

Tasmanian **Coastal Works** Manual

A best practice management guide for changing coastlines

Leah Page and Veronica Thorp

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Author(s): Leah Page and Veronica Thorp

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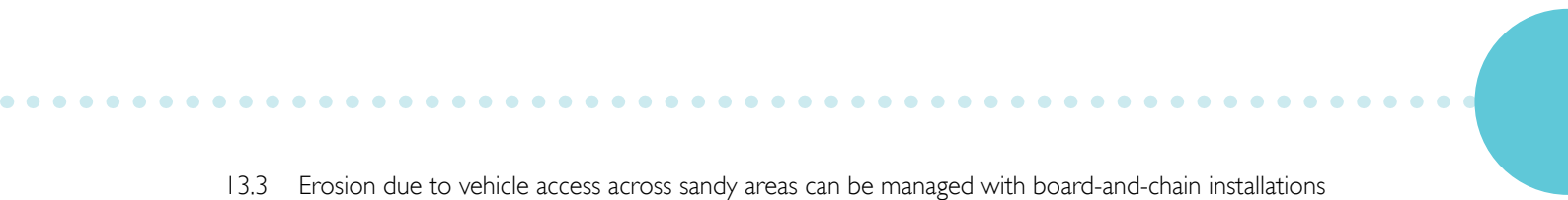
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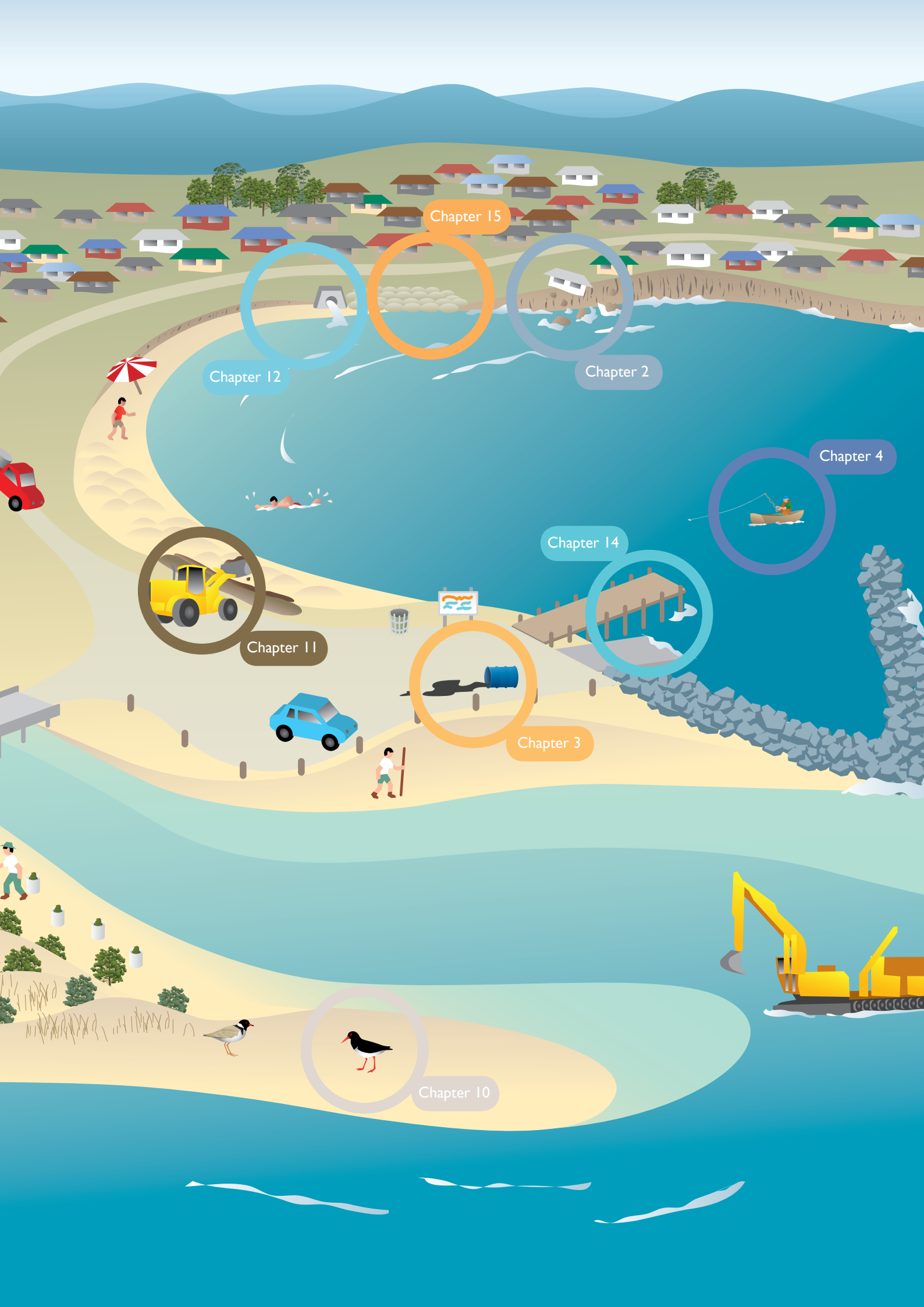
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Introduction

Tasmania's coast is a valuable and irreplaceable asset with diverse and sensitive natural and cultural values that require protection. Coastal landscapes of dunes, beaches, rocky shorelines, coastal wetlands, estuaries and saltmarshes support important vegetation communities and wildlife habitat. Tasmania's coast is also rich in Aboriginal heritage values and an important part of contemporary Aboriginal culture.

Coastal wildlife is diverse and significant, including migratory shorebirds and waders that stopover on Tasmanian wetlands, and shorebird species, hardly seen on mainland Australia, that nest on more remote beaches. The cool temperate coastal waters contain significant marine communities including vast seagrass beds, kelp forests and a very high level of endemism (species only found here).

Historically Tasmania's coastline has hosted industries and economies ranging from shipping and transport, whaling and sealing, through to mining of lime. Today coastal areas provide essential port infrastructure and are critical to transport and shipping operations. A number of heavy industries have been established on the coast, primarily to make use of the supply of water for cooling, and other industries such as fishing and aquaculture are intrinsically reliant on coastal areas.


Beautiful or iconic stretches of coastline are often the site of tourism ventures and developments such as resorts, caravan parks and golf courses. Extensive coastal areas adjacent to our cities and towns are prime real estate for coastal subdivisions whilst more remote locations often have coastal shack communities.

Tasmanians are fortunate to have such an abundance and variety of coastal areas to enjoy for recreation, and they have a long association with living and recreating on the coast.

Greater evidence of climate change and sea level rise on coastal environments in Tasmania is expected to emerge during this century. Many stretches of Tasmania's coastline already experience occasional inundation, and shoreline erosion events are becoming more frequent and widespread.

With the risks of inundation, erosion and recession already increasing, the management of natural and built assets needs to adapt to this threat. Climate change and sea level rise must now be considered

Tab photo: Friendly Beaches dunes – east coast of Tasmania. © Leah Page.



when planning and carrying out any management or development activity in the coastal zone to manage the coast sustainably.

The coast is under pressure from human use including modifications of shoreline areas for industry and development, the removal of native vegetation, introduction of weeds, and the introduction of pollutants and excess nutrients into estuaries. The vulnerability of coastal systems to climate change is exacerbated by increasing human-induced pressures in the coastal zone (DPIPWE 2010).

The intention of this manual is to help land managers to manage coastal environments for the protection of coastal values into the future, to ensure that works practices do not impact on coastal values and to encourage coastal works that are effective and of the highest environmental standard.

The Manual will also help land managers to better understand and address the possible on-ground consequences of climate change and sea level rise. Using this manual and other recommended resources, land managers will be better informed to plan the most suitable approach for the type and scale of the work being undertaken, taking into account the unique characteristics of each coastal area.

Purpose of the Manual

This manual and the accompanying guidelines provide practical information and guidance on the sustainable management of Tasmania's coast for council staff (e.g. parks and reserve managers, engineers and planners), other on-ground coastal managers, work crew leaders and contractors. This information will help avoid unnecessary damage and make rehabilitation of coastal areas more effective.

The Manual gives guidance on which environmental management issues should be considered and how to minimise the risk of causing environmental damage and impacts on coastal values. It contains information on identifying coastal values and assets and seeking assessments and approvals. It also summarises the main legal and policy obligations for protecting coastal areas and provides sources of further information.

The Manual covers both construction and ongoing maintenance for small- to medium-scale coastal management activities (including those classified as Level 1 under the *Environmental Management and Pollution Control Act 1994*).

The planning and approval process for industrial development and coastal subdivisions is beyond the scope of this manual. Land managers, however, have a responsibility to ensure that developments in the coastal zone minimise impacts on coastal values both during their construction and over their life span.

Managers of aquaculture facilities, golf courses, caravan parks and resorts can improve their environmental standards by following the best practice ideas throughout this manual such as maintaining native vegetation, removing weeds, protecting wildlife habitat and cultural heritage values, and reducing sediment and pollution run-off into waterways.

How to use the Manual

The Manual is organised into 15 chapters accompanied by a series of guidelines and checklists on specific management issues or approaches that complement each chapter. These can be found at the back of the manual.

The Manual provides information on climate change impacts as they relate to specific issues. Most chapters also have a climate change section that summarises this information, where available.

Some chapters provide design and siting guidelines (where appropriate) and others contain information on key issues to consider in order to attain best practice standards. Wherever possible, case studies illustrate successful approaches to best practice coastal management techniques.

Each chapter, except Chapter 1, has a 'Tools and resources' section at the end of chapter to direct users to documents, maps and other resources. Website addresses are provided wherever possible. All tools and resources are also collated in Appendix 5.

Complete citations of all documents referred to in the text and listed in the tools and resources sections are provided in a reference list at the end of the manual.

Guidance for minor works undertaken by community groups is available in the *Community Coastcare handbook* (Thorpe 2005).

Chapter overview

Chapter 1 Working on the coast

Contributors : Kathy Noble (Coastal and Marine Branch, DPIPW), Mike Pemberton (Biodiversity Conservation Branch, DPIPW)

Background on understanding local coastal processes (interactions of wind, waves, tides and currents) on both hard and soft elements of the changing and dynamic coastline.

Planning and understanding coastal land management legislation and frameworks prior to starting works is important, to save time, effort and money while doing a good job. Approvals and permits are required for most works on the coast. Follow-up inspections are advisable, to find out whether the works are successful and if maintenance is required.

Chapter 2 Climate change and the coast

Contributors: Chris Rees (Coastal and Marine Branch, DPIPW), Chris Sharples (Consultant)

An overview of the latest climate change information, predictions for Tasmania, and some of the implications of these changes for Tasmania's coastal environment


Chapter 3 Coastal hazards

Contributors: Chris Rees (Coastal and Marine Branch, DPIPW), Jocelyn Phillips (Coastal and Marine Branch, DPIPW)

Information about risk management and common coastal hazards such as storm damage and oil spills.

Chapter 4 Community values

Contributors: Kristy Blackburn (Southern Coastcare Association of Tasmania), Anna Wind (Cradle Coast NRM), Sally and Chris Johns (Southern Beaches Landcare & Coastcare Inc)



Working with the community, effective consultation and understanding social and recreational values of coastal areas.

Chapter 5 Cultural heritage management

Contributors: Elizabeth Tew (Aboriginal Heritage Tasmania), Ester Guerzoni (Heritage Tasmania)

Cultural heritage values, how to protect them and how to work with the Aboriginal community to manage Aboriginal heritage values.

Chapter 6 Coastal landscape management

Contributors: Chris Rees (Coastal and Marine Branch, DPIPW), Chris Sharples (Consultant), Vishnu Prahalad (University of Tasmania), Jason Bradbury (Land Conservation Branch, DPIPW)

An overview of the range of Tasmanian coastal landscapes and some key management practices to protect coastal landforms and the vegetation and wildlife values they support.

Chapter 7 Vegetation management

Contributors: Tim Rudman (Biodiversity Conservation Branch, DPIPW), Anthony Reid (Biodiversity Conservation Branch, DPIPW), Christine Corbett (Greening Australia)

Information about the conservation and management of natural coastal vegetation.

Chapter 8 Weed and disease management

Contributors: Mike Askey-Doran (Land Conservation Branch, DPIPW), Karen Stewart (Land Conservation Branch, DPIPW), Tim Rudman (Biodiversity Conservation Branch, DPIPW), Sandy Leighton (Southern Tasmanian Councils Authority)

Information about preventing the spread of weeds and diseases whilst undertaking coastal land management activities.

Chapter 9 Fire management

Contributors: Sandra Whight (Parks and Wildlife Service, DPIPW)

The role of fire in coastal ecosystems and fire hazard reduction works.

Chapter 10 Wildlife and pest management

Contributors: Rosemary Gales (Biodiversity Conservation Branch, DPIPW), Anthony Reid (Biodiversity Conservation Branch, DPIPW), Richard Schahinger (Biodiversity Conservation Branch, DPIPW), Alistair Morton (Marine Farming, DPIPW), Eric Woehler (Birds Tasmania)

Information about protecting wildlife habitat and values and threatened species and managing feral animals and marine pests.

Chapter 11 Soil management and earthworks

Contributors: John Chrispijn (Derwent Estuary Program), Rob Moreton (Land Management Branch, DPIPW), Chris Grose (Land Management Branch, DPIPW), Regan Parkinson (Land Management Branch, DPIPW)

Information on best practice excavation works, soil and water management plans and protecting against acid sulfate soil contamination.

Chapter 12 Stormwater and crossings

Contributors: John Chrispijn (Derwent Estuary Program)

Information on stormwater and crossings and how to minimise impacts on coastal ecosystems and values.

Chapter 13 Access management

Contributors: Lynne Sparrow (Parks and Wildlife Service, DPIPW), Stuart Dudgeon (Parks and Wildlife Service, DPIPW), Richard Greenhill (Hobart City Council), Jennifer Burdon (Parks and Wildlife Service, DPIPW)

Best practice techniques for designing and constructing and maintaining roads, tracks and access infrastructure, including signs.

Chapter 14 Structures and facilities

Contributors (Julie Woolley, Marine and Safety Tasmania)

Best practice techniques for designing, siting, constructing and maintaining coastal infrastructure such as boat ramps and public facilities.

Chapter 15 Shoreline modification

Contributors: Chris Rees (Coastal and Marine Branch, DPIPW), Chris Sharples (Consultant), Jason Bradbury (Land Conservation Branch, DPIPW), Ruth Eriksen (Aquatic Science)

Guidance on minimising impacts on coastal values when undertaking shoreline modification, reclamation and dredging.

Guidelines and checklists

Guidelines and, when required, checklists for specific work activities, are collated at the end of the Manual and are colour-coded to correspond with the relevant chapter.

The guidelines are designed to be used as stand-alone tools that can be issued to planners, engineers, contractors or works crew leaders to stimulate thinking about key coastal issues or best practice techniques when planning and undertaking coastal works. Dot points could be extracted for use as environmental clauses in contracts to improve environmental standards.

Several guidelines have detailed procedures and designs that are either not readily available elsewhere, or have been adapted to coastal conditions.

List of guidelines

- 4.1 Working with community groups
- 4.2 Partnership agreement template
- 5.1 Working with the Aboriginal community
- 6.1 Dune forming fence
- 6.2 Portable dune forming fence
- 6.3 Brush dune forming fence
- 6.4 Seagrass & seaweed removal from beaches
- 7.1 Plant propagation
- 7.2 Planting tube-stock
- 7.3 Revegetation in coastal areas
- 7.4 Slashing and mowing in coastal areas
- 8.1 Weed management in coastal areas
- 8.2 Weed and disease hygiene in coastal areas
- 10.1 Working in penguin habitat
- 10.2 Working in shorebird habitat
- 11.1 Trench digging
- 11.2 Acid sulfate soils
- 12.1 Bridges and causeways
- 12.2 Culverts
- 13.1 Track construction in coastal areas
- 13.2 Track structures - steps, boardwalks and ladders
- 13.3 Auditing tracks
- 13.4 Fencing
- 15.1 Rock revetments
- 15.2 Geotextile revetments



Appendices, Glossary and References

Appendix 1: Sets out the legislation and policy requirements for coastal management.

Appendix 2: Organises the legislation according to work activity areas.

Appendix 3: Where to obtain information; contact details for key organisations.

Appendix 4: Lists useful community and non-government organisations.

Appendix 5: Lists useful tools and products, organised by activity area.

A glossary, list of acronyms and references can be found at the end of the Manual.

Working on the Coast

- 1.1 Tasmania's coastline*
- 1.2 Coastal processes*
- 1.3 Managing conflicting uses of coastal areas*
- 1.4 Legislation*
- 1.5 Assessments and approvals*
- 1.6 Working with contractors*
- 1.7 Before work starts*
- 1.8 Monitoring and evaluation*

This manual provides best practice guidelines for many small-scale works in coastal areas. It is designed for local government, other land managers and contractors who undertake works on the coast.

The Manual explains the physical coastal processes that shape our coastline and the unique and important coastal values that require careful management. It describes key impacts of common coastal work activities and provides recommendations of what to do and what to avoid during these activities to protect coastal values.

The coastal environment is dynamic and complex and the shoreline is always changing in response to the interactions between wind, waves and tides. Coastal systems are delicately balanced to survive in these highly changeable environments. Management of these areas is further complicated by the number of authorities having land management and legislative responsibilities, some of which overlap or are not clearly defined.

Marine and coastal ecosystems are predicted to be highly vulnerable to the impacts of climate change. Coastal wetlands will be particularly vulnerable to changes in hydrology and the impacts of sea level rise. Significant areas of Tasmania's coast are at risk of erosion from exposure to sea level rise and storm surge inundation (DPIPWE 2010).

To work successfully in the coastal zone, and to avoid costly problems in the future, land managers will need an understanding of physical coastal processes, and have the wisdom to know when it is better to do nothing, by applying the precautionary principle. It is important to seek specialist advice and consulting broadly with other coastal stakeholders and the community.

1.1 Tasmania's coastline

Tasmania's coastline boasts vast and diverse coastal features such as estuaries, dunes, sandy beaches, rocky shores and headlands, sea cliffs, lagoons, tidal creeks and rivers, intertidal flats, rocky reefs, harbours and open coast. It also supports a wide range of habitats and ecosystems such as heathlands, woodlands, saltmarshes, seagrass beds, sponge gardens and kelp forests, as well as a rich variety of birds, fishery resources and marine life.

Tasmania's coast is a valuable and irreplaceable asset with diverse and sensitive natural and cultural values that require protection. Many coastal areas are highly valued for recreation, tourism, resources (such as fisheries), amenity and intrinsic values.

Tasmania has a remarkably long coastline for its size, due to a highly indented shoreline with large estuaries, harbours and embayments, and many offshore islands,

Figure 1.1 South coast track in the World Heritage Area
© Chris Rees



including those in the Furneaux Group and King, Maria, Bruny and Macquarie islands (Sharples 2006). Tasmania has a longer coastline than Victoria and NSW combined (Mount 2001).

No place in Tasmania is more than 115km from the sea and most population centres and major industries are on or near the coast. Many Tasmanians live, work and play on the coast.

1.2 Coastal processes

The coastal zone is not a stable and constant environment, but a dynamic place that can change rapidly in response to natural processes such as seasonal weather patterns.

Waves, winds, currents, tides and storms are the major forces on the coast. The results of actions and interactions of these natural forces on the shoreline and near-shore seabed are called coastal processes. These include erosion and deposition, movement of dunes, longshore drift, and the effects of storms on the coastline.

There are complex issues at the land and sea interface and an understanding of the connectivity between the catchment and the coast is essential in managing coastal issues and landscapes. Activities in the catchment can affect the water quality of our river systems and wetland areas, which in turn impacts on the health of coastal and marine environments. This can have implications for natural values such as seagrass beds, fish stocks and biodiversity.

Many coastal foreshores are still responding to the last sea level rise around 6 000 to 7 000 years ago and will continue to respond to increases in sea level associated with climate change.

The geology, alignment of coastal landforms and local

geomorphology (orientation and shape of coastal landforms) can all influence how coastal processes operate. The alignment of the coast influences the way waves are bent (refracted) as they approach the shore and the way they are aligned to the coast, and therefore how sand is moved along the shoreline.

Waves

Waves are formed by winds blowing over the sea. Waves are the most important force on sandy coasts because they transport sand on- and offshore and can also move sand along the shore. In winter, beach profiles often become steeper due to stronger wave action, which removes sand from the beach and deposits it on offshore sandbars. In summer, calmer waves bring sand back to the beach (Figure 1.2).

The relative amounts of summer deposition and winter erosion can mean sand dunes gradually move either seaward or landward. Beaches backed by parallel ridges (eg. Seven and Nine Mile, Rheban and many in the north-west) demonstrate a history of accretion (sand build up) and seaward expansion. Others, like Roches Beach in the east and Ocean Beach in the west, appear to have entered a new phase of sustained erosion.

Currents

Nearshore currents are created by winds, waves, tides and river flows. These currents may transport large amounts of sand and alter the shape of offshore sandbars.

Longshore currents (longshore drift) occur when waves come in at a slight angle to the shoreline. Each wave washes sand grains diagonally up the beach, the sand moves down the beach with the backwash and is then edged a little further along the beach by the next wave.

As a result, the sand is carried in a zigzag pattern along the beach and can cause an overall movement of sand and currents in one direction, called longshore drift. The effects of longshore drift can be observed by noting where sand builds up against a solid object (e.g. a groyne) or by the way a spit forms across a river mouth.

Rip currents can also carry large amounts of sand to offshore bars during wilder weather.

Tides

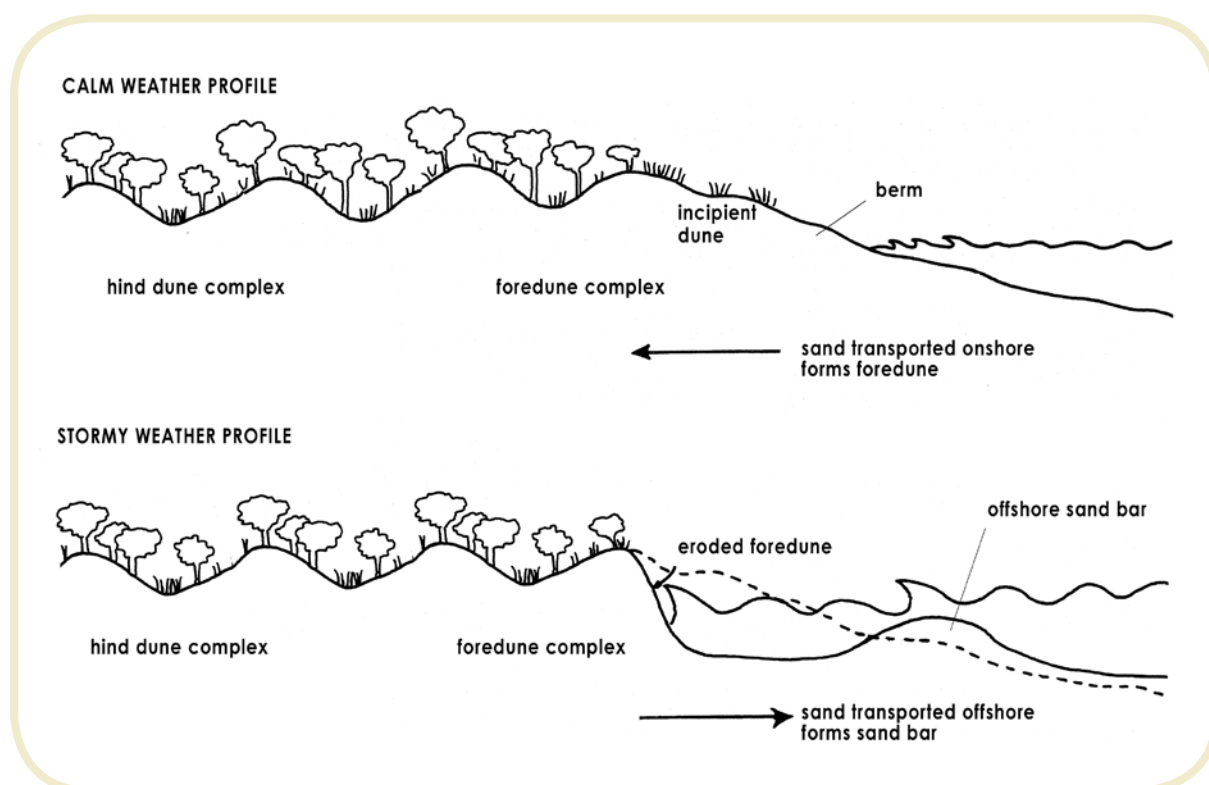
Tides play a more indirect role in transporting sand and altering the shape of sandy coastal areas. The ebb and flow of tidal waters can create tidal currents that transport sand and are mostly seen in areas where there is a narrow passage between landforms.

Tides play an important role in coastal estuaries where the regular inundation of low-lying areas often supports saltmarsh and wetland habitats which are important water filters and fish nursery areas.

In the lunar month, the highest tides occur roughly every 14 days, at the new and full moons, when the gravitational pull of the moon and the sun are in line. These are called **spring tides** (Tarbuck & Lutgens 1987).

On Australia's east coast, the highest tides occur

Figure 1.2 Beaches and foredunes undergo major cycles of change, as storm waves drag sand out to the surf zone and calmer swells bring the sand back onshore. The beach, foredune and offshore sandbar are all part of the one dynamic system. Source: Community Coastcare handbook (Thorp 2005)



during the winter months of June, July and August, and the summer months of December, January and February. The highest of each of these periods (i.e. one in winter and one in summer, totalling two per year) are known as the **king tides**.

The winter king tide usually occurs at night and may go unnoticed. Consequently the summer king tide, usually during the daytime, catches the most attention (Tarbuck & Lutgens 1987).

Wind

Wind takes over as the main dune-forming process above the high tide mark. Wind picks up sand grains deposited by waves and moves them landwards until vegetation (or other obstructions) slows the wind, and the sand grains fall. Sand grains become trapped in vegetation and form dunes. Wind is also a cause of dune erosion and blowouts, often when vegetation has been disturbed and sand becomes mobile.

Storms

Storms can dramatically change beach, dune and bar systems in a very short period. Storms produce high energy and steep waves that can erode beaches, destroy foredunes and even erode the dunes behind. It often takes years after a storm before the original dune is restored; intervention may be required if public safety is at risk.

In some locations, 90% of the amount of sand moved by the annual longshore drift can occur in just two weeks during very stormy periods. A major storm or succession of storms is likely to occur every 20 years or so.

Shoreline erosion and recession

Erosion is the wearing away of land or the removal of beach or dune sediments by wave action, tidal currents, wave currents, wind or drainage. Erosion may result in long-term losses of sediment and rocks, or merely the temporary redistribution of coastal sediments.

Recession is the result of ongoing erosion with no sediment replenishment, resulting in the landward retreat of the shoreline.

The impacts of sea level rise and climate change will result in more frequent and severe storm events and higher sea levels will increase the rate of coastal erosion and lead to coastal recession in many coastal areas.

Sediment budget

Sediment budget refers to the balance between sediment added to and removed from the coastal system by coastal processes. When more material is added than is removed, there is a surplus of sediment and the shore builds seaward. Coastal erosion occurs when coastal processes remove more material from the shore than is added.

The movement of sand and sediment in coastal areas is very important to the way humans use the coast. Sand can build up in unwanted areas (river channels) and be eroded from valued sandy landforms such as beaches. Understanding coastal processes is essential to ensuring that coastal works do not cause unwanted changes to sand movement such as increasing erosion.

Figure 1.3 Significant saltmarsh areas are associated with Duckhole Rivulet within the Pitt Water-Orielton Lagoon Ramsar site in south-east Tasmania.
© Vishnu Prahalad

1.3

1.3 Managing conflicting uses of coastal areas

Tasmania's coast is an irreplaceable asset of natural, economic, recreational, cultural and historical significance. Managing the coast and coastal resources requires a balance between these values. Sometimes the range of activities and values associated with any particular area of coastline can be in conflict.

Planning for coastal areas needs to take into account the range of coastal values, assets and land use types, to ensure that land use is appropriate for the area and not likely to create conflict in the future.

Coastal land management is further complicated because a range of legislation and a number of different authorities are responsible for managing the spectrum of coastal values.

There are no simple answers for managing conflicting uses but the best outcomes are achieved through a holistic approach that includes consideration of natural, economic and cultural values, the natural processes, community perception, the land use, threats and unique local issues. Broad consultation, expert advice and planning are essential.

Tips for managing conflicting uses

- Public safety must be paramount
- Identify all of the stakeholders in your particular area
- Identify all of the values through consultation with stakeholders and by seeking expert advice
- Identify all the natural and cultural heritage values – seek expert advice
- Identify the threats, both present and future
- Provide lots of opportunities for stakeholders to be involved in planning and decision-making, as this will reduce conflict in the long term
- Ensure that you understand the relationships between the potential coastal uses and values – some may be completely incompatible



Case Study 1.1: Pitt Water-Orielton Lagoon Ramsar site – an example of the complexity of managing coastal areas

Pitt Water-Orielton Lagoon is an extensive and diverse wetland system in south-eastern Tasmania providing habitat for migratory and resident shorebirds and is an important estuarine ecosystem for marine life. The lagoon area provides habitat for a number of threatened bird species and is one of only a few locations in the world that is home to the threatened Tasmanian live-bearing seastar (*Parvulastra vivipara*).

The wetland supports a number of threatened plant species as well as some of the most significant saltmarsh habitat in Tasmania. The area is an important nursery for the commercially valued school shark and also supports commercial oyster farming. Recreational activities include fishing, paddling, windsurfing and kite-surfing. The area is also rich in Aboriginal heritage values.

The wetland is surrounded by residential development and high-intensity agricultural land as well as some light industry and a golf course.

Pitt Water-Orielton Lagoon is one of 10 internationally recognised Ramsar sites in Tasmania. Ramsar wetlands are recognised as Wetlands of International Importance by the Ramsar Convention, an intergovernmental treaty that provides the framework for international cooperation for the conservation and wise use of wetlands.

Parts of the wetland area are also managed as a Nature Reserve under the *National Parks and Reserves Management Act 2002*. The Parks and Wildlife Service (DPIPWE) is responsible for

managing the nature reserve; Crown Land Services (DPIPWE) is responsible for the management of any unallocated Crown land; the Biodiversity Conservation Branch of DPIPWE is responsible for upholding the commitment to the Ramsar Convention; the Sorell and Clarence City Councils are responsible for stormwater management and any areas of council land.

In addition, the wetland is bisected by two causeways managed by the Department of Infrastructure, Energy and Resources.

A range of other legislation also covers the heritage values, threatened species, fisheries and marine resources and weed management. The migratory shorebirds that use this area annually are protected under a number of international agreements including CAMBA*, JAMBA** and ROKAMBA^, to which Australia is a signatory.

In addition to these natural and cultural values the area receives stormwater from the surrounding residential areas, is under pressure from inappropriate access by vehicles, horse and dogs, has some significant weed incursions and is subject to agricultural run-off from the surrounding catchment.

A management plan for the area has been created by the Parks and Wildlife Service to guide its activities and a collaborative project, being implemented by a committee that represents the majority of the stakeholders, has produced some good outcomes in managing access, controlling weeds, protecting Aboriginal heritage, raising awareness and protecting bird values and habitat.

*China-Australia Migratory Bird Agreement **Japan-Australia Migratory Bird Agreement ^Republic of Korea-Australia Migratory Bird Agreement

1.4 Legislation

This section details the legislative framework of coastal management decision-making and the more common legislation that will be triggered by activities and works in coastal environments.

Coastal management in Tasmania is complex and a number of authorities are responsible for different jurisdictions. Always seek advice to ensure that planned activities meet the legislative requirements.

In addition to the information provided here, **Appendix 1** lists all of the relevant legislation for coastal management. The legislative and policy requirements for each type of activity are listed in **Appendix 2**.

1.4.1 Resource Management and Planning System

All planning decisions made in Tasmania fall under the umbrella of Tasmania's Resource Management and Planning System (RMPS). All the legislation that contributes to the RMPS has five common objectives that drive decisions about the use of land and natural resources in the state:

- promote the sustainable development of natural and physical resources and the maintenance of ecological processes and genetic diversity
- provide for the fair, orderly and sustainable use and development of air, land and water
- encourage public involvement in resource management and planning
- facilitate economic development in accordance with these objectives
- promote the sharing of responsibility for resource management and planning between the different spheres of government, the community and industry in the state.

The RMPS covers:

- local planning schemes that are prepared and administered by councils
- state policies applicable to particular issues, which must be adhered to by both local and state government
- a single appeal system involving the Resource Management Planning Appeal Tribunal (RMPAT)
- a suite of processes and instruments which gives legislative effect to the RMPS objectives above

1.4.2 Tasmanian coastal legislation

Aboriginal Relics Act 1975

The *Aboriginal Relics Act 1975* provides for the preservation of Aboriginal relics and the declaration, management and protection of Protected Sites. Under the Act, Aboriginal heritage is referred to as 'relics', and includes such things as artefacts, paintings, carvings, engravings, arrangements of stones, middens, or any objects, sites, or places that show signs of the activities of Aboriginal inhabitants.

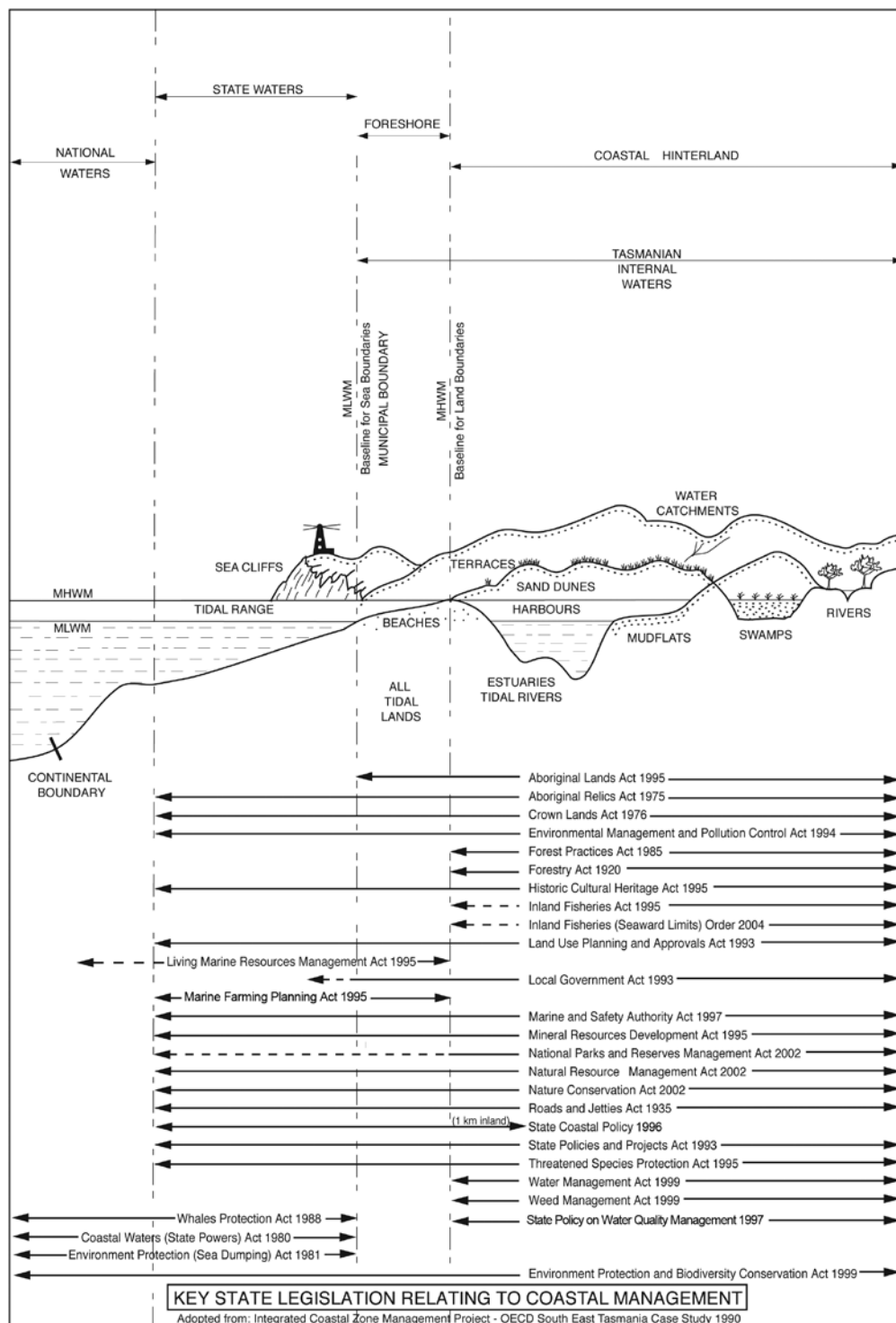
All Aboriginal heritage is protected under the *Aboriginal Relics Act 1975*. If at any time during works Aboriginal heritage is suspected, you must cease works immediately and contact Aboriginal Heritage Tasmania for appropriate management advice.

Crown Lands Act 1976

In Tasmania, the majority of coastal land is Crown land covered by the *Crown Lands Act 1976*. The Act governs the management and use of Crown land, including land that is licensed or leased from the Crown.

Crown Land Services (DPIPWE) is responsible for the assessment of all applications for the use of Crown land, including the private use of land reserved

Figure 1.4 Key state coastal legislation. Adapted from: Integrated coastal zone management project – OECD south-east Tasmania case study 1990.



under the *Crown Lands Act 1976* and land reserved under the *National Parks and Reserves Management Act 2002*. The Parks and Wildlife Service are however responsible for the day to day management of land reserved under the *National Parks and Reserves Management Act 2002*.

All land below the high water mark falls under the jurisdiction of the Crown. Developments involving Crown land may also require approval from council under the *Land Use Planning and Approvals Act 1993*.

Environmental Management and Pollution Control Act 1994

The *Environmental Management and Pollution Control Act 1994* (EMPCA) is the primary environment protection legislation in Tasmania. The role of EMPCA is to integrate local government and state planning assessment, and environmental management and approvals. Three classes of activities are identified under EMPCA (Levels 1 to 3), reflecting the range of potential environmental impacts.

Local government authorities have responsibility for the assessment, approval and environmental regulation of smaller-scale activities (Level 1) and must endeavour to prevent or control activities that might cause pollution.

The implementation of approved activities, along with any conditions, is regulated through a permit process under the *Land Use Planning and Approvals Act 1993*. Level 1 approved activities are deemed to pose the lowest level of risk to the environment.

This manual covers both construction and ongoing maintenance for small- to medium-scale coastal management activities (including those classified as Level 1 under EMPCA) undertaken by local government works crews, other government agencies, contractors, consultants and other parties.

Historic Cultural Heritage Act 1995

The *Historic Cultural Heritage Act 1995* provides protection of heritage with respect to places of archaeological, architectural, cultural, historical, scientific, social and technical significance.

Land Use Planning and Approvals Act 1993

The *Land Use Planning and Approvals Act 1993* (LUPAA) is the central Act within the RMPS. It provides the framework and key components for strategic and statutory land use planning and development. LUPAA requires that a local council planning scheme must aim to further the objectives of the RMPS, be consistent with any state policies, and have regard to the council strategic plan.

LUPAA provides for the creation, application and administration of planning schemes by planning authorities. Council planning schemes set out the requirements that apply to new land use and development. Planning controls on land use are applied in the form of zones and associated development controls.

The Tasmanian Planning Commission (formerly the Resource Planning and Development Commission, RPDC) is responsible for assessing planning schemes and planning-scheme amendments that are prepared by local planning authorities. Appeals against decisions made by local planning authorities are resolved through RMPAT.

Living Marine Resources Management Act 1995

The *Living Marine Resources Management Act 1995* promotes the sustainable management of living marine resources, provides for management plans relating to fish resources, and protects marine habitats. Living marine resources refers to all fish

species and other marine life including marine plants and vegetation such as seagrass and seaweed. It does not include whales or aquatic mammals or birds, or freshwater fish.

The Act applies to both commercial and recreational fisheries, as well as to aquaculture, marine reserves, marine pollution, release and importation of fish, diseases and pests, and other marine habitat-protection issues.

The Act and its regulations set minimum sizes of fish that can be taken; establish allowable fishing equipment and techniques, total allowable catches and bag limits for fisheries; give powers to fisheries officers, and allow for Fisheries Management Plans to be prepared.

National Parks and Reserves Management Act 2002

The *National Parks and Reserves Management Act 2002* provides for the management of national parks and other reserved lands. These include national parks, state reserves, nature reserves, game reserves, conservation areas, nature recreation areas, regional reserves, historic sites, private nature reserves and private sanctuaries. The Act sets out the values and purposes of each reserve class and how they should be managed according to management objectives for each class.

Nature Conservation Act 2002

The *Nature Conservation Act 2002* provides for the conservation and protection of the fauna, flora and geological diversity of Tasmania and for the declaration of national parks and other reserved land. The Act also provides for conservation covenants and reservation of private lands.

Schedule 1 sets out the different classes of reserved land, and outlines their values and the purpose for reservation.

Schedule 3a sets out a list of threatened native vegetation communities. In addition to individual threatened species, a number of threatened coastal vegetation communities are defined (e.g. riparian vegetation, wetlands, saltmarsh).

State Policies and Projects Act 1993

This Act deals with the making of Tasmanian Sustainable Development Policies, the integrated assessment of projects of state significance, the State of the Environment Reporting and for related purposes. The two state policies most relevant to the coastal zone are the *State Coastal Policy 1996* and the *State Policy on Water Quality Management 1997*.

State Coastal Policy 1996

The *State Coastal Policy 1996* has a central objective of sustainable development of the coastal zone. All activities, uses and developments that might impact on the coast are required to meet the objectives, principles and outcomes of the State Coastal Policy.

The policy has three main guiding principles:

- protection of natural and cultural values of the coast
- use and development of the coast in a sustainable manner
- integrated management and protection of the coastal zone is a shared responsibility.

The coastal zone is defined in the *State Coastal Policy 1996*, and revised in 2003 in accordance with the *State Coastal Policy Validation Act 2003*, as the area encompassing state waters and all land to a distance of 1 km inland from the high water mark.

The main vehicles for implementing the State Coastal Policy are through land use planning controls, marine farming development plans, and local council strategic and operational plans.

Where there is a discrepancy between the State Policy and the provisions of a council planning scheme, the State Policy takes precedence.

A review of the *State Coastal Policy 1996* started in 2004, resulting in a proposed new *draft State Coastal Policy 2008*, which has yet to be formally adopted.

Until a new State Coastal Policy is gazetted, the *State Coastal Policy 1996* remains in force.

State Policy on Water Quality Management 1997

The central objective of the *State Policy on Water Quality Management 1997* is sustainable management of Tasmania's surface and groundwater resources, by protecting or enhancing their qualities while allowing for sustainable development.

Protected Environmental Values (PEVs), which describe the current uses and values of waterways, must be set for all Tasmanian surface waters, including estuarine and coastal waters. PEVs have been documented in a consultative process that involved all interested industry and community groups.

PEVs are useful in determining which key indicators should be monitored, and target levels for protecting or improving water quality for designated uses. In general, these values should be protected by implementation of best practice environmental management, and by compliance with emission limits set by the regulatory authority to minimise pollution of waterways.

Threatened Species Protection Act 1995

Threatened species are native species that are listed under state and federal legislation to receive special protection. Tasmanian species become listed under the *Threatened Species Protection Act 1995* due to restrictions in their abundance, range or habitat, or threatening processes likely to result in population reduction.

Management options to protect listed species include declaring areas of critical habitat, preparing and implementing recovery and threat-abatement plans, and instigating interim protection orders. Interim protection orders prevail over planning schemes, and can include the prohibition or regulation of any activity likely to affect the habitat adversely.

Weed Management Act 1999

The *Weed Management Act 1999* is the central legislation covering weed control and eradication in Tasmania. A core component is the legal process of declaring a weed species under the Act. Once declared, appropriate actions can then be taken against the plant species, including preparing a weed management plan. The legislation also addresses compliance requirements, and powers of inspectors appointed under the Act.

1.4.3 Commonwealth legislation

Environment Protection and Biodiversity Conservation Act 1999

Activities that are likely to have an impact on matters of national environmental significance, for example listed threatened species and ecological communities, or listed migratory species, may also trigger an assessment under the federal *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

This assessment is conducted by the Australian Government, and the assessment is triggered by the referral of the matter to the Minister for the Environment.

1.5 Assessments and approvals

Before planning or undertaking works at any location, check who owns the land and what approvals and permissions are required. Works on public land, such as beaches, dunes and coastal reserves, will require the permission and approval of the land manager/

owner. This would generally be Crown Land Services (CLS), Parks and Wildlife Service (PWS) or the local council. For private land, permission of the landowner will be required.

Land below high water mark is generally Crown land; works there require approval under the *Crown Lands Act 1976*. There are also some Crown reserves extending up to 30m inland from high water mark. These are shown on the Tasmanian 1:25 000 scale topographic maps.

Councils and state agencies, such as PWS and CLS, can assist in identifying ownership of the land and the responsible land management authority. They can also

Table 1.1 Approval processes for coastal management activities

Councils	State government	Australian Government
Planning approval under the local planning scheme.	Approvals under the various state Acts detailed in section 1.4, such as <i>Aboriginal Relics Act 1975</i> , <i>Crown Lands Act 1976</i> , <i>Environmental Management and Pollution Control Act 1994</i> , <i>Land Use Planning and Approvals Act 1993</i> , <i>Living Marine Resources Management Act 1995</i> , <i>National Parks and Reserves Management Act 2002</i> , <i>Nature Conservation Act 2002</i> , <i>Threatened Species Protection Act 1995</i> , <i>Weed Management Act 1999</i> .	Compliance with <i>Environment Protection and Biodiversity Conservation Act 1999</i> may require approvals.
Building approval under the Building Code of Australia.	Each agency has different processes and requirements for approvals that they administer.	
The Engineering, Works and Parks and Recreation branches of local government are also required to obtain planning and building approvals from within their local governments.		

advise on the nature of any approvals required and how to go about lodging an application for approval.

Common approval processes are summarised in Table 1.1. Each land manager may also have requirements for certain formal assessments to be carried out so that values such as natural and cultural heritage and the potential impacts of a proposed activity are systematically considered.

Reserve Activity Assessment (RAA), Parks and Wildlife Service

The RAA system applies to all reserves managed under the Tasmanian *National Parks and Reserves Management Act 2002*. Depending on the nature and size of the proposed activity, an RAA assessment may be required for works undertaken in any reserves administered by PWS. The proposed activity will be assessed in order to minimise or reduce the potential for impacts on the reserve values. In some instances this may require input from specialists.

Aboriginal Heritage Assessment, Aboriginal Heritage Tasmania

Any development or works outside an existing development footprint should involve Aboriginal Heritage Tasmania at the beginning of the planning stage. It will advise if an Aboriginal heritage investigation or mitigation measures are needed to protect Aboriginal heritage. The level of investigation required will depend on the size and complexity of the project, the potential for Aboriginal sites to be present and what sites are already known in the area.

Crown Land Services Assessments, Department of Primary Industries, Parks, Water and Environment (DPIPWE)

Any activity occurring on Crown land requires

approval from Crown Land Services (CLS). Crown land may be sold, leased or made available for use under licence. It includes lands such as beaches, coastal and river reserves, public reserves, reserved roads, road verges, schools and hospitals. Coastal land or land adjoining inland waters will generally not be available for sale.

Formal application must be made to CLS to purchase the land or hold a lease or a licence over it. Application forms are found on the DPIPWE website.

A leaseholder has exclusive possession of the Crown land for a fixed term and pays rent. A licence does not provide for exclusive possession and is usually issued for access purposes or temporary short term use. Sale gives freehold title of the land upon payment of market value or an agreed price and is generally by public auction, tender or private treaty.

CLS assesses applications for land purchases and developments taking into account its merits, the management objectives for the land, and a public benefits test. Applications are considered by a Technical Advisory Group made up of government stakeholders with technical expertise across a number of areas, including environmental, European and Aboriginal heritage, and conservation. The public benefits test assesses the economic, social and environmental benefits of the proposal.

Environmental Impact Assessment (EIA), DPIPWE

The Environment Protection Authority Board's environmental impact assessment process applies to projects that are classified as Level 2 activities (under Schedule 2 of the *Environmental Management and Pollution Control Act 1994*), or other activities as determined by the Director of the Environment Protection Authority.

The scale and impact of the proposed activity determines whether an environmental impact assessment is required. Many of the activities covered in this Manual would be regarded as Level 1 activities, and therefore would not require a formal environmental impact assessment. These activities will, however, still require assessments of coastal values in order to minimise impacts on coastal environments and to abide by environmental legislation. Some of the more complex and larger activities, such as shoreline protection works, may be classified as Level 2 activities.

Threatened Species Assessment, Australian Government

The *Environment Protection and Biodiversity Conservation Act 1999* protects nationally listed threatened species by requiring activities or developments that are likely to have a significant impact upon a nationally listed threatened species to undergo a formal environmental impact assessment and approval process.

Additional assessments

If formal assessment processes are not deemed necessary it is still important to ensure that all natural and cultural values are identified before works commence.

Check with the Tasmanian Heritage Office and the heritage section of PWS for heritage values.

Search the Tasmanian Geoconservation Database at DPIPW for geoheritage sites.

Seek expert advice on wildlife and vegetation values from the DPIPW Biodiversity Conservation Branch and the Wildlife Management Branch.

Seek expert advice on coastal processes and coastal landforms from a coastal geomorphologist.

1.6 Working with contractors

In many circumstances contractors will be engaged to undertake works in coastal areas, such as fencing, earthmoving, vegetation management and weed control.

The qualifications and performance standards that need to be met will differ from one land manager to the next.

Contractors may not always be up to speed with latest best practice or have an understanding of the complex values and issues within the coastal environment. The guidelines throughout this manual will provide a benchmark for 'best practice' standards to expect from contractors.

Choose contractors with high environmental standards. Seek references or evidence of environmental credentials.

Provide clear environmental management targets in contract schedules. Works guidelines in this manual could be used as a basis for clauses in agreements with contractors.

A contractor who gets the job done in half the expected time might save money initially, but it could take a lot more time and money to fix problems that result from cutting corners or not following correct procedures.

1.7 Before work starts

This section deals with the importance of planning coastal management works and provides a step-by-step process for good management of work activities. Effective works on the coast require thorough planning and preparation, risk assessment and monitoring. Works must adhere to all relevant Australian and Tasmanian Acts, regulations, codes, strategies, and management plans.

Undertaking environmental management activities and construction works in coastal areas without adequate care could lead to environmental damage, which may be difficult and expensive to remediate. Works in the wrong place or completed incorrectly can soon be destroyed by natural coastal processes.

It makes sense to develop a works plan, obtain specialist advice, get the correct approvals, and notify or involve nearby residents and other interested people. It may be necessary to do cultural and natural heritage surveys before commencing works, to locate and identify values such as Aboriginal heritage, geoheritage, threatened species or vegetation of high conservation value.

Managing coastal environments is not an exact science and sometimes innovative methods may be more appropriate than traditional approaches. The guidelines in this manual do not rule out other approaches, as long as they are supported by specialist advice.

1.7.1 Things to consider

Works on unstable coastal landforms such as dunes, cliffs and beaches can increase erosion, which in extreme cases can lead to loss of structures (e.g. retaining walls) and danger to the public.

Coastal vegetation is important habitat and plays a role in stabilising foreshore areas. Some coastal vegetation communities are threatened or contain threatened species. Works should avoid impacts on threatened species, minimise damage to vegetation and implement rehabilitation where required.

Works on soft and sandy shorelines will be especially vulnerable to the increasing frequency of storm surges and rising sea level associated with global changes in climate.

Works should be appropriate for the site: soft methods (e.g. revegetation) are preferable to 'hard' structures (e.g. seawalls) on the shoreline. Hard structures need engineering advice and require ongoing maintenance.

Acid sulfate soils in some areas can cause great damage to coastal structures and natural values if disturbed by excavation. Some areas have toxic sediments (e.g. heavy metals from mines or refineries) that may cause water pollution if disturbed.

Particular precautions are required with the use of machinery, particularly large machines such as excavators and bulldozers, on fragile and unstable coastal soils.

Machinery and equipment can transport weeds and diseases, and should be cleaned off-site before travel to the work site.

Commercial activities that rely on protecting natural ecosystems (e.g. fisheries and ecotourism) may be adversely affected by some works.

Some wildlife such as shorebirds, penguins and threatened species are extremely vulnerable to disturbance of their coastal habitat.

Works in coastal areas may disturb Aboriginal or other heritage sites and destroy cultural heritage values.

Consultation with the community is important to gain support for works and activities. Working with local organisations such as Coastcare groups is critical to ensure that proposed works will not impact on existing coastal management work being undertaken by volunteers.

A works plan should be prepared before starting work, outlining the works to be done and who will do them, ensuring staff or contractors have appropriate skills and training for the job.

The plan should include a risk assessment detailing the measures that will be used to minimise the risk of causing environmental damage. It should specify the proposed methods and procedures and identify the materials, labour and costs, both for the works and for maintenance and ongoing monitoring.

1.7.2 Prepare a plan – six steps to effective coastal works

Planning is essential for all work activities to ensure works are undertaken effectively, efficiently, safely and with minimal impact on the environment. This section outlines how to plan effective coastal works.

Environmental management and construction projects require careful investigation and planning to ensure that the works:

- are effective in solving the environmental problem
- are appropriate for the specific site conditions (including impacts of sea level rise and climate change)
- are undertaken with minimal intervention at the site
- minimise damage to the environment
- maintain the integrity of ecosystems
- respect and protect Aboriginal heritage places and other heritage places
- involve the community through consultation and participation.

Some key coastal issues to include in the plan

Identify sensitive vegetation communities and threatened species that might be affected by the works and need to be protected. A scientific survey may be needed.

Design works specifically for conditions at the site (e.g. direction of the prevailing wind/s, waves and movement of marine sediments) and interfere as little as possible with the coastal processes and ecosystems. Time activities to accommodate the tides and seasonal changes in winds, weather and storms. Consider seeking a specialist advice on whether the proposed work methods, design and placement of structures are suitable for local conditions, especially on soft or sandy coasts. Consider and seek advice on the local natural coastal processes.

Identify and avoid any potential impacts on wildlife and plan to reduce these impacts. Seek advice if working near sensitive wildlife habitat, such as shearwater rookeries or penguin colonies. Time activities to allow for seasonal breeding cycles for birds such as penguins and nesting shorebirds. Also consider providing for wildlife requirements (e.g. when revegetating an area, remember some shorebirds require bare patches to build their nest in the sand).

Protect Aboriginal and cultural heritage values. Ensure that these values are identified and any specifications for activities adhered to.

Work with the local community: in particular, it is important to collaborate with local environmental groups such as Coastcare groups.

Protect surface and ground water quality. Take steps to minimise pollution and changes to the natural drainage patterns of the shore area.

Minimise construction and excavation on the seabed or shoreline. Manage it carefully under the advice of engineers and a coastal geomorphologist. Identify potential acid sulfate soils and toxic sediments.

Avoid introducing marine and terrestrial weeds, pests and diseases (e.g. on the wheels of vehicles, in mulch products and via boats), particularly phytophthora root rot (*Phytophthora cinnamomi*) and rice grass.

Plan for sea level rise by avoiding major works in highly vulnerable locations and factoring into the design and siting of coastal infrastructure the latest sea level rise predictions by the Intergovernmental Panel on Climate Change (IPCC). Coastal storms and storm wave surges are likely to occur more frequently in the future. This will remove sand from dunes, cause flooding in coastal areas and increase the salinity of coastal groundwater and freshwater wetlands (Sharples 2006; IPCC 2001).

Occupational health and safety (OH&S) and public safety are important when installing structures or providing facilities. Adhere to Australian Standards. Ensure that public safety, use and enjoyment are maintained. Provide adequate warning signs, fencing and other barriers while undertaking works that may endanger public safety. Provide safe, well-marked alternative access routes, if necessary, during works.

Protect aesthetic values. As far as possible, structures should be concentrated at certain locations to reduce the environmental and visual impacts (from both short and long views, from both land and water) on the general area.

The works program should include rehabilitation of the site, if necessary, and provide for regular follow-up to make sure the works are effective and in good repair. Schedule revegetation works for the most appropriate time of year for the best plant-survival rates.

Step 1 - Seek specialist advice

Good specialist advice can help to prevent or solve problems caused by constructions that are not properly sited or designed for the changing conditions on the coast. Inappropriate works can cause a range of issues including erosion or deposition of sand where it is not wanted.

Coastal geomorphologists have knowledge of managing coastal sands, soils and landforms such as dunes and cliffs.

A coastal engineer has experience in designing and constructing bridges, boating facilities and other structures to take account of tides, currents, sediment movement and other local coastal processes.

Other relevant specialists include Aboriginal Heritage Officers, biologists and ecologists.

In these situations it is essential to seek specialist advice:

- a new hard engineering structure (e.g. a concrete wall) is proposed for a soft or sandy coastline
- the structure is large enough to trap sediment or change wave action (e.g. shoreline stabilisation techniques, groynes on sandy beaches, seawalls)
- an existing hard structure is creating ongoing problems (e.g. sand being trapped by a boat ramp).
- soft engineering techniques are being investigated and it is difficult to know which technique is most appropriate for the existing conditions (e.g. mesh or brush fences, and/or revegetation)
- there is a risk of disturbance to significant or threatened vegetation communities, flora or fauna, or cultural and Aboriginal heritage sites.

It is possible that minor upgrades to hard structures such as jetties and boat ramps will not require

specialist advice (e.g. resurfacing, or filling in holes at the end of boat ramps caused by boat propellers). However these works should be undertaken with great care and with consideration of coastal values. If values are disturbed or impacted by the work activity, specialist advice should be sought immediately.

Step 2 - Communicate, communicate, communicate

Make a communications plan. This includes notifying all neighbours and users likely to be affected by the works. The scale and type of activity will determine the level of community consultation required.

Identify the different values of all coastline users, not just local residents and regular visitors. This is important even for small-scale projects. One stretch of coastline may be used at different times for a variety of recreational and economic pursuits. Recognising the values and interests of the various people who use the area will help to identify and minimise conflicts between them.

Community consultation is important to inform people and gain public support for coastal works and developments that might affect public use and enjoyment of coastal areas. Consultation takes time and money, but it may be cheaper than having contractors and expensive equipment standing idle while a dispute brings work to a halt. Consider also the cost to future generations of doing the wrong thing.

Consult the local Coastcare group or other interested groups before undertaking major works to make sure the works do not interfere with their activities. Many public works (e.g. management of weeds, native vegetation and wildlife) require ongoing work and maintenance and will be more successful if they are joint projects carried out in partnership with

the community. **Refer to section 4.2 Working with community.**

Step 3 - Undertake a risk assessment

Risk can be defined as the likelihood of an event occurring and the consequence if that event occurs. Risk assessment helps answer the questions:

- what is going to happen?
- how likely is it to happen?
- how vulnerable am I to it?
- how do I manage that?

Risk assessment enables land managers to deal with uncertainty through a step-by-step process to examine the current or potential environmental impacts of work activities and to deal with them before they become a problem. Environmental risk assessments follow the same basic principles as assessing a workplace for occupational health and safety (OH&S) risk.

The main stages:

- identify any environmental hazards associated with the proposed work
- assess the likelihood and potential environmental consequences of the hazards
- identify the environmental risk
- prioritise the risks to get an idea of which measures need the most attention (sometimes the small things are very significant)
- determine the control measures needed to prevent environmental harm, or to minimise impacts if something does occur – if no measures are available to bring risk within acceptable levels, then the project may need to be redesigned, or perhaps even halted

- review, apply and monitor environmental protection measures for effectiveness and ongoing maintenance.

Simplify risk assessment processes by linking coastal and environmental risk assessments to existing OH&S risk assessments.

Step 4 - Seek approvals

Obtain permission from the land manager and/or landowner and all relevant authorisations for the works, to ensure that activities are undertaken appropriately and within the law.

Land tenure on the coast can be complex. If there is any doubt, land tenure can be identified through the Land Titles office at DPIPW. **Refer to section 1.5 Assessments and approvals.**

Step 5 - Supervise works

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

Step 6 - Monitor and review

Monitor the effectiveness of the works plan during the course of activities and be prepared to respond to changed circumstances.

1.8 Monitoring and evaluation

Keeping records of the results of coastal management works will help to judge success and inform future decisions. The more details are gathered, the easier it will be to understand why something worked in one location and not in another.

This information will also improve opportunities for organisations to work in partnership with each other and to access external funds for projects, by demonstrating the need for funds or proving the ability of the organisation to undertake the works.

Ongoing monitoring will pick up any problems or changes early on and reduce the cost of mitigating or managing those problems.

Monitoring

Monitoring is the regular gathering of information in a consistent manner. It is a way to keep track of the condition of an area or asset.

Monitoring may include photographic records, water quality testing, beach profile measurements, visitor use statistics, asset condition assessments and habitat or natural value assessments.

A monitoring plan should specify the sites to be monitored, the procedures to be used, the timing or frequency of sampling or assessing and the format of reporting.

Evaluation

Evaluation is the systematic review of an activity or project. It indicates whether the activity has provided the result intended. Evaluation involves collecting and analysing information, often through monitoring and generating a report.

Evaluation enables information to be used to plan for future projects, review management methods and techniques, and determine the worth of a particular activity.

Tips for photographic records

Photographic records enable before-and-after comparisons and are very useful for monitoring impacts or outcomes of activities.

- Set up photopoints – mark the exact spot from which you take your first photo; over time, take subsequent photos from the same spot.
- Try to choose an angle that includes some distinguishing features in your photo.
- Aim to take photos at the same time of day and, as far as possible, with the same camera settings.





2 Climate change and the coast

At the time of producing this manual a number of key Tasmanian government initiatives were still underway and are expected to be achieved over the course of 2011:

- Development of a new Tasmanian Framework for Action on Climate Change
- Finalisation of the state's Regional Planning Initiative
- Development of a state Framework for Mitigating the Impact of Natural Hazards through Land Use Planning
- Consideration of a new State Coastal Policy for Tasmania.

As with all topics addressed by the Manual, chapters will be regularly updated online as these initiatives are finalised and new information is released.

This chapter provides an overview of the implications for climate change to coastal management. It describes the coastal landforms, natural values and types of infrastructure most likely to be affected by climate change and sea level rise, and provides information for assessing inundation, erosion and recession risks for a chosen location. Predicted climate and sea level rise changes over this century and the science and the science of climate change and sea level rise are touched on only briefly because many other publications summarise the science well. There is a table summarising climate change information found in other chapters of the Manual and tools and resources for assessing and planning for climate change impacts are at the end of this chapter.

The Manual adopts a precautionary approach to climate change and sea level rise and suggests that coastal managers should plan for the upper levels of predicted changes. This approach will be in tune with growing agreement among researchers that climate change impacts are emerging more rapidly than earlier thought.

Projections based on the best scientific evidence suggest that the global climate will continue to change and sea levels to rise well beyond this century. Many stretches of Tasmania's coastline already experience occasional inundation, and shoreline erosion events are becoming more frequent and widespread.

- 2.1 *Adapting to climate change*
- 2.2 *Predicted climate and sea level rise changes and consequences*
- 2.3 *Managing the coast for climate change*
- 2.4 *Tools and resources*

Tab photo: Existing infrastructure already underwater at high tide in south-east Tasmania. © Leah Page.



2.1

Over the next century these changes may be very significant in some areas, and could cause major alterations to our coastline and the way we use it. Management of natural and built assets needs to adapt to this.

2.1 Adapting to climate change

This section discusses the importance of adapting to climate change and sea level rise in addition to the already complex and challenging task of managing the existing natural and human pressures on the coast.

Climate change and the rise and fall of sea levels are not new phenomena on this planet and, left alone, the coast's natural systems have great capacity to adapt and establish a new equilibrium. In undisturbed environments plant and animal communities can adjust and move with the changing shoreline, and in unpopulated and undeveloped areas these mechanisms can largely be left to proceed unaided. However, in more developed areas, existing private and public assets may not only hinder natural adaptation by causing 'coastal squeeze' (pressure on natural and cultural heritage values), but also require protection in their own right.

In this manual it is recognised that, in Australia and other countries, artificial shoreline protection is a very costly business, it will impact on the aesthetic and ecological values of coasts, and all protective structures have a limited life span. Tasmania's relatively small population is unlikely to have the economic resources to protect any but the most important built assets and shorelines from erosion and inundation. To help reduce the future cost of shoreline protection, some underlying principles are suggested for managing climate change and sea level rise.

Work in partnership with local communities and other stakeholders.

Base decisions on good scientific knowledge – investing in appropriate studies can help avoid very costly and damaging mistakes.

As far as possible, do not interfere with natural processes.

Manage the coast's vegetation and habitats to enhance their natural resilience to change.

Avoid locating new buildings and other infrastructure where there is any chance they might interfere with natural processes, and/or require protection within their expected life span.

Where intervention is absolutely necessary, thoroughly assess any potential consequences for adjacent shorelines.

Choose 'soft' reversible coastal protection options in preference to more permanent 'hard' structures.

Recognise that any intervention to protect assets will almost certainly be costly, ongoing, and continue to increase in scale as sea level continues to rise.

These principles are largely self explanatory. In essence the advice is to plan well with good information and, where engineering or other works are proposed, take every measure to keep disturbance of the area to an absolute minimum (this may involve a review of the existing works culture).

Consider whether the area or asset to be managed is defensible in the long term – in a growing number of places around the world it is being recognised that parts of the coast will have to be left to respond in their own way.



It is also important to recognise the value of no-regrets, low-regrets and win-win adaptation options when managing climate change risks:

no-regrets:

policies and decisions that will have immediate benefits under present-day climate conditions

low-regrets:

low-cost policies, decisions and measures that have potentially large benefits over time

win-wins:

policies, decisions and measures that help manage several coastal hazard or climate related risks at once, or bring other environmental and social benefits, e.g. preservation of natural character.

(Derived from: *Coastal hazards and climate change: A guidance manual for local government in New Zealand*, Ministry for the Environment 2008b)

2.2 Predicted climate and sea level rise changes and consequences

This section summarises climate change predictions and impacts on coastal areas. Information on managing some of these impacts is provided in Chapter 3 Coastal hazards.

Over the coming century scientists expect the sea level to continue to rise, at times at an accelerated rate as has been observed over the last few decades. The Intergovernmental Panel on Climate Change Fourth Assessment Report (IPCC 2007) conservatively estimated a sea level rise of up to 79cm by 2100, however this figure did not allow for polar ice-sheet melting. Measurements since 2007, and improved understanding of ice-sheet responses,

show that sea level rise of over 1.0m 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.

Most state governments in Australia roughly agree on the sea level rise benchmarks to use for future planning and management decisions. For example, for planning purposes New South Wales now assumes a sea level increase of 40cm above 1990 levels by 2050 and 90cm by 2100. Victoria has recommended working to a figure of 80cm by 2100, and Queensland is recommending the same 2100 value. It is likely that these benchmarks will be revised upwards following the release of the next IPCC report. There may be small discrepancies between exact figures but there is agreement that sea levels will rise considerably, the mean high and low water mark will increase and storm surges will reach further inland.

Many of Tasmania's coastal areas will be at risk from sea level rise and more severe storm surges associated with climate change, with impacts including increased coastal erosion and recession of erodible shorelines, inundation and flooding of low-lying areas, and coastal infrastructure. Coastal infrastructure in high-risk locations is likely to incur damage or require redesign or relocation.

2.2.1 Storms and inundation

Sea conditions are rarely flat like a pond, and storms in particular can dramatically add to the water level as well as creating very high energy conditions on the shore. Storms are usually caused by low-pressure systems in the atmosphere, with high wind speeds that can generate large waves.

Low pressure, tide and effects of wind can all contribute to a storm surge, or the height of the

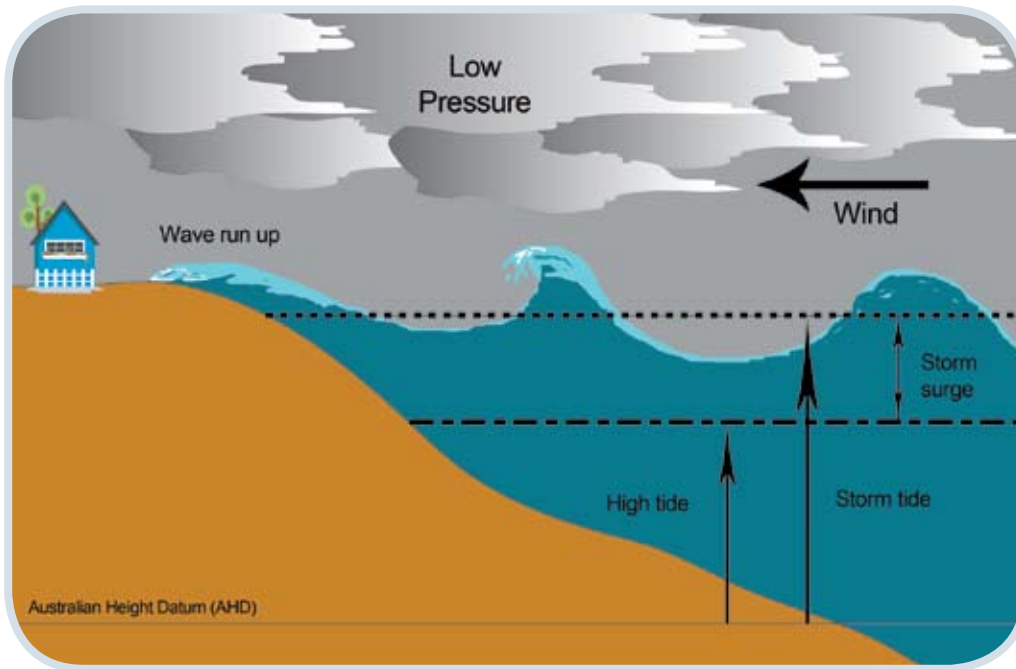


Figure 2.1 Storms greatly increase the height of tides and the level of wave run-up. Storm surge (due to wind and low pressure) increases the height of the tide and wind pushes the waves further onshore. Final inundation height = storm tide + wave run-up.

water above the predicted tide level. Wind blowing across water creates waves, currents and 'wave set-up' where sea water is pushed up into bays and estuaries and piles up against shores. The stronger the wind, the greater these effects will be. All of these can increase the water height during a storm. When a wave breaks it can also 'run up' the shoreline to an even greater height, depending on the size of the wave and the slope of the shore. Together the final water level is called the 'storm tide'.

Effect of low-pressure systems in Tasmania

Low atmospheric pressure itself causes a rise in sea level. Less downward pressure on the sea surface allows the sea level to rise about 1cm per 1hPa fall in pressure.

For example, in the extreme storm off north-east Tasmania that hit the Sydney–Hobart yacht race in 1998 pressure dropped to just below 980hPa. This means that if all other factors were equal, the sea level was approximately 40cm higher than a typical high pressure system of around 1020hPa at that time of year.

In addition, the same low-pressure system that is producing a storm may result in tens of centimetres of rain in nearby catchments. When this rain enters the lower reaches of rivers, estuaries and narrow mouthed bays, it may be unable to escape if a storm tide is also pushing up coastal water levels. This can rapidly cause increased flooding in estuaries.

Severe storms coinciding with a high tide and interacting with the shape of the coastline can not only flood low-lying coastal areas but also quickly cause severe erosion. All of these processes are natural and affect shores episodically under stable sea levels. However, with sea level rise, storm surges that have the ability to cause erosion and flooding will become more frequent, and wave or sea water intrusion will reach higher levels than in the past. Any significant rise in sea level will mean that storm events appear to occur more often because what used to be a minor storm event will become a larger magnitude event due to the increased sea level.



Potential consequences of storms during high tides in light of sea level projections

In simple terms, sea level rise will raise the average water level of oceans and estuaries. As the average water level rises, so too will high and low tide levels affecting the natural processes responsible for shaping the coastline. Exactly how the coast and estuaries will respond is complex and often driven by local conditions but, in general, higher sea levels will lead to:

- increased or permanent tidal inundation of land by seawater
- recession of beach and dune systems and to a lesser extent cliffs and bluffs
- changes in the way that tides behave within estuaries
- saltwater extending further upstream in estuaries
- higher saline water tables in coastal areas and
- increased coastal flood levels due to a reduced ability to effectively drain low-lying coastal areas

These physical changes will have an impact on coastal ecosystems, access to and use of public and private lands, historical and cultural heritage values, arable land used for agriculture, freshwater access, public and private infrastructure, and low-lying areas of coastal land that are affected by flooding.

From *NSW Sea Level Rise Policy Statement* (Department of Environment, Climate Change and Water 2009a)

2.2.2 Coastal erosion and recession

Climate change has implications for the natural coastal processes of coastal erosion and accretion.

Erosion (wearing away of sand, rock and sediment) and accretion (build-up of sand or sediment) are normal cyclical events on soft sediment coastlines (such as beaches and dunes). Where sea levels are rising a threshold is reached where erosion outstrips accretion and the beach will erode more than it is replenished. Once this tipping point is reached, the shoreline will tend to retreat (this process is known as coastal recession).

Many open-coast sandy beaches in south-east Australia have yet to reach this critical threshold, although some appear to have already passed it. Probable examples in Tasmania include the high energy south-west beaches and those subject to unusual conditions such as Roches Beach in south-east Tasmania. Once a beach is in a receding state, the rate of recession and how far it will continue will depend very much on the local characteristics of the area, such as the geomorphology, underlying bedrock, modifications to the shoreline and development of coastal land behind the beach.



2.3 Managing the coast for climate change

This section provides information on the implications of climate change and sea level rise for managing the natural and built environment in coastal areas. Management of the coast and planning new infrastructure or development must take climate change and sea level rise into account. To do this requires an understanding of localised coastal and marine processes and assessing risks to coastal values and infrastructure.

Risk management and responding to hazardous events, such as storms, are critical to coastal planning and management in the light of climate change. In some areas, planning for retreat will also be required.

Refer to Chapter 3 Coastal hazards.

Adapting to climate change will cost money. However, planning early to reduce the vulnerability of natural ecosystems and infrastructure to climate change impacts, and initiating appropriate adaptation strategies to reduce these impacts, will save money in the long term.

A growing number of detailed studies of specific coastal areas have identified the extent of the risk from climate change and sea level rise. In Tasmania, Clarence City Council has produced a thorough report *Climate change impacts on Clarence coastal areas – Final report*. (SGS Economics et al. 2009) identifying buildings and infrastructure in low-lying coastal areas in the municipality at risk over this century. This study was in response to community concerns about erosion of beaches and flooding events in coastal areas.

A further example, from Victoria, is a report to the Gippsland Coastal Board on the implications of climate change and sea level rise on vulnerable coastal areas (Gippsland Coastal Board 2008).

The concerning findings of both the Gippsland and Clarence studies highlight the importance of understanding inundation and erosion risks to property and infrastructure in vulnerable low-lying coastal areas. Both these reports have used the best available science, including high-resolution mapping of the height of the land above sea level (digital elevation model). This is obviously essential when working out how far sea level rise or storm tides will penetrate inland. They have also used good geological mapping of the coast to identify, for example, how far soft erodible sediments extend inland and what type of underlying bedrock is present.

In Tasmania the Sharples Report (Sharples 2006) provides information about the state's coastal landform types and their vulnerability to coastal processes such as erosion, recession and storm surge flooding, as a result of sea level rise. Sharples' data on the shoreline type for any part of Tasmania can be found on the Land Information System for Tasmania (LIST) website, and has more recently been incorporated into the national Smartline map, which can be used on the OzCoasts website.

2.3.1 Climate change and coastal values

This section includes a very brief discussion of the natural and cultural coastal values most likely to be affected by climate change and sea level rise. More detailed information is available in Vulnerability of Tasmania's natural values to climate change (DPIPWE 2010). **Refer also to Chapter 6 Coastal landscape management, Chapter 7 Vegetation management and Chapter 10 Wildlife and pest management.**

In general, the coastlines that are vulnerable to inundation or erosion and recession are low-lying and/or composed of soft erodible materials. However other important factors include the degree of exposure to ocean storms and swells, or to locally



generated wind waves (which may be quite erosive over longer fetches within estuaries and lagoons) and whether the location is in an estuary or embayment fed by an inland catchment where a river flood peak may be held up by a storm tide.

Beach and dune systems may be more resilient to sea level rise because of their dynamic nature and ability to accrete new sediments. There is a summary of the range of coastal landscapes and landforms in **Chapter 6**, which describes both soft sediment (sandy) and rocky coastlines and coastal values.

Coastal wetlands, and the vegetation communities and biodiversity associated with these systems, will be affected by changes to rainfall patterns and water regimes, along with inundation associated with sea level rise and increased intrusion of salty groundwater.

Vegetation communities and wildlife habitat in other coastal environments will also be affected by changes to rainfall patterns, increased temperatures and changes to fire regimes. Weeds and pests may be favoured by the changed conditions and put increased pressure on species and systems. Loss of threatened species and diminished biodiversity are likely to occur.

The marine environment is also vulnerable to increases in water temperature and changes to ocean currents, which will see species expand their range and compete with Tasmania's unique temperate marine life. Increased acidification of oceans due to rising absorption of CO₂ has the potential to impact on many marine species.

It is more important than ever to conserve natural values and communities and restore degraded ecosystems to help them adapt to the impacts of climate change.

Tasmania's coastline is rich in Aboriginal heritage values and there are also significant maritime and

cultural heritage sites. These sites are at risk of damage or loss from erosion and sea level rise.

Recreational areas on the coast will also be affected by erosion and sea level rise. Some sites may become hazardous due to erosion and storm events. Coastal recreation and residential areas may require special management to enable current use to continue. In other areas, retreat may be the only viable option and land managers may need to identify new, more appropriate areas for coastal living and recreation where possible.

2.3.2 Climate change and built assets

Particular built asset types might be more vulnerable to climate change and sea level rise than others. Any low-lying infrastructure near the coast should be assessed for erosion and inundation risk from rising sea levels and other consequences.

It is often forgotten that water tables will rise and salt water will penetrate further inland in ground water as the average sea level rises. Buried linear infrastructure may be particularly vulnerable, including sewer, storm water and water mains, buried electrical and telecommunications cabling, and gas mains.

Greater hydrostatic pressure on some types of foundations, cellars, tunnels, underground car parks, pools, tanks and sumps will occur. The possibility of mechanical damage and/or corrosion of susceptible structures and materials is real and should be included in maintenance checks. When planning new infrastructure of these types, the design should take into account rising ground water and possible salt water intrusion.

Roads, rail and other transport infrastructure may also be affected by higher ground water levels causing softening and greater plasticity in the underlying substrate.



Information for planning, designing and constructing coastal infrastructure (such as seawalls and revetments, stormwater outfalls, roads and tracks, boat ramps and crossings) to minimise impacts on the environment is considered in more detail in later chapters. **Refer to Chapter 12 Stormwater and crossings, Chapter 13 Access management, Chapter 14 Structures and facilities and Chapter 15 Shoreline modification.** The Manual does not provide particular guidance on how to manage the infrastructure itself to mitigate climate change effects. Expert advice from engineers will be required.

2.3.3 Climate change and coastal industry

Climate change has the potential to affect industries in coastal areas, like tourism, agriculture, fisheries and aquaculture. Major industries should be making their own detailed assessment of the long-term consequences of climate change.

Coastal industries that are based on the productive capacity of the environment, such as fisheries and aquaculture, will be susceptible to rising water

Figure 2.2 The impacts of sea level rise have been noticeable during king tide events. Tidal waters of the Hunter River submerging residential areas in Newcastle, NSW. The king tide in December 2008 combined with a low pressure system to inundate low-lying areas of New South Wales and Queensland. Source: A snapshot of future sea levels: Photographing the king tide (Watson and Frazer 2009). © Bruce Coates





temperatures, changes to ocean currents and ocean acidification. Agriculture will need to take into account changing weather patterns, especially rainfall and altered fire regimes. Any industries with shore-based infrastructure will need to plan for sea level rise.

The tourism industry has an affinity for coastal locations, and planning and maintenance of both major and minor infrastructure will need to take climate change and sea level rise into account. The ecological values on which many recreational tourism initiatives are based may also be affected. The industry does, however, have the opportunity to play a valuable part in raising public awareness of these changes.

2.3.4 Tools for assessing climate change impacts

Antarctic Climate Ecosystems Cooperative Research Centre (ACE CRC) web tool

This web based tool is based on the history of sea levels mapped at 29 ports around Australia

provided by the Australian National Tidal Centre. A number of projected sea level rise scenarios from the Intergovernmental Panel on Climate Change, Assessment Report Four (AR4; IPCC 2007) are used in the calculations. The user of the tool may expect to gain an understanding of the increase in probability of extreme events caused by a rise in average sea level. The tool is only available to those who have undertaken a workshop and understand the limitations of the data.

Coastal values of southern, northern and north western Tasmania: NRM projects (Coastal Values data)

Through three projects, easily accessible mapped data sets on vegetation, species habitat and geomorphology have been produced to support better strategic planning, land use planning and management of the coast. The projects looked at a 100m-wide coastal strip (from the high water mark) of the Northern, Southern and Cradle Coast Tasmania Natural Resource Management (NRM)

Table 2.1 Mapped data sets for the Coastal Values data projects.

Vegetation and fauna layers (8)	Geomorphology layers (9)
• Vegetation	• Geomorphic lines – Condition
• Native vegetation condition	• Geomorphic lines – Geoconservation values
• Native vegetation viability	• Geomorphic lines – Sensitivity
• Vegetation significance	• Geomorphic lines – Lower intertidal landforms
• Weeds	• Geomorphic lines – Upper intertidal landforms
• Observed fauna habitat	• Geomorphic lines – Backshore landforms
• Potential fauna habitat	• Polygons – Historic dune mobility
• Fauna significance	• Polygons – Present dune mobility
	• Polygons – Soft sediment landforms



Regions, and collected and assessed a range of coastal vegetation, species habitat and geomorphic values data. National parks and some larger coastal reserves are not included. Available mapped data sets are summarised in Table 2.1.

All these mapped data sets are available on the Tasmanian Land Information System LIST website.

Follow the links to the 'Coastal Values' layer in the layer management function of LISTMaps. Experienced GIS Software users can also download the data sets from the DPIPWE website, or obtain them on CD from the Coastal and Marine Branch, EPA Division, DPIPWE, to upload onto their own computers. Supplementary resources such as Interpretation Manuals and photographs are also available for download.

Foreshore values mapping

The foreshore values database holds information on the values and condition of the foreshore for the three NRM regions in Tasmania. It provides baseline information on the condition of foreshores and identifies pressures for measuring impacts on key marine and coastal ecosystems. It is designed to enable an integrated approach to foreshore management, and is aimed at managers, interested stakeholders and the wider community.

For the purposes of this project, the foreshore is defined as 'the area between the high and low water marks where tidal influence exists, together with saltmarshes, rock platforms and un-vegetated beaches (excluding dunes)'. Adjoining areas are also included where relevant.

The mapped data available includes a single line map for each of four indices and the 13 supporting attributes of foreshores:

- Natural value – biology and geomorphology
- Human use value – amenities, recreation and European heritage
- Condition – ecological disturbance, geomorphology and introduced marine species and beach weeds
- Pressure – anthropogenic modification, recreation and tourism, pollution sources, vulnerability to climate change, and introduced marine species and beach weeds

These electronic mapping layers can be viewed on the Land Information System Tasmania (LIST) website, or requested from DPIPWE. The mapping layers can operate as a stand-alone interpretive tool or be used with other maps.

Maps of vulnerability of the coast to sea level rise (Smartline)

The vulnerability of coastal areas has been mapped by Sharples 2006 using available data, termed a '1st pass' assessment. A more detailed assessment or 2nd pass assessment is currently underway. Maps of coastal landform types and their vulnerability to sea level rise can be found under 'Climate Change' layers on the LIST. 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.

Tasmanian Coastal Vulnerability Assessment Project (Tasmanian Planning Commission)

The objective of the Project is to assess the physical vulnerability of Tasmania's coast to climate change.

The first stage of the Project is being undertaken



by the University of Tasmania in partnership with the Antarctic Climate and Ecosystems Cooperative Research Centre (ACE CRC) and the Commonwealth Scientific and Industrial Research Organisation (CSIRO). It involves modelling the extent of potential future coastal inundation under various sea level rise projections and storm surge events.

The modelling results have been mapped using the *Climate Futures for Tasmania* project, Light Detection and Ranging (LiDAR) and Digital Elevation Model (DEM), which provides a new generation of mapping accuracy for the most populated areas of the Tasmanian coast. It is anticipated that the Project outputs will inform strategic land use planning and decision making in the coastal zone.

TASMARC project: monitoring shoreline erosion in Tasmania

The Tasmanian shoreline monitoring and archiving (TASMARC) project is a joint project between the Antarctic Climate Ecosystems Cooperative Research Centre (ACE CRC) and the University of Tasmania (UTAS). It aims to increase knowledge of the effects of rising sea levels and storm surges by carrying out long term monitoring of shoreline movement on beaches on vulnerable parts of Tasmania's coastline.

TASMARC relies on volunteers to survey beach profiles. Over time the TASMARC project aims to build a record of long- and short-term changes to beaches and an understanding of how beaches recover after storms. Results are to be published on the web in late 2010. The network of coastal locations being monitored with TASMARC is growing, and volunteers wanting to monitor new sites are welcomed. For more information contact: nicholas.boden@acecrc.org.au

2.3.5 Adapting coastal land management activities for climate change impacts

This section directs the reader to parts of the Manual where impacts of climate change and sea level rise on natural values are discussed and management adaptations or guidelines are provided to respond to the risk of climate change and sea level rise. Determination of risk and appropriate measures will be specific to each location and situation. Collect all relevant information on the site as suggested in **Chapter 1** and make an assessment of the level of risk using the suggested tools in **section 2.4** or seek specialist advice.

Figure 2.3 A TASMARC monitoring site is identified by a simple fixed marker. © Leah Page



Table 2.2 Where to find climate change information throughout the Manual. *

Topic	Section
Chapter 1 Working on the coast	
Coastal processes	1.2
Chapter 3 Coastal hazards	
Storm surges, erosion and other coastal hazards	3.2
Remediation after storm events	3.3
Chapter 4 Community Values	
Throughout chapter where appropriate	
Chapter 5 Cultural heritage management	
Climate change and cultural heritage	5.3
Chapter 6 Coastal landscape management	
Assessing dune erosion	6.2.5
Methods for stabilising dunes	6.2.6
Climate change and dune systems	6.2.8
Climate change and beaches, barways, spits and river mouths	6.3.4
Climate change and estuaries, coastal wetlands and saltmarsh	6.4.9
Climate change and soft rock coastlines	6.6.1
Chapter 7 Vegetation management	
Vegetation management and climate change	7.8
Chapter 8 Weed and disease management	
Climate change and weeds and disease in Tasmania	8.6
Chapter 9 Fire management	
Climate change and fire	9.4
Chapter 10 Wildlife and pest management	
Climate change, wildlife management and pests	10.6
Chapter 11 Soil management and earthworks	
Climate change and acid sulfate soils	11.4.6
Chapter 12 Stormwater and crossings	
Climate change and stormwater management	12.1.7
Chapter 13 Access management	
Throughout chapter, in particular in sections 'Guidelines for..'	
Chapter 14 Structures and facilities	
Throughout chapter, in particular in sections 'Guidelines for..'	
Chapter 15 Shoreline modification	
Shoreline protection works	15.1

*Throughout the Manual, climate change considerations and issues are mentioned where information is available.



2.4 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**.

Antarctic Climate Ecosystems Cooperative Research Centre (ACE CRC) web tool

This web based tool is based on the history of sea levels mapped at 29 ports around Australia provided by the Australian National Tidal Centre.

www.sealevelrise.info

Australian coastal Smartline geomorphic and stability map version 1: Project report (Sharples et al. 2009b)

Climate change 2009: Faster change and more serious risks (Steffen 2009)

Climate change impacts on Clarence coastal areas – Final Report (SGS Economics et al. 2009)

www.ccc.tas.gov.au/

Climate change risks to Australia's coast – A first pass national assessment. (Department of Climate Change 2009)

www.climatechange.gov.au

Climate change, sea level rise and coastal subsidence along the Gippsland coast. (Gippsland Coastal Board 2008)

www.gcb.vic.gov.au/sealevelrise

Coastal climate change – The science basis.

(Department of Climate Change and Energy Efficiency 2010)

Australian Government Fact Sheet

www.climatechange.gov.au

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

Provides an overview of coastal engineering principle and practice in Australia and includes many checklists useful for those contemplating a coastal project at any scale.

<http://www.engineersaustralia.org.au/search/resources/?query=coastal>

Coastal hazards and climate change: A guidance manual for local government in New Zealand. (Ministry for the Environment NZ 2008b)

www.mfe.govt.nz/

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

CSIRO GIS layer: Wave height direction and period in the Australian region.

A compilation of essential wave statistics. Although the map appears very coarse each pixel is attributed with locally relevant data obtained from satellite instruments.

http://www.marine.csiro.au/marq/edd_search.Browse_Citation?txtSession=8083



Climate change and coastal risk assessment project.

A suite of tools and documents including:

- Coastal risk management plan: Template and guidelines (DPIW 2009)
- Coastal hazards in Tasmania: General information paper (DPIW 2008c)
- Climate change and coastal asset vulnerability: An audit of Tasmania's coastal assets potentially vulnerable to flooding and sea-level rise (DPIW 2008b)
- Sea-level extremes in Tasmania: Summary and practical guide for planners and managers (DPIW 2008e)
- Historical and projected sea-level extremes for Hobart and Burnie, Tasmania (Hunter 2008)
- Background report: Coastal flooding - Review of the use of exceedence statistics in Tasmania (DPIW 2008a)

www.dpiw.tas.gov.au/climatechange

Draft Queensland coastal plan: Draft state planning policy coastal protection. (Department of Environment and Resource Management, QLD 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 or by request from DPIPWE.

www.thelist.tas.gov.au

General practice note 18: Managing coastal hazards and the coastal impacts of climate change (Department of Planning and Community Development, VIC 2008)

www.dpcd.vic.gov.au/planning

Historical and projected sea-level extremes for Hobart and Burnie, Tasmania. (Hunter 2008)

Technical Report by Antarctic Climate & Ecosystems Cooperative Research Centre (ACE CRC).

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

NSW sea level rise policy statement (Department of Environment, Climate Change and Water, NSW 2009)

Position analysis - climate change, sea-level rise and extreme events: impacts and adaptation issues. (Antarctic Climate & Ecosystems Cooperative Research Centre 2008)

www.sealevelrise.info

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

TASMARC project: monitoring shoreline erosion in Tasmania

TASMARC relies on volunteers to survey beach profiles. For more information contact: nicholas.boden@acecrc.org.au

Understanding sea-level rise and variability (Church et al. 2010)

3

Coastal hazards



At the time of producing this manual a number of key Tasmanian government initiatives were still underway and are expected to be achieved over the course of 2011:

- Development of a new Tasmanian Framework for Action on Climate Change
- Finalisation of the state's Regional Planning Initiative
- Development of a state Framework for Mitigating the Impact of Natural Hazards through Land Use Planning
- Consideration of a new State Coastal Policy for Tasmania.

As with all topics addressed by the Manual, chapters will be regularly updated online as these initiatives are finalised and new information is released.

This chapter details common coastal hazards and incidents and strategies to reduce risks and manage these incidents when they occur.

A hazard can be defined as a potential source of harm, injury or difficulty. The classes of hazard considered in this chapter include both the consequences of natural physical coastal events, such as storms and erosion, and those hazards created by the transport and storage of oil and chemicals. All these have the potential to cause harm to people, property and the environment.

Sudden, hazardous events such as floods, erosion, storm surges, king tides and tsunamis are a possibility for Tasmania's coastline, while soft, sandy coastlines are especially prone to landslips and serious erosion. Climate change and sea level rise will also exacerbate the risk of coastal hazards, and storm frequency and severity are likely to increase over time.

It is important that appropriate mitigation techniques are used to minimise the damage from hazardous events. Planning for emergencies can make responses more timely and effective. For places with sensitive values, such as cultural heritage sites and threatened species habitats, developing and correctly implementing an emergency response plan can minimise the impact of an event.

3.1 Planning for hazard management

3.2 Storm surges, erosion and other coastal hazards

3.3 Remediation after storm events

3.4 Oil and chemical spills on the coast

3.5 Tools and resources

Tab photo: Wave erosion has left bank in potential unstable and unsafe state at Conningham in southern Tasmania. © Kevin Phillips.

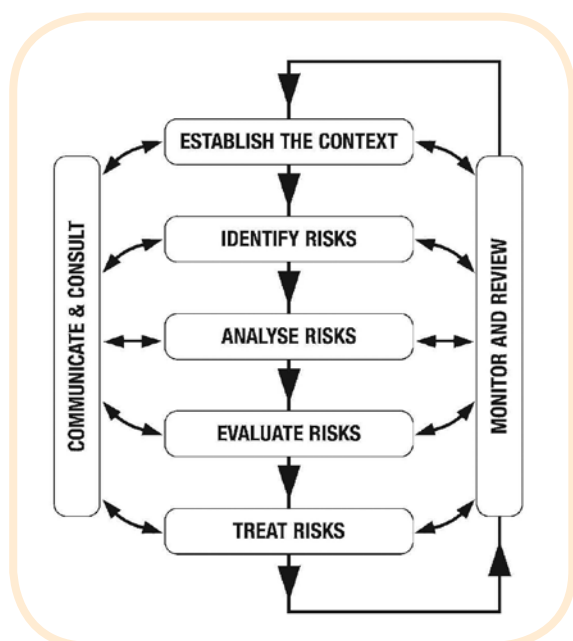


3.1 Planning for hazard management

This section provides information on planning for hazard management and minimising risk. Coastal hazards are a physical process or events on the coastline that could potentially be harmful to a person's life, health, property, or the environment (Tarbuck & Lutgens 1987).

The risk posed by a coastal hazard can be determined by looking at the likelihood of it occurring, the level of vulnerability to that hazard and the consequences of the event happening. The Australian Standard AS/NZS ISO 31000:2009 *Risk management* provides a framework for identifying risk and this has been used throughout Australia, adopted by Emergency

Figure 3.1 The risk management process. Source: Australian Government, *Emergency Management in Australia: Concepts and Principles*, (Emergency Management Australia 2004). © Commonwealth of Australia reproduced by permission.



Management Australia, the Tasmanian State Disaster Committee and the Tasmanian Climate Change and Coastal Risk Assessment Project.

Assessing risk of coastal hazards in Tasmania requires consideration of regional and local factors, including coastal processes, land use, modification of the shoreline and the types of coastal landforms. For example, a soft, sandy coastal embayment is more vulnerable to coastal hazards than a rocky headland or a cobbled beach. Landforms such as spits, coastal estuaries and lagoons are among the most mobile and dynamically changing environments on earth (Sharples 2006).

Mapping the vulnerability of the coastline is a good foundation for planning and management of coastal hazards (Sharples 2006). Most planning and regulatory standards use an emergency response plan based on good technical advice which:

- identifies risks
- sets out clear procedures and responsibilities
- complies with government regulations, policies and strategies.

A risk assessment to identify, analyse and evaluate existing and emerging risks is a critical first step in developing a good risk management plan. The Australian Standard AS/NZS ISO 31000:2009 *Risk management* provides a generic framework for identifying, analysing and communicating risk. This standard has been adopted throughout Australia.

To identify risks and vulnerable sites, advice may be required from a coastal engineer; coastal geomorphologist (a specialist in coastal soils and landforms), Aboriginal Heritage Tasmania, botanists or wildlife biologists.

For sources of information, see **section 3.5 Tools and resources**.



3.2

3.2 Storm surges, erosion and other coastal hazards

Storms and Flood Emergency

Contact State Emergency Service 132 500

<http://www.ses.tas.gov.au/>

Climate change is projected to have an impact on the frequency and intensity of extreme weather events such as storms, bushfires, drought and heatwaves. In particular, coastal storms, with flooding and storm surges, will create extreme sea level events resulting in coastal inundation and erosion. Therefore, sea level

rise will exacerbate the existing problems of erosion or inundation of coastal land caused by high tides, storm surges and low-pressure systems.

In future we can expect physical changes to shorelines as they adapt to changing sea levels, especially on vulnerable areas such as soft sandy, muddy, clayey and gravelly shores and low-lying coastal areas (Sharples 2006).

3.2.1 Hazardous erosion

Sand dunes can develop hazardous erosion scarps that are prone to toppling, and in some areas may pose a risk to the public. These may be formed by severe erosion during high-magnitude storms or when several low-magnitude storms in quick succession

Figure 3.2 Recent erosion scarp exposing old soils at North Beach on Perkins Island. © Chris Sharples





Figure 3.3 Evidence of flood tide levels on the banks of the Leven River in north-west Tasmania. © Haylee Alderson

make it difficult for the coastline to recover. There may be insufficient time between storm events for normal swell waves to push sediment back on shore.

Erosion of sandy environments occurs seasonally, mostly during the winter months when storms generate waves that can erode the front of foredunes. In the summer months gentler swell waves push the sediment back to the shoreline and rebuild the foredune. This process can take up to a few years to repair severe storm damage, aided by dune vegetation that can trap and bind sand.

Erosion of rocky shorelines may create hazardous cliff areas. Softer rocky shorelines, such as semi-consolidated sediments, cannot be replenished by sand and sediment. Erosion of these shorelines leads to coastal recession. The retreat of the shoreline may threaten coastal infrastructure and make access hazardous for the public.

Refer to section 3.3.1 Dune reshaping after storms (in this chapter), Chapter 6 Coastal landscape management and Chapter 15 Shoreline modification.

3.2.2 Storm surges and extreme storm events

Over 20% of Tasmania's coastline will be vulnerable to sea level rise and more severe storm surges associated with climate change (Sharples 2006).

A storm surge is an area of heightened sea level at the coast caused by a low-pressure system and strong winds from offshore storms and high tides (DPIW 2009). For every hectopascal fall in barometric pressure, the sea level will rise about 10mm. However, the strong winds are the most significant factor as they push water against the coast and, if combined with significant rainfall and a high tide, there may be flooding along the coastline (DPIW 2008).

Planners, managers and developers need to know the probability of an event happening during the expected life of a development; it is no longer appropriate to use the traditional approach of designing for storm-surge events recurring every 100 years (Hunter 2008). For many locations in Tasmania, a sea level rise of 50cm will mean that these events will occur every year, or even more frequently, by 2100 (Church et al. 2008).

This new focus is important for risk management, where development and management regimes can be adapted to reduce the risks to acceptable levels. For a brief explanation of the most recent climate change and sea level rise assessment tools **refer to section 2.3.4 in Chapter 2 and sections 3.2.8 and 3.5 in this chapter.**



3.2.3 Storms and floods

Storms and floods, like drought, are a normal and inevitable part of climate variability. Controlling the effects of storms and floods is very difficult, however, land managers must seek to minimise risks to public health and safety, property and infrastructure.

Flash floods usually happen on the coast when a large amount of rain falls in a localised area over a very short period of time, in combination with a high or spring tide. These localised storms would generally be within the capacity of the stormwater drainage system, but in a spring tide high water levels may prevent the rainwater draining away. The excess water may build rapidly and flood roads, gardens and buildings. In these situations with low-lying areas full of

water, it can be impossible to pump water away until the tide recedes.

A flood risk plan should be developed, to provide a clear process for reviewing flood risks and procedures for monitoring the effect of flood risk management measures over time. As well as assessing safety and economic factors, a flood risk plan will include the social impacts of floods, such as stress and disruption.

The flood risk plan should set out a method for developing a flood risk matrix, which will identify 'intolerable' flood risks that should be reduced or eliminated. Further information can be found on the Melbourne Water website.

Figure 3.4 Excavator cleaning up flood debris in the Leven River in Ulverstone in north-west Tasmania. © Phil Barker





3.2.4 King tides

When associated with low pressures and/or storm events, the highest tides of each season, known as **king tides**, can lead to localised inundation and flooding. This will be exacerbated by sea level rise.

Key impacts of spring or king tides:

- localised tidal inundation penetrating through stormwater systems and affecting private property, public reserves and local road networks
- limited clearance between the peak water level and the top of seawalls currently protecting waterfront properties, commercial precincts, public reserves and significant public infrastructure
- widespread submergence of gravity stormwater drainage systems, fixed jetties and wharf infrastructure, as well as public walkways, boardwalks, bicycle paths and car parks situated around intertidal foreshores
- substantial narrowing of useable beach widths
- overtopping of beach berm barriers in areas where intermittently open and closed lakes and lagoons are currently closed to the sea
- increased tidal currents within estuaries and larger rip systems on open-coast beaches
- inundation and destruction of nesting in roosting sites of endangered birds (such as little terns)
- immediate threats to Aboriginal cultural heritage sites such as middens close to intertidal margins
- breaching sewage pump stations and associated sewage infrastructure
- flooding commercial premises and dwellings within 50cm of the king tide level
- wave action submerging and overtopping public ocean baths and similar facilities.

Figure 3.5 Coastal inundation event associated with king tide in NSW in January 2009. Tidal waters of Coffs Creek penetrating back up through stormwater system. Source: A snapshot of future sea levels: Photographing the king tide (Watson and Frazer 2009). © Mel Bradbury





3.2.5 Landslides

Landslides are a natural hazard that can be studied in order to understand their distribution, frequency of movement, triggering conditions and likely effects. By properly understanding them it is often possible to minimise the effects on engineered structures (e.g. houses and roads) and the community.

For example, landslide susceptibility maps produced by Mineral Resources Tasmania can be used by town planners to avoid unstable areas when new subdivisions are being proposed. The Mineral Resources website has maps of landslide susceptibility and of legislated landslip areas (declared areas), a database of landslide information and events in Tasmania, and monitoring and investigation of some Tasmanian landslips.

Other information on coastal rock falls, collapse, slumping and retreat of hard rock coastal cliffs and progressive erosion, retreat and/or slumping of soft (typically clayey-gravelly) bedrock or colluvial (loose rock) shores has been mapped as part of the *Indicative mapping of Tasmanian coastal vulnerability to climate change and sea-level rise: explanatory report* (Sharples 2006). This data is available on the LIST website.

3.2.6 Tsunami

A tsunami is a series of ocean waves with very long wavelengths (typically hundreds of kilometres) caused by large-scale disturbances of the ocean, such as:

- earthquakes
- landslide
- volcanic eruptions
- explosions
- meteorites

These disturbances can either be from below (e.g. underwater earthquakes with large vertical displacements, submarine landslides) or from above (e.g. meteorite impacts).

The English translation of the Japanese word '*tsunami*' is 'harbour wave'. The previously used terms, tidal waves and seismic sea waves are misleading, as tsunamis are unrelated to the tides and can be caused by non-seismic events such as landslides.

A landslide on the steep underwater slope about 50km off the Australian coastline could generate a local tsunami. This might be triggered by a small earthquake or the landslide might feel like an earthquake at the coast. It would take less than 30 minutes for the tsunami to reach the coast. Tsunamis are also often confused with storm surges, even though they are quite different phenomena.

**Call 1300 TSUNAMI (1300 878 6264)
for the latest warning information.**

**For emergency assistance, call your local
emergency authority on 132 500.**

The east coast of Australia is recognised as being vulnerable to mega-tsunamis, like the one that devastated coastlines around the Indian Ocean on 26 December 2004. Australian civil authorities are now preparing tsunami action plans to deal with this low-probability but high-consequence event.



3.2.7 Assessing inundation and erosion risks

How do you decide if a site requires a risk assessment for inundation and erosion, including the possible longer-term effects of climate change and sea level rise?

In general, a risk assessment should be considered for sites on low-lying coastal land and erodible landforms where there is a risk to public or private infrastructure, public safety or important plant and animal communities.

It should not be assumed that 'sheltered' shores (e.g. in estuaries or tidal lagoons) are at less risk; indeed such places experience as much flooding and erosion as open coasts.

For a particular work site, check whether there has been a previous risk assessment. Some information sources are suggested in the Tasmanian coastal risk management project template (see Table 3.1).

Assessing the risk

The major risks from rising sea levels and extreme events are coastal inundation erosion and recession. In Tasmania severe storms, floods, shoreline erosion and other hazards already affect coastal areas, causing damage to property and infrastructure and risking loss of life.

A rising sea level and potentially greater storm activity will produce an ever-growing risk of inundation and erosion in low-lying coastal areas. Events will occur increasingly more often in the future.

The severity of the risks in a given location will be affected by a range of factors related to climate, oceanography, geomorphology, geology and the way low-lying areas have been modified by construction or drainage.

Table 3.1 Example of a component of the risk assessment template in the Coastal risk management plan (DPIW 2009)

Level of existing Risk Assessment	Yes/No
Location has been highlighted as at risk by simply looking at topographical maps or digital elevation models	
Area has been highlighted by a previous report (e.g. Sharples 2006)	
Risk has been determined by site visit	
Calculations of still-water sea levels are available	
Assessment of extreme tide events is available	
Detailed storm surge and wind wave calculations are available	



As the sea level rises, storm events reach higher levels on the shore, so appear to increase in magnitude and frequency resulting in severe flooding events becoming more frequent. This will put vulnerable coastal locations and infrastructure at increasing risk of inundation or erosion. It is important to assess the risk of an extreme event occurring during the lifetime of any existing or new infrastructure and then plan accordingly.

Assessing this risk as accurately as possible will allow for prioritisation of climate change risks, and subsequent adaptive responses. A thorough assessment will also include consideration of these management responses in light of other risks (including impacts on natural and cultural values), resource availability and cost of works faced by the land manager.

3.2.8 Risk assessment tools

Assessing the erosion and inundation risk in a given coastal location can be a complex task and requires good data, and the skills and experience to analyse it. A number of tools have been produced to assist in this exercise, which can provide a degree of reliability that, for some activities and locations, may be adequate. For more critical areas and projects, it is important to seek specialist advice.

For example, experience suggests that applying the Tasmanian coastal risk assessment tool (Tool # 1 in Table 3.2) to an area might require up to two weeks' work and a budget of approximately \$10 000.

Figure 3.6 It may be useful to understand the history of a site by looking at a time sequence of aerial photos. Most of Tasmania has coverage of aerial photography dating back to the 1950s (post-Second World War). This aerial photo of Ringarooma River mouth in northern Tasmania clearly shows landward movement of the coastal dune system © DPIPWE





Table 3.2 Risk assessment tools currently available

	Tool	Description	Project	Organisation and web address
1	Climate Change and Coastal Risk Assessment Tool - Template, Guidelines and Case Study	A method and template for producing a coastal risk management plan for a coastal area or asset.	Climate Change and Coastal Risk Assessment Project	Tasmanian Department of Primary Industries, Parks, Water and Environment www.dpipwe.tas.gov.au/climatechange
2	ACE CRC Web Tool	An internet-based decision-support tool that estimates the probability that a given asset will be flooded by the sea during its lifetime, under different climate projections.	Tasmanian Coastal Vulnerability Project	Antarctic Climate & Ecosystems CRC www.sealevelrise.info/
3	High resolution (LiDAR-based) Coastal inundation modelling for selected sea level rise and storm scenarios. Refer to Chapter 2.	Spatial maps accurate to 25cm modelling the extent of coastal inundation under various sea level rise projections and storm surge events. LiDAR data exist for the most populated parts of the Tasmania coast.	This project is in progress, and will provide inundation modelling for those areas of the state's coastline covered by LiDAR.	Tasmanian Planning Commission www.planning.tas.gov.au/ Available on the LIST under Topographic Information – Relief – Climate Future LiDAR coverage.
4	New Zealand Coastal Hazards Manual and related factsheets	Understanding and managing coastal hazard and related climate change risks.	Coastal hazards and climate change: a Guidance Manual for local government in New Zealand (Ministry for the Environment 2008)	Ministry for Environment, NZ www.mfe.govt.nz/



3.3 Remediation after storm events

This section deals with managing hazardous shorelines and landforms after extreme storm events. Rehabilitation of coastal landforms and shorelines is sometimes required, to protect public safety, to restore wildlife habitat or to stabilise the damaged area.

Public safety is the most important factor in remediating hazardous sites, but you should minimise damage to the natural environment and cultural sites, wherever possible.

After storms or landslides, where unstable foredunes or cliffs are hazardous, erect warning signs or temporary exclusion fences. Obtain specialist advice from a coastal geomorphologist about the risk to the public and any remediation work.

Before attempting remediation, obtain specialist advice to assess the situation and consider different options for managing the issue and site. **Refer to Chapter 6 Coastal landscape management.**

3.3.1 Dune reshaping after storms

The steep faces of foredunes carved by severe and prolonged storms are unstable and can be hazardous to beach users. Eventually the dune face will slump to a more stable shape, but until this happens it may be necessary for land managers to erect warning signs or temporary fences or to undertake dune reshaping. If in doubt, obtain specialist advice about the risk to the public.

As the erosion effects of sea level rise on sandy shores become more common, some beaches will begin to exhibit almost permanently scarped and slumping dune fronts. This has already been the

case for several decades on high energy south-west Tasmanian beaches which are receding earliest in response to sea level rise.

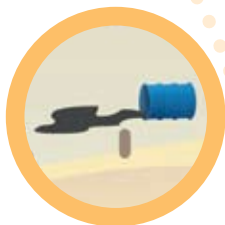
If public risk is particularly high, machinery can be cautiously used to slump the seaward face of the dune to create a more stable dune profile. Do not undertake this type of work without specialist advice from a coastal geomorphologist and permission from the land manager.

Minimise damage to vegetation during works, as plant roots help bind and stabilise sand, and other plant roots and stems that drape down the dune face will trap wind-blown sand and help to repair the damaged foredune.

Consult Aboriginal Heritage Tasmania well before works, and notify them if you believe an Aboriginal heritage site or relic has been uncovered. **Refer to Chapter 6 Coastal landscape management, for more information on dune stabilisation.**

3.3.2 Monitoring remediation works

All erosion control structures require regular maintenance to make sure they remain serviceable. Inspections and maintenance are very important during and after stormy periods to check that structures are in place, are working as intended and are in good condition. Structures can be quickly damaged or destroyed by waves and winds, and become a hazard to the public. Prepare an inspection and maintenance plan, which includes inspections on a regular basis and after major storm events. **Refer to Chapter 6 Coastal landscape management, for more information on monitoring landform remediation works.**



3.4

3.4 Oil and chemical spills on the coast

To report a chemical or oil spill

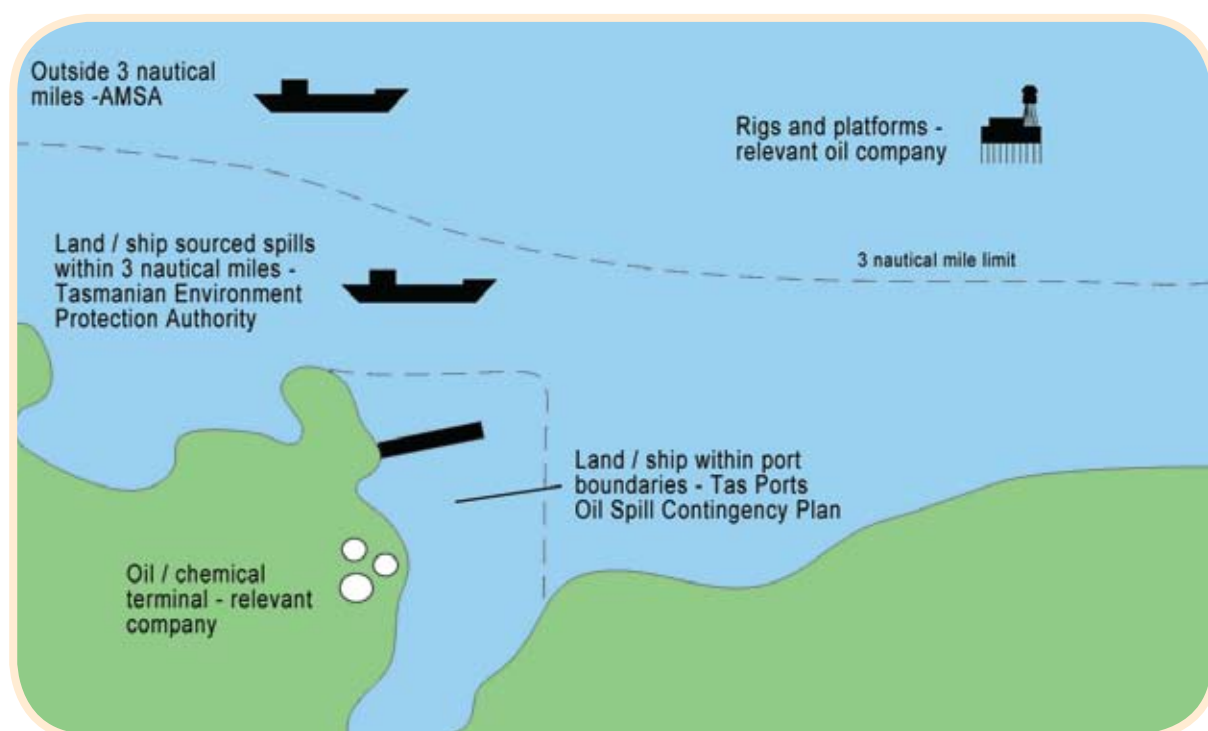
Contact the Environment Protection Authority's 24-hour Pollution Incidents and Complaints Hotline: 1800 005 171

Oil spills in the marine environment can range from small levels of contamination from recreational boats to large-scale spills from commercial operations. All oil spills can impact on wildlife, fisheries, coastal and marine habitats, and human health, as well as the commercial and recreational resources of coastal communities. In the case of large-scale events, these impacts can be widespread and long term.

Procedures for combating oil spill pollution are contained within the *Tasmanian marine oil pollution contingency plan (TASPLAN)* (DPIWE & SES 2001); Tas Ports oil spill contingency plans are localised plans for specific ports where a spill occurs within port boundaries.

The Australian Maritime Safety Authority (AMSA) is responsible for oil spill responses outside of 3 nautical miles.

Figure 3.7 Agencies responsible for oil and chemical spills in Tasmania.





Initial reports of a marine oil spill should be made to the State Oil Pollution Control Officer on the 24-hour response number. The officer will advise the chair of the State Marine Pollution committee (where relevant), and other relevant agencies and personnel. A response appropriate to the spill type is then undertaken. An initial assessment will be carried out by trained personnel, which could include people from Tas Ports and the Department of Primary Industry, Parks, Water and Environment (DPIPWE).

In the oil spill response incident control system, roles and responsibilities are assigned to people in the areas of logistics, operations, finance, administration and planning. The Incident Control Officer is in charge of these sections, forming an incident control team that is responsible to the Tasmanian Marine Pollution Controller.

Local governments participate in the incident control team in several key ways:

- representing the Local Government Association on the State Marine Pollution Committee
- cleaning up shorelines
- providing local advice on areas threatened by pollution
- assisting with liaison between the State Marine Pollution Committee, the incident controller and local communities
- assisting in clean-up operations within areas under their control, in larger operations.



Figure 3.8 The sunken vessel in the Tamar River in Launceston – note small patch of black coloured oil behind vertical fender. © Duane Richardson

Case Study 3.1: Recreational boat sinking at Seaport, Launceston, in January 2010

A minor oil spill from a wooden yacht that sank in the Tamar River at Launceston's Seaport Marina was reported to the Environmental Protection Authority's (EPA) Environmental Complaints and Incidents 1800 005 171 Hotline by Tasmania Police on 25 January 2010.

The EPA's State Oil Pollution Control Officer (SOPCO) based in Hobart responded to the report.

SOPCO then contacted Tas Ports, who advised that, if required, they would send responders and oil-spill-absorbent materials to Seaport from Bell Bay.

An officer from the EPA in Launceston was sent to Seaport to do an initial inspection. The notes and photographs he took were forwarded (via email) to the SOPCO in Hobart, who examined this material and decided that the deployment of oil-absorbent booms was not necessary in this instance.

Another SOPCO from the EPA Ulverstone office

was in Launceston at the time and took over the investigation. When contacted, the owner of the vessel reported, that at the time of sinking, the vessel had very little fuel onboard and approx 5L of lube oil in the engine. He arranged for enough water to be pumped out of the vessel's hull at low tide to make it sufficiently buoyant to be towed to a nearby slip. The next day the hull was examined but no leaks or sprung planks were found.

The only explanation offered for the sinking was that the vessel became stuck fast in the silt/mud at low tide and as the tide rose again the hull filled with water. Apparently other vessels have sunk in similar incidents in the Tamar River around the marina.

On this occasion it was fortunate that the vessel had little fuel and oil onboard and a significant spill of hydrocarbons into the river was avoided.



3.5 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**.

Australian Standard

AS/NZS ISO 31000:2009 Risk management

Bureau of Meteorology

Current Tasmanian weather warnings

www.bom.gov.au/weather/tas/

Climate change impacts & risk management: A guide for business and government (Australian Greenhouse Office, Department of the Environment and Heritage 2006)

A guide to integrating climate change impacts into risk management and other strategic planning activities in Australian public and private sector organisations to assist Australian businesses and organisations to adapt to climate change.

<http://www.climatechange.gov.au/what-you-can-do/community/local-government/~media/publications/local-govt/risk-management.ashx>

Floodplain mapping, flood data and flood timelines in Tasmania

www.dpiw.tas.gov.au/ Go to Water > Tasmania's water resources > Floods

Geodata Services

Aerial photographs and mapping products.

geodata.clientservices@dpipwe.tas.gov.au

Guidelines for responding to the effects of climate change in coastal and ocean engineering. (National Committee on Coastal and Ocean Engineering 2004)

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

Melbourne Water

Flood management information.

http://www.melbournewater.com.au/content/drainage_and_stormwater/flood_management

Mineral Resources Tasmania

Landslide susceptibility maps

<http://www.mrt.tas.gov.au>

Sea-level change around Tasmania: Information paper (Department of Primary Industries Water and Environment 2004c)

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

Tasmanian Flood Warning Centre, Bureau of Meteorology

Issues flood warnings

www.bom.gov.au/hydro/flood/tas/



Hazard management planning

The following agencies and resources will be useful in preparing for hazardous events and remediation works.

Climate change and coastal risk assessment project.

A suite of tools and documents including:

- *Coastal risk management plan: Template and guidelines* (DPIW 2009)
- *Coastal hazards in Tasmania: General information paper* (DPIW 2008c)
- *Climate change and coastal asset vulnerability: An audit of Tasmania's coastal assets potentially vulnerable to flooding and sea-level rise* (DPIW 2008b)
- *Sea-level extremes in Tasmania: Summary and practical guide for planners and managers* (DPIW 2008e)
- *Historical and projected sea-level extremes for Hobart and Burnie, Tasmania* (Hunter 2008)
- *Background report: Coastal flooding - Review of the use of exceedence statistics in Tasmania* (DPIW 2008a)

www.dpiw.tas.gov.au/climatechange

Management Australia (EMA)

Australian Emergency Manual Series

- Manual 1 Emergency management concepts and principles
- Manual 2 Australian emergency management arrangements
- Manual 7 Planning safer communities—land use planning for natural hazards
- Manual 14 Post disaster survey and assessment

- Manual 17 Multi-agency incident management
- Manual 19 Managing the floodplain
- Manual 20 Flood preparedness
- Manual 22 Flood response
- Manual 24 Reducing the community impact of landslides
- Manual 43 Emergency planning

EMA highlighted the potential benefits of its 'Critical Infrastructure Protection Modelling and Analysis' (CIPMA) program for disaster management in the coastal zone in their submission to the House of Representatives Standing Committee on Climate Change, Water, Environment and the Arts report *Managing our coastal zone in a changing climate* (House of Reps. SCCWEA 2009).

www.ema.gov.au

State Emergency Service, Department of Police and Public Safety

Tasmanian Emergency Risk Management Project (CD-ROM) conducted risk assessments of natural and technological hazards and proposed risk treatment strategies for the three Tasmanian regions.

Hazardous material emergency manual (SES 2001)

State summary: The Tasmanian emergency risk management project - a community perspective includes GIS maps of flooding, storms, wildfire, severe weather and earthquake/landslip risks

Tasmanian hazardous materials emergency plan (SES 2005)

www.ses.tas.gov.au



Tasmanian Fire Service

6230 8600 or 1800 000 699

www.fire.tas.gov.au

Tasmania Police, Department of Police and Public Safety

www.police.tas.gov.au

Oil spills

Australian Marine Oil Spill Centre (AMOSC)

www.aip.com.au/amosc/

Australian Maritime Safety Authority (AMSA)

Has recently undertaken a series of initiatives involving new technological developments to assist in larger-scale oil and chemical pollution response in the marine environment. Details are in *Oil Spills in the Australian Marine Environment: Environmental Consequences and Response Technologies* (Gilbert 1999).

National Guideline for the Development of Oiled Wildlife Response Contingency Plans (AMSA 2002)

Safety First in Oiled Wildlife Response (Video). (AMSA 2002)

National Marine Oil Spill Contingency Plan: Australia's National Plan to Combat Pollution of the Sea by Oil and Other Noxious and Hazardous Substances (AMSA 2005)

<http://www.amsa.gov.au>

National Oil Spill Response Atlas (OSRA)

The National Oil Spill Response Atlas for Australia is a computerised Geographic Information System (GIS) that authorities can use to identify priorities for protection and to manage clean ups.

The OSRA program identifies marine and shoreline ecosystems and biological resources, and provides information on response options (e.g. chemical dispersant use, shoreline clean-up techniques and disposal sites for wastes).

National OSRA datasets include:

- biological, environmental, wildlife and man-made resources
- geomorphological mapping and shoreline sensitivity to oil spills
- human-use resource considerations
- logistical and infrastructure information to support a spill response

OSRA data is available through the List www.thelist.tas.gov.au/ or phone 1300 135 5130.

State special plan for environmental pollution emergencies (in prep).

The state special plan is a strategic document listing roles and responsibilities in the case of an environmental emergency. The State Emergency Service and the Environmental Protection Authority are the contact points for this document.

Tasmanian marine chemical spill contingency plan (TASCHEMPLAN). (DPIWE 2003)

Tasmanian marine oil pollution contingency plan (TASPLAN). (DPIWE & SES 2001)





4

Community values

- 4.1 *Recreation and social values of the coast*
- 4.2 *Working with community*
- 4.3 *Tools and resources*

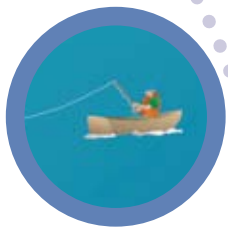
This chapter provides a summary of contemporary community values and use of the coast and the impacts associated with those activities. It also provides guidance for engaging local communities and working with community groups when undertaking coastal management works.

Tasmanians are fortunate to have such vast and diverse coastal areas to enjoy and they have a long association with living and recreating on the coast. However some recreational pursuits can be very damaging to coastal values in particular areas, or if not managed appropriately.

Community involvement is essential to achieving the protection and conservation of natural and cultural heritage along Tasmania's coastline. Many coastal areas are fortunate enough to have dedicated community groups of local volunteers that regularly care for the coastal environment.

For the broader community, education, awareness-raising and the use of interpretive tools and products are important to encourage community stewardship of coastal areas. Involving the community in coastal management planning and decision-making processes will help to foster this stewardship.

Tab photo: Sunset at a popular beach in south-east Tasmania. © Leah Page.



4.1 Recreation and social values of the coast

This section outlines some of the key recreational pursuits and the impacts on Tasmania's coastline associated with those activities. Specific management actions are provided, where available, and detailed in other chapters where appropriate.

Recreational pursuits include fishing, surfing, sailing, kayaking, birdwatching, swimming, bushwalking, horseriding, dog-walking and camping. Some recreational activities can have unwanted impacts on the coastal environment. Some recreational community groups, such as surf clubs and sailing clubs, rely on the coast for their activities. The provision and maintenance of infrastructure or access for recreational activities need to be balanced against the preservation and protection of coastal values.

Figure 4.1 Tasmanians have a strong affinity with the coast. © Leah Page



The provision of facilities is covered in **Chapter 14** and requires careful planning and consultation to ensure that facilities are appropriate for the users, meet occupational health and safety (OH&S) requirements and will not impact on natural or cultural values. It is also now important to ensure that facilities are appropriate for sea level rise predictions and other potential climate change impacts. **Refer to Chapter 13 Access management and Chapter 14 Structures and facilities.**

4.1.1 Recreational use conflicts

In many instances recreational activities are concentrated on tracks, beaches and reserves where the different needs of various users may conflict. Recreational values can also be in conflict with other coastal land uses, such as industry and commercial fishing operations. Some activities are inappropriate in some locations where the impact on coastal values is unsustainable, such as disturbance to bird breeding areas or threats to endangered flora and fauna.

The needs of various users must be managed in conjunction with human impacts on coastal values. Providing opportunities for communities to enjoy and use the coast may involve providing facilities and will always involve managing public risk and liability and impacts.

4.1.2 Recreational fishing

Over-fishing and illegal fishing practices are obvious impacts, but the activities of recreational fishers can have various other impacts on the coast. Irresponsible boating practices can lead to the spread of marine pests and discharge of pollutants and litter into coastal waters; inappropriate access to fishing spots through dunes and beaches and ad-hoc launch sites exacerbates coastal erosion, spreads weeds and



threatens wildlife such as breeding shorebirds. **Refer to section 4.1.3 Recreational boating and section 4.1.6 Coastal access**

What coastal land managers and recreational fishers can do to minimise harm:

- Fishing regulations have been developed to support sustainable fisheries and reduce the risk of over fishing. Get involved with initiatives such as Fishcare to improve awareness of catch limits, fishing pressure and responsible boating practices.
- Recreational gill nets are banned and are extremely hazardous to marine life, often killing many non-target species including penguins. Recreational fishers should take care to protect birds and other wildlife from hooks and fishing line.
- Consider providing facilities for cleaning and gutting fish at suitable locations; otherwise provide information to encourage fishers to clean fish at home.
- Support efforts to inform the public of the human health issues associated with seafood collection and consumption, in particular shellfish.

Figure 4.2 Pacific Gull entangled and drowned in fishing line. © Anna Wind



4.1.3 Recreational boating

Recreational boating is a great way to enjoy the many coves and bays that make up Tasmania's unique coastline. It provides access to areas that may otherwise be inaccessible and for this reason recreational boaters need to be particularly careful to minimise their impact on the coastal environment. **Refer to section 4.1.6 Coastal access.**

Coastal land managers, in conjunction with the Tasmanian Port Authority and Marine and Safety Tasmania (MAST), are responsible for boating facilities, including the maintenance of shipping channels and launching ramps. Land managers should investigate infrastructure and practices at slipways and improve facilities to meet best practice environmental standards. **Refer to Chapter 14 Structures and facilities.**

Pests and pollutants

Recreational vessels may inadvertently spread introduced species, attached to the hull, in gear or areas that are not cleaned and dried thoroughly. A piece of the introduced alga *Undaria pinnatifida* (wakame) left on a net or anchor will survive for



one or two days, possibly more. Microscopic spores floating in water in the bottom of boats will stay alive for a similar time. In mooring areas and marinas, boat hulls can quickly become infested which can result in the rapid spread of the weed around the state (DPIPWE website, accessed 7th October 2010).

What boat users can do to minimise harm:

- Remove any weeds, animals or sediment from boats, trailers and gear and place them in the bin, not back in the water. After each trip CHECK, CLEAN, DRAIN and DRY your boat, trailer and gear. Using water with a mild detergent, disinfectant or soap, wash vessels and equipment away from the shore where it will not drain into the marine environment.
- Slip and clean moored boats regularly, at least every year and anytime there is a build up of fouling. Maintain the boat with a suitable antifouling paint (ensure paint residue does not get washed into the water) and treat internal seawater systems (including water inlets and bilge tanks) regularly – flush with fresh water or an approved treatment. Ensure appropriate disposal of sewage and bilge water at an approved pump out facility.
- Fishing gear and rubbish not stowed correctly on board can end up as marine debris in coastal waters. Poorly maintained boats or irresponsible practices at boat ramps can lead to oils and pollutants draining into waterways.

Wildlife

Inappropriate access of foreshore areas to launch boats or landing on offshore islands can threaten vegetation and wildlife communities through spreading weeds or trampling vegetation, leading to erosion and disturbing breeding birds. **Refer to section 4.1.6 Coastal access.**

Recreational boat operators will come into contact with wildlife and must minimise impacts on wildlife and wildlife habitat. Boat operators can report whale sightings and strandings on the whales hotline. Humpback and southern right whales are the two best known species that make the annual winter migration north to breed.

Boat operators are not permitted to go any closer than 100m to a whale in any boat and should only approach from the side of the whale. The *Australian national guidelines for whale and dolphin watching* (Dept Environment & Heritage 2005) outlines standards that allow people to observe and interact with whales and dolphins in a way that ensures animals are not harmed. **Refer to Chapter 10 Wildlife Management.**

Motor boats

Motor boats may increase shoreline erosion in susceptible sheltered waters of estuaries and inlets, particularly when driven at high speeds. Some Tasmanian water bodies are suffering unnatural and largely unnecessary erosion as a result of boating activities. Once initiated, the erosion caused by wave wake or other vessel effects may be very difficult to control. Remediation works may be expensive or in themselves cause further habitat damage or loss of amenity. The trends towards increasing boat ownership, more powerful engines and rising sea level all add to the potential for problems so there is a need for greater awareness of vessel effects on both natural values and other users of our waterways. All boaters can help care for Tasmanian waterways by limiting their wake to a size appropriate to the area (DPIPWE website, accessed 7th October 2010).

Marine and Safety Tasmania (MAST) enforces a 5-knot speed limit in most port areas and has regulations limiting vessel speed to control damage to shores,



facilities and other vessels. *Tasmania Marine and Safety (Motor Boats and Licenses) By-laws 1997*, Section 28 states, amongst other things, that a person must not drive a motorboat at a speed exceeding 5 knots within 60m of any shoreline, river bank, etc. (DPIPWE website, accessed 7th October 2010).

Within the World Heritage Area, motorised boating is only permitted on specified water bodies – for details contact the Tasmanian Parks and Wildlife Service.

4.1.4 Kayaking

Kayaking is often considered to be minimal impact but, as well as the potential to create some of the same problems as recreational boating, there are also some special considerations with kayaking, especially because it can provide access to remote locations and proximity to coastal wildlife.

Guidelines for minimal impact kayaking

- Take home all rubbish, including empty packaging, food scraps and sanitary products. Collect rubbish left by others if possible.
- Use existing campsites and tracks whenever possible. If visiting a previously undisturbed site,

Figure 4.3 Hauling boats out onto the shoreline is destructive to the vegetation and can lead to increased erosion.
© Leah Page





Figure 4.4 Kayaking allows access to remote coastal locations such as the Bathurst Channel in south-west Tasmania.

© Chris Rees

keep movement around the area to a minimum. Carry, rather than drag, your kayak.

- Use a fuel stove for cooking. Campfires leave ugly scars, reduce the availability of dead timber as habitat and can escape and start destructive wildfires.
- When depositing human waste, burying it is a minimum requirement: consider disposal in the sea. Best of all, carry it away with you.
- Avoid using soap or detergent when camping. Beach sand is an excellent alternative for cleaning cookware.
- Maintain a respectful distance from all wildlife, both on land and water (100m from whales).
- Do not disturb breeding wildlife. Avoid landing on smaller offshore islands used for breeding, and camp well away from other breeding sites.

4.1.5 Camping

Many Tasmanians have long enjoyed camping in coastal areas and some families have returned to the same sites annually for many years. Environmental knowledge and understanding of human impacts on coastal values has increased significantly over the years and camping practices have had to be modified to reflect this knowledge. Ongoing education of campers and provision of appropriate facilities is essential to minimise impacts from coastal camping.

Guidelines for minimal impact camping

- Camping in coastal areas should be restricted to formed campsites. Keep camping equipment and vehicles within site boundaries. Many coastal campsites are located within reserved land and are managed by the Parks and Wildlife Service with strict guidelines about permissible activities depending on the status of the reserve.
- Dispose of waste properly, to minimise environmental impacts. Visitors should take all rubbish away with them or use rubbish receptacles if provided. Disposal of black water (toilet and kitchen waste water) into campground composting toilets will destroy the composting process. Dispose of black water only at facilities listed in the *Caravan and holiday park guide to Tasmania*. (Tourism Tasmania, n.d.)
- Do not remove or damage plants, animals, historic artefacts and rocks: they are protected.
- Do not cut or remove dead trees and branches for firewood or other purposes: they provide refuges and homes for wildlife.
- Do not disturb Aboriginal middens (shell and bone deposits), which are found in and around sand dunes, or remains of historic use such as huts, footings, walls and fences. These sites are protected.
- Avoid digging drains, channels or pits, they are destructive to the vegetation and landscape; and channel water which will increase erosion.
- Campfires are permitted in some camping areas (except on days of total fire ban) and usually only in fireplaces provided. Fires should not be left unattended and should be kept small. They must be extinguished fully with water before leaving. It is an offence to leave a fire unattended without fully extinguishing it. Total fire bans can be imposed at short notice - it is advisable to carry a fuel stove.
- Do not feed wildlife: inappropriate food can make them very ill and feeding discourages them from foraging for themselves. Maintain a respectful distance from all wildlife.
- Dogs and horses are permitted in some camping areas – check with the land manager for permission and conditions.



4.1.6 Coastal access

Historically, coastal accessways were often developed in an ad-hoc manner and often by adjacent landholders. Land managers need to work together and develop plans to ratify public access, to ensure protection of fragile or valuable environments. This involves identifying access points and undertaking public awareness (including signage) and management actions to direct access in foreshore areas, to reduce erosion and degradation. This work should be undertaken in collaboration with local community care groups and in consultation with public users.

Designated coastal access needs to be provided; the demographics of the area and the user groups should

be considered, to ensure that access is appropriate. It might be necessary to consider ramps for disabled access. Many elderly people can use steps with hand rails but could not use ladder-and-chain-style access. ***Refer to Chapter 13 Access management.***

Access to beaches and coastal areas by 4WD vehicles, quad bikes and trail bikes can be extremely damaging to the coastal environment, leading to destruction of natural and cultural values. Aboriginal heritage sites, dune vegetation, dune stability and breeding shorebirds are all extremely vulnerable to vehicles on beaches.

Vehicles can spread weeds and diseases and cause severe erosion, and can lead to compaction of the

Figure 4.5 Access to coastal areas by trail bikes, quad bikes and 4WDs can be extremely destructive and should be very carefully managed. © Shaun Thurstans





Figure 4.6 Poorly designed and sited rubbish bin in southern Tasmania. © Leah Page

sand, affecting the animals living within the sand (meiofauna) which are an important food source for sea and shorebirds. On popular beaches and dune systems, 4WD vehicles, quad bikes and trail bikes can also be dangerous to other beach users.

What coastal land managers can do:

- Consult with user groups and establish the reasons for 4WD access and the social context of the activity. Provide education about the impacts of vehicles on beaches and dunes through signage, newsletters and notices. Most importantly invite representatives of recreational groups to get involved in coastal management and encourage them to inform their members of coastal values, the risks associated with their activity and the best ways to minimise those risks.
- Review beaches with vehicle access and assess environmental impacts against social benefit. Consolidate vehicle access through dune systems and provide board-and-chain tracks to reduce dune erosion. Signage is essential on beaches where boat launching is permitted, to tell users to restrict vehicle access to the launch site. **Refer to Chapter 13 Access management.**
- Enforcement of vehicle restrictions requires collaboration between all land managers, usually the Parks and Wildlife Service and local council as well as Tasmania Police.

Offshore islands

There are around 600 named islands, rocks and reefs

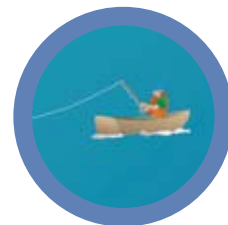
around the Tasmanian coast. The majority of these are true islands, with most of the landmass lying just above the high water mark.

Many islands support flora and fauna of conservation significance, including breeding populations of seabirds and seals. Because of their geographic separation, offshore islands are very vulnerable to the introduction of weeds, pests and diseases, but their isolation also makes them highly defensible against threats and impacts.

Anyone accessing offshore islands must take care not to introduce new weeds, pests or diseases, by practising good hygiene for boats and personal equipment. Visitors should take care to minimise disturbance to vegetation communities and wildlife. Land managers should consider involving local communities in management plans for offshore islands and should play a role in educating the broader community about the value and sensitivity of these important environments.

4.1.7 Litter

Litter in coastal landscapes has a visual impact and degrades vegetation communities and wildlife habitat. Litter in coastal waters (known as marine debris) threatens wildlife, who may become entangled in or eat it. Illegal dumping of household waste and unwanted items in coastal areas is a public health hazard, is destructive to the local environment and has a very serious aesthetic impact.



Rubbish bins

For many popular coastal locations, rubbish collection services are the responsibility of the land manager. Sometimes it is acceptable in more remote areas to encourage people to take their rubbish away with them. But if other public facilities are provided at a site, users will often expect to be able to dispose of rubbish there, too.

Figure 4.7 Rubbish bins for specific purposes such as dog faeces need to be accompanied by signage and checked regularly to ensure that the bags provided are not creating a litter problem. © Leah Page



What coastal land managers can do:

- Ensure that the size and design of the rubbish bins are appropriate for the amount and type of waste. Bins designed to prevent scavenging by seagulls and possums should be considered in coastal areas.
- Provide separate bins for waste/rubbish, recyclables and dog faeces, where appropriate.
- Consider where the bins are located and how often they are emptied. Monitor usage to ensure bins are located in the right spot.
- To minimise litter escaping into the environment, ensure that bins are never more than 75% full and ensure that spilt litter is cleaned up when bins are serviced.

Rubbish dumping

Coastal areas are also sometimes used as dumps for garden waste, household refuse, unwanted items such as furniture and even cars. Dumping of garden waste may introduce weeds and diseases. Rubbish looks unsightly, can destroy vegetation and impact on wildlife values, and cause contamination of waterways.

There are also considerable public health and safety risks associated with the dumping of household refuse and large items.

Any illegal rubbish dumping should be reported to Tasmania Police or the local land management authority; usually Crown Land Services, the local council or the Parks and Wildlife Service.

Education of the public and strict enforcement is essential to manage the issue of illegal dumping.

Marine debris

Sources of marine debris include stormwater, fishing and aquaculture industry waste, shipping operations



and recreational use of coasts and waterways. Marine debris can entangle and strangle or cause starvation of marine wildlife, pollute water and look unsightly, detracting from recreational enjoyment.

Common marine debris items include plastic bags, cigarette butts, ropes and bait box straps, plastic wrappers and small pieces of plastic. Cigarette butts persist for a long time in the environment, ropes and straps are very prone to causing entanglement, and small pieces of plastic and bags and wrappers are commonly ingested by marine life.

The Tasmanian Fishing Industry Council is the peak commercial fishing industry body in Tasmania. It has developed a code of conduct for a responsible seafood industry and actively promotes to its members the importance of reducing marine debris and encourages the provision of improved waste facilities.

Many community groups undertake clean-up activities and these efforts should be supported by land managers and other coastal stakeholders. Marine debris clean-up operations must consider the impact of the activity on other coastal values, in particular wildlife, such as breeding shorebirds. **Refer to Chapter 10 Wildlife management.**

The installation and servicing of litter traps on stormwater facilities can greatly reduce stormwater pollutants entering waterways. **Refer to Chapter 12 Stormwater and crossings.**

4.1.8 Surfing and water recreation

In addition to recreational boating, kayaking and jet-skiing, popular water sports in Tasmania include scuba diving, surfing, kite surfing, wind surfing, snorkelling and swimming.

These activities can have unwanted impacts on coastal

values. Popular surfing spots often have formalised access and sometimes other facilities; other surf spots are more remote and not easily accessed. It is important that surfers and other users minimise their impact on coastal values when accessing the foreshore, in particular where there no formalised access or facilities are provided.

Artificial reefs

The creation of artificial reefs to modify swells to change the surf conditions should be avoided. Complex hydrological processes are responsible for the transport and deposition of sand on beaches and any modification to wave action and swells could upset the balance of this process. This is of particular concern with climate change also increasing the pressure on shorelines through sea level rise and increased storm activity.

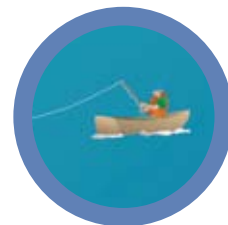
4.1.9 Coastal views

Coastal views are highly prized and enjoyed by Tasmanians. Developments and structures on the coast can degrade the visual appearance of the area. Sometimes local residents in coastal areas try to modify their own coastal view by illegally removing vegetation in adjacent coastal reserves.

View field maintenance

The visual appearance of the coast fosters a powerful sense of place within local communities, enriches recreational experiences and adds to enjoyment of coastal areas.

Planning for coastal development should consider the importance of maintaining coastal landscape views or view fields (the view of the coastline from another vantage point). There are very few prescriptive guidelines for view field maintenance in existing



policy and legislation, so currently it is up to individual planning bodies to consider these issues when assessing development applications.

Illegal removal of vegetation

Some coastal foreshores have suffered the illegal removal of coastal vegetation by adjacent landowners, usually to open up coastal views. Removal of vegetation from any coastal foreshores can cause severe damage to these fragile ecosystems and lead to erosion and instability. In light of sea level rise, foreshore stability is increasingly important, as is protecting remnant coastal vegetation and ecosystems such as wetlands.

It is critical to educate the public about the value of coastal vegetation and ways in which they can care for their coastal areas. Law enforcement will also be needed where problems are occurring. **Refer to section 7.7 Vegetation removal.**

4.1.10 Horseriding

Horseriders enjoy riding along beaches and on a number of coastal horseriding trails around the state. Like vehicles on beaches, horses can spread weeds and diseases (in their hooves and droppings) and can easily trample shorebird nesting sites, eggs and chicks. Some riders utilise catch bags to collect their horse droppings.

Access to coastal areas for horses should be restricted to particular locations. It is important to consult with user groups and establish workable outcomes that provide access whilst protecting important coastal values. Education about the impacts of horses on beaches and dunes can be provided through signage, newsletters and notices.

Most importantly, representatives of horseriding recreational groups should be invited to get involved

in coastal management and encouraged to inform their members about coastal values, the risks associated with their activity and the importance of sticking to designated tracks to minimise those risks.

4.1.11 Dog-walking

Walking dogs on beaches is an extremely popular recreational activity and many local councils have dog management plans that designate particular beaches for this. Dogs on beaches raise obvious health and safety concerns for other beach users that need to be managed; restrictions on dog access often apply to popular beaches during the summer months.

Figure 4.8 Many dog owners enjoy exercising their pets on the beach but some beaches should be dog free to provide space for wildlife. © Leah Page





Dogs can also have significant impacts on coastal wildlife and should be totally excluded from some beaches where coastal values are sensitive, such as those where shorebirds breed.

Dogs leave behind scents that will impact on the behaviour of wildlife. Even the sight of a dog in the distance will stress shorebirds and other wildlife who recognise its shape as a predator. When dogs chase birds, the feeding time of the birds is reduced, affecting their ability to provide enough food for themselves and their young. Unsupervised dogs can eat shorebird eggs and attack and kill penguins, shearwaters and other wildlife.

Dog owners should be educated about coastal values and potential impacts of their dog in coastal areas. They should be encouraged to use beaches designated for dog-walking and obey any local restrictions, and should carry bags to collect dog faeces and dispose of these appropriately.

Community organisations such as Birds Tasmania, the Tasmanian Conservation Trust, the Southern Coastcare Association of Tasmania and the Natural Resource Management (NRM) regional bodies have joined forces to deliver community awareness events such as 'Dog's Breakfasts' at popular beaches: dog owners and their pets are given a free BBQ and the owners are educated about coastal values in their area and ways to minimise their dog's impact on these values.

4.1.12 Birdwatching

Birdwatching is a significant recreational activity in Tasmania that is increasing in popularity and attracting tourists to Tasmania from the mainland and from overseas. Ecotourism and specifically birdwatching make an economic contribution to Tasmania, but the exact value is unknown. Volunteers from Tasmania and further afield get involved in bird counts and observations for organisations like Birds Tasmania and Wildcare.

Viewing coastal birds should be undertaken with great care. Seek advice from the local Parks and Wildlife Service and Birds Tasmania.

Shearwater and penguin burrows can be easily damaged or destroyed by inappropriate access. Because these birds come ashore at dusk, lighting is often required to view them, which can be very disturbing to the birds. Ensure torches are covered with red cellophane to minimise this disturbance.

Refer to Chapter 10 Wildlife management.

4.1.13 Removal of seaweed and other coastal resources

Sand, seaweed pebbles and driftwood are resources that have a value as landscaping or gardening products. However, it is illegal to remove seaweed and other resources from public beaches without approval from the land manager, and a licence from Crown Land Services (DPIPWE).

Seaweed and seagrass wrack plays a role in trapping sand and building up beaches. It also provides habitat and food for small invertebrates and micro-organisms that live on the beach, which are an important part of the food chain, in particular for shorebirds. On shorebird breeding beaches seaweed also provides camouflage for nests and shelter for chicks.

Land managers who remove wrack for aesthetic reasons should only remove it from above the low tide mark and only on high-use beaches that do not support breeding shorebirds.

Sand should not be removed from the beach or dunes as this can lead to instability and erosion. It is illegal to remove sand without a permit. Sand mining requires specialist advice and consideration of the local processes of erosion and deposition to determine if the activity is sustainable. **Refer to Chapter**



11 Soil management and earthworks.

Beach rocks and pebbles also play an important role in slowing down wave action, therefore reducing coastal erosion. It is illegal to remove any rocks, pebbles and stones without a permit.

Logs and driftwood on beaches have a function of trapping sand and providing shorebirds with shelter and a place to hide from predators. If it is necessary to remove large logs that pose a hazard, the land manager's approval is required.

4.1.14 Surf clubs, rowing clubs and sailing clubs

Surf clubs, sailing clubs and often rowing clubs are located on coastal foreshores and their activities rely on access to the coast. These clubs play an important role in providing healthy experiences in the coastal environment, particularly for young people. However,

the intensity of their activities on the foreshore can have unwanted impacts on the coast.

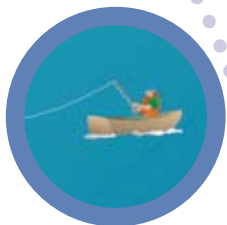
In summer, surf clubs hold regular training activities, at least weekly and a number of state-wide carnivals occur on various beaches, involving large numbers of people. They generate a lot of rubbish and can harm local vegetation and wildlife, in particular breeding shorebirds.

Sailing clubs and rowing clubs also train regularly and hold events that attract large numbers of people to foreshore areas.

Sporting clubs should work closely with local land managers to ensure their activities are not damaging coastal values. This is particularly important when planning events. Adequate facilities and resources for cleaning up after events need to be provided. Coastal sporting clubs should raise awareness of coastal values and the potential impacts of their activities on the coastal environment with their members.

Figure 4.9 Surf club carnivals attract large numbers of people to the beach which can impact on coastal values. They are a great opportunity to raise awareness about coastal issues and protecting the coastal environment. © Leah Page





4.2 Working with community

This section deals with involving the local community in coastal management and working with local community groups, in particular environmental groups. Works on the coast will be more effective if they have community support rather than indifference, or even opposition.

Before developing a works plan, pro-active land managers involve the local community, so that people know what works are planned and why, and have the chance to put forward their ideas and concerns. Communication and collaboration at the start will help to identify important issues and to gain acceptance and support for projects.

Community groups (such as Coastcare groups) often undertake very significant coastal land management works in partnership with local land managers and other coastal stakeholders.

It is essential to recognise, respect and support Aboriginal connections and concerns for the coast. This includes consulting with Aboriginal communities about proposed activities that may interfere with Aboriginal values. Working with the Aboriginal community involves its own set of requirements and legislation and is covered in **Chapter 5 Cultural heritage management**.

Figure 4.10 Coastcare volunteers learning about coastal issues at a regional workshop.

© Southern Coastcare Association of Tasmania





4.2.1 Identifying stakeholders

For any given coastal area in Tasmania there will be user groups and members of the community that have a vested interest in the area. Before commencing works it is important to identify who will be interested in or affected by the proposed activity. It is even better to establish long-term partnerships with community stakeholders that will allow meaningful dialogue on coastal management issues.

When planning projects on the coast, it is important to identify the different values of all coastline users, not just local residents and regular visitors. One stretch of coastline may be used at different times for walking, swimming, picnicking, dog-exercising, fishing, surfing, boating, birdwatching, off-road-vehicle driving, horseriding, surf carnivals, sports training, education and ecotourism. Identifying and recognising people's different values will also help to identify and minimise conflicts between different users.

People living next to a coastal reserve are the most likely to become involved in hands-on activities. They are also more likely to help with ongoing maintenance and reporting and deterring vandalism and arson.

Know your community. Local councils can best achieve this by having a dedicated employee such as an NRM Officer who regularly works with the community in their municipality on environmental management issues. If there is local volunteer group in the area it probably has its own aspirations and plans for the area and may even be working with other agencies to achieve them.

Local communities often don't know or care who manages the coastline (local council, Parks and Wildlife Service, Crown Land Services), they just want it managed in a way that reflects their values.

4.2.2 Consultation with the community

Community consultation is important to inform people and gain public support for coastal works and developments that might affect public use and enjoyment of the area. Residents and visitors feel that their concerns, ideas and needs have been carefully addressed. It is important that they understand the reasons behind a project especially if they oppose it. This may elicit support for protecting cultural and natural heritage, even if it might interfere with some people's recreational activities.

Consultation with established community groups should be ongoing and involves visiting group work sites, participating in group meetings and inviting group representatives to be involved in land management planning and decisions. Local people often know more about some local issues (e.g. bird nesting sites) than the professional managers.

The broader community is consulted when projects or management issues arise. Putting a notice in the newspaper advising of works is not enough. It is better to have face-to-face contact, such as conducting informal beach walks or public workshops. Brochures in local shops, surveys, temporary signs and letterbox drops are good ways of informing people and inviting consultation. Developing a community engagement strategy is advisable.

Consultation takes time and money, but it may be cheaper than having contractors and expensive equipment standing idle while a dispute brings work to a halt. Consider also the cost to future generations of doing the wrong thing.



4.2.3 Types of community organisations

There are many different community organisations with an interest or involvement in coastal land management.

Key individual community organisations and their contact information is summarised in **Appendix 4**.

Environmental non-government organisations (NGO's) such as Birds Tasmania, the Tasmanian Conservation Trust, Ocean Planet and the Understorey Network provide advice to community groups and, in some instances, coordinate coastal projects for groups.

For a fee, **volunteer providers** such as Conservation Volunteers Australia, Green Corps and other organisations provide teams of volunteers with

an experienced leader to undertake a range of environmental activities, from weeding and revegetation to track work and monitoring.

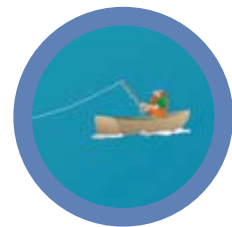
Local community groups such as Coastcare and Landcare groups get involved in coastal land management and Scout clubs or sporting groups such as Surfriider's Foundation are keen to get involved in beach clean-ups or revegetation projects.

Community support organisations such as the Southern Coastcare Association of Tasmania and Tasmanian Landcare Association provide support and regional coordination for local volunteer groups. **Refer to 4.2.4 Volunteer support programs.**

Many **schools** have environmental programs and are interested in coastal issues and coastal management. These little environmentalists will be the custodians

Figure 4.1 | School group involved in water quality monitoring. © Leah Page





of the land in the future and it is never too early to introduce them to best practice coastal management. It is very effective when an expert in coastal issues takes the time to work with staff and students.

Community organisations such as the Understorey Network and local Coastcare groups create opportunities for working with school groups when resources allow. School groups can get involved in revegetation works and monitoring programs. Coastal land managers and NRM regional bodies should consider working with school groups whenever possible.

4.2.4 Volunteer support programs

A range of organisations and programs offer support to community volunteer groups interested in coastal management. Umbrella groups such as the Tasmanian Landcare Association (TLCA), Southern Coastcare Association of Tasmania (SCAT), the Tasmanian Conservation Trust (TCT) and Wildcare provide opportunities and resources and foster networks and linkages among local volunteer groups.

The TLCA and Wildcare maintain databases of volunteers keen to work on short-term projects or particular activities such as whale-stranding rescue operations.

Conservation Volunteers Australia also works on short-term projects. For a fee, it provides a highly motivated workforce that can work in partnership with land management authorities to manage and protect the coastline.

Regional NRM bodies provide opportunities for funding, training and guidance on regional issues. They have facilitators that support community groups and encourage groups to address regional priorities.

Many local groups utilise Australian Government

programs (e.g. Caring for Our Country) to access funding for their projects.

Land managers (e.g. local councils, Parks and Wildlife Service) can provide support through developing agreed management plans with local volunteer groups and providing on-ground assistance.

Volunteer support programs can help:

- individuals to join an existing group or set up a new one
- identify local problems and possible solutions
- work with groups and land managers to develop projects and apply for funding
- identify local specialists and other volunteers (e.g. schools, Scout clubs)
- make sure that community projects are well planned, with input from land managers, and fit into local or regional coastal management plans
- ensure community projects are technically sound and feasible, and comply with relevant legislation.

4.2.5 Understanding community groups

Many people in Coastcare, Landcare, Fishcare, Wildcare, progress associations, service clubs, youth clubs and similar groups regularly volunteer many thousands of dollars' worth of time and resources for environmental projects. Most are from environmental care groups like Coastcare, and local Scout groups and service clubs often partner with Coastcare groups to tackle specific projects.

Volunteers from environmental care groups are often very skilled and experienced and highly motivated but should not be regarded as a free labour force. Some will also have work and personal commitments; others may be retirees with varying physical abilities.

All volunteers deserve respect and need to be



supported and appreciated. Most do not want rewards but request that land managers provide resources (e.g. tools and equipment), funding, expertise (e.g. training) or advice, and approval of activities.

Community groups come in many forms but most have a least a basic structure that requires them to hold regular meetings and be accountable to their members. Many Coastcare and other groups are incorporated bodies that satisfy a host of legal criteria, including having a committee, insurance and a constitution. When working with community groups it is important to remember that they have a responsibility to fulfil the functions within their constitution and/or to respond to the needs and directives of their membership.

Most groups hold monthly meetings at which members plan activities and manage their administrative affairs and funds.

Most groups also hold monthly, or regular working bees where members work on local projects and on-ground activities to protect or enhance their coastal environment.

The majority of volunteers prefer hands-on activities and find the administrative burden of running an incorporated body taxing. Umbrella organisations like Wildcare, Tasmanian Landcare Association and the Southern Coastcare Association of Tasmania attempt to reduce some of this administrative burden on groups through different initiatives such as advice on insurance and incorporation and coordination of regional projects.

Membership fees are usually nominal and projects require external funding, often in the form of government or corporate grants. Such funds are highly competitive; applications take a considerable amount of effort to apply for; and funds are tied to

defined and non-negotiable expectations from the funding body. Funding can also be sourced from NRM regional bodies, state government programs and corporate sponsorships.

4.2.6 Working with community groups

Supporting volunteers does not have to be expensive. Many organisations and volunteer programs have extension officers or facilitators who can help to seek funding and develop agreements between volunteers and land managers. Volunteers also appreciate help with funding applications from other sources.

Many public works (e.g. management of weeds, native vegetation and wildlife) require ongoing work and maintenance and will be more successful if carried out in partnership with the community. Community groups can help with many tasks, including the essential monitoring and maintenance after weed removal, planting and maintaining revegetation projects, conducting wildlife tours to educate the public about protecting wildlife, and developing signage to raise public awareness of such issues. However, there should not be exclusive reliance on volunteers to undertake land management responsibilities.

Local councils that invest in their own NRM facilitators have very successful working relationships with volunteer groups working on coastal management issues. Organising and holding educational workshops and working bees can be a good way to support groups and attract new volunteers. Support from the land manager greatly increases volunteers' motivation and enjoyment. Without this support, community groups can become discouraged and fade away. Some local councils offer simple small grant schemes for community groups in their area, to support and acknowledge the contribution made by their volunteers.



The volunteering experience should be a two-way relationship. Volunteering is a vital component of a healthy community. The volunteering experience should be enjoyable and satisfying. The best way to achieve this is with regular consultation through meetings and a formal agreement with the groups, to outline everyone's responsibilities and establish common goals. **Refer to section 4.2.9 Partnership agreements.**

It is also important to train works crews and contractors to avoid practices that may (often unintentionally) cause damage and upset local residents or dedicated volunteers who care for their environment, such as depriving wildlife of habitat by cutting down old trees, or removing fallen branches just because they look untidy.

4.2.7 Guidelines for collaborating with community groups

Community groups can be great advocates for your organisation and your work if you develop a healthy partnership with them.

- Provide a regular open channel for community groups to provide input in coastal management decisions and planning (i.e. NRM facilitators in land management agencies).
- Consult with community groups before planning coastal management works. Provide at least six weeks' notice wherever possible to allow groups to consult their members at one of their regular monthly meetings then consolidate that input into a response.

Figure 4.12 Some local councils provide resources in the form of tool trailers to assist Coastcare and Landcare groups with their activities. © Leah Page





- Provide support for community groups in the form of resources, advice and training. Visit the sites where the community groups are working and make note of their concerns and aspirations.
- Encourage community groups to seek support and advice from other NRM organisations, such as NRM regional bodies and community group umbrella organisations such as the Tasmanian Landcare Association and the Southern Coastcare Association of Tasmania.
- Become familiar with NRM funding programs and the constraints and processes involved. Be prepared to respond in a timely way when funding rounds open. Community groups will often be keen to apply and will need support and approvals from land managers prior to submitting funding applications.
- Review existing works programs, activities and management plans to ensure that land management practices align with community group programs and activities, and that community group activities are compatible with local, regional and state strategies. If there are inconsistencies, work with the group to resolve these.
- Establish a partnership agreement or management plan with your local community group to provide clear direction on everyone's responsibilities and establish common goals. Review these regularly with the group.
- Attend meetings and working bees when possible to update groups on land management activities and plans and to hear about the groups' activities and plans.

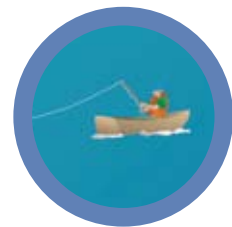
Common community group concerns

- Management decisions made without consultation
- Tight time frames for providing input or feedback that do not allow enough time for consultation with members
- Lack of support from local land managers and other agencies to raise awareness of coastal values and provide education about coastal issues
- Lack of enforcement of illegal coastal activity such as vegetation removal

4.2.8 Community involvement in working groups and advisory bodies

Coastal projects will benefit from community group representation on steering committees, working groups and advisory bodies. Ongoing coastal land management activities will benefit from ongoing consultation with community groups.

Land managers often have to liaise with numerous groups. One approach is to form a working group involving all local groups and the land manager in a meeting twice a year to exchange information about works plans, programs, aspirations and issues. This would not replace individual consultation with each group but could be an effective way for a land manager to receive input on development proposals and other works programs and local groups could benefit from the opportunity to discuss their activities in the region and share ideas and concerns with each other.



4.2.9 Partnership agreements between land managers and community groups

Asset and site plans should include reference to community groups with an interest in that particular location. Ideally they should include strategic actions that will be undertaken to support and work with the community group/s. It is even better to establish a partnership agreement with key groups, to establish a truly collaborative approach to coastal land management.

The purpose of a partnership agreement is to provide guidance to the community group and the land manager for certain activities related to the management of coastal land. The agreement may satisfy legislative requirements for authorisation to work on the land manager's property, but more importantly it will provide details of each party's role and responsibilities and provide a foundation for community group works to be undertaken in collaboration and with the support of the land manager.

Keep partnership agreements as simple as possible and use plain English. A partnership agreement should specify key pieces of information that will assist its implementation. The agreement could specify the location or areas covered by the agreement and provide some background information on those locations and also on the community group and its aspirations and history of involvement. The agreement could also nominate a liaison person for each party.

Works program

A partnership agreement outlines the works program to be undertaken by the group and the works or support that will be undertaken by the land manager. It can list tasks that the group, in consultation with the

land manager, has agreed to undertake. It can also list support that the land manager will give to the group's tasks in the form of works, training, resources etc.

The works program may include a site plan, maps and other technical information and a time frame for agreed activities. It may be specific (e.g. authorising particular works on a certain day) or it may describe a general work program. It is important to remember that a works program does not hand over management responsibilities to the community group: rather, it outlines the scope and any limitations of the community group's work activities and what the group can expect from the land manager. It also provides strategic direction for planning activities and seeking funding.

Examples of works community groups might undertake:

- weed management
- foreshore management such as access management and removal of feral oysters
- protection of threatened species habitat
- visitor services site management (e.g. camping or picnic areas)
- walking track maintenance or construction
- revegetation of degraded areas
- maintenance of cultural heritage assets (e.g. historic huts)
- rubbish collection and removal, such as marine debris beach clean-ups
- monitoring coastal values such as penguins, shorebirds or vegetation
- monitoring coastal processes



Examples of land manager works and support:

- management advice for the area
- risk assessment of proposed activities
- training for group members
- administrative support for the group (e.g. photocopying, newsletter distribution)
- logistical support (e.g. transport) for group activities
- provision of personal protective equipment (PPE)
- provision of materials (e.g. herbicide, timber)
- provision of funding (where appropriate or possible)
- loan of tools
- assistance with specialist equipment and/or skills (e.g. design of track work, rubbish removal, spraying weeds, chainsaws, large vehicles)
- general assistance with on-ground works
- events to recognise the contribution of community group volunteers
- assistance with grant applications
- assistance with organising community events
- assistance with promotion of activities

Support and assistance from land managers

Land managers can provide important guidance and assistance to community groups, using their staff resources to undertake risk assessments with the group and help them to implement high standards of OH&S through training and the provision of safety equipment. Land managers can offer to provide supervision of tasks where deemed necessary by both parties.

The partnership agreement should clarify responsibilities for OH&S and specify the processes for undertaking a risk assessment and reporting hazards or incidents.

Land managers could explore the possibility of providing insurance cover for groups working on their land. It is highly recommended that groups also seek their own insurance cover, regardless of arrangements with land managers, as coastal land tenure is complicated and confusing and volunteers may find themselves unwittingly working on another manager's land.

The partnership agreement can also provide some key organisational tips for community groups, such as recording volunteer attendance, registration and annual activity summaries. This information will assist groups in demonstrating a safe work environment and will be valuable when seeking funding or recognition for work activities.



4.3 Tools and resources

Complete details of all printed publications listed here are provided in a reference list at the end of the Manual. A list of community support organisations is provided in **Appendix 4**. Other tools and resources including websites are collated in **Appendix 5**.

Australian national guidelines for whale and dolphin watching (Department of Environment and Heritage 2005)

<http://www.environment.gov.au/coasts/publications/pubs/whale-watching-guidelines-2005.pdf>

Caravan and holiday park guide to Tasmania. (Tourism Tasmania)

Annual publication

Fishwatch

0427 655 557

Report suspected illegal fishing and fishing offences

Leave no wake: Minimal impact sea kayaking

Brochure available from Parks and Wildlife Service and information on the website

www.parks.tas.gov.au

NRM regional bodies and volunteer support organisations

See Appendix 4

Partnership Agreement template

See Guidelines at the back of this Manual

Recreational Sea Fishing Guide

Produced annually by DPIPWE

www.dpipwe.tas.gov.au

Stow it don't throw it (brochure)

Guidelines for minimising risk of rubbish and pollutants for boating activities

Australian Maritime Safety Authority (AMSA)

http://www.amsa.gov.au/publications/Marine_Environment_Protection/Stow%20it.pdf

Whale hotline

0427 942 537

Report whale sightings and strandings



5

Cultural heritage management



- 5.1 *Aboriginal heritage*
- 5.2 *Historic and maritime heritage*
- 5.3 *Climate change and cultural heritage*
- 5.4 *Tools and resources*

This chapter deals with Tasmania's rich cultural heritage. Cultural heritage values include Aboriginal heritage sites and artefacts and historic heritage sites and artefacts, both are protected under specific legislation.

Cultural heritage places offer an insight into past ways of life, and for Aboriginal people they provide a powerful connection to place.

Cultural heritage sites are often fragile and easily damaged. They can be difficult to identify and once they are lost or destroyed they are gone forever.

Everyone who undertakes land management works has a legal and moral obligation to protect Tasmania's cultural heritage values for future generations.

*Tab photo: Remnant Jetty Bridport northern Tasmania.
© Renee Hodskiss.*



5.1

5.1 Aboriginal heritage

This section deals with Aboriginal heritage management and the importance of working with the Tasmanian Aboriginal community to ensure that Aboriginal heritage values are valued and protected.

Aboriginal occupation of Tasmania stretches back at least 40 000 years, and the entire Tasmanian landscape is part of the Aboriginal story. As a result, there are numerous Aboriginal heritage places including shell middens, rock markings, stone quarries, stone arrangements, rock shelters and fish traps in coastal areas.

All Aboriginal places are important, as each one is an integral part of the 'country'. 'Country' describes all of the areas that Aboriginal people traditionally used or occupied. Aboriginal people have strong physical and spiritual links with the 'country'.

Tasmanian Aboriginal people have strong and ongoing connections to coastal landscapes and heritage sites. They are the primary source of information about their heritage and should be involved in its protection, identification and management.

5.1.1 Tasmanian Aboriginal people

Tasmanian Aboriginal culture is one of the oldest living cultures on earth. Sites bearing signs of occupation and past traditions and practices have been scientifically dated back to 40 000 years ago.

Tasmanian Aborigines lived through ice ages and major geographical change such as the sea level rise which inundated the Bassian Plains, separating Tasmania from mainland Australia.

Tasmanian Aborigines are the only group of humans

Figure 5.1 Aboriginal midden on the north-east coast of Tasmania. © Chris Rees





to evolve in isolation for 10 000 years. Their culture and heritage is unlike any other and they are a diverse group of people with many nations, languages and traditions.

Aboriginal heritage places, both tangible and non-tangible, provide a spiritual link for Aboriginal people to their tradition, culture and roots. These places are of great interest to archaeologists and historians globally.

Tasmanian Aboriginal people have a long association with the coast and have sustainably used coastal resources for thousands of years, gathering food items such as short-tailed shearwaters (yolla or muttonbirds), seals, swan eggs and shellfish. Today many Tasmanian Aboriginal people continue to practice traditional cultural practices such as going birding (gathering yolla) and collecting coastal resources such as shells, grasses and kelp to make necklaces, baskets and water carriers.

Aboriginal middens can be found on most Tasmanian coastlines and contain layers of shell, stone artefacts, charcoal, ochre and animal bones. Aboriginal shell middens hold ancient cultural knowledge and information and are extremely important on a local and a global scale.

Middens provide an insight into the way people lived in Tasmania and the resources that were available in any particular area. With the ongoing threat from development and sea level rising, middens are a non-renewable source of information and hold great potential for further understanding and appreciation of the lives of Tasmanian Aboriginal people.

5.1.2 Legislation and approvals

Currently Aboriginal heritage in Tasmania is protected under both Tasmanian and Commonwealth heritage legislation.

The *Aboriginal Lands Act 1995* (Tasmania) covers management of access to land and waters for mineral and petroleum exploration purposes.

The *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* (Commonwealth) protects Aboriginal Heritage at a National level.

The *Aboriginal Relics Act 1975* protects Aboriginal 'relics', 'protected sites' and 'protected objects' in Tasmania.

'Relic' is defined as:

- any artefact, painting, carving, engraving, arrangement of stones, midden, or other object made or created by any of the original inhabitants of Australia or their descendants before 1876;
- any object, site, or place that bears signs of the activities of any such original inhabitants or their descendants which occurred before 1876; or
- the remains of the body of an original inhabitant or of a descendant who died before the year 1876 that are not buried in:
 1. any land that is or has been set aside or used as a burial ground or cemetery under any Act, deed, or other instrument; or
 2. a marked grave in any other land.

A 'protected site' is land where a relic is situated which the Minister has declared ought to be protected and preserved.

A 'protected object' is the specified relic to which a Ministerial order declaring a protected site relates.



It is an offence under the *Aboriginal Relics Act 1975* to:

- destroy, damage, disfigure, conceal, or otherwise interfere with a protected object or relic
- carry out an act which is likely to endanger a protected object
- remove a relic from where it was found or abandoned
- sell or otherwise dispose of a relic or remove it from the state
- destroy, damage, deface or otherwise interfere with any fencing or notice erected, or any other work carried out in, or in respect of, a protected site under the Act, other than in accordance with a permit granted by the Director of National Parks and Wildlife
- remove a protected object from a protected site, other than in accordance with a permit granted by the Tasmanian Minister. (However, the Director of National Parks and Wildlife can direct the removal of protected objects from a protected site to a place of safety if he or she is satisfied that they are likely be damaged, destroyed or lost.)

The penalty for a contravention is a fine of up to \$1000 or imprisonment for up to six months.

You must report any discovery of Aboriginal heritage relics

Any person who finds a relic must (with limited exceptions), inform the director or an authorised officer as soon as practicable after the find. The penalty for failing to comply with this requirement is a fine of up to \$1000.

You must have a permit before doing anything that will impact on Aboriginal heritage

All Aboriginal heritage places are protected under the *Aboriginal Relics Act 1975* and any action that will have an impact on Aboriginal heritage, no matter its size

or condition, requires a permit under section 14 of the Act. All Aboriginal heritage places are protected, whether on private or public land.

5.1.3 Role of Aboriginal Heritage Tasmania

Aboriginal Heritage Tasmania is the state government agency responsible for preventing natural and human actions from adversely affecting Aboriginal heritage places and values.

Aboriginal Heritage Tasmania works with the Tasmanian Aboriginal community to recognise and respect Tasmanian Aboriginal culture and heritage, and secure the protection and promotion of Tasmanian Aboriginal heritage for present and future generations.

The agency is responsible for administering the *Aboriginal Relics Act 1975* and provides land management and expert advice for responsible management of Tasmanian Aboriginal heritage. It also undertakes research and interpretive activities to help protect and promote Tasmanian Aboriginal heritage throughout the state.

The vast cave middens of the Rocky Cape National Park in the state's north-west provide one of the most complete records of the lifestyle of coastal Aboriginal people anywhere in Australia.

Material accumulated in the cave middens reveal 8000 years of continuous occupation. Evidence shows that seals, scale fish and a variety of shellfish, supplemented by other game and edible plants such as grass tree and fern, formed a large part of the diet at Rocky Cape. Tools used for gathering and preparing food and for other cultural activities have also been discovered at the site.



5.1.4 Tasmanian Aboriginal Land and Sea Council

Tasmanian Aboriginal Land and Sea Council (TALSC) plays a role in consulting with and representing the Aboriginal community through providing advice and services to the public and land managers on heritage, land management and land rights issues as well as sea management and sea issues.

TALSC offers the following range of services:

- Cultural awareness and education program
- Heritage and site assessments
- Aboriginal heritage consultancy advice and services
- Direction for and provision of 'Welcome to Country' at events

The Tasmanian Aboriginal Land and Sea Council endorses Aboriginal Heritage Officers (AHO). It investigates areas of land for the presence or absence of Aboriginal heritage and provides advice on the ongoing management of this heritage.

5.1.5 Tasmanian Aboriginal Site Index (TASI)

Aboriginal Heritage Tasmania is the custodian of the Tasmanian Aboriginal Site Index (TASI), which provides the main listing of recorded Aboriginal heritage places. Over 11 000 places are listed on the Index, which is maintained by Aboriginal Heritage Tasmania in the Department of Primary Industries, Parks, Water and the Environment (DPIPWE).

Access to TASI is a formal process. For any

Figure 5.2 Middens provide a wealth of information about the lifestyle of Aboriginal people in a particular area and are an extremely valuable historic record. © Aboriginal Heritage Tasmania





development/works outside an existing footprint, contact Aboriginal Heritage Tasmania at the beginning of your planning process. Access forms are available from Aboriginal Heritage Tasmania or on the website. TASI is used by Aboriginal Heritage Tasmania to determine whether on-ground Aboriginal heritage assessments are required prior to development.

5.1.6 Aboriginal heritage assessments

In most cases, the purpose of conducting an Aboriginal heritage assessment is to:

- locate indicators of (known or previously unrecorded) Aboriginal heritage within a specific project area
- help protect Aboriginal heritage by offering mitigation advice
- provide recommendations regarding the need for further investigation
- inform the proponent of its obligations under the Act.

Therefore the most important part of a survey report is to clearly state:

- what the proposed project is
- if and how it will affect any Aboriginal heritage
- whether there are any alternatives to the impact on Aboriginal heritage or options for mitigating damage.

This information is then used by AHT to:

- keep an accurate record of Aboriginal heritage sites
- make desk-top decisions about the need for further investigations, the requirement for a permit under the Act and/or the future management of sites
- ensure that the proponent is complying with the Act
- make decisions and recommendations to the Minister regarding permit applications.

It is the role of AHOs to determine whether Aboriginal heritage will be affected by the proposed activities. AHT needs accurate reports with adequate information to be able to make decisions and provide further advice to proponents regarding legislative requirements.

Aboriginal Heritage Tasmania will advise you what level of assessment is required for your development. Aboriginal heritage assessments are undertaken by an archaeologist and/or Aboriginal Heritage Officers according to the *Standards and guidelines for consulting archaeologist and Aboriginal heritage officers*.

A consultancy brief will be provided by Aboriginal Heritage Tasmania. This template forms the basis for the work to be carried out and will help define the survey requirements for both the proponent and the consultant. It also sets out Aboriginal Heritage Tasmania's expected Aboriginal heritage investigation and reporting standards.

The brief for an Aboriginal heritage assessment needs to include details of the project and all associated infrastructure and techniques and methods that will be used to carry out the work.



5.1.7 Guidelines for working with the Aboriginal community

Before undertaking works in the coastal zone you need to consult with the Aboriginal community. Contact Aboriginal Heritage Tasmania and request a desktop TASI search of your proposed work site.

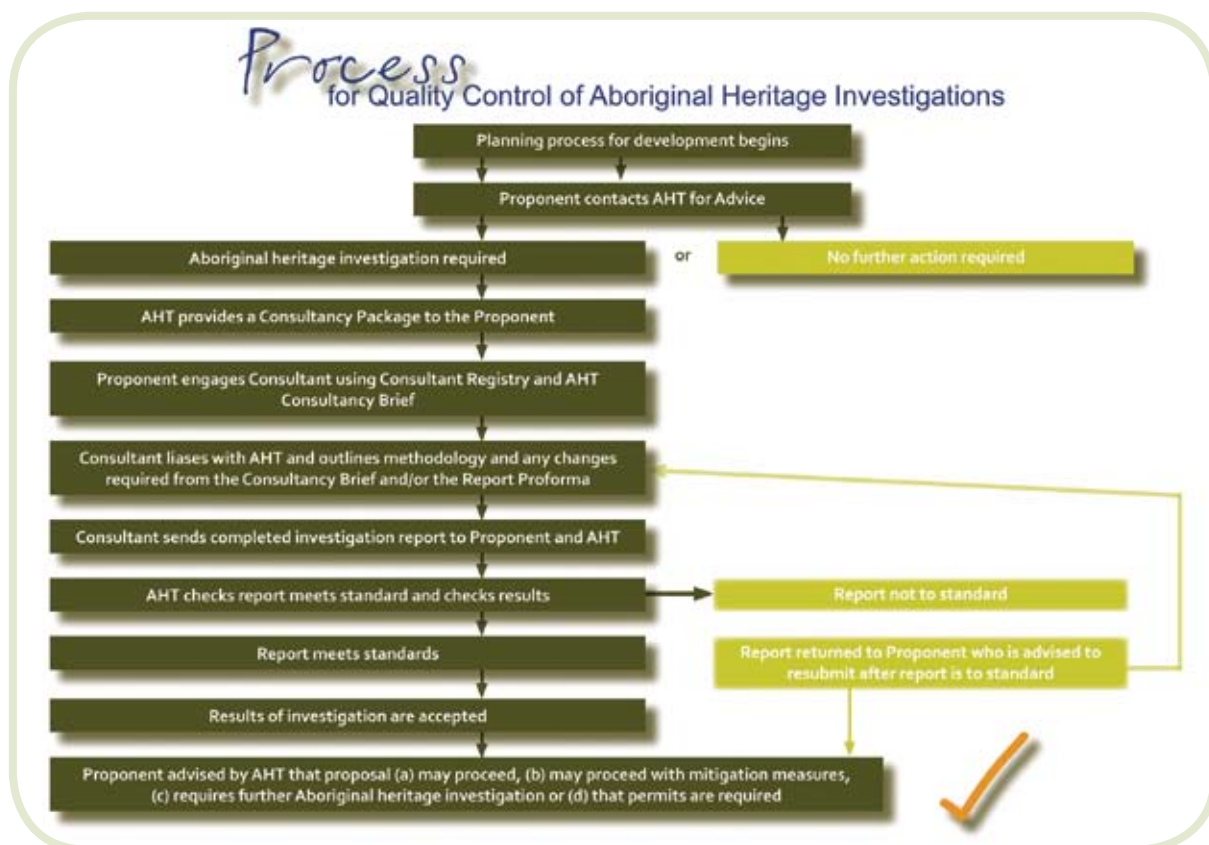
An Aboriginal assessment is often required before a project can be undertaken. A survey will identify any constraints on the proposed activities that might be necessary to avoid damage to Tasmanian Aboriginal heritage values.

Aboriginal involvement in some projects may be required, especially if they are close to or on Aboriginal heritage places.

You may be required to undertake specific rehabilitation techniques that have been developed for dealing with Aboriginal heritage places. These recommendations will be part of your assessment and can be discussed with Aboriginal Heritage Tasmania or the Tasmanian Aboriginal Land and Sea Council.

You must stop work immediately if you discover any Aboriginal artefacts. Contact Aboriginal Heritage Tasmania for advice. It is often a simple case of having

Figure 5.3 Procedure for Aboriginal heritage investigations.
Source: Aboriginal Heritage Tasmania website accessed 7th October 2010.





the site recorded and minimising future disturbance.

Tasmanian Aboriginal people should be involved in the development of any interpretative and educational material associated with Tasmanian coastal areas. Their association with the coast is so significant that material that fails to incorporate acknowledgement of Aboriginal custodianship and values is no longer acceptable.

Include a 'Welcome to Country' at events. Contact TALSC for more information.

Aboriginal Heritage Tasmania can provide advice about protecting heritage places, including development setback requirements and all other aspects of Aboriginal heritage protection and management. Additional information can be obtained from TALSC.

5.2 Historic and maritime heritage

Historic places mark the many important events and activities that shaped the more recent history of Tasmania. These include convict sites, pioneer cemeteries, old buildings, shack communities and mining sites. Tasmanian maritime heritage includes numerous shipwrecks, some Victorian-era light stations, and a range of old wharves, jetties and ports.

5.2.1 Legislation and approvals for historic heritage

Under the *Historic Cultural Heritage Act 1995*, a works application is required for any works or development which may impact on the significance of a place entered in the Tasmanian Heritage Register. Where proposed works are minor and will not affect the significance of the place, the Heritage Council

may provide an 'exclusion' from the normal works application process.

Heritage Tasmania is the state government body that fulfils statutory responsibilities under the *Historic Cultural Heritage Act 1995*.

The *Commonwealth Historic Shipwrecks Act 1976* protects historic wrecks and associated relics that are more than 75 years old and in Commonwealth waters, extending from below the low water mark to the edge of the continental shelf. Shipwrecks within Tasmanian state waters are protected under the *Historic Cultural Heritage Act 1995*.

In Tasmania, the Historic Heritage Section of the Parks and Wildlife Service is the government authority responsible for the management of the State's historic shipwrecks and other maritime heritage sites.

The Burra Charter: The Australia ICOMOS Charter for the conservation of places of cultural significance provides detailed guidance for assessing the significance of cultural heritage places.

The *National Parks and Reserves Management Act 2002* covers historic sites within Tasmania's parks and reserves system.

5.2.2 Types of heritage listings

The Tasmanian Heritage Register lists places that the Tasmanian Heritage Council considers to be of historic cultural heritage significance, that is, of significance to any group or community in relation to the archaeological, architectural, cultural, historical, scientific, social or technical value of the place.

Other government listings include the Tasmanian Historic Places Index held by DPIPW. Supplementary lists may exist in local government planning schemes, and in management plans under



the *National Parks and Reserves Management Act 2002*.

Historic shipwrecks are listed in the *Australian National Shipwrecks Database* hosted by the Australian Government, Department of Sustainability, Environment, Water, Population and Communities.

The Tasmanian Heritage Register and local planning scheme schedules list places of mainly national and State significance. Other sites of significance to local communities and places not yet listed or assessed for entry on these lists may be at risk from development.

5.2.3 Managing historic and maritime heritage

The main objective for managing historic and maritime heritage is to preserve the heritage values for future generations, adding to our understanding of human history in Tasmania.

Management often involves minimising the adverse effects of natural processes and human actions on these often fragile heritage values.

Key management objectives for protection of historic heritage:

- identifying and recording of historic heritage sites
- seeking specialist advice
- determining conservation significance and management requirements of the site
- undertaking protective projects
- involving local community groups
- increasing community awareness by interpreting cultural values to broader community and visitors

Coastal land managers have an obligation to know the whereabouts of historic heritage sites and to ensure that their works program and activities do not have an adverse impact on those sites and their values.

Figure 5.4 Shipwreck off the coast of northern Tasmania.
©Stewart Wells, Heritage Tasmania





They can play a role in educating the community about historic sites and values and in working with local community groups to protect and restore historic heritage values.

Before undertaking works in coastal areas it is important to consider historic or maritime heritage values.

- Identify if any sites are present by contacting Heritage Tasmania and/or the Historic Heritage Section of the Parks and Wildlife Service.
- Ensure that historic or maritime heritage will not be adversely affected by work activities or the building of infrastructure.

5.2.4 Tasmanian Heritage Council

The Tasmanian Heritage Council came into existence in 1997, following the proclamation of the *Historic Cultural Heritage Act 1995*. The Council is made up of councillors representing diverse community and professional interests including property owners, farmers and graziers, conservation interests and areas of expertise such as history, architecture, archaeology, engineering and tourism.

The Heritage Council is a statutory body, separate to government, responsible for the administration of the Act and the establishment of the Tasmanian Heritage Register. Its primary task is as a resource management and planning body, focused on heritage conservation issues. As such, any development on heritage-listed places require the approval of the Heritage Council before works can commence.

5.2.5 Tasmanian Heritage Register

The Tasmanian Heritage Register is a register of those places that are recognised as being of historic cultural heritage significance to the whole of Tasmania. These places are important to Tasmania and Tasmanians because of their contribution to our culture and society. They are also important as part of the cultural fabric that is so much a part of our tourism industry, our state's identity and brand.

The Register is maintained by the Heritage Council under the *Historic Cultural Heritage Act 1995*. Any person may nominate a place to be entered in the Heritage Register.

5.2.6 Community historical societies

In many coastal areas there are community groups with an interest in local historic heritage. These historical societies meet regularly and share their research on local history features and stories. They seek funds to protect or restore heritage sites and features; promote historic sites and features with signage, publications and guided tours; and are often a wealth of knowledge and enthusiasm.

Any planning for management of historic heritage values should be undertaken in collaboration with community historical societies where they are present.



5.3 Climate change and cultural heritage

The Tasmanian coastline is rich in Aboriginal heritage values and sites. These and other heritage values and sites on the coast are susceptible to impacts of climate change, in particular sea level rise. Low-lying sites are at risk of coastal inundation due to sea level rise. There are risks to heritage infrastructure from rising groundwater, erosion and landslips, and exposure of acid sulfate soils that can lead to corrosion. **Refer to section 11.4 Acid sulfate soils.**

Many Aboriginal heritage sites are already located in intertidal and subtidal areas as a result of sea level rise associated with the last interglacial period. More and more coastal Aboriginal heritage sites will be affected by rising sea levels and therefore it is more important than ever to protect Aboriginal sites and values from human impacts such as works activities.

Land managers should monitor sites carefully for any change or potential impact and undertake risk assessments to determine the best strategies for mitigation and protection of heritage values where appropriate.

5.4 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

A list of Aboriginal Heritage Officers

Available from the Tasmanian Aboriginal Land and Sea Council (TALSC).

<http://www.talsc.net.au/>

Aboriginal Heritage Tasmania

<http://www.aboriginalheritage.tas.gov.au>

Information about the importance of protecting Aboriginal heritage.

- List of registered archaeologists
- Standards and Guidelines for Consulting Archaeologist and Aboriginal Heritage Officers
- Forms requesting access to TASI database for Aboriginal heritage site searches

Ask First: A guide to respecting Indigenous heritage places and values (Australian Heritage Commission 2002)

Historic and maritime heritage

Australian national shipwreck database

<http://www.environment.gov.au/heritage/shipwrecks/database.html>

Heritage Conservation Funding Program

Aims to assist heritage property owners by providing funding. The Heritage Council operates the program on behalf of the Tasmanian Government. Places permanently entered in the Tasmanian Heritage Register are eligible.

Heritage Tasmania

Advice on works on heritage sites

1300 850 332.



6 Coastal landscape management



- 6.1 *Legislation and approvals*
- 6.2 *Coastal dune systems*
- 6.3 *Beaches, spits, sandbars and river mouths*
- 6.4 *Estuaries, coastal wetlands and saltmarsh*
- 6.5 *Rocky shores*
- 6.6 *Soft-rock shores*
- 6.7 *Offshore islands*
- 6.8 *Tools and resources*

This chapter provides an overview of Tasmania's diverse coastal landscapes and relevant key management issues.

The Tasmanian coastal landscape includes rocky reefs, sandy beaches, sea cliffs, headlands, lagoons, river estuaries, harbours and open coast. The diversity of landforms and temperate conditions support a rich variety of terrestrial, intertidal and marine communities and species, some common, some threatened and others only found in Tasmania (endemic).

The interplay of coastal processes, such as wind and waves, with the different rocky and sandy landforms, combined with tidal ranges, rainfall, river discharge and climate, has moulded the Tasmanian coast. Vegetation too has played a very significant role in shaping many of these landscapes, such as plants stabilising soft sediments on dunes and in seagrass beds.

The Tasmanian coastal environment is vulnerable to the impacts of climate change, with significant areas of coast at risk of erosion from exposure to sea level rise and storm surge inundation.

More than 1440km of Tasmania's coastline has been identified as being at risk of coastal flooding, and more than 975km of shoreline are at risk of erosion, sand dune mobility, rock falls and slumping as a result of sea level rise and storm surges (Sharples 2006), with consequent impacts on natural values. Impacts on Tasmania's coastal landforms will be complex and variable, reflecting the diversity of coastal systems (DPIPWE 2010).

Changes in rainfall and temperature will change vegetation communities which will in turn modify these landscapes further, and rainfall changes and the potential for decreased flow in some river systems

*Tab photo: Friendly Beaches – east coast of Tasmania.
© Leah Page.*



6.1

will modify estuarine environments.

Managing unstable coastal landforms such as dunes and beaches is not easy and technical advice is essential. Vegetation management is critical as coastlines alter rapidly when vegetation is destroyed and sediments become re-mobilised.

Inappropriate coastal works can easily be destroyed by waves, tides, currents or winds. In addition they can also cause problems in nearby coastal areas, such as erosion and movement of sand to places where it is not wanted. Coastal works must be undertaken with great care: many works in the past have been ineffective or caused needless damage to coastal values through poor planning and inappropriate techniques.

6.1 Legislation and approvals

Management of coastal landforms such as dunes, beaches and wetlands involves a range of legislation and approval processes that provide for protection of natural and cultural values and authority from land managers. In addition to the legislation detailed in **Chapter 1**, the most likely legislation to be applied is provided in **Appendices 1 and 2**.

Permission from the land manager must be given before any management of coastal landscapes takes place, and assessments and approval will probably be required to ensure that coastal values are identified and protected. Works on Crown land, which includes many coastal reserves and all land below high water mark, require approval from Crown Land Services (DPIPWE). Seek advice from Crown Land Services about which assessments and approvals are required.

Estuaries and river mouths often support port

operations and boating facilities, therefore the *Marine and Safety Authority Act 1997* and the *Tasmanian Ports Corporation Act 2005* also come into effect in these areas.

6.2 Coastal dune systems

This section describes the role and functions of coastal dune systems and provides guidance on how best to manage these dynamic landforms.

Coastal dunes are generally active landforms, with a few exceptions, and require special management. There is usually a cyclic pattern of erosion and deposition on open coast beaches and foredunes. The vegetation on the dunes plays a vital role in the balance of the dune/beach system by holding the sand in place. Because dunes are highly mobile, sand blows can occur naturally. In fact many plants and animal species (e.g. dune grasses) and various ecosystems depend on dune movement for their survival.

However, human impacts and coastal processes can lead to significant sand blows and erosion that require management. Dune vegetation is easily damaged by vehicles, livestock and pedestrian traffic, burning and grazing. Once the vegetation is gone, it is difficult for plants to re-establish in the dry, loose, wind-blown sand. Loss of dune vegetation may lead to wind and wave erosion and loss of sand from the system.

Stable dunes are fairly rare. Most dune fronts around Tasmania are mobile and the movement of their sand can result in extensive erosion. In some areas, such as south-west Tasmania, this is probably related to the rise in sea level, 14cm since 1841 and still rising (Hunter et al. 2003) and the limited supply of sand. Exceptions include the east coasts of Flinders Island and King Island, where large amounts of sand are accumulating.



6.2.1 Values of dunes

A healthy dune system protects the shoreline from erosion and the backshore from flooding. The sand bank provides for natural replenishment of the beach and the dunes trap wind-blown sand, protecting the coastal landscapes behind. These unique environments support many specialised coastal plants that bind the sand together. Some shorebirds depend on sand dunes for nesting habitat and many other wildlife species depend on the dunes and their vegetation.

Many dunes around Tasmania contain shell middens, as well as other Aboriginal place types, such as artefact scatters, that are important Aboriginal heritage places.

Coastal dunes are one of the important coastal landscapes for monitoring the impact of changes in sea level, because they erode quickly when the sea is rising.

Geoconservation values of coastal dunes

Tasmania's many sandy landforms include: parallel dunes at Marion Bay; beach ridges at Seven Mile Beach; parabolic dunes at Henty dunes; headland bypass dunes at Stephens Bay–Noyhener Beach in the south-west; and cliff-top dunes at Cape Deslacs at Clifton Beach. Dating some of the Henty dunes at Strahan has shown them to be 500 000 years old (Bradbury, J. pers. comm. 14th Sept 2010).

Coastal dunes and other sandy landforms are an important part of our heritage and are protected for their geoconservation values. Some sites of geoconservation significance may be fossil (non-renewable) and there are numerous fossil dune forms and fossil shorelines inland of the current coast, some of which preserve evidence of coastal processes during the last Interglacial phase circa 125 000 years ago. Other geoconservation sites are active landforms that require maintenance of the natural rates of change and movement.

Figure 6.1: Dune system at Noyhener Beach, Port Davey, in Tasmania's south-west. © Chris Sharples





Many outstanding landscapes and areas of high nature conservation value are protected as parks and reserves. Most significant sites have management plans that control developments, for instance, local government planning schemes often have 'visual protection areas'.

Trying to stabilise dunes may not be appropriate at sites with high geoconservation values. In some areas, especially along the north-east and west coasts, some dunes are naturally mobile, and attempting to stabilise the sand may interfere with natural processes and values. Before attempting such work, seek advice from a coastal geomorphologist and refer to the Tasmanian Geoconservation Database on Tasmania's Land Information System (the LIST) on the internet.

6.2.2 Understanding dune systems

Coastal sand dunes are formed by the transport of sand onto the beach by wave action and then landward from the beach by wind. Vegetation growing on the shoreline traps the sand, forming a ridge. Dune grasses colonise these ridges and more sand builds up over time, forming a dune.

Successive lines of dunes can form parallel dunes, where slow shoreline growth or 'progradation' has occurred. Where phases of rapid shoreline growth have occurred in the past, a series of lower parallel beach ridges may exist behind the present shore, representing earlier temporary shoreline positions.

Under stable sea level conditions, the seaward side of the dune system is maintained by the cyclic patterns of erosion and deposition. The dunes further landward become stabilised by vegetation. The dunes on the seaward side, known as foredunes, are regularly eroded by storm waves, and replenished during calmer weather when waves bring sand back to the beach.

Dune vegetation plays an important role by trapping sand and stabilising the dunes. Dune vegetation is specially adapted to withstand the windy, salty environment. The type of dune vegetation determines the shape and profile of the dunes. The protection provided by the foredunes enables more complex vegetation to develop in the hind dunes.

Under some conditions, including vegetation dieback or increased storm erosion frequency, foredunes and hind-dunes may become unstable, with blowouts developing into parabolic (or transgressive) dunes that move inland. This occurs naturally in many cases, but can also be triggered by human disturbances.

Figure 6.2 Coastal grasses trap wind-blown sand and form dunes. © Terry Hartin





Figure 6.3 The dune system at Friendly Beaches on Tasmania's east coast displaying a healthy incipient dune.
© Leah Page



Foredunes are the dune(s) nearest the sea in a dune system that runs parallel to the beach. They are formed by windblown sand deposited within vegetation. Foredunes are active within short time frames (less than 50 years, i.e. within planning time frames) and are subject to cycles of erosion and deposition. If the beach is actively depositing sediment then an incipient foredune will be present in front of the foredune. If the beach is actively eroding then only a scarped established foredune will be present.

An **incipient dune** is a small ephemeral dune located in front of an established foredune at the upper margin of the beach, behind the swash (water washing onto beach) zone. One or more incipient dunes may be present. They may exist for a season, a year or longer (e.g. more than 10 years). Their durability depends on a number of factors, including whether they form around seasonal, annual or perennial pioneering plant species, seaweed or flotsam, but primarily upon whether the coast is grossly eroding or in a state of deposition.

A **foredune complex** is the active part of a coastal dune system that is parallel to the shore. It includes the incipient dune and established foredunes (of which there may be more than one). A foredune complex has a natural tendency to undergo significant physical change within periods of less than 50 years as part of normal landform processes. Disturbance such as vegetation removal can lead to instability. The term 'frontal dune' is no longer recommended as it is ambiguous and does not indicate the stability or otherwise of a dune complex.

Hind-dune complex refers to older dunes lying behind the foredune complex, which have a natural tendency to be stable over periods longer than 50 years unless natural or artificial disturbances cause blowouts. These are the dunes where trees and larger vegetation are established and these dunes are often exploited by coastal developments.



6.2.3 Dune management

It is often possible to reduce the effects of wind erosion by fixing (stabilising) the sand with natural vegetation. On the other hand, very little can be done to stop the effects of waves and currents eroding dune fronts, except with properly designed and costly 'hard' engineering constructions, such as rock walls and groynes. Attempts to control coastal erosion with cheap under-engineered structures very commonly fail.

Such hard structures should be used with great care however, because they deflect the waves and sand, and can result in worse erosion problems nearby, including scouring of beaches in front of the structures. Hard engineering solutions are usually expensive and will require ongoing and costly maintenance. **Refer to Chapter 15 Shoreline modification.**

'Soft' techniques, such as revegetation, allow the flow of the natural coastal processes. As a result they are generally more physically effective and cost-effective, and less destructive than hard structures such as large rocks and concrete seawalls. Using soft engineering solutions wherever possible can save much effort and money.

However, past attempts to stabilise dunes have caused problems in adjacent coastal areas, including increased erosion, sedimentation, and invasion of exotic species such as marram grass – which was previously used to stabilise dunes and is now a significant weed problem – which alter the natural shapes and dynamics of dunes.

It is essential to understand the history of dune development and changes over time at a particular site and the way the coastal system operates. This will provide an indication of how the proposed works

Figure 6.4 Fresh dune erosion scarp at Ocean Beach on Tasmania's west coast. © Chris Sharples





may alter sand movement. Often, with careful planning and assessments of the direction of dune movement and sand availability, past problems can be avoided.

Many dunes are naturally unstable and mobile. These can be very difficult to stabilise permanently and the reasons for doing so need to be clearly justified and worth the effort and expense that will be required.

6.2.4 Types of dune conservation and stabilisation works

Stabilisation may be appropriate where there is a small blowout, or erosion caused by vegetation damage or removal. Using structures such as mesh fences, brush mulches or geotextiles slows the movement of sand so that plants can establish and hold the sand in place.

Avoid works in the foredunes unless they are to maintain access to the foreshore or for protective or rehabilitation work.

The types of works selected will depend on the purpose, budget and the site conditions. Suitable works may include any or all of the following:

- dune-forming fences (mesh or brush)
- geotextiles, jute mesh, brush mulches and other surface stabilisation methods
- revegetation (*refer to Chapter 7*)
- access control: fences, barriers, signs (*refer to Chapter 13*)

Repairing erosion caused by wave attack is very difficult and costly. Such repair works are usually unsuccessful and it is impossible to fix dune fronts on eroding beaches in the long term. The natural erosion (coastal recession) of many beaches will increase with the predicted rise in sea level and will become increasingly harder to prevent with artificial interventions as sea level continues to rise.

6.2.5 Assessing dune erosion

Before planning rehabilitation works, assess whether the problem is caused by natural coastal processes or human activities, and whether it is possible to manage the sand movement or erosion.

Dune erosion, sand blows and blowouts do not need treatment if they are caused by natural processes and/or are not causing a problem. Erosion and small blowouts caused by human activities, such as grazing livestock or on- or off-road vehicles, may require stabilisation.

Seek specialist advice to identify the factors that drive natural coastal dune processes, in particular the seasonal patterns in wind speed, wind direction, tide and wave action, the natural dune mobility or stability that might be expected given local rainfall, micro-topography and exposure to winds, and the likely effects of the works.

If a dune blowout appears to be caused by human activity, find out whether the blowout is growing or stabilising by itself. If revegetation is occurring naturally, the blowout may stabilise by itself.

Even large coastal sand blows will eventually stop within some hundreds of metres from the beach. If a foredune is receding, assess foredune erosion to see if the problem can or should be treated.

Dune erosion can be measured by establishing a benchmark behind the dune. Take measurements at regular intervals from the benchmark over the dune, to the dune erosion scarp. Ideally, the protocols used in the Tasmanian shoreline monitoring and archiving (TASMARC) project should be adopted. **Refer to Chapter 2 Climate change and the coast**



6.2.6 Methods for stabilising dunes impacted by wind erosion

The main methods of stabilising dunes are to remove human activities that are causing the problem, and/or to obstruct wind erosion with fences, mulches, jute mesh or geotextiles so as to allow revegetation.

The methods described here are suitable for relatively small sand blows and minor erosion of foredunes caused by local artificial disturbances (unless the beach and dune is steadily receding due to natural coastal processes or recent sea level rise).

It is important to monitor the works carefully to assess success and to repair any damage quickly.

Remove destabilising activities and allow natural regeneration

If a dune has started to blow due to human activity, such as inappropriate access, immediately take steps to control the activity. Otherwise there is no point trying to fix the damage.

Choose a suitable method for stabilisation. Consider leaving the area to fix itself by fencing it off and monitor the result for up to a year (or less if revegetation is too slow to stabilise the site). Reduce or restrict access to the area while it is being rehabilitated.

Do not allow livestock to graze there, and keep them off dunes after stabilisation. Avoid grazing on dunes that are mobile or potentially mobile.

Figure 6.5 Geotextile dune-forming fence erected near surf club in South Australia is helping to trap sand and discourage access whilst plantings of dune grasses become established. © Leah Page





Use dune-forming fences, brush or textiles

If a sand blow does not stabilise by itself, these methods will reduce erosion. They slow the ground-level wind speed and allow sand to deposit. Then native vegetation can establish and start to bind the sand.

Dune-forming fences are useful for small blowouts and areas where stabilisation could take some years. They are more permanent than brush mulches, jute mesh or geotextiles and are cost-effective, but take several years to work. These fences are meant to be covered by sand and can stay in place when this happens; then, if a higher dune is required, construct another fence on top.

Avoid using dune-forming fences along a progressively or frequently eroding beachfront, as they will not be successful unless the prevailing wind blows straight onto the beach, allowing sand blown off the beach to rebuild dunes faster than storms are eroding them. There must also be enough sand supply in the dune-beach system to rebuild the dunes, which is rarely the case on a progressively receding shore.

Obtain specialist advice about where and how fences should be placed. This will be based on the site conditions, including prevailing wind speeds and directions. Choose the cheapest materials if the fences are likely to be buried quickly.

The most important areas of a sand blow to stabilise are the edges, especially the forward edge and other places where the wind is funnelling sand away more quickly.

During works, protect the vegetation that stabilises the sand by restricting access by vehicles and people.

Assess the need for revegetation. If there is no natural vegetation nearby to supply seed, plant the area with appropriate local native species, or use direct seeding

after the works are in place. *Refer to Chapter 7 Vegetation management.*

Geotextiles and jute mesh fabrics

Geotextiles are mesh materials that help to stabilise the sand and retain water. But they quickly become covered with sand if there is a lot of sand movement. Geotextiles can be expensive and can be easily vandalised. For stabilising sand dunes they are only recommended for difficult sites or where urgent repairs are needed. However, geotextile sand bags are a useful product for creating banks and revetments and have been used successfully in other Australian states to stabilise eroded foreshores. *Refer to Chapter 15 Shoreline modification.*

Choose a cost-effective textile. Jute mesh is relatively cheap, it allows light through, and plants can grow through it. Jute mesh lasts longer if it is placed as a double layer. It breaks down after a few years, so replace it if revegetation is very slow.

Peg the edges down well to stop the wind from dislodging the material. Secure the mesh by placing it at least 1 m into stable vegetation on each side. Check regularly that the textile is not becoming loose or damaged.

Do not use geotextiles in accessways as they will trap sand and obstruct access.

6.2.7 Ongoing maintenance of dune stabilisation works

All dune stabilisation works require regular maintenance to make sure they are in good repair and are effective. Dunes are so unstable that works can be very quickly damaged or destroyed by wind and waves. Inspect and carry out maintenance on new works after stormy periods.



6.3

Inspection and maintenance should check that:

- structures are in place and secured, especially at the margins of the erosion
- access to the area is controlled adequately so rehabilitation can occur
- erosion is not getting worse
- structures are not becoming a hazard to the public.

6.2.8 Climate change and dune systems

Recent climate science has progressed significantly since the Intergovernmental Panel on Climate Change's (IPCC) Fourth Assessment Report (IPCC 2007), and sea level rise projections are currently being revised upwards.

Climate change and sea level rise impacts on dunes include more frequent storms removing sand from the dune system and foredunes changing shape and receding in response to the removal of sand. Provided the dune system is healthy, the dunes can migrate landwards as shorelines retreat. However in areas where very little dune system remains, the rise in sea level and more frequent storms could result in complete loss of this natural buffer and associated habitats, leading to increased erosion and inundation of coastal areas.

Monitoring of dunes may be able to provide an indication of climate change. Many Tasmanian beaches show evidence of ongoing retreat and some of progradation (build-up or growth) over the past few decades. It is likely that at least some of the erosion and retreat is linked to recent sea level rise induced by climate change; however, it is difficult to tell how much is just a part of natural variability.

The vulnerability of coastal systems to climate change is exacerbated by increasing human-induced pressures

in the coastal zone. Coastlines that are subject to development have a lower capacity to adapt to changes in sea level, because they are no longer in their natural state of being dynamic and highly mobile. In addition, if human responses to rising sea levels are to defend the coast with artificial structures such as sea walls, the existing potential for natural shoreline adjustment to the changing conditions will be further reduced (DPIPWE 2010).

6.3

Beaches, spits, sandbars and sandy river mouths

This section describes the extremely dynamic coastal landforms of beaches, spits, river mouths and barways, the coastal processes that shape them and techniques for managing these landscapes.

The erosion and movement of sand along sandy coasts can cause problems such as loss of beaches and the growth of sandbars and spits. Continual sand movement and change is an ongoing natural process on many coasts, but problems may be caused or exacerbated by human constructions such as hardening of the foreshore, bridges and groynes, or dams upstream restricting water flows through river mouths.

It is critical to understand how a coastal system operates before doing any proposed works, so that you can predict the effects of proposed works and deal wisely with any changes to the movement of sand. This is particularly important now, with climate change and projected sea level rises predicted to increase storm erosion of sandy landforms. Proper planning, design and maintenance of appropriate beach and sandy coast conservation and remediation works will make these land management activities more effective.



6.3.1 Values of sandy coastlines

River mouths, beaches and sandspits are highly valued by local industry, communities and tourists for commercial and recreational activities. Larger rivers provide ports and shelter for boats, and river mouths need to be kept open to provide access to open water. Smaller river mouths are used for fishing and boating; and beaches are enjoyed for relaxation and recreation.

These environments are rich in natural and cultural values too. Beaches and sand spits are important nesting places for shorebirds, including threatened species such as fairy terns. Aboriginal heritage sites are often associated with the rich estuarine areas of river mouths. Beaches support highly specialised vegetation that can withstand the windy, salty conditions. Beneath the sand a diverse and immeasurable meiofauna community breaks down plant and animal material

and plays a vital role in the food chain, especially in the diet of many sea and shorebirds.

Certain mobile spits and barways in Tasmania have important geoheritage values. Highly significant sandy landforms in Tasmania include a bay mouth spit at Nine Mile Beach in Great Oyster Bay; mid-bay spits at Seven Mile Beach; an old barrier island (King Island) and extensive sand sheet deposits inland from Tomahawk Bay in the north-east.

Natural coastal erosion, longshore drift and tidal currents supply and replenish the sand for local beaches and others further along the coast. Beaches, spits and sandbars are always changing in response to changes in waves, tides and currents.

Figure 6.6 Natural beach in northern Tasmania. © Chris Sharples





6.3.2 Managing beaches, spits, barways and sandy river mouths

Waves, wind and currents move sand along many open coastlines by a process known as longshore drift. Beach sand is also moved on and off the shore by the action of waves, tides and currents. During stormy weather or large swells, sand is removed from the beach and deposited offshore in sand bars. During calmer weather the waves deposit the sand back onto the beach, forming a berm or ridge parallel to the shoreline.

Storm waves can move huge amounts of sand quite quickly. Beaches and sand spits can also lose or gain sand as a result of damage to adjacent foredunes by human activities such as sand extraction, vehicle and pedestrian access, burning and grazing.

Structures that are built in an attempt to control the movement of sand include groynes, breakwaters, seawalls and river training walls. However, these coastal protection works are expensive to build and maintain, and long-term success is difficult to achieve. Hard structures (e.g. concrete seawalls) on soft sandy coastlines affect wave patterns and can lead to erosion nearby.

Many of these structures have been built without adequate understanding of local processes, or are under-engineered, and continue to cause local problems. Before planning new constructions, it is crucial to get proper assessments of coastal processes (the actions and interactions of wind, waves and currents) and proper engineering advice, and to consider potential sea level rise.

Such works usually need regular maintenance and, unless they are extremely robust, will normally only buy some time for a particular section of eroding coast. It is much cheaper and more environmentally sound to avoid trying to control the movement of sand and waves on sandy coasts, and plan developments in sympathy with existing coastal processes.

Choosing the appropriate site is critical for structures that extend across the shore and/or into the water, such as groynes. Such structures are susceptible to wave erosion and sediment build-up, as well as corrosion from salt water, and can be expensive to maintain. Resilient but permeable structures are generally preferable to rigid and impermeable structures that resist wind and waves and impede sediment movement.

It is extremely difficult to stabilise spits at river mouths. Spits will always form in the direction of the prevailing waves. Works to protect beaches from erosion caused by wave attack, or to breach spits or maintain barways, are very difficult and costly, and may require heavy machinery, which can cause severe damage to adjacent areas.

Where recession of beaches is causing concern, land managers and residents might consider artificially replenishing the beach, known as beach nourishment. However, this requires intensive research, is expensive and ongoing and may create unforeseen impacts on the coastal ecosystem. Nonetheless, in some urbanised and highly valuable recreational beaches it may be a desirable management option. **Refer to Chapter 15 Shoreline modification.**



6.3.3 Guidelines for working on barways, spits and sandy river mouths

Sandbars, barways, spits and river mouths are highly mobile systems. They should be left alone where possible, to protect natural ecosystems – and to avoid considerable ongoing expenses. Many coastal lagoons are temporarily cut off from the sea by the growth of a sandbar, which may be breached after heavy rain, usually in winter.

Where a barway is causing elevated water levels upstream that threaten property and infrastructure, artificial opening may be necessary. Ecological consequences need to be balanced against economic damage and systems have been developed to facilitate the prior identification of trigger points when breaching is justified. The Victorian *Estuary entrance management support system* (EEMSS) (Arundel 2006)

provides information to guide land managers.

In locations where shipping and boating is a priority, river training walls are sometimes built on either side of a river mouth to improve navigation. The constricting walls are designed to speed up the water flow, which increases the scouring action of the river so as to prevent build-up of sandbars in the river mouth. However, training walls at river mouths exposed to longshore drift can cause shoreline erosion on their downdrift side and can be undermined, or cause sand to be deposited where the training wall ends, unless the training walls terminate in deep water on the seaward side of the structure.

Before starting works, thorough investigation and planning is essential. This may take some time. Obtain specialist advice from an experienced coastal

Figure 6.7 River mouths and spits, such as this one on the Prosser River, provide valuable habitat for shorebirds.

© David Moser





geomorphologist, who can advise on the natural sand movements. If structures are being considered, consult a coastal engineer to ensure a properly designed structure. Specialist advice is essential to find out whether managing sand movement is possible and will save you money in the long term.

Potential environmental impacts

- Breaching barways or spits can greatly alter the movement of sand and currents, sometimes with unexpected effects. To keep them open in the long run, expensive ongoing maintenance work is inevitable.
- River training walls can act as groynes, and often project much further out to sea than ordinary groynes, with the potential to cause extensive erosion further along the coast.
- Disturbing beaches, barways, spits and river mouths may damage valuable habitat for wildlife, including shorebirds and marine life.
- Disturbing sandy landforms may damage Aboriginal heritage places or geoconservation values.

Minimise environmental impacts

Obtain specialist advice from a coastal geomorphologist to identify what drives the natural coastal processes (seasonal patterns in wind speed, wind direction, tides and wave action) and the likely changes to sand movement and coastal processes that will result from the works.

Obtain specialist advice on the potential impact on any Aboriginal heritage, historic sites or geoheritage sites.

Identify the cause of the problem. Beach erosion and moving or growing barways and spits do not need treatment if they are caused by natural processes and

if artificial developments have been appropriately sited to avoid damage from natural coastal mobility. However, where erosion and sand movement is caused by human activities disturbing the natural sand transport patterns, and this is causing a problem, then intervention may be necessary.

Barways and coastal lagoon barriers should not be breached unless public safety is demonstrably at risk, water quality is a risk to public health or there is significant risk of economic damage to property or land.

If breaching of spits and barways is required (e.g. to prevent flooding or allow boat access), it should only be undertaken with extreme caution. Breaching a barred lagoon at the end of winter rains, if that is when the barway normally opens, may cause less harm than breaching in summer.

Obtain specialist advice about the potential impacts of breaching a lagoon barrier. Consider the local watercourse and catchment and waterbirds, aquatic life and other wildlife. The ecosystems and life in coastal lagoons are adapted to the natural seasonal changes in water level.

Design and engineer the river training walls properly to minimise erosion of the riverbed, which can undermine the walls. To limit erosion, sand can be pumped from the updrift shore to the downdrift shoreline, bypassing the training walls. But these are expensive and ongoing operations. Also, sand might be deposited where the training wall ends (because the river flow slows and loses energy), meaning that the training wall needs to be extended into deeper water (where sand deposition is not an issue). If sand is deposited after training walls are constructed, dredging may be required. **Refer to Chapter 15 Shoreline modification.**



6.3.4 Climate change and beaches, barways, spits and river mouths

Climate change impacts in coastal areas are not limited to sea level rise. Changes to rainfall will affect river flows, which affects the natural flushing regime of river mouths. In areas where rainfall has decreased and water has already been diverted for agricultural reasons, the river flows may be reduced dramatically enough that the river mouth becomes closed off by sediment. However in open river mouths the rising sea level and increased storminess is likely to result in increased erosion of soft estuarine river banks.

All of these changes in sediment flows have implications for maintaining beaches for recreation, river access and barways for boating, and the natural habitats and values of the coastal environment such as sand spits for shorebird nesting.

Beaches with healthy dune systems have more resilience to climate change impacts. Sand in healthy beach-dune systems is episodically exchanged between the dune, beach and subtidal zone in an ongoing cycle. Storm waves remove sand into the subtidal zone and gentle waves return sand to the beach where it is blown back into the dunes. This process is still counteracting sea level rise effects on many Australian open coast sandy beaches. **Refer to section 6.1 Coastal dune systems.**

Some beaches will be highly susceptible to loss of sand from increased storm activity and higher sea levels. These beaches are the ones with no supply of sediment or wave action to replenish the losses. Beaches where artificial disturbances have already modified the sand supply may be more susceptible to receding due to sea level rise than otherwise would have been the case.

Figure 6.8 The river training walls at Ulverstone are not preventing the build up of sediment as intended. © Jocelyn Phillips





The IPCC is revising sea level rise projections since its *Fourth Assessment Report* (IPCC 2007). It is likely that coastal communities are going to put increased pressure on land managers to protect beaches from erosion and recession.

However it is neither possible nor desirable to defend all erodible shores. Land managers are going to need to assess locations to determine for which areas beach protection works are suitable and viable and which areas should be allowed to recede and find a natural equilibrium.

It is increasingly important to protect the natural areas and values that remain from human impacts because the added pressure of climate change and sea level rise will result in increased stresses on these environments, making it harder for these ecosystems to adapt.

6.4 Estuaries, coastal wetlands and saltmarsh

This section provides information on the diverse waterway and wetland landscapes of Tasmania and some key management issues that must be considered in these areas. This manual is only concerned with estuaries and coastal wetlands such as saltmarsh, intertidal flats and coastal lagoons and not freshwater systems or inland lakes.

The Tasmanian coastline has a large number of estuaries due to the many coves, embayments and river systems. The two most significant estuaries from a land management perspective are the Tamar Estuary in the north and the Derwent Estuary in the south.

Coastal estuaries and wetlands in Tasmania support significant seagrass beds which are important fish

nursery areas. The diverse range of wetland types, including lagoons, saltmarsh and mudflats, all have specialised and unique vegetation communities and provide important habitat to coastal wildlife. Protecting the water quality in estuaries and wetlands is essential for the health of many aquatic species, habitats and ecosystems, including fish and other marine life such as seagrass and kelp.

Coastal embayments (sometimes known as coastal re-entrants) are important landscapes for indicating sea level rise impacts due to climate change. Their sheltered location away from ocean waves and swell means that they are not readily replenished with sand and erosion activity is therefore ongoing and obvious.

Tasmania has numerous coastal habitats of significant conservation value, including several Ramsar wetlands of international significance recognised for their migratory bird values, such as Pitt Water-Orielton Lagoon, Moulting Lagoon and Lavinia State Reserve (a feeding stopover on King Island for the endangered orange-bellied parrot). The Robbins Passage–Boullanger Bay wetlands in the far north-west provide breeding, roosting and feeding habitat for the largest diversity and density of migratory and resident shorebirds found anywhere in Tasmania, with more shorebirds present there than the rest of Tasmania combined.



6.4.1 Estuaries

An estuary is a semi-enclosed or periodically closed coastal body of water in which the aquatic environment is affected by both freshwater and marine systems.

The convoluted Tasmanian coastline results in a number of marine embayments, many of which have estuaries associated with them. Each estuary is a unique environment due to its shape, size, depth, degree of tidal variation and catchment characteristics such as rainfall, run-off and vegetation cover. Tasmania has many types of estuaries including coastal inlets, drowned river valleys, barrier estuaries, river estuaries and coastal lagoons.

Presently, catchments in the west, north-west and south are characterised by high rainfall and run-off, resulting a predominance of river estuaries, whereas catchments in the east and north-east are relatively dry and barrier estuaries and coastal lagoons dominate. Estuaries in the north possess much greater tidal ranges (approximately 3m) than those on the east, south and west coasts (1m).

Because the nature of estuaries is determined by a balance of factors such as rainfall, tidal levels, and vegetation cover, they are highly susceptible to climate change impacts. Significant changes in the types of estuaries that can be supported at different sites around Tasmania can be expected as climatic changes become more pronounced.

Figure 6.9 Boullanger Bay in Tasmania's north-west is an important wetland area for migratory birds. © Vishnu Prahalad





The sheltered tidal waters of estuaries support unique communities of plants and animals which are specially adapted for life at the margin of the sea, and estuarine environments are among the most productive on earth. A wide range of habitat types is found in and around estuaries. In temperate regions such as Tasmania, these include beaches and dunes, rocky foreshores, saltmarshes and other wetlands, intertidal flats, seagrass beds, kelp forests and rocky reefs.

Estuaries are essential for the survival of many birds, fish and mammals. Estuaries have been referred to as the 'nurseries of the sea', as they provide many species of fish with sheltered waters for spawning and safe habitat for juveniles to develop. Many commercially valuable fish species depend on estuaries during some point in their life cycles. Some migratory birds rely on estuaries as resting and feeding grounds during their long journeys.

Most of Tasmania's major cities and towns are situated on estuaries, from which they receive many direct economic benefits. Tourism, fisheries, aquaculture and other commercial activities thrive on the natural resources supplied by estuaries and their protected coastal waters support important public infrastructure, providing ports and harbours vital for shipping, transport and industry.

In Tasmania, many of the remaining Aboriginal sites are situated along estuarine shorelines. Estuaries and their surrounds also offer aesthetic and recreational pleasures such as boating, fishing, swimming and birdwatching.

Human use and development creates significant pressures such as agricultural run-off from the catchment, development of foreshore areas and the impacts associated with intensive human use, all of which affect the water quality of the estuary as well as impacting on other coastal values.

Rice grass (*Spartina anglica*) is an invasive weed that often occupies the intertidal, muddy flats of estuaries. This weed is a threat to the ecology of estuaries and adjacent saltmarshes, changing native flora and fauna habitat. In Tasmania, the major infestations are in the Smithton, Rubicon/Port Sorell, Tamar River, Bridport, St Helens/Georges Bay, Little Swanport and Derwent Estuary regions (DPIPWE website accessed 7th October 2010).

Seagrass beds

A number of estuarine and other sheltered coastal environments support extensive seagrass beds, the most significant of which is Robbins Passage in north-west Tasmania. Whilst not an estuary, this extensive sheltered waterway supports vast areas of seagrass. Seagrass beds help to stabilise coastal sediments and are important fish nursery areas. They are some of the most productive ecosystems on earth but are in decline and are threatened by water pollution and disturbance of the sea floor. It is important to ensure that any activities such as dredging and boat moorings avoid seagrass.

6.4.2 Threats to estuaries

Protecting water quality is critical to sustaining healthy estuary ecosystems. As estuaries receive water from catchment and urban run-off, they are susceptible to land management practices within the catchment, such as agricultural run-off, which can degrade water quality.

Discharges from industry or waste water treatment plants (point source inputs) can also degrade water quality and damage marine ecosystems. Pollution may be in the form of heavy metal contamination, increased nutrient levels, faecal contamination and increased sediment loads. Pollutants or excess



nutrients can result in algal blooms or putrid, smelly water; particularly in coastal lagoons.

At a local level, pollution may come from discharge of boat wastes, boat maintenance facilities, use of herbicides near waterways; poor control of sediment at coastal construction and work sites, stormwater and litter. Litter entering waterways via stormwater gutters can entangle and starve penguins, seals and other wildlife.

Poor water quality is the primary factor in the destruction of seagrass beds, which play a key ecological role in coastal and estuarine ecosystems. The major loss of seagrass beds is one of the most serious issues in Tasmania's estuarine and marine environments. Coastal development, along with damage from land reclamation, dredging and, to a lesser extent, boat moorings, all contribute to the destruction of seagrass.

Poor water quality not only has an impact on marine ecosystems and species, it has implications for humans too, including unsightly stained shorelines and unpleasant odours from algal blooms; beach closures due to health risks to humans; toxins in the food chain and death of valued recreational fishing species.

6.4.3 Coastal wetlands

Coastal wetlands include lagoons, saltmarshes and associated intertidal flats and can be defined as any coastal area periodically covered in water. Ephemeral wetlands are only wet for short periods of time; they can remain dry for very long periods.

For the purposes of this manual, wetlands that are open to the ocean are described as estuaries and referred to in **section 6.4.1 Estuaries**.

Important features of wetlands ecosystems:

- breeding grounds for many animals, especially macroinvertebrates, fish and waterbirds
- provide protection from floods
- provide habitat and protection for animals
- areas of high biodiversity
- important refuge areas for wildlife in times of drought

Coastal wetlands tend to be highly productive environments, supporting both high biodiversity and large numbers of individual species. Lagoons and saltmarsh are habitat for many unique species and provide nurseries for fish and other marine life and, because of this, they are critical to Tasmania's commercial and recreational fishing industries. Saltmarshes are particularly specialised and are discussed in **section 6.4.5 Saltmarsh**.

Many coastal wetlands in Tasmania provide habitat for several listed rare and endangered flora and fauna species, in particular migratory birds. Over 25 species of migratory birds are listed on the Japan–Australia Migratory Birds Agreement (JAMBA) and/or China–Australia Migratory Birds Agreement (CAMBA) and the Republic of Korea–Australia Migratory Birds Agreement (ROKAMBA) conventions.

Wetlands play an important role in purifying our waterways by filtering water through specialised plant and bacteria communities. They can be important for recreational and commercial activities, although many, in particular ephemeral (sometimes dry) and saltmarsh wetlands, have been traditionally undervalued. In Tasmania many wetlands have been degraded and reduced in area since European settlement.

Native vegetation within and adjacent to wetlands plays an important role in their ecosystem function and processes, providing important habitat and food resources for organisms as well as filtering nutrients



and capturing sediment.

The riparian zone is defined as the strip of land immediately adjacent to the wetland that influences, and is influenced by it. The vegetation within this zone protects the wetland from erosion and excess nutrient and sediment input. The vegetation within wetland areas in Tasmania can range from herblands and sedgeland to swamp forests (DPIW 2008d).

Aquatic wetland vegetation provides important habitat and a food source for aquatic species such as macroinvertebrates, frogs, native fish and waterbirds, as well limiting light for algal growth and stabilising sediments (DPIW 2008d).

6.4.4 Ramsar wetlands in Tasmania

Wetlands with significant natural values are recognised both nationally and internationally.

Tasmania has 89 wetlands listed in the *Directory of Important Wetlands in Australia* (Blackhall et al. 2001); of these, 10 are designated under the Ramsar Convention as being of international significance.

Ramsar wetlands meet particular criteria under the convention such as supporting rare, vulnerable and endangered species of plants or animals; supporting substantial numbers of waterbirds; maintaining genetic diversity; or having special values of endemic plant or

Table 6.1 List of Tasmanian Ramsar wetlands

Ramsar wetland	Location	Size (hectares)	Type
Apsley Marshes	Mouth of the Apsley River adjacent Moulting Lagoon	880	Freshwater and estuarine
East Coast-Cape Barren Island Lagoons	Cape Barren Island	4473	Estuarine
Flood Plain Lower Ringarooma River	Far north-east coast of Tasmania, between Cape Portland and Waterhouse Point	3519	Freshwater and estuarine
Interlaken*	Lake Crescent, Central Highlands	517	Freshwater
Jocks Lagoon	South-east of St Helens on the north-east coast	19 [^]	Freshwater and estuarine
Lavinia	North-east coast of King Island	7034	Freshwater and estuarine
Little Waterhouse Lake	North-east Tasmania just south of Waterhouse	57 [^]	Freshwater and estuarine
Logan Lagoon	South-east Flinders Island	2257	Estuarine
Moulting Lagoon	Central east coast	4507	Estuarine
Pitt Water-Orielton Lagoon	South-east coast	3334	Estuarine

*Freshwater wetland

[^]rounded up



animal species or communities.

Tasmanian Ramsar wetlands provide important habitat for resting migratory shorebirds, waterbirds and waders. They provide important habitat for many resident birds too. Moulting Lagoon, for example, supports vast numbers of black swan.

Many Ramsar wetlands provide protection for threatened wetland and saltmarsh species. The threatened propeller plant (*Stenanthemum pimeleoides*) is found almost exclusively in Moulting Lagoon. Pitt Water-Orielton Lagoon is one of only five locations in Tasmania (and the world) that is home to the tiny, threatened, live-bearing seastar (*Parvulastra vivipara*).

Ramsar Convention

Australia is a signatory to the Ramsar Convention on wetlands (1971), an intergovernmental treaty that provides the framework for international cooperation for the conservation and wise use of wetlands. Management of Ramsar wetlands, in accordance with the duties and obligations of signatories to the convention, is presently undertaken through the *Environment Protection and Biodiversity Conservation Act 1999*.

National Guidelines for Ramsar Wetlands are currently being developed by the Australian Government to provide a framework for Ramsar Convention implementation in Australia and to provide jurisdictions and other interested parties with

Figure 6.10 Red-necked stints migrate annually from the northern hemisphere to feed at Pittwater-Orielton Lagoon on the saltmarsh fringe. © Vishnu Prahalad





clear guidance on the management of Ramsar sites.

The *Implementation of the Ramsar Convention on Wetlands in Tasmania, Australia* (Prahald & Kriwoken 2010) Provides information on the legislative framework and other initiatives that have been undertaken to manage and protect Ramsar wetlands and the way Tasmania declares and manages them. Three case studies illustrate the interaction of multi-stakeholder implementation of Ramsar wetland management in Tasmania and the future course of action to support the Ramsar Convention and the conservation of wetlands in Tasmania.

Ramsar legislation

Ramsar values are protected under the Australian Government's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Under the Act, Ramsar wetlands are defined as a matter of National Environmental Significance and therefore any actions, works or activities within Ramsar sites that are likely to have a significant impact require the approval of the Commonwealth Minister for the Environment.

The following are considered to be significant impacts:

- areas of the wetland are destroyed or substantially modified
- there is a major and measurable change in the natural hydrological regime of the wetland (e.g. change to the timing, duration and frequency of ground and surface water flows to and within the wetland)
- the habitat or lifecycle of native species dependent upon the wetland is seriously affected
- there is a major and measurable change in the physico-chemical status of the wetland (e.g. salinity, pollutants, nutrients, temperature, turbidity)
- invasive species are introduced into the wetland.

6.4.5 Saltmarsh

Saltmarshes are wetland-like areas associated with estuaries that contain communities of plants and animals that can tolerate high soil salinity and periodic inundation by marine or brackish water.

Coastal saltmarshes are dynamic ecosystems which support highly specialised flora and fauna species and provide temporary habitat for numerous other species (such as shorebirds) which use saltmarshes opportunistically, regularly or sporadically.

Saltmarshes are important habitats, which provide essential feeding, roosting and breeding areas for a large variety of birds, particularly migratory species. These intertidal areas are also important nursery areas for a range of marine organisms (DPIW 2008d).

Saltmarshes are influenced by tidal movement and therefore are generally located within estuaries and along the high tide zones of low-energy coastlines. Saltmarshes should be considered as part of the estuary system and managed with the estuary as a whole.

The tidal regime controls both the salinity and level of inundation and as such is the most important factor influencing saltmarsh character (DPIW 2008d). Saltmarshes also receive freshwater inputs and hence are affected by land and catchment activities (DPIW 2008d).

Saltmarsh often exhibits distinct vegetation zonation. Saline areas of saltmarsh at lower tide levels are dominated by succulent herbs and shrubs such as samphire or beaded glasswort (*Sarcocornia quinqueflora*). Tidal creeks and freshwater streams cut through the saltmarsh, supporting the mildly salt-tolerant rushes, grasses and sedges which act as the water-filtration system, and in the higher tide regions non-succulent herbs survive.



Apart from the structurally dominant higher plants of the saltmarsh, there is a vastly extensive benthic (bottom-dwelling) algal community that lives on the uppermost layers of the saltmarsh substrate, including the tidal channels and marsh pools (Mount et al. 2010).

This ordered vegetation structure means that saltmarshes are very susceptible to sea level rise. Increased sea levels will result in saltmarsh areas being inundated further and more often and unless the vegetation communities can retreat inland they will not be able to withstand these changes.

Like many freshwater-dependent ecosystems, vegetation surrounding saltmarshes plays an important role in maintaining the health and

ecological integrity of the ecosystem. Vegetation adjacent to saltmarshes protects them from pollutants and nutrient inputs, stabilises surrounding banks or dunes to reduce erosion and provides habitat for a wide range of animals including low-tide and high-tide visitors, such as fish and waterbirds (DPIW 2008d).

Saltmarshes act as a buffer and filtration system for sediments and nutrients, while also providing important nutrients to estuarine systems. Bacteria found in and on the mudflats, commonly associated with saltmarsh areas, decompose organic matter and maintain a delicate balance of nutrients and detritus within the saltmarsh. The detritus and nutrients nourish plants and are an essential part of the saltmarsh food chain.

Figure 6.1 | Saltmarsh at Pittwater-Orielton Lagoon Ramsar site in south-east Tasmania. © Vishnu Prahalad





The specialised qualities of saltmarsh vegetation mean that saltmarsh areas support many unique and threatened species. Silky wilsonia (*Wilsonia humilis*) forms mats of grey amongst other saltmarsh vegetation, and is listed as rare under the *Tasmanian Threatened Species Protection Act 1995*.

Several saltmarshes in Tasmania have decreased in area. In the south-east, in Pitt Water and South Arm areas, 17ha (5% since the 1970s) were lost due to coastal erosion. The saltmarsh shorelines have eroded at about 6cm to 20cm a year, with erosion highest on the shorelines more exposed to wind-generated waves. Nearly 31ha of saltmarshes in the area were lost due to land reclamation (Prahald 2009).

In the north-west of Tasmania (west of Stanley), levees or embankments have been built over 21km (about 20%) of the shoreline, reclaiming land from saltmarsh. While the exact area of saltmarsh lost is yet to be ascertained, these levees have no doubt had a major impact on saltmarsh extent in the area (Mount et al. 2010).

6.4.6 Threats to coastal wetlands and saltmarsh

Traditionally saltmarsh and wetlands (in particular ephemeral wetlands) have been undervalued and perceived as wasteland. Many have suffered from direct drainage or alterations to water flows upstream and are also subject to pollution from catchments, urban developments, and localised activities.

Wetlands are threatened by changes to water quality through pollution or sediment, increases in nutrients from freshwater run-off; changes to water regimes; introduction of weeds and removal or loss of native vegetation. These human processes all have impacts on wetland health.

Loss of vegetation communities destroys habitat for both terrestrial and aquatic species such as migratory birds and fish, and has implications for biodiversity and threatened species. Removal of fringing vegetation can further reduce habitat quality by exposing the marsh to other human impacts such as weed invasion and pollution due to increased temperature, light and noise (Prahald in Mount et al. 2010).

Excess nutrients in wetlands can cause increased occurrences of algal blooms and encourage aquatic weed invasion. This in turn can reduce the biodiversity of the wetland and the capacity to filter water.

Certain land practices associated with intensive animal production and agriculture, both within the wetland and upstream in the catchment, are extremely destructive to coastal wetlands. Drainage for agriculture, removal of water for irrigation, damming to retain water for irrigation, nutrient run-off, stock grazing and land clearing (vegetation removal) all threaten wetland values and ecosystems.

Saltmarshes are vulnerable to clearing and land reclamation for coastal housing and industrial developments. They are often considered wastelands and ideal sites for rubbish dumps. Landfill directly affects the flora and fauna of the saltmarsh through the destruction of habitat and can also influence hydrology, physical structure and water quality of the saltmarsh (DPIW 2008d).

The construction of roads and tracks within saltmarshes can be detrimental to the ecology, through the physical effects of excavation, pollutants that enter the saltmarsh via run-off and restriction of tidal/water flow within the saltmarsh area (DPIW 2008d).

While roads and tracks adjacent to saltmarshes are not considered to be as damaging to saltmarshes as those constructed within the ecosystem, they can still



restrict in-flowing water movement and contribute to pollutants and sediment entering the saltmarsh via run-off (DPIW 2008d).

Horseriding and recreational access by 4WDs and trail bikes are also very destructive to saltmarsh areas, destroying vegetation and introducing weeds. Inappropriate access disturbs wildlife, in particular migratory and resident shorebirds, many of which are threatened species protected under a range of legislation.

Many smaller wetlands and saltmarshes are located on private land or unallocated Crown land, where their values might be poorly protected. Inappropriate access by livestock, horses and vehicles can lead to trampling and destruction of the fragile vegetation. Other threats include dumping of waste and incursions of weeds, diseases and feral pests.

Climate change impacts such as projected sea level rise and changes in rainfall will lead to coastal inundation and altered water regimes which will have very significant impacts on vegetation communities,

aquatic communities and biodiversity. **Refer to section 6.4.9 Climate change and estuaries, coastal wetlands and saltmarsh.**

6.4.7 Protecting estuaries, coastal wetlands and saltmarsh

Land managers should work together on whole-of-catchment approaches to estuary and wetland management. Natural Resource Management regional bodies can coordinate regional projects to address catchment issues and funding is often available through Australian Government programs and incentives.

Monitor discharges from industry and wastewater plants, to ensure that nutrients and other pollutants are maintained at acceptable levels. Improve stormwater outfalls. Wherever possible provide vegetated swales or treatment trains and minimise pipes on the beach. **Refer to Chapter 12 Stormwater and Crossings.**

Figure 6.12 This saltmarsh on private land at Rokeby is illegally accessed by vehicles which are causing damage to the vegetation which includes a threatened species. © Wendy Andrew





Ensure that saltmarsh communities are valued for their uniqueness and the role they play in our coastal ecosystem. Retain any existing areas of wetland and saltmarsh in an undisturbed condition. Often the best management practice is to 'leave alone'. Do not drain saltmarsh areas or allow soil or other material to be dumped there.

Establish buffer zones around saltmarsh and wetland areas of at least 200m, to protect against influx of nutrients and pollutants.

Avoid building drains or levees that alter drainage patterns, direct fluids and waste into wetland or saltmarsh areas, or act as barriers that prevent saltmarsh migrating inland with sea level rise.

Control access and keep horses, livestock and recreational vehicles out of saltmarsh areas. Fencing

will not only control access but may also prevent dumping of soil, rubbish and chemicals.

Monitoring of saltmarsh is essential to determine the current health of saltmarsh communities and to ensure that land managers and specialists are alerted to any changes or degradation.

Use signage and information sheets or brochures to educate the local community about saltmarsh values. Work in collaboration with local community groups when developing signs and informative material.

The Private Land Conservation Program aims to develop and encourage an integrated approach to private land management and planning that helps landowners to fully benefit from the sustainable management of their properties' natural diversity. The program promotes high-level recognition of

Figure 6.13 Damage to saltmarsh vegetation from livestock grazing is obvious when compared with ungrazed vegetation on the other side of the fence. © Vishnu Prahalad





the biodiversity values of natural systems and the need to appropriately protect them, and supports individuals who voluntarily manage these systems for conservation outcomes. Conservation covenants can be an effective way to protect wetland values on private land. More information is available from DPIPWVE.

6.4.8 Guidelines for working in coastal wetlands and saltmarshes

Sometimes it is necessary to undertake works in fragile wetland and saltmarsh areas to remove weeds or rubbish, erect fencing or undertake more comprehensive rehabilitation of wetland values.

Always seek specialist advice before planning or undertaking works and ensure that you have identified all the natural and cultural values that you need to protect during your activity.

Avoid using machinery in wetland and saltmarsh areas as the vegetation is easily destroyed and is extremely difficult and expensive to rehabilitate. You can also introduce weeds and waterborne diseases and pathogens. If you must use machinery, seek specialist advice and use operators with environmental credentials.

Ensure that you adequately control any soil and runoff from works adjacent to wetlands and saltmarsh. Monitor water quality before and after works to determine if there has been any impact.

Avoid using herbicides in wetland areas or near waterways. If herbicide must be used, consult the Department of Primary Industry, Parks, Water and Environment (DPIPWE) weed specialists and be sure to choose one that is approved for use around waterways. Herbicides cause pollution, expose the soil to erosion and kill frogs and other animals (avoid

spraying in their breeding seasons).

Follow the DPIPWVE Codes of Practice, Guidelines and Information Sheets for using herbicides, which can be found at the DPIPWVE biosecurity website.

When mowing or slashing, ensure that slashed material is removed and does not get into the waterway. Sometimes it is safe to spread slashed material on site away from the waterway but only if it does not contain ripe weed seeds. *Refer to Chapter 7 Vegetation management.*

6.4.9 Climate change and estuaries, coastal wetlands and saltmarsh

The ability of estuarine and wetland systems to respond to the sea level rise hazard depends on their current condition. If they are healthy and resilient, they will be able to respond more strongly; weakened, threatened and pressured habitats will succumb to sea level rise more readily (Prahald in Mount et al. 2010).

Current IPCC projections of sea level rise will result in inundation of low-lying wetland and saltmarsh areas. Changes to rainfall will result in altered water regimes which further complicate the situation.

Altered salinity, sediment inputs and nutrient loadings are all likely to put estuarine-dependent species under threat. Inundation of low-lying areas around Tasmanian estuaries could affect saltmarshes, wetlands and intertidal sandflats – important wading bird habitat (DPIPWE 2010).

Other concerns include changes in estuarine fisheries and habitats, and increased vulnerability to marine pests and weeds (DPIPWE 2010).

Specialised saltmarsh vegetation will need space (refugia) to colonise inland to remain within its

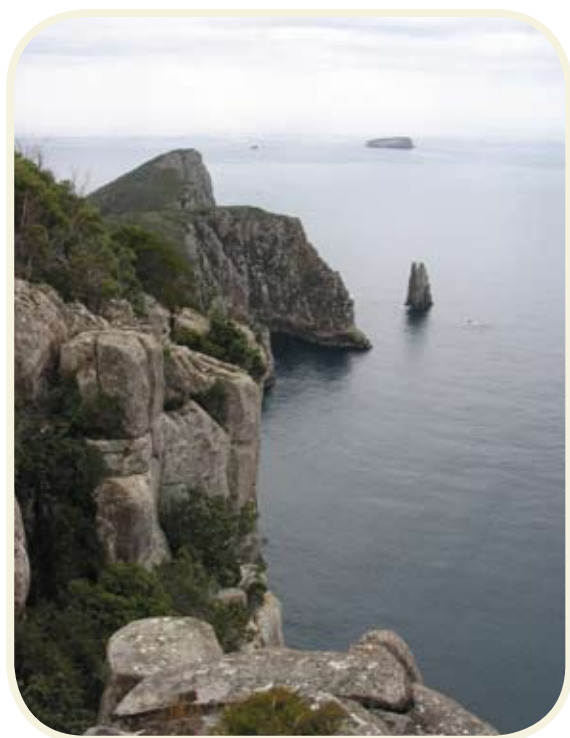


optimal tidal range. These communities can migrate landwards if the topography permits and there are no obstacles such as roads or seawalls. If these unique and important wetland areas are to survive, land managers will need to provide opportunities and space for the saltmarsh to encroach inland wherever possible.

Land managers should seek expert advice about where local saltmarsh communities might retreat to. Modelling of future sea level rise in local areas using a high-resolution digital elevation model such as LiDAR (light detection and ranging) mapping, is a useful means of identifying potential saltmarsh migration pathways and refugia. LiDAR data and basic overlays

Figure 6.14 The south-east coast of Tasmania features dolerite cliffs that form spectacular coastlines.

© Chris Rees



can be viewed on the LIST.

Often barriers such as roads prevent the movement of saltmarsh and wetland communities landward. In some areas it may be possible to provide culverts under roads or other shoreline infrastructure in order to enable wetland areas to retreat.

The future extent and migration pathways of tidal wetlands in the Derwent Estuary, in the event of projected future sea level rise, has been predicted in *The future of the Derwent Estuary saltmarshes and tidal freshwater wetlands in response to sea level rise* (Pralhad et al. 2009). The current extent of all tidally influenced wetlands and saltmarshes and their immediately adjacent freshwater wetlands were mapped (though not verified on the ground) and then the entire estuary was analysed with inundation modelling using the best available sea level rise projections for the year 2100.



6.5 Rocky shores

This section describes the formations of rocky coastal landscapes in Tasmania. Where the coast is exposed to the forces of the ocean, soft sediments can be removed and the bedrock directly eroded by the sea. In such areas sea cliffs and sea-stacks are common.

Much of the south-western coast from Cape Sorell to South East Cape is like this, as are parts of the south-eastern coasts of south Bruny Island, the Tasman Peninsula, Maria Island and Freycinet Peninsula.

Given appropriate conditions, other formations may include sea caves, rock arches and wave-cut platforms, examples of all of which are seen on the Tasman Peninsula.

More resistant zones of bedrock gradually wear away to form rocky reefs offshore. Rocky reefs provide important habitat for marine communities.

Rocky shore often provide rocky intertidal habitat that can support a complex assemblage of marine invertebrates. Many sessile (non-moving) invertebrate species such as ascidians (seasquirts) and sea anemones require a rocky substrate to attach to. Other invertebrates such as seastars, urchins and many molluscs (snails) live on rocky shorelines and shelter in crevices and scrape algae off the rocks. Rocky outcrops and headlands are important roosting spots for seabirds such as cormorants and gulls, and rocky intertidal areas are important foraging areas.

Rocky shorelines are least likely to show major effects of climate change but rising seas will submerge wave platforms and intertidal rocky habitats, which may affect intertidal marine assemblages.

Hard-rock coastlines are, in general, likely to show only negligible change through coastal erosion within human lifetimes. Some hard-rock shores in

Figure 6.15 The north-east coast of Tasmania boasts striking granite outcrops. © Chris Rees





Tasmania have shore platforms 10m to 20m wide, which is indicative of the limited amount of erosion they have undergone over the last 6500 years while the sea has been roughly at its present level. Gently to moderately sloping hard-rock coasts are the safest places for near-shore coastal development, including residences, as in most cases they are likely to experience only minimal erosion or flooding from projected sea level rise over the next few centuries. Sloping hard-rock shores comprise about 20% of Tasmania's coastal length (Sharples 2006) and are common in the Hobart region and along parts of the east, north and west coasts.

However, steep coastal slopes and vertical sea cliffs in hard rock may exhibit increased instability through rock falls and slumping, especially where most exposed to high wave energy or where composed of intensely fractured bedrock, as is the case with many Tasmanian sea cliffs of Permian-age siltstone bedrock. Hard-rock sea cliffs comprise a further 20% of Tasmania's coastal length (Sharples 2006) and areas near their edges are generally less suitable for development.

Although hard-rock coasts are generally the safest for development, any plans for development in such locations should consider the nature, slope, fracturing and stability of the bedrock, as some locations will have potential for slumping and instability.

6.6 Soft-rock shores

This section describes soft-rock sediment types in Tasmania, which are more prone to erosion. Management issues and techniques for these shorelines are described in **Chapter 15 Shoreline modification**.

Although there are many hard-rock coastlines in Tasmania, certain bedrock types are relatively soft and more prone to erosion than hard rock, albeit less rapidly responsive to erosion than soft unconsolidated sandy and muddy shores. These soft (semi-consolidated) rock coastlines do not recover from erosion events in the way that sandy shores and dune systems can, as they are composed of significant proportions of clay and/or cobble material which, once eroded, is not returned by fair-weather swells to rebuild the shorelines in the way that occurs on sandy coasts.

Many of these soft-rock shores have been slowly but progressively eroding throughout the last 6500 years while sea level has been stable at roughly its present level, and their rate of erosion is likely to increase with future sea level rise. In contrast to hard-rock shores, soft-rock shores typically exhibit noticeable change through erosion, within a human lifetime.

The most important soft-rock shore types in Tasmania are those formed in Tertiary-age clays, soft sandstones and clayey gravels, although shores formed in slumped deposits of basalt debris are another important type. Examples of soft-rock coastlines in Tasmania whose erosion is currently threatening roads and houses include those in the Margate-to-Coningham region and along parts of the Tarooma coast south of Hobart, at Parnella near St Helens, at Ansons Bay and in a number of locations in the Tamar Estuary.

Long term erosion of soft-rock cliffs also characterise the northern shore of Macquarie Harbour, although



there is little infrastructure or development at risk there. Basaltic debris (ancient landslides) also form soft-rock shores along parts of the north coast between Devonport and Stanley, including key locations such as Boat Harbour.

On open coasts the higher wave energy has mostly already eroded shorelines to a point where they have become buried under sandy deposits and form sandy coastlines. But often, in comparatively sheltered inlets and embayments, less energetic locally generated wind waves are still progressively eroding the shore and in some cases is already putting infrastructure at risk in some areas mentioned above.

6.6.1 Climate change and soft-rock shores

Soft-rock shores with a lower gradient are mostly prone to simple progressive erosion and recession; however, many of these shores form steep-to-cliffed shores (as at Taroona and Parnella), and these are prone to occasional slumps and block-slides. Soft-rock shores may present a range of management issues in light of climate change and sea level rise, since the rise in sea level – and hence increased frequency of wave attack – means that the rate of erosion and slumping of these shores is likely to increase.

Soft-rock coastlines are increasingly being considered an early indicator of climate change impacts, as the early effects such as increased rates of erosion are not masked by the erosion-accretion cycles characteristic of sandy or saltmarsh shores.

Figure 6.16 Eroded soft-rock coastline in southern Tasmania. © Chris Sharples





Because of the inability of soft sediment coastlines to rebuild themselves after erosion, land managers will need to assess for which areas shoreline protection works are suitable and viable and which areas should be allowed to recede and find a natural equilibrium. It may be deemed necessary to undertake shoreline protection works such as revetments to protect infrastructure assets of high community value.

The location of soft-rock shorelines predominantly in sheltered waters of estuaries means that they are already under pressure from a range of human developments and uses. It is increasingly important to protect remaining natural areas and values from human impacts, because climate change and sea level rise will increase stresses on these environments, making it harder for the associated ecosystems to adapt.

In many cases it will be preferable to allow soft-rock shores to erode, allowing the associated landforms and ecosystems to migrate landwards as sea level rise moves the shores.

6.6.2 Erosion control on soft-rock shores

Soft-rock shorelines need to be monitored regularly for new erosion events and hazardous damage. The monitoring program should include checks after storm events, particularly in high use areas where damage could be dangerous to the public.

Maintaining or re-establishing native vegetation along the foreshore may help to stabilise the bank. Areas where lawn has been encouraged to grow to the water's edge are highly susceptible to erosion due to the lack of substantial root systems. Restoring native vegetation may improve shoreline stability but in some cases large trees can be undermined by shoreline erosion and will actually exacerbate the problem when they eventually topple, pulling large clumps of bank with them.

Seek expert advice before undertaking any revegetation work to attempt to stabilise these types of shorelines.

If possible, it is best to allow the shoreline to recede until naturally stabilised but in some instances it may be necessary to artificially stabilise the shoreline. There is a range of temporary and permanent shoreline stabilisation techniques; all need to be planned carefully in consultation with geomorphologists, coastal engineers and other coastal specialists, and will incur initial and ongoing (maintenance) costs.

As is the case with other types of coastal erosion, it is important to recognise that under-engineered protection works are likely to rapidly fail. Any works intended to stop erosion of soft-rock shores need to be well designed and robustly constructed. In most cases this will mean creating a mostly artificial shoreline.

Refer to Chapter 15 Shoreline modification.



6.7 Offshore islands

This section highlights the unique and significant habitats of offshore islands. There are around 600 named islands, rocks and reefs around the Tasmanian coast. Many islands support flora and fauna of conservation significance, including breeding populations of seabirds and seals.

Because of their geographic isolation, offshore islands can support unique and isolated species such as the Pedra Branca skink (*Niveoscincus palfremani*), only found on Pedra Branca Island. This isolation also makes them very vulnerable to introduced species such as weeds and pests. It is extremely important that visitors to offshore islands take care not to introduce any weeds, pests or disease by ensuring that everything they bring onshore – e.g. boats, equipment, boots – is clean.

Offshore islands are one of the few landscapes where complete eradication of existing pests is possible; land managers should consider implementing weeds and works programs to target these issues.

Offshore islands often have historic heritage values such as lighthouses and other remnant structures associated with early whaling and shipping that require protection. In some more urban areas offshore islands are a refuge for wildlife such as seabirds and shorebirds.

Figure 6.17 Offshore islands, such as the Breaksea Islands near Port Davey in the south-west, provide important habitat for seabirds. © Chris Rees





6.8

6.8 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**.

A Wetlands strategy for Tasmania (DPIWE 2004a)

Aboriginal Heritage Tasmania

Desktop searches for Aboriginal heritage sites

www.aboriginalheritage.tas.gov.au

Coastal dune management: A manual of coastal dune management and rehabilitation techniques (NSW Department of Land and Water Conservation 2001)

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

Conservation of freshwater ecosystem values (CFEV) project: Technical report (DPIW 2008d)

Information on Tasmania's wetlands and their conservation values, developed within DPIPWE as part of the Conservation of Freshwater Ecosystem Values Project. Web-based information is available through Water Information Systems Tasmania

www.dpipwe.tas.gov.au Go to Water > CFEV program > CFEV resources or

<http://waterplanning.org.au/news/conservation-of-freshwater-ecosystems-values-project>

DPIPWE biosecurity website

Codes of practice, guidelines and information sheets for using herbicides

www.dpipwe.tas.gov.au

Estuary entrance management support system (Arundel 2006)

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 (Sharpley 2006)

Keeping it clean: A Tasmanian field hygiene manual to prevent the spread of freshwater pests and pathogens (Allan & Gartenstein 2010)

http://www.nrmsouth.org.au/uploaded/287/15130799_22keepingitcleanweb.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>



Private Land Conservation Program

www.dpipwe.tas.gov.au Go to managing our natural resources > the private land conservation program

Rivercare guideline for the use of herbicides near waterways and wetlands

www.dpipwe.tas.gov.au Go to food and agriculture > Agricultural & Veterinary Chemicals > Codes of Practice & Guidelines

Saltwater wetlands rehabilitation manual.

(Department of Environment and Climate Change NSW 2008b)

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

The coast of Australia (Short & Woodroffe 2009)

The future of the Derwent Estuary saltmarshes and tidal freshwater wetlands in response to sea level rise (Prahald et al. 2009)

Waterways and wetlands works manual: Environmental best practice guidelines for undertaking works in waterways and wetlands in Tasmania (Gallagher 2003)



7 Vegetation management



7.1 *Conservation of coastal vegetation*

7.2 *Plant and vegetation community identification*

7.3 *Revegetation*

7.4 *Plant propagation*

7.5 *Landscaping with native plants*

7.6 *Stock management*

7.7 *Vegetation removal*

7.8 *Vegetation management and climate change*

7.9 *Tools and resources*

This chapter deals with managing coastal vegetation adjacent to the shoreline where specialised plants such as dune grasses, saltbushes and pigface grow; riparian vegetation adjacent to coastal wetlands; specialised wetland vegetation such as saltmarsh; and coastal vegetation found in coastal reserves, private land and along roadsides adjacent to the coast.

Native coastal vegetation provides wildlife habitat, stabilises sand, and is important for its biodiversity values. Coastal wetland vegetation is highly specialised and plays an important role in water quality. The major threats to coastal vegetation are clearing for development, unrestricted access to the coast, coastal weeds, fire and illegal clearing for views. Protection of vegetation and management of access, weeds and fire are important parts of many coastal works.

Priorities for vegetation conservation and management include communities that play significant functional roles (such as saltmarshes and dune plants), threatened species or communities and plants that provide habitat for significant fauna.

Managing roadside and other vegetation in coastal areas is not very different from managing vegetation in non-coastal areas, with the possible exception of sand blows, which occasionally affect roadside vegetation and roads.

Managing native vegetation closer to the shore is a much greater challenge than managing vegetation growing in more protected coastal areas. Vegetation near the shoreline is exposed to salt spray, sea breezes and intense sun, and plants near the high

Tab photo: Native vegetation at Bellerive in south-east Tasmania. © Leah Page.



water mark or in low-lying areas are often inundated by high tides or storm waves.

Native vegetation is adapted to these natural coastal processes and it is important to recognise that coastal vegetation communities require these natural cycles and processes to survive, and should be managed accordingly. Climate change is increasing coastal stresses and will make it difficult to determine where vegetation protection or intervention is required or will be successful.

Vegetation management activities should be monitored closely (measuring the response of the vegetation to each management strategy) and evaluated and adjusted in response to emerging issues. This is often termed 'adaptive management' and should form the basis of all vegetation management practices.

7.1

Conservation of coastal vegetation

This section deals with special considerations for threatened vegetation communities and threatened plant species which are a priority for protection and rehabilitation in the coastal zone.

A wide range of threatened native vegetation communities may occur in the coastal zone. In Tasmania these include: the coastal complex on King island, *Eucalyptus globulus* dry forest and woodland, heathland on calcarenite, *Melaleuca ericifolia* swamp forest, seabird rookery complex and wetlands.

Many threatened species occur in the coastal zone, such as Tasmania's only EPBC-listed* saltmarsh species, *Limonium baudinii* (Tasmanian sea-lavender), known

Figure 7.1 Threatened lemon beauty head (*Calocephalus citreus*) occurs in the Ramsar wetland, Orielton Lagoon. This rare species is found in dry, disturbed grassland areas in a few locations in south-east Tasmania. © Lynne Sparrow





only from the Triabunna area. These species are further threatened by processes such as vegetation clearance, weeds and disease, inappropriate fire regimes, inappropriate stock grazing and climate change. The most efficient and cost-effective way to manage most of the state's threatened species is to address these threatening processes. (*See section 7.1.1.)

As a general principle, healthy intact vegetation should be left undisturbed. Natural disturbance will naturally regenerate and should not require specific management. However, vegetation management may be required for hazard removal (e.g. fuel loads or dangerous trees), for revegetation where damage has occurred or for stabilisation of dunes.

Land managers have a duty of care to maintain undisturbed vegetation cover for threatened species. Seek expert botanical advice where threatened communities or threatened species may be affected by proposed actions.

Mapping of some threatened plants and threatened vegetation communities is available through the Natural Values Atlas and Coastal Values data sets on the internet. **Refer to section 7.8 Tools and resources.** It should be noted that not all areas have been mapped. On-ground surveys and field checks are advised if significant vegetation intervention is being considered. Consult vegetation specialists for more information.

7.1.1 Legislation

A number of pieces of legislation cover native vegetation management. Please refer to **Appendix 1 and 2** for details.

Predominantly the *Threatened Species Protection Act 1995* and *Nature Conservation Act 2002* provide for the protection of vegetation communities at a state

level and the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides for the same at a national level.

Threatened species in Tasmania are classified, according to the level of threats to its survival, as endangered, vulnerable or rare in the schedules of the *Threatened Species Protection Act 1995*.

7.2 Plant and vegetation community identification

This section deals with the importance of correctly identifying plant species and communities to ensure native vegetation is managed appropriately.

Correct identification is important to ensure that appropriate native species are planted at a particular site, to identify weeds and also to avoid removing native species wrongly identified as weeds.

Land managers should become familiar with scientific names for native plants, as there can be many different common names in use. This is also important when ordering plants from a nursery as certain species (e.g. prickly Moses, *Acacia verticillata*) have different subspecies (e.g. *Acacia verticillata* subsp. *verticillata*), some of which may not thrive on the coast.

All native species should be identified at vegetation rehabilitation sites and other work sites, wherever possible, to assist the conservation of threatened species and vegetation communities.

If a new or unrecognised plant is discovered in an area then specialist advice should be sought from DPIPW. It may be a threatened species or a new weed incursion.



Flora surveys can be seasonally dependent and therefore it may be necessary to time surveys to allow for particular seasonal variations to be assessed.

7.2.1 Local and non-local native species

'Local provenance' plants are adapted to the local conditions, and are often genetically distinct from the same species growing elsewhere in the state or Australia. They may also provide the most suitable food and habitat for native wildlife, which is adapted to the local plant species.

Wherever possible it is best to use species of local origin in any revegetation projects as this provides the best outcomes for the coastal ecosystem. Australian or Tasmanian natives that are not local to the area may grow more prolifically if introduced and dominate a vegetation community in much the same way as a weed, leading to lower biodiversity and reduced habitat for some fauna.

It is important to correctly identify species and be aware of the source of revegetation plants. Some northern Tasmanian species, such as coast tea-tree (*Leptospermum laevigatum*) and swamp paperbark (*Melaleuca ericifolia*) are regarded as weeds in the south. Coast wirilida (*Acacia uncifolia*) occurs naturally only on King and Flinders islands. Sydney coast wattle (*Acacia longifolia* subsp. *longifolia*) is very similar to the widespread native coast wattle (*Acacia longifolia* subsp. *sophorae*).

7.2.2 Vegetation mapping and assessment

It is important for land managers to identify the vegetation communities within the areas for which they are responsible.

Guidelines for mapping vegetation are in *A technical manual for vegetation monitoring* (Barker, 2001). There

are skilled consultants available that can undertake vegetation mapping. The *TASVEG vegetation condition manual* provides a methodology for assessing vegetation condition (Michaels 2006).

Some mapping can be found on the TASVEG maps, Tasmania's Land Information System, (the LIST) and the Natural Values Atlas. Consider all mapping to be indicative and check the site in question to verify accuracy.

TASVEG

TASVEG is a Tasmania-wide vegetation map, produced by the Tasmanian Vegetation Mapping and Monitoring Program (TVMMP) within the Department of Primary Industries, Parks, Water and Environment (DPIPWE). TASVEG uses 154 distinct vegetation communities to produce maps at a scale of 1:25 000.

TASVEG incorporates mapping from various sources, such as that done for the Regional Forest Agreement. Non-forest community types include grasslands, heathlands, scrub, wetlands and saltmarshes as well as riparian and coastal vegetation, woodlands and forest remnants. A number of these vegetation communities are listed as threatened under the *Tasmanian Nature Conservation Act 2002*.

TASVEG is the official state vegetation map and land managers should use its classifications in planning and assessment processes to ensure consistency. The maps are available online through the LIST (go to LISTmap), or from the Tasmanian Vegetation Monitoring and Mapping Program (TVMMP) at DPIPWE. An important resource is the TASVEG 2.0 Metadata release notes to accompany the LIST maps, available from DPIPWE.

From Forest to Fjaeldmark: Descriptions of Tasmania's vegetation (Harris & Kitchener 2005) is an essential companion for people using TASVEG. It contains not



7.3 Revegetation

only descriptions of all the vegetation communities, but also keys that help to differentiate them and identify them, and a state-wide map of the distribution of each vegetation type.

Note that vegetation maps are always being updated, and are not always accurate at a property scale. They are just a guide to the vegetation at a site – get confirmation from a local botanist.

*Figure 7.2 Plants in the native pea family in Tasmania such as *Bossiaea cinerea* are often confused with the highly invasive gorse weed. Take care to identify plant species carefully, a number of coastal species have weed look-alikes. © Leah Page*



This section provides information to guide revegetation works in coastal vegetation communities. Revegetation may be necessary to restore vegetation degraded by vehicle or foot traffic, burning, grazing, sand extraction, land clearing or weeds. Vegetation loss can destabilise dunes and increase the natural rate of erosion, as well as remove important wildlife habitat and reduce biodiversity.

Revegetation should replicate the patterns of the local natural vegetation, especially where different native species live in zones based on distance from the sea. Wherever possible it is best to propagate and plant species that are native to the local area.

As part of the planning process, identify any natural and cultural values in the area that may be affected by revegetation works. Seek specialist advice. This is particularly important for shorebird and seabird rookeries such as penguin colonies.

Access control, and weed and fire management are also important aspects of vegetation management. **Refer to Chapter 13 Access management, Chapter 8 Weed and disease management and Chapter 9 Fire management.**

7.3.1 Planning a revegetation strategy

Thorough investigation and planning are essential for effective revegetation and to minimise the resources or effort required in the future.

Many coastal areas contain important and protected Aboriginal heritage sites. To determine whether there are values in the area or if your works are likely to impact on heritage values, before commencing works contact Aboriginal Heritage Tasmania (AHT), who can provide advice, assessments and permits if required. If an Aboriginal site or artefact is discovered, stop work immediately and contact AHT.



Some dunes that appear to be degraded might be naturally unstable areas, of high geoconservation significance. Search the Tasmanian Geoconservation database before working in dunes, to ensure they are not of heritage value. **Refer to Chapter 6 Coastal landscape management.**

Identify any natural values or threatened species and communities that require protection, with reference to DPIPWE's Natural Values Atlas website, the Coastal Values data set and specialist advice. Bare sand patches and blowouts can occur naturally, and are essential nesting sites for some shorebirds, including hooded plovers and pied oystercatchers, which are declining in numbers. There are particular considerations when working around penguins and shorebirds (covered in **Chapter 10 Wildlife management**).

Undertake mapping and assessment to identify the area's vegetation type. Explore the TASVEG maps initially. A survey of nearby healthy vegetation may be required if the site is highly degraded. Seek specialist advice to ensure the nearby vegetation is not a different community.

Consult with local community groups such as Coastcare groups when planning revegetation works. Many groups undertake revegetation as part of their activities and may be able to contribute time to planting or monitoring revegetation works. Community organisations such as the Understorey Network have vast experience in propagating and growing native plants and non-government organisations such as Greening Australia have undertaken many revegetation and monitoring projects.

The *Bushcare Toolkit*, whilst dated, still provides good information for vegetation management planning and revegetation methods. Refer to the *Tasmanian*

Bushcare Toolkit, Kit 2, Managing your bush (Kirkpatrick et al. 1999) and the *Tasmanian Bushcare Toolkit, Kit 4, Revegetating your farm* (Gilfedder et al. 1999).

General principles of revegetation planning:

- Identify and map the native vegetation and weeds.
- Identify and map causes of vegetation loss (e.g. uncontrolled access).
- Identify the highest priority locations for revegetation.
- Choose the best methods to restore native vegetation and make the site more resilient to weed invasion.
- Develop a works program to rehabilitate vegetation in the most effective way with the resources available.
- Monitor and record results.
- Be prepared to follow up with weeding (and possibly planting) for years afterwards.

7.3.2 Methods of vegetation restoration and revegetation

Vegetation restoration can be undertaken by allowing or assisting natural regeneration of the vegetation or by actively planting native species (revegetation). In some instances ecological burning may be appropriate but this needs to be determined by a fire ecologist. The types of works selected will depend on the purpose, budget and site conditions.



Natural regeneration

Encouraging natural regeneration (allowing the vegetation to grow back by itself) is the cheapest and easiest option. This will only occur if there is sufficient natural vegetation nearby as a seed source. Protecting the area from vehicles, stock and pedestrians is essential for regeneration, so there may be some costs for infrastructure to manage access. But constructing fences or other barriers can be cheaper in the long run than repeated planting in sites exposed to high foot traffic or grazing. **Refer to Chapter 13 Access management.**

Monitoring is essential to assess whether natural regeneration is occurring. It will take at least one to two years before native seedlings appear. If no regeneration occurs, use one or more of the following methods.

Assisting natural regeneration

Natural regeneration may be assisted in various ways:

- Remove weeds that are preventing seed germination or suppressing native plant growth. **Refer to Chapter 8 Weed and disease management.**
- Lightly scarify or rake the soil at the time of seed fall, to help create a seedbed and bury or hide seed, so that ants do not eat them.
- Lay native brush bearing ripe seed. Native brush cut from the area as part of access or vegetation management works can be laid down to stabilise the sand and provide a source of seed. Brush must be cut when seed is ripe, usually summer. Brush discourages grazing of new vegetation by rabbits and wallabies, and trampling by people.
- In some circumstances fire can be useful, but use it cautiously and only in vegetation types that may

Figure 7.3 Natural regeneration of coastal dune vegetation. © Leah Page





benefit, such as coastal heathland. It is essential to seek advice from a fire ecologist. Land managers must approve use of fire; they may require a fire permit from Tasmania Fire Service. Qualified firefighters should undertake the burning.

- Do not fertilise (unless the topsoil has been removed), because coastal plants are adapted to low levels of soil nutrients and may be out-competed by weeds such as pasture grasses.

Planting native species

Many native species are useful as ornamental plants around facilities or recreational areas. They are attractive and will be easier to maintain than introduced species. **Refer to section 7.5 Landscaping with native species.**

Revegetation of natural areas should only be necessary in places where natural regeneration is too slow. Planting can help where natural regeneration is inadequate, or if revegetation is required more quickly (e.g. to provide habitat for wildlife or to rehabilitate areas after construction works). Revegetating with tube-stock or direct seeding can be difficult in coastal sands and sandy soils.

Figure 7.4 Revegetation work by volunteers on Carlton Bluff in south-east Tasmania. © Understorey Network





7.3.3 Where to plant coastal species

Coastal vegetation grows in zones based on proximity to the sea (see Figure 7.5 and Tables 7.1 and 7.2).

Coastal plants are classed as primary, secondary or tertiary species for the purposes of revegetation. The primary species grow closest to the sea (in the foredune zone). Secondary species grow a little further inland, and the tertiary species grow in more sheltered places, further inland.

The most effective revegetation usually starts with the primary species.

Primary, secondary and tertiary species

Primary species (sand-binding grasses, succulent creepers) grow in unstable sand nearest the sea. These pioneer plants can cope with being partly buried by sand. However, only *Spinifex sericeus* and *Austrofestuca littoralis* can grow in rapidly accumulating sand.

Secondary species (grasses, sedges, herbs, low shrubs) can also grow close to the sea but do not tolerate much burial by sand.

Tertiary species (taller shrubs, trees) can grow behind the top of the foredune but many species grow better further back from the sea.

Figure 7.5 Zones where plants grow on coastal dunes. Based on *Coastal, Heath and Wetland Vegetation* (Kirkpatrick & Harris 1999) in *Vegetation of Tasmania* Reid et al. (eds).

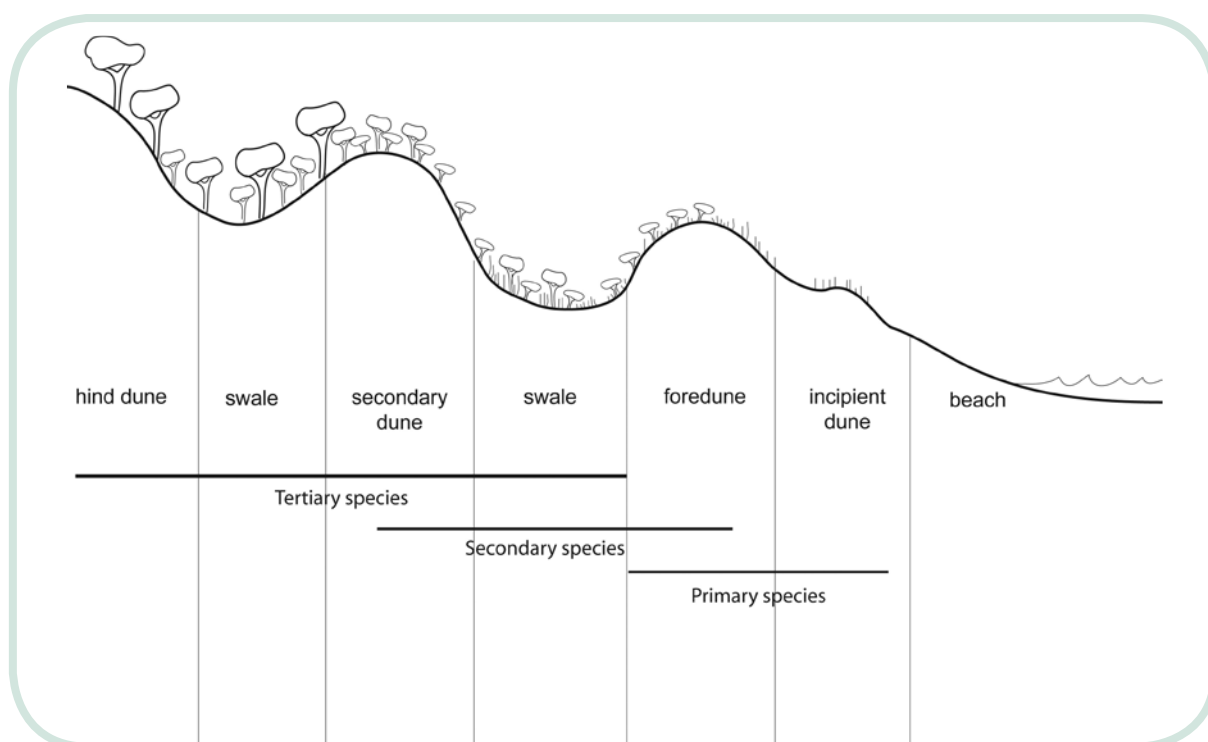




Table 7.1 Recommended places to plant species on coastal dunes.

Zone	Scientific name	Common name
Primary species Sand and salt tolerant. Plant on seaward side of foredune in unstable sand.	<i>Spinifex sericeus</i> * <i>Austrofestuca littoralis</i> <i>Carpobrotus rossii</i> <i>Tetragonia implexicoma</i> <i>Atriplex cinerea</i>	spinifex coast fescue native pigface bower spinach grey saltbush
Secondary species Tolerate salt spray. Plant on foredune behind established primary species.	<i>Senecio pinnatifolius</i> <i>Poa poiformis</i> <i>Distichlis distichophylla</i> <i>Isolepis nodosa</i> <i>Acacia longifolia</i> subsp. <i>sophorae</i> <i>Acaena novae-zelandiae</i> <i>Pelargonium australe</i> <i>Leucopytha brownii</i> (northern Tasmania) <i>Lomandra longifolia</i> <i>Kennedia prostrata</i> <i>Austrostipa flavescens</i> <i>Rhagodia candolleana</i> <i>Ozothamnus turbinatus</i> <i>Olearia axillaris</i> (northern Tasmania) <i>Correa alba</i> <i>Leucopogon parviflorus</i> <i>Dianella</i> species (coastal species only)	coast groundsel coast tussock grass salt grass knobby clubrush coast wattle buzzy native geranium cushion bush common sagg running postman yellow spear grass seaberry saltbush coast everlasting coast daisy bush white correa coast beard-heath flax-lilies
Tertiary species Need protection from wind and salt spray. Plant behind foredune crest once primary and secondary species established.	<i>Banksia marginata</i> <i>Myoporum insulare</i> <i>Leptospermum scoparium</i> <i>Leptospermum laevigatum</i> (northern Tasmania)	silver banksia boobyalla manuka coast tea-tree
Plant on second dune.	<i>Allocasuarina verticillata</i> <i>Dodonaea viscosa</i> var. <i>spathulata</i> <i>Acacia dealbata</i>	drooping she-oak native hop silver wattle
Plant on hind dunes.	<i>Bursaria spinosa</i> <i>Acacia verticillata</i> subsp. <i>verticillata</i> <i>Acacia melanoxylon</i> or other local <i>Acacia</i> species Local <i>Eucalyptus</i> species	prickly box prickly moses blackwood eucalypts

Most species, apart from *Spinifex* and *Austrofestuca*, can also be planted further back. Some species are found nearer the sea, but they will establish better if planted further inland. **Spinifex sericeus* is difficult to propagate and grow in southern Tasmania because the species prefers warmer temperatures – it is near the limit of its climatic range. Source: *Community Coastcare handbook* (Thorp (2005), based on Coastal, Heath and Wetland Vegetation (Kirkpatrick & Harris 1999) in *Vegetation of Tasmania*. Reid et al. (eds)



On exposed bare sites, only primary species should be planted, to stabilise the soil and provide a buffer for secondary species (which are usually planted in the following years).

Secondary species are suitable for planting on the seaward side of the foredune but only if the primary vegetation is in place to provide shelter.

Tertiary species can be planted later when conditions are suitable for their growth, or at the same time in sheltered sites.

Planting to stabilise dunes

A well-developed vegetation cover reduces wind erosion by raising the wind above the ground surface. The minimum vegetation cover required to fix sand can vary between 30% to 60%, depending on how exposed the site is to the prevailing wind, the types of vegetation and the density of planting. Generally, the higher the percentage of vegetation covering the ground, the more resistant the surface is to erosion, but this depends on the type of vegetation.

Low-growing plants, such as grasses, are more effective at stabilising sand than trees or shrubs. This is because 90% of wind-borne sand is transported in the 0.5m closest to the ground. Planting a mix of plants of different height and life form will lift the wind above the ground more effectively.

In some circumstances blowouts in dunes or coastal erosion sites may occur in areas of non-native vegetation such as dunes dominated by marram grass. Blowouts in marram grass dunes may need to be rehabilitated with marram grass, particularly if dunes are encroaching onto roadsides, as has occurred in the Scamander marram dunefield.

The *Tasmanian Community Coastcare handbook* (Thorp 2005) has more detailed information about local variations in dune vegetation, saltmarsh and coastal heathland vegetation.



7.3.4 Planting methods

The methods selected will depend on the purpose, budget and site conditions. Suitable methods may include any or all of the following:

- tube-stock or other seedlings
- direct seeding (requires careful soil preparation)
- laying brush (useful for small areas if brush with ripe seed is available).

Large-scale direct seeding is not often used on sand dunes as it is difficult to operate machinery safely on soft undulating areas and seed does not germinate well in loose soils. This method may be appropriate on some coastal sites, but requires extensive preparation well in advance of sowing. Useful guidelines are provided in the *South Australian Coastcare community handbook* (Brooke et al. 2001).

The following methods have been adapted for planting in sand or very sandy soils.

Table 7.2 Zones where native plants grow on headlands and cliffs (in order starting nearest the sea).

Zone	Scientific name	Common name
Damp saline niches closest to the sea	<i>Sarcocornia quinqueflora</i> <i>Samolus repens</i> <i>Apium prostratum</i>	beaded glasswort brookweed sea celery
Succulent herbs	<i>Disphyma crassifolium</i> <i>Carpobrotus rossii</i> <i>Tetragonia implexicoma</i> <i>Tetragonia tetragonoides</i>	round-leaved pig face pigface bower spinach New Zealand spinach
Tussock grasses	<i>Austrostipa stipoides</i> <i>Poa poiformis</i> and/or <i>Poa labillardierei</i>	coast spear grass coast tussock grass
Heath	<i>Melaleuca</i> , <i>Leptospermum</i> , other plants in the <i>Myrtaceae</i> family <i>Asteraceae</i> family	coastal tea-trees, melaleucas daisy shrubs
Scrub	Plants in the <i>Myrtaceae</i> family Plants in the <i>Asteraceae</i> family	tea-trees, melaleucas coastal daisy shrubs
Woodland	<i>Allocasuarina</i> species	she-oaks
Low forest	<i>Eucalyptus viminalis</i> <i>Eucalyptus amygdalina</i> <i>Eucalyptus globulus</i> (eastern Tasmania) <i>Eucalyptus nitida</i> (north-west and western Tasmania)	white gum black peppermint blue gum Smithton peppermint

The number of zones may be fewer on some sites. Source: *Community Coastcare handbook* (Thorp (2005), based on Coastal, Heath and Wetland Vegetation (Kirkpatrick & Harris 1999) in *Vegetation of Tasmania*. Reid et al. (eds)



Tube-stock or other seedlings

Planting tube-stock is a reliable planting method if undertaken correctly. For successful planting, follow the steps in the **Guidelines** accompanying this manual.

Direct seeding by hand

Direct seeding is the spreading of seed onto carefully prepared soil. To be successful it requires good soil, adequate moisture and a lack of weed competition. This method has had limited success in coastal soils, especially on sand dunes. In loose, bare sand, seeds will often be uncovered or buried too deeply before they can germinate and the seedlings become established.

Direct seeding requires planning well in advance to ensure the site is thoroughly weed-free. This can involve weeding for two years or more prior to seeding; follow-up weeding is essential for years afterwards.

Collect seeds in late spring and summer (**see section 7.4.2 Propagation from seed**) and plant when soils have a high soil moisture content. This may be after heavy rainfalls have started in late autumn or winter; however, heavy rainfall after direct seeding may result in seed being washed away so care must be taken.

Choose sites where soil is not too loose or too hard. Heavy soils should be soft enough to enable water, air and roots to easily penetrate.

Rake the top few centimetres of soil with a rake-hoe (a heavy duty firefighting tool that combines both a rake and a hoe and is particularly useful for scraping away leaf litter and the top layer of soil) and sprinkle a pinch of seeds (mixed with sand to help make sowing more even). Lightly rake in the seeds and then firm down the soil with the back of the rake-hoe. Bury the seeds at a depth of about one or two times their size.

7.3.5 Monitoring revegetation projects

Revegetation is often quite difficult on the coast, and many projects have limited success. It is important to keep good records of works and the progress of revegetation, to find out whether the methods used are successful. Revegetation practices can then be modified to achieve the best results.

If good records are kept, it will be possible for someone else to determine the ecological effectiveness of the works, even if scientific monitoring was not the original purpose of record-keeping.

Ongoing monitoring will enable land managers to identify problems as they arise, such as new weed incursions, and help to determine future maintenance needs.

Use vegetation mapping and photopoints (locations, identified by marking with a tent peg or using a hand-held GPS, used to take photos at regular intervals from the same point) to record revegetation progress. Methods are provided in *A technical manual for vegetation monitoring* (Barker 2001) and *A user's guide to monitoring vegetation* (McCoull & Barnes 2002).

Tasmanian Vegetation Condition Assessment

Vegetation Condition Assessment (VCA) is one of the options for monitoring rehabilitation. It may be used alongside other techniques that assess particulars of plant survival etc.

The Vegetation Condition Assessment is a method for monitoring vegetation condition over time and comparing it to the benchmark health for that vegetation community. Different remnants of the same vegetation type can be compared using their benchmark scores.

This method is in fact a simple approach but needs



to be done by a trained person in accordance with *A manual for assessing vegetation condition in Tasmania* (Michaels 2006). A number of Natural Resource Management (NRM) officers have been trained in using this method and should be approached for assistance. Contact the regional NRM organisations, refer to **Appendix 4**.

The method is most useful where some of the integrity of the native vegetation remains, allowing a native TASVEG unit to be defined for the area. It must be used when monitoring change over time if the data is to be contributed to regional environmental status reports.

Ecological monitoring projects

Ecological monitoring projects are more extensive (complex and long-term scientific) projects, usually organised by vegetation ecologists, which systematically measure the health of the native vegetation.

There are three common types:

- monitoring the impact of a change in the environment (e.g. monitoring the impact of a wildfire or a development)
- monitoring the impact of a management treatment (e.g. monitoring the impact of an ecological burn or a particular grazing regime)
- monitoring changes in plant populations or communities over time (e.g. monitoring a population of rare plants in a particular location).

An ecological monitoring project typically takes many years to complete because it must record changes over a number of seasons. To be effective, it requires a commitment to conducting reliable and systematic measurements, including control sites, which requires considerable resources and planning. This can only be achieved if a professional ecologist, who should

also analyse the results and recommend the most appropriate management responses to changes in the vegetation, scientifically designs the project.

Land managers must approve any ecological monitoring project and commit to being involved in reviewing the outcomes and modifying or improving land management practices as required. This adaptive management should continue in a cycle that includes measuring the biodiversity response of each management change. Methods suitable for ecologists and non-ecologists are provided in *A technical manual for vegetation monitoring* (Barker 2001), including monitoring ecological burns.

7.3.6 Marking sites for protection or management

Significant vegetation communities and values, such as threatened species, can be identified at the site through markers, which will inform all land managers and users of the presence of these values and help them to manage the site appropriately to protect these values. There are several marking methods but simple signage is most effective.

Enviromark

Enviromark is a corridor management system designed for managing threats and significant values along corridors (corridors of land with native vegetation left intact, which allows fauna to move across a wider territory and maintains connectivity of vegetation communities). It is designed for managing corridors along roads, railways and powerlines, and other areas where significant values are at risk, including coastlines.

This simple system can be used by land managers to protect threatened species, maximise vegetation conservation and habitat values and manage weeds



and revegetation areas. It assists councils and other corridor managers in fulfilling their obligations under weed and threatened species legislation.

The Enviromark system provides an integrated set of field markers, specifications, user guide, training and monitoring and evaluation (Figure 7.6).

The field markers show the location of the significant value or threat. The colours and symbols on the markers indicate the issue being managed, while the codes relate to relevant specification sheets, which set out how normal maintenance activities (e.g. mowing and slashing, drain clearing, grading, pruning and weeding) and constructions can be modified to avoid damaging significant conservation values or spreading weeds. In this way management plans and strategies can be translated into appropriate on-ground actions.

Enviromark is being used to manage weeds of national significance and of regional significance, as well as threatened species, significant native habitat, revegetation areas, no-spraying areas, hygiene areas and stockpile and parking areas. It is being used in three states so far, by both state corridor managers and local councils.

The system is run by Greening Australia (Tasmania), which produces the materials and conducts training sessions. Refer to *Introduction to Enviromark: a system for managing roadside and corridor vegetation* at the Greening Australia website.

Figure 7.6 Enviromark field markers. The picture on the right shows the revegetation marker on a roadside planting site. Although the new plantings are obvious now, in summer they will be hidden in long grass and vulnerable to accidental damage or destruction by slashers, herbicide or fire. Source: *Introduction to Enviromark: a system for managing roadside and corridor vegetation*. (Greening Australia, n.d.)





7.4 Plant propagation

This section provides guidance for successful plant propagation. It is more cost-effective to rely on natural regeneration of native vegetation, but in some circumstances propagating plants may be necessary to supplement the natural growth. Growing plants for coastal rehabilitation is quite different from growing plants for ornamental gardens. It requires tough plants with deep root systems that will survive being planted out in dry, salty and windy sites.

It is important to grow only plants that have been propagated from parent material (seed or cuttings) collected from local plants that are native to the area. This local provenance stock is adapted to the local conditions, provides the best habitat for wildlife and is often genetically distinct from the same species growing elsewhere.

The main propagation methods are by seed, cuttings and division. Many common coastal plants will propagate readily from one or more of these methods, which are generally used in spring or autumn. The Tasmanian Understorey Network plant database has information about the identification, habitat and propagation of most Tasmanian native species.

7.4.1 Guidelines for successful plant propagation

Propagating only plant species that are native to the local area will protect genetic diversity and provide hardy plants suitable for local conditions.

Correct identification is important to avoid propagating the wrong species. In some cases, such as prickly Moses (*Acacia verticillata*), certain subspecies may not thrive on the coast (only *Acacia verticillata* subsp. *verticillata* is adapted to dry coastal sites). **Refer to section 7.2 Plant and vegetation community identification.**

Planning ahead is essential because propagation can take months or more and plants must be ready for the planting season (usually late autumn and winter).

Standard propagation methods may require modifying to produce hardy plants suitable for coastal planting.

Correct hygiene is critical to avoid spreading weeds, pests or diseases.

7.4.2 Propagation from seed

Propagation from seed enables land managers to ensure stock for planting comes from local species and that genetic populations are maintained. Propagation from seed involves collecting seed (a permit may be required); drying and cleaning seed; and planting the seed.

7.4.3 Propagation from cuttings

Most native plants will grow from cuttings. The exceptions include eucalypts, she-oaks and some acacias.

- Early morning is the best time to take cuttings.
- Choose healthy plants without signs of disease or insect attack.
- Take tip cuttings (tips) at the end of shoots and from the top of the plant, to avoid soil contamination.
- Softwood cuttings (from new soft shoots) can be taken whenever new shoots are available, usually after flowering. Cut a number of tips 100–150mm in length.
- Semi-hardwood cuttings can be taken in March or April. Cut tips 50–80mm long.
- Avoid cuttings with buds or flowers. If this is not possible, cut them off.



- Place cuttings in moist paper or in plastic bags (labelled with the species name). Keep cuttings cool. Place in an Esky-type cooler with a freezer block, if travelling long distances.
- Plant cuttings deeply into trays or pots of sterile, well-drained potting mix (e.g. 3 parts river sand, 1 part Cocopeat (coir dust made from coconut husks), 1 part perlite or vermiculite).
- Use mist spray indoors to keep cuttings moist. Supplying heat under pots indoors is generally unnecessary – striking may take longer, but the success rate is likely to be higher without a heat bed.
- Alternatively grow the cuttings in a warm, shady place outdoors for a few days before gradually moving them to a sunnier spot. Use bottom-watering or spray gently each day to keep them moist.
- Harden off indoor cuttings before planting, by putting them outside for an hour or two in cooler, sunnier conditions and gradually increasing the time each day.
- When the cuttings have rooted, transfer each seedling to its own pot. Gently remove each cutting from its pot and tease out the root mass. Put one cutting into each pot, so that the roots are straight, and firm the soil around the stem. Label the pot and water gently.
- Place pots in a sheltered, sunny (but not hot) spot, and water regularly. Plants may take from one to 18 months to grow 100–150mm tall, large enough for planting.

7.4.4 Propagation from division

Grasses, sedges and similar plants can be propagated by dividing the tussocks.

Divide plants just before or during the start of the root-growing season. This time will vary between species. It may be in late autumn, winter or early spring. Refer to the Understorey Network plant database.

Use a mattock to divide the plant into 100–300mm diameter sections, preferably after watering. Lift the plant carefully to retain the roots, and cut back the top to about 10cm.

Plant divisions in 50mm diameter tubes filled with potting mix and a little slow-release fertiliser.

7.4.5 Plant hygiene when propagating

Good hygiene is critical when collecting propagation material in coastal areas, to avoid spreading weeds, pests and diseases from an infested area to an unaffected area on vehicles, machinery and other equipment and boots.

Take care not to introduce plant diseases like phytophthora root rot (*Phytophthora cinnamomi*).

Generally *P. cinnamomi* will not be an issue in coastal revegetation, in primary sand dunes, saltmarsh and coastal scrub (e.g. *Meleuca ericoides*). If working in coastal heath or heathy forest/moorland do not propagate and plant out without further advice on the disease status of the site and the nursery hygiene required to minimise the chance of diseased stock being used.

Do not take seed or cuttings from plants in infected areas. Maps of areas with, or susceptible to, phytophthora are at the DPIPWE weeds website. Seed and cuttings will not spread *P. cinnamomi*, but your shoes might.



7.5

Wash boots and other equipment before visiting coastal vegetation or moving to another site.

Keep vehicles clean, especially underneath.

Also refer to Chapter 8 Weed and disease management and section 7.8 Tools and resources.

7.5

Landscaping with native plants

This section briefly describes the opportunity to improve the vegetation values of public spaces and urban areas through the use of local native plant species in landscaping and gardens.

Local native plants can be incorporated into gardens and urban public spaces in the same way in which exotic plants are used. There are many striking coastal plants, from ground covers and grasses to shrubs, flowering plants and screening trees. They offer a good variety of colours and textures and are highly

Figure 7.7 Cleaning boots and personal equipment is the best way to prevent the spread of weeds and diseases. Source: Keeping it clean: A Tasmanian field hygiene manual to prevent the spread of freshwater pests and pathogens.

© Hydro Tasmania





suited to plantings designed to create visual interest and contrast.

Being suited to the local conditions, local natives will be easier and cheaper to maintain and have the added benefit of providing habitat for local wildlife.

Consider collaborating with the local community to create landscaped native gardens in recreational spaces or high-use points along the coast. These gardens can become an inspiration and a learning tool for local residents who are struggling to maintain traditional exotic gardens.

There are several brochures and resources that provide information on selecting native plants, including the South Australian publication *Coastal gardens: A planting guide* (Adelaide and Mount Lofty Ranges Natural Resources Management Board n.d.), which provides information on plant selection for landscaping in a variety of different styles. **Refer to section 7.9 Tools and resources.**

Figure 7.8 Local native plants incorporated into public open space at Port Willunga in South Australia, has greatly improved the aesthetic value of this popular coastal location. © Leah Page





7.6

7.6 Stock management

This section provides guidance for minimising impacts of livestock on coastal vegetation. Allowing livestock access to coastal dunes and wetlands for grazing or water can easily cause environmental damage, which may be difficult and expensive to remediate. Coastal dunes and wetlands are particularly fragile and highly vulnerable to damage by livestock.

Livestock grazing in coastal dunes (in addition to rabbits, wallabies and wombats) can increase wind erosion by reducing the plant cover and exposing bare sand. The hard hooves of livestock break the ground surface and sever the soil-binding plant roots, which may result in erosion and remobilisation of dunes. For these reasons, grazing should be avoided on actively or potentially mobile dunes. Livestock can also introduce and transport weed species.

Also, as livestock are likely to expend more energy climbing dunes than grazing in paddocks, this may negate the feed value of these areas.

Tasmania has many coastal wetlands, including lagoons and saltmarshes, which provide food and habitat for numerous animals. Grazing in wetlands can destroy the vegetation, spread weeds, damage the soil structure and degrade the water quality.

Excluding livestock from wetlands and pumping their drinking water into troughs can increase their weight gain. The stock are less prone to disease and footrot, erosion problems are reduced and water supplies kept clean, producing benefits and savings that can offset the cost of fencing and water-supply equipment.

Future sea level rises will threaten coastal wetlands. Protecting them from stock grazing pressure should help these important ecosystems adjust to future changes.

Figure 7.9 Livestock are very destructive to coastal areas. Stock should be excluded from dunes and wetland areas. © Emma Williams





7.6.1 Impacts of stock grazing in coastal environments

Coastal dunes and wetlands have important nature conservation values including threatened communities and species. They are vital nesting and feeding places for shorebirds, penguins, shearwaters and waterbirds, including threatened species such as fairy terns.

Many of the threatened plants in coastal environments have a highly restricted distribution, with small vulnerable populations in dunes and wetlands that could be eliminated by poor site management. Certain dunes have important geoheritage values that can be damaged by stock grazing.

Management plans have been prepared for some significant wetlands. Seek specialist advice from the Department of Primary Industries, Parks, Water and the Environment (DPIPWE) to identify whether these wetlands will be affected by the proposed stock grazing.

Grazing should be avoided in dunes and wetlands, especially foredune complexes and other mobile dunes and saltmarshes. ***Refer to Chapter 6 Coastal landscape management.***

Vegetation loss from over-grazing can destabilise dunes and increase erosion, allowing large quantities of sand to be blown onto productive paddocks.

Grazing in or near water may degrade the water quality with excess nutrients and bacteria. As a result, grazing may damage valuable habitat for wildlife.

Aboriginal heritage values can be disturbed and compromised by erosion caused by stock grazing.

7.6.2 Guidelines for grazing in dunes

Where grazing is practised in coastal dunes, thorough management is necessary and the following guidelines are recommended.

- Obtain specialist advice about the potential impacts of grazing on dunes and other sandy landforms (from a geomorphologist) and the vegetation and wildlife (from a biologist) in sensitive areas, to identify areas where grazing should be avoided or managed carefully.
- Avoid grazing livestock on dunes where this could damage vegetation with high conservation values or cause erosion (e.g. on mobile or potentially mobile dunes).
- Where grazing is practised, reduce the stocking rate, and use short grazing periods
- Restrict grazing preferably to the moist months of the year but avoid or limit grazing, if possible, when the vegetation is establishing itself or flowering (usually in spring and summer). Heavy grazing at these times makes it hard for the plants to develop roots or to flower and set seed.
- Maintain a vegetation cover of at least 30%, preferably 60%, to stabilise the sand (depending on how exposed the site is to the prevailing wind and the types of vegetation). Do not use fire to increase green pick, as this can promote erosion.
- Avoid grazing after wildfire, when the bare soil is prone to erosion. Fire often triggers the germination of new seedlings, which could be destroyed by trampling if grazing occurs.
- Exclude stock from dunes, by fencing, to help improve the stability of vulnerable dunes that have been damaged by grazing.



7.6.3 Guidelines for grazing near wetlands

The following guidelines are recommended when managing livestock in or near wetlands. Careful management is necessary and includes the following measures.

- Avoid grazing livestock on sensitive coastal wetlands such as saltmarshes. Excluding grazing is the best option on all wetlands, where practicable.
- Check the conservation significance of wetlands with the Biodiversity Conservation Branch, DPIPW. Prepare management plans for significant wetlands.
- If grazing is allowed, obtain specialist advice about managing it wisely (e.g. using appropriate grazing intensities and maintaining water levels and quality).
- Determine a sustainable stocking rate appropriate to the seasonal conditions, and use short grazing periods.
- Avoid or limit grazing when plants are actively growing and producing seed (spring and summer), where practicable.
- Grazing in wetlands that dry out is least damaging when the wetland is totally dry. Exclude stock while the wetland is drying out, as trampling on boggy soil will destroy the vegetation mat that is important to sustain a healthy wetland.
- Ideally, provide alternative watering points away from the wetland. If that is not viable, fence off most of the wetland so access is limited to the most suitable watering point(s). Consider the options for fencing and alternative watering systems in *Managing streamsides: stock control, fencing and watering options* (Wright & Jacobson 2000) available from DPIPW.

7.6.4 Ongoing monitoring of grazing

Monitoring is important to see whether grazing levels are appropriate and to check for any damage to coastal values and systems. Visit the site regularly to monitor grazing and ensure damage is minimal.

It may be necessary to repair erosion, protect water quality or deal with weeds.

Inspection and maintenance should check the effects of grazing on the vegetation, landforms and wildlife or water quality.

Figure 7.10 Damage to wetland area from inappropriate stock access. Source: Waterways and wetlands works manual: Environmental best practice guidelines for undertaking works in waterways and wetlands in Tasmania (Gallagher 2003)





7.7 Vegetation removal

This section deals with legal vegetation removal by land managers and illegal vegetation removal. It is sometimes necessary to remove native vegetation as part of land management works such as to reduce fire hazard in coastal reserves, to remove dangerous trees, to clear lines of sight along coastal roadsides or to provide access to the foreshore. ***More information on vegetation management for fire hazard reduction is available in Chapter 9 Fire management.***

Identify any threatened species or communities and ensure appropriate approval has been granted before any vegetation removal works are undertaken. Removal of vegetation from coastal foreshores such as dunes and wetlands can cause severe damage to these fragile systems and lead to erosion and foreshore instability. Such works should be avoided if possible and only undertaken with specialist advice.

Consult with the local community prior to undertaking works. This is very important as many local residents and community group volunteers will be distressed by the removal of vegetation, in particular large trees, if they do not understand the reasons for their removal. Give them enough time to become informed about the proposed vegetation removal and to ask questions and seek advice.

Ensure that appropriate riparian buffers are maintained as vegetation on the edge of waterways protects the water from neighbouring land uses and pollutants.

Some coastal foreshores have been subject to illegal removal of coastal vegetation by adjacent landowners, usually to open up coastal views. Land managers can play a role in educating the public about the value of coastal vegetation and in enforcing illegal activity.

7.7.1. Tree removal and pruning

Sometimes it is necessary to remove or prune large trees. Inappropriate techniques look unsightly and do not allow the tree to heal properly, causing rot in the remaining limb which can spread into the trunk and reduce the structural integrity of the tree, making it unsafe. Correct pruning techniques will protect both the appearance and structural integrity of the tree.

Tree pruning and removal should only be undertaken by qualified and experienced staff and contractors. All staff and contractors should be briefed on the environmental considerations of the site and any restrictions or specific work practices that are required to meet those considerations. Appropriate supervision is required to ensure environmental standards are being met.

Figure 7.11 Correct pruning cut allows for wound to heal, preventing water from rotting the remaining limb and trunk. © Leah Page





7.7.2 Guidelines for slashing vegetation

Slashing is a form of mechanical vegetation removal that can be undertaken with large specialised machinery, smaller mowers and hand-held brush-cutters.

As for any coastal works, land managers should complete a risk assessment, which should also consider potential impacts to the coastal environment and values.

Identify the following values:

- areas that are being actively managed by a local Coastcare or other community group – ensure the slashing will not be detrimental to any revegetation or natural regeneration works
- vegetation values that warrant protection
- natural or wildlife values that may be at risk from accessing the site with machinery and slashing
- Aboriginal or other heritage values that might be affected by the works – seek assessments and approvals if that is the case
- Aesthetic values and visual appearance.

Implement the following practices to minimise impacts on other values:

- Consider the life cycle of local native species. Allow flowering and seed ripening before slashing, to maintain the seed supply and the capacity for natural regeneration.
- Brief all staff and contractors on environmental considerations for the site and any consequent restrictions or specific work practices required. Appropriate supervision is required, to ensure environmental standards are being met.
- Scalping is sometimes used as a weed management tool where immediate rehabilitation is planned. Be aware that slashing scalps the

ground if the mower is set too low and causes substantial soil disturbance, leaving bare patches of earth subject to erosion. In sandy soils the risk of erosion and destabilisation is very high.

- Remove grass clippings after mowing and edging if possible, as they can be washed or blown down stormwater drains or into waterways, spreading weeds, causing problems for gross pollutant traps and reducing water quality.
- Maintain appropriate riparian buffers on the edge of waterways to protect the water from neighbouring land uses and pollutants.
- Take care with fuel products especially around waterways and avoid spills when filling machinery. Ensure that managing a fuel spill is covered within the risk assessment. Clean up any spills immediately.
- Remove all litter and debris prior to slashing to prevent further spreading of these contaminants.
- Ensure mowers and brush-cutters project grass clippings away from waterways, drains and gutters and use a grass catcher in sensitive areas. If possible, send collected grass clippings to a composting facility or worm farm (where it will be recycled for use in gardens).
- Avoid mowing or slashing if the ground is very wet, as this can lead to erosion, and tyre tracks can become unwanted water conduits.
- Slashing has a history of spreading weeds. Ensure the sites to be slashed are surveyed for weeds and slashing is undertaken when there is the least risk of them being in seed. Ensure all machinery and vehicles are free from weeds and diseases prior to bringing them on site. If weeds or disease are present at the site, ensure that tools, boots, vehicles and machinery are cleaned at a suitable location before leaving the site. **Refer to Chapter 8 Weed and disease management.**



7.7.3 Illegal removal of vegetation

The illegal removal of coastal vegetation to 'improve' views is unfortunately not uncommon. Another common reason for illegal vegetation removal is the harvesting of timber for firewood.

Vegetation destruction in coastal areas not only destroys vegetation communities and wildlife habitat, but may put threatened species at risk and, in many cases, makes foreshore areas more susceptible to coastal erosion.

Education and enforcement are critical to managing illegal vegetation removal, as many perpetrators simply do not realise that their actions have a serious impact.

Local residents and community group volunteers are often the first to notice illegal vegetation removal and are willing to report it to authorities. These reports should be followed up promptly by the land manager, involving Tasmania Police where appropriate.

Where vegetation has obviously been illegally removed to 'improve' a view, some local councils, both interstate and in Tasmania, have erected signage on public land to impede the perpetrator's view and serve as a deterrent to others who might consider similar action.

7.8 Vegetation management and climate change

Figure 7.12 Kingborough Council has erected a sign where local residents illegally removed coastal vegetation.
© Bridget Jupe



This section provides an overview of potential climate change impacts on native coastal vegetation and is primarily sourced from the *Vulnerability of Tasmania's natural environment to climate change: An overview* (DPIPWE 2010).

Climate change is likely to lead to ecosystem changes and local species extinctions. Changes such as decreased rainfall and increased temperature, and increased frequency of extreme events such as drought, storm surges, and fire, will variably impact on biodiversity in different regions in Tasmania (DPIPWE 2010).

Native coastal vegetation is already under pressure from a range of threats including weeds and diseases, inappropriate fire regimes, and illegal or inappropriate clearing. It is difficult to predict the ways in which climate change will interact with these existing pressures.



Possible particular impacts on coastal vegetation:

- marram grass out-competing native grasses
- loss of coastal habitat; reduction in area of beach grasslands and beach sedgeland
- loss of shrubland communities such as coast beardheath (*Leucopogon parviflorus*) shrubland
- loss of coastal communities such as sandy beaches and dunes and loss of frontline beach foredune
- saltmarsh migrating inland, if suitable habitat is available
- inundation of coastal wetlands and saltmarshes where they are unable to migrate inland.

Some of these changes will put threatened species and restricted distribution species found only on coastal dunes at risk. In north-west Tasmania these include coast speedwell (*Veronica novae hollandiae*) and *Stackhousia spathulata*.

To mitigate the impact of climate change, it is essential to conserve natural vegetation communities and ecosystems and restore degraded ones, thereby protecting habitat diversity. In view of uncertainty about the specific impacts of climate change, maintaining diversity will act as an insurance policy (DPIPWE 2010).

7.9 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**.

Threatened species

Threatened Communities listing

<http://www.dpipwe.tas.gov.au> Go to native plants and animals > threatened species > list of threatened species

Threatened native vegetation community information sheet: Threatened native vegetation communities (Forest Practices Authority 2007)

Information sheet for identifying threatened vegetation communities

http://www.fpa.tas.gov.au/fileadmin/user_upload/PDFs/Botany/threatened_veg_intro_info_sheet.pdf

Plant ID and mapping tools

Use field guides and keys to identify plants. Further weed identification resources are provided in **section 8.7**.

A key to Tasmanian vascular plants

University of Tasmania

Based on pictures and perhaps the easiest to use of the keys

<http://www.utas.edu.au/dicotkey/dicotkey/key.htm>



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

Community Coastcare handbook (Thorp 2005)

Photo comparisons between weeds and similar looking native species

Guide to the flowers and plants of Tasmania (Simmons et al. 2008)

Herbarium: Tasmanian Museum and Art Gallery

Advice about identification and natural distribution of species <http://www.tmag.tas.gov.au/Herbarium>

Natural Values Atlas

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

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

Plant Identikit Series: Coastal plants of Tasmania and woodland wildflowers of Tasmania (Australian Plants Society Tasmania 1988-2003)

Tasmania's natural flora (Whiting et al. 2004)

The little book of common names for Tasmanian plants (Wapstra et al. 2005)

Revegetation and monitoring

In addition to the resources for plant and plant community identification, the following may be helpful for planning and monitoring revegetation works.

A manual for assessing vegetation condition in Tasmania, Version 1.0. (Michaels 2006)

A technical manual for vegetation monitoring (Barker 2001)

A users guide to monitoring vegetation (McCoull & Barnes 2002).

Coastcare community handbook (South Australia) (Brooke et al. 2001)

From Forest to Fjaeldmark: Descriptions of Tasmania's vegetation (Harris & Kitchener 2005)

Available on the DPIPW website

<http://www.dpipwe.tas.gov.au>

Introduction to Enviromark, A system for managing roadside and corridor vegetation

www.greeningaustralia.org.au

Monitoring remnant bushland (Greening Australia 2002)

Technical notes available from Greening Australia

http://www.granitenet.com.au/assets/files/Landcare/FB_MonitoringRemnant.pdf

TASVEG metadata notes and on-line maps available through the LIST website, under Vegetation

<http://www.thelist.tas.gov.au/>



Plant propagation

Community Coastcare handbook (Thorp 2005)

Detailed information about propagating common coastal species is in Chapter 13.

FloraBank Model

Code of practice for community-based collectors and suppliers and other guidelines on the website

www.florabank.org.au

Royal Tasmanian Botanical Gardens

Provides advice on seed propagation. In 2005 the Gardens established the Tasmanian Seed Conservation Centre (TSCC), a seed-bank focused on Tasmania's native flora. The TSCC conducts current international best practice in seed collecting, cleaning, storage and germination. Current priorities are focused on rare and threatened flora but the seed-bank aims to ultimately hold multiple provenance collections for all Tasmania's flora. Germination tests are regularly conducted on collections to ascertain and monitor seed viability. Germination testing data for the seed-bank collections are made publicly available on the RTBG website.

<http://www.rtbg.tas.gov.au/index.aspx?base=227>

In addition 26 pages of information on the germination and dormancy of wild seed can be found at Tasmanian Seed Conservation Centre web pages.

<http://www.rtbg.tas.gov.au/index.aspx?base=224>

Understorey Network

Plant database provides information on the identification, habitat and propagation of most Tasmanian native species. Seeding times, best times for taking cuttings and a step-by-step method for plant propagation is provided in: *The understorey network guide to growing native plants in Tasmania* (Thorp 2001) available from the Understorey Network.

www.understorey-network.org.au

Landscaping with native plants

In addition to plant identification and propagation tools, the following resources will be helpful when landscaping with native plants.

Coastal gardens: A planting guide (Adelaide and Mount Lofty Ranges Natural Resources Management Board, n.d.)

Very useful booklet on which native plants can replace more traditional exotics. Also provides design ideas for a number of landscaping styles. Although plants described are local to South Australia, many of the species, or similar ones, are also native to Tasmania

www.amlnrm.sa.gov.au

Plants for a water friendly garden: Native plant field guide (Clarence City Council, n.d.)

A booklet providing photos and descriptions of native plants suitable for the Clarence municipality but could be applied more broadly across south-east Tasmania. A water-friendly garden is displayed at the Rosny Historic Centre in Clarence in southern Tasmania.

<http://www.ccc.tas.gov.au/webdata/resources/files/PlantBkFINAL3.pdf>



Urban forest biodiversity program

Information on establishing native plants and making gardens wildlife-friendly

www.backyards4wildlife.com.au

Weed and disease hygiene

More information about weed and disease management is available in **Chapter 8 Weed and disease management**.

Interim *Phytophthora cinnamomi* management guidelines (Rudman 2005)

Keeping it clean: A Tasmanian field hygiene manual to prevent the spread of freshwater pests and pathogens (Allan & Gartenstein 2010)

Tasmanian washdown guidelines for weed and disease control (Rudman et al. 2004)

Grazing

Managing streamsides: Stock control, fencing and watering options (Wright & Jacobson 2000)

Detailed guidelines and fencing designs. Available from DPIPWE

www.dpipwe.tas.gov.au

Tasmanian Bushcare Toolkit, Kit 9, other bush types (Kirkpatrick 1999)



8

Weed and disease management



- 8.1 Weed management
- 8.2 Methods of weed control
- 8.3 Monitoring weed management works
- 8.4 *Phytophthora* root rot
- 8.5 Weed and disease hygiene
- 8.6 Climate change and weeds and disease in Tasmania
- 8.7 Tools and resources

This chapter deals mainly with the special considerations for weed and disease management on or near the shoreline. Many aspects of coastal weed management away from the immediate shoreline are the same as further inland, but conditions are quite different beside the sea, where salt laden winds, unstable sands, and sandy soils are common.

Weed and disease management is an essential component of any coastal works. Weeds often spread quickly after any disturbance to the soil and diseases are easily introduced via machinery, tools and mulches. Weeds are a major problem in many coastal areas, and their removal is often the most important part of any revegetation program.

Weeds degrade coastal ecosystems by competing with native plants, reducing biodiversity, disrupting ecological processes (e.g. weeds like boneseed and gorse may increase the frequency of fire) and disrupting coastal processes (e.g. by altering dune shape – marram grass). Diseases such as *phytophthora* root rot can be devastating to coastal heath vegetation.

Disturbance of the soil, including the removal of existing weeds, can expose the soil and promote new weed growth. It can also destabilise dunes, cause erosion and result in the introduction of soil pathogens. Planting and/or mulching may be required soon after weeding, to prevent more weeds from establishing.

*Tab photo: Boneseed infestation in south-east Tasmania.
© Leah Page.*



8.1

8.1 Weed management

This section deals with the tools and techniques required for effective weed management.

Good weed management – not just trying to eradicate weeds – is part of good land management. It aims to maintain native biodiversity and landscape resistance to invasion by weeds, by protecting sites that are weed-free, restoring natural vegetation cover and improving soil health. In the long run, this approach will prevent weed invasion and reduce the damage caused by weeds and the time and money spent on controlling weeds. **Refer to Chapter 7 Vegetation management.**

Many coastal sites have a large number of weeds present from grasses and small herbs through to large shrubs or trees. To make effective use of the resources available, good weed management does

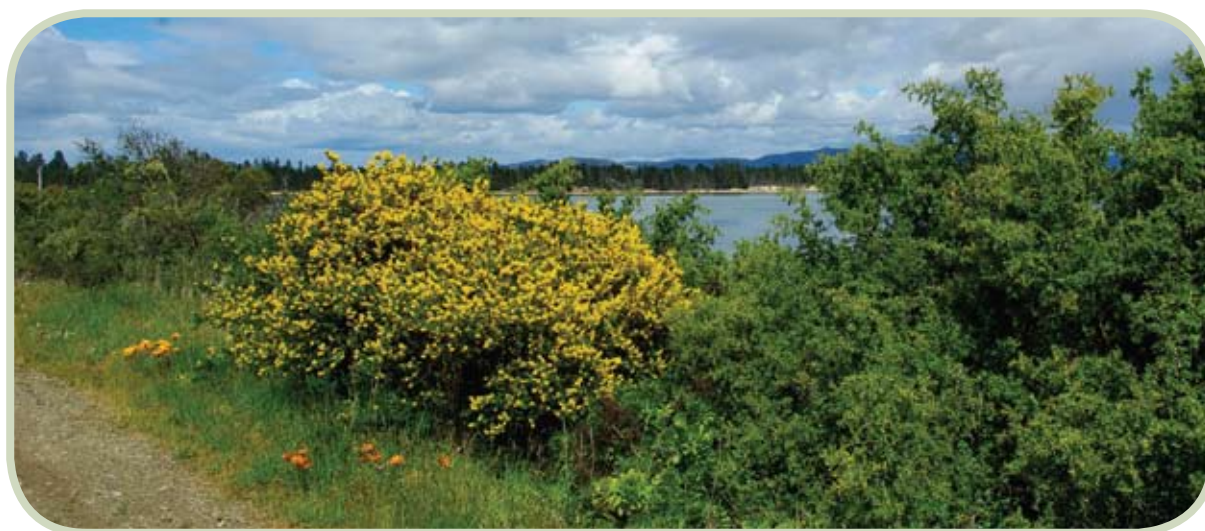
not necessarily require that all weed species are controlled or that complete eradication of any one weed species will achieve biodiversity protection. It is important to determine the priorities and degree of weed control required for any particular site.

Making landscapes resistant to weed invasion requires an integrated approach. This means using a variety of control methods to target each weed, reducing the risk of introduction of weeds and improving the health of the site to reduce the risk of weeds re-establishing.

Timing of weed control is also important, to ensure that weed species are treated when they are most vulnerable.

Weed management is obviously a long-term exercise. To have a real impact, it needs thorough planning and regular targeted work on an annual basis, done at the right time.

Figure 8.1 Roadsides in coastal areas can be subject to a number of significant weed invasions. This roadside is supporting a community of African boxthorn *Lycium ferocissimum*, boneseed, *Chrysanthemoides monilifera* subsp. *monilifera*, Montpellier broom, *Genista monspessulana*, gazania, *Gazania linearis*, and some plants that have escaped from nearby gardens. © Leah Page





8.1.1 Legislation and policy

In addition to legislation detailed in **Appendices 1 and 2**, the following legislation provides specifically for the management of weeds.

The objectives of the *Weed Management Act 1999* further the objectives of the resource management and planning system (RMPS) of Tasmania and, in particular, provide for the control and eradication of weeds, having regard to the need to:

- minimise the deleterious effects of weeds on the sustainability of Tasmania's productive capacity and natural ecosystems
- promote a strategic and sustainable approach to weed management
- encourage community involvement in weed management
- promote the sharing of responsibility for weed management between the different spheres of government, natural resource managers, the community and industry in Tasmania.

A core component of the legislation is the legal process of declaring a weed species under the Act. A Statutory Weed Management Plan (SWMP) must be prepared for all declared weeds under the Act.

The *Plant Quarantine Act 1997* provides for the quarantine of plants and the control of pests and diseases. The **Tasmanian Biosecurity Policy 2006** and the **Tasmanian Biosecurity Strategy 2006** provide guidance for the implementation of the Act.

8.1.2 Weeding in coastal environments

Weed management activities have potential impacts on other coastal values and it is important to plan for ways to minimise those impacts when weeding in coastal environments.

Unique and vulnerable values such as Aboriginal heritage sites and shorebirds must be considered when planning weed management on the coast. There are many Aboriginal heritage sites along the coast such as middens and artefact scatters that will be vulnerable to soil disturbance associated with mechanical weed removal. Weeding on Aboriginal sites might require a permit under the *Aboriginal Relics Act 1975*. **Refer to Chapter 5 Cultural heritage management.**

Beach-nesting shorebirds and colonies of penguins and shearwaters can be adversely affected by the level of activity and disturbance associated with weed-removal techniques. In less natural coastal environments, weeds sometimes play useful roles in stabilising dunes and even protecting wildlife habitat. For instance, African boxthorn can provide shelter for penguin or bandicoot burrows and removing these weeds during breeding times, and without a careful replacement strategy, can put wildlife at risk. **Refer to Chapter 10 Wildlife management.**

Weeding activities that disturb and expose the soil can promote weed growth, destabilise dunes and cause erosion. Planting and/or mulching may be required soon after weeding, to prevent more weeds from establishing.

New weeds and diseases can be introduced on vehicles, footwear or dumped garden rubbish, and by birds, wind and waves. To protect the spread of weeds and protect natural ecosystems, it is vital to practise good weed and disease hygiene during all coastal work activities.

8.1.3 Planning for weed management

Plan works carefully: a good tool is the development of a local weed management plan. Plans should comply with the *Tasmanian Weed Management Act*



1999, statutory weed management plans for declared weeds, national strategies for Weeds of National Significance (WoNS) and regional weed strategies.

Seek specialist advice from Weed officers within regional Natural Resource Management organisations and Department of Primary Industries, Parks, Water and Environment (DPIPWE) Regional Weed Management Officers.

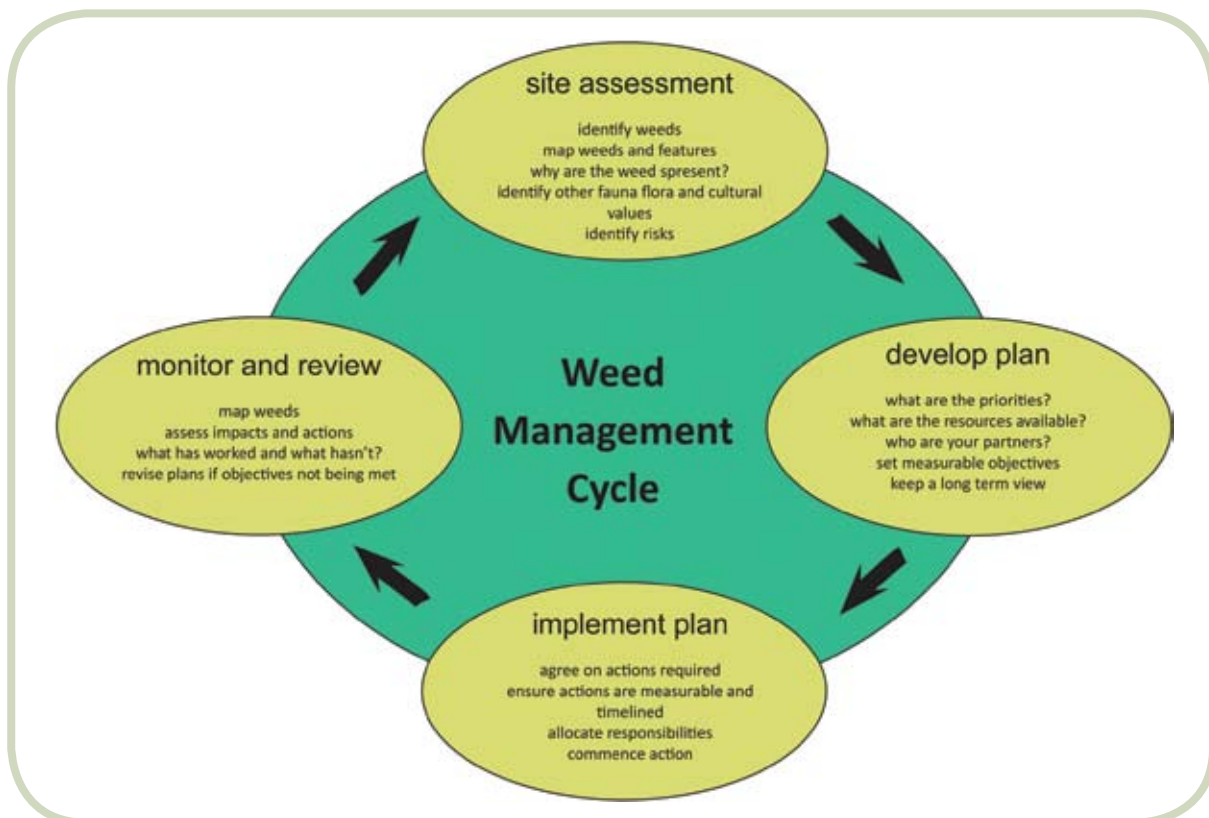
Consult with local groups such as Coastcare about their involvement in and aspirations for weed management in the area. Many of these groups have acquired external funding enabling them to

develop local weed management plans. It is extremely beneficial and important to incorporate these into any new management plans.

The *Bushcare Toolkit, Kit 3, Weeds in your Bush* (Glazik & Rudman 2002) has comprehensive guidelines for weed management planning.

As part of the planning process, identify risks to other coastal values as a result of weed management works. Consult specialists such as wildlife and cultural heritage experts.

Figure 8.2 Weed management cycle. Adapted from *Introductory weed management manual* (Cooperative Research Centre for Australian Weed Management, Natural Heritage Trust Australia & Department of the Environment and Heritage, 2004)





General principles of weed management planning:

- Mapping the weeds will enable sound weed management planning and progress to be assessed (refer to *A field manual for surveying and mapping nationally significant weeds*, McNaught et al. 2006).
- Identify the weed problems.
- Identify the causes of weed problems.
- Determine the priority weed species. These are the greatest threats to native vegetation and wildlife.
- Determine the resources available.
- Identify the best times and the best methods to control priority weeds to minimise environmental damage.
- Identify whether rehabilitation will be required and any land management changes are needed to make the site more resilient to future weed invasion.
- Develop a works program to control weeds in the most timely and effective way with the resources available.
- Implement the works program
- Monitor and record results.
- Be persistent in applying follow-up treatment.

These steps need to be repeated over time. Weed management is an ongoing cycle of planning, doing, reviewing and re-planning, as set out in Figure 8.2.

What are the weeds? What effect are they having?

Which weeds are a high priority? Why should they be controlled?

Who is going to control the weeds? How and when will they control the weeds?

8.1.4 Weed identification

Some coastal weeds are similar in appearance to native species, so it is very important that plants have been identified correctly before management works commence.

Good weed identification resources are available. The *WeedDeck* is a pocket-sized deck of laminated cards with full colour photos for identifying weeds. The *Community Coastcare handbook* has helpful comparisons between common weeds and look-alike native species. **Refer to 8.7 Tools and resources.**

It is important that land managers are trained to identify weed species so that they can play a role in identifying new weed incursions during the course of their land management activities.

8.1.5 Priorities for weed control

Effective weed management requires prioritisation. It is not possible to manage all weeds in a given area and it is important to maximise the benefit of any investment in weed works. Some weeds are more invasive than others and some vegetation communities and habitats are more susceptible to weed invasion or have other values that warrant special consideration or protection. Some land managers have limited resources and capacity for weed management.

In prioritising weed management works, first consider state and regional plans, which cover all declared weeds, Weeds of National Significance (WoNS) and weed alerts.

Assess the impact of each weed and the feasibility of controlling it. Weeds that invade bushland and threaten native plants by out-competing them are known as environmental weeds. The result can be the death of these native plants and often the animals,



birds, insects and other creatures that depend upon them. This loss can in turn cause further declines in local biodiversity.

Consider any localised or site-specific issues such as impacts on fauna, threatened species or communities, geoheritage and cultural heritage. Consideration of available and future resources will also govern priorities. Sensitive habitats with few weeds or new incursions of invasive weeds may be more important than large established infestations of WoNS.

In many cases weed surveys may uncover new weed problems and these should be reported to DPIPWE Regional Weed Management Officers for documentation. They can provide advice on the importance of managing new weeds and their likely impact. Reporting weeds improves the understanding of the behaviour of weeds.

Declared weeds

The *Tasmanian Weed Management Act 1999* requires that each declared weed is contained or eradicated. Approved Statutory Weed Management Plans (SWMPs) are on the DPIPWE website.

The SWMP for each declared weed specifies what land managers are required to do to manage that weed within each municipality. It provides information about the distribution and extent of the weed, restrictions and measures required to control, eradicate or restrict the spread of a weed.

Weed Plan: Tasmania's weed management strategy (DPIWE 2005) and *Response Plan* are also on the DPIPWE website.

Declared coastal weeds with SWMPs in place:

African boxthorn
blackberry*
boneseed*
gorse*
bridal creeper*
English broom
pampas grass
Montpellier broom
Spanish heath
serrated tussock*

(* indicates a Weed of National Significance)

Weeds of National Significance (WoNS)

Weeds of National Significance (WoNS) are listed in the *National Weeds Strategy: A strategic approach to weed problems of national significance* (ANZCC & ARMCANZ 1997). All WoNS are declared under the *Tasmanian Weed Management Act 1999*.

Seven of the 20 Weeds of National Significance occur in Tasmania: blackberry, willow, serrated tussock, bridal creeper, boneseed, Chilean needle grass and gorse. From time to time, Australian Government funding is targeted at the management of WoNS weeds, because of their national recognition.

National Alert List weeds

The Alert List for Environmental Weeds, available on the Australian Government weeds website, is a list of 28 non-native plants that threaten biodiversity and cause other environmental damage. Although only in the early stages of establishment, these weeds have the potential to seriously degrade Australia's ecosystems. In Tasmania these include *Calluna vulgaris* or heather; orange hawkweed and horsetail species.



Tasmanian beach weeds

The *Tasmanian beach weed strategy* (Rudman 2003) contains information for identifying and managing sea spurge (*Euphorbia paralias*), marram grass (*Ammophila arenaria*), sea wheat grass (*Thinopyrum junceiforme*), pyp grass (*Erharta villosa*) and beach daisy (*Arctotheca populifolia*). The strategy is on the DPIPWE weeds website.

Rice grass

The *Strategy for the management of rice grass* (*Spartina anglica*) in Tasmania, Australia (DPIWE 2002) contains information for identifying and managing this estuarine weed. The strategy is on the DPIPWE weeds website.

8.1.6 Deciding whether to eradicate or contain weeds

Eradication may not be realistic. Certain weeds are widespread, aggressive colonisers that are impossible to eradicate. It is generally too difficult to remove large infestations of some long-established species such as marram grass. But it is extremely important to report and control new infestations in areas that were previously free of the weed, including those listed in the *Tasmanian beach weed strategy for marram grass, sea spurge, sea wheat grass, pyp grass and beach daisy* (Rudman 2003).

Containment to prevent and control new infestations is more realistic than eradication if the weeds are widespread and well established. Focus on treating outlying infestations, on the fringes, rather than the main infestations. This will help to prevent the spread of weeds into new areas. Containment also involves restoring

Figure 8.3 Boneseed seedlings have germinated where adult plants have been removed and require follow-up removal.
© Leah Page





weeded areas by assisting regeneration of native vegetation to limit opportunities for weeds to re-invade.

For those areas where it is not the objective to remove the weed, it may be appropriate to mitigate against the impact of the weed by periodically controlling infestations to prevent the population growing to the point where it is detrimental to the native biodiversity.

NOTE: Regardless of your decision, it is essential that weed programs are followed up with monitoring and control at least annually.

8.1.7 Timing of weed management works

Knowing the life cycle of each species is essential to determine the timing of different treatments. Refer to the *Introductory weed management manual* (CRC for Australian Weed Management 2004).

The best times for various methods of weed control are shown in Table 8.1.

Some methods, such as slashing weeds, may also remove seed heads of native vegetation – thereby reducing the success of natural regeneration. Before

Table 8.1 Weed control methods and timing for the southern temperate zone.

	Woody weeds	Shrubs	Herbaceous plants	Grasses	Vines & scramblers	Bulbs, tubers & rhizomes
Mulch/smother			All year	All year		All year
Solarisation			Spring & summer	Spring & summer		Spring & summer
Pull*	Before seed set	Before seed set	Before seed set	Before seed set	Before seed set	Before seed set
Cut & paint	Spring	Spring			Spring & summer	
Foliar spray			Spring	Spring & summer	Spring & summer	Spring & summer
Inject	Spring				Spring	
Wipe					Spring	Before flowering

*Most weeds in Tasmania are flowering by September and set seed soon after. As a general rule, pulling weeds out in September–October is the safest option (avoid shorebird nesting beaches) but there are exceptions, such as Spanish heath, which is best done earlier (June–July). Note that flowering times vary from season to season, and often by months, not just weeks. Check the growth and flowering times of individual species to ensure weeds are targeted at the optimum times.



undertaking non-specific mechanical weed control, it is important to consider the life cycle of local native species and time works to benefit them.

Shorebirds nest on many Tasmanian beaches from September to March and disturbance to their breeding sites could be fatal for their eggs and chicks.

Refer to Chapter 10 Wildlife management.

SPRATS (Sea Spurge Remote Area Teams) have incorporated shorebird monitoring into their weed work programs. They have worked closely with Birds Tasmania and the Parks and Wildlife Service to minimise their impacts on breeding and roosting birds.

Refer to case study 8.1.

Best time for hand removal

There are optimal times for hand removal of some common coastal weeds. However, when planning the timing of weed-removal activities, it is important to consider other environmental, cultural and recreational values.

Shorebirds nesting between September and March will be disturbed by activities on beaches and dunes. Penguin and shearwater rookeries should also be avoided during breeding and moulting times. **Refer to Chapter 10 Wildlife management.**

Best times for hand-removal of some common coastal weeds:

Early spring: boneseed, boxthorn, brooms, Cape Leeuwin wattle, Spanish heath, sweet pittosporum (but watch for attached fruit), tree lucerne

Spring: coprosma, rice grass, sea spurge (CAUTION: spurge sap produces a toxic sap that is irritating to the skin and can be particularly painful if rubbed into the eyes)

This is shorebird breeding season.

Autumn: sea spurge, boneseed



Figure 8.4 Sea spurge volunteers removing weeds at Pennerowne Point in the remote south-west. © Nick Fitzgerald

Case Study 8.1: Weed Management on Tasmania's South & West Coasts

Sea Spurge Remote Area Teams

*Winners of the 2009 Community Award
Tasmanian Awards for Environmental Excellence*

Sea spurge and marram grass are devastating coastal ecosystems across southern Australia including Tasmania's World Heritage-listed south and west coasts. SPRATS (Sea Spurge Remote Area Teams) formed in 2007, following a trial weeding program and site surveys, to tackle coastal weeds in the south-west before it was too late. SPRATS received the 2009 Tasmanian Award for Environmental Excellence in the Community section for their achievements.

The SPRATS volunteers have a 10-year plan to remove these weeds from the coastline between Cape Sorell and Cockle Creek. In the past three summers they have surveyed the south-west coastline; 350km of its 600km has been mapped as susceptible to invasion. To date they have treated 315km (91%) of susceptible areas. SPRATS groups have secured funding support from the Australian Government to undertake their valuable work.

While sea spurge is the main weed problem, the volunteers are also targeting marram grass. Both weeds form huge colonies which displace native sand-dune vegetation and also blanket flat sandy areas used for nesting by beach birds, including rare and endangered species such as the little tern.

The south-west coast presents a number of challenges including inaccessibility, rugged terrain, wild weather and thick scrub. These challenges are part of the attraction for SPRATS volunteers, who are experienced bushwalkers.

Their remote area weeding techniques are highly practical and effective, with the potential to remove up to 99% of weeds after two or three treatments. SPRATS have developed best practice techniques that minimise the impact of their weeding activities on significant coastal values such as shorebirds and Aboriginal heritage.

By the end of the 2012–13 field season SPRATS are aiming to have controlled all infestations of these weeds, and to be concentrating on surveillance and follow-up of minor infestations. SPRATS work closely with the Parks and Wildlife Service, Birds Tasmania and regional NRM bodies and are also supported by Wildcare Inc.



8.2 Methods of weed control

It is important to choose methods that minimise disturbance of the soil near the shore, especially in sand dunes, which are easily destabilised.

The porosity of some soil types – especially sandy soils – and the amount of organic matter and clay they contain can affect the way herbicides work and move once they enter the ground. Herbicides generally move further in sand and sandy soils, but have a shorter residual effect (i.e. do not last as long in the soil). The typically windy weather on the coast is often unsuitable for spraying weeds – a sea breeze may blow up suddenly by mid-morning.

Choose weed control methods that suit the purpose, budget and site conditions, and avoid damaging native vegetation.

Often the most efficient and cost-effective way to control weeds is to combine a number of different methods, at different times. Each method needs to target the weeds when they are most vulnerable.

Many weed species, especially perennials, are successful because they have more than one way of reproducing. To control or eradicate these species from a site, a three-pronged approach may be necessary:

1. kill/remove the mature plants
2. kill/remove newly emerged seedlings
3. stop opportunities for further re-infestation.

Suitable weed control works may include any or all of the following:

- prevention/cultural control
- mechanical/physical removal
- biological control
- chemical control
- fire.

Guidelines for weed control methods are readily available from the DPIPWWE weeds website and are only briefly covered here.

8.2.1 Prevention/cultural control

Methods include over-planting to shade weeds and cultivation to stop seed germinating. These are ineffective alone and are normally combined with other methods. Burning can be useful in some situations, but may have undesirable effects in others. Burning should only be considered in consultation with biodiversity, vegetation, wildlife and fire specialists.

8.2.2 Mechanical/physical removal

Methods include hand-pulling, slashing, mowing, scalping, burning, steam and solarisation. Mechanical removal is almost never a solution by itself, but it can reduce the mass of weeds to be treated and limit further seeding. Timing of these methods is critical – they must be done at or before flowering.

Hand-weeding can be easy and effective for a number of weeds, particularly young plants that have not developed an extensive root system. This method can be very effective when dealing with small infestations of woody weeds (e.g. boneseed, broom and sweet pittosporum). It is not suitable for plants that produce lots of small underground bulbs (e.g. bridal creeper). If tubers are carefully dug out and surrounding area sieved then this can be a good way to treat isolated bridal creeper plants.



Mowing and slashing are not suitable for plants that may regrow from roots or fragments (e.g. poplars) – and can make it much harder to control them by other methods. Mowing is also not appropriate for weeds that send out extensive underground root systems such as pyp grass.

Wherever possible, if slashing grass, do it before weeds flower and set seed, and after the flowering and seed-setting of native species.

Scalping causes substantial soil disturbance and is only appropriate in areas dominated by weeds where immediate rehabilitation is planned. This works quite well for plants such as monbretia and watsonia, but in sandy soils the risk of erosion and destabilisation is very high.

Burning can be useful as an initial treatment for certain species (e.g. gorse, blackberry and willow) in some situations. It must be followed up with spraying or other treatment. Burning should only be considered in consultation with biodiversity, vegetation, wildlife and fire specialists.

8.2.3 Biological control

Sometimes invertebrate predators or pathogens from the country where the weed originated can be introduced to reduce the vigour of the weed infestation.

Biological control can be useful for a few species that have been identified as suitable after stringent testing. To eradicate a weed from a site, consider direct controls instead. If using a biological control, the site needs to be monitored for effectiveness and this may place limitations on the use of direct control techniques such as spraying.

Before using chemicals, find out if any biological control agents are present. Contact a Regional Weed

Management Officer in DPIPWE or the Tasmanian Institute of Agricultural Research (TIAR) Biological control program.

8.2.4 Chemical control

Herbicides can be applied by cut and paint, drill and fill, or stem injection methods, or by spraying. Herbicides have the advantage of not disturbing the soil, but they are poisons that should be used with great care, especially near waterways and coastal environments. Minimise their use.

Personal health and safety are paramount: anyone handling and using herbicides should wear correct personal protective equipment and is advised to attend a ChemCert training course on chemical use at the Tasmanian Skills Institute. Land managers should address these matters in a risk assessment prior to any chemical control works.

When spraying weeds, wear a protective suit, gloves, eye goggles and breathing apparatus. After applying herbicides, wash hands and any other skin that may have come into contact with the chemical. Store and dispose of the chemicals safely.

Avoid spraying chemicals in winds greater than 15 km/hr, or when conditions are hot, dry and dusty. Significant spray drift can occur even in very still conditions, when it is hot, dry and dusty, as droplets stay in the air for longer periods. Spray drift can harm native plants and pollute nearby waters, killing frogs and other aquatic life. If spraying near waterways, check that the chemical is appropriate for this use: read the label. To reduce spray drift and target small plants, a plastic guard (like an upside-down funnel shape) can be attached to the end of the nozzle.

Selecting the appropriate herbicide and dilution is critical. Get specialist advice about the best herbicide



to use and any dilutions required. Note that by law, only chemical herbicides registered for specific weeds and situations may be used. Information on choosing herbicides, and precautions when using herbicides, are available in the *Tasmanian Bushcare Toolkit, Kit 3, Weeds in your bush* (Glazik & Rudman 2002).

Follow the DPIPWWE Codes of practice, guidelines and information sheets for using herbicides, available from the DPIPWWE website.

Note that some herbicide use is off-label (meaning that it is necessary to apply the herbicide using methods not included on the label). This is often the case when treating environmental weeds as they are usually not listed on the label. A general off-label permit exists in Tasmania for a range of herbicides, weeds and situations for environmental use. If in doubt, contact a DPIPWWE Regional Weed Management Officer.

Follow herbicide instructions carefully. It is very important to wear the recommended personal protective equipment and read the information on the label and any other documentation provided (which is often in a plastic sleeve attached to the container), e.g. the Material Safety Data Sheet. Never remove the label from the container, and always ensure all the documentation is on-site during weed control work.

The cut-and-paint method is the best technique for large or woody weeds. Check with DPIPWWE Regional Weed Management Officers about correct dilutions of herbicide for this purpose. Add a dye to herbicides to identify treated plants and any unintended damage to native plants, and to make spillage easy to see.

Figure 8.5 Spray application of herbicides should only be undertaken by trained individuals with the appropriate personal protective equipment. © Tim Rudman





8.3

8.3 Monitoring weed management works

All weed management works require regular maintenance for years afterwards. It is essential to monitor the area, at least annually, for new weeds and spread of existing weeds into new areas. Community groups can play an important role in monitoring but should be supported by land managers and other community coordinators.

Inspection and maintenance should involve:

- photopoint photos
- mapping changes to weed distribution and extent
- checking for germinants (e.g. seedlings)
- checking for regrowth of previously treated plants
- searching for new weed invasions
- determining what ongoing works are required and when.

Marking weed-infested sites with information signs can be useful to inform all land managers, contractors and users of the presence of weeds and the management techniques required to minimise their spread. **Refer to section 7.3.6 Marking sites for protection or management.**

Tasmanian Weed Alert Network

The Tasmanian Conservation Trust (TCT) has received funding from the Tasmanian Community Fund to re-establish the Tasmanian Weed Alert Network during 2009–2011. The project is being run in collaboration with the Department of Primary Industries, Parks, Water and Environment's Weed Management Section, Tasmanian Herbarium, Tasmanian Farmers and Graziers Association and the Tasmanian Weed Society. This project aims to establish the Tasmanian Weed Alert Network as a self-sustaining network of volunteers which assists with preventing the establishment of new weeds in Tasmania.

8.4 Phytophthora root rot

This section provides information on an important soil-borne disease in Tasmania. Phytophthora root rot (*Phytophthora cinnamomi*) is a key management issue in the relatively warm and moist lowland parts of Tasmania. It is a microscopic pathogen (disease-causing organism) that can be spread by moving soil and infected machinery and vehicles.

P. cinnamomi spores and infected root material can be transported in minute quantities of soil the more soil is moved, the more risk of infection increases. Machinery, especially earth-moving equipment, vehicles, infected planting stock and the movement of infected soil or gravel, produce the greatest risk of infestation of native vegetation.

P. cinnamomi (root rot or die-back) is listed as a key threatening process in the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999*. A national *P. cinnamomi* threat abatement plan has been prepared and is supported by national guidelines.

The pathogen is recognised as being a very real and rapidly spreading threat to many of Tasmania's plant species and communities. It has the capacity to kill a wide variety of native plant species and is widely recognised as one of the most threatening of all disease epidemics to affect native plant communities anywhere on the globe (Schahinger et al. 2003).

Signs of phytophthora infection include patches of dead or dying peas and heaths, often extending down slopes and showing older areas of mortality towards the centre. Sedges and grasses remain unaffected.

In areas with phytophthora root rot, follow procedures outlined in the *Interim Phytophthora cinnamomi management guidelines* (Rudman 2005).

8.5 Weed and disease hygiene

See also section 5.3 Plant Disease Management in the *Tasmanian reserve management code of practice* (PWS et al. 2003).

P. cinnamomi Management Areas have been designated to protect plant communities and species that are highly susceptible. The locations of these and maps of areas infested with or susceptible to phytophthora are at the DPIPWWE weeds website.

Vulnerable vegetation types include coastal heathlands, heathy eucalypt woodlands and buttongrass moorland. Phytophthora root rot is unlikely to be an issue in wetland or foreshore beach vegetation.

The best way to prevent the spread of phytophthora is to clean all tools and machinery before entering and leaving work sites. **Refer to section 8.5 Weed and disease hygiene.**

Figure 8.6 Evidence of die-back in grass trees due to phytophthora root rot disease. © Tim Rudman



This section highlights the importance of good weed and disease hygiene, which is critical in coastal areas to avoid introducing weeds and diseases in imported materials and spreading weeds or diseases from an infested area to an uninfested area on vehicles, machinery, other equipment and clothing.

Mulches are often used to prevent the spread of weeds onto bare patches of soil. It is important to ensure that imported landscape materials such as mulches are free of weeds and diseases – ask for a statement from the vendor. Mulches tend to be made from a variety of products with varying origins and may contain weed propagules (e.g. seeds or root fragments). Use mulches made from single products (e.g. gum bark) or which are heat treated in some way (avoid materials treated with chemicals or irradiation, which may harm the natural vegetation).

Avoid slashing in weed infected areas when seed heads are mature, to reduce the risk of spreading the weed on-site and collecting seeds on machinery that could be transported to new sites.

Wash down tools, machinery and personal equipment when moving between work sites. This is particularly important when a site is known to be either infested or free of weeds and disease. Although wash-down procedures take time, they will soon save time and money by greatly reducing future weed and disease management needs.



Washdown is advisable:

- before entering a new site
- after operating in an area affected by a weed or disease
- after transporting weeds or soil known to be infected with weed seeds or a plant pathogen
- before moving machinery along roadsides or river banks
- before transporting soil and quarry materials.

Washdown standards are detailed in DPIPWE *Tasmanian washdown guidelines for weed and disease control* (Rudman et al. 2004).

Personal equipment and small tools

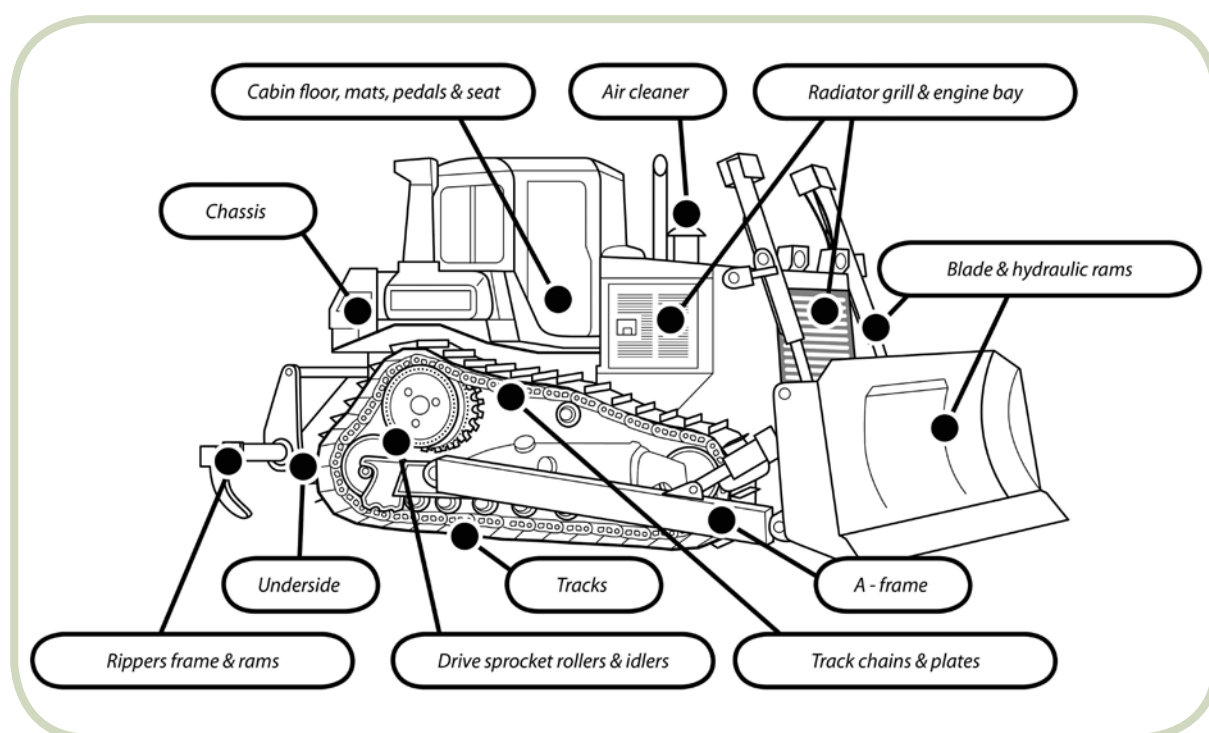
Portable washbaths are recommended for washing footwear and small tools.

Washbaths can be made from a fish box (or other suitably sized plastic box) fitted with an open weave plastic doormat, a scrubbing brush, a pair of safety gloves, glasses, detergent or fungicide, and a container of clean water. For backpacking, a 2L bottle, scrubbing brush, safety gloves and glasses can be used for washing small tools and boots.

A biocide such as F10SC or Phytoclean™ should be added to washbaths to control the spread of pathogens and disease (e.g. *P. cinnamomi*) if required.

Figure 8.7 Important washdown points on vehicles and machinery to control the spread of weeds and diseases.

© DPIPWE





Machinery

Permanent commercial washdown stations are installed in most large towns.

Portable washdown stations can be taken out into the field and involve a tank and pump fixed to a trailer. A shovel, crow bar and stiff brush are also required. Where a blowdown only is required, compressors or portable blower vacs may be used along with a small brush.

Ensure the siting of the portable washdown station will minimise the potential to spread weeds and diseases. Choose sites at the edge of the work site where the land slopes back into the infested area and will not enter a watercourse. Mud free sites are best but avoid sensitive vegetation.

General washdown techniques for machinery:

- remove cover plates etc that can be quickly and easily removed and replaced
- ensure no clods of dirt or loose soil are present after washdown (smeared soil stains are acceptable)
- ensure radiator grills and the interior of vehicles are free of accumulations of seed and other plant material.

Note that some machinery, such as harvesting equipment, cannot be washed with water because of potential damage to sensitive electronic equipment. Always consult and comply with the manufacturer's recommended cleaning method. Such equipment can be treated with an air compressor.

8.6 Climate change and weeds and disease in Tasmania

This section summarises some of the potential impacts of climate change on weed and disease in Tasmania and recommended management approaches.

There may be unexpected and complex changes with weeds and diseases as Tasmania's climate varies into the future. The complex interactions between climate, carbon dioxide (CO₂), plants, pathogens and competition amongst species are not well understood.

Some current weeds and diseases may be less favoured by the changing conditions and others may thrive. New problems could also emerge as some vegetation communities may have less capacity to dominate existing weeds. Vegetation communities may become more susceptible to disease or weed invasion as new niches become available if ecosystem function degrades. For more information see *Vulnerability of Tasmania's natural environment to climate change: An overview* (DPIPWE 2010).

As the scale of climate shifts and the effects of carbon dioxide on plants are better understood, the way agencies and land managers approach weed and disease management will need to change. For instance, *P. cinnamomi* may become active in susceptible wet forest or rainforest communities at low elevation. If so, authorities would need to be prepared for this, and rehabilitation plans would need to consider using the best-adapted stock rather than stock of local provenance.

Weeds may spread to new areas of the state and decisions about which weeds to control will need to consider new potential and emerging threats. As weed problems change, reporting new incursions



will be a critical early warning system for effective management.

For the time being, management should continue dealing with the current problems but, increasingly, climate risk management guidelines will become available to aid preparation for emerging new threats. However, the highest priority now is to maintain healthy diverse ecosystems, to foster resilience and maintain the biological links across the landscape. Weed and disease management should support this through the principle of working from the most intact to the least intact areas, and addressing the most damaging and potentially damaging invasive species.

8.7 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**.

Weed identification

Alert List for Environmental Weeds

<http://www.weeds.gov.au/publications/guidelines/alert/index.html>

Bush invaders of south-east Australia (Muyt 2001)

Coastal weeds of Tasmania: Are you growing invaders? (Connolly 2003)

A booklet containing descriptions and management recommendations for 50 environmental weeds and a list of alternative Tasmanian native coastal plants for use in garden plantings.

Community Coastcare handbook. (Thorp 2005)

Photo comparisons between weeds and similar-looking native species

Environmental weeds: A field guide for SE Australia. (Blood 2001)

Natural Values Atlas

Maps and records of recorded vegetation values

<http://www.dpipwe.tas.gov.au/>



WeedDeck

Handy pocket sized ID cards of the major weeds of Australia

<http://www.sainty.com.au/>

Weeds of the south east: An identification guide for Australia (Richardson et al. 2006)

Weed management

A field manual for surveying and mapping nationally significant weeds (McNaught et al. 2006)

Australian weeds strategy – A national strategy for weed management in Australia (Natural Resource Management Council 2006)

Coastal weed strategy for the Cradle Coast natural resource management region (Coastal Weeds Working Group 2008)

DPIPWE Codes of practice and guidelines

Information for using herbicides on the website

www.dpipwe.tas.gov.au Go to Biosecurity > Agricultural & Veterinary Chemicals > Codes of Practice & Guidelines

- Code of practice for ground spraying
- Code of practice for spraying in public spaces
- Guidelines for disposing of washings and rinsates
- Rivercare guideline for the use of herbicides near waterways and wetlands
- Guidelines for interpreting labels

DPIPWE weed control guides

Control guides for specific weeds replace the former weed service sheets and are available online.

www.dpipwe.tas.gov.au Go to > Weeds, Pests & Diseases > Weeds > Weeds Index

DPIPWE weed information

Information on the website includes Approved Statutory Weed Management Plans, the *Strategy for the management of rice grass (Spartina anglica) in Tasmania, Australia* (DPIWE 2002) and *Weed plan: Tasmania's weed management strategy* (DPIWE 2005).

www.dpipwe.tas.gov.au Go to > Weeds, Pests & Diseases > Weeds

Introductory weed management manual

(Cooperative Research Centre for Australian Weed Management et al 2004)

Southern Tasmanian weed strategy (Schrammeyer 2005)

Contains descriptions and management recommendations for 80 environmental weeds.



Tasmanian beach weed strategy (Rudman 2003)

www.dpipwe.tas.gov.au Go to Weeds, Pests & Diseases > Weeds > Weed Legislation and Management Plans > Tasmanian Beach Weeds Strategy

Tasmanian Bushcare Toolkit, Kit 3, Weeds in your bush. (Glazik & Rudman 2002)

Tasmanian Institute of Agricultural Research (TIAR) Biological Control Program

A joint venture between the University of Tasmania and DPIPWE

<http://www.tiar.tas.edu.au/extensive/biological-control-of-weeds>

Tasmanian reserve management code of practice (Parks and Wildlife Service et al. 2003)

Tasmanian Skills Institute. Chemical Handling Training

Contact Loretta Satterly on (03) 6434 5846.

Weed and disease hygiene

Conservation of Tasmanian plant species & communities threatened by *Phytophthora cinnamomi*: Strategic regional plan for Tasmania (Schahinger et al. 2003)

Keeping it clean: A Tasmanian field hygiene manual to prevent the spread of freshwater pests and pathogens (Allan & Gartenstein 2010)

Interim *Phytophthora cinnamomi* Management Guidelines (Rudman 2005)

Management of *Phytophthora cinnamomi* for biodiversity conservation in Australia: Part 2 . National best practice guidelines. (O'Gara et al. 2005)

<http://www.environment.gov.au/biodiversity/invasive/publications/pubs/part2.pdf>

Management areas *P. cinnamomi* and maps of infected areas

www.dpipwe.tas.gov.au Go to Weeds, Pests & Diseases > Plant Diseases > Phytophthora > Distribution of *P. cinnamomi*

Tasmanian washdown guidelines for weed and disease control. (Rudman et al. 2004)

Detailed procedures for preventing the spread of weeds and diseases from tools and machinery

Threat Abatement Plan for dieback caused by the root-rot fungus *Phytophthora cinnamomi* (Environment Australia, 2002)

A national threat abatement plan

<http://www.environment.gov.au/biodiversity/threatened/publications/tap/pubs/phytophthora.pdf>

9

Fire management



- 9.1 *Bushfires*
- 9.2 *Fire hazard reduction*
- 9.3 *Ecological burns*
- 9.4 *Climate change and fire*
- 9.5 *Tools and resources*

This chapter deals with fire hazard reduction and fire management as tools for maintaining coastal vegetation communities, how to reduce impacts on coastal areas when fighting fires, and potential climate change issues.

Fire is a fundamental aspect of the Australian environment and many vegetation types require periodic fire to maintain ecological values. However, not all fires are desirable. They can threaten human life and property, cause ecological damage (if too frequent or too intense) and cause temporary reduction of air quality or disruptions to the public.

Coastal vegetation communities in Tasmania are fire prone and are generally well adapted to fire. However, fire is not desirable in all vegetation communities and fire regime requirements (the combination of season, intensity and frequency of burning) vary from one vegetation type to another. For example, in some vegetation types, fires occurring too frequently can bring about long-term changes in vegetation community structure, introduction of weeds and destabilisation of dunes.

Fire management is more than just controlled burning, it is how land managers and fire authorities respond to wildfires: manage fuel, ecology and community expectations; and facilitate recovery once a fire has passed.

There are three key fire management agencies in Tasmania, The Tasmania Fire Service (TFS), the Parks and Wildlife Service (PWS) and Forestry Tasmania (FT). These agencies work together under the Inter-Agency Fire Management Protocol and are responsible for responding to wildfires and undertaking year-round fire management.

*Tab photo: Managing fire on King Island.
© Parks and Wildlife Service.*



Local councils and private landholders are also responsible for managing fire hazards on their land.

The primary objective for fire management is to protect human life and property. Other important objectives include maintenance of natural diversity and protection of conservation values, but these can only be pursued in so far as they are consistent with the primary objective.

Climate change projections indicate that south-eastern Australia is likely to become hotter and drier. Tasmania may not feel the impact of this as strongly as the other south-eastern states but more frequent extreme-weather days are likely to occur, thus increasing the risk of wildfire.

This chapter deals with the special considerations required for fire management in coastal areas, particularly near the shoreline. It must only be used in conjunction with the suite of guidelines available from the TFS and in consultation with fire authorities and experts.

9.1 Bushfires

This section deals with minimising impacts of bushfire-fighting on the coastal environment. For comprehensive information on bushfires and wildfires, consult the TFS.

Uncontrolled bushfires can threaten lives, houses and other property, and put native vegetation and animals at risk. Landowners and land managers have a responsibility to reduce the threat of bushfire through careful planning and fire hazard reduction, and to minimise the environmental impacts of firefighting.

Fire can move very rapidly in dry coastal vegetation and residents need to be prepared for this. Leaving their home can be risky unless roads are clear. This is

especially true in long, narrow shoreline subdivisions with only one access road or a limited number of very narrow roads.

Beaches are not necessarily safe from fire, as coastal dune vegetation is highly flammable (e.g. marram grass and coast wattle). Even the dry seaweed on a beach can burn.

Being prepared for bushfire in coastal areas involves planning and obtaining specialist advice well before bushfires are expected. The local fire brigade can provide on-ground advice about fire permits, burning off and local vegetation.

Other land management activities may increase the risk of destructive fires, such as leaving piles of combustible materials on sites, allowing weeds to prevail, allowing fuel loads to build up and not providing or allowing for adequate access for firefighting equipment. **Refer to section 9.2 for information on fire hazard reduction.**

9.1.1 Guidelines to reduce impact on coastal areas when fighting fires

When fighting fires public safety and protection of infrastructure is paramount, but the following guidelines will help to minimise impact on fragile coastal areas.

- Minimise disturbance of vegetation and dune profiles – sand or very sandy soils in dunes and beaches are easily destabilised.
- Use existing roads and fire breaks as control lines wherever possible, to minimise construction of additional control lines.
- Rehabilitate any disturbance to dune and shoreline profiles, and damage to vegetation. If machinery must encroach onto these fragile areas, ensure that restoration of the dune profile and

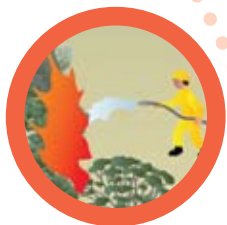


rehabilitation of the vegetation are undertaken as soon as possible once the fire has passed, and as part of the rehabilitation works program. **Refer to Chapter 6 Coastal landscape management and Chapter 7 Vegetation management.**

- If possible, consult specialists and obtain information about natural and cultural values in the area.
- Avoid damage to Aboriginal cultural heritage values such as middens.
- Avoid damage to fragile penguin or shearwater rookeries.
- Keep vehicles off beaches known to host shorebird populations (breeding season, from September to March, coincides with bushfire season).
- Avoid introducing weeds and diseases on machinery and equipment. Ensure all equipment is maintained clean and mud-free, including personal equipment such as boots.
- Keep vehicles off saltmarsh areas. These highly fragile environments often support rare and threatened vegetation and are important for waterway health. Vehicles and machinery can have a severe impact on saltmarsh, which is difficult to rehabilitate.
- Minimise risk of fuel and chemical spills: secure chemicals securely during transport and service machinery away from waterways, wetlands and saltmarsh.
- Remove any rubbish as soon as practicable.
- Avoid leaving debris in penguin and shearwater rookeries, as it may obstruct birds' access to their nests.
- Work with local community groups such as Coastcare when planning rehabilitation of burnt-out areas. They can be a great source of knowledge and have a strong sense of ownership of their local patch.

Figure 9.1 The immediate aftermath of a fire on King Island. © Parks and Wildlife Service





9.2

9.2 Fire hazard reduction

This section deals with maintaining vegetation in coastal areas to reduce the threat of bushfires. Fire management near the shore requires special care, especially in sand or very sandy soils, which are easily destabilised – it is important to minimise disturbance of the soil. In addition, changeable weather and sea breezes need to be taken into account.

Increased fire frequency due to arson and accidental fires can be detrimental for coastal areas. Some coastal plants, such as the Oyster Bay pine, are easily killed by fire.

Managing fuel loads through slashing, prescribed burns and constructing access tracks are often essential components of fire management. These works should be governed by a fire management plan that includes a risk assessment, prepared in consultation with specialists, to balance the impacts on all values in the area.

9.2.1 Legislation and approvals for fire hazard reduction

In addition to the legislation in **Appendices 1 and 2**, fire management activities must abide by the *Fire Service Act 1979* which states that all landowners/occupiers have a responsibility to maintain their properties to reduce fire hazard.

Permission from the landowner is required for any fuel hazard reduction work; in the case of prescribed burns the TFS should also be consulted. Approvals from Aboriginal Heritage Tasmania and other government agencies may also be required if the work has the potential to impact on other environmental and cultural values.

Depending on the location and vegetation type, there are a number of fire danger prescriptions that must be considered prior to burning. These are set out in the publication *Planned burning in Tasmania* –

Figure 9.2 Back burning on King Island. © Parks and Wildlife Service





operational guidelines and review of current knowledge (Marsden-Smedley 2009).

9.2.2 Methods and potential impacts of fire hazard reduction

Methods of fire hazard reduction include prescribed (planned) burns, slashing, mowing, grazing and mechanical removal of fuel. Prescribed burns should only be undertaken in consultation with fire management authorities.

Fire management works can cause environmental damage by:

- removing vegetation
- increasing erosion
- spreading weeds and diseases on equipment and vehicles
- harming native plants and animals
- harming Aboriginal heritage and historic heritage
- removing wildlife habitat (e.g. prickly bushes protecting penguin burrows).

A well-researched and balanced risk assessment will minimise any impacts of fire management on natural and cultural values on the coast. Generally, the impacts of carefully managed fire management works are far more beneficial than the consequences of high-intensity wildfire in areas where no works have been undertaken.

The use of fire as a vegetation management tool in coastal areas should only be undertaken by trained professionals in consultation with a fire ecologist. The use of fire in coastal areas by private landowners is not recommended.

9.2.3 Guidelines to minimise impact of fire hazard reduction on coastal areas

Environmental damage can be minimised when undertaking fire hazard reduction work, such as slashing vegetation and creating access and containment lines, by careful consideration of the values in the area and careful consultation and planning.

- Plan fire hazard reduction works and undertake a risk assessment, including consultation with specialists and fire experts. In particular, consult the Threatened Species Unit, and the Biodiversity Conservation Branch, DPIPW.
- Always obtain specialist advice from a fire ecologist before undertaking prescribed burns.
- Undertake a fuel hazard assessment prior to any prescribed burns, to target the specific fuel load/species and to enable measurement of success.
- Consult the local community care group to ensure that any hazard reduction work will not destroy their restoration and conservation efforts.
- Protect Aboriginal heritage values. Many coastal areas contain shell middens that are important Aboriginal heritage places. **Refer to Chapter 5 Cultural heritage management.** Fire should not be used in Aboriginal cultural heritage sites without consultation and permission. Contact Aboriginal Heritage Tasmania.
- Prevent the spread of weeds and diseases by machinery used to reduce fuel loads. Slashers and mowers are particularly notorious for trapping seeds and spreading them to new locations. It is essential to practise good weed hygiene to reduce the spread of weeds.



- Minimise disturbance of soil and ensure slashing, mowing and vegetation removal does not leave bare patches that can be invaded by weeds.
- Minimise disturbance of fragile dune systems, as they can be destabilised.
- Avoid damage to fragile penguin or shearwater rookeries.

Reduce the spread of weeds

- Plan fire hazard reduction works so that weed-free areas are dealt with first.
- Clean machinery, tools and even boots between sites.
- Only use contractors with a high standard of weed hygiene.
- Time slashing to discourage seed-setting of weed species and encourage seed-setting of native species. Sometimes this is achieved simply by moving activities by only a couple of weeks.

Table 9.1 Fire intervals for different coastal vegetation types for fire hazard reduction burns.

Vegetation type	TASVEG code	Recommended prescribed fire regime
Coastal heathland	SCH	8-30 years
Saltmarsh	AUS	No planned burning
<i>Acacia longifolia</i> coastal scrub	SAC	Unknown
Coastal scrub	SSC	10-30 years
Seabird rookery complex	SRC	Exclude fire
<i>Banksia serrata</i> woodland	NBS	8-30 years
Coastal grass and herbfield	GHC	5-20 years
Marram grassland	FMG	Exclude fire
<i>Eucalyptus amygdalina</i> coastal forest and woodland	DAC	6-20 years
<i>Eucalyptus viminalis</i> – <i>Eucalyptus globulus</i> coastal forest and woodland	DVC	6-30 years
<i>Callitris rhomboidea</i> forest (Oyster Bay pine)	NCR	No planned burning
<i>Acacia dealbata</i> forest	NAD	Unknown
<i>Allocasuarina verticillata</i> forest	NAV	Not necessary

The fire regimes that best maintain a particular vegetation type vary with the condition of the vegetation. Please note that these are only recommended regimes that require ongoing monitoring. Adapted from *Tasmanian Bushcare Toolkit, Kit 2, Managing your bush* (Kirkpatrick et al. 1999).



9.2.4 Monitoring hazard reduction work

All hazard reduction works require regular ongoing monitoring and maintenance to make sure they are effective.

Inspection and maintenance should check:

- whether fuel hazards are still present
- whether rehabilitation is required (e.g. for soil erosion or vegetation, or weed invasions)
- the impacts on or response of natural and cultural values to the burn (ongoing monitoring)
- what further works are required and when.

Land managers should

- Identify and assess fire hazards and risks.
- Issue hazard abatement notices to landowners.
- Prepare fire management plans for larger vegetated coastal reserves and areas.
- Play a role in community education of bushfire response and hazard reduction in conjunction with the Tasmania Fire Service.
- Assess and monitor all coastal revegetation projects to ensure there is no unacceptable increase in the bushfire risk to public and private assets and that they do not compromise the effectiveness of firebreaks, fire trails and other fire abatement measures.

Local councils can:

- Use the local planning scheme to ensure developments have adequate bushfire protection and are excluded from areas where this cannot be provided.
- Ensure that developments enable creation of defensible space with minimal vegetation removal.
- Not permit new developments if fire protection requires clearing of adjoining coastal reserves.

9.3 Ecological burns

This section deals with fire as a useful management tool for maintaining the diversity of coastal vegetation communities where biodiversity is at risk of declining. For instance fire can help to preserve plant species diversity in coastal heathlands and some plants, such as many acacias and eucalypts, need fire for seeds to germinate.

An ecological burn is a specialised prescribed burn that targets a particular vegetation community or species in a particular area to achieve specified ecological objectives.

Ecological burns are a complex, specialised management tool that should only be used under the guidance of a fire ecologist and in consultation with the state fire authorities. Ecological burns should be part of a comprehensive community/species recovery plan, including a biodiversity monitoring system and the identification of an appropriate fire regime, based on the requirements for that particular community/species.

9.3.1 Planning for ecological burns

Planning for ecological burns involves identifying and monitoring a range of parameters, from fuel characteristics and weather; moisture and landscape qualities to ecological objectives, and requires consultation with a fire ecologist and other specialists.

Ecological burning has two aims:

- to increase and/or promote fire-dependent species or associations (e.g. the foraging habitat of orange-bellied parrots requires periodic burning)
- to reduce and/or remove unwanted species or associations (e.g. weeds).



9.3

These aims typically include:

- species regeneration (the frequency used will vary between different species)
- habitat manipulation to increase native animal food availability (e.g. New Holland mouse)
- development of mosaics of burnt and unburnt areas.

Ecological burning is used in coastal heathland in north east Tasmania to maintain habitat for the New Holland mouse.

The threatened New Holland mouse, *Pseudomys novaehollandiae*, lives in coastal heathland in north-east Tasmania and benefits from regular firing of its habitat. Numbers increase soon after fire, as this releases the seeds that are the mouse's main food source. However, if another fire occurs before the new plants can produce seed, then the mouse will be left with little food and the population will be at risk.

Figure 9.3 New Holland mouse. © Billie Lazenby





9.3.2 Fire as a weed management tool

Fire can be used as a weed management tool but it requires careful organisation and must be integrated with other techniques to ensure weed regeneration is not stimulated by fire.

To protect other natural values, fire should only be used for weed management under the direction of a fire ecologist and in consultation with fire authorities.

In Tasmania, the main species for which fire is used for weed management are gorse (*Ulex europaeus*) and, to a lesser extent, broom (*Cytisus* spp. and *Genista* sp.), Spanish heath (*Erica lusitanica*) and blackberry (*Rubus fruticosus*) (Marsden-Smedley 2009).

Weeds should be treated by mechanical or chemical means prior to burning. The increased fire intensity caused by piles of slashed weed can be beneficial in killing shallowly buried seeds and can enhance seedling germination of more deeply buried seeds, to enable follow-up treatment (Marsden-Smedley, 2009).

Fire will result in extensive areas of bare ground, requiring revegetation to reduce the subsequent reinvasion by weeds. The costs associated with this type of intensive weed management are such that it will probably only be justified in areas adjacent to, or within high value ecological or natural assets (Marsden-Smedley, 2009).

9.3.3 Monitoring of ecological burns in coastal areas

After a fire, monitoring is important to see whether the ecological burning objectives were achieved, and to check for any damage to ecosystems. A comprehensive monitoring plan should be developed in consultation with specialists. In addition to the monitoring requirements prescribed in the plan, inspection and maintenance should also check:

- progress of natural regeneration
- damage such as weed invasions or soil erosion
- dune erosion and destabilisation - look for ripples on the sand surface, which are reliable indicators of erosion.

9.4 Climate change and fire

Anecdotally, there have been increased dry lightning storms igniting more wildfires; however, these are generally not in coastal management zones. The biggest fire risk in coastal areas continues to be human activity – both arson and accidental fires.

There is a broad increased risk of larger areas being burnt by wildfire as the number of extreme weather days increases. Predicted increasing numbers of drought years will also affect the ability of species to recover after fire.

There are concerns that drier summers are more likely for western Tasmania, which will increase the length of the fire season and the number of vegetation types dry enough to burn – including fire-sensitive vegetation.

There is potential for shorter intervals between fires, with more summer burning, especially in fire-adapted



vegetation communities such as coastal heath. Some species may not have time to replenish their seedbank, or even set seed before the next fire (if intervals are less than five years). This will result in changes to habitat structure and flow-on impacts for the whole ecosystem.

Changes in vegetation response to fire may mean that fire management strategies and protocols that were designed for existing fire regimes will become less applicable.

Community perception of increased fire risk could readily lead to higher demand for hazard-reduction activities on public land. Poorly planned mechanical fire breaks may cause erosion and weed management issues. Increases in fuel hazard reduction and fire abatement activities, such as frequent prescribed burns, could lead to worse ecological impacts than those created by the natural changes associated with climate change (Dunlop & Brown 2008).

9.5 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**.

Bushfires

Bureau of Meteorology

Up-to-date weather forecasts and some climate change predictions

<http://www.bom.gov.au/tas/>

Emergency Services

Phone 000

Tasmania Fire Service (TFS)

Local advice and permits

Includes bushfire information and publications about hazard reduction and planned burning.

Phone 1800 000 699

www.fire.tas.gov.au

Guidelines for development in bushfire prone areas of Tasmania. Living with fire in Tasmania (Bushfire Planning Group, Tasmania Fire Service, 2005)



Fire hazard reduction

Aboriginal Heritage Tasmania

Desktop searches for Aboriginal heritage sites

www.aboriginalheritage.tas.gov.au

Overall fuel hazard guide for South Australia

(Department for Environment and Heritage, SA 2008)

Fuel hazard assessment standards

Planned burning in Tasmania: Operational guidelines and review of current knowledge. (Marsden-Smedley 2009)

This document must be consulted if planning a controlled burn.

Tasmanian reserve management code of practice

(Parks and Wildlife Service et al. 2003)

The broad principles for fire management set out in the Tasmanian reserve management code of practice are appropriate guidelines for all vegetation types including coastal vegetation.

Ecological burns

In addition to the resources listed above the following are useful if considering ecological burns.

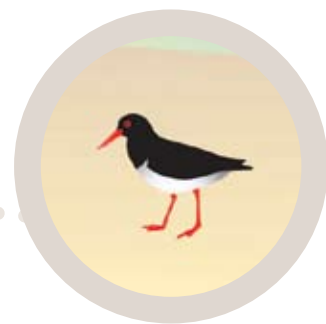
Flammable Australia: The fire regimes and biodiversity of a continent (Bradstock et al. 2002)

Tasmanian Bushcare Toolkit, Kit 2, Managing your bush (Kirkpatrick et al. 1999)

Bush information and management

<http://www.dpipwe.tas.gov.au> Go to Home > Managing Our Natural Resources > Bush Information and Management > Tasmanian Bushcare Toolkit





10 Wildlife and pest management

10.1 Conservation of coastal wildlife and marine animals

10.2 Seabirds

10.3 Shorebirds

10.4 Injured and orphaned wildlife

10.5 Feral animals and introduced pests

10.6 Climate change, wildlife management and pests

10.7 Tools and resources

This chapter deals with the special considerations required for wildlife management on or near the shoreline and in marine environments, with special reference to threatened species, particularly sensitive wildlife values and the significant threats posed by feral animals and marine pests.

Tasmania's diverse coastal, estuarine and marine ecosystems support a rich variety of coastal and marine life including shorebirds and seabirds, seals, whales and globally significant marine assemblages. This includes a number of threatened species, such as the spotted handfish (endemic to Tasmania), fairy tern and southern right whale. Many of these animals are highly adapted to and dependent on the coastal environment, whilst some species are found in other habitats too.

Native wildlife is important in environmental terms and is highly valued as part of the richness of Tasmania's coastline. The protection of wildlife and marine species is an essential component of any coastal works activity. Sometimes the purpose of coastal works is to assist in the protection of wildlife species from threats and human disturbance.

Many aspects of wildlife management away from the immediate shoreline are the same as further inland. More care, however, is necessary in the immediate coastal zone and intertidal area, as many species are highly adapted and cannot survive anywhere else. Increasing human use of coastal areas in most parts of Tasmania, and climate change impacts such as sea level rise and changes in ocean currents, make it more important than ever to protect coastal wildlife and habitat.

*Tab photo: Pelicans at Musselroe Bay, northern Tasmania.
© Kathy Noble.*



10.1

10.1 Conservation of coastal wildlife and marine animals

This section provides information on the spectrum of wildlife values in the coastal and marine environment, with particular attention to threatened species. Tasmania has vast areas of natural coastline that provide habitat for many diverse and specialised coastal animals.

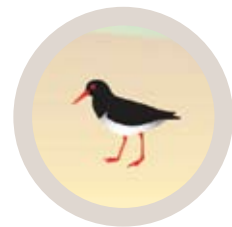
Many birds frequent our coastlines. Little penguins nest in sand dunes, on rocky shores, under dense

vegetation and on offshore islands; migratory shearwaters nest in soft soils on the steeper headlands. Hooded plovers and other shorebirds breed along many of the more remote beaches, while terns, shy albatross, gannets and many other seabirds breed on offshore rocks and islands.

New Zealand and Australian fur seals haul out on offshore islands. Humpback and southern right whales migrate along Tasmania's east coast. Pilot whales, dolphins, sperm whales and killer whales are all visitors to our coastal waters and, sadly, some species sometimes strand on the Tasmanian coast.

Figure 10.1 Humpback whales are frequent visitors to Tasmanian waters on their annual migration along the east coast.
© Biodiversity Conservation Branch DPIWE





Many terrestrial mammals also inhabit coastal areas: echidnas, wallabies, bettongs, bandicoots and eastern quolls are common, even in more urban environments. Reptiles, skinks and snakes live throughout Tasmania's coastal areas, with some species unique to offshore islands, and frogs inhabit coastal wetlands.

Tasmania's marine environments contain some of the most distinctive flora and fauna (marine assemblages) in the world. Many of these species are endemic to Tasmanian waters (i.e. not found anywhere else in the world). In fact, Tasmanian temperate waters have globally significant levels of endemism (DPIWE 2000b). A number of marine protected areas around Tasmania have been established to help protect these unique temperate species. These reserves are managed under the *Living Marine Resources Management Act 1995*. Some reserves are subject to 'no take' fishing restrictions, defined by the Fisheries Rules 1999.

In many coastal areas, increased pressure from development and human use of coastal resources results in permanent destruction and loss of habitat, which threatens coastal and marine wildlife. Other pressures include wandering cats and dogs, feral animals, marine pests, litter, pollution, sea level rise and other climate change impacts that may see changes in marine assemblages, vegetation communities and wildlife habitat.

10.1.1 Legislation

All Tasmanian species are protected under the *Nature Conservation Act 2002*; marine species are protected under the *Living Marine Resources Management Act 1995*.

Legislation that specifically relates to threatened species protection is listed here. **See also Chapter 1 Working on the Coast and Appendices 1 and 2 for more detailed legislative information.**

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* lists threatened species and ecological communities; migratory species and threatening processes; and prepares recovery plans, wildlife conservation plans and threat abatement plans (TAPs).

The *Threatened Species Protection Act 1995* provides for the protection and management of threatened native flora and fauna and promotes the conservation of native flora and fauna.

10.1.2 Tasmanian threatened species on the coast

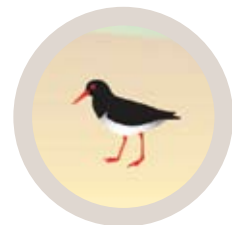
'Threatened species' refers to those species listed under the *Threatened Species Protection Act 1995*. Some listed species have recovery plans and there are also threat abatement plans that cover threats common to a number of species.

Tasmania's coastline is home to more than 35 threatened fauna species including the white-bellied sea eagle (*Haliaeetus leucogaster*), shorebirds and seabirds such as the little tern (*Sterna albigrons sinensis*) and fairy tern (*Sterna nereis*), and mammals such as the New Holland mouse (*Pseudomys novaehollandiae*), New Zealand fur seal (*Arctocephalus forsteri*) and many whale species, including the southern right whale (*Eubalaena australis*). Threatened invertebrates include the live-bearing seastar (*Parvulastra vivipara*) and the chequered blue butterfly (*Theclinessthes serpentata lavara*).

Many species declared as threatened in Tasmania are also protected under Commonwealth legislation. Table 10.1 lists a number of threatened fauna species that live on the coast and their key threats (but this is not a comprehensive list).

Table 10.1 Examples of threatened coastal fauna in Tasmania, their current status and key threats. (Not a comprehensive list.)

Common Name	Scientific name	Habitat	Status Tasmania	Status Commonwealth	Threats
Mammals					
New Zealand fur seal	<i>Arctocephalus forsteri</i>	Haul-outs around the coast	rare		Fishing entanglements, fisheries interactions (including aquaculture)
New Holland mouse	<i>Pseudomys novaehollandiae</i>	Prefers coastal heath vegetation (predominantly NE Tas)	endangered		Habitat loss and destruction, inappropriate fire regimes, predation by feral pests
Southern right whale	<i>Eubalaena australis</i>	Migrates annually through east coast waters	endangered	endangered	Habitat or resource destruction
humpback whale	<i>Megaptera novaeangliae</i>	Migrates annually through east coast waters	endangered	vulnerable	Habitat or resource destruction
Birds					
white-bellied sea eagle	<i>Haliaeetus leucogaster</i>	Nests on offshore islands and rocky headlands	vulnerable		Habitat destruction
little tern	<i>Sterna albifrons sinensis</i>	Breeding colonies on beaches under threat	endangered		Habitat loss and destruction, predation by feral pests, human impacts
fairy tern	<i>Sterna nereis</i>	Breeding colonies on beaches under threat	vulnerable		Habitat loss and destruction, predation by feral pests, human impacts
shy albatross	<i>Thalassarche cauta</i>	Offshore species	vulnerable	vulnerable	Long-line fishing
Fish					
spotted handfish	<i>Brachionichthys hirsutus</i>	Declining isolated colonies in Derwent Estuary and adjoining bays	endangered	endangered	Disturbance to seabed through dredging, pumping and marine development
Invertebrates					
chevron looper moth	<i>Amelora acontistica</i>	Saltmarsh in Cremorne and Lauderdale area	vulnerable		Habitat destruction: driving off-road vehicles on saltmarsh; stock grazing leading to displacement of native plants, weed invasion and soil compaction; changes to drainage pattern
chequered blue butterfly	<i>Theclinessthes serpentata</i> larva	Saltmarsh in Pittwater and Lauderdale area	rare		As per looper moth
live-bearing seastar	<i>Parvulastra vivipara</i>	Small number of locations on rocky intertidal in SE Tas	vulnerable	vulnerable	Loss of habitat due to development, collection



Everyone undertaking works on the coast has a responsibility to protect threatened species. Coastal land management activities must identify the presence of threatened species as part of planning and risk assessments and put in place measures to manage impacts from work activities on threatened species.

Conservation categories of threatened species

The following definitions apply under Tasmania's *Threatened Species Protection Act 1995*

Endangered: a species that is either:

- in danger of extinction because long-term survival is unlikely while the factors causing the species to be endangered continue operating

or

- presumed extinct on the grounds that no occurrence of the species in the wild can be confirmed during the past 50 years.

Vulnerable: a species that is likely to become endangered while the factors causing it to be vulnerable continue operating.

Rare: a species that has a small population in Tasmania which is not endangered or vulnerable but is at risk.

Figure 10.2 Fairy terns are listed under the *Threatened Species Protection Act 1995*. © Birds Tasmania





Nomination of a new threatened species

Threatened species status is under ongoing review. Anyone can nominate a species for consideration through an official nomination process. If a species recovers, the committee can remove it from the threatened species list.

The Tasmanian Scientific Advisory Committee (SAC) has produced a set of guidelines (or rule sets) based on scientific information which determines whether a species qualifies as being threatened (extinct, endangered, vulnerable or rare) in Tasmania. The criteria are based on internationally accepted definitions but are modified to suit the Tasmanian regional context.

10.1.3 Guidelines for protecting wildlife during coastal management works

Specific information for the protection of threatened species and significant species such as shorebirds and penguins is provided in other sections of this chapter.

Management and conservation of wildlife needs to be taken into account in development proposals and in all aspects of planning for works in coastal and marine environments in Tasmania. Consider the potential impacts of work activities on wildlife and marine species.

Coastal works that create disturbance to marine areas can have a devastating impact on the unique temperate marine assemblages. Localised sediment disturbance, pollution, and increases in nutrient levels can all have an impact on marine species.

Identify any marine habitats or values that might be affected by the works. Seek specialist advice and assessments and approvals where required. More complex coastal works such as shoreline protection structures will require a comprehensive assessment of

the marine values of the site and likely impacts.

Identify any wildlife values and habitats that may be affected by the work activity. Assessments and approvals may be required. Seek specialist advice.

Ensure works are properly supervised by qualified people and that follow-up surveys are done. Ensure all staff and contractors are aware of the operational constraints required to protect wildlife values and habitat.

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

Land management activities in coastal reserves and foreshore areas should promote biodiversity outcomes and reduce the impact of weeds and feral pests.

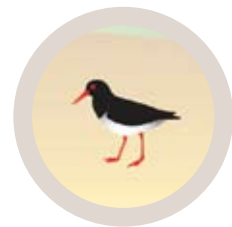
10.1.4 Special considerations for protecting threatened species

In addition to the guidelines in 10.1.3, the following matters must be considered in areas where threatened species are present.

It is an offence to take a threatened species without a permit. 'Take' includes kill, injure, catch, damage, destroy or collect and can include the destruction of critical habitat for a threatened species.

Consider potential impacts of coastal works on threatened species and critical habitats. Any development-related threats to listed species must be discussed with the Department of Primary Industries, Parks, Water and Environment (DPIPWE) Policy and Conservation Assessment Branch (PCAB), which is responsible for coordinating advice.

Before planning or undertaking works on the coast,



determine whether there are threatened species in the proposed work area.

- Search the EPBC database
- Search lists on the Department of Primary Industries, Parks, Water and the Environment (DPIPWE) website for locations of threatened species.
- Consult specialists in the Threatened Species Section of DPIPWE.
- Check for the existence of recovery plans for species in your work area, which can provide guidelines to ensure your works are complementary to species management work.

Make use of existing recovery and threat abatement plans prepared by specialists. These can provide guidance for protecting particular species such as procedures for vegetation clearance on coastal land.

Develop asset or area management plans, in consultation with specialists, which provide specified objectives and actions in areas known to support threatened species. Identify threatening processes and their impacts.

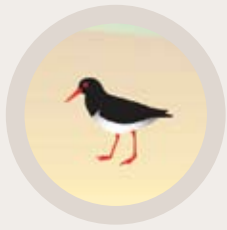
Monitoring is essential to maintain up-to-date information on threatened species and their habitat and to improve management outcomes. Be sure to incorporate monitoring protocols into any asset or area management plan. Report any occurrences of threatened species in areas outside of their known range to the Threatened Species Section, DPIPWE.

10.1.5 Relocating coastal species

Sometimes it is necessary to relocate coastal species, either for their own protection or for health and safety reasons. Seagulls, for example, can form large breeding colonies during August and September in locations such as ports or along railway lines or causeways.

Pest controllers are sometimes engaged by land management authorities such as Tas Ports to relocate the birds away from areas used for industry or transport. The relocation operations are expensive and are usually only undertaken when the damage caused by large numbers of birds and their excrement is very costly or when human health or safety are at risk.

Seagull faeces can harbour a number of diseases and can be very damaging to freight. Colonies along causeways are a hazard to motorists as fledgling birds fly across the road erratically.



Case Study 10.1: Protecting threatened seastars during construction works in south-east Tasmania

In 2002 the Department of Infrastructure, Energy and Resources (DIER) upgraded McGees Bridge on the Sorell Causeway at the Pittwater–Oriental Lagoon Ramsar site. DIER worked with the Tasmanian Parks and Wildlife Service and Threatened Species Section of DPIWWE to ensure that natural coastal values in the area would be protected.

As part of the assessment process it was confirmed that the sandstone footings of the old bridge were home to a population of the threatened live-bearing seastar, *Parvulastra vivipara* (formerly *Patiriella vivipara*).

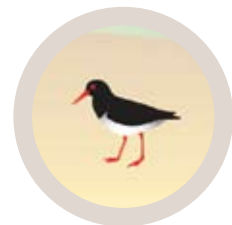
The seastar is restricted to discrete locations in south-east Tasmania because it reproduces by bearing live young and therefore does not have a dispersal stage.

To protect this unique and threatened species, teams of volunteers relocated thousands of seastars to a nearby rocky shoreline while construction work was under way.

In addition, the bridge design was modified to ensure that the surface of the new bridge footings would be suitable for the seastars. Once the work was finished, the seastars were collected and moved back to their original location.



Figure 10.3 Threatened live-bearing seastar *Parvulastra vivipara* © Bill Albion



10.2 Seabirds

This section provides information for protecting significant seabird species such as penguins and shearwaters. Threatened seabirds such as tern species are covered in **section 10.3** with shorebirds.

Penguins and shearwaters and their burrows are protected under the *Nature Conservation Act 2002*.

Potential impacts of climate change, in particular sea level rise and resulting erosion of coastal margins such as sandy beaches over the next 50 to 100 years, will compound existing conservation issues and will almost certainly have an impact on seabird habitat. Predicted sea level rise may flood the existing nesting, roosting and foraging habitats of many species.

10.2.1 Little penguins

Little penguins (*Eudyptula minor*) are small, flightless birds standing about 30cm tall, ranging in length from about 40cm to 45cm and weighing around 1kg. Their average life expectancy is approximately seven years, although there are records of some reaching over 20 years.

Little penguins come ashore after dark and return to the sea before first light to reduce exposure to predators.

Penguins colonise coastal areas that have suitable habitat and few predators. They can occupy coastal areas up to 500m from the shore and nest in a wide variety of habitats including both shallow and deep burrows, rock crevices and beneath dense

Figure 10.4 Moulting penguins are easily identified due to the amount of feathers around them and should be left alone.

© Perviz Marker





vegetation canopies, which shelter them from the sun and predators. A typical burrow consists of a tunnel 60–80cm long with a nest bowl at one end, large enough for a little penguin to stand in, even though the entrance may often be much smaller. Little penguins are opportunistic birds, nesting where they can achieve maximum shelter (Pryor & Wells 2009).

They breed between August and February, coinciding with an annual upsurge in marine productivity. The nesting period (around six to eight weeks), followed by the moult period (usually February to April) are particularly vulnerable times in the lives of little penguins, when they are most at risk of starvation or predation.

Understanding and considering the life cycle and habits of the little penguin when planning coastal management works will minimise any impacts on the species.

Moulting penguins

It is easy to mistake a moulting penguin for a sick or injured bird. In late summer and autumn 'scruffy-looking' penguins come ashore to moult. Usually these birds stand or rest by themselves in a sheltered area and are surrounded by freshly moulted feathers. Penguins at the start of moult are usually plump, with dull feathers sticking out from the body. They often appear hunched and 'miserable'. Birds well into moult have large patches of old feathers missing, with clean new feathers emerging.

A moulting penguin is best left alone. If it is threatened by dogs or people, contact the nearest Parks and Wildlife Service (PWS) office or the DPIPW Wildlife Hotline. If you must move the penguin, take care because they can bite when threatened. Keep it in a cool, secure, quiet place and do not handle or feed it.

Many species of sub-Antarctic penguins come ashore to moult on Tasmania's beaches. Report all instances of such events to DPIPW on the 24-hour Wildlife Hotline.

10.2.2 Threats to little penguins

Foxes and domestic and feral cats and dogs are highly destructive predators. Controlling them is essential for the survival of little penguins.

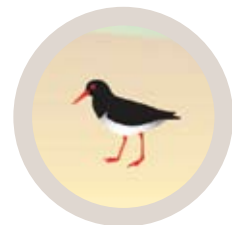
Marine debris and other forms of litter can be lethal to penguins. Discarded fishing nets, line and tackle and other plastic rubbish can entangle penguins and either choke or starve them to death. Oil and chemical spills also have a devastating effect on them.

Habitat loss to development and disturbance by removing shelter and nesting material, threaten the survival of little penguin colonies. Dumping of garden waste and other material can block access to burrows. Every year, many little penguins are killed on coastal roads adjacent to colonies.

Localised overfishing is a significant threat to little penguins, disrupting their feeding habits and making them go further offshore to get enough food to feed themselves and their young and prepare for their fast during the moult.

Grab-all nets (gillnets) are extremely destructive in two ways: they catch and kill all wildlife caught in them, which includes a large number of little penguins; and they disrupt the food chain on which seals, sharks and the little penguin rely, affecting breeding success. Gillnets are a threat especially when set near colonies.

Sea level rise will have an impact on available nesting sites, and increased frequency of extreme storm events and storm surges may result in destruction of existing rookeries, forcing penguins to relocate.



10.2.3 Protecting little penguins

Coastal land managers have a key role to play in the conservation of little penguin habitat, particularly around built-up areas. This role extends to training of planners, maintenance crews and natural resource managers and education of coastal user groups.

In areas with little penguin colonies, it is critical to protect birds when they are moving to or from the sea, by prohibiting dogs for one hour before and after sunrise and sunset from July to April.

Consider signage, fencing and other management approaches to educate residents and minimise impacts of dogs and cats on little penguins. Take into consideration the fact that it is preferable not to promote the location of some penguin colonies. Consult specialists at DPIPWE.

If penguins need to cross a road to access their colony and nests, consider management actions to

keep them off the road, and educate residents and road users. Consider fencing to keep penguins off the road or providing tunnels under the road so that penguins can safely access their burrows. A penguin tunnel has been installed at Eaglehawk Neck in collaboration with the local Coastcare group and has reduced the number of penguins being killed on the road.

10.2.4 Guidelines for working in little penguin habitat

New development applications must consider potential impacts on little penguins and their habitat.

Manage the timing of works and weed removal to minimise impact. Do not work in and around a penguin colony during breeding and moulting times, as the birds can be stressed and may abandon their nests if disturbed. The best months for works are usually from May to July, provided the birds have finished raising chicks and have completed their moult. Avoid works if any birds are present at the site.

When planning works in coastal areas adjacent to penguin colonies, you must consider the impact of lighting, noise and intense vibration on the penguins and minimise these impacts wherever possible.

Weed removal must be gradual, and combined with revegetation work, to ensure sufficient nesting habitat is always available. Prickly weeds are the only safe habitat for small marsupials and birds in many areas. Nesting penguins often shelter under African boxthorn, an invasive weed species.

Spraying of herbicides is not recommended in penguin colonies and should not be conducted in sites with sandy soils. Herbicides may persist within the soil, as the low organic content inhibits the breakdown of herbicides and may be harmful

Figure 10.5 Little penguin on eggs in burrow.
© Perviz Marker





to nesting penguins. If herbicide needs to be used, the cut-and-paste, scrape-and-paint or drill-and-fill methods are recommended, where appropriate (Pryor & Wells 2009).

The preferred species for revegetation in and around little penguin colonies generally include *Tetragonia implexicoma*, *Rhagodia candolleana* and *Poa* spp., but this depends on the site. *Acacia sophorae* is generally not suitable as its lower branches become rooted in the ground and are too entangled for penguins to negotiate (Pryor & Wells 2009). Information on appropriate species can be obtained from the Understorey Network.

Avoid leaving rock or gravel on the roadside during road work or other infrastructure activities as these obstacles can impede little penguins trying to cross the road.

Ensure that any rubbish from work activities is removed from the site at the completion of works. Provide adequate and appropriate rubbish facilities at boat ramps and other coastal facilities and ensure that they are serviced regularly.

Include local residents and community groups in planning for management actions to protect little penguins. Local residents can make a big difference to improving outcomes for little penguins by making changes in their behaviour, such as keeping dogs locked up and not modifying the foreshore environment.

10.2.5 Short-tailed shearwaters

Short-tailed shearwaters (*Puffinus tenuirostris*) are migratory birds that breed on Tasmanian headlands from September to April. They travel approximately 30 000km on their annual round trip from the Arctic region to south east Australia.

Approximately 23 million short-tailed shearwaters breed in about 280 colonies across south-eastern Australia with 18 million of these arriving in Tasmania each year. Adult birds will return to the same burrow throughout their lifetime.

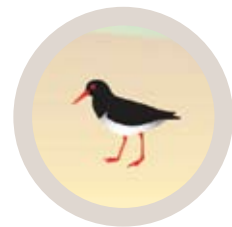
Colonies are usually found on headlands and islands, covered with tussocks and succulent vegetation such as pigface and ice plant or sea spinach. Headlands allow for easy take-off and landing. The largest colony is on Babel Island (part of the Furneaux Group in Bass Strait), which has around 3 million burrows.

Other colonies are less remote and are often associated with penguin colonies. Birds in their burrows are vulnerable to attack from feral animals and dogs that are allowed to roam free.

Short-tailed shearwaters are a very significant part of contemporary Aboriginal culture. Chicks (Tasmanian muttonbirds or yolla) are harvested annually from their burrows for their prized meat and oil. The chicks are taken under strict controls and the commercial season is limited to the period 27 March to 30 April. Many colonies are managed by the Aboriginal community in collaboration with DPIPWE.

Figure 10.6 Short-tailed shearwater. © Steve Johnson





Outside of these areas, protection of shearwater colonies and habitat can be achieved by following the guidelines for penguin habitat protection. It is important to keep machinery out of colonies as the burrows can be easily destabilised. Even walking around in colonies can be destructive: specialist advice and great care are needed for any access.

Shearwaters washed up on beaches

Short-tailed shearwaters are the most numerous bird found washed up on beaches from February to May each year, typically after a storm or a period of poor weather. At this time, chicks have fledged and are getting ready to migrate but cannot fly very well, so can fall and get washed onto beaches. Often they are starving, exhausted or even hypothermic.

Shearwaters should be placed in a box (*do not attempt to feed them*) and released at night on a beach (preferably from an elevated site) or taken into the nearest PWS office, or the Wildlife Management Branch of DPIPW at 134 Macquarie Street, Hobart (during office hours). Call the Wildlife Emergencies 24-hour Hotline for advice if necessary. **Refer to section 10.7 Tools and resources.**

10.2.6 Threats to shearwaters

Although there appear to be huge numbers of short-tailed shearwaters, they are still vulnerable to over-harvesting and habitat destruction. In places, pigs, cattle and sheep have destroyed whole colonies. Soil erosion after fire can destroy suitable sites for burrowing.

Gillnet fisheries in the North Pacific accidentally drown up to 50 000 birds annually.

Currently, approximately 200 000 chicks are harvested and sold annually in Tasmania by

commercial operators. Birds also ingest small plastic particles while at sea, which may limit their ability to maintain condition and will contribute to deaths during migration.

Feral cats and roaming dogs (and now foxes) are also a problem, as they find shearwater chicks easy prey.

Trampling of burrows by humans can also cause the death of birds. Similarly, erosion caused by recreational vehicles can destroy suitable sites for burrowing. It is important to keep off colonies.

Natural mortality occurs mainly during the first migration due to exhaustion and starvation. The average lifespan is 15–19 years but birds can live for up to 38 years (Parks and Wildlife Service website accessed 15th Sept 2010).

10.2.7 Protecting shearwaters

Because of the shearwater's international migratory habitats, the species has become the subject of a joint protection project between Japan and Australia – the Japan Australia Migratory Bird Agreement (JAMBA). Both countries monitor the shearwater population while the birds are in their area.

In Tasmania, limits are imposed to prevent over-harvesting and a number of wildlife sanctuaries protect shearwater colonies. Japan and other countries are attempting to minimise the number of birds drowned by their fishing operations. It is hoped that these conservation methods will ensure the survival of one of the world's most amazing migratory birds (Parks and Wildlife Service website accessed 15th Sept 2010).



10.3

10.3 Shorebirds

This section provides information for minimising impacts on migratory and resident shorebirds. Small seabirds such as little and fairy terns are also considered here, due to their nesting behaviour on sandy beaches.

Shorebirds are coastal birds that breed on beaches and forage on the shoreline and in wetland areas, feeding mainly on small crustaceans and invertebrates. Tasmania is home to both migratory and resident shorebirds.

Migratory species breed in the northern hemisphere and migrate vast distances annually to feed and rest along Tasmania's coastlines and wetlands.

Tasmanian shorebirds are present on the coast all year round. Beaches and foreshores provide habitat for their entire life cycle: foraging, roosting and breeding. Tasmania is believed to be a relatively secure refuge for shorebirds compared to mainland Australia.

Figure 10.7 Pied oystercatchers nest on Tasmanian beaches from September to March. © Birds Tasmania



However, decreases in shorebird breeding populations along the Tasmanian coast, particularly on beaches in the south-east and east and at other popular beaches, have been well documented by Birds Tasmania over the past two to three decades.

Many shorebirds and small terns such as the fairy tern and little tern are listed as threatened species in the *Threatened Species Protection Act 1995*. Others, such as hooded plovers (*Thinornis rubricollis*), are rapidly decreasing in breeding numbers through much of Tasmania. Threats are common to all species of shorebird and tern and include destruction/loss of habitat due to coastal development and disturbance (poor breeding success) from recreational activities such as horseriding and vehicles on breeding beaches.

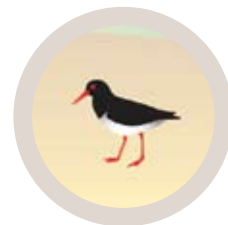
10.3.1 Migratory shorebirds

Migratory shorebirds visit Australia from the Arctic tundra in the northern hemisphere every year from September to March. Migratory birds travel on an established route known as the East Asian – Australasian Flyway. Birds on the flyway make an annual migration of over 25 000km, some flying for more than 10 000km non-stop.

Many coastal areas in Tasmania are important feeding and resting sites, where birds will rest and replenish fat reserves for their long migration back to breeding grounds in the northern hemisphere.

Sites such as Robbins Passage in the north-west, Moulting Lagoon on the east coast and Pitt Water - Orielson Lagoon and Ralphs Bay in the south-east are very important migratory bird habitats.

All migratory shorebirds are listed in the Australian Government's *Environment Protection and Biodiversity Conservation Act 1999* and under international migratory bird agreements including the Ramsar



Convention and JAMBA, the China–Australia Migratory Bird Agreement (CAMBA) and the Republic of Korea–Australia Migratory Bird Agreement (ROKAMBA). **Refer to Table 10.2**

Ramsar Convention

Many important migratory bird habitats are also protected under the *Ramsar Convention on Wetlands* (1971). Australia is a signatory to the intergovernmental treaty that provides the framework for international cooperation for the conservation and wise use of wetlands.

Management of Ramsar wetlands is in accordance with the duties and obligations of signatories to the convention and is presently undertaken through the *Environment Protection and Biodiversity Conservation Act 1999*.

Figure 10.8 Bar-tailed godwits travel over 10 000 km from their breeding grounds in the northern hemisphere to rest here over the northern winter. © Alan Fletcher, Birds Tasmania



National guidelines for Ramsar Wetlands are currently being developed by the Australian Government to provide a framework for Ramsar Convention implementation in Australia and provide jurisdictions and other interested parties with clear guidance on the management of Ramsar sites.

Migratory Bird Agreements

Australia is a signatory to the Japan–Australia Migratory Bird Agreement (JAMBA), the China–Australia Migratory Bird Agreement (CAMBA) and the Republic of Korea–Australia Migratory Bird Agreement (ROKAMBA).

These international bird agreements provide an important mechanism for pursuing conservation outcomes for migratory birds, including migratory shorebirds. They are bilateral agreements between two countries and more work is needed to influence conservation outcomes across their migratory path (flyway) which extends through multiple countries.

In Australia all migratory bird species listed in these bilateral agreements are protected under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*.

10.3.2 Resident shorebirds

Tasmania's resident shorebirds comprise four species: Australian pied oystercatcher (*Haematopus longirostris*), sooty oystercatcher (*Haematopus fuliginosus*), hooded plover (*Thinornis rubricollis*) and red-capped plover (*Charadrius ruficapillus*).

Hooded plover populations have decreased by more than 25% since 1982, (E. Woehler pers. comm. 2010) and monitoring programs by Birds Tasmania indicate that these decreases are continuing. In New South Wales only 10 or so breeding pairs of hooded



plovers remain and numbers of shorebirds in some mainland states are now at critically low levels and in danger of becoming locally extinct.

Due to the ecological similarities regarding nesting habitat and sensitivities to disturbance, little terns and fairy terns, although strictly seabirds, are included in shorebird protection programs. Caspian terns (*Hydroprogne caspia* formerly *Sterna caspia*) also breed on Tasmanian beaches but nests are rarely seen.

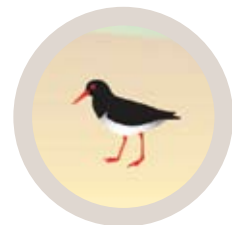
Many Tasmanian beaches are important nesting areas for resident shorebirds and seabirds between

1 October and 31 March each summer. Shorebird eggs are laid in shallow scrapes in the sand. They are hard to spot and therefore can be easily squashed by vehicles or trodden on by the unaware.

Young chicks are flightless for up to seven weeks (depending on species) and will run to the dunes, nearest vegetation or water to hide. Nests are small (around 10cm for plovers, smaller for terns) and well camouflaged, typically at the base of foredunes above high water mark and wrack, but also can be in light vegetation.

Table 10.2 Migratory bird species that make the annual migration to Tasmania over the northern hemisphere winter.

Common name	Scientific name	International bird agreements
bar-tailed godwit	<i>Limosa lapponica</i>	JAMBA, CAMBA, ROKAMBA
caspian tern	<i>Hydroprogne caspia</i> formerly <i>Sterna caspia</i>	JAMBA, CAMBA, ROKAMBA
curlew sandpiper	<i>Calidris ferruginea</i>	JAMBA, CAMBA, ROKAMBA
eastern curlew	<i>Numenius madagascariensis</i>	JAMBA, CAMBA, ROKAMBA
fleshy-footed shearwater	<i>Puffinus carneipes</i>	JAMBA, ROKAMBA
great knot	<i>Calidris tenuirostris</i>	JAMBA, CAMBA
greenshank	<i>Tringa nebularia</i>	JAMBA, CAMBA, ROKAMBA
grey plover	<i>Pluvialis squatarola</i>	JAMBA, CAMBA, ROKAMBA
grey-tailed tattler	<i>Tringa brevipes</i>	JAMBA, CAMBA, ROKAMBA
Latham's snipe	<i>Capella hardwickii</i> formerly <i>Gallinago hardwickii</i>	JAMBA, CAMBA, ROKAMBA
lesser golden plover	<i>Pluvialis dominica</i>	JAMBA, CAMBA
lesser sand plover	<i>Charadrius mongolus</i>	JAMBA, CAMBA, ROKAMBA
pectoral sandpiper	<i>Calidris melanotos</i>	JAMBA, ROKAMBA
red-necked stint	<i>Calidris ruficollis</i>	JAMBA, CAMBA, ROKAMBA
ruddy turnstone	<i>Arenaria interpres</i>	JAMBA, CAMBA, ROKAMBA
short-tailed shearwater	<i>Puffinus tenuirostris</i>	JAMBA, CAMBA, ROKAMBA
terek sandpiper	<i>Xenus cinereus</i>	JAMBA, CAMBA, ROKAMBA



Nesting birds will see people approaching from a distance of 100m or more (long before you see them) and will leave their nests, eggs and chicks. Exposed eggs and chicks will cook on hot sunny days, and chill on cool/wet days, both result in breeding failure. Exposed eggs and chicks are also vulnerable to predation by gulls and forest ravens and possibly currawongs. All dogs are predators of both chicks and eggs.

10.3.3 Signs that nesting shorebirds are present

- Nests are (relatively) easily located by behaviour of birds (calls etc.) and their footprints in sand leading to/from the nest.
- Nesting birds may distract you; pied oystercatchers will make alarm calls to their partners and chicks, some will fly at you.
- Terns will 'attack' you, swooping low over your head, calling and appearing very 'excited' – actually very agitated and distressed.

- Terns may abandon the colony if disturbed, so it is critical to avoid disturbing nesting adults.

10.3.4 Threats to shorebirds

The majority of resident shorebirds live on the beaches that are popular for human recreational activities, including (but not limited to) dog-walking, four-wheel-driving, horseriding, driftwood collecting, beachcombing and walking. There have been increases in beach use in more remote locations that were previously never or rarely visited by people (e.g. on the South Coast track, in the Arthur-Pieman, Waterhouse and Southwest Conservation Areas and the Tasmanian Wilderness World Heritage Area).

In recent years, at a number of beaches, breeding has become restricted to the least disturbed areas, or ceased entirely if adult birds have aged and died without successfully reproducing, due to continuous disturbance from human activities during their

Figure 10.9 Shorebird nests are simple scrapes in the sand and difficult to detect. Eggs and chicks are easily trampled by people or horses or crushed by vehicles. Left: fairy tern chick, Right: hooded plover eggs.

© Dr Eric Woehler and Valeria Ruoppolo





summer breeding season. While shorebird numbers may appear to be stable at a particular site, records have shown that breeding has not been successful at some sites for years (E. Woehler pers. comm. 9th August 2010).

Particular human activities such as taking 4WD vehicles and horses onto beaches can be devastating to nesting shorebirds.

Shorebirds also face threats from climate change impacts. Sea level rise and increased storm frequency will result in the modification of suitable breeding beaches and wetland areas that are used as feeding and resting sites, through coastal erosion and inundation.

Shorebird eggs and chicks are extremely camouflaged and are easily trampled by walkers, horses and vehicles on beaches. Beach users will disturb the foraging of resident and migratory shorebirds, preventing the adults from incubating or feeding their young for extended periods. Disturbance that makes birds leave their nests during hot days or cold nights will result in thermal stress to the eggs and chicks, and can result in their death.

Disturbance and destruction by feral or uncontrolled animals such as dogs, cats and foxes are key threats to shorebirds and seabirds. Dogs and people frighten birds away from their feeding and nesting sites. Domestic and feral cats kill high numbers of birds every year. Even well-behaved dogs, if they are allowed to run off-lead, are a threat. Just the sight of a dog can be enough to frighten and disturb birds.

10.3.5 Protecting shorebirds

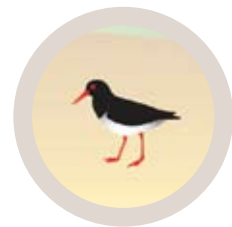
Signage and information brochures can help to alert local residents and visitors to the bird values in the area and foster a sense of appreciation for these unique animals.

Consider temporary fencing of shorebird nests on high-use beaches. This needs to be undertaken with caution and to be accompanied by education and awareness-raising. At popular events such as surf carnivals, temporary fencing works best when volunteers or land management staff can be on hand to watch over the sites and inform beach users about shorebird values and threats.

Control access of dogs, horses and vehicles on shorebird beaches during breeding and migratory bird times, from September to March.

Birds Tasmania volunteers undertake annual monitoring of shorebird numbers and breeding success. Land managers could support these activities by undertaking their own monitoring in collaboration with Birds Tasmania.

Consider providing artificial shelters for breeding birds and their young. Techniques can be found in *A practical guide for managing beach-nesting birds in Australia* (Maguire 2008).



10.3.6 Guidelines for working in shorebird habitat

Time works to avoid shorebird breeding season if possible (sometimes the best time to manage weeds clashes with the shorebird season).

Minimise time spent working in breeding territory or close to nest, eggs and chicks, to reduce adults' times off nests, eggs and chicks.

Avoid disturbing nesting birds at night, to prevent eggs chilling: beach sands cool rapidly at night and eggs left unattended will fail.

Assume that nests, eggs and chicks are present even if you haven't found them: reduce your time at the top of the beach to the minimum time required to remove weeds or undertake works.

Travel along the tide line, preferably limiting intense activities to low tide to keep people and any vehicles away from nesting birds.

Avoid damage to the dune landscape that may affect the profile of the dunes and make it difficult for young birds to seek shelter.

Include local residents and community groups in planning for management actions to protect shorebirds. Local residents can make a big difference to improving outcomes for little penguins by making changes in their behaviour, such as keeping dogs locked up and not modifying the foreshore environment.

10.3.7 Monitoring shorebirds

Birds Tasmania undertakes annual monitoring of shorebird numbers. Community groups and land managers can assist by providing information to Birds Tasmania when working in shorebird areas.

Useful data includes:

- reports of nesting shorebirds and small terns, including GPS data and estimates of numbers
- reports of migratory shorebirds – estimates of numbers/species
- evidence of entanglement – photographs.

Birds Tasmania can provide data sheets and bird identification guides, and possibly assist in the identification of carcasses.

Remember: do not disturb birds when you are collecting data.



10.4

10.4 Injured and orphaned wildlife

This section provides information on assisting injured and orphaned wildlife and reporting wildlife emergencies.

Wildlife can be injured inadvertently, for instance in road accidents, from entanglement in fishing line, as a result of chemical or oil spills, or through deliberate cruelty. Accidents that kill parent animals may leave their offspring with little chance of survival.

Compassion and care for wildlife is commendable, but keep personal safety in mind. It is best to get appropriate advice before approaching injured or resting wildlife, as some animals can become stressed and will attack if they feel threatened. In the meantime, it is important to protect the animal from people and dogs. Seek advice from the local PWS office, the RSPCA, the Wildlife Management Branch of DPIPW or a veterinarian.

If professional help cannot be obtained within 24 hours, follow the procedures on the DPIPW website. Before attempting capture, observe the animal for any signs of illness or injury to help the vet or officer identify the animal's problem.

10.4.1 Legislation

In addition to the legislation detailed in **section 10.1.1**, the state *Whales Protection Act 1988* provides further protection for whales in Tasmanian waters.

Most Tasmanian wildlife is protected by law and can only be rehabilitated with a permit. The Wildlife Management Branch of DPIPW is responsible for issuing permits and keeps a list of trained wildlife carers who may be able to help.

10.4.2 Seals on beaches

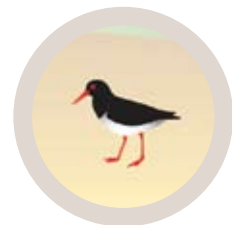
Seals regularly come ashore (haul out) for a number of reasons and are not necessarily injured. They may just need time to rest or groom or moult. Keep a safe distance—seals have large teeth and a long, flexible neck which they can whip around with surprising speed. They can inflict painful wounds and carry a number of diseases that may include tuberculosis.

Sick or injured seals may also be found on the beach. Seals are among the most inquisitive of creatures and often end up with rope, fishing net or packaging strap wrapped around their necks. As the seal grows, this material gradually strangles it.

All seals are wholly protected throughout Australian waters.

Figure 10.10 Australian fur seals are curious animals and as such risk becoming entangled in marine debris.
© Biodiversity Conservation Branch DPIPW





Do not approach any seal without advice from the nearest PWS Field Centre or the Biodiversity Conservation Branch at DPIPWE. In the meantime, keep dogs away and advise people not to approach the animal. It is important to report all sightings of seals on Tasmanian beaches to the Biodiversity Conservation Branch on the Wildlife Hotline or Whales Hotline. *Refer to section 10.7 Tools and resources.*

10.4.3 Oiled animals

Treating oiled seabirds is highly specialised and should not be attempted without prior training – animals need extensive attention to remove the oil, and intensive after-care.

Contact the Wildlife Hotline if you discover oiled seabirds or mammals.

Wildlife emergency contacts

Wildlife Hotline 6233 6556 (24 hours)

Whale Hotline 0427 WHALES or 0427 942 537

This is a 24 hour monitored telephone service to receive calls of all cetacean sightings and strandings.

RSPCA 6244 3033 or 1300 139 947 (animal cruelty enquiries)

10.4.4 Whale strandings

The information in this section was taken from the *Tasmanian Whale Stranding Handbook and Directory* (DPIWE & DTPHA 2005) and the DPIPWE website.

Of all Australian states, whale strandings occur most frequently in Tasmania. A disproportionate number of these strandings have occurred in the Circular Head and Macquarie Harbour – Ocean Beach areas.

Common and bottlenose dolphins, both of which typically strand singularly, are the most commonly reported species. Sperm whales and long-finned pilot whales also are frequently reported, the latter usually in large pods. In 2008 for example, 188 pilot whales were reported as stranded near Sandy Cape. In November 2003 over 100 long-finned pilot whales stranded on a remote stretch of coastline south of Strahan. A detailed record of Tasmanian strandings is available on the DPIPWE website.

Most strandings are reported in the summer months, although it is not clear whether this is a consequence of increased human activity along the coast during this time of the year or an increase in the number of whales passing the coast.

Responses to whale and dolphin strandings are managed on a joint basis between the Parks and Wildlife Service and the Biodiversity Conservation Branch, DPIPWE.

Successful whale stranding outcomes depend on immediate notification, seeking expert advice and mobilisation of people and equipment.



Why whales strand

The reasons whales strand are not yet fully understood. Some theories include whales following nutrient-rich waters that have been driven closer to southern Australia by climatic conditions. They may be confronted with rough seas or a single individual may stray too close to the shore and become stranded. Toothed whales have very tight family bonds. A stranded animal might continue to call and other members of the pod might follow the call, which can lead to the rest of the pod encountering a similar fate. Occasionally, stranded whales are found to be suffering from infections of the inner ear, which may affect their ability to navigate, using echo-location.

Also, certain topographical features may increase the risk of strandings. Wide, gently sloping beaches are not detected by the reflection of sonar pulses. This may result in the whales approaching too close to the shore. Similarly, bays with narrow mouths flanked by rocky headlands may give the whales the impression that they are trapped with no way out. This can cause panic which may result in beaching. In the case of stranded small whales and dolphins, it is possible that

killer whales (orcas) have panicked the pod, forcing them shoreward.

Helping stranded whales

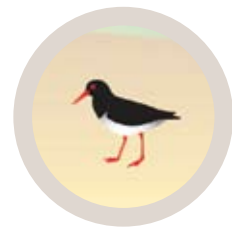
In the case of single strandings of small whales such as dolphins, it may be possible to successfully return the animal to the sea – but always seek expert advice. A mass stranding is a more formidable problem, and requires a coordinated approach.

The first priority in any attempt to save a stranded pod of whales is to seek help. Contact the Whale Hotline number. Provide details of the exact location of the stranded animals, their numbers, condition, the species (if you know), their size and any other details that may be useful.

Members of the local community and bystanders will be very keen to rescue the whales but, without experienced staff from PWS or DPIPWE, this can be very dangerous. It is essential to get assistance immediately to coordinate any response involving the general public.

Figure 10.11 A mass whale stranding, such as this one of long-finned pilot whales on the west coast of Tasmania, attract large numbers of volunteers who want to assist the whales. © Chris Arthur





Before specialist help arrives

Overheating is a big problem for stranded whales. Dig holes for the flippers so that they are hanging free. Allow water to enter these holes to assist in cooling, as the flippers and tail are important areas for heat exchange. Cover the body from the burning and drying effects of sun and wind – towels or seaweed will suffice – but don't cover the blowhole. Wet the animal down, ensuring that water does not enter the blowhole.

Once authorities have arrived, the animals will be assessed and the release coordinated so that the entire surviving pod is released. If released individually the animal will often restrand simply because it does not know where to go or responds to the continued distress calls of the individuals that are still stranded. Whales are highly social creatures. It is important not to underestimate the need to maintain their group structure.

Despite their formidable size, whales appear reluctant to cause any harm to their rescuers. Nonetheless, accidents can happen.

- Don't stand on the shoreward side of a whale, as a wave can easily roll the animal on top of you.
- Beware of sudden movements of the tail.
- Most importantly, beware of hypothermia. Tasmanian waters are cold. Rescuers should be well equipped with thick wetsuits and a change of warm clothes. Be well aware of how long you have spent in the water.

WILDCARE whale rescue volunteers

WILDCARE coordinates a group of first-response whale rescue teams made up of trained volunteers that can be called on to assist in the event of a stranding. The teams are contacted by the Parks and Wildlife Service or the Biodiversity Conservation Branch of DPIPW.

Members of the public who are interested in assisting with whale rescues can join WILDCARE Inc and register for whale rescue on the membership form. They will receive information about WILDCARE Inc, whale rescue courses, and the formation of First Response Teams.



10.4.5 Animals and road accidents

Remove dead wildlife from the side of the road wherever possible. Carcasses left on the side of the road attract predators such as quolls, devils and birds of prey, which in turn can be killed by traffic.

Check the pouch of marsupials for young that may have survived the impact and could be rehabilitated by wildlife carers.

Your own safety is the priority, so only stop if it is safe to do so.

Reducing roadkill

Refer to the DPIPWE website for guidelines for reducing roadkill, which include the following ideas:

- Provide shelter (e.g. vegetation) on roadsides for animals to hide in.
- Build underpasses with 'funnel fencing' to encourage animals to cross underneath the road. The fences are set at an angle of 45° to the road (like a funnel) to guide animals into the underpass, and extend out into the roadside vegetation.
- Provide escape routes to help animals cross barriers (e.g. building a ramp down a steep roadside bank will enable animals to get off the road when a vehicle approaches).
- Do not create containment walls that prevent animals leaving the road.
- Erect signage to alert drivers to wildlife and use rumble strips to slow cars down in areas where wildlife cross roads.
- Do not leave material piled up on roadsides in areas known to be regularly used as crossings by animals, such as adjacent to penguin colonies.

10.5 Feral animals and introduced pests

Some feral animals (including uncontrolled domestic animals) and introduced species (from outside Tasmania) have a significant impact on our coastal and marine life. Cats and dogs allowed to roam freely in coastal areas can do enormous damage to wildlife. Foxes will increase this predator pressure if the species becomes established in coastal areas.

Introduced species can out-compete native species for resources such as habitat and food. They can change the local environment and landscape, making it less hospitable to native species.

Marine pests can cause dramatic changes to localised marine ecosystems, displace native species and impact on marine resource values.

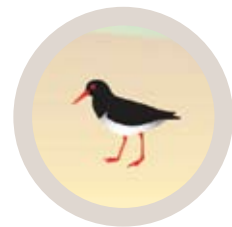
Knowing how to identify feral animals and marine pests can help to prevent the spread of these pests and a number of identification tools have been developed. **Refer to section 10.7 Tools and resources.**

10.5.1 Legislation

Protection is afforded to Tasmanian wildlife by the *Nature Conservation Act 2002* and the *Threatened Species Protection Act 1995*.

The *Living Marine Resources Management Act 1995* provides for management of marine pests. Some marine pests are listed as noxious species under the Act and a permit is required to possess them.

Obtain a permit or more information from the Department of Primary Industries, Parks, Water and Environment, Water and Marine Resources Division.



Australian Quarantine Act 1908

Australian Quarantine and Inspection Service (AQIS) is the Australian government agency responsible for enforcing Australian quarantine laws. A permit is required for the importation of specimens into Australia.

10.5.2 Feral animals

It is important to reduce threats from feral animals. Cats and foxes are the greatest threats to coastal wildlife, while dogs are a problem in some areas, especially where penguins or shorebirds are present.

Introduced species, such as rabbits, can cause massive damage by eating native species and/or displacing native fauna, and can cause erosion of coastal landforms such as dunes.

10.5.3 Managing feral animals

The most cost-effective approaches to feral animal management are prevention and early intervention.

Some species, such as the feral cat and rabbit, may have a significant impact on the environment but are widespread, numerous and impossible to eradicate from Tasmania due to social, financial or technological constraints. However, they can be eradicated from offshore islands, and efforts can be made to limit or exclude them around areas of high conservation significance on Tasmania's mainland, such as breeding areas or sites containing threatened plant species.

*Figure 10.12 These penguins were killed by dogs (most likely domestic dogs allowed to roam free at night).
© Perviz Marker*





Responsible pet ownership

Education of pet owners is extremely important in managing impacts of pets on coastal wildlife.

Local councils can play a role in education of the public about keeping pets such as cats locked up and not taking dogs into wildlife areas. Education about the disposal of unwanted pets, especially exotic species is also highly valuable.

Call the Fox Hotline (1300 369 688) if you find any trace of a fox.

Contact the local Parks and Wildlife Service (PWS) or council office or the Wildlife Management Branch (6233 6556) to report feral cats or dogs in sensitive coastal areas.

Figure 10.13 Northern Pacific seastar collection is an ongoing process. It is possible to maintain some coastal areas free of the seastar pest. © Dr Michael Sierp



10.5.4 Marine pests

There are innumerable non-indigenous species in the Tasmanian marine environment and the vast majority have very little impact on their new environment and local species. Some introduced species, however, do have very serious impacts on the Tasmanian marine environment and are considered marine pests.

Most marine pests are introduced into Australian waters by international vessels exchanging ballast water or as biofouling (i.e attached to the hull or other submerged area). In 2001 mandatory ballast water management requirements for international shipping were introduced. Requirements for managing domestic ballast water and international biofouling are still being developed.

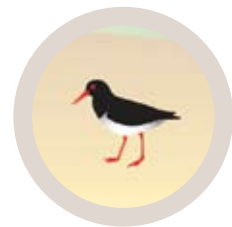
Once a marine pest has been introduced into Australia it can be further spread around our waters by a variety of mechanisms such as recreational and commercial fishing vessels and natural coastal processes.

It is important to report new incursions to make sure that new species are identified before they become established.

There are a number of recognised marine pests in Tasmania, including the northern Pacific seastar (*Asterias amurens*), and the European green crab (*Carcinus maenas*). These can threaten our marine environment and marine industries.

10.5.5 Impacts of marine pests

Marine pests cause damage to the marine environment such as out-competing or smothering native species. Some pests, like the northern Pacific seastar, are voracious predators of native species. In some instances this can also have an impact on aquaculture and fisheries operations. Once a species



is introduced in the marine environment, eradication is almost impossible.

The introduced commercial Pacific oyster has settled on shorelines along Tasmania's north-east and south-east coasts. They have sharp-edged shells that can injure humans or pets so are detrimental to the recreational and amenity values of the coastline.

Marine pests can also damage marine infrastructure and encrust or clog components of marine vessels.

10.5.7 Managing marine pests

The most important thing that coastal land managers can do is report any sightings of marine pests, particularly in new areas.

Some community groups are interested in ongoing removal of pests such as feral oysters or northern Pacific seastars. It is possible to locally eliminate these species from an area but it involves ongoing monitoring and follow-up. Expert advice and permits may be required. A permit is only required for listed noxious species.

Noxious species listed under the *Living Marine Resources Management Act 1995*:

Northern Pacific seastar (*Asterias amurensis*)

European carp (*Cyprinus carpio*)

black striped mussel (*Mytilopsis sallei*)

European shore crab (*Carcinus maenas*) – also known as green crab

wakame (*Undaria pinnatifida*), other than in the restricted zone

giant fan worm (*Sabella spallanzanii*)

green algae (*Caulerpa taxifolia*)

In some coastal communities the commercial Pacific oyster (*Crassostrea gigas*) has recruited onto shorelines and is harming recreational and amenity values as well as competing for space with Tasmanian native oysters (*Ostrea angasi*).

These wild oysters have become known as feral oysters to the local communities and aquaculture industries that are working together to manage the problem. Teams of volunteers collect feral oysters for disposal or use hammers to destroy them. Permits are not required to undertake these eradication activities, but permission from the land manager is required. It is important to ensure that feral oysters are correctly identified and distinguished from native oysters.

In some areas feral oysters are relocated to aquaculture facilities where they can continue to grow and then become part of the commercial stock. Removal of feral oysters for commercial purposes requires a permit as specified by the *Fisheries (Shellfish) Rules 2007*. Oysters can only be harvested from areas that are approved for shellfish harvesting, and must meet the requirements of the Tasmanian Shellfish Quality Assurance Program (TSQAP).

Feral oysters should not be eaten

It is not recommended that people eat feral oysters that they have removed from the shore, as oysters are capable of accumulating toxic algae, heavy metals and other toxins from the marine environment at levels dangerous to humans.



Boat users

Land managers who use boats need to be aware of the potential to spread marine pests and take appropriate measures to minimise the risk.

Introduced marine pests may be spread by ballast water discharge, hull fouling on commercial and recreational vessels, and marine farming operations. The pests can be spread if wash-water and biological material from cleaning boat hulls are not contained at slipways or other boat repair and maintenance facilities.

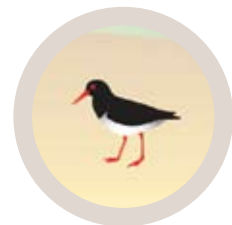
Introduced marine species spread easily if boats, trailers and fishing equipment are not cleaned after

leaving an infested area. For instance, a piece of wakame left on a net or anchor survives for at least one or two days, and so do microscopic spores floating in water in the bottom of a boat. In mooring areas and marinas, boat hulls without effective antifouling treatment can become infested,

- Follow the guidelines for preventing marine pests, including ballast water management requirements and boat maintenance at the DPIPWE Sea Fishing & Aquaculture website.
- Follow the *Environmental Guidelines for Boat Repair and Maintenance* (Department of Tourism, Parks, Heritage and the Arts 2009).

Figure 10.14 Boat hull cleaning removes marine pests but the wash water needs to be contained and treated at the boat facility, such as here at the Clean Lift facility at Prince of Wales Bay. © Ruth Eriksen





10.6 Climate change, wildlife management and pests

Climate change will add increased pressure to coastal and marine wildlife and has the potential to exacerbate existing impacts from other factors such as habitat loss and disturbance and feral pests.

Rising sea levels will result in further habitat loss for shorebirds and seabirds. Inundation of wetland areas may result in loss of habitat and foraging sites for shorebirds. Changes to coastal vegetation as a result of increased temperatures and changed rainfall patterns will have an impact on wildlife habitat. Changed rainfall patterns will also result in changes to freshwater flows, which will have implications for estuarine species.

In coastal waters the southern extension of warmer waters will cause a southward shift in species distributions. Warmer ocean temperatures in Tasmania now support species that were not previously viable due to cold water temperatures in winter. Ecosystems usually found in more temperate regions are shifting southward, and many of Tasmania's endemic species have a limited capacity to adapt to such change (DPIPWE 2010).

It is more important than ever to minimise human impacts on native wildlife and marine life, to afford these species the best possible chance of adapting to the effects of climate change.

To mitigate the impact of climate change, it is essential to conserve natural terrestrial, freshwater and marine ecosystems and restore degraded ecosystems, protecting existing ecosystems and a diversity of habitats. In view of uncertainty about the specific impacts of climate change, maintaining diversity of habitats will act as an insurance policy (DPIPWE 2010).



10.7 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**.

Threatened species

Coastal Values

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

www.thelist.tas.gov.au

Consultant's brief

A consultant's guide providing the minimum requirements for information needed to assess the potential impact/s of proposed activities on biodiversity and geodiversity

<http://www.dpiw.tas.gov.au/inter:nsf/WebPages/SSKA-ZUM4AN?open>

Environment Australia Biodiversity website

A range of information on biodiversity, the EPBC Act and lists of species protected under the Act.

<http://www.environment.gov.au/biodiversity/index.html>

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>

REDmap

A Tasmanian initiative inviting the community to spot, log and map marine species that are uncommon in Tasmania, or along particular parts of our coast. The information collected is mapped and displayed on the REDmap website, demonstrating how species distributions may be changing over time. Report sightings of unusual marine species on the REDmap website

www.redmap.org.au

Threatened species listing statements and recovery plans

More information on threatened species' needs and survey requirements are available within the specific listing statements and recovery plans on the DPIPWE website

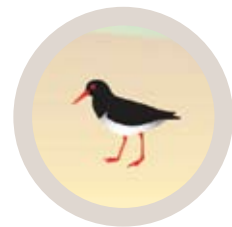
<http://www.dpipwe.tas.gov.au/threatenedspecieslists>

Threatened Species Section, DPIPWE

Provides threatened species localities and potential habitat according to site information from a 1:25 000 mapsheet (TASMAP series). Also provides concise information about every Tasmanian threatened animal, including information on the species' conservation status, identifying features, distribution, habitat, biology, important locations, key threats, management recommendations, and other ways to help.

ThreatenedSpecies.Enquiries@dpiwwe.tas.gov.au

<http://www.dpipwe.tas.gov.au>



Threatened Species Strategy (Department of Primary Industries Water and Environment 2000b)

Implementing the *Threatened Species Protection Act 1995*

Outlines the approach to conserving Tasmania's threatened species to ensure: that threatened species can survive and flourish in the wild; that threatened species and their habitats retain their genetic diversity and potential for evolutionary development; and to prevent further species becoming threatened. The Strategy addresses key threatening processes and priority threatened species.

Birds

A practical guide for managing beach nesting birds in Australia (Maguire 2008)

Birds Tasmania

Advice and input in planning for shorebird protection

Co-existing with Little Penguins in the Derwent Estuary - Information and guidelines (Pryor & Wells 2009)

<http://www.derwentestuary.org.au/file.php?id=309>

Guidelines for works in areas of Little Penguin habitat (Marker & Wind 2008)

<http://www.nrmtas.org/projects/cradle/penguinmanagement.htm>

Shorebird information kit

A box of resources for education and display purposes.

Available from the Parks and Wildlife Service, Interpretation Section on request.

Understorey Network

For information on appropriate plant species for revegetation works around little penguin colonies

www.understorey-network.org.au

Wildlife Management Branch

Advice and training for caring for injured and orphaned wildlife

Wildlife emergency contacts

Local Parks and Wildlife Service Field Centre

RSPCA 6244 3033 or 1300 139 947 (animal cruelty enquiries)

Whale Hotline

0427 WHALES or 0427 942 537

A 24-hour monitored telephone service to receive reports of all cetacean sightings and strandings.

Wildlife Management Branch of DPIWWE

6233 6556 (24 hour) – for urgent wildlife problems (other than whales)

An injured animal or orphaned animal may be taken to the Wildlife Management Branch at 134 Macquarie Street in Hobart during office hours (Monday to Friday, 9am to 5pm).



Feral animals and pests

Australian Government: National system for the prevention and management of marine pest incursions.

The Tasmanian Government is a signatory to the National System for the prevention and management of marine pest incursions. The National System aims to prevent new pests arriving, respond when a new pest does arrive and minimise the spread and impact of pests that are already established in Australia.

DPIPWE Fox Eradication Branch

www.dpipwe.tas.gov.au/fox

DPIPWE website

Information about marine pests specific to Tasmania

DPIPWE Sea Fishing & Aquaculture website has guidelines for preventing marine pests, including ballast water management requirements and boat maintenance

www.fishing.tas.gov.au

DPIPWE Marine Pest hotline 0408 380 377

To report new pests, or infestations in new areas.

Environmental guidelines for boat repair and maintenance (Department of Environment, Parks, Heritage and the Arts 2009)

Feral animals in Australia

Federal Government: Department of Environment, Water, Heritage and the Arts, Biodiversity Section website

www.environment.gov.au/biodiversity/invasive/ferals/index.html

Feral card deck

A priority list of terrestrial and freshwater feral animal species for Tasmania, in the form of a handy laminated deck of cards with photos and descriptions of feral animals to assist identification.

Contact the Tasmanian Conservation Trust for more information.

Guide to best practice management of point source pollution at boat repair and maintenance facilities (NRM South 2008b)

National Introduced Marine Pest Information System

Marine pest information sheets available online. Follow links from

www.marinepests.gov.au

National System for the Prevention and Management of Marine Pest Incursions

National best practice guidelines for all pathways at risk of transporting marine pests

http://www.marinepests.gov.au/national_system

Soil management and earthworks



11.1 Soil and water management

11.2 Excavation and ground disturbance

11.3 Extraction

11.4 Acid sulfate soils

11.5 Tools and resources

This chapter deals with controlling sediment (soil and water runoff) as part of building and construction works, minimising disturbance from earthworks, extracting materials on or near the coast, and the importance of managing the impact of acid sulfate soils (ASS).

Coastal landforms and ecosystems have many functions and values that require protection from the impacts of earthworks and excavation associated with works in the coastal zone. Coastal dunes, for instance, protect houses and other developments from tidal surges and winds, while saltmarshes and seagrass meadows are critical fish nursery areas.

Clearing of vegetation and earthmoving activities can initiate soil erosion and, if not controlled, unwanted sediments could be discharged into wetlands or estuaries. In some areas these sediments might be contaminated toxic (e.g. heavy metals from mines or refineries) or acid sulfate soils, which, if disturbed, can cause water pollution or damage to structures. Even small-scale projects involve soil disturbance and can damage the coastal environment.

To protect the coastal environment, works activities should involve minimal impact on soils, landforms and receiving waters. This is achieved by planning for protection of coastal values, minimising soil disturbance and implementing effective erosion and sediment control measures.

The *Soil and water management on building and construction sites, fact sheets* (Derwent Estuary Program 2009) provide more technical detail on some of the issues presented in this chapter.

Tab photo: Machinery being used to remove pines from dunes. © Leah Page.



11.1 Soil and water management

This section provides information to help mitigate the impacts of building and construction site activities on soils, landforms and receiving waters in coastal areas through the use of erosion and sediment control measures.

Erosion is the removal of soil by the flow of wind and water. It occurs naturally, but can be intensified by building and construction activities. When erosion occurs soil particles become suspended in water or air and are transported downstream or downwind, eventually settling out as sediment, sometimes far away from the building or construction site.

Soil erosion on building and construction sites can be a major source of sediment pollution in waterways. Considerably more soil erosion is likely to occur during the construction phase than will occur in the rest of the building's lifetime. In fact, a single building block can lose four truckloads of soil in one storm. Any sediment that moves off-site typically enters stormwater drains, clogging the stormwater system and transporting attached pollutants, including oils, heavy metals and hydrocarbons, into local waterways. Excessive sediment that enters waterways can kill fish and aquatic plants, silt up streams, and block stormwater pipes, which can lead to increased flooding.

11.1.1 Legislation and approvals

There is a range of legislation that provides for soil management during building and construction in the coastal zone. **Appendices 1 and 2** provide details of legislation likely to be relevant. Local councils have the power and responsibility to regulate the building and construction industry.

It is essential to have the approval of the land

manager before undertaking any earthworks. On areas of public land the land manager may be the local council or DPIPW (Crown Land Services or Parks and Wildlife Service). Because of the high level of disturbance it will also be essential to identify any potential Aboriginal or cultural heritage sites and any significant wildlife or vegetation values. Assessments and approvals may be required.

11.1.2 Appropriate soil and water management for coastal areas

Consider sediment and erosion control at the planning stage, well before any ground disturbance/construction occurs. The alternative – addressing sediment and erosion control as an additional feature after planning and design has been developed – can both limit opportunities for effective soil and water management and increase the cost of the system.

Planning should include identification of the values of the area, including potential threats such as coastal processes, toxic sediments and preparations for erosion and sediment control and rehabilitation.

Avoid works on unstable coastal landforms such as seabeds, mobile dunes (in particular foredunes), cliffs and beaches. If such works cannot be avoided, they must be carefully managed as they can greatly increase erosion, which may lead to loss of infrastructure, danger to the public and loss of wildlife habitat.

Foredunes are especially vulnerable to erosion if the vegetation is removed or the dune is damaged by machinery during construction works. The best way to avoid damage to foredunes during works on the shore is to protect the vegetation that stabilises the sand. Repair damage as soon as possible. **Refer to Chapter 6 Coastal landscape management and Chapter 7 Vegetation management.**

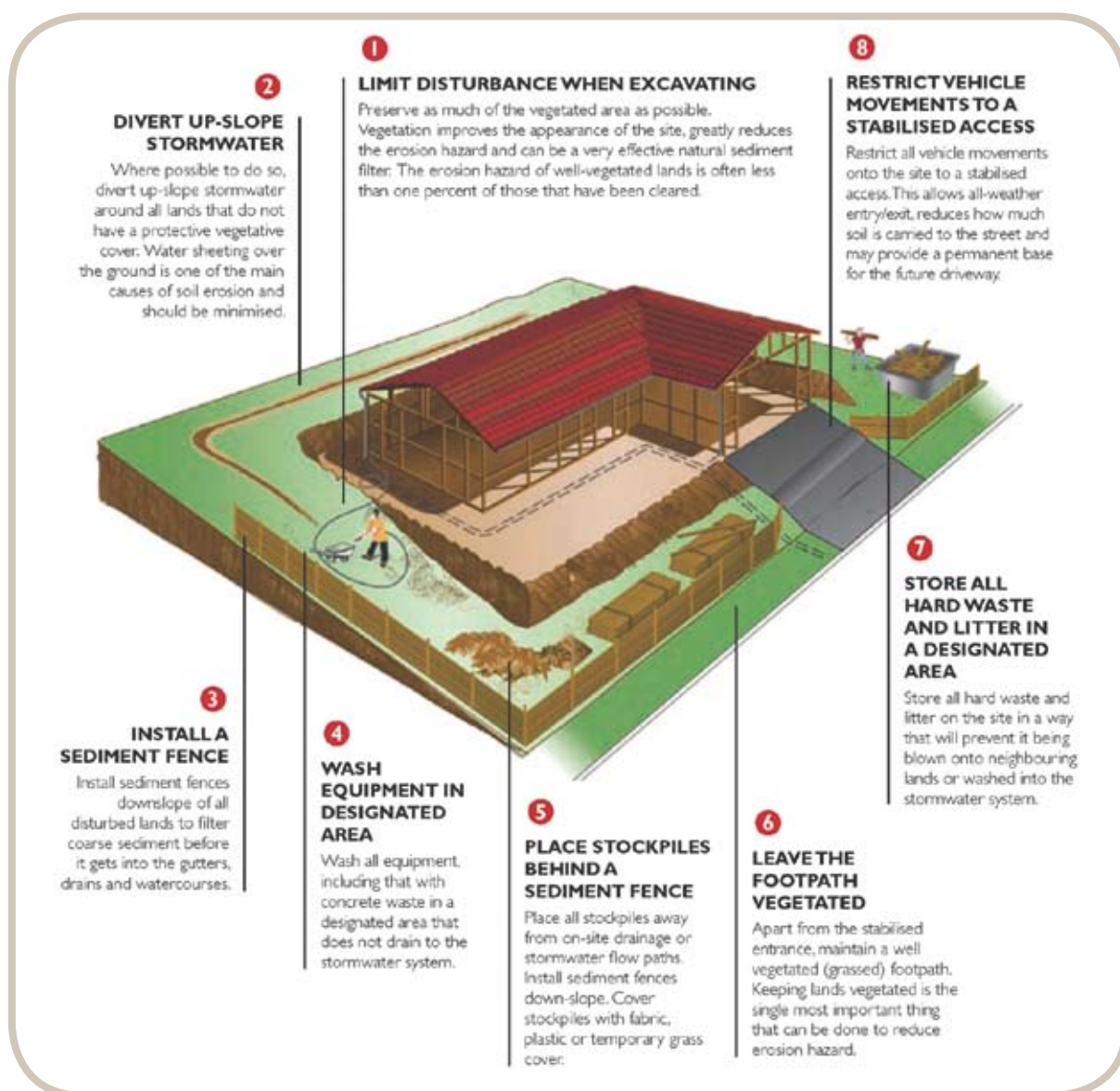


Inappropriate excavation can increase the vulnerability of beaches and other soft coastlines to erosion and flooding caused by rising sea levels.

Choose a site and methods that minimise interference

with coastal processes, landforms and ecosystems. Obtain technical advice from a geomorphologist and/or engineer; and check the Geoconservation database, because some coastal landforms have

Figure 11.1 Example of sediment and erosion control measures that should be implemented on construction sites.
Source: Soil and water management on building and construction sites, fact sheets (Derwent Estuary Program 2009)





important geoheritage values. Available on the internet on Tasmania's Land Information System (LIST).

Avoid impacts on coastal habitats or ecosystems. Seek specialist advice and identify all natural values, such as threatened species, significant wildlife habitat and important vegetation communities. Obtain specialist advice if working near sensitive wildlife habitat, such as shearwater rookeries or penguin colonies. Also consider providing for wildlife requirements (e.g. when revegetating an area, remember that some shorebirds require bare patches to build their nest in the sand).

It is important to identify and protect cultural heritage values, conducting surveys where necessary. Assessments, surveys and permits may be required from Aboriginal Heritage Tasmania and Heritage Tasmania. **Refer to Chapter 5 Cultural heritage management.**

Some areas have toxic sediments (e.g. heavy metals from mines or refineries) and acid sulfate soils (ASS), which may cause water pollution or damage to structures if disturbed. Investigate the possibility of the presence of ASS prior to any development. Use the ASS information on the DPIPWE ASS web page or mapping from the LIST (**see section 11.5 Tools and resources**). Obtain specialist advice about safe methods for disposing of excavated materials that contain toxic materials (e.g. heavy metals) or ASS (**See section 11.4**).

Machinery, vehicles and vessels used during construction can introduce weeds, pests and diseases and should be cleaned off-site before travel to the work site.

11.1.3 Sediment collection structures

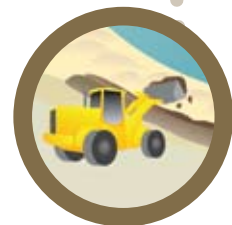
Sediment collection structures are designed to intercept and collect sediment in runoff before it reaches waterways. They should be designed to cope with major rainstorms of the type expected to occur in the area. Install the structures before the development begins.

Sediment collection structures require regular inspection and maintenance. After each significant rainfall event, check for damage or clogging by silt and debris.

Sediment collection structures may include, but are not necessarily limited to, the following:

- Sediment fences are usually constructed of heavy duty geotextile and must be installed parallel to the contours of the site. They can also be placed around stormwater pits.
- Fibre rolls are log-like products consisting of biodegradable fibres. They can be hessian socks filled with mulch or straw, or rolled coir (coconut fibre) placed across drainage lines or installed around stormwater pits to filter sediment from runoff.
- Stormwater pit traps are baskets or trays placed just below the entrance to the stormwater pit to prevent sediment entering the drain.

Refer to the Soil and water management on building and construction sites, fact sheets (Derwent Estuary Program 2009) for more information.



11.1.4 Soil and Water Management Plans (SWMPs)

Subdivisions or activities that create more than 250m² of ground disturbance will typically require a Soil and Water Management Plan (SWMP) to be submitted to council with the building or development proposals, prior to any site disturbance. Once approved by council in a building or planning permit, all building and construction works need to be conducted in accordance with the SWMP.

SWMPs are specific site plans or drawings that detail sediment and erosion control measures on building and construction sites. They show the type, location, design, installation and maintenance schedule for all these measures and should be considered as the blueprint for controlling all anticipated erosion and for preventing sediment from leaving a site.

A SWMP can easily be developed by overlaying information on a copy of the engineering site drawings. The plan must detail the site development and all the systems intended to minimise erosion and trap sediment.

If one is required, submit the SWMP to council. Ensure that council approval is given before you start work or you may be in breach of your permit.

Keep a copy of the council-approved SWMP at the site at all times and ensure that all on-ground workers understand the SWMP. Implement, update and maintain the control measures shown in the SWMP.

See *Soil and water management on building and construction sites fact sheet 3. Soil and water management plans (Derwent Estuary Program 2009)* for further information.

11.2 Excavation and ground disturbance

This section covers excavation and ground disturbance for small-scale activities, such as access management and trench digging and larger scale activities such as the construction of coastal infrastructure. Erosion control structures and soil and water management plans will be required for construction sites. Large-scale activities will require Environmental Management Plans, which will specify measures for minimising impacts on coastal values.

Avoid works on unstable coastal landforms such as seabeds, shoreline mobile dunes (in particular, foredunes), cliffs and beaches. If unavoidable, manage such works carefully. Foredunes are especially vulnerable to erosion if the vegetation is removed or the dune is damaged by machinery during construction works. The best way to avoid damage to foredunes during works on the shore is to protect the vegetation that stabilises the sand. Repair damage as soon as possible.

Particular precautions are required with the use of machinery, particularly large machines such as excavators and bulldozers, on fragile and unstable coastal soils.

Refer to Chapter 15 Shoreline modification for particular information on shoreline protection structures, reclamation and dredging.



11.2

Excavation can be detrimental to coastal values by:

- damaging Aboriginal heritage
- damaging historic cultural heritage
- damaging sites of geoconservation significance
- disturbing landforms such as saltmarshes, tidal flats, barways and river mouths
- removing the sand supply from dunes, beaches, estuary beds or seabeds
- increasing erosion and sedimentation (locally or nearby)
- destroying terrestrial or marine vegetation
- destroying wildlife habitat (e.g. fish nurseries) or disrupting breeding (e.g. shorebirds)
- disturbing bottom sediments and releasing contaminants (e.g. heavy metals)
- disturbing acid sulfate soils
- polluting water
- producing large amounts of spoil, which may be contaminated
- spreading marine and terrestrial weeds, pests and diseases.

Figure 11.2 Construction of coastal road in southern Tasmania. © Chris Rees





11.2.1 Appropriate ground disturbance methods

Planning earthworks, including identifying values of the area as well as potential threats, is important when selecting appropriate construction equipment and methods that will minimise coastal disturbance.

Before commencing work, ensure all assessments have been done and approvals received, including approval from the land manager. Ensure that all staff and contractors have been briefed on the coastal values that need to be considered within the work area and any restrictions or conditions required to protect them. Provide appropriate supervision to ensure these conditions are met.

Keep ground disturbance to a minimum. Time construction works to minimise the duration of soil exposure (e.g. avoid works when prolonged heavy rain or strong winds are expected) and to allow planting of bare areas during late autumn and winter.

Protect surface water and groundwater quality. Take steps to minimise pollution and changes to the natural drainage patterns of the shore area. Install erosion control structures and implement erosion control strategies. These will significantly reduce the need for and the size and cost of installing sediment collection structures.

Each site is different; sediment and erosion control measures need to be designed on a site-by-site basis.

Minimise ground disturbance as far as is practicable. All earthworks should be kept to a minimum and should be closely linked with the commencement of major works. Thorough and careful planning is the best way to minimise environmental impacts. At the planning stage, consider the following:

- Avoid the need for earthworks, by working with the natural contours of the site. Limit building or

construction on steep inclines. On slopes, choose a subfloor method that will minimise excavation.

- Limit the area of soil disturbance (the excavation envelope) to the minimum required, e.g. the building footprint only.
- Identify suitable sediment and erosion control measures for the excavation envelope.
- Schedule earthworks in phases throughout the project, to reduce erosion potential; rehabilitate exposed areas quickly, to reduce the amount of soil exposed at one time.
- Retain as much stripped topsoil as possible for re-use during landscaping and site rehabilitation.

Before starting site works, the following actions will help to minimise the risk of ground disturbance:

- Identify vegetation, including grass buffers, around the construction site to preserve throughout the development. Mark this as a 'no go' area on all work plans, including the Soil and Water Management Plan (if required).
- Install sediment and erosion control measures.
- Ensure the operators of earthmoving equipment are aware of the excavation envelope and where stockpiles will be located.

Once site works have commenced:

- Ensure vegetation buffers are protected.
- Carry out staged excavation and stabilisation (if applicable).
- Maintain sediment and erosion control measures.
- Stabilise soil stockpiles by placing sediment fences around their lower edges, cover with fabric, plastic or vegetation.

See *Soil and water management on building and construction sites fact sheet 5. Minimise soil disturbance (Derwent Estuary Program 2009) for further information.*



11.2.2 Precautions when using heavy machinery in coastal areas

On fragile and unstable coastal soils, special precautions are required with the use of machinery, particularly large machines such as excavators and bulldozers.

Ensure the type and size of heavy equipment is appropriate for the site and the works. Use smaller machines wherever possible, to reduce damage to coastal systems. Keep off foredunes and other unstable areas wherever possible.

Use soil roughening techniques to minimise impacts when using heavy machinery (i.e. non-wheeled vehicles) on exposed slopes. Don't smoothly grade slopes with compacted soils. This will increase runoff, is hard to revegetate and is highly susceptible to soil erosion.

Don't track heavy machinery across the slope. The track marks will create furrows that water will flow down when it rains.

Use erosion control measures before starting earthworks and protect excavations during construction to prevent collapse of unstable or loose earth or sand.

Ensure operators and other workers follow all occupational health and safety procedures, for their own safety and to protect the environment (refer to the Workplace Standards Tasmania website).

Where oil or other fuels are stored, develop a plan to manage accidental spills.

Stabilise and rehabilitate the site as soon as practicable. Temporary stabilisation methods may be necessary if planting cannot take place within a reasonable time.

Follow the guidelines in the Soil and water management on building and construction sites fact sheet 5. Minimise soil disturbance (Derwent Estuary Program 2009).

11.2.3 Trench digging

Trench digging for the installation of pipes and services is often part of construction projects.

Planning is critical, to minimise environmental damage and erosion, and many of the principles described for excavation in coastal areas apply to trenches. In particular, erosion control measures need to be planned for and implemented before works start.

Ensure that trenches will not be exposed to water flows, as this can create serious erosion problems. Schedule works when rain is unlikely and keep trenches open for no more than three days. Minimising the size of the trench through careful planning is the simplest way to reduce erosion and also saves work.

Deposit excavated material up-slope of the trench and install diversion measures to control soil and water flow. Diversion measures such as banks or berms need to be aligned and spaced according to the slope of the land and the potential for erosion due to soil type and rainfall. The diversion measures need to discharge any runoff into a stabilised area or a sedimentation trap and ensure that runoff will not be channelled or funnelled together, which will increase erosion.

Retain the topsoil for rehabilitation. Backfill and rehabilitate trenches as soon as possible. Ensure subsoil is filled in first, then compact soil to 95% standard compaction, add topsoil, level it, and top up as necessary should subsidence occur.

Take care while backfilling to prevent the trench operating as a subsoil drain. The backfill should



therefore be properly compacted and trench stops installed where gradients are considered steep enough to warrant them.

Dispersive soils and tunnel erosion

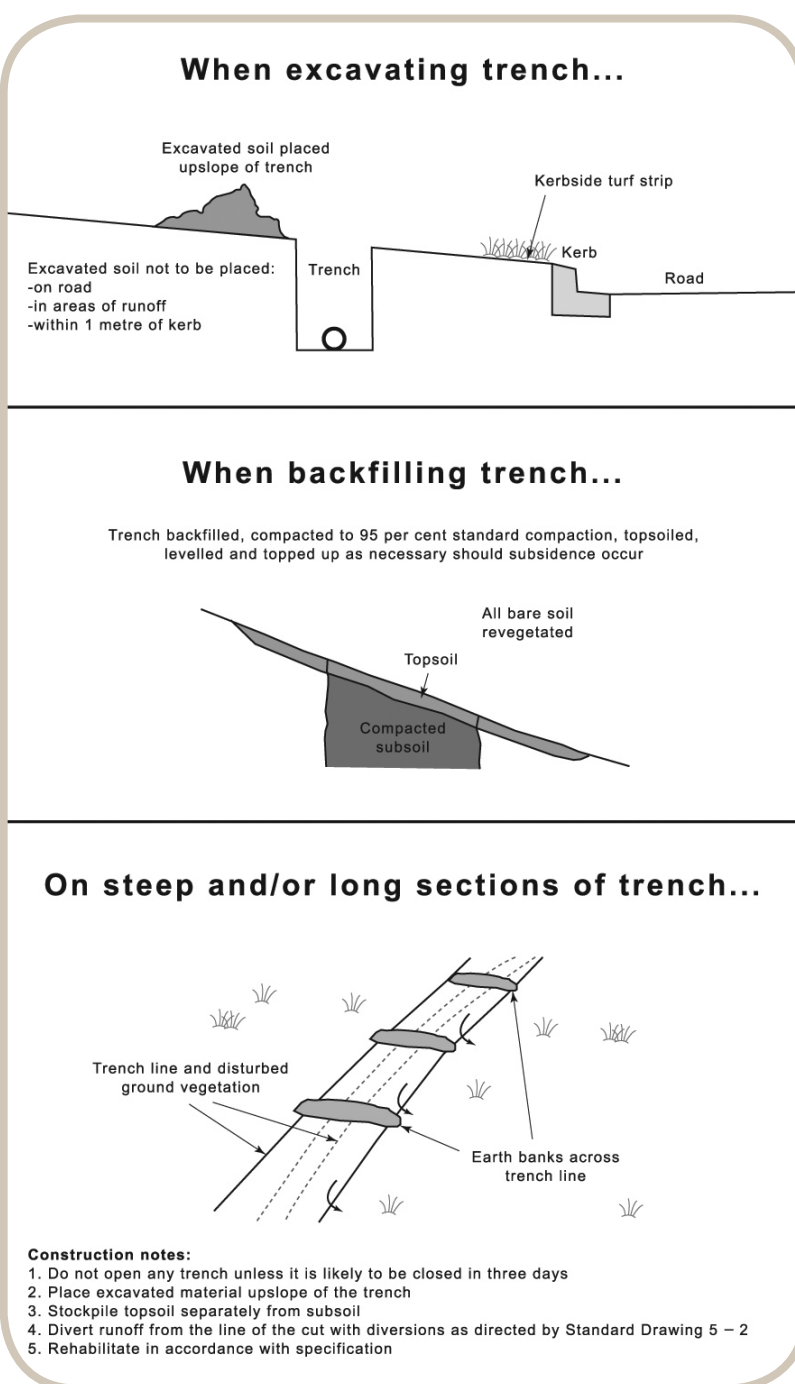
Excavation may increase the risk of soil dispersion and can result in tunnel erosion. Tunnel erosion results from the dispersion of clay soils in water (also known as dispersive or sodic soils). These clay soils collapse or disperse to form dissolved slurry when in contact with fresh water. Tunnel erosion usually occurs in the subsoil first, and drains can quickly enlarge and then collapse to form gullies.

Minimise the risk:

- Consider having the subsoil tested by a soil specialist for dispersive or sodic soils.
- Prevent ponding of water wherever possible.
- Always bury exposed subsoils with topsoil and revegetate.

Refer to Soil and water management on building and construction sites fact sheet 9. Protect service trenches and stockpiles (Derwent Estuary Program 2009).

Figure 11.3 Best practice techniques to minimise erosion when digging trenches.
Source: *Managing urban stormwater: Soils and construction*, vol 2A (Department of Environment and Climate Change 2008a)





11.3 Extraction

This section deals with the extraction of sand and gravel for use as construction materials for buildings and roads. Coastal beaches, dunes and rivers are sometimes used as sources of these materials, but extraction can severely degrade or destroy these ecologically sensitive and dynamic landforms.

Extraction of material from the shoreline, seabed, estuary or riverbed (e.g. sand, shingle, shell) can only be sustained if the natural processes can replace that material. Determining the capacity of natural processes to replenish material requires specialist study and could be expensive.

Extracting sand or gravel from a waterway is only acceptable in rare situations where it benefits the waterway – for instance, where human activities have caused a build-up of sediment that has eroded or changed the course of a stream, or destroyed habitat. For example, at some sites sediments released from old mining operations have formed a sediment slug (a large body of sediment that gradually moves downstream).

Any extraction works should minimise the amount of sediment entering adjoining waterways or coastal waters, and use appropriate sediment traps. Rehabilitation works should be undertaken during and after mining, extraction or exploration activities. These works must be appropriate for the intended future use of the site and, as far as practicable, should be completed before the expiry of the mining lease or exploration permit.

11.3.1 Legislation and approvals for extracting materials

There is a range of legislation that could be triggered by plans for extracting minerals and resources. Refer to **Chapter 1 and Appendices 1 and 2** for details of general legislative requirements. In addition to these, the *Mineral Resources Development Act 1995* provides for the development of mineral resources consistent with sound economic, environmental and land use management, and applies to all land and minerals in Tasmania.

Mineral exploration is regulated by the *Mineral Resources Development Act 1995*. Mineral Resources Tasmania (MRT) is responsible for administering the Act. Most mineral exploration work is undertaken with a licence and in accordance with the *Mineral exploration code of practice* (Bacon 1999).

Mining exploration for economic mineral deposits requires the completion of an Exploration Licence Application Form, from the Registrar of Mines, Mineral Resources Tasmania. MRT officers must be consulted before on-ground exploration activities start. A rehabilitation plan may be required.

Quarrying or mining requires an application for a mining lease. Details of proposed mine and quarry developments (including planned rehabilitation practices) must be provided on an 'Environmental Impact Information – Mining Form', from Mineral Resources Tasmania.

Where the annual disturbance is less than 5000m³ for sand or stone and 1000 tonnes for metallic mines, the operation is classified as a Level 1 operation and a council planning permit and environmental approval are required. Above that level, a Development Proposal and Environmental Management Plan is also required by DPIPW. A comprehensive plan is required by Mineral Resources Tasmania for any



necessary decontamination or rehabilitation of the site.

Where a quarry is operated by Forestry Tasmania in state forest, exclusively for constructing and maintaining roads, a certified forest practices plan (quarry) is required rather than a mining lease and a planning permit.

Extracting gravel or rock for lawful roadworks within a road reserve does not require a separate extractive industry approval from council or DPIWVE, or a mining lease from MRT.

Removing natural materials from Crown land requires a licence under the *Crown Lands Act 1976*. Most shorelines are Crown land, some private landholders have title to the high water mark or beyond. Areas below high water mark generally belong to the Crown.

11.4 Acid sulfate soils

This section covers the importance of managing acid sulfate soils in the coastal environment and the implications for coastal works and development. Acid sulfate soils (ASS) are soils that contain iron sulfides. When the iron sulfides are exposed to the air and become oxidised, sulfuric acid is released. Soils in which the sulfides have not been oxidised are often called potential acid sulfate soils (PASS).

Sediments (layers of soil) that are rich in iron sulfides occur naturally, and may underlie other soils. As sea water is a rich source of sulfates, ASS is most likely to be found in areas where marine sediments have accumulated (both recently and in the past when sea levels were higher).

ASS can be exposed to air through lowering of groundwater levels during a drought or through

disturbance by excavation associated with development and land management activities such as water extraction. When ASS are exposed to oxygen, oxidation of the sulfides can occur, generating large amounts of sulfuric acid in the process. Re-wetting of these materials can flush this acid into drains and waterways.

Release of sulfuric acid from the soil can in turn release iron, aluminium and other heavy metals (particularly arsenic) from the soil. Once mobilised in this way, the acid and metals can have a variety of adverse impacts: killing vegetation, seeping into and acidifying groundwater and water bodies, killing fish and other aquatic organisms, and degrading concrete and steel structures to the point of failure.

11.4.1 Legislation and approvals

A range of legislation applies to protecting coastal environments from the impacts of acid sulfate soils. Refer to **Appendices 1 and 2** for a summary of the relevant legislation.

Permission to undertake works on any land with ASS or PASS must be given by the relevant landowner or land manager. On areas of public land, the land manager may be the local council or DPIWVE (Crown Land Services or Parks and Wildlife Service).

In areas under the control of the local planning scheme, councils have a responsibility to ensure any application involving ASS is assessed properly, and will advise on the appropriate approvals and whether an ASS management plan is required.

Approvals will also be required if the works are on land managed by other agencies. In some instances, the application may be referred to the Environment Protection Authority (EPA) for assessment.



11.4.2 Impacts of acid sulfate soils

Acid sulfate soils are found in coastal areas of Tasmania. These soils are generally harmless in a dormant state but, once disturbed, the soil reacts with oxygen in the air to form sulfuric acid.

Acid generated by ASS can corrode infrastructure, in particular concrete and roads. Accelerated corrosion of metals, etching of concrete and exposure of aggregate are typical early signs of attack by acidic water. The acid and heavy metals that may also be released from the soil are harmful to marine ecosystems and pose a threat to humans, livestock, wildlife and vegetation.

As long as the soils remain under the water table, oxidation cannot occur. However, once oxidised, re-wetting the soils following disturbance through excavation or water extraction can produce highly acidic leachate. To improve water quality and minimise impacts, disturbed areas may need expensive rehabilitation and/or treatment. Specialist advice will be required in these situations.

Indicators of ASS impacts include cloudy blue-green water or excessively clear water; iron stains, poor pasture, scalded soil, a yellow soil layer or a dark-grey soil layer.

ASS can be prone to subsidence and foundations or earthworks built on these soils may slowly settle or subside unevenly. Structures may require either extensive piles or the laying of an extensive load-spreading membrane. This increases construction costs.

Any development that disturbs the natural sediments, whether terrestrial, estuarine or subaqueous, has the potential to expose and oxidise ASS.

Risk activities include:

- coastal developments, such as housing, resorts, marinas and canal estates
- coastal reclamation
- infrastructure development such as roads, bridges, pipelines and residential services
- agricultural activities such as field drainage, water extraction and deep cultivation
- marine or estuarine activities such as dredging.

Black ooze

In some low-energy water environments, monosulfidic black ooze (MBO) can accumulate. These gel-like substances often occur in freshwater drains and watercourses, or on the floor of sheltered bays, coastal lagoons and estuaries. Changes to water flow or increased boat traffic up stream can result in disturbance of these sediments. Once disturbed, MBOs can lead to rapid deoxygenation of the water, which will kill fish.

MBOs are predicted to occur in parts of Pittwater, Moulting Lagoon, Georges Bay and Macquarie Harbour; disturbance could have significant adverse impacts on the aquaculture industry, residential developments and biodiversity.

Figure 11.4 Monosulfidic black ooze. © Rob Moreton





11.4.3 Acid sulfate soils in Tasmania

In Tasmania, there are extensive areas of ASS in low-lying areas along the northern and eastern coastlines, extending inland along estuaries and marshlands, and in inland back swamps and floodplains at elevations of less than 20m above mean sea level.

ASS is also found on Flinders and King Islands, and other areas. Maps prepared by DPIPW, available on the LIST website, indicate possible areas that are likely to contain ASS.

In Tasmania, ASS is most likely to be found in areas of recent and older marine sediments associated with accumulations of organic matter and which have generally remained in a saturated state.

A survey for acid sulfate soils by Mineral Resources Tasmania (Gurung 2001) indicated that about 200km of Tasmania's coastline could have sediments that contain iron sulfides. The survey found evidence of acid drainage from disturbance of ASS in a number of locations, including intensively farmed areas in

the north-west. More recent work by DPIPW in 2008–2009 predicted that some 91 000ha of land may have a high risk of encountering potential ASS and a further 616 000ha has a low risk.

To date, the impact of ASS in Tasmania has been limited. This probably reflects the relatively low development pressure that these areas have encountered. This pressure is set to increase in coming years with a growth in coastal development, creation or enlargement of marinas, land reclamation and dredging. However, at least one fish kill in Tasmania has been linked to ASS.

On mainland Australia, massive kills of fish, crustacean and oysters have been attributed to ASS and extensive disturbance and exposure of sulfidic sediments has resulted in millions of dollars' worth of damage to fisheries and aquaculture, infrastructure, and coastal land – a situation that can be avoided in Tasmania.

11.4.4 Reducing impacts of acid sulfate soils

Small-scale activities will not disturb very large areas of ASS but disturbance of the soils on a small scale, whilst not requiring a management plan, may have an impact on any infrastructure installed and could cause small-scale localised contamination.

Larger-scale projects in ASS areas can easily lead to environmental damage, which may be difficult and expensive to remediate. Thorough investigation is essential before starting works, to identify whether there is a probability of encountering ASS and, on that basis, determine whether the works are appropriate.

If acid sulfate soils can be avoided, by relocating or redesigning the proposed project, then this should always be the first option. Prevention of

Figure 11.5 Blue-green cloudy water is evidence of acid sulfate soil. © Rob Moreton





acid discharge is better than trying to rehabilitate degraded land and water.

Careful observation of the soil material and any leachate should be maintained in case unexpected ASS materials are encountered.

Workers should be aware of the signs and indicators of ASS and work should cease immediately if such signs are observed, if ASS are encountered or if there is any suspicion that ASS are present and there is no management plan. Then specialist advice should be sought for the production of a management plan.

It is probably not always necessary to relocate small-scale works away from acid sulfate soil areas, but it is important to reduce the amount of disturbance of these sediments and undertake measures to minimise impacts.

- Cover in situ soils with clean fill, to provide adequate depth for foundations or excavations so that ASS layers are not intercepted.
- Minimise disturbance, dig small shallow holes where possible.
- Redesign the earthworks layout.
- Redesign existing drains.
- Minimise groundwater fluctuations.
- Neutralise by incorporating neutralising agents, e.g. lime, into the soil.
- Strategically re-bury PASS in deep voids below the groundwater table, and cover with either water or compacted soil to exclude oxygen.

Indicators of acid sulfate soils

- cloudy blue-green water, milky white water, crystal clear water, or yellowish brown water
- iron staining and reddish-brown deposits in creeks or drains
- poor pasture or swamp vegetation
- scalded soil
- orange or yellow soil layers or mottles
- sticky grey to bluish-grey soils with orange streaks
- gooey black sediments on bottom of drains
- rotten-egg smell from freshly exposed soils
- fish deaths and diseases
- etching of concrete and exposure of aggregate – typical early signs of attack by acidic water



11.4.5 Acid sulfate soils management plan

A management plan may be required for large-scale works that may disturb ASS or groundwater. A plan will detail the procedures to minimise and/or neutralise any impacts from the disturbance of ASS. Guidelines for the content of a management plan are presented in the Tasmanian acid sulfate soil management guidelines (DPIPWE 2009a).

Planning should include specialist advice and measures to minimise potential impacts, including problems in areas that might be drained and disposal of dredged material.

Other matters to consider:

Assess the need for supporting structures on subsidence-prone soils

Identify rehabilitation methods, including the appropriate disposal of any ASS material.

Obtain specialist advice about safe methods for disposing of excavated materials that contain toxic materials or acid sulfate soils.

11.4.6 Climate change and ASS

Potential climate change impacts on areas with ASS or PASS include sea level rise and more frequent and severe storm events, leading to inundation and erosion. Increased erosion of coastal dune systems, tidal mud flats and estuary riverbanks could lead to more acid sulfate soils being exposed.

Changes to rainfall and associated river flows may actually lead to lowering marshes and wetlands and decrease the flow of waterways in some areas, which could also result in exposing acid sulfate soils.

With increased stress on coastal systems due to climate change, it is important to minimise disturbance of acid sulfate soils to avoid adding pressure to already stressed ecosystems.

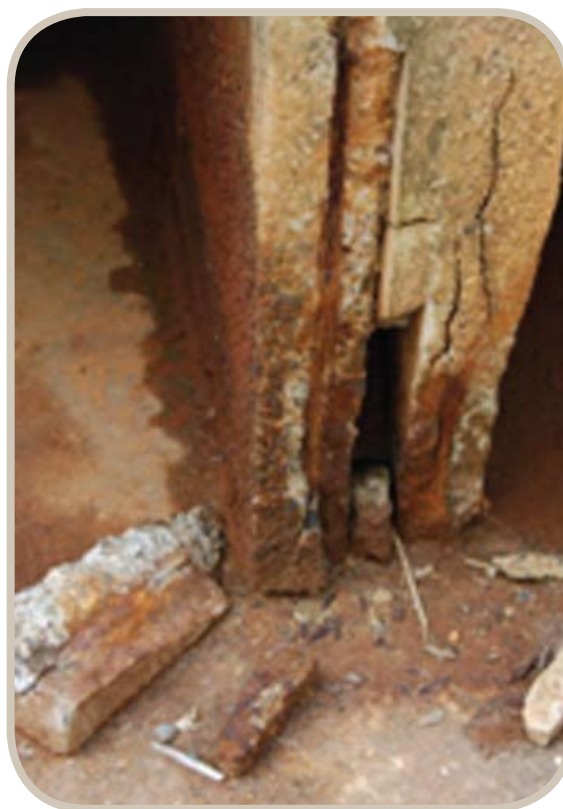


Figure 11.6 Acid damage to bridge. © Rob Moreton



11.5 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 search for Aboriginal heritage sites

www.aboriginalheritage.tas.gov.au

Coastal Values data

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

www.thelist.tas.gov.au

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

Natural Values Atlas

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

<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

Soil and water management on building and construction sites, fact sheets (Derwent Estuary Program 2009)

The fact sheets can be obtained as hard copies in a folder from the Derwent Estuary Program, or local councils in southern Tasmania and are available on both the Derwent Estuary Program and NRM South websites.

www.derwentestuary.org.au

http://www.nrmsouth.org.au/information/view_Publications_15130754/view_Technical_Sheets_Manuals_Reports_15130759/

The factsheets are divided into sediment control measures and erosion control measures. Erosion control measures hold the soil in place and reduce soil removal by rainfall or runoff. Sediment control measures capture the eroded soil from the runoff preventing it from leaving the building or construction site.



There are 19 fact sheets, each covering different sediment and erosion control measures. Use the fact sheets as needed. Remember: each site is different and sediment and erosion control measures need to be assessed on a site-by-site basis.

1. Soil & Water Management on Large Building & Construction Sites
2. Soil & Water Management on Standard Building & Construction Sites
3. Soil & Water Management Plans
4. Dispersive Soils – High Risk of Tunnel Erosion
5. Minimise Soil Disturbance
6. Preserve Vegetation
7. Divert Up-slope Water
8. Erosion Control Mats & Blankets
9. Protect Service Trenches & Stockpiles
10. Early Roof Drainage Connection
11. Scour Protection – Stormwater Pipe Outfalls & Check Dams
12. Stabilised Site Access
13. Wheel Wash
14. Sediment Fences & Fibre Rolls
15. Protection of Stormwater Pits
16. Manage Concrete, Brick & Tile Cutting
17. Sediment Basins
18. Dust Control
19. Site Revegetation

Transport Tasmania

Roadwork specification R92 – Underground Service Facilities.

www.transport.tas.gov.au

Tasmanian reserve management code of practice (PWS et al. 2003)

Soil conservation and land rehabilitation guidelines

Workplace Standards Tasmania

For OH&S procedures

www.wst.tas.gov.au

Extraction

Mineral Resources Tasmania

Exploration Licence Application Form, Environmental Impact Information - Mining Form

Mineral exploration code of practice (4th ed) (Bacon 1999)

Quarry Code of Practice (Department of Primary Industries, Water and Environment, and Department of Infrastructure, Energy and Resources 1999)

www.mrt.tas.gov.au



Acid sulfate soils

Acid sulfate soil information kit

Collation of resources from around Australia, includes the National Strategy and a booklet on keys to success. Available from the National Acid Sulfate Soil website

<http://www.environment.gov.au/archive/coasts/cass/index.html>

DPIPWE Land Conservation Branch

Instructions on how to use the maps on the LIST for ASS

Tasmanian acid sulfate soil management guidelines (DPIPWE 2009a)

Includes guidelines for the development of ASS management plan

Links to pamphlets, poster and more information on ASS are also available here

www.dpipwe.tas.gov.au/acidsulfatesoils

Guidelines for sampling and analysis of lowland acid sulfate soils (ASS) in Queensland (Ahern et al. 1998)

http://www.derm.qld.gov.au/land/ass/pdfs/sample_analysis_guide.pdf

National strategy for the management of coastal acid sulfate soils (NSW Agriculture 2000)

Prepared by National Working Party on Acid Sulfate Soils

http://www.mincos.gov.au/_data/assets/pdf_file/0003/316065/natass.pdf

The LIST

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.



12 Stormwater and crossings

12.1 Drainage and stormwater management

12.2 Crossings – bridges, causeways and culverts

12.3 Tools and resources

This chapter deals with managing stormwater networks and outlets that convey stormwater runoff into coastal areas, and providing crossings over coastal waterways. It is primarily concerned with activities adjacent to the immediate foreshore. Further information on natural waterways such as wetlands and saltmarshes can be found in Chapter 6 Coastal landscape management.

*Tab photo: Bridge over Carlton River, south-east Tasmania.
© Leah Page.*



12.1

12.1 Drainage and stormwater management

This section provides information for improving stormwater management and minimising environmental impacts when installing pipelines and stormwater infrastructure in coastal areas.

As stormwater flows over the ground it picks up a range of pollutants including oils, litter, metals and sediments, which are transported into the coastal area. Pathogens, weed seeds and nutrients can also be transported.

Increased stormwater velocity and volume, as a result of developments and hardening of surfaces (roads, paths etc.) can increase the erosion caused by water runoff and the capacity of flows to carry sediments and pollution into the coastal environment.

Properly managed, stormwater is a significant resource. Good stormwater management involves conserving water and managing pollution at the source, before it reaches waterways. This approach is better and more cost-effective than treating the effects of pollution downstream. Better quality runoff maintains healthy waterways and protects coastal ecosystems and values such as fisheries and recreational opportunities.

Water Sensitive Urban Design (WSUD) is an essential part of low-impact coastal development that is more attuned to natural hydrological and ecological processes. It gives greater emphasis to on-site collection, treatment and utilisation of stormwater flows as part of an integrated system that may be applied in addition to or in lieu of conventional stormwater measures. For more information on WSUD, see **section 12.1.4**.

When planning developments in coastal areas, ensure that stormwater drainage is carefully designed, constructed and maintained so as to minimise impacts on the natural water cycle and coastal values. This requires responding to the constraints and opportunities of each individual site. Carefully consider site characteristics such as coastal values and processes, soil type, slope, groundwater conditions, rainfall, and the scale and density of development.

*More technical detail is available in **Water Sensitive Urban Design: Engineering procedures for stormwater management in southern Tasmania (Deeks & Milne 2005)** and the **Draft state stormwater strategy (Derwent Estuary Program in prep)**.*

12.1.1 Legislation and policies

Common legislation and approval processes are detailed in **Chapter 1** and a summary of all relevant legislation is provided in **Appendices 1 and 2**. Water management is specifically legislated under the *Water Management Act 1999* and the *State Policy on Water Quality Management (1997)*.

The *State Policy on Water Quality Management (1997)* requires local governments to prepare and implement a Stormwater Management Plan (SMP) where urban runoff threatens the values, uses and water quality of downstream waterways. The *Draft State Stormwater Strategy (Derwent Estuary Program, in prep)* and *Draft Model Urban Stormwater Management Plan (DPIWE 2000a)* were developed to assist local government to meet its stormwater management obligations under the policy.



12.1.2 Impacts of poorly managed stormwater in coastal environments

Stormwater systems can conserve water and provide a valuable alternative water supply. However poorly managed drainage and stormwater systems may have the following adverse effects in coastal areas:

- Structures may interfere with natural coastal and estuary processes, which can alter the transport of sand by tides, waves and currents and cause erosion or sediment build up.
- Loss of structures or damage to them may be caused by rising sea level (e.g. there may be increased scour around pipes due to increased wave action).
- The nutrients and pollution from drainage outlets may degrade the quality of receiving waters and damage sensitive ecosystems, such as saltmarshes, mudflats, wetlands and fish nursery areas. Nutrients may cause algal blooms and growth of nuisance algae, which can kill seagrass, degrade structures and make rocky shorelines hazardous to pedestrians.
- Pathogens (e.g. faecal bacteria) in stormwater from drainage outlets may contaminate and reduce the recreational amenity of the surrounding coast. Litter in stormwater, such as plastic bags, are visually displeasing and may strangle and starve wildlife.
- Any drainage works in coastal areas risk disturbing acid sulfate soils (ASS). Appropriate investigations

Figure 12.1 Eroded stormwater outlet associated with public access has become a hazard. © Kevin Phillips





should be undertaken to identify any possible occurrence of ASS and management plans developed to address them if disturbance is deemed to be large scale.

12.1.3 Planning for stormwater management

Appropriate stormwater treatment systems will depend on the purpose of the treatment and the characteristics of the site. Aim to use systems that are least likely to cause environmental damage and that maximise benefits to the environment.

Consider drainage and stormwater design at the planning stage, well before any ground disturbance/ construction occurs. The alternative – addressing stormwater design as an additional feature after planning and design has been developed – can both limit opportunities for effective stormwater drainage and increase the cost of the system.

It is cheaper and more effective to reduce and control stormwater pollution at the source. Community education programs can persuade people to clean up

litter from streets and wash their cars on lawns and understand the impacts of illegal sewer connections to stormwater systems.

Coastal stormwater drainage can also be susceptible to damage by wave erosion and/or sand or sediment build-up and can be expensive to maintain. Works on the shoreline may cause increased wind or wave erosion. Structures on or near the shore are vulnerable to damage from sea level rise (Sharples 2006). Therefore planning for drainage and stormwater design is essential. Consult an environmental engineer.

Consult a coastal geomorphologist about placement and the best design and construction methods for the site, including the location of outlets into the sea or waterways, and the distance pipes extend into the water.

Identify any natural or cultural heritage values that require protection. Seek specialist advice – assessments and approvals may be required. Values include Aboriginal heritage, vegetation communities, threatened species and significant wildlife habitat. The Coastal Values data and Natural Values Atlas are helpful resources for natural values. **Refer to 12.3 Tools and resources.**

Consider alternative stormwater treatment systems (WSUD) to reduce impacts associated with piped systems and design drains, and other stormwater management systems to meet engineering requirements (Australian Standards).

Minimise the number of outlets into the sea or estuary (e.g. rationalise outlets and/or use existing outlets).

Use a variety of methods to treat stormwater to remove a wider range of pollutants and reduce peak flows.

Figure 12.2 Inappropriately sited pipeline on beach is hazardous and looks unsightly. © Leah Page





Site selection

When locating stormwater drainage, choose a site that minimises interference with natural systems, especially coastal processes (e.g. movement of sediment by waves and currents) and marine hydrology (seasonal patterns of tidal flushing, etc). Also consider the following issues:

- Avoid unstable or very erodible sites (e.g. dunes and slip-prone areas), natural drainage channels and stream banks.
- Assess the potential for works to mobilise contaminated sediments (e.g. heavy metals).
- Minimise impacts on natural or cultural heritage values (e.g. threatened species or Aboriginal middens).
- Avoid areas infected with phytophthora root rot (e.g. most lowland heath vegetation).
- Avoid areas that can mobilise contaminated sediments (heavy metals) or acid sulfate soils. Disturbing ASS can lead to corrosion and loss of structures.
- Avoid pipes discharging on beaches.
- Avoid obstructing public access to and along the shoreline.

Installation

Before construction works, prepare a works plan that outlines the works to be undertaken and the measures that will be used to minimise the risk of causing environmental damage.

Ensure all staff and contractors are aware of the environmental considerations and any operational constraints required to protect environmental values. Provide supervision to ensure best practice standards are met.

Pipelines

In the past, stormwater outlet pipes have been placed on beaches. This is not appropriate for public access, health and safety reasons. Pipelines crossing the seabed can harm seagrass and other important marine habitats. Installation of pipes into waterways may also need to consider navigation for boats. If pipes into the sea are required, consult an environmental engineer for effective design and seek the advice of a coastal geomorphologist.

Minimise the number of outlets into the sea or estuary. Remove pipes in favour of on-site stormwater systems (e.g. WSUD) or reconnect new networks into existing outfalls where appropriate.

Limit the impacts of existing stormwater pipe outfalls on the shore. Redesign outlets by reducing pipe length on the beach. If there is enough room, discharge the outfall into a vegetated swale for pollution treatment and flow reduction. Where space is limited, encasing the outlet with natural rock can break up concentrated flows, reduce the velocity of flows to non-erosive rates and stabilise the outflow point.

If the pipe is highly visible (e.g. along a beach), natural rock and vegetation placement can conceal the outfall. If the outfall becomes council infrastructure, appropriate design approvals are required.



Gross Pollutant Traps

Gross pollutant traps (GPTs) – structural litter and pollution collection devices – have been installed on the end of outfalls on beaches to improve water quality. Locating them in the tidal zone has caused problems with sand blocking up the GPTs. Better results can be achieved by locating them near the pollution source, e.g. the drainage networks from a shopping centre, service station or car park. Litter traps installed on individual stormwater drainage pits are suitable for smaller stormwater catchments or where there are litter hotspots.

Figure 12.3 Inappropriate siting of stormwater outfall on beach causes scouring and restricts pedestrian access.
© DPIPW



12.1.4 Water Sensitive Urban Design

Water Sensitive Urban Design (WSUD) is the design of stormwater infrastructure that aims to minimise impacts of developments on waterways and the coast. This is achieved by source control strategies that treat, store, and infiltrate stormwater runoff on-site before it can affect receiving waters. This is a change from the traditional approach, which was to get water 'piped and delivered off site' as quickly as possible.

WSUD represents best practice in Australia for water conservation and stormwater management and is ideally suited to developments on the coast incorporating specifically constructed elements including rainwater tanks, permeable pavements, vegetated swales, biofiltration systems ('raingardens'), green roofs and stormwater treatment wetlands.

Many WSUD methods are low-cost and can be retrofitted into existing catchments or incorporated at the design stage of new developments, avoiding the need for installing expensive piped stormwater networks and associated works e.g. pavements, kerbs and other infrastructure.

WSUD structures can be attractive parts of the landscape, adding aesthetic values to housing developments.



WSUD key principles:

- protecting water quality of surface and ground waters
- maintaining the natural hydrologic behaviour of catchments
- protecting natural features and ecological processes
- minimising demand on potable water supply systems
- integrating water into the landscape to enhance visual, social, cultural and ecological values
- collecting, treating and/or reusing run-off, including roof water and other stormwater
- reusing treated effluent and minimising wastewater generation
- increasing social amenity in urban areas through multipurpose green space and landscaping

A well designed WSUD system can result in significant reductions of stormwater pollutants i.e. an 80% reduction in sediments, 70% reduction in litter and substantial reductions in nutrients, heavy metals and hydrocarbon loads. In Tasmania (as in other Australian states such as Victoria and Queensland), the removal of the following key pollutants is recommended for stormwater management targets that WSUD systems need to meet:

- 80% reduction in the average annual load of total suspended solids (TSS) based on typical urban stormwater TSS concentrations.
- 45% reduction in the average annual load of total phosphorus (TP) based on typical urban stormwater TP concentrations.
- 45% reduction in the average annual load of total nitrogen (TN) based on typical urban stormwater TN concentrations.

To meet these targets, WSUD systems should conform to accepted Tasmanian and Australian practices, such as site-specific modelling of pollutant-generation against different WSUD techniques using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) proprietary software or the guidance provided in *Water sensitive urban design: Engineering procedures for stormwater management in Southern Tasmania* (Derwent Estuary Program 2005). Stormwater flow management estimates need to be prepared according to methodologies described in *Australian Rainfall and Runoff* (Engineering Australia 2004) or through catchment modelling completed by a suitable professional.



12.1.5 Treatment trains

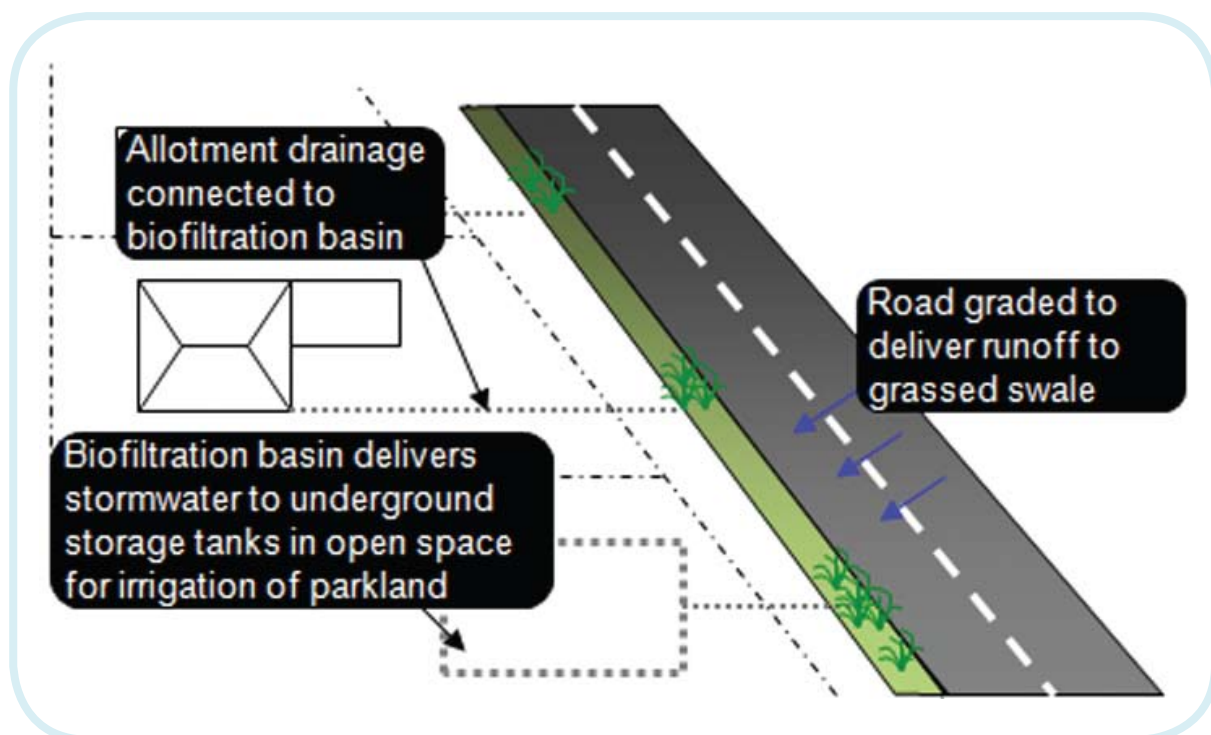
Stormwater is best managed distributing a combination of WSUD features within a development or catchment, creating a treatment train – a series of treatment systems that complement one another to achieve clean stormwater and reduce peak flows in a catchment.

Each stormwater treatment measure operates over a particular hydraulic loading rate and pollutant size range, treating gross particulates (litter, larger organic matter, etc.) first, then coarse particulates (sediment) and finally fine, colloidal and dissolved material.

To be most effective, the selection and placement of the different WSUD systems in the treatment train

should be determined during the site planning and design phase. Treatment trains can be applied at a wide range of scales within a development, such as housing layout (including design of single residential allotments and subdivisions) and streetscape layout (including road and car park design).

Figure 12.4 Example of stormwater treatment train strategy for a typical suburban street. Source: Draft state stormwater strategy (Derwent Estuary Program, in prep)





Case Study 12.1 Water Sensitive Urban Design – Cornelian Bay

Stormwater is treated by a number of WSUD methods before it enters Cornelian Bay.

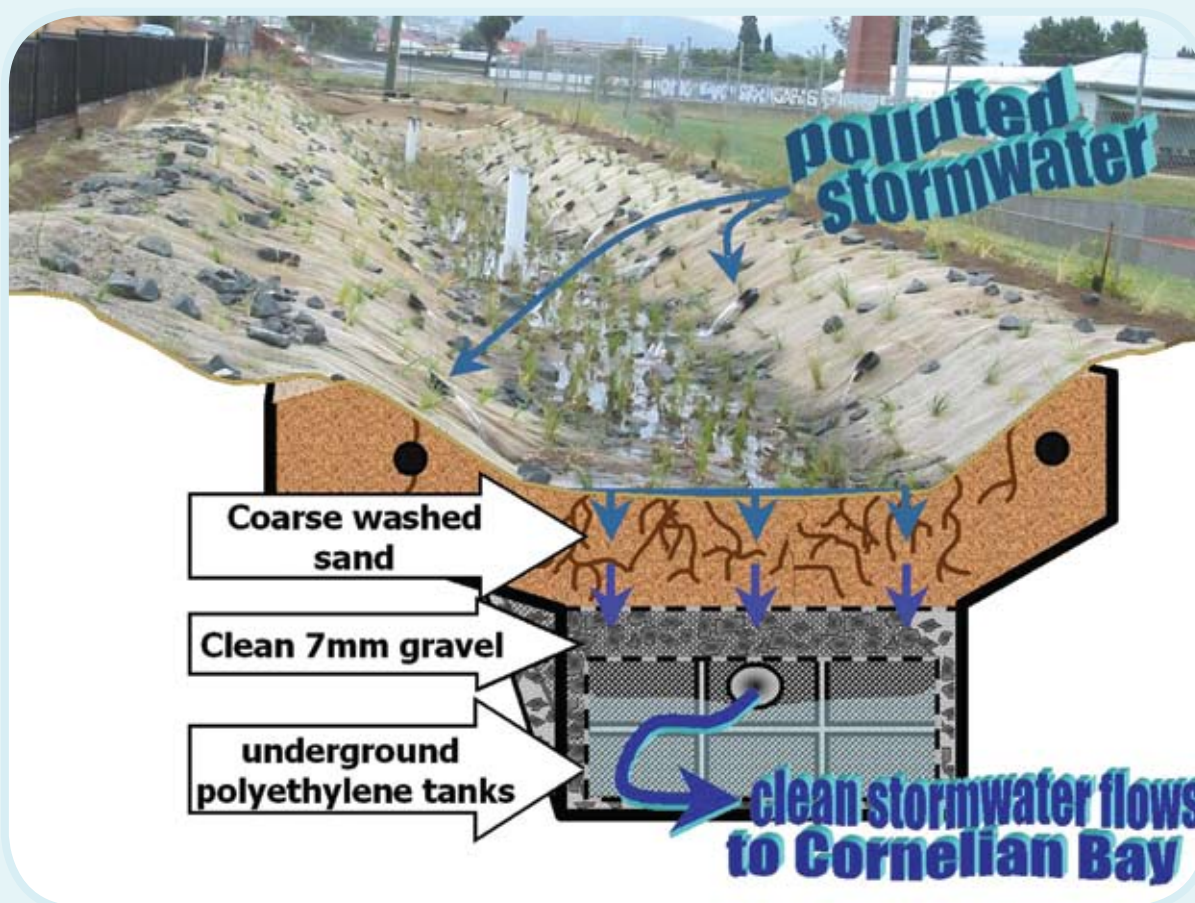
First it is filtered by an underground pollutant trap, which removes litter, oil and coarse sediment.

Water is filtered again as it passes through a vegetated channel and yet again as it percolates through sand, which removes fine sediments and their attached pollutants.

After passing through the sand, the water travels through a layer of gravel underlain by a filtering 'geofabric', before entering the subsurface tanks.

In the tanks, a biofilm (a layer of bacteria) traps remaining pollutants and breaks them down into harmless substances.

Figure 12.5 Cornelian Bay integrated stormwater treatment train, first rainfall after installation. Plants have since become more established. © Hobart City Council





Case Study 12.2 Water Sensitive Urban Design – New Town Bay

A floating litter trap was installed near the mouth of New Town Rivulet to remove gross pollutants. The trap is easily serviced and prevents litter from the urban environment being washed into the Derwent Estuary.

Refer to the Hobart City Council and Derwent Estuary websites

Figure 12.6 New Town Bay floating litter trap.
© Hobart City Council



Figure 12.8 The stormwater rain garden is effective and looks great. © John Chrispijn



Case Study 12.3 Stormwater wetlands – Lauderdale

The project involved the relocation and lining of existing stormwater drains and the construction of a treatment wetland with six permanent pools and a meandering drainage channel on a 5ha site. The project's goal was to improve the quality of the residential stormwater discharged to Lauderdale Canal and Ralphs Bay – an important migratory bird habitat.

Figure 12.7 Lauderdale stormwater wetlands.
© John Chrispijn



Case Study 12.4 Small bioretention basin in North Hobart

A small biofiltration system (rain garden) installed in Lefroy St, North Hobart is capturing and treating runoff from a Council owned car park 1400 m² in size. Natives were used, *Isolepis nodosa* (knobby clubrush) and *Lomandra longifolia* (mat rush), to plant out the rain garden. A 100mm slotted drain pipe at the base of the rain garden directs the treated stormwater into the adjoining Providence Gully Rivulet.



12.1.6 Ongoing maintenance of stormwater structures

All structures should be maintained regularly to minimise the risk of causing erosion, and obstructing the passage of pedestrians, fish and other fauna. Debris and sediment may block narrow stormwater pipes, particularly if trash screens have been installed. Inspections and maintenance should be carried out on a regular basis and after heavy rainfall or storm events.

Inspection and maintenance should include the following.

- Check for erosion around the stormwater structure and check that structures are secure and not becoming a hazard to the public.
- Check pipe openings and litter traps, and remove debris to allow passage of fish and other animals. Gross pollutant traps will require regular removal of debris.
- Maintain the vegetation around the structure. Remove weeds and ensure vegetation is growing where it should and not interfering with the useability and function of the structure.

Vegetation maintenance around stormwater structures

Avoid as far as possible using herbicides along or in drains (as this causes pollution, kills frogs and exposes the soil to erosion). To maintain grass swales, slash the vegetation rather than using herbicides. Ensure that slashed material is removed and does not get into the waterway. Sometimes it is safe to spread slashed material on site away from the waterway, but only if it doesn't contain ripe weed seeds. **Refer to Chapter 7 Vegetation management.**

If spraying is required near waterways, check that the

appropriate chemical is used and avoid spraying in the breeding seasons of frogs and other animals. Use only herbicides registered for use near waterways. If in doubt, contact a Regional Weed Management Officer at DPIPWE.

Follow the Codes of practice, guidelines and information sheets for using herbicides, available from the DPIPWE biosecurity website.

Refer also to Transport Tasmania (2003) *Roadworks specification R34 –Drainage maintenance*.

12.1.7 Climate change and stormwater management

Climate change makes it more important than ever to employ water-sensitive urban designs in stormwater management practices. It also makes the protection of natural and cultural coastal values during coastal management works critical, as climate change places increased pressure on coastal ecosystems.

New structures on the coast need to take into account the latest Intergovernmental Panel on Climate Change (IPCC) sea level rise predictions (currently 80cm over the next 100 years). Structures will be susceptible to wave action and storm surges if not sited appropriately.

Sea level rise will also result in increased inundation of low-lying coastal areas that might impact on the effectiveness of stormwater treatment facilities. King tide events already cause localised flooding when seawater is pushed back up into the stormwater systems of more urban coastal environments. It is important to seek expert advice and use the latest information and modelling when planning stormwater facilities or structures. Refer to *Indicative mapping of Tasmanian coastal vulnerability to climate change and sea-level rise: Explanatory report* (Sharples 2006).



12.2 Crossings – bridges, causeways and culverts

This section describes design and installation of waterway crossings, such as bridges, causeways and culverts in coastal areas and techniques for minimising impacts on coastal processes, values and ecosystems. Habitat, vegetation and cultural heritage values can be damaged during construction of waterway crossings. Construction can also cause significant bank and bed disturbance in waterways. These structures can create barriers to fish movement and ongoing bank erosion.

All crossings require careful design, siting and construction to cater for the special conditions and values at their location and the coastal processes such as waves, tides and sand movement. Such structures are vulnerable to damage from coastal processes; when designing them, planners and engineers need to consider projected sea level rise and increased storminess associated with climate change.

Appropriately designed causeways or culverts will maintain tidal flows and allow the passage of fish and other animals. Well-designed bridges and causeways can be attractive parts of the landscape and serve as useful viewing points and fishing places.

12.2.1 Legislation and approvals

There is a range of legislation that provides for protection of coastal values when undertaking works on the coast. In addition to legislation mentioned in **section 12.1.1, Chapter 1** provides an overview of common legislation and **Appendices 1 and 2** provide information on all the coastal legislation. Of particular relevance to crossings is the *Inland Fisheries Act 1995*, which prevents the obstruction of fish passage.

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.

If the structure crosses land managed by the Parks and Wildlife Service (PWS), under the *National Parks and Reserves Management Act 2002*, approval of PWS will be required. This is necessary before submission of council planning applications.

Necessary approvals may include council planning and building approvals, and permits under the local planning scheme.

12.2.2 Types of crossings

The type of crossing selected will depend on its purpose and the characteristics of the site. In all cases, the type of structure used should cause the least amount of environmental damage. In descending order of preference for crossings over watercourses, choose a bridge, arched culvert, open-bottom box culvert, closed-bottom box culvert, or pipe culvert (Gallagher 2003).

Bridges

Bridges are raised structures that carry a path or a road over a waterway. Typically, they are used on estuaries or rivers with clearly defined drainage channels. Usually a bridge has few or no structures in the water, so it does not impede flows.



Bridges are the most appropriate crossings for sites with:

- actively eroding banks
- a channel too steep for a culvert
- steep banks that would need considerable infilling if a culvert was used
- threatened species, fish habitat or aquatic vegetation.

Culverts

Culverts are arched, boxed or piped conduits that allow water to pass under a road or other structure. They are usually made of concrete or galvanised corrugated steel pipe. The location and size of the culvert is determined by the stream flows and the need for it to be safe during high flows. Like bridges, some large box and arch culverts do not significantly alter the riverbed or the width of the channel.

Many aquatic animals avoid or are unable to go through culverts. Culverts channel the water flow over the smooth concrete surface and increase flow velocity. Poorly designed or poorly embedded culverts prevent upstream movement and natural mixing of aquatic species.

Wherever possible, use bridges instead of culverts. Try alternative inverted U-shaped designs or irregular shapes. If round culverts are necessary they should be fully embedded in the stream bed and ideally should have an artificial substrate provided down the mid-line of the pipe (e.g. cemented rocky gravel).

Causeways

Causeways are structures that raise the base of the river or estuary bed. There are culverts underneath to allow water to go through the causeway when flows are low, but it may be inundated during floods

Figure 12.9 The Sorell causeway bisects Pittwater-Orielton Lagoon, a Ramsar site in south-east Tasmania. © Leah Page





or by storm waves. Typically, causeways are located on waterways with intermittent flows, poorly defined drainage channels, and wide shallow estuaries where it is too expensive to construct a bridge.

12.2.3 Impacts of crossings on coastal environments

Interfering with natural coastal and estuarine processes may alter the transport of sand by tides, waves and currents. Bridge and causeway construction across estuaries and other shorelines in the past has sometimes involved filling in wetlands and destroying vegetation and intertidal habitat.

Causeways across estuaries may severely restrict tidal flows and reduce the tidal prism (the volume of water moving in and out of the estuary). This may increase the rates of siltation and deterioration in water quality, which in turn may damage seagrass beds and other habitats.

The reduced fluctuation in tide levels and velocities upstream from a causeway, together with highly reduced salinity levels, may lead to considerable changes in plant communities and animals. If they restrict flows, causeways may cause more frequent local flooding.

Loss of structures or damage may be caused by rising sea level (e.g. there may be increased scour around structures due to increased wave action).

Poorly designed bridge and causeway approaches may erode and deposit large amounts of sediment and road pollutants into the waterway or impede sediment flushing.

Bridge footings and bank armouring (e.g. rocks) may stop animals moving along the banks. This may force animals to cross nearby roads, which increases their chances of being killed.

Causeways and culverts may hamper fish migration and movement of platypus and water rats (e.g. where there are high velocities through narrow pipes, or a steep drop-off from a culvert). If several small culvert pipes are used rather than one large barrel, they might be too small or dark for fish to swim through.

Debris and sediment may block narrow culverts, particularly if trash screens or stock barriers have been installed. The accumulated debris could stop migratory species passing through by creating a physical barrier or increasing flow velocity.

12.2.4 Planning for crossings in coastal environments

Before constructing crossings, prepare a works plan that outlines the works to be undertaken and the measures that will be used to minimise the risk of causing environmental damage.

- Ensure that all planning and approvals processes have been met.
- Consult coastal geomorphologists, engineers and hydrologists about the crossing design and placement. All structures should be designed by a suitably experienced engineer in consultation with a coastal geomorphologist.
- Seek specialist advice about fauna, flora and aquatic values in the area. Design crossings to accommodate requirements of threatened or highly valued species. Time works to avoid disturbance to sensitive species such as shorebirds. Consider temporary relocation of threatened species if appropriate. **Refer to Case Study 10.1 Protecting threatened seastars during construction works in south-east Tasmania**
- Identify any cultural heritage values that may require protection. Consult with Heritage Tasmania and Aboriginal Heritage Tasmania, who



can advise whether there are any values in the area.

- Structures should generally comply with the relevant requirements (e.g. Australian Standards, Austroads and Transport Tasmania guidelines).
- Align structures perpendicular to the direction/s of the prevailing waves and sediment movement, wherever possible. This will minimise obstruction of the movement of sediment.
- Provide for navigation, where boating occurs.
- Preserve the connectivity of the waterway by minimising any constriction of water flow and simulating natural channels and water flows.
- Plan works in watercourses and estuaries to coincide with low water flows, unless this may have adverse effects on plant communities and animals (especially threatened aquatic, estuarine and marine species).
- Avoid works in areas infected with phytophthora root rot. Implement good hygiene practices to avoid spreading weeds and diseases on machinery, tools and equipment.
- Restore the natural vegetation as soon as possible, to minimise the potential for bank erosion. It may be necessary to use geotextiles to stabilise banks.

Site selection for crossings

Choosing the appropriate site is critical for structures that extend across the shore and into the sea. The structures are susceptible to damage by wave erosion and/or sediment build-up and can be expensive to maintain. Works on the shoreline may also cause increased wind erosion.

- Choose a site that minimises interference with natural coastal systems and processes (including wave action and seasonal cycles of sediment

accretion/erosion) and marine hydrology (seasonal patterns of tidal flushing, currents, etc.).

- Avoid unstable areas such as dunes, slip-prone areas, very erodible soils, natural drainage channels and stream banks. Avoid shoreline or marine vegetation, floodplains, wetlands and other sensitive sites, as far as possible.
- Choose sites away from significant cultural or natural heritage values as identified during planning.
- Avoid areas where the works could mobilise contaminated sediments or acid sulfate soils (ASS). Disturbing ASS may lead to environmental damage that requires remediation and also corrosion and loss of structures. **Refer to section 11.4 Acid sulfate soils.**
- Site a causeway on a straight stretch of the waterway with a minimal gradient.
- Site a causeway on a stable substrate where there is scour-resistant material immediately downstream.

12.2.5 Installing and constructing crossings

All works crews and contractors should be briefed on the environmental standards to be met by the project and adequate supervision should be provided to ensure these standards are met.

Minimise disturbance to the shoreline or to riverbanks, bed and natural flows. Avoid deep box cuts on the approaches to bridges and causeways.

Minimise erosion by protecting estuary banks or streambanks and bridge or causeway embankments with concrete, timber, geotextiles, vegetation or rocks where appropriate. Stabilise watercourse beds (e.g. by armouring the bed with large rocks). Use energy dissipaters if there is insufficient natural protection against scouring or erosion, but only where they do



not obstruct the passage of aquatic fauna. Obtain advice from a coastal engineer about the appropriate materials and methods for the site.

Employ sediment and erosion control measures during construction, to minimise sediment flow into the waterway. Install cross-drains (at right angles to the roads) to drain water from the approach road into a sediment trap or the roadside vegetation. Place the drains at least 20m away from the crossing.

Both ends of the causeway should be 'keyed in' to the bank for 3–5m. Construct the surface of the causeway with erosion-proof material, such as interlocking angular rock or concrete or flexmat (a concrete and webbing mat).

Operate construction equipment in a manner that causes the least disturbance to the watercourse or estuarine bed and banks.

- Keep machinery out of the channel as much as possible, and minimise entry points.
- Do not dump construction materials (e.g. concrete) or push fill into the water.
- Locate surplus fill at least 10m from the shoreline, estuary or watercourse banks, separated by an effective filter strip of vegetation.

Keep water away from fresh concrete for at least seven days, where feasible. As fresh concrete is highly alkaline, it can make water uninhabitable for fish and other fauna. Some fast-drying mixes may allow a shorter curing time.

Figure 12.10 Small-scale private crossing over saltmarsh area - whilst in poor condition, it does allow the free passage of water. © Leah Page





12.2.6 Special considerations for bridges and causeways on the coast

These guidelines provide some points to consider to produce the best possible outcome for the coastal environment.

Design and construct structures to accommodate all water flow conditions. Design permanent bridges and causeways over rivers and estuaries to withstand the one-in-50-year flood level and storm surges. Consider the latest IPCC predictions for sea level rise. Specialist advice will be needed on a range of technical issues (e.g. hydrology and hydraulics).

Design and position the structure perpendicular to the waterway. Design and space the causeway openings to maximise tidal flushing.

Preserve the waterway's natural hydraulic regime (pattern of water flows) as much as possible. Place bridge piers and footings above the high water mark, to avoid constricting the channel and reducing the flow area. If bridge piers and footings must be placed in the channel, align them parallel to the flow so that the flow is not directed onto the banks. Use the minimum number of piers, shaped to minimise eddying and scouring of the waterway. Include erosion protection if scouring is likely to occur.

Consult the Inland Fisheries Service to ensure the passage of fish will be provided for. Design structures and time works to minimise disturbance to the passage of fish and other aquatic fauna. Provide enough space under the bridge for animals to walk along the riverbanks, where practicable. Seek specialist advice and refer to the design considerations in the *Policy and guidelines for fish friendly waterway crossings* (NSW Department of Primary Industries) and *Why do fish need to cross the road?* (Fairfull & Witheridge 2003).

On a multi-lane bridge, if the risk of pollution from road run-off is minimal, consider using grated decking so that light and moisture can penetrate.

If the bridge is to be used by the public and heavy vehicles, detailed design drawings should be submitted that satisfy all the relevant Australian Standards and are certified by a qualified engineer.

Design structures to look attractive and to suit the coastal landscape, as well as provide access for vehicles, bicycles and pedestrians. Wherever appropriate and affordable, allow for safe fishing places on a bridge or causeway.

12.2.7 Special considerations for culverts

These guidelines provide some points to consider, to produce the best possible outcome for the coastal environment.

When planning watercourse crossings where fish are likely to be present, consult a specialist and seek technical information on culvert design and placement. The *Forest Practices Code* (Forest Practices Board 2000) has design and installation requirements (page 15) to assist the passage of aquatic freshwater fauna, some of which will apply to estuarine species as well. Consult the Inland Fisheries Service to ensure the passage of fish will be provided for appropriately.

Ensure the culvert's capacity can accommodate peak flow volumes, so that the top of the inlet is not submerged in peak flows by more than 0.5m (in low to moderate-high erodibility class soils) or 0.1m (in high to very high erodibility class soils), unless measures are used to protect against erosion where the water discharges at the downstream end.

Open-bottom culverts with the natural streambed running through them are preferable to other culverts. Ensure they do not break up the streambed



material, and are large enough not to constrict flows or trap debris during normal flow conditions.

If an open-bottom culvert is not suitable:

- One large culvert spanning the width of the waterway is preferable to two or more small culverts, as it is usually more hydraulically efficient.
- Use culvert pipes of sufficient strength (e.g. reinforced concrete pipes) to handle anticipated bearing loads. The minimum diameter of culvert pipes should be 300mm (or 375mm in areas with

Figure 12.11 Inappropriate culvert is sited poorly and does not allow passage of fish at low flows. Source: Wetlands and waterways manual (Gallagher 2003)



high or very high erodibility class soils, where the risk of culvert blockage or failure is high).

- If multiple culverts are needed to span the riverbed, one or more should be slightly lower than the others to concentrate low flows and allow fish to swim through.
- Place the culvert perpendicular to the flow, to minimise the length needed (less than 4m) and to allow fish to swim through.
- Ensure the culvert gradient is gently sloping, similar to the stream gradient. To allow fish passage, avoid using culverts on a waterway with a gradient of more than 2% (1:50). The gradient immediately downstream of the culvert should be less than 5% (1:20), so fish can approach the culvert outlet.
- If possible, design the culvert so that its hydraulics (water flows) are similar to those of the stream, and the weakest fish species can swim through. The water depth should allow the largest fish species to remain submerged.
- Ensure the culvert has at least 600mm of space above the typical base flows (low flows of the stream), so that it is light enough inside to encourage fish to enter and swim through.
- Ensure that water velocities in the culvert are similar to those at the site before the culvert was constructed. There should also be no differences in the flow rates upstream, inside the culvert, and downstream.
- Cementing baffles or large angular rocks (typical of the area) along the base of longer concrete culverts will reduce flow velocities and allow aquatic animals to pass through.
- Lining the base of the culvert with a rough concrete finish and/or natural substrate will increase turbulence and make it easier for fish to swim through. Velocities of less than 0.3m per second will allow most native fish to swim through a 5m culvert.



- To control erosion at the outlet, place a rip-rap apron (V-shaped to allow fish passage at low water levels) at a distance of up to six times the culvert diameter beyond the outlet, particularly if the slope of the riverbed is greater than 2% (1 in 50).
- Ensure the capacity is large enough to accommodate the anticipated debris and sediment load.

12.2.8 Ongoing maintenance of crossings

All crossings should be maintained regularly to minimise the risk of causing erosion and flooding, or obstructing the passage of fish and other animals. Regular inspections and maintenance should be carried out on new crossings, after storms and periods of high flow, and before fish and other animals begin migrating.

Minimise disturbance to the passage of fish and other aquatic fauna during maintenance works.

Refer to Transport Tasmania's *Roadworks specification R34 – Drainage maintenance and Austroads AP-127/97: Concrete structures durability, inspection and maintenance procedures –Position paper*.

Figure 12.12 Wherever possible box culverts are best as they can accommodate high flows and are open at the bottom to allow for natural sediment beds. © Leah Page





Inspection and maintenance should include the following:

- Clear debris from the crossing's surface, entrance and exit.
- Remove debris and sediment from culverts, if more than a third of the entrance is blocked, to allow passage of fish and other animals.
- Check erosion is not a problem.
- Check structures are secure and not becoming a hazard to the public.

12.3 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**.

Drainage and stormwater

A model stormwater management plan for Hobart Regional Councils – a focus on the New Town Rivulet Catchment (Derwent Estuary Program 2004)

www.derwentestuary.org.au

Aboriginal Heritage Tasmania

Desktop search for Aboriginal heritage sites

www.aboriginalheritage.tas.gov.au

Australian Runoff Quality (ARQ) (Institution of Engineers, Australia 1987, reprinted 1998)

A broad design guideline produced by the National Committee on Water Engineering. Provides an overview of good practice in managing urban stormwater in Australia and contains:

- procedures for estimating stormwater contaminants
- design guidelines for stormwater quantity and quality management improvement methods (e.g. gross pollutant traps, vegetated swales and buffer strips and other aspects of water sensitive urban design)
- procedures for estimating the performance of these practices
- advice about developing integrated urban water cycle management practices
- advice about hydrocarbon management



Coastal Values data

Vegetation, species habitat and geomorphic values data for a 100m wide coastal strip of the northern, southern and north western Tasmania Natural Resource Management regions. Available on the LIST.

www.thelist.tas.gov.au

Draft State Stormwater Strategy (Derwent Estuary Program in prep)

Herbicide use

DPIPWE Codes of practice, guidelines and information sheets for using herbicides

- Code of practice for ground spraying
- Code of practice for spraying in public spaces
- Rivercare guideline for the use of herbicides near waterways and wetlands

www.dpipwe.tas.gov.au (Go to Biosecurity > Agricultural & veterinary chemicals > Codes of practice & guidelines)

Hobart City Council website

www.hobartcity.com.au

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

Model for urban stormwater improvement conceptualisation (MUSIC)

A proprietary software product. MUSIC is a user-friendly tool designed to meet the needs of urban stormwater engineers, planners, policy staff and managers in consultancies and state, regional and local government agencies.

Natural Values Atlas

The Natural Values Atlas provides authoritative, comprehensive information on Tasmania's natural values. Download a free registration form from the website to access

<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

Transport Tasmania

- Roadwork specification R92 – Underground service facilities
- Roadworks specification R 32 Drainage: Culverts, pipelines and structures
- Roadworks specification R34 – Drainage maintenance

www.transport.tas.gov.au

- Bridgeworks specifications (whole series)
http://www.transport.tas.gov.au/road/specifications/bridgeworks_specifications



Water sensitive urban design: Engineering procedures for stormwater management in southern Tasmania (Deeks & Milne 2005)

Waterways and wetlands works manual: Environmental best practice guidelines for undertaking works in waterways and wetlands in Tasmania. (Gallagher 2003)

Crossings

Aboriginal Heritage Tasmania

Desktop search for Aboriginal heritage sites

www.aboriginalheritage.tas.gov.au

Austrroads

Austrroads 1997, AP-127/97: Concrete structures durability, inspection and maintenance procedures – Position paper

Available for download from the Austrroads website. Registration is required for download. Registration and products are free.

<http://www.onlinepublications.austrroads.com.au>

Fish passage at culverts: A review, with possible solutions for New Zealand indigenous species (Boubée et al. 1999)

<http://www.doc.govt.nz/upload/documents/science-and-technical/culverts01.pdf>

Forest Practices Code (Forest Practices Board 2000)

Section B6

Policy and guidelines for fish friendly waterway crossings (New South Wales, Department of Primary Industries, n.d.)

Waterways and wetlands works manual: Environmental best practice guidelines for undertaking works in waterways and wetlands in Tasmania. (Gallagher 2003)

Why do fish need to cross the road? Fish passage requirements for waterway crossings (Fairfull & Witheridge 2003)

http://www.dpi.nsw.gov.au/_data/assets/pdf_file/0004/202693/Why-do-fish-need-to-cross-the-road_booklet.pdf



13 Access management

13.1 Roads, vehicle tracks and car parks

13.2 Walking tracks and trails

13.3 Boardwalks, steps, sand ladders and viewing platforms

13.4 Fences and other access control measures

13.5 Signage

13.6 Tools and resources

This chapter deals with design principles and site selection to minimise environmental damage when constructing roads, tracks and access control structures on coastal land near the shoreline.

Providing public access to the coast is important but controlling access is often necessary to protect coastal landforms and to maintain public safety. It is important to plan road and track development, and to control illegal tracks, particularly in sensitive locations such as actively mobile sand dunes, Aboriginal places, and penguin and shearwater colonies. Proper planning, design, construction and maintenance of structures will help to increase their life span, save money and minimise impacts on coastal values. Promoting environmentally responsible practices to the public (e.g. with signs and education programs) will encourage people to respect access control measures and stay on defined tracks.

Constructing roads, tracks, paths and fences on unstable landforms, such as sand dunes, requires good technical advice, to ensure effort and money is not wasted. Inappropriately designed or sited access management works can easily be destroyed by wind, waves or overuse, or lead to degradation.

Tab photo: Near Four Mile Creek on east coast of Tasmania. © DPIPW.



13.1

13.1 Roads, vehicle tracks and car parks

This section only addresses the special considerations involved with constructing and maintaining roads and vehicle access in coastal areas. Other resources provide more detailed information and specifications for road works. **Refer to section 13.6 Tools and resources.**

Before works start, thorough investigation and planning is essential. Assessments, approvals and an Environmental Management Plan (EMP) may be required. Small projects with no EMP require a works plan, which should outline the works to be undertaken and the measures that will be used to minimise the risk of causing damage to coastal values.

Choosing the appropriate site and construction

methods is important for works near the shoreline, as inappropriate locations or methods can destabilise or damage coastal areas and result in increased maintenance expenses.

Extra care is required to minimise impacts when working on sandy soils, especially dunes, which can be erodible or highly erodible. Even on hind-dunes that appear stable, exposing loose sand underlying the generally thin topsoils may significantly increase the risk of severe erosion or destabilisation.

The coast has a diverse range of values and uses, and space is in high demand. Planning may need to manage conflicting or competing uses. Tracks, roads and car parks will increase visitor use in a particular area; new accessways need to be sited carefully to ensure they will not create unmanageable impacts on natural values or conflict with other coastal uses.

Figure 13.1 A coastal road in south-east Tasmania maintained by the local council. © Leah Page





13.1.1 Legislation and approvals for roads and car parks

The *Roads and Jetties Act 1935* covers the legislative requirements of road planning and construction, in addition to legislation set out in **Appendices 1 and 2** covering coastal planning, environmental management, and natural and cultural values. The *Land Use Planning and Approvals Act 1993* specifies that approval from the land manager is required before works can proceed.

Much of the planning for roads and car parks needs professional services and, depending on the scale, an Environmental Management Plan (EMP) may be required. An EMP will assess values such as natural and cultural heritage and the potential impacts of a proposed activity.

All roads need to meet Australian Standards. The Department of Infrastructure, Energy and Resources (DIER) is responsible for the provision and management of infrastructure associated with the state road system. All roadwork adjacent to the state road system require the approval of DIER, who may stipulate that a Traffic Management Plan (TMP) be designed and implemented.

Works cannot be undertaken on municipal, reserve or Crown land without authority. Many coastal roads come under the authority of Crown Land and assessments and approvals from Crown Land Services will be required.

All tracks and roads that are planned to cross land managed by the Parks and Wildlife Service (PWS), under the *National Parks and Reserves Management Act 2002*, will require an assessment of values and other matters before they can be considered for approval by the PWS (Reserve Activity Assessment). This is necessary before submission of council planning applications. Environmental and heritage

assessments can take some time, so forward planning is essential.

The following approval processes may apply:

- Obtain written approval from DIER for the construction of new road access or major upgrading of existing road access onto state roads.
- Consult the local council where construction of new, or substantial upgrading of, existing access onto municipal roads is required.
- Obtain approvals from the adjoining authority when a new road connects with an existing road owned by another authority.
- Any gravel or rock that is extracted as part of lawful earthworks/construction of the road alignment from within a road reserve is considered to be part of a road construction activity. It does not require a separate extractive industry approval from council, PWS or the Department of Primary Industries, Parks, Water and Environment (DPIPWE), or a mining lease from Mineral Resources Tasmania.
- Approvals from Aboriginal Heritage Tasmania, Heritage Tasmania and/or the Environment Protection Authority may be needed.

13.1.2 Site selection for roads and car parks

Guidelines for selecting sites for new roads, tracks or car parks:

Minimise interference with natural coastal processes.

Avoid significant natural or cultural heritage values (e.g. high conservation value vegetation, threatened species and significant fauna populations such as penguins).

Consider sea level rise and coastal vulnerability to



erosion, recession and flooding. Ensure that new roads or raising roads will not create barriers to tidal flows, or landward retreat of significant vegetation communities. Bridges and culverts may be necessary.

Avoid unstable areas such as beaches, dunes, wetlands, slip-prone areas, highly erodible soils, natural drainage channels and stream banks.

Avoid works in areas infected with or vulnerable to *Phytophthora cinnamomi* (root rot) and follow protocols to reduce the risk of spreading the disease.

Avoid works in acid sulfate soils (ASS). Many ASS are prone to subsidence and roads built on these soils may settle slowly or subside unevenly. Vibration from passing traffic tends to make settling problems worse.

Avoid landslip areas. Potential landslip zones include slopes that are steep, have soaks or springs, or show evidence of ground movement (e.g. slumping, subsidence, landslips, natural terracing caused by soil creep, or bent tree trunks). Consult an appropriate specialist (e.g. a coastal geomorphologist) if there is any doubt about slope stability.

Limit access to the shoreline by focusing it into single points that serve groups of structures or are multi-purpose.

Locate roads and access tracks on existing informal access lines, if appropriate, to minimise their impact.

13.1.3 Constructing roads and vehicle tracks on the coast

Ensure all planning has been undertaken and approvals acquired. Consultation with specialists is essential to identify and protect all natural and cultural values. Surveys are often necessary and formal assessment procedures, such as Environmental Impact Assessments, may be required for some activities in some locations.

Many coastal areas contain important natural and cultural values. The Tasmanian coastline is rich in Aboriginal heritage values. Some dunes and other sandy landforms have geoheritage values. Other natural values such as threatened species or important vegetation communities may also be present.

Community groups are often interested in access management and it is important to consult with them when planning vehicle access work. Their local knowledge about visitor use and particular problems is often valuable.

Consultation with the broader community is an important way to increase awareness of coastal issues and encourage compliance with road alterations and access control. Roads are a community facility and community consultation will be necessary if planning new vehicle tracks or closing old ones.

All staff and contractors should be briefed about environmental considerations for the site and any restrictions or specific work practices that are required. Provide appropriate supervision to ensure environmental standards are being met.

Ensure all machinery and vehicles are free from weeds and diseases prior to bringing them on site. If weeds and disease are present at the site then ensure that tools, boots, vehicles and machinery are cleaned at a suitable location before leaving the site. Only import material from sites that are free from disease and weeds. **Refer to Chapter 8 Weed and disease management.**

Minimise the potential for causing sedimentation of watercourses in road design, construction and maintenance. The *Transport Tasmania: Roadworks specification—Environmental protection* covers erosion control measures such as sediment traps, silt traps and protection fencing. Investigate and, if necessary,



take precautions to minimise disturbance to acid sulfate soils. Predictive maps of potential acid sulfate soils are available on the LIST. **Refer to Chapter 11 Soil management and earthworks.**

Provide regular cross-culverts to reduce longitudinal drainage flows in side drains. Roads should be fully drained with culverts, table drains, or other drainage structures as required. Minimise the number of watercourse crossings. To help the passage of fish and other aquatic animals, ensure that culverts are designed and installed appropriately. **Refer to Chapter 12 Stormwater and crossings.**

Ensure that new roads and road upgrades take into account the latest sea level rise predictions from the Intergovernmental Panel on Climate Change (IPCC) into account. It is important that roads do not interrupt tidal flows. Raising roads to protect them against sea level rise impacts can create tidal barriers, which will change the flushing regime and lead to degradation or destruction of waterways. Avoid creating tidal barriers by installing appropriate culverts or bridges. Consider moving roads landward to allow for the retreat of natural coastal areas, in particular coastal wetlands and saltmarsh vegetation communities, as low-lying areas become inundated.

Use local materials where available to minimise construction traffic. Minimise the area cleared for construction to reduce the extent of soil disturbance. Fit the road to the topography to minimise cuttings and embankments. Take extra care on very erodible (sandy) soils.

Retain topsoil for rehabilitation at the site. If there is surplus soil, use it at nearby sites requiring rehabilitation or dump it in a planned, suitably located soil dump. This is particularly important in catchments that provide drinking water.

Protect aesthetic values as far as possible. Minimise

visual impacts by taking account of existing vegetation and the effects of vegetation removal. Safety considerations will require the removal of sufficient trees to allow the road to dry after heavy rain, and to provide adequate lines of sight on frequently used roads.

Where practicable, remove all vegetation debris from the roadside and dispose of appropriately (e.g. avoid dropping weed seeds on disturbed soil or in native vegetation). Otherwise, stockpile vegetation debris for mulching at revegetation sites or burning at a suitable location and time.

The construction process can result in road edges being excavated and material being deposited on the roadside. Minimise deposits and excavations in areas where penguins and other wildlife cross the road as blocking their access can lead to roadside deaths.

Figure 13.2 Cleaning soil and plant material off vehicles before entering and leaving sites will minimise spread of weeds and diseases. © Forestry Tasmania





For sealed roads, minimise excavation and the use of imported material in the foundation (pavement preparation) where practicable, by stabilising the natural material that is sub-grade. Depending on the soil type, methods can include the use of crushed rock or polymers, geotextile and chemical stabilisation by use of lime in clays and cement for sands.

13.1.4 Special considerations for minor roads and vehicle access tracks on erodible soils

It is sometimes necessary to provide vehicle access on erodible soils (e.g. within sand dune systems), for purposes such as access to the coast or fire breaks. Highly erodible soils in coastal environments include loam and sand with sparse vegetation cover. Very highly erodible soils include sand and fine gravel with very sparse vegetation.

In addition to the guidelines in **section 13.1.3**, extra care is required to minimise damage to vegetation and soil exposure on erodible soils, particularly on crests and upper slopes of dunes where the potential for erosion is greatest.

Minimise tracks on coastal dunes and take extra precautions to protect unstable soils and vegetation. Often vegetation is all that is holding the dune together and anything that causes vegetation death will decrease stability. Where possible, locate tracks in swales between dunes, preferably in hind-dune areas (except where drainage is poor). Only build tracks with steep gradients when the soil structure will permit positive and steady traction.

Tracks that cut through the dune system to the beach must not be aligned perpendicular to the beach. This will expose the track to onshore winds and increase erosion and sand loss. Align tracks at an angle to the direction/s of the prevailing winds, wherever possible.

This will minimise loss of sand from the beach and reduce maintenance costs.

Prevent or at least minimise side-cuts into the dunes. Protect side-cuts with a layer of brush placed over the exposed sand or use jute matting, or revegetation.

Protect heavily used tracks on steep dunes by laying a board-and-chain track or sand ladder from the crest to the bottom. Protect the track edges with scrub, jute mesh or similar materials, and fence the sides of the track. Specifications for vehicle board-and-chain ladders are available in *Coastal dune management: a manual of coastal dune management and rehabilitation techniques* (Department of Land and Water Conservation 2001).

Protect drainage lines and mid- and lower slopes, as these areas are the most prone to erosion and sedimentation. Refer to the *Forest practices code* (Forest Practices Board 2000). Construct cross-drains at approximately right angles to the water flow, with an outlet for water to discharge into the surrounding vegetation. Take advantage of natural drainage points. Follow drainage guidelines for tracks in Table 6, 'Maximum spacing between cross-drains on snig tracks' in the *Forest practices code*. Install culverts or bridges where needed to protect conservation values, such as tidal flushing of wetland areas and passage of fish. **Refer to Chapter 12 Stormwater and crossings.**

Avoid building tracks in wet conditions (except in emergency situations), as ruts can form, causing water to bypass culverts, cross-drains and natural drains.

Repair boggy sections with rock, matting (bark or brush), or cording (small logs) to prevent further damage and allow vehicle or pedestrian access. Drain and backfill any standing puddles with suitable material. Where boggy sections and/or puddles have been bypassed causing multiple tracks, rehabilitate the bypasses after repairing the main track. Restore rutted



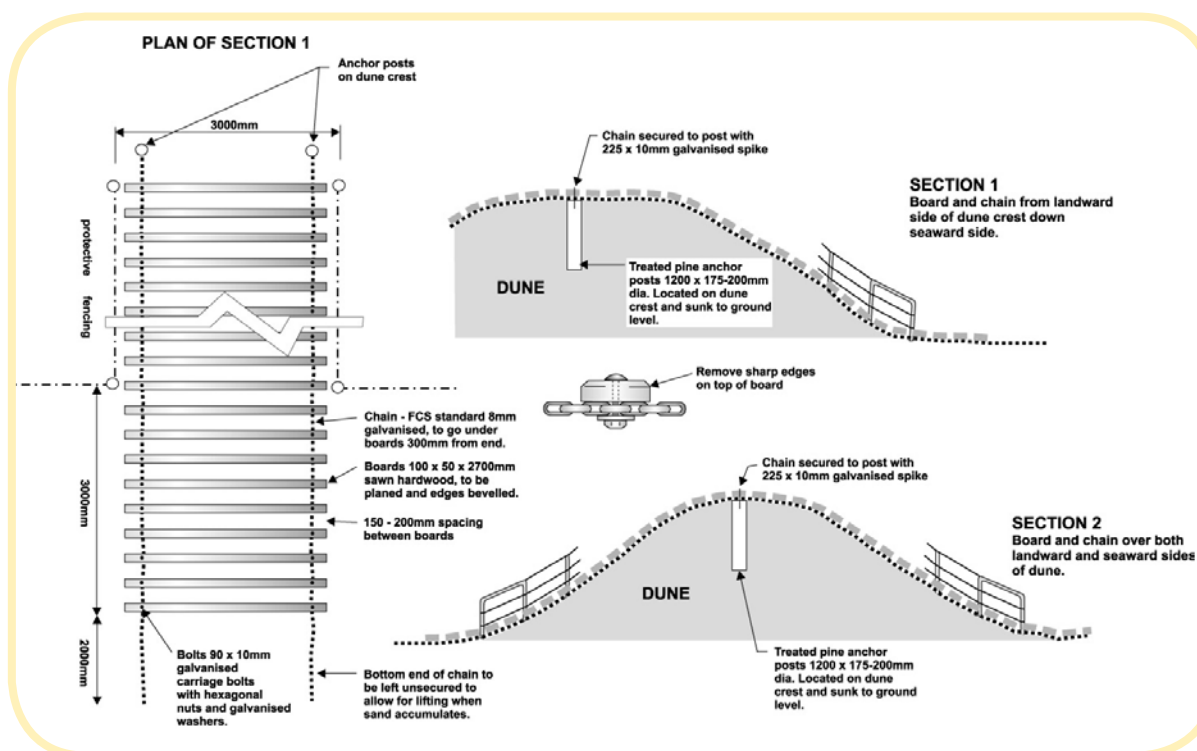
tracks with backfilling, but provide adequate drainage to prevent scour recurring. Regularly inspect roads and tracks so that problems can be quickly (and more easily) managed.

13.1.5 Special considerations for car parks

In addition to the guidelines in section 13.1.3, special consideration and planning is required for car parks, to ensure that they are located and constructed in a way that minimises impacts on the coastal environment.

Detailed technical drawings for car parks are available in the Coastal management specification manual (Green Skills Inc 2010).

Figure 13.3 Erosion due to vehicle access across sandy areas can be managed with board-and-chain installations (sand ladders). Source: © Coastal dune management: a manual of coastal dune management and rehabilitation techniques (Department of Land and Water Conservation 2001)





- Avoid placing car parks in sensitive sites. Do not excavate foredunes and other unstable sands. Wherever possible, concentrate facilities and access in particular areas.
- Consider changes to recreational usage and the associated impacts that may result from new or upgraded access and car parking.
- Allow sufficient room for boat-towing cars to turn, where necessary.
- Allow for expansion or changes to future use.
- Mark boundaries with bollards, rocks or other structures.
- Provide walkways from the car park to the coastal location, to avoid widespread impacts.
- Plan for managing runoff from large hardened surface areas. Provide adequate stormwater drainage – otherwise water could channel down beach accessways, leading to erosion and costly maintenance.
- Treat stormwater from car parks to remove sediments and hydrocarbons before the stormwater enters natural waterways. Water sensitive urban design features, such as vegetated dispersal or filtration fields or settling ponds, can be used. **Refer to Chapter 12 Stormwater and crossings.**
- Consider placing oil and silt arrestor pits on lines draining parking areas. An oil and silt arrestor pit is typically a formed concrete pit that contains baffles to slow the flow, to allow silt to settle, and also trap oils by forcing the flow of water through a submerged outlet, keeping the oil on top of the still water.

Figure 13.4 Car park at Sandy Bay's Long Beach incorporating bollards, large rocks and landscaping with native vegetation, is both functional and attractive. © Leah Page





13.1.6 Controlling off-road vehicle access

Vehicle access to beaches needs to be very carefully managed and in many areas it is illegal or should be prevented. Vehicles are a hazard to other beach users and can harm the coastal environment in a number of ways, including destruction of shorebird nesting sites, compaction of sand which impacts on animals living in the sand (meiofauna), erosion of fragile dune areas, destruction of wetlands and introduction of weeds and diseases.

Where vehicle access is permitted, encourage visitors to use designated access tracks through the use of markers, signs and fencing and by working with recreational vehicle groups and tourism operators to

increase awareness of coastal values and threats.

Where 4WD vehicles are crossing sand dunes indiscriminately, encourage drivers to use one main track. This might be achieved by upgrading and stabilising the main track, as most drivers prefer good tracks. The other tracks can then be rehabilitated.

Manage public access to reduce the potential for damage by off-road vehicles. Consider road barriers such as very big rocks or bollards for protecting values where other measures, such as signs, have failed to prevent illegal activities.

Very big rocks can be used as a barrier. Landscaping them into the ground makes them harder to move and less confrontational in appearance. A line of rocks in the open can be seen as a challenge by users who feel disenfranchised or aggrieved by the barriers.

Regular inspections and maintenance will be required, to ensure that barriers remain in place and are working effectively.

13.1.7 Ongoing maintenance of roads and car parks

To remain in good condition, all roads and vehicle tracks require regular maintenance. It is important to maintain a stable surface and a functional drainage system, particularly in steep terrain or on very erodible soils. This will minimise erosion and sediment entering watercourses from roads.

Carry out inspection and maintenance at regular intervals or more often, as required.

Roads and tracks in coastal areas are highly susceptible to coastal processes and the harsh coastal environment. Some roads and vehicle tracks on soft sediment shorelines are currently under threat of erosion due to shoreline recession. Inspect roads

Figure 13.5 Damage to sand dunes at Sandy Cape on Tasmania's west coast. © Shaun Thurstans





and vehicle tracks after extreme storms and coastal inundation events such as king tides.

Detailed guidelines for maintaining roads and access tracks are contained in the *Tasmanian reserve management code of practice* (PWS et al. 2003) and include the following:

- In steep terrain and high and very high erodibility class soils, patrols should be carried out regularly and after heavy rain. As a minimum, inspect roads at least twice a year (in autumn and winter).
- Assess condition using knowledge of user types, expected standard of road and Australian Standard risk assessment procedures.
- Inspect and maintain silt traps and sumps.
- Regularly and systematically monitor and maintain crossing structures (e.g. bridges and fords) particularly wooden structures. This should be done by qualified persons e.g. engineers for elevated structures.
- Clear table drains and culverts.
- Protect culvert outlets to prevent scouring.
- Fill settlement cracks.
- Replace drainage structures before failure.
- Replace or remove crossing structures prior to their physical collapse, to avoid impeding water flow.
- Restore the road structure and/or construct water bars to prevent erosion.
- Clean or replace guideposts and traffic warning signs.
- Identify tracks or roads that are only used infrequently or not at all and consider closing them.

13.2 Walking tracks and trails

This section deals predominantly with walking tracks along the coastline. However, some tracks are shared by a variety of user groups and land managers are increasingly recognising the importance of catering for these multiple uses.

Coastal tracks and trails provide access to foreshore areas, linkages between coastal sites and, in some instances, recreational opportunities for various user groups such as mountain-bike riders and horseriders. The design of coastal tracks needs to consider the purpose of the track, the user groups, the local coastal processes and the natural and cultural values of the area.

Careful planning and quality construction by skilled and trained track workers are the keys to success and can greatly reduce the cost and amount of future maintenance. Planning for ongoing maintenance is essential. Before approving new tracks, consider the capacity and resources available to maintain the existing ones.

13.2.1 Legislation and approvals for tracks and trails

In addition to legislation set out in **Appendices 1 and 2** covering coastal planning, environmental management and natural and cultural values, the *Civil Liability Act 2002* reduces the likelihood of public liability issues on Crown Land.

Tracks cannot be constructed on public land without the authority of the land manager. The land manager may be the local council or DPIPW (Crown Land Services or Parks and Wildlife Service). Assessments and approvals may be required to protect natural and cultural values. Land managers should commit to ongoing maintenance and allocate the appropriate resources.



13.2.2 Planning new tracks and upgrading existing tracks

Before considering the creation of a new track or trail it is important to review the existing track network with the local community. It might be possible to improve existing tracks first. New tracks should not be constructed if there is not the capacity to maintain the new track – or even existing tracks.

Consider the need for and purpose of the track.

- Is the track to provide access to the foreshore or coastal features?
- Is it a linear track to allow travel from one location to another?
- Is it a multi-purpose track?

Answering these questions will help identify the expected usage of the track, the type of track required and the potential funding required for ongoing maintenance.

It is important to identify and consult the intended user groups to ensure the track's suitability for those users. Consider track sharing, to suit multiple user groups, access for the mobility impaired and the protection of the attractiveness of the area. Consultation with the local community is essential to identify local values and issues and to ensure support for new tracks and approaches to providing access, especially if planning new tracks or closing old ones. Consider upgrading existing tracks for multi-use or disabled access.

Community groups such as Coastcare groups are often interested in access management and it is important to consult them when planning track work. They often have valuable local knowledge about visitor use and particular problems.

Design tracks so that they are visually pleasing and

suit the natural environment, and are easy for visitors to find (e.g. use poles to mark where paths enter beaches).

Consult specialists, to identify and protect all natural and cultural values. Many coastal areas contain important Aboriginal heritage relics and sites. Some dunes and other sandy landforms have geoheritage values. Other natural values such as threatened species or important vegetation communities may be present.

Contact Aboriginal Heritage Tasmania, a desktop search will determine if an assessment and/or permit is required. Aboriginal heritage officers will be able to guide your work activities to minimise any damage to Aboriginal heritage.

Investigate the incidence of acid sulfate soils (ASS) and if necessary take precautions to minimise their disturbance. **Refer to Chapter 11 Soil management and earthworks, section 11.4.**

Consider the impacts of potential climate change such as increased inundation levels due to sea level rise and extreme storms. New tracks in coastal foreshore areas need to consider the latest IPCC predictions for sea level rise and incorporate these into the design or site selection. It is important that tracks do not destabilise coastal areas through removal of vegetation, channelling of water or increased wind erosion.

The *Trails Tasmania strategy* (Inspiring Place Pty Ltd 2007) provides primary and secondary criteria to assist with assessment and approval of new track proposals.

Thorough planning is the only way to ensure sustainability of the track and the coastal environment and will help establish partnerships; provide information that could be used for funding



applications or sponsorship proposals; and may help identify strengths and weaknesses.

Site selection

Careful planning and choosing the appropriate site will minimise impacts and future maintenance needs.

- Accessways and tracks through sand dunes should be sited in natural gullies. Avoid creating tracks on dune crests. Unvegetated dunes, cliff tops, wetland edges and potential landslip zones are unstable areas and may be unsuitable.
- Avoid works on or near beaches and foredunes, unless they are required to provide access to the shoreline.
- Avoid or minimise interference with the natural coastal processes and reduce exposure to severe wave action.
- Avoid disturbing significant natural or cultural heritage values.
- Choose already disturbed sites where people want to go (e.g. where people usually cross dunes), wherever possible. This will lead to greater public acceptance and use of these tracks. Aim to reduce the number of access points through dune systems.
- Follow the contours of the land where appropriate. This will often be more cost-effective and have less impact on the landscape than other options.

Figure 13.6 Coastal path at Bellerive designed for multi-use. © Leah Page





13.2.3 Guidelines for track construction in coastal areas

Design

It is important that structures comply with Australian Standards and with the requirements of relevant land use zoning, management plans and track management strategies.

Tracks and structures that provide access for mobility impaired people should be considered where required or appropriate, particularly for features such as viewing points and beaches.

Classify tracks according to recognised track classification schemes, using the six classes detailed in *AS 2156 Australian Standards: AS 2156 Part 1 Walking tracks. Classification and signage*.

Do not create infrastructure unless absolutely necessary. Minimise the construction of bridges and walls. This will make the track cheaper to construct and cheaper and easier to maintain.

Avoid creating new tracks in areas infected with *P. cinnamomi* (root rot) or uninfected areas if the vegetation type is highly susceptible to the disease (such as coastal heath vegetation) or there are threatened plants or communities that require protection. Washdown stations will be required on existing tracks that move from infected areas to uninfected areas. Consider re-routing such tracks if possible.

For multi-use tracks, vehicle barriers should be wide enough for bike riders to pass through the opening without having to dismount. For horse trails, provide step-over barriers to prevent vehicle access. Consider overhead clearance under trees and install signs at a height that can be read by horseriders.

Technique

All staff and contractors should be briefed on the environmental considerations for the site and any restrictions or specific work practices that must be implemented. Provide appropriate supervision to ensure that environmental standards are being met.

Ensure that all machinery and vehicles are free from weeds and diseases prior to bringing them on site. If weeds and disease are present at the site then ensure that tools, boots, vehicles and machinery are cleaned at a suitable location before leaving the site. Only import material from sites that are free from disease and weeds. ***Refer to Chapter 8 Weed and disease management.***

Take precautions to minimise disturbance to acid sulfate soils (ASS). A rotten-egg smell or yellow deposits when digging are likely indicators of ASS. Minimise the potential for causing sedimentation of watercourses in track design, construction and maintenance. ***Refer to Chapter 11 Soil management and earthworks.***

Use staff trained and skilled in designing, auditing, maintaining and constructing tracks. Poor design or construction will lead to high ongoing maintenance costs. There are highly skilled and experienced contractors that can be engaged to construct coastal access and tracks. In addition, organisations like Conservation Volunteers Australia can provide a valuable labour force when supervised by an experienced track worker.

For construction work, use hand tools in preference to machinery as this will minimise the impact on the site and reduce the risk of introducing weeds and diseases. Take precautions to prevent the spread of weeds and diseases by cleaning hand tools and work wear.



Make the most of natural features and use natural, local materials wherever possible. These will provide a more attractive result and will often be more durable.

Tracks that cut through the dune system to the beach must not be aligned perpendicular to the beach. This will expose the track to onshore winds and increase erosion and sand loss. Align tracks at an angle to the direction/s of the prevailing winds, wherever possible. This will minimise loss of sand from the beach and reduce maintenance costs.

Align tracks on the uphill side of large trees to minimise damage to tree root systems.

In well-protected dunes with little foot traffic, no additional track surface is required. A natural sandy path is the most attractive surface, if it is not exposed to excessive wind erosion.

In busier or windy sites, a protective surface is often necessary to reduce wind and water erosion, and to improve public safety. Choose local materials such as stone, gravel or bush timber to create a more natural appearance, wherever possible. If using sawn timber;

Figure 13.7 Laying geotextile protects Aboriginal heritage material by minimising future disturbance to the midden.
© Aboriginal Heritage Tasmania



try to construct the track with gentle curves.

Gravel is generally most suitable on fairly level paths. Gravel paths should be about 100mm high to allow rainwater to run off. Define the edges with free-draining crushed rock and boulders. Sometimes it is necessary to retain the edges of tracks. This is best done with drystone walls using local materials wherever possible.

Minimise water crossings whenever possible as they create the most potential to affect water quality, through erosion and washing of sediments into the waterway. Hardened track structures may be required, such as culverts and bridges. Seek engineering advice for the construction of bridges. In some instances, the use of rock may be all that is required to harden the trail over boggy or soft terrain. **Refer to Chapter 12 Stormwater and crossings.**

Controlling the movement of water on the track through good design is paramount for minimising erosion and reducing track maintenance. Running water will erode the track, whilst pooling water will create boggy areas and rot structures. Divert water and encourage it to sheet across the track not flow along it. Create regular grade reversals (zigzags) or grade dips (undulations) to ensure water will flow across and not along the track. A slope of fall of 3–5° will encourage water to sheet and not channel across the track.

Water bars (wood or rock across the track at angles to divert water) can be used to assist track drainage but are not ideal as they require maintenance to keep them working well and can be a tripping hazard.

Consult with the Aboriginal community and seek advice and permission where it is not possible to avoid the cultural site. A permit to conceal sites can be issued by Aboriginal Heritage Tasmania where appropriate. Generally, middens can be protected



by the laying of geotextile material on top of them and then laying the track gravel or rock over the top. This creates a semi-permeable layer that prevents the track material mixing with the Aboriginal relic material. Regular maintenance will identify when the geotextile material is becoming exposed and the track material needs to be topped up. If any new sites or artefacts are discovered, stop work and contact Aboriginal Heritage Tasmania.

13.2.4 Walking track classifications

The Australian Standards (AS2156.1-2001) provide information to guide the design of tracks and suitable facilities and management. Six classes of walking tracks are defined in the Standards. Generally these classify the tracks from easy to advanced or severe. Mountain-bike and horseriding tracks have different classification systems to reflect their specialised use.

Table 13.1 Track classifications for Australian tracks. Adapted from Australian Standards: AS 2156 Part 1 Walking tracks. Classification and signage

Track Classification	Description	Inspection interval	Management considerations
Class 1	High numbers of visitors incl. those with impaired mobility.	30 days or less	Facilities such as toilets and car parking, signage. Steps must be accompanied by ramps.
Class 2	High numbers of visitors.	90 days or less	Facilities such as toilets and car parking, signage. Minimal use of steps.
Class 3	Slightly modified natural environment.	6 months or less	May have facilities such as toilets. Steps may be common. Limited interpretation signage
Class 4	Undisturbed natural environments with defined and distinct tracks.	6-12 months and after storm events	Minimal signage, minimal facilities.
Class 5	Indistinct tracks, remote locations.	6-18 months	Signage only for management purposes.
Class 6	Unmanaged tracks. Users responsible for public safety.	Not managed for public risk.	Facilities and signage generally not provided.

There are also standards for mountain-bike trails, produced by the International Mountain Bike Association (IMBA) which could be considered for multi-use tracks.



Case Study 13.1: Track redevelopment at Alum Cliffs, Kingborough, southern Tasmania

The Alum Cliffs track near Kingston is a high-profile community asset managed by Kingborough Council. By 2007 large sections of the track were closed because it was unsafe and causing damage to coastal values, including Aboriginal heritage sites. It was very steep in some places, with inappropriate water crossings over gullies.

Timber steps and structures were very old and in need of maintenance, and in some places the track was dangerously close to unstable cliffs. Sections of the track were suffering erosion due to poor design, and sand loss on Kingston Beach was making access to the shoreline difficult in places.

Kingborough Council was committed to reopening the track and undertook an assessment/audit in 2007 which recorded all major features, issues and boundaries with a GPS, and deemed that many of issues could be managed with realignment of the track and replacement of old structures.

The council received input from a tracks and trails advisory group with representatives from key community groups such as dog walkers, walking clubs and Coastcare groups.

Work was undertaken by experienced track workers, rerouting sections of the track to avoid the Aboriginal heritage sites and to take the track away from the cliff edge. Steep sections were improved by following the gullies and this enabled water crossings to be relocated more appropriately. Water crossings were also improved with the installation of bridges so that water flow was no longer inhibited. Track gradients and alignments were modified to address drainage and erosion concerns.

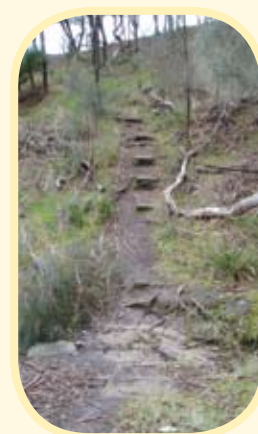
The track is a Class 3 with all-natural surfaces except for a midden area that could not be avoided. A permit from Aboriginal Heritage Tasmania was issued to conceal the midden and geotextile was laid underneath a gravel surface to protect the heritage material.

The track has been reopened and the modifications have protected vegetation, cultural heritage and waterways; reduced erosion; improved safety; increased ease of maintenance; and even resolved some conflicting user issues.

Ongoing work will involve improving drainage where required and realignment of some sections that are impacting on sensitive vegetation or unstable foreshores.

Figure 13.8 Crossing upgrade on Alum Cliffs track. The old water crossing was steep and hazardous. The new water crossing is further up the slope and improves the gradient of the track but, most importantly, the bridge does not impede water flows and protects the banks from erosion.

© Johannes May





13.2.5 Audits and maintenance of tracks and trails in coastal areas

Existing tracks and trails should be audited before new tracks are considered. Auditing enables an inventory of tracks to be created and identification of any hazards or maintenance required.

Auditing also enables tracks to be classified according to the Australian Standards. These classifications provide guidance for maintenance schedules and may also provide a mechanism for land managers to prioritise maintenance of their track network.

Create and implement an audit and maintenance plan, which should ensure that all issues identified during an audit are addressed before the next audit.

Before constructing new tracks, develop a maintenance plan. Do not create new tracks unless the plan indicates that there will be sufficient resources to maintain them.

Maintenance plans should ideally be part of a broader management plan that identifies a risk management process, hazard inspection guidelines, annual maintenance program and clarifies management roles and responsibilities.

Many coastal tracks cross over multiple land tenures. It is important that land managers work together to map and determine which sections of the track they are responsible for, and to establish clear and consistent management guidelines.

Alternatively a lease or licence agreement will enable one management authority to take on management and public liability for the entire track so that a consistent management approach is applied.

Identify areas where one well-constructed track could replace numerous poorly constructed (or not maintained) tracks. Rehabilitate or close tracks that

are hazardous, or where the landform or vegetation is being damaged. Identify areas under pressure from overuse or creation of illegal tracks.

Tracks in coastal areas are highly susceptible to the impacts of coastal processes and the harsh coastal environment. Some tracks on soft sediment shorelines are currently under threat of erosion due to shoreline recession. Inspect tracks after extreme storms and coastal inundation events such as king tides.

Inspect the track for hazards, checking the condition of the track against the elements of classification in AS2156.1-2001. These include assessments of the condition of the track surface including the height of trip hazards (such as tree roots), track width, structures and signage, erosion or damage, obstructions, and the condition of vegetation along the edge of the track – in particular, overhanging limbs or overgrown vegetation.

Techniques include photopoints, recording GPS points of hazards and areas requiring maintenance, and making observations about level of use and potential for increased pressure (such as new local subdivisions).



13.3

13.3 Boardwalks, steps, sand ladders and viewing platforms

This section deals with the installation of hard structures on coastal tracks to provide access to beaches and coastal areas or to protect sensitive coastal values.

Hard access structures such as boardwalks and steps can provide for improved access to coastal areas and enhanced recreational experiences. They can also provide protection for sensitive areas and landscapes whilst allowing visitors access to enjoy these environments.

Hard structures can be made from a variety of materials, with new products (such as recycled plastics) being developed all the time. All are

expensive to install and must satisfy building approvals to meet Australian Standards and require a high level of ongoing maintenance. Do not consider new structures unless there is the capacity and resources to maintain them. Plan for their replacement in approximately 20 to 25 years and prepare an asset management plan and asset replacement plan for all structures on tracks.

In high-use coastal areas and adjacent coastal facilities, such structures are often necessary to provide access whilst minimising impacts such as destabilisation of dunes.

Special care will be required during construction to prevent and control erosion as sandy shorelines are often unstable and subject to erosion. Structures that extend across the shore must be appropriately designed and placed to minimise damage from salt water and wave action.

Figure 13.9 Boardwalk at Windermere Bay protecting fragile coastal vegetation. © Derwent Estuary Program





13.3.1 Legislation and approvals for hard access structures

In addition to legislation set out in **Appendices 1 and 2** covering coastal planning, environmental management, and natural and cultural values, the *Civil Liability Act 2002* reduces the likelihood of public liability issues on Crown land.

Track structures on public land require the authority of the land manager. The land manager may be the local council or DPIW (Crown Land Services or Parks and Wildlife Service). Assessments and approvals may be required to protect natural and cultural values. Land managers should commit to ongoing maintenance and allocate the appropriate resources.

Structures must comply with the *Building Act 2000* and *Building Regulations 2000*.

13.3.2 Guidelines for boardwalks, steps and sand ladders

In addition to the considerations detailed in **section 13.2.2 and 13.2.3** the following guidelines are specific to hard access structures in coastal areas.

Aim to minimise infrastructure in the coastal zone. Consolidate access structures in areas that are less susceptible to storm surges and general coastal processes. Take into account the latest IPCC predictions for sea level rise and plan structures to withstand these within their lifetime. Steps and boardwalks are relatively expensive to construct and maintain. It is preferable to locate them at the more protected ends of beaches where severe wave erosion is less likely.

Structures that provide access for the mobility impaired should be considered where required or

Figure 13.10 Steps encroached on by erosion were becoming unsafe and have since been removed. © Chris Sharples





appropriate, particularly for features such as viewing points and beaches.

It is important that structures comply with Australian Standards. Steps or other structures crossing Crown land, which includes all land below high water mark, require formal assessment and approval.

Adapt the design and placement to suit the site conditions. Avoid perching structures on top of dunes. Use existing blowouts and gullies for structures and avoid attempting to provide access over the foredune, as it is subject to movement and variability.

Timber is a commonly used material but new products, such as prefabricated recycled plastics are available. If using timber ensure it is durable and environmentally responsible. Hardwood boards are expensive but will outlast pine in some circumstances

(depending on exposure to moisture) and are less inclined to warp and become hazardous. However quality hardwood can be hard to source; oversized pine is usually used and can last about 15 years. The durability of the timber is improved by treatment with preservative followed by surface coating.

Plan for ongoing future maintenance by establishing a maintenance regime to ensure structures are inspected regularly.

Boardwalks and steps

Boardwalks are useful for controlling access and protecting highly sensitive or fragile areas. Steps are useful for providing access through foredunes or down steep coastal foreshores. Steps can be completely elevated timber structures or a timber

Figure 13.11 Steps require regular maintenance to keep them looking good and working well. © Leah Page





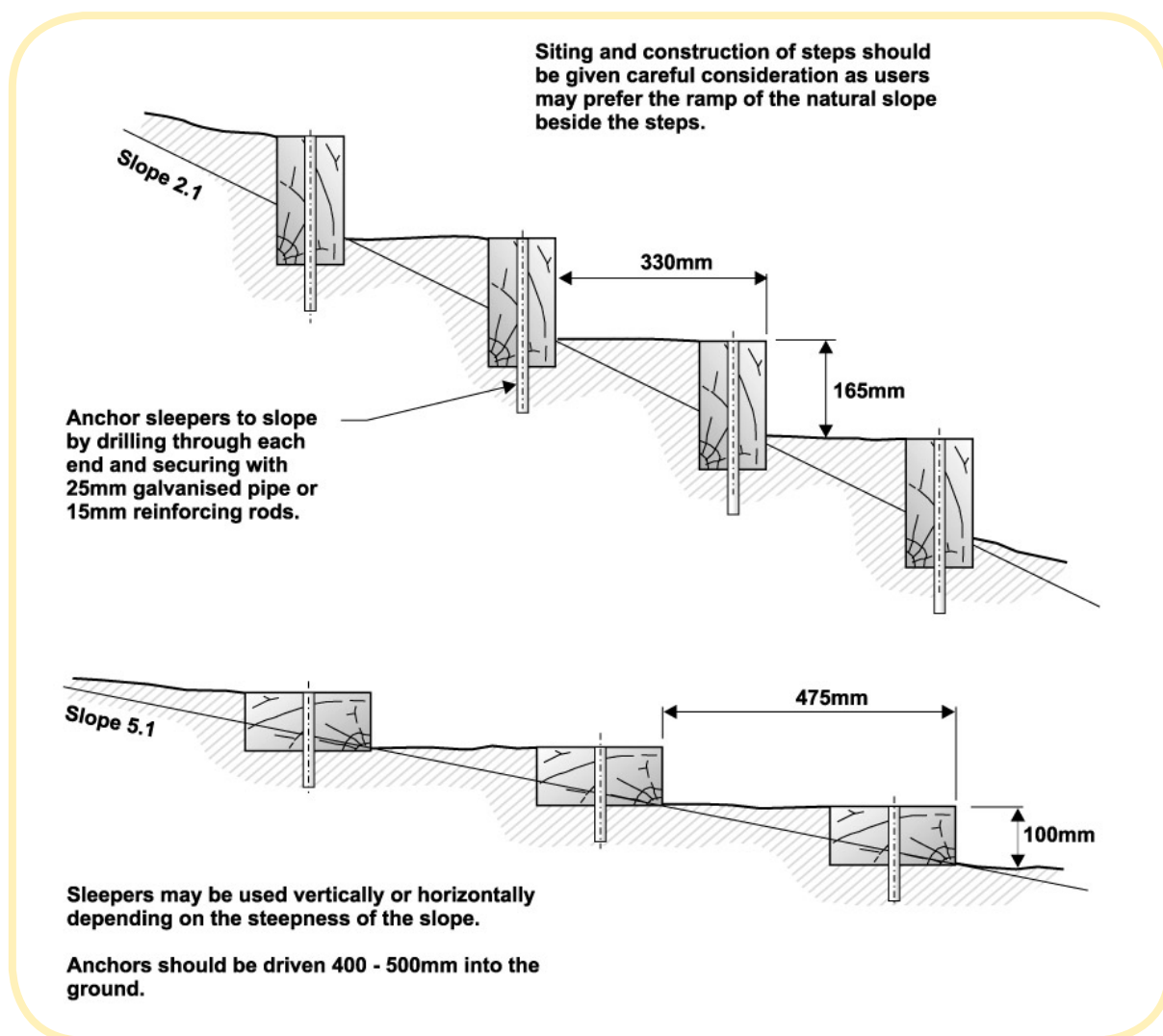
and gravel combination built into the contour of the land. Whilst the installation of boardwalks and steps will involve some disturbance, they minimise ongoing disturbance and erosion due to foot traffic, making them useful in high-use areas.

In areas with high visitor numbers, the boardwalk width should allow for two-way flow and have step

runners (guides along the edges of the steps) to discourage walkers from deviating around the steps and causing erosion.

Protect the edges of boardwalks with scrub, jute mesh or similar materials and consider fencing alongside to encourage people to stay on the track.

Figure 13.12 Gravel and timber step design. Source: *Coastal dune management: a manual of coastal dune management and rehabilitation techniques* (Department of Land and Water Conservation 2001)





The risers (the vertical part of a step) can be constructed with treated timber logs or railway sleepers, with sand placed behind the timber to provide a step. Geotextile can be used to reduce potential loss of fill around steps. Anchor the risers firmly (e.g. by driving reinforcing rod or galvanized pipe through them into the ground (see Figure 13.12).

Potential sea level rise and eroding beaches can create costly maintenance problems. A 'sacrificial' lower section on timber steps will save money, as only the lower part of the structure will be damaged by storm surges. The lower section is separate from the upper section and can be replaced. Refer to the technical drawings for steps and stairs in the *Coastal management specification manual* (Green Skills Inc 2010).

Sand ladders (board-and-chain)

Sand ladders are better than steps on some steep dune faces (e.g. on eroding beaches). Ladders work best if erosion is caused mainly by walkers or wind rather than waves.

Ensure board-and-chain slats are a suitable distance apart for easy walking (e.g. 150–200mm between 100mm-wide boards). As a general guide, increase the spacing on steeper slopes (e.g. on sand ladders) to make them safer to climb. Refer to the *Coastal dune management: a manual of coastal dune management and rehabilitation techniques* (Department of Land and Water Conservation 2001).

Sand ladders on sand-dune faces need to be flexible, so they can adjust (or be adjusted) to the changing dune profile (e.g. after storm waves). Inspect boards regularly to see whether they need lifting or replacing.

Figure 13.13 Pedestrian sand ladder minimises erosion of the dune. © Leah Page





Sand ladders may not be suitable in high-use areas or where access needs to cater for a broad cross-section of the community. For example, some elderly people find it hard to walk on sand ladders and the rungs can be a trip hazard if the sand does not build up around them.

Sand ladders are suitable in situations where the level of use is causing erosion but is not high enough to warrant a more expensive structure, and in highly dynamic coastal environments where the risk of loss or damage to hard structures is too high to warrant more expensive steps or boardwalks.

13.3.3 Viewing platforms

Viewing platforms can be built to provide safe viewing places, while at the same time protecting sites from overuse. They can be interesting and attractive structures if they are well designed to suit the site. It is best to integrate them with existing structures such as steps and boardwalks.

Viewing platforms must be designed by engineers and constructed to the Australian safety standards so that they are not a hazard to users, and checked by an engineer after construction. They should be designed to be aesthetically pleasing, blend into the landscape, and be easy for visitors to find.

The *Coastal management specification manual* (Green Skills Inc 2010) has detailed drawings and specifications for constructing viewing platforms.

Figure 13.14 A lookout platform of stone and gravel was built to protect a shell midden at Redbill Point, Bicheno. Source: *Community Coastcare handbook* (Thorp 2005).





Figure 13.15 The viewing platform at Turners Beach incorporates mesh flooring to allow water, air, sand and light to penetrate to the vegetation below. Its location on the foreshore required the installation of rock to protect the structure from wave action. Geotextile sand containers or local rock material are other options. © Justin Smith

Case Study 13.2 Minimal impact viewing platform design

Conventional beach access construction methods can cause extensive disturbance to dune systems and the surrounding environment. In the past, heavy machinery has been used to ram poles and dig large holes for footings.

When Central Coast Council collaborated with Turners Beach Coastcare group to undertake the installation of a viewing platform at Turners Beach, environmental considerations were paramount.

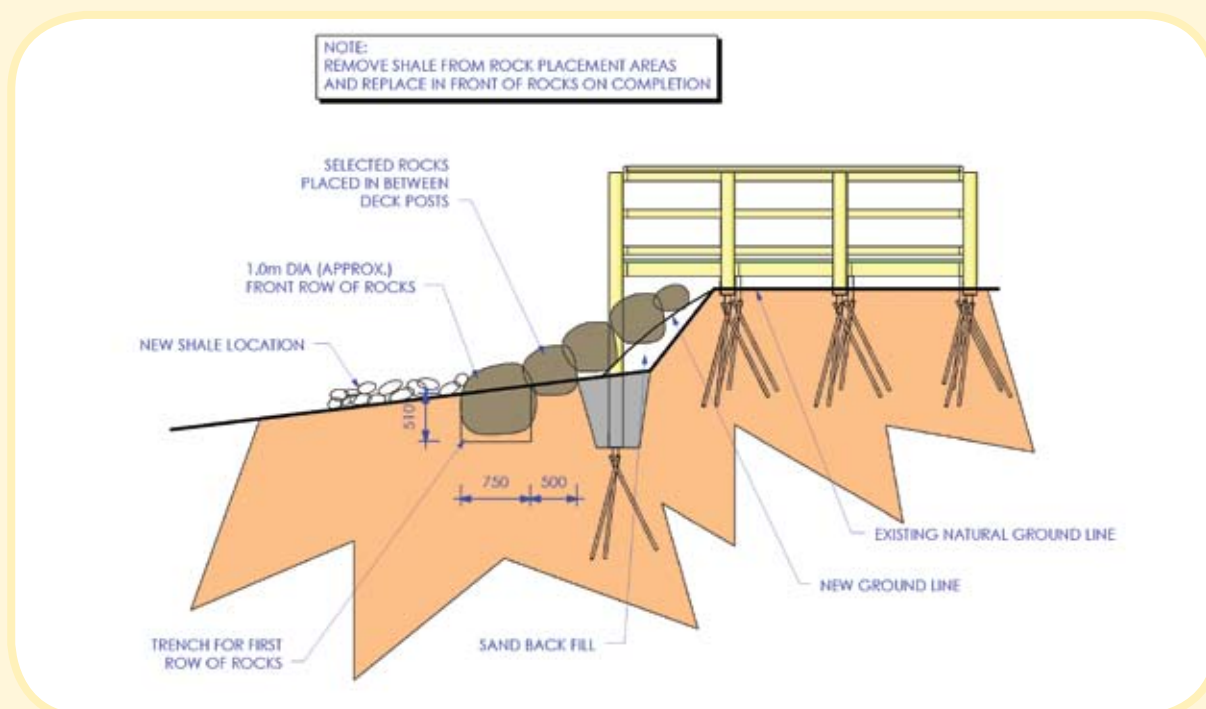
They ensured that the design and installation of the structure had minimal impact on the environment and

integrity of the natural dune system. This was largely due to the new innovative Mega Anchor System that enabled anchors to be driven into the sand with minimal disturbance and without the need for heavy machinery.

They also incorporated fibreglass-reinforced plastic for the decking. This type of decking allows for natural movement of water, air, sunlight and sand through the structure, enabling plants to re-establish underneath, which will maintain the stability of the dune.

The platform has also been modified to cater for mobility impaired people, affording them the opportunity to view the beach.

Figure 13.16 The Mega Anchor design minimised disturbance of the dune during installation. © Justin Smith





13.3.4 Ongoing maintenance of hard access structures

Structures require regular auditing and maintenance to make sure they are in good condition. They are very susceptible to damage from wind and waves and can easily become a hazard to the public.

Carry out regular safety inspections in accordance with Australian Standards specifications. Inspect structures regularly and after heavy rain, wind, unusually high tides and storm events.

Check:

- the condition of structures
- the condition of vegetation beside the track (including weeds and diseases)
- the extent of erosion (depth and width).

Remember that structures subject to sand burial (e.g. on foredunes) will need regular lifting and adjustments to compensate for shifting sands.

Identify structures that are only used infrequently or no longer used, and consider removing them. Consult the local community and assess cultural significance before closing structures. Detailed guidelines for maintaining and closing tracks are in the *Tasmanian reserve management code of practice* (PWS et al. 2003).

13.4 Fences and other access control measures

This section deals with fences and other access control measures in coastal foreshore areas. Specialised fences can also be used to assist in dune stabilisation and this is covered in **Chapter 6 Coastal landscape management**.

Fences and other measures are often necessary to control access and protect unstable or fragile coastal soils, vegetation and wetlands from damage by people, vehicles or livestock.

Fences and other barriers such as bollards, may be installed to protect dunes, saltmarshes or wildlife habitats from pedestrians, or to confine foot and vehicular traffic to defined tracks and to stop people forming new tracks in sensitive areas. Barriers are useful to delineate car parks.

13.4.1 Legislation and approvals for fencing and access control

In addition to legislation set out in **Appendices 1 and 2** – covering coastal planning, environmental management, and natural and cultural values – assessments and approvals may be required to protect natural and cultural values.

Fences and other access control structures cannot be erected on public land without the authority of the land manager. The land manager may be the local council or DPIPW (Crown Land Services or Parks and Wildlife Service). Land managers should commit to ongoing maintenance and allocate the appropriate resources.



13.4.2 Types of access control

The types of works selected will depend on the purpose, budget and the site conditions and may include any or all of the following:

Logs, bush timber or bollards can be used to delineate areas.

Track markers made from treated pine posts with an identifying colour and/or symbol can be used along beach access tracks and may be all that is required to control access. They are much cheaper to install and maintain than fencing and have minimal visual impact. **Refer to Case Study 13.1.**

Very big rocks can be used to block vehicle access. Large rocks and bollards are useful for restricting vehicle access, but 4WD users have been known to remove them.

Fences can be used to control access (e.g. plain wire, wire mesh and post and rail; see Table 13.2).

Signs may be used strategically to complement other access control measures and foster sustainable behaviour. **See section 13.5 Signage.**

13.4.3 Bollards

Bollards can be used to manage public access by providing access for pedestrians and excluding vehicles. Consider making bollards an attractive feature by decorating them with coastal themes.

Bollards can be expensive and are most appropriate for urban or high-use areas. A simple cheaper alternative is a treated pine post.

Very big rocks are useful in less urban environments,

Figure 13.17 Large rocks and bollards can be used to stop vehicle access onto a walking track. Source: Community Coastcare handbook (Thorp 2005)





to prevent vehicle access. *Refer to section 13.1.6 Controlling off-road vehicle access.*

Maintain visual amenity by landscaping around bollards and other barriers.

Regular inspections and maintenance will be required to ensure barriers remain in place and are working effectively.

13.4.4 When to use fencing in coastal areas

Fencing can be expensive both to install and maintain. Regular maintenance is essential to ensure that damaged fences do not become a public hazard. Before installing fencing in coastal areas it is important to clearly identify the problem to be managed and consider whether fencing is the best option. There are other access control measures that may be less expensive and more effective.

Fencing is a useful way to keep livestock and vehicles off dunes and out of wetland and saltmarsh areas, where they can be very destructive.

It can delineate public spaces, control human access to the foreshore and keep people off sand dunes or out of vegetation.

Temporary fencing can protect shorebird nests or recently planted vegetation. It could also be used to prevent access to hazards such as eroded shorelines – in particular, steep dune faces or cliff faces changed as a result of storms. (The type of fencing required will depend on the severity of the risk.)

13.4.5 Guidelines for fencing in coastal foreshores

Fencing is a specialised task and there are a number of qualified and experienced fencing contractors around. It is important to choose good quality materials and experienced contractors or staff to get the best result. Many different techniques and materials are available; the appropriate choice will be determined by the reason for the fence and budgetary constraints. Some fencing contractors offer workshops to train staff and community groups.

Planning

Ensure that land tenures have been correctly identified and, where there is more than one land manager, that agreement has been reached on the type of fence and the responsibilities for ongoing maintenance.

The installation of fencing will involve disturbance to vegetation and soil: consult specialists and identify natural and cultural values before works commence. When selecting the site, consider Aboriginal heritage values and natural values such as penguin rookeries.

Adapt the design and placement to the site conditions. Avoid unstable areas such as unvegetated dunes, cliff tops, wetland edges and potential landslip zones, unless the structures are built to protect public safety or sensitive sites. Avoid visually prominent locations (e.g. dune tops and beaches), as far as possible.

Consider the latest IPCC predictions for sea level rise when planning fencing projects and determine the level of risk of failure for the expected life span of the fence. Consider not just sea level rise but also increased frequency of storms.



Whenever possible, locate fences on the sea front well back from the highest waves; otherwise they are likely to be washed away by storms. Only fence on the seaward side of the dunes if absolutely necessary. It is important to keep people off the foredunes but fences on receding beaches will require very high levels of maintenance as they become dislodged and damaged by high tides and storm events.

It is important to allow for wildlife movement by raising the fence above the ground and using widely spaced mesh at the base of the fence. Consider also the placement of the fence to minimise impacts on wildlife movement. There are specific fencing techniques for protecting wildlife such as penguins.

Refer to Chapter 10 Wildlife and pest management.

Design

Select the appropriate structure for the conditions. Plain wire fences are relatively cheap and easy to construct and maintain. Fencing suppliers will supply designs and costings for little or no cost. The advantages and disadvantages of fencing types used on dunes are compared in Table 13.2.

A simple drip-line fence (Figure 13.18) or even a string fence provides a psychological barrier rather than a physical barrier and can be used to protect sensitive sites. A drip-line fence is just a single wire covered in black polypipe tubing looped between low treated pine posts (75-100mm) and fastened by stapling.

Table 13.2 Comparison of dune fence types (Adapted from NSW Department of Land and Water Conservation 2001, Coastal dune management: A manual of coastal dune management and rehabilitation techniques)

Fence type	Recommended location	Advantages	Disadvantages
Drip line	Along seaward side of dunes.	Simple and cheap. Easy to maintain.	Psychological barrier only.
Plain wire	Along access tracks where wave damage or sand burial unlikely.	Cheap. Simple to erect. Easy to maintain.	Less of a deterrent. Rusts.
Galvanised wire	As above.	Does not rust.	Slightly more costly. Easy to vandalise.
Wire mesh	Landward sides and along access tracks on medium- to high-use beaches where there is little risk of damage.	Height is a greater deterrent. Strong.	Expensive. High maintenance. Rusts. Difficult to lift.
Post and rail	On high- to medium-use beaches where there is little risk of wave damage or burial. Around public amenities.	Looks good. Strong, durable. Low maintenance.	Very high initial cost.



A simple temporary fence built from garden stakes and bailing twine or hazard tape is suitable for delineating temporary exclusion zones such as around nesting shorebirds or areas that have recently been revegetated.

Installation

All staff and contractors should be briefed on environmental considerations for the site and any restrictions or specific work practices that are required to protect coastal values. Provide appropriate supervision to ensure environmental standards are being met.

Ensure all machinery and vehicles are free from weeds and diseases prior to bringing them on site. If

weeds and disease are present at the site then ensure that tools, boots, vehicles and machinery are cleaned at a suitable location before leaving the site. **Refer to Chapter 8 Weed and disease management.**

Take precautions to minimise disturbance to acid sulfate soils (ASS). A rotten-egg smell or yellow deposits when digging are likely indicators of ASS. Minimise the potential for causing sedimentation of watercourses in track design, construction and maintenance. **Refer to Chapter 11 Soil management and earthworks.**

Time works to avoid significant wildlife events such as shorebird and penguin breeding season where appropriate.

Figure 13.18 A simple dripline fence can act as a psychological barrier to keep people off fragile dune areas.
© Peter Lingard.





Figure 13.19 This poorly maintained coastal fencing looks unsightly and has become a hazard to the public. A simple, cheaper fencing alternative such as a dripline fence on the seaward side would be more appropriate. © Leah Page



Plant native vegetation adjacent to the fence to make it look more attractive. Over time the vegetation might provide enough of a barrier and allow for the removal of the fence.

Do not attach geotextiles to access control fences; otherwise sand will accumulate in the accessway.

If fencing in conjunction with board-and-chain accessways (sand ladders), ensure enough space is left between the ends of the boards and the fence to allow for regular lifting of the boards when they are covered in sand.

Figure 13.20 Some skilled and experienced fencing contractors offer fencing workshops to land managers and community groups. Volunteers from Wildcare Deslacs at Clifton Beach getting tips from John Easton. © Leah Page





Case Study 13.3: Non-fencing access control using trail markers at Southern Beaches

The Southern Beaches Landcare/Coastcare group in south-east Tasmania was frustrated with the degradation of the foreshore due to informal tracks and encroachments affecting the dunes, headlands and cultural and natural heritage.

The group consulted broadly with the local community and worked closely with the local council to develop a passive approach to access management. Rather than fencing off areas of the dunes, they used bollards painted in different colours and with different bird images (painted by a local artist) to denote the different tracks.

The attractive track-marking has made it easy for people to 'stick to the track', protecting the dunes without the need for fencing, thereby minimising infrastructure and ongoing maintenance. This low-impact solution does not interrupt peoples' enjoyment of the beach or impede the free movement of native animals and the dynamic movement of sand.

The group wanted to give something back to the community and make it easy for people to do the right thing. The local community has embraced the track marking and appreciate the convenience of being able to find 'their' track home through the dunes.

The implementation of this project has reduced the ad-hoc development of tracks through the foreshore and enabled the natural regeneration of degraded areas.

Figure 13.21 Each track marker is colour coded to make it easy for users to identify the track they want.

© Leah Page





13.4.6 Ongoing maintenance of fences and access control structures

Fences and other access control structures require regular maintenance to ensure they are in good condition. This is important to protect public safety and to minimise erosion and damage to vegetation. Structures should be subject to regular safety inspections in accordance with Australian Standards specifications.

- Inspect fences regularly and after unusually high tides or storm events.
- Check structures are in place and secure and not a hazard to the public.
- Fences may need to be re-strained.
- Wire fences on foredunes will usually need to be replaced in time, due to sand blasting and corrosion. Posts will be undermined and dislodged on receding beaches, due to wave action
- Where more than one land manager/owner is involved it is important to reach an agreement for ongoing fence maintenance.

13.5 Signage

This section provides tips and guidelines for installing signs with minimal impact on coastal environments and for creating signage that conveys messages to visitors about coastal values and areas (interpretative signage). Hazard and safety signs must meet Australian Standards; their design is not covered in this manual.

Signs are valuable tools for communicating messages to visitors. A well-designed sign can persuade visitors to understand and appreciate an area and to behave in an environmentally responsible manner. Involving the local community can assist with providing local content for the sign, and may reduce vandalism.

Temporary signs are useful to help keep people off sites while work is in progress, or vegetation is being regenerated. Signs are often used in addition to fences and other structures to control access to certain sites.

When the cost of signs is spread over their expected life, they are relatively cheap compared with other forms of communication, such as brochures and face-to-face communication. However, signs do require some maintenance and will need replacing after some years.

13.5.1 Legislation and approvals for signage

Permission from the land manager will be required before installing any signs. Most local councils have a sign policy and may require formal approval before installation. Land managers should commit to ongoing maintenance and allocate the appropriate resources.

Due to the disturbance required to install signage, assessments and approvals may be required to protect natural and cultural values such as Aboriginal heritage sites. Seek specialist advice about wildlife and vegetation values and consult Aboriginal Heritage Tasmania.



Before designing a sign:

- identify the message (e.g. keep dogs away from penguin habitat)
- identify the target audience (e.g. dog owners)
- consider whether a sign is the best means of communicating your message: would other ways be better (e.g. a community meeting or distributing brochures)?

13.5.2 Uses of signs

Signs are used in coastal areas to provide instruction or direction, convey hazard or safety information and to provide information on the coastal values or interesting features in the area.

Interpretation signs are used to convey information and messages in a way that engages people's interest. They can help people understand what is special or interesting about an area and motivate them to modify their activities for the protection of coastal vegetation, wildlife or heritage.

All interpretive, educational and information signs should be of a high quality and follow principles of good graphic design (e.g. clear, attractive layout) and readability (e.g. the size and style of the print).

Develop signs in partnership with the land manager/s to help meet their goals and to conform to their standards.

Figure 13.22 Signs can provide important information and look great at the same time, like the recreational fishing limit information signs at boat ramps and popular fishing spots. © Leah Page



Use a sign to:

- manage access and protect coastal vegetation, wildlife or cultural heritage
- inform people about facilities, regulations and hazards
- inform people about the special features of the local area, so they come to appreciate its values
- raise community awareness and understanding about conservation projects such as rehabilitating eroded areas, and protecting nesting shorebirds
- raise the profile of agencies, and gain support for projects



13.5.3 Sign installation

Ensure all planning has been done and approvals acquired. Consultation with specialists is essential to identify and protect all natural and cultural values. Many coastal areas contain important Aboriginal heritage places. Some dunes and other sandy landforms have geoheritage values. Other natural values such as threatened species or important vegetation communities, may be present.

Community groups are often interested in signage in their local area and it is important to consult with them when planning new signs. The local knowledge of local values, visitor use and particular problems can be valuable.

All staff and contractors should be briefed on environmental considerations for the site and any restrictions or specific work practices that should be implemented. Provide appropriate supervision to ensure environmental standards are being met.

Ensure all tools are free from weeds and diseases prior to bringing them on site. If weeds and disease are present at the site then ensure that tools, and work wear are cleaned at a suitable location before leaving the site. **Refer to Chapter 8 Weed and disease management.**

Take precautions to minimise disturbance to acid sulfate soils (ASS). A rotten-egg smell or yellow deposits are likely indicators of ASS. **Refer to Chapter 11 Soil management and earthworks.**

Site selection

Consider other existing signs and the overall quantity of signage in the area. Too much signage can look unattractive and puts people off reading their messages.

Where possible, place signs on existing structures (e.g. walls and poles). Before attaching signs to historic buildings, check whether this is appropriate and seek permission.

Place directional signs and warning signs where they are easily noticed (e.g. near car parks and at the start of tracks to the beach). A car park is often a good place for signs as the traffic may discourage vandalism.

Place signs about 4m away from the far side of a fence or out of reach of cars, to discourage vandalism.

Avoid placing signs above eye level, as far as possible. Signs that project above the skyline are unsightly and detract from the aesthetic qualities of natural areas. Consider the neighbours when deciding where to put the sign – if it irritates residents (e.g. by spoiling their view) they might not be respect it.

Interpretation signs do not need to be as highly visible as warning or directional signs. As a rule, place the middle of interpretation signs at the average adult hip height.

Orientation

Wherever possible place signs so that they are not facing due north, as sunlight will shorten their life.

If there is a map on the sign, orient it in a way that relates to the surrounding landscape and will make sense to viewers.



13.5.4 Sign manufacture

When planning signs, consider their design, construction, materials, durability, maintenance and compatibility with the landscape. Follow the land management authority's requirements for sign design, materials and construction. Refer to the *Tasmanian reserve management code of practice* (PWS et al. 2003).

If they are well made and properly installed, signs should not require much maintenance over their lifetime. Consider the level of vandalism in the area and the level of exposure to the elements, and choose materials that will require minimal maintenance. Various materials are available – consult sign manufacturers, as technological advances are constantly providing new products.

Many manufacturers now use a combination of materials (including UV-protective coating and vandal-proof surfaces) and some offer five-year guarantees. It is often worth paying for more expensive materials of higher quality if they will last longer and need less maintenance.

Figure 13.23 Some coastal facilities such as boat ramps require important information to be available to the public, but too many signs can look cluttered.
© Leah Page



Many smaller warning and directional signs are prefabricated in recycled plastic or aluminium. Routed treated timber is cheap, attractive and suitable for simple directional signs.

Signs need a durable finish or cover, backing, stand and posts. To protect the sign from wind vibration and other damage, firmly attach the panel to a rigid backplate or other flat surface. Gluing or framing the panel is better than drilling holes for bolts, because this can cause corrosion.

The best sign supports are posts made from galvanised pipe, which can be powder-coated. Sturdy treated pine posts are suitable for timber and some metal signs. Set the supports well into the ground – to a depth of a third or more of the post height.

Marine grade aluminium is best for interpretation signs near the coast. Anodised aluminium signs, which can incorporate detailed photos and images, are very attractive. They are expensive but long-lasting, and scratches don't destroy the picture. Screen-printed signs and printed vinyl are cheaper options.

A scratch-resistant top, which can be removed and replaced if damaged, is useful if vandalism is likely to be an issue. Inspect signs regularly for damage. Unless visible damage is repaired promptly, it is likely to encourage further vandalism.

A simple design for a sign and sign shelter is available in the *Coastal management specifications manual* (Green Skills Inc 2010).



13.5.5 Sign design

Use colours and materials that are attractive and sympathetic to the surroundings. The old saying that a picture is worth a thousand words is especially true for signs. Attract readers by incorporating images (e.g. local photos and illustrations) that reflect their interests – surfing, fishing, boating, weather – or make the sign a work of art.

Minimise the amount of information on the sign; use the fewest possible words to convey the message. The text should be easy to read from a distance of about 5m.

The most effective messages are positive and non-threatening. If people know why they are being requested to do or not do something, they are more likely to cooperate.

Consider colour-blind people, particularly when designing maps (e.g. do not use red text on brown/green backgrounds).

Figure 13.24 A sign at Park Beach encourages people to respect the area. The sign incorporates work by local artists and is placed so as not to obstruct the view of the surf from the car park. © Leah Page



Signs about management issues (e.g. no driving on the beach, no camping, day use only, no fires) should be short, simple and easy to understand. The widely understood international pictograms are useful for conveying these messages to non-readers.

Ensure roadside signs comply with the state-wide *Integrated visitor information system*. (Graham & Associates and HMT Planning 1999).

13.5.6 Ongoing maintenance of signs

Create an inspection and maintenance schedule for all signs.

Check structures are secure and not becoming a hazard to the public. Signs that are damaged or no longer needed should be removed, unless they have historic value.

Clean up vandalism and contact the manufacturer if replacement parts or cover plates are required.

Figure 13.25 Signs can be a work of art like this bird sign at Medeas Cove in St Helens. Source: Community Coastcare handbook (Thorp 2005)





13.6 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

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

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)

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>

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



Roads, vehicle tracks and car parks

Acid sulfate soils

Predictive maps of possible acid sulfate soil occurrence

www.thelist.tas.gov.au/

Austroads publications

Available for download from the Austroads website. Registration is required to download these products. Registration and products are free.

<http://www.onlinepublications.austroads.com.au>

- *Austroads 2003, AP-G1/03: Rural road design—A guide to the geometric design of rural roads (8th edn).*
- *Austroads 2003, AP-R217/03: Environmental considerations for planning and design of roads + reference CD ROM.*
- *Austroads 2003, AP-R180/00: Road runoff & drainage: Environmental impacts and management*
- *Austroads 2003, AP-R185/01: Environmental risk management guidelines and tools for road projects*
- *Austroads 2003, AP-R232/03: Guidelines for treatment of stormwater runoff from the road infrastructure*

Forest practices code (Forest Practices Board 2000)

Road classifications, geometric designs and maintenance standards for low volume roads (Guimarra 2001)

Transport Tasmania

Roadworks specifications, Road hazard management guide, and Technical advice sheets

- Roadworks specification R75 – Environmental protection
- Roadworks specification R76 – Roadside maintenance
- Roadworks specification R34 – Drainage maintenance (August 2003)

www.transport.tas.gov.au

Tracks and trails

Australian Standards

- AS 2156 Part 1 Walking tracks. Classification and signage
- AS 2156 Part 2 Walking tracks. Infrastructure design
- AS 1428.1 – 1428.2 Design for access and mobility
- AS/NZS ISO 31000:2009, Risk management - Principles and guidelines

Replaces AS 4360-2004 Risk management as the leading resource for risk management.

Austroads

AGRD06A/09 Guide to traffic engineering practice Part 6A - Pedestrian and cyclist paths

Available for download from the Austroads website. Registration is required to download these products. Registration and products are free.

<http://www.onlinepublications.austroads.com.au>



International Mountain Bicycling Association trail difficulty rating system

<http://www.imba.com/resources/freeriding/trail-difficulty-rating-system>

Tasmanian reserve management code of practice (Parks and Wildlife Service et al. 2003)

Track infrastructure design manual (Hobart City Council, in prep)

Track maintenance manual (Hobart City Council, in prep)

Trail planning guidelines: Guidelines to assist with the planning, design, construction and maintenance of sustainable recreational trails in Tasmania (Sport and Recreation Tasmania, in prep)

Trails Tasmania strategy (Inspiring Place Pty Ltd 2007)

Improving recreational trail opportunities and preparing inventory of existing trails

Walking track management manual (Parks and Wildlife Service 2003)

Hard access structures, fencing and access control

Coastal dune management: A manual of coastal dune management and rehabilitation techniques (NSW Department of Land and Water Conservation 2001)

Coastal management specification manual (Green Skills Inc 2010)

Tasmanian reserve management code of practice (PWS et al. 2003)

Wallaby proof fencing: A planning guide for Tasmanian primary producers Statham & Statham 2010)

Guidelines for excluding wildlife with fencing, but also includes features such as wombat gates for allowing wildlife access.

Signage

Australian Standards

- *AS 2156 Part 1 Walking tracks. Classification and signage*
- *AS 2899.1-1986 Public information symbol signs – General information signs*

Draft sign manual (Parks and Wildlife Service 2000)

Sign manual (Angel & McArthur 1995)





14 Structures and facilities

- 14.1 Legislation and approvals*
- 14.2 Construction work in coastal areas*
- 14.3 Launching ramps and other boating facilities*
- 14.4 Buildings, toilets and other amenities*
- 14.5 Tools and resources*

This chapter deals with how to minimise environmental damage when constructing and maintaining buildings and other public amenities in coastal areas. Proper planning, design and maintenance of structures will improve longevity, minimise maintenance and save money.

Thorough investigation and planning before building is important to protect sensitive coastal or marine environments such as foredunes, wetlands and saltmarshes. Many coastal areas, especially soft or sandy sites, are prone to erosion, and low-lying areas are vulnerable to sea level rise. Structures may be at risk of damage from wind, waves or currents and erosion, and sedimentation can be a problem in marine areas.

The visual appearance of coastal structures and the needs of the community and users of the area must be considered in planning and design. When planning new facilities, upgrades or removal of old facilities, community consultation is essential, and is most effective when done in collaboration with local community groups.

The types of structures that are commonly built on shoreline areas include picnic facilities, toilets, shore-based aquaculture facilities, boating and surf club facilities. In some urban areas, coastal environments are dominated by ports and industry, whilst in other urban areas the coast is modified for recreational facilities and access. Often there are few spaces left where natural processes and systems can persist. **Refer to Chapter 13 Access Management** for information on access structures such as boardwalks and steps.

Tab photo: Built up foreshore of the Tamar Estuary, northern Tasmania. © Chris Rees.



14.1 Legislation and approvals

In addition to the legislation and approvals set out in **Chapter 1 and Appendices 1 and 2**, the following may apply.

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.

Developments must comply with the *Tasmanian Building Act 2002* and the *Building Code of Australia* (Australian Building Codes Board) as well as council planning schemes. Obtain a building or plumbing permit (usually from the local council) for all building and plumbing before work is commenced. The *Building Code of Australia* includes requirements for access to buildings for people with disabilities.

Approvals may require appropriate site rehabilitation works.

14.2 Construction work in coastal areas

Designing coastal structures is not an exact science and innovative designs may be more appropriate than traditional approaches. The information in this manual does not preclude other approaches, as long as they are supported by specialist advice and a sound maintenance program, to ensure that structures have minimal impact on the coastal environment and are kept in good condition.

Specialist advice is essential to assess whether the design and placement of structures is suitable for the local conditions. Building structures on unstable landforms and in coastal waters is often not appropriate but is sometimes necessary for the provision of important services and access.

Structures will be more effective if their design, siting and construction are based on good technical advice from a coastal engineer and a coastal geomorphologist. Inappropriately designed or sited coastal structures can easily be destroyed by wind or waves or become a danger to the public. They can also damage coastal values such as important wildlife habitat and cause serious erosion or sand build-up in adjacent areas.

Construction work in coastal areas must minimise impacts 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 with specialists and undertake any necessary assessments. **Refer to Chapter 1 Working in coastal environments.**

It is essential to ensure all works staff and contractors are briefed on minimising environmental impacts during construction work and that adequate supervision is provided to ensure best practice



environmental standards are being implemented.

Refer also to Chapter 11 Soil Management and earthworks.

14.2.1 Climate change and coastal infrastructure

Constructions in marine and estuarine waters and on or near the shoreline are highly susceptible to the impacts of sea level rise and coastal inundation.

Design and construction of structures (or upgrading existing facilities) should take into account such changes to the coastline within the life span of the structure, employing the best construction methods and materials for the situation and intended life span of the asset, and ensuring that maintenance over the structure's life span is feasible and affordable. Specialist advice from engineers will be needed.

Appropriate building setbacks, minimum floor levels, appropriate engineering assessments and appropriate construction techniques will all be part of adapting to predicted sea level rise and coastal inundation.

In view of predicted climate change and sea level rise, existing infrastructure that is low-lying or built on erodible shorelines should be assessed for the risk of erosion or inundation.

Coastal vulnerability maps are available on the LIST as part of *Indicative mapping of Tasmanian coastal vulnerability to climate change and sea-level rise* (Sharples 2006). Specialist advice from a coastal geomorphologist will help with decisions about the best place to site structures.

The *Coastal risk management plan* (DPIW 2009) can assist in determining the likely risks to a structure and strategies to reduce risk. **Refer to Chapter 3 Coastal hazards.**

It might be that the asset planned is itself an adaptive management structure, such as a seawall or groyne. **Refer to Chapter 15 Shoreline modification.**

14.2.2 Designing and planning coastal infrastructure

Before works start, thorough investigation and planning are essential. This may take some time.

Obtain technical advice from an experienced coastal geomorphologist and an engineer before works are planned. Proposed works and structures that would extend below high water mark or on unstable coastal landforms should be checked by a suitably qualified person (e.g. engineer; building surveyor; architect, landscape architect or environmental health officer).

Obtain all relevant planning and building approvals for the works. Structures below high water mark or on other Crown lands require approval under the *Crown Lands Act 1975*.

Have designs and plans for built structures assessed and approved by a qualified building surveyor. Adhere to all relevant Australian and Tasmanian Acts, regulations, codes, strategies, management plans and standards including occupational health and safety standards.

When considering the location of coastal structures, take into account:

- the level of hazard or risk for the site or for adjoining or nearby properties or infrastructure – ensure it is not increased by the new structure
- the risk of water pollution from inundation of any materials, substances or wastes on the site – avoid or minimise
- the need for minimising future engineering or remediation works to ensure likely costs do not exceed the public benefit of the development.



Aim to minimise infrastructure in the coastal zone. Consolidate structures in high-use areas with existing facilities wherever possible.

Structures that provide access for disabled people should be considered where required or appropriate, particularly at coastal access points such as viewing points and beaches.

Assess the environmental damage that could result from the construction works and develop measures to minimise the damage. An Environmental Management Plan may be required for larger projects. For smaller projects, prepare a specific site plan for all works, outlining the works to be conducted and measures to reduce environmental damage.

Identify all natural coastal and marine values and develop procedures to protect and minimise disturbance of these values. Seek specialist advice.

Minimising environmental damage might include procedures like controlling sediment and erosion; avoiding works near shorebird breeding sites during the nesting season (September to March); developing an oil spill plan or ensuring that all machinery,

vehicles and vessels are free from weeds, pests and diseases before and after works; conserving soil and rehabilitating disturbance to the site as soon as practicable. **Refer to Chapter 11 Soil management and earthworks.**

Seek advice from Aboriginal Heritage Tasmania about the potential to disturb Aboriginal heritage sites. An Aboriginal Heritage Assessment and permits may be required.

Seek public input to proposals for new developments and upgrades of existing facilities. Consult with 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. Notify all neighbours and users likely to be affected by the works. Keep in mind that, if they are not consulted, annoyed beach-users may remove unwanted structures.

Provide facilities that look attractive, with a quality of design and materials that complement adjacent structures and landscapes and does not detract from the character of the area. Even a toilet building can

Figure 14.1 Structures in recreational areas of coastal landscapes are a necessary part of providing services and their visual appearance can be improved by the use of murals. This is also a great way to involve the local community.

© Leah Page





have aesthetic appeal. The colours should generally fit with the colours of the landscape and vegetation, but brightly coloured structures may be appropriate in some situations (e.g. to make facilities easier to find among vegetation).

Position and design structures so that they will not cause nuisance or hazard from excessive noise, odours, overlooking or overshadowing, visual intrusion or an altered microclimate.

Buildings should be consistent with the scale of the built character of the surrounding area, unless the existing development detracts from the natural setting. Confine developments, as far as practicable, to areas that have already been disturbed. Establish a limited site disturbance zone (e.g. to 1 m) beyond the wall of the structure.

Ensure the building design and location includes measures to survive bushfires. Refer to *Building in bushfire prone areas* (Ramsay & Dawkins 1993) and *Landscape and building design for bushfire areas* (Ramsay & Rudolph 2003).

Design structures to minimise maintenance requirements for the duration of their service life. Where the life span of a structure is likely to be less than 25 years, plan for its eventual removal. Favour design and construction methods that allow the removal of the structure without major new impacts on environmental and conservation values.

14.2.3 Works guidelines for maintaining coastal infrastructure

Coastal structures and facilities must be inspected regularly to identify any hazards or maintenance required. Small-scale works to undertake minor repairs often do not require approval processes but still have the potential to impact on coastal values.

It is important to identify and protect coastal values during all work activities. Specialist advice may be required.

Any works or modifications outside of the original footprint of the site will require consultation with Aboriginal Heritage Tasmania.

Assess existing structures for susceptibility to climate change impacts such as erosion and inundation caused by sea level rise. Use the latest Intergovernmental Panel on Climate Change (IPCC) projections of sea level rise and coastal vulnerability maps (Sharples 2006) to identify vulnerable locations. Use the *Coastal risk assessment tool* (DPIW 2009) to assess likelihood of risk and to establish mitigation or adaptation processes for particular assets.

All staff and contractors should be briefed on the environmental considerations of the site and any restrictions or specific work practices that must be implemented to meet those considerations. Appropriate supervision is required to ensure environmental standards are being met.

Ensure all machinery and vehicles are free from weeds and diseases prior to bringing them on site; if weeds and disease are present at the site then ensure that tools, boots, vehicles and machinery are cleaned at a suitable location before leaving the site. Only import material from sites that are free from disease and weeds. **Refer to Chapter 8 Weed and disease management.**

Control sediment and erosion from work sites by applying sound soil management.

Investigate the incidence of acid sulfate soils (ASS) and if necessary take precautions to minimise their disturbance. A rotten-egg smell or yellow deposits when digging are likely indicators of ASS. Minimise the potential for causing sedimentation of watercourses



in track design, construction and maintenance. **Refer to Chapter 11 Soil management and earthworks.**

Identify coastal values such as important wildlife habitat, vegetation communities and threatened species. Consult specialists and undertake any necessary assessments. Put practices in place to minimise impacts on these values, such as timing the construction works to avoid bird breeding seasons in areas where shorebirds, penguins or seabirds are present. **Refer to Chapter 7 Vegetation management and Chapter 10 Wildlife and pest management.**

Plan for ongoing future maintenance by establishing a maintenance regime to ensure structures are inspected regularly.

14.2.4 Ongoing maintenance of structures and facilities on the coast

All buildings should be maintained regularly to minimise the risk of them becoming a public hazard. Conduct regular safety inspections as specified in the Australian Standards and after heavy rain, storms or unusually high tides.

Boating facilities require regular maintenance to make sure they are safe and in good condition and to monitor any erosion or sedimentation associated with the structure.

Inspection and maintenance should include the following.

Figure 14.2 The boat ramp at Ulverstone has a floating pontoon to minimise impacts on the sea floor and interference with sand transport along the shoreline. © Jocelyn Phillips





- Check structures are secure and not becoming hazardous to the public.
- Check that surface- and groundwaters are not being polluted.
- Make sure erosion is not a problem.

All built structures require maintenance regularly, and immediately after storms, to ensure they remain serviceable. They can be quickly damaged or destroyed by wind and waves and result in broken timbers, missing steps, sharp edges, dislodged nails and fastenings, and debris that can become a hazard to the public.

Structures built on sandy coasts are subject to the problem of sand accumulation at certain times of

the year. It is not possible to keep them continually clear without major works (which disrupt the natural coastal processes) or by installing an expensive permanent sand bypass system (e.g. trapping the sand and pumping it elsewhere, as used at the Tweed River entrance in Queensland).

Carry out preventative maintenance at regular intervals or as required, to minimise further impacts.

- Prepare an inspection and maintenance plan.
- Ensure regular preventative or necessary maintenance is carried out.

Figure 14.3 Small private skids and boat sheds are common on many of Tasmania's beaches. Whilst some are well cared for, others are in need of repair and could be considered hazardous. © Leah Page





14.3 Launching ramps and other boating facilities

Piers, jetties and other boating facilities provide for recreational boating and fishing and commercial fishing operations. Marine structures can obstruct currents and waves and are likely to affect the transportation of sediment. Structures may be susceptible to wave erosion, loss of beach sand or sand build-up and managing these impacts can become expensive.

Detailed site investigations are an essential part of planning and designing marine structures. Site investigations should include an examination of the geotechnical characteristics of the proposed site and the likely effects of structures on coastal and marine ecosystems.

Choosing the appropriate site and design is critical for launching ramps and other boating facilities that extend across the shore and into the water. It is also important to investigate the likely effects of wind and storm surge on the structure and its use, particularly in light of climate change and sea level rise predictions. This will ensure that the structure will stand up to the local conditions and be safe to use during all weather and tide conditions.

Matters of public safety and the location of existing support infrastructure, such as road or rail access and channel depth, may sometimes override other considerations, making it necessary to place structures in locations where they will interfere with coastal processes (e.g. to provide a safe harbour). In such cases aim to keep interference with coastal processes and values to the minimum required for the desired effect and plan for ongoing management of adverse environmental impacts (e.g. by replenishing lost beach sand).

14.3.1 Types of boating facilities

A **boat launching ramp** is designed mainly for launching trailer-borne recreational vessels and small commercial vessels and includes associated car parking facilities.

A **jetty** or **pier** is a horizontal decked walkway, built on piers or piles, which provides access from the shore to a waterway.

A **pontoon** is a floating structure used for access to the water or a vessel.

A **skid** is an inclined ramp used for the manual launching of small craft but does not include a slipway. Skids permit small boats to be drawn out of the water without the use of winches, trolleys or cradles. A skid may also be used for rigging and launching small vessels and providing access to a boatshed.

A **small slipway** is a structure (usually two supported parallel rails on which a wheeled cradle is run) to draw a vessel out of the water for maintenance and repair. A larger slipway is part of a boating industry facility or a commercial marina.

14.3.2 Approvals for marine structures

Structures on the shoreline often cross over land and water that is governed by different authorities.

Structures below high water mark require Crown Land Services approval and a Crown Land lease. Depending on the structure's size and nature, submission of a Development Proposal and Environmental Impact Statement may also be required. Local council planning approvals and building approvals and permits are also necessary.

If the works cross land managed by the Parks and Wildlife Service (PWS) under the *National Parks and Reserves Management Act 2002*, then approval



of PWS will be required. This is necessary before submission of council planning applications.

All structures should comply with the *Building Act 2000* and *AS4997-2005 Guidelines for maritime structures* and the design and engineering guidelines in *AS3962-2001, Guidelines for design of marinas and ramp construction*.

These guidelines cover the design of near shore coastal and estuarine structures such as jetties, wharves, berthing dolphins, floating berths, seawalls, breakwaters, boat ramps laterally restrained, floating structures and building substructures over water. These standards can be used to determine the desirable position of structures within a harbour, based on the predominant wave conditions.

14.3.3 Role of Marine and Safety Tasmania (MAST)

Major commercial ports are owned and managed by Tasmanian Ports Corporation Pty Ltd. Marine and Safety Tasmania (MAST) manages some commercial and recreational facilities, but the majority of facilities are owned and managed by local councils, PWS, Hydro Tasmania and Crown Land Services. Details regarding ownership of marine facilities are available on the MAST website.

MAST oversees the construction process for its structures and also oversees some construction of facilities not owned by MAST through the Recreational Boating Fund (RBF). In these cases, after completion of a project and MAST managing for a warranty period of 12 months, the management is transferred to the owner.

When a facility is being constructed and it is not owned by MAST or has not occurred under the RBF process, then the only time MAST will be required to

comment on the construction is if the new structure interferes with safe navigation or moorings in the area. This is picked up in the planning process, with the council forwarding a referral letter to MAST.

In sensitive ecosystems, engineering and design criteria that meet Australian Standards may not be enough to minimise environmental impacts. As a result, in some situations and environments (e.g. offshore from national parks and near marine reserves) stricter, novel or more 'environmentally friendly' alternative designs may be required. The criteria for such developments should be evaluated case by case.

14.3.4 Potential impacts of ramps and marine facilities

Structures that extend into the water can interfere with the transport of sand by tides, waves and currents. All marine structures, especially solid structures such as launching ramps, should be designed and suitably sited to avoid redirecting waves and sand where they are not wanted. This can lead to erosion or deposition of sand and erosion of soft-sediment cliffs nearby. Even a well-designed structure put in the wrong place can be damaged by wind or waves.

The installation of these structures can impact on coastal vegetation, wildlife habitat and values, and marine communities. Construction activity can disturb toxic sediments or expose acid sulfate soils. **Refer to Chapter 11 Soil management and excavation.**

Changes to drainage patterns on the shoreline can create or exacerbate shoreline erosion. The use of certain materials can be toxic to aquatic organisms.

Boat ramps and jetties can cause shadowing of marine plants and result in loss of biodiversity in the vicinity of the structure. Marine facilities can be sources of



pollution from fishing debris and chemical and oil spills.

Structures on soft and sandy shorelines are particularly vulnerable to rising sea level and increasing frequency of storm surges associated with global changes in climate. Refer to the maps of vulnerability to rising sea levels in *Indicative mapping of Tasmanian coastal vulnerability to climate change and sea-level rise* (Sharples 2006), and the *Guidelines for responding to the effects of climate change in coastal and ocean engineering* (National Committee on Coastal and Ocean Engineering 2004).

14.3.5 Planning for marine structures

Careful design and site selection of coastal structures is very important. New shore-based and marine structures should only be built where the structures meet a demonstrated need. Many structures on the coast were built long ago using methods and placed at sites that are now recognised as detrimental to coastal and marine environments. If community usage is established, it may be appropriate to maintain or improve existing facilities to best manage the impacts of human activities in the area.

Siting, design, construction and maintenance of structures should be sensitive to the natural, cultural and aesthetic qualities of the local coastal environment. As far as possible, structures should be concentrated at certain locations to reduce the visual and environmental impacts on the general area.

In more natural areas, structures should blend in as far as possible with the surrounding landscape (viewed from both the shore and the water). Locate the facilities where activities will have the least impact on existing amenities or views. Of course, public safety is also important (e.g. a breakwater may be needed to provide a safe harbour for fishing boats taking refuge from a heavy swell).

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 undertake any necessary assessments.

Consult with local Coastcare groups and the community, who have useful local knowledge. Coastcare volunteers have a strong connection to the coast they have been caring for and should be included in coastal management decisions.

Site selection

If a new structure is needed and there is a choice of site, select a location that complies with the following requirements.

- Choose a safe site that minimises interference with natural ecosystems and the movement of water and sand, as far as possible.
- Avoid or minimise disturbance to sites with cultural heritage, geoconservation or other heritage values. A survey may be required to identify these values.
- Choose a site with no threatened species or ecosystems of high conservation value. Other habitat values should also be protected, wherever possible.
- Avoid areas where the works could mobilise contaminated sediments.
- Minimise visual and ecological disturbance by choosing less sensitive sites for these works and integrating them with other uses. Locate the facilities where boating activities will complement the area's existing amenities (e.g. roads) and where adequate car parking is available.
- Choose waters with adequate navigation depth and existing vehicular access.



- Avoid interfering with pedestrian access to and along the shoreline.
- Position marine structures to enable access at all tide levels.
- Consider the latest IPCC sea level rise predictions and the vulnerability of the site to erosion and inundation.

14.3.6 Design of marine structures

Obtain technical advice from an experienced geomorphologist and/or marine engineer before works are planned. Specialist advice is essential to identify the possible effects of marine structures on the natural coastal processes. This will include the factors that drive seasonal patterns of wind speeds, wind directions and tide and wave action.

Choose structures and materials that can survive the local conditions, such as saltwater, strong winds and wave action. In areas where there is a marked variation in tides, floating pontoon-style structures are a preferred option. Use non-slip surfaces for marine structures, to minimise hazards to pedestrians or vehicles.

Structures that are resilient or permeable (non-solid) may be preferable to rigid and impermeable structures that resist wind and wave and/or impede sediment movement. Permeable materials (e.g. slats or mesh) are preferable where solid materials will stop light reaching marine vegetation.

Marine structures built on piers are preferable to solid structures. The use of piers avoids altering water movement patterns and minimises changes in the natural patterns of erosion and deposition. Align marine structures to minimise changes to the patterns of movement and supply of marine sediment. It is

critical to allow for full tidal flushing and passage of fish wherever possible. Piers will allow for the free movement of tides, and aquatic and terrestrial animals. ***Refer to Chapter 6 Coastal landscape management and Chapter 12 Stormwater and crossings.***

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.

14.3.7 Constructing and maintaining marine structures

Before constructing any boating facilities, approvals are required, which will probably specify any environmental management constraints. Maintenance of existing structures will most likely not require approvals but can still be very damaging to coastal values if not planned with those values in mind.

Before maintenance is undertaken a works plan should be prepared. It should outline the works to be undertaken and the measures that will be used to minimise the risk of causing environmental damage.

The following measures should be required of all contractors and others working in coastal areas.

- When using machinery, take particular care to avoid environmental damage, especially with large machines such as excavators and bulldozers operating on fragile and unstable coastal soils and in or near sensitive marine habitats, such as seagrass beds.



- Ensure that machinery does not introduce weeds or diseases into coastal areas, by cleaning soil and plant material from machinery before and after works.
- Maintain coastal structures to keep them in place and in good repair. This is a significant cost in areas that are unstable or vulnerable to strong winds and waves.
- Minimise excavation of shorelines and avoid works in important ecosystems and habitats, to reduce the impact of marine structures on the coastal environment.
- 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.
- Avoid fish nursery areas, seagrass beds, saltmarshes, intertidal 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 the breeding seasons of nearby fish, birds or other wildlife.

Maintenance at slipways

For large slipways, additional maintenance may be required as recommended in *Environmental guidelines for boat repair and maintenance* (DEPHA 2009), which includes the following recommendations:

- Before slipping and during boat cleaning activities, inspect the waste management system sumps, filters, grates and grids and remove trapped solids.
- Clean and maintain oil/water separators and holding tanks/pits.

14.3.8 Design guidelines for small slipways and skids

Ensure all relevant assessments for natural and cultural values and all approvals have been undertaken.

Consult engineers and coastal geomorphologists before designing marine infrastructure.

For skid construction follow the natural shoreline profile.

The recommended slope is not steeper than 1:2.7. Where the slope is more than 1:8 provide a safe foothold with spaced decking or cleats.

For skids, a slatted, mesh or perforated structure is preferable as this will allow light to penetrate to marine vegetation below.

For slipway construction, follow the natural shoreline profile. Do not cut or excavate the natural intertidal rock. Extend the slipway to allow storage of the vessel wholly above mean high water mark on the land.

Place work areas above the intertidal zone (at least 1m above the mean sea level or Australian Height Datum (AHD)).

Use impervious work surfaces or other means to



minimise the amount of waste materials (including untreated washwater and biological material) entering the water. For instance, install traps at the lower end to collect wastes and regularly clean out the traps.

14.3.9 Design guidelines for moorings

Avoid moorings in seagrass beds or other sensitive habitat, wherever possible. Traditional chain-anchored moorings can disturb the bottom and damage seagrass when dragged across the sea floor during storms and at changes of tide. Moorings with a flexible connection between the mooring and the vessel are preferable.

A mooring must not be laid without a permit from Marine and Safety Tasmania (MAST). MAST requires that moorings are lifted and inspected every two years, more often in some areas.

Seagrass friendly mooring systems use a moveable arm raised off the sea floor which is attached to a fixed anchor. After a small amount of disturbance during installation, these moorings allow seagrasses and other marine plants, and soft-sediment animals to remain, live and grow uninhibited.

Seagrass Friendly Mooring System

Made of galvanised steel, the Seagrass Friendly Mooring System incorporates an anchor pole tipped with a screw helix (or auger). The pole is either 1500mm long (small 'marker buoy' version) or 3800mm long (mooring version). Fixed to the top of the screw-in anchor is a 280mm load spreader that sits underneath the seabed and can rotate about the screw-in pole, ensuring the anchor does not pull into the sea bed sideways under horizontal strain.

A 400mm swivel head on a nylon bearing is attached to the top of the screw anchor, to allow for easy 360° movement of a 1100mm seawater-driven spring-loaded shock absorber that gives 1m of shock absorption, chiefly from seawater being forced out of small gaps in the cylinder body (rather like a piston) but also from the spring itself. Future incarnations of this shock absorber for boats larger than 40ft would have a two spring.

A length of 24mm 'Aquatec' marine-grade rope is attached to the shock absorber and the surface buoy. This rope is buoyant, which keeps the shock absorber off the seabed even under extreme low tide conditions.

The Seagrass Friendly Mooring is installed and maintained from a boat fitted with a hydraulic auger drive. The moorings are currently being tested in several locations on coastal New South Wales and Queensland with encouraging results.



14.3.10 Design guidelines for launching ramps, jetties and pontoons

Ensure all relevant assessments for natural and cultural values have been undertaken and approvals obtained. Consult engineers and coastal geomorphologists before designing marine infrastructure.

Minimise the construction of protective structures, such as breakwaters, as these may affect natural patterns of coastal erosion and sediment movement in adjacent shoreline areas, and may look unattractive and detract from the visual and recreational values of the area.

To minimise shoreline alterations, consider using marine ways (dollies) or hoists (straddle carriers) instead of very large ramps. Hoists require a pier or quay. At sites with a gradual submarine slope, a marine way prevents the need for a pier, quay or dredging and allows vegetation to be preserved.

Jetties should be built only where excessive exposure to waves makes ramps and pontoons unacceptable. Jetties or wharves on piles are usually more appropriate than solid fill, to allow water to flow beneath the structure. Pile driven piles are preferred as they create less disturbance of the seabed. When piers made from solid fill are replaced, the material should be disposed of at an approved landfill site.

Design should consider the following:

- Provide sufficient area for car parking and turning for vehicles towing boat trailers onto the structure.
- Restrict size and length of structures to the minimum needed, yet ensure planning for future use.
- Use structures made with slats or mesh to allow light to penetrate to marine vegetation where practicable.
- Leave surfaces untreated, or stain or paint them in colours compatible with the character of the area (except as required for safety reasons).
- Use floating pontoons in preference to fixed ones, which require disturbance of the seabed during installation.

Protect public safety:

- Provide non-mountable kerbs on jetties and wharves in areas generally used by wheeled vehicles, including wheelchairs, where practicable. Handrails are recommended where this does not interfere with access to the water or boats.
- Provide a safety ladder on jetties and wharves where it would be difficult for someone who falls from the structure to get safely to shore.

14.3.11 Design guidelines for large slipways

Large slipways will be designed by an engineer and subject to a suite of approvals. Design should consider the following:

- Allow for pedestrian and boat access at all tides. Alteration of the shoreline may be reduced through using a boat lifting facility instead of rails.
- Ensure the paving design allows for very high loads (e.g. under fork lift trucks and hardstand cradles for boats).
- Provide collection and disposal facilities for solid and liquid wastes, including hazardous wastes (e.g. fuel, oil, cleaners, used sump oil, hull scrapings and paints) to prevent pollution of the ground and water. Provide pump-out or other facilities for wastewater disposal from boats.
- Construct a permanent catch drain above the high water level to collect and direct residues,



waste liquids and solids from the boat work area to a collection pit via a silt trap. Make the work areas slope slightly so wastewater will flow into the pit. Make the collection pit large enough to hold the first flush of contaminated stormwater and/or the expected volume of wastewater from wet cleaning processes.

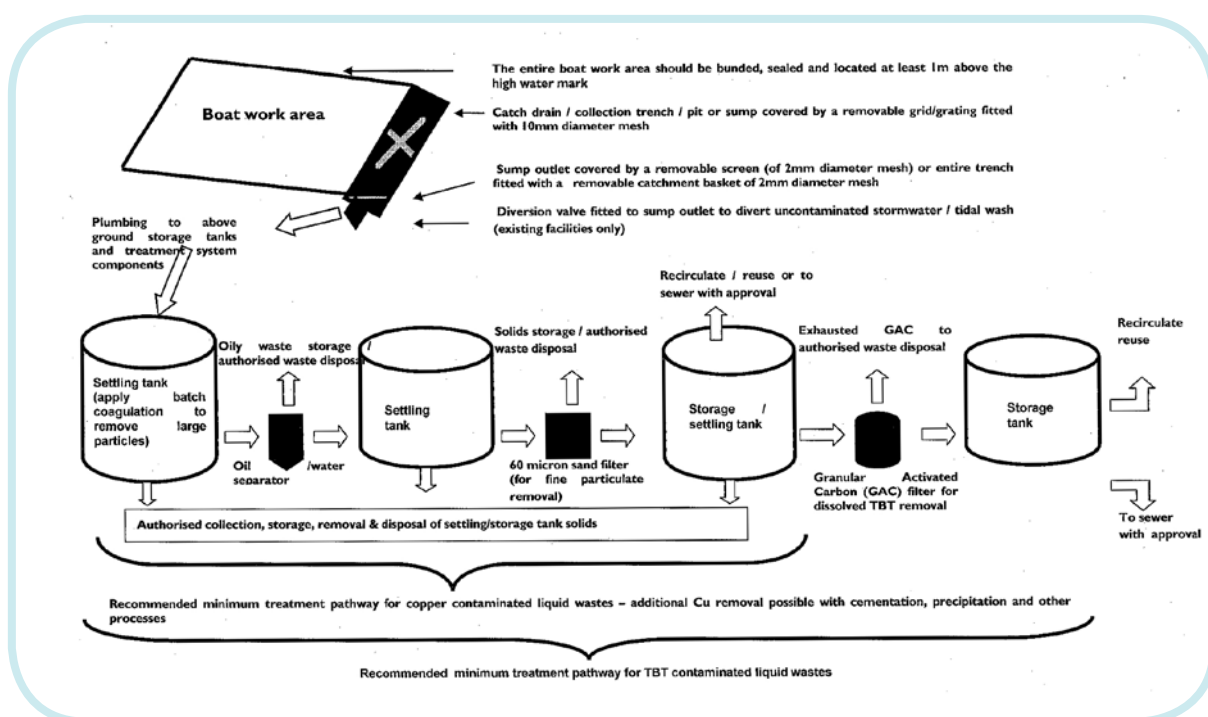
14.3.12 Waste management at slipways

Point source pollution generated during vessel maintenance can contaminate coastal waters and sediments, leading to negative impacts on the local community, the fishing and aquaculture industry, recreational users and the ecosystem itself. Maintaining good water and sediment quality is vital for all these uses and values (NRM South 2008b).

There are important measures that can be incorporated into slipway design to minimise impacts of waste pollution on the coastal and marine environment:

- Cover the work area, where possible, to minimise entry of rainwater and reduce contamination of stormwater.

Figure 14.4 Waste management and treatment of liquid wastes from slipways. Source: *Environmental Guidelines for Boat Repair and Maintenance* (Department of Environment, Parks, Heritage and the Arts 2009).





- Bund the boat work area and hardstand, where practicable, and construct drains to divert uncontaminated stormwater around the slipway site, contain the runoff from the boat work area and minimise the amount of stormwater requiring treatment.
- Regularly clean and maintain work areas and ensure that no litter or wastewater from cleaning or maintenance work falls or drains into stormwater.
- Do not allow water to run off or be released from the work areas without first being treated to remove toxic substances, turbidity and discolouration.
- Collect any contaminated stormwater in a holding tank and either dispose of it via a licensed waste transporter, or treat it on-site to an appropriate standard for discharge or reuse.

Encourage responsible boat maintenance.

- Slipway work (e.g. hull blasting) should be done above the catch drain so that any wastes drain into it.
- Hulls should not be cleaned within 50m of the shoreline, wherever possible, if the hardstand is not sealed and bunded, and the washdown waters and other wastes could enter estuarine or marine waters.
- Oil filtration devices should be fitted to bilge pumps; commercial oil absorption materials should be placed in bilges; and contaminated bilge water and other wastes should be discharged responsibly.

14.4 Buildings, toilets and other amenities

This section outlines considerations for building new structures and maintaining existing structures in the immediate coastal zone, including change rooms, huts, picnic shelters, outdoor furniture and rubbish bins.

As a general rule, buildings and amenities such as outdoor furniture and rubbish bins should be placed away from the shoreline wherever possible. The shoreline is a sensitive area, where unstable soils and sediments are prone to erosion and landslip and vulnerable to sea level rise. Consider not just the impact of installation but the ongoing impacts of accessing the facility for servicing (e.g. emptying rubbish bins) or maintenance. Some buildings and amenities, however, will need to be provided on or near the shoreline for recreation, work or safety purposes.

A new built structure should only be considered where the need for it can be clearly demonstrated, and its construction and use avoids or minimises damage to coastal processes (e.g. movement of sand between the dune-beach-shore system) and ecosystems.

Where possible, consolidate structures into areas of high use or existing facilities. Promote community use of shared structures such as public ramps rather than private boat sheds.

Choosing the appropriate site is critical for structures on or near the shore. These structures are susceptible to damage by wave erosion or sand or sediment build up. They can be expensive to maintain and can cause problems in adjacent shoreline areas by changing the sediment budget. Works in coastal sand dunes can funnel wind and increase wind erosion causing blowouts and mobility of the dune system.



Choose a site that avoids or minimises interference with coastal processes (e.g. wave actions, wind and cyclic beach sediment budgets).

Identify and protect natural and cultural values during construction and for the life of the structure.

The use of creative design, form, colour and siting will make buildings and amenities more attractive and this can deter vandalism. The style of the building design should be appropriate to its setting, e.g. in urban areas the style may be formal in character whereas in more natural settings the style may be informal.

Involve the local community wherever possible, as they are often the reason for the facility being provided. Work in collaboration with the local Coastcare or community group. Members often have valuable local knowledge and their own aspirations for the area they have been caring for.

14.4.1 Site selection

If a new structure is needed and there is a choice of site, select a site that complies with the following requirements.

- Avoid unstable areas such as dunes, slip-prone areas, very erodible soils, natural drainage channels and stream banks.
- Protect aesthetic values by concentrating structures at certain locations to reduce the visual and environmental impacts on the general area.
- Choose sites away from significant natural or cultural heritage values. Avoid building on natural vegetation, floodplains, wetlands and other ecologically sensitive sites.
- Avoid works in areas infected with phytophthora root rot.
- Avoid works in acid sulfate soils (ASS) wherever possible, as disturbing ASS can lead to

environmental damage and corrosion and loss of structures.

- Consider the latest sea level rise predictions from the IPCC and the vulnerability of the site to inundation and erosion due to sea level rise.

14.4.2 Special considerations for outdoor furniture and amenities

Design outdoor furniture and amenities to be functional, suit the needs of the user and be adequate for the expected use levels. They should be safe, solid and constructed from durable materials that will stand up to salt spray, high winds, storms and sun. New, innovative designs may be more effective and attractive than conventional designs.

Use non-abrasive, non-splintering materials with all edges and corners rounded and avoid protruding bolts, screws, nails and similar items that might injure users.

Stainless steel can be substituted for galvanised fittings and fixings to greatly improve the life of these items. Stainless steel fittings (brackets etc.) will require stainless steel fixing, to avoid galvanic corrosion where metals come into contact.

Provide a range of table sizes and seating arrangements to cater for disabled visitors and various group sizes and ages. Sloping seat surfaces will allow water to run off.

Provide rubbish bins with secure lids (to prevent scavenging by possums or dogs) and ensure they are emptied regularly.

Consider the types of rubbish bins to be provided and ensure that their size and design are adequate to handle the amount and type of waste. Land managers should provide separate bins for waste/rubbish and recyclables. Consider where the bins are located and



how often they will be emptied.

The use of CCA (copper, chromium, arsenic) treated timber for seating and tables and other areas with which humans come into contact is no longer permitted. New treated timbers are being developed and there is a large range of prefabricated tables and seating that are made from recycled plastic.

Shelters provide shade and a focal point for recreational activities. In exposed locations it may be necessary to choose shelters with walls that provide protection against prevailing winds. In determining wind breaks, site aesthetics may need to be considered as well as the potential for making the most of views. Curved roofs can be used to soften the visual impact of structures.

14.4.3 Special considerations for toilets

Toilets and facilities to treat and dispose of wastewater require careful design and siting. Effluent from poorly designed toilets can travel a long way (down-slope and sideways and into the water table) and may pollute wetlands or sand where children play.

The appropriate type of toilet and wastewater treatment system will depend on the soil and other site conditions, water supply and costs (including maintenance) and projected public demand.

Details of approved commercially available wastewater treatment systems are available from councils and from the Building Standards and Regulation Section, Workplace Standards Tasmania, Department of Infrastructure, Energy and Resources.

Protect nearby soil and water from contaminated effluent discharge. Seek advice from an engineer about the appropriate type of toilet, wastewater

Figure 14.5 An unsightly concrete toilet has become a mosaic work of art thanks to a local artist working with the local school community. © Leah Page





treatment and disposal systems to install.

Ensure that qualified professionals design and install all structures, including on-site wastewater treatment plants, rising mains and associated sewerage reticulation. The design plans for wastewater treatment systems should provide full details of the treatment system to be used.

The design and installation of on-site wastewater disposal systems (including absorption trenches, absorption beds, evapo-transpiration-assisted beds, absorption/seepage trenches or mounds and sub-surface irrigation areas) must be done in accordance with the relevant statutory requirements and Australian Standards.

Ensure sites for wastewater disposal are evaluated by a qualified geotechnical engineer or environmental health officer experienced in this field. A site evaluation report must be completed in accordance with the Australian Standard *AS/NZS 1547:2000 On-site domestic-wastewater management and the Code of Practice for On-Site Wastewater Disposal* (Australian Institute of Environmental Health, Tasmanian Division) and the *Tasmanian Plumbing Code* (DIER 1994).

Any on-site wastewater disposal must not create an unreasonable risk to public health or local surface- or groundwater quality. Systems should be designed to cater for peak flow conditions and should fully treat wastewater within the boundaries of the designated treatment site.

Avoid installing septic tanks on sandy sites. Where toilets are required, install systems that will not pollute groundwater (e.g. pump-out toilets) and arrange for disposal of sewage at approved facilities off-site.

Sewage generated from pump-out facilities must be disposed of by a licensed waste transport business, approved to collect, transport and dispose of waste at

an approved facility.

Maintain all toilets regularly to minimise the risk of them causing pollution or becoming a health hazard or eyesore.

Types of toilet

Toilets are of three types:

Wet toilets are flush toilets connected to sewers, or to septic tanks. Flush toilets are preferred by users, but discharge larger volumes of effluent and are expensive to maintain.

Dry toilets include pit or composting toilets. These use much less water than conventional flush toilets, but require more regular maintenance.

Vault toilets have a holding tank that requires pumping out from time to time. Vault toilets avoid pollution on-site but require more site disturbance to install, and are expensive to pump out. They can be visually intrusive if the holding tank sits above the ground.



I4.5 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

Australian Standards

Available from ASI Global

phone 1300 654 646

www.standards.com.au

- *AS3962-2001 Guidelines for design of marinas*
- *AS4997-2005 Guidelines for design of maritime structures*
- *AS/NZS ISO 31000:2009 Risk management - Principles and guidelines*
Replaces AS 4360-2004 *Risk management* as the leading resource for risk management.

Climate change and coastal risk assessment project.

A suite of tools and documents including:

- *Coastal risk management plan: Template and guidelines* (DPIW 2009)
- *Coastal hazards in Tasmania: General information paper* (DPIW 2008c)
- *Climate change and coastal asset vulnerability: An audit of Tasmania's coastal assets potentially vulnerable to flooding and sea-level rise* (DPIW 2008b)
- *Sea-level extremes in Tasmania: Summary and practical guide for planners and managers* (DPIW 2008e)
- *Historical and projected sea-level extremes for Hobart and Burnie, Tasmania* (Hunter 2008)
- *Background report: Coastal flooding - Review of the use of exceedence statistics in Tasmania* (DPIW 2008a)

www.dpiw.tas.gov.au/climatechange

Coastal management specification manual: a guide for the construction of coastal management infrastructure (Green Skills Inc 2010)

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



Environmental guidelines for boat repair and maintenance (Department of Environment, Parks, Heritage and the Arts 2009)

Environmental guidelines for marinas in the Great Barrier Reef Marine Park (Bugler 1994)

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

Guide to best practice management of point source pollution at boat repair and maintenance facilities (NRM South 2008b)

Guidelines for responding to the effects of climate change in coastal engineering design (National Committee on Coastal and Ocean Engineering 2004)

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

MAST Mooring Factsheet

<http://www.mast.tas.gov.au>

Natural Values Atlas

The Natural Values Atlas provides authoritative, comprehensive information on Tasmania's natural values. Download a free registration form from the website to access.

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

Occupational Health and Safety

www.wst.tas.gov.au

Seagrass friendly Mooring System

<http://www.seagrassmooring.com.au/>

Siting and design guidelines for structures on the Victorian coast (Victorian Coastal Council, 1998)

Smartline or coastal vulnerability maps

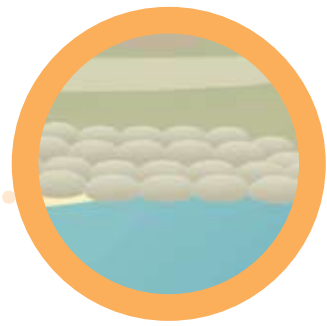
Maps of coastal landform types and their vulnerability to sea level rise can be found under 'Climate Change' layers on the LIST and the OzCoasts website. The data is presented as a 'smart line' following the coastline, with information on the geology of the coast readily interpreted for particular coastal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

www.thelist.tas.gov.au

www.ozcoasts.org.au

Tasmanian reserve management code of practice (Parks and Wildlife Service et al. 2003)





15 Shoreline modification

- 15.1 Shoreline protection works
- 15.2 Reclamation and dredging
- 15.3 Climate change and shoreline modification
- 15.4 Tools and resources

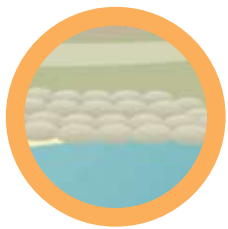
This chapter provides an overview of shoreline protection works and special considerations to minimise the impacts of such works and structures on the coastal environment.

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.

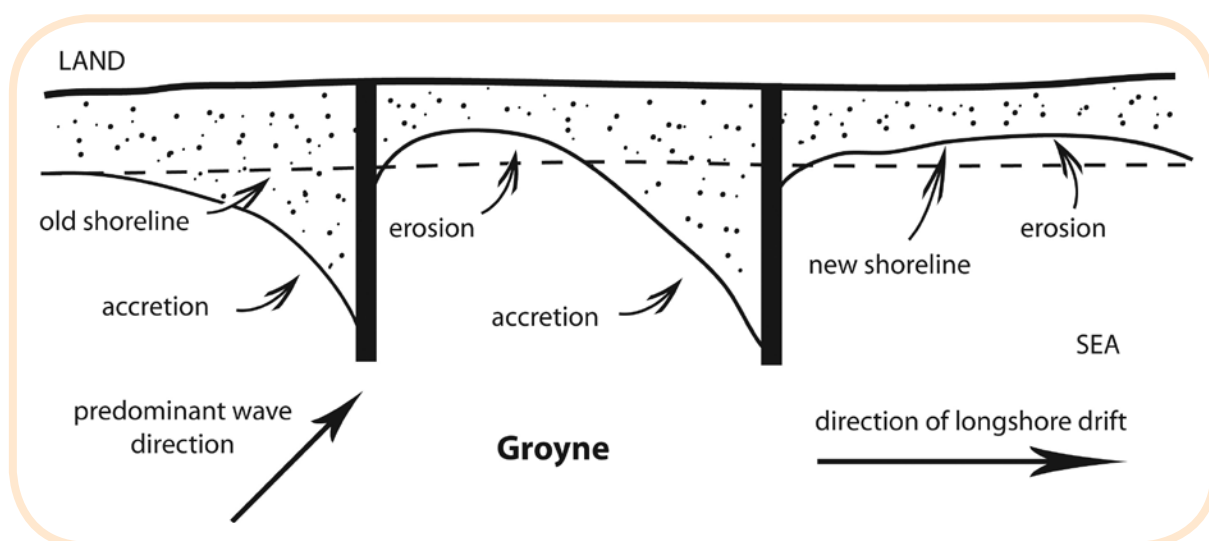
Seek expert advice and consider the advantages and disadvantages of each type of protection works before investing in planning them. Consider also combined treatments and allowing the shoreline to retreat.

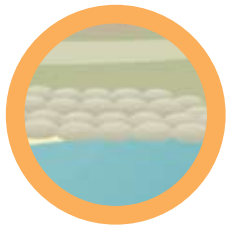
15.1.3 Groynes

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.

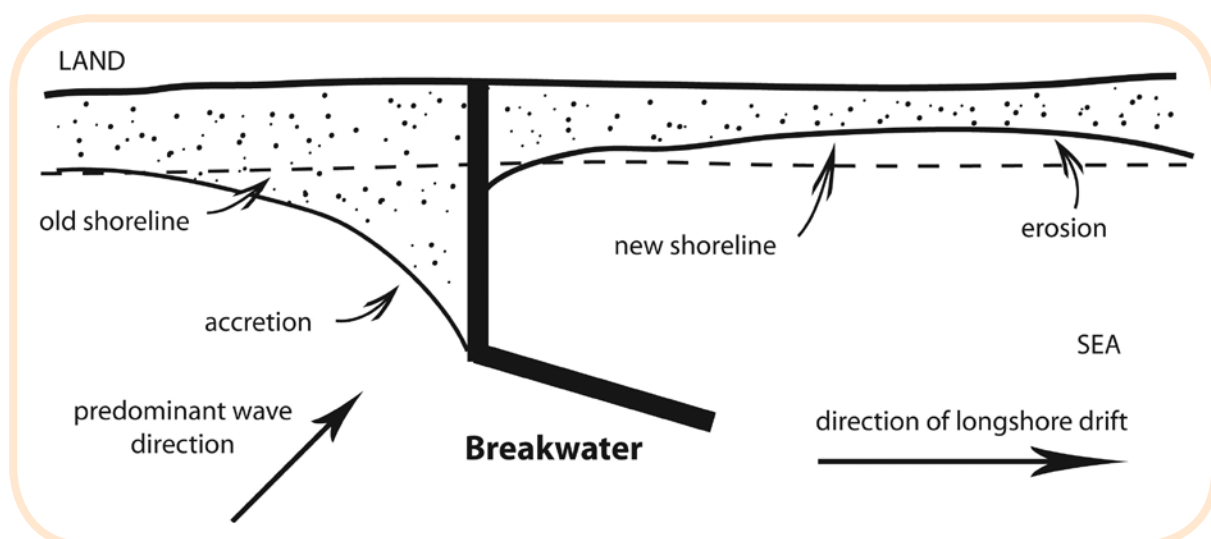
All breakwaters are costly to construct and maintain, and their use is generally limited to providing sheltered areas that are not exposed to full wave attack. They have high maintenance costs due to scouring around the ends and the eventual weakening of the structure. A low breakwater is less expensive 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.

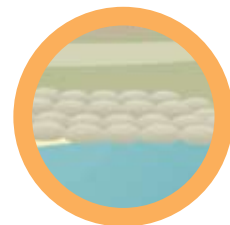
Breakwaters can influence sand movement and result in significant erosion or unwanted deposition on the protected inshore side of the structure. Dredging is usually required to keep navigation channels open.

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'Keefe 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

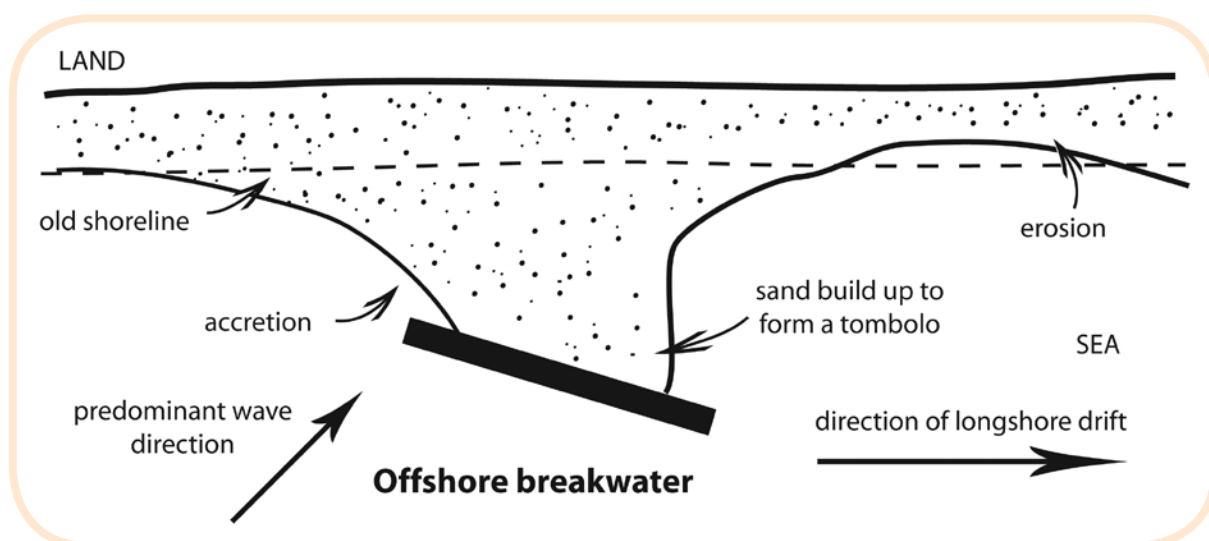
of sand from longshore drift (or from artificial beach replenishment) for a groyne to be successful.

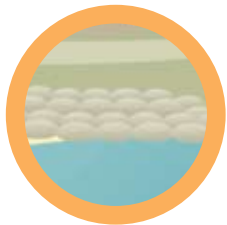
Identify any natural or cultural values in the area, including threatened species, important coastal and marine habitat and Aboriginal and maritime heritage. Consult specialists and seek any necessary assessments and approvals.

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.

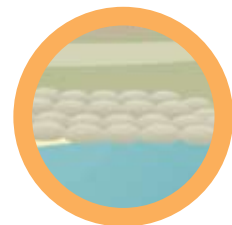
15.1.6 Seawalls

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.**

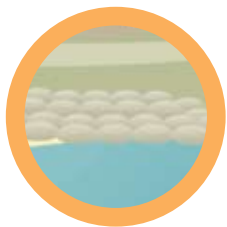
15.1.8 Guidelines for planning and installing seawalls

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

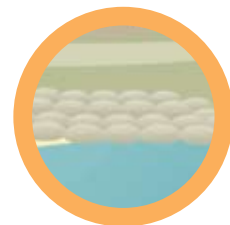
The range of construction options includes concrete, walls built with caissons (concrete boxes), and brick or block walls.

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.

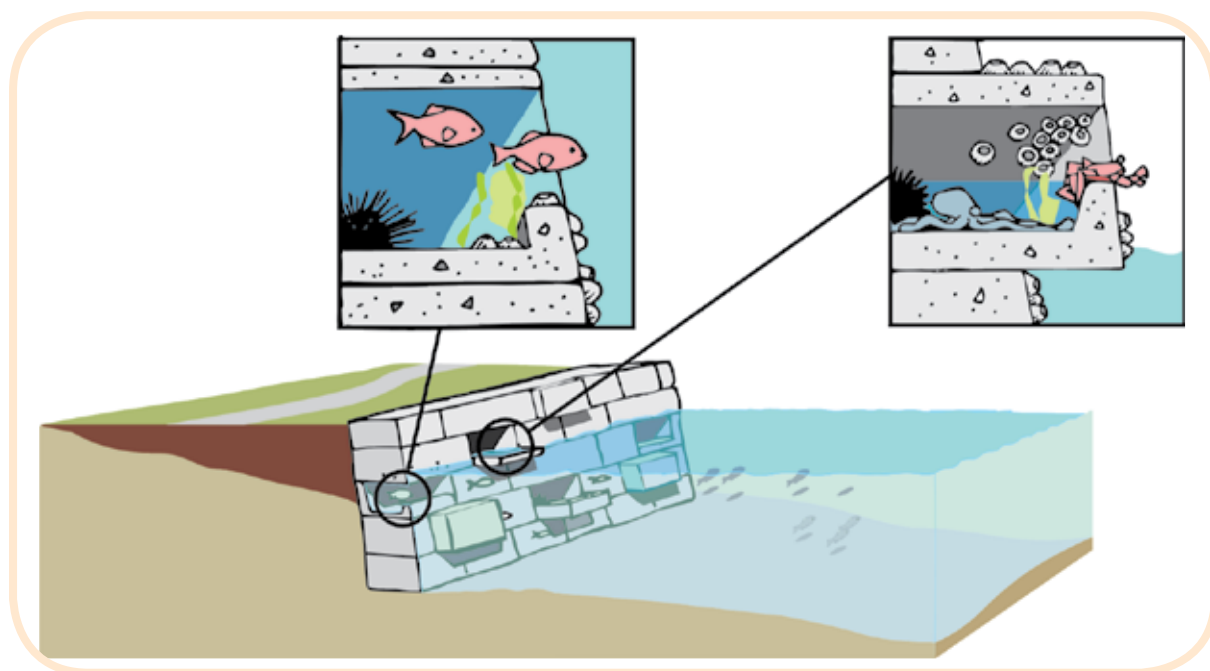
Because revetments are permeable, they can become susceptible to scouring behind the wall caused by poor seepage control and/or waves surging over the top. If extreme, this can lead to the collapse of the revetment. Good design and careful consideration of coastal processes including sea level rise can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





(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.

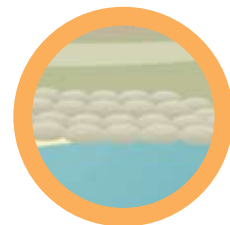
Thorough planning and specialist advice are essential. Managing problems after construction is more expensive than dealing with them in the planning stage. All revetment works must meet legislative requirements and may require approval from a number of agencies. An assessment of the proposed activity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

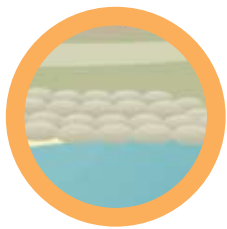
Because rock revetments are permeable structures, seepage may result in the removal of material from behind the structure, and eventual failure by collapse landwards. Install correctly designed soil filters or geotextiles to avoid damage by seepage. Protect geotextiles from light, e.g. put a gravel layer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

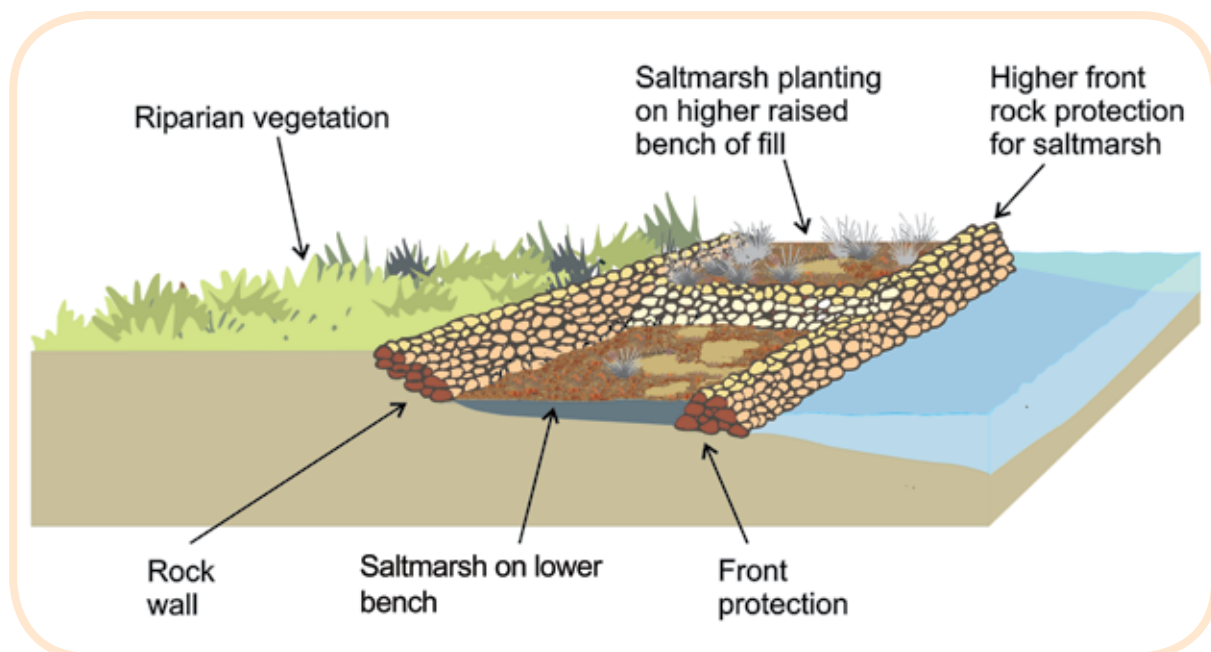
Climate change and sea level rise predictions based on IPCC predictions must be incorporated into the design. Consider not just elevated water levels but inundation, and increased wave energy and storminess.

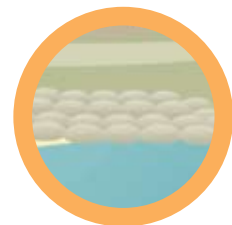
Incorporate features such as rock pools and crevices into the design to provide habitat for marine life. Revetments can be designed to have a step profile with a bench for saltmarsh or coastal vegetation, thereby providing an intertidal environment. This type of design is often more attractive and maintains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

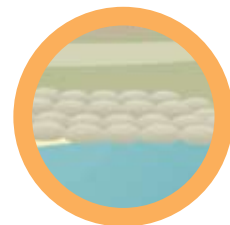


storms continuing to threaten infrastructure. It was proposed that a low rock revetment be constructed along the entire length of the beach to provide protection. Part of the original revetment would be rebuilt.

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

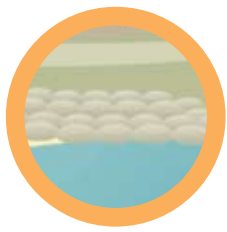
and not the integrity of the structure, whose life will vary depending on its application. As for all foreshore protection structures, an appropriate maintenance regime is required. Removal of structures is relatively straightforward, although complete recovery of all the geotextile material can be difficult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

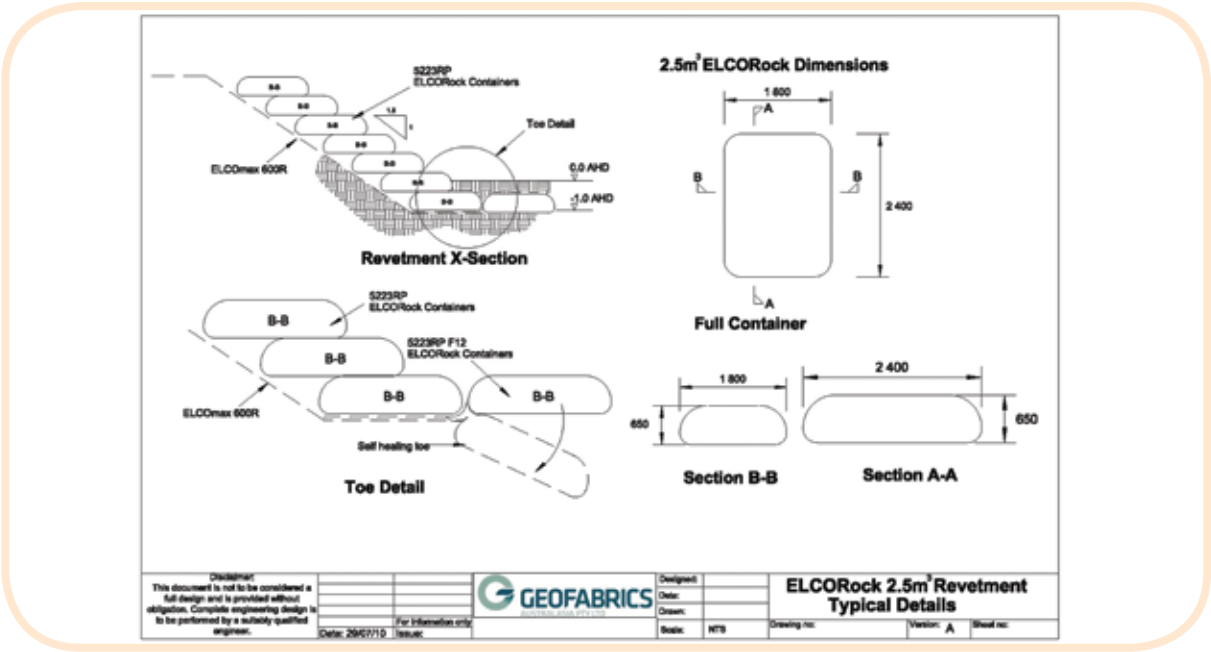
Beach nourishment or replenishment is the process of bringing sand in from another source to replace the sand being lost from the beach. Other techniques include scraping sand from the subtidal zone back up onto the beach, pumping sand from offshore and using geotextiles and other dune rehabilitation 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.

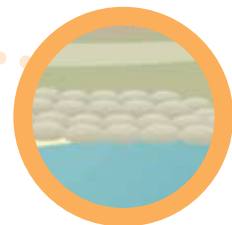
Any decision to undertake beach nourishment requires careful and costly scientific research of the existing coastal processes unique to the site. Beach nourishment will be expensive, will require ongoing maintenance and, even with careful planning and research, can lead to unforeseen impacts on the coastal 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.

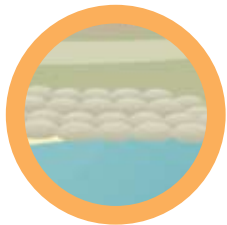
15.2 Reclamation and dredging

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.

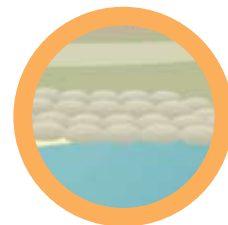
If proposing substantial reclamation or draining of the shoreline or seabed, seek public input. Consult local Coastcare groups even for very small projects. Local volunteers have a strong connection to the coast they have been caring for and should be included in coastal management decisions.

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.

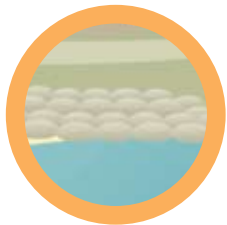
Dredging may produce large amounts of spoil that may be contaminated, including the exposure of subaqueous acid sulfate soils, and will require specialist disposal. Disposal of contaminated waste is tightly regulated, and clean-up of contaminated material may be required before it can be accepted by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

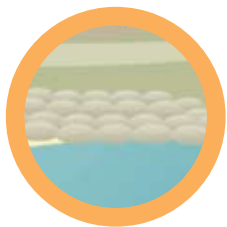
Suction dredges are suitable for smaller projects, such as removal of sand for beach replenishment, where no cutting is required. A grab dredge can be used in situations where there is not enough depth for a trailer or cutter suction dredge, but these can produce a lot of sediment disturbance.

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 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).

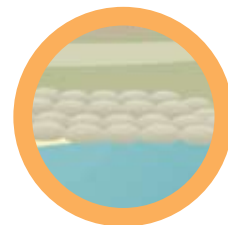
The IPCC Fourth Assessment Report (IPCC 2007) conservatively estimated a sea level rise of up to 79cm by 2100; ongoing research is predicting that sea level rise of over 1m and as high as 1.5m is possible, and sea levels will continue to rise long after 2100. It is anticipated that these higher projections 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.

It 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_uid=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

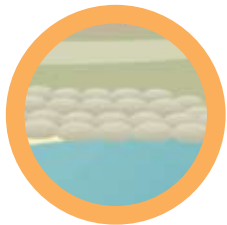
Vegetation, species habitat and geomorphic values data for a 100m-wide coastal strip of the northern, southern and north-western Tasmania NRM Regions. Available on the LIST

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

Appendix I: Summary of legislation

The following list is a summary of the main legislation governing coastal management activities in Tasmania. There are also statutory plans and approval processes that need to be considered when undertaking works in coastal areas. **Appendix 2** organises the legislation into topic areas covered in the Manual.

Legislation	Principle/scope
Tasmanian Legislation	
<i>Aboriginal Relics Act 1975</i>	Protection of the physical remains of Aboriginal occupation in Tasmania.
<i>Crown Lands Act 1976</i>	Management, sale, and disposal of Crown lands, including the granting of leases and licences for activities on Crown Land.
<i>Environmental Management and Pollution Control Act 1994</i>	Primary environmental protection legislation dealing with environmental harm from pollution and waste management, and avoiding environmental impacts. Regulation of pollution and emission controls in the marine environment.
<i>Environmental Management and Pollution Control (Waste Management) Regulations 2000</i>	The disposal of controlled waste to prevent direct or indirect environmental harm, for recreational, commercial, domestic, agricultural or industrial processes.
<i>Fire Service Act 1979</i>	All landowners/occupiers have a responsibility to maintain their properties to reduce fire hazard.
<i>Historic Cultural Heritage Act 1995</i>	Protection of heritage with respect to places of archaeological, architectural, cultural, historical, scientific, social and technical significance.
<i>Land Use Planning and Approvals Act 1993</i>	Provides framework for strategic and statutory land use planning and development. Regulates land use and development through planning schemes.
<i>Living Marine Resources Management Act 1995</i>	Regulation and protection of the living marine environment, provision of sustainable fisheries management plans.
<i>Local Government Act 1993</i>	Provides for the creation of council by-laws, issuing of abatement notices for environmental nuisance, and managing and owning public land.
<i>Local Government (Building and Miscellaneous Provisions) Act 2003</i>	Requires creation of a littoral or riparian reserve with subdivision.
<i>Marine and Safety Authority Act 1997</i>	Establishes MAST, responsible for ensuring safe operations of vessels, provides for the development and management of marine facilities, and manages environmental issues relating to vessels.
<i>Marine Farming Planning Act 1995</i>	Regulation of planning and management for marine farming.

<i>Mineral Resources Development Act 1995</i>	Provides for the development of mineral resources consistent with sound economic, environmental and land use management, and applies to all land and minerals in Tasmania
<i>National Parks and Reserves Management Act 2002</i>	Management of parks and reserves based on management objectives of each class of reserve, declaration and management of Marine Protected Areas (marine reserves). Administered through Parks and Wildlife.
<i>Nature Conservation Act 2002</i>	Management and protection of some estuarine/marine species & communities.
<i>Plant Quarantine Act 1997</i>	Provides for the quarantine of plants and the control of pests and diseases
<i>Roads and Jetties Act 1935</i>	Relates to roads, highways and the control and management of certain jetties and marine facilities.
<i>State Coastal Policy 1996</i>	Protection of natural and cultural values of the coast, sustainable development of the coast, and integrated management and protection of the coastal zone.
<i>State Coastal Policy Validation Act 2003</i>	Validates the State Coastal Policy 1996 and amends the coastal zone to include State waters and all land to a distance of one kilometre inland from the high-water mark.
<i>State Policies and Projects Act 1993</i>	Deals with the making of Tasmanian Sustainable Development Policies, the integrated assessment of Projects of State Significance, the State of the Environment Reporting and for related purposes.
<i>State Policy on Water Quality Management 1997</i>	Protection and enhancement of water quality, including monitoring of water bodies, facilitating integrated catchment management, through the application of the precautionary principle.
<i>Tasmanian Building Act 2002</i>	Regulates the construction and maintenance of buildings and building and plumbing matters and to provide for permits, enforcement matters and resolution of disputes.
<i>Tasmanian Planning Commission Act 1997</i>	Establishes the Tasmanian Planning Commission (TPC), assessment of planning schemes, State Policies and Projects of State Significance.
<i>Tasmanian Ports Corporation Act 2005</i>	Provides for matters relating to the control of the Tasmanian Ports Corporation Pty Ltd and its assets.
<i>Threatened Species Protection Act 1995</i>	Classification and listing of threatened flora and fauna, protection of threatened marine species.
<i>Water Management Act 1999</i>	Provides for the control and eradication of declared weeds and the promotion of a strategic and sustainable approach to weed management
<i>Whales Protection Act 1988</i>	Protection for whales in Tasmanian waters. The Commonwealth Whale Protection Act 1980 was replaced by the EPBC Act.
<i>Weed Management Act 1999</i>	Provides for the control and eradication of declared weeds and the promotion of a strategic and sustainable approach to weed management.

Commonwealth Legislation	
<i>Environment Protection (Sea Dumping Act) 1981</i>	Protect & preserve the marine environment with respect to pollution related to dumping at sea. Assessment and permitting of proposals to load and dump wastes in accordance with the National Ocean Disposal Guidelines for Dredged Material 2002.
<i>Environment Protection and Biodiversity Conservation Act 1999</i>	Provides a framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places, including World Heritage properties, Ramsar wetlands, listed threatened species and ecological communities, listed migratory species, Commonwealth marine areas, and National heritage places.
<i>National Environment Protection Council Act 1994</i>	Establishes the National Environment Protection Council for protection from air, water, soil, or noise pollution. Under this Act measures (NEPMs) have been developed for a range of environmental issues, and these are adopted as State Policies.
<i>National Environment Protection (Assessment of Site Contamination) Measure 1999</i>	Under the NEPC Act, this NEPM has now become a Tasmanian State Policy. It establishes a nationally consistent approach to the assessment of site contamination and provides adequate protection of human health and the environment, where site contamination has occurred.
International Legislation	
<i>Convention on the Prevention of Marine Pollution by Dumping of Wastes or other Matter (London Convention 1972)</i>	Prevent pollution of the sea through the dumping of waste and other matter liable to create hazards to human health, harm living resources and marine life, damage amenities or interfere with other legitimate uses of the sea.



Appendix 2: Legislation and policy requirements for activities

The following information table is intended to assist those undertaking small-scale activities in coastal areas with a list of the relevant legislation, codes of practice or other guidelines that apply to works on the coast. Local council planning schemes will cover nearly all the requirements.

The list is not complete as it does not include the regulations and amendments to the Acts (refer to www.thelaw.tas.gov.au).

The following table is categorised by the area of interest (environment, cultural heritage etc.) and the nature of works activities within each category. The appropriate contact points and phone numbers for obtaining information and approvals are listed in **Appendix 3 Where to obtain more information**.

Activity	Legislation, codes, policies, guidelines and key strategies
Environmental Management	
Sand dune modification and stabilisation	<i>Environmental Management & Pollution Control Act 1994</i> <i>National Parks & Reserves Management Act 2002</i> Quarry Code of Practice Local Council planning scheme
Fences	<i>National Parks & Reserves Management Act 2002</i> Local Council planning scheme Tasmanian Reserve Management Code of Practice
Modifying geoheritage	<i>Nature Conservation Act 2002</i>
Shoreline modification—groynes, rocks, sea walls	<i>Nature Conservation Act 2002</i> Local Council planning scheme <i>Crown Lands Act 1976</i> <i>Environmental Management and Pollution Control Act 1994</i>
Pontoons	Local Council planning scheme
Stock grazing	State Policy on Protection of Agricultural Land Local NRM Plans Local Council planning scheme
Excavation of land	Local Council planning scheme <i>Land Use Planning and Approvals Act 1993</i> <i>Mineral Resources Development Act 1995</i> <i>Crown Lands Act 1976</i> (lease over seabed and/or shoreline) Quarry Code of Practice

Weed management	<i>Weed Management Act 1999</i> State Weed Management Plan Tasmanian Beach Weed Strategy Regional Weed Management Plan Local weed management plans Pocket Guide for Safe Herbicide Use in the Bush Tasmanian Reserve Management Code of Practice
Spraying weeds	<i>Agricultural & Veterinary Chemicals (Control of Use) Act 1996</i> Regulations & Orders Code of Practice for Spraying in Public Places Pocket Guide for Safe Herbicide Use in the Bush Tasmanian Reserve Management Code of Practice
Revegetation	<i>Nature Conservation Act 2002</i> <i>National Parks & Reserves Management Act 2002</i> Tasmanian Reserve Management Code of Practice
Native animal management	<i>Tasmanian Threatened Species Protection Act 1995</i> <i>Environment Protection and Biodiversity Conservation Act 1999</i> <i>Nature Conservation Act 2002</i> <i>Animal Farming (Registration) Act 1994</i> Wildlife Regulations
Pet/feral animal control	<i>Animal Welfare Act 1993</i> <i>Animal Health Act 1995</i> Tasmanian Reserve Management Code of Practice
Reclamation, excavation	Local Council planning scheme <i>Crown Lands Act 1976</i>
Dredging	<i>Environmental Management & Pollution Control Act 1994</i> <i>Crown Lands Act 1976</i> <i>Environment Protection (Sea Dumping) Act 1981</i> <i>National Environment Protection Council Act 1994</i> National Environment Protection (Assessment of Site Contamination) Measure 1999 Local Council planning scheme
Marine farms	<i>Marine Farming Planning Act 1995</i>
Works to protect marine habitats	<i>Living Marine Resources Management Act 1995</i>
Mowing and other vegetation management works	<i>National Parks & Reserves Management Act 2002</i> Tasmanian Reserve Management Code of Practice
Controlling introduced marine pests	<i>Living Marine Resources Management Act 1995</i>

Cultural values	
Aboriginal heritage	<i>Aboriginal Relics Act 1975</i> Local Council planning scheme
Works affecting historic heritage Any works in a place listed on the Tasmanian heritage register	<i>Historic Cultural Heritage Act 1995</i> Local Council planning scheme
Works affecting visual quality	Local Council planning scheme Tasmanian Reserve Management Code of Practice Siting & Design Guidelines—Victorian Coastal Council
Public Access & Services	
Construction of buildings (toilets, change rooms etc)	Local Council planning scheme
Construction of jetties, marinas, slips and boat launch ramps	<i>Land Use Planning & Approvals Act 1939</i> <i>Crown Lands Act 1976</i> Local Council planning scheme Tasmanian Reserve Management Code of Practice
Reclamation	<i>Environmental Management & Pollution Control Act 1994</i> <i>Crown Lands Act 1976</i> National Environment Protection (Assessment of Site Contamination) Measure 1999 Local Council planning scheme
Signs	Local Council planning scheme Tasmanian Reserve Management Code of Practice
Use of heavy machinery	Tasmanian Reserve Management Code of Practice
Road and track construction	Local Council planning scheme Tasmanian Reserve Management Code of Practice Track Planning Guidelines
Off-road vehicle access	Tasmanian Reserve Management Code of Practice
Recreational fishing	<i>Living Marine Resources Management Act 1995</i>
Construction of bridges	Waterways and Wetlands Works Manual
Use of large rocks and other barriers	Tasmanian Reserve Management Code of Practice
Moorings	Marine and Safety Tasmania (MAST) regulations
Installation of pipes (sewer, stormwater etc)	Local Council planning scheme
Fire hazard reduction work	Tasmanian Reserve Management Code of Practice
Beach nourishment	Tasmanian Reserve Management Code of Practice <i>Crown Lands Act 1976</i> Local Council planning scheme <i>Environmental Management & Pollution Control Act 1994</i>



Water quality control	<i>Public Health Act 1997</i> <i>Water Management Act 1999</i> State Policy on Water Quality Management 1997 Water Management Plan National Action Plan for Water Quality & Salinity
Septic tanks and other forms of on-site waste treatment	<i>Public Health Act 1997</i> Tasmanian Plumbing Code 1994 Local Council health regulations Tasmanian Reserve Management Code of Practice
Development in hazardous areas	Local Council planning scheme

Appendix 3: Where to obtain more information

The following contact information is intended to provide a primary source of information and directions for where to go for further assistance. The following list is not exhaustive. Land managers and NRM regional bodies can provide more information on where to seek advice. Key contacts for community and non government organisations (NGO's) are detailed in **Appendix 4**.

The table below is categorised by the area of interest (environment, cultural heritage etc.) and the nature of works activities within each category. For each activity the appropriate contact point and telephone number is listed. Correct at time of publication.

Activity	Contact point	Phone
Environment		
Acid sulfate soils	DPIPWE: Land Conservation Branch www.dpipwe.tas.gov.au	6336 5441
Climate change	Tasmanian climate change office www.dpac.tas.gov.au/divisions/climatechange	6270 5485
Excavation and soil management	DPIPWE: Land Conservation Branch www.dpipwe.tas.gov.au	1300 368 550
Feral animal control	DPIPWE: Wildlife Management Branch www.dpipwe.tas.gov.au Tasmanian Conservation Trust www.tct.org.au	1300 368 550 6234 3552
Fire hazard management and protection	Tasmania Fire Service www.fire.tas.gov.au Parks & Wildlife Service: Fire Management www.dpipwe.tas.gov.au	6230 8600 1800 000 699 6233 6767
Introduced marine pests	DPIPWE: Marine Environment www.dpipwe.tas.gov.au	6233 3370 0408 380 377

Shoreline modification and stabilisation works (e.g. sea walls, dredging, reclamation)	DPIPWE: Crown Land Services www.dpipwe.tas.gov.au	6233 6413
	DPIPWE: Land Conservation Branch www.dpipwe.tas.gov.au	1300 368 550
	DPIPWE: Marine Environment (dredging, reclamation) www.dpipwe.tas.gov.au	6233 6587
	Marine & Safety Tasmania (dredging navigation channels) www.mast.tas.gov.au	6233 8801
Stormwater	Derwent Estuary Program	6233 3742
	DPIPWE Stormwater Management Officer	6233 3595
Vegetation management	DPIPWE: Biodiversity Conservation Branch www.dpipwe.tas.gov.au	1300 368 550
	Greening Australia www.greeningaustralia.org.au	6223 6377
	Understorey Network www.understorey-network.org.au	6234 4286
		0407 352 479
Waste management services (e.g. septic tanks)	DPIPWE: Crown Land Services www.dpipwe.tas.gov.au	6233 6413
	Environmental Health Department of the relevant Local Council	
Water quality	DPIPWE: EPA Division www.dpipwe.tas.gov.au	6233 6518
Weed management	DPIPWE: Land Conservation Branch	1300 368 550
	Regional Weed officers www.dpipwe.tas.gov.au	
Wetlands management	DPIPWE: Biodiversity Conservation Branch www.dpipwe.tas.gov.au	1300 368 550
Wildlife protection	DPIPWE: Wildlife Management Branch www.dpipwe.tas.gov.au	1300 368 550
	Wildlife emergencies (24 hours)	
	DPIPWE: Threatened Species Unit www.dpipwe.tas.gov.au	6233 6556 1300 368 550
	Derwent Estuary Program (penguins) www.derwentestuary.org.au	
	Birds Tasmania (shorebirds) www.birdsaustralia.com.au	6233 3742
		0419 138 054

Heritage		
Aboriginal places	DPIPWE: Aboriginal Heritage Tasmania www.aboriginalheritage.tas.gov.au	6233 6613
	Tasmanian Aboriginal Land and Sea Council www.talsc.net.au	6231 0288
Historic sites	DPIPWE: Heritage Tasmania www.heritage.tas.gov.au	6233 2037 1300 850 332
	Parks and Wildlife Service: Heritage section www.parks.tas.gov.au	6233 2387
Geoheritage sites	DPIPWE: Land Conservation Branch www.dpipwe.tas.gov.au	1300 368 550
Access and facilities		
Fencing	TAFE Tasmania www.tafe-college.org/tafe-tasmania	6231 1779
	Conservation Volunteers Australia www.conservationvolunteers.com.au	
Moorings	Marine & Safety Tasmania www.mast.tas.gov.au	6233 8801
Off road vehicle access	Department of Primary Industries, Parks, Water & the Environment: Crown Land Services www.dpipwe.tas.gov.au	6233 6413
	Parks and Wildlife Service www.parks.tas.gov.au	1300 135 513
Public facilities (e.g. picnic tables, change rooms, toilets barbeques)	DPIPWE: Crown Land Services www.dpipwe.tas.gov.au Parks and Reserves Department of the relevant Council	6233 6413
Road and bridge construction	DPIPWE: Crown Land Services www.dpipwe.tas.gov.au Engineering Department of the relevant Local Council	6233 6413
Signs	DPIPWE: Crown Land Services www.dpipwe.tas.gov.au	6233 6413
	Parks and Wildlife Service: Interpretation Section www.parks.tas.gov.au Parks and Reserves Department of the relevant Local Council	6233 2184
Slips, marinas, launching ramps	DPIPWE: Crown Land Services www.dpipwe.tas.gov.au	6233 6413
	DPIPWE: Land Conservation Branch www.dpipwe.tas.gov.au	1300 368 550
	Marine & Safety Tasmania www.mast.tas.gov.au	6233 8801



Tracks and trails	Sport and Recreation Tasmania www.development.tas.gov.au Parks and Wildlife Service www.parks.tas.gov.au Parks and Reserves Department of the relevant Local Council	6233 5888
Recreation		
Fishing and boating	DPIPWE: Wild Fisheries Branch www.fishing.tas.gov.au Marine & Safety Tasmania www.mast.tas.gov.au	1300 135 513
Horse riding and dog walking	Local Council	6233 8801
General recreation	Sport and Recreation Tasmania www.development.tas.gov.au	6233 5888

Appendix 4: Community Organisations


Community involvement is central to achieving the protection and conservation of natural and cultural heritage along Tasmania's coastline. It is essential to consult with community groups before planning coastal management works. The following is a list of key community support organisations within Tasmania.

Useful organisations

Organisation	Purpose	Contact information
Birds Tasmania	<p>Birds Tasmania is a volunteer organisation committed to raising awareness of bird values in Tasmania and is the Tasmanian branch of Birds Australia.</p> <p>Birds Tasmania volunteers actively participate in the management of bird species and habitat through bird counts and surveys and involvement in steering committees and working groups.</p>	<p>GPO Box 68 Hobart TAS 7001</p> <p>Phone: 0419 138 054</p> <p>www.birdsaustralia.com.au/the-organisation/tasmania</p>
Conservation Volunteers Australia	<p>Conservation Volunteers Australia (CVA) partners with individuals, businesses and governments to involve local and international volunteers in work on environmental conservation projects.</p> <p>They provide teams of volunteers with an experienced leader for a fee to undertake a range of environmental activities from weeding, revegetation, track work and monitoring.</p> <p>They are also a registered training organisation and deliver accredited training and capacity building workshops.</p>	<p>63 Melville Street, Hobart TAS 7000</p> <p>Box 4675 Hobart TAS 7000</p> <p>Phone: (03) 6231 1779</p> <p>Fax: (03) 6231 1794</p> <p>www.conservationvolunteers.com.au</p>
Derwent Estuary Program	<p>The Derwent Estuary Program (DEP) is a regional partnership between local governments, the Tasmanian state government, commercial and industrial enterprises, and community-based groups to restore and promote the Derwent Estuary.</p>	<p>7 Franklin Wharf, Hobart TAS 7000</p> <p>GPO Box 1751, Hobart TAS 7001</p> <p>Phone: (03) 6233 3742</p> <p>Fax: (03) 6233 3800</p> <p>www.derwentestuary.org.au</p>

Green Corps	<p>Green Corps is an Australian Government youth development and environmental training program administered by the Department of Education, Employment and Workplace Relations (DEEWR) in consultation with other Australian Government departments.</p> <p>Green Corps works in consultation with CVA to provide teams of job seekers, with a team leader, who can undertake natural resource management tasks.</p>	<p>Contact through Conservation Volunteers Australia, or call 13 17 64 or visit www.deewr.gov.au/jobservicesaustralia</p>
Greening Australia	<p>Develops projects to engage the community in vegetation management to protect and restore the health, diversity and productivity of Australian landscapes.</p>	<p>GPO Box 1191, Hobart TAS 7001 Industry House, 30 Burnett St, North Hobart Phone: 03 6223 6377 Fax: 03 6223 6392 www.greeningaustralia.org.au</p>
Natural Resource Management (NRM) Regional Bodies	<p>Tasmania has three regional Natural Resource Management (NRM) regional bodies. Each play a role in connecting volunteers in their region to environmental planning and on-ground activities. The NRM regional bodies will also be able to provide you with up to date information on Federal, State Government and other funding opportunities available to volunteer organisations and land managers.</p>	<p>Cradle Coast NRM (approx Port Davey to Devonport) PO Box 338, Burnie TAS 7320 Phone: 03 6431 6285 www.cradlecoastnrm.com</p> <p>NRM North (approx Devonport to Bicheno) PO Box 1224, Launceston TAS 7250 Phone: 03 6333 7777 www.nrmnorth.org.au</p> <p>NRM South (approx Bicheno to Port Davey) PO Box 425, South Hobart TAS 7004 Phone: 03 6221 6111 www.nrmsouth.org.au</p>
Ocean Planet	<p>Ocean Planet is a branch of Environment Tasmania, a not-for-profit conservation council advocating for protection, conservation and rehabilitation of Tasmania's natural environment. Ocean Planet promotes a sustainable future for Tasmania's marine environment and all that relies on it, our unique wildlife, our idyllic Tasmanian lifestyle and a secure fishing industry for generations to come.</p>	<p>PO Box 1073 Hobart TAS 7001 www.oceanplanet.org.au</p>

Southern Coastcare Association of Tasmania (SCAT)	<p>The Southern Coastcare Association of Tasmania (SCAT) represents approx 40 Coastcare groups in southern Tasmania from Dover to Swansea to Port Arthur. SCAT can put volunteers and coastal stakeholders in touch with member groups.</p> <p>SCAT coordinates training and networking opportunities for Coastcare groups and coastal management stakeholders, and provides small grants for on-ground works.</p>	<p>GPO Box 632, Hobart TAS 7001</p> <p>Phone: 0447 003 540</p> <p>www.scat.org.au</p>
Sustainable Living Tasmania	<p>Sustainable Living Tasmania is a community resource and education centre working to provide a direct, local, realistic and accessible contribution to the protection and restoration of the natural environment, and the development of homes and cities for a sustainable future.</p>	<p>1st floor, 71 Murray St, Hobart TAS 7000</p> <p>Phone: (03) 6234 5566</p> <p>Fax: (03) 6234 5543</p> <p>www.sustainablelivingtasmania.org.au</p>
Tasmanian Conservation Trust	<p>The Tasmanian Conservation Trust (TCT) aims to foster and assist the conservation of flora, fauna and important natural values.</p> <p>The TCT works with other environmental and community groups by providing advice and project coordination where required and representing community and groups on steering committees and submissions for planning and land management decisions.</p>	<p>2nd fl, 191-193 Liverpool St, Hobart TAS 7000</p> <p>Phone: (03) 6234 3552</p> <p>Fax: (03) 6231 2491</p> <p>www.tct.org.au</p>
Tasmanian Landcare Association (TLCA)	<p>The Tasmanian Landcare Association (TLCA) is a statewide umbrella organisation for Landcare, Coastcare, Waterwatch and 'Friends of' groups.</p> <p>The TLCA can provide contact and other information regarding their member groups. The TLCA assists groups with strategic planning and provides funding for administrative costs and on-ground works.</p>	<p>PO Box 21, South Hobart TAS 7004</p> <p>Phone: (03) 6234 7117</p> <p>www.taslandcare.org.au</p>
Tasmanian Parks and Wildlife Service Volunteer Facilitators	<p>The Tasmanian Parks and Wildlife Service (PWS) has a number of staff whose role is to facilitate the effective involvement of volunteers in reserve management activities and to provide support for local environmental groups working on PWS land.</p> <p>PWS Volunteer Facilitators operate out of local PWS field offices around Tasmania.</p>	<p>www.parks.tas.gov.au</p>
Understorey Network	<p>The Understorey Network is a group of individuals from all walks of life around Tasmania, who believe that the understorey is important. They promote the protection of existing native vegetation, and the use of local native understorey in revegetation, are an independent and not-for-profit community organisation.</p>	<p>PO Box 4535, Bathurst Street Hobart TAS 7000</p> <p>Phone: (03) 6234 4286</p> <p>Mobile: 0407 352 479</p> <p>www.understorey-network.org.au</p>



Volunteering Tasmania	Volunteering Tasmania is the state's peak body on volunteering. It provides information and support to volunteers and those who would like to volunteer and also resources, information and advice to organisations that work with volunteers. Volunteering Tasmania forms partnerships with government, business and the community to enhance and develop volunteering in Tasmania.	57D Brisbane Street, Hobart TAS 7000 Phone: 1 800 677 895 www.volunteeringtas.org.au
Wildcare Inc	WILDCARE has around 3,000 individual members undertaking environmental volunteer work on PWS and privately managed land throughout Tasmania. WILDCARE provides \$40,000 each year to support the volunteer activity that their members undertake. WILDCARE provides insurance and other administrative support for individuals wanting to be involved in on-ground works.	GPO Box 1751 Hobart TAS 7001 Phone: (03) 6233 2852 www.wildcaretas.org.au

Funding opportunities

Funding opportunities for volunteer organisations and their project partners change all the time depending on government programs, current priorities and emerging issues. Funds are available to help community volunteers engage with land management organisations in the planning and undertaking of on-ground works.

Sources of funding include the Tasmanian, Australian and local governments, umbrella organisations, private companies, trusts, and Natural Resource Management (NRM) regional bodies. The organisations listed above will be able to provide up to date information on the current opportunities available.

Appendix 5:

Tools and key resources

These resources are websites, tools and kits. All publications referred to in the tools and resources section at the end of each chapter can be found in the references list.

Activity	Resource
Environment	
Acid sulfate soils	<p>Acid sulfate soil information kit</p> <p>Collation of resources from around Australia, includes the National Strategy and a booklet on keys to success. Available from the National Acid Sulfate Soil website http://www.environment.gov.au/archive/coasts/cass/index.html</p> <p>DPIPWE Land Conservation Branch</p> <p>Instructions on how to use the maps on the LIST for ASS.</p> <p>Links to the guidelines, pamphlets, poster and more information on ASS are also available here www.dpipwe.tas.gov.au/acidsulfatesoils</p> <p>The LIST</p> <p>Predictive maps of possible acid sulfate soil occurrence</p> <p>www.thelist.tas.gov.au/</p> <p>Log onto www.dpipwe.tas.gov.au/acidsulfatesoils and follow the instructions on how to use the LIST database to access ASS predictive mapping.</p>
Biodiversity	<p>Environment Australia Biodiversity website</p> <p>A range of information on biodiversity, the EPBC Act and lists of species protected under the Act.</p> <p>http://www.environment.gov.au/biodiversity/index.html</p> <p>REDmap</p> <p>A Tasmanian initiative inviting the community to spot, log and map marine species that are uncommon in Tasmania, or along particular parts of our coast. The information collected is mapped and displayed on the REDmap website, demonstrating how species distributions may be changing over time. Report sightings of unusual marine species on the REDmap website</p> <p>www.redmap.org.au</p>

<p>Coastal values identification</p>	<p>Coastal values data</p> <p>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.</p> <p>www.thelist.tas.gov.au</p> <p>Foreshore Values Mapping</p> <p>Provides baseline information on the condition of foreshores and identifies pressures for measuring impacts on key marine and coastal ecosystems. Available on the LIST or by request from DPIPWE.</p> <p>www.thelist.tas.gov.au</p> <p>coastal.enquiries@environment.tas.gov.au</p> <p>Marine habitat mapping</p> <p>Data collected for south and east coasts of Tasmania depicting a range of marine habitats. From the coastline to the 40m depth contour.</p> <p>Contact NRM South for more information.</p> <p>Natural Values Atlas</p> <p>The Natural Values Atlas is Tasmania's comprehensive database for flora and fauna information including threatened species. Registration is free and is required to use the service.</p> <p>www.naturalvaluesatlas.tas.gov.au</p> <p>Seamap</p> <p>Mapping seabed habitat types across the NRM regions. Series of independently funded projects. Useful for identifying marine and estuarine habitat types.</p> <p>http://www.utas.edu.au/tafi/seamap/</p>
<p>Feral animal control</p>	<p>DPIPWE Fox Eradication Branch</p> <p>www.dpipwe.tas.gov.au/fox</p> <p>Feral animals in Australia</p> <p>Federal Government: Department of Environment, Water, Heritage and the Arts, Biodiversity Section website.</p> <p>www.environment.gov.au/biodiversity/invasive/ferals/index.html</p> <p>Feral card deck</p> <p>Handy laminated deck of cards with photos and descriptions of feral animals to assist identification.</p> <p>Contact the Tasmanian Conservation Trust for more information.</p> <p>DPIPWE: Introduced Animals of Tasmania & Know your ferals information on the website</p> <p>www.dpipwe.tas.gov.au</p>

Fire management	<p>Bureau of Meteorology</p> <p>Up-to-date weather forecasts and some climate change predictions http://www.bom.gov.au/tas/</p> <p>Emergency Services</p> <p>Phone 000</p> <p>Tasmania Fire Service (TFS)</p> <p>Local advice and permits</p> <p>Includes bushfire information and publications about hazard reduction and planned burning.</p> <p>Phone 1800 000 699 www.fire.tas.gov.au</p>
Introduced marine pests	<p>DPIPWE website</p> <p>Information about marine pests specific to Tasmania</p> <p>DPIPWE Sea Fishing & Aquaculture website has guidelines for preventing marine pests, including ballast water management requirements and boat maintenance. www.fishing.tas.gov.au</p> <p>DPIPWE Marine Pest hotline</p> <p>0408 380 377</p> <p>To report new pests, or infestations in new areas.</p> <p>National Introduced Marine Pest Information System</p> <p>Marine pest information sheets available online. Follow links from www.marinepests.gov.au</p> <p>National System for the Prevention and Management of Marine Pest Incursions</p> <p>National best practice guidelines for all pathways at risk of transporting marine pests http://www.marinepests.gov.au/national_system</p>
Landscaping	<p>Urban forest biodiversity program</p> <p>Information on establishing native plants and making gardens wildlife-friendly. www.backyards4wildlife.com.au</p>
Plant and vegetation identification	<p>A key to Tasmanian vascular plants</p> <p>University of Tasmania</p> <p>Based on pictures and perhaps the easiest to use of the keys. http://www.utas.edu.au/dicotkey/dicotkey/key.htm</p> <p>Herbarium: Tasmanian Museum and Art Gallery</p> <p>Advice about identification and natural distribution of species. http://www.tmag.tas.gov.au/Herbarium</p>

Plant Propagation	<p>FloraBank Model</p> <p>Code of practice for community-based collectors and suppliers and other guidelines on the website www.florabank.org.au</p> <p>Royal Tasmanian Botanical Gardens</p> <p>Provides advice on seed propagation http://www.rtbg.tas.gov.au/index.aspx?base=227</p> <p>Information on the germination and dormancy of wild seed can be found at Tasmanian Seed Conservation Centre web pages. http://www.rtbg.tas.gov.au/index.aspx?base=224</p> <p>Understorey Network</p> <p>Plant database provides information on the identification, habitat and propagation of most Tasmanian native species. www.understorey-network.org.au</p>
Shorebirds	<p>Birds Tasmania</p> <p>Advice and input in planning for shorebird protection.</p> <p>Shorebird information kit</p> <p>A box of resources for education and display purposes. Available from the Parks and Wildlife Service, Interpretation Section on request.</p>
Threatened species	<p>Consultant's brief</p> <p>A consultant's guide providing the minimum requirements for information needed to assess the potential impact/s of proposed activities on biodiversity and geodiversity. http://www.dpiw.tas.gov.au/inter:nsf/WebPages/SSKA-7UM4AN?open</p> <p>Environment Australia Biodiversity website</p> <p>A range of information on biodiversity the EPBC Act and lists of species protected under the Act. http://www.environment.gov.au/biodiversity/index.html</p> <p>Threatened Communities listing</p> <p>http://www.dpipwe.tas.gov.au Go to native plants and animals > threatened species > list of threatened species</p> <p>Threatened species listing statements and recovery plans</p> <p>More information on threatened species' needs and survey requirements are available within the specific listing statements and recovery plans on the DPIPWE website. http://www.dpipwe.tas.gov.au/threatenedspecieslists</p>
Vegetation monitoring	<p>Introduction to Enviromark, A system for managing roadside and corridor vegetation</p> <p>www.greeningaustralia.org.au</p> <p>TASVEG metadata notes and on-line maps available through the LIST website, under Vegetation</p> <p>http://www.thelist.tas.gov.au/</p>

Weed and disease management	<p>Alert List for Environmental Weeds http://www.weeds.gov.au/publications/guidelines/alert/index.html</p> <p>DPIPWE Codes of practice and guidelines Information for using herbicides on the website. www.dpipwe.tas.gov.au Go to Biosecurity > Agricultural & veterinary chemicals > Codes of practice and Guidelines</p> <ul style="list-style-type: none"> • Code of practice for ground spraying • Code of practice for spraying in public spaces • Guidelines for disposing of washings and rinsates • Rivercare guideline for the use of herbicides near waterways and wetlands • Guidelines for interpreting labels <p>DPIPWE weed control guides Control guides for specific weeds replace the former weed service sheets and are available online. www.dpipwe.tas.gov.au Go to > Weeds, Pests & Diseases > Weeds > Weeds Index</p> <p>Management areas <i>P. cinnamomi</i> and maps of infected areas www.dpipwe.tas.gov.au Go to Weeds, Pests and Diseases > Plant Diseases > Phytophthora > Distribution of <i>P. cinnamomi</i></p> <p>Tasmanian Institute of Agricultural Research (TIAR) Biological Control Program A joint venture between the University of Tasmania and DPIPWE. http://www.tiartas.edu.au/extensive/biological-control-of-weeds</p> <p>Tasmanian Skills Institute. Chemical Handling Training Contact Loretta Satterly on (03) 6434 5846.</p> <p>WeedDeck Handy pocket sized ID cards of the major weeds of Australia. http://www.sainty.com.au/</p>
Wildlife	<p>Local Parks and Wildlife Service Field Centre 1300 368 550</p> <p>RSPCA 6244 3033 or 1300 139 947 (animal cruelty enquiries)</p> <p>Whale Hotline 0427 WHALES or 0427 942 537 A 24-hour monitored telephone service to receive reports of all cetacean sightings and strandings.</p> <p>Wildlife Management Branch of DPIPWE 6233 6556 (24 hour) – for urgent wildlife problems (other than whales)</p>

Climate change and hazards	
Climate change and sea level rise	<p>Antarctic Climate Ecosystems Cooperative Research Centre (ACE CRC) web tool</p> <p>This web based tool is based on the history of sea levels mapped at 29 ports around Australia provided by the Australian National Tidal Centre.</p> <p>www.sealevelrise.info</p> <p>Climate change and coastal risk assessment project.</p> <p>A suite of tools and documents including:</p> <ul style="list-style-type: none"> • Coastal risk management plan: Template and guidelines (DPIW 2009) • Coastal hazards in Tasmania: General information paper (DPIW 2008c) • Climate change and coastal asset vulnerability: An audit of Tasmania's coastal assets potentially vulnerable to flooding and sea-level rise (DPIW 2008b) • Sea-level extremes in Tasmania: Summary and practical guide for planners and managers (DPIW 2008e) • Historical and projected sea-level extremes for Hobart and Burnie, Tasmania (Hunter 2008) • Background report: Coastal flooding - Review of the use of exceedence statistics in Tasmania (DPIW 2008a) <p>www.dpiw.tas.gov.au/climatechange</p> <p>CSIRO GIS layer: Wave height direction and period in the Australian region.</p> <p>A compilation of essential wave statistics. Although the map appears very coarse each pixel is attributed with locally relevant data obtained from satellite instruments.</p> <p>http://www.marine.csiro.au/marq/edd_search.Browse_Citation?txtSession=8083</p> <p>LiDAR</p> <p>Laser light instrument flown in aircraft to provide detailed height data to generate topographic maps of Tasmania's coastline with 25cm contours up to 10 m above sea level. Useful for identifying coastal areas vulnerable to sea level rise.</p> <p>www.thelist.tas.gov.au</p> <p>Smartline or coastal vulnerability maps</p> <p>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.</p> <p>www.thelist.tas.gov.au</p> <p>www.ozcoasts.org.au</p> <p>Tasmarc project: monitoring shoreline erosion in Tasmania</p> <p>TASMARC relies on volunteers to survey beach profiles. The network of coastal locations being monitored with TASMARC is growing, and volunteers wanting to monitor new sites are welcomed. For more information contact:</p> <p>nicholas.boden@acecrc.org.au</p>

Hazard management	<p>Australian Standard AS/NZS ISO 31000:2009 Risk management</p> <p>Bureau of Meteorology Current Tasmanian weather warnings www.bom.gov.au/weather/tas/</p> <p>Emergency Management Australia (EMA) Australian Emergency Manual Series www.ema.gov.au</p> <p>Floodplain mapping, flood data and flood timelines in Tasmania www.dpiw.tas.gov.au/ Go to water > Tasmania's water resources > Floods</p> <p>Geodata Services Aerial photographs and mapping products. geodata.clientservices@dpiw.tas.gov.au</p> <p>Melbourne Water Flood management information. http://www.melbournewater.com.au/content/drainage_and_stormwater/flood_management</p> <p>Mineral Resources Tasmania Landslide susceptibility maps http://www.mrt.tas.gov.au</p> <p>Tasmanian Fire Service 6230 8600 or 1 800 000 699 www.fire.tas.gov.au</p> <p>Tasmanian Flood Warning Centre, Bureau of Meteorology Issues flood warnings www.bom.gov.au/hydro/flood/tas/</p> <p>Tasmania Police, Department of Police and Public Safety www.police.tas.gov.au</p>
Works	
Dredging and reclamation	<p>Australian Standards</p> <ul style="list-style-type: none"> • 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

Excavation and soil management	<p>Mineral Resources Tasmania</p> <p>Exploration Licence Application Form, Environmental Impact Information—Mining Form</p> <p>www.mrt.tas.gov.au</p> <p>Transport Tasmania</p> <p>Roadwork specification R92 – Underground Service Facilities.</p> <p>www.transport.tas.gov.au</p> <p>Workplace Standards Tasmania</p> <p>For OH&S procedures</p> <p>www.wst.tas.gov.au</p>
Shoreline modification	<p>Information on Seabees construction in NSW:Wamberal environmental impact statement</p> <p>www.gosford.nsw.gov.au/Information/Documents/postings/eis_wamberal.htm</p>
Stormwater	<p>Model for urban stormwater improvement conceptualisation (MUSIC)</p> <p>A proprietary software product. MUSIC is a user-friendly tool designed to meet the needs of urban stormwater engineers, planners, policy staff and managers in consultancies and state, regional and local government agencies.</p> <p>Transport Tasmania</p> <p>Roadwork specification R92 – Underground service facilities</p> <p>Roadworks specification R 32 Drainage: Culverts, pipelines and structures</p> <p>Roadworks specification R34 – Drainage maintenance</p> <p>www.transport.tas.gov.au</p> <p>Bridgeworks specifications (whole series)</p> <p>http://www.transport.tas.gov.au/road/specifications/bridgeworks_specifications</p>
Heritage	
Aboriginal places	<p>A list of Aboriginal Heritage Officers</p> <p>Available from the Tasmanian Aboriginal Land and Sea Council (TALSC).</p> <p>http://www.talsc.net.au/</p> <p>Aboriginal Heritage Tasmania</p> <p>Desktop searches for Aboriginal heritage sites</p> <p>Information about the importance of protecting Aboriginal heritage.</p> <p>http://www.aboriginalheritage.tas.gov.au</p>
Geoheritage sites	<p>Tasmanian Geoconservation Database</p> <p>Accessed via the LIST or the Natural Values Atlas.</p>
Historic sites	<p>Australian national shipwreck database</p> <p>http://www.environment.gov.au/heritage/shipwrecks/database.html</p> <p>Heritage Conservation Funding Program</p> <p>Aims to assist heritage property owners by providing funding. The Heritage Council operates the program on behalf of the Tasmanian Government. Places permanently entered in the Tasmanian Heritage Register are eligible.</p> <p>Heritage Register</p> <p>www.heritage.tas.gov.au</p>

Access and facilities	
Mooring	<p>Seagrass Friendly Mooring System</p> <p>Marine & Safety Tasmania: Mooring guidelines</p> <p>www.mast.tas.gov.au</p>
Road and bridge construction	<p>Austroad publications</p> <p>Available for download from the Austroads website. Registration is required to download these products. Registration and products are free.</p> <p>http://www.onlinepublications.austroads.com.au</p> <ul style="list-style-type: none"> • <i>Austroads 1997, AP-127/97: Concrete structures durability, inspection and maintenance procedures – Position paper</i> • <i>Austroads 2003, AP-G1/03: Rural road design—A guide to the geometric design of rural roads (8th edn).</i> • <i>Austroads 2003, AP-R217/03: Environmental considerations for planning and design of roads + reference CD ROM.</i> • <i>Austroads 2003, AP-R180/00: Road runoff & drainage: Environmental impacts and management</i> • <i>Austroads 2003, AP-R185/01: Environmental risk management guidelines and tools for road projects</i> • <i>Austroads 2003, AP-R232/03: Guidelines for treatment of stormwater runoff from the road infrastructure</i> <p>Transport Tasmania</p> <p>Roadworks specifications, Road hazard management guide, and Technical advice sheets</p> <ul style="list-style-type: none"> • Roadworks specification R75 – Environmental protection • Roadworks specification R76 – Roadside maintenance • Roadworks specification R34 – Drainage maintenance <p>www.transport.tas.gov.au</p>
Signs	<p>Australian Standards</p> <ul style="list-style-type: none"> • <i>AS 2156 Part 1 Walking tracks. Classification and signage</i> • <i>AS 2899.1-1986 Public information symbol signs – General information signs</i>
Slips, marinas, launching ramps	<p>Australian Standards</p> <p>Available from ASI Global phone 1300 654 646</p> <p>www.standards.com.au</p> <ul style="list-style-type: none"> • <i>AS3962-2001 Guidelines for design of marinas</i> • <i>AS4997-2005 Guidelines for design of maritime structure</i> <p>MAST Mooring Factsheet</p> <p>http://www.mast.tas.gov.au</p> <p>Seagrass friendly Mooring System</p> <p>http://www.seagrassmooring.com.au/</p>

Tracks and trails	<p>Australian Standards</p> <ul style="list-style-type: none"> • AS 2156 Part 1 Walking tracks. Classification and signage • AS 2156 Part 2 Walking tracks. Infrastructure design • AS 1428.1 – 1428.2 Design for access and mobility • AS/NZS ISO 31000:2009, Risk management - Principles and guidelines <p>Replaces AS 4360-2004 Risk management as the leading resource for risk management.</p> <p>Austroroads</p> <p>AGRD06A/09 Guide to traffic engineering practice Part 6A - Pedestrian and cyclist paths</p> <p>Available for download from the Austroroads website. Registration is required to download these products. Registration and products are free.</p> <p>http://www.onlinepublications.austroroads.com.au</p> <p>International Mountain Bicycling Association trail difficulty rating system</p> <p>http://www.imba.com/resources/freeriding/trail-difficulty-rating-system</p>
Recreation	
Fishing and boating	<p>Fishwatch: Report suspected illegal fishing and fishing offences.</p> <p>0427 655 557</p> <p>Recreational Sea Fishing Guide</p> <p>Produced annually by DPIPWE and available on the DPIPWE website</p> <p>Leave no wake: Minimal impact sea kayaking</p> <p>Brochure available from Parks and Wildlife Service and information on the website</p> <p>www.parks.tas.gov.au</p> <p>Stow it don't throw it</p> <p>Guidelines for minimising risk of rubbish and pollutants for boating activities</p> <p>Australian Maritime Safety Authority (AMSA)</p> <p>http://www.amsa.gov.au/publications/Marine_Environment_Protection/Stow%20it.pdf</p>
Horse riding and dog walking	Local Council

Glossary

Note: The definitions of terms apply specifically to this document.

Aboriginal heritage sites/values	There are numerous places on the coast where there is evidence of Aboriginal life before white settlement. The Aboriginal Relics Act 1975 protects Aboriginal Relics, sites and objects. For example shell middens, rock markings, stone quarries, stone arrangements, rock shelters and fish traps.
Accretion	Sand build up
Acid sulphate soils	Soils containing iron sulfides, found in low-lying waterlogged areas, generally less than 5 metres above sea level. When exposed to air (e.g. when drained), the sulfides oxidise to produce sulfuric acid which corrodes infrastructure and pollutes waterways.
Aesthetic values	For example (and these are entirely subjective) a beautiful sea and landscape view from a hillside viewing area with medium to long range views (eg D'Entrecasteaux Channel from Woodbridge Hill); a place where the vegetation has been protected and meets the high-water mark (e.g. Mt William National Park); and scenic drives such as the east coast highway to Swansea.
Amenity	The natural or physical characteristics of an area that contribute to people's appreciation of its pleasantness, aesthetic values and cultural and recreational attributes.
Annual Exceedance Probability	The probability of at least one exceedance event happening during a period of time. See exceedance event.
Armour	A protective layer of rock or concrete units.
Australian Height Datum (AHD)	Mean sea level reference point. A level reference point, uniform throughout Australia, based on observations of mean sea level at over 30 tide gauge stations along the coastline. Note that the AHD for Tasmania was established at the mean sea level measured in 1972 at Burnie and Hobart. The subsequent sea level rise means that the AHD at Hobart now lies 38mm below mean sea level (assuming an average linear rate of sea level rise relative to the land of 1.2 mm/year for south-east Tasmania since the late 1800s).
Average Recurrence Interval (ARI)	The long-term average number of years between the occurrence of a flood as big as (or larger than) the selected event. For example, floods with a discharge at least as great as the 5-year ARI design flood will occur on average once every 5 years. The ARI expresses the average period between extreme events.

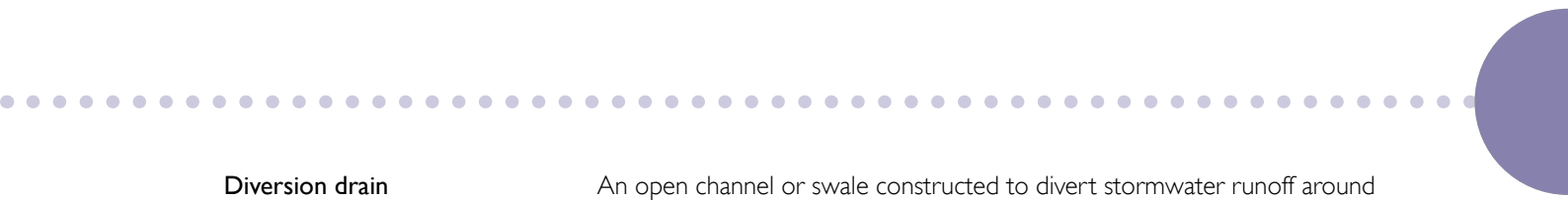


Batter	An earth slope formed from placed fill material or cut into the natural hillside (e.g. during road construction). A cut batter is an exposed sloping surface cut by excavation during earthmoving operations. A fill batter is an exposed sloping surface created by deposition of fill.
Batter drain	A reinforced drain that carries water down a batter without causing erosion.
Batter toe drain	A drain constructed at the base of a slope to direct runoff away from exposed areas.
Beach nourishment	The process of replenishing sand on a beach artificially by delivery of sediment dredged or excavated elsewhere.
Beach replenishment	The process of replenishing sand on a beach either naturally by longshore transport or artificially. See beach nourishment.
Beach Ridge	Beach ridges are linear, symmetric or asymmetric convex ridges formed of sand, gravel or shell debris. There are 2 types of beach ridges, storm built or wind built.
Berm	The nearly horizontal part of the beach, formed by wave action dumping material, finishing at the high tide mark.
Biodiversity	The variety of life forms: different species of plants, animals and micro-organisms, the genes they contain and the ecosystems they form.
Black water	Wastewater containing faecal matter and urine.
Blowout	Bare sand on a sand dune subject to wind erosion and prone to movement. Results when vegetation has been disturbed on a sand dune and sand becomes mobile.
Boat launching ramp	(Boat ramp) A structure designed for launching trailer-borne recreational vessels.
Box culvert	A culvert of rectangular cross-section.
Breakwater	A structure aligned parallel to shore, sometimes connected to the shore, to provide protection from waves.
Bund	A low barrier to divert water off a slipway or similar structure.
Burra Charter	Defines the basic principles and procedures to be followed in the conservation of Australian Heritage Places. It was adopted at a meeting in the town of Burra, South Australia in 1979.

Caisson	A concrete box-type structure used for structural purposes such as retaining walls.
Catch drain	A diversion channel constructed above a road or batter to intercept runoff water and divert it to a stable water disposal area or channel before it reaches the road or batter.
Catchment	The area of land from which water drains to form creeks, rivers, lakes, wetlands and aquifers.
Causeway	A natural or constructed crossing that enables vehicles to ford a drainage feature. The pavement may be of concrete, gravel, bitumen, rock, logs or the natural surface.
Climate Change	An increase in the average temperature of the air and oceans due to burning of fossil fuels and deforestation. Also known as global warming. Greenhouse gases such as carbon dioxide trap solar radiation causing an increase in temperature.
Coast	<p>As defined in the <i>State Coastal Policy 1996</i> 'coastal area' means:</p> <ul style="list-style-type: none"> a) the area of land and state waters identified in a planning scheme or any other instrument required to manage or control use or development, which encompasses the coastal assets, values and processes which are to be conserved, used or developed; or, in the absence of an area so identified; b) all land to a distance of one kilometre inland from high water mark and State waters.
Coastal landforms	In earth science or geology fields, a landform is a distinct physical feature. They are defined by their location in the landscape and their terrain. For example a beach, cliff, estuary, lagoon, sand spit, dune, tombolo, barrier island, bay, cove, gulf, wave cut platform, headland, peninsula etc.
Coastal processes	The action of natural forces (wind, waves, tides, currents) on the shoreline and near-shore seabed. These include the effects of storms, erosion and deposition, movement of dunes, longshore drift and inundation.
Coastal reserve	An outdated but commonly used term for reserved land under the <i>National Parks and Reserves Management Act 2002</i> between the low water mark and approximately 30 metres inland. Now coastal reserves are reclassified into the new terms: State Reserve, Nature Reserve, Conservation Area or Nature Recreation Area depending on the values and objectives for the area.




Coastal values	A component of the coastal environment for example vegetation communities (mud flats, heath, sandy beaches), wildlife habitat (eg the endangered swift parrot prefers grassy forest dominated by <i>Eucalyptus globulus</i>), and coastal landform types (eg hard rock shorelines, cobble beaches).
Community engagement	The process by which community organisations and individuals build ongoing permanent relationships for the purpose of applying a collective vision for the benefit of the community.
Consolidation	The process by which sand or soil reduces in volume under load over a period of time (due to drainage of water from the pores between the grains).
Consult	A common mistake is to inform a group of people of what you are doing. Consulting means to ask advice from or refer a project idea for information and input. It means being open to changing your project to suit the needs and interests of others.
Corridor	The land area to accommodate road, rail, pipelines, services and utility infrastructure.
Critical habitat	Under the <i>Threatened Species Act 1995</i> , management options to protect listed species include declaring areas of land as critical to listed flora or fauna.
Cross-drain	A culvert, pipe or shallow channel laid diagonally across the surface of a road or track to divert water from the surface or from the roadside ditch.
Culvert	One or more adjacent pipes or enclosed channels for conveying a stream underneath a roadway or other structure.
Cultural heritage	The value that a place has in terms of its aesthetic, historic, scientific or social significance for the present community and for future generations.
Cultural heritage value	Aboriginal relics, artefacts, paintings, middens, lighthouses, buildings, ship wrecks, are examples of cultural heritage values in both Aboriginal and European cultures.
Cut or cutting	A construction produced by the removal of the natural formation of earth or rock, whether sloped or level.
Deposition	Sand build up through the action of wind and waves.
Design wave height	The wave height adopted for the purposes of designing coastal structures such as breakwaters and seawalls. It is chosen to ensure that the structures are not at undue risk of wave damage.



Diversion drain	An open channel or swale constructed to divert stormwater runoff around exposed areas.
Drainage line	A channel down which surface water naturally concentrates and flows, conveying water only during or immediately after periods of heavy rainfall.
Drainage pit	An in-ground structure, usually with a covered inspection opening, used for collection and transfer or redirection of drainage water into an underground pipe drain.
Downdrift	Direction of alongshore movement of sediments.
Dune	Hill, bank, ridge, or mound of loose, wind-blown sand. Often stabilised by vegetation.
Ecosystem	All the biological, chemical and physical entities and the inter-relationships and dependencies that occur between these entities in a specific environment, e.g. an estuary.
Ecotourism	(Ecological Tourism) responsible travel to fragile, pristine and usually protected areas that strives to be low impact and small scale. It purports to educate the traveller, provide funds for ecological conservation, and directly benefit the economic development and political empowerment of small communities and foster respect for different cultures and human rights.
Embankment	Fill material, usually earth or rock, placed with sloping sides and usually longer than it is high.
Endemic/Endemism	Not found anywhere else in the world.
Energy dissipater	A structure that slows fast-moving flows to prevent erosion of a channel.
Environmental harm	An adverse effect on the environment where the effect on the environment and humans is wide scale or high impact.
Environmental hazard	A potential source of harm, injury or difficulty.
Environmental risk	The level of risk to causing harm to the environment.
Erosion	Removal of soil particles by wind and water.
Established foredunes	A single dune or series of dunes behind the swash zone and incipient dune(s) at the back of a beach. They may be vegetated to some extent but are active landforms, i.e. not stable within a 50 year timeframe.
Estuary	The semi-enclosed tidal part of a river where salt water meets fresh water.




Exceedence event	A climatic event that exceeds a given threshold, such as a storm wave height that exceeds existing levels. Such events have the potential to be extreme weather or storm events.
Exit pad	An elevated pad of coarse gravel overlaying a geotextile fabric. A timber or metal shaker ramp is often located on top of the gravel pad. Used at road exits to reduce sediments leaving a construction site.
Filter strip	A band of closely-growing vegetation, usually grass, planted between a pollution source and a receiving waterbody.
Flood	Temporary covering of land by water in an area not normally covered by water.
Foredunes	The dunes nearest the sea in a dune system. Foredunes run parallel to the beach, they can be symmetric or asymmetric dune ridges (located at the landward edge of the beach). They are formed by windblown sand deposited within vegetation. Generally, they occur as two main types, incipient and established foredune(s).
Foredune complex	The active part of the shore-parallel coastal dune system that has a natural tendency to significant physical change within periods of less than 50 years (i.e. is unstable within planning timeframes) given the existing and predictable geomorphic context (landform processes). The foredune complex includes the incipient dune (where it exists) and one or more established foredunes (depending on the area's geomorphic context). Established foredunes are not stable within the 50 year timeframe, but may be vegetated to some extent.
Foreshore	The area of land adjacent to a waterbody; a shoreline.
Footing	The widening at the base of a structure to spread the load to the foundation material.
Frontal dune	The most seaward ridge of sand in the dune system. The frontal dune may or may not be naturally vegetated with plants. In areas where smaller ridges of sand are forming in front of an established dune ridge, the frontal dune may include more than one ridge. It may be an incipient or established foredune. However, there can be broad morphological and ecological variations within these two types, dependant on the amount of sediment available, wind and wave conditions, bay plan form and plant species. The term should never be used to indicate stability or otherwise of a dune complex, and should not be confused with foredunes, as defined above.




Funnel fencing	Fencing designed to direct animals into a road underpass or culvert. The fences are set at a 45 degrees angle in both directions from the road (rather than parallel to it) to guide animals into the underpass. The fences stretch out to the roadside vegetation.
Gabion	A wire basket(s) usually filled with stone used for structural purposes such as retaining walls.
Gabion mattress	Gabions comprising larger baskets, much longer than they are deep, divided into compartments.
Geoconservation/geoheritage value	Some coastal dunes and other sandy landforms are protected for their values for example fossil dune forms, fossil shorelines provide evidence of old coastlines circa 125,000 years ago.
Geomorphic	Of or relating to geomorphology.
Geomorphology	The study of landforms, their forms, origins, development and processes. The shape of land surface forms and the processes producing them.
Geotextile	A thin, flexible permeable sheet of synthetic material used to allow the movement of water through the pores of the material while holding soil particles in place.
Gross Pollutant Trap	A traditional structure that intercepts and retains coarse sediment, rubbish and debris from runoff water.
Groundwater	Water stored underground in the pore spaces between soil particles or rock fractures. The water below the water table.
Groyne	Barriers that are 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.
Habitat	The place or type of site where an organism or population naturally occurs.
Hard engineering techniques	Structural techniques that use permanent concrete and rock constructions to stabilise the coastline and protect assets located behind. For example sea walls, groynes, breakwaters and revetments.
Hazard	A potential source of harm, injury or difficulty.




High conservation value	Specialist input is required to determine if land has a high conservation value for example an Aboriginal Heritage survey may provide evidence of Aboriginal artefacts. A coastal geomorphologist will survey a site for aspects of geoheritage. A vegetation specialist can identify plants and habitats where threatened, vulnerable or rare species may be present. These are all examples of high conservation values.
Hind-dune complex	Dunes lying behind the foredune complex, which have a natural tendency to stability in planning time-scales.
Hydraulic regime	Water level fluctuations in a waterbody (e.g. changes in river flows).
Hydrology	The study of the distribution and movement of water.
Hydrostatic pressure	The pressure exerted by a fluid at rest due to gravity.
Impervious	A solid surface that does not allow water to penetrate.
Incipient dune	Small ephemeral dune(s) located in front of established foredunes at the upper margin of the beach. Their duration can be seasonal, annual, or they may remain intact for long periods (e.g. more than 10 years). The durability of incipient dunes depends on a number of factors, including whether they form around seasonal, annual or perennial pioneering plant species, seaweed or flotsam.
Integrated management	A shortened version of the term Integrated Coastal Zone Management (ICZM) which means a holistic approach to looking at issues in the coastal zone. For example being inclusive of all the relevant legislation, integrating decisions across all relevant sectors to the issue and developing consistency and cooperation across government levels to achieve better outcomes for the environment.
Intertidal foreshore	Also known as the intertidal zone or foreshore, is the area exposed to the air at low tide and underwater at high tide.
Jetty	A horizontal decked walkway built on piers or piles, which provides access from the shore to a waterway.
Kelp forest	Underwater areas of high density kelp, smaller areas are called kelp beds.
King tide	On Australia's east coast the highest tides occur in summer and winter months due to the gravitational pull of the sun and moon combined. The highest of these is the king tide.



Landslip	The group of slope movements wherein shear failure occurs along a specific surface or combination of surfaces (eg rock falls, failure of slopes). Can occur in offshore, coastal and onshore environments.
Level spreader	A bank or mound constructed sideways across a slope to convert a concentrated runoff flow into a slower-moving, shallow, widespread flow (to reduce erosion).
LiDAR	Light Detection and Ranging, a remote sensing technology that uses light from a laser and measures properties of scattered light from vegetation communities, land surfaces, buildings etc. This method has also been used to accurately map the contours of land along the coastline accurate to within 25cm.
LIST	Land Information System Tasmania. Central Tasmanian Government land information (e.g. topographic mapping) data system, operated by DPIPWVE.
Litter trap	A stormwater gross pollutant trap. A form of barrier such as a net or filter is placed under a street gutter or at the end of a pipe to reduce leaf litter, cigarette butts and general street litter from entering a waterway or bay.
Littoral drift	See longshore drift.
Local provenance (of plants)	Native plants that grow locally from local genetic stock.
Longshore	Parallel to and near the shoreline: the same as alongshore.
Longshore current	The movement of waves coming in to shore at a slight angle, returning down the beach and then repeating the process with the general progression of sand in one direction called longshore drift.
Longshore drift	Movement of sand along the shore, in the near-shore zone, usually resulting from alongshore currents generated by wave action. Also called littoral drift or longshore transport.
Mean High Water Mark	The mean of high water (high tide level) over a long period of time.
Meiofauna	Tiny animals living within the sand.
Migratory birds	Include shorebirds and waders migrate 26,000 km each year between their breeding grounds in the northern hemisphere (Arctic Circle) and the non-breeding areas in the southern hemisphere (Australia and New Zealand). They travel along the East-Asian - Australasian Flyway one of 8 flyways in the world. There are internationally recognised agreements to protect them such as JAMBA (Japan Australia Migratory Bird Agreement), CAMBA (China Australia Migratory Bird Agreement) and ROKAMBA (Republic of Korea Australia Migratory Bird Agreement).




Mooring	A wire, chain, or other structure placed in or on the shoreline or seabed for securing a vessel, excluding an anchor.
National environmental significance	Under the Environment Protection Biodiversity Conservation Act 1999, actions that are likely to have a significant impact on matters of national environmental significance require approval from the Australian Government Minister for the Environment. The Minister will decide whether approval is required under the Act. The 8 matters of national environmental significance protected under the Act are: world heritage properties, national heritage places, wetlands of international importance, listed threatened species and ecological communities, migratory species, Commonwealth marine areas, the Great Barrier Reef Marine Park, nuclear actions.
Natural values	The variety of different plant communities, animal habitats and coastal landforms, land and seascapes, water quality and quantity. Also called natural resources.
Nearshore currents	Currents created by winds, waves, tides and river flows.
Natural Resource Management (NRM)	The management of natural resources such as land, water, soil, plants and animals.
NRM regions	Natural resource management regions are based on catchments or bioregions. The Australian Government, in association with state and territory governments, has identified 56 regions covering all of Australia. Tasmania has 3 NRM regions: NRM North, NRM South and Cradle Coast NRM.
Parabolic dune	U-shaped dunes with elongated arms pointing downwind because they have been fixed by vegetation and their crests point upwind.
Parallel ridge/Parallel dunes	Also known as longitudinal dunes. Some dunes elongate parallel to the prevailing wind, possibly caused by a larger dune having its sides blown away.
Pavement	The portion of the road, excluding shoulders, placed above the design sub-grade level for the support of, and to form a running surface for, vehicular traffic.
Perched culvert	A culvert where the inlet or outlet is above the waterway. This can obstruct fish passage because it requires a fish migrating upstream to leap into the culvert.
Permeable	Porous material that allows the passage of water.
Permian	A geological period of time from 299 to 251 million years before present. The time when all land masses formed a single continent - Pangea.




Photopoints	An established (defined) point from which a series of photos can be taken over time to illustrate change.
Physical processes	On the coast, these are the wind, waves, currents and tides that all influence the shape of the coast.
Pier	(1) An intermediate support in a bridge or jetty. (2) A structure to which a vessel is secured for loading and unloading cargo.
Pile	A long, heavy section of timber, concrete or metal driven into the earth or seabed as a support or protection.
Pontoon	A floating structure used for access to the water or a vessel.
Progradation	The process of sand accumulation on a beach and shoreline build up or growth seawards.
Protected object	The specific relic to which a Ministerial order declaring a protected site relates.
Protected site	Land where a relic is situated which the Minister has declared ought to be protected and preserved.
Provenance	Source (e.g. of plant seeds or cuttings).
Quay	A docking area built for loading/unloading of vessels. Docks are parallel allowing loading/unloading from one side of the ship.
Ramsar site	The Ramsar list of wetlands of international importance now includes 1,888 sites. The Ramsar Convention is an international treaty for the conservation and sustainable use of wetlands. The first meeting of nations involved was at Ramsar, a town in Iran in 1971 and came into force in 1975.
Recession	Ongoing erosion with no sediment replenishing the shoreline resulting in the landward retreat of the shoreline.
Refraction (of waves)	(1) Process by which the direction of a wave moving in shallow water at an angle to the seabed contours is changed. Part of the wave advancing in shallower water moves more slowly than the part still advancing in deeper water, causing the wave crest to bend toward alignment with the underwater contours. (2) Bending of wave crests by currents.



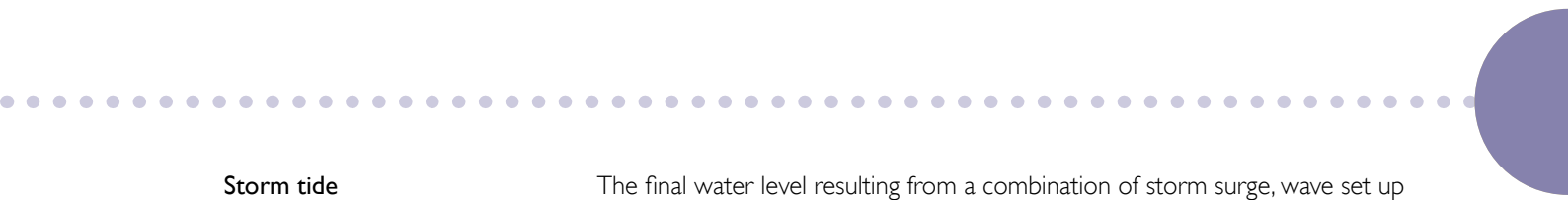
Relic	The <i>Aboriginal Relics Act 1975</i> protects Aboriginal relics, protected sites and protected objects in Tasmania. Relic is defined to mean any artefact, painting, carving, engraving, arrangement of stones, midden or other object made or created by any of the original inhabitants of Australia or their descendants before 1876; any object site or place that bears signs of the activities of the original inhabitants; or the remains of the body of an original inhabitant or of a descendant who died before the year 1876 that are not buried in a marked grave or cemetery.
Resident shorebird	Year round resident birds who breed and feed in one area for example pied oyster catchers, terns and gulls.
Reserve Activity Assessment	An assessment undertaken by PWS for reserves managed under the <i>Tasmanian National Parks and Reserves Management Act 2002</i> .
Revetment	A facing of stone, concrete, etc., built to protect an embankment or shore structure against erosion by waves or currents.
Retaining wall	A wall constructed to maintain in position a mass of earth or to resist sideways pressure from the adjoining ground.
Riparian vegetation	Riverside vegetation.
Rip current	Also known as riptide, a strong channel of water flowing seaward from near the shore through the surf line. Typical flow is 0.5 metres per second up to 2.5 metres per second.
Rip rap	A layer, facing, or protective mound of stones, randomly placed to prevent erosion or scour at a structure or embankment; also the stone so used.
Riser	The vertical portion of a step, between two steps.
Risk assessment	Understanding the hazard or threat, the likelihood of occurrence, vulnerability to that hazard and the likely consequence or impact.
Rock armour	A protective layer of rock.
Rookery	A penguin or shearwater rookery is a colony of breeding birds where there are nests, burrows, chicks etc.
Rubble	Rough, irregular fragments of broken rock or concrete.
Rubble-mound structure	A mound of stones (randomly placed) protected with a cover layer of selected stones or specially shaped concrete armour units (e.g. a breakwater).




Rumble strip	A series of small ridges placed across the lane of a road to warn the driver to slow down (e.g. if a stop sign is ahead).
Runoff	Water from rain or other water that flows over the land surface. See stormwater.
Sand blow	Or blowouts are caused when protective dune vegetation is damaged (by vehicles, livestock and pedestrian traffic, burning and grazing) and sand becomes mobile.
Saltmarsh	An intertidal vegetation community where the waves are subdued and sediments accumulate in estuaries and inlets. Where the water is highly saline at the mouth of a river the saltmarsh is dominated by succulent herbs and shrubs such as glasswort. Where inflowing rivers and streams make the water less saline, tussock rushes, tussock sedges, tussock grasses and non-succulent herbs are more prominent.
Scour	Removal of material under water (e.g. by waves or currents at the base or toe of a shore structure).
Sea Level Rise	<p>Current sea level rise is due significantly to global warming and in Tasmania recent analysis from CSIRO and the Antarctic Climate and Ecosystems Cooperative Research Centre shows current observed sea level rise of around 3mm per year (this is consistent with the upper level of projected sea level rise. As temperatures increase from global warming, there will be further sea level rise from thermal expansion of the oceans, melting of ice caps, glaciers and ice sheets. The Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (2007) projections for sea level rise for the twenty first century is 18-59cm with a potential addition of 10-20cm depending on the ice melt from Greenland and Antarctica.</p> <p>Ordinarily, average local sea level (where tide and wave influence is smoothed out) is influenced by atmospheric pressure, ocean currents and local ocean temperature. Short term changes to sea level include astronomical tides, storm surges and atmospheric pressure, El Nino/Southern Oscillation, seasonal variations such as salinity and flooding, and earthquakes and tsunamis.</p>
Seawall	A structure separating land and water areas, mainly to prevent erosion and other damage by wave action.
Sediment budget	The amount of sediment available in both onshore and offshore landforms for movement onshore and offshore by coastal processes.




Sediment trap	A structure (or vegetative barrier) designed to intercept contaminated run-off from disturbed areas and retain the sediment so it does not enter stormwater pipes or waterways.
Sedimentation	Deposition of eroded sediments, usually by wind or water.
Sedimentation basin	An area where run-off water is detained to allow the settling of sediment particles.
Sediments	Particles (mineral and organic) of varying size that are being moved (or have been moved) by the action of wind, water or gravity, which come to rest on the Earth's surface (either on land or in water).
Shorebird	Also referred to as migrant shorebirds, nesting shorebirds and breeding shorebirds. Includes species such as plovers, sandpipers, snipe and curlews. They often nest just above high water and are vulnerable to human use of the beach.
Shoreline	The area of land adjacent to a waterbody; foreshore.
Slipway	A structure with parallel rails for drawing a vessel out of the water for maintenance and repair.
Skid	A small inclined ramp used for the launching of boats, which does not include a slipway.
Soft engineering techniques	Building with natural processes and relying on natural elements such as sand, dunes and vegetation or brush to prevent erosive forces from reaching the backshore. These techniques include beach nourishment and sand dune stabilisation.
Sponge garden	A group of marine animals occurring in large, complex plant-like colonies (phylum <i>Porifera</i>) and have a porous structure and a silica or calcium based skeleton.
Spring tide	The highest tide occurring approximately every 14 days when the gravitational pull of the sun and moon are combined at the new and full moon
Stakeholder	Someone from community, business, industry or government who has an interest or an investment in a project
Storm surge	An area of elevated sea level at the coast caused by a low pressure system and intense winds from offshore storms. There is a temporary rise in sea level of about 10mm per hectopascal due to a fall in atmospheric pressure.



Storm tide	The final water level resulting from a combination of storm surge, wave set up and wave run up.
Stormwater	Water that runs off land, frequently carrying various forms of pollution, such as rubbish, animal droppings and dissolved chemicals. It is carried in stormwater channels and discharged directly into creeks, rivers, the harbour and the ocean.
Stormwater detention	Temporary storage of stormwater, with controlled release into the drainage system.
Straddle carrier	A vehicle specially constructed to lift and move a boat in a dock area.
Sub-grade	The trimmed or prepared portion of the formation on which a road pavement is constructed.
Sustainable development	A pattern or resource use that aims to meet human needs for generations to come while preserving the environment. Coined by the Brundtland Commission as meeting the needs of the present without compromising the ability of future generations to meet their own needs.
Sustainable management	The application of sustainable practices in the areas of business/industry, society/community and the environment by managing activities in each area so that they will benefit current and future generations.
Swale	(1) A grassed open drainage channel designed to intercept and convey surface runoff to a drainage network inlet and to promote infiltration of water and interception of sediment by the vegetation. (2) A depression between two coastal dunes.
Swell	Wind-generated waves travelling out of their generating area.
Table drain	The drain beside and parallel to a road, with its lowest portion below the pavement base. It is part of the road formation.
Threatened species	A plant or animal listed as endangered (Schedule 3), vulnerable (Schedule 4) or rare (Schedule 5) of the Tasmanian <i>Threatened Species Protection Act 1995</i> . Endangered listings mean the species is in danger of extinction and long term survival is unlikely unless the factors causing it to be so are corrected. Vulnerable listings are likely to become endangered while the factors causing it to be vulnerable continue operating. A species is listed as rare if it has a small population in Tasmania that is at risk.
Tidal inundation	Flooding at high, spring or king tide with sea water moving up through the stormwater systems.




Tidal prism	The volume of water moving in and out of an estuary.
Transgressive dune	Principally unvegetated sand dune or sand sheet moving landward (ie transgressing a former landscape).
Treatment train	A series of treatment systems that together remove a variety of pollutants from stormwater and reduce peak flows in a catchment.
Tsunami	A series of ocean waves with very long wave lengths caused by large-scale disturbances of the ocean (eg earthquakes, landslides, volcanic eruptions, explosions, meteorites).
Turbidity	Cloudiness in water caused by suspended sediments.
Visual Amenity	People visually relate to and place value on their surroundings and then derive a benefit from how it looks. The enjoyment of the coast can be from within a car driving through or between coastal towns or on a beach as much as from a viewing platform.
View field	The siting and design of structures or removal of trees can alter a perspective that many people have built a relationship with over time. For example, a development application to change a two story building to a five story building may alter the view field of the coastline and estuary that has been available to people who live in or have visited the area for many years.
Vegetated swale	Open shallow channels with vegetation used to filter and convey stormwater run-off.
Water bar	A water diversion device (e.g. a log) used on constructed trails to divert water off the trail and prevent erosion.
Water Sensitive Urban Design	Stormwater management systems that conserve water and remove sediments and pollutants.
Wave return wall	A wave located at the top of a seawall, designed to throw back the waves.
Wave run up	When a wave breaks it can also run up the shoreline to an even greater height depending on the size of the wave and slope of the shore.
Wave setup	Where seawater is pushed up into bays and estuaries and piles up against shores due to wind blowing across water creating waves and currents.
Wetland	A permanently or intermittently wet area, shallow water or land/water margin that supports a natural ecosystem of plants and animals adapted to wet conditions.



Wharf	A structure (including quays, piers and jetties) from which passengers or goods may be taken on board or landed from vessels.
Wrack	Seaweed/seagrass or other vegetation cast onto the shore by wave action.

Acronyms

ACECRC	Antarctic Climate Ecosystems Cooperative Research Centre
AEP	Annual Exceedance Probability
AHD	Australian Height Datum
AHT	Aboriginal Heritage Tasmania (unit of DPIPW)
AHO	Aboriginal Heritage Officer (endorsed by TALSC)
ARI	Average Recurrence Interval
ARQ	Australian Runoff Quality (guidelines)
ASS	Acid Sulfate Soils
CAMBA	China–Australia Migratory Bird Agreement
CLS	Crown Land Services
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEP	Derwent Estuary Program
DIER	Department of Infrastructure, Energy and Resources
DPIPW	Department of Primary Industries, Parks, Water and Environment
EEMSS	Estuary Entrance Management Support System
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EMPCA	<i>Environmental Management and Pollution Control Act 1994</i>
EPA	Environment Protection Authority (Tasmania)
EPBC	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
GPS	Global Positioning System



GPT	Gross Pollutant Trap
IMBA	International Mountain Bike Association
IPCC	Intergovernmental Panel for Climate Change
JAMBA	Japan–Australia Migratory Bird Agreement
LiDAR	Light Detection And Ranging
LIST	Land Information System Tasmania
LUPAA	<i>Land Use Planning and Approvals Act 1993</i>
MAST	Marine and Safety Tasmania
MBO	Monosulfidic Black Ooze
MRT	Mineral Resources Tasmania
NRM	Natural Resource Management
OH&S	Occupational Health and Safety
PASS	Potential Acid Sulfate Soil
PCAB	Policy and Conservation Assessment Branch (DPIPWE)
PEV	Protected Environmental Value
PPE	Personal Protective Equipment
PWS	Parks and Wildlife Service
RAA	Reserve Activity Assessment (PWS assessment process)
RBF	Recreational Boating Fund
RMPAT	Resource Management and Planning Appeal Tribunal
RMPS	Resource Management and Planning System
ROKAMBA	Republic of Korea-Australia Migratory Birds Agreement
SCAT	Southern Coastcare Association of Tasmania
SMP	Stormwater Management Plan
SPRATS	Sea Spurge Remote Area Teams



SWMP	Statutory Weed Management Plans
SWMP	Soil and Water Management Plan
TALSC	Tasmanian Aboriginal Land and Sea Council
TASI	Tasmanian Aboriginal Site Index
TASMARC	Tasmanian shoreline monitoring and archiving project
TASVEG	A Tasmanian-wide vegetation map
TCCO	Tasmanian Climate Change Office
TCT	Tasmanian Conservation Trust
TFS	Tasmania Fire Service
TLCA	Tasmanian Landcare Association
TMP	Traffic Management Plan
TPC	Tasmanian Planning Commission
TVMMP	Tasmanian Vegetation Mapping and Monitoring Program
VCA	Vegetation Condition Assessment
WMP	Weed Management Plan
WoNS	Weeds of National Significance
WSUD	Water Sensitive Urban Design



References and further reading

A

Adelaide and Mount Lofty Ranges Natural Resources Management Board, n.d., *Coastal gardens: A planting guide*, Adelaide and Mount Lofty Ranges Natural Resources Management Board.

Ahern, CR, Ahern, MR and Powell, B 1998, *Guidelines for sampling and analysis of lowland acid sulfate soils (ASS) in Queensland*, Queensland Acid Sulfate Soils Investigation Team, Department of Natural Resources, Brisbane.

Allan, K and Gartenstein, S 2010, *Keeping it clean: A Tasmanian field hygiene manual to prevent the spread of freshwater pests and pathogens*, Natural Resource Management South, South Hobart.

Angel, G and McArthur, S 1995, *Sign manual*, Forestry Tasmania, Hobart.

Antarctic Climate and Ecosystems Cooperative Research Centre 2008, *Position analysis: Climate change, sea-level rise and extreme events: impacts and adaptation issues*, Antarctic Climate and Ecosystems Cooperative Research Centre, Hobart.

Aquenal Pty Ltd 2008, *Assessment and mapping of foreshore values, condition and pressures for the Southern natural resource management region: Explanatory report and user guide*, report for Natural Resource Management South, Aquenal Pty Ltd, Aquatic Environment Analysts, Hobart.


Arundel, H, ed. 2006, *Estuary entrance management support system*, report for the Glenelg Hopkins Catchment Management Authority, Hamilton, Victoria.

Australian and New Zealand Environment and Conservation Council and the National Health and Medical Research Council 1992, *Australian and New Zealand guidelines for the assessment and management of contaminated sites*, Australian and New Zealand Environment and Conservation Council and the National Health and Medical Research Council, Canberra.

Australian and New Zealand Environment and Conservation Council and the Agriculture and Resource Management Council of Australia and New Zealand 2000, *National water quality management strategy - No. 7a, Australian guidelines for water quality monitoring and reporting*, Australian and New Zealand Environment and Conservation Council, and Agriculture and Resource Management Council of Australia and New Zealand, Canberra.

Australian and New Zealand Environment and Conservation Council and the Agriculture and Resource Management Council of Australia and New Zealand 2000, *National water quality management strategy - paper 4a, Australian and New Zealand guidelines for fresh and marine water quality*, Australian and New Zealand Environment and Conservation Council and the Agriculture and Resource Management Council of Australia and New Zealand, Canberra.

Australian and New Zealand Environment and Conservation Council, and Agriculture and Resource Management Council of Australia and New Zealand 1997, *National weeds strategy: A strategic approach to weed problems of national significance*, Agriculture and Resource Management Council of Australia and New Zealand, Canberra.



Australian Greenhouse Office, Department of the Environment and Heritage 2006, *Climate change impacts & risk management: A guide for business and government*, Department of the Environment and Heritage, Canberra.

Australian Heritage Commission 2002, *Ask First: A guide to respecting Indigenous heritage places and values*, Australian Heritage Commission, Canberra.

Australian Maritime Safety Authority 2002, *National guideline for the development of oiled wildlife response contingency plans*, Australian Maritime Safety Authority, Canberra.

Australian Maritime Safety Authority 2005, *National marine chemical spill contingency plan (Chemplan): Australia's national plan to combat pollution of the sea by oil and other noxious and hazardous substances*, Australian Maritime Safety Authority, Canberra.

Australian Maritime Safety Authority, n.d. *Safety first in oiled wildlife response* (DVD), Australian Maritime Safety Authority, Canberra.

Australian Plants Society Tasmania 1988-2003, Plant identikit series, *Coastal plants of Tasmania and woodland wildflowers of Tasmania*, Australian Plants Society Tasmania, Hobart.

B

Bacon, CA 1999, *Mineral exploration code of practice* (4th ed), Mineral Resources Tasmania, Hobart.

Barker, P 2001, *A technical manual for vegetation monitoring*, Resource Management and Conservation, Department of Primary Industries, Water and Environment, Hobart.

Blackhall, SA, McEntee, AC and Rollins, E 2001, 'Tasmania', In: *A directory of important wetlands in Australia*, 3rd ed, Environment Australia, Canberra.

Blood, K 2001, *Environmental weeds: A field guide for SE Australia*, CH Jerram & Associates and CRC for Weed Management Systems, Adelaide.

Boubée, J, Jowett, I, Nichols, S and Williams, E 1999, *Fish passage at culverts: A review, with possible solutions for New Zealand indigenous species*, National Institute of Water and Atmospheric Research, Department of Conservation, New Zealand.

Bowden, KF 1983 *Physical oceanography of coastal waters*, Wiley and Sons, New York.

Bradbury, J 27th August 2010 Personal communication.

Bradstock, RA, Williams, JE and Gill, AM, eds. 2002, *Flammable Australia: The fire regimes and biodiversity of a continent*, Cambridge University Press, Cambridge, UK.

Brooke, P, Sandercock, R and Stove, K 2001, *Coastcare community handbook*, Department for Environment and Heritage, Adelaide.

Brown, P 2001, *The fish habitat handbook: How to reduce the impacts of land-based development on South Australia's fish habitats*, Primary Industries and Resources, Marine Habitat Program, Adelaide.

Bugler, M ed 1994, *Environmental guidelines for marinas in the Great Barrier Reef Marine Park*, Great Barrier Reef Marine Park Authority, Townsville.

Bushfire Planning Group, Tasmania Fire Service 2005, *Guidelines for development in bushfire prone areas of Tasmania*, Living with fire in Tasmania, Tasmania Fire Service, Hobart.

C

Church, JA, White, NJ, Aarup, T, Wilson, WS, Woodworth, PL, Domingues, CM, Hunter, JR and Lambeck, K 2008a, *Understanding global sea levels: past, present and future*, Sustainability Science, Special Feature: Original Article, doi:10.1007/s11625-008-0042-4.

Church, JA, White, NJ, Hunter, JR and Lambeck, K 2008b, *A post-IPCC AR4 update on sea level rise*, Antarctic Climate and Ecosystems Cooperative Research Centre, Hobart.

Church, J, Woodworth, PL, Aarup, T and Wilson, S 2010, *Understanding sea-level rise and variability*, Wiley, UK.

Clarence City Council, n.d., *Plants for a water friendly garden: Native plant field guide*, Clarence City Council.

Clay, C ed 2010, *Professional short course, acid sulfate soils: Identification, assessment and management, Tasmania course notes*, Southern Cross GeoScience, Lismore, New South Wales.

Coastal Weeds Working Group 2008, *Coastal weed strategy for the Cradle Coast natural resource management region*, Cradle Coast Natural Resource Management Committee, Cradle Coast Authority, Burnie.

Connolly, A 2003, *Coastal weeds of Tasmania: are you growing invaders?: A guide to coastal and environmental weeds of Tasmania*, Department of Primary Industries, Water and Environment, Hobart.

Cooperative Research Centre for Australian Weed Management, Natural Heritage Trust Australia and Department of the Environment and Heritage 2004, *Introductory weed management manual*, CRC for Australian Weed Management, Canberra.

D

Dear, SE, Moore, NG, Dobos, SK, Watling, KM and Ahern, CR 2002, 'Soil management guidelines' In: *Queensland acid sulfate soil technical manual*, (version 3.8), Department of Natural Resources and Mines, Indooroopilly, Qld.

Deeks, B and Milne, T 2005, *Water sensitive urban design: Engineering procedures for stormwater management in Southern Tasmania*, Derwent Estuary Program, Department of Primary Industries Water and Environment, Hobart.


Department for Environment and Heritage 2008, *Overall fuel hazard guide for South Australia*, Department for Environment and Heritage, Adelaide, South Australia.

Department of Climate Change 2009, *Climate change risks to Australia's coast — A first pass national assessment*, Australian Government Department of Climate Change, Canberra.

Department of Climate Change and Energy Efficiency 2010, *Fact sheet: Coastal climate change — the science basis*, Australian Government, Canberra.

Department of Commerce and Manly Hydraulics Laboratory 2003, *Wamberal Beach and property protection, environmental impact statement*, Report No. MHL935, prepared on behalf of Gosford City Council, Manly Vale.

Department of Environment and Climate Change 2008a, *Managing urban stormwater: soils and construction, volume 2a installation of services*, New South Wales Department of Environment and Climate Change, Sydney.



Department of Environment and Climate Change 2008b, *Saltwater wetlands rehabilitation manual*, New South Wales Department of Environment and Climate Change, Sydney.

Department of Environment and Climate Change 2009, *Environmentally friendly seawalls: A guide to improving the environmental values of seawalls and seawall-lined foreshores in estuaries*, New South Wales Department of Environment and Climate Change, on behalf of Sydney Metropolitan Catchment Management Authority, Sydney.

Department of Environment and Conservation 2006, *A resource guide for local councils: erosion and sediment control*, New South Wales Department of Environment and Conservation, Sydney.

Department of Environment and Resource Management 2009, *Draft Queensland coastal plan: Draft state planning policy coastal protection*, Department of Environment and Resource Management, Brisbane.

Department of Environment, Climate Change and Water NSW 2009a, *NSW sea level rise policy statement*, New South Wales Department of Environment, Climate Change and Water, Sydney.

Department of Environment, Parks, Heritage and the Arts 2009, *Environmental guidelines for boat repair and maintenance*, Environment Division, Department of Environment, Parks, Heritage and the Arts, Hobart.

Department of Planning and Community Development 2008, *General practice note 18: Managing coastal hazards and the coastal impacts of climate change*, Department of Planning and Community Development, Melbourne.

Department of Primary Industries and Water 2007, *Shellfish fishery policy document - Information supporting the shellfish management plan for the fisheries (shellfish) rules*, Wild Fisheries Management Branch, Department of Primary Industries and Water, Hobart.

Department of Primary Industries and Water 2008a, *Background report: Coastal flooding—review of the use of exceedance statistics in Tasmania*, Department of Primary Industries and Water, Hobart.

Department of Primary Industries and Water 2008b, *Climate change and coastal asset vulnerability: an audit of Tasmania's coastal assets potentially vulnerable to flooding and sea-level rise*, Department of Primary Industries and Water, Hobart.

Department of Primary Industries and Water 2008c, *Coastal hazards in Tasmania: General information paper*, Department of Primary Industries and Water, Hobart.

Department of Primary Industries and Water 2008d, *Conservation of freshwater ecosystem values (CFEV), Project technical report*, Conservation of freshwater ecosystem values program, Department of Primary Industries and Water, Hobart.

Department of Primary Industries and Water 2008e, *Sea-level extremes in Tasmania: summary and practical guide for planners and managers*, Department of Primary Industries and Water, Hobart.

Department of Primary Industries and Water 2009, *Coastal risk management plan: Template and guidelines*, Department of Primary Industries and Water, Hobart.

Department of Primary Industries, Parks, Water and Environment 2009a, *Tasmanian acid sulfate soil management guidelines*, Department of Primary Industries, Parks, Water and Environment, Hobart.

Department of Primary Industries, Parks, Water and Environment 2009b, *Information Bulletin 105: Classification and management of contaminated soil disposal*, Department of Primary Industries, Parks, Water and Environment, Environment Protection Authority.

Department of Primary Industries, Parks, Water and Environment 2010, *Vulnerability of Tasmania's natural environment to climate change: An overview*, Resource Management and Conservation, Department of Primary Industries, Parks, Water and Environment, Hobart.

Department of Primary Industries, Water and Environment 2000a *Draft model urban stormwater management plan*, Department of Primary Industries, Water and Environment, Hobart.

Department of Primary Industries, Water and Environment 2000b *Threatened species strategy*, Threatened Species Unit, Nature Conservation Branch, Department of Primary Industries, Water and Environment, Hobart.

Department of Primary Industries, Water and Environment 2002, *Strategy for the management of rice grass (Spartina anglica) in Tasmania, Australia*, 2nd edn, Department of Primary Industries, Water and Environment, Hobart.

Department of Primary Industries, Water and Environment 2003, *Tasmanian marine chemical spill contingency plan (TasChemPlan)*, Department of Primary Industries, Water and Environment, Hobart.

Department of Primary Industries, Water and Environment 2004a, *A wetlands strategy for Tasmania*, Resource Management and Conservation Division, Department of Primary Industries, Water and Environment, Hobart.

Department of Primary Industries, Water and Environment 2004c, *Sea-level change around Tasmania: Information paper*, Department of Primary Industries, Water and Environment, Hobart.

Department of Primary Industries, Water and Environment 2005, *Weed plan: Tasmania's weed management strategy second edition*, The Tasmanian Weed Management Committee, Hobart.

Department of Primary Industries, Water and Environment and State Emergency Service 2001, *Tasmanian marine oil pollution contingency plan (TASPLAN)*, Department of Primary Industries, Water and Environment, Hobart.

Department of Primary Industries, Water and Environment, and Department of Infrastructure, Energy and Resources 1999, *Quarry Code of Practice*, Department of Primary Industries, Water and Environment and Department of Infrastructure, Energy and Resources, Hobart.

Department of Primary Industries, Water and Environment, and Department of Tourism, Parks, Heritage and the Arts 2005, *Tasmanian whale stranding handbook and directory*, Department of Primary Industries, Water and Environment, and Department of Tourism, Parks, Heritage and the Arts, Hobart.

Department of the Environment 1984, *Guidelines for the rehabilitation of quarries and extractive pits*, Department of the Environment, Hobart.

Department of the Environment and Heritage 2005, *Australian national guidelines for whale and dolphin watching*, Australian Government, Department of the Environment and Heritage, Canberra.



Department of the Environment and Heritage 2006, *Climate change impacts and risk management – a guide for business and government*, Australian Greenhouse Office, Department of the Environment and Heritage, Canberra.

Department of the Environment, Water, Heritage and the Arts 2009, *National assessment guidelines for dredging*, Australian Government, Department of the Environment, Water, Heritage and the Arts Canberra.

Department of the Environment, Water, Heritage and the Arts, Australian Government 2009, *National assessment guidelines for dredging 2009*, Australian Government Department of the Environment, Water, Heritage and the Arts, Environment Assessment Branch, Canberra.

Department of Tourism, Arts and the Environment, Tasmania 2007a, *Vegetation, fauna habitat and geomorphology coastal values information for the Southern Tasmania natural resource management region, Interpretation manual*, Coastal and Marine Branch, DTAE, Hobart.

Department of Tourism, Arts and the Environment, Tasmania 2007b, *Vegetation, fauna habitat and geomorphology coastal values information for the Northern Tasmania natural resource management region, Interpretation manual*, Coastal and Marine Branch, DTAE, Hobart.

Derwent Estuary Program 2004, *A model stormwater management plan for Hobart regional councils – a focus on the New Town Rivulet catchment*, Derwent Estuary Program, Department of Primary Industries, Water and Environment, Hobart.

Derwent Estuary Program 2005, *Water sensitive urban design: Engineering procedures for stormwater management in Southern Tasmania*, Report prepared by the Wet Environment for the Derwent Estuary

Program, Department of Primary Industries, Water and Environment, Hobart.

Derwent Estuary Program 2009, *Soil and water management on building and construction sites, Fact sheets*, Derwent Estuary Program, Department of Primary Industries, Water and Environment, Hobart.

Derwent Estuary Program, in prep, *Draft state stormwater strategy*, Derwent Estuary Program, Department of Primary Industries, Parks, Water and Environment.

Dunlop, M and Brown, PR 2008, *Implications of climate change for Australia's national reserve system: a preliminary assessment, Report to the Department of Climate Change*, Department of Climate Change, Canberra.

E

Emergency Management Australia 2004, *Emergency management in Australia: Concepts and principles, Manual number 1*, Australian Government, Canberra.

Engineers Australia, National Committee for Water Engineering 2006, *Australian runoff quality: A guide to water sensitive urban design*, ed. Wong, THF, Engineers Media, Crows Nest, New South Wales.

Environment Australia 2002, *Threat abatement plan for dieback caused by the root-rot fungus *Phytophthora cinnamomi**, Department of the Environment and Heritage, Canberra.

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

Environment Protection Authority 1996, *Environment Protection Authority publication 480 – environmental guidelines for major construction sites*, Environment Protection Authority, Melbourne.

Environment Protection Authority 2001, *Best practice environmental management guidelines for dredging*, Environment Protection Authority, Melbourne.

Environment Protection Authority 2009, *Classification and management of contaminated soil for disposal*, Information Bulletin No. 105, Environment Protection Authority, Hobart.

Eriksen, R in prep, *Dredging and land reclamation in the Derwent: a guidance document to support best practice management*, prepared for the Derwent Estuary Program, Department of Primary Industries, Parks, Water and Environment by Aquatic Science, Hobart.

F

Fairfull, S and Witheridge, G 2003, *Why do fish need to cross the road? Fish passage requirements for waterway crossings*, NSW Fisheries, Cronulla, pp. 16.

Forest Practices Authority 2007, *Threatened native vegetation community information sheet: Threatened native vegetation communities*

Forest Practices Board 2000, *Forest Practices Code*, Forest Practices Board, Hobart.

G

Gallagher, S 2003, *Waterways and wetlands works manual: Environmental best practice guidelines for undertaking works in waterways and wetlands in Tasmania*. Department of Primary Industries, Water and Environment, Hobart.

Gilbert, TD 1999, *Oil spills in the Australian marine environment: Environmental consequences and response technologies*. Proceedings of the Australian Oil and Gas Conference 22-23 April 1999, Perth, Western Australia, Australian Maritime Safety Authority, Canberra.


Gilfedder, L, Smith, T and Glazik, R 1999, *Tasmanian bushcare toolkit, kit 4, Revegetating your farm*, in Kirkpatrick, JB and Gilfedder, L, eds. 1999, *Tasmanian bushcare toolkit*, Department of Primary Industries, Water and Environment, Hobart.

Gippsland Coastal Board 2008, *Climate change, sea level rise and coastal subsidence along the Gippsland coast*, Gippsland Coastal Board, Bairnsdale, Victoria.

Giummarra G 2001, *Road classifications, geometric designs and maintenance standards for low volume roads*, Research Report AR354, ARRB Transport Research Ltd, Vermont South, Victoria.

Glazik, R and Rudman, T 2002, *Tasmanian bushcare toolkit, kit 3, Weeds in your bush*, in Kirkpatrick, JB and Gilfedder, L, eds. 2002, *Tasmanian bushcare toolkit*, Department of Primary Industries, Water and Environment, Hobart.

Gourley, MR, Harper, BA, Cox, RJ, Stone, PB and Webb T 2004, *Coastal engineering guidelines for working with the Australian coast in an ecologically sustainable way*, Engineers Australia, National Committee on Coastal and Ocean Engineering, EA Books, Barton, ACT.



Graham, RJ & Associates and HMT Planning 1999, *The Tasmanian Visitor Information System. A proposal for an integrated approach to visitor information for Tasmania*.

Green Skills Inc 2010, *Coastal management specification manual: a guide for the construction of coastal management infrastructure*, prepared for the South Coast Management Group, Albany, Western Australia.

Greening Australia, n.d., *Introduction to Enviromark, A System for Managing Roadside and Corridor Vegetation*, Greening Australia, Hobart.

Greening Australia 2002, *Monitoring remnant bushland*, Technical note 8, Greening Australia, Hobart.

Gurung, S 2001, *Tasmanian acid drainage reconnaissance: Distribution of acid sulphate soils in Tasmania*, Mineral Resources Tasmania, Department of Infrastructure, Energy and Resources, Hobart.

H

Hardie, M 2008, *Dispersive soils and their management: Technical reference manual*, Department of Primary Industries and Water, Launceston, Tasmania.

Harris, S and Kitchener, A 2005, *From forest to fjaeldmark: Descriptions of Tasmania's vegetation*, Department of Primary Industries, Water and Environment, Printing Authority of Tasmania, Hobart.

Hobart City Council, in prep, *Track infrastructure design manual*, Hobart City Council.

Hobart City Council, in prep, *Track maintenance manual*, Hobart City Council.

Hobart Regional Councils 1999a, *Guidelines for soil and water management*, Hobart Regional Councils, Hobart.

Hobart Regional Councils 1999b, *The soil and water management code of practice for Hobart regional councils*, Hobart Regional Councils, Hobart.

House of Representatives Standing Committee on Climate Change, Water, Environment and the Arts 2009, *Managing our coastal zone in a changing climate*, The Parliament of the Commonwealth of Australia.

Hunter, J 2009a, *Estimating sea-level extremes in an uncertain future: Workshop manual*, Antarctic Climate & Ecosystems Cooperative Research Centre, Hobart.

Hunter, J 2009b, *Estimating sea-level extremes under conditions of uncertain sea-level rise*, Technical Paper, Kluwer Academic Publishers, Netherlands.

Hunter, JR 2008, *Historical and projected sea-level extremes for Hobart and Burnie, Tasmania*, Technical report prepared by the Antarctic Climate and Ecosystems Cooperative Research Centre. Department of Primary Industries and Water, Hobart.

Hunter, JR, Coleman, R and Pugh, D 2003, *The sea level at Port Arthur, Tasmania, from 1841 to the present*, Geophysical Research Letters, vol. 30(7).

Hydro Tasmania Consulting 2008, *Natural resource management coastal values mapping project, Geomorphology interpretation report and manual*, Report prepared for Natural Resource Management North and Cradle Coast Authority by Hydro Consulting, Hydro-Electric Corporation, Hobart.

I

Inspiring Place Pty Ltd 2007, *Trails Tasmania strategy*, Developed for Sport and Recreation Tasmania, Department of Economic Development, Tourism and the Arts, Hobart.

Institution of Engineers Australia 1987, *Australian Rainfall and Runoff: A Guide to Flood Estimation*, Vol. 1, Editor-in-chief D.H. Pilgrim, Revised Edition 1987 (Reprinted edition 1998), IEA, Barton, ACT

Intergovernmental Panel on Climate Change 2001, *Third assessment report, climate change*, Reports of the Intergovernmental Panel on Climate Change (United Nations committee).

Intergovernmental Panel on Climate Change 2007, *Fourth assessment report, climate change*, Reports of the Intergovernmental Panel on Climate Change (United Nations committee).

J

K

Kirkpatrick, JB 1999, *Tasmanian bushcare toolkit, kit 9*, 'Other bush types', in Kirkpatrick, JB and Gilfedder, L, eds. 1999, *Tasmanian bushcare toolkit*, Department of Primary Industries, Water and Environment, Hobart.

Kirkpatrick, JB and Harris, S 1999, 'Coastal, heath and wetland vegetation' in Reid, JB, Hill, RS, Brown, MJ and Hovenden, MJ, eds., *Vegetation of Tasmania*, Flora of Australia supplementary series No. 8, Australian Biological Resources Study, Hobart.

Kirkpatrick, JB, Gilfedder, LA and Rudman, T 1999, *Tasmanian bushcare toolkit, kit 2*, Managing your bush, in Kirkpatrick, JB and Gilfedder, L, eds. 1999, *Tasmanian bushcare toolkit*, Department of Primary Industries, Water and Environment, Hobart.

L

Launceston City Council 2000, *The soil and water management code of practice for Launceston City Council*, Launceston City Council, Launceston. Tasmania.

M


Maguire, GS 2008, *A practical guide for managing beach nesting birds in Australia*, Birds Australia, Melbourne.

Marker, P and Wind, A 2008 revision, *Guidelines for works in areas of Little Penguin habitat*, Coastcare, Hobart.

Marsden-Smedley, JB 2009, *Planned burning in Tasmania: operational guidelines and review of current knowledge*, Fire Management Section, Parks and Wildlife Service, Department of Primary Industries, Parks, Water and the Environment, Hobart.

McCoull, CJ and Barnes, RW 2002, *A user's guide to monitoring vegetation, nature conservation report, 02/1*, Nature Conservation Branch, Resource Management and Conservation, Department of Primary Industries, Water and Environment, Hobart.

McNaught, I, Thackway, R, Brown, L and Parsons, M 2006, *A field manual for surveying and mapping nationally significant weeds*, Bureau of Rural Sciences, Canberra.



Michaels, K 2006, *A manual for assessing vegetation condition in Tasmania, Version 1.0*, Resource Management and Conservation, Department of Primary Industries, Water and Environment, Hobart.

Ministry for the Environment 2008a, *Climate change effects and impacts assessment: a guidance manual for local government in New Zealand, 2nd Edition*, Mullan, B, Wratt, D, Dean, S, Hollis, M, Allan, S, Williams, T, Kenny, G and Ministry for the Environment, Wellington, New Zealand.

Ministry for the Environment 2008b, *Coastal Hazards and Climate Change: a guidance manual for local government in New Zealand. 2nd Edition*. Revised by Ramsay, D, and Bell, R. (NIWA). Prepared for Ministry for the Environment.

Mount, R *Tasmania's coastline and coastal waters*, unpublished report, Resource Planning and Development Commission, Hobart.

Mount, RE and Nandagopalan, V, Prahalad, V, and Sharples, C and Tilden, J and Morrison, BVR and Lacey, MJ and Ellison, JC and Helman, MP and Newton, JB 2010, *Circular Head coastal foreshore habitats: sea level rise vulnerability assessment: final project report to Cradle Coast NRM*, School of Geography and Environmental Studies, University of Tasmania, Hobart.

Muyt, A 2001, *Bush invaders of south-east Australia: a guide to the identification and control of environmental weeds found in south-east Australia*, RG and FJ Richardson, Meredith, Victoria.

N

National Committee on Coastal and Ocean Engineering, Engineers Australia 2004, *Guidelines for responding to the effects of climate change in coastal and ocean engineering*, The Institution of Engineers Australia, Canberra.

National Environment Protection Council 1999, *National Environment Protection (Assessment of Site Contamination) Measure 1999*, National Environment Protection Council, Adelaide.

Natural Resource Management Council 2006, *Australian Weeds Strategy – A national strategy for weed management in Australia*, Australian Government Department of the Environment and Water Resources, Canberra ACT.

Natural Resource Management South 2008a, *A guide to developing an environmental management plan for managing waste at boat maintenance and repair facilities*, Natural Resource Management South, Hobart.

Natural Resource Management South 2008b, *Guide to best practice management of point source pollution at boat repair and maintenance facilities*, Natural Resource Management South, Hobart.

Natural Resource Management South and Southern Tasmania Councils Authority 2010, *Weeds of Southern Tasmania – a guide to environmental and agricultural weeds of Southern Tasmania*, Natural Resource Management South and Southern Tasmania Councils Authority, Hobart.

New South Wales Agriculture 2000, *National strategy for the management of coastal acid sulfate soils*, New South Wales Agriculture, National Working Party on Acid Sulfate Soils.

New South Wales Department of Environment and Climate Change 2008, *Best practice guidelines for saltmarsh*. Department of Environment and Climate Change, NSW.

New South Wales Department of Land and Water Conservation 2001, *Coastal dune management: a manual of coastal dune management and rehabilitation techniques*, Prepared by Rod Kidd, Department of Land and Water Conservation, NSW.

New South Wales Department of Primary Industries, n.d., *Policy and guidelines for fish friendly waterway crossings*, Department of Primary Industries, NSW.

North Barker Ecosystem Services 2008, *Natural resource management coastal values mapping project, vegetation and fauna habitat, interpretation manual*, Report prepared for Natural Resource Management North and Cradle Coast Authority by North Barker Ecosystem Services, Hobart.

O

O'Gara, E, Howard, K, Wilson, B and Hardy, GE St J 2005, *Management of *Phytophthora cinnamomi* for biodiversity conservation in Australia: Part 2 – National best practice guidelines*, a report funded by the Commonwealth Government Department of Environment and Heritage by the Centre for *Phytophthora* Science and Management, Murdoch University, Western Australia.

O'Keeffe, PD 1978, *Sediment budgeting*, Beach Conservation, Issue No. 30, Beach Protection Authority, Queensland.

P

Parks and Wildlife Service 2000, *Draft sign manual*, Parks and Wildlife Service, Hobart.

Parks and Wildlife Service 2003, *Walking track management manual*, Parks and Wildlife Service, Tasmania

Parks and Wildlife Service, Forestry Tasmania and Department of Primary Industries, Water and Environment 2003, *Tasmanian reserve management code of practice*, Department of Tourism, Parks, Heritage and the Arts, Hobart

Prahalad, NV 2009, *Temporal changes in South East Tasmanian saltmarshes*, Master's Thesis, School of Geography and Environmental Studies, University of Tasmania, Hobart.

Prahalad, NV, Lacey, MJ and Mount, RE 2009, *The future of the Derwent Estuary saltmarshes and tidal freshwater wetlands in response to sea level rise*, Technical report for the Derwent Estuary Program and Natural Resource Management South, School of Geography and Environmental Studies, University of Tasmania, Hobart.

Pryor, H and Wells, F 2009, *Co-existing with little penguins in the Derwent Estuary — information and guidelines*, Derwent Estuary Program, Hobart.

Q

R

Ramsay, C and Dawkins, D 1993, *Building in bushfire prone areas – information and advice*, CSIRO and Standards Australia, Melbourne.

Ramsay, C and Rudolph, L 2003, *Landscape and building design for bushfire areas*, CSIRO Publishing, Collingwood.

Resource Planning and Development Commission 2003, *State of the Environment (SoE) Report Tasmania 2003*, Resource Planning and Development Commission, Hobart.

Richardson, FJ, Richardson, RG and Shepherd, RCH 2006, *Weeds of the south east: An identification guide for Australia*, RG and FJ Richardson, Meredith, Victoria.

Rudman T 2003, *Tasmanian beach weed strategy for marram grass, sea spurge, sea wheatgrass, pyp grass and beach daisy*, *Nature Conservation Report 03/2*, Nature Conservation Branch, Department of Primary Industries, Water and Environment, Hobart.

Rudman T 2005, *Interim Phytophthora cinnamomi management guidelines*, *Nature Conservation Report 05/7*, Biodiversity Conservation Branch, Department of Primary Industries, Water and Environment, Hobart.

Rudman, T, Tucker, D and French, D 2004, *Tasmanian washdown guidelines for weed and disease control*, Department of Primary Industries, Water and Environment, Hobart.

S

Schahinger, R, Rudman T and Wardlaw, TJ 2003, *Conservation of Tasmanian plant species & communities threatened by Phytophthora cinnamomi*, *Strategic regional plan for Tasmania*, Technical report 03/03,

Nature Conservation Branch, Department of Primary Industries, Water and Environment, Hobart.

Schrammeyer, E 2005, *Southern Tasmanian weed strategy*, NRM South, Hobart

SGS Economics and Planning Pty Ltd and Water Research Laboratory, University of New South Wales 2009, *Climate change impacts on Clarence coastal areas – Final report*, Clarence City Council, Clarence, Tasmania.

Sharples, C 2006, *Indicative mapping of Tasmanian coastal vulnerability to climate change and sea-level rise: explanatory report, 2nd edition*; Report to Department of Primary Industries and Water, Tasmania, with accompanying mapping.

Sharples, C, Mount, RE and Pedersen, TK 2009a, *The Australian coastal Smartline geomorphic and stability map version 1: manual and data dictionary*, a report to Geoscience Australia and the Department of Climate Change, Canberra, by School of Geography and Environmental Studies, University of Tasmania.

Sharples, C, Mount, RE, Pedersen, TK, Lacey, MJ, Newton, JB, Jaskierniak, D and Wallace, LO 2009b, *The Australian coastal Smartline geomorphic and stability map version 1: Project report*, a report to Geoscience Australia and the Department of Climate Change, Canberra, by School of Geography and Environmental Studies, University of Tasmania, Hobart.

Short, AD and Woodroffe, CD 2009, *The coast of Australia*, Cambridge University Press, Melbourne.

Short, AD, Trembanis, AC and Turner, IL 2000, *Beach oscillation, rotation and the Southern oscillation, Narrabeen Beach, Australia*, *Proceedings International Conference of Coastal Engineering*, pp 2439-2452, American Society of Civil Engineers.

Simmons, M, Wapstra, H and Wapstra, A, eds 2008,

A guide to flowers and plants of Tasmania, Launceston Field Naturalists Club Inc, Launceston.

Sport and Recreation Tasmania, in prep, *Trail planning guidelines: guidelines to assist with the planning, design, construction and maintenance of sustainable recreational trails in Tasmania*, Sport and Recreation Tasmania.

State Emergency Service 2001, *Hazardous material emergency manual*, State Emergency Service on behalf of the Tasmanian Hazardous Materials Management Committee, ed, P Koob, Hobart.

State Emergency Service 2003, *State summary: The Tasmanian emergency risk management project - a community perspective*, with accompanying CD-ROM, State Emergency Service, Hobart.

State Emergency Service 2005, *Tasmanian hazardous materials emergency plan*, State Emergency Service, Hobart.

State Emergency Service, in prep, *State special plan for environmental pollution emergencies*, State Emergency Service, Tasmania.

Statham, M and Statham, HL 2010, *Wallaby Proof Fencing: a planning guide for Tasmanian primary producers*, 2nd Edition, Tasmanian Institute of Agricultural Research, Hobart.

Steffen, W 2009, *Climate Change 2009: faster change and more serious risks*, Department of Climate Change, Canberra.

Stone, Y, Ahern, CR and Blunden, B eds 1998, *Acid sulfate soils manual*, Acid Sulfate Soil Management Advisory Committee, Wollongbar, NSW, Australia.

Swan River Trust 2009, *Best management practices for foreshore stabilisation: Approaches and decision support framework*, Swan River Trust, Western Australia.

T

Tarbuck, EJ and Lutgens, FK 1987, *The Earth: An introduction to physical geology*, 2nd Ed, Merrill Publishing Company, Columbus, Ohio.

Tasmanian Government 2006, *Tasmanian biosecurity policy - ensuring Tasmania's biosecurity future*, Department of Primary Industries and Water on behalf of the Tasmanian Biosecurity Committee, Devonport.

Tasmanian Government 2006, *Tasmanian biosecurity strategy - ensuring Tasmania's biosecurity future*, Department of Primary Industries and Water on behalf of the Tasmanian Biosecurity Committee, Devonport.

Thorp, V 2001, *The understorey network guide to growing native plants in Tasmania*, The Understorey Network, Hobart.

Thorp, V 2005, *Community Coastcare handbook - caring for the coast in Tasmania*, Tasmanian Environment Centre, Hobart.

Tourism Tasmania, n.d., *Caravan and holiday park guide to Tasmania*, Tourism Tasmania, Hobart.

Tourism Tasmania, Parks and Wildlife Service and Forestry Tasmania 1997, *Tasmanian walking tracks strategy and marketing plan*, Inter-agency working party (Statewide Walking Tracks Strategy), Department of Environment and Land Management, Hobart.



U

United States Army Corps of Engineers (USACE) 2002, *Coastal engineering manual*, EM 1110-2-1100, US Army Corps of Engineers, Coastal Engineering Research Center, Washington, DC.

V

Victorian Coastal Council 1998, *Siting and design guidelines for structures on the Victorian coast*, prep by Tract Consultants Pty Ltd and Chris Dance Land Design Pty Ltd for the Victorian Coastal Council, East Melbourne.

W

Wapstra, H, Wapstra, A, Wapstra, M and Gilfedder, L 2005, *The little book of common names for Tasmanian plants*, Department of Primary Industries, Water and Environment, Hobart.

Ward, T, Butler, E and Hill, B 1998, *Environmental indicators for national state of the environment reporting - estuaries and the sea, Australia: State of the Environment* (Environmental Indicator Reports), Department of the Environment, Canberra.

Watchorn, L 2000, *Planning guidelines for the Tamar Estuary and foreshore*, Department of Primary Industries, Water and Environment, Launceston, Tasmania.

Watson, PJ and Frazer, A 2009, *A snapshot of future sea levels: Photographing the king tide 12 January 2009*, Department of Environment, Climate Change and Water, New South Wales, Sydney South.

Whiting, J & Tasmania's Natural Flora Editorial Committee, 2004, *Tasmania's natural flora*. Tasmania's Natural Flora Editorial Committee, Ulverstone, Tasmania.

Woehler, E 2nd August 2010, personal communication.

Wright, D and Jacobson, T 2000, *Managing streambanks: Stock control, fencing and watering options*, Department of Primary Industries, Water and Environment, Hobart, Tasmania.

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Z