Barrow group nature reserves

management plan 82

2015

Department of Parks and Wildlife

Conservation Commission WESTERN AUSTRALIA

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This management plan was prepared on behalf of the Conservation Commission of Western Australia by the former Department of Environment and Conservation prior to its separation and subsequent establishment of the Department of Parks and Wildlife and the Department of Environment Regulation (DER) on 1 July 2014. The responsibilities of the department will be implemented as outlined in this management plan. Key department staff will liaise with DER in relation to the remaining parts of this management plan.

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Front cover photos

Main Southerly perspective of the western coastline of Barrow Island Nature Reserve.
Photo – Dr Fran Stanley/Parks and Wildlife
Top left Barrow Island euro (*Macropus robustus isabellinus*).
Top right A nesting flatback turtle (*Natator depressus*).

Header photo Flatback turtle hatchling. Photos – Kevin Crane

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Vision

By 2025, and in partnership with key stakeholders and the wider community, the key physical, biological and cultural values of the Barrow group nature reserves will be more widely understood and conserved. The area supports petroleum and gas processing activities that will continue to be managed to ensure the area retains its ongoing value as an important ecological asset for the benefit of present and future generations.

Conservation Commission of Western Australia
Department of Parks and Wildlife

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The final management plan was prepared by a department planning team consisting of Michelle Rumball (lead planning coordinator), Kym Pearce, Laurina Bullen, Allisdair MacDonald, Dr Peter Kendrick, Paul Connolly, Misty Shipway and Brendan Dooley. Former planning team members include Dr Fran Stanley, Paul McCluskey, Terese Dimascia, Hayley Valentine and Kerrie Gorman.
Maps have been produced by Aaron Rivers and Jake Geddes.

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- the Conservation Commission of Western Australia.

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Introduction

1. Overview

The *Barrow group nature reserves management plan 82 2015* (the management plan) covers Barrow Island Nature Reserve and Boodie, Double and Middle Islands Nature Reserve (the planning area) located within the Shire of Ashburton. These reserves are about 1,250 kilometres north of Perth and 56 kilometres west of the mainland between Onslow and Dampier (see Map 1). Day-to-day environmental management is undertaken by the Department of Parks and Wildlife (the department) and industry operators as required by the scope of environmental approval conditions, approved environmental management plans/programs and other relevant documents.

The reserves are particularly valued for:

- their diverse and relatively unaltered fauna assemblages
- their extensive karst systems and the subterranean fauna they support
- the important habitat they provide for nesting marine turtles (especially the green [*Chelonia mydas*] and flatback [*Natator depressus*] species) and migratory shorebirds.

The nature reserves are also important because they contain an array of conservation significant fauna species and populations (see Map 2), including species that are threatened, priority-listed, endemic, short-range endemic, relictual and/or disjunct. Some flora species and communities are also priority-listed, at, or near, the extent of their range and/or are restricted in distribution within the planning area. Other important ecosystems such as intertidal mudflats, rock platforms and mangroves, rock piles and cliffs, claypans and caves are also present. The isolation of the islands and the scarcity of non-indigenous species (NIS) have made the planning area an important refuge for significant representatives of the state's fauna. The planning area therefore serves as an important reservoir from which founder populations can be sourced for fauna reconstruction programs on other islands and the mainland in Western Australia.

Petroleum titles (such as production licences and exploration permits) exist over the entire planning area, except for the southern part of Double Island (see Map 1). The Barrow Island Joint Venture (BWIJV) has been extracting petroleum from Barrow Island Nature Reserve since 1967. It accessed Boodie, Double and Middle Islands Nature Reserve in the 1960s and, although wells were drilled, no extraction has taken place on this reserve. The Gorgon Joint Venture (GJV) began construction of a liquefied natural gas (LNG) facility on Barrow Island Nature Reserve in 2009. The GJV is to establish the project in accordance with environmental approval conditions granted under state and federal environmental legislation[1], which will assist in managing the ecological impacts discussed in this management plan.

The major threats to biodiversity and other key values include land clearing, altered hydrological regimes, introduction of NIS, altered fire regimes, gravel extraction and contamination and/or pollution.

This management plan was prepared by the department on behalf of the Conservation Commission of Western Australia (the Conservation Commission) under the provisions of the *Conservation and Land Management Act 1984* (CALM Act). It provides a statement of policies, guidelines and a summary of

[1]*State Ministerial implementation statements (Nos. 769, 800, 865 and 965 as at 2 April 2014) and the federal Ministerial implementation statements (References 2003/1294, 2005/2184 and 2008/4178), and any further approvals that come into force during the life of this management plan stipulate environmental conditions which the GJV must conform before, during and upon completion of its project. These include the development of project-specific management plans, reports, systems and programs that primarily address the necessary management/mitigation actions for any ecological impacts that may be caused through its operations. They also include the establishment of expert panels to provide specialist advice on dredging, marine turtles and quarantine (for a list of approved GJV environmental management plans see section* Further reading*).*

operations proposed to be implemented by the department. It also informs subsidiary operational plans that provide more management detail, which may include fire risk mitigation, education, science and heritage management plans.

This management plan acknowledges that conditional environmental approval has been granted for the current petroleum and gas processing operations on Barrow Island Nature Reserve (see section *Further reading*). It does not impose additional environmental requirements on those industry operations.

As with all terrestrial CALM Act management plans, this management plan has been prepared in accordance with section 19(f) of the CALM Act and its key focus is to fulfil departmental legislative responsibilities to protect the key values of the planning area. To do this, the department will collaborate and engage with industry operators, other appropriate agencies and the wider community.

2. Management plan area

This management plan covers two existing nature reserves totalling 24,070 hectares that are vested in the Conservation Commission and managed by the department. Both reserves are set aside for the purpose of 'conservation of flora and fauna' and are known as:

- Barrow Island Nature Reserve (Reserve 11648, Class A), which covers an area of 23,483 hectares
- Boodie, Double and Middle Islands Nature Reserve (Reserve 38728, other than Class A), which covers an area of 586.7 hectares.

Barrow Island was originally gazetted as a Class C reserve in 1908 to protect its flora and fauna. It was upgraded to a Class A reserve in 1910 and in 1979 it was classified as a nature reserve. Boodie, Double and Middle Islands Nature Reserve was gazetted in 1984. Both reserves extend to the low water mark and therefore include the intertidal zone. Collectively they are referred to as the Barrow group nature reserves and in this management plan, the 'planning area' (see Map 1).

Pasco Island is a small parcel (2.6 hectares) of unallocated Crown land (UCL) located about 500 metres off the eastern coast of Boodie Island (see Map 1). This management plan proposes its addition to the Boodie, Double and Middle Islands Nature Reserve due to its proximity to the existing nature reserve and its high conservation value. Any reserve additions, or changes in the classification of existing reserves or the category of land, will be subject to consultation within government prior to the additions or changes occurring.

The planning area is entirely located within the Cape Range subregion of the Carnarvon Interim Biogeographic Regionalisation for Australia bioregion. Kendrick and Mau (2003) provide a general description of this subregion. Currently, about 17.5 per cent of the land in this subregion is managed by the department and the planning area comprises about 31 per cent of its conservation reserves.

Desired outcome

The planning area is protected by providing the most appropriate tenure arrangements for conservation.

Management actions

1. Incorporate Pasco Island into Boodie, Double and Middle Islands Nature Reserve, subject to consultation within government.
2. Manage Pasco Island in accordance with this management plan once it is vested in the Conservation Commission.

3. Other tenure and land arrangements

The department's *Management Plan for the Montebello/Barrow Islands Marine Conservation Reserves 2007–2017 Management Plan No. 55* (DEC 2007) provided for the establishment of the adjoining Barrow Island Marine Park and the Barrow Island Marine Management Area, including the specific management zone: Bandicoot Bay Conservation Area (for 'Benthic Fauna/Seabird Protection'). The Bandicoot Bay Conservation Area has been gazetted under the *Fish Resources Management Act 1994* to the high water mark as part of an order to establish fishing restrictions. Management of this area under DEC (2007) only applies seaward from the low water mark. The area between the low and high water mark is part of the planning area and its management is therefore addressed in section 8.2 *Native animals and habitats*. This management plan complements the management of these marine reserves.

Bandicoot Bay Conservation Area. Photo – Kevin Crane

The Barrow Island Port Area also adjoins part of the planning area (see Map 1). The high water mark boundary of the port overlaps the planning area's low water mark boundary. The Department of Transport (DoT) has delegated management of the port area to Chevron Australia Pty Ltd. The Materials Offloading Facility and LNG jetty are not part of the planning area.

Industrial activities have the potential to impact on the ecological integrity of the planning area. Until 2009, the BWIJV was the only permanent industry presence in the planning area. The current operator of the BWIJV is Chevron Australia Pty Ltd. The lease (L 1H R2) was renewed for an additional period of 21 years in early 2009.

The *Barrow Island Act 2003* (the Barrow Island Act) enables land on Barrow Island Nature Reserve to be used, under the *Land Administration Act 1997* (Land Administration Act), for gas processing project purposes. The GJV has been granted approval under the *Gorgon Gas Processing and Infrastructure Project Agreement* (the State Agreement; Schedule 1 to the Barrow Island Act), to establish a gas processing project that produces 15 million tonnes per annum of LNG and 300 terajoules per day of domestic gas on Barrow Island Nature Reserve. The gas will be extracted from the Greater Gorgon and Jansz gas fields. Government granted conditional environmental approval for this project to proceed in 2009 (see section *Further reading*). The operator of the GJV is Chevron Australia Pty Ltd.

In accordance with the Barrow Island Act, the GJV is required to seek appropriate Land Administration Act titles (that is, leases, licences or easements) for its operations. The first long-term lease will be valid for a period of up to 60 years and total land tenure at any time cannot cover more than 300 hectares of previously uncleared land. Parts of the L 1H R2 lease have been surrendered to enable the grant of Land Administration Act leases to the GJV for certain infrastructure requirements. Construction started in 2009 and the first LNG for export and domestic use is expected in 2015.

All remaining parts of the planning area, except for the southern part of Double Island, are covered by petroleum exploration permits (see Map 1). Although not part of the planning area, activities undertaken in some offshore petroleum production licence areas (L 10 and TL/3) may also have adverse impacts on the intertidal habitat within the planning area and so are considered in this management plan.

4. Key values and threats

4.1 Key values

The planning area:

- includes the second largest island off the Western Australian coast
- is an important site of biological refuge because of its isolation from certain threatening processes occurring on the mainland (for example, it has low levels of NIS, including no non-indigenous vertebrates)
- contains flora species that are restricted within the planning area and/or are at, or near, the limits of their range, as well as priority-listed flora species and communities
- has a high number of fauna species with high conservation value (for example, species that are threatened, priority-listed, endemic, disjunct, relictual, locally restricted, at the limits of their range and/or significant according to regional, national or international criteria). These species include marine turtles, migratory shorebirds, a variety of subterranean fauna, eels and snakes, the black-footed rock wallaby (*Petrogale lateralis lateralis*) and populations of the Barrow Island boodie (*Bettongia lesueur* ssp.), Barrow Island spectacled hare-wallaby (*Lagorchestes conspicillatus conspicillatus*), Barrow Island euro (*Macropus robustus isabellinus*), Barrow Island golden bandicoot (*Isoodon auratus barrowensis*) and the Barrow Island black and white fairy-wren (*Malurus leucopterus edouardi*)

Barrow Island spectacled hare-wallaby (*Lagorchestes conspicillatus conspicillatus*). Photo – Dorian Moro/Chevron Australia Pty Ltd

- has an extensive hydrogeological karst system that supports a subterranean community of high conservation significance
- includes regionally and nationally significant rookeries for the threatened green and flatback marine turtles
- has important habitat for migratory shorebirds and is also used by these species as a staging and destination terminus
- contains other significant habitat values such as intertidal mudflats, rock platforms, mangroves, rock piles and cliffs, claypans and caves
- has a significant fossil record that indicates local historical biodiversity and evolution
- has a history of Aboriginal and other Australian use including 13 registered Aboriginal cultural heritage sites, potential for stratified heritage deposits dating back to the Pleistocene epoch and some informal pearling camps
- has considerable data established from long-term ecological research since the early 1900s and particularly since the mid-1960s.

4.2 Key threats

Existing and potential key threats to biodiversity and landform values within the planning area include:

- land clearing
- gravel extraction
- introduction of NIS and the spread and proliferation of existing weed species
- large intense bushfires
- contamination and/or pollution (including artificial lighting)
- altered hydrological regimes
- physical barriers to fauna movement caused by the position of infrastructure
- direct harm to fauna from the operation of machinery/vehicles.

Management purpose

5. Legislative framework

The following environmental legislation is relevant to the planning area:

- The CALM Act, which provides for the management of lands and waters vested in the Conservation Commission and the Marine Parks and Reserves Authority, respectively
- The *Wildlife Conservation Act 1950*, which provides for the protection of native flora and fauna on all state lands and waters
- The *Contaminated Sites Act 2003* (Contaminated Sites Act), which provides for the identification, investigation, assessment, registration and remediation of contaminated sites
- The *Environmental Protection Act 1986* (Environmental Protection Act), which provides for the prevention, control and abatement of pollution and environmental harm, and for the conservation, preservation, protection, enhancement and management of the environment. This includes environmental impact assessments and auditing compliance against environmental approval conditions issued under Part IV of the Environmental Protection Act. Assessment and issuing of vegetation clearing permits under the Environmental Protection Act has been delegated to the Department of Mines and Petroleum for clearing associated with petroleum activities.

Other state and federal legislation can affect some of the department's activities, confer specific powers on the department and involve other authorities or agencies in activities in the planning area.

Importantly, section 4 of the CALM Act stipulates that it does not derogate from any of the powers of petroleum legislation. Petroleum legislation allows industry unrestricted access to its lease/licence/permit areas to carry out any activities necessary for the purposes of exploring for, recovering and processing petroleum resources. These activities are regulated by the Department of Mines and Petroleum (DMP) to ensure that sound practices are in place, especially with respect to relevant environmental, safety and resource issues. State and federal environmental approval conditions may also place certain management obligations upon the relevant industry operators.

Key legislation relevant to the petroleum and gas processing operations in the planning area includes:

- the *Petroleum Act 1936* (governs only the BWIJV operations)
- the *Petroleum Pipelines Act 1969* (governs construction, operation and maintenance of pipelines and carbon dioxide injection wells used during petroleum operations)
- the *Petroleum and Geothermal Energy Resources Act 1967*
- the Barrow Island Act (ratifies and authorises implementation of the State Agreement; makes provisions for Land Administration Act tenure to be granted for gas processing project purposes and makes provisions for the disposal of carbon dioxide by injection beneath Barrow Island Nature Reserve).

The federal *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides for the protection of the environment, especially in relation to matters of national environmental significance. The presence of migratory birds protected under international conservation agreements such as the Japan–Australia Migratory Bird Agreement (JAMBA), China–Australia Migratory Bird Agreement (CAMBA),

Republic of Korea–Australia Migratory Bird Agreement (ROKAMBA) and the Bonn Convention, affords the planning area additional protection under the EPBC Act.

This management plan provides a summary of operations proposed to be undertaken by the department in the planning area as required under the CALM Act and addresses federal and international obligations. It also provides guidance for the preparation of subsidiary management documents (such as operational management plans) that provide more detail for specific management activities.

Specified throughout this management plan are policies relevant to the planning area, which may be revised or superseded during the life of the management plan. For departmental policies, see www.dpaw.wa.gov.au/about-us/36-policies-and-legislation.

5.1 Management agreements

Industry-related Memorandums of Understanding (MOUs) associated with the planning area have been prepared and endorsed. They include:

- an MOU between the department and Chevron Australia Pty Ltd (on behalf of the GJV) that sets out the arrangements for the provision of services and facilities to enable the department to undertake its role with respect to the GJV (best summarised in Clause 12 of the State Agreement)
- an MOU between the participants of the Barrow Island Coordination Council (BICC) and the department that sets out the working arrangements with respect to management of emergency incidents including suspected or actual breaches of quarantine.

There is also an opportunity to clarify the broader working relationships between all key stakeholders (for example, the department, industry operators and other government agencies) especially where legislative responsibilities potentially overlap. It is anticipated that this will assist integrated and successful management across the planning area.

An MOU also exists between the department and the Department of Lands in relation to the management of fire and declared plants and animals on UCL and unmanaged reserves outside the metropolitan area, regional centres and townsites. This MOU applies to the management of Pasco Island until it is incorporated into Boodie, Double and Middle Islands Nature Reserve.

Desired outcome

Key values will be protected and conserved through the support and implementation of statutory and non-statutory documents.

Management actions

1. Collaborate with other government departments that have responsibilities in relation to environmental compliance on and around the planning area, such as the EPA, Department of Environment Regulation (DER), DMP and DoT, to maintain a whole-of-government approach to environmental management in the planning area.
2. Promote close liaison combined with clear, integrated, coordinated and cooperative management arrangements between all key stakeholders within the planning area.

6. Management plan implementation

6.1 Administration

The day-to-day implementation of this management plan will be undertaken by departmental staff under the direction of the Pilbara Regional Manager. Figure 1 depicts the basic process that authorises the preparation and on-ground implementation of this management plan, as well as its relationship with other petroleum and gas processing arrangements (subject to section 4 of the CALM Act).

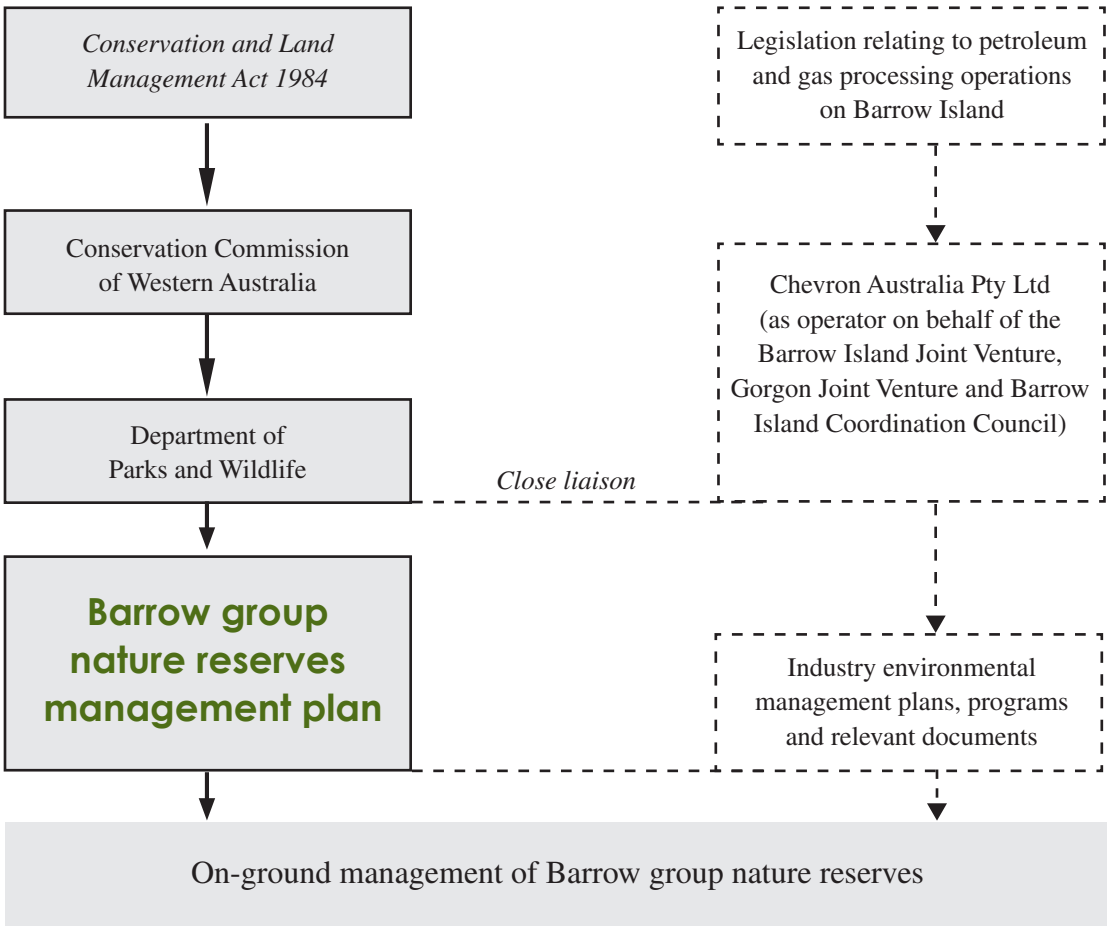

Figure 1: Diagram depicting the preparation and implementation of the *Barrow group nature reserves management plan 82 2015* in context with other key stakeholders and their environmental management arrangements.

The department also has a responsibility to liaise with BICC in relation to the terms and implementation of this management plan, where it relates to the activities of the BICC participants (Clause 13 (e)(ii) of the State Agreement).

Implementation of this management plan (and other industry-related documents) may lead to:

- new knowledge and subsequently the need to apply adaptive management
- identification of gaps in knowledge that require more research.

It is proposed that an annual forum is held with industry operators to discuss opportunities for adaptive management and further research, as well as any other issues relating to the management of key values in the planning area. Findings from this forum should be distributed to all participants in a timely manner.

Department and Chevron Project staff discuss rehabilitation of a site on Barrow Island Nature Reserve.
Photo – Wesley Manson/Parks and Wildlife

6.2 Performance assessment

The Conservation Commission will assess the implementation of this management plan in accordance with section 19(1)(g)(iii) of the CALM Act. The key performance indicators (KPIs) in this management plan reflect desired outcomes for the planning area while management actions guide the department's contribution to achieving these KPIs. Achievement of desired outcomes may depend on other stakeholders fulfilling their respective environmental management requirements.

Some of the KPIs measure changes in populations. Any sustained change may trigger the need for more investigation to determine the cause of that change. Some changes are naturally occurring and human intervention may not be desirable for various reasons. Other changes may be human-induced and every effort should be made to mitigate the negative impact. These types of KPIs may also require reporting on an annual (or other) basis but determining reliable trends or outcomes may not be possible without several years of reporting. Data at the time of plan approval provides the baseline for the performance measure, unless previous baseline information is available.

Providing accurate and relevant data and information to show the implementation of this management plan through KPIs and management actions is essential. Data may be obtained from industry operators, other government agencies or the wider community if it is available to the department through approved processes. Other information may be obtained from work carried out by the department, and may include the following:

- regular imagery, photographs, mapping or figures such as graphs to show spatial and temporal changes
- data obtained through on-site observations or investigations
- on-ground surveys
- incident investigation reports or records
- licence audit reports
- written correspondence notifying industry operators where compliance (for example, with respect to quarantine management) has been achieved or where improvements in management may be required.

6.3 Term of the management plan

This management plan is valid for a period of 10 years and comes into operation from the date that a notice is published in the Government Gazette. During this time, amendments to the final management plan are allowed, under section 61 of the CALM Act. If an amendment is necessary, the proposed changes will be released for public comment. At the end of the 10-year period, the management plan may be reviewed and a new management plan prepared. In the event that the management plan is not reviewed and replaced at the end of the 10-year period, the management plan will remain in force until a new management plan is approved.

Desired outcome

Successful implementation of this management plan.

Management actions

1. Apply best practice and adaptive management to this management plan to incorporate new knowledge and management techniques as they become available.
2. Organise an annual forum, with support and participation from industry operators (by way of relevant joint venture representatives), to discuss current issues in all key areas of management outlined in the management plan.
3. Liaise with specific bodies or individuals (for example, the BICC Manager, Integrated Emergency Response and Quarantine Operator, Island and Mainland BICC representatives and established expert panels (marine turtle, quarantine and dredging) in accordance with agreed processes, for relevant matters covered in this management plan.
4. Establish and maintain a portfolio of data and information throughout the life of the management plan as evidence that the management plan has been implemented.

Turtle Bay north beach. Photo – Michelle Rumball/Parks and Wildlife

Managing the natural environment

Emphasis in management of natural values in the planning area will include:

- protecting and conserving significant flora and fauna, particularly marine turtles, subterranean fauna, short-range endemic species and migratory shorebirds
- maintaining the integrity of ecological systems and processes of the intertidal and terrestrial environments
- improving baseline information on biodiversity, particularly the ecology of species of high conservation significance and lesser known species, as well as the condition of undisturbed but vulnerable environments such as subterranean habitats
- preventing the establishment, and undertaking eradication or control, of non-indigenous species
- managing fire to protect and promote biodiversity, and to protect life and property
- preventing and/or remediating contamination and/or pollution
- undertaking rehabilitation of any disturbed and unused sites.

7. Physical environment

7.1 Climate change

Climate change is considered to be a factor that is likely to affect biodiversity within the planning area in the long term. With little opportunity for species to migrate to a more suitable habitat, the impacts of climate change upon biodiversity are expected to be more severe on the islands compared with the Western Australian mainland (Conservation Commission 2009). In particular, it is predicted that sea levels will rise, storms will be more frequent and severe, and changes will occur in sea currents, temperature, rainfall, humidity and the risk of large uncontrolled bushfires (Conservation Commission 2009). Being able to accurately determine that a key value has been adversely and directly affected by climate change is difficult and unlikely to be identified during the life of this management plan. If monitoring indicates that climate change could be influencing key values, the department will consider further management options.

7.2 Geology, landforms and soils

The planning area falls within the Barrow sub-basin of the Northern Carnarvon Basin. The geology, landforms and soils of Barrow Island Nature Reserve are described in detail by various authors such as Campbell *et al.* (1984); Crank (1973); Lewis and Grierson (1990); McNamara and Kendrick (1994); Parry (1967); and Smith (1962). Only a brief description is available for Boodie (Buckley 1980; Morris 1990), Middle and Pasco islands (Buckley 1980). Information on Double Island is not well documented.

The geology, landforms and soils of Barrow Island Nature Reserve provide or support a range of ecologically important habitats, including an extensive underground karst system that probably extends to a depth of more than 100 metres below sea level (Humphreys 1995), surface caves, nesting beaches, intertidal mudflats, rock platforms, cliffs, rock piles, burrows and termite mounds. Claypans are an uncommon landform, with potential for evidence of prehistoric human occupation. They provide episodic freshwater for native fauna and vegetation types that are geographically restricted. Limestone formations contain fossils, which provide information on the area's prehistoric biodiversity and evolution. McNamara and Kendrick (1983, 1994) present a comprehensive discussion on this key value. Deep alluvial soils within the drainage lines on Barrow Island Nature Reserve support a variety of locally significant

vegetation communities. Aside from such direct relationships with vegetation (including its function as a natural seed store), soils also provide habitat for mycorrhizal fungi and other soil biota. Appropriate topsoil management following clearing is therefore essential in preparing for future ecosystem rehabilitation.

Barrow Island Nature Reserve has a range of ecologically important habitats including this cave at Biggada Creek which provides shelter for a group of euros during the hottest part of the day. Photo – Kevin Crane

Several activities have the potential to adversely affect the ecological values associated with the geology, landforms and soils. Contamination or pollution of the karst and soil, and direct disturbance caused by earthworks and infrastructure development, may be difficult to remediate. Other potential impacts include:

- loss of topsoil
- soil erosion
- compaction
- altered natural geomorphological dynamics and processes (for example, changes in beach profiles including accretion and sediment erosion).

7.3 Hydrology

The planning area has little free surface water. Pools of freshwater form on Boodie Island following heavy rain, indicating that a lens of freshwater may occur at shallow depth (P Kendrick, pers. comm. 2009). A soak with brackish water is present on the southern end of Boodie Island, but this does not have surface water unless excavated (Morris 1990). No more occurrences of freshwater are known for this island, or on Middle and Double islands.

Barrow Island Nature Reserve contains significant organised surface drainage patterns. Saline water bodies exist at the mouths of several creek systems (including Biggada Creek, pictured), and soaks with brackish water are found at a few locations. Because of the sporadic nature of high rainfall events and the high evaporation and infiltration rates, seeps (such as rock overhang and cave drips) are ephemeral, although fresh water is present at shallow depth throughout the year (Chevron Australia 2005a; Osborne *et al.* 2000; Smith 1962). Standing water may be found on the claypans for short periods following rain events, because of the lower permeability of the soils in these areas (Chevron Australia 2009a; Osborne *et al.* 2000).

Biggada Creek. Photo – Kevin Crane

The groundwater is described as anchialine because of the subsurface connection between the unconfined aquifer and the ocean. This system, influenced by tidal fluctuations, creates a halocline where the fresh groundwater meets the denser, saline sea water

(Chevron Australia 2005a; Humphreys 2001). This can provide critical habitat for many subterranean aquatic species and communities with highly specific ecological water requirements. If the integrity of this anchialine system is disturbed, then it is likely to have serious consequences for any inhabitants, particularly the halocline specialists (Humphreys 1995, 2001; Humphreys and Vine 1991). On Barrow Island Nature Reserve some sites have been contaminated with hydrocarbon products, which may have affected groundwater quality. Such sites are required to be managed by BWIJV in accordance with the Contaminated Sites Act.

Changes to hydrology may adversely affect the subterranean environment and other ecosystems, including important vegetation communities. This can occur because of construction of infrastructure and roads, groundwater abstraction and hydrocarbon or other chemical leaks or spills. Hydrological changes that may be caused by such activities include:

- contamination via surface or subsurface drainage, and increased risk of contamination near open conduits (such as caves, sinkholes or bores) to groundwater
- alterations to natural drainage patterns, depriving some areas of water and directing water into other areas where it may have serious impacts (for example, into caverns, leading to subsidence and sometimes collapse, or increased sedimentation)
- saltwater intrusion caused by over-abstraction of overlying freshwater
- disruption of inter-relationships between surface and aquifer environments (for example, altered recharge rates through vegetation clearing, soil profile modification or surface flow distribution).

There is no independent regulation of water use in the planning area but licences under Part V of the Environmental Protection Act and environmental approval conditions assist with the groundwater monitoring requirements associated with industrial activities (see section 14 *Water resources*).

Desired outcome

Geology, landforms, soils and hydrology are protected and conserved.

Management actions

1. Document and identify paleontological values of the planning area and assess risk to these values.
2. Collect information about the physical environment (particularly relating to the ecology and heritage of the planning area) to determine whether key values are being negatively impacted by human activity.
3. Notify industry operators and relevant agencies when the department detects adverse ecological impacts upon the physical environment that a) may be the result of petroleum and/or gas processing activities and b) are considered to be inconsistent with the terms of environmental approval conditions and/or subsequent industry environmental management programs/plans.

8. Biological environment

This part of the management plan draws largely upon species records obtained from NatureMap (DEC 2009a), environmental impact assessments and other publications by Chevron Australia Pty Ltd and their various consultants.

8.1 Native plants and plant communities

Knowledge of the vascular flora on Barrow Island Nature Reserve is comprehensive. The lower plants such as mosses and lichens are not well known. A basic description of the vegetation on Boodie, Double and Middle Islands Nature Reserve and Pasco Island has been provided in Buckley (1980).

Barrow Island Nature Reserve contains 377 known flora species (Astron 2009). Mattiske Consulting (1997) and Trudgen (1989) described the known flora of Barrow Island Nature Reserve as being, for the most part, typical of the arid Pilbara region but having floral affinities with the Cape Range area, especially along the coast. Some species and vegetation types known from Barrow Island Nature Reserve are unique among the islands on the North West Shelf (Astron Environmental Services 2002). The flora of Barrow Island Nature Reserve is dominated by families such as Poaceae (grasses), Chenopodiaceae (goosefoots), Fabaceae (legumes, peas and wattles), Malvaceae (mallows) and Asteraceae (daisies) and in particular by the genera *Triodia* (hummock-forming grasses) and *Acacia* (wattles) (Mattiske Consulting 1997).

The planning area contains several plant species of conservation significance, including:

- one endemic species (*Cucumis* sp. Barrow Island)
- 12 species that have a restricted distribution in the planning area and are at, or near, the geographical limits of their range. Fifteen additional species are geographically restricted within the planning area but are not at, or near, the extent of their range, while nine species are at, or near, the geographical limits of their range but are not considered to be restricted in their distribution (Astron 2009). A single stand of *Cordia subcordata* that was recorded on Boodie Island may potentially be a disjunct isolate from its range (the northern Kimberley coastline), though it could also be the result of a previous introduction
- three priority species – *Helichrysum oligochaetum* (Priority 1), *Cucumis* sp. Barrow Island (Priority 2) and *Corchorus congener* (formerly *C. interstans*) (Priority 3)
- one species, tangling melaleuca (*Melaleuca cardiophylla*), that has a low regeneration capacity
- flora species that have either been rarely collected but specimens have been catalogued (42 species), rarely collected and no specimens are catalogued (53 species), or inadequately identified (74 species).

Bat's wing coral tree (*Erythrina vespertilio*) is restricted in distribution on Barrow Island Nature Reserve. Photo – Kevin Crane

Tangling melaleuca is important because it is one of the key habitat types for some restricted fauna species, including the Barrow Island population of the black and white fairy-wren (RPS BBG and Mattiske Consulting 2005). Historically, this species has not responded well to ecosystem rehabilitation efforts and is one of 15 species identified as 'recalcitrant' (Outback Ecology 2006a).

Astron (2009) identified 755 vegetation associations, representing five categories across Barrow Island Nature Reserve. Two flora-based Priority 1 ecological communities ('*Triodia angusta*-dominated creekline vegetation (Barrow Island)' and 'Coastal dune native tussock grassland dominated by *Whiteochloa airoides*') have been identified. The '*Triodia angusta*-dominated creekline vegetation (Barrow Island)' community has recognised conservation status because of its relative rarity, the important habitat it provides for some native fauna and the high level of historical disturbance or loss through activities such as gravel extraction (Chevron Australia 2009a; Outback Ecology 2005; RPS BBG and Mattiske Consulting 2005). The department's priority ecological communities list indicates that the 'Coastal dune native tussock grassland dominated by *Whiteochloa airoides*' community is highly vulnerable to invasion by buffel grass (*Cenchrus ciliaris*).

The most common vegetation type of the intertidal zone is macroalgae, with seagrass meadows sparsely interspersed (Chevron Australia 2009b; DEC 2007). Both provide a direct food source for green turtles, and shelter, food and/or substrate for a large variety of benthic species. These in turn become a food source for other marine turtle species such as the flatback and hawksbill (*Eretmochelys imbricata*) (DEC 2007; Pendoley Environmental and RPS BBG 2005; RPS BBG 2005a).

One species of mangrove, the white mangrove (*Avicennia marina*), occurs on the south and east coasts of Barrow Island Nature Reserve. It provides protection and stabilisation of the shoreline, as well as habitat for fauna (RPS BBG 2005b; RPS Environment and Planning Pty Ltd 2009).

Mangroves (*Avicennia marina*) in Bandicoot Bay Conservation Area. Photo – Michelle Rumball/Parks and Wildlife

One of the significant threats to native flora and vegetation communities in the planning area is land clearing. A clearing permit is required under the Environmental Protection Act (section 51C) unless an exemption listed in Schedule 6 of that Act applies or the clearing is prescribed in the Environmental Protection (Clearing of Native Vegetation) Regulations 2004. An exemption applies for the clearing of no more than 300 hectares of previously uncleared land for the Gorgon gas project on Barrow Island Nature Reserve (see section *Further reading*).

Other threats to the native flora and vegetation communities include:

- altered soil conditions (for example, loss of nutrient-rich topsoil, contamination such as hydrocarbon spills or leaks, erosion, compaction, inversion and transportation of soil and seed through dust)
- physical disturbance or removal of landforms and substrates
- disturbance to the condition and availability of natural water resources (for example, by interruption to drainage, groundwater abstraction, or contamination)
- vegetation composition changes through invasion of colonising native species in areas surrounding a disturbance
- introduction of non-indigenous species
- inappropriate fire regimes.

Climate change and intensive grazing of young palatable seedlings by native mammals may also threaten vegetation communities, especially during ecosystem rehabilitation.

8.2 Native animals and habitats

Thirteen species of mammals (including two species of bat), 119 terrestrial and migratory bird species, 43 terrestrial reptile species, one species of frog, four species of marine turtles and three subterranean vertebrate species have been regularly recorded on Barrow Island Nature Reserve (Moro and MacAuley 2010a,b,c). At least 2,000 taxa of invertebrates, including 34 subterranean invertebrates, have also been recorded on the island (Callan *et al.* 2011). The diversity of fish and marine invertebrates inhabiting intertidal areas is unknown.

The planning area contains many fauna species of regional, state, national and international conservation significance. In 2012 there were:

- 23 threatened species including the Barrow Island boodie; the Barrow Island golden bandicoot; the Barrow Island spectacled hare-wallaby; the Barrow Island euro; the black-footed rock wallaby; the Barrow Island black and white fairy-wren; the fairy tern (*Sternula nereis nereis*); the green, flatback, hawksbill and loggerhead (*Caretta caretta*) turtles; and a range of subterranean fauna
- four priority species: the water-rat *(Hydromys chrysogaster*) (Priority 4); spear-beaked cave shrimp (*Stygiocaris stylifera*) (Priority 4); a subterranean blind snake (*Ramphotyphlops longissimus*) (Priority 2); and the Australian bustard (*Ardeotis australis*) (Priority 4). The latter species has not been recently recorded in the planning area

- 68 bird species protected under the EPBC Act (Moro and MacAuley 2010c), which include 40 species listed under international agreements (that is, JAMBA, CAMBA, ROKAMBA and the Bonn Convention)
- 22 endemic fauna species
- more than 40 potential short-range endemics (Biota Environmental Sciences and RPS BBG 2005a), predominantly consisting of reptiles, invertebrates and subterranean fauna. Some of these species are newly discovered, only known from Barrow Island Nature Reserve or only known from one or two specimens.

The planning area is well recognised for its important subterranean fauna (EPA 2012). It contains:

- a high species richness (significant on an international scale, especially for amphipods)
- 12 threatened, one Priority 2 and one Priority 4 species
- a Priority 1 ecological community ('Barrow Island subterranean fauna'), which includes a suite of occurrences across Barrow Island Nature Reserve
- some relictual subterranean species with linkages within and outside Australia
- species previously undescribed, not known from other locations or only known from one or two specimens. The planning area is special in that it has three known subterranean vertebrate species – a subterranean blind snake (the first truly troglobitic reptile to be described globally), the blind gudgeon (*Milyeringa justitia*) and a subterranean eel (this animal has been observed, but no specimen has so far been retained). These are all species restricted, or likely to be restricted, to the planning area.

It is anticipated that the known diversity of subterranean fauna will increase with future investigations. More detail on subterranean fauna values can be found in Biota Environmental Sciences and RPS BBG (2005b); Chevron Australia (2005a); Humphreys (1993, 1995, 2001); and Humphreys and Vine (1991).

Subterranean ecosystems on Barrow Island Nature Reserve may be at least partially dependent upon energy derived via chemoautotrophic bacterial systems metabolising petroleum-sourced chemical products. These bacteria may be considered keystone species (Biota Environmental Sciences and RPS BBG 2005b; Humphreys 2001).

Barrow Island black-footed rock wallaby (*Petrogale lateralis lateralis*). Photo – Russell Lagdon/Chevron Australia Pty Ltd

Termites make a significant contribution to key ecological processes on Barrow Island Nature Reserve by providing habitat and a food resource for other species, as well as mobilising nutrients within the ecosystem (Chevron Australia 2005a). It is unclear whether any of these roles are unique to termites (that is, whether they are keystone species) (K Morris, pers. comm. 2008).

The planning area is recognised as one of the most important areas for native fauna conservation in the state because its geographic isolation has resulted in it becoming an important refuge for many species that have either declined or become extinct on the mainland (EPA 2006a). However, geographic isolation may possibly lead to genetic differentiation including low genetic diversity. Populations that have low genetic diversity may become more vulnerable to threatening processes, increasing the risk of local extinction. Species with restricted habitat may also be at risk, especially from events such as bushfire. The Barrow Island population of black-footed rock wallaby is an example where both of these circumstances may apply (Chevron Australia 2005a).

Habitats

Butler and Buckley have described eight major habitats for Barrow Island:

1) marine
2) tidal
3) creek or seasonal drainage lines
4) coastal complexes and dune systems
5) flats
6) claypans
7) limestone ridges
8) valley slopes and escarpment slopes (CALM 1999 and Outback Ecology 2005).

On a finer scale, Outback Ecology (2005) lists specific animal habitat preferences for Barrow Island Nature Reserve. The diversity of fauna has been attributed to the range of habitats available, as well as the geographical isolation of the island.

The physical environment (that is, geology, landforms, soils and hydrology) is the foundation for these habitats and strongly influences the distribution of vegetation (RPS BBG and Mattiske Consulting 2005) and ultimately terrestrial fauna species and communities. Oceanographic and geological processes (for example, currents, waves, and tidal and sediment movements) are integral in maintaining the ecological structure and function of the six intertidal habitats (limestone platform reefs, rocky shores, sandy beaches, sand/mud flats, coral reefs and mangroves) and the distribution of their inhabitants (Chevron Australia 2005a; DEC 2007).

Some of the sandy beaches contain regionally significant rookery sites for two species of marine turtle (green and flatback), and intertidal habitats are important for foraging juveniles, nesting females and those adults that appear to be resident (Chevron Australia 2009c; DEC 2007; Kendrick and Mau 2003). *The National Recovery Plan for Marine Turtles in Australia* (DEH 2003) identifies the planning area as a habitat critical to the survival of these species. The planning area represents the south-west extent of nesting of the flatback turtle. Hawksbill turtles are regular breeders and loggerhead nesting is only occasional.

The coastline of the planning area is recognised for its regional, national and international significance for migratory shorebird species. It is considered to be a staging and destination (terminus) site for some species, supports high numbers of shorebirds over the breeding period and offers important winter habitat for the non-breeding migratory birds. Barrow Island Nature Reserve is designated as an Important Bird Area[2] because of its importance to shorebirds. It is equal tenth among the 147 important sites for seven migratory shorebirds in Australia and is the fourth and fifth most important site in Australia for the ruddy turnstone (*Arenaria interprens*) and grey-tailed tattler (*Tringa brevipes*), respectively (Bamford and Moro 2011).

A flatback hatchling. Photo – Kevin Crane

The highest populations of migratory shorebirds were found in the tidal mudflats in the south and south-east of Barrow Island Nature

Reserve (Bamford and Moro 2011). The habitat of Bandicoot Bay in the south of Barrow Island Nature Reserve offers a large intertidal reef and mudflats for waders and is protected as part of the Bandicoot Bay Conservation Area (DEC 2007). Barrow Island Nature Reserve is also regionally significant for the local fairy tern and the resident ophthalmicus race of the sooty oystercatcher (*Haematopus fuliginosus*) (Bamford *et al.* 2005).

Double Island is considered a regionally significant site for breeding wedge-tailed shearwaters (*Ardenna pacificus*). Other species such as the bridled tern (*Onychoprion anaethetus*) and white-bellied sea eagle (*Haliaeetus leucogaster*) have also been observed breeding at this site (Bamford *et al.* 2005). Buckley (1980) also noted several seabird nesting sites on Middle, Boodie and Pasco islands.

Other important habitats include the karst system that extends throughout the majority of the planning area, supporting significant subterranean species and communities, and shelter habitats such as cliffs and rock piles that are important refuges for fauna such as boodies and bats, and fire-sensitive flora.

Natural processes, as well as human activities, may have potential impacts on the local marine turtle populations. This management plan only deals with terrestrial impacts except where marine impacts occur in the intertidal zones. When terrestrial impacts are combined with marine impacts[3], the consequences may be severe, particularly with respect to the flatback turtle population. Publications by Chevron Australia (2009c); DEC (2009b) and Pendoley Environmental and RPS BBG (2005) provide comprehensive information on the threats to marine turtles.

Other native fauna, faunal communities and habitats are also vulnerable to impact from natural processes and human activities. Impacts may include unnatural behaviour (of fauna), injury (of fauna), destruction (of fauna and habitat) or physical alteration (of habitat). These threats are discussed in more detail in other sections of this management plan. Barrow Island Nature Reserve has been a source for translocation of fauna species and may continue to be in the future, if deemed necessary.

Although the biodiversity is relatively well known for Barrow Island Nature Reserve, several knowledge gaps still exist, particularly in the biology and ecology of some native species, communities and habitats. There is also a lack of knowledge on the cumulative impacts of human activities on some native fauna and habitats. Available information is even less for the smaller surrounding islands (Boodie, Double and Middle islands). To assist in addressing these issues, a more comprehensive species and habitat inventory needs to be completed. Particular requirements for this inventory and other research priorities are detailed in section 19 *Reporting, research and monitoring*.

Desired outcome

Native species, communities and habitats are protected and conserved.

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[2]*IBA criteria were developed by Birdlife International (further defined in Dutson* et al. *2009). Barrow Island Nature Reserve meets the criteria of regularly supporting >1% of the global species population of pied oystercatcher (*Haematopus longirostris*), grey-tailed tattler, red-necked stint (*Calidris ruficollis*) and fairy tern. Barrow Island Nature Reserve also meets the IBA criteria of supporting a representative population of restricted range species for the biome-restricted spinifexbird (*Eremiornis carteri*) and supports threshold numbers of globally threatened species– the vulnerable Barrow Island subspecies of white-winged fairy-wren (see www.birdata.com.au/iba.vm).*

[3]*In partnership with industry operators, the department will manage ecological impacts upon the marine environment (including marine turtles) in accordance with DEC (2007) and other industry environmental management plans and relevant documents. The Marine Turtle Expert Panel (MTEP) was established under Ministerial implementation statement 800. The MTEP role is to provide advice to the Minister for Environment and the GJV on marine turtle management and monitoring. It is to be consulted on marine turtle-related matters relevant to the project. The MTEP comprises independent turtle experts, representatives from the department and other agencies, and Chevron.*

Objective

Work with industry operators to avoid (unless otherwise permitted through the relevant industry environmental approval conditions) significant and adverse disturbance or alterations to important populations, communities of native flora and fauna and their habitats.

Management actions

1. Identify knowledge gaps relating to threatened, priority and under-studied flora and/or fauna, population numbers and distributions and important habitats, and undertake, support or encourage work to fill such knowledge gaps.
2. Recognise threatened or poorly known species by seeking to list them under state and/or federal legislation as appropriate.
3. Collect information about the biological environment to determine whether key values are being negatively impacted by human activity. Particular focus will be given to:
    - the '*Triodia angusta*-dominated creekline vegetation (Barrow Island)' ecological community
    - the 'Coastal dune native tussack grassland dominated by *Whiteochloa airoides*' ecological community
    - migratory shorebird populations
    - subterranean fauna species and communities
    - local marine turtle populations, especially with respect to light, noise and marine operations
    - species with restricted distributions, especially those occurring in areas of disturbance
    - species listed for special protection by the state and federal governments
    - other local or regionally significant species and communities.
4. Notify industry operators and appropriate agencies, and take action as necessary, when the department detects adverse ecological impacts upon the biological environment that a) may be the result of petroleum and/or gas processing activities and b) are considered to be inconsistent with the terms of the relevant industry environmental approval conditions and/or subsequent industry environmental management programs/plans.
5. Collaborate with industry operators and other agencies to determine appropriate responses to wildlife incidents.

Key performance indicators

Performance measure	Target	Reporting requirements
Abundance and diversity of seabirds and shorebirds using key sites from Barrow Island Nature Reserve, as referenced	No sustained decrease of seabird and shorebird diversity or abundance due to human activity on Barrow Island Nature Reserve	Annually*
The conservation status of threatened or priority species or species of local significance in the planning area	Assessment of available evidence indicates no adverse change in the conservation status of threatened and priority species or species of local significance in the planning area. Where required, knowledge gaps are addressed.	Every five years

*Annual monitoring during the first three to five years is recommended to detect possible fluctuations in seabird and shorebird numbers and diversity (M Bamford, pers. comm. 2012 and N Dunlop, pers. comm. 2012).

9. Protecting the natural environment

9.1 Non-indigenous and other problem species

NIS can be introduced in a number of ways, including vessels/aircraft carrying contaminated clothing, food and other materials such as personal luggage, plant, palletised and containerised goods, vehicles and machinery, floating debris, birds and wind. NIS may also fly, swim or drift into the planning area. Introduction of NIS is one of the most significant threats to biodiversity in the planning area because:

- they have a wide range of adverse impacts upon native ecosystems (for example, species competition and predation, and modification of ecosystem structure, function and composition), and different NIS species can work in concert with each other to devastating effect on local biodiversity
- they are difficult and expensive to manage, given that they can spread and reproduce quickly, and may prove impossible to eradicate. Despite stringent monitoring, it is possible that NIS may remain undetected until after a significant population has been established
- native island populations may be intrinsically vulnerable to local extinctions, especially those with low genetic diversity or restricted habitats. Pressure from NIS is likely to exacerbate this tendency.

A small number of NIS have established in the planning area in comparison to nearby islands and the mainland. Most established NIS on Barrow Island Nature Reserve occur in disturbed areas (Chevron Australia 2009d). The risk of introductions has been increased during the construction phase of the Gorgon gas project due to mobilisation of personnel and resources required to build the project. GJV has established and implemented a Quarantine Management System (QMS) to prevent further introduction of NIS to the island, to prevent proliferation of existing NIS on the island, and to detect and eradicate non-indigenous terrestrial plants and animals and marine pests that may be introduced to the island, as a consequence of the Gorgon gas project. The QMS has been approved by government. The department is responsible for full-time independent review and monitoring of quarantine management in the planning area and at mainland GJV sites in Western Australia.

The GJV and BWIJV participants have agreed that the GJV operator will be the BICC Manager and the Integrated Emergency Response and Quarantine Operator. This operator will have responsibility for emergency response to and, where necessary, remediation of, any suspected or actual breach of quarantine in the operations of any of the BICC participants. Responsibility for ongoing response and remediation in respect of such incidents will generally be handed over to the operator of the joint venture that has tenure over the area where the incident occurs.

In accordance with the arrangements set out in the relevant MOU discussed in subsection 5.1 *Management agreements,* the department will liaise with the Chevron Person in Charge where it considers that a quarantine breach has occurred.

Imbalances in natural ecosystems can result in native species becoming problematic and causing similar impacts to NIS. If such a situation arises, the problem species may need to be controlled where the risk to other native species is considered unacceptable.

Environmental weeds

Twenty-eight non-indigenous vascular plant species have been recorded on Barrow Island Nature Reserve. In 2009, 12 species were recorded on Barrow Island, three species were recorded on Boodie Island and one on Middle Island (RPS Environment and Planning Pty Ltd 2010). Chevron Australia Pty Ltd has successfully removed a number of weed species from Barrow Island Nature Reserve.

Kendrick and Mau (2003) noted that buffel grass, found on Barrow and Boodie islands, is the species of highest concern because of its known major impact upon island vegetation communities. They also identified kapok (*Aerva javanica*) as a species that has been difficult to eradicate from Middle Island and remains a high priority for surveillance and control.

Animals

Barrow Island Nature Reserve is particularly noteworthy for being the biggest land mass in Australia with no extant non-indigenous vertebrates. There are known non-indigenous invertebrates on Barrow Island Nature Reserve although the exact number of species is unclear. Historically, black rats, house mice, honey bees, wasps and frogs have all been introduced to the planning area (Chevron Australia 2005a) but Chevron Australia Pty Ltd and the then DEC combined to successfully eradicate them. More recently, quarantine personnel working in the GJV have intercepted various vertebrate and invertebrate NIS on, or close to, Barrow Island Nature Reserve.

Human activity can influence native animal behaviour and populations, as follows:

- Artificial lighting has the potential to impact native species. Management actions associated with reducing lighting impacts can be found in sections 9.3 *Waste disposal, contamination and pollution* and 15 *Accommodation and infrastructure.*
- Native species can proliferate if scavenging opportunities for food or water are available, and may become problem species because of this.
- Native fauna may intensively graze vegetation in areas subject to rehabilitation, which can reduce the success of such works.

Barrow Island golden bandicoot (*Isoodon auratus barrowensis*) feeding on turtle eggs. Photo – Kevin Crane

Desired outcome

Key values are not significantly and adversely impacted by non-indigenous species.

Objective

Work with industry operators to:

- prevent new introductions and proliferation of non-indigenous species throughout the planning area
- reduce the number of, and area occupied by, existing non-indigenous species.

Management actions

1. Undertake full time, independent review and monitoring of:
   a. quarantine operations and processes on Barrow Island (for example, vessels)
   b. quarantine operations at mainland supply bases.
2. Participate in review of operational quarantine procedures and actions.
3. Discuss quarantine actions with, and provide advice to, industry operators as necessary.
4. In the event that non-indigenous species are introduced onto Barrow Island Nature Reserve following commencement of the Gorgon project, and with support from GJV through the provision of funding as required by Ministerial implementation statement 800, implement control measures with a priority for those non-indigenous species with new populations or those that have high levels of invasiveness, distribution and/or environmental impact.
5. Assess non-indigenous species and problem species to determine if eradication is feasible and initiate control as necessary in the planning area.
6. Develop and disseminate information to the wider community regarding best practice quarantine management in the planning area.

Key performance indicator

Performance measure	Target	Reporting
The presence of non-indigenous species	Progress towards successful eradication of targeted non-indigenous species	Annually

9.2 Fire

The vegetation of Barrow Island Nature Reserve is characterised by the presence of communities dominated by spinifex (Muller 2009). These communities will burn readily and with great intensity, even under relatively mild conditions. Despite this, only a single large bushfire has occurred on Barrow Island Nature Reserve since reliable recordkeeping began in the 1960s. That fire burnt approximately 90 per cent of the island (CALM 1999). Since then, a number of small fires have been ignited by lightning strikes, electrical malfunction or other accidental ignitions but these have been quickly suppressed. No prescribed burning has been undertaken on Barrow Island Nature Reserve. The fire history of Boodie, Double and Middle Islands Nature Reserve is unknown, although patchier fuels and a lack of spinifex on these islands make the vegetation less likely to burn.

Muller (2009) undertook an analysis of the risk posed by bushfire on Barrow Island Nature Reserve. A summary of his key findings follows:

- The risk of ignition is low.
- Large areas of the island contain very dense *Triodia*. Direct attack suppression is unlikely to succeed against a bushfire burning in these areas under severe fire weather conditions.
- Rapid response and effective initial attack is essential to suppress bushfires.
- It is highly unlikely that resources could be deployed from the mainland in time to contribute effectively to fire suppression on the island.
- Suppression capability will be diminished if a bushfire occurs outside the oilfield area.
- There is a moderate amount of high-value infrastructure on the island (note that biodiversity assets were not assessed).

Environment and biodiversity

A bushfire on any of the four islands may have a number of deleterious impacts on the biota. These may include the disturbance of habitat and increased vulnerability to weed invasion and soil erosion, and loss of the topsoil and its seed bank. Significantly, there is potential for a large proportion of Barrow Island

The dense spinifex vegetation communities of Barrow Island Nature Reserve have the potential to fuel high-intensity island-wide bushfires. Photo – Kevin Crane

Nature Reserve to burn in a single event (Muller 2009). Such an event would create a considerable risk of local extinction for fire-sensitive taxa on the island. It is less likely that the entirety of Boodie, Double or Middle islands would be affected in a single event, due to those islands carrying lighter fuel loads.

Little is known about the fire ecological requirements of local taxa. It is therefore unclear what role bushfire may play in maintaining biodiversity in the planning area. It has been suggested that fire might increase the availability of nitrogen to plants (see section 9.4 *Ecosystem rehabilitation*) and may increase the rate of spinifex regeneration (Casson 2003). Observations suggest that many palatable species resprouting after a fire may be selectively grazed. This is of concern as the size and intensity of fire may have implications for the re-establishment of some flora species.

A major fire within the oilfield may present indirect risks to fauna and flora, for example, glass-reinforced epoxy flowlines can be impacted by intense fire conditions (as observed in the M station fire, 2003 and Q block fire, 2011: P Kendrick, pers. comm. 2011), resulting in contamination and/or pollution of the surrounding environment by pipeline contents and combustion products.

Life and asset protection

A large fire on Barrow Island Nature Reserve would pose a significant threat to the safety of people on the island and to infrastructure associated with the oilfield. The combination of terrain, the arrangement of the road network, hazardous on-ground infrastructure and the presence of obstacles to vehicles creates a risk of entrapment of personnel in the event of a major fire. The presence of people and infrastructure on Barrow Island Nature Reserve will increase over coming years as the Gorgon gas processing plant and associated facilities are developed.

The department has legislative responsibilities under the CALM Act and *Bush Fires Act 1954* to undertake bushfire management (that is, fire prevention and suppression works) on lands that it manages. Additionally, the *Emergency Management Act 2005* sets out the emergency management arrangements for the state, requiring that a number of emergency response plans be maintained. The response plan for bushfire is *Westplan Bushfire*, which sets out the department's role and obligations as a 'Controlling Agency', together with that of other relevant agencies, in contributing to bushfire suppression planning and response operations.

Bushfire management is guided by the department's *Policy Statement No. 19: Fire Management Policy* (CALM 2005), its code of practice for bushfire management (DEC 2008), relevant bushfire management guidelines and advice from specialist departmental staff. The Conservation Commission's *Position Statement No. 1 – Fire Management* (Conservation Commission 2011) also provides guidance on fire management.

The department will also develop an integrated fire management strategy for the whole of Barrow Island Nature Reserve in consultation with BWIJV, GJV, Chevron Australia Pty Ltd, DMP, the Conservation Commission, Department of Fire and Emergency Services and the Shire of Ashburton. The strategy will aim to protect human life, infrastructure and biodiversity from fire. Key issues to be considered in the strategy include:

1. bushfire risk mitigation – a fire management plan for Barrow Island Nature Reserve will be developed in consultation with stakeholders, focusing on pre-suppression bushfire risk mitigation actions and activities. The fire management plan will be implemented by the department in partnership with other stakeholders
2. fire suppression – a documented understanding of suppression activities, including roles, responsibilities, notification requirements and possible authorisations, will be prepared in consultation with stakeholders
3. fire management arrangements for the Gorgon gas project, as outlined in the Chevron Australia (2009e) and required by Ministerial implementation statement 800.

Bushfire management (including prescribed burning and bushfire suppression) on Boodie, Double and Middle Islands Nature Reserve will only be undertaken if the risk to key values (see section 4 *Key values and threats*) becomes unacceptably high.

Desired outcomes

1. Humans are protected from uncontrolled fires.
2. Major infrastructure is protected from harm caused by bushfire.
3. Harm caused to biodiversity and the environment by bushfire is minimised.

Management actions

1. Develop and implement an integrated Barrow Island Nature Reserve fire management strategy in consultation with key stakeholders.
2. Develop and implement a fire management plan for Barrow Island Nature Reserve, in accordance with the fire management strategy and in consultation with key stakeholders.
3. Document arrangements, including roles and responsibilities, for fire suppression on Barrow Island Nature Reserve in consultation with key stakeholders.
4. As far as possible and practicable, suppress bushfires when the risk to biodiversity on Boodie, Double and Middle Islands Nature Reserve becomes unacceptably high.

9.3 Waste disposal, contamination and pollution

Petroleum and gas processing activities produce a variety of wastes that require disposal. Chevron Australia Pty Ltd manages waste disposal from its industrial activity. Some of the key documents that guide management of industrial solid, liquid and hazardous waste include Chevron Australia (2009f, 2009g, 2009h, 2009i and 2009j). State and federal environmental approval conditions apply to GJV's waste management, including the specific requirement for at least 80 per cent of the reservoir carbon dioxide removed during its gas processing operations to be trapped and disposed of via deep well injection.

Accidental spills and historical oilfield practices in petroleum production, waste disposal and storage of dangerous goods have already resulted in soil, groundwater and coastal contamination over some areas of Barrow Island Nature Reserve. Contamination and/or pollution (see *Glossary*) may be high- or low-risk events, depending upon frequency and/or consequence. In general, contamination differs from pollution in that it is restricted to a medium such as land or water (that is, it does not include light or noise emissions). Because there is potential for both events to occur, both terms are used in this management plan.

Terminal tanks on the east coast of Barrow Island Nature Reserve near Town Point. Photo – Dr Fran Stanley/Parks and Wildlife

The state government maintains a register of contaminated sites in Western Australia. While no contaminated sites are registered on Boodie, Double and Middle Islands Nature Reserve, there are suspected contaminated sites, including old drilling leases, on these islands. Barrow Island is listed on the contaminated sites register, with several facilities such as the terminal tanks (pictured), under active investigation and remediation. All existing contamination sites have originated from BWIJV operations in the planning area.

The potential impacts upon karst environments (including their fauna) and the extent of environmental harm has not yet been determined. It is believed that hydrocarbons affect species and communities through metabolic effects and smothering (Chevron Australia 2008) and toxicity (Battelle 2007).

BWIJV has a monitoring and remediation program in operation for known contaminated sites on Barrow Island Nature Reserve. Remediation is undertaken by implementing oil recovery processes such as manual, absorbent, vacuum or skimmer recovery and mechanical collection. Remediation efforts are limited where contaminants are close to infrastructure and generally involve less disruptive methods such as monitoring and attempting to enhance *in situ* natural remediation through chemoautotrophic bacterial systems. RPS BBG (2007) gives a brief description of each of these processes.

The BWIJV is also installing glass-reinforced epoxy flowlines, which are less likely than carbon steel flowlines to leak through corrosion. However, this could present another contamination risk as glass-reinforced epoxy flowlines are more vulnerable to fire than steel flowlines.

Light emissions affecting important marine turtle nesting beaches and intertidal areas will originate from flaring and lights on the Gorgon gas processing plant, associated infrastructure and vessels (Chevron Australia 2005a). Chevron Australia (2009c) and DEC (2009b) have described the potential impacts that artificial lighting may have on nesting and hatchling flatback turtles. Some of the key lighting impacts may include:

- misorientating or disorientating hatchlings (on land and in water)
- increasing vulnerability to predation in high visibility conditions
- causing abnormal nocturnal behaviours
- causing gravid female turtles to either attempt to nest at sub-optimal sites or shed their eggs at sea.

Seabird populations, including those breeding on Double Island, may also be affected by lighting impacts (Bamford and RPS BBG 2005; Chevron Australia 2008, 2009a). Industry operators have addressed lighting impacts through the environmental approvals process, subsequent environmental management plans and relevant documents and licence conditions.

Noise and vibration may impact on fauna movement and behaviour, as well as affect shorebird and turtle eggs, potentially reducing hatchling success (Chevron Australia 2005b). Waste disposal by deep well injection, including geosequestration of carbon dioxide, may impact on subterranean fauna and the karst habitat if there is a leak or if unpredicted migration of the gas or other disposed material occurs. Other waste management actions that may lead to pollution incidents include contamination of the intertidal zone through discharge of brine and treated wastewater, leaks, atmospheric emissions and dust, littering and inappropriate disposal of food waste.

Any person, company or other entity that causes pollution or contamination is primarily responsible for remediation of the site and, where possible, to the standard outlined in section 9.4 *Ecosystem rehabilitation*. The industry operators have agreed that the responsibility for ongoing response and remediation will revert to the operator of the joint venture that holds the tenure where the incident occurred. The department is responsible for remediation of any site affected by pollution or contamination resulting from its activities.

DER administers legislation that governs the management of emissions and discharges from premises prescribed under the Environmental Protection Regulations 1987. In particular, DER oversees waste disposal and issues licences in accordance with the Environmental Protection Act for prescribed premises. These licences may be renewed periodically if the licensee can demonstrate that licence requirements have been met.

Other legislation also applies to prevent contamination from petroleum infrastructure such as pipelines. DMP is responsible for administering this legislation and also conducts audits that include overseeing pipeline maintenance. DoT is responsible for shipping activities in state waters and for the statewide *Oil Spill Contingency Plan* (Department of Transport 2010). Documents such as the environmental management program associated with the BWIJV lease agreement and relevant industry environmental management plans/programs required under the state and federal environmental approval conditions, assist in preventing the occurrence of contamination and/or pollution, and stipulating remediation requirements if an incident does occur.

Desired outcome

Key values are not significantly and adversely impacted by waste disposal and the occurrence of pollution and/or contamination.

Management actions

1. Where required, assist DER to monitor industry operator compliance with the Environmental Protection Act (including associated licences) and the Contaminated Sites Act with respect to waste and escaped pollutants.
2. Liaise with the BICC manager to ensure the department is updated on changes to plans and procedures for emergency response to escaped pollutants.
3. Notify industry operators and appropriate agencies (such as DER's Contaminated Sites Branch) when the department detects adverse ecological impacts that may have been caused by industrial waste management, contamination or pollution that is considered to be inconsistent with the terms of the relevant industry environmental approval conditions and/or subsequent industry environmental management programs/plans.
4. Support industry operators to develop best practice in managing waste, pollution and contamination.
5. Support research trials associated with alternative remediation techniques.
6. Respond to, and advise DER of, any occurrence of non-industry-related contamination and/or pollution incidents where prevention fails.
7. Develop plans for managing oiled wildlife as required, which are complementary to state oil spill contingency plans.

9.4 Ecosystem rehabilitation

It is the department's first preference to avoid significant disturbance to any natural environment. Where disturbance does occur, ecosystem rehabilitation should be considered. Industry operators have committed to rehabilitation of disturbed areas upon decommissioning. GJV will also undertake, at the request of the department, rehabilitation at any site outside its disturbance footprint where fire relating to its operations occurs. Ecosystem rehabilitation on Barrow Island Nature Reserve has already commenced over an area of 236 hectares (since records began in 1990) and has included decommissioned gravel pits, well sites and roads (Chevron Australia 2007; Outback Ecology 2007).

Ecosystem rehabilitation is already progressing over some cleared and unused areas of Barrow Island Nature Reserve. Photo – Michelle Rumball/Parks and Wildlife

The necessity for, and complexity of, ecosystem rehabilitation varies according to the type and extent of disturbance. In some cases, natural regeneration with little or no intervention may be preferred. Regardless of the method used, success will be measured by assessing information on physical values such as water, nutrients, top soil and organic matter, and flora and vegetation against completion criteria derived from key ecological processes that evaluate ecosystem function. Remote sensing at appropriate resolutions is valuable for demonstrating overall outcomes but programs may require additional information such as targeted fauna surveys to demonstrate full ecosystem rehabilitation.

With respect to GJV, the state and federal environmental approval conditions for long-term rehabilitation of disturbed sites require that such sites are:

- self-sustaining
- comparable to, compatible with, and able to be managed as part of, surroundings consistent with the conservation objectives of a Class A nature reserve
- as close as practicable to the pre-existing natural biodiversity and ecosystem functional values
- re-colonised by key species and communities that were originally displaced when the site was disturbed.

Additional considerations include application of fire, which is an important process in nutrient flow and availability, which then in turn is important for vegetation and ecosystem development (Outback Ecology 2006b, 2007). Absence of fire from the planning area may reduce the occurrence of palatable natural regeneration, contributing to increased grazing pressures at rehabilitation sites (Outback Ecology 2007).

Outback Ecology (2006a) has identified 15 recalcitrant species in the planning area. For example, domination by *Triodia angusta* in rehabilitated communities on Barrow Island Nature Reserve is apparent, with a reduced rate of *T. wiseana* establishment within sites previously dominated by this species (Outback Ecology 2006b). It is also possible that some species may have a phytotoxic effect (allelopathic) that inhibits the growth of other species being rehabilitated in the area.

Desired outcome

Disturbed ecosystems are rehabilitated to a stable condition that resemble, as closely as practicable, the pre-existing natural ecosystem composition, function and processes, according to the agreed completion criteria.

Objective

Work with industry operators to ensure that disturbed areas are progressively rehabilitated in accordance with agreed completion criteria.

Management actions

1. Work with industry operators to develop completion criteria for rehabilitation.
2. Collect information on, and monitor, the percentage of rehabilitation that has occurred.
3. Provide advice to industry operators on environmental management plans/programs and other relevant documents associated with ecosystem rehabilitation.
4. Support the decision of industry operators to allow natural regeneration (that is, no intervention required) where it is appropriate and likely to be successful in restoring the entire disturbed site.
5. Minimise impacts upon ecosystem rehabilitation sites (for example, restrict access, protect from bushfire, adjacent land clearing and altered surface hydrology).
6. Notify industry operators when the department considers ecosystem rehabilitation to be inconsistent with the terms of the relevant industry environmental approval conditions or subsequent industry environmental management programs/plans.
7. Identify priority areas of research (for example, investigating the ecological requirements of recalcitrant species) and undertake spatial/temporal trend monitoring using techniques such as fauna and flora surveys and aerial photography or remote sensing.

Key performance indicator

Performance measure	Target	Reporting
Agreed rehabilitation completion criteria with industry operators	Implementation of rehabilitation works toward agreed completion criteria	Every five years

Managing cultural heritage

Activities being undertaken in the planning area (including land management), have potential to disturb cultural heritage sites. The *Aboriginal Heritage Act 1972* (Aboriginal Heritage Act), CALM Act and the department's *Policy Statement No. 18: Recreation, Tourism and Visitor Services* (DEC 2006) provide guidance for the department to identify and protect such sites and/or objects from non-industry-related impacts, in partnership with relevant stakeholders (for example, local Aboriginal groups). Industry operators have responsibilities to manage their impacts on cultural heritage and have management plans and processes in place.

10. Aboriginal culture and heritage

Archaeological records show that traditional Aboriginal use of Barrow Island Nature Reserve has occurred, although use over the last 6,000 years had been reduced or prevented as a consequence of Holocene epoch sea level rise (Osborne *et al.* 2000 and Smith *et al.* 2006). Some evidence suggests that Aboriginal people were present on these islands as part of their involvement in the pearling industry following European settlement (Hook *et al.* 2004).

Barrow Island Nature Reserve has 13 sites that are recorded on the state *Register of Aboriginal Sites.* The most significant of these is a pearler's camp at Bandicoot Bay (Site No. 891), which is of national, state and regional importance (Hook *et al.* 2004). Little cultural heritage information is available for Boodie, Double and Middle Islands Nature Reserve. It is probable that sites may exist that are not known or officially registered, especially in areas of claypans, coastal dunes, habitable caves and drainage lines (Chevron Australia 2009k and Hook *et al.* 2004).

More than 150 Aboriginal artefacts have been collected from Barrow Island Nature Reserve. Of interest are the stone tools that indicate cultural links with areas beyond the Pilbara (Hook *et al.* 2004). A mythological narrative about the origin of Pannawonica Hill and its links to Barrow Island Nature Reserve is also described by Dench (Hook *et al*. 2004).

The Conservation Commission and the department acknowledge the strong desire of traditional custodians to care for country according to their traditional laws, to be involved in the management of lands to which the CALM Act applies and to strengthen cultural ties to the land. This can lead to the preservation of natural and cultural heritage, enriching cross-cultural awareness and providing cultural, spiritual and economic benefits to Aboriginal people and the wider community.

Although the planning area is not claimed under native title, Aboriginal groups have expressed their interest in the area (Hook *et al.* 2004). Departmental impacts on Aboriginal cultural heritage are unlikely during the life of the management plan but the department will still apply the Department of Aboriginal Affairs's *Aboriginal Heritage Due Diligence Guidelines* to assist with minimising the impact on Aboriginal heritage values and sites (see www.daa.wa.gov.au/Documents/HeritageCulture/Heritage%20management/AHA_Due_Diligence_Guidelines.pdf?epslanguage=en). The department will consult with, and involve, relevant Aboriginal groups in accordance with these guidelines. Approvals may also be required under the Aboriginal Heritage Act before any departmental works that may impact on Aboriginal cultural heritage values can proceed.

Desired outcome

The value of the land to the culture and heritage of Aboriginal persons is protected and conserved.

Management actions

1. Facilitate research on, and documentation of, Aboriginal cultural and heritage values within the planning area.
2. Ensure that Aboriginal heritage sites are protected from unauthorised disturbance.

11. Other Australian heritage

The planning area and its surrounds have a long history associated with exploration, whaling, quarantine and hospitalisation, barracoon and slave markets, pearling and pastoralism, turtle hunting, fishing, phosphate mining, oil and gas extraction, and nature conservation (Hook *et al.* 2004). Atomic testing on the nearby Montebello Islands in the early 1950s resulted in entry around the planning area being temporarily restricted. In 1966, Barrow Island Nature Reserve was declared the site of Western Australia's first major ongoing commercial oil discovery (Crank 1973 and Parry 1967). These petroleum production operations are still being undertaken by BWIJV.

Some informal pearling camp sites, for which historical material has been collected, have been discovered on Barrow Island Nature Reserve. Little other Australian heritage information is recorded for Boodie, Double and Middle Islands Nature Reserve but it is also likely to contain historical archaeological material (Hook *et al.* 2004). Any formally registered other Australian heritage site is protected under the *Heritage of Western Australia Act 1990*. In this case, approval may be required before any works that may impact on other Australian heritage values.

Although it has never been found, the *Marietta*, possibly a pearling lugger, is recorded as having been wrecked in the waters off Barrow Island Nature Reserve in 1905 (Osborne *et al.* 2000). It is believed that other shipwrecks may have occurred in the vicinity (DEC 2007) and any pre-1900 shipwrecks or debris discovered in the planning area will be protected under relevant state and/or federal legislation.

Desired outcome

Other Australian heritage values are conserved and protected.

Management actions

1. Facilitate research on, and documentation of, cultural heritage values within the planning area, including those that contain a mix of Aboriginal and other Australian activities.
2. Ensure that heritage sites are protected from unauthorised disturbance.

Managing resource use

12. Petroleum and gas development

The planning area and its surrounds contain extensive petroleum and gas resources, including significant petroleum reservoirs located beneath Barrow Island Nature Reserve. These resources will continue to be extracted and processed for commercial purposes throughout the life of this management plan. More detail on specific petroleum operations and their titles can be found in section 3 *Other tenure and land arrangements,* as well as Map 1 (for petroleum title boundaries) and Map 3 (for petroleum infrastructure).

Petroleum and gas construction and processing activities have caused impacts on Barrow Island Nature Reserve, for example vegetation clearance, spills and leaks, NIS introductions, disturbance of marine turtle breeding and feeding, fauna deaths and altered fire regimes. Industry operators address these impacts through approved environmental management plans/programs and related documents. The department will continue to work closely with industry operators to protect key values from these impacts.

The department, DER and the EPA have a legislative role in industry environmental regulation and compliance. DMP regulates petroleum activities within the planning area and works with industry to ensure compliance with environmental management plans/programs and related documents and, more generally, good oilfield practice.

A lufkin at Bandicoot Bay. Photo – Dr Fran Stanley/Parks and Wildlife

Desired outcome

Key values are not significantly and adversely impacted by petroleum and gas processing activities.

Management action

1. Work with industry operators and regulators to implement existing environmental management plans/programs and related documents and to update them as required.

13. Basic raw materials

Gravel has been extracted as a basic raw material within the planning area for infrastructure development and road construction/maintenance (Chevron Australia 2009a) since 1967. On Barrow Island Nature Reserve there are less than five active borrow pits and many more decommissioned borrow pits. These

pits, together with any future pits, may adversely affect the structure, function and composition of ecosystems, including creekline systems where most gravel extraction has occurred. Gravel extraction has been identified as a principal threat to some vegetation types on Barrow Island Nature Reserve, including the priority ecological community (Priority 1) '*Triodia angusta*-dominated creekline vegetation (Barrow Island)'.

Basic raw material extraction is managed by DMP. Petroleum legislation does not permit any unreasonable or unnecessary levels of interference with soils or geomorphology, though BWIJV is able to extract gravel and other basic raw materials within its lease to carry out its operations.

The GJV is not permitted to access any basic raw materials on Barrow Island Nature Reserve outside the site of the Gorgon gas processing plant (Chevron Australia 2005a). Where importation of additional basic raw materials is required for construction purposes on Barrow Island Nature Reserve, it is subject to the QMS.

BWIJV has incorporated the practice of reclamation of gravel for re-use from decommissioned leases, roads and windrows, subject to appropriate consideration of weed management and other concerns. Borrow pits must be rehabilitated upon decommissioning.

Desired outcome

Key values are not significantly and adversely impacted by basic raw material extraction.

Management actions

1. Liaise with DMP and industry operators regarding the extraction of basic raw materials, potential ecological impacts, quarantine management and rehabilitation.
2. Notify industry operators and appropriate agencies when the department detects adverse ecological impacts that may be caused by basic raw material extraction and use that is considered to be inconsistent with the terms of the relevant industry environmental approval conditions or subsequent industry environmental management programs/plans.

14. Water resources

BWIJV uses water from the Flacourt Sands Aquifer from about 900 to 1,200 metres below ground to supply its oilfield operation for processing (URS Australia Pty Ltd 2009). The GJV sources most of its processing and potable water supplies from the sea and treats it through reverse osmosis desalination plants (Chevron Australia 2009g). Supplies are occasionally supplemented by fresh water imported via barge from the mainland.

Water abstraction can alter groundwater levels (availability) and overdrawing can cause saltwater intrusion, leading to a disruption in the groundwater halocline (Humphreys 1993, 2001). These effects may significantly impact upon species with specific ecological water requirements (for example, subterranean fauna and native plants and plant communities) and may have flow-on effects to other parts of the ecosystem.

A licence under the *Rights in Water and Irrigation Act 1914* is not required for water abstraction in the planning area because it does not fall within a proclaimed groundwater area. The Department of Water thus has no regulatory role in water resource use. DMP only regulates water abstraction where it is associated with management of a petroleum reservoir that falls within the scope of the *Petroleum and Geothermal Energy Resources Act 1967*. No other water use in the planning area is independently regulated, although it may be guided by industry groundwater monitoring and abstraction plans, which are self-audited/self-monitored by the relevant industry operator.

15. Accommodation and infrastructure

Departmental and industry personnel, contractors and volunteers on Barrow Island Nature Reserve are accommodated in camps located on the east coast, south of Town Point. A significant amount of infrastructure such as roads, airport, well pads, storage tanks, pipelines, bores, a processing facility and the Materials Offloading Facility are present on Barrow Island Nature Reserve. No accommodation or permanent infrastructure exists on Boodie, Double and Middle Islands Nature Reserve.

A significant amount of infrastructure exists on Barrow Island Nature Reserve including this tanker loading pipeline on the east coast, near Town Point. Photo – Kevin Crane

The installation and long-term presence of any structure can cause the following threats:

- direct disturbance or removal of landforms or soils (including extraction of gravel or other basic raw materials)
- vegetation clearing or removal of habitat
- alteration of surface hydrology
- alteration of coastal processes (including near-shore currents, wave action and sediment processes), potentially leading to changes in marine turtle nesting behaviours and smothering of, or structural changes in, intertidal ecosystems
- physical barriers to fauna movement
- fauna entrapment and non-natural fauna behaviour
- increased risk of introducing non-indigenous species from the importation of materials
- fire (by a fault) or exacerbation of fire (through contact with flammable material)
- contamination and/or pollution such as light and carbon emissions
- accidental spills or leaks of substances such as hydrocarbons.

Under Clause 5(1) of the State Agreement, GJV has a responsibility to consider using existing services and structures on Barrow Island Nature Reserve to minimise cumulative impacts on key values. Industry operators seek appropriate approvals for any relevant works or construction and prepare environmental management plans, programs and other related documentation that prescribe how impacts to the environment will be managed during those works.

All areas of decommissioned structures are to be restored in accordance with industrial requirements (for example, legislation and environmental approval conditions) and, where compatible, section 9.4 *Ecosystem rehabilitation.* If any structure is potentially able to assist in the monitoring of ecological impacts (for example, groundwater bores) its retention should be considered for future use by the department.

Desired outcome

Key values are not significantly and adversely impacted by the establishment, operation and decommissioning of accommodation and infrastructure.

Management actions

1. Provide advice to government agencies responsible for assessing proposals put forward by industry operators with regard to environmental management.
2. Where appropriate, establish low-impact structures within the planning area for the purposes of promoting and managing its key values.
3. Where appropriate, and in liaison with industry operators, consider the retention of infrastructure that is no longer required for petroleum and gas processing activities, to assist in monitoring ecological impacts in the future.

16. Access

Uncontrolled public access to the planning area could result in disturbance to key values and place the workforce and infrastructure on Barrow Island Nature Reserve at risk. The most significant threats include:

- the introduction of NIS
- the introduction of fire, for example through campfires.

Based on these threats, the department will pursue the prohibition of public access to the planning area under section 62(1)(b) of the CALM Act.

BWIJV and GJV hold permits, licences and leases (issued under petroleum legislation and the Land Administration Act) over the majority of the planning area and therefore may restrict public access to these areas.

The planning area will be accessed by departmental and other state and federal government personnel, GJV and BWIJV personnel (including contractors and other individuals associated with operations), other industrial personnel who are in transit to their respective work places (at offshore rigs and other islands) and researchers and volunteers working on specific programs. Access within industrial sites is restricted by the requirements of occupational health and safety considerations, requiring specific briefings, inductions, training and demonstrated competence, including for the use of road networks. All authorised access to the planning area is managed by GJV and BWIJV and is subject to the application of the QMS. The department will comply with the QMS, though it is not restricted in accessing the planning area to undertake its legislative responsibilities under the CALM Act, Environmental Protection Act or any other legislation, including reserve management.

All roads and tracks are managed by either the department (if constructed for ‘necessary operations’) or the relevant industry operator that authorised the construction. Where the roads or tracks are poorly located, in poor condition and difficult to maintain, no longer required by industry operators or where there are adverse impacts on the environment (other than those permitted through the relevant industry environmental approval conditions), consideration should be given to their closure and rehabilitation. Some roads, no longer required by industry operators, may be handed over to the department for ongoing management access.

Desired outcomes

1. Key values are not significantly and adversely impacted by human access.
2. Risks to the workforce and infrastructure on Barrow Island Nature Reserve issued under petroleum legislation and the Land Administration Act are minimised.

Management actions

1. Pursue restricting public access to the planning area in accordance with section 62(1)(b) of the CALM Act and associated regulations and inform the wider community of the reasons why public access may need to be prohibited.
2. Comply with the QMS for Barrow Island Nature Reserve as implemented by Chevron Australia Pty Ltd.
3. Work with the relevant industry operator to:
   - provide and maintain strategic road and track access consistent with managing key values
   - close and rehabilitate any roads or tracks unsuitable for access or no longer required by the department and/or other major users.
4. The department will consider re-opening closed tracks, or establishing new tracks, where a need is identified to carry out necessary operations.

17. Workforce recreation

Recreational activities undertaken by operational personnel in the planning area include limited fishing, use of existing roads and tracks for walking and cycling and water-based activities. Consultation has indicated that continuing to permit these activities is important to this sector of the workforce.

Uncontrolled recreational activities by operational personnel could compromise key values particularly where recreational equipment (including vehicles for transport) disturbs or harms native species and/or important habitats. Limited low-impact recreational activities by operational personnel will only be permitted on Barrow Island Nature Reserve and will be subject to the relevant internal processes of Chevron Australia Pty Ltd and the approval of the department. Access to recreational sites will be restricted to existing roads. Workforce recreation should be managed and directed away from areas of high conservation significance.

Recreation should be avoided in conservation-significant areas, including high density marine turtle nesting beaches as shown above. Photo – Michelle Rumball/Parks and Wildlife

In addition to recreation by Chevron Australia's operational personnel, departmental personnel based on Barrow Island Nature Reserve are able to pursue recreational activities in the planning area.

To help in minimising the incidence of injury to personnel recreating in the planning area, the department will implement *Policy Statement No. 53 – Visitor Risk Management in the Department of Environment and Conservation* (DEC 2011), which provides for the implementation of a risk management program for the planning area.

Desired outcomes

1. Key values are not significantly and adversely impacted by workforce recreation.
2. Workforce recreation is carried out safely.

Management actions

1. In consultation with industry operators, develop a workforce recreation plan for Barrow Island Nature Reserve that outlines ways of minimising potential impacts and may include the following:
    - identification of recreation areas
    - a description of activities permitted in identified recreation areas
    - a code of conduct in relation to recreational areas and activities, aimed at raising environmental awareness and minimising potential impacts
    - identification of strategies aimed at managing health and safety risks present in recreation areas
    - recreation impact monitoring programs and management responses.
2. Work with industry operators to:
    - prohibit recreation in areas of high conservation significance such as cave systems, significant turtle nesting beaches, significant migratory shorebird habitat and sites of cultural significance, or alternatively, ensure supervision of recreation is undertaken at these sites to a level acceptable by the department
    - limit disturbance in high-use recreation sites by restricting access to single tracks
    - apply vehicle restrictions (for example, speed reductions, multiple occupancy) for recreation purposes as required
    - modify recreation arrangements where required.
3. Support the Department of Fisheries in its monitoring of sustainable recreational fishing, especially in Bandicoot Bay Conservation Area and Barrow Island Marine Park.
4. Inform operational personnel on the potential impacts of recreation on key conservation values. This could include promoting and/or facilitating environmentally based recreation activities.

Involving the community

18. Community involvement and support

Community involvement and support is an integral part of the department's operations, including the development and implementation of this management plan. The department's *Policy Statement No. 18: Recreation, Tourism and Visitor Services* (DEC 2006) provides guidance for facilitating this. It aims to develop community awareness and appreciation of the state's natural environment and promote community involvement in, and support for, its protection and conservation (DEC 2006). However, because access may be limited to the planning area, community involvement is primarily focused on volunteers and the workforce based on Barrow Island Nature Reserve. Their contribution is important because it not only assists the department with its work capabilities and skills base, but also fosters communication links, establishes wider ownership of, and appreciation for, land management and conservation and encourages appropriate behaviour. Aboriginal involvement in caring for country is also recognised as being important in the conservation of key values. This issue is discussed in more detail in section 10 *Aboriginal culture and heritage.*

Interested community members had an involvement throughout the preparation of this management plan. Initial comments were sought early in the planning process and the draft management plan was released to the public for a two-month submission period, after which all submissions were considered and incorporated where they improved the quality of the management plan. Ongoing community support will be essential for the successful implementation of this management plan.

Desired outcome

Ongoing community involvement in, support for and increased understanding and appreciation of, conservation of key values.

Management actions

1. Continue to promote and facilitate opportunities for volunteers and the workforce based on Barrow Island Nature Reserve to contribute to conservation programs (for example, turtle monitoring) as well as to make informal observations and participate in regular monitoring and reporting procedures.
2. Provide, and support others in providing, the workforce, volunteers and the wider community with educational material, including training opportunities, to increase understanding of the importance of the key values, their associated threats and ecological impacts, and how they are being managed.

Reporting, research and monitoring

19. Reporting, research and monitoring

Reporting is an important part of protecting the key values. It consists of three major areas:

- environmental performance
- breaches and/or incidents
- research results.

The first two components keep all stakeholders with legislative management responsibilities informed and allow for prompt responses to assist with amelioration of impacts where required. Examples of such reports include the effectiveness of lighting controls, the number of fire incidents, introductions of NIS, contamination and/or pollution incidents, the amount of vegetation that has been cleared and the number of incidents involving fauna injury or death. The third type of reporting assists in understanding spatial and temporal changes in biodiversity and processes relating to biodiversity. Research and monitoring reports may include periodic assessments of native species and communities, new species identifications, trends observed in plant and animal populations or processes that affect them.

The planning area is one of the most important areas in the state for long-term ecological research because:

- it already has a well-established knowledge base to support further investigations, including for a better understanding of the local ecology
- in general, its biological assemblages are relatively unaltered in historic times, especially fauna. In particular, there are opportunities to research and monitor small to medium-sized mammals that may be absent or rare elsewhere
- it contains many species and communities of conservation significance and several species that are unique to subterranean habitats on Barrow Island Nature Reserve
- it contains habitats of local, national or international importance
- there are only low levels of some major threatening processes that occur on the mainland
- islands provide natural laboratories for studying the effects of geographical isolation on biodiversity. Barrow Island Nature Reserve is especially significant because of stratified deposits in sheltered locations. These deposits have the potential to document ecological, faunal and human pre-historical patterns of change from the Pleistocene to the present epoch.

Research on the key values of Barrow Island Nature Reserve, especially its natural biodiversity, has been undertaken over the years, particularly since the mid-1960s when petroleum operations began. The role of West Australian Petroleum Pty Ltd and Chevron Australia Pty Ltd is acknowledged in establishing this data and actively managing their projects to minimise impacts on key values.

Issues have arisen where methodologies and mapping scales such as vegetation classifications have been inconsistent between various existing research and monitoring projects, which prevented easy comparison of data and the assessment of ecological changes over time. The evaluation of management actions has been more complicated by the use of output-based indicators (the action has been completed), rather than outcome-based indicators (the action was effective in achieving desired outcomes).

Throughout the life of this management plan, the department will endeavour to address (in collaboration with industry operators, universities and other researchers) gaps in knowledge, focussing on those with the highest priority for research and monitoring. Addressing such gaps will include, but not be limited to:

- establishing broadscale mapping of vegetation communities, at a resolution consistent with contemporary expectations of an important and intensively managed nature reserve
- gathering information on past and present species and community occurrences (including the requirement to maintain annual species and communities lists), status of populations and communities, ecological requirements of species and communities, threatening processes and population trends of known species. Marine turtles, shorebirds, subterranean fauna, other potential short-range endemic species and restricted vegetation types should remain a key focus for monitoring, especially where there is high potential for adverse cumulative impacts resulting from petroleum and gas processing activities.
- gaining an understanding of the function of the key ecosystems, such as the subterranean environment
- investigating new methods to better manage ecosystem rehabilitation, quarantine, control of NIS, risk and suppression of uncontrolled bushfire and contamination and/or pollution occurrences
- establishing baseline information for Boodie, Double and Middle Islands Nature Reserve as well as components of the ecosystem on Barrow Island Nature Reserve that are not extensively known (for example, fish and invertebrates)
- investigating the taxonomy and biology of newly discovered or unclassified species
- investigating the ecological history of fauna, flora and ecology of Barrow Island Nature Reserve, and the development of the present-day biodiversity patterns
- investigating the heritage value of claypans, habitable caves and coastal dunes.

Some science-based offset programs (*North West Shelf Flatback Turtle Conservation Program, Threatened Species Translocation and Reintroduction Program* and *Dredging Surveillance and Audit Program*) have already been identified as part of the state government approvals for the Gorgon gas project. These programs are being implemented by the department, including within the planning area.

Reporting, research and monitoring are all important components in making informed decisions to achieve best practice environmental management and in determining the success of this management plan. With multiple managers in the planning area, this goal will require coordination and integration between different management groups, including the sharing of information. This will also ensure that funds and resources will be used in the most effective and efficient way.

Desired outcome

The management of key values is assisted through appropriate and ongoing reporting, research and monitoring.

Objective

Liaise with industry operators to:

- share information relevant to the management of key values that is gained through reporting, research and monitoring. This should be undertaken in a timely manner and involve all key stakeholders with management or auditing responsibilities within the planning area.
- continue developing the ecological knowledge base of the planning area and associated management (including adaptive management) requirements.

Management actions

1. Collate and consolidate existing information on ecological values of the planning area and maintain a spatial inventory of species and communities that may require special protection (for example, using NatureMap).
2. Develop and implement a research and monitoring program for the planning area that:
   - provides for implementation of research priorities identified in this management plan
   - standardises data collection methods, mapping and presentation to assist with trend analysis
   - specifies outcome-based (rather than output-based) evaluation methods (that may include the use of indicator species) to identify spatial and temporal trends
   - uses appropriate control sites, where necessary
   - integrates and collaborates with GJV and BWIJV research and monitoring projects where possible
   - responds to any non-industry-related management issues, where practicable
   - communicates high priority research projects to external organisations.
3. Review the information that is required to be provided to the department by industry operators as part of their reporting and data sharing obligations required by their environmental approval conditions and other environmental commitments contained within environmental management plans/programs and related documents.
4. Provide departmental data and reports associated with the management of key values to industry operators where appropriate.
5. Encourage the workforce based on Barrow Island Nature Reserve and volunteers to assist with reporting and any research or monitoring opportunities that arise.
6. Ensure that departmental research and monitoring programs do not impact on other environmental monitoring programs being run by industry operators as part of a compliance requirement.
7. Support, and where required assist with, the implementation of science-based offset programs undertaken in the planning area.

Key performance indicators

Performance measure	Target	Reporting
Level of information shared between key stakeholders	Where appropriate, information is provided to key stakeholders as outlined in this management plan	Annually
Implementation of research and monitoring	Research and monitoring is progressively undertaken in accordance with the research and monitoring program	Every three years

Glossary

adaptive management	A process of responding positively to change. The term adaptive management is used to describe an approach to managing complex natural systems that builds on common sense and learning from experience, experimenting, monitoring and adjusting practices based on what was learnt.
anchialine	Habitats that consist of bodies of water, usually with a restricted exposure to open air, always with more or less extensive subterranean connections to the sea (Stock and Iliffe 1986)
aquatic	Living or growing in or on water
avifauna	Birds of a particular region
Barrow Island vegetation associations	The five categories of vegetation associations (as described by Astron 2009) are: 1) restricted vegetation (distribution) 2) restricted vegetation (flora) 3) restricted vegetation (distribution and flora) 4) restricted vegetation (botanical relicts) 5) other vegetation.
benthic	Living in, or using, the bank or bed surface of water bodies
biodiversity	The variety of all life forms: the different plants, animals and micro-organisms, the genes they contain and the ecosystems they form; often considered at three levels: genetic diversity, species diversity and ecosystem diversity
bioregion	A land and water territory whose limits are defined not by political boundaries, but by geographical limits of human communities and ecological systems
biota	relating to living things; caused or produced by living organisms
brackish	Water resource that contains 1,500–5,000 milligrams per litre of total dissolved salts (mg/L TDS)
chemoautotrophic	The process by which or ability of organisms to derive nourishment from chemical reactions and inorganic compounds
completion criteria	As defined in EPA 2006b, completion criteria are specific targets (defined by measured outcomes or milestones) required for monitoring and reporting of rehabilitation projects. They must be sufficiently stringent to ensure that the overall objectives of rehabilitation have been met.
conservation	The protection, maintenance, management, sustainable use, restoration and enhancement of the natural environment

contamination	The state of being contaminated. Contaminated is defined in the Contaminated Sites Act as having a substance present in or on that land, water or site at above background concentrations that presents, or has the potential to present, a risk of harm to human health, the environment or any environmental value.
critical habitat	Critical habitat is habitat identified as being critical to the survival of a listed threatened species or listed threatened ecological community. Habitat is defined as the biophysical medium or media occupied (continuously, periodically or occasionally) by an organism or group of organisms or once occupied (continuously, periodically or occasionally) by an organism, or group of organisms, and into which organisms of that kind have the potential to be reintroduced (federal EPBC Act).
disjunct	Separated or disjoined populations of organisms. Populations are said to be disjunct when they are geographically separated from the main range
disorientating	Interfering with a marine turtle's ability to orient in a constant direction, including swimming (Witherington and Martin 1996)
ecological community	An integrated assemblage of species that inhabits a particular area
endemic	Flora or fauna that is confined in its natural occurrence to a particular region
environmental weed	An unwanted plant species growing in natural ecosystems that modifies natural processes, usually adversely, resulting in the decline of the communities they invade; usually an introduced plant
environmental management documents	This includes BWIJV Environmental Management Programs and GJV Environmental Management Plans.
episodic	Irregular, occasional or sporadic
ephemeral	Something that exists only briefly or for a short period
evolution	Change across successive generations in the heritable characteristics of biological populations
extant	Still existing
fauna	The animals inhabiting an area; including mammals, birds, reptiles, amphibians and invertebrates. Usually restricted to animals occurring naturally and excluding feral or introduced animals
fire regime	A fire regime is a description of fire in terms of its fire frequency (how often it occurs on a site), fire intensity (how hot it is), season (what time of year it occurs), scale (how big it is) and its spatial diversity (how patchy it is at a landscape and local scale).
flora	The plants growing in an area; including flowering and non-flowering plants, ferns, mosses, lichens, algae and fungi (although algae and fungi are not considered plants). Usually restricted to species occurring naturally and excluding weeds
genetic	To do with the hereditary units that are composed of sequences of DNA
geology	The study of the history of the earth and its life, especially as recorded in rocks

geomorphological	Pertaining to structures, origin and development of the topographical features of the earth
geosequestration	Capturing greenhouse gas emissions and pumping them into underground reservoirs
groundwater	All free water below the surface in the layers of the Earth's crust
habitat	The place where an animal or plant normally lives and reproduces
halocline	A salinity gradient where two masses of water such as fresh water and sea water meet
heritage	Something inherited from a past generation that is valued
hydrology	The scientific study of the characteristics of water, especially of its movement in relation to the land
indigenous	Native or belonging naturally (to a place)
intertidal	Area between low and high water tidal marks
invertebrate	Animals without backbones, for example, insects, worms, spiders and crustaceans
landform	All the physical, recognisable, naturally formed features of land having a characteristic shape; includes major forms such as a plain, mountain or plateau, and minor forms such as a hill, valley or alluvial fan.
littoral	Relating to the shore of a sea, lake or ocean.
karst	A region composed of limestone or dolomite and characterised by underground drainage systems, sinkholes and gorges
key threatening processes	That which threatens or may threaten the survival, abundance or evolutionary development of a native species or ecological community.
misorientating	Causing a marine turtle to move in the wrong direction (Witherington and Martin 1996)
mycorrhizal fungi	Fungi that forms symbiotic associations with roots of plant species and can survive in the presence of a live host
NatureMap	NatureMap is an online mapping program that consolidates many spatial records associated with the natural biodiversity across the state. It is regularly updated and available for the public to make general enquiries. See www.naturemap.dpaw.wa.gov.au/.
necessary operations	Activities conducted by the department that are necessary for the preservation or protection of persons, property, land, waters, flora or fauna, or for the preparation of a management plan
non-indigenous	Not belonging naturally (to a place)
organic	Of, relating to, or derived from, living organisms
phytotoxic	Inhibitory to the growth of, or poisonous to, plants
pollutant	A substance that causes pollution
pollution	Defined in the Environmental Protection Act as direct or indirect alteration of the environment a) to its detriment or degradation; b) to the detriment of an environmental value; or c) of a prescribed kind

prescribed burning	The controlled burning of fuels to decrease the intensity and rate of spread of bushfires
priority species	A departmental term for flora and fauna that may be rare or threatened but for which there is insufficient survey data available to accurately determine their true status. Priority species also include rare species that are currently not threatened. Species are grouped from 1 to 5 according to the perceived urgency for more surveys: • Priority 1: Taxa with few, poorly known populations on threatened lands • Priority 2: Taxa with few, poorly known populations on conservation lands • Priority 3: Taxa with several, poorly known populations, some on conservation lands • Priority 4: Taxa in need of monitoring • Priority 5: Taxa that are conservation dependent (i.e. their conservation status is dependent on ongoing active management)
problem species	In the context of this management plan, problem species refers to a native species that has become unnaturally high in number and/or is causing severe adverse impacts on the surrounding natural environment
recalcitrant	Species that have not naturally re-established or occur infrequently on rehabilitated sites when compared with analogue vegetation communities (Chevron Australia 2007)
rehabilitation	The process necessary to return disturbed land to a predetermined state, in terms of surface, vegetation cover, land use and/or productivity
relictual	A surviving individual, population, community or species that is characteristic of an earlier period in evolutionary history
remediation	The removal of pollutants and/or contaminants from environmental media for the general protection of human health and the environment.
saline	Water resource that contains more than 5,000mg/L total dissolved salts
short range endemic	Short range endemics are generally classified by having a distribution of less than 10,000km^2 (Harvey 2002)
soil erosion	A combination of processes in which soil is loosened, dissolved, or worn away, and transported from one place to another by climatic, biological or physical agents
species richness	The number of different species in a community or other defined unit
statutory	Enacted or required by law
subterranean	Underground or below the Earth's surface
sustained change	Any continuous decrease or increase
stygobites	Obligate groundwater-dwelling fauna
specialists	Species that have relatively tightly defined niches and have a narrow range of tolerance
taxa	A defined unit (e.g. species or genus) in the classification of plants and animals

threatened flora and fauna listings	• Fauna declared under the Wildlife Conservation Act (WA) as likely to become extinct or rare, or otherwise in need of special protection: o Schedule 1 (S1): Fauna that is rare or likely to become extinct o Schedule 2 (S2): Fauna presumed extinct but might be rediscovered o Schedule 3 (S3): Birds protected under an international agreement o Schedule 4 (S4): Other specially protected fauna • IUCN Red List categories used to rank threatened species in WA: o EX: Extinct (no reasonable doubt that the last individual has died) o EW: Extinct in the wild (known only to survive in cultivation, in captivity or as a naturalised population/s well outside the past range) o CR: Critically endangered (extremely high risk of extinction in the wild) o EN: Endangered (very high risk of extinction in the wild) o VU: Vulnerable (high risk of extinction in the wild) o NT: Near threatened (likely to qualify for a threatened category in the near future) • Under the federal EPBC Act, fauna listed under section 179 may be: o EX: Extinct o EW: Extinct in the wild o CR: Critically endangered o EN: Endangered o VU: Vulnerable o CD: Conservation-dependent
threatening process	Defined under the EPBC Act as a key threatening process if it threatens or may threaten the survival, abundance or evolutionary development of a native species or ecological community
troglobitic	Terrestrial species that are obligatory inhabitants of air-filled caves, cavities or interstices in the karst above the watertable (Biota Environmental Sciences and RPS BBG 2005b; Chevron Australia 2005a and Humphreys 1995)
vertebrates	Animals that have a spinal column, which includes fish, amphibians, reptiles, birds and mammals
wastes	Defined in the Environmental Protection Act as matter, whether liquid, solid, gaseous or radioactive, and whether useful or useless, which is discharged into the environment; or prescribed to be waste

Acronyms and abbreviations

Barrow Island Act	*Barrow Island Act 2003*
Aboriginal Heritage Act	*Aboriginal Heritage Act 1972*
BICC	Barrow Island Coordination Council is a single industrial entity established in accordance with Clause 13 of the *Gorgon Gas Processing and Infrastructure Project Agreement* (Schedule 1 to the *Barrow Island Act 2003*; the State Agreement). Its primary role is to provide coordinated management of industry-related incidents. The current BICC participants are the GJV and the BWIJV.
Bonn Convention	Convention on the Conservation of Migratory Species of Wild Animals
BWIJV	Barrow Island Joint Venture
CAMBA	China–Australia Migratory Bird Agreement
CALM Act	*Conservation and Land Management Act 1984*
Conservation Commission	Conservation Commission of Western Australia
Contaminated Sites Act	*Contaminated Sites Act 2003*
DER	Department of Environment Regulation
DMP	Department of Mines and Petroleum
DoT	Department of Transport
Environmental Protection Act	*Environmental Protection Act 1986*
EPA	Environmental Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
GJV	Gorgon Joint Venture
industry operators	The operator on behalf of Gorgon and Barrow Island joint ventures, any future body undertaking industry operations, within the planning area and the Barrow Island Coordination Council (BICC)
IBA	Important Bird Area
IUCN	International Union for Conservation of Nature
JAMBA	Japan–Australia Migratory Bird Agreement
KPI	key performance indicator
Land Administration Act	*Land Administration Act 1997*
LNG	liquified natural gas
management plan	*Barrow group nature reserves management plan*
MOU	Memorandum of Understanding

MTEP	Marine Turtle Expert Panel
NIS	non-indigenous species
planning area	Barrow Island Nature Reserve and Boodie, Double and Middle Islands Nature Reserve
QMS	Quarantine Management System
ROKAMBA	Republic of Korea–Australia Migratory Bird Agreement
State Agreement; Schedule 1 to the Barrow Island Act	*Gorgon Gas Processing and Infrastructure Project Agreement*
the department	Department of Parks and Wildlife
UCL	unallocated Crown land
WA	Western Australia

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Further reading

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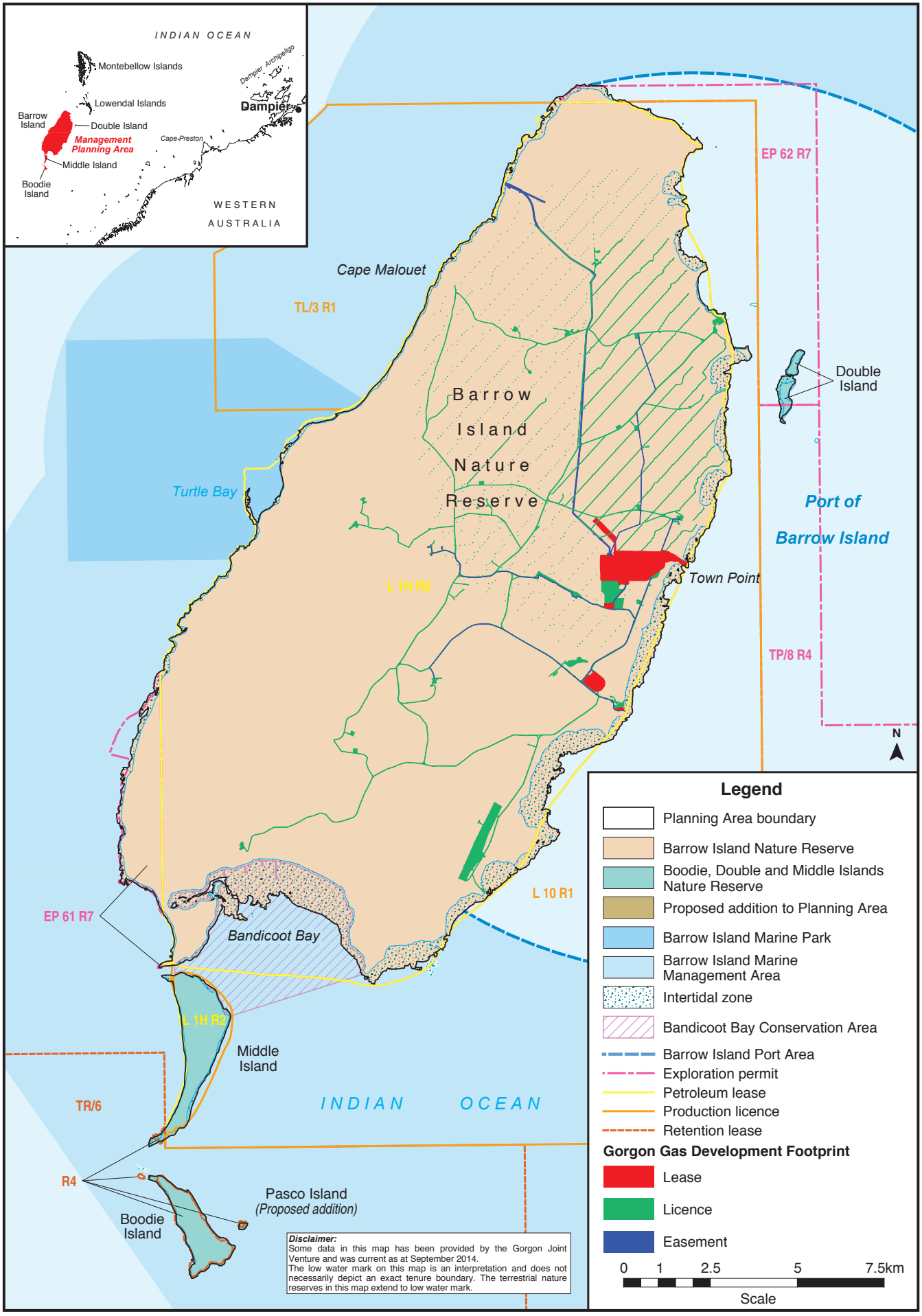
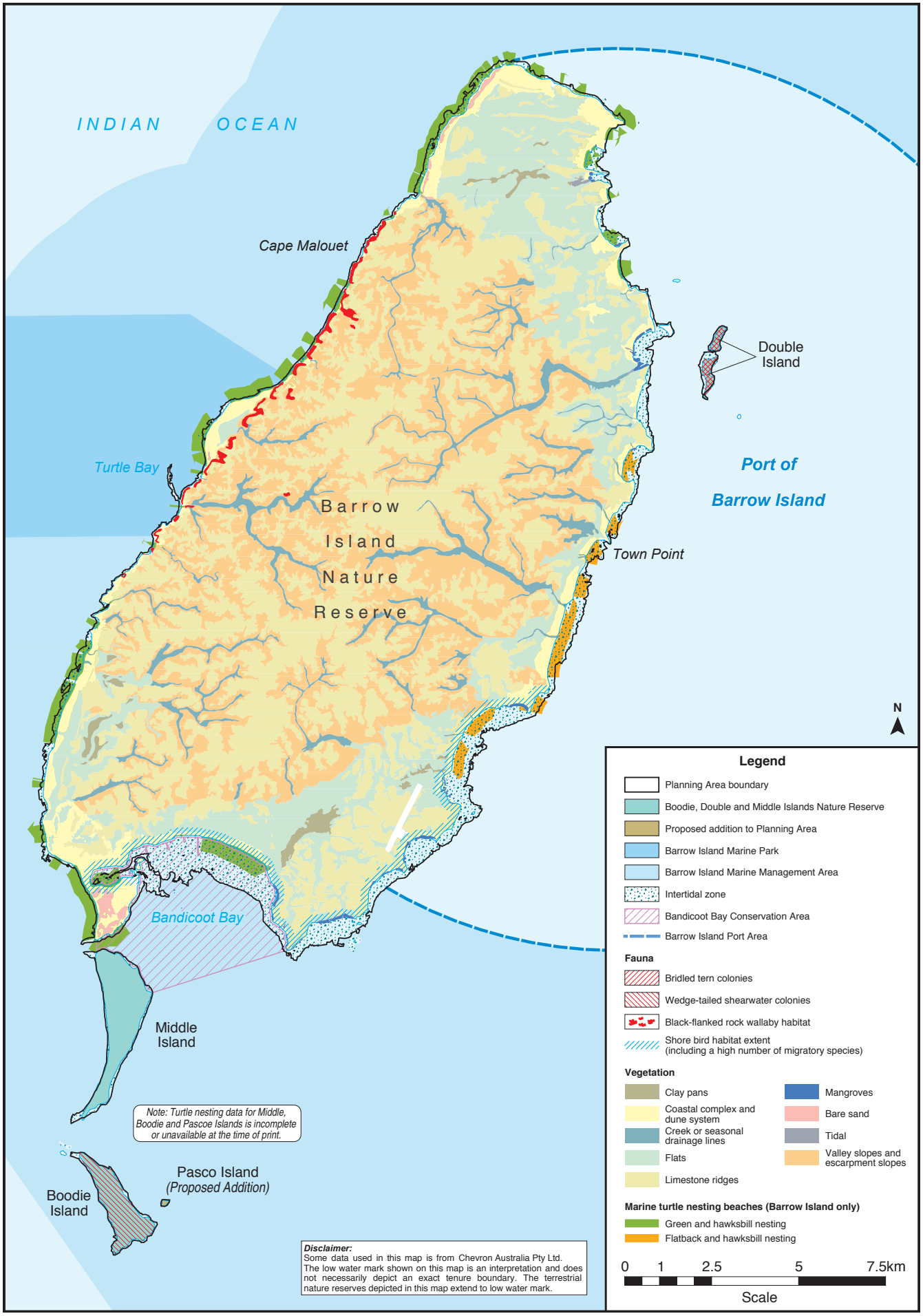
Documents listed in *References* and *Further reading* should be sought by contacting the author/owner.

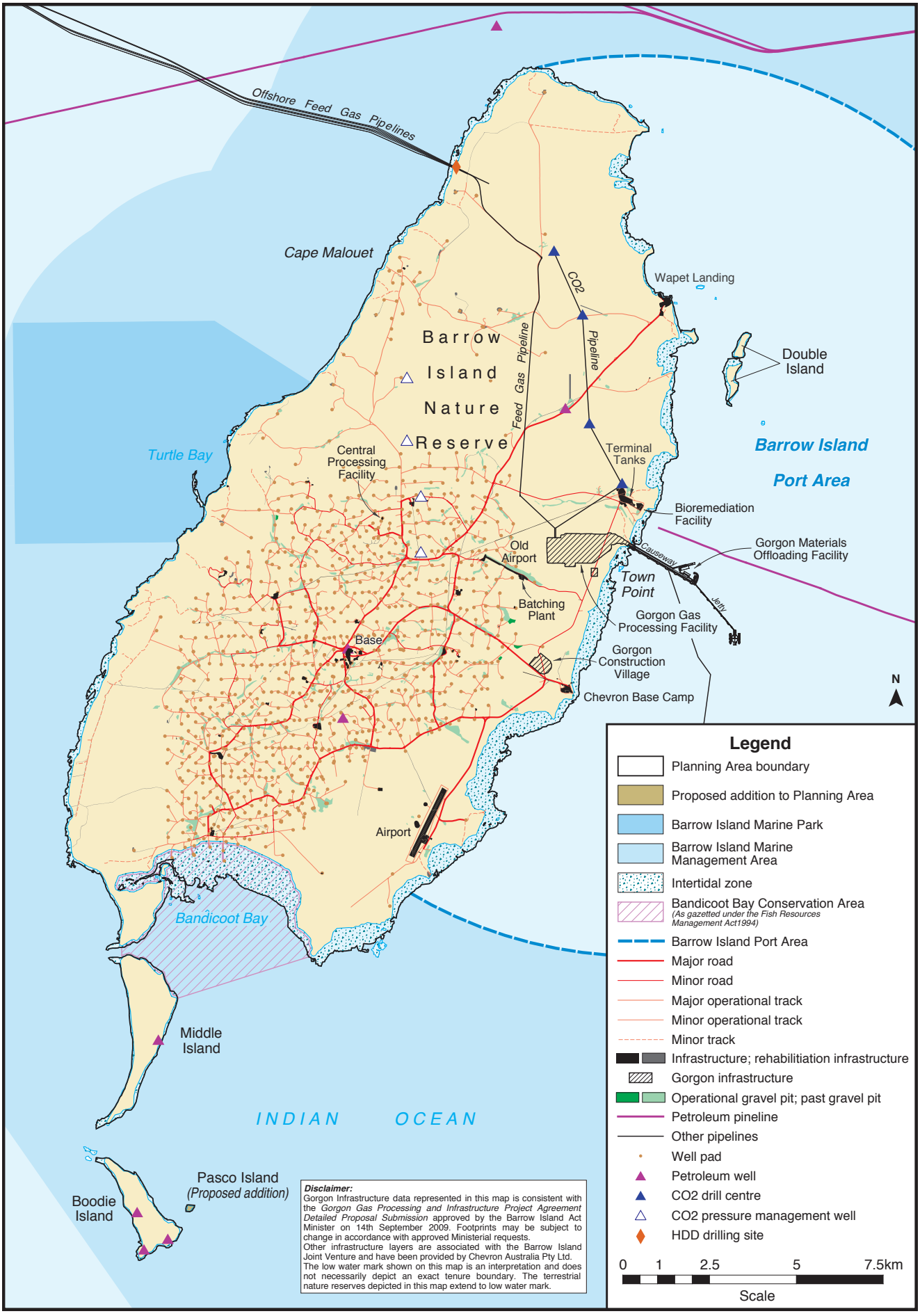
Map 1 Management plan area and tenure



Map 2 Key species and habitats



Map 3 Accommodation, infrastructure and access



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