

15 Shoreline modification

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This chapter provides an overview of shoreline protection works and special considerations to minimise the impacts of such works and structures on the coastal environment.

Often shorelines are modified with seawalls and revetments in urban areas to prevent coastal recession and provide stable foreshore areas. Revetments are sometimes used in less urban situations as an erosion control measure. Beaches in areas subject to erosion are sometimes replenished ('nourished') with sand dredged from other areas.

Coastal landforms and ecosystems, especially dunes, beaches, sand spits, saltmarshes, tidal flats and seagrass beds, can be destroyed or seriously degraded by modifications of the shoreline, reclamation or dredging. These works can also alter the movement of sediment, leading to changes in nearby beaches and other soft sandy or silty landforms on the coast. Dredging may disturb toxic sediments and affect water quality.

As a result, a precautionary approach should be followed. All these works should be avoided if they are likely to cause significant damage to the coastal or marine environment. If the works will result in substantial benefits and there is minimal damage to the coastal landforms and ecosystems, such works may be acceptable. However, sites must be carefully selected and the works done with great care; including a geomorphological assessment, professional engineering design and independent review.

*Seawall at Sandy Bay near Hobart.
© Leah Page.*



15.1 Shoreline protection works

This section describes a number of structures and methods that can be used to mitigate shoreline erosion. Shoreline stabilisation can be expensive, will require ongoing maintenance and, even with careful planning and research, may lead to unforeseen impacts on the coastal ecosystem that potentially require ongoing management. It is difficult to control sand being moved by storm surges, waves and high tides in the long term.

Marine structures such as groynes and breakwaters can be used to trap sand on beaches. However, to do this they interrupt the flow of sand along beaches and can result in increased erosion elsewhere, and even loss of beaches in adjacent foreshore areas. Collect quality data on local coastal processes wherever possible.

It is often necessary, for safety reasons, to build structures such as groynes and breakwaters to provide shelter for moorings, jetties and other facilities for boats.

Building shoreline structures such as rock walls to stop erosion in one place can transfer erosion problems along the coast. The damage and the costs can be huge. Coastal protection works should only be done if expensive infrastructure, such as roads or buildings, or public safety are at risk. Structures should be properly designed by a suitably qualified person, such as a coastal engineer in consultation with an experienced geomorphologist, and subject to independent review.

15.1.1 Legislation and approvals

Shoreline modification is complex and must meet a number of legislative requirements. Refer to **Appendices 1 and 2** for details of the legislation most likely to apply.

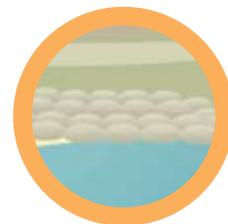
All shoreline modification works will require approval of the land manager and will almost certainly require assessments and approvals. Identify the land manager; they will be responsible for ensuring all appropriate assessments and approvals are undertaken.

Structures on the shoreline often cross over land and water that is governed by different authorities. The Crown owns the seabed and water, regardless of whether the landowner has a high water mark title. Structures below high water mark also require DPIPWE Crown Land Services approval and a Crown Land Lease. Depending on the structure's size and nature, DPIPWE may require submission of a Development Proposal and Environmental Impact Statement.

The Environment Protection Authority (EPA) of DPIPWE is responsible for assessing applications for level 2 activities as classified under the *Environmental Management and Pollution Control Act 1994*.

15.1.2 Types of shoreline protection works

The type of works selected will depend on the purpose, budget and site conditions. They will require assessment and approval and should be consistent with the local planning scheme and local management plans.



Suitable works may include:

- groyne
- breakwaters
- seawalls
- revetments (soft and hard)
- training walls and levees
- beach nourishment

These techniques have been used with varying success. Some have been successful while others require expensive ongoing maintenance, and even replacement, after being broken up by storm waves. Some have caused further problems, such as directing erosion to sites nearby.

Success is heavily dependent on understanding the interaction between coastal geomorphology and hydrodynamic processes, then choosing the appropriate protection measure for the particular site.

Seawalls, groyne and breakwaters are likely to

affect the natural processes of coastal erosion and deposition.

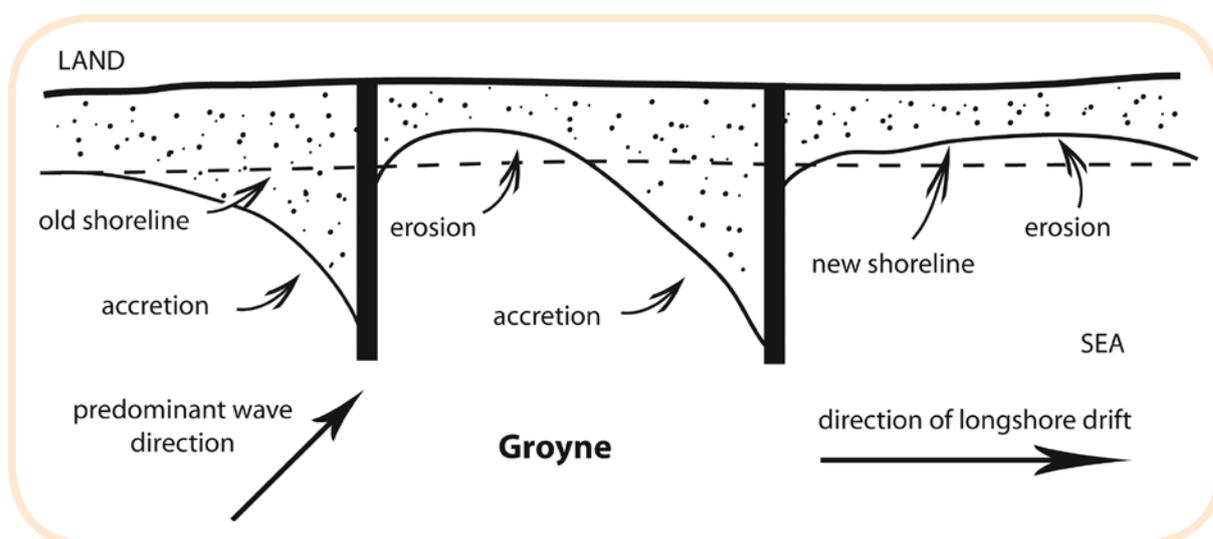
Seek expert advice and consider the advantages and disadvantages of each type of protection works before investing in planning them. Consider also combined treatments and allowing the shoreline to retreat.

15.1.3 Groyne

Groynes are barriers built across or perpendicular to the beach and into the water, to trap sand. They can be used to provide sheltered waterways and to increase the width of the beach. They are traditionally built from rock, concrete or timber but are now also being constructed with geotextile sandbags.

Groynes are built at right angles to the beach, to trap sand moving offshore along the beach (longshore drift). Sand typically becomes trapped on the updrift side of the groyne, and is eroded on the downdrift side. The groyne will continue to trap sand until

Figure 15.1 The effects of a groyne on sediment flow, deposition and erosion. Adapted from *Sediment Budgeting* (O'Keefe 1978)





its storage capacity is reached. Once this happens, sometimes sand will bypass the groyne and be deposited on the downdrift side.

Groynes are not always successful and can sometimes contribute to further erosion.

15.1.4 Breakwaters

Breakwaters are built more or less parallel to the beach but some distance offshore, with similar construction methods to groynes. They may or may not be connected to the shore. Their purpose is to reduce the intensity of wave action and so reduce coastal erosion and/or to provide a safe harbour. Offshore breakwaters can be used to reduce erosion on a beach that has no net longshore transport of sand and can therefore not trap sand with groynes.

Breakwaters are traditionally built from rock, concrete or timber but are now also being constructed with geotextile sandbags.

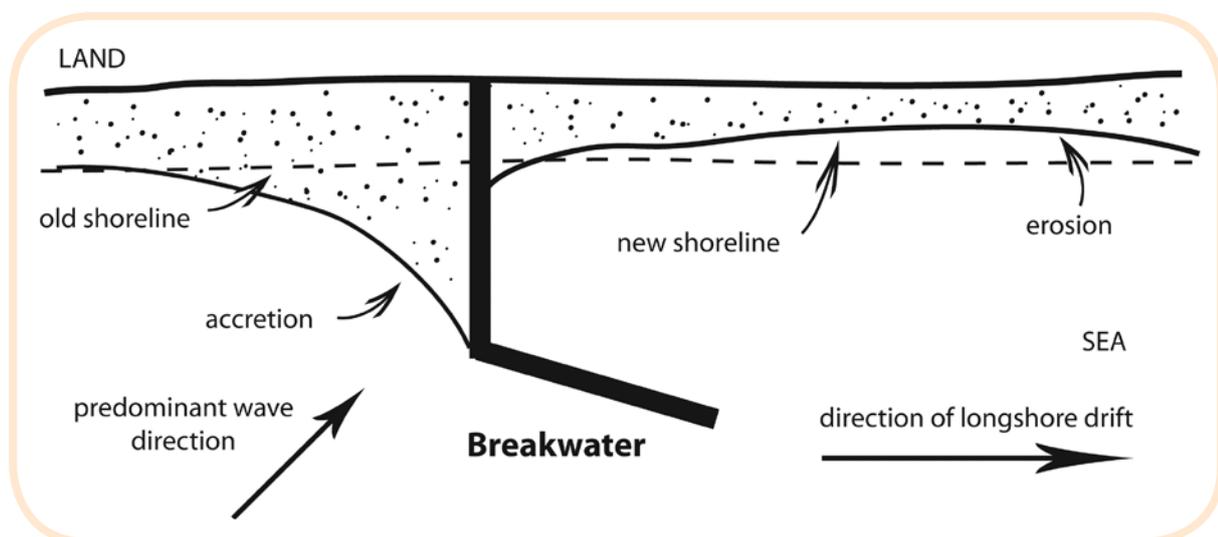
All breakwaters are costly to construct and maintain, and their use is generally limited to providing sheltered areas that are not exposed to full wave attack. They have high maintenance costs due to scouring around the ends and the eventual weakening of the structure. A low breakwater is less expensive than a high one, and allows waves to overtop it; a low breakwater can be hidden by storm waves and may therefore be more hazardous for watercraft.

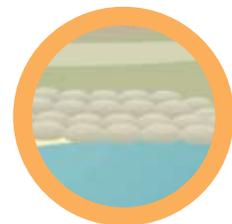
Breakwaters can influence sand movement and result in significant erosion or unwanted deposition on the protected inshore side of the structure. Dredging is usually required to keep navigation channels open.

If sand is deposited on the inshore side of the breakwater and the breakwater is sufficiently close to the beach, then the deposited sand will build up and may eventually extend out to the offshore breakwater.

Fully submerged breakwaters, consisting of underwater mounds or artificial reefs made of sand and small rocks, have been used in other countries

Figure 15.2 The effects of a breakwater on sediment flow, deposition and shoreline erosion. Adapted from *Sediment Budgeting* (O’Keeffe 1978)





for coastal protection. In calm conditions, the waves change little as they pass over the breakwater. Under storm conditions, however, the larger waves break on the structure, dissipating wave energy and reducing shoreline erosion.

15.1.5 Guidelines for planning and installing groynes and breakwaters

Thorough planning and specialist advice are essential. Managing problems after construction is more expensive than dealing with them in the planning stage. Before planning, ask if there is an alternative method to provide the outcome. Marine structures with a minimal footprint on the sea floor are always preferable, as they have less impact during construction and less impact on coastal ecosystems.

Obtain specialist advice to identify the interactions between coastal processes and hydrodynamics including wave approach(es) and drift currents, before deciding to install a groyne. There must be a supply

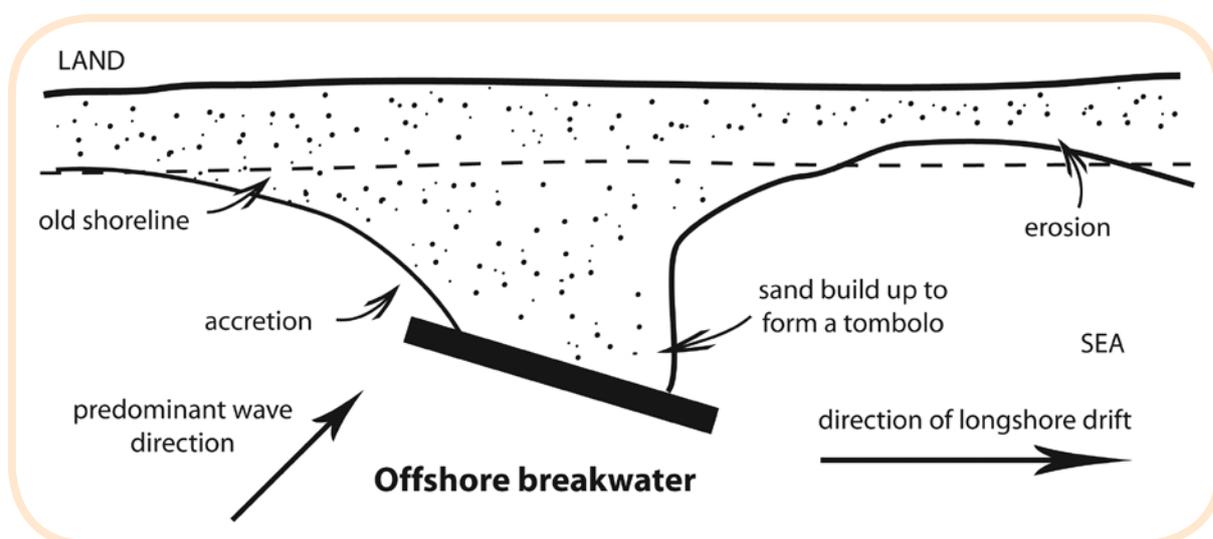
of sand from longshore drift (or from artificial beach replenishment) for a groyne to be successful.

Identify any natural or cultural values in the area, including threatened species, important coastal and marine habitat and Aboriginal and maritime heritage. Consult specialists and seek any necessary assessments and approvals.

Choose a suitable site that minimises interference with the seasonal patterns of waves, currents, tidal flushing, sediment movement and other natural coastal processes. Design the groyne/s to suit the direction/s of the prevailing waves, currents and sediment movement at the specific location.

Align the structure to ensure that only the desired interference of sand transport will occur; and to minimise unwanted changes to the wave patterns and the supply of marine sediment in adjacent areas. Take into account the effects of coastal landforms such as headlands on these factors.

Figure 15.3 An offshore breakwater encourages deposition on the beach. Sometimes sediment is deposited all the way out to the breakwater, forming a coastal feature known as a tombolo. Adapted from *Sediment Budgeting* (O'Keefe 1978)





A series of groynes can trap sand and build small beaches between them. But the first groyne can starve the beach (and other groynes) further along the shore of sand, or cause erosion. Design each groyne to allow some sand to spill around the structure; or regularly import sand (beach replenishment) if this is a viable option.

Minimise excavation of sensitive areas such as the shoreline and seabed and avoid works in important ecosystems and wildlife habitats, wherever possible.

Avoid interfering with pedestrian access to and along the shoreline. Minimise visual disturbance by choosing less sensitive sites for structures and/or integrating them with other uses. With careful design, they can become viewing areas with steps built in for access.

Breakwaters and groynes are traditionally built from rocks, timber or concrete but other materials are available, such as gabions and geotextile sandbags. Gabions are heavy wire or mesh baskets placed next to each other and filled with shingle or broken rock, then the tops are wired down. Gabion mattresses are larger baskets, much longer than they are deep, that are divided into compartments. Gabions and gabion mattresses can shift and settle to fit the substrate. Geotextile sandbags are prefabricated textile containers filled with sand that are laid like bricks.

Refer to 15.1.11 Sandbag revetments or geotextile sand containers.

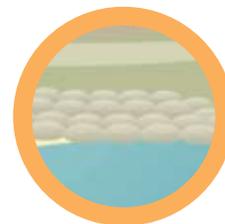
15.1.6 Seawalls

Seawalls are rigid structures (traditionally vertical concrete or rock walls) erected on the shoreline to combat shoreline erosion and recession and prevent inundation of low-lying areas. River training walls are included in **Chapter 6**.

Seawalls are often used in urban coastal areas in a bid to protect foreshore infrastructure. The demand for these coastal structures may increase with the need to mitigate the impacts of climate change and sea level rise. Traditional vertical seawalls have limited potential to provide marine habitat and are poor replacements for natural shorelines. Preferable options are curved, stepped or sloping walls, to allow the wave energy to dissipate rather than assault the wall. **Refer to 15.1.9 Revetments.**

Seawalls are often constructed at the back of high-use beaches in urban areas to stop the shoreline retreating and to protect infrastructure and recreational facilities. Seawalls may reflect or even amplify wave action and often lead to increased erosion of beaches. Where seawalls are used at the back of a beach, ongoing beach nourishment may be required to maintain the beach profile. For this reason seawalls are commonly used in conjunction with other beach protection measures such as groynes and beach replenishment.

Where seawalls are determined to be the most appropriate management tool for foreshores, they should be built to minimise environmental impacts and more closely mimic natural foreshores to provide greater environmental value (NSW Department of Environment, Climate Change and Water and the Sydney Metropolitan Catchment Management Authority 2009).



15.1.7 Impacts of seawalls

The construction of the seawall will most likely involve significant disturbance to the intertidal zone and may disturb toxic materials such as heavy metals or introduce sediments into the estuary or coastal waterway.

Seawalls may increase erosion of the beach in front of the wall and accelerate erosion at the end of the wall. Subsequent beach replenishment or other beach protection measures are usually required. Vertical concrete walls cause the most serious erosion of beaches. When waves hit the wall they are reflected back, and scour sand from the beach. As the beach becomes lower and flatter, the waves become larger, the scouring increases, and the beach is eventually lost. By this time, the wall itself may be undermined if not anchored adequately.

Seawalls can disrupt the natural flow of sand across the beach. They are unsuitable for non-urban environments as they interfere with dune formation and beach replenishment by cutting off the sand in the dunes from the beach system. This reduces the amount of sand available for movement on and off the beach and dunes.

Timber seawalls very seldom control erosion of sandy coasts except for a fairly short period. When waves pound the wall, water pushes through narrow spaces and erodes the sand behind the wall. Eventually the wall is undermined and becomes ineffective.

In estuarine areas, horizontal seawalls result in a loss of intertidal habitats and impact on marine species such as juvenile fish, birds and entire invertebrate communities.

Seawalls can result in a build up of seagrass wrack floating on the surface, which would normally be washed up on the shoreline, where it provides habitat and food for invertebrates. The floating wrack shades

the sea floor, which kills off the seagrass and severely degrades the habitat.

Seawalls are not suitable for river-mouth environments. River mouths are highly dynamic environments. Water and sediment flows fluctuate and respond to changes in coastal processes and the river mouth needs some freedom to adjust in response to these changes. In some circumstances, where shipping and boating requirements are significant, training walls are erected to maintain navigation channels. **Refer to Chapter 6 Coastal landscape management.**

15.1.8 Guidelines for planning and installing seawalls

Thorough planning and the development of an Environmental Management Plan are essential. Managing problems after construction is more expensive than dealing with them in the planning stage. Seek all necessary approvals and assessments. **Refer also to section 15.2 Reclamation and dredging.**

Seek specialist advice from coastal geomorphologists and coastal engineers. Design the structure to take account of coastal processes (including the direction of prevailing currents and winds and wave action), rising sea level, public safety, and natural and cultural heritage values (including marine life).

Consider the movement of sand along the shoreline and possible effects further along the shoreline. Minimise the deposition of sediment into the estuary or coastal waterway.

Recent research recommends incorporating artificial rock pools into the design of seawalls to provide intertidal habitat where it has been removed. This will help to maintain the biodiversity of intertidal marine communities.



Design the seawall as a continuous structure over the full length of coastline to be protected. Otherwise, erosion around the ends of a short wall can lead to collapse.

Avoid use of rigid concrete or rock seawalls, which are more compact in size but can fail catastrophically from freak waves or erosion at the base.

Make the wall curved or with a backward slope, to dissipate wave energy (even though it will be larger and more costly).

Add a relatively impermeable blanket (rock, clay, etc) along the crest of the wall, to reduce the risk of scour caused by wave overtopping. Alternatively, place a curved wave deflection barrier (a wave return wall) along the crest, which significantly reduces wave overtopping and allows the wall to be lower.

Ensure the design of seawalls and similar solid structures on the shore allows adequate filtered drainage. Many impermeable structures have collapsed in the seaward direction because of soil and water pressures behind them, or failed due to seepage loss of fine fill.

Sea level rise predictions must be considered. If waves regularly break over the seawall the structure will be undermined. Refer to maps of vulnerability to sea level rise (Sharples 2006) to see if the site is appropriate for the works. Use the latest IPCC (Intergovernmental Panel on Climate Change) sea level rise projections to determine the minimum height allowance required for the life of the structure.

Allow for the effects of long-term erosion or increases in sea level on the design wave height (the height designed to cope with the maximum expected wave height). The mass of the armour (e.g. rocks) required to protect flexible structures is proportional to the cube of the design wave height. A doubling of

the design wave height would require an eight-fold increase in armour mass to provide the same level of protection.

Construction method and materials

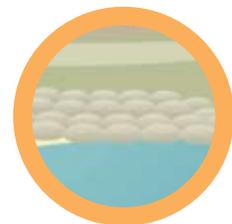
The range of construction options includes concrete, walls built with caissons (concrete boxes), and brick or block walls.

Concrete armour units, such as Seabees are hexagonal concrete blocks with a hole in the centre. The holes in the blocks help to dissipate wave energy. The blocks are placed over an underlayer of secondary rock armour and a geotextile filter.

Seabees are designed to be interlocked for maximum strength, but if they are interlocked, the seawall may behave like a rigid rather than a semi-rigid structure. Placing armour units in a stepped pattern provides a rough surface that increases turbulence on the wall, which helps absorb wave energy.

Improving environmental outcomes of existing seawalls

Traditional vertical seawall structures can be improved by placing rock in front of the wall to provide intertidal habitat. Alternatively, structures that increase the surface area of the wall and provide crevices or pools can be retrofitted to existing vertical walls to create habitat for intertidal marine species such as seastars.



15.1.9 Revetments

Revetments are common along the New South Wales coast. They provide more opportunities to create habitat for marine and coastal wildlife and vegetation than vertical seawalls. They cause less wave reflection than seawalls and survive storms for longer, but generally require regular maintenance to keep their structural integrity. Revetments can sustain considerable damage without totally failing, but take up more foreshore space than vertical seawalls.

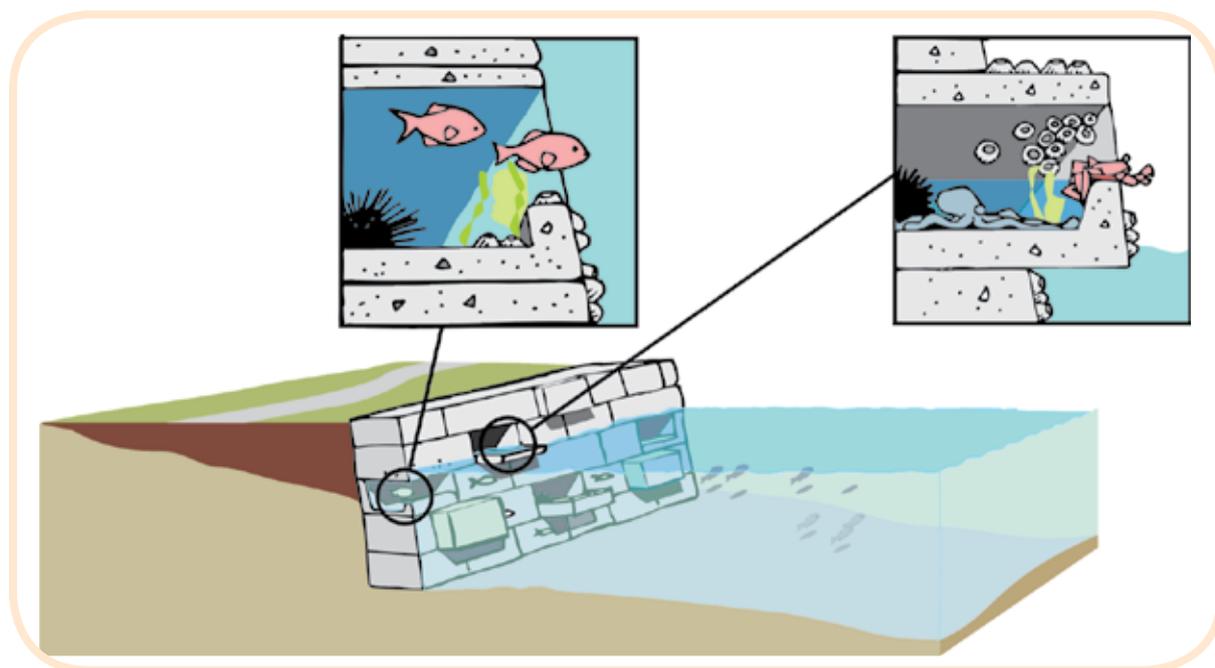
Because revetments are permeable, they can become susceptible to scouring behind the wall caused by poor seepage control and/or waves surging over the top. If extreme, this can lead to the collapse of the revetment. Good design and careful consideration of coastal processes including sea level rise can overcome this risk.

Revetments are constructed from materials such as rock or shingle, manufactured concrete armour units such as gabions, or manufactured geotextile products. Geotextile revetments tend to be more compact than those made of rock, and may be less susceptible to total failure than more solid structures.

Design must consider a thorough analysis of the site and the coastal processes in the context of the expected life and maintenance regime of the structure. The coastal processes that need to be considered include the types of wave action, i.e. swells or wind driven waves; the water levels (taking into account sea level rise, storm surges and king tides); and speeds of currents. Water flows from the land may also be an important consideration.

Climate change and sea level rise predictions based on Intergovernmental Panel on Climate Change

Figure 15.4 A seawall with blocks that extend outwards to create a varied surface, and cavities to provide sheltered intertidal-pool and subtidal-cave habitats for a variety of organisms. © NSW DECCW and the SMCMA.





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(IPCC) predictions must be incorporated into the design. Consider not just elevated water levels but inundation, and increased wave energy and storminess.

15.1.10 Rock revetments

Rock revetments are used to increase the stability of eroding foreshores. They are costly to install and require regular maintenance. They must be designed by a coastal engineer in consultation with a coastal geomorphologist; otherwise they may be subject to failure or create erosion problems further along the foreshore.

Rock revetments have some advantages over vertical seawalls: they provide more opportunities to create habitat for marine and coastal wildlife and vegetation;

cause less wave reflection and survive storms for longer and can sustain considerable damage without total failure. However, they do take up more foreshore space.

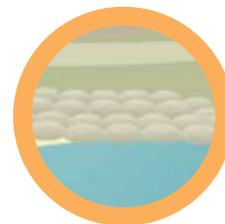
Thorough planning and specialist advice are essential. Managing problems after construction is more expensive than dealing with them in the planning stage. All revetment works must meet legislative requirements and may require approval from a number of agencies. An assessment of the proposed activity will determine the potential for environmental harm.

When to use rock revetments

Rock revetments can be suitable for high wave energy environments, but the potential for scouring in the upper reaches should be considered carefully.

Figure 15.5 Best practice rock revetment that is aesthetically pleasing and provides intertidal habitat at Bobbin Head, Cowan Creek, Hawkesbury River, NSW. © Daniel Wiecek, DECCW





They should not be used when erosion is due to interruption of sediment transport such as a poorly sited groyne (Swan River Trust 2009).

Because of the degree of back preparation required and their large footprint, they should not be used in sensitive coastal environments where there will be an unacceptable loss of natural or cultural values. Before planning and construction, it is important to identify all natural and cultural values that may be affected by the works. Consider threatened species, Aboriginal heritage, wildlife habitat and marine habitat.

Design of rock revetments

Revetments can be visually intrusive and reduce enjoyment of recreational spaces if poorly designed or sited.

Because rock revetments are permeable structures, seepage may result in the removal of material from behind the structure, and eventual failure by collapse landwards. Install correctly designed soil filters or geotextiles to avoid damage by seepage. Protect geotextiles from light, e.g. put a gravel layer behind the rock or other armour material.

Consider the scale of the back preparation, as some vegetation may be lost.

Revetments must be designed by an experienced coastal engineer. Design must consider a thorough analysis of the site and the coastal processes in the context of the expected life and maintenance regime of the structure. The coastal processes that need to be considered include the types of wave action (i.e. swells or wind waves); the water levels (taking into account sea level rise, storm surges and king tides);

Figure 15.6 Revetment degradation due to either scour by overtopping waves or seepage loss of fill. © Jocelyn Phillips





and speeds of currents. Water flows from the land may also be an important consideration.

In sandy environments, revetments constructed from much smaller rocks (200–350mm diameter) are a more natural design than conventional seawalls (with rocks over 500mm in diameter). Provided a sufficient volume of rock is placed appropriately, a stable beach profile develops naturally during storm conditions. The main drawback is that the beach is a mixture of rocks and sand.

Identify existing bank conditions, seek local knowledge and expert advice. Ensure the toe is well founded to minimise the risk of undermining. Ensure the revetment has an appropriate crest height to reduce the risk of scouring from waves regularly overtopping the revetment.

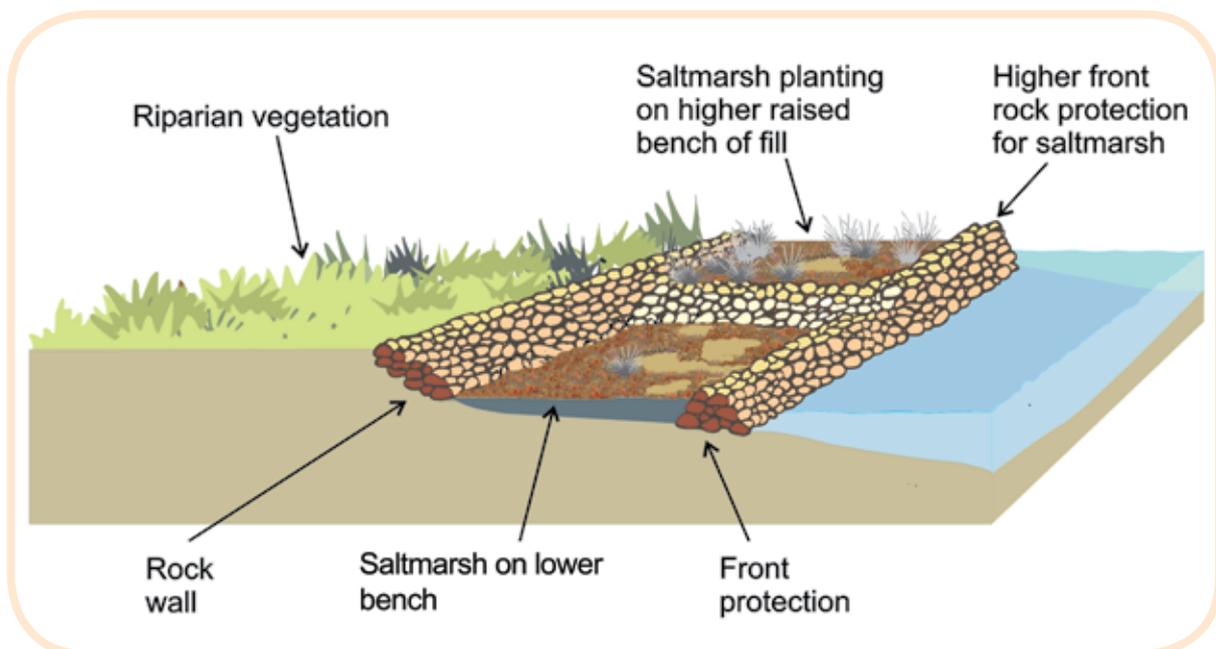
Climate change and sea level rise predictions based on IPCC predictions must be incorporated into the design. Consider not just elevated water levels but inundation, and increased wave energy and storminess.

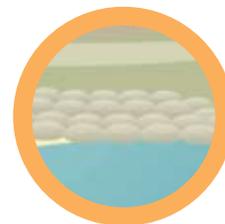
Incorporate features such as rock pools and crevices into the design to provide habitat for marine life. Revetments can be designed to have a step profile with a bench for saltmarsh or coastal vegetation, thereby providing an intertidal environment. This type of design is often more attractive and maintains access.

Materials

Use local rock, where available, or match the rock as closely to the surrounds as possible. This improves

Figure 15.7 Rock revetment incorporating bench for saltmarsh and tidepool area. Adapted from: *Environmentally Friendly Seawalls: A guide to Improving the Environmental Values of Seawalls and Seawall-lined Foreshores in Estuaries* © NSW DECCW and the SMCMA.





habitat values and visual amenity.

Choose rocks and materials that will minimise the presence of fine materials that can easily become suspended.

Installation

Ensure all works staff and contractors are briefed on minimising environmental impacts. Provide adequate supervision to ensure best practice environmental standards are being implemented.

Minimise impacts on coastal values during installation. Time works to avoid significant wildlife events such as times when shorebirds and penguins breed or fish spawn.

It is important during construction to minimise the amount of sediment disturbance. Choose high-quality rock material that has minimal fine sediment. It may

be necessary to install sediment traps or other sediment containment techniques (e.g. curtains or walls) to contain plumes created during construction. Consider wave and flow dynamics and undertake the work during appropriate tides and weather conditions to minimise sediment flows. Schedule works for times when tides, currents and waves will be most favourable for minimising disturbance and spread of sediments and disturbed materials.

Minimise the amount of excavation of the shoreline and the impacts on the coastal vegetation. Rehabilitate disturbed areas as soon as possible.

Follow-up surveys and ongoing monitoring are essential, to detect any adverse impacts from the construction works and any consequent changes to coastal processes. Monitoring is also required to assess the integrity of the structure and the need for maintenance.

Figure 15.8 Rock revetment with bench in Claydon Reserve, Kogarah Bay, Georges River, NSW. © Daniel Wiecek, DECCW





Case Study 15.1: Raspins Beach revetment

Raspins Beach on Tasmania's east coast had been actively eroding for more than three decades, with a loss of several hundred metres of sandy shoreline. This erosion is thought to be partly attributable to a change in the flooding regime of the Prosser River due to dam construction. Fewer peak flood events caused the main channel to migrate along Raspins Beach. The river's location, when combined with south-easterly storms and more water flowing down the river, caused massive erosion events. Infrastructure, including a main highway, was at risk. A rough rock revetment was built in the 1990s in an attempt to halt erosion and, despite being poorly constructed, it helped to slow down the erosion process.

In 2001, in an attempt to slow the erosion, the mouth of the Prosser River was relocated to the south to reduce the scour along the beach. As a result, there was a noticeable build-up of sand at the southern end of the beach (closest to the relocated river mouth), but erosion continued at the northern end, with

Figure 15.9 The rock revetment at Raspins Beach on the east coast has trapped sand and is stabilised by vegetation. © Leah Page

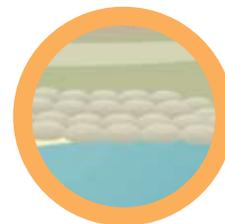


storms continuing to threaten infrastructure. It was proposed that a low rock revetment be constructed along the entire length of the beach to provide protection. Part of the original revetment would be rebuilt.

As this is reserved land, the Parks and Wildlife Service assumed the project management role. The local council and the Department of Infrastructure, Energy and Resources provided funding and were involved in the early stages of project planning. The local progress association, immediate neighbours, local industries and the wider community were notified via local newspaper articles, letters, road warning signs, council newsletter and shop-window notices. The project involved a full activity assessment to ensure that values (including shorebirds and Aboriginal heritage) were protected.

Combined with the river mouth relocation, which allowed the significant off-shore sand reservoirs to migrate back to the beach, the actions have succeeded in arresting erosion and have seen the formation of a significant sand dune at the southern end of the beach. The rock revetment is no longer obvious as it is now covered by sand. Having a gentle slope (less than 1:1.5), the rock revetment, if exposed to wave action in the future, is not subject to wave wash. The weak point, which has been subject to wave overtopping, is the section of 1990s rock revetment which was not rebuilt, as this section juts out and is lower than the rest of the revetment.

Photos have been taken of the beach at intervals to assess the success of the revetment.



15.1.11 Sandbag revetments or geotextile sand containers

Sandbag revetments or geotextile sand containers have been used in many locations in other Australian states to stabilise foreshores against erosion. They provide an alternative to traditional seawalls and hard, rocky revetment structures. They can be used in much the same way as other prefabricated armour units.

Geotextile revetment structures should be designed by experienced coastal engineers. It is particularly important to specify the crest and toe elevation of the wall and the required slope in the design. Geotextile manufacturers provide generic construction details (Figure 15.11) to guide the engineering design.

Manufacturers indicate a life span of 10–15 years, but this most likely relates to the degradation of the fabric

and not the integrity of the structure, whose life will vary depending on its application. As for all foreshore protection structures, an appropriate maintenance regime is required. Removal of structures is relatively straightforward, although complete recovery of all the geotextile material can be difficult (Swan River Trust 2009).

The materials for sandbag revetments are usually supplied by geotextile manufacturers. Construction requires the hire of specialised filling frames and lifting devices. Some earthworks contractors may already have the appropriate machinery; otherwise, hired plant could be used by the land manager's works crews.

To fill the bags, sand is required and water is pumped into the filling frame to create a slurry. Sand should generally be sourced off-site. Ensure that the sand is appropriately specified and tested (coarse fragments

Figure 15.10 Geotextile sand container revetment at Blythe Heads in north-west Tasmania. © Jocelyn Phillips





can be abrasive, fines can leach). The manufacturer will generally supply any other equipment needed to fill and seal the bags. Smaller bags require sewing equipment, while large bags are sealed by rope and a marine sealant (Swan River Trust 2009).

15.1.12 Beach nourishment

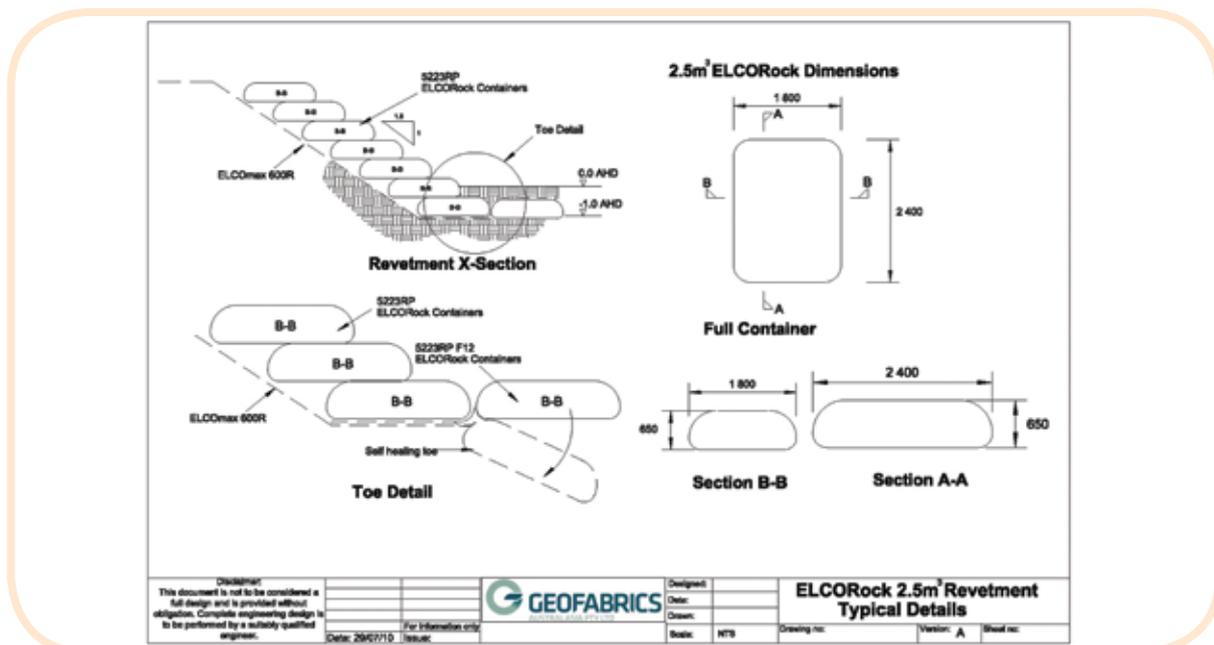
Beach nourishment or replenishment is the process of bringing sand in from another source to replace the sand being lost from the beach. Other techniques include scraping sand from the subtidal zone back up onto the beach, pumping sand from offshore and using geotextiles and other dune rehabilitation techniques to trap more wind-blown sand. Beach nourishment in other states is often combined with other foreshore stabilising techniques such as hardening of the foreshore and groynes to help trap the sand.

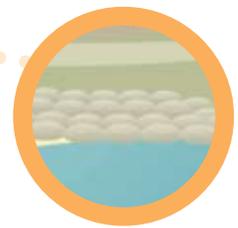
Any decision to undertake beach nourishment requires careful and costly scientific research of the existing coastal processes unique to the site. Beach nourishment will be expensive, will require ongoing maintenance and, even with careful planning and research, can lead to unforeseen impacts on the coastal ecosystem that create a need for additional ongoing management. Impacts on coastal wildlife such as feeding and nesting shorebirds also need to be assessed.

It is important to identify as clearly as possible the reasons for the coastal recession and to understand the movement of the sand (sand budget). Identify any other land management or human causes for the loss of sand, such as foreshore hardening or sand control works further along the shoreline.

If sand must be brought in from elsewhere, consider the best source. Proximity to the site will reduce

Figure 15.1 | An example of construction details provided by the manufacturer for a geotextile sand container revetment. © Geofabrics Australia





transport costs and assist ongoing maintenance. If sand is to be acquired via pumping or dredging from offshore then a whole suite of other environmental impacts associated with those activities must be taken into account.

The acquired sand must be clean and match the existing sand as closely as possible, with grains the same size or coarser. If the imported material has a finer grain, the sand will be less anchored and will erode away more quickly.

Beach scraping requires a sufficient supply of sand in the subtidal zone. Work out how much sand is returned to the subtidal zone with longshore drift and calculate how much can be removed with minimal impact. Sand scraping will damage the sea floor and the tiny animals that live within the sand, which support other coastal wildlife such as shorebirds.

Identify any Aboriginal heritage sites and ensure that damage to Aboriginal heritage values are minimised and managed accordingly, in consultation with the Aboriginal community. Contact Aboriginal Heritage Tasmania.

15.1.13 Ongoing maintenance of shoreline protection works

Structures built on sandy coasts may suffer from an accumulation of sand or erosion, or fail suddenly after storms, and become a hazard to the public. All structures require regular maintenance to ensure that they remain serviceable. Inspections and maintenance are very important during and after stormy periods.

Prepare an inspection and maintenance plan that requires inspections to be done regularly and after major storm events.

Inspection and maintenance should check that structures are in place, in good condition and not

becoming a hazard to the public.

Monitoring of geotextile revetments includes assessing the success of the structure. It is best achieved with before-and-after photos; and visual inspections of the structure for damage. Damaged geotextile bags can be repaired and patch kits are often available from the manufacturer. Individual bags can often be replaced, if necessary.

15.2 Reclamation and dredging

This section describes works involving reclamation and dredging and ways to minimise impacts on the coastal environment if these activities cannot be avoided. Such works include reclaiming extra land for recreation, modifying river channels for navigation and keeping river entrances and approaches to boat ramps clear.

In the past, reclamation was commonly used to gain extra flat land for urban development. As a result, many of Tasmania's important wetlands, seagrass beds, saltmarshes and tidal flats have been lost. Unfortunately, these are the most biologically productive coastal ecosystems, the most critical habitats for wildlife, and the basis of most of our fisheries.

Reclamation works are still occasionally done to provide land for recreation or development, to improve public access to or along the foreshore and in intertidal areas, and to modify navigation channels.

Dredging is the removal of underwater sediments usually by excavation or suction. It is often used to enlarge, deepen or create a navigable channel; to dig a trench for pipes or cables; to obtain sand for beach replenishment; or to remove unsuitable or unwanted



materials. Ongoing dredging may be required to maintain shipping channels or safe access in estuaries and at river mouths.

At the sites of dredging and disposal of dredged material, the seabed and associated communities are disturbed. For some distance, suspended sediments may cause turbidity in water and increased deposition on the seabed and in the surrounding area. Plan operations carefully to minimise turbidity from disturbed fine sediments and consider the disposal of dredged material, particularly if it is contaminated. If necessary, use sediment settling systems.

The information in this section has been largely sourced from the Derwent Estuary Program's *Dredging and Land Reclamation in the Derwent* (Eriksen in prep.).

15.2.1 Legislation and approvals for reclamation and dredging

Reclamation and dredging are complex operations and will involve a broad spectrum of legislative requirements. Refer to **Appendices 1 and 2** for details of the legislation most likely to apply.

All reclamation and dredging works will require approval. There are no discretionary or minimum work limits in any legislation.

Reclamation works are generally only allowed where the land is leased or purchased from the Crown (Department of Primary Industry, Parks, Water and Environment – DPIPW) or where the Crown grants a licence. Works on Crown land, which includes all land below high water mark, require approval from DPIPW Crown Land Services.

Proposed reclamations are subject to comprehensive assessment of the terrestrial and marine values of the site and likely impacts, (including cultural heritage,

wildlife, threatened species, marine and coastal vegetation). If they are approved, strict conditions usually apply. Land created through reclamation is automatically public land administered under the *Crown Lands Act 1976*.

A licence to dredge must be obtained from DPIPW Crown Land Services. It requires an environmental assessment, which may include sampling of flora and fauna before and after dredging, including videos of the seabed.

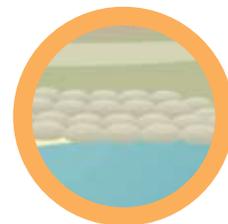
A planning permit from the local council may be required. The council must determine if the land use that depends on the reclamation is permitted.

Applications for Level 2 activities are assessed by the Environment Protection Authority (EPA). If waste is to be disposed of in marine waters it will be considered a Level 2 activity.

Advice and/or authorisation from Environment Protection Authority (EPA) is needed if the activity is likely to degrade the marine environment (e.g. disturbing or depositing material on the seabed, or interfering with fish, animals or plants on the seabed).

The disposal of dredge spoil on land will require the approval of the local planning authority. There are constraints on how and where dredge spoil can be disposed of, especially if it is contaminated in any way.

Dredging of channels and barways for navigation purposes must be approved and supervised by Marine and Safety Tasmania (MAST).



15.2.3 Planning for reclamation and dredging

Thorough planning and the development of an Environmental Management Plan are essential. Managing problems after construction is more expensive than dealing with them in the planning stage. Before planning, consider whether there is an alternative method to provide the outcome, such as the construction of a jetty instead of a wharf.

Structures with a minimal footprint on the sea floor are always preferable, as they have less impact during construction and less impact on coastal process such as sand movement. Always design to minimise the amount of reclamation undertaken or the amount of dredge spoil produced.

Planning should consider:

- the purpose of the reclamation or dredging
- alternatives to undertaking reclamation or dredging
- significant natural and cultural values of the site
- the physical constraints of the site (such as susceptibility to storm surge, reclamation extent, erosion and siltation, sediment type, water depth)
- movement of sand and coastal processes at the site
- the source of material used in the reclamation
- the most appropriate dredging technique
- environmental impacts of the project on surrounding air, soil and water quality
- environmental threats such as marine pests, acid sulfate soils and sea level rise
- waste prevention from dredging, potential use of dredged material and waste disposal of dredge spoil

- mitigation or remediation measures to be put in place, and methods for monitoring the effectiveness of those measures through a monitoring program.

The Environmental Management Plan must provide all the information required by government agencies to undertake a comprehensive assessment of the proposal. Always seek specialist advice. For large projects a considerable level of effort and technical input will be required.

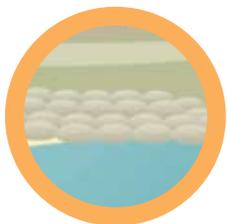
The level of detail is proportional to the degree of perceived risk and likelihood of environmental harm. The plan should detail monitoring requirements and best practice environmental management principles to ensure impacts from the proposed development are minimal or insignificant.

Generally there will be a requirement to conduct a marine flora and fauna survey if the proposed development is located within 5km of a known location of a threatened species. Online searches to determine if a marine survey is required can be undertaken by DPIPW. The survey must be undertaken by a suitably qualified professional, and will need a permit if the survey work has the potential to disturb listed threatened species. Video transects may also be required. Further details can be obtained from DPIPW.

15.2.4 Impacts of reclamation

Reclamation should be done only when absolutely necessary because it can severely damage ecosystems and may degrade nearby marine and estuarine environments. It is always best to leave the natural shoreline intact. Modification of the profile or shape of the shoreline can increase erosion at the site or further along the coast.

Reclamation may directly disturb or damage



Aboriginal heritage, historic or maritime heritage or geoconservation values. The subsequent changes to the shape of the shoreline may also increase the susceptibility of these sites to the impacts of sea level rise.

Reclamation works can release fine suspended sediments in estuaries and on some sandy shorelines underlain by fine sediments. Controlling turbidity from disturbed fine sediments is often a significant problem requiring careful operational planning and the use of sediment control or settling systems. Seagrass beds are particularly susceptible to increases in turbidity.

Disturbance to landforms such as saltmarshes, tidal flats, barways, and river mouths can destroy wildlife habitat such as fish nursery areas and breeding sites for shorebirds, and can completely alter these fragile environments. Wetlands are especially vulnerable to impacts from disturbance of acid sulphate soils, particularly if water levels and flows change significantly. **Refer to Chapter 6 Coastal landscape management.**

The use of machinery and subsequent disturbance of coastal areas can result in the spread of marine and terrestrial weeds such as rice grass, or other pests and diseases.

15.2.5 Works guidelines for reclamation

There are two main methods of reclamation:

- progressively infilling from the shoreline towards the sea
- erecting structures and then draining and backfilling the area contained by the structures.

The following points provide an idea of the scope of considerations when undertaking reclamation. Comprehensive information on reclamation can be found in the Derwent Estuary Program's *Dredging and*

Land Reclamation in the Derwent: a guidance document to support best practice management. (Eriksen in prep.).

Before works are planned, obtain technical advice from an experienced coastal geomorphologist and an engineer. Undertake all of the necessary planning and seek approvals – all reclamation works will require approval; none of the legislation specifies discretionary or minimum work limits.

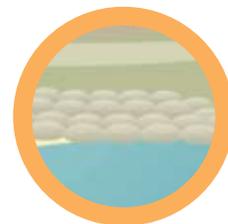
If proposing substantial reclamation or draining of the shoreline or seabed, seek public input. Consult local Coastcare groups even for very small projects. Local volunteers have a strong connection to the coast they have been caring for and should be included in coastal management decisions.

Minimise impact on coastal processes such as sand movement, cultural values such as Aboriginal heritage sites, wildlife and vegetation values such as threatened species, wildlife habitat and important coastal vegetation communities. Consult specialists and do any necessary assessments.

Avoid fish nursery areas, seagrass beds, saltmarshes, tidal flats, wetlands and other important ecosystems. Obtain specialist advice on the potential impacts on fisheries and wildlife, including threatened species (some migratory birds, spotted handfish, etc.). Time works to avoid breeding periods for nearby fish, birds or other wildlife.

Use the most up-to-date estimates of sea level rise to ensure the works will function as intended for their life span. The design must take the latest IPCC sea level rise projections into account.

Avoid allowing reclamation to be used as a means of disposing of materials, such as domestic and industrial waste. Fill must be clean and should generally be purchased from an approved source. Reclamation materials must be solid, inert, uncontaminated,



non-hazardous, and should not be waste of any kind. Avoid disturbing toxic materials such as metals, organochlorines (e.g. pesticides), algae (dinoflagellates) or sulfidic sediments (acid sulfate soils).

Avoid substantial reclamation unless there are exceptional circumstances (e.g. the benefits far outweigh the adverse effects). Avoid reclamation for private developments such as roads, walkways, housing developments and beach improvement, or for public developments where there are feasible alternatives (e.g. bridges, floating structures and wharves) for public access.

Ensure the reclamation does not detract from the natural character of an area. Do not use building rubble as facing materials (the outer layer). Building rubble includes old concrete beams, pieces of iron and steel, concrete, bricks and topsoil removed from building sites.

Ensure works are properly supervised by qualified people and that follow-up surveys are done. Ensure all site personnel are aware of operational constraints required to meet environmental standards and conditions.

Minimise damage to nearby areas during works and rehabilitate the site soon after works are completed. Ensure follow-up surveys and monitoring are undertaken.

15.2.6 Impacts of dredging

Dredging can disturb important marine ecosystems and disrupt coastal processes by altering the supply of sand to beaches. Removal of material from the intertidal area or seabed (e.g. sand for beach replenishment) can only be sustained if the natural coastal processes can replace that material. Seek specialist advice from a coastal geomorphologist.

The sediment disturbance can smother seagrass beds and harm other sensitive marine life.

Dredging can disturb toxic sediments, and release contaminants into the water that affect marine life. Toxic substances can accumulate in fish and shellfish and, in some species, may exceed food safety standards.

Nutrients, particularly nitrogen and phosphorus (which increase the rate of growth of marine plants), might also be released from sediments during dredging. This can trigger algal blooms, including toxic algae.

Dredging equipment can transport species from one port (or even country) to another, leading to new exotic marine pest invasions. All equipment should be inspected and cleaned before transport to a new area.

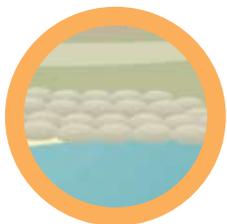
Dredging may produce large amounts of spoil that may be contaminated, including the exposure of subaqueous acid sulfate soils, and will require specialist disposal. Disposal of contaminated waste is tightly regulated, and clean-up of contaminated material may be required before it can be accepted by a waste-handling facility.

15.2.7 Works guidelines for dredging

All dredging works will require approval. There are no discretionary or minimum work limits in any legislation. Dredging requires an environmental assessment, which may include sampling of flora and fauna before and after dredging. Video sampling of the seabed may be needed, and core sampling of the sediment may be required to test for heavy metals and other potential pollutants as well as fauna living in the sediment.

Dredging should only be undertaken for the purposes of obtaining sediment for environmental rehabilitation or dredging of channels and barways for navigation purposes, requiring approval from MAST.

Dredging for obtaining sediment (e.g. for beach



nourishment) should only be undertaken in areas of rapid accretion of sediments or on unvegetated sand or mud. Seek specialist advice and technical assessments to determine the most appropriate site.

Identify any natural values that require protection, including threatened species and important marine habitats. Seek specialist advice. Dredging may not be appropriate or approved if it is likely to have an impact on these values.

Some marine areas contain subaqueous acid sulfate soils (ASS) and any dredging spoil placed on land will oxidise and release acid into waterways. Avoid dredging sediments containing metals, organochlorines (e.g. pesticides), toxic algae or acid sulfate soils, if possible. This should be investigated prior to dredging. Check ASS maps on the LIST. Test sediments before dredging, if there is any chance of disturbing contaminated material.

Use dredging methods that cause the least environmental damage for the particular site or situation. Dredging operations must employ control measures for limiting escape of sediments, such as silt curtains or screens hung vertically from a floating support to reduce transport of silt and suspended solids from the site. Avoid smothering seagrass beds and other sensitive habitat with sediment, wherever possible. These measures will not control dissolved contaminants such as nutrients or heavy metals.

Time dredging works to coincide with weather and tidal conditions that will minimise the transport of suspended material and to avoid sensitive ecological windows, e.g. breeding, spawning or larval stages of threatened or vulnerable species.

Take care with machinery and vessels to avoid transferring marine pests to a new environment.

The disposal of dredge spoil on land will require

the approval of the local planning authority. Do not allow disposal of dredged material where it will cause environmental damage (e.g. degrade water quality, or modify riverbanks and create sites prone to landslip). Do not dispose of dredge spoil on the shoreline, seabed or at sea when there are practicable alternatives. Refer to the *Planning Guidelines for the Tamar Estuary and Foreshore* (Watchorn 2000).

When dredge spoil is deposited on land, refer to the Australian Standards for sampling potentially contaminated soil (AS 4482.1 – 1997 and AS 4482.2 – 1999) and the *DPIPWE Information Bulletin 105 Classification and management of contaminated soil disposal* (DPIPWE 2009b).

If deposition of contaminated material is approved on the shoreline or seabed, it must be decontaminated beforehand, capped with a coarser material to prevent leaching of contaminants and movement after extreme natural hazards and events or diluted to minimise adverse effects on marine animals and plants.

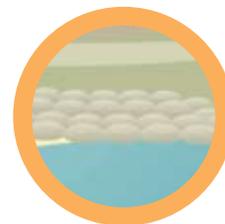
Consult local boat users and MAST before changing navigation channels.

Ensure works are properly supervised by qualified people and that follow-up surveys are done. Ensure all site personnel are aware of operational constraints required to meet environmental standards and conditions.

Instigate effective monitoring during and after construction to demonstrate performance criteria have been met.

Channels through rice grass

Rice grass (*Spartina anglica*) is a vigorous weed that was introduced to Tasmanian estuaries to reclaim land and stabilise mudflats. The grass quickly spreads, destroying fish habitat, smothering native plants and



changing flow regimes of waterways.

It is currently established in at least seven coastal regions in Tasmania, including Australia's two largest infestations, the River Tamar (420 ha) and the Rubicon estuary (135ha). These figures were obtained from a survey in 2000. (DPIPWE website accessed 7th Oct 2010).

Ensure dredging practices minimise the risk of spreading rice grass pieces. Do not dispose of rice grass in the water as it spreads readily from pieces of rhizome.

15.2.8 Dredging techniques

Most dredging in Australia is carried out using a trailer hopper dredge (THD) or cutter suction dredge (CSD).

Trailer hopper dredge (THD)

A trailer hopper dredge is a self-propelled ship with a large hopper to contain the dredge spoil. A draghead attached to a suction pipe is lowered to the seafloor and slurry of sediment and water is pumped into the hopper. THDs are used primarily in maintenance dredging where sufficient navigable depth exists and large volumes are to be removed.

The dredged material can be disposed of back into the marine environment or discharged through a floating pipeline back to shore. THDs create turbid plumes of sediment and therefore dredging of fine-grained sediments is a concern with this method.

Cutter suction dredge (CSD)

CSDs are usually mounted on a barge and consist of a rotating cutter head that collects a slurry of sediment and water that is pumped through a discharge pipeline. Some loss of sediment can occur.

CSDs are advantageous where stiff soils and rocks are

to be removed, principally in capital dredging projects. The dredged material is usually discharged directly into the marine environment.

Other dredges

Suction dredges are suitable for smaller projects, such as removal of sand for beach replenishment, where no cutting is required. A grab dredge can be used in situations where there is not enough depth for a trailer or cutter suction dredge, but these can produce a lot of sediment disturbance.

15.2.9 Ongoing maintenance for reclamation and dredging

Follow-up surveys and monitoring may be required, to check whether the reclamation and dredging project affects water quality, marine vegetation or wildlife. These requirements may be specified by the local council or by DPIPWE. Revegetation works associated with reclamation may require ongoing maintenance.

Dredging works require regular inspections to make sure they are effective (e.g. allowing safe navigation). The movement of sand can change unexpectedly with changes in currents and tides.

- Inspect dredged areas regularly and after heavy wave action.
- Inspect rice grass channeling operations regularly to ensure the rice grass meadows do not slump and release sediments into an estuary.
- Monitor levels of toxic substances in bottom-dwelling fish in areas where toxic sediments are disturbed.



15.3

15.3 Climate change and shoreline modification

This section discusses the implications for climate change when consider shoreline modification.

Whilst there is likely to be an increased demand for shoreline protection, it is important to ensure that any plans for protection or reclamation work carefully consider the complex coastal issues involved.

For many locations in Tasmania, a 50cm sea level rise would result in the present one-in-100-year storm surge event becoming annual or even more frequent by the end of the 21st century (Church et al. 2008).

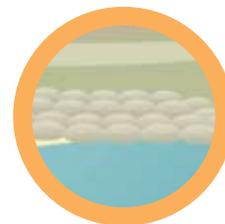
The IPCC Fourth Assessment Report (IPCC 2007) conservatively estimated a sea level rise of up to 79cm by 2100; ongoing research is predicting that sea level rise of over 1m and as high as 1.5m is possible, and sea levels will continue to rise long after 2100. It is anticipated that these higher projections will be reflected in the next IPCC report expected in 2014. Check the latest IPCC sea level rise predictions and use the most up-to-date estimates to ensure the works will function as intended for their life span.

The IPCC predictions and rising awareness of climate change are resulting in increased community concern about shoreline stability and receding coastlines. Coastal communities and many industries and economies rely on coastal infrastructure and access to the coast. In some cases works will be required in order to maintain access and services.

All shoreline protection works and reclamation must be designed to minimise impacts on coastal processes and values and be designed to cope with the predicted sea level rise for their expected life span. Any modifications to the shoreline require ongoing maintenance and this can be very expensive, especially if dredging is required to maintain changes to sand movement.

In some cases it will make more sense to retreat and let the coast settle to a new equilibrium and this will present challenges for land managers.

It is increasingly important to protect the natural and cultural values in coastal areas from human impacts and existing stress factors. The added pressure of climate change and sea level rise will result in increased stress on these environments and it is more important than ever to ensure that works in coastal areas and modifications to the shoreline consider and protect coastal values.



15.4 Tools and resources

Complete details of all printed publications listed here are provided in a reference list at the end of the Manual. Other tools and resources including websites are collated in **Appendix 5**.

Aboriginal Heritage Tasmania

Desktop searches for Aboriginal heritage sites

www.aboriginalheritage.tas.gov.au

Acid sulfate soils

Tasmanian acid sulfate soil management guidelines (DPIPWE 2009a)

Includes guidelines for the development of ASS management plan

Predictive maps of possible acid sulfate soil occurrence

www.thelist.tas.gov.au/

Log onto www.dpipwe.tas.gov.au/acidsulfatesoils and follow the instructions on how to use the LIST database to access ASS predictive mapping.

Australian Standards

- *AS 4482.1—1997 Guide to the sampling and investigation of potentially contaminated soil Part 1: Non-volatile and semi-volatile compounds*
- *AS 4482.2—1999 Guide to the sampling and investigation of potentially contaminated soil Part 2: Volatile substances*

Best management practices for foreshore stabilisation: Approaches and decision support framework (Swan River Trust 2009)

Coastal engineering guidelines for working with the Australian coast in an ecologically sustainable way (Gourley et al. 2004)

http://www.engineersaustralia.org.au/shadomx/apps/fms/fmsdownload.cfm?file_uuid=3879135B-B37F-5284-CB7B-DF97CDD2AB61&siteName=ieaust

Coastal engineering manual (United States Army Corps of Engineers 2002)

Part V, Chapter 3: Shore Protection

<http://chl.erdc.usace.army.mil/cemtoc>

Coastal Values data

Vegetation, species habitat and geomorphic values data for a 100m-wide coastal strip of the northern, southern and north-western Tasmania NRM Regions. Available on the LIST

www.thelist.tas.gov.au

DPIPWE Information Bulletin 105: Classification and management of contaminated soil disposal (DPIPWE 2009b)

Dredging and land reclamation in the Derwent: A guidance document to support best practice management (Eriksen in prep)

Environmentally friendly seawalls: A guide to improving the environmental values of seawalls and seawall-lined foreshores in estuaries (Department of Environment, Climate Change and Water 2009)



Foreshore values mapping

Provides baseline information on the condition of foreshores and identifies pressures for measuring impacts on key marine and coastal ecosystems. Available on the LIST

www.thelist.tas.gov.au

Indicative mapping of Tasmanian coastal vulnerability to climate change and sea level rise (Sharples 2006)

Information on Seabees construction in NSW: Wamberal Environmental Impact Statement

www.gosford.nsw.gov.au/Information/Documents/postings/eis_wamberal.htm

Marine habitat mapping

Data collected for south and east coasts of Tasmania depicting a range of marine habitats. From the coastline to the 40m depth contour. The data set is intended to be used to fulfil coastal management objectives according to the *Living Marine Resources Act 1995*.

Contact NRM South for more information

National assessment guidelines for dredging

(Department of the Environment, Water Heritage and the Arts 2009)

<http://www.environment.gov.au/coasts/pollution/dumping/publications/guidelines.html>

National environment protection (assessment of site contamination) measure (Environment Protection and Heritage Council 1999)

http://www.nepc.gov.au/sites/default/files/ASC_NEPM_ASC_NEPM_199912.pdf

Natural Values Atlas

Provides authoritative, comprehensive information on Tasmania's natural values. To access, download a free registration form from the website

<https://www.naturalvaluesatlas.tas.gov.au>

Planning guidelines for the Tamar Estuary and foreshore (Watchorn 2000)

Smartline or coastal vulnerability maps

Maps of coastal landform types and their vulnerability to sea level rise can be found under 'Climate Change' layers on the LIST and the OzCoasts website. The data is presented as a 'smart line' following the coastline, with information on the geology of the coast readily interpreted for particular coastal areas.

www.thelist.tas.gov.au

www.ozcoasts.org.au