consulted over predicted effects and management measures at an early stage. This allows for effective input into EMMP development and may provide solutions to or support for management measures (e.g., community monitoring). Project community liaison officers (CLOs) or steering groups can facilitate this process.

2.4 EMMP Review

As a "living" document, an important part of the EMMP development process is amendment and alteration throughout a project's life to improve environmental management. This practice has the added benefit of improving future EMMPs based on lessons learnt.

The timing of reviews will vary for each project, but typically coincide with:

- a significant environmental incident;
- the availability of improved environmental management processes;
- alteration of the project scope;
- an environmental audit (where the implementation of the EMMP should be audited on a regular basis); and,
- project completion.

Any review should focus on the effectiveness of environmental procedures and controls and re-evaluate/re-define them as required. A copy of each iteration of the EMMP should be kept, documenting the improvement process. Updated EMMPs may require submission to relevant entities (government departments, funding institutions, etc.) for their own consideration and records.

3 Scope and Structure

The scope and content of an EMMP should reflect both the significance of the project's predicted environmental impacts and a project's scale (i.e., the risk). It should also reflect the nature of the works proposed. These will have a significant bearing on the topics covered in the EMMP (e.g., if traffic impacts are not predicted to be significant, then traffic management controls and monitoring requirements may not be needed in the EMMP). As a result, this Toolkit is not intended to be a rigid template but rather a framework, the required content of every EMMP will be unique to its project (or programme).

However, there are common elements that should be included in an EMMP regardless of the project details. The following sections identify and describe these common elements. These elements are:

- Introduction - a project description.
- Management structure and responsibilities.
- Environmental management measures.
- Monitoring and review.

3.1 Introduction and Objectives

An introduction should provide a brief description of the background to the project, including its nature and objectives, relevant legislation, and the objectives of the EMMP. It should also identify the key stakeholders. The EMMP may reference the applicable EIA; BUT this information should not be repeated in detail.

Importantly it should set out or cite the project's approval conditions, any licences or permits required to be obtained, and any other requirements that apply to the project, e.g., voluntary agreements, stakeholder agreements, etc.

The EMMP objectives should be project specific, and not broad policy statements, that provide clarity on what the EMMP is trying to achieve (the impacts to be managed and monitored). They can include objectives that relate to general site management, special site features and best practice environmental management.

3.2 Project description

A project description should provide enough detail to define the nature and scope of the project (and thereby the topics to be covered by the EMMP). Again, the EMMP need not repeat all the information in the EIA.

It should include information on:

- Location - the site location and its environmental characteristics should be described and a plan indicating the location of key facilities and activities provided.
- Activities - a description of the project activities (construction and operation) should be provided. This may include:
  - » a brief description of construction or operation processes
  - » working or operating hours, including details of any activities that may be undertaken outside of these hours
  - » numbers and types of workers to be employed, and
  - » machinery and equipment to be used.
- Timing and scheduling - anticipated commencement and completion dates should be listed. If the project is to be completed in stages, then the dates for each stage should be identified.
- Materials – including hazardous substances [provide examples] with Safety Data Sheets (SDS) and any sources of imported or novel construction materials that may require special handling, e.g., lithium batteries, solar panels.

Example - Project Description

"Dredging and the disposal of dredged material is to be carried out to provide a larger vessel (with a draft of -6.0m) with access to a new wharf and a berth adjacent to an existing boat ramp.

The dredge footprint is 13,000m2 with a dredged volume of 22,500m3. Dredging is proposed to take approximately 8 weeks in the dry season. The preferred method of dredging is a high-rise excavator working from the reef platform, loading the dredged material onto dumper trucks which will then be unloaded onshore (in the works site).

The dredged material will be stockpiled, with 13,500m3 of the material to be used as backfill for the wharf to be located adjacent to a new berth. The remainder of the dredge material is expected to be used for the wharf pavement, hardstand leveling and maintenance purposes on the project site, depending on volumes of backfill required and the suitability of the dredged material.

The wharf is to be constructed of concrete caissons, which are large watertight containers that form the foundation of the structure, to be secured to the reef platform with steel bars and backfilled. The caissons will be pre-cast and delivered to site. The deck will be poured in-situ from an onsite concrete batching plant and crushed dredged material. The wharf construction is expected to take 9 months, including railings, fenders (barriers which prevent ships from hitting the structure), lighting, a new boat ramp, a passenger walkway and terminal building etc."

This project description is succinct and captures all the main information required to characterise the works.

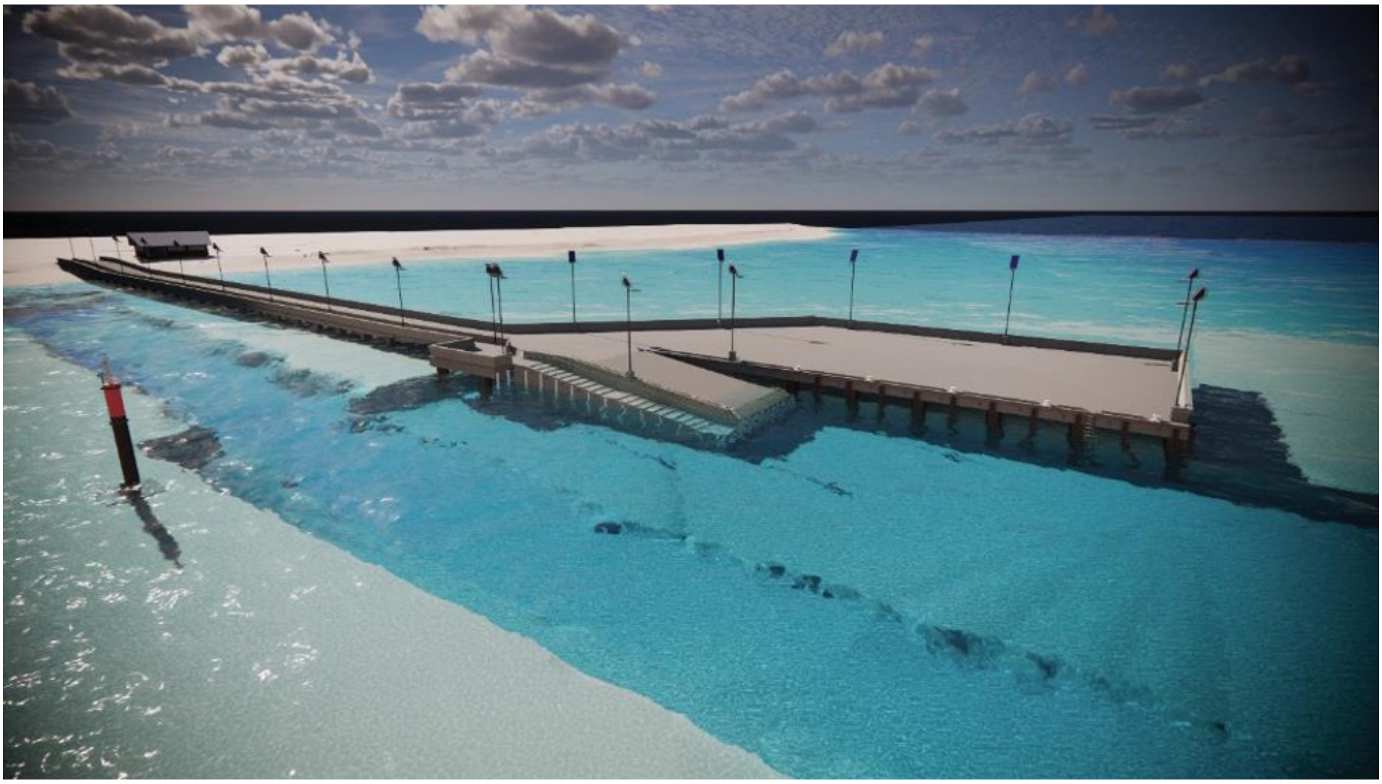

Figure 1: Example wharf and new dredged berth, adjacent to existing boat ramp

3.3 Management Structure and Responsibilities

3.3.1 Organisation

An EMMP should provide an organisation structure for the project, focusing on the names and positions of personnel responsible for environmental management. A description of the roles and responsibilities of each position should be provided, including the roles and responsibilities of any subcontractors. Example roles and responsibilities table for a dredging project is included as Table 2.

Position	Contact Details	Responsibilities
Project Manager	Contractor, Phone number, Alternate phone number, Email address	• Overall responsibility for compliance with all permits and EMMP/EMS requirements; preparation of the EMMP • Adaptive management decisions
Dredging Contract Manager	Phone number, Alternate phone number, Email address	• Operational and contractual matters relating to the dredging operation • Implementation of management measures as detailed in this EMMP
Vessel Master	Phone number, Alternate phone number, Email address	• All matters related to the safety of vessel and crew • Compliance with maritime laws • Implementation of management measures as detailed in this EMMP
Site Environment Officer	Reporting to the Project Manager Phone number, Alternate phone number, Email address	• Implementation of the mitigation and monitoring programme • Staff induction and 'toolbox' talks and pre-start training • Review of adaptive monitoring and management data • Notification of trigger level exceedances to Project Manager and Dredging Contract Manager • Implementation of corrective actions • Environmental reporting at agreed timeframes (daily, weekly, monthly)
Site Staff	Phone number, Alternate phone number, Email address	• Compliance with relevant legislation • Implementation of management measures as detailed in this EMMP
Environmental Authority	Government Phone number, Alternate phone number, Email address	• Contact for spills, non-conformances, and reporting • Regular review of performance and monitoring results • Ensure compliance with government requirements
Contract Engineer	For the employer Phone number, Alternate phone number, Email address	• Supervise, monitor, and enforce contractor's implementation of the EMMP (and all other contractual obligations) • Environmental audits through inspections and report review

Table 2: Example roles and responsibilities table (dredging project)

3.3.2 Reporting

A description of the reporting requirements for the project should be provided and include:

- pre-construction and pre-operation compliance;
- daily, weekly, monthly construction monitoring;
- reporting non-compliance and corrective actions;
- complaints management;
- third-party auditing (e.g., Environmental Authority or Contract Engineer); and,
- any reports required by government agencies.

The EMMP should include templates for or examples of typical reports and identify the position responsible for report preparation and document control procedures.

3.3.3 Training

All employees engaged on a project should undergo general environmental awareness training, specific to the works site (e.g., that identifies protected species or sites of cultural significance to be avoided), and training about their responsibilities under the EMMP. Employees in this instance means all people working on-site, including contractors, subcontractors, and members of the community. The training should ensure that all employees understand their obligation to exercise due diligence for environmental matters.

Tip - What is environmental training?

Site specific environmental training should aim to:

- provide workers with the knowledge to identify environmental issues associated with their activities (relevant to the site) and good practice methods to minimise impacts; and,
- outline environmental obligations relevant to construction activities.

Once training is complete site workers should be able to:

- understand common environmental terms;
- state their legal obligations and responsibilities in relation to environmental management;
- recognise common environmental impacts on site and potential impacts resulting from their work activities;
- identify accepted current environmental management good practice for relevant workplace activities; and,
- identify situations where they require further advice about appropriate work practices to minimise environmental damage.

Effective environmental training greatly reduces project risks.

EIA workshops and trainings improve understanding of environmental issues associated with development activities and strengthen compliance and enforcement

3.3.4 Emergency response

The EMMP should nominate a contact person or persons for emergencies (from small spills to cyclones). This person(s) must be always available and have the authority to stop or otherwise direct works. It should also document the procedures to be followed in the event of an environmental emergency.

The EMMP should include:

- names and contact details for nominated emergency response personnel;
- details of the responsibilities of emergency response personnel;
- contact details for local emergency services (police, ambulance, fire);
- procedures to follow in the event of an emergency to minimise environmental harm; and,
- contact details for notifying relevant government agencies.

3.4 Environmental Management Measures

3.4.1 Comprehensive – risk based

An EMMP should specify all environmental management activities, mitigation, and control measures to be used to prevent or minimise environmental impacts at the site, for those impacts identified in the EIA process (or for the purposes of the EMMP) as being of sufficient significance to require mitigation.

This is the risk assessment aspect of the EMMP, where the management measures identified should be proportionate to the risk. It will affect the EMMP in two ways, first, by deselecting those topics that do not need to be considered (for example, the scope of the project described above could be limited to the coastal and marine environment [2] and, therefore, effects on terrestrial flora and fauna may not need to be managed). Second, by helping to define the extent of the management measures required. That is, where potential impacts are predicted to be limited, then the scale of management required similarly can be limited (e.g., for the above project noise effects on nearby communities are not expected to be significant and, therefore, simple working hour/day constraints are likely to be sufficient; and the slow rate of production associated with the use of an excavator working at low tide to dredge the channel, means that a sediment plume is not predicted to occur and observations could be visual rather than monitored via turbidity sampling). However, where potential impacts are predicted to be more significant, then the management measures required are likely to need to be more extensive (e.g., in-situ concrete pours will require strong controls, including a spill response plan, and the use of crushing plant could generate significant dust that requires appropriate siting of the plant, screens, and cleaning protocols).

As set out in **Section 2.2**, for each control measure responsibility should be assigned to specific personnel and timeframes established for its implementation and monitoring. Where monitoring measures are identified, the EMMP should state the minimum performance level to be achieved (where appropriate [3]) and remedial action to be taken if it is not achieved.

Appendix 1 includes an example of a management, mitigation and monitoring measures table that can form the basis of an EMMP and examples of such measures for the construction phase.

3.4.2 Works plans

Works plans (or method statements) can be important reference tools for an EMMP and should cover environmental controls. In this context, works plans should include the following, as appropriate:

- details of the works;
- details of key locations (e.g., location of active excavation or open holes), allocated parking areas, excavation or dredge spoil dumps, fuel and chemical stores;
- environmentally sensitive areas on and/or adjacent to the works site;
- waterways, including drains;
- proposed control measures (e.g., erosion and sediment controls);
- restrictions (e.g., on access, traffic movements); and,
- monitoring protocols and locations.

2 Although the location of the construction site needs to be considered in this context.
3 Monitoring in some cases may simply involve the confirmation of an action (e.g., self-contained latrines on site).

3.4.3 Record keeping

As part of an EMMP a register should be kept of relevant records, including:

- site inspection checklist;
- non-compliance and Corrective Action Report;
- complaints record;
- environmental incident report;
- environmental training register;
- waste register; and,
- monitoring checklist.

Example - Erosion and Sediment Control Plan

Erosion and Sediment Control Plans (ESCP) are a common requirement of coastal engineering projects and can be complex, however, they can also be relatively simple. Below is an example of a ESCP that shows site contours, overland flow direction, stockpiles and proposed erosion and sediment control installations. While simple, this (Figure 2) gives a good indication of how water flows on the site and how erosion and sediment transport will be controlled.

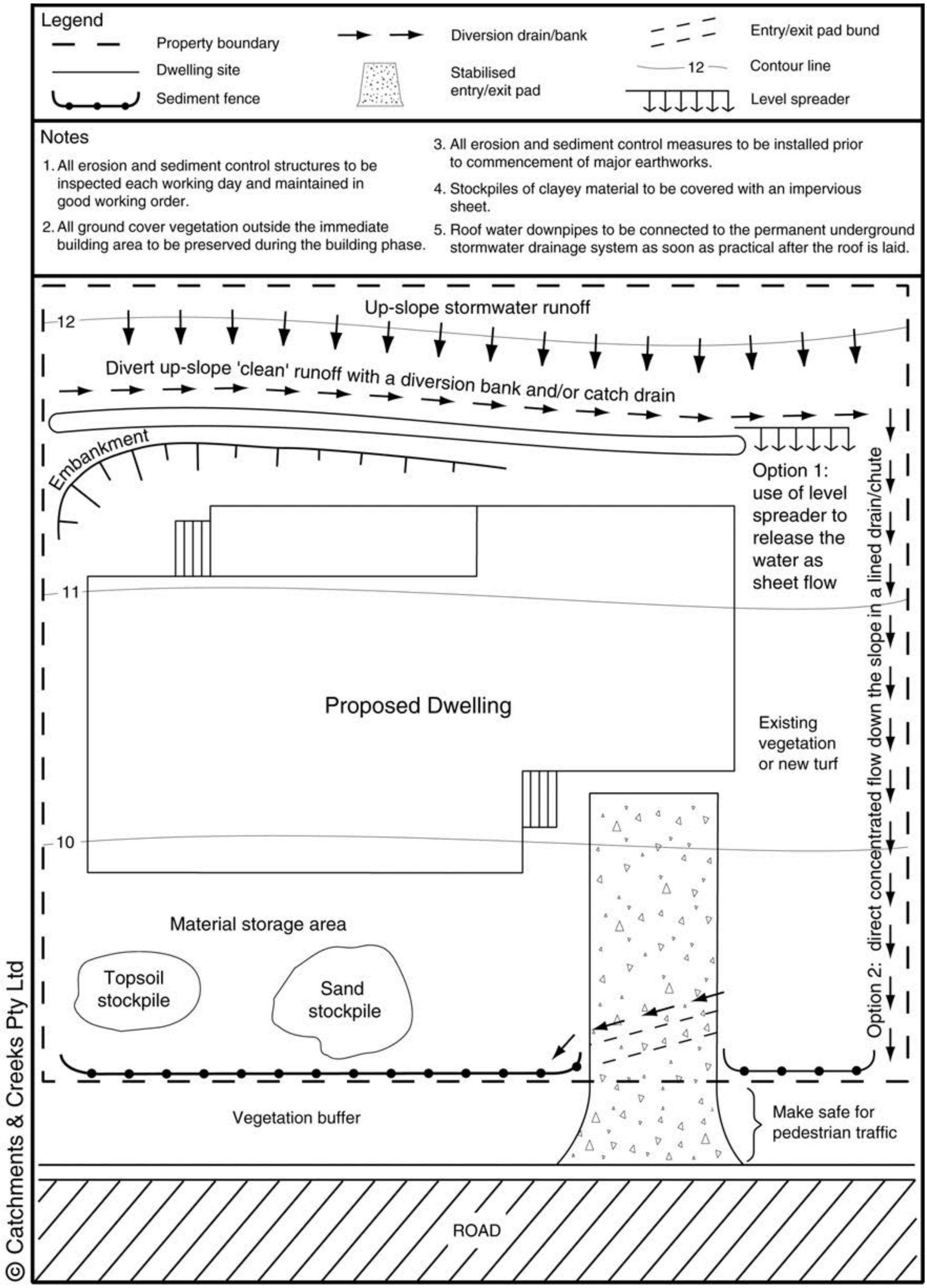

Figure 2: Example ESCP

3.5 Monitoring and Review

3.5.1 Monitoring

This section of an EMMP should explain how environmental management activities and controls will be monitored. A monitoring checklist should be developed specifying when monitoring activities need to be carried out, who is responsible and what monitoring methods will be employed. It should include space for sign-off to verify that the monitoring was undertaken and the results are compliant with criteria. Further, the checklist must specify if, and when, follow-up action is required and who is responsible. Details of how monitoring records will be distributed and stored should also be provided.

3.5.2 Corrective actions

The EMMP should define procedures for dealing with non-compliance with environmental management controls, environmental incidents and emergencies. The details provided should define who is responsible for taking action in the event of a non-compliance or emergency. Procedures should be put in place to record environmental incidents, non-compliance, and corrective and preventative actions.

Tip - Triggers and corrective actions

Environmental monitoring on coastal engineering projects can range from a complex suite of water quality parameters, with trigger limits defined in legislation, to more simple monitoring, such as visual inspections. When monitoring indicates an exceedance of a trigger limit, corrective action, such as stopping work or altering work methods, should take place.

A simple example of the link between monitoring, a trigger and a corrective action is monitoring of dust from site activities. Often such monitoring takes the form of visual inspection, and the trigger is dust settling outside the site. When this is observed a range of corrective actions could be triggered, such as:

- Using sea water or not potable water to suppress the dust.
- Delaying the activity until the wind drops or changes direction.
- Changing the equipment used to limit dust (e.g., sweeping instead of using blowers).
- Limiting the speed of vehicles on site.

3.5.3 EMMP review

This section should describe how and when the EMMP will be reviewed. This should include reviewing the environmental controls and procedures in place to make sure they are still applicable to the activities being carried out and are effective. It should cover:

- when reviews will be done and how often;
- who will be responsible for reviewing the EMMP and making subsequent changes;
- how the site or project team will be informed of any changes; and,
- when the reviewed EMMP should be submitted to the environmental authority.

Traditional men's house, Yap Island, Federated States of Micronesia (FSM). Credit: Stuart Chape

4 EMMP Template

This section provides a template that could be used to develop an EMMP for coastal engineering projects.

<table>
<tr><th colspan="2">Table 3: EMMP Template</th></tr>
<tr><td>Project Name</td><td><Name Here></td></tr>
<tr><td>Project Proponent</td><td><Name Here></td></tr>
<tr><td>Introduction & Objectives</td><td><Insert project details as per Section 3.1 of this document, to cover approval and consent conditions as appropriate></td></tr>
<tr><td>Project Description</td><td><Insert project details as per Section 3.2 of this document></td></tr>
<tr><td>Environmental Management Structure and Responsibilities</td><td><Insert project details as per Section 3.3.1 of this document>

EXAMPLE
<table>
<tr><th>Position</th><th>Contact Details</th><th>Responsibilities</th></tr>
<tr><td>Site Supervisor</td><td>Phone number,
Alternate phone number,
Email address</td><td>• Daily prestart meeting
• Daily monitoring programme
• Daily reporting
• Reporting of incidents or exceedances to authorities if required</td></tr>
</table>
</td></tr>
<tr><td>Environmental Reporting and Training</td><td><Outline details of the site environmental reporting and training requirements as per Sections 3.3.2 and 3.3.3 of this document></td></tr>
<tr><td>Emergency Response</td><td><List applicable emergency contacts as per Section 3.3.4 of this document>
<table>
<tr><th>Agency or Role</th><th>Contact Number</th></tr>
<tr><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Environmental Management Activities and Controls</td><td><Insert information as per Section 3.4.1>

An example of how to display this information is provided below for the management of water quality. If such an approach is to be used, a similar table will be required for all topics relevant to the works and the site. Appendix 1 provides another example</td></tr>
</table>

Table 3: EMMP Template

EXAMPLE: Water Quality Management
Environmental objectives
• To avoid a detrimental impact on the water quality of the receiving environment • To comply with the following legislation: <insert relevant legislation> • To comply with the conditions of approvals associated with the site: <insert relevant conditions> • <insert any other relevant objectives>
Potential environmental impacts
1. Detrimental impact on the water quality and marine environment of the site **2.** Non-compliance with legislative requirements **3.** <insert any other impacts identified in EIA documentation>

Control measures	Responsibility
<insert control measures as per Section 3.4.2 – these may be covered in EIA documentation> <include environmental control plans where applicable> **EXAMPLE:** Install silt fences to ensure sediment is not released to waters	<Insert site-specific detail here>
Monitoring	Responsibility
<insert monitoring details as per Section 3.5.1 of this document – these may be covered in EIA documentation> **EXAMPLE:** • daily inspection of silt fences to ensure they are maintained to the specifications in the ESC plan • during rain events visual inspection to ensure no sediment laden runoff is leaving the site	<Insert site-specific detail here>
Reporting	Responsibility
<insert reporting details specific to this topic> **EXAMPLE:** daily checklist completed with the details of the sediment fence check included	<Insert site-specific detail here>
Performance indicators	
• EXAMPLE: No spills resulting in detrimental impact on the water quality and marine environment of the local area • <insert any relevant indicators>	
Corrective actions	
EXAMPLE: Non-conformance with this EMMP shall be documented alongside the corrective actions taken Corrective actions may include: • Updating operating procedures and associated documentation (such as this EMMP) • Feedback from emergency response or exercise incorporated into operating procedures (should an unacceptable risk be identified) • Re-training staff to address the area of skills lacking • Review of effectiveness of induction training programme • Corrective works in the event of a design flaw/malfunction • <insert other site-specific corrective actions>	
Works Plans	<Insert or cross-reference work plans as per Section 3.4.2 of this document.>
Record Keeping	<Insert record keeping details as per Section 3.4.3 of this document>
Monitoring and Review	<Insert monitoring and review information as per Section 3.5 of this document>

5 EMMP Review Checklist

A checklist is provided in Appendix 2 that can be used to review submitted EMMPs.

APPENDIX 1 Example EMMP Measures

Project activity	Predicted impact	Management or Mitigation Measure		Monitoring	
		Action	Responsibility	Approach & Timing	Responsibility
CONSTRUCTION PHASE					
Construction in dry season	Dust nuisance – in and around construction areas (e.g., crusher) and from exposed spoil storage site	Limit or suspend activity near village during periods of strong winds Use sea water for dust suppression (inc. to the access road within 50m of an occupied dwelling) Cover spoil storage site	Contractor	Visual inspections, daily	Site Environment Officer & Contract Engineer's site representative
Operation of construction plant and vehicles	Exhaust emissions affecting air quality	Use of vehicles certified as compliant Maintenance of equipment Avoid idling when not in use	Contractor	Certification, at outset and every six-months Visual inspections, daily	Site Environment Officer & Contract Engineer's site representative
Construction of a temporary working platform on reef platform	Damage to the works platform and sediment accumulation	Provision of and adherence to a site-specific work plan, to include (i) definition of boundaries/work plan, (ii) avoidance of locations of high environmental value, (iii) details of construction methodology, (iv) risk assessment, (v) details of management measures, (vi) monitoring plan.	Contractor (preparation) Contract Engineer (approval)	Measurement of sediment accumulation (photos), monthly[4] Pre-and post-working platform construction survey[5]	Site Environment Officer reporting to the Contract Engineer Contractor's marine ecologist reporting to the Contract Engineer

4 In this case, a trigger level should be set that – if reached – requires a response from the contractor. This trigger should be included in the work plan management measures.

5 If an unacceptable level of damage arises, this would need to be rectified by the contractor and the criteria for this (again) should be set out in the work plan.

APPENDIX 2 EMMP Review Checklist

Requirements	Addressed Yes/No	Further information required	Observations/ comments
General Administrative Requirements			
All required approvals have been provided to the contractor and details are available, including conditions on the works			
Works on site have not commenced without an approved EMMP			
The site environmental officer holds relevant qualifications and has sufficient experience			
A periodic review procedure has been included, incorporating a system to continuously improve the EMMP			
General Administrative Requirements			
Information on site inspections: • Identifies if controls are adequate, functional, and applied • Identifies appropriate management and corrective measures • Covers frequency			
Information on monitoring includes: • Specific monitoring locations • Specific methods • Monitoring parameters • Criteria/objectives to be measured against • Details on timing, frequency, and duration • Details on the management of non-conformances • Reporting requirements			
Complaint management (environmental) A procedure exists for registering and following through on complaints pertaining to relevant environmental[6] matters			
Environmental incident notification and management A procedure is set out that adequately addresses notification and management requirements for environmental incidents, in accordance with local legislation			

6 'environmental' in this context includes the natural, human (social) and cultural (heritage) environment

Requirements	Addressed Yes/No	Further information required	Observations/ comments
Site induction includes: • Basic responsibilities and roles for environment management • Specific locations of significant environmental or heritage value • Measures and strategies for environmental management • Ancillary activity locations (including turnaround points, construction water, stockpile sites, and material sources) • Systems for notification of potential environmental non-conformances or incidents • Management and contingency plans for unexpected events (spills, UXO, chance finds etc)			
EMMP covers the environment management of all works, including temporary works and ancillary (side-tracks, stockpiles, water sources and contractor's site facilities and camps)			
NOTE: The following topics (in alphabetical order) are not applicable to all projects. Where the EIA and EMMP have not identified the below as requiring management, the sections included below may be ignored or deleted. Equally, other topics not covered here may need to be included.			
Air Quality			

EMMP includes diagrams and descriptions of:
• Air quality receivers in relation to the site and baseline criteria
• Air quality monitoring methodology, including:
  ◦ Equipment and its location
  ◦ Duration
  ◦ Frequency
  ◦ Details of person responsible
• Strategies and measures for management that are both practicable and reasonable to minimise adverse effects on air quality and dust
• Contingency plan for criteria exceeding emissions			

Requirements	Addressed Yes/No	Further information required	Observations/ comments
Chemicals and Fuels			
EMMP includes diagrams and descriptions of: • Chemicals or fuels of volume exceeding 250L stored on site, including storage location, management and containment practices, and maximum quantity to be stored at one time • Practicable and reasonable measures for contamination avoidance and avoidance of discharge of any chemicals or fuels • Spill response measures • Contingency plan for discharge or contamination event • Details of approvals held, where necessary, regarding chemical and fuel use and storage			
Consultation and Communication			
EMMP includes details of the project's communication and consultation plan vis-à-vis engagement with the local community and affected stakeholders and grievance redress mechanism			
Contaminated Land			
EMMP includes diagrams and descriptions of: • Locations of known contamination and associated in situ contaminant types • Practicable and reasonable measures for management and monitoring of each applicable site • A contingency plan for discovery of contaminants on site, or release of contaminants from site A separate Contaminated Site Management Plan may be required to be produced and approved, including methods of: • assessment • remediation • compliance testing			

Requirements	Addressed Yes/No	Further information required	Observations/ comments
Cultural Heritage			
EMMP includes: • Proponent's Cultural Heritage Officer's contact details • Locations of sites/places of cultural heritage on or in proximity to site • Buffer zones or exclusion zones around identified cultural heritage sites/places • List of works in proximity to site/place of cultural heritage • Practicable and reasonable management measures to avoid disturbance A separate Cultural Heritage Monitoring Plan may need to be produced and approved where heritage values are high/at risk			
Geomorphology and Soils			
EMMP includes: • A description of any works that could adversely affect geomorphic form and function, e.g., the beach, and soils/ soil structure • A description of any spoil storage or disposal sites, and their proposed management • Practicable and reasonable management measures to avoid disturbance • Practical and reasonable measure to monitor change and strategies to rectify any problems that arise or to rehabilitate the site Separate Dredging and Erosion & Sediment Control Plans may need to be produced.			
Health & Safety (H&S)			
EMMP includes details of: • Measures to be taken to ensure the H&S of workers • Detailed measures to be taken to ensure the H&S of the local community, including site safety measures, as well as training relating to culturally appropriate/inappropriate behaviours, etc • Information provision related to gender awareness, child protection, STIs, etc • Proposed regular toolbox talks • Emergency assistance procedures • A grievance redress mechanism A separate Health & Safety Plan and Code of Conduct should be produced, and an Emergency Response Plan.			

Requirements	Addressed Yes/No	Further information required	Observations/ comments
Light			
EMMP includes details of: • Proposed lighting • Light generating activities, locations of such, and expected duration of works, including hours of operation • Practical and reasonable light minimisation strategies, including an impact contingency plan			
Marine Habitats (corals, macroalgae, etc.)			
EMMP includes diagrams and descriptions of: • Natural and critical (threatened and protected) marine habitats in and close to the site • Identification of the activities likely to affect such habitats • Practical and reasonable strategies and measures for protection of such habitats • Details of suitably qualified staff (a marine ecologist) to ensure that appropriate protection is in place • Monitoring strategy, including the definition of exceedance criteria (triggers) and correction actions			
Material Sourcing			
EMMP includes diagrams and descriptions of: Water sourcing • Primary water consumption activities • Construction water source(s) and expected volumes • Applicable conditions and requirements for water take • Strategies to maximise efficiency of water use • Monitoring procedures Construction materials • Sources of sand, gravel, or fill, etc. including volumes • Proximity to site • Requirements for storage and access • Required approvals • Biosecurity measures • Extraction site management plan (where applicable) • Rehabilitation process (where applicable) Other • Other material sources and management measures			

<table>
<tr><th>Requirements</th><th>Addressed Yes/No</th><th>Further information required</th><th>Observations/ comments</th></tr>
<tr><td colspan="4">Native or Protected Fauna</td></tr>
<tr><td>EMMP includes diagrams and descriptions of:
• Native fauna breeding locations and habitats in proximity to the site and limits of clearing
• Identification of the type of activities likely to impact breeding, habitat, or fauna activities
• Practical and reasonable strategies and measures for management of native fauna, their breeding places and habitats, and passages (e.g., fish and marine fauna)
• Details of suitably qualified staff for use in fauna management, including emergency wildlife care details
• Procedures and plan for fauna rescue and release, including the treatment of fauna injured by works
• Information on fishing, hunting, local resource use etc</td><td></td><td></td><td></td></tr>
<tr><td colspan="4">Noise</td></tr>
<tr><td>EMMP includes diagrams and descriptions of:
• Location of facilities, utilities, infrastructure, and sensitive receptors potentially impacted by the works (including churches, schools etc. and)
• Mitigation measures for impacts to marine fauna
• Noise generating activities, locations of these, and expected duration of works, including hours of operation
• Practical and reasonable noise management strategies, including a noise impact contingency plan</td><td></td><td></td><td></td></tr>
<tr><td colspan="4">Vegetation (Flora)</td></tr>
<tr><td>EMMP includes:
• A drawing demonstrating the contractor’s intended limits of vegetation clearance and the location of significant, valued, or protected vegetation
• Practical and reasonable strategies and management measures to minimise vegetation clearing and impacts on other vegetation (including through the introduction of alien or invasive species)
• Measures can include:
    • Progressive rehabilitation/native planting
    • Protection of vegetation or preservation of individual trees</td><td></td><td></td><td></td></tr>
</table>

Requirements	Addressed Yes/No	Further information required	Observations/ comments
Vibration			
EMMP includes: • Location of critical facilities, utilities, infrastructure, and vibration sensitive receptors potentially impacted • Exclusion zones for blasting from sensitive receivers and habitats • A list of works that will cause significant vibration • Applicable criteria for measuring construction vibration • Practical and reasonable strategies for vibration management, both for human comfort and structural/ building impacts • A contingency plan for observable damage to structures			
Waste and Sanitation			
EMMP includes: • Type and quantity estimates of waste, including their source • Waste management strategies: avoidance, reuse, recycling, energy, recovery, and disposal • Measuring and recording procedures for waste generated, reused, recycled, or disposed of • Details of adequate and appropriate site sanitation provision			
Water Quality			
EMMP includes details of: • Water bodies potentially affected by the works • Works (including temporary works and ancillary activities) which have the potential to impact water quality • Locations that may be affected or where discharges may occur, including the location of potential contaminants • Flow paths to water bodies within and in proximity to the site • Practical and reasonable water quality management strategies and measures (e.g., a dredging plan) • Monitoring plan for water quality in accordance with risk • Procedures and plan in event of that water quality is affected by the works or upon receiving complaints.		**Low risk** - Visual monitoring may be sufficient - Monitoring plan should set out approach, locations, and frequency **Medium or high risk** - Field and laboratory testing as monitoring requirements - Monitoring plan must meet local water quality objectives and legislation	

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