

**CORAL COAST MARINA
DEVELOPMENT PTY LTD**

**CORAL COAST RESORT
DRAFT PUBLIC ENVIRONMENT REPORT
(EPBC REFERENCE NO. 2000/98)**

VOLUME I

VERSION 4

NOVEMBER 2001

REPORT NO: 2001/94

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AN INVITATION TO COMMENT ON THIS DRAFT PUBLIC ENVIRONMENT REPORT

This draft Public Environment Report describes the proposal by Coral Coast Marina Development Pty Ltd (the proponent) to construct and operate a resort village (**Coral Coast Resort**). Coral Coast Marina Development Pty Ltd's proposal will provide a broad range of residential, short stay and holiday accommodation to be constructed around an inshore marina at the Mauds Landing townsite near Coral Bay in the north west of Western Australia. The proposed development is adjacent to the Ningaloo Marine Park, approximately eight kilometres from Commonwealth waters.

Consistent with the guidelines issued by the Commonwealth Environment Minister under Section 97 of the *Environment Protection and Biodiversity Conservation Act 1999* this draft Public Environment Report provides a description of the proposal, its location and a description of the existing environment. A description of potential impacts on matters of National Environmental Significance and strategies for their mitigation and offsets is provided.

Relevant matters of National Environmental Significance upon which comments are sought are identified and reported on in this document. These are:

- **listed threatened species and communities;**
- **listed migratory species;**
- **Commonwealth marine environment**

Matters of national environmental significance relating to World Heritage Properties, RAMSAR wetlands, nuclear actions and direct impacts on Commonwealth land are not triggered by this proposal and accordingly are not considered in this draft Public Environment Report. All other environmental issues are dealt with under the State assessment process.

Comments provided during the comment period will be incorporated in finalisation of this draft document. This document is available for comment from 26th November 2001 to 24th December 2001.

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4. Mauds Landing Biological, Marine Water and Sediment Quality Survey, May 2000.
5. Indicative Specific Area Marine Management Plan.
6. Boat Source Data and Assumptions.
7. Draft Natural Resources Management Agreement.
8. Strategy for the Management of Turtles in Bateman Bay and Adjacent Commonwealth Waters.
9. Correspondence from the Baiyungu People Providing an Undertaking to Assist in Turtle and Marine Mammal Management.
10. Coral Coast Resort Qualitative Risk Assessment.

GLOSSARY OF TERMS AND ABBREVIATIONS

4WD	four wheel drive vehicle
AHD	Australian Height Datum
ANZECC	Australian and New Zealand Environment and Conservation Council.
CALM	Department of Conservation and Land Management (Western Australia)
CAMBA	Agreement for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment between the Government of Australia and the People's Republic of China 1986
CCMD	Coral Coast Marina Development Pty Ltd
CCR	Coral Coast Resort
COAG	Council of Australian Governments
DEP	Department of Environmental Protection (Western Australia)
DNV	Det Norske Veritas
DIA	Development Impact Area
DIN	Dissolved Inorganic Nitrogen
EMS	Environmental Management System
EPA	Environmental Protection Authority (Western Australia)
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i> (Commonwealth)
FES	Fire and Emergency Services
FWA	Fisheries Western Australia
JAMBA	Agreement for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment between the Government of Australia and the Government of Japan 1974
kg	kilogram

kL	kilolitre
km	kilometre
KMS	key management strategies
L	litre
LGA	Local Government Authorities
LNG	Liquid Natural Gas
LPG	Liquid Petroleum Gas
m	metre
MfP	Ministry for Planning
m/s	metre per second
MPA	Marine Protected Area
MPRA	Marine Parks and Reserves Authority
MSMA	Maud Specific Management Area
NRMA	Natural Resource Management Agreement
NES	National Environmental Significance
nm	nautical mile
NMP	Ningaloo Marine Park
NRSMMPA	National Representative System of Marine Protected Areas
OCS	Offshore Constitutional Settlement
PER	Public Environment Report
RO	Reverse Osmosis
RV	Recreational Vehicle
SAMMP	Specific Area Marine Management Plan
SCUBA	Self Contained Underwater Breathing Apparatus
SES	State Emergency Service

TBT	Tributyltin
TDS	total dissolved solids
TSS	total suspended solids
UASB	Upflow Anaerobic Sludge Blanket
WA	Western Australia
WWT	wastewater treatment
WWTP	wastewater treatment plant
WRC	Water and Rivers Commission (Western Australia)

EXECUTIVE SUMMARY

This Public Environment Report (PER) describes Coral Coast Marina Development Pty Ltd's (CCMD) proposal to construct and operate a resort village [Coral Coast Resort (CCR)] providing a broad range of residential, short stay and holiday accommodation at the Mauds Landing townsite near Coral Bay in the north west of Western Australia. The proposed development to take place is adjacent to the Ningaloo Marine Park (NMP), approximately 8km from Commonwealth waters.

The coastline adjoining Ningaloo Reef and Cape Range has been assessed for potential tourist development by planning agencies in Western Australia, with the Mauds Landing site selected as the most favourable, and perhaps the only site suitable for substantial tourist development within the region.

The management objectives of the NMP are conservation and recreation as well as science and education. The key ecological values of NMP (Commonwealth waters) are the rich and diverse marine communities, assemblages of pelagic and demersal fish and benthic communities. Both State and Commonwealth portions of the NMP are managed as far as possible as a single unit by Environment Australia, the Western Australian Department of Conservation and Land Management (CALM) and Fisheries Western Australia (FWA).

The marine park is an element of the National Representative System of Marine Protected Areas (NRSMPA). The NRSMPA is being developed cooperatively by the Commonwealth, State and Northern Territory governments responsible for the conservation, protection and management of the marine environment. A number of animal species of national importance are known from both Commonwealth and State administered portions of the NMP, and the adjoining land.

It is estimated that at full development the total population of the Coral Coast Resort (CCR) (based on 80% average occupancy) will be approximately 2025 persons, comprising 1330 tourists and 695 residents and staff. Of these, it is anticipated about 1120 will be new residents or visitors, and the balance will overflow from the existing Coral Bay settlement and surrounding informal camps.

A proportion of the anticipated visitors and residents will recreate within NMP. This has the potential to add to existing pressures on both the marine environment and support systems.

Based on existing boating trends at Coral Bay, it is predicted that at full development (2009), an extra 480 private and commercial boat journeys will occur weekly from the CCR.

It is predicted an additional demand for seasonal whale watching, whale shark and turtle interaction (on water) and turtle egg laying/hatching experiences will be created. This increased demand is summarised in Table A1 below.

TABLE A1
PREDICTED EXISTING (CORAL BAY) AND ADDITIONAL
DEMAND FOR SEASONAL ECOTOURISM AND FISHING EXPERIENCES,
CORAL COAST RESORT

Activity	Estimated Participation/Annual Demand				
	Coral Bay and Mauds Landing				⁶ Additional CCR (2009)
	Coral Bay Existing		¹ Projected (CCR & Coral Bay 2009)		
	#	% beds	#	% beds	
SCUBA Diving ²	23100	3.8	14212	3.8	8282 dives
Whale watching ^{3, 4}	2646	0.4	1628	0.4	949 observers
Whale shark experiences (snorkelling) ³	1792	0.3	1103	0.3	642 snorkellers
On water manta ray, turtle & dugong interaction (snorkelling) ³	20790	3.1	12791	3.1	7454 snorkellers
Turtle egg laying /hatching experiences ⁵	2234	0.3	782	0.3	801 observers
Fishing Charter	9870	1.7	6073	1.7	3539 fishers

Notes:

- ¹ Assumes demand for informal campsites will decrease with additional serviced campsites, and otherwise regulated, and reduction of existing Coral Bay visitation commensurate with the number of official accommodation units available (477), and using accepted tourism industry beds per class of accommodation.
- ² Hire and Fill data and Dive Industry statistics.
- ³ Limited ecotourism operator data, Coral Bay.
- ⁴ CALM data.
- ⁵ Based on tour participation observations provided by Coral Bay operators.
- ⁶ Additional to existing (2001) demands.

It is anticipated that implementation of the CCR proposal will relieve overflow demand at Coral Bay and cater for increasing demand. Based on limited caravan park site utilisation figures for the period 1994 to 1999 demand at the Coral Bay settlement is estimated to have grown by approximately seven percent annually.

The CCR will be developed over an estimated seven-year period and will also provide limited opportunities for holiday, residential and retirement purposes at a scale incidental to and in keeping with the resort. Site servicing, including reticulated sewage and wastewater treatment, secure managed landfill, water and power will be implemented in such a manner as to allow ready connection of the existing Coral Bay settlement with a view to mitigating current impacts. Current disposal practices for sewerage and solid wastes from the existing Coral Bay facilities are known to impact on the marine park water quality, and to support fox populations that are known to impact on turtle recruitment respectively.

The CCR, to which this document refers, includes the following features:

- marina;

- marina village (comprising a serviced resort complex, convenience retail, food and beverage facilities, CALM Environment and Interpretive Centre and Cultural Centre);
- tourist accommodation (including Caravan and Chalet Park, Beach 'annex' to the resort providing further serviced suites, Backpackers Hostel, Tourist Villa and Townhouse sites);
- supporting coach terminal, auto/marine maintenance, boat launching and parking facilities;
- Sports and Community Centre;
- residential accommodation;
- staff accommodation; and
- infrastructure and services (reticulated sewerage and waste water treatment plant, gas fired diesel power station, reticulated potable water supply, managed landfill site) principally sited in a services area located approximately 2km inland and 3km from the resort.

The resort and marina waterways themselves will provide a range of features such as protected swimming beaches, constructed snorkelling reef, interpretive centre, sports and recreation facilities and entertainment venues that will provide an alternative to traditional recreational uses of the NMP.

The CCR is currently the subject of a formal assessment by the Western Australian Environmental Protection Authority (EPA). The Report and Recommendations providing the EPA advice on this proposal are in preparation, and follow a twelve week public submission period during which time the community were provided with an opportunity to comment on and recommend improvements to the project. At the time of the State referral of this project, the Western Australian Environmental Impact Assessment system had yet to be accredited under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Consistent with administrative guidelines issued by the Commonwealth Environment Minister under the EPBC Act, this PER document provides a description of the proposal, its location and a description of the existing environment. Descriptions of potential impacts on matters of national environmental significance, and mitigation of these impacts, are provided.

Relevant matters of National Environmental Significance identified in the EPBC Act reported on in this document are **listed threatened species and communities and migratory species listed under international agreements.**

Although the proposed action is being taken outside Commonwealth land, implementation of activities at Mauds Landing **may impact on a Commonwealth marine area.** Accordingly an assessment of these potential impacts is also undertaken. Matters of national environmental significance relating to World Heritage Properties, RAMSAR wetlands, nuclear actions and direct impacts on

Commonwealth land are not triggered by this proposal and accordingly are not considered in this PER.

Known populations of a number of listed migratory and threatened species are present in the waters adjacent to the proposed development, and in Commonwealth waters. Increased boating and usage pressure has the potential to have adverse impacts on the habitat and lifecycle (eg. breeding, feeding, migration and the life expectancy) of the listed migratory and threatened species as is presented in Table A2 below.

TABLE A2
LISTED THREATENED AND MIGRATORY SPECIES UNDER
THE EPBC ACT (COMMONWEALTH) AND WILDLIFE CONSERVATION
ACT (WA) THAT ON THE BASIS OF THEIR KNOWN DISTRIBUTION
MAY ON OCCASION BE OBSERVED IN THE NMP

Species		EPBC Threatened Fauna - Endangered	EPBC Threatened Fauna - Vulnerable	EPBC Migratory	Western Australian Wildlife Conservation Act
Blue whale	<i>Balaenoptera musculus</i>	✓		✓	✓
Southern right whale	<i>Eubalaena australia</i>	✓			✓
Fin whale	<i>Balaenoptera physalis</i>		✓		✓
Humpback whale	<i>Megaptera novaeangliae</i>		✓	✓	✓
Sei whale	<i>Balaenoptera borealis</i>		✓		✓
Indo-pacific humpbacked dolphin	<i>Sousa chinensis</i>			✓	
Spinner dolphin	<i>Stenella longirostris</i>			✓	
Dugong	<i>Dugong dugon</i>			✓	✓
Whale shark	<i>Rhincodon typus</i>		✓	✓	
Indian Yellow-nosed albatross	<i>Thalassarche carteri</i>		✓	✓	
Soft-plumaged petrel	<i>Pterodroma mollis</i>		✓		
Southern giant petrel	<i>Macronectes giganteus</i>	✓			
Loggerhead turtle	<i>Caretta caretta</i>	✓		✓	✓
Flatback turtle	<i>Natator depressus</i>		✓	✓	✓
Green turtle	<i>Chelonia mydas</i>		✓	✓	✓
Hawksbill turtle	<i>Eretmochelys imbricata</i>		✓	✓	✓

Source: adapted from Commonwealth of Australia (2000).

Notes:

Migratory (EPBC Controlling Provisions 20 and 20A): the action may substantially modify, destroy or isolate an area of important habitat of the migratory species **and/or** seriously disrupt the lifecycle (breeding, feeding, migration or nesting behaviour) of an ecologically significant proportion of the population of the species.

Threatened – Endangered/Vulnerable (EPBC Controlling Provisions 18 and 18A): the action may reduce the area of occupancy of the species and seriously disrupt the lifecycle (breeding, feeding, migration or nesting behaviour) of an important population of the species.

In planning to mitigate these potential impacts, the proponent has made a number of commitments in this PER to minimise the environmental impact of the development. A summary of the commitments is provided in Table A3. The list presented recognises that impacts of the action on coastal waters have the potential to impact on Commonwealth waters, and is accordingly broad.

The following summary is provided in relation to species of national environmental significance identified as being potentially affected through the implementation of this proposal.

Whale Sharks

Whale sharks (*Rhincodon typus*) congregate at Ningaloo on a seasonal basis. The whale sharks move from offshore waters into the NMP where they congregate from March to May each year. Peak whale shark numbers occur about two weeks after the mass asynchronous coral spawning, when it is suggested rapidly expanding zooplankton population growth provides an abundant and rich food source for the planktivorous whale sharks. Between 200-400 whale sharks, believed to be mostly juvenile males, can occur in the NMP over a period of about ten to twelve weeks annually. The location of the main aggregation of whale sharks within the NMP varies from year to year and in some years may not occur at all in the northern portion of the Park.

As whale sharks mainly occupy the turbulent waters along the outer edge of the reef front where the current is flowing northward (the Ningaloo Current), contact in trailed (small) craft is unlikely and most likely human interaction will continue through professional ecotourism operators. Licences allowing interaction between tour boat operators and whale sharks are issued by CALM, and the industry regulated through licensing and application of a code of practice.

Other than the potential to disrupt the lifecycle (breeding, feeding, and migration) of an ecologically significant proportion of the population of the species due to increases in visitor numbers and boating traffic, there are few other pressures on populations of whale sharks in Australian waters. Existing and potential uses and/or pressures include physical disturbance resulting from snorkellers and boat noise, and the possibility of boat collisions principally during commercial whale shark watching tours.

Based on both current demand, and industry patterns (Table A1), increased demand for whale shark interactions are predicted to require an additional 60 boat trips at 80% boat utilisation. At full implementation of the CCR development this would require an additional 0.8 boats/day each carrying thirteen snorkellers over the approximate ten-week period of the whale shark schooling.

It is considered that a single point of embarkation/disembarkation within this portion of NMP, regulatory (licensing) controls in place by CALM, and the improved monitoring and education opportunities afforded by the resort, together with greater regulatory presence will ensure disruption to whale shark lifecycles does not occur. Additionally, the observation that most of the whale sharks that congregate are juvenile males, rather than for example breeding females, implies that significant impacts on the lifecycle of the whale shark population are unlikely to occur.

Dugongs

Dugongs (*Dugong Dugon*) are dispersed along the entire length of the Ningaloo Reef Tract. Based on CALM aerial surveys undertaken in 1989 and 1994, the total

population of dugong in the NMP is estimated to be in the order of 1000 individuals. The density of dugongs within the NMP is similar to that of other significant dugong habitats in northern Australia. The dugongs in this area probably move freely between the NMP and Exmouth Gulf, and perhaps the nearshore waters further east. Dugong is the only fully herbivorous marine mammal in Australia. It is now extinct or near extinct in most of its former range that extended from East Africa to South East Asia and the Western Pacific (Commonwealth of Australia 1995). Northern Australia has the last significant population (estimated as 80,000 in 1995). The species is large, long lived and has a slow reproductive cycle.

Dugongs are generally not resident within Bateman Bay as seagrass habitat is not widespread and biomass low, nor do they commonly occur in the Commonwealth portion of the NMP. Ecotourism operators may encounter a dugong on average every second trip when travelling within the lagoon.

Major concerns in managing the species relate to overfishing by indigenous communities, mortalities in fishing nets, and loss of seagrass habitat. Occasional boat strikes are known in Australian waters. The dugong is listed by the IUCN as 'vulnerable to extinction' and under the EPBC Act it is listed as a migratory species but not as threatened fauna.

In relation to fishing by indigenous communities, the owners of Cardabia Station, the Baiyungu people, have given an undertaking to assist in cetacean, dugong and turtle management in the area.

Set fishing nets are only allowed in limited areas within the NMP, and increased regulatory presence will reduce the likelihood that illegal netting occurs within Bateman Bay and adjoining areas. Trawling does not occur.

Seagrass habitat is not widespread within Bateman Bay, and dugong encountered are considered to be in transit. Seagrass in the Mauds Landing area comprise *Posidonia coriacea*, *Amphibolis antarctica* and *Halophila ovalis*. *A. antarctica* was recorded at only a few sites to the north of Mauds Landing. *P. coriacea* occurs at low density (<1 to 10% seafloor cover) over parts of Bateman Bay, but was only recorded at higher densities in discrete patches. These are located at depths of 5-10m along 1.5km of shoreline, extending some 600m out to sea and commencing 4km north of Mauds Landing as well as the northern side of Cardabia Passage at depths of 16-18m. No seagrass will be lost by the construction of the resort.

As dugong is only encountered opportunistically, the species is not subject to ecotourism pressures from activities such as snorkelling. When encountered, groups may be given the opportunity to snorkel with dugong or observe them from the boat. Based on current demand for snorkelling trips and industry patterns (Table A1), an increase in snorkelling activities of an additional 371 boat trips at 66% boat utilisation may result, with resulting opportunistic encounters with dugongs. At full implementation of the CCR development, this demand would require one additional boat to carry 17 snorkellers at 66% utilisation.

It is considered that the limited potential to impact on seagrass, greater control afforded by the single point of embarkation/disembarkation within this portion of

NMP, the improved monitoring and education opportunities afforded by the CCR, and greater regulatory presence will ensure disruption to dugong lifecycles does not occur. Management options, such as the control of boating activities in sensitive areas will be identified and implemented if monitoring indicates increased pressures.

Humpback Whales

Humpback whales (*Megaptera novaeangliae*) migrate to Ningaloo (and further north) to use Ningaloo and Exmouth Gulf to breed, calve and rest. Recorded humpback whale numbers have been increasing significantly along the west coast.

The humpback whales return to NMP waters in spring (September/October) during their southern migration to summer feeding grounds in Antarctica.

Existing and potential uses and/or pressures include physical disturbance in the form of boat collisions and boat noise principally due to commercial whale watching tours. The current incidence of entanglement of cetaceans in fishing gear or litter is considered to be low, as historically commercial fishing has been limited in the area.

Based on current demand for whale watching trips over approximately twelve weeks of their migration and industry patterns (Table A1), an increase in whale watching requiring an additional 67 boat trips at 50% boat utilisation may result. At full implementation of the CCR development this would require an additional 0.8 boats per day carrying eleven observers for the period of the whale migration, approximately 12 weeks.

It is considered that single point embarkation/disembarkation within this portion of NMP, regulatory (licensing) controls in place by CALM, and the improved monitoring and education opportunities afforded by the resort, together with greater regulatory presence will ensure disruption to humpback whale lifecycles does not occur.

Turtles

Four species of turtle utilize the waters adjacent to Mauds Landing. *The Green* (*Chelonia mydas*), *Hawksbill* (*Eretmochelys imbricata*), *Loggerhead* (*Caretta caretta*) and *Flatback* (*Natator depressus*) turtles are known in the area. Aerial surveys of the NMP suggest that an estimated population of approximately 4300 turtles (all species) is resident within the NMP. Turtle densities are extremely high at Ningaloo and exceed the highest densities recorded on the Great Barrier Reef and most of the areas in Torres Strait.

Green turtles feed on macroalgae and are by far the most common turtle on Ningaloo Reef. However very few (two to five per cent) breed on Bateman Bay beaches.

Loggerhead turtles are carnivorous, feeding mainly on molluscs and crustaceans. They may utilize the mussel beds 3km northeast of Mauds Landing, and occur in significant numbers on the backreef either side of Cardabia Passage. Loggerheads are known to nest on beaches in Bateman Bay, and make up the vast majority (greater than 95%) of the seventy-one and sixty-nine turtle nests being recorded during the

1999-2000 and 2000-2001 seasons respectively. These nesting loggerheads make up about 0.5% of the total known adult female nesting population of loggerheads in Western Australia. Hawksbill turtles are at the end of their range in the Ningaloo area, feed mainly on sponges and are more often located in deeper water, seaward of Ningaloo Reef.

Flatback turtles are probably the next most abundant breeding species of marine turtle in Western Australia after the green turtle and are listed as vulnerable under the EPBC Act.

The major impacts on turtles while in Australian waters are:

- loss of eggs to feral animals;
- mortality of adults while in prawn nets;
- shark nets and gill nets;
- collisions with speed boats;
- subsistence hunting by indigenous communities; and
- habitat degradation.

Feral animal control will include the construction and operation of a managed landfill site to service the region and active feral animal control programs to reduce fox numbers. This will replace a current facility that has poor controls.

Fishing nets are only allowed in limited areas within the NMP, and increased regulatory presence will reduce the likelihood that illegal netting occurs within Bateman Bay and adjoining areas. There is no commercial prawn fishery. Similarly shark and gill are not currently used within the Ningaloo Reef Tract.

Based on recent boat counts and utilisation patterns at Coral Bay, it is anticipated that implementation of this proposal will result in an increase in 159 boats ranging from car toppers to moored commercial and private vessels. Based on counts carried out during Easter 2001 about 98 boats operate out of the existing Coral Bay facilities during peak holiday periods. At any one time up to 46% of boats are in use.

Boating related impacts on species of National Environmental Significance will alter however will be offset as the need to travel along the sensitive backreef areas to gain ocean access from launch sites in Bills Bay will no longer be necessary as the CCR will provide direct access to Cardabia Passage. Backreef areas are important marine turtle feeding and resting areas. As for dugong, marine turtles are encountered opportunistically during commercial snorkelling trips. At full implementation of the CCR development this demand would require an additional one commercial boat/day carrying 17 snorkellers.

In relation to the direct impacts of construction resort and marina, the marine breakwaters and entrance channel will remove approximately 300 m of beach and foredune that may be used for turtle nesting. The breakwaters will extend 200m seaward from the high water mark (HWM) and may present an obstacle to turtle nesting or movement. Plotting of loggerhead turtle nests during the 2000/01 summer identified three nesting sites on the beach immediately in front of the proposed resort, likely representing a single breeding female. The majority of turtle nesting occurs

approximately 6km to the north of the development. Nesting turtles represent a breeding population of about 24 loggerheads and one or two green turtles. This constitutes about 0.5 % of the estimated stock of breeding female loggerhead turtles in Western Australia.

Lighting will be managed by implementation of best practice lighting procedures consistent with turtle conservation including the use of sodium vapour lamps in all public areas. The location of the resort behind the primary and secondary dune systems will also limit impacts. All aspects of turtle management will be described in a Turtle Management Plan to be developed in consultation the CALM and relevant experts, to be implemented immediately following approval. Additional demands for tourist places on escorted nesting, hatching experiences will require six quadbikes or 4WD places daily.

Removal of 300 m of beachfront is unlikely to be of significance in the context of surrounding values. This will not prevent the turtles from nesting on the adjoining beaches where turtle nesting presently occurs. Additionally, pro-active measures such as waste management, fox control and turtle nest management are envisaged to offset additional pressures and increase recruitment rates. Redirection of existing boat traffic away from the sensitive back reef area will reduce the possibility of boat strikes in that area.

Vehicle, particularly 4WD access to the beachfront will be prevented from the CCR. Vehicle access from adjoining Cardabia Station and onto CALM controlled beaches of the marine park will be the subject of discussions with these parties with a view to minimising impacts on nesting turtles.

Monitoring, Review and Audit

The possible impacts arising from implementation of this proposal on Commonwealth marine waters will be managed through the design, location, infrastructure and management programs identified in the project design. The summary of commitments for development of the resort is given in Table A3. Factors that will impact on State waters and accordingly have the potential to impact on Commonwealth waters and measures to limit these impacts are summarised in Table A4.

Planning for the resort incorporates all service utilities including sewerage, power, solid waste landfill and reticulated water, with the majority of utilities to be located in a services area proposed for establishment 2km inland and approximately 3km from Mauds Landing. Should the Coral Bay settlement connect to these facilities, it is believed water quality impacts, litter and the occurrence of feral animals will reduce.

Control of the impact of greater visitation to the area will be managed through the monitoring, development and implementation of resultant management strategies regionally in collaboration with government regulatory agencies. Discussions have been held with CALM in relation to the development of a Specific Area Marine Management Plan (SAMMP) consistent with the 'Ningaloo Marine Park Management Plan' and the objectives of the Department of Conservation and Land Management (CALM) in management of the area.

The SAMMP will provide a detailed description of the ecological and social values of the area surrounding the proposed development. This will include the existing Coral Bay area and where impacts may occur, relevant Commonwealth waters. Management objectives, strategies and targets will be further refined and a comprehensive monitoring program implemented with a view to measurement against these objectives and continual improvement. Included in the SAMMP are descriptions and considerations in the management of ecosystem target species such as whale sharks, marine turtles, and marine mammals.

The SAMMP, together with all aspects of the construction and operation of the CCR, will be controlled by a set of specifications and standards under the umbrella of ISO 14000. The environmental management system (EMS) developed will present a structured approach ensuring sound environmental management is in place for all significant aspects of the project. This will include the adoption of pollution prevention techniques and the mitigation of negative environmental impacts potentially resulting from increased '*people pressure*' on the Ningaloo Reef environment generally and the species identified as being of national environmental significance specifically.

TABLE A3
CORAL COAST RESORT
SUMMARY OF COMMITMENTS RELATED TO ISSUES OF NATIONAL IMPORTANCE

Commitment No.	Topic	Action (what, where, how)	Objective (Why)	Timing (When)	Advice (To Whom)
1	EMS	Prepare and implement health; safety and environmental management systems for the CCR that will comply with OHSAS 18001 and ISO 14001.	To develop, implement, review and maintain the proposed OH&S and EMS	Prior to implementation of the construction program of the CCR.	EPA on advice of the DEP.
2	Ningaloo Reef	Prepare a Specified Area Marine Management Plan (SAMMP) for the Maud Specific Management Area (MSMA).	• Avoid or limit impacts on biota (corals, marine flora and fauna),	Pre-construction (prior to placement of breakwater materials).	DEP on advice from CALM and FWA.
		Implement a SAMMP for the MSMA.	• Avoid or limit impacts in the non-living environment (sediments, water quality).	Construction and operation, with review 5 years after the completion of construction.	
3	Ningaloo Marine Park Management	Proponent to enter into Natural Resources Management Agreement.	Provide adequate resources to support agency functions in the area, and in so doing reduce impacts.	Pre-construction.	DEP on advice from CALM and FWA.
4	Marine Fauna	Develop management strategies for recreational finfish target species.	To ensure the biodiversity of fish communities and sustainability of fish stocks.	Pre-construction, construction and operation.	DEP on advice from FWA.
5	Marine Fauna (Turtles)	Prepare Turtle Management Plan and Turtle Nesting Surveillance Program.	Avoid or limit impacts on marine turtle populations, especially during sensitive nesting periods.	Pre-construction (prior to placement of breakwater materials).	CALM in consultation with Environment Australia and the local community.
		Implement a Turtle Management Plan and Turtle Nesting Surveillance Program.		Construction and operation, with review 5 years after the completion of construction.	CALM.
7	Mauds Landing Shoreline	Prepare a Shoreline Movement Management Plan.	• Maintain the stability of foreshore areas.	Pre-construction (prior to placement of breakwater materials).	DEP on advice from CALM and Department of Planning and Infrastructure.
		Implement a Shoreline Movement Management Plan.	• Maintain or improve those areas presently degraded.	Construction and operation, with review 5 years after the completion of construction.	

Commitment No.	Topic	Action (what, where, how)	Objective (Why)	Timing (When)	Advice (To Whom)
8	Mauds Landing Foreshore	Prepare a Foreshore Management Plan.	- Avoid or limit impacts on biota (corals, marine flora and fauna). - Maintain or improve those areas presently degraded.	Pre-construction (prior to placement of breakwater materials).	DEP on advice from CALM and MfP.
		Implement a Foreshore Management Plan.		Construction and operation, with review 5 years after the completion of construction.	
14	Cyclone/ Flood/ Storm Surge/ Fire/ Fuel Spillage	Develop an Emergency Response Plan.	Put in place specified procedures to enhance public safety in the event of exceptional climatic/oceanographic occurrences or fire.	Construction	DEP on advice from Department of Planning and Infrastructure, Police, Fire and Emergency Services WA.
		Implement an Emergency Response Plan.	Provide equipment and put in place specified procedures in the event of a fuel spillage in the marina.	Operation	Police, Fire and Emergency Services WA, SES.
15	Marine Water Quality	Develop a Construction Management Plan.	Put in place specified procedures to control, identify and manage construction and dewatering impacts on the nearshore marine environment.	Pre-construction	DEP on advice from CALM, DME and Environment Australia.
		Implement a Construction Management Plan.	Carry out, for the duration of the construction period, procedures to control, identify and manage construction and dewatering impacts on the nearshore marine environment.	Construction	DEP on advice from CALM.
16	Marine Water Quality	Provide a lined and fully bunded facility for fuelling heavy machinery.	Limit potential impacts from construction hydrocarbon spillage.	Construction	DEP on advice from DME.
17	Marine Water Quality	Develop a Nutrient and Irrigation Management Plan.	Reduce nutrient losses to the nearshore marine environment.	Construction	DEP on advice from WRC and CALM.
		Implement agreed Nutrient and Irrigation Management Plan.		Operation	DEP on advice from WRC and CALM.
18	Marine Water Quality	Provide a boat sewerage pump-out facility.	Reduce sewerage discharges into the marina and nearshore marine environment.	Construction	DEP
19	Marina Water and Sediment Quality	Develop and implement a Marina Water Quality and Sediment Monitoring Program and compare the results to those predicted in the nutrient modelling, and make appropriate adjustments annually.	Reduce nutrient losses to the marina and nearshore marine environment.	Operation	DEP on advice from WRC.

Commitment No.	Topic	Action (what, where, how)	Objective (Why)	Timing (When)	Advice (To Whom)
20	Liquid and Solid Waste Management	Design a managed landfill site to service the Mauds Landing Townsite and Coral Bay.	Reduce leachate entering the unconfined aquifer.	Pre-construction	DEP on advice from Waste Management WA and the Shire of Carnarvon.
		Construct and operate a managed landfill site.		Construction and operation	DEP in consultation with the Shire of Carnarvon.
21	Liquid and Solid Waste Management	Design reticulated sewerage and a WWTP to service the Mauds Landing Townsite, with provision for expansion to allow the connection of the Coral Bay settlement.	Reduce leachate entering the unconfined aquifer.	Pre-construction	DEP in consultation with the Water Corporation and Shire of Carnarvon.
		Design and construct reticulated sewerage and a WWTP to service the Mauds Landing Townsite, with provision for expansion to allow the connection of the Coral Bay settlement.		Construction	DEP in consultation with the Water Corporation and Shire of Carnarvon.
22	Groundwater Quality and Quantity	Develop a Shallow Groundwater Monitoring Program.	Monitor groundwater quality in the unconfined aquifer with a view to identification and mitigation of contributing sources.	Pre-construction	DEP in consultation with Geological Survey of WA, DME and WRC.
		Implement a Shallow Groundwater Monitoring Program.		Pre-construction (baseline), construction and operation.	DEP in consultation with WRC.
23	Management and Education	Proponent to provide funding toward the construction and fitting out of an environment and interpretive centre.	Provide a facility to support regulatory agency functions within the region, and for education.	Construction	DEP on advice from CALM and FWA.
42	Marine Fauna (Nationally Threatened and listed Migratory Species)	Prepare a National Threatened and listed Migratory Species Management Plan.	Avoid or limit impacts on species of national significance.	Pre-construction (prior to placement of breakwater materials).	CALM in consultation with Environment Australia and the local community.
		Implement a National Threatened and listed Migratory Species Management Plan.		Construction and operation, with review 5 years after the completion of construction.	CALM

TABLE A4
CORAL COAST RESORT
SUMMARY OF FACTORS THAT MAY IMPACT ON COMMONWEALTH WATERS

ENVIRONMENTAL FACTOR	OBJECTIVE	EXISTING ENVIRONMENT	POTENTIAL IMPACT	ENVIRONMENTAL MANAGEMENT	PREDICTED OUTCOME
Biophysical:					
Coral	To maintain the ecological function, abundance, species diversity and geographic diversity of corals.	There are no substantial coral communities in close proximity to Mauds Landing. Directly offshore 6.5km to N and 2km W, bare sand substrate is dominant.		Development and implementation of a Specific Area Marine Management Plan (SAMMP). Enter into a binding agreement with CALM and FWA to provide additional resources for Ningaloo Marine Tract management on approval of proposal.	No direct impact.
Marine Flora	To maintain the ecological function, abundance, species diversity and geographic diversity of seagrasses.	Impacted area consists of sandy substrates with limited macroalgae. Seagrasses offshore from Mauds Landing are restricted to a discrete area containing patches of <i>Posidonia coriacea</i> and <i>Halophila ovalis</i> .	Direct loss due to placement of breakwaters and accretion. Construction impacts include limited dredging during channel construction, followed by a period of reduced water quality (increased suspended solids) during initial operation.	Development and implementation of a SAMMP. Development and implementation of a Construction Management Plan (CMP) on approval of proposal.	No direct losses of macro algal dominated pavement communities. No seagrasses will be directly affected.

ENVIRONMENTAL FACTOR	OBJECTIVE	EXISTING ENVIRONMENT	POTENTIAL IMPACT	ENVIRONMENTAL MANAGEMENT	PREDICTED OUTCOME
Marine Fauna	To maintain the ecological function, abundance, species diversity and geographic diversity of marine faunal communities.	Bare sand substrates near Mauds Landing with minimal attached flora or fauna. Turtles, including loggerheads are known to nest on beaches in Bateman Bay. Dugong and manta rays are known to visit the area.	Direct loss of about 5ha of bare sand and dependent communities. Loss of approximately 200m of beach that may be used for turtle nesting. Light impacts.	Implementation of public education and information programs. Development and implementation of a SAMMP. Development and implementation of a Turtle Management Plan and Nesting Surveillance Program. Development and implementation of a Marine Mammal Management Plan	Some minor loss of turtle nesting habitat offset by improved management opportunities. Manta rays are common in northern Bateman Bay.
Substrate	Maintain the integrity, function and environmental values of the biological components of the near shore environment, including Ningaloo Reef, due to impacts resulting from alteration of the substrate.	Complex geomorphology of the Ningaloo Reef Tract supports a wide diversity of habitats and ecological niches. It is anticipated that about 5ha of sand habitat and dependant communities will be directly lost.	The works proposed are anticipated to be minor given the generally robust nature of much of the sub-tidal geomorphology.	Development and implementation of a SAMMP. Development and implementation of a Shoreline Movement Management Plan.	Some minor local change of substrate immediately adjacent to the marina entrance channel.
Foreshore and Dunes	To ensure construction and recreational use of the foreshore dune systems does not lead to erosion that may result in detrimental impacts on the near shore marine environment.	Refracted swell approach Mauds Landing virtually parallel to the beach. Accordingly there is little longshore sand transport under normal conditions. The development will purposefully not extend onto fragile foredune areas, with nearly 40% of the Mauds Landing Townsite being set aside for dune conservation.	Episodic movement of sand can be accommodated in breakwater design. Foreshore areas within the development will be formalised through signage, pathway and landscape features.	Dune and foreshore areas formalised through signage, pathway and landscape features. Development and implementation of a Shoreline Movement Management Plan. Development and implementation of a Foreshore Management Plan.	Predicted impacts can be minimised through integrated development and implementation of management procedures and public education.

ENVIRONMENTAL FACTOR	OBJECTIVE	EXISTING ENVIRONMENT	POTENTIAL IMPACT	ENVIRONMENTAL MANAGEMENT	PREDICTED OUTCOME
Marine Water Quality	Maintain the quality of marine waters and sediments to ensure that existing and potential users, including ecosystem maintenance, are protected consistent with the <i>Draft Australian and New Zealand Guidelines for Fresh and Marine Water Quality</i> , ANZECC July 1999.	The waters of NMP are largely pristine with some deterioration noted in respect to nutrient enrichment and elevated microbiological levels and TBT levels in Bills Bay adjacent to the Coral Bay settlement. Some elevation of arsenic and metal concentrations off Mauds Landing have been measured, possibly as a result of residual contamination from historical activities. The waters within the NMP are, by world standards, nutrient-poor.	Nutrient enrichment of waters by human activities such as: • sewage discharge; • contaminated groundwater inputs; and • surface runoff. Modelling has indicated that water quality will remain of a high standard. Accidental and deliberate spills from: • boats; • hull antifouling treatments; • fuelling & industrial discharges.	Maintenance of water quality near shore marine waters will rely on intensive management of nutrient inputs. Development and implementation of a monitoring component in the SAMMP. Development and implementation of a Construction Management Plan. Development and implementation of an Emergency Response Plan. Development and implementation of a Nutrient and Irrigation Management Plan.	Some minor changes to water quality adjacent to the marina entrance channel offset by a significant improvement in near shore water quality in S. Bills Bay following relocation of major boating and should local connection to deep sewerage at Coral Bay occur. No impacts as Commonwealth Waters or species of National importance.
Marina Water and Sediment Quality		The marina will be connected to Bateman Bay by an entrance channel of minimum depth 4.5m. Anticipated area of Marina will be 47.5ha.		Development and implementation of a monitoring component in the SAMMP. Exclude vessels with TBT treated hulls from mooring within the marina.	Maintenance of water and sediment quality within an acceptable range.
Liquid and Solid Waste Disposal	Liquid and solid wastes should be contained and isolated from groundwater and surface surrounds.	All living units at the resort will be fully serviced, including deep sewerage solid waste collection and landfill disposal.	Potential for losses to shallow groundwater of treated effluent and leachate.	Development and construction of the first cell of a managed landfill site.	Some limited potential to impact on shallow groundwater, offset by a significant improved in

ENVIRONMENTAL FACTOR	OBJECTIVE	EXISTING ENVIRONMENT	POTENTIAL IMPACT	ENVIRONMENTAL MANAGEMENT	PREDICTED OUTCOME
Liquid and Solid Waste Disposal (continued)		A landfill site will be established, with an area sufficient to provide a minimum 25-years capacity. Provision has been made to accommodate the Coral Bay settlement in all utilities.	Further problems of litter and vermin from poorly managed landfill.	Design and install deep sewerage to the resort and construct a wastewater treatment plant.	superficial groundwater quality in S. Bills Bay should local connection to deep sewerage at Coral Bay occur.
Groundwater Quality and Quantity	Maintain the quality of groundwater to ensure that existing and potential uses, including ecosystem maintenance are protected, consistent with the <i>Draft Australian and New Zealand Guidelines for Fresh and Marine Water Quality</i> , ANZECC July 1999 and NHMRC/ ARMCANZ <i>Australian Drinking Water Guidelines - National Water Quality Management Strategy</i> .	Water is currently drawn from the Birdrong Artesian Formation for Coral Bay. Anticipated water requirements for the resort is approximately 0.5 million kL/annum. Investigations indicate a sustainable draw from the Birdrong Formation of about 10 million kL/ annum.	Nutrient enrichment of shallow ground waters can result from activities such as: - leach drain discharge; - fuel & oil spills; - contaminated surface runoff. These may in turn enter the shallow water of Bateman Bay.	Development and implementation of a Shallow Groundwater Monitoring Program. Development and implementation of an Emergency Response Plan.	Some limited potential to impact on shallow groundwater. Monitoring and the development of response procedures will ensure the EPA's objectives can be met.
Recreation	To facilitate and manage a diverse range of recreational activities stemming from the provision of the resort facility and to educate users within the resort	Recreational use of the Ningaloo Marine National Park and adjoining lands include: use of headlands, dunes and beaches;	Greater 'people pressures' on fish stocks and ecotourism target species. Conflicts for available natural resources (unspoiled beaches, vista etc).	Management measures described for this factor must especially be viewed as part of a complementary suite of management practices, including: fisheries management, wildlife management, marine transport and safety measures to achieve this stated objective.	Greater physical pressure on the resources of the Ningaloo Marine Tract will result from this proposal.

ENVIRONMENTAL FACTOR	OBJECTIVE	EXISTING ENVIRONMENT	POTENTIAL IMPACT	ENVIRONMENTAL MANAGEMENT	PREDICTED OUTCOME
Recreation (continued)	and Coral Bay, within an equitable and ecologically sustainable framework, and consistent with the objectives of the current Ningaloo Marine Park Management Plan.	• seascapes, including views of clear waters, reefs, breaking surf and clear oceans; • recreational fishing targeting finfish from shore or by boat; • water sports; and • marine based tourism.		These include: • funding to support regulatory agency function; • develop and implement a SAMMP; • assess fin fish stocks; and • develop management strategies for ecotourism target species.	This will in part be offset by the reduction on current impacts, provision of alternative tourist activities and enhanced management capability based on additional funding and research, and resultant strategies.

1. INTRODUCTION

1.1 Background and Project Benefits

Coral Coast Marina Development Pty Ltd (CCMD) proposes to develop a serviced resort village providing a broad range of residential, short stay and holiday accommodation at Mauds Landing, a gazetted townsite situated on the North-West Cape of Western Australia approximately 1200km north of the capital city of Perth (Figure 1). Mauds Landing is situated within the Shire of Carnarvon and is positioned between the towns of Carnarvon and Exmouth being approximately 250km north of Carnarvon and 150km south of Exmouth.

The proposed Coral Coast Resort (CCR) is to be supported by incidental recreational, tourist and commercial services, consistent both with the needs of visitors to the location and the need for environmental protection. The proposed resort will also provide limited permanent residential accommodation.

Based on 80% average peak occupancy it is estimated that the total population at full development would be approximately 2025 persons comprising 1330 tourists and 695 residents and staff.

The CCR at Mauds Landing provides environmentally and ecologically sustainable opportunities to provide both quality facilities and experiences outside of the Bills Bay Sanctuary Zone to cater for the increasing visitor numbers to the region. More importantly, Mauds Landing provides the opportunity and resources for effectively managing increases in visitor numbers within the Ningaloo Reef Tract area, including current overcrowding at Coral Bay.

The Mauds Landing Townsite has a gross area of approximately 250ha and is situated approximately 3km north of the existing Coral Bay (Bills Bay) settlement and adjacent to the NMP. Commonwealth waters are located approximately 8km from the proposed development site. The location of the proposed resort relative to the Coral Bay settlement and proposed services area is presented in Figure 2.

The CCR will be developed along principals consistent the Gascoyne Coast Regional Strategy (Ministry For Planning 1996), and has the support of the Western Australian Government.

Consistent with Western Australian Government requirements, the development will consist of:

- an inland marina servicing a range of shallow and moderate (to 3.5m) draft vessels;
- staged tourist development consistent with the Gascoyne Coast Regional Strategy;
- permanent residential development be limited to 200 dwellings plus staff accommodation;

- a mix of dwelling types, in equal proportions, including apartments, strata units and single residential; and
- supporting infrastructure consistent with the scale of the development.

The project has a number of direct and indirect benefits both to the environment and people of the region. Through development, the CCR will reduce further pressures on the Sanctuary Zone at Bills Bay. Additional environmental benefits include:

- construction of an inland marina that will allow the majority of boating activities to be shifted from Bills Bay and provide direct access to Cardabia Passage without impacting on sensitive coral areas, including back reef areas important for loggerhead turtles;
- inclusion of safe recreation areas including a constructed snorkelling reef that will provide recreational alternatives for visitors without impacting on Ningaloo Reef. Together with the Environment and Interpretive Centre, such facilities will reduce direct pressure and provide opportunities to educate visitors on the sensitive nature of the reef environment. Corals are proposed to be propagated on the artificial reef and will not require translocation;
- the project incorporates all service utilities including sewerage, wastewater treatment, power, solid waste landfill and reticulated water. The landfill site will be sized to accommodate solid waste from the existing Coral Bay settlement. CCMD has also made a commitment to design utilities, including sewerage and power, so that they can be upgraded to accommodate the requirements of the existing Coral Bay development. This will reduce the risk of leaching of effluent nutrient into Bills Bay that has been identified as contributing to reduced water quality and accordingly, damage to the coral systems within the Sanctuary Zone;
- potential to reduce overcrowding at Coral Bay generally, and specifically during periods of peak visitor demand;
- the opportunity for the relevant authorities, notably the Department of Conservation and Land Management (CALM) and Fisheries Western Australia (FWA), to develop and institute more effective management controls on the Sanctuary Zone at Bills Bay and the greater NMP area as a consequence of a permanent on-site presence, resulting in better control of recreational fishing, more adequate control of recreational boats, greater control of marine safety, substantially safer boat access and management, and substantially improved boat handling and launching facilities; and
- through the provision of an Environment and Interpretive Centre and other facilities such as boat launching ramps, the ability for management agencies such as CALM and FWA, to generate substantially increased revenue for management of NMP.

1.2 The Proponent

The CCR is proposed by Coral Coast Marina Developments Pty Ltd a private company formed in October 1987 with the specific purpose of developing a resort at Mauds Landing.

The registered office of CCMD is:

Coral Coast Marina Development Pty Ltd
Suite 1, Poynton House
Cnr. Poynton Ave and Burgess Street
MIDLAND WA 6056

Phone: (08) 9274 0711
Fax: (08) 9274 1665

No proceedings have ever been taken against CCMD under Commonwealth, State or Territory law pertaining to the protection of the environment or conservation and sustainable use of natural resources.

1.3 Ningaloo Marine Park

The Ningaloo Marine Park (NMP) consists of Ningaloo Marine Park (Commonwealth Waters) and Ningaloo Marine Park (State Waters). NMP (Commonwealth Waters) was declared by proclamation under the *National Parks and Wildlife Conservation Act 1975* on 7 May 1987. This declaration is continuously in force under the provisions of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Commonwealth Waters are located approximately 8km from the site of the proposed action. The various zones of NMP are indicated in Figure 3.

NMP (Commonwealth Waters) is managed predominantly for conservation, recreation, science and education, and is to be managed as a World Conservation Union (IUCN) Category II-National Park (Environment Australia, 2000). Management of Category II National Parks is mainly for ecosystem conservation and recreation.

Commonwealth of Australia (2000) has identified the strategic objectives of the Commonwealth portion of the NMP as:

Conservation

- To maintain the marine biodiversity of the marine park; and
- To maintain key ecological processes and life support systems.

Recreation

- To provide for and manage recreational and cultural uses to the extent compatible with the conservation objectives for the marine park.

Science and Education

- To promote education, nature appreciation and scientific research on the biological, geophysical and cultural values of the marine park.

National System

- To manage the area as part of a comprehensive, adequate and representative system of marine protected areas to contribute to the long term ecological viability of marine and estuarine systems.

The management of NMP in concert with Western Australian Government agencies is further described in Section 4.1.

1.4 Legislative Context

A brief compilation and description of existing legislation, policies and other instruments governing marine resource allocation, use, conservation and environmental protection of the NMP is presented below. This includes cross-jurisdictional arrangements between Commonwealth and State agencies in which responsibilities for legislation and other initiatives are vested.

1.4.1 International Conventions, Commonwealth and State Legislation and other Instruments Affecting Ningaloo Marine Park

The legal and constitutional framework for marine areas in Australia is outlined in information provided in Australia's Oceans Policy (Commonwealth of Australia 1998).

Maritime Zones

Australia has declared a range of Maritime Zones under the Commonwealth *Seas and Submerged Lands Act 1973*.

The Maritime Zones are measured from the Territorial Sea Baseline (generally the low water line). The zones include:

- State Coastal Waters from the Territorial Sea Baseline seaward to 3 nautical miles (nm);
- Territorial Seas, from the Territorial Sea Baseline seaward to 12nm;
- Contiguous Zone, from 12nm seaward to 24nm;
- Exclusive Economic Zone (EEZ), extending seaward from 12nm across the continental shelf to 200nm; and
- The Australian Fishing Zone (AFZ), extending seaward from 3nm to 200nm.

These zones are illustrated in Figure 4.

The States and Territory were given power to legislate over coastal waters as part of the Offshore Constitutional Settlement (OCS). Through the OCS, the Commonwealth, in effect, agreed to give States primary responsibility over coastal waters out to 3nm. Beyond that limit, the Commonwealth retains primary responsibility. In some cases there are Joint Authority agreements in place between Commonwealth and State agencies to provide the mechanisms for satisfying legal and regulatory requirements

Relevant International Conventions, Treaties and Protocols

A number of relevant international conventions, treaties and protocols to conventions, and other high level instruments are listed below. Information is derived from Commonwealth of Australia (1998) and Gordon (2000). A brief description of some of the more relevant conventions, treaties and protocols (bolded) in relation to this proposal is also provided.

- Agenda 21;
- United Nations Framework Convention on Climate Change (UNFCCC) 1992;
- Kyoto Protocol to the United Nations Framework Convention on Climate Change 1997
- Montreal Protocol on Substances That Deplete the Ozone Layer 1987;
- **United Nations Convention on the Law of the Sea (UNCLOS) 1982;**
- Convention on Biological Diversity 1992;
- **Convention on International Trade in Endangered Species of Wild Fauna and Flora 1973 (CITES);**
- Convention on Wetlands of International Importance (RAMSAR Convention) 1971;
- **Agreement for the Protection of Migratory Birds and Birds in Danger of extinction and their environment between the Government of Australia and the Government of Japan 1974 (JAMBA);**
- **Agreement for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment between the Government of Australia and the People's Republic of China 1986 (CAMBA);**
- **International Convention for the Regulation of Whaling (International Whaling Convention) 1946;**
- MARPOL 73/78;

- Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matters (London Dumping Convention) 1972;
- UNESCO World Heritage Convention 1972; and
- Convention on Conservation of Migratory Species of Wild Animals (Bonn Convention) 1979.

United Nations Convention on the Law of the Sea (UNCLOS) 1982

The convention establishes maritime zones of the coastal States and entered into force on 16 November 1994. Signatories to this Convention have imposed on them international obligations to conserve and manage sustainable living and non-living resources in Australian waters. Chapter XII of the Convention covers protection and preservation of the marine environment.

Convention on International Trade in Endangered Species of Wild Fauna and Flora 1973 (CITES)

This convention regulates trade in species threatened with extinction and has links to Australian Commonwealth environmental legislation, particularly Schedules of the EPBC Act. The list identified endangered, threatened and vulnerable species of plants and animals including several marine species such as turtles and mammals eg. whales and dugong. The latter is listed by IUCN as 'vulnerable to threatened' but is not listed under the Commonwealth legislation.

Agreement for the Protection of Migratory Birds and Birds in Danger of extinction and their environment between the Government of Australia and the Government of Japan 1974 (JAMBA)

This bilateral Agreement reflects Australia's commitment to protect migratory birds and birds in danger of extinction, through efforts to manage habitat and species. Its relevance to the proposed development is in regard to the potential and actual use of coastal tidal flats/shorelines and offshore areas by migratory shorebirds and seabirds, respectively, for resting, shelter, feeding and/or breeding.

Agreement for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment between the Government of Australia and the People's Republic of China 1986 (CAMBA)

As for JAMBA, this agreement relates to the potential and actual use of coastal tidal flats/shorelines and offshore areas by migratory shorebirds and seabirds, respectively, for resting, shelter, feeding and/or breeding.

International Convention for the Regulation of Whaling (International Whaling Convention) 1946

This Convention was established to provide for the regulation of whaling. While whaling is now banned in Australia's waters, it has been replaced by a new "ecotourism" industry (whale watching). There continues to be concerns that boats,

aircraft and divers may have impacts on whale behaviour. Regulations have been introduced to govern how closely observers may approach whales.

UNESCO World Heritage Convention 1972

The aim of the Convention is to protect, anywhere in the world, natural and/or cultural heritage of such outstanding universal value that its conservation is of concern to all people. Member countries must ensure that they identify, protect, conserve and present their listed World Heritage properties. There is support for the listing of the Ningaloo Reef.

Convention on Conservation of Migratory Species of Wild Animals (Bonn Convention) 1979

This Convention provides a framework for enhancing the conservation status of rare and threatened migratory species. Five endangered migratory species are known to occur within the NMP and a further seven migratory species are subject to agreements.

1.4.2 State and Federal Government Departments with a Statutory Responsibility in the Management of the Ningaloo Marine Park

Regulatory responsibility for the management of impacts on the Ningaloo Marine Tract ranges across a number of agencies. These have been summarised by CALM (2000) and are reproduced in Table 1.

TABLE 1
AUTHORITIES AND AGENCIES WITH RESPONSIBILITIES IN THE
NINGALOO MARINE PARK (STATE &/OR COMMONWEALTH WATERS)

Environment Australia (Commonwealth)	• Provides protection for matters of national environmental significance. • Joint assessment may be triggered if Commonwealth has jurisdiction, but not proposed for Commonwealth waters. • Environment Australia and Commonwealth Environment Minister administer the Act.
Marine Parks and Reserves Authority (Western Australia)	• Vesting body for the Marine Park. • Provides policy advice to the Minister for the Environment. • Audits management plan implementation by CALM.
Marine Parks & Reserves Scientific Advisory Committee (Western Australia)	• Provides scientific advice to the Minister for the Environment. • Provides scientific advice to the MPRA.
Department of Conservation and Land Management (Western Australia)	• Manage marine conservation reserves vested in the marine parks and Reserves Authority. This includes the: a) preparation of management plans; b) implementation of the management plan; c) co-ordination with other agencies; d) implementation of education and monitoring programs; e) wildlife research and management; f) management of nature-based tourism; and g) lead role in enforcement (non-fisheries issues). • Ensures integrated management of marine conservation reserves with adjoining mainland and island conservation reserves. • Administer the Wildlife Conservation Act

Fisheries Western Australia (Western Australia)	• Manages and regulates commercial and recreational fishing, aquaculture and pearling in marine conservation reserves. • Lead role in enforcement of fisheries legislation within the marine park.
Department Planning and Infrastructure (Western Australia)	• Responsible for all boating regulations including licensing, safety standards, marker buoys, moorings and jetties. • Chairs and supports the State Coordinating Committee that provides the mechanism to coordinate the management of marine pollution incidents.
Department of Environmental Protection (Western Australia)	• Assists the Environmental Protection Authority in the process of assessing proposals that may significantly affect the marine environment, including marine conservation reserves. • Administers pollution control legislation.
Environmental Protection Authority (Western Australia)	• Assesses reports and makes recommendations on proposals that may significantly affect the marine environment, including marine conservation reserves.
Department of Minerals and Energy (Western Australia)	• Administers acts that control mineral and petroleum exploration and development. • Administers petroleum storage and dispersing.

1.5 Approval and Planning Considerations

Development at Mauds Landing is the subject of local and regional planning provisions adopted by both Local Authorities and the Western Australian Government to direct development in this region, as well as approval by the Commonwealth Environment Minister.

1.5.1 Commonwealth Environmental Approval

The EPBC Act defines the environmental responsibilities of the Commonwealth and implements fundamental reforms to strengthen existing environmental standards. It implements the Council of Australian Governments (COAG) Agreement 1997 defining the Commonwealth's role by reference to matters of national environmental significance.

The EPBC Act provides protection for matters of National Environmental Significance (NES). These are:

- World Heritage properties;
- RAMSAR wetlands of international importance;
- Nationally threatened animal and plant species and ecological communities;
- Internationally protected migratory species;
- Commonwealth marine areas; and
- Nuclear actions.

The EPBC Act also protects the environment on Commonwealth land and regulates the actions of Commonwealth Departments and agencies that may have significant impact on the environment.

Environment Australia and the Commonwealth Environment Minister administer this Act.

The EPBC Act replaces five existing Commonwealth Acts dealing with environmental issues. These include:

- *Environment Protection (Impact of Proposal) Act 1974;*
- *Endangered Species Protection Act 1992;*
- *National Parks and Wildlife Conservation Act 1975;*
- *Whale Protection Act 1980; and*
- *World Heritage Properties Conservation Act 1983.*

Consistent with Australia's Oceans Policy (Commonwealth of Australia 1998), the EPBC Act identifies the marine environment as one of a range of matters of National Significance.

With limited exceptions, all actions and decisions that may have significant impact on the environment will be subject to the environment protection procedures under the EPBC Act.

The Commonwealth may jointly assess proposals that may impact on Commonwealth lands or matters of national significance. However at the time of referral of this proposal, the Western Australian system of Environmental Impact Assessment (EIA) had not been accredited under the EPBC Act.

On the 8th December 2000 the Minister for the Environment and Heritage determined that an approval was required to carry out the action to which this PER document refers. Environment Australia received preliminary information for the action on 2nd January 2001. On the 29th January 2001 Senator Hill determined that a PER must be prepared to enable assessment of the proposal to construct and operate the CCR.

1.5.2 State Environmental Approval

The Western Australian Environmental Protection Authority (EPA) considered an earlier proposal by CCMD (Bowman Bishaw Gorham 1995) and concluded that the development could be managed to meet its environmental objectives identified in its Bulletin 796 (EPA 1995). Subsequently, the Minister for the Environment determined that the proposal should not proceed because of concerns regarding impacts on groundwater resources, the size of the development generally and resulting potential broader impacts from increased tourist numbers on the sensitive Ningaloo Reef system. Following the Minister for the Environment's determination on the previous proposal, CCMD worked closely with the State Government to review the project and address areas of concern raised within Government and the community.

In April 1999, State Cabinet invited CCMD to submit a revised proposal for a resort development at Mauds Landing and endorsed a set of guidelines for the development. The detail of this modified proposal is included in this PER.

1.5.3 Planning Approval

The Gascoyne Coast Regional Strategy (Ministry for Planning 1996) supports the development of a quality tourist facility at Mauds Landing and recognises the major benefits such development will bring both to the locality and the region. The Strategy

also identifies Mauds Landing as the most suitable location for any further residential development on this section of the west coast and recognises the importance of a residential component to the broader viability of a tourist facility at the location.

The subject land is zoned "Resort Development" under the Shire of Carnarvon Town Planning Scheme (TPS) No. 11, and accords with the Exmouth – Learmonth Structure Plan (Ministry for Planning 1998) and the Gascoyne Coast Regional Strategy (Ministry for Planning 1996).

The latter document also identified opportunities to overcome existing conflicts in Bills (Coral) Bay. These included, amongst others, the provision of alternative swimming, recreational and boat mooring and launching facilities that will reduce people pressures on Bills Bay and in so doing enable removal of private boating activities, all with a view to prevent:

- further damage to corals;
- conflicts between boats and swimmers; and to
- limit the impact on regional tourism assets such as Ningaloo Reef.

1.6 Scope of this Public Environment Report

This Public Environment Report has been prepared to provide:

Background information relating to the proposal including:

- the proponent; and
- Statutes relevant to the establishment and implementation of the project.

Consideration of selected site including:

- a description of the proposed site;
- modifications to the conceptual plan that if implemented would reduce the extent or significance of potential impacts; and
- particular environmental constraints associated with the site that must be protected.

Characteristics of the proposal:

- project description including existing and proposed infrastructure;
- direct impacts including a description of biophysical characteristics of the area to be impacted;
- potential discharges including potential emissions and wastes generated to air, to water (surface, groundwater, marine), and to land, related to the characteristics and sensitivities of the receiving environment, including Commonwealth Waters; and

- indirect impacts including interruptions to biophysical processes (eg. tidal flushing, littoral transport, sedimentation), regional implications (eg. infrastructure requirements, water supply, wastewater treatment, power supply waste facilities, housing and their associated impacts).

Identification of significant environmental issues relative to the requirements of the EPBC Act:

- concluded from the characteristics of proposal and characteristics of site and significant issues;
- identification of available technical and scientific information relevant to both the proposal and specific site;
- relating impacts to matters of NES and relevant policies including the goals, objectives and guiding principles of ecologically sustainable development;
- availability of sufficient information to make a full assessment or identification of further information required, assessment of risk and resulting need; and
- a statement on the significance of the likely impacts.

How impacts will be managed:

- Direct impacts including the determination of what impacts may result from carrying out the action of implementing the proposal, and relate these to EPBC Administrative Guidelines on Significance.

2. DESCRIPTION OF THE PROPOSAL

2.1 Overview

The CCR at Mauds Landing is proposed as a resort village providing a broad range of short stay and holiday accommodation and limited permanent residential accommodation. The proposed development site adjoins the NMP (State Waters) that supports, amongst others, important populations of a number of listed migratory and threatened species.

Development of this resort will supplement the facilities available in Coral Bay, and in so doing have the potential to reduce existing impacts. CCMD has undertaken to establish the necessary services and infrastructure to support the proposed development. This will provide the opportunity for the extension of reticulated sewerage, managed sanitary landfill disposal and a superior potable water supply to all users in the area.

The Structure Plan for CCR (Figure 5) is based on the development of an inland marina and lagoon system.

The marina village will house the CALM Environment and Interpretive Centre as well as Cultural/Tourist facilities. A broad range of tourist accommodation and related facilities will also be developed including:

- caravan and chalet park;
- beach "annex" to the marina village resort providing further serviced suites;
- backpackers hostel;
- tourist villa and townhouse sites;
- sports and community centre; and
- supporting coach terminal, auto/marine, and boat launching and parking facilities.

The core tourist facilities are located overlooking a large swimming bay within which it is proposed to provide a protected reef for recreation, visitor education and research purposes. Corals will be propagated on the reef. The propagated coral reef is not being developed to provide habitat equivalence for the Ningaloo Reef, but rather to provide an alternative focus for activity in a safe environment. Van Treeck and Schuhmacher (1998) note that the installation of appropriate structures in ecologically unobjectionable locations could meet the requirements of diver training, environmental education and recreation functions without impacting on sensitive areas.

A further 62ha, situated outside the formal Mauds Landing Townsite boundary, will be developed to accommodate a services area. The CCR will be fully serviced with technically advanced utilities. A dual reticulated water supply will provide both cold potable water for drinking and cold artesian water for irrigation and non-potable uses. Gas will be reticulated throughout the CCR. Establishment of a services area on the adjoining pastoral lease has been agreed with the owners of Cardabia Station.

Table 2 presents a summary of the critical features of the project.

TABLE 2
PROJECT SUMMARY

SITE AREA	AREA (ha)
Mauds Landing Townsite	250
External services area	62

RESORT LAND USE	AREA (ha)	%	DESCRIPTION OF PROPOSAL WHEN FULLY IMPLEMENTED
Dune conservation & non-developed areas	118.0	47.2	Development in fragile dune areas will be limited to fencing and path construction to limit impacts due to public access.
Marina water body	46.5	18.6	- The inland marina will be linked to Bateman Bay by an entrance channel and 2 associated breakwaters that project up to 200m seaward. - The entrance channel excavated to -5.0m AHD and the core marina area to a minimum water depth of -4.5m AHD decreasing to -3.5m AHD into the northern embayment. - The southern (protected) swimming embayment will be excavated to a maximum of -2.0m AHD grading to the beach. - To include a constructed reef with propagated corals.
Marina beaches	3.5	1.4	Public beaches in inland swimming areas.
Marina village, commercial area & serviced apartments	4.0	1.6	120 serviced resort accommodation, retail, food, beverage, entertainment, visitor centres. - Will also provide limited conference and food and beverage facilities. - Will support commercial and entertainment facilities.
Caravan & chalet park	4.0	1.6	- To comprise a total of 100 bays with supporting camping and coach camping areas. - A total of 20 chalets/park cabins.
Backpackers hostel	1.0	0.4	Back packers and youth accommodation comprising a total of 60 beds.
Timeshare	3.6	1.4	100 resort timeshare units.
Serviced apartments	3.5	1.4	130 serviced resort accommodation.
Tourist villas & townhouses	6.7	2.7	180 resort villas and townhouses with associated facilities.
Auto/coach/marine services	0.9	0.3	- Service station/auto services site. - Workshop areas for automotive, caravan and marine repairs and services.
Parks & major open spaces	6.5	2.6	Principally paved areas with limited ongoing water requirements.
Northern access reserve	8.0	3.2	Roads and dry "river bed" drainage swale.
Sports & community centre	1.6	0.6	Public sporting and community facilities.
Village & boat/car parking	3.2	1.3	- A boat trailer car park servicing two boat-launching ramps with car parking capacity for some 120 boat/trailer units. - Secure boat-parking area.
Staff residential lots	1.7	0.7	- Estimated that a total staff compliment of 339 full time equivalents 40 managed freehold lots 420 m².

RESORT LAND USE	AREA (ha)	%	DESCRIPTION OF PROPOSAL WHEN FULLY IMPLEMENTED
Staff group housing	3.8	1.5	• 130 managed villa and duplex units.
Permanent residential lots	12.6	5.0	• A total of 200 freehold residential lots 420m² - 700m² • Anticipated average dwelling occupancy at completion of the CCR to be in the order of 2.54 persons per dwelling.
Roads and minor open spaces	20.7	8.3	• Road reserves and minor open space areas.
RESORT LAND USE	AREA (ha)	%	DESCRIPTION OF PROPOSAL WHEN FULLY IMPLEMENTED
High level water storage	0.5	0.2	• Water storage and treatment area at Mauds Hill
TOTAL resort	250.0	100.0	
External services area	62	100.0	• Located 2km inland of resort • Infrastructure designed to accommodate expansion sufficient to service existing Coral Bay settlement including: - water treatment plant (575kL/day capacity) full development; - gas fired diesel power generators (3900 KVA capacity); - managed landfill with anticipated 25 years plus capacity; and - light industrial services area.
Breakwaters			• Dredging of 100,000m³ spoil taken disturbed area 4ha (land) and 2.5ha (marine) (including placement of stone)

The following sections describe in more detail the components of the CCR Structure Plan, the services and utilities, the management and maintenance structures and the proposed staging.

2.2 Social Setting

The two principal towns of the Gascoyne Region are Carnarvon and Exmouth with the only other settlement of significance being at Coral Bay. There are a range of other permanent and temporary settlements, including a squatter settlement at Point Quobba, the salt and gypsum operation at Lake MacLeod, fishing and airforce bases at Learmonth and numerous official and unofficial camping grounds and pastoral homesteads.

Carnarvon, with a 1996 population of 8,616 is the regional administrative centre and provides a wide range of services and facilities. Exmouth, with a 1996 population of 3,908, is a district centre servicing the north of the region. It provides support services including education and health care, but does not support a high school or other higher order facilities. The Coral Bay settlement is a tourist village with a permanent population of about 150 and a visitor population that peaks at over 2,000 principally during holiday seasons, but which increasingly is realising a steady and significant flow of visitors during off-holiday periods.

At Carnarvon, Coral Bay settlement and Exmouth accommodation facilities include caravan parks, motels/hotels and holiday units. Along the coastline there are numerous supervised and unsupervised camping areas. Some stations in the region

offer farm stay accommodation. There is no international standard accommodation within the region.

In its 1996 study, the Gascoyne Coast Regional Strategy identified overcrowding as a common occurrence in the Coral Bay settlement, particularly in the caravan-park and camping ground facilities. Severe overcrowding occurs during the July school holiday period. There are approximately 477 legal accommodation units in the Coral Bay settlement. Peak usage however is estimated to exceed this number. The daily population in Coral Bay at peak times during school holidays and Easter is approximately 2500 people (Ministry for Planning 1996), although figures of up to 4000 people have been quoted (Cary et al. 2000).

2.3 Description of the Coral Coast Resort Development

2.3.1 Marina

The CCR will be developed around an inland marina providing for safe boating and swimming facilities.

The marina will be linked to Bateman Bay by an entrance channel and associated breakwater structures projecting approximately 200m into Bateman Bay. The Marina entrance is situated approximately 8km from Commonwealth waters (Figure 3).

The core marina area will be developed to a minimum water depth of -4.5m AHD decreasing to -3.5m AHD and -2.8m AHD into the northern embayment. These depths will accommodate all reasonably sized recreational craft under normal tidal variations. The southern swimming embayment will be excavated to a maximum of -2.0m AHD grading to beach and the eastern swimming embayment to -1.5m AHD grading to the beach.

The size of the inland marina and associated waterways, approximately 46.5ha, is governed largely by the need to generate sufficient fill in order to raise the surrounding development above design storm surge levels and cyclonic rainfall levels. Consideration of flushing requirements as well as aesthetic factors has influenced the configuration of the waterway.

Beach widths vary from approximately 10-30m under typical tidal conditions and the swimming embayments will be shark netted to ensure safe swimming conditions. Private and commercial boating will be limited to the marina core area and the northern embayment, either in pens (public and private) or in the case of trailer-borne craft, to two boat launching ramps and associated boat trailer parking facilities situated to the immediate west of the marina village.

Projections of total recreational and commercial boat usage indicate a maximum of 159 craft within the CCR, including commercial charter vessels, being either trailer-borne craft or craft temporarily or permanently penned within the marina. Of these, and based on current (Coral Bay) boat utilisation trends, it is predicted that between 44 and 79 boats would be in use at any one time, including commercial charter vessels. A total of up to 100 pens are proposed at maximum development in either

public or commercial pens in the vicinity of the marina village or private pens which would be limited to the core area of the marina adjacent to areas of hard-walling.

Based on current boat ownership and utilisation, and in consideration of the number of living units at Coral Bay, a further 68 trailed craft will be garaged at the Coral Bay settlement, but will likely use the boat launching facilities at the CCR.

The entrance channel to the marina provides safe, all weather access to the deeper water (>5m) of Bateman Bay. The marina will provide direct access to Cardabia Passage for commercial and other boats wishing to operate outside the barrier reef.

The marina waterway will include recreational facilities including a constructed reef upon which corals will be propagated.

2.3.2 Tourist Accommodation

The CCR proposes a broad range of tourist accommodation so as to cater as fully as possible to the broad spectrum of tourist markets. In total, it is proposed to provide 710 dedicated short stay "units" ranging from caravan and backpackers facilities through to fully serviced short stay apartments. Tourist accommodation sites, including the marina village resort, total approximately 20ha and are focussed for the most part around the marina waterway and marina village. Assuming an average peak period occupancy level of 80% which is comparable to locations such as Broome, peak visitor numbers are estimated at 1330 persons at full development. All areas will be designed for universal use including wheelchair access.

The specific components comprising major tourist accommodation proposed within Coral Coast include:

- **Serviced apartments** comprising two self-contained, serviced apartment complexes totalling 250 units within the CCR. Internal courtyard facilities will provide localised recreation including a pool and a total of 120 units are proposed within the marina village complex. The marina village resort will also provide limited conference and food and beverage facilities.

Construction of the serviced apartments will be undertaken progressively over the first stages of the CCR with the first stage of 60 apartments within the marina village being completed on opening of the CCR.

- A **caravan and chalet park** of approximately 4ha is proposed to the immediate southwest of the marina village. The caravan and chalet park directly adjoins its own marina beach, with safe swimming, and is proposed to comprise a total of 100 bays with supporting camping and coach camping areas. Landscaping techniques and species selection for grasses and over storey species will be carefully managed to minimise fertiliser applications and limit water requirements.

It is intended that construction of the caravan and chalet park be undertaken as part of the first stage of the CCR and be operational upon opening of the CCR.

- ***Backpackers and youth accommodation*** is proposed to provide a total of 60 beds and its location immediately adjoining the marina village will ensure a high level of convenience and access. Construction of the backpacker's hostel is proposed to be undertaken as part of the first stage of the CCR and be operational upon opening of the CCR.
- A ***timeshare resort*** will provide a total of 100 units of varying one and two storey construction in close proximity of the marina village facilities, and is proposed towards the latter stages of the overall resort construction.
- ***Tourist Villas & Townhouses*** will provide a total of 180 units with the townhouses being predominantly semi-detached, two-storey configuration and the villas detached, predominantly single storey configuration. Construction of the tourist townhouses and villas is to be undertaken over the middle to latter stages of the overall resort construction.

2.3.3 Residential Accommodation

The CCR will contain limited residential opportunities for staff and permanent residents to be located within the marina. The Structure Plan proposes a total of 200 permanent residential dwellings and a further 170 staff dwellings. The total residential compliment is provided as an equal mix of single lots, apartment lots and group housing.

Total ***permanent residential*** accommodation is limited to 200 dwellings. Based on an average peak period occupancy of 80%, the resulting permanent residential population at full development is estimated at 405 persons.

Lot sizes proposed would minimise water requirements for outdoor/garden purposes minimise the need for application of fertilisers to lawn and garden areas and minimise external maintenance requirements.

Staff Residential requirements within the CCR have been assessed as approximately 339 full time equivalents. A mix of housing requirements will be provided to meet staff requirements.

2.3.4 Marina Village - Commercial

At maximum development it is proposed that the marina village will comprise a general/convenience store, support convenience stores including newsagency, butcher, delicatessen, liquor store, and specialty tourist based retailing including clothing, jewellery and souvenirs. It will also comprise a number of specialty services (tour and dive operators, chandlery, personal and banking services, etc). Development of commercial facilities within the marina village will be progressively developed, as demand requires, with base level services being available from the opening of the CCR.

Additional to retail/service floor spaces proposed, the marina village will also accommodate food and entertainment services including tavern, restaurants/cafes/fast foods with extensive outdoor seating areas.

The marina village will also include the NMP environment and interpretive centre and the marina "shop front" for a cultural centre to be developed on Cardabia Station for the local Aboriginal community.

The marina village will include landscaped parking, catering for up to 280 vehicles as well as tourist coaches. All landscaping will use low maintenance local genome species where available, requiring limited water and fertiliser application. A boat trailer carpark servicing two boat-launching ramps with car parking capacity for up to 120 car/trailer units will also be provided. Although provision is made for a service station within the marina resort area, the bulk of servicing for automotive, caravan and marine repairs will be provided from within the 'satellite' services area.

A coach terminal site will provide for tours throughout the region as well as airport transfers to the CCR from the international airport at Learmonth.

2.4 Provision of Services

The provision of utilities to CCR requires the establishment of a services area that is proposed to be located approximately 3km south-east of the CCR with access from the existing Coral Bay Road (Figure 2).

The services area occupies approximately 62ha, inclusive of buffer screening, and is situated some 1.5km east of the existing Coral Bay settlement in an inter-dunal swale that is well screened from the Coral Bay Road. The services area will comprise major utilities sites for power production, water and effluent treatment as well as a landfill disposal site. It is also envisaged that a small cell of "industrial" land will be required for development of support and supply facilities including satellite maintenance workshops and cold and dry storage facilities for food and other goods and equipment required to sustain both this resort and Coral Bay.

The services area has been sized so that it can also accommodate service and waste disposal requirements of the existing Coral Bay settlement. Additionally, the utilities infrastructure will have the capability for expansion to service the utilities needs of Coral Bay.

Infrastructures, particularly power, water and wastewater treatment, will be staged from commencement of construction according to demand. Services will include:

Water Supplies

Groundwater for treatment to suitable standards is available from the deep artesian Birdrong Formation. The water will need to be desalinated for drinking and domestic water purposes.

Experience with use of this water in the existing Coral Bay settlement has shown that the artesian water, cooled as necessary, is quite acceptable with minimal treatment for non-potable uses. Accordingly it is proposed to provide a dual water supply to the CCR comprising treated potable water and cooled artesian water for non-potable domestic and garden requirements.

For the purpose of preliminary planning, total artesian water demand for the CCR is estimated at 0.52 million kilolitres per annum, based on an average consumption of 700 litres per person per day, based on daily average demands of:

- Potable water 125 litres
- RO waste 125 litres
- Domestic non-potable 125 litres
- Irrigation 250 litres
- Contingency losses 75 litres (Koltasz Smith & Partners 2000).

Communications with the Water and Rivers Commission (WRC) and investigations by Rockwater Pty Ltd (1994) confirm that 10 million kilolitres can be sustainably drawn from the Birdrong Formation.

A review of options for treatment of the water to potable standards water from the Birdrong Formation concluded that reverse osmosis (RO) is the most practical treatment method.

Suitable grasses and vegetation have been shown to flourish and thrive at the existing Coral Bay settlement when irrigated with the Birdrong artesian water. Irrigation management techniques specific to this area are required to ensure satisfactory irrigation, with a view to minimising water losses.

Waste Water Treatment and Disposal

The development will be deep seweraged and wastewater pumped via a pressure main for treatment at the services area located 2km inland.

The proposed wastewater treatment plant will receive water for treatment from various sources that are of varying salinity. Brackish water will generally be that used within the development for washing and other domestic purposes before passing through to the wastewater treatment plant. Similarly potable water and RO return water, will also pass through to the wastewater treatment plant. The mix of waste potable water (TDS 500 to 700mg/L) and waste raw water (TDS 6000mg/L) entering the wastewater treatment plant as feed water is expected to have a TDS level equating to approximately 3000mg/L.

Treatment of wastewater is proposed by means of either an Upflow Anaerobic Sludge Blanket (UASB) or the more traditional sewerage pond wastewater treatment system with the capacity to treat up to 575kL/day at full development. Plants treating similar water quality and quantity are in operation and provide suitable quality treated waters.

The plant capacity has been sized to cope with residents and visitors, including day visitors on tour. The plant will also treat sewage received from a pump-out facility for boats with on-board storage. Disposal will be via evaporation ponds with a gross capacity of 888kL/day, including waste RO backflush waters. Sludges produced in the water treatment system will either be used as biosolids or deposited in the landfill, dependant on quality.

Power Generation and Transmission and Gas Supplies

Energy requirements of the CCR will be met from reticulated electricity supply, together with reticulated gas from bulk storage at the services area. A number of options for renewable base load power generation been considered (Appendix 2) with gas powered diesel generators being the preferred option. The primary fuel will be Liquid Petroleum Gas (LPG), with an emergency diesel supply in the case of interruption.

Total generating capacity requirement is estimated at 3,900kVA. The generation plant will be located in the services area and comprise gas powered diesel generators, installed in a series as demand increases, supplying power via a high voltage distribution system. Additional generating plant could be added to meet load increases by the connection of Coral Bay, as and when required.

LPG, primarily for cooking purposes, will be reticulated to all sites within the CCR from a pressure vessel located within the services area.

Telecommunications

A major communications carrier will provide communications infrastructure for the development. Services will include standard telecommunications telephone services linking to a small telephone exchange facility.

Refuse Disposal

A suitable refuse disposal site has been identified in the southern portion of the services area and its progressive development will service the combined locations of Coral Bay and the CCR for many years. As the surface of the services area is between 8m and 18 m AHD and groundwater at approximately at AHD, a minimum separation of 5m between the base of the landfill cell and water table will be maintained. In planning for 5000 residents, visitors and support staff, an assumption has been made that 1.2 tonne of uncompacted refuse/person/annum will be produced at a compacted density of 300kg/m³. The proposed site will have an area of 25ha (25+ years' life). Compaction will be achieved by heavy equipment and the site will effectively be manned permanently by maintenance personnel operating other service infrastructure within the services area. Active landfill areas will be fully fenced and feral animal controls implemented.

By initiating a managed refuse collection and controlled landfill operation, and no longer using the unsuitable site currently servicing Coral Bay, the Coral Bay precinct will return to a clean environment relatively free of wind blown debris and with an opportunity of reducing the magnitude of current impacts. The proposed landfill site will be designed and managed in accordance with the *Code of Practice Rural Landfill Management (Draft)*, Landfill Category C, which received greater than 1500 tonnes per annum. (DEP 2000).

Resort refuse management will include:

- public waste minimisation education programs;

- implementation of a kerbside collection scheme incorporating residences, commercial properties, public facilities and boat mooring areas;
- provision of a bulk waste collection service from any construction and/or demolition sites;
- optimum and effective use of the landfill site to be developed for the purpose, and consistent with Waste Management WA requirements; and
- maximisation of recycling benefits including green waste collection and treatment.

Relevant specifications within the Code of Practice to limit environmental impacts to be implemented include:

- wire fencing around the site and putrescible face comprising a 1.m fence topped with three barbed wire strands, and lockable gates to restrict access;
- daily covering of waste material comprising 150mm of clean fill, tip face aligned according to prevailing wind, use of windbreaks such as earth bunds and mobile litter screens, and supplementary litter control such as litter collection;
- maintenance of a minimum 5m between the base of the landfill and the water table, stormwater diversion and removal of standing water;
- no deliberate burning of putrescible waste, recycling of green waste, maintenance of fire breaks and fire response contingencies.

Stormwater and Storm Surge Management

Piped stormwater systems within the CCR road system will only be used where necessary. Stormwater will generally be disposed of by overland flow directed away from the marina and towards the low-lying eastern lakes with local compensation areas being installed where necessary and located away from the marina edge. Gross pollutant traps will be installed and maintained. The minimum building and fill levels to be set from consideration of storm surge and flood levels are consistent with this objective.

Previous storm events have resulted in inundation of the lakes and low-lying area east of the development for periods of several days. This area extends into the Mauds Landing Townsite. From an examination of plans available from the Royal Australian Survey Corps (1982) land fill for the CCR will reduce the area available for flooding by less than 10% and result in minimal reduction in volume available to accommodate flood waters.

Main access road levels will need to be raised and it will be necessary to permit stormwater levels to equalise across the road through culverts consistent with accepted engineering practice. Some areas east of the CCR fall below sea level and following major storm event water is expected to lie for some time, as occurs at present.

2.5 Emergency Services

It is proposed that base level, volunteer operated emergency services be provided to the CCR by CCMD comprising:

- Fire and Emergency Services;
- Nursing Station and First Aid; and
- Sea Search and Rescue.

These services will be operated by the utilities provider and initial basic equipment will be provided as part of the development costs. It is proposed as part of staff recruiting and training to attract and develop suitably trained volunteers capable of responding to an emergency situation.

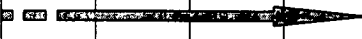
Higher-level emergency services will be sourced from Carnarvon or Exmouth as need requires.

As a component of the CCR construction and operation of Environmental Management Systems (EMS) emergency response protocols will be developed to address events such as marine fuel spillage and marine emergencies.

2.6 Staging

As previously noted, the development of CCR to the level described is anticipated to occur over a minimum seven-year timeframe. Table 3 provides the projected development staging of the various components of the CCR.

**TABLE 3
PROJECTED DEVELOPMENT STAGING**

Development	Units	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7
Civil Construction Work								
Marina Village Hotel	60							
	60							
Marina Commercial								
Serviced Apartments	65							
	65							
Caravan Park	100							
Chalet Park	20							

Development	Units	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7
Backpackers	60							
Tourist Villas	40							
	40							
	20							
Tourist Townhouses	25							
	25							
	30							
Timeshare	20							
	80							
Staff Residential	170							
Permanent Residential	200							

It should be noted that the first stage includes the initial marina and civil construction period that effectively will span the first two years. Initial occupancy will occur in the third year.

Initial tourist accommodation is proposed to comprise the caravan and chalet park, backpackers hostel and the first stage of the marina resort being 60 serviced apartments within the marina village. Construction of the first stage tourist accommodation will commence part way through marina and civil construction works so as to be completed and operational on opening of the CCR.

The balance of tourist accommodation is proposed for progressive construction over the remaining five-year period and, subject to demand, it is anticipated that development will occur at the rate of approximately 120 tourist units per annum

Infrastructure particularly power, water and sewerage will be staged from commencement of construction according to demand.

3. EXISTING ENVIRONMENT

3.1 Physical Environment

3.1.1 Climate

The climate of the NMP and the coastal Gascoyne Region is semi-arid to arid, being characterised as having long hot summers and short temperate winters. The average annual maximum temperature is 27.1°C (Bureau of Meteorology 2000) with summer daytime temperatures ranging from low 20s to low 30s (May et al. 1989).

Since records have been kept at Cardabia Station (1913 until present) an average annual rainfall of 221 mm was recorded (abutting the site). Rain is predominantly associated with cyclonic disturbances occurring during February and March. Consequently rain-events are irregular but sometimes intense, with a 40% variation on average occurring from year to year (May et al. 1989). During the winter period more regular but less intense rainfall occurs. The mean annual evaporation rate is high (1700-3000mm), generally exceeding precipitation throughout the year. Consequently there is no water surplus and no permanent streams originate within the area (Department of Conservation and Environment 1984).

Regionally, the intensity and position of high-pressure systems that undergo seasonal latitudinal migration dictate the synoptic wind patterns. During winter they are located in the more northerly latitudes (25°-30°S) generating a southeasterly or easterly airflow. During summer the winds become more westerly or southwesterly as the high-pressure cells move southward and a sub-monsoonal depression forms over the north of the continent.

In the region, storm winds of high intensity are associated with the passage of cyclones, thunderstorms and pressure gradient intensifications. The latter are more prevalent during winter when they can produce easterly gales of two to three days' duration. Strong winds from cyclones and thunderstorms may occur in summer and their direction and strength is highly variable and unpredictable. In a local context the prevailing winds result primarily from the diurnal sea/land breezes. Consequently the prevailing winds in the area are from the south (Department of Planning and Urban Development 1992) with brisk southerly sea breezes dominating on approximately 70% of afternoons (May et al. 1989).

3.1.2 Topography

Marina Area

The Mauds Landing Townsite consists primarily of high parabolic dunes behind the Point Maud coastline and low shoreline parallel beach ridges behind the Bateman Bay coast terminating beyond the eastern site boundary at the seaward end of Pleistocene dunes. A large relict tidal flat exists behind the dunes extending eastward. The parabolic dune system within the western part of the site (behind Point Maud) reaches heights of up to 30m (Maud Hill), whilst the beach ridges lying parallel to the coastline occurs at a maximum elevation of approximately 9m at their southern extent, but are more typically 4-6m AHD.

Services Area

The Services area site consists of longitudinal dunes oriented in an approximately north northeast to south-south-west direction. The dunes tend to be low and undulating with heights between approximately 10m and 20m AHD.

3.1.3 Landforms

Marina Area

The geomorphology at the Marina area, ie. Mauds Landing, is considered by Hesp (1986) to be on the boundary of a geomorphic subregion described as being dominated by Holocene parabolic dunes overlying Holocene relict tidal flats and Pleistocene coastal dunes, alluvial sediments, aeolian plains, dunes and coral terraces.

The predominant landform at Mauds Landing is a relict foredune plain to the seaward side of an extensive relict tidal flat or salt pan. When the sea level was higher than present the topographic low point between the Pleistocene and Holocene terrains formed the large tidal flat and associated mangrove system, with an entrance opening near Mauds Landing. Once the sea level fell this became supratidal and was probably rapidly closed off by foredune formation along Mauds Landing beach. The original tidal entrance may be seen where arcuate, east-west trending dune ridges are present.

Point Maud itself lies on a prominent foreland, dominated by vegetated parabolic dunes and one active parabolic dune. The dunes overlie relict tidal flats and the southern margin of the Mauds Landing relict foredune plain (Hesp 1986). The south-facing margin of Point Maud has a narrow fringe of foredunes that extend to the Point.

Services Area

The services area is dominated by longitudinal desert dunes and associated interdunal swales. The floors of the swales often have calcretised Pleistocene dunes cropping out.

3.1.4 Geology

Marina Area

At the Marina area the geology is mapped by Hocking *et al.* (1985) as comprising the Holocene units 'Ql' - Coastal Lacustrine Deposits and 'Qs'. Hocking *et al.* (1985) describes Unit 'Ql' as comprising calcareous and gypsiferous clays, silt and sand and evaporitic deposits (mainly gypsum and halite). Unit 'Ql' crops out in the southern and eastern sections of the Marina area that overlap onto the salt pan. Unit 'Qs' is described by Hocking *et al.* (1985) as comprising mostly calcareous sand that is variably quartzose in the form of coastal dunes, beaches and beach ridges. Unit 'Qs' in the Marina area is mapped as being present in the northern and western portions of the area.

Services Area

The geology cropping out at the Services area is mapped by Hocking *et al.* (1985) as comprising the aeolian sandstone Member 'Qbe' of the Bundera Calcarenite. Hocking *et al.* (1985) describes 'Qbe' Member as a variably calcreted calcarenite of Pleistocene age and aeolian origin with calcrete soils and dune shapes locally preserved. It is also interpreted to be a highly permeable aquifer.

3.1.5 Hydrology

Surface Hydrology

Rainfall on western portion of the Marina area and Services area infiltrates directly into the dune soil profile with accumulation in localised low areas where water is dispersed by infiltration, evaporation, or taken up and transpired by vegetation.

The balance of the Marina site east of the dunes is generally flat and low-lying and storm runoff drains to the southeast, generally towards the salt lake areas that form a large shallow basin. The capacity of this shallow basin and salt lake system is sufficiently large so that stormwater and runoff from major storm events is collected and stored before eventual dissipation by evaporation with some infiltration into the shallow unconfined groundwater aquifer. This area collects all surface runoff from Mauds Landing and its hinterland and has no oceanic outlet.

Groundwater

The hydrogeology of the area is determined by the nature of the shallow strata, coastal features, and the deep strata of the Carnarvon Basin (Hocking, Moors & Van der Graaff 1987). There are two relevant aquifer levels, a shallow unconfined aquifer and a deep confined aquifer known as the Birdrong Sandstone Formation. Although a detailed hydrological study has never been undertaken in the site area, the Birdrong sandstone artesian aquifer is known to be located at a depth of approximately 800m (Rockwater 1994; Woodward-Clyde 1993).

Most of the shallow groundwater in the Mauds Landing-Coral Bay area is saline. Bores drilled to depths of 13-60m at distances up to 10km inland from Point Maud encountered water in the salinity range 10000 to 14000mg/L total soluble salts (TSS). Salinities increase from east to west, and reach 35000mg/L at depth near the coast where a wedge of sea-salinity water underlies less saline water. There is also believed to be a shallow thin lens of fresher groundwater in the area, and an old well near Point Maud is reported to have been capable of supply 900L/day (Woodward-Clyde 1993).

The shallow aquifers receive recharge waters at infrequent intervals by direct infiltration of rainfall and run-off from hills and ranges, such as the Giralia Range located 27km inland from Point Maud. Apart from a small area west of Giralia Range and the shallowest water at Point Maud, all the unconfined groundwater in the area is saltier than 6000mg/L TSS, indicating that saline groundwater is being diluted very slowly, if at all (Rockwater 2000).

Beneath the Coral Bay/Mauds Landing area, shallow groundwater flows from east to west towards the sea. The flat topography, near sea level elevations, and shallow groundwater depths observed beneath the salt lake flats, indicate the water table is very flat and flow rates are likely to be extremely low.

The deeper, confined Birdrong aquifer extends throughout most of the Carnarvon Sedimentary Basin (Shark Bay to Onslow) and extends over approximately 77,000m² on-shore. This aquifer is the source for the town of Denham's water supply as well as for the salt mining operations at Lake MacLeod and Useless Loop (Department of Planning and Urban Development 1992; Woodward-Clyde 1993). The two caravan parks at the Coral Bay settlement each have a bore extracting from this aquifer. These bores provide brackish water (around 5000mg/L TSS) at approximately 60°C with outflow rates varying from 1670kL/day ('Bayview') and 2160kL/day ('Peoples') (Department of Planning and Urban Development 1992; Woodward-Clyde 1993). The aquifer is considered to be a reliable water source (Woodward Clyde 1993) and is widely utilised for stock bores throughout the region (Department of Planning and Urban Development 1992).

The Waters and Rivers Commission Report – Gascoyne Region Water Review and Development Plan 1996 (Water & Rivers Commission 1996) estimates that the renewable resource within the Lyndon – Minilya Basin of the Birdrong Formation is approximately 10.6 million kL/annum. Discussions with the Commission confirm that the proposed total demand is acceptable. The estimated drop in the piezometric head at the Coral Bay settlement, which also draws from the Lyndon – Minilya Basin, is estimated at only 1m on a 42m head.

Recent discussions with the Water and Rivers Commission and Rockwater confirm that the required quantities of water are expected to be available from the Birdrong Formation and that the Commission will issue a licence for groundwater abstraction.

Investigations have indicated that the sustainable yield of the Birdrong Formation will not be compromised by the extraction required to supply the CCR. The full text of the groundwater report relating to the CCR proposal is included in ATA Environmental (2000a).

3.1.6 Oceanography

D'Adamo and Simpson (2001) present a summary of the oceanography of the Ningaloo Reef area.

Tides

Oceanographic conditions vary markedly from the open ocean to the west of the Ningaloo Reef to the sheltered coastal waters east of the reef. The position and extent of the reef has a dominant influence on the near shore currents and waves.

Point Maud is considered to be in the transitional zone between the small, primarily diurnal tides (one tidal cycle per day) of the southwest coast and the large semi-diurnal tides (two tidal cycles per day) of the North West Shelf (Simpson & Masini 1986; Hearn & Parker 1988). The Department of Transport (M. P. Rogers &

Associates 2000)) has taken tidal measurements within 5km of Mauds Landing that indicate that the mean spring (largest) tidal range to be about 0.9m, and about 0.4m during neap tides.

The highest ocean water levels would be caused by storm surge occurring when severe cyclones pass through the area. Studies completed by Steedman Science and Engineering (1989) indicated that the peak storm surge during a 100-year period cyclone would be approximately 1.9m. This would be in addition to the astronomical tides described above.

Sea Temperatures

Mean offshore water temperature ranges from 22°C (range 19°C to 24°C) in July to 26°C (range 26°C to 31°C) in January (Australian National Parks and Wildlife Service 1990; Commonwealth of Australia 2000). Within the lagoon more extreme temporal and spatial variations are likely to occur. Limited measurements for the lagoon (waters lying between the shore and the outer reef) off Mauds Landing are available (D'Adamo & Simpson 2001) and confirms lagoonal and open water temperatures similar to those reported by May et al. (1989).

Simpson and Masini (1986) recorded mean temperatures over the Ningaloo Reef Tract from 22.1°C (October) to 26.1°C (May) and suggested that areas of limited flushing may experience more extreme temperatures, with winter minima approaching ambient air temperatures (18-20°C). It was considered that quiescent lagoonal waters might exhibit pronounced diurnal temperature variations consistent with insular heating and night time cooling.

Currents

Regionally the Leeuwin Current, a southward flow of warm, relatively low-salinity water, dominates offshore water circulation. Major currents in the vicinity of NMP, extracted from Commonwealth of Australia (2000), is presented in Figure 6. The Leeuwin Current is at its strongest from March to July and broadly follows the edge of the outer continental shelf and slope to the inner shelf. The Leeuwin Current is coupled with a northward undercurrent and is greatly attenuated by wind stress in summer (Holloway & Nye 1985; Hearne & Parker 1988).

Along the inshore shelf, there is a seasonal wind driven northward flowing counter current to the Leeuwin Current (Taylor & Pearce 1999). This northward flowing current is known as the Ningaloo Current and occurs from September to mid-April when it is driven by southeasterly winds. Inter-annual variations in the southeasterly winds and in the Leeuwin Current produce year-to-year variations in the Ningaloo Current.

Taylor and Pearce (1999) note that the Ningaloo Reef is a classic fringing reef with a shallow lagoon. Oxygenated low turbidity oceanic water is carried in to the lagoon over the reef by wave action, to be pumped out and carried northward by the Ningaloo Current.

Behind the outer reef, circulation within the lagoon is more complex, driven by the varying and interacting influences of wind, wave and tidal forces. These can be considerably modified by the local morphology of the coast and reef, particularly the location and size of passages through the reef system.

Generally, the consistent swells arriving from the south and southwest break against the reef and generate wave-driven circulation cells (May, Lenanton & Berry 1983). These involve oceanic water flowing over the reef into the lagoon and then moving parallel to the coast before exiting via the reef passages (Hearn & Parker 1988).

Measurements reported in Hearn and Parker (1988) indicate that in Osprey Bay, about 120km further north on the Ningaloo Reef, the lagoon has flushing times of less than 24 hours. The action of waves breaking onto the reef was shown to cause significant transfer of ocean water across the reef and then drive the currents along the lagoon to the north. In this location, the wave-driven current is strongly moderated by tidal changes in water level.

Bateman Bay is generally wider and shallower than Osprey Bay. This will tend to reduce the relative importance of the wave-driven transport across the reef in the near shore currents. Currents affecting Bateman Bay are believed to be controlled by the relative magnitude of the wind, tide and wave force.

The largest currents in the southern portion of Bateman Bay are believed to be caused by the persistent and strong southerly winds and the mass transport of water over the Ningaloo Reef caused by wave breaking over the shallow reefs. It is estimated that mild currents would often be present in Bills Bay and the southern portion of Bateman Bay. They would be primarily driven by wave and wind forcing and moderated by tidal action. Figure 6 shows predominant water current patterns adjacent to Mauds Landing.

Typically the currents would be in the order of 0.1 to 0.2m/s. Some of the water would flow out of the reef gaps in Bills Bay and the rest would continue north into Bateman Bay. It is reasonable to expect a localised increase in the current speed through the narrow channel near Point Maud. Rough estimates indicate that in this narrow channel, the currents may reach 0.5m/s.

Waves

Offshore from the Ningaloo Reef, the wave pattern is dominated by long, low swell waves from distant storm activity occurring in the southern Indian Ocean, and from steep and choppy seas generated over local fetches by the prevailing sea breezes.

The available data indicates that the swell approaches from the southwest in winter when wave heights are typically 2m to 3m and periods range from 10 to 16 seconds. During summer there is a shift to a more southerly direction. The waves heights are slightly lower typically 1m to 2m. The seas generated by the local sea breeze would be approximately 1m to 2m in height, having a 4 to 6 second period due to fetch limitations. The most extreme wave conditions would be caused by tropical cyclones in the vicinity of the area. Steedman Science and Engineering (1989) completed numerical modelling of the waves generated by Tropical Cyclone Hazel. This storm

was believed to create wave conditions representative of the 100-year return period condition for the Mauds Landing site. These were estimated to be characterised by significant wave heights of more than 6.2m immediately outside the reef line, and 3.7m in 7m of water near Mauds Landing in Bateman Bay.

This illustrates the effect of reef-line in attenuating waves as they travel from the deep offshore waters towards the shore at Mauds Landing. The reef-line also provides significant protection from the more usual waves conditions of southerly swell and seas. The 1 to 4m southerly swells would be refracted to the west-southwest, travelling through the gap in the reef known as Cardabia Passage, and then being further refracted by the bathymetry in Bateman Bay before reaching the shore almost parallel to the beach. These waves would break near the shore having been reduced to approximately 0.5 to 1m in height.

Hearn and Parker (1988) and D'Adamo and Simpson (2001) have described the circulation and transport of lagoonal waters within the NMP in terms of offshore currents, waves, tidal action and winds.

Near shore circulation is driven by wave pumping of water over the reef tract and moderated by tidal action (D'Adamo & Simpson 2001). A general northward longshore drift is sustained by prevailing and sea breeze action (Hearne & Parker 1988). These processes are presented diagrammatically in Figure 6. D'Adamo and Simpson (2001) note that in terms of flushing a residence time for lagoonal waters of less than one-day results with longer residence times for pockets of water near strong shoreline currents.

3.1.7 Marine Geomorphology

The coast from North West Cape in the north to Gnarraloo Bay in the south is formed mostly of Pleistocene (1.5 million to 10000 years ago) limestone and Holocene (since the end of the last Ice Age, about 10000 years ago) sands. These overlie the margin of a Miocene (from 26 to 7 millions years ago) limestone anticline (broad, raised stratified rock crest) (Marine Parks and Reserves Selection Working Group 1994).

The major marine geomorphological features are a gently sloping submarine shelf underlain by Pleistocene limestone with a veneer of marine sediments and interrupting this shelf, a fringing barrier reef system. The continental shelf in this region known as the Dirk Hartog Shelf, is relatively narrow and within 40km of the coast just south of North West Cape (Marine Parks and Reserves Selection Working Group 1994). Commonwealth of Australia (2000) notes that between Point Cloates and Jurabi Point, depths of 100m occur within 6km of shore. The shelf rises abruptly to the outer barrier reef, which consists of limestone and coral (Department of Conservation and Environment 1984). Water depths in Commonwealth Waters range from about 30m to greater than 500m (Environment Australia 2000).

The Ningaloo Reef comprises a partially dissected basement of Pleistocene marine or aeolian sediments, or Tertiary limestone covered by dead or living coral, the reef flat is on average several hundred metres wide (May et al. 1989).

In the vicinity of the proposed development area (State Waters) the reef is discontinuous and there is a break or 'passage' directly offshore (Plate 1). Just north and south of Point Maud the reef is only 1-2kms offshore (Department of Conservation and Environment 1984), and plays a fundamental role in coastal processes.

Sediments in the lagoon are generally coarse calcareous sand with finer calcareous sand or silt in deeper basins and gutters (May et al. 1989). These longshore drainage channels skirt the shoreward edge of the reef and may be up to 12m deep (May, Lenanton & Berry 1983). The underlying limestone may occasionally be exposed as bare pavement where the sand veneer has been swept away. Marine habitats of the lagoonal area in close proximity to the location of the proposed action are presented in Figure 7.

3.1.8 Coastal Processes and Marine Water Quality

Pollution impacts on Commonwealth Waters are limited due to the limited runoff as a result of low rainfall and high evaporation rates, and limited human development. Major oil spills resulting from shipping may have catastrophic consequences, however historical data would indicate that the likelihood of such an event is low.

As Commonwealth waters are located approximately 8km from the site of the proposed action, water quality impacts are much more likely to result in Bateman Bay and adjoining areas.

The sandy beach in the southern portion of Bateman Bay is believed to be stable and in balance with the incoming, persistent low amplitude swell waves. The measured beach profiles are typically swell-built and there is expected to be little longshore transport of sediment under these usual conditions. The swell is believed to slowly feed the beach system with sediment produced in the nearby reefs.

The largest movements of sand are believed to occur under the action of severe tropical cyclones. In work completed by Port and Harbour Consultants (cited in M. P. Rogers & Associates 2000) the longshore transport during an extreme cyclone was examined. This analysis indicated that during a severe cyclone, there was significant transport of sand along the sandy beaches in the southern portion of Bateman Bay. The direction of sand transport was to the south towards Point Maud, and varied from about 30,000m³ opposite Cardabia Passage to about 10,000m³ at the proposed marina site, to a negligible amount at Point Maud.

The cross-shore transport during such a storm would also be significant. During a very rare, severe cyclone event the cross-shore sediment movement has been estimated to cause erosion of up to 50m from the present vegetation line during the 100-year return period event. In the months and years that follow such an extreme storm, the persistent, low-amplitude background swell would bring some of this eroded sand back onshore and naturally build up the beach (M. P. Rogers & Associates 2000). A copy of the Coastal Engineering Study undertaken as M. P. Rogers & Associates is included as Appendix 3. Available evidence indicates that these large erosional events on the Bateman Bay shore may be followed by a period of deposition that can recover the earlier beachline position.

The waters of Bateman Bay are regularly flushed by the wind, tide and wave forced currents described in 3.1.2 above. Because of the wave-driven water transfer across the Ningaloo Reef ('pumping') and tidal flows through the reef gaps, the near shore water will be regularly mixed and exchanged with new ocean water on a daily basis (D'Adamo & Simpson 2001). Except for the possible influx of pollutants and nutrients from the waters of Bills Bay, the water in Bateman Bay should be representative in composition to that of the nearby ocean.

The DEP undertook an assessment of water and sediment quality in Bills Bay and Mauds Landing in response to concerns from the local community regarding nutrient enrichment and possible microbiological contamination (DEP 1995). The report concluded that the elevated concentrations of inorganic nitrogen and faecal coliforms in the groundwater along the shoreline of Bills Bay and adjacent marine waters, was likely sourced from groundwater contaminated by sewage. This had the effect of increasing nutrient concentrations in nearshore waters increasing phytoplankton biomass, light attenuation through the water profile, and macro algae within the bay.

The results of heavy metal and organotin analyses indicated elevated levels of arsenic, chromium, iron, manganese and zinc relative to other sites at Mauds Landing, and extremely high levels of tributyltin (TBT) close to mooring locations within Bills Bay. DEP (1995) noted that TBT was an issue as the extreme toxicity of this chemical was hazardous to a range of marine flora and fauna.

3.2 Biological Environment

3.2.1 Terrestrial Vegetation Flora Fauna

Terrestrial Environment

The Mauds Landing area is located within the Carnarvon Biogeographic Region that extends from Shark Bay northwards to Onslow (Thackway & Cresswell 1995).

No vegetation communities or flora occurring at the site are listed as Threatened under the EPBC Act. A number of fauna species of NES occur or may occur in nearby waters and adjoining lands and implementation of the development may:

- have the potential to have a significant adverse impact the habitat, lifecycle (eg. breeding, feeding, migration and the life expectancy) and spatial distribution of a number of species of NES; or
- result in impacts on the Commonwealth portion of NMP.

The following information on terrestrial fauna identifies aspects relevant to the potential impacts of the proposal.

Vertebrate Fauna

The fauna habitats and species likely to occur at the site have been assessed during preparation of a Western Australian public assessment document (ecologia 1994).

The project area is largely dominated by the coastal scrub-heath habitat, which consists of *Acacia* shrublands on coastal dunes and swales, and samphire flats surrounding salt lakes. The remaining habitats of beachfront and temporary saline wetlands constitute only minor portions of the project area. The habitats are widely distributed on a regional scale.

The CCR project area is expected to contain fauna species that are generally widespread and abundant in similar habitats throughout the region. Previous capture records, known distributions and habitat preferences, suggest as many as 189 vertebrate species potentially occur in the project area. This total includes 18 mammal (including 4 introduced species), 116 bird, 51 reptile and 4 amphibian species. It is unlikely however, that all of the potential species listed co-occur within the project area at any one time due to spatial constraints and various temporal variations in the physical environment. Numerous nomadic or migratory species may only occur in the area after substantial rain, or at certain times of the year.

No terrestrial fauna recorded or predicted to occur within the site is listed as Threatened under provisions of the EPBC Act. The beachfront habitat however, provides opportunities for nesting by marine turtles, which are listed as Threatened. Marine turtles, together with other marine species, that are listed as Threatened Species under the EPBC Act and are known to occur within the nearby and offshore waters, and along the beach and intertidal zones in the Ningaloo area, and therefore may be impacted by the proposal, are discussed in Section 3.2.2 of this report.

Four species of introduced mammal occur within the project area. These include the cat (*Felis catus*), fox (*Vulpes vulpes*), house mouse (*Mus musculus*) and rabbit (*Oryctolagus cuniculus*). The feral goat (*Capra hircus*) also inhabits this area (Bowman Bishaw Gorham 1995). Introduced species particularly foxes have the potential to significantly impact the fauna at the site, including marine turtles, through predation, modification of the habitat and competition.

The list of potential birds is extensive and includes species that might be vagrant or may only visit under rare conditions, such as waterbirds that may use hypersaline soaks when they are completely inundated following heavy rain. The majority of birds identified as potentially occurring have distributions that extend into all the zoogeographic sub-regions of Australia, including most of the migratory and highly nomadic species. For other species, the project area lies near the northernmost extension or the southern limit of their range and these species therefore may not occur at the site.

Numerous shorebirds and seabirds that occur in the area may use the beachfront habitat fronting the site. The beachfront habitat within the site comprises three zones, namely the intertidal, the beach and bands of tidal debris. This habitat typically lacks significant vegetative cover and structural diversity and would be used largely for foraging by waders and other birds. The area consists of the wide beach backed by sparsely vegetated foredunes supporting *Spinifex longifolius* and *Eulalia aurea*.

Australia has international commitments in relation to trans migratory birds that are listed under the EPBC Act. Listed Migratory Species include those identified under the JAMBA and CAMBA bilateral agreements and the Bonn Convention. Marine

avifauna listed as Migratory Species under provisions of the EPBC Act that are known to occur in the Cape Range National Park and NMP and could potentially occur at the site are provided in Table 4.

TABLE 4
BIRDS RECORDED IN CAPE RANGE NATIONAL PARK AND NMP THAT
ARE LISTED AS MIGRATORY SPECIES¹ UNDER THE EPBC ACT 1999

COMMON NAME	SCIENTIFIC NAME
Southern Giant-Petrel	<i>Macronectes giganteus</i>
Wedge-tailed Shearwater	<i>Puffinus pacificus</i>
Flesh-footed Shearwater	<i>Puffinus carneipes</i>
Yellow-nosed Albatross	<i>Diomedea chlororhynchos</i>
Wilson's Storm-Petrel	<i>Oceanites oceanicus</i>
Brown Booby	<i>Sula leucogaster</i>
Lesser Frigatebird	<i>Fregata ariel</i>
Eastern Reef Egret	<i>Egretta sacra</i>
Osprey	<i>Pandion haliaetus</i>
White-bellied Sea-Eagle	<i>Haliaeetus leucogaster</i>
Black-tailed Godwit	<i>Limosa limosa</i>
Bar-tailed Godwit	<i>Limosa lapponica</i>
Little Curlew	<i>Numenius minutus</i>
Whimbrel	<i>Numenius phaeopus</i>
Eastern Curlew	<i>Numenius madagascariensis</i>
Common Greenshank	<i>Tringa nebularia</i>
Wood Sandpiper	<i>Tringa glareola</i>
Common Sandpiper	<i>Tringa hypoleucos</i>
Grey-tailed Tattler	<i>Tringa brevipes</i>
Ruddy Turnstone	<i>Arenaria interpres</i>
Great Knot	<i>Calidris tenuirostris</i>
Red Knot	<i>Calidris canutus</i>
Sanderling	<i>Calidris alba</i>
Red-necked Stint	<i>Calidris ruficollis</i>
Curlew Sandpiper	<i>Calidris ferruginea</i>
Pacific Golden Plover	<i>Pluvialis fulva</i>
Grey Plover	<i>Pluvialis squatarola</i>
Lesser Sand Plover	<i>Charadrius mongolus</i>
Greater Sand Plover	<i>Charadrius leschenaultii</i>
Oriental Plover	<i>Charadrius veredus</i>
Caspian Tern	<i>Sterna caspia</i>
Lesser Crested Tern	<i>Sterna bengalensis</i>
Crested Tern³	<i>Sterna bergii</i>
Common Tern	<i>Sterna hirundo</i>
Bridled Tern	<i>Sterna anaethetus</i>
White-winged Black Tern²	<i>Chlidonias leucopterus</i>
Common Noddy	<i>Anous stolidus</i>

Source: adapted from CALM, 1997)

¹ Listed as Migratory Species as at 29 September 2001

² Recorded by Keeling and Parker (1986) seaward of the outer reef

³ Listed under JAMBA but not as a Migratory Species under the EPBC Act 1999.

Note: Species listed in bold have been recorded at Point Maud (Meyer, 2001)

Point Maud itself is recognised as an important roosting and loafing site and CALM has indicated that Point Maud is the only location in the nearby vicinity of the proposed development where significant numbers of seabirds congregate (Meyer 2001). At least 20 species of seabirds have been recorded at Point Maud during surveys conducted by CALM.

In total, the monitoring undertaken by CALM has recorded eight species that are Migratory Species as listed on 29th September 2001. The Crested Tern is listed under JAMBA however, this species does not appear to be currently listed as a Migratory Species. These species are identified in Table 4 and details of records of Migratory Species listed under the EPBC Act and JAMBA/CAMBA agreements that have been recorded at Point Maud during the CALM monitoring are provided in Table 5. An additional species observed by CALM at Point Maud and identified as a sandpiper may be protected under the EPBC Act and has therefore been included. Insufficient information was provided however, to confidently determine the specific species being referred to and whether the species is specially protected.

The monitoring undertaken by CALM suggests there is some current potential disturbance of seabirds by dogs, walkers and vessels (refer to Table 5).

The previous faunal assessment by ecologia (1994) indicated several listed Migratory Species under the EPBC Act could potentially use terrestrial habitats within the site other than the beachfront and sparsely vegetated dunes. These comprise:

- | | |
|--------------------------|----------------------------|
| • Great Egret | <i>Egretta alba</i> |
| • Marsh Sandpiper | <i>Tringa stagnatilis</i> |
| • Common Greenshank | <i>Tringa nebularia</i> |
| • Red-necked Stint | <i>Calidris ruficollis</i> |
| • Sharp-tailed Sandpiper | <i>Calidris acuminata</i> |
| • Lesser Sand Plover | <i>Charadrius mongolus</i> |
| • Fork-tailed Swift | <i>Apus pacificus</i> |
| • Rainbow Bee-eater | <i>Merops ornatus</i> |

Most of these species would be expected to occur occasionally, on an opportunistic basis, within the saline lake area when the conditions are suitable. The Rainbow Bee-eater and Fork-tailed Swift may occur in the coastal scrub-heath, or samphire flats. The habitats within the site represent only a minor portion of available similar habitats in the surrounding areas.

A survey of migratory shorebirds will be undertaken over a 2km range from the site between November 2001 and February 2002. The information obtained from this survey along with an evaluation of the impacts of the proposal on any listed migratory birds identified in the survey and mitigation measures if required will be provided in the final PER.

TABLE 5
RECORD OF SEABIRD OBSERVATIONS – POINT MAUD
1990 TO MARCH 2001

	1990	1991	1999	2000									2001	
	Aug	Feb	Oct	Jan	Feb	March	April	July	Sept	Oct	Nov	Dec	Feb	March
Date	22nd	3rd	5th	13th	17th	22nd	8 th	25th	1 st	4th	9th	8th	18th	8th
Time	?	1815	1310	1335	1115	1120	1445	1450	1030	1400	1020	1030	1200	1100
¹ Tide (1,2,3or4)													4	1
Wind/weather				20kts SW								15kts SW	15/18 SW	calm.
<i>Any disturbance?</i>			Dog tracks	4 Walkers					Walkers	Walkers	Walkers	Vessel		
(Southern) Giant Petrel									1 (BBond)					
Wedge-tailed Shearwater				1										
Red Knot										2				
Sanderling			15					10	40	10				30
Caspian Tern	600				1				2					15
Lesser Crested Tern	400				1710	600	200	6		230	1 juv			
Crested Tern	1500	3	30	20	115	35	35	70+30juv	150	13			12	50
Common Tern		800	150						300		900	80	4000	3000
White winged Black Tern		120					100							
Sandpiper ?						40								

Source: Meyer (2001)

Notes:

¹Tide 1=High, 2=Ebbing, 3=Low, 4=Rising

Conservation Significance

The primary conservation significance of the sparsely vegetated beachfront habitat is as potential nesting locations for Threatened marine turtles, particularly the Loggerhead turtle. Recent records of the Loggerhead turtle nesting in Bateman Bay highlight the area's importance. The occurrence of marine turtles in the area is discussed in the section on the marine biological environment (Section 3.2.2).

3.2.2 Marine Biological Environment

Marine Habitats

Commonwealth of Australia (2000) categorises the following habitats present within the NMP:

- open ocean, supporting planktonic and pelagic sea creatures including species of fish such as tuna and billfish, whales and whale sharks;
- the seabeds of both the continental slope and shelf, supporting demersal (bottom-living) fish, mollusc and crustacean species; epibenthic flora (algae) and fauna (eg. sponges, soft corals); and in fauna (eg. burrowing bivalves, crustaceans);
- coral reef, comprising the reef and lagoon; and
- intertidal systems formed at the point of contact between the land and the sea, including rocky shores, sandy beaches and mangroves.

Commonwealth Waters comprise the open waters and seabeds of the continental slope and continental shelf, a depth range from about 30m to greater than 500m. State waters include coral reef and intertidal habitats that include the beach zone to 40m (horizontal distance) above the HWM to the junction with Commonwealth waters.

Species of National Environmental Significance occur across all habitats that make up the NMP.

The major marine habitats of the Mauds Landing region (Moncks Head to Bruboodjoo Point) have been mapped and described by CALM (1997), and has been amended following field programs related to baseline collection of data for this project. This is presented in Figure 7. CALM recognise the following habitats in this region:

- (i) Sandy beaches;
- (ii) Shoreline and reef platforms;
- (iii) Sandy seafloor;
- (iv) Lagoonal and reef platforms;
- (v) Intertidal/shallow coral reef communities;
- (vi) Subtidal coral reef communities;
- (vii) Macroalgal beds;

- (viii) Seaward reef platform; and
- (ix) Pelagic.

Additional benthic habitats within Commonwealth waters include:

- (x) Seabed of the continental slope; and
- (xi) Seabed of the continental shelf.

A brief description of each of these habitats is contained in Table 6.

Nearshore marine habitats were inspected in May 2000 during the field survey for this Report (ATA Environmental 2000a). Further information is drawn from CALM records and Bowman Bishaw Gorham (1995).

1. Sand beaches
Occur in patches between areas of reef platform.
2. Shoreline reef platform
This occurs extensively along the shoreline from Moncks Head to Bruboodjoo Point, interspersed with areas of sandy beach.
3. Sandy seafloor
Occurs along fringing beaches or offshore as patches covering large areas of seafloor.
4. Lagoonal reef platforms
Limestone platforms, often with a veneer of sand cover much of the lagoon area north of Point Maud.
5. Intertidal/shallow coral reef communities
These communities are less than 1m above lowest astronomical tide. They form much of the reef crest along the outer reef line and occur in a few patches within lagoon areas.
6. Subtidal coral reef communities
Occurs extensively inside Bills Bay and along the outer reef edge.
7. Macroalgal beds
Occur on slightly raised limestone pavements where limestone is consistently exposed and sand inundation is not a problem. One patch occurs within the Maud Specific Management Area (MSMA) proposed within this document, and located some 10km north of Point Maud.
8. Seaward reef platform
The seaward reef platform is a broad gently sloping platform that occurs along the outer edge of the fringing barrier reef.

TABLE 6
MARINE HABITATS OF MAUDS LANDING AND SURROUNDING AREAS

HABITAT CLASSIFICATION	ZONE	TIDAL RANGE	SUBSTRATE TYPE	RELIEF	MACRO-BIOLOGY	SUB-CATEGORIES	COMMENTS
Beach	State	Intertidal Supratidal	Sand	Low	Bare		- Continuous intertidal sand - Unvegetated - Mobile sands
Shoreline reef platform	State	Intertidal	Igneous Metamorphic Sedimentary	Low	bare algal turf		- Continuous reef platform along the shoreline - May be bare or have macroalgal turf or sand patches - Intertidal gastropods and other invertebrates may be present
Coral reef communities	State	Intertidal & subtidal	N/A	High & low	Hard & soft corals Other sessile invertebrates	Coral reef communities (subtidal) - Subtidal, often high live coral cover, coral colonies with sand patches in lagoons - Seaward reef slopes - Deep lagoon Coral reef communities (intertidal or shallow) - Intertidal or shallow - <1m lowest astronomical tide (LAT) - Often live coral cover is low - Reef crest - Back reef - Reef flat - Shallow lagoon.	- Typical coral reef community – hard coral, soft coral, sponges, bryozoans, ascidians etc. - Seaward reef slope, reef crest, back reef, reef flat and individual bommies - Some sand, pavement, macroalgae or seagrass interspersed

HABITAT CLASSIFICATION	ZONE	TIDAL RANGE	SUBSTRATE TYPE	RELIEF	MACRO-BIOLOGY	SUB-CATEGORIES	COMMENTS
Subtidal reef platform	State	Subtidal	Igneous Metamorphic Sedimentary	Low	Diverse algae Sessile invertebrates (including sponges, sea-whips, seapens)	Subtidal reef platform (high relief) >1m high - Lagoonal reef platform - Seaward reef platform	- Includes limestone pavement or low relief reef - May be covered with macroalgae or seagrass, patchy mobile sands - May incorporate sand patches, rubble and scattered isolated corals
Macroalgal dominated limestone reef	State	Subtidal	Sedimentary	High & low	Large fleshy macroalgae Invertebrates	Macroalgae dominated limestone reef (low relief) >1m high	- Typically covered in macroalgae with diverse invertebrate life in overhangs & caves - May incorporate sand patches, rubble and scattered isolated corals
Sand	State	Subtidal	Sand (generally white)	Low	Bare May have seagrass or macroalgal patches		- Little or no vegetation - May have patches of other habitat - May overlay reef platform - May have patches of seagrass of macroalgae - May have seasonal vegetation
Pelagic	State, Common -wealth	In waters >50 m	Various	n/a	Mainly pelagic fish and invertebrates supported by zooplankton feeding on phytoplankton populations		- Low nutrient waters - This category is specific to those areas that are greater than 50 m in depth - May have various substrates however the water column is dominant
Seabed of the continental shelf	Common - wealth	Subtidal	Sedimentary, sand overlying limestone	Low	Sessile flora and fauna consist of algae, sponges and soft corals. Anticipated diverse crustacean and mollusc fauna.		- Depths 30 m to 170 m - May have a diverse crustacean and mollusc fauna - Depths greater than 40m may be dominated by sponges

HABITAT CLASSIFICATION	ZONE	TIDAL RANGE	SUBSTRATE TYPE	RELIEF	MACRO-BIOLOGY	SUB-CATEGORIES	COMMENTS
¹ Seabed of the continental slope	Common wealth	Subtidal	Sedimentary, soft sediments of mud, sand and fine ooze	Low, downward dipping	Benthic fauna likely dominated by sponges, burrowing worms and crustaceans.		- Depths 170m to greater than 800m.

¹ Modified from Environment Australia (2000).

9. Pelagic Zone

The pelagic habitat includes all of that area greater than 30m deep offshore from the seaward reef platform. Because of the water depth, and its remoteness from the Mauds Landing project, no information was collected on the seafloor for the purposes of this report. Some descriptive data is available from Commonwealth of Australia (2000).

10. Continental Slope and Shelf

The seabeds of the Commonwealth portion of the NMP were not investigated during the baseline marine assessment. The habitat includes all of that area greater than 30m deep offshore to greater than 800m. Some descriptive data is available from Commonwealth of Australia (2000).

Figure 7 modified from data compiled by CALM from aerial photography and confirmed by survey, illustrate the marine habitats located in the vicinity of Mauds Landing and adjoining pelagic zone. These habitats and the deeper waters of Stanley Pool and offshore Ningaloo Reef, support a rich and diverse assemblage of fishes and invertebrates, several species of marine mammals and reptiles.

Marine Communities

Coral Reef Communities

The Ningaloo Reef Tract extends from Gnarraloo Bay to Point Murat, a distance of about 280km (Simpson & Masini 1986). It comprises one of the five major coral reef assemblages that are recognised on the west-coast, with the others being:

- the patch and fringing reefs off the Kimberley coast;
- shelf edge atolls on the north west coast;
- fringing and patch reefs off the Pilbara coast; and
- temperate coral reefs of the Houtman Abrolhos Islands.

Ningaloo Reef is the largest existing fringing reef system in Australia and occurs off an arid central west-coast landscape. The aridity of this region allows reef development in close proximity of the coast due to the lack of terrestrial run-off, which minimises water turbidity (Hatcher 1988). The Ningaloo Reef Tract, together with reefs of the Pilbara coast, are scientifically important as they are the only major reef structures in Australia in an arid climate providing opportunities for direct comparison with reefs of the Great Barrier Reef.

In Western Australia, 318 species of scleractinian corals from 70 genera, have been recorded (Veron & Marsh 1988). Of these, 53 genera are represented in the Ningaloo Reef (Simpson 1987) with Acroporidae and Faviidae dominating.

There are no extensive coral communities in very close proximity to the proposed development site at Mauds Landing. However, large, diverse and regionally significant coral communities are characteristic of the NMP. Local examples of important coral communities include the:

- extensive lagoonal coral community south of Point Maud in Bills Bay;

- shallow backreef of Ningaloo Reef located approximately 2km to the west; and
- highly diverse coral community located 9km north of Mauds Landing on the edge of Stanley Pool.

The lagoon at Bills Bay is generally 3m deep and supports an extensive coral community dominated by arborescent (branching) *Acropora* and tabular (flat) *Montipora* species. This community is the largest lagoonal coral assemblage along the Ningaloo Reef Tract. Its importance has long been recognised and most of the community has been designated a marine reserve for over 20 years. Severe mortalities occurred to the corals in 1989 due to anoxic conditions that followed the coral spawning in March of that year (Simpson, Cary & Masini 1993).

The Ningaloo Reef backreef is generally very shallow with live corals often being exposed on extremely low tides. This is a high-energy zone and is usually dominated by digitate and corymbose *Acropora* spp., with secondary corals being massive faviids and poritids, encrusting *Montipora* spp. and ramose *Pocillopora* spp. The backreef community throughout the Ningaloo Reef Tract was extensively affected by the corallivorous muricid gastropod *Drupella cornus*, with up to 98% mortality to corals being reported in some areas (Forde 1994). The backreef near Mauds Landing was significantly affected with high mortalities to corals in some areas, but very limited effects in others.

The coral reef on the inner edge of Stanley Pool, 9km north of Mauds Landing, is possibly unique on the Ningaloo Reef Tract. It is a lagoonal community varying in depth from about 5 to 10m with a highly diverse coral fauna. The most notable coral formations are massive *Porites* colonies that are over 6m in height. Other genera observed in recent surveys include *Acropora*, *Montipora*, *Galaxea*, *Pocillopora*, *Mycodinium*, *Astreopora*, *Hydnophora*, *Merulina*, *Serriatopora*, *Stylophora*, *Echinopyllia*, *Pavona*, *Pectinia*, *Fungia*, *Goniopora*, *Lobophyllia*, *Symphyllia* and most of the genera of the family Faviidae. No one genus is dominant and the diversity occurs over a relatively small area, with the total area of the community estimated as less than 8ha.

A number of natural disturbances to the marine environment have been documented over recent decades as knowledge of the Ningaloo Reef Tract has been gained principally through the work or under the direction of CALM's Marine Conservation Branch. For Ningaloo, the predatory snail *D. cornus*, which feeds on corals, became extremely abundant in the early 1980's and devastated coral populations on the back reef (Osborne & Williams 1992). A mass mortality of corals event occurred in March 1989 during when it is estimated that the live coral cover in the Bills Bay area decreased from 42.9 to 9.4% (Grubba & Cary 2000). During this event, the majority of corals spawned several nights earlier than anticipated during a flood rather than an ebb tide and onshore wind conditions. The effect was to restrict the dispersal of coral propagules with large amounts of coral spawn trapped in the bay forming extensive slicks. Extensive fish kills also occurred.

Localised damage to sensitive lagoonal areas also occurs within Bills Bay and adjoining areas due to boating activities. CALM is currently preparing a specific area management plan to in part address these concerns (Simpson 2000).

The existing Coral Bay settlement has also been identified as a source of contaminants in Bills Bay (DEP 1995). These include zinc and iron, which are slightly elevated compared to the surrounding area, and arsenic, cadmium and particularly TBT that were above the criteria (DEP 1996) for high levels of ecosystem protection. Elevated nutrients, particularly nitrogen, have also been identified and indicate contaminated groundwater as the source.

A series of field surveys to 'assess the health' of major benthic habitats of the marine park have been undertaken by CALM in collaboration with the Australian Institute of Marine Sciences (AIMS). The primary objective of the most recent survey (May 2000) was to re-survey 17 monitoring sites established in Bills Bay in 1989 and again in 1994.

Corals may be affected as a consequence of main induced impacts arising from boating activities and mooring, direct breakage caused by reef walking, and indirect impacts as a consequence of water quality changes.

Seagrass Communities

Seagrasses in the Mauds Landing area are restricted to a discrete area containing patches of *P. coriacea* and to more dispersed occurrences of sparse *H. ovalis*. The *P. coriacea* patches are located at depths of 5 to 10m along 1.5km of shoreline, extending some 600m out to sea and commencing 4km north of Mauds Landing. *Posidonia* is a temperate genus and the community near Mauds Landing comprises the most northerly meadows of *P. coriacea* presently identified. Leaves of species washed up on various local beaches would indicate that similar isolated communities occur on other areas of Ningaloo Reef. The seagrass *A. antarctica*, also a temperate species, occurs in patches and is close to its known northern limits of distribution (Butler & Jernakoff 1999).

H. ovalis is a tropical species and is widespread throughout the Ningaloo Reef and Rowley Shelf region. Its representation near Mauds Landing is restricted to sparse and patchy occurrences, usually in shallow sediments overlying limestone. These areas include a small macroalgae-dominated area near Point Maud and limestone pavements northwest of Mauds Landing. *Halophila* is eaten by dugong and is therefore ecologically important. The sparse occurrences of *H. ovalis* near Mauds Landing in association with the dugong's seasonal and itinerant nature, suggest that the seagrass communities occurring in the study area while being possibly locally significant are of limited regional significance.

Macroalgal Communities

Macroalgal communities are not well represented in the Mauds Landing area. Small areas of sparse macroalgae occur near the western end of Point Maud. Sparse, stunted macroalgal-mixed coral filter feeder communities occur on the fringing shoreline

platform located approximately 4km northeast of Mauds Landing. *Sargassum* is the dominant genera in each of these areas.

Well-developed macroalgal communities also occur extensively along the Ningaloo Reef Tract. The nearest backreef algal community to Mauds Landing occurs on the backreef immediately north of Mauds Entrance (Cardabia Passage), approximately 7km to the northwest. Although these communities are ecologically important, being highly productive and providing food for green turtles, limited examples occurring in the Mauds Landing area are not considered to be regionally significant.

The nearshore area of Bills Bay presently supports large amounts of *Sargassum*, with individual plants having lengths of up to 2m in length (Bowman Bishaw Gorham 1995)

Pavement Communities

Localised areas of low-profile pavements occur near Point Maud, and to the northeast of Mauds Landing. The area near Point Maud supports the shallow, mixed macroalgal and *H. ovalis* community, as discussed above. The platforms to the northeast of Mauds Landing occur in two forms:

- an extensive area of exposed calcarenite platforms and boulders located 5.5km northeast of Mauds Landing; and
- an exposed beach rock and coastal platform on the shoreline that mirrors the subtidal geomorphology at this location.

The pavement gently slopes from the shoreline to about 10m depth and extends parallel to the shore for about 4km. At its southern extent the platform supports occasional sponges, corals (*Turbinaria* sp.), macroalgae (*Sargassum* spp.) and turf algae. Coral density increases northwards along the pavement culminating in the previously described high-diversity coral reef located at the edge of Stanley Pool, approximately 9km north from Mauds Landing.

There are also areas of exposed pavements located approximately 3km to the northeast of Mauds Landing which consist of isolated, low-relief outcrops. These pavements are virtually void of attached fauna however one area is completely covered by mussels. Of these platform areas those having only low relief, which are depauperate of sessile organisms, would probably be periodically inundated by sand. The more permanently exposed pavements provide a habitat for reef fishes. Although locally significant, pavement communities occur extensively along the inner lagoon on the Ningaloo Reef Tract (May, Lenanton & Berry 1983).

Sand Communities

All of the marine substrata near to Mauds Landing are bare sands. The nearest hard substratum to Mauds Landing are sparse outcrops of calcarenite with macroalgal coverings, located approximately 1.2km to the west. The sandy substratum is slightly undulating and varies subtly in shade, suggesting variations in age and mobility. This

is consistent with the geomorphology of Point Maud, which is an accretionary cusp, whereas the limestone cliffs further to the north indicate an eroding coastline.

The deeper pavements support numerous browsing and carnivorous molluscs, such as cerithids and mitras and at times filter feeding bivalves. Mobile invertebrate found in the sands include echinoderms, such as starfish (Asteroidea), sea urchins (Echinoidea), feather stars (Crinoidea), brittle stars (Ophiuroidea) and sea cucumbers (Holothurioidae). Ninety species of echinoderm, representing 56 genera, are reported as occurring along Ningaloo Reef (Marsh & Marshall 1983). Sand dollars (Family Laganidae) and heart urchins (Family Spatangidae) occur in the sand flats near Mauds Landing.

Marine Fauna

Several marine species listed as Threatened or Migratory under the EPBC Act are known to occur within the nearby and offshore waters, and along the beach and intertidal zones in the Ningaloo area. These species with the exception of migratory birds, which are discussed in Section 3.2.1, are listed in Table 7. Table 7 also identifies marine species that are listed under relevant Western Australian legislation.

TABLE 7
LISTED THREATENED AND MIGRATORY SPECIES UNDER
THE EPBC ACT (COMMONWEALTH) AND WILDLIFE CONSERVATION
ACT (WA) THAT ON THE BASIS OF THEIR KNOWN DISTRIBUTION
MAY ON OCCASION BE OBSERVED IN THE NMP

Species		EPBC Threatened Fauna - Endangered	EPBC Threatened Fauna - Vulnerable	EPBC Migratory	WA Wildlife Conservation Act
Blue whale	<i>Balaenoptera musculus</i>	✓		✓	✓
Southern right whale	<i>Eubalaena australia</i>	✓			✓
Fin whale	<i>Balaenoptera physalis</i>		✓		✓
Humpback whale	<i>Megaptera novaeangliae</i>		✓	✓	✓
Sei whale	<i>Balaenoptera borealis</i>		✓		✓
Indo-pacific humpbacked dolphin	<i>Sousa chinensis</i>			✓	
Spinner dolphin	<i>Stenella longirostris</i>			✓	
Dugong	<i>Dugong dugon</i>			✓	✓
Indian Yellow-nosed albatross	<i>Thalassarche carteri</i>		✓	✓	
Soft-plumaged petrel	<i>Pterodroma mollis</i>		✓		
Southern giant petrel	<i>Macronectes giganteus</i>	✓			
Loggerhead turtle	<i>Caretta caretta</i>	✓		✓	✓
Flatback turtle	<i>Natator depressus</i>		✓	✓	✓
Green turtle	<i>Chelonia mydas</i>		✓	✓	✓
Hawksbill turtle	<i>Eretmochelys imbricata</i>		✓	✓	✓
Whale shark	<i>Rhincodon typus</i>		✓	✓	

Source: adapted from Commonwealth of Australia (2000).

Notes: **Migratory (EPBC Controlling Provisions 20 and 20A):** the action may substantially modify, destroy or isolate an area of important habitat of the migratory species **and/or** seriously disrupt

the lifecycle (breeding, feeding, migration or nesting behaviour) of an ecologically significant proportion of the population of the species.

Threatened – Endangered/Vulnerable (EPBC Controlling Provisions 18 and 18A): the action may reduce the area of occupancy of the species and seriously disrupt the lifecycle (breeding, feeding, migration or nesting behaviour) of an important population of the species.

Species shown in bold in Table 7 are further discussed in detail in the following sections on the basis that implementation of the controlled action may substantially modify, destroy or isolate an area of important habitat of the species and/or seriously disrupt the lifecycle (breeding, feeding, migration or nesting behaviour) of an ecologically significant proportion of the population of the species.

Implementation of the proposal will increase boating and usage pressure and has the potential to have a significant adverse effect on the lifecycle and spatial distribution of a number of these species.

The development will attract people into the region and could lead to additional demand for ecotourism experiences, including turtle egg laying and hatching, snorkelling, SCUBA diving and whale shark and whale interactions. Providing for this demand will place greater pressures on turtle breeding stock. Dugongs are also known from State waters within the area.

Some species other than listed species, such as finfish, sharks and rays are also discussed because they are considered important to the ecology of the Ningaloo reef system.

Marine Mammals

Marine mammals inhabiting the waters near Mauds Landing include dugong, common bottlenose dolphins (*Tursiops truncatus*), Indo-Pacific humpback dolphin (*Sousa chinensis*), and a number of different whale species.

The dugong (*Dugong dugon*) inhabits shallow, warm nearshore coastal waters of the Indian and western Pacific oceans (Strahan 1998). Along the Australian coast, this species typically occurs in waters from Shark Bay in Western Australia around the northern coast to Moreton Bay in Queensland. The dugong is herbivorous, feeding almost entirely on seagrasses but occasionally also marine algae and benthic invertebrates. Dugongs indicate a preference for seagrasses pioneer species of the genera *Halophila* and *Halodule*. These are low in fibre, high in available nitrogen and easily digested.

Being mammals, dugongs must surface to breathe and need to do so with greater regularity than other aquatic mammals such as whales and dolphins as they can hold their breath for only a few minutes.

The dugong is long lived, surviving 70 years or more and has a low reproductive rate (Stokes & Dobbs 2001). A female will raise a calf every three to five years. It is estimated that the maximum increase in a population is 5% each year provided all females breed at maximum potential (Wachenfeld, Oliver & Morrissey 1999). A high level of adult survivorship is essential in maintaining populations. Calves are born

typically between September and November in shallow waters, away from seagrass meadows.

The dugong population in Australia is estimated to be the largest remaining in the world. About 80 000 dugongs are reported to occur in Australian waters, an estimated 12 000 of which occur in the Great Barrier Reef World Heritage Area, although recent studies suggest the population on the southern Great Barrier Reef is declining. The decline in numbers has been attributed to unsustainable mortality from human-related causes such as habitat loss, commercial mesh nets (fishing nets), shark nets set for bather protection, and hunting (Great Barrier Reef Marine Park Authority 2001).

Dugongs are dispersed along the entire length of the Ningaloo Reef Tract. Based on aerial surveys undertaken in 1989 and 1994, the total population of dugong in the NMP is estimated to be in the order of 1000 individuals (Preen et al. 1997). The density of dugongs within the Park is similar to that of other significant dugong habitats in northern Australia. The dugong in this area probably move freely between NMP and Exmouth Gulf, and perhaps the nearshore waters further east (Bowman Bishaw Gorham 1995). Daily movements of 25km largely in response to tidal flows and accessibility of seagrass meadows are common (Strahan 1998).

Bottlenose dolphins are common along Ningaloo Reef and are expected to regularly occur in the vicinity of Mauds Landing. The density of dolphins in the NMP is similar to that observed elsewhere in tropical Australian areas. Less common are humpback dolphins, which are a tropical species that is rarely sighted south of Exmouth Gulf.

Humpback whales, minke whales (*B. acutorostrata*), fin whales (*B. physalis*), blue whales (*B. musculus*), brides whales (*B. edeni*) and killer whales (*Orca orca*), occur in the offshore waters westward of Ningaloo Reef (May, Lenanton & Berry 1983). Of these, humpback whales regularly pass along the reef during the northern and southern migrations, while the other species are less common.

The humpback whale (*Megaptera novaeangliae*) is a cosmopolitan species that occurs in coastal waters off Australia during winter and spring. The whales feed mainly in nutrient-rich antarctic waters during summer, migrating northwards to winter breeding grounds off the Kimberley coast. Northerly migrating whales can be seen in the Ningaloo region June to August and southward bound whales including calves occur August to November (Commonwealth of Australia 2000). Migration occurs within 10 to 20kms of the shore. Table 8 presents the occurrence of humpback whales at locations along the Western Australian coastline, and relevant activities taken from WA Department of Minerals and Energy (undated).

Mating occurs between about June and October with calving 11 to 11.5 months later during the months of June to October (Environment Australia 2001a). Calving occurs in tropical coastal waters with cows and calves undertaking southern migration to summer feeding grounds in the Antarctic region. During migration pregnant females and cows with calves typically travel last.

TABLE 8
OCCURRENCE OF HUMPBACK WHALES AT LOCATIONS ALONG THE
WESTERN AUSTRALIAN COASTLINE

Known important locations	Duration												Importance of areas
	September				October				November				
Campden Sound and adjacent areas													Calving area
Exmouth Gulf													Resting area with calves
Shark Bay													Resting area with calves
Geographe Bay													Resting area with calves

Commercial whaling substantially reduced humpback whale populations, however, following a ban on whaling, populations are now increasing. The current annual population increase is estimated at about 10% (Environment Australia 2001a). At least six distinct Southern Hemisphere populations are recognised. The population occurring on the west coast of Australia, Group IV, is historically the largest population of humpback whales in the southern hemisphere (Heyward, Revill & Sherwood, 2000). This population is presently estimated to be roughly between 3000 to 4000 animals (Environment Australia 2001a).

Populations of humpback whales are considered to be threatened by direct disturbance along migration path and in breeding areas through whale watching and interactions, defence operations, collision with large vessels, coastal seismic operations, entanglement in fishing nets, marine pollution and debris (Environment Australia 2001a). FWA (2000) note that entanglement of marine mammals in the NMP is rare.

Seabirds and Shorebirds

Over 30 species of seabirds, including some marine shorebirds, are reported to occur on the coastal islands, mainland coastal and offshore waters of the Ningaloo area (CALM, 1997 and Commonwealth of Australia 2000).

Seabirds occurring in the area that are listed as Migratory Species under the EPBC Act or JAMBA/CAMBA international agreements are identified in Table 9. In total sixteen species protected under bilateral agreements or as Migratory Species under provisions of the EPBC Act are known from the NMP and adjacent waters. Of these, six species are known to breed in the Ningaloo area.

According to monitoring data from CALM thirteen of the seabirds listed as occurring in the area have been confirmed in the Mauds Landing area and occur at Point Maud (Meyer, 2001).

TABLE 9
SEABIRDS REPORTED AS OCCURRING IN THE NMP AND ADJACENT AREAS

Common Name	Scientific Name	Migratory Species ²	Breeding Season
Cape Petrel ¹	<i>Daption capense</i>		Do not breed in the region
Southern Giant Petrel	<i>Macronectes giganteus</i>	✓	Do not breed in the region
Great-winged Petrel ¹	<i>Pterodroma macroptera</i>		Do not breed in the region
Soft-plumaged Petrel	<i>Pterodroma mollis</i>		Do not breed in the region
Wedge-tailed Shearwater¹	<i>Puffinus pacificus</i>	✓	October to May
Flesh-footed Shearwater ¹	<i>Puffinus carneipes</i>	✓	Do not breed in the region
Hutton's Shearwater ¹	<i>Puffinus huttoni</i>		Do not breed in the region
Little Shearwater ¹	<i>Puffinus assimilis</i>		Do not breed in the region
Yellow-nosed Albatross ⁴	<i>Diomedea chlororhynchus</i>	✓	Do not breed in the region
Wilson's Storm-Petrel ¹	<i>Oceanites oceanicus</i>	✓	Do not breed in the region
White-faced Storm-Petrel	<i>Pelagodroma marinus</i>		Do not breed in the region
Brown Booby ¹	<i>Sula leucogaster</i>	✓	No record for this area
Australasian Gannet	<i>Morus serrator</i>		Do not breed in the region
Lesser Frigatebird ¹	<i>Fregata ariel</i>	✓	No record for this area
Pied Cormorant	<i>Phalacrocorax varius</i>		Opportunistic
Australian Pelican	<i>Pelecanus conspicillatus</i>		Opportunistic
Eastern Reef Egret	<i>Egretta sacra</i>	✓	September to February
Osprey	<i>Pandion haliaetus</i>	✓	April to October
White-bellied Sea-Eagle	<i>Haliaeetus leucogaster</i>	✓	May to November
Beach Stone Curlew	<i>Esacus neglectus</i>		August to October
Pied Oystercatcher	<i>Haematopus longirostris</i>		July to September
Pacific Gull	<i>Larus pacificus</i>		Do not breed in the region
Silver Gull¹	<i>Larus novaehollandiae</i>		September to December
Caspian Tern¹	<i>Sterna caspia</i>	✓	June to November
Gull-billed Tern	<i>Sterna nilotica</i>		No record for this area
Lesser Crested Tern¹	<i>Sterna bengalensis</i>	✓	No record for this area
Crested Tern¹	<i>Sterna bergii</i>	✓ ³	March to August
Roseate Tern¹	<i>Sterna dougallii</i>		August to December
Common Tern¹	<i>Sterna hirundo</i>	✓	Do not breed in the region
Fairy Tern¹	<i>Sterna nereis</i>		July to September
Bridled Tern ¹	<i>Sterna anaethetus</i>	✓	No record for this area
Sooty Tern¹	<i>Sterna fuscata</i>		No record for this area
White-winged Black Tern¹	<i>Chlidonias leucoptera</i>	✓	No record for this area

Source: Adapted from Commonwealth of Australia, 2000 Attachment 7)

Species listed in bold have been recorded at Point Maud (Meyer, 2001)

¹ Recorded by Keeling and Parker (1986) seaward of the outer reef and thus likely to be in Commonwealth waters.

² Listed as Migratory Species under EPBC Act 1999.

³ Listed under JAMBA but not as a Migratory Species under the EPBC Act 1999.

⁴ Species has recently been separated into two.

Three seabirds occurring in the NMP are listed as Threatened under the EPBC Act. The Yellow-nosed Albatross is known from the area (CALM 1997). This species has recently been separated into two distinct species, the Indian Yellow-nosed Albatross (*Thalassarche carteri*) and Atlantic Yellow-nosed Albatross (*Thalassarche chlororhynchus*). The Indian Yellow-nosed Albatross is listed as Threatened (Vulnerable). Both species have the same general distribution and occur off the southern Australian coast, northwards to about Shark Bay and are seasonal visitors to Western Australian seas between January and November but do not breed in the area (Burbidge, Johnstone & Fuller 1996).

The Soft-plumaged Petrel (*Pterodroma mollis*) is listed as a Threatened (Vulnerable) species under the EPBC Act. There is no record of the Soft-plumaged Petrel occurring at Mauds Landing. This species is a visitor to Western Australian seas northwards to areas north of NMP between March and September but is most common off southern and western continental shelves south of about the Mauds Landing area (Burbidge, Johnstone & Fuller 1996).

Southern Giant Petrel (*Macronectes giganteus*) is listed as Threatened (Endangered). This species has been recorded in the vicinity of the CCR site during monitoring of seabirds and shorebirds at Point Maud by CALM (Meyer 2001). This species is a non-breeding visitor to Western Australian seas between February to December, mostly during June to September, and is scarce to moderately common north of about Perth (Johnstone & Storr 1998).

Marine Turtles

Marine turtles are marine reptiles that are recognised internationally as species of particular conservation concern. There are six marine turtle species listed as endangered according to the 1990 IUCN (World Conservation Union) Red List of Threatened Animals. Of these, five are known to occur in Australian waters and four are known to breed on Western Australian beaches:

- Loggerhead turtle;
- Green turtle;
- Flatback turtle; and
- Hawksbill turtle.

These turtles are known occur within the NMP (Environment Australia 2001a). Leatherback turtles (*Dermochelys coriacea*) are considered to be at the extreme of their range but may occur occasionally within NMP (May, Lenanton & Berry 1983).

Aerial surveys of the NMP suggest that an estimated population of approximately 4300 turtles (all species) is resident within the Park (Preen et al. 1997). Turtle densities are extremely high at Ningaloo and exceed the highest densities recorded on the Great Barrier Reef and most of the areas in Torres Strait.

Sandy beaches within the NMP between Coral Bay and North West Cape are recognised as important nesting rookeries for predominantly loggerhead and green turtles. Approximately 6,000 hatchlings (primarily loggerhead turtles) were recorded during 2000/01 from 68 nest sites from beaches within Bateman Bay (Mack 2001).

Turtle Characteristics and Known Threats

Dobbs (2001) notes that for most species of Australian turtles, including those found in the World Heritage Areas, there is inadequate knowledge of the sizes of their populations, distributions, or the location of key foraging habitats. The management of marine turtles is difficult because of their complex ecology (Environment Australia 1998).

In presenting a draft recovery plan for marine turtles in Australia, Environment Australia (1998) identified a number of characteristics that make it difficult to manage turtles. These include, amongst others:

- they spend most of their lives in the marine environment;
- hatchlings disperse widely and follow individual migratory pathways;
- they cross many jurisdictions, national and international boundaries;
- they exhibit a complex breeding behaviours (females return to their natal beach to lay several clutches of eggs);
- hatchlings and adults are influenced by environmental cues;
- not all females nest each year;
- individuals are long-lived and slow to mature;
- they occupy different habitats at different stages of their lives; and
- they are subject to a range of impacts at different stages of their lifecycle.

Known threats to survival of marine turtles include:

- fox predation of nests;
- incidental catch in fisheries gear and shark control gear;
- ingestion of synthetic material¹;
- vessel strike;
- coastal development;
- tourism impacts;
- disease; and
- indigenous harvest of adults, juveniles and eggs for food or tortoiseshell.

¹ Plastic bags are sometimes mistaken by some marine turtle species for squid and are ingested. This often results in the formation of air bubbles within the turtles gut, resulting in increased buoyancy, greater susceptibility to boat strike and possible death through starvation.

The major impact on turtles in the Ningaloo area is loss of eggs to feral animals. (Mack 2001).

Loggerhead Turtle

Loggerhead turtles are listed as Threatened (Endangered) and Migratory under the EPBC Act. In Western Australia the loggerhead turtle appears to be the least abundant of the marine turtle occurring within Western Australian waters (Marine Turtle Newsletter 1993), and is possibly even scarcer than the Hawksbill turtle (Prince 1994a). Loggerhead turtles have a carnivorous diet that includes shellfish, crabs, sea urchins and jellyfish (Environment Australia 1998).

In Western Australia loggerhead turtles generally nest 3 times per year (late October through to early March), with nesting intervals ranging between 13 to 17 days. The mean number of loggerhead eggs per clutch is 127 (Environmental Australia 1998).

In contrast to the other marine turtles occurring in Western Australian waters, the known nesting distribution of the loggerhead turtle is one with a slightly more southerly focus. The major loggerhead turtle nesting sites in Western Australia are confined to the Lower Pilbara and the Gascoyne regions, with Dirk Hartog Island,

near Shark Bay confirmed as the single most important nesting site in Western Australia and the southern Indian Ocean. The site may accommodate in excess of 75% of all nesting adult females that occur within the Western Australian population (Prince 1998; 2001). There are few, if any, loggerhead nesting sites south of Shark Bay due to the lack of adequate nesting habitats (ie. sandy beaches).

Cumulatively, between 1993/94 and 1999/2000, 4,230 nesting adult female loggerheads were tagged from Dirk Hartog Island, Shark Bay nesting beaches (Prince 2000), with 662 of these recorded as remigrants. A further 736 nesting adult females were tagged from beaches on South Muiron Island and the beaches on the adjacent North West Cape between 1986 and 1993/94. Approximately 90% of these were from South Muiron Island between 1990/91 and 1993/94 (Prince 1998). It is probable that many of the regularly used loggerhead nesting sites in Western Australia are not currently located within existing or proposed conservation reserves.

In the vicinity of the proposed Resort, as many as 6,000 turtle hatchlings (an estimated 95% of which were loggerhead) were recorded during 2000/01 from 68 nest sites from beaches within Bateman Bay. A further 71 nests were recorded from Bateman Bay during the 1999/2000 season (Mack 2001). The locations of marine turtle nests on the lower section of Bateman Bay over the 2000/2001 nesting season is presented in Figure 7.

The number of nests represents approximately 24 adult females, less than 0.5% of the total known nesting adult female loggerhead population in Western Australia. Given that loggerhead turtles generally nests 3 times per season and provide breeding conditions are optimal, this population has the capacity to produce over 9,000 offspring per season. Loggerheads may utilise the mussel beds 3km north east of Mauds Landing, and are known to occur in significant numbers on the backreef either side of Cardabia Passage (Bowman Bishaw Gorham 1995).

Until recently, predation by foxes was responsible for the loss of up to 70% (~6,400 individuals) of the egg and hatching production of loggerhead turtles from beaches between Point Maud and Oyster Point (Prince 2001), resulting in a long standing, significant impact on the local loggerhead population. However a fox eradication program has recently been undertaken in the vicinity of Mauds Landing that is likely to result in a sharp decline in local loggerhead turtle mortality rates. Animal capture rates of foxes at nesting beaches on Bateman Bay have dropped from in excess of 50 to 34 in five years (Mack 2001). However, it is unlikely that any quantifiable change in the local adult female Loggerhead population will be detected for at least another 10-15 (Mack 2001).

As is the case for most marine turtle, the sex ratio of loggerhead turtle hatchling varies between beaches and is likely to be a function of beach temperature. Loggerhead turtles have an aversion to artificial light in the near-ultraviolet range of the spectrum (green/yellow to yellow) and, depending on the intensity of the artificial light, are less likely to become disorientated (Lutz 1996).

Green Turtle

Green turtles are listed as Threatened (Vulnerable) and Migratory under the EPBC Act. In Western Australia, green turtles are considered to be the most abundant of the marine turtle species. The green turtle has an essentially herbivorous diet, with macroalgae (seaweed etc) its primary source of nutrition. However, some juveniles of the species are known to be carnivorous (Environment Australia 1998).

In Western Australia, the approximately 20,000 adult nesting females are believed to breed annually in the North West Shelf region (Environment Australia 1998). In WA, green turtles are known to nest approximately three times per season (between late November and March) with intervals between nesting in the range of 10 to 17 days (Environment Australia 1998). The average number of eggs per clutch of is 115.

The most important nesting sites in Western Australia are centred on the sandy mainland beaches of the North West Cape – NMP area, the Muiron Islands, Serrurier (Long Island), the coastal areas of Barrow Island, some of the Monte Bello Islands and some of the islands of the Dampier Archipelago (Prince 1994a). Although by far the most commonly occurring turtle within the NMP, very few adult females (< 5%) are known to breed on the sandy beaches of Bateman Bay, to the immediate north of Coral Bay (Mack 2001).

Between 1986 and 1997, the Western Australian Marine Turtle Project (WAMTP) tagged and released 11471 nesting adult female green turtles in Western Australia. The principal breeding rookery is on Lecepede Island, to the north west of Broome where 5171 adult females were tagged. Detailed observations of mainland rookery sites within the NMP – North West Cape area have only ever been made over the 1988/89 and 1989/90 seasons (Prince 1998). Over 4,000 nesting adult female green turtles were tagged from the North West Cape – Muiron Islands. No green turtle nesting sites are known from Dirk Hartog Island near Shark Bay (Prince 2001).

Tagged green turtles have an annual mortality arising from hunting of the order of 1-2%, although an under reporting of captured tagged turtles has been reported. It has been suggested that very few green turtles are taken by Aboriginals in Western Australia, with half of those tagged on Lacepede Island nesting sites reported taken to date have actually been taken by Aboriginal people in the Northern Territory (Kowarsky 1982).

Studies of green turtles hatchlings have indicated that they are strongly attracted artificial light in the near – ultraviolet (yellow) region of the spectrum (Lutz 1996). Hatchlings often become disorientated by an artificial light source, and dependant on the intensity may mistake for the sea.

A substantial, regionally important nesting population of green turtles are dependant on Western Australian rookeries for their ongoing survival (Limpus 1982). Only one or two green turtles are known to nest on Bateman Bay beaches.

Flatback Turtle

The Flatback turtle is listed as Threatened (Vulnerable) and Migratory under the EPBC Act, and in Western Australia is probably the next most abundant breeding species of marine turtle after the green turtle (Marine Turtle Newsletter 1993). Flatback turtles are carnivorous, feeding mostly on soft bodied prey such as sea cucumbers, soft corals and jellyfish (Environment Australia 1998).

In Western Australia, the nesting period for Flatback turtles is generally between November and February (with records of nesting during the July-August period in King Sound (Prince 1994b)), with intervals between nesting ranging between 13 to 16 days. The mean number of Flatback eggs per clutch is 54 (Environment Australia 1998). It may nest alone or in mixed species groups (Prince 1994b), which may account for the relatively small number of known nesting sites.

In Western Australia, Flatback turtle nesting is typified by widespread use of scattered beaches on both near-shore and offshore islands and on the mainland (Prince 1994b). Very few observations of the Flatback turtle have been reported at sea, with those made generally associated with nearby nesting sites. The majority of rookeries and nesting sites centred off the south-western Pilbara Coast (south west of Cape Thoun and the eastern coast of Barrow Island), with smaller rookeries identified in King Sound and the Cambridge Gulf in the Kimberley region. There has been no confirmation of Flatback turtles having been recorded from south of the Exmouth Gulf area (Prince 1994b). Between 1986 and 1997, only around 1000 nesting adult female Flatback turtles have been tagged and released in Western Australia, 560 of which were from south west of Cape Thoun and 181 from Rosemary Island in the Dampier Archipelago (Prince 1998).

Hawksbill Turtle

Hawksbill turtles are listed as Threatened (Vulnerable) and Migratory under the EPBC Act. They occur worldwide and are found in tropical and warm temperate water (Environment Australia 1998). In Western Australia, though not abundant, it appears to be a regular visitor to areas to the north of Shark Bay, with breeding sites centred on the Pilbara region islands (Marine Turtle Newsletter 1993). The Western Australian population is the only large population of the species remaining in the Indian Ocean (Environment Australia 1998).

The diet of the Hawksbill turtle is comprised primarily of sponges, although the species has been known to feed on seagrasses, algae, soft corals and shellfish.

In Western Australia, Hawksbill turtles usually nest 3 times per year between August and November at 15-day intervals. The average number of eggs per clutch is 130 (Environment Australia 1998).

Hawksbill turtle nesting sites are often difficult to detect and those known are centred on the Pilbara islands (Dampier Archipelago to Monte Bello group) and northern Gascoyne including some NMP – North West Cape beaches. There has been some difficulty in the detection of nesting sites possibly due to extended seasonally diffuse nesting patterns. Since 1986, 1050 nesting adult female Hawksbill turtles have been

tagged on Rosemary Island, with another 304 from Varanus Island. The nesting locations from the NMP – North West Cape beaches area are thought to involve very few nesting adult female Hawksbill turtles (Prince 1998). Hawksbills are generally located in the deeper water seaward of Ningaloo Reef (Bowman Bishaw Gorham 1995)

Leatherback Turtle

The leatherback turtle (*Dermochelys coriacea*), the largest of the turtle species, also has the most widespread distribution. They are listed as *Special Protected Fauna* under the Western Australian Act (Environment Australia 1998).

Although not reported from Ningaloo Reef, the leatherback is a likely regular, non-nesting migrant visitor to Western Australia (Prince 1994a) and the study area is within its assumed distribution and occasional individuals may occur in the study area (May, Lenanton & Berry 1983). Between 2 to 6 sightings of the leatherback are recorded off the north west coast each year, with an occasional individual caught in lobster float lines in the south west of the state. These populations are likely to be dependent on breeding locations outside of Western Australian waters.

Other Marine Reptiles

Aside from the four species of marine turtle that may occur from waters adjacent to Mauds Landing, other marine reptiles potentially occurring include several species.

Sea snakes are not common inhabitants of Ningaloo Reef but occur as occasional visitors. Sea snakes are typically tropical and are much more common north of North West Cape. Nine species of marine sea snakes from five genera have distributions that include Exmouth Gulf or further south (Storr, Smith & Johnstone 1986). Any of these species could possibly be encountered near Point Maud, although usually in the offshore waters.

Sharks and Rays

The Ningaloo Reef Tract also has a diverse and abundant shark and ray population. Sharks are most common on the seaward side of the Ningaloo Reef, where whalers such as the grey reef shark (*Carcharhinus amblyrhynchos*), are often encountered on the shallow backreef. Small reef sharks such as the white tip shark (*Triaenodon obesus*), and black tip reef shark (*C. melanopterus*), are most common, although the large and harmless tawny nurse shark (*Nebrius ferrugineus*) is also often encountered.

Aggregations of small grey reef sharks and black tipped white sharks have been observed in Bills Bay over many years (Norman 1999). Up to 100 sharks has been observed displaying a close following behaviour. It has been suggested that Bills Bay is a mating and parturition area for these sharks.

The largest of the tropical sharks, the whale shark, tiger shark (*Gaeocерdo cuvie*), and the hammerhead shark (*Sphyrna* spp.), are also present.

Whale sharks congregate at Ningaloo on a seasonal basis and as a consequence have been subject both to tourist and scientific interest (Taylor 1997; Davis et al. 1997; Taylor & Pearce 1999). The whale sharks move from offshore waters into the NMP where they congregate from March to May each year when corals undergo mass spawning. Peak numbers of whale sharks occur about two weeks after the coral spawning. It is believed that the release of massive amounts of coral larvae, and the synchronised spawning of other marine species, is utilised by the zooplankton as a food source. The zooplankton then undergoes rapid population growth and provides an abundant and rich food source for the planktivorous whale sharks.

The location of the main aggregation of whale sharks within the NMP varies from year to year and may not occur at all in the northern part of the Park in some years. It is believed that the amount of coral spawning may affect the location and numbers of the whale shark congregations. Between 200-400 whale sharks, believed to be mostly juvenile males, can occur in the Park. The whale sharks mainly occupy the turbulent waters along the outer edge of the reef front where the current is flowing northward (the Ningaloo Current). The locations of whale shark interactions in the vicinity of the proposed action, drawn from CALM records, is shown in Figure 8.

Whale sharks are the subject of immense tourist interest (Davis et al. 1997; Norman 1999). The whale shark tourist industry has developed into a major tourist attraction. Regulations control boat activity and diver access in the vicinity of whale sharks, and it is recognised that modifications to the regulations are ongoing as the needs of the whale sharks are recognised. Nevertheless, in the past, there have been instances of boat contacts with whale sharks (blue antifouling paint marks on the whale sharks, propeller damage to fins), and some whale sharks, particularly previously injured animals, avoiding boats (Norman 1999).

The Ningaloo Reef Tract also supports a diverse and abundant ray population. These include the giant manta ray (*Manta birostris*), large black ray (*Dasyatis thetidid*), black-blotched stingrays (*Taeninura melanospila*), and small rays such as the blue-spotted stingray (*D. kuhlii*), and the blue spotted fantail stingray (*T. lymma*). During aerial surveys undertaken in 1989 and 1994, manta rays were common in the northern half (Point Cloates to North West Cape) of the NMP (Preen et al. 1997). Manta rays are most often encountered immediately outside the Ningaloo Reef and appear to be more common in autumn. Other rays occur throughout the Ningaloo Reef Tract from deep offshore waters to shallow near shore waters (Bowman Bishaw Gorham 1995).

Fish

The Ningaloo Reef Tract supports extremely diverse populations of reef fishes including many tropical species that are at the southern limits of their range and subtropical species that do not extend further north. Ayeling and Ayeling (1987) and Hutchins (1994) have undertaken surveys of species presence and abundance within the Ningaloo Reef Tract.

Point Cloates is considered to be the northern extent of the subtropical fish' distribution (Allen & Swainston 1988). An example of this is the baldchin groper, *Choerodon rubescens*, which is prolific at the Houtman Abrolhos, common on the

reef flats and deeper slopes south of Point Cloates, but very rare north of Point Cloates.

The fish fauna that is found in the Mauds Sanctuary Zone is composed of a mixture of warm-temperate, subtropical and tropical species. According to Hutchins (1994) there are 307 fish species found within lagoonal areas and on the reef to a depth of approximately 20m. Pelagic fish beyond the reefs are not included, but would certainly increase species numbers. Most of the species recorded are tropical (91%) with subtropical species making up a further 7%.

One factor thought to be responsible for the high diversity of reef fishes occurring along the Ningaloo Reef is the proximity of the continental shelf and the influence of the Leeuwin Current. The continental shelf is closest to mainland Western Australia along the Ningaloo Reef and the south-flowing Leeuwin Current directly affects the reef communities. Numerous fish occur at both the Rowley Shoals and Ningaloo Reef that have not been found at other inshore tropical locations of Western Australia. This would suggest that fish populations at Ningaloo Reef are augmented by recruitment of fish larvae from the Rowley Shoals (Hutchins 1994).

In the Mauds Landing area, fish numbers are greatest on the shallow energetic areas of the outer Ningaloo Reef. Large numbers of fish are also found in association with the shallow, coral environments of the Ningaloo Reef backreef, particularly at the diverse coral community 9km north of Mauds Landing. In these areas wrasse (Labridae) and the smaller reef fish such as damselfishes (Pomacentridae), gobies (Gobiidae), and cardinalfishes (Apogonidae), are the most common and diverse groups. The most common of the larger or more spectacular fishes include the parrotfishes (Scaridae), surgeonfishes (Acanthuridae), and butterflyfishes (Chaetodontidae). A major recreational catch survey was completed for the Gascoyne Region (FWA 1999) and a fisheries environmental management review completed (FWA 2000). The results of these studies are further discussed in section 4.3.5.

The pavement habitats near Point Maud and north-east of Mauds Landing support a relatively impoverished fish fauna, with turf algae eating fishes such as parrotfishes and surgeonfishes being the most common. The bare sand substrates surrounding Mauds Landing have a very depauperate fish population, with occasional schools of pelagic fishes such as trevally (Carangidae), and mullet (Mugilidae), being the most frequently encountered.

Marine Invertebrates

The Ningaloo Reef Tract supports a very diverse range of marine invertebrates, the majority of which are tropical species. Molluscs are particularly abundant and the most investigated of the marine invertebrate groups. They occur in all marine and intertidal habitats present near Mauds Landing ranging from only occasionally inundated or splashed beach rock, to submerged sand plains and coral reefs.

Molluscs on the intertidal platforms include the periwinkles (Family Littorinoidea), and limpets (Families Acmaeidae and Patellidae) in the upper intertidal zones, and oysters (*Saccostrea* spp.) at the midtide level. The platforms 4km north of Mauds Landing have particularly well developed *Saccostrea* communities, hence the local

name of "Three-Mile Oyster Reef". The deeper pavements support numerous browsing and carnivorous molluscs such as cerithids and mitras and at times filter-feeding bivalves. The most notable such community is the mussel bed (*Brachidontes* sp.) located 3km from Mauds Landing.

Coral reefs provide a great range of habitats and support a varied molluscan fauna. These range from the large clams (*Tridacna maxima*) interspersed among the corals, to tiny muricids within the dead coral branches. The most ecologically important of the molluscs on coral reefs near Mauds Landing is the coral eating gastropod, *D. cornus*. This snail has occurred in large numbers on coral reefs throughout the Ningaloo Reef, resulting in significant reductions in live coral cover. The marine substrates closest to Mauds Landing are bare sands, and molluscs are expected to be the dominant fauna of the submerged plains. Bivalves of the genus *Donax* are ubiquitous in lower intertidal beach sands and are expected to occur at Mauds Landing along with polychaete worms.

Wells (1980) reported that about 433 species of mollusc had been identified along Ningaloo Reef prior to 1978. The range of habitats available for molluscs and the position of Ningaloo Reef as a biogeographical cut-off zone would suggest that this is a conservative count and many more species probably occur.

Crustaceans are a second important component of the invertebrate fauna of the Point Maud region. Most of those present are inconspicuous, being small and nocturnal. The most impressive of the crustaceans occurring in the vicinity of Mauds Landing is the Panulirid decapods better known as crayfish. Three species occur near Mauds Landing; the western rock lobster (*Panulirus cygnus*), which is most common; the green cray or painted rock lobster (*P. versicolor*), which occurs sparsely in coral communities; and the painted cray or ornate rock lobster (*P. ornatus*), which is rare in the area.

The most common crustacean at Mauds Landing is the ghost crab, (*Ocypode ceratophthalmia*), that inhabits the high intertidal beach zone. These crabs are nocturnal, and venture into the sand dunes to forage at night.

The third major group of mobile invertebrate found in the Mauds Landing area are echinoderms, which include the starfish (Asteroidea), sea urchins (Echinoidea), feather stars (Crinoidea), brittle stars (Ophiuroidea) and sea cucumbers (Holothurioidea). Ninety species of echinoderm, representing 56 genera, are reported as occurring along Ningaloo Reef (Marsh & Marshall 1983). Like the molluscan fauna, these are mainly tropical species, many of which are near their southern distribution limit. Common and conspicuous echinoderms found on the reefs near Mauds Landing include the blue starfish (*Linckia laevigata*), and the black holothurian (*Holothuria atra*).

Condition of the Marine Environment

The NMP is in a largely pristine condition. Human activities since European colonisation have largely left the marine environment unaffected. However there have been localised disturbances that have impacted on water quality and have direct

impacts on biota. These include both natural disturbances and, on a more local scale, human induced disturbances such as fuel spillages near boat ramps (FWA 2000).

Anthropogenic and Natural Disturbances

A variety of natural disturbances to marine environments have been documented over recent decades as knowledge of marine environments has been gained. For Ningaloo, *D cornus*, a predatory snail that feeds on corals, became extremely abundant in the early 1980's and devastated coral populations along the Ningaloo Reef (Osborne & Williams 1992). In 1989, a massive synchronised spawning of corals in association with calm oceanic conditions caused anoxic conditions to occur in Bills Bay (Simpson, Cary & Masini 1993). Due to the large concentration of organic material and the subsequent breakdown of that material, substantial mortality of corals occurred. Such events are believed to occur periodically in tropical northwestern Australia. Substantial recovery of corals in Bills Bay and surrounding areas is noticeable (Grubba & Cary 2000).

Human influences have also caused some localised effects on parts of the NMP. Former human activities include a whaling station that previously operated at Norwegian Bay, a turtle factory that was located at Coral Bay until the late 1960's and professional fishing, including rock lobsters, which occurred throughout the Park. The effects of these activities tend to be transitory in nature with whale numbers now recovering along the Western Australian coast and high turtle numbers being present at Ningaloo.

Following the declaration of the Ningaloo Marine National Park, human activities are now regulated and more controlled. The major human influences presently existing in the vicinity of Mauds Landing (Monks Head to Bruboodjoo Point) is the Coral Bay settlement and increased access to the reef provided for tourists.

Point Maud was originally the site of a jetty constructed for exporting produce from the inland grazing industry. While the jetty no longer remains, traces of elevated chemicals are present and may represent residual contamination from the historical commercial activities (DEP 1995). These include chromium, iron, manganese and zinc which were elevated above levels at a nearby site, but not significantly high, and arsenic, cadmium and TBT which were above the DEP (1995) criteria for high levels of ecosystem protection (E2) (DEP 1996).

While human activities are now regulated in the marine park, some effects on the marine environment have been recorded. The Coral Bay settlement has been identified as the source of some contaminants in Bills Bay (DEP 1995). These include zinc and iron which may have been slightly elevated compared to nearby area, and arsenic cadmium and particularly TBT which were elevated above the criteria (DEP 1996) for high levels of ecosystem protection (E2) (Pearce 1990).

As described in Section 3.1.4, nutrients have also been identified as contaminants of Bills Bay (DEP 1995). The source of the nutrients is the groundwater from the Coral Bay shoreline, and ultimately sewage from the Coral Bay settlement. Elevated nutrient levels in Bills Bay are believed to have caused increased phytoplankton growth, light attenuation through the water column and algal growth. While the

ecosystem within the NMP is adapted to low nutrient levels, excess nutrients may possibly change the functioning of the ecosystem and the dominance of corals in the vicinity of the Coral Bay area.

Additionally, the presence of several large charter boats, up to 18m in length, swinging on their moorings in shallow areas of coral, and the practice of mooring commercial and private boats near or onto coral colonies has substantially affected coral communities adjacent to the shore line at Coral Bay. Typical mooring practices in Bills Bay adjacent to the Coral Bay settlement is shown in Plate 2. While the area affected is very localised and does not represent a substantial component of the total coral area in Bills Bay, it is the most safely accessible area of coral available from the Coral Bay Beach.

The boat mooring area for charter boats at Coral Bay is isolated from desirable fishing and diving locations by the large area of corals in the shallow waters of Bills Bay. The exit to Coral Bay is via a channel heading south, close to, and parallel to the shoreline, and then along a channel inside the barrier reef heading north. Accidental damage to corals during low tides, either from contact or prop-wash is unavoidable and undesirable. There is also likely to be damage to corals from boats anchoring in coral areas and not using appropriate moorings.

Fishing, with limitations, is allowed in most of the marine park but not in the designated Sanctuary Zones. Fishing will affect the abundance of some species of fish. Additionally, some people may ignore or not fully comply with the fishing restrictions.

Human activity also presents a threat to human users of the marine park. The unique feature of Coral Bay is that a coral reef is accessible to snorkellers based on the beach, yet the snorkellers have to negotiate boat traffic to arrive there. The presence of a boat channel for both charter boats and smaller private boats presents a danger to snorkellers who swim out to the coral reefs to the south of Coral Bay and in the mooring area.

Nutrients and Ecosystem Processes

Very little is known about the processes that have produced the present Ningaloo ecosystem. As is characteristic of the total west coast of Western Australia, the marine waters at Ningaloo have very low ambient nutrient levels. There does not appear to be an offshore supply of nutrients resulting from upwelling (Taylor & Pearse 1999). Input of nutrients into the Ningaloo ecosystem is possibly through the groundwater system from a hinterland that is also low in nutrients or from coastal currents. Possibly periodic riverine floods of the Minilya and Gascoyne Rivers to the south provide nutrients into the coastal waters. The northern flowing coastal currents could then transport them into the Ningaloo region.

The northward flowing Ningaloo Current and the further offshore Leeuwin Current (and eddies between the two) help to trap nutrients and plankton within the Ningaloo system, thereby reducing loss of nutrients (Taylor & Pearse 1999; D'Adamo & Simpson 2001). Nutrients can be lost from the system through offshore movement of

suspended/dissolved materials and plankton or migration of pelagic species that spend some time feeding at Ningaloo (whale sharks, anchovies, pelagic fish).

The baseline establishment field survey for this report (Appendix 4) did not reveal any obvious nutrient sinks within the Moncks Head to Bruboodjoo Point area where large quantities of nutrients have accumulated (such as organic sediments). Commonwealth of Australia (2000) notes the presence of organic sediments on the seabed of the continental slope.

As a result of the low ambient nutrient conditions, corals largely dominate the Ningaloo ecosystem. Macroalgae do occur in patches, but the only extensive area near this proposal is restricted to a patch approximately 10km north of Point Maud. A short algal turf, while not having a large biomass, probably covers much of the hard substrate in coral reef areas and is a significant contributor to primary productivity. Seagrasses also occur at low density north of Point Maud, and again are an indicator of low ambient nutrient conditions. Corals, with symbiotic algae contained in their tissues, macroalgae, algal turf, coralline algae and seagrasses are the major primary producers in the Ningaloo ecosystem. The importance of fleshy macroalgae and seagrasses in tropical areas as food for turtles has been widely noted (Environment Australia 2001b).

Nutrient levels determine the balance between coral and macroalgal dominance (Hatcher 1988). High nutrient levels result in macroalgae becoming dominant whereas corals thrive where nutrients are in short supply. Changes in nutrient levels are believed likely to change the balance between algal and coral dominance.

Secondary producers, or consumers, are abundant in the Ningaloo ecosystem. Herbivorous fish are in extremely high abundance in reef areas and maintain the algal turf in short condition. Grazing invertebrates such as sea urchins and molluscs also prevent excessive growth of algae. Large herbivores such as dugongs eat seagrasses and turtles consume macroalgae.

Predators, as typical of a tropical ecosystem, are also present in high abundance and diversity. The major group of invertebrate predators is probably the corals that derive part of their energy by trapping plankton. Other predatory invertebrates include molluscs such as whelks and octopi, and crustaceans such as the mantis shrimp. Predatory fish such as cod, groper, snapper and sharks are extremely abundant. Other vertebrate predators include some species of turtles as well as dolphins.

Pelagic planktivorous species form another major group of consumers. These include both whale sharks and manta rays. At Ningaloo the period after coral spawning in April appears particularly attractive for these species. Thus while nutrients appear in short supply within the Ningaloo Reef, the area supports an extremely diverse, abundant and productive ecosystem.

3.3 Social Environment

A review of human usage in NMP is provided in Cary et al. (2000).

3.3.1 Land Uses

The 250ha of land that comprises the Mauds Landing Townsite are currently Vacant Crown Land that was gazetted as a townsite in 1896. The land is undeveloped and though no longer part of the pastoral lease of Cardabia Station, has been used for grazing purposes until relatively recently. Until its closure in 1947 as a coastal port, Mauds Landing served many local pastoralists both in the provision of supplies and shipment out of the area of various goods, predominantly wool. Little remains of the Mauds Landing jetty, nor physical evidence of its former occupation in more recent times by commercial fishermen. A low-grade light aircraft strip is situated to the immediate south of the townsite boundary.

Access to both the airstrip and Mauds Landing is along gravel roads with a small, unsealed parking area being located in the vicinity of the old jetty. The most commonly used off road vehicle access track to the beach at Bateman Bay is shown in Figure 9. The beaches at Mauds Landing are principally used for fishing and beach walking, and access to the beach by four-wheel drive vehicle is unrestricted. The beaches northward from Point Maud are heavily used by four-wheel drive and off road vehicles, largely for the purposes of gaining access to preferred fishing locations. Informal or 'wild' campsites are common on the coast between Mauds Landing and Bruboodjoo Point, with up to 57 being identified by CALM in this area, during aerial surveys.

An access track is also available to Maud Hill.

3.3.2 Existing Visitor Numbers

There are approximately 477 legal accommodation units in Coral Bay. Ministry for Planning statistics (Ministry for Planning 1995) indicates the following occupation rates for relevant classes of accommodation units:

- short stay residential – caravan and tents, 2 people per unit;
- backpacker accommodation – 1 person per unit;
- chalets and villas – 2.54 people per unit; and
- permanent residents – 2.54 people per unit.

An estimate for the legal upper limit for population of Coral Bay is 1212 persons based on the conservative application of 2.54 people for each of the 477 living units.

Peak usage however is estimated to exceed this number. The daily population in Coral Bay at peak times during school holidays and Easter is approximately 2500 people (Ministry for Planning 1996), although daily figures of up to 4000 people, and an annual average of 46,000 for 1999 have been identified (Cary et al. 2000).

No site data is available for overnight/short stay residential accommodation in Coral Bay. However one of the caravan parks identified an increase of 40% for first time visitor arrivals between 1994 and 1999 (Cary et al. 2000).

Estimates of visitor numbers have been made and are based on the observations of tourism operators, residents and government agency representatives residing in or regularly visiting Coral Bay. These estimates are provided in Table 10, and presented in Figure 10.

Based on these estimates, Coral Bay provides about 605,000 bed nights annually, at an average occupancy of 3.5 people in each living unit.

TABLE 10
ESTIMATED TOTAL SITE NIGHTS (2001 AND PROJECTED TO 2009) –
CORAL BAY AND INFORMAL CAMPSITES TO BRUBOODJOO POINT

Month	Coral Bay 2001 (est)	¹ Coral Bay (maximum)	² Total Camps (persons)	Predicted Total Maud Region (2001)	³ Predicted Total (2009)
Jan	945	1212	64	1009	1362
Feb	750	1212	26	776	1047
Mar	750	1212	26	776	1047
Apr	2415	1212	129	2544	3434
May	1560	1212	26	1586	2141
June	1560	1212	26	1586	2141
July	2850	1212	129	2979	4021
Aug	1560	1212	26	1586	2141
Sept	1560	1212	26	1586	2141
Oct	1845	1212	103	1948	2630
Nov	750	1212	26	776	1047
Dec	2415	1212	64	2479	3347
Averages	1580	1212	56	1636	2208

Notes

- ¹ Assumes Coral Bay visitation commensurate with the number of official accommodation units available (477), and using conservative industry beds of 2.54 persons per unit (Ministry for Planning 1995). Planning approval was given for a further 60 additional backpacker units (1 person per unit) during 2000. Projected totals in 2009 include 60 additional people.
- ² Estimated camp occupancy north of Coral Bay to Bruboodjoo Point.
- ³ Predicted on a flat increase of 5% per annum above 2001 estimates.

3.3.3 Boat Utilisation of Bills Bay

Coral Bay is a popular access point to the central portion of the NMP.

The Department of Planning and Infrastructure has referred a proposal to establish a boat launching facility at North Bills Bay to the EPA to provide an alternative to current boat launching and mooring in South Bills Bay. A marine traffic study was undertaken to quantify existing and potential marine traffic (including swimmers) as an aid to the evaluation of the most appropriate site for the boat ramp. The study combined community survey and counts.

Count data indicated up to 30 boats anchored or moored in Bills Bay during the survey period (in part coinciding with school holidays), with up to 46% of all boats

active outside of Bills Bay (Gascoyne Development Commission 1999). No count was made of boats launched over the beach between survey times. Simpson (2001) advised that over 60 recreational boats moored or anchored during peak periods, with a further 15 commercial vessels operating from Coral Bay. These include two licensed whale shark boats, nine charter vessels and three coral viewing vessels.

Observations were made on recreational and commercial boat numbers present at Coral Bay and surrounding informal campsites during the Easter school holidays 2001 and non-holiday periods following. The following counts were undertaken and results tabulated:

- foreshore counts - boat trailers and boats at anchor/on the beach, including car-toppers obviously in use;
- caravan park empty - boat trailers and car toppers obviously in use parked in the caravan park and other public places (road verges);
- caravan park loaded - boats on trailers and loaded car toppers each parked in the caravan park and other public places (road verges);
- informal camps - count of informal camps along Bateman Bay, including boats (principally car toppers/light trailed craft either on the car, in the camp or on the beach; and
- moored boats - boats either at a formal or temporary mooring, or beached.

The following assumptions were made:

- total boats - summed empty trailers and car-toppers either on the beach, caravan parks or public areas, less moored non-commercial boats; and
- total boats in use - summed empty trailers and car-toppers either on the beach, caravan parks or public areas, less one half of moored non-commercial boats.

Averages and summary boat data is presented in Table 11. Observations on weather and approximated visitor numbers are also provided. The weather was conducive to boating, particularly in the morning.

On the limited data collected in April and May 2001, on average 98 private boats were present during the school holiday period, of which 46% were in use at 0800, and 28% in use at noon. During non-holiday periods, boat utilisation increased to 57% and 44% at 0800 and noon respectively, although on a much reduced number of boats (about 39). About 13 commercial boats were observed operating during the review period.

Potential impact of boat use in the marine park can include:

- physical injury and disturbance to wildlife;
- hydrocarbon losses during fuelling and boat operation;

- nutrient enrichment due to discharge of sewage;
- damage to coral reef and other benthic biota due to anchoring activities, boat groundings and suction; and
- foredune and beach erosion (launching and retrieving).

The Gascoyne Development Commission (1999) also noted that the beach adjoining Bills Bay east of the boat mooring area was the most popular for beach goers at almost any given time of day, approximately doubling those south of Fletchers Hill, the coastal promontory west of the Coral Bay settlement. Over the period surveyed (three days between 25 August to 21 September 1999), an average of 134 swimmers were recreating on the Bills Bay beach east of the boat mooring area at midday. Numbers reduced to an average of 98 at 2pm, rising to an average of 107 at 4pm. Recreational use of the beach south of Fletchers Hill peaked at 4pm on the days surveyed averaging 68 swimmers.

TABLE 11
AVERAGE NUMBER OF BOATS OBSERVED AT CORAL BAY DURING HOLIDAY AND NON-HOLIDAY PERIODS,
SELECTED DAYS APRIL AND MAY 2001

	FORESHORE				CARAVAN PARK (trailers/roof empty)				CARAVAN PARK (boats on trailer)				INFORMAL CAMPS		MOORINGS		TOTALS (BOATS)		
	cartop	<5.5m	>5.5m	total	cartop	<5.5m	>5.5m	total	cartop	<5.5m	>5.5m	total	total camps	total boats	total	Comme- rcial	All	in use	% in use
Ave holidays	6	20	5	31	2	2	3	7	11	16	8	34	21	17	31	9	98	37	37
Ave non holidays	1	6	2	9	1	1	0	2	6	6	2	14	6	5	12	10	39	20	50
ave hols 0800	7	25	6	38	3	2	3	8	9	11	7	27	21	16	35	13	101	46	46
ave hols 1200	5	15	5	25	2	2	4	7	13	20	8	41	21	18	26	6	96	27	28
ave non hols 0800	2	7	2	11	1	1	0	2	4	5	2	11	6	5	15	12	41	24	57
ave non hols 1200	0	5	2	7	0	1	0	1	6	6	2	14	5	5	9	8	35	16	44

Date	Day	Weather	Winds 0800		Winds 1200		Description	Population Estimate
			dirn	strength	dirn	strength		
20/4/01	Holiday Fri	Hot, fine, mild night.	calm	0	NE	15km/hr	Caravan Parks full lots of informal camping	2700
22/4/01	Holiday Sun	humid, overcast	E	10km/hr	NE	20km/hr	Caravan Parks full lots of informal camping	2700
4/5/01	Post holiday	fine, clear, warm-hot	SE	10kn/hr	ENE	15km/hr	Caravan Parks 1/3 full. Few informal campsites.	800

Opportunistic observations of boat traffic during the Gascoyne Development Commission survey indicated that ninety percent of boats used the in shore channel past Fletcher Hill to depart from, or return to Bills Bay, with the majority of these (84%) passing within 25m to 100m of the shore. This area is well known for its outstanding lagoonal corals and is frequented by snorkellers wishing to view them. All respondents to the Gascoyne Development Commission survey swam or snorkelled in Bills Bay on a daily basis (Gascoyne Development Commission 1999).

3.3.4 Boat and Tour Related Activities

SCUBA diving, fishing, whale watching and snorkelling are popular activities for visitors to the NMP. Shore based turtle egg-laying and hatching tours are also seasonally popular being catered for by either self-drive 'quad' motorbikes or in 4WD vehicles. Cary et al. (2000) describes these activities.

Snorkelling activities may be private from either shore or boat, or as participants in organised snorkelling tours from either shore or boat. Snorkelling participants may have the opportunity to view and interact with a range of species within both State and Commonwealth controlled portions of the marine park. Snorkelling to view corals, reef fish, turtles, manta rays occur in shallow waters, generally within the lagoon. Occasionally dugongs are also encountered.

In the pelagic zone, snorkellers may swim with whale sharks and whale-watching tours can view humpback and other whales. Commercial operators engaged for these activities are licensed and managed by CALM.

Figure 8, based on the observations of eco-tourism operators in the Coral Bay area and CALM unpublished data (Meyer, 2001) indicates the major wildlife interaction and viewing areas in the central Ningaloo Reef area. The lines radiating out from the entrance of the proposed resort indicate distances of five, ten, fifteen and fifty kilometres which relate to reasonable travel distances for each of the boat classes cartoppers, small trailed boats of less than 5.5m length, larger trailed boats of greater than 5.5 m length, and large commercial craft respectively.

On this basis, whale and whale shark interactions, principally undertaken in Commonwealth waters, will generally be limited to more seaworthy larger trailed and moored vessels. All boat classes are capable of travel within lagoon. The locations of wildlife interaction sites within the Mauds Landing area and immediately offshore is presented in Figure 8.

Pressures on species of national importance and their support systems relevant to the proposed action include:

- physical injury and disturbance/harassment;
- environmental degradation due to hydrocarbon losses during fuelling and boat operation;
- environmental degradation due to nutrient enrichment resulting from discharge of sewage;

- environmental degradation due to sedimentation resulting from construction and boating activities;
- damage to coral reef and other benthic biota due to anchoring activities, boat groundings and propeller suction;
- damage to coral reef and other benthic biota due to SCUBA diving and snorkelling activities;
- increase in predator numbers;
- ingestion of litter; and
- foredune and beach erosion.

A discussion about the current environmental threats resulting from a number of boat and shore based activities are presented in section 4.3.5, and management strategies identified in section 4.4.

Very little data is available on visitor numbers engaged in organised boat and tour related activities operating out of Coral Bay. Numbers of visitors engaging in these activities independently either in private boat or from shore is unknown.

Estimates of visitor participation in organised boat and tour related activities have been made and are based on the observations of tourism operators, residents and government agency representatives residing in or regularly visiting Coral Bay. These estimates are provided in Table 12.

TABLE 12
SUMMARY OF ESTIMATED CORAL BAY BOAT AND
TOUR RELATED ACTIVITIES, 2001 & PROJECTED TO 2009

SCUBA DIVING	
Time of demand	Occurs all year
# boats	4 boats
places	100
boat utilisation	66 %
total divers	23100 dives
% of beds diving	3.8
additional demand to 2009	8085 to 2009
at 66% boat utilisation	490 boat trips
at 90% boat utilisation	359 boat trips
FISHING CHARTER	
Time of demand	Occurs all year
# boats	3 boats
places	47
boat utilisation	60 %
total fishing days	9870 fishers

% of beds fishing	1.7 %
additional demand to 2009	3455 fishers
at 66% boat utilisation	368 boat trips
at 90% boat utilisation	245 boat trips
SNORKELLING/ECOTOURISM EXPERIENCES	
Time of demand	all year
# boats	4 ³ boats
places	90
boat utilisation	66 %
total snorkellers	20790 ⁴ dives
% of beds snorkelling	3.4 %
additional demand	7277 to 2009
at 66% boat utilisation	490 boat trips
at 90% boat utilisation	359 boat trips
HUMPBACK WHALE VIEWING	
Time of demand	Limited to migration, up to 12 weeks
# boats	3 ⁵ boats
places	63
boat utilisation	50 %
total participants	2646 observers
% of beds viewing	0.4 % 1.9% for the 12 week period of migration
additional demand	926 (to beginning of 2009)
at 50% boat utilisation	88 boat trips
at 80% boat utilisation	55 boat trips
WHALE SHARK EXPERIENCES	
Time of demand	Limited to period following coral spawning, 10 weeks
# boats	2
places	32
boat utilisation	80 %
total participants	1792 snorkellers
% of beds snorkelling (annual)	0.3 % 1.5% for the 10 week period of congregation
additional demand	627 to 2009
at 80% boat utilisation	49 boat trips
at 90% boat utilisation	44 boat trips
BEACH TURTLE NESTING/ HATCHING EXPERIENCES	
Time of demand	Combined nesting and hatching 14 weeks
operators	3
# quadbikes/4WD places	24
utilisation	95 %
total participants	2234.4 participants
% of beds viewing	0.4 % 1.4% for the 14 week period of beach activity
additional demand	782
at 95% vehicle utilisation	additional 8 places daily

Activities for the balance of recreational use of the Ningaloo Marine National Park and adjoining lands include:

- use of headlands, dunes and beaches (for swimming, sunbathing, walking, beach fishing use of recreation vehicles and eco-tourism);
- recreational fishing targeting finfish from shore or by private boat; and
- water sports, including swimming, snorkelling and SCUBA diving from shore or from private boat, and to a lesser extent windsurfing and sailing.

4. THE IDENTIFICATION OF AND MANAGEMENT OF ENVIRONMENTAL IMPACTS

4.1 Objectives for the Ningaloo Marine Park

4.1.1 Commonwealth Waters

A draft Management Plan for NMP (Commonwealth Waters) has recently been produced (Commonwealth of Australia 2000). The draft Plan specifies the management goals and strategies for NMP (Commonwealth Waters). The goals relate to the strategic objectives of the marine park which, are:

Conservation

- To maintain the marine biodiversity of the marine park.
- To maintain key ecological processes and life support systems.

Recreation

- To provide for and manage recreational and cultural uses to the extent compatible with the conservation objectives of the marine park.

Science and Education

- To promote education, nature appreciation and scientific research on the biological, geophysical and cultural values of the marine park.

National System

- To manage the area as part of a comprehensive, adequate and representative system of marine protected areas to contribute to the long-term ecological viability of marine and estuarine systems.

4.1.2 State Waters

The principle thrust of the Government of Western Australia (1998) policy document in relation to marine conservation is

"...to have one comprehensive reserve system under the Conservation and Land Management Act".

The specific objectives of the marine conservation reserve system, as stated in *New Horizons - The Way Ahead In Marine Conservation and Management*, (Government of Western Australia 1998) are to:

- preserve representative as well as special ecosystems in the marine environment; and

- put a formal management framework in place to ensure the various uses of marine conservation reserves are managed in an equitable, integrated and sustainable manner.

An element of the formal management framework for marine parks is the development of Marine Management Plans in which specific pressures are identified as impacting on, or have the potential to impact on areas within the marine park.

The current Marine Management Plan for Ningaloo Reef (State waters) is being reviewed.

CALM (1989) defined the following objectives for the NMP:

1. To manage State and Commonwealth areas as one Park.
2. To integrate management and development of the Park with adjacent areas of land to achieve maximum effectiveness and optimum allocation of management resources.
3. To manage adjoining coastal land so that access to the Park is achieved with minimum disruption to the rights of adjoining landholders.
4. To conserve native species, habitats and natural processes.
5. To provide recreational opportunities and facilities that maximise the quality of experience sought by visitors.
6. To promote an appreciation and understanding of the marine environment and sites of cultural significance in the Park, through information, interpretation and education.
7. To manage recreational and commercial fishing without adversely affecting fish populations.
8. To provide for tourism, to the extent consistent with maintenance of resources.
9. To ensure that all development and activities are consistent with the maintenance of species populations, habitats, natural features, and cultural and scenic values.
10. To conduct research programs aimed at understanding how impacts of use and natural processes affect the maintenance and management of the Park.

The Western Australian EPA has further identified the following objectives for Ningaloo Reef in relation to this proposal (EPA Guidelines in ATA Environmental 2000b):

- i) Maintain the ecological function, abundance, species diversity and geographic distribution of marine flora and fauna, locally and regionally.

- ii) Maintain the integrity, function and environmental values of Ningaloo Reef and foreshore area.
- iii) Demonstrate that the environmental values of Ningaloo Reef and NMP will not be compromised by this proposal.

The combination of these stated objectives forms the framework against which additional pressures brought about by implementation of the action will be assessed.

FWA is responsible for the management of the State's fish resources and pearling industry. It is also responsible for the majority of fish resources within the Western Australian sector of the Australian Fishing zone through arrangements with the Commonwealth Government.

FWA is given power to manage the State's fish resources through *the Fish Resources Management Act 1994*. The legislation allows FWA to:

- i) manage commercial fishing, recreational fishing and aquaculture;
- ii) supervise fisheries activities;
- iii) conserve and protect fish stocks; and
- iv) establish Fish Habitat Protection Zones.

4.2 Management of Pressures within the Marine Park Area

Marine Protected Areas (MPA's) are declared to protect and maintain biological values and ensure ecological sustainability while keeping human use options open (Davis & Tisdell 1995). These objectives can be achieved providing integrity, function and environmental values of the impacted MPA can be sustained, and obligations met in relation to protecting species of national environmental significance.

4.2.1 Strategy for the Control of Impacts.

CALM (2000) notes that an important step in maintaining the ecological and social values of a marine park is to undertake a risk assessment that considers the range of existing and potential pressures (cf. threats) on the park's key values and their associated ecological and social implications. Risk can be assessed by considering the factors in Table 13.

TABLE 13
RANGE OF POTENTIAL PRESSURES IN A
MARINE PARK AND RESULTANT IMPLICATIONS

PRESSURE	RESULTANT IMPLICATION
<i>Temporal scale</i>	Pressures that continue over a longer time frame are often of greater concern than short-lived pressures.
<i>Spatial scale</i>	Pressures that affect a large area are often of greater concern than localised pressures.
<i>Trophic level and conservation status of the</i>	Pressures that impact on lower trophic levels (i.e. primary producers) are of greater concern than those at higher trophic levels (i.e. secondary consumers) as a result of

PRESSURE	RESULTANT IMPLICATION
<i>species affected</i>	potential cascading effects on the whole ecosystem.
<i>Probability of occurrence</i>	The greater the likelihood of the occurrence, the greater the concern.
<i>Consequences of the event</i>	The ecological or socio-economic implications and the manageability of the pressure

modified from CALM (2000)

In considering the existing uses and nature of the NMP there is only limited knowledge of factors such as fishing pressure and the response of ecotourism species to continued pressure are not well known. Further, the short-term and long-term cumulative ecological effects of these activities on the environment are not well understood.

The pressures on the park's values are either a primary (direct) or secondary (indirect) impact of user activities.

In the following information, potential impacts resulting from the implementation of the CCR have been assessed and a range of management strategies focusing on the design, location, provision of infrastructure and management programs have been incorporated in the project design.

Resort nearshore and marina waterway water quality management strategies are linked to the;

- control of construction impacts (eg. de-watering, dredge management);
- the provision of services at an inland location (WWTP and landfill);
- management of nutrient inputs to private gardens and public open spaces; and
- direction of potentially contaminated stormwater inland and away from the marina/ocean.

By ensuring high standards are maintained for inshore water quality, any impacts in Commonwealth waters will be minimised.

Direct or indirect impacts on matters of National Environmental Significance will be managed through the implementation of monitoring and resultant management strategies developed in collaboration with government regulatory agencies. These are principally outlined in a Draft Specific Area Marine Management Plan (SAMMP) proposed to be developed for the immediate impacts area surrounding the site of the action, and to include provision for the assessment of impacts on any area accessed from the proposed Marina. It is proposed that the SAMMP be incorporated as an element of the 'Ningaloo Marine Park Management Plan (State Waters)'.

4.2.2 Management of Construction Impacts

A summary of the factors that may impact on the environment as a consequence of the implementation of the CCR was presented in Table A4.

In relation to construction, the range and scale of these impacts, and accordingly their environmental significance will depend primarily on:

- the sensitivity of impacted environments;
- fauna and flora present;
- the physical characteristics of the area;
- existing water quality;
- type of material to be excavated; and the
- manner of construction.

Matters in relation to all but the final point above (manner of construction) have previously been described in section 3 of this document. This section described the manner proposed for the construction of the CCR, specifically as it relates to the management of environmental impacts.

Dredging, wave action, erosion of unstabilised dredged banks, and leaching of unconsolidated spoil mounds can increase turbidity. Siltation and suspended turbidity effects result in the burial of benthic organisms, loss of seagrass, and stress on coral reefs.

Mitigation of Construction Impacts

The potential consequences and design features/procedures proposed to mitigate these impacts is summarized in Table 14 below.

Features of the Coral Coast Resort to Mitigate Impacts

All site construction activities will be regulated through health, safety and environmental management plans to comply with the OHSAS 18001 and ISO 14001 group of standards.

In relation to site selection, the proposed development is located on a degraded salt plan behind the primary dune system. The marina entrance will pass through the dune that will otherwise remain intact and be managed for ecosystem maintenance. Existing blowouts will be stabilized, and beach access formalized. The marina has been designed to maximum advantage of the natural attributes of the site including establishment on salt flats adjoining on a north-facing beach in the lee of a significant coastal projection, access to relatively deep and generally protected waters with maximum fetch considerate of prevailing wind and weather conditions.

TABLE 14
SUMMARY OF POTENTIAL IMPACTS AND MITIGATION OF
CONSTRUCTION IMPACTS ARISING FROM THE IMPLEMENTATION
OF THE CORAL COAST RESORT

Activity	Consequence to the Environment	Potential Environmental Impacts	Potential Social Impacts	Mitigation
Project Management	• Ensure procedures and protocols are in place to minimize impacts	POSITIVE	POSITIVE	• Implement health, safety and environmental management systems to OHSAS 18001 and ISO 14001 • Implement a construction management plan
Disposal of dewatering waters	• Turbidity • Sedimentation • Smothering • Noise • Air Emissions	• Reduced water quality • Habitat loss • Elevated toxicants • Disturbance of fauna • Reduced air quality • Increased turbidity • Smothering benthic fauna	• Community impacts: - recreation; - fisheries; and - tourism	• Design and siting of the marina • Siltation controls: - Silt curtains; and - Settling ponds • Selection of techniques • Selection of equipment
Dredging/dredge spoil disposal	• Turbidity • Sedimentation • Smothering • Noise • Air Emissions	• Reduced water quality • Habitat loss • Elevated toxicants • Disturbance of fauna • Reduced air quality • Increased turbidity • Smothering of benthic fauna	• Community impacts: - recreation; - fisheries; and - tourism	• Minimisation of dredging (dry excavation) • Siltation controls: - Silt curtains; and - Settling ponds • Selection of equipment • Timing of dredging
Site preparation	• High dust load • Contaminated stormwater • Noise • Air emissions	• Soil erosion • Reduced water quality • Direct habitat destruction • Loss of flora and fauna • Disturbance of fauna • Reduced air quality	• Loss of archeological sites • Community impacts: - recreation; - fisheries; and - tourism • Aesthetics	• Design and siting to avoid sensitive areas known • Archeological material will be undisturbed • Implementation of contemporary dust management measures • Selection of equipment
Construction activities	• Dust emissions • Air emissions • Noise • Toxicants • Fertiliser/pesticides	• Disturbance of fauna • Elevated toxicants • Reduced water quality • Elevated nutrients	• Community impacts: - recreation; - fisheries; and - tourism • Aesthetics	• Noise and emission control • Timing of activities • Selection of equipment • Gross pollutant traps • Settling basins • Management and contingency plans • Bunded fuel storage and fuelling stations

Activity	Consequence to the Environment	Potential Environmental Impacts	Potential Social Impacts	Mitigation
Construction activities (continued)				• Pile driving, not jetting of piles • Site selection
Placement of breakwater stone	• Smothering • Turbidity • Habitat destruction • Noise • Toxicants • Air Emissions	• Reduced water quality • Habitat loss • Elevated toxicants • Disturbance of fauna • Increased turbidity • Smothering of benthic fauna • Interruption of coastal processes	• Community impacts: - recreation; - fisheries; and - tourism	• Noise and emission control • Timing of activities • Selection of equipment • Management and contingency plans • Bunded fuel storage and fuelling stations • Site selection

Adapted from Great Barrier Reef Marine Park Authority (1994).

Marina breakwaters will be constructed on an area comprising thin sands over pavement habitat (Figure 7), and well represented locally. About 4ha will be directly affected, however this loss will be off set by the creation of new habitats suitable for colonisation. Breakwaters are also known to attract fish into an area. No seagrasses or corals were identified during baseline surveys from the area to be disturbed. Baseline surveys included extensive diver trawls.

The marina water body and resort will be constructed using 'dry' techniques (excavation) requiring dewatering. This method will greatly minimize dredging impacts known to result in primary and secondary level effects (Great Barrier Reef Marine Park Authority 1994).

Dewatering waters will be discharged into stilling basins and the quality of overflow will be regulated through the use of silt screens.

Dredging will be limited to the opening of the channel mouth following construction of the both the marina basin, breakwaters and revetments. The method of construction and design considerations are presented in the Mauds Landing Coastal Engineering Study presented in full in Appendix 3. In relation to the marina design, the need for excavation has been reduced by locating deep draught boat access points and service areas closest to the entrance. Limited dredging will be undertaken using cutter suction techniques, with dredge spoil being deposited on the development area. Silt screens and bunds will again be used to reduce re-suspended sediments in return waters. On the basis of the Coastal Engineering Study undertaken, it is considered the need for maintenance (operational) dredging will be minimal.

Preliminary drilling in support of the geotechnical assessment of the marina site indicates that there will be no need for drill and blast. Piles will be driven into sand and soft calcarenite without a need for blasting.

Dust will be created during construction due to vehicular movement on unsealed roads and ground disturbing construction activities. Dust generated during construction will be minimised by the application of best practice in dust suppression (including vegetation retention and re-establishment; wind fencing; use of water,

organic mulches or chemical agents to stabilise disturbed areas, and watering of surfaces and rehabilitation of disturbed areas).

The Western Australian EPA Policies, Guidelines and Criteria for Environmental Impact Assessment No. 18, *Air Quality Impacts from Development Sites* is applicable to the control of dust from construction activities, and will be applied. As fine dust fractions are not produced in the construction activity located in a rural setting, other particulate management methods are unlikely to be relevant. The marina basin and construction site will be located behind the largely intact primary and secondary dune systems, and accordingly significant impacts are unlikely to occur on adjacent marine areas.

Fuel delivery and storage systems will be designed and constructed (including bunding) in accordance with Australian Standard AS1940 (Standards Australia, 1993) and requirements of the Department of Minerals and Energy's (DME) Dangerous Goods Division and the *Explosives and Dangerous Goods Act 1961*. All fuelling of construction machinery will be undertaken in a dedicated fully lined and banded fuelling station. Contingency measures will be developed in the event of any loss of bulk fuels to the environment.

Used oil will be collected and transported off-site by a licensed contractor as required.

Use of fertilizers and pesticides in the construction phase will be limited. Resort stormwater design will be directed away from the marina waterway in all but exceptional rainfall events.

In relation to noise impacts, the principal area of concern (bird roosting and loafing areas at Point Maud) occurs approximately 1.7km from the breakwater construction site. Single point calculations based on free field in noise has been carried out. Based on a measured sound power of 98dB(A) at 7m for generic earth moving plant, free field reduction in sound power will see the level reduced to an L_{A10} of about 40dB(A) within the distance to the bird roosting areas to the west of the development site. Although these daylight noise levels will be above background, they will generally not exhibit any tonal or impact components known to startle or disturb seabirds.

Breakwater material will be transported on public roads from quarries located near Learmonth to Mauds Landing and stockpiled on the southern side of the entrance channel. The breakwater material will then be moved into its final position using land-based equipment. The core material will be specifically selected to limit fines within practical specifications and so will reduce turbid plumes. The construction of the breakwaters will take about 6 to 8 months to complete, and will be programmed during daylight hours to avoid critical turtle nesting. Matters in relation to the control of dust, noise and fuel management above are also relevant to the construction of breakwaters.

4.2.3 Management of Operational Impacts

Marina runoff and the discharge of sewage from boats may affect the natural productivity of the receiving environment resulting in the death of stress due to competition to corals, algae and a range of animals. Operation of boats from the

marina can result in direct physical changes to shorelines and impacts to sensitive biota such as reefs, seagrasses waterfowl, dugong, turtles and cetaceans.

The potential for environmental impacts however resulting from the operation of a marina is a function of many variables, including marina location, design, services offered, number and type of boats served and marina management and operational performance. As a result, the potential for and degree of environmental change can vary between different marinas.

Mitigation of Operational Impacts

The potential consequences and design features/procedures proposed to mitigate these impacts is summarised in Table 15 below.

TABLE 15
SUMMARY OF POTENTIAL IMPACTS AND MITIGATION OF
OPERATIONAL IMPACTS ARISING FROM IMPLEMENTATION OF
THE CORAL COAST RESORT

Activity	Consequence to the Environment	Potential Environmental Impacts	Potential Social Impacts	Mitigation
Maritime Wastes and Effluent	- Hydrocarbons - Toxicants - Sewage effluent - Antifouling compounds	- Reduced water quality - Toxicity impacts on flora and fauna - Habitat loss - Change in ecosystem structure	- Public health risk - Community impacts: recreation; fisheries; and tourism - Aesthetic loss - Clear up costs	- Dedicated fuelling wharf with intrinsically safe dispensers - Shore side sewage collection facilities - Education - Greater enforcement capability - Emergency response plan - Containment of materials
Oil Spills	Maritime and coastal vessels cannot be supported by facilities proposed for CCR however enhanced response capability for unrelated maritime incidents will result from implementation.			
Coastal Processes	- Altered oceanographic processes - High residence times	- Beach erosion - Sand accretion - Sand transport - Habitat loss - Nutrient enrichment - Accumulation of wastes	- Public health risk - Community impacts: recreation; fisheries; and tourism - Aesthetic loss	- Predesign modelling - Design features - Foreshore and coastal management plans
Stormwater Runoff	- Sediments/organics: - toxicants - nutrients - litter	- Reduced water quality - Toxicity impacts on flora and fauna - Nutrient enrichment - Change in ecosystem structure	- Public health risk - Community impacts: recreation; fisheries; and tourism - Aesthetic loss	- Drainage control: - direct stormwater away from marina - gross pollutant traps - scheduled maintenance as per EMP

Activity	Consequence to the Environment	Potential Environmental Impacts	Potential Social Impacts	Mitigation
Land and Water Impacts 'People Pressure'	Environmental impacts resulting from urbanisation and resource depletion including impacts on ecotourism species are described in Sections 3.3.5 and 4.4.			
Solid Waste Disposal	- Leachate impacts on groundwater - Wind blown rubbish impacts on fauna - Air impacts (burning) - Feral animals or vermin	- Water quality degradation - Air quality degradation - Toxicity impacts on flora and fauna - Marine entanglement - Feral animal impacts on fauna	- Public health risk - Community impacts: - tourism - Clean up costs	- Waste management strategy - Managed landfill site remote from coast - Best practice management of landfill including: - manning - fencing - vermin control - buffer zone - litter control - operation
Liquid Waste Treatment and Disposal	- Human pathogens - Toxicants - Organic nutrients - Elevated salt	- Water quality degradation - Nutrient enrichment - Toxicity impacts on flora and fauna	- Public health risk: - effluent - vermin - Bioaccumulation - Community impacts: - tourism - fisheries - Aesthetics - Clean up costs	- Waste management strategy (away from coast) and design of plant - Evaporation, no disposal - Monitoring program and contingency - Manning
Harbour Operations	- Noise congestion - Hazardous materials	- Reduce amenity - Public safety - Reduce water quality	- Public risk - Bioaccumulation - Stress/loss of amenity	- EMS - Regulatory control - Service area requirements - Ongoing monitoring

The specification of performance standards for marina equipment will be used to minimise pollutant releases. CCMD will implement health, safety and environmental management systems to OHSAS 18001 and ISO 14001 systems, to be integrated with an environmental management plan to address all aspects of the operation of the marina and resort. This will include, amongst others, routine maintenance relating to the collection of litter, inspection and maintenance of fuel pumps and liquid waste pump-out facilities, gross pollutant traps and marina structures.

Pollutants in stormwater runoff, spills and discharges from boats can impact water quality in the marina basin during operation. These pollutants can include suspended sediments, organic and inorganic nutrients, hydrocarbons, metals and bacteria. The stormwater management system will be designed to direct stormwater away from the marina waterbody in all but the most extreme rainfall events. Silt and gross pollutant traps will be installed on all discharge points and basins. Stormwater management

will comprise a component of the Environmental Management Plan implemented for the site. The Environmental Management Plan will include education, waste minimization, first flush retention, trapping and management of wastes.

A critical element of management of the environment impacts of operating the CCR and marina is user education. In addition to identifying opportunities to reduce impacts on wildlife and flora through sensitive boat use, a focus of the program will be to inform the boating public about the potential health and environmental hazards associated with the discharge of either treated or untreated wastes into the marina basin and adjoining NMP, impacts on phosphate detergents and hydrocarbons spillage.

A fuelling facility will be provided and located on a fixed land backed wharf, and accessible without passing through the main berthing area. The fuelling facility will be connected by flexible fuel supply lines and with automatic cut-off valves and nozzles, vacuum operated pumps and dry break couplings. Fuelling will only be undertaken by or under the direction of authorized personnel. Appropriate emergency response procedures will be developed, with ready access to the fuel berth by emergency vehicles and access to clean-up equipment provided. Provision of dedicated fuelling facilities for both private and commercial boats can be offset against the current practice of filling both commercial and private boats 'over the beach' at Bills Bay from small containers.

Breakwaters and protective works are described in the Coastal Engineering Study provided in full in Appendix 3. All are designed to withstand a category 5 cyclone and incorporate an allowance for sea level rise as predicted to results from the 'Greenhouse Effect'. In comparison, it is recommended that Marinas in the Great Barrier Reef Marine Park be designed to withstand a lesser category 4 cyclone (Great Barrier Reef Marine Park Authority 1994).

Amenities to be provided at the marina include showers, toilets and basins. All amenities will be provided with consideration for ease of use by disabled persons. A marina wide onshore wastewater collection system will be constructed at a centrally located pump-out installation within the marina. Liquid wastes and, dependant on pump-out velocities, bilge water will be directed to the main sewer using differential pressures or on-board grinder pumps. No system for the collection of liquid waste is currently in use at the Coral Bay settlement.

Wastewater will be treated in the services area situated some 2km from the coastline. The services area is located in an interdunal swale that is well screened from all vantage points, and is described in section 2.4 of this document. In addition to wastewater treatment, the services area will also include power generation, a landfill disposal site, and a small cell of "industrial" land for development of support and supply facilities including satellite maintenance workshops and cold and dry storage facilities for food and other goods and equipment. This area is required to sustain both the CCR and the Coral Bay settlement, and will replace that occurring within short stay and residential areas in Coral Bay.

The services area has been sized so that it can also accommodate service and waste disposal requirements for, and offset the impacts of the existing Coral Bay settlement,

which currently treats and disposes of its liquid wastes in ponds established on secondary dunes inland from Bills Bay. Treatment of wastewater is proposed by means of either an Upflow Anaerobic Sludge Blanket (UASB) or the more traditional sewerage pond wastewater treatment system with the capacity to treat up to 575kL/day at full development. The plant capacity has been sized to cope with projected residents and visitors, including day visitors on tour, and includes provision for sewage received from a pump-out facility for boats with on-board storage. Disposal will be via sealed evaporation ponds with a gross capacity of 888kL/day, including waste.

The geology and hydrogeology of the proposed CCR site and services area has been considered and is described in section 3.1. The flat topography, near sea level elevations, and shallow groundwater depths observed beneath the salt lake flats, indicate the water table is very flat and flow rates are likely to be extremely low. Environmental Bore Logs presented in ATA Environmental (2001) indicate the groundwater at the wastewater treatment plant underlie strongly indurated sands at about 15.5m below ground level. Monitoring bores have already been established in the service area. Accordingly in the event that there is a failure of containment of effluents from the evaporation pond, movement of treated effluent towards the coast will be very slow and readily detected in monitoring bores already in place. The potential to impact on marine water quality is considered very low. Contingency plans, such as using monitoring bores to recover contaminated groundwater will be developed.

Solid waste collection and disposal services will be provided to all accommodation units within the CCR. Fish cleaning facilities (including waste disposal) will also be provided. Strategically placed and serviced rain and vermin-proof litter receptacles, convenient to boat users, will be installed and regularly emptied. A managed landfill site will be established within the services area to service both the CCR and Coral Bay settlement. This has been previously described in section 2.4. Provision of secure fencing, waste compaction and the provision of daily cover, removal of standing water and vermin eradication programs will control feral animal numbers. CCR visitors and residents will be provided with education materials in relation to the importance of correct management of litter, and appropriate signage will be provided. The potential impacts of this proposal need to be offset against the impacts of the current landfill site, established on the salt flats near the Coral Bay settlement, that does not meet the WA DEP's minimum specification.

Australian Design Regulations and various Australian Standards specify allowable noise outputs from mobile sources and fixed plant respectively. The Shire of Carnarvon has delegated powers to manage noise from one premise to another or from public places under delegation from the *Environmental Protection (Noise) Regulations 1997*, although this does not extend to mobile noise sources. Noise from the operation of certain watercraft, particularly where there is a tonal element, are known to be particularly intrusive.

As sound travels across water easily, management of noise is important to limit impacts on sensitive animal groups such as seabirds. Public education will be important in this regard. CCMD will not encourage the use of specific watercraft (jetskis and speedboats) within the marina waterbody or in Bateman Bay, particularly

in view of the presence of seabirds listed under various international agreements (JAMBA and CAMBA) on Point Maud. An area has already been set aside by CALM for recreational watercraft use off shore of Moncks Head.

Off road vehicles currently access beaches at Mauds Landing along unmade roads and informal tracks. There are many off road vehicle tracks through the primary and secondary dunes to access the beach at Bateman Bay and the most commonly used beach access track is indicated in Figure 9. As well as causing damage to coastal landforms, operation of off road vehicles are known to disturb seabirds and increase mortality amongst turtle hatchlings caught in wheel ruts when off road vehicles are used adjacent to turtle nesting areas (see figure 7). Figure 9 also identifies two prohibited areas for vehicles near Bills Bay proclaimed under the *Control of Vehicles (off-road areas) Act 1978* designated in part to protect environmental values. CCMD will support a submission for a prohibited area to vehicles at Point Maud west of the proposed CCR under the *Control of Vehicles (off road areas) Act 1978* specifically for the protection of seabirds and significant flora as indicated in Figure 9.

Implementation of the CCR will result in a physical barrier for off road vehicle movement eastward along the beach from a popular current access point at the former Mauds Landing Jetty. Off road vehicles will no longer be able to access turtle nesting sites from this beach access point. Vehicles are also known to travel along the beach in a westerly direction to Point Maud, and monitoring undertaken by CALM suggests there is some current potential disturbance of seabirds by dogs, walkers and vessels in this area. Management strategies to limit impacts from this beach access point will be identified in the Foreshore Management Plan proposed to be developed and implemented on approval of proposal. As well as identifying opportunities and techniques for the revegetation of bare sand areas and stabilisation of blowouts and sand drifts, management strategies proposed within the Foreshore Management Plan will include:

- restriction of off-road vehicles;
- rebuilding of the incipient dune where required;
- formalisation of pedestrian beach access (including fencing and signage);
- prevention of weed species invading native coastal vegetation; and
- installation of informative signage.

Following implementation, CCMD will work together with CALM, the Shire of Carnarvon and the Baiyungu Aboriginal Corporation (lessees of Cardabia Pastoral Station) to limit or exclude access to beaches from and nearby the CCR. Appropriate signage, traffic control devices and education and supplement car parks established behind the dune systems at the former Mauds Landing jetty, a site adjacent to the western breakwater, and at the northern most extremity of the development with a view to limiting vehicle access.

CCMD will support the establishment of a further off road prohibited area comprising the western portion of the townsite and beaches (see Figure 9) to reduce impacts on seabirds and protect populations of *Acacia ryaniana*, a Priority 2 Flora identified under the CALM *Declared Rare and Priority Flora List* (Atkins 2001), known from the parabolic dunes in this area. CCMD will further prohibit the operation of quad bikes from businesses within the CCR.

CCMD do not have powers to exclude beach access from areas outside the Mauds Landing townsite. The owners of Cardabia Station or CALM can only control Beach access from Cardabia Station (including the 40m strip above high water mark that constitutes a portion of NMP). CCMD will work with these parties to educate short-term visitors and residents to the CCR in relation to impacts arising from the use of off road vehicles on beaches.

4.2.4 Specific Area Marine Management Plan.

The model reported in ANZECC *Best Practice in Performance Reporting in Natural Resource Management* (ANZECC, 1997) has been used in the development of Marine Management Plans for Marine Parks in Western Australia (CALM 2000).

A similar model has been developed for the identification and management of impacts within the immediate impact area surrounding the site of the action. Should the CCR development proceed, this SAMMP will be finalised in consultation with CALM, Environment Australia and other agencies with a role in the Management of NMP. Prior to implementation the SAMMP will be made publicly available for comment.

The SAMMP defines two areas for specific management within the broader NMP. The Maud Specific Management Area (MSMA) and Development Impact Area (DIA) contained within the MSMA are anticipated to present the extent of the biological and physical changes that will result from implementation of the action respectively. However, it is clear that changes arising from greater visitation may occur outside these defined areas. The strategies within the SAMMP will focus primarily on mitigating the effects of human activities. These can be direct effects such as damage to coral habitats by indiscriminate mooring and anchoring or through localised over-fishing. Further impacts have been identified as those resulting from ecotourism experience tours on target species such as whale sharks, whales, dugong and various species of turtle. An indicative SAMMP is presented in Appendix 5, and will be finalised with Environment Australia and CALM prior to the construction or placement of any marine structure.

The SAMMP also identifies a number of pro-active strategies involving education and extension programs and active participation of resource users and the local community in the on-going management of the area. This is consistent with both Commonwealth and State objectives for the NMP.

4.3 Predicted Increased Human Usage Following Implementation of the Proposed Controlled Action

4.3.1 Land Use

The proposed action will not occur on Commonwealth lands, with the marina waterway and resort being established approximately 8kms from Commonwealth waters. It is unlikely that alterations to the physical environment associated with implementation of this proposal such as changes in landform or geomorphology will have any impact on Commonwealth waters.

However, and in relation to Controlling Provisions 23 and 24A (Commonwealth Marine Environment), there is a potential concern that implementation of the action may have a substantial adverse effect on the life history parameters of a population of a marine species and/or their spatial distribution. Important populations of a number of listed migratory and threatened species are present in the waters both adjacent to the proposed development and offshore in the Commonwealth managed area. Increased boating and usage pressure has the potential to have adverse impacts on the habitat, lifecycle (eg. breeding, feeding, migration and the life expectancy) of these listed and threatened species. The areas of possible conflict in matters of National Environmental Significance are largely a function of population pressures and increased demand for tourism services operating in State and Commonwealth waters from the proposed resort. Predictions of increased visitor numbers and likely demand on ecotourism activities are presented below.

4.3.2 Anticipated Increase in Visitation

Table 10 in section 3.3.2 presented an estimation of the total site nights for Coral Bay and informal campsites to Bruboodjoo Point. A further prediction of anticipated growth to 2009, based on estimates of increased visitation and irrespective of the implementation of the CCR concept is also provided.

It is believed that implementation of the CCR will in the first instance provide alternative accommodation for 'overflow' short stay residential visitors from the existing Coral Bay facilities and surrounding informal camps. Table 16 presents a summary of predicted Coral Bay and CCR visitor numbers following completion of the CCR, taken to be 2009.

Based on these estimates, Coral Bay and Mauds Landing combined provide a predicted 3288 bed nights daily at full implementation (2009), at an average occupancy of two people in each living unit. Data on projected site nights by month for the Coral Bay area and CCR is presented in Figure 10.

TABLE 16
ESTIMATED TOTAL SITE NIGHTS – CORAL COAST RESORT, CORAL BAY and INFORMAL CAMPSITES TO BRUBOODJOO POINT, 2009

A	B	C	D	E	F	G	H	I
Month	CORAL BAY					⁴ CCR Estimated Total (2009)	⁵ CCR New Visitors	⁶ Totals Coral Bay and CCR
	2001 (est)	¹ CB maximum 2001 (2009)	² 2001 Total Camps	Predicted total (2001)	³ Estimated Total (2009)			
Jan	945	1212 (1272)	64	1009	1362	2000	1910	3272
Feb	750	1212 (1272)	26	776	1047	1500	1724	2772
Mar	750	1212 (1272)	26	776	1047	1500	1724	2772
Apr	2415	1212 (1272)	129	2544	3434	2500	338	3772
May	1560	1212 (1272)	26	1586	2141	2000	1131	3272
June	1560	1212 (1272)	26	1586	2141	2000	1131	3272

A	B	C	D	E	F	G	H	I
Month	CORAL BAY					⁴ CCR Estimated Total (2009)	⁵ CCR New Visitors	⁶ Totals Coral Bay and CCR
	2001 (est)	¹ CB maximum 2001 (2009)	² 2001 Total Camps	Predicted total (2001)	³ Estimated Total (2009)			
July	2850	1212 (1272)	129	2979	4021	2700	0	3972
Aug	1560	1212 (1272)	26	1586	2141	2000	1131	3272
Sept	1560	1212 (1272)	26	1586	2141	2000	1131	3272
Oct	1845	1212 (1272)	103	1948	2630	2500	1142	3772
Nov	750	1212 (1272)	26	776	1047	1500	1724	2772
Dec	2415	1212 (1272)	64	2479	3347	2000	0	3272
Averages	1580	1212 (1272)	56	1636	2208	2017	1091	3288

Notes:

- ¹ Assumes Coral Bay visitation commensurate with the number of official accommodation units available (477), and using conservative industry beds per class of accommodation (Ministry For Planning 1995). Approval was given in 2001 for a further 60 backpacker units (single occupancy). For predictions of 2009 visitors, 1272 persons have been used
- ² Estimated camp occupancy north of Coral Bay to Bruboodjoo Point. An estimated 2 persons per camp has been used for calculations
- ³ Predicted on a flat increase of 5% of 2001 estimates for each of seven years (35% increase).
- ⁴ Monthly estimates provided by CCMD.
- ⁵ New visitors to CCR (Column H) have been calculated by:
 - determining overflow by subtracting Coral Bay maximum (Column C) from estimated total (Column F); and
 - subtracting this overflow from CCR estimated total (Column G).
- ⁶ Column C plus Column G

4.3.3 Increase in Private and Commercial Boat Numbers

Section 3.3.3 presents a summary of existing boat utilisation at Bills Bay based on limited boat counts over the Easter holidays 2001 and subsequent non-holiday periods. Easter boat counts coincided with a period of peak utilisation and an estimated population within the Coal Bay settlement of a combined total of about 2700 visitors and residents.

Implementation of the CCR will provide an opportunity to relieve overcrowding at the Coral Bay settlement, with the potential to reduce numbers the limit identified by Department of Planning 1996. Based on the ratio of visitation during the boat counts to that identified as the reasonable maximum by the WA Department of Planning, a maximum population at Coral Bay of 1212 visitors and residents, it is estimated 55 boats (trailed craft and car-toppers) with an additional conservative factor of 10 boats, and including four glass bottom commercial vessels may continue to operate from Bills Bay, or be garaged at the existing Coral Bay facilities. It is further anticipated that all trailed boats will be launched at the ramps provided in the CCR.

A further 68 boats, currently operating out of the Coral Bay settlement, and including the balance of large commercial vessels are likely to relocate to Mauds Landing. Based on calculations of additional commercial and charter boat demands, calculated boat ownership for residents at the CCR (see section 8.1 in Appendix 3 and Appendix

6 of this report), and short term residents as adjusted following recent boat counts in Coral Bay, additional boats at the CCR are expected to total 159 comprising:

- 33 trailed and 8 penned vessels owned by permanent residents;
- 27 trailed and 7 penned vessels owned by residential staff;
- 44 trailed vessels owned by short stay residents;
- 20 visiting yachts;
- 15 additional commercial vessels; and
- 5 vessels operated by CALM and FWA.

In combination with boats anticipated to remain in Coral Bay, a total of 227 boats are anticipated to operate in the Region.

Based on boat usage trends identified in Section 3.3.3, during busy holiday periods 46 % of boats can be anticipated to be in use at 0800 (105 boats), and 28% (64 boats) at noon.

Boat source data and assumptions made in the determination of these numbers are presented in Table 11.

4.3.4 Enforcement of Boating Controls

CCMD does not have any jurisdiction nor can it exclude boating or any related activity (mooring controls, boat launching across CALM reserves, fuelling from small containers) from any areas outside the designated marina waterway.

However CALM has indicated its intention to implement boating controls within southern Bills Bay (Simpson 2000) specifically addressing issues of mooring and swimmer safety.

The provision of public, all weather launching ramps within the CCR will enable CALM to remove environmentally 'unfriendly' moorings from within Bills Bay. Currently, a significant proportion of the beach at southern Bills Bay (a CALM reserve) is utilised for launching and retrieval of boats and for the parking of vehicles and boat trailers. Relocation of private boating from Bills Bay will result in the relocation of boating activity to an area less susceptible to physical and pollution impacts of boating, and, open all Bills Bay beaches to beach goers while eliminating the present high risk of swimmer/snorkeller and boating conflicts.

Commercial forces will also be prominent in directing the focus of some charter (fishing) and commercial ecotourism experience (whale sharks, humpback whale viewing) boats to Mauds Landing by virtue of the greater proximity to Cardabia Passage. This will remove the need for a significant proportion of large boat traffic to travel along the sensitive back reef area adjacent to the Cardabia Passage. Commercial boats focussing on features within Bills Bay (such as coral viewing) are anticipated to continue to operate from the Coral Bay settlement.

4.3 5 Boat and Tour Related Activities

Discussion and estimates of visitor participation in organised boat and tour related activities are presented in Section 3.3.4. Table 17 presents estimates of additional

demand for organised boat and tour related activities in 2009 at full implementation of the CCR.

Potential impacts of additional pressures on target finfish or ecotourism target species are discussed in Section 4.4.

Potential for SCUBA Diver and Snorkelling Impacts

Coral reefs are subject to a high frequency of recurrent biological and physical disturbances, with often large temporal and spatial scales (Hughes & Connell 1999).

Recently there has been an increase in awareness that humans can alter the temporal and spatial scales of natural disturbance regimes of coral reef (Nystrom, Folk & Moberg 2000), and accordingly their dependant communities.

TABLE 17
SUMMARY OF ESTIMATED CORAL BAY BOAT AND TOUR RELATED ACTIVITIES

	Length of Season	Coral Bay	Coral Coast Resort	
		Predicted Additional demand to 2009	Predicted Demand 2009 based on visitor N ^{os} .	¹ Net based on visitor N ^{os} less Coral Bay overflow
SCUBA DIVING				
additional places	all year	8085 dives	39467 dives	8282 dives
Additional boats at 66% util.		490 boat trips	992 boat trips	502 boat trips
all boats at 90% util.		359 boat trips	727 boat trips	368 boat trips
FISHING CHARTER				
additional places	all year	3455 fishers	16863 fishers	3539 fishers
Additional boats at 60% util.		368 boat trips	744 boat trips	736 boat trips
all boats at 90% util.		245 boat trips	496 boat trips	251 boat trips
SNORKELLING/ECOTOURISM EXPERIENCES				
additional places	all year	7277 divers	35520 divers	7475 divers
Additional boats at 66% util.		490 boat trips	992 boat trips	502 boat trips
all boats at 90% util.		359 boat trips	727 boat trips	368 boat trips
HUMPBACK WHALE VIEWING				
additional places	12 weeks	926 seats	4521 seats	949 seats
Additional boats at 50% util.		88 boat trips	179 boat trips	90 boat trips
all boats at 90% util.		55 boat trips	112 boat trips	56 boat trips
WHALE SHARK EXPERIENCES				
additional places	10 weeks	627 snorkellers	3062 snorkellers	642 snorkellers
Additional boats at 80% util.		49 boat trips	120 boat trips	71 boat trips
all boats at 90% util.		44 boat trips	88 boat trips	45 boat trips
BEACH TURTLE NESTING/HATCHING EXPERIENCES				
		782	3818	801
all places at 95% util.	14 weeks	8 places	32 places	9 places

Notes ¹ Net increase in demand for boat and tour related activities has been determined by subtracting Coral Bay predicted additional demand (2001 to 2009) and Coral Bay overflow from the predicted increase in demand arising from the implementation of the CCR.

Similarly, recreational SCUBA diving has generally been perceived as an activity entirely compatible with the sustainable use of marine resources (Harriott, Davis & Banks 1997). However the notion that tourism can be a benign form of development is not necessarily true (Hawkins & Roberts 1992; 1993), with even snorkelling being identified as damaging to coral reefs (Allison 1996; Hawkins & Roberts 1993).

Corals have been demonstrated to be capable of regrowth from damaged colonies and from fragments following severe coral death pulses and in recovering from minor damage (Liddle and Kay 1987). Nystrom, Folk and Moberg (2000) have documented the natural disturbance regime of coral reefs. This information is extended in Table 18 to include a description of anthropogenic impacts related to diving-based activity.

TABLE 18
¹ CHARACTERISTICS OF NATURAL AND DIVING BASED ACTIVITY
TOURISM DISTURBANCE REGIME OF CORAL REEFS

Process	Spatial Extent	Frequency	Duration
² NATURAL			
Predation and grazing	1-10cm	Weeks to months	Minutes to days
Coral collapse (bioerosion)	1m	Months to years	Days to weeks
Bleaching or disease of individual corals	1m	Months to years	Days to weeks
Storms	1-100km	Weeks to years	Days
Hurricanes/cyclones	10-1000km	Months to decades	Days
Mass bleaching	10-1000km	Years to decades	Weeks to months
Crown-of-thorns outbreaks	10-1000km	Years to decades	Months to years
Epidemic disease	10-1000km	Months to century	Years
Sea-level or temperature change	Global	10 ⁴ – 10 ⁵ years	10 ³ – 10 ⁴ years
ANTHROPOGENIC			
³ Anchor impacts or boat groundings	1 – 5m	Months to years	minutes
³ Trampling	1-10cm	daily	Minutes to hours
³ Diver impacts	1-30cm	daily	Minutes to hours
Increased turbidity	1-2km	days to months	Days to months
Acute non-persistent chemical pollutant	1-2km	Years to decades	Minutes to days
Persistent chemical pollutants	1-5km	Months to years	Years to centuries

Notes:

¹ Adapted from Nystrom, Folk & Moberg (2000).

² There remains considerable conjecture about the role of man induced indirect change on 'natural' processes. The removal of predators, for example, has been implicated in outbreaks of pests such as Crown-of-Thorns starfish of *Drupella* population increases.

³ Acute damage such as breakage may result in affected corals being more susceptible to disease.

Nystrom, Folk and Moberg (2000) note that a major difference between many human-induced and natural disturbances is their persistence. Natural disturbances tend to

occur in a pulsed manner whereas anthropogenic disturbances often appear in a more persistent manner and slowly accumulate.

Historically the primary concern relating to impacts had been with associated activities such as boat anchoring and groundings, and the potential for discharge of pollutants from vessels. However heavy diving pressures at certain sites have resulted in a few heavily dived sites having been decreed as being close to or even above their capacity to sustain underwater activity without appreciable degradation occurring.

Recent attempts to identify the carrying capacity of coral reefs for SCUBA diving have sought to equate the damage done at the site with the number of people who participating in diving activities at the site. Estimates vary widely, with Hawkins and Roberts (1992) suggesting 50,000 dives per site annually as being sustainable in Egypt. More conservatively, Rouphael and Inglis (1997) have identified sustainable limits of between 4,000 and 6,000 dives per site per year for Caribbean coral reefs. Observations of a number of sites at which this level of utilisation is already occurring confirms direct physical damage to reefs to be relatively small (Hawkins et al. 1998).

Harriott, Davis and Banks (1997) in concluding a report on recreational diving and its impact in MPA's in Eastern Australia, identified action needed to be considered urgently in cases where greater than 20,000 dives occurred on a single site within a year. Depending on the characteristics of the site, even 5,000 dives may be unsustainable. The considerable variation in the physical and biological variation in coral reefs will be reflected in the susceptibility of these sites to disturbance (Hughes & Connell 1999) and accordingly the number of visitors that can be accommodated at them (Rouphael & Inglis 1997).

By comparison, annual use at Bonaire (a 'divable' coastline of about 52km) was 180,000 dives in 1991 (Rouphael & Inglis 1997) and at John Pennecamp Marine Reserve in the Florida Keys 150,000 dives annually at a single site. Within Australia, 20,000 dives per year have been reported for Julian Rocks in Northern NSW, and 15,000 and 10,000 dives annually have been reported for each of Heron Island (spread over a large number of moorings (dive sites) and Lady Elliott Island respectively.

Based on current rates of participation, predicted annual increase in boat-based ecotourism related activities as a consequence of the implementation of the action will result in an increase of about 12,900 and 14,300 snorkelling and SCUBA dive experiences respectively. Further pressure (principally inshore) will result from independent shore based snorkelling and diving conducted from private boats.

Salm (1986) proposed that the carrying capacity of coral reefs for marine tourism be influenced by the size and shape of the reef, the coral assemblages, the type of activity pursued at the site and the relative experience of the participants. SCUBA diving, snorkelling and reef walking were predicted to have the largest impact at small reefs, where fragile forms of coral were abundant (Salm 1986). Damage occurs when SCUBA divers kick, hold, bump into, stand or kneel on coral either accidentally or intentionally (Rouphael & Inglis 1997). Harriott, Davis and Banks (1997) determined that contact made by fins resulted in 78% of coral breakages in a series of observations undertaken at various sites on the Great Barrier Reef. Price et al. (1995) similarly identified fins as the major source of breakage, followed by contact from the

use of still and video cameras, equipment strikes, standing, holding and touching during impacts studies at Sharm al Sheikh in the Red Sea.

Cary et al. (2000) notes that snorkelling is a popular activity amongst visitors to the NMP. Data from a questionnaire conducted by the Gascoyne Development Commission (1999) identified the intention of each visitor to swim daily. The Coral Bay foreshore on Bills Bay is very popular for day and short stay visitors snorkelling privately. Similarly, the lagoonal waters south of Pearson Point are very popular for shore-based snorkelling.

Table 12 identifies the estimated percentage of visitors participating in snorkelling and SCUBA diving activities from Coral Bay. Four licensed commercial operators regularly offer snorkelling as a component of their wildlife interaction tours. Snorkelling tours are conducted for an estimated 3.4 % of Coral Bay visitors to State managed waters of the NMP generally within the protected lagoon. Based on estimated data presented in Table 12, it is predicted that an additional 7,277 snorkelling places will need to be provided to meet the demand resulting from the implementation of the CCR. Impacts, relating to fuel spillage, habitat damage due to boat anchoring, propeller damage and snorkellers litter impacts and physical disturbance to wildlife will occur almost entirely within State waters. Snorkelling impacts on whale sharks, as they occur in deep waters, are considered separately below.

It is predicted that 3.8% of the day and short stay visitors engage in commercial SCUBA diving activities offered from Coral Bay (Table 12). Projected to the year 2009 and with the implementation of the CCR, this will result in the demand for approximately 8,085 additional commercial SCUBA diving places. Cary et al. (2000) notes three popular dive locations within the Coral Bay area. As for snorkelling, impacts related the SCUBA diving relating to fuel spillage, habitat damage due to boat anchoring, propeller damage and litter impacts and physical disturbance to wildlife will occur almost entirely within State waters, as Commonwealth waters are too deep for recreational SCUBA diving.

Measures to mitigate diver impacts relate to the improvement of diver knowledge through education, the improvement of diver skills in critical areas such as buoyancy control, the provision of appropriate resources to limit impacts and regulatory limits and controls.

Harriott, Davis and Banks (1997) emphasises the importance of providing appropriate boat moorings in MPAs to limit the greatest single most damaging aspect impacting on coral reefs, and management of the number of divers on any one site to sustainable levels.

In relation to diver skills, 70% of damage was observed as having been done by 4% of divers during a recent field observation in Eastern Australia (Harriott, Davis & Banks 1997). Prior et al. (1995) noted that these shortcomings could be addressed by better diver education (including videos and brochures) and skills improvement, or by channelling inexperienced divers to less susceptible dive sites. Marine park and dive site managers could use economic instruments to raise revenue to increase regulatory presence or introduce regulatory instruments to ban such activities as photography

that are known to result in inordinate damage to coral reef structures (Prior et al. 1995).

Potential Whale Shark Experience Impacts

The whale sharks move from offshore waters into the NMP where they congregate from March to May each year (Taylor 1997; Davis et al. 1997; Taylor & Pearce 1999), with peak numbers of whale sharks occur about two weeks after the coral spawning. Intense interest in snorkelling with whale sharks results in the demand for commercial tours, over a period of about ten weeks, in Coral Bay by two boats with a combined capacity of about thirty two places.

Most interactions with an estimated 200-400 whale sharks in the NMP, believed to be mostly juvenile males, occur in Commonwealth waters off Point Cloates. Figure 8 presents unpublished data from CALM (Myer 2001) that identifies the location of whale shark interactions derived from commercial operator logbooks. The whale sharks mainly occupy the turbulent waters along the outer edge of the reef front where the current is flowing northward (the Ningaloo Current) (Davis et al. 1997)

Light aircraft locate whale sharks and direct commercial vessels to intercept them. Whale sharks are a threatened and migratory species protected under Controlling Provisions 20 and 20A of the EPBC Act, and are protected under (Western Australian) Wildlife Conservation (Close Season for Whale Sharks) Notice (1996) (*Wildlife Conservation Act 1950*). Under this notice, only CALM authorised and licensed operators can interact with whale sharks (Cary et al. 2000).

Over the limited (approximately ten week) period of the whale shark congregation, a predicted 1.5% of day and short stay visitors engage in whale shark interaction activities offered from Coral Bay (Table 13). Projected to the year 2009 and with the implementation of the CCR, this will result in demands for approximately 627 additional places on commercial boats. To meet this additional demand, one additional commercial boat carrying sixteen passengers at 80% utilisation would be required.

Anticipated impacts related the whale shark experiences may occur as a consequence of fuel spillage, nutrient impacts resulting from sewage discharge from boats, litter impacts and physical disturbance to wildlife, and will occur almost entirely within Commonwealth waters, consistent with the location of the whale shark.

Although it is possible private vessels can travel independently offshore to interact with whale sharks, this will be limited to larger vessels only. The probability of locating whale sharks is limited without direction from light aircraft.

Potential Humpback Whale Tour Impacts

Humpback whales occur in the offshore waters westward of Ningaloo Reef (May, Lenanton & Berry 1983). Humpback whales regularly pass along the reef during the northern and southern migrations. By the nature of their close passage along the Western Australian coast, humpback whales are subject to pressures resulting from both commercial and private whale watching activities offshore of boat access points along the coastline from Cape Leeuwin to Exmouth Gulf.

All turtles found on Ningaloo are under various controlling provisions of the EPBC Act, (Environment Australia 2000), and under the Western Australian *Wildlife Conservation Act 1950*.

Over the limited (approximately fourteen week) period of the breeding, a predicted 1.4 percent of day and short stay visitors engage in night-time turtle nesting viewing activities offered from Coral Bay (Table 12). Projected to the year 2009 and with the implementation of the CCR, this will result in demand for additional 782 places on commercial tours using either four wheel (quad) bikes or a 4WD vehicle. To meet this additional demand, one additional 4WD carrying six passengers or six additional quadbikes would be required.

Anticipated impacts related the beach nesting and hatching experiences may occur as a consequence beach erosion and nest disturbance, greater feral animal pressures (especially foxes), and physical disturbance to wildlife, and will occur entirely within State waters and controlled lands.

Due to the proximity to Mauds Landing, turtle nesting and hatching can be viewed either privately or in organised groups. Cary et al. (2000) notes that there are currently no licences to cover these activities and identifies a need to develop a code of conduct.

Potential impacts on the values of NMP resulting from additional recreational fishing

With the implementation of the Coral Bay Resort, and at 80% occupancy, it is anticipated an additional 2025 visitors, staff and permanent residents will be resident in the CCR. Issues in relation to the increase in visitation to the Coral Bay area are discussed in section 4.3.2. At peak periods it is estimated that in 2009 and following implementation of the Coral Coats Resort, up to 172 boats may be present within the marina in addition to about 55 anticipated to remain at the existing Coral Bay settlement, although using CCR boat ramps. Based on boat count data collected during Easter 2001, up to 50 % of boats may be in use at any time.

Due to overcrowding in Coral Bay during busy holiday periods, it is considered total visitation will not increase proportionally to the number of extra accommodation units provided within the CCR. As for boat based ecotourism demand (see Table 17) it is anticipated that recreational fishing pressure will approximately double, with half of this increase due to the additional capacity provided by the CCR, and the balance due to growth in visitation at the existing Coral Bay settlement.

Jones Lang Wooton (1993) note that in relation to the natural resources of the Coral Bay area, these resources are under stress and that they may have already surpassed their carrying capacity for tourism. Residents of the Coral Bay settlement and tourism operators mirrored these concerns during the initial community consultation, concerned that additional tourism on the scale proposed, would exceed the 'carrying capacity' of the Ningaloo Reef and Bills Bay in particular.

Notwithstanding periodic overcrowding, the trend for increasing visitation to Coral Bay continues, with Cary et al. (2000) noting an increase of 40% in new arrivals at

one of the Coral Bay caravan parks over the period 1994 to 1999. Main Roads WA undertakes annual traffic counts at various locations on the Minilya- Exmouth and Coral Bay Road and elsewhere. Recent count data for the Coral Bay Road indicates the average annual daily counts to have increased by 28% over the period 1996 to 1998.

The Coral Bay area is located in the Gascoyne fisheries management area and is renowned for its outstanding shore based, dingy and recreational fishery based on a diversity of fish. Recreational fishers participation rate increased to 30% of the States population (520,000) in 1996 (Paterson, quoted in FWA 1999). FWA (1999) note that with the development of coastal roads and boat refuges and residential developments such as marinas, waters previously protected from extensive fishing pressure due to isolation are now coming under increasing pressure. Current indicators (both scientific and social) of the 25 fisheries with enough data available to make a critical assessment show that 19 fisheries are fully exploited (in a sustainable manner), five are fully or over exploited and one is under exploited (FWA 1999).

Recreational fisheries management actions to control localised depletion of fish stocks within the Gascoyne have included specific area controls at Ningaloo in 1992, landing limits in Exmouth Gulf in 1993, strict controls on the take of pink snapper in Shark Bay's inner gulfs in 1997, and subsequent bag limits (1998), and the introduction of a management system for the charter and aquatic tour industry in 1999 (FWA, 1999).

A major recreational catch survey was completed for the Gascoyne Region in March 1999. Although species such as golden trevally are most often caught, major concerns in relation to the sustainability of some of the lesser-caught bottom species such as spangled and red emperor, arise due to the relatively slow growth and recruitment rates of these species.

FWA have recently completed a fisheries environmental management review for the Gascoyne Region (FWA 2000). FWA note that the effects of all forms of fishing in WA are thought to be relatively low when compared with fishing practices overseas and elsewhere in Australia. Difficulty associates with the environmental effects with between and within particular types of fishery are also noted.

A profile of recreational fishing within the Gascoyne Region is presented in FWA (2000). Very little is known at present regarding the exploitation status of most species other than stocks also targeted by commercial fishers, nor has stock or breeding assessment been undertaken. Input (restrictions on fishing methods) and output (bag and size limits) as well as community education management methods are identified. Line fishing, with much being boat based and focussing on reef species such as cod, coral trout and emperors as well as snapper, sharks and pelagic species is identified (FWA 2000).

Significant effects associated with the recreational fishing industry identified FWA (2000) include:

- Ecosystem effects comprising such impacts as;
 - localised overfishing identified as a decline in catch per unit effort,

Minke whales, fin whales, blue whales, brydes whales and killer whales, although known from the area, are not targeted by commercial operators but they may come upon them opportunistically.

Humpback whales have been identified as species of under the EPBC Act, and are protected under (Western Australian) Wildlife Conservation (Close Season for Marine Mammals) Notice (1996) (*Wildlife Conservation Act 1950*). Under this notice, only CALM authorised and licensed operators can interact with humpback whales (Cary et al. 2000).

Over the limited (approximately twelve week) period of the humpback whale migration, a predicted 1.9% of day and short stay visitors engage in whale watching activities offered from Coral Bay (Table 12). Projected to the year 2009 and with the implementation of the CCR, this will result in demands for approximately 926 additional places on commercial boats. To meet this additional demand, one additional commercial boat carrying eleven passengers at 50% utilisation would be required.

Anticipated impacts related the humpback whale viewing may occur as a consequence of fuel spillage, nutrient impacts resulting from sewage discharge from boats, litter impacts, and physical disturbance to wildlife resulting from boat or propeller strikes. These impacts may occur in a combination of State and Commonwealth waters, consistent with the location of the humpback whale. In contrast to whale sharks however, private boat owners in trailer mounted and moored vessels can operate in areas frequented by humpback whales (see Figure 8).

Potential impacts arising from shore based Turtle Nesting and Hatching Tours

A brief overview of the biology and occurrence of specific marine turtle species at NMP and the Mauds Landing area respectively is presented in section 3.2.2.

Four marine turtles are known to breed on Western Australian beaches including the green, loggerhead, hawksbill, and flatback. These turtles are known occur within the NMP (Environment Australia 2000). Leatherback turtles are considered to be at the extreme of their range but may occur occasionally within NMP (May, Lenanton & Berry 1983).

Aerial surveys of the NMP suggest that an estimated population of approximately 4300 turtles (all species) is resident within the Park (Preen et al. 1997). Sandy beaches within the NMP between Coral Bay and North West Cape are recognised as important nesting rookeries for predominantly loggerhead and green turtles, and is subject to both a commercial and private tourism pressures during the breeding season (summer).

Beaches of Bateman Bay support a breeding population of loggerhead turtles (estimated at about 24 females) and one or two green turtles. 68 nests were recorded between Point Maud and Oyster Bridge over the 2000/01 breeding season. The location of these sites relative to the site of the proposed action is presented in Figure 7.

- changes in species abundance, for example the local decline in prize table fish targeted by recreational anglers,
 - depletion of keystone species the activities of which are considered to be critical for ecosystem maintenance,
 - indirect impacts resulting from such the reduction in numbers and resulting alteration of the balance between predators and pests such as Drupella,
- Effects of habitat modification, comprising such impacts as;
 - effects on coral and seagrass communities due to propeller scour and anchoring damage,
 - Effects of fishing pollution and debris, resulting from each of;
 - Gear loss, and
 - Boat related pollution,
 - Terrestrial and coastal effects due to dune and beach erosion, disruption of hydrodynamic patterns, reef trampling; and the increase in wastes and toxicants.

Other environmental impacts attributable to fishing such as changes in genetic composition, benthic impacts, sediment disturbance, resulting from activities such as trawling and marine based aquaculture are considered to result largely from commercial and particularly trawl fishery activities. Influences from natural environmental variability such as the strength of the Leeuwin Current although impacting on Regional scale environmental process occur independent of anthropogenic actions, the resulting impacts may be compounded to result in a much greater local consequence due to recreational fishing.

Implementation of the CCR proposal will result in increased fishing pressure on fish stocks both in the immediate vicinity of the marina and more widely. Fishing pressures are anticipated to double between 2001 and full implementation of the CCR anticipated in 2009. Demand for fishing charters are likely to increase, and with it pressure on prize and other fish, as indicated in Table 18. It should also be noted that about half of this additional fishing pressure is predicted to occur regardless of the implementation of the CCR.

Implementation of the CCR will also result in a change on the size and type of boat operating in this portion of the NMP. The greater proportion of larger (greater than 5.5 m) moored boats may result in fishing pressures being extended beyond traditional fishing grounds. The proportion of moored boats as a proportion of total boats operating in the region is predicted to rise from 16 % at present to approximately 26% by 2009 as a result, as indicated in section 4.3.3 and tables presented in Appendix 6. Anticipated demand for fishing charters is presented in Table 17.

FWA note that in relation to the effects of fishing, pressure on many fish stocks is increasing in the Region, particularly as a result of the opening of new areas due to improved fishing technology, better gear and tackle and increase in fishing effort and numbers (FWA 2000). Specific fishing impacts are summarised in Table 19.

TABLE 19
DISCUSSION OF CURRENT ENVIRONMENTAL THREATS RESULTING
FROM RECREATIONAL FISHING AT NINGALOO REEF, AND
PROPOSED MITIGATION

Impact	Status – Gascoyne Region	Management Response - CCR
Bycatch	Impacts largely limited to net fishing	Input and output measures in place. Public education and monitoring support
Anchor damage	• Of concern on coral reefs. • Impacts limited on seagrasses and sandy substrates	• Public education and monitoring support; • Relocation of boats from Coral Bay • Reduction in large boats travelling down back reef to Cardabia Passage
Propeller damage	• Of concern on coral reefs in high activity areas. • Impacts limited on seagrasses and sandy substrates although larger boats may lift seagrass and increase suspended sediments	• Public education and monitoring support; • Relocation of boats from Coral Bay • Reduction in large boats travelling down back reef to Cardabia Passage; • Direct access to deeper water and Cardabia Passage
Litter	A problem mainly around fishing spots and camps	• Public education and monitoring support; • Development of a managed landfill site
Human Waste	An isolated problem near unserviced areas	• Public education and monitoring support; • Development of waste water treatment facility; • On-shore sewage pump-out facility
Diver Damage	At popular dive sites, from divers searching for rock lobsters and inexperienced snorkellers and SCUBA divers	• Public education and monitoring support; • Marina based diver training opportunities; • Input controls on heavily dived sites
Collisions with marine mammals	Appear rare and unlikely	• Public education and monitoring support; • Boating controls as increased impacts noted.
Entanglement of marine mammals	• Appear rare • Coarseness of line, size of mesh and length of net make it unlikely.	• Fishing controls in place (constant attendance);
Beach Erosion	• Principally due to beach use by off road vehicles	• Public education and monitoring support; • No commercial quadbike activities from CCR; • No beach access from CCR.
Turtle Breeding Impacts – off road vehicle use	• Direct damage to nests; • Laying disturbance due to human observation; • Wheel ruts and depression impacts on hatchlings	• Public education and monitoring support; • Not commercial quad bike activities from Resort; • No beach access from CCR. • Appoint turtle management officer • Greater regulatory presence; • Feral animal eradication program and managed landfill site
Fuel spillage	• a problem at boat ramps; • an issue is boats are refuelled over at beach	• Public education • Marina refuelling facilities; • Emergency response capability

Source – modified from FWA (2000).

Recreational fisheries management will be a significant focus of the SAMMP, with monitoring requirements and priorities for fish management being developed in consultation with FWA. A draft SAMMP is included in Appendix 5.

There is a clear need to develop a baseline for fish stocks prior to the CCR being operational. This will require:

- baseline catch and effort data for the area; and
- biological information for select species being collected.

The level of protection afforded individual fish species is based on a number of factors including species distribution, abundance, life history and an assessment of the ecological and social importance of the species in the context of the area.

Together with FWA, a program will be developed that will enable the collection of recreational catch, fishing effort and the biology of key fish species with the Ningaloo Reef Tract. This has been identified as a major obstacle to the resolution of fishery management and resource sharing. It should be noted that with the development of a single point of boat entry for the Coral Bay area and additional resources provided to manage recreational fisheries, the development of the marina would provide an opportunity to better manage fisheries within the area.

Extraction patterns would need to be established to anticipate the likely effects on the species in question, as well as the level and manner of protection that will be afforded. It would also be necessary to assess the impact of extraction on the social values of the park, as localised depletion may reduce the opportunity for nature appreciation (eg. viewing of "icon" species), nature photography and the quality of the recreational fishing experience. FWA, in accordance with ecologically sustainable development principles, will manage species for which extraction is considered acceptable. The remaining species will be protected throughout the marine park using statewide legislation. Finfish are totally protected from extractive activity in Sanctuary Zones of the park and in Special Purpose (Scientific Reference) Zones.

4.4 Coral Coast Resort - Description and Management of Ecological and Social Impacts

Format

The format of this section is based on the best practice principles outlined in the report entitled *Best Practice in Performance Reporting in Natural Resource Management* (ANZECC 1997), and those adopted by CALM in the development of marine management plans for marine parks in Western Australia.

The Western Australian Marine Parks and Reserves Authority (MPRA) has adopted this model so as to facilitate better conservation and management outcomes and a more objective and effective approach to auditing CALM management plans.

Auditing and reporting against objectives is further described in section 4.5.3.

For the remainder of this section, performance against which the management of ecological and social values is measured is presented in terms of:

- management objectives;

- management strategies;
- performance measures;
- management targets; and
- key performance indicators.

A description of the values in the NMP, with reference to the description of the existing environment (Section 3) is provided, together with a description of the relevant impacts of the action. A brief explanation of these terms is presented in Table 20.

TABLE 20
AN EXPLANATION OF THE TERMS USED IN THE DESCRIPTION OF
RELEVANT IMPACTS, PROPOSED SAFEGUARDS AND MITIGATION
MEASURES RELATIVE TO THE PROPOSED ACTION

Value	Present objective in management of the value. It is against this objective that the measure of acceptability or otherwise of the value will be made.
Background	The current state of the environment will be described and an overview of pressures given.
Existing and potential uses and/or pressures	A summary of existing and potential uses and/or pressures will be presented.
Current major pressure	Current major pressures, if any, will be described.
Impacts of the action	Prediction of the impacts of carrying out the proposed action.
Evaluation	Evaluates magnitude of predicted impacts
Management objective	Management objectives identify what the primary aims of management are and reflect Environment Australia's responsibility in relation to the <i>EPBC Act</i> . Reference will also be drawn to the <i>Conservation and Land Management Act 1984</i> . Where significant pressure/s on an ecological value has/have been identified, the management objective addresses the specific pressure/s. When there is not an obvious existing pressure or threat, the management objective provides broader direction to management in relation to protecting the value from the most likely future threats.
Strategies and mitigation	Management strategies provide specific direction on how the management objective/s for each value might be achieved. All strategies outlined in this plan have been defined as high (H), medium (M) or low (L) priority to provide an indication of their relative importance. Specific (H) strategies considered to be critical to achieving the long-term objectives of the marine park are designated as <i>key management strategies (H – KMS)</i> .
Predicted Outcome	A description of the predicted outcome of the action relevant to the management objective or Environment Australia's Administrative Guidelines.

Performance measure	1. Performance measures against direct and indirect impacts are indicators of management effectiveness in achieving Environment Australia's objectives and targets. Where possible they are quantitative, representative, simple and cost-effective.	Desired trend	Desired trend (negative or positive) in assessing performance measure is indicated.
Short-term target	Management targets represent the end points of management . Targets where possible are measurable, time bound and expressed spatially. Ecological targets are set as either the 'natural state' or some acceptable departure from the 'natural state' as set through relevant statutory mechanisms. The short-term target provides a benchmark for management to achieve within a specified time period and, in most cases, is a step to achieving the long-term target.		
Long-term target	The long-term target provides a specific benchmark to assess the success or otherwise of management action within the life of the management plan.		

Discussion of Impacts, Proposed Safeguards and Mitigation Measures

4.4.1 Geomorphology

Ecological value	<i>Geomorphology: A complex seabed and coastal topography consisting of barrier, sub-tidal and inter-tidal reefs, protected inshore lagoons and deeper basins, beaches and headlands. The geomorphology forms a part of the support system that directly impacts on the lifecycle and spatial distribution of listed migratory and threatened species, and has the potential to impacts on the Commonwealth Marine Environment.</i>
Background	The marine and coastal geomorphology and geology of the coast from North West Cape to Gnarraloo Bay is described in the "<i>A Representative Marine Reserve System for Western Australia</i>" (Marine Parks and Reserves Selection Working Group 1994). A summary is provided in section 3.1.3. A coastal engineering study has been undertaken, the results of which are included in Appendix 3. The coastal engineering study concludes that the largest movements of sand are believed to occur under the action of severe tropical cyclones. The major marine geomorphological features are a gently sloping submarine shelf underlain by Pleistocene limestone with a veneer of marine sediments that extend to Commonwealth waters, and interrupting this shelf, a fringing barrier reef system at the edge of which the proposed action is located. Commonwealth waters occur 8km from the site of the proposed action. In the vicinity of the proposed development area the reef is discontinuous and there is a break (Cardabia passage) directly offshore. Just north and south of Point Maud the reef is only 1 to 2kms offshore (Department of Conservation and Environment 1984), and plays a fundamental role in coastal processes. The complex geomorphology of the area supports a wide diversity of habitats and ecological niches which, in turn, contribute to the high marine biodiversity of the area.

	The most significant pressure on the geomorphology is increasing recreational use of coastal landforms and coastal development. Coastal facilities such as groynes and marinas have the potential to significantly affect sedimentation patterns resulting in major changes to beaches. Uncontrolled recreational use of fragile coastal dunes and headlands can also lead to considerable erosion of these features. Management of the lagoon area and backreef, including the adjoining coastal land reserves, needs to be integrated with a focus on protecting sensitive areas from inappropriate use. This may be achieved by the provision of coastal facilities (i.e. boardwalks and roads) or through excluding access to specific areas. Given the robust nature of much of the subtidal geomorphology and the nature of existing activities in the area, there are no current major pressures on this component of the ecosystem.
Existing and potential uses and/or pressures	1. Recreational use of coastal landforms. 2. Coastal development (eg. groynes, marinas and boat launching ramps). 3. Commercial and recreational fishing activities. 4. Off road vehicle activity impacting on dune stability. 5. Navigation: • installation of markers; and • removal of hazards.
Current major pressure	None, however some areas of dune disturbance, possibly attributable to off road vehicle activity is evident and is identified in FWA (2000) as a possible threat. Minimal effect in the nearshore area.
Impacts of the action	Breakwaters will need to be constructed to protect entrance channel for either CCR or for boat launching facilities being considered for either Moncks Head or North Bills Bay. The marina development will be inland and a 'dry' operation in which the bulk of the earthworks are undertaken by earthmoving equipment prior to the sea being allowed to enter. The opening being protected by two groynes projecting 200m from HWM, constructed of armour stone and select clean fill. Accordingly it is anticipated that about 5ha of sand habitat and dependent communities will be directly lost by the implementation of this development The coastal engineering study (M. P. Rogers & Associates 2000) concludes that longshore transport of sediment is anticipated to be negligible under the prevailing swell wave regime. During extreme cyclonic storms (November to April) there is expected to be significant movements of sand along the southern shores of Bateman Bay toward Point Maud. Approximately one cyclone per year passes within 200km of Mauds Landing. Severe cyclones occur on a one in one hundred year return period (M. P. Rogers & Associates 2000). Calculations suggest that during a particularly severe storm, as up to 10 000m³ of sand could be moved towards the breakwater site and the sand trapped on the northeastern side of the entrance breakwater. This would also result in the development of new beach alignments for a distance of 300 to 500m either side of the breakwaters. It is also anticipated that in the period following the cyclone, the swell will re-shape the beaches to pre-storm alignments. Turtles protected under the EPBC Act and under international treaty are known to nest on Bateman Bay beaches, with five nests occurring within 500m of the breakwater entrance during the 2000/01 nesting period. 95% of turtle nests known from the area are loggerheads. The bulk of turtle nesting activity occurs approximately 6km from the CCR, and well away from any influence of the breakwaters. A description of existing turtle interactions within the impacted area

	is presented in Section 3.2.2. Mitigation of impacts on turtles is presented in Section 4.4.9.
Management objectives	1. To ensure the structural complexity of the near shore geomorphology is not altered by human activities such that ecological values are diminished. 2. To ensure recreational access and use do not degrade coastal landforms in the townsite or adjacent areas.
Evaluation	Periodic movement realignment of the beach resulting from cyclonic events occurs over a long return period. Turtle nests are located well up the beach profile and beach scour associated with these events is unlikely to cause disturbance. It is CCMD's view that geomorphological impacts in the Commonwealth Marine area are unlikely to occur due to the distance between the action and Commonwealth Marine waters.
Strategies and mitigation	1. Develop and implement, in consultation with CALM and FWA, a monitoring component in the SAMMP for the MSMA, including but not limited to: • turbidity; • light extinction through the water column. 2. Develop and implement a Shoreline Movement Management Plan (CCMD, CALM, Department of Planning and Infrastructure). (H). The plan will include: • characterisation of sediment changes; • coastal (including sediment) accretion and erosion; • measurement of beach profiles, accretion and erosion rates; and • identification of remedial actions (contingencies) for cyclonic event. 3. Implementation of the monitoring phase of the plan for a minimum period of 5 years following completion of the development followed by a review. 4. Identify and implement effective management controls of coastal recreational activities through liaison with coastal land managers (including CALM and CCR) through controlled access and use of beaches and headlands adjacent to the park (CALM, CCMD, LGAs, Cardabia Station). (M) 5. Manage recreational use of coastal features within Mauds Landing where these activities are likely to result in degradation of coastal landforms (CCMD). (M) 6. Liaise with CALM for management of recreational use of coastal features within the reserve adjoining the Bateman Bay but outside the Mauds Landing townsite where these activities are likely to result in degradation of coastal landforms (CALM). (M) 7. Restate relevant management objectives and targets of coastal protection in induction and other educational materials produced for the CCR in relation to the geomorphology (CCMD, CALM, LGA). (M) 8. Develop short-term management targets as required (CALM). (M) 9. Educate park users about the ecological importance of the park's geomorphology (CCMD, CALM). (L)
Predicted Outcome	It is CCMD's view that implementation of the action will result in the loss of a small area of sand habitat and dependent communities otherwise well represented locally and regionally. Modelling indicates the coastline is stable and will return to its equilibrium state following storm or cyclonic events. Accordingly it is CCMD's view that there will be no impacts on Commonwealth Marine area (Controlling Provisions 23 and 24A). As the majority of turtle nesting does not occur in the zone of influence of the breakwaters, CCMD further consider that there will not be any significant impacts on important populations of loggerhead turtles (Controlling Provisions 18 and 18A) listed threatened species. Green turtles nest only occasionally and hawksbill are not known to nest in the area and will in CCMD's view be unaffected by sand movement. Accordingly Controlling

	provisions 18(4) and 18A (listed threatened species in the vulnerable category) and 20 and 20A (listed migratory marine species) are not considered applicable.		
Performance measures	1. Area of seabed disturbance (ha.) 2. Area of coastal degradation (ha.)	Desired trend/s	1. Constant or Negative 2. Constant or Negative
Short-term targets	To be developed prior to the operations phase of CCR.		
Long-term targets	That there will be no significant variation in the real extent of structural geomorphological landforms (maintenance of structural integrity) due to human activities from 2001 levels.		

4.4.2 Oceanography

Ecological value	Oceanography: <i>A level of knowledge of the flow of waters over a range of spatial and temporal scales in high use areas to enable threats to the conservation values of the Bills Bay and Bateman Bay to be determined. Although the impacts arising from implementation of the action are unlikely to impact on Commonwealth marine waters, species on NES occur within the area of potential impacts, and increased pressures must be considered.</i>		
Background	Taylor and Pearce (1999) note that Ningaloo Reef is a classic fringing reef with surf coming over the reef bring a torrent of richly oxygenated water into the lagoon which returns to the open ocean via gaps in the reef. D'Adamo and Simpson (2001) have undertaken a review of the oceanography of Ningaloo Reef and adjacent waters. A brief review of this work and other relevant literature is presented in section 3.1.2. The southward flowing Leeuwin Current is seasonally dominant in Commonwealth waters, and has a major influence on the biogeography of the State's marine flora and fauna. Seasonally (spring, summer) the northward flowing Ningaloo Current (Taylor & Pearce 1999) transports cool water relatively close to shore. Other major influences on tropical and northern temperate waters are the regular occurrence of severe tropical storms (ie. cyclones), particularly off the northwest coastline, together with the high wave energy of the west coasts. Oceanographic conditions vary markedly from the open ocean to the west of the Ningaloo Reef to the sheltered coastal waters east of the reef. Inter-annual variations in the southeasterly winds and in the Leeuwin Current produce year-to-year variations in the Ningaloo Current (Taylor & Pearce 1999). The sandy beach in the southern portion of Bateman Bay is believed to be stable and in balance with the incoming, persistent, low amplitude swell waves. The measured beach profiles are typically swell-built and there is expected to be little longshore transport of sediment under these usual conditions. The swell is believed to slowly feed the beach system with sediment produced in the nearby reefs.		
Existing and potential uses and/or pressures	1. Coastal development (eg. groynes, marinas and boat launching ramps). 2. Impacts of global scale changes in life support systems such as global warming.		
Current major pressure	None, however breakwaters will need to be constructed to protect entrance channel for either CCR or for boat launching facilities being considered at present for either Moncks Head or North Bills Bay.		

Impacts of the Action	Construction of the breakwaters will extend about 200m into Bateman Bay. Commonwealth marine waters occur about 8km from this point. As the action occurs immediately up current of a significant coastal spit, impacts on longshore processes will be minimised.		
Management objectives	1. To ensure the sufficient knowledge is gained on oceanographic processes to be able to accurately predict the impacts of change at a local scale.		
Evaluation	Following construction, there will be a short period as sedimentation and erosional forces 'balance' the modified landform. Water flushing times are known to increase in close proximity to strong shoreline curvatures, however in the context of natural features such as Point Maud itself, it is CCMDs view that these impacts are unlikely to be significant.		
Strategies and Mitigation	1. Develop an appropriate understanding of the circulation and mixing of the MSMA waters (CCMD, CALM). (H – KMS) 2. Measure and interpret the impacts of man made structures within the MSMA and compare to predicted effects.		
Predicted Outcome	It is CCMD's view that there will be no impacts on Commonwealth marine area (controlling provisions 23 and 24a) given the characteristics of the oceanographic processes responsible for water circulation and the distance to Commonwealth waters. Minimal interruption to oceanographic processes in Bateman Bay adjacent to the site of the proposed action are anticipated by CCMD. Currents will carry sediments northwards under normal conditions, however given the results of coastal engineering studies (see Appendix 3) and commitments to maintain marine water quality (see section 4.4.4) no significant impacts on important populations of loggerhead turtles (controlling provisions 18 and 18a), listed threatened species, or their support mechanisms are anticipated. Green turtles nest only occasionally and the flatback and hawksbill are not known to nest in the area and will be unaffected by sand movement. Accordingly controlling provisions 18(4) and 18a (listed threatened species in the vulnerable category) and 20 and 20a (listed migratory marine species) are not applicable.		
Performance measures	To be developed prior to the operations phase of the CCR.	Desired trend/s	To be developed prior to the operations phase of the CCR.
Short-term targets	To be developed prior to the operations phase of CCR.		
Long-term targets	Oceanographic process is not interrupted by human activities from 2001 levels.		

4.4.3 Intertidal reef platforms and communities

Ecological value	Intertidal reef platforms and communities: <i>Water depths preclude the occurrence of intertidal reef platforms and communities within Commonwealth marine water. However maintenance of a diverse range of intertidal reef platforms in waters adjacent to the action ranging from highly protected backreefs to reefs fully exposed to the action of swell waves is important for the maintenance of species on NES known regionally.</i>
Background	The marine geomorphology is described in Marine Parks and Reserves Working Group (1994) and briefly reviewed in section 3.1.3. Commonwealth waters offshore from the site of the proposed action comprise the pelagic zone and associated benthic communities. Species of NES such as humpback whales and whale sharks are known to seasonally pass through Commonwealth and in the case of the former, occasionally enter State controlled waters.

	The Ningaloo Reef comprises a partially dissected basement of Pleistocene marine or Aeolian sediments, or Tertiary limestone covered by dead or living coral, the reef flat is on average several hundred metres wide (May et al. 1989). These areas contribute significantly to the variety of habitats and therefore the biological diversity of the marine park. Habitats present are described in section 3.2.2 and presented in Figure 7. Large fish numbers are associated with the energetic reef zones and coral lagoons, including back-reef areas (Hutchins 1994). Marine turtles are known to feed on invertebrates and macroalgal assemblages occurring in intertidal and shallow subtidal reef platforms, particularly on protected backreef areas. In Australia, the conservation status of very few invertebrate species is known with a number likely quite vulnerable due to their restricted habitats (Commonwealth of Australia 1995). Shoreline reef platforms on the eastern margin of Bateman Bay in contrast, comprise of a combination of igneous, metamorphic and sedimentary substrate types and are generally bare or covered in algal turf. The biological attributes and accessibility of shoreline intertidal reefs often attract limited commercial and some recreational (eg. collecting, fishing,) activities beyond the sanctuary zone within the marine park Reef walking and beach recreational fishing can impact on the flora and fauna on these reef platforms through trampling. This is particularly true at Oyster Bridge within the marine park, including an area north of Mauds Landing. These pressures are generally greatest on shoreline intertidal platforms due to the ease of access. Backreef tidal platforms are often difficult to access.
Existing and potential uses and/or pressures	1. Recreational and commercial fishing outside the Maud Sanctuary area 2. Shell and oyster collecting 3. Physical disturbance (eg. trampling) while collecting and beach fishing 4. Tourism 5. Scientific research
Current major pressures	1. Physical disturbance (eg. trampling) while collecting and beach fishing (FWA 2000) 2. Some minor local damage to macroalgae, invertebrate and coral communities due to snorkeller and diver activity, especially in Bills Bay. 3. Commercial and recreational collecting activities (molluscs including oysters) have the potential to deplete local populations.
Impacts of the Action	Commonwealth marine waters occur about eight kilometers from the site of the proposed action and do not include any intertidal areas. Construction of the breakwaters will extend about 200 m into Bateman Bay. The impacted area of about 5ha consists of shallow sands over pavement. Direct loss of habitat will occur due to placement of breakwaters and sand accretion as currents restore sediment 'balance'. No intertidal reef platforms and communities are present, with the first shoreline reef platforms occurring some 6km to the north of the site of the proposed action.
Management objectives	Ensure the species diversity and abundance of marine flora and fauna on the intertidal reef platforms in the marine park outside the sanctuary zone are not significantly impacted by shell or specimen collecting, fishing and reef-walking activities.

Existing and potential uses and/or pressures	The implementation of the CCR proposal at Mauds Landing or further expansion of Coral Bay may, without proper management, have the following impacts: 1. Nutrient inputs from: • sewage discharge from vessels; • urban stormwater runoff. 2. Toxicant inputs from: • accidental spillage of fuel and oils from boating activity; • hull antifouling of commercial and recreational boats; • urban stormwater runoff; and • oil spills from passing shipping. 3. Pathogen inputs from: • sewage discharge from vessels; • urban stormwater runoff; and 4. Litter from: • commercial and recreational boating/fishing activities; and • urban stormwater runoff.
Current major pressures	1. Boat impacts and prop suction damage to lagoon and backreef. 2. Fuelling of commercial vessels continues in southern Bills Bay from small containers, with occasional spillage.
Impacts of the Action	In relation to waters leaving the marina, CCMD believed that no discernible changes in marine water nutrient status would occur beyond the immediate zone of influence at the channel entry, and accordingly no measurable environmental impact. CCMD also believe that there will be no impacts on Commonwealth waters.
Management objective	To ensure the water quality of the MSMA and adjoining Commonwealth waters is not significantly impacted by the input of contaminants.
Evaluation	Nutrient enriched waters may enter the marina waterbody and accordingly the nearshore waters of Bateman Bay. Measures, such as the adoption of low nutrient landscaping strategies will be taken to minimise mass loadings. Modeling has been undertaken under reasonable worst case conditions and has demonstrated low potential for nutrient impacts beyond the immediate mixing zone. Should Coral Bay proprietors connect to the proposed reticulated sewerage system, existing leach drains and evaporative pond systems located on the primary dunes can be decommissioned and nutrient contributions to Bills Bay will likely reduce. An extensive monitoring system is proposed to evaluate impacts with a view to initiating management strategies
Strategies and Mitigation	The nearshore marine water quality management strategy is linked to the control of construction impacts (eg. dewatering, dredge management), provision of services inland (WWTP and landfill), management of nutrient inputs to private gardens and public open spaces and to the direction of potentially contaminated storm water inland and away from the marina/ocean. Dewatering waters will be directed to fabric lined soakage basins and allowed to infiltrate back into the shallow groundwater. No direct discharge of recovered groundwater to the marine environment will occur. Further management strategies include: 1. Make available alternative wastewater treatment facilities for Coral Bay. (CCMD in consultation with Govt.) (H - KMS). 2. Develop and implement, in consultation with CALM and FWA, a monitoring component in the SAMMP for the MSMA, including but not limited to: • nutrients;

4.4.4 Water Quality

Ecological value	Water quality: <i>The water quality within both the pelagic (Commonwealth) and near shore (State) portions of NMP are representative of oceanic waters, being largely pristine. Maintenance of water quality in the area adjoining the action is important to sustain species of NES known regionally.</i>
Background	The waters within the NMP are, by world standards, nutrient-poor as a result of both low riverine inputs and the absence of significant up welling of nutrient rich waters from the deeper oceans. Marine park water quality is largely pristine notwithstanding some localised deterioration noted in respect of nutrient enrichment (inorganic nitrogen), elevated microbiological levels and TBT levels in Bills Bay adjacent to the Coral Bay settlement. This has been discussed in DEP (1995), and briefly reviewed in section 3.1.8. FWA (2000) have identified local hydrocarbon impacts near boat ramps due to beach fuelling. A recent sediment and water quality survey undertaken within nearshore areas adjoining both the site of the proposed action and Commonwealth waters (ATA Environmental 2000a), indicates nutrient levels within the recorded range and an absence of nutrient sinks within sediments. Whilst the management of shipping and potential impacts of oil pollution following a shipping disaster is outside the scope of this PER, the preparation for management response in the event of such an incident will be undertaken in association with CALM and emergency response agencies. Nutrient modeling predicting likely nutrient concentrations in the marina and nearshore marine environment has been undertaken (M. P. Rogers & Associates 2000), and the report reproduced in full in Appendix 3. Figures 11 and 12 present the results of modeling (summer peak) of Dissolved Inorganic Nitrogen (DIN) and Phosphorous (P) within the marina water body and adjoining marine environment respectively. Results for the winter peak for DIN and P are presented in Figures 13 and 14 respectively. These results indicate it is highly likely that, upon entering Bateman Bay, the initial mixing with oceanic water would result in marina water being indistinguishable from background. This is largely a function of the small annual load of nutrient entering the development waterway, constituting about 62kg of DIN and 14kg of phosphorus (M. P. Rogers & Associates 2000). Maintenance of the quality of nearshore marine waters, and accordingly any impacts on species of NES, will rely on intensive management of nutrient inputs within the development generally. Boating activity is likely to increase in Bateman Bay and the proposed marina as a consequence of the implementation of this action. Current levels of boat use are presented in section 3.3.3, and predicted increases presented in section 4.3.3. Boat movements will alter as a consequence of implementation of this action, resulting in reduced journey times (and km travelled) for all boats wishing to access open water areas using Cardabia Passage. This will also result in reduced commercial boat traffic adjacent to sensitive backreef areas between 'Moncks Head and Cardabia Passage. These backreef areas are noted as important feeding and resting areas for turtles.

Evaluation	It is CCMD's view that no direct impacts on intertidal reef platforms and communities, although some additional pressures may occur as a consequence of the anticipated increase in visitation. Accordingly it is CCMD's view that there will be no impacts on relevant communities in Commonwealth waters.		
Strategies and Mitigation	1. Provide support for regulatory agencies in the enforcement of zoning requirements through the provision of single point (boating) access (H - KMS) 2. Initiate research programs consistent with the NMP (State Waters) Management Plan 1989-1999 or as amended to characterise the flora and fauna of selected intertidal reef platforms within the marine park with a view to establishing short-term management targets (CCMD, CALM, FWA). (H - KMS) 3. Assess the nature, level and potential impacts of human activities on intertidal reef platforms within the MSMA and adjoining Commonwealth waters (CCMD, CALM). (H) 4. Educate park users about the potential detrimental effects of indiscriminate specimen collecting and reef walking (CCMD, CALM). (H)		
Predicted Outcome	CCMD predict that there will be no impacts on Commonwealth marine area (controlling provisions 23 and 24a) given the bathymetry of the area. As the nearest intertidal reef platforms and community is located 6km from the site of the proposed action, there will be no direct loss of habitat. Currents will carry pollutants northwards under normal conditions, however given the results of coastal engineering studies (see appendix 3) and commitments to maintain marine water quality (see section 4.4.4) no significant impacts on intertidal reef platforms and community and accordingly important populations of loggerhead turtles (controlling provisions 18 and 18a), listed threatened species, that may opportunistically feed on them are anticipated. Herbivorous green and omnivorous hawksbill turtles are known in the area, but the principal feeding ground occurs on shallow backreef areas about 3km to the west of the action. Accordingly controlling provisions 18(4) and 18a (listed threatened species in the vulnerable category) and 20 and 20a (listed migratory marine species) are not considered applicable. Matters in relation to impacts on species of NES will be addressed in following sections.		
Performance measures	1. Diversity 2. Abundance (non-targeted species) 3. Abundance (targeted species)	Desired trend	1. Constant or positive 2. Constant or positive 3. Constant or positive
Short-term targets	To be developed prior to implementation of the CCR.		
Long-term targets	1. That the diversity of flora and fauna on intertidal reef platforms of the park are not reduced from baseline levels (to be determined) as a result of human activities. 2. That the abundance of protected flora and fauna on intertidal reef platforms does not differ between the Maud Sanctuary Zone and otherwise in the MSMA.		

	- metals; - indicators of microbiological contamination (CCMD, CALM). (H - KMS) 3. Develop and implement a Construction Management Plan, including but not limited to the following elements: - Dewatering Management Plan; - Dredge Management Plan. (CCMD, CALM), (H) 4. Develop and implement an Emergency Response Plan, including but not limited to the following elements: - fuel spillage; - fire and explosions; - collision between vessels; and - sewage and chemical spills. (CCMD, CALM, Department of Planning and Infrastructure, Police, FES, SES) (H) 5. Provide a lined and fully bunded facility for fuelling heavy construction machinery. (CCMD, DME) (H) 6. Develop and implement a Nutrient and Irrigation Management Plan (NIMP), including but not limited to: - management strategies; - recommendations for low nutrient/water requirement plants and grasses; - prescribed fertiliser applications; - prescribed fertiliser and watering regime; and - annual fertiliser application audit. (CCMD, DEP, WRC, CALM)(H) 7. Provide a boat sewerage pump-out facility, and inform users of the NMP using the CCR as a point of entry about regulations on boat sewage disposal. (CCMD, CALM, Department of Planning and Infrastructure). (H) 8. On an annual basis, compare the water quality results to those predicted in the nutrient modelling and make appropriate adjustments. (CCMD) (M) 9. Map ecological and social values of the park that are particularly sensitive to oil spills and provide this information to the State Committee for Combating Oil Pollution. (CCMD, CALM, Department of Planning and Infrastructure). (H)		
Predicted Outcome	Modelling indicates that nutrient loadings to the nearshore marine environment will be low. Accordingly, it is CCMD, view that there will be no impacts on Commonwealth Marine area (Controlling Provisions 23 and 24A). Nutrients will not promote algal growth either through the water column or as epiphytes on sea grasses or macroalgae. Infrastructure such as fuelling and sewage pump-out facilities will reduce hydrocarbon leakage from small container fuelling and sewage disposal at sea respectively. Effluent leach drains and evaporation ponds located on the primary dune system at Coral Bay can be decommissioned, reducing current impacts. Accordingly with sustained water quality, it is CCMD's view that there will not be any significant impacts on important populations of loggerhead turtles (Controlling Provisions 18 and 18A) listed threatened species, listed threatened species in the vulnerable category (Controlling Provisions 18(4) and 18A) and listed migratory marine species (Controlling Provisions 20 and 20A).		
Performance measures	1. Nutrients: Chlorophyll <i>a</i> and inorganic nutrient (N) conc. in seawater. 2. Toxicants: conc. in seawater.	Desired trend	1. Constant or negative 2. Constant or negative

	3. Pathogens: Faecal coliform conc. in seawater (limited sites). 4. Litter: Mass (kg) of litter at selected monitoring sites.		3. Constant and/or negative 4. Negative
Short-term targets (KPI)	1. See tables 6 and 7, Appendix 4. 2. As per: <i>Australian and New Zealand Guidelines for Fresh and Marine Water Quality</i> (ANZECC October 2000). - Environmental Quality Objectives identified in the Southern Metropolitan Coastal Waters Study (DEP 1996).		
Long-term targets (KPI)	Ensure that the water quality adjoining the proposed action and adjacent Commonwealth waters meet agreed standards or guidelines for the maintenance of biodiversity including species of NES, ecosystem integrity, direct and secondary contact recreation and seafood for human consumption.		

4.4.5 Seagrasses and Macroalgal Communities

Ecological value	Seagrasses and Macroalgal Communities: <i>Seagrasses and macroalgal communities are not present on substrates that occur within Commonwealth waters offshore from the site of the proposed action. However maintenance of seagrasses and macroalgal communities in shallow marine waters adjoining the site of the proposed action, and on adjacent reefs that may be impacted by increased visitation is important to sustain species of NES known regionally. Maintenance of the species and extent of perennial seagrasses is important, as they are an important habitat and nursery area for marine life.</i>
Background	Marine plants are important primary producers and are highly susceptible to a range of pressures that may occur on both short and long-time scales (Ward, Butler & Hill 1998). These include local scale problems such as pollution and broad scale changes brought about by such effects as climate change. The abundance and species presence of seagrasses and macroalgae in the waters adjoining the CCR are described in section 3.2.2. Scattered hard pavement areas near Point Maud are macro-algae dominated. Localised areas of low-profile pavements occur near Point Maud, and to the northeast of Mauds Landing. The area near Point Maud approximately 2km west of the proposed CCR supports the shallow, mixed macroalgal and <i>Halophila</i> community <i>Halophila</i> is eaten by dugong and is therefore ecologically important. Green turtles are essentially herbivorous and hawksbill turtles are known to feed on a diet essentially of sponges, seagrasses and algae. The sparse occurrences of <i>H. ovalis</i> near Mauds Landing in association with the seasonal and itinerant nature of dugong suggest that the communities occurring in the study area is of limited regional significance. The principal feeding habitat for turtles are shallow backreef areas, to the north and south of Cardabia passage (see Figure 7). Observation of seagrasses within the MSMA indicate that they are generally in good condition although some localised damage may have occurred due to anchors being set in Bateman Bay. There is no evidence of heavy epiphytic growth on seagrasses at present.

	Well-developed macroalgal communities occur extensively along the Ningaloo Reef tract. The nearest backreef algal community to Mauds Landing occurs on the backreef immediately north of Mauds Entrance (Cardabia Passage), approximately 7km to the northwest. Significant subtidal macroalgal communities with high floral diversity occur on reef and pavement substrates within the MSMA. Although these communities are ecologically important, being highly productive and providing food for green turtles, (Environment Australia 1998) the limited examples occurring in the Mauds Landing area are not considered regionally significant (Bowman Bishaw Gorham 1995). These communities are important primary producers and refuge areas for diverse fish and invertebrate assemblages, including turtles. Unlike perennial seagrass communities, most algal communities can quickly recover from disturbance, and accordingly should be assessed annually (Commonwealth of Australia 1998). Macroalgae are considered similarly in good condition. A discussion of the management of water quality impacts is presented in section 4.4.4 above. Algae that detach from reefs often form drifts on the water's surface before accumulating on the seabed or shore as algal wrack. This wrack is ecologically significant in that it contains large numbers of invertebrates, which are prey for surf zone fishes and birds. The decomposition of the wrack also has ecological benefits by releasing nutrients and suspended organic particles into the water.
Existing and potential uses and/or pressures	1. Mooring and anchoring 2. Nutrient inputs from point sources (eg. urban drains) 3. Propeller scour 4. Groundwater discharges (eg. nutrients and pesticides)
Current major pressure	None
Impacts of the Action	In relation to waters leaving the marina, CCMD believe that no discernible changes in nutrient status will occur beyond the immediate zone of influence at the channel entry, and accordingly no measurable environmental impact and therefore there will be no impacts on Commonwealth waters. Increased boat usage will result in increased anchoring damage and propeller scour. Current boat utilisation of the Coral Bay area is described in section 3.3.3. Projected future boat utilisation is presented in section 4.3.3. Boat use patterns will likely change following implementation of the proposed action. Boating activities in Bills Bay will decrease with a more direct route to Cardabia passage becoming available.
Management objective	To ensure changes in water quality, existing and future mooring and anchoring activities and boat usage do not permanently damage seagrasses and macroalgal communities within nearshore marine areas adjoining the CCR.
Evaluation	Seagrasses and macroalgae do not occur in Commonwealth waters adjacent to the site of the proposed action. Macroalgal are the most important producer on reef areas, and dominate hard substrates within the lagoon. Seagrasses are neither widespread nor exhibit high densities within Bateman Bay. FWA (2000) note that anchor and scour damage is limited on seagrasses and sandy substrates, although larger boats may lift seagrass and increase suspended sediments. Nutrient enriched waters may enter the marina water body and accordingly the nearshore waters of Bateman Bay, although measures to minimise mass loadings,

	and accordingly potential macroalgal growth and epiphytic growth impacting on seagrasses will be taken. Boating impacts are limited at present, however are anticipated to increase following implementation of the proposed action. One of the seagrass species present is eaten by the dugong and is therefore ecologically important, however, the sparse occurrences of seagrass near Mauds Landing in association with the seasonal and itinerant nature of the dugong suggest that the communities occurring in the relevant area are of limited regional significance. Macroalgal communities are important as feeding habitat for protected turtles. Boating in backreef areas is unlikely to increase due to the nature of the broken reef present. Some damage may occur to macroalgal communities on pavements in Bateman Bay, due to increased boating activities, however the extent of the beds and limited quantum of increase for these activities will ensure sustainability of the habitat. An extensive monitoring system is proposed to evaluate environmental impacts with a view to initiating management strategies.
Strategies and Mitigation	Strategies for management of seagrasses will include the provision of infrastructure to limit nutrient impacts, support of regulatory agencies, education, surveillance, research and monitoring. The techniques proposed for the MSMA will include gross measures of abundance supplemented by combinations of transect quadrat and leaf-blade measurements as appropriate. Seagrass and macroalgae will be monitored annually and assessed using multivariate statistical analyses to summarise change where appropriate and will be presented as time-series data. Additional strategies include: 1. Develop and implement, a SAMMP for the MSMA, including but not limited to: • complete habitat mapping, including seagrass and pavement algal communities within the MSMA ; • develop management strategies and priorities for management; and • construction impact program be developed with contingencies being prescribed. (CCMD, CALM, FWA). (H) 2. Ensure all existing moorings within the MSMA are either removed or meet a specified environmentally acceptable standard within three years of the operational phase of the CCR, and that all new moorings meet the specified environmentally acceptable standard. (CALM, Department of Planning and Infrastructure, CCMD). (H – KMS) 3. Educate users of the important ecological role of seagrasses and macroalgae and the potential impact of human activities particularly boat moorings, boat travel through shallow areas and nutrient pollution on these communities. (CCMD, CALM). (H - KMS) 4. Assess proposals for new moorings. Moorings will not be permitted if they compromise vessel safety/navigation or if the installation and use of the mooring is likely to have significant impact on the ecological values (CALM, Department of Planning and Infrastructure). (H) 5. Monitor seagrass and macroalgal health within the MSMA (CCMD, CALM). (H)
Predicted Outcome	Modeling indicates that nutrient loadings to the nearshore marine environment will be low. Accordingly CCMD believe that there will be no impacts on Commonwealth marine area (Controlling Provisions 23 and 24A). Nutrients will

	not promote algal growth either through the water column, macroalgae or as epiphytes on sea grasses or macroalgae. Improved mooring systems and public education will mitigate additional boating damage to seagrasses and macroalgae. Accordingly, it is CCMD's view that there will not be any significant impacts on important populations of green and hawksbill turtles (Controlling Provisions 18 and 18A) listed threatened species, listed threatened species in the vulnerable category (Controlling Provisions 18(4) and 18A) and listed migratory marine species such as the dugong (Controlling Provisions 20 and 20A).		
Performance measures	Aboveground biomass (areal extent and density) of perennial seagrasses.	Desired trend	Constant or positive
Short-term target (KPI)	No permanent losses in the aboveground biomass of perennial seagrasses and macroalgal habitat from 2000 levels in defined areas of highest existing risk.		
Long-term target (KPI)	No permanent loss in perennial seagrass aboveground biomass from 2000 levels as a result of human activities in the MSMA.		

4.4.6 Shorebirds & Seabirds

Ecological value	Shorebirds & Seabirds: <i>More than 35 shorebirds and seabirds that are listed as Migratory Species under the EPBC Act and/or protected under JAMBA and CAMBA are known to occur in the Ningaloo area, and over 30 seabirds occur on islands and nearshore and offshore waters in the region.</i>
Background	Although no listed Migratory Species are known to breed at Point Maud, the area is an important roosting and loafing site for a variety of shorebirds and seabirds. Nine species listed as Migratory Species under the EPBC Act and/or protected by bilateral agreements have been recorded at Point Maud during surveys undertaken by CALM between 1990 and 2001. CALM (1997) notes that more than 30 species of seabirds are reported to occur on the coastal islands, mainland coastal and offshore waters of the Ningaloo area. Monitoring of birds at Point Maud by CALM has identified some current potential disturbances by dogs, walkers and vessels. Development of the Mauds Landing Townsite and resulting greater visitation will result in additional pressure on these bird populations. However the construction of the CCR will present a physical barrier to 4WD vehicles and quadbikes that currently freely travel down Point Maud while travelling northward. The presence of the marina waterway may result in drivers and riders using an alternative inland route behind the CCR to gain access to northern beaches, and so lessen impacts on Point Maud. Data relating to the anticipated increase in visitation to the Coral Bay area following implementation of the proposal is presented in 4.3.2. Current landfill management practices are poor and include poor fencing, inadequate cover, excessive open face, wind blown litter and poor vermin control. It is proposed this landfill be replaced by a new and actively managed facility in the services area.

	Commonwealth of Australia (2000) has identified that education is a major strategy to achieve the management goals and thus a strategic objective of the NMP. The desired outcome of public education is to increase public awareness and understanding of conservation and management issues in the area and of the marine environment in general. This will include information on the importance of the protection of bird habitats, and litter management.
Existing and potential uses and/or pressures	1. Expansion of tourism activities at Point Maud 2. Entanglement in fishing gear 3. Entanglement with or ingestion of marine debris 4. Oil spills/pollution
Current major pressure	None
Impacts of the Action	It is CCMD's view that implementation of the proposed action will not impact on protected migratory birds and seabirds occurring within the project area, in nearby waters or passing through Commonwealth marine waters. The action will however result in both an increase in the number of people in the Coral Bay area generally, and result in a shift in the major concentration of people away from the more southerly Coral Bay to a location about 1.7km from the principal bird roosting areas. Greater visitation will also result in an increase in litter generated, greater fishing efforts with a resulting potential increase in entanglement of birds, and an increase in potential disturbance. Increased boat traffic also has the potential to increase oil and fuel spillage.
Management objective	To ensure that human activity does not significantly disturb seabird populations in the MSMA.
Evaluation	Solid wastes will be disposed of to a managed landfill that will be superior to that currently in use with a view to limiting vermin and bird access to litter. Physical activities and noise from the development site during construction and operation is unlikely to cause significant disturbance of shorebirds or seabirds, which largely occur at Point Maud, due to the distance separation and wind patterns. As the construction of the CCR will present a physical barrier to 4WD vehicles and quadbikes these vehicles will be directed to use an alternative inland route and bypass bird roosting areas at Point Maud. The Point Maud area including the beach and dunes is proposed as a prohibited area for 4WDs and quadbikes, and amendment to the currently prohibited area under the <i>Control of Vehicles (Off-road areas) Act 1978</i> will be sought. Bollards and signage will be provided to restrict access to the area. The importance of bird habitat protection and management of fishing waste (including discarded tackle and fishing line) will be included in literature and induction material produced for the CCR and adequate signage will be erected. Visitors will be encouraged to limit speeds and take due caution to avoid disturbance and potential injury of shorebirds and seabirds. Fuel spillage will be reduced by operation of a fuelling facility to replace current practices which include over the beach filling from small containers for all classes of vessels, including commercial. The ability to respond to hydrocarbon losses will be enhanced by appointment of a Marina Manager and the development and implementation of an Emergency Response Plan that will include a spill management protocol.

	Fox control measures implemented on site will reduce pressures on shorebird and seabird populations from introduced predators. Monitoring of species and abundance at Point Maud will be undertaken on a regular basis by CCMD and/or as a result of the permanent presence of a CALM officer at the site.		
Strategy and Mitigation	1. Educate visitors and residents about the ecological significance of the MSMA's seabird populations and the potential detrimental impacts of human disturbance. (CCMD, CALM). (H) 2. Enter into a Natural Resources Management Agreement with CALM and FWA to: • Construct a world class interpretation and environment centre in keeping with the standards of the overall development, and prepare appropriate resources. (CCMD, CALM). (H) 3. Develop and implement an Emergency Response Plan, including but not limited to: • fuel spillage; • collision between vessels; • sewage and chemical spills; • loss of containment at bulk hydrocarbon storage facilities (including boat bunkering). (CCMD, Department of Planning and Infrastructure Police, FRS, SES, CALM) (H) 4. Develop, construct and operate the first cell of a managed landfill site in the services area. The identified site will have sufficient capacity for 20 years disposal. (CCMD, Waste Management WA, LGA) (H) 5. Prohibit 4WD and quadbike access to the Point Maud area through the use of signage and bollards, and possible amendment to the declared area under the <i>Control of Vehicles (Off-road areas) Act 1978</i>. (CCMD, LGA) (H) 6. Undertake regular monitoring of seabirds at Point Maud (CCMD, CALM) (M)		
Predicted Outcome	It is CCMD's view that there will be no impacts on the Commonwealth marine area (Controlling Provisions 23 and 24A). Mitigation measures and public education will reduce foreseen impacts resulting from addition pressures brought about by implementation of the proposed action. Listed migratory marine species such as the eight birds protected under bilateral agreements known from the NMP do not nest at Mauds Landing and adjacent waters (Controlling Provisions 20 and 20A) and mitigation measures described will negate additional pressures.		
Performance measures	1. Species diversity 2. Abundance	Desired trend	1. Constant or positive 2. Constant or positive
Short-term target	Maintain the species diversity and abundance of resident and transient birds within the MSMA.		
Long-term target	Maintain the species diversity and abundance of resident and transient birds within the MSMA.		

4.4.7 Corals and Other Invertebrate Communities

Ecological value	Invertebrate communities: <i>Coral reefs are high profile marine habitats, of high value for tourism and biodiversity values. Although the impacts arising from implementation of the proposed action are unlikely to impact on Commonwealth marine waters, species on NES occur within the area of potential impact, and increased pressures must be considered</i>
Background	Benthic invertebrates of the pelagic zone have not been investigated, but are likely to be representative of the area in general and, by virtue of the limited utilisation of the continental shelf and continental slope, are at present unlikely to

	show any man induced change. The seabed of the continental shelf will likely consist of algae, sponges and soft corals and an anticipated diverse crustacean and mollusc fauna. Sedimentary, soft mud sediments of the continental slope will likely support a benthic fauna likely dominated by sponges, burrowing worms and crustaceans (Commonwealth of Australia 2000) Invertebrates within the State managed portion of the NMP include animals such as corals, rock lobster, squid, cuttlefish, sponges, bivalve and gastropod molluscs, jellyfishes and anemones. Shallow areas of the Ningaloo Reef support a very diverse range of marine invertebrates, the majority of which are tropical species. A brief summary of the groups present and their importance in the Ningaloo Reef system is presented in section 3.2.2. A review of potential impacts on coral reef systems caused by snorkelling and recreational SCUBA diving is presented in section 4.3.5. Australia is recognised as having both the largest area of coral reefs, and those that can be considered remaining in good condition (Commonwealth of Australia 1996). All hard corals (<i>Scleractinia</i>) are listed on Appendix 2 of the Convention on International Trade in Endangered Species (CITES). Flora and fauna of the intertidal platforms have been discussed in section 4.4.3. The deeper pavements support numerous browsing and carnivorous molluscs, such as cerithids and mitras and at times filter-feeding bivalves. The most notable such community is the mussel located 3km from Mauds Landing. Coral reefs provide a great range of habitats and support a varied molluscan fauna ranging from the large clams (<i>Tridacna maxima</i>) interspersed among the corals to tiny muricids within the dead coral branches. The marine substrates closest to Mauds Landing are bare sands and molluscs are expected to be the dominant fauna of the submerged plains. Bivalves of the genus <i>Donax</i> are ubiquitous in lower intertidal beach sands and are expected to occur at Mauds Landing along with polychaete worms. Coral reefs are subject to many different natural and anthropogenic disturbances that may affect reef condition both spatially and temporally. These include changes in sea level, temperature, light attenuation through the water column, and various pollutants including nutrients. Disturbances to coral reef systems range from trivial, such as those caused to individual corals by fish bites, to significant regional and global scale episodes caused by such vectors as major tropical storms, <i>El Nino</i> events, large scale sedimentation and major predation episodes (Simpson, Cary & Masini 1993). The degree of impact to coral reef ecosystems caused by disturbance depends upon the magnitude and frequency of the event and the time necessary for recovery. A variety of natural disturbances to marine environments have been documented over recent decades as knowledge of marine environments has been gained. For Ningaloo, <i>D. cornus</i>, a predatory snail that feeds on corals, became extremely abundant in the early 1980's and devastated coral populations along the Ningaloo Reef (Osborne & Williams 1992). In 1989 a massive synchronised spawning of corals, in association with calm oceanic conditions, caused anoxic conditions to occur in Bills Bay (Simpson, Cary & Masini 1993).
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	Significant damage due to boat traffic has occurred to areas of lagoonal corals in Bills Bay and the informal 'boat track' southward toward Moncks Head. Unmanaged snorkelling and SCUBA diving can also result in significant impacts on coral reefs. Current diving pressures have been described in section 3.3.4, and projected boat diver increases should the action proceed are predicted in section 4.3.5. There remains considerable conjecture about the role of man induced indirect change on 'natural' processes. The removal of predators, for example, has been implicated in outbreaks of pests such as Crown-of-Thorns starfish or <i>Drupella</i> population increases. A major element of the management of human impacts on Ningaloo Reef is the provision of adequate resources to monitor and regulate activities. If the proposal is implemented, CCMD will undertake to enter into a Natural Resources Management Agreement (NRMA) with CALM and FWA to support regulatory activities on approval of proposal. This support will provide the opportunity for the relevant authorities, to develop and institute more effective management controls on the Sanctuary Zone at Bills Bay and the greater NMP area as a consequence of a permanent on-site presence. Monitoring capability will be significantly improved as a consequence, and educational opportunities enhanced. A draft of the NRMA is included as Appendix 7. Monitoring proposed will be modelled on the AIMS Long-Term Monitoring survey techniques (manta tows and video techniques) and supplemented as necessary. Established sites, chosen to complement CALM's existing network will be revisited annually or as agreed with CALM, and sufficient to detect change. Mapping the areal extent of coral reefs will be repeated five years from the initial survey. For reporting and interpretation, changes in coral reef flora and fauna species composition will be assessed using multivariate statistical analyses to summarise change and time-series data will be presented.
Existing and potential uses and/or pressures	1. Anchor damage, prop-wash and impacts from boats on sensitive coral formations. 2. Activities that degrade critical habitats such as high turbidity stormwater from unsealed parking areas following intense rainfall events. 3. Trophic interactions. 4. Diffuse and point source pollution such as nutrient discharges.
Current major pressures	1. Anchor damage, prop-wash and boating impacts 2. Smothering of corals and other invertebrates.
Impact of the Action	It is CCMD's view that implementation of the proposed action will not impact on soft corals occurring on the continental shelf in Commonwealth waters. FWA (2000) note that anchor and scour damage to coral reefs is of concern in high activity areas. Larger boats may increase suspended sediments. The action will result in both an increase in the number of people in the Coral Bay area generally, and accordingly those wishing to recreate within the shallow lagoonal and adjacent areas on the seaward side of Ningaloo Reef. Most of these activities will occur in State waters. The effects of anchor damage, prop-wash and impacts from boats on sensitive coral formations can clearly been seen along the 'boat track' and frequently visited areas within Bills Bay. Coral breakage is also evident at frequently dived sites, principally caused by fine strikes due to diver inexperience or poor buoyancy. Increased boat traffic also has the potential to increase oil and fuel spillage, together with a greater potential for smothering due to dredging impacts or stormwater discharge. Increased fishing pressure for

	prize bottom fish and as a consequence of greater visitation, which in turn allows for the increase of their natural prey that may be in turn cause higher coral mortalities may lead to loss of coral diversity or abundance.
Management objective	1. To ensure the species diversity and abundance species are not significantly impacted by human activities in the MSMA.
Evaluation	It is CCMD's view that the provision of improved mooring systems and public education will mitigate additional boating damage to seagrasses and macroalgae has previously been discussed in section 4.4.5. Similar moorings at designated diving sites would reduce anchor damage and boat impacts on sensitive coral formations. With the relocation of the commercial vessels from Bills Bay, prop wash effects will also be reduced. Stormwater with high levels of suspended solids are known to leave unsealed parking areas and roadways at Coral Bay during significant rainfall events. This particulate can smother corals, as can sediments suspended by prop wash and suction. All areas within the proposed CCR will be sealed or paved, and stormwater will be directed away from the marina waterway to a series of depressions to the east of the development. The marina waterway will be excavated 'dry' using earthmoving machinery, and dredging will be limited to removing the final section of the entrance channel once the excavation is completed and the void filled. Measures to manage diver impacts relate to the improvement of diver knowledge through education, the improvement of diver skills in critical areas such as buoyancy control, the provision of appropriate resources to limit impacts and regulatory limits and controls. Management strategies such as diver rotation through a number of dive sites to limit utilisation to, for example, 5,000 dives per annum would ensure damage was controlled to below that which would not affect the ecological values of the marine park. Based on predicted diver demand, this would require a minimum 6 SCUBA sites were used on rotation. The development of a single point of entry for all commercial and recreational boats in the marine park, greater regulatory presence, availability of safe and protected constructed snorkelling reef and snorkelling trail, and education opportunities afforded by improved management would all assist in maintaining environmental values.
Strategies and Mitigation	- Develop and implement, a SAMMP for the MSMA and other areas accessed from CCR, including but not limited to: - detailed habitat mapping of the MSMA; - water quality measurement; - development of management strategies and priorities for management; - implementation of SAMMP prior to breakwater materials being placed; - SAMMP with annual reporting and 5-year review from effective completion of the development. (CCMD, CALM, FWA, Environment Australia) (H – KMS) - CCMD will enter into a Natural Resources Management with CALM and FWA to provide resources for environmental and resource management in the NMP. (CCMD, CALM, FWA) (H – KMS) - Identify opportunities to remove large boat traffic from the Mauds Sanctuary area. (CALM, Department of Planning and Infrastructure). (H – KMS) - Undertake research programs to characterise invertebrate diversity and abundance in different zones in the MSMA. (CCMD, CALM). (H - KMS) - Identify invertebrate species that will be protected from recreational or commercial fishing in the park and provide the necessary legislative protection to achieve this. (FWA, CALM, CCMD). (H-KMS)

	6. Educate visitors and residents about the ecological significance of the MSMA's coral reefs and the potential detrimental impacts of human disturbance, including diver training. (CCMD, CALM). (H)		
Predicted Outcome	It is CCMD's view that there will be no impacts on Commonwealth marine area (Controlling Provisions 23 and 24A). Management and mitigation measures and public education will reduce foreseen impacts resulting from addition pressures brought about by implementation of the action. Improved mooring systems and public education will mitigate additional boating and diver damage to coral reef. Accordingly, it is CCMD's view that there will not be any significant impacts on the support structure of important populations of loggerhead, green, flatback and hawksbill turtles (Controlling Provisions 18 and 18A) listed threatened species, listed threatened species in the vulnerable category (Controlling Provisions 18(4) and 18A) and listed migratory marine species such as the dugong (Controlling Provisions 20 and 20A).		
Performance measure	1. Diversity 2. Abundance	Desired trend	1. Constant or positive 2. Constant or positive
Short-term target	Live coral density increases to pre-1989 levels within Bills Bay. Live coral density to 2001 levels within specified areas of Bills Bay		
Long-term target	1. Non-target invertebrate diversity and abundance in the MSMA is maintained or increases over current levels (to be determined prior to the implementation phase of CCR). 2. Within the Maud Sanctuary Zone, invertebrate diversity and abundance is maintained or increases over current levels (to be determined prior to the implementation phase of CCR).		

4.4.8 Fish

Ecological value	Fish: <i>A rich fish fauna that includes an interesting mix of tropical, and sub-tropical species. The impacts arising from implementation of the proposed action may impact on Commonwealth marine waters, by increasing the fishing pressure on bottom dwelling species of ecological importance to species of NES that occur within the area of potential impact.</i>
Background	The Ningaloo Reef Tract supports extremely diverse populations of reef fishes including many tropical species that are at the southern limits of their range and subtropical species that do not extend further north. Ayeling and Ayeling (1987) and Hutchins (1994) have undertaken surveys of species presence and abundance within the Ningaloo Reef Tract. A brief summary of the representative groups of finfish and their importance is presented in section 3.2.2. One factor thought to be responsible for the high diversity of reef fishes occurring along the Ningaloo Reef is the proximity of the continental shelf and the influence of the Leeuwin Current (Taylor & Pearse 1999). In the Mauds Landing area, fish numbers are greatest on the shallow energetic areas of the outer Ningaloo Reef. Large numbers of fish are also found in association with the shallow, coral environments of the Ningaloo Reef backreef, particularly at the diverse coral community 9km north of Mauds Landing (Bowman Bishaw Gorham 1995). There are currently no permits issues to Deepwater Trawl vessels to fish within the NMP (Cary at al 2000). The pavement habitats near Point Maud and north-east of Mauds Landing support a relatively impoverished fish fauna with turf algae eating fishes, such Parrotfishes and Surgeonfishes, being the most common (Bowman Bishaw

	Gorham 1995). The bare sand substrates surrounding Mauds Landing have a very depauperate fish population with occasional schools of pelagic fishes such as trevally and mullet being the most frequently encountered. The rich fish fauna is not only of intrinsic ecological value but it is also important in that it has significant tourism and recreation potential. Divers and snorkellers have the opportunity to view a wide diversity of subtropical and tropical species in an area that is readily accessible. CALM (2000) notes that the management of fish species that are taken for recreational and commercial purposes under the <i>Fisheries Resources Management Act 1994</i> also need to consider the viability of the populations of these species in the context of maintaining the values of the marine park. Impacts of removal of important fishes in such matters as natural control of pests of coral organisms has previously been described in section 4.4.7. Recreational rod and line fishing from shore or boat based within the NMP is permitted within recreation and general use zones and must comply with FWA regulations regarding daily bag limits, size limits protected and fish possession limits. FWA in Cary et al. (2000) determined that recreational fishing effort from boats launched from major boat ramps to be 54 000 boat hours and 45,000 days fished in 1998/99 (all of Ningaloo Reef). Predicted current effort from commercial boats for Coral Bay is about 10,000 fishing days. No estimation of shore based fishing pressures has been made. Fish are totally protected from extractive activity in Maud Sanctuary zones that comprise the southern extent of the MSMA. The major potential pressures on the diversity and abundance of non-target finfish in the Ningaloo Marine Tract are incidental extraction by commercial and recreational fishing activities (ie. by-catch), alteration or loss of critical habitats, and declines in water quality. The anticipated increase in demand for boat trips specifically for the purpose of fishing is described in section 4.3.5. To overcome this potential problem, consideration is required as to the appropriateness of recreational and/or commercial extraction of these species. This decision may be based upon a number of factors including species distribution, abundance, life history and an assessment of the ecological and social importance of the species within the context of the area. FWA notes that catch effort and biological data is inadequate within the NMP and the Gascoyne Region generally (FWA 1999; 2000). Management of fisheries impacts has been presented in section 4.3.5, and summarised in Table 19. Without management, an increase visitation will increase fishing pressures and with it bring about a likely reduce target fish numbers and incidental catch. Although no species of national significance make up target finfish species, fishing effort may degrade critical habitats through such impacts as anchoring or propeller damage, and implications on trophic interactions by removal or target fish species may result in an increase in pest species. Entanglement in fishing tackle has previously been noted for seabirds. The details of the monitoring program will be agreed upon with CALM and be consistent with and complement the Ningaloo Marine Management Plan currently under review.
Existing and potential uses and/or pressures	1. Incidental recreational and commercial extraction. 2. Activities which degrade critical habitats 3. Trophic interactions

Current major pressures	Anecdotal evidence of local depletion of certain prize fish.
Impact of the Action	CCMD calculate that implementation of the proposed action will bring about an approximate 21% increase in demand for fishing charters over that predicted for 2009. As a consequence, fishing pressure on the diversity and abundance of target and non-target finfish in the NMP will increase, and alteration or loss of critical habitats, and declines in water quality may occur. Although species of NES will not be specifically targeted, the above changes may also result in a disruption to trophic interactions important for maintaining balance in habitats that make up the support systems for reef based protected animals such as turtles and dugong.
Management objective	To ensure the species diversity and abundance of non-target fish species are not significantly impacted by human activities in the MSMA.
Evaluation	Finfish are totally protected from extractive activity in Maud Sanctuary zones that comprise the southern extent of the MSMA. Regulation of fish extraction from this and other areas of the NMP will be enhanced by the provision of resources at CCR that will result in permanent regulator presence. Strategies for the management of further fishing pressure should the proposed action take place include assessment of bag and species specific and size limits. Education programs directed at fishers, increased surveillance and research and monitoring. The techniques proposed for these elements of the SAMMP will, together with CALM, FWA and local tourism operators include: protocols and strategies to manage manta ray tourism experiences with a view to identifying sustainable levels of interaction, triggers to identify unacceptable impacts and management procedures should this occur.
Strategies and Mitigation	1. Educate users of the importance of maintaining fish diversity and the potential impacts of human activities, on these populations. (CCMD, CALM). (H - KMS) 2. Funding toward the construction and outfitting of an Environment and Interpretive Centre to support regulatory agency functions within the region. The Centre will also provide educational opportunities for visitors. (CCMD, CALM, FWA). (H - KMS) 3. Develop, in consultation with CALM and FWA, a SAMMP for the MSMA, including but not limited to: • management strategies for ecotourism target species such as whales, whale sharks, manta rays, marine turtles and dugong. (CCMD, CALM, FWA, Environment Australia). (H - KMS) 4. Undertake research programs to characterise finfish diversity and abundance in different zones in the MSMA. (CCMD, CALM). (H - KMS) 5. Identify finfish species that will be protected from recreational or commercial fishing in the MSMA and provide advice to regulatory agencies. (CCMD, FWA, CALM). (H-KMS)
Predicted Outcome	It is CCMD's view that there will be no significant impacts on Commonwealth marine area (Controlling Provisions 23 and 24A), although some increased fishing will occur. CCMD believe that the additional management capability and mitigation measures allowed by single point of entry and public education will reduce foreseen impacts resulting from addition pressures brought about by implementation of the proposed action. Improved mooring systems and public education will mitigate additional boating pressures. Accordingly CCMD believe that there will not be any significant impacts on the support structure of important populations of loggerhead, green, and hawksbill turtles (Controlling Provisions 18 and 18A) listed threatened species, listed threatened species in the vulnerable

	category (Controlling Provisions 18(4) and 18A) and listed migratory marine species such as the dugong (Controlling Provisions 20 and 20A).		
Performance measure	1. Diversity 2. Abundance	Desired trend	1. Constant or positive 2. Constant or positive
Short-term target	To be developed prior to the implementation phase of CCR.		
Long-term target	1. Non-target fish diversity and abundance in the park is maintained or increases over current levels (to be determined). 2. In sanctuary zones, fish diversity and abundance in the park is maintained or increases over current levels (to be determined).		

4.4.9 Turtles

Ecological value	Turtles: <i>Four species of sea turtles have been reported in the MSMA, with two known to breed in Bateman Bay. All four species are protected under the EPBC Act.</i>
	Turtles are seriously threatened worldwide. Four species of turtle known to utilise the waters adjacent to Mauds Landing include the green, loggerhead, hawksbill and flatback. Of these, the green and loggerhead are known to nest on beaches opposite to and to the north of the site of the proposed action. A brief summary of the biology of these turtles in a Western Australian context is presented in section 3.2.1. Under the EPBC Act the green, hawksbill and flatback turtles are listed as vulnerable and the loggerhead is listed as endangered. Under the <i>Western Australian Wildlife Conservation Act 1950</i> the loggerhead is listed as rare. The green turtle feeds on macroalgae and are by far the most common turtle on Ningaloo Reef. A dense and diverse macroalgal assemblage occurs in backreef areas adjoining Cardabia Passage. Loggerhead turtles are carnivorous, feeding mainly on molluscs and crustaceans. They may utilise the mussel beds 3km northeast of Mauds Landing, and are also known to congregate on backreef areas during the day. Hawksbill turtles are omnivorous, feeding mainly on sponges and are more often located in deeper water, seaward of Ningaloo Reef. These are the turtle most likely to occur in Commonwealth waters. Aerial surveys of the NMP suggest that an estimated population of approximately 4300 turtles (all species) is resident within the Park (Preen et al. 1997). Seventy-one turtle nests were recorded in Bateman Bay during the 1999/00 season (Mack 2001), with a further 68 during the summer of 2000/01. Nesting turtles represent a breeding population of about 24 loggerheads and one or two green turtles. This constitutes about 0.5 % of the estimated stock of breeding female loggerhead turtles in Western Australia. The major impacts on turtles while in Australian waters are mortality of adults while in prawn nets, shark nets and gill nets, collisions with speed boats, subsistence hunting by indigenous communities, habitat degradation and predation on eggs by feral animals (Commonwealth of Australia 1995). FWA (2000) does not identify any of these impacts as resulting from recreational fishing activities in the Gascoyne. Mack (2001) states that the single greatest threat to loggerhead turtles on the Ningaloo Reef is nest disturbance by foxes.

	Construction of the marine breakwater and entrance channel will remove approximately 300 m of beach and foredone that may be used for turtle nesting. The breakwaters will extend 200m from the HWM and may present an obstacle for turtle nesting. Plotting of loggerhead turtle nests during the 2000/01 summer (Figure 7) identified three nests on the beach immediately in front of the proposed resort. The majority of nesting occurs approximately 6km to the north of the development, linked to the presence of shoreline reef platforms. A strategy for the management of turtles in Bateman Bay and adjacent Commonwealth waters is presented in Appendix 8. Implementation of this proposal will result an estimated 159 boats operating from CCR. This will include 68 boats relocated from those currently operating in Coral Bay. Implementation will result in a reduction, particularly of commercial boats, travelling down the sensitive backreef areas utilised by protected turtles for resting and feeding. Further issues in relation to human pressures on turtles resulting from the implementation of this action have been presented in section 4.3.5. Owners of Cardabia Station have given an undertaking to assist in turtle and cetacean management in the area. A copy of correspondence to this effect is presented in Appendix 9.
Existing and potential uses and/or pressures	1. fox predation of nests; 2. incidental catch in fisheries gear and shark control gear; 3. ingestion of synthetic material; 4. vessel strike; 5. tourism impacts (harassment, disturbance of nesting) ; 6. disease; and 7. indigenous harvest of adults, juveniles and eggs for food or tortoiseshell.
Current major pressure	Currently significant interactions with loggerhead turtle nesting populations on organised and informal tours. Nest disturbance by feral animals considered the greatest threat.
Impact of the Action	Turtle impacts principally occur within State controlled waters, and within the Ningaloo Reef. All aspects of turtle management will be described in a Turtle Management Plan (see Appendix 8 for draft of this plan) to be finalised, on approval of the proposal in consultation the CALM and relevant experts. The impacts of feral animals, particularly foxes will be through direct control (baiting and trapping) and reduction in alternative food availability with the construction and operation of a managed landfill site. Landfill management will also reduce litter that could be ingested by turtles. The Baiyungu people have given an undertaking to assist in management of turtles in the area, which will reduce pressures from the indigenous harvest. In relation to incidental catch, there is no commercial trawling in State or Commonwealth waters of the central portion of Ningaloo Reef, and limited recreational netting is strongly regulated, requiring nets are only set in certain areas and cleared regularly. The possibility of vessel strikes and harassment may increase as a result of the operation of additional boats arising from the implementation of the proposed action
Management objective	To ensure turtles within the MSMA, including those protected under the EPBC Act, are not significantly disturbed by human activities.

Evaluation	CCMD believe that the control of fox populations through construction of a managed landfill site and eradication programs will have the greatest impact on the success of turtle recruitment on Bateman Bay. The loss of 300m of nesting habitat will result in females that otherwise nest in that specific location moving to alternative acceptable areas of the beach. Opportunities to reduce indigenous harvesting of turtles and turtle products will also be sought. The possibility of vessel strikes and harassment may increase as a result of the operation of additional boats arising from the implementation of the proposed action. However, this is mitigated by a reduction in larger commercial vessels and potentially private vessels passing along the sensitive backreef areas important for turtle resting and feeding. Increased demand for commercial turtle nesting and hatching tours have been identified. Beach access from CCMD controlled lands will be managed. Further opportunities to control beach access from CALM controlled beaches and Cardabia land will be investigated. CCMD believe that opportunities for improved education resulting from the single point of entry and provision of an environment and interpretive centre are also seen as an important component of limiting impacts.		
Strategies and Mitigation	1. Develop and implement a Turtle Management Plan and Turtle Nesting Surveillance Program including: • public education; • lighting controls; • maintenance of nesting habitat; • off road vehicle controls; • litter; • environmental degradation. (CCMD, CALM, Environment Australia, Local Community) (H-KMS) 2. Maintain records of the incidence of entanglement, boat collisions and deaths of turtle species. (CCMD, CALM, and Local Community). (M) 3. Ensure turtle interaction activities do not impact wildlife, through education programs and liaison with charter operators. (CCMD, CALM). (M)		
Predicted Outcome	It is CCMD's view that there will be no impacts on the Commonwealth marine area (Controlling Provisions 23 and 24A). Mitigation measures and public education will reduce foreseen impacts resulting from addition pressures brought about by implementation of the proposed action. Listed migratory marine species such as green and hawksbill turtles will be managed such that the action will not substantially modify, destroy or isolate an area of important habitat, nor seriously disrupt the lifecycle (breeding, feeding, migration or nesting behaviour) of the population (Controlling Provisions 20 and 20A). Similarly, CCMD believe that the additional pressures on the threatened and vulnerable loggerhead, green, flatback and hawksbill turtles, will not reduce the area of occupancy of any of the species or seriously disrupt the lifecycle (breeding, feeding, migration or nesting behaviour) of the populations, particularly of loggerheads known to breed on Bateman Bay (Controlling Provisions 18 and 18A, 18(4) and 18(A)).		
Performance measure	1. Reported animal entanglements /year* 2. Reported animal-boat collisions /year* 3. Report annual recruitment from nesting activities on Bateman Bay* * as a proportion of fauna population	Desired trend	1. Negative 2. Negative 3. Positive from 2001 figures.
Short-term target	To be developed as a component of a Turtle Management Plan prior to construction commencing at CCR.		
Long-term target	No significant disturbance to turtles in the MSMA from human activities.		

4.4.10 Whale Shark

Ecological value	Whale Shark: <i>Whale sharks move from offshore waters into the NMP where they congregate from March to May each year.</i>
Background	The location of the main aggregation of whale sharks within the NMP varies from year to year. Between 200-400 whale sharks, believed to be mostly juvenile males, can occur in the Park. The whale sharks mainly occupy the turbulent waters along the outer edge of the reef front where the current is flowing northward (the Ningaloo Current). The locations of whale shark interactions in the vicinity of the proposed action, drawn from CALM records, is shown in Figure 8. The principal area of interaction occurs in State and Commonwealth controlled waters south west of Point Cloates A brief overview of cetaceans on the Western Australian coastline is presented in section 3.2.2. An overview of the potential impacts of increased visitation and boat traffic resulting from the implementation of the proposed action is presented in section 4.3.5. Whale sharks are the subject of immense tourist interest (Davis et al. 1997; Norman 1999). The whale shark tourist industry, including snorkelling, has developed into a major tourist attraction (Cary et al 2000). Light aircraft locate whale sharks and direct commercial vessels to intercept them. Whale sharks are a threatened and migratory species protected under Controlling Provisions 20 and 20A of the EPBC Act, and are protected under (Western Australian) Wildlife Conservation (Close Season for Whale Sharks) Notice (1996) (<i>Wildlife Conservation Act 1950</i>). Under this notice, only CALM authorised and Licensed operators can interact with whale sharks (Cary et al. 2000). These regulations control boat activity and diver access in the vicinity of whale sharks. Nevertheless, in the past, there have been instances of boat contacts with whale sharks (blue antifouling paint marks on the whale sharks, propeller damage to fins), and some whale sharks, particularly previously injured animals, avoiding boats (Norman 1999).
Existing and potential uses and/or pressures	- Physical disturbance: - boat collisions and boat noise; and - commercial whale-watching tours. - Nutrient inputs from sewage discharge from boats - Pollution from fuel spills. - Entanglement (e.g. in litter, ropes, discarded fishing gear)
Current major pressure	None at present, although there is evidence of boat-induced injury or contact and avoidance behaviour.
Impact of the Action	Based on anticipated demand, and additional 71 boat trips annually, requiring one additional boat operating at 80% capacity will be required to meet demand over the period of the whale shark watching season. Possible impacts related to the increased demand for whale shark interactions include pollution from fuel spillage, nutrient impacts resulting from sewage discharge from boats, litter impacts, and physical disturbance to wildlife resulting from boat activity or propeller strikes.
Management objective	To ensure cetaceans in the MSMA are not significantly disturbed by human activities
Evaluation	Only CALM authorised and Licensed operators can interact with whale sharks. Although, trailer drawn and moored private boats that will operate out of CCR can access waters used by whale sharks under appropriate sea conditions. Based

	Other species opportunistically encountered by tourism operators in oceanic waters along the central portion of NMP include the Indo-Pacific humpback dolphins, minke, southern right, and blue whales, together with a range of smaller toothed whales and dolphins. Humpback calves are occasionally observed entering Bateman Bay to rest in the calm waters off Mauds Landing (Hunt 2001). Killer whales, (<i>Orcinus orca</i>), have also been observed within Bateman Bay. Humpback whales have been identified as species of NES under the EPBC Act, and are protected under (Western Australian) Wildlife Conservation (Close Season for Marine Mammals) Notice (1996) (<i>Wildlife Conservation Act 1950</i>). Under this notice, only CALM authorised and Licensed operators can interact with humpback whales (Cary et al. 2000). FWA note that boat collisions with marine mammals appear rare and unlikely (FWA 2000) These impacts may occur in a combination of State and Commonwealth waters, consistent with the location of the humpback whale. In contrast to whale sharks however, private boat owners in trailer mounted and moored vessels can operate in areas frequented by humpback whales (see Figure 8). The current incidence of entanglement of cetaceans in fishing gear or litter is considered to be low as historically commercial fishing has historically been limited in the area (Commonwealth of Australia 2000).
Existing and potential uses and/or pressures	- Physical disturbance: - boat collisions and boat noise; and - commercial whale-watching tours. - Entanglement (eg. in litter, ropes, discarded fishing gear)
Current major pressure	None at present
Impact of the Action	Based on anticipated demand, and additional 90 boat trips requiring one additional boat operating at 60% capacity will be required to meet demand over the period of the whale watching season. Possible impacts related the increased demand for whale watching include pollution from fuel spillage, nutrient impacts resulting from sewage discharge from boats, litter impacts, and physical disturbance to wildlife resulting from boat activity or propeller strikes.
Management objective	To ensure cetaceans in the MSMA are not significantly disturbed by human activities.
Evaluation	Only CALM authorised and Licensed operators can interact with humpback whales, although trailer drawn and moored private boats that will operate out of CCR can readily access waters used by whales. Based on predictions of visitation trends and resulting demands, implementation of the action would only result in one additional commercial boat trip daily.
Strategies and Mitigation	- Develop and implement a Marine Mammal Management Plan in consultation with CALM and the local community, including but not limited to: - record of interactions; - records of entanglement, boat collisions and stranding; - response procedures. (CCMD, CALM, Environment Australia) (H-KMS) - Maintain records of the incidence of entanglement, boat collisions and stranding of cetacean and turtle species (CCMD, CALM, and Community). (M) - Ensure whale interaction activities do not impact wildlife, through education programs and liaison with charter operators. (CCMD, CALM) (M)
Predicted Outcome	Impacts may occur either in Commonwealth marine area (Controlling Provisions 23 and 24A) or State controlled water. It is CCMD's view that State controls on

	commercial operators, research and public education will reduce foreseen impacts resulting from addition pressures brought about by implementation of the proposed action. Humpback whales, a listed migratory marine species will be managed such that the action will not substantially modify, destroy or isolate an area of important habitat, nor seriously disrupt the lifecycle (breeding, feeding, migration or nesting behaviour) of migrating population (Controlling Provisions 20 and 20A). Similarly, it is considered that additional pressures on the threatened and vulnerable humpback whales, based on the quantum of increase following implementation of the proposed action, will not reduce the area of occupancy of the species and seriously disrupt the lifecycle (breeding, feeding) or migration (Controlling Provisions 18 and 18A, 18(4) and 18(A)).		
Performance measure	1. Reported animal entanglements/year* 2. Reported animal-boat collisions/year* * as a proportion of fauna population	Desired trend	1. Negative 2. Negative
Short-term target	To be developed prior to the operational phase of CCR.		
Long-term target	No significant disturbance to cetaceans in the park from human activities.		

4.4.12 Dugong

Ecological value	Dugong: <i>Small and scattered populations exist within state waters of the NMP. Maintenance of a support mechanisms within state waters adjoining the action is important to sustain species on NES known regionally</i>
Background	Dugong (<i>Dugong dugon</i>) is the only fully herbivorous marine mammal in Australia. Populations within the NMP are small and scattered (Cary et al 2000). The species is large, long lived and has a slow reproductive cycle. Dugong inhabits shallow, warm nearshore coastal waters of the Indian and western Pacific oceans (Strahan 1998). Along the Australian coast, this species typically occurs in waters from Shark Bay in Western Australia around the northern coast to Moreton Bay in Queensland. The dugong population in Australia is estimated to be the largest remaining in the world. About 80 000 dugongs are reported to occur in Australian waters, an estimated 12 000 of which occur in the Great Barrier Reef World Heritage Area. The total population of dugong in the NMP is estimated to be in the order of 1000 individuals (Preen et al. 1997). Dugongs are encountered by commercial operators and individuals opportunistically within the Ningaloo Reef. FWA note that boat collisions with marine mammals appear rare and unlikely (FWA 2000). Due to the low abundance of seagrass present within Bateman Bay, it is likely that those encountered are transient between more substantial meadows to the north and south. Major concerns in managing the species relate to overfishing by indigenous communities, mortalities in fishing nets, and loss of seagrass habitat.
Existing and potential uses and/or pressures	- Physical disturbance: - boat collisions and boat noise; and - commercial whale-watching tours. - Entanglement (eg. in litter, ropes, discarded fishing gear)
Current major pressure	None known.

	on predictions of visitation trends and resulting demands, implementation of the proposed action would only result in one additional commercial boat trip daily during the whale shark season. Due to the distance to interaction sites and reliance on spotter planes to locate whale sharks, contact is principally with Licensed commercial boats.		
Strategies and Mitigation	1. Maintain records of the incidence of entanglement, boat collisions and injury to whale sharks (CCMD, CALM, and Community). (M) 2. Ensure whale shark interaction activities do not impact wildlife, through education programs and liaison with charter operators (CCMD, CALM) (M)		
Predicted Outcome	Impacts may occur in the Commonwealth Marine area (Controlling Provisions 23 and 24A) or State controlled water. It is CCMD's view that State controls on commercial operators, research and public education will reduce foreseen impacts resulting from addition pressures brought about by implementation of the proposed action. Whale sharks, a listed threatened marine species, will be managed such that the action will not substantially modify, destroy or isolate an area of important habitat, nor seriously disrupt the lifecycle (breeding, feeding, migration or nesting behaviour) of migrating population (Controlling Provisions 20 and 20A).		
Performance measure	1. Reported animal-boat collisions/year * 2. Reported incidences of avoidance measures by whale sharks* * as a proportion of annual contacts.	Desired trend	1. Negative 2. Negative
Short-term target	To be developed prior to the operational phase of CCR.		
Long-term target	No significant disturbance to whale sharks in the park from human activities.		

4.4.11 Cetaceans

Ecological value	Cetacean: <i>Of the cetaceans recorded in Australian waters, Humpback whales occur regularly in NMP. Together with the common dolphin, humpback whales may also regularly be seen in State controlled waters.</i>
Background	Six species of toothed whale have been recorded from the Ningaloo area, while eight species of baleen whale have been recorded in the deeper waters offshore. Five of the eight species of baleen whales are listed as <i>rare or likely to become extinct</i> under the <i>Western Australian Wildlife Conservation Act 1950</i> due to over-exploitation during the whaling era. Humpback whale numbers have increased significantly since the cessation of whaling. The Group IV population occurring on the west coast of Australia, is historically the largest population of humpback whales in the southern hemisphere (Heyward, Revill & Sherwood, 2000). The southern right, humpback and blue whales are also protected under the <i>Environment Protection and Biodiversity Conservation Act 1999</i>, being listed as endangered. The common dolphin and humpback whales are the only cetaceans that are regularly seen in the NMP waters. While the dolphins are probably resident in park waters, humpback whales are transitory visitors to these waters during their annual migration northward along the Western Australian coastline. A brief overview of humpback and other cetaceans on the Western Australian coastline is presented in section 3.2.2. An overview of the potential impacts of increased visitation and boat traffic resulting from the implementation of the action is presented in section 4.3.5.

Impact of the Action	Possible impacts related the increased demand ecotourism tours include pollution from fuel spillage, nutrient impacts resulting from sewage discharge from boats, litter impacts, and physical disturbance to dugong due to snorkeller activity, boat activity or propeller strikes.		
Management objective	To ensure dugong within State waters adjacent to the proposed action are not significantly disturbed by human activities		
Evaluation	The Baiyungu people have given an undertaking to assist in management of marine mammals in the area, which will reduce pressures from the indigenous hunting. In relation to entanglement, there is no commercial trawling in State or Commonwealth waters of the central portion of Ningaloo Reef, and limited recreational netting strongly regulated, requiring nets are only set in certain areas and cleared regularly. The possibility of vessel strikes and harassment may increase as a result of the operation of additional boats arising from the implementation of the proposed action. However this is mitigated by a reduction in larger commercial vessels and potentially private vessels passing along the sensitive backreef areas between Point Maud and the barrier reef. Increased demand for commercial snorkelling tours have been identified. Opportunities for improved education resulting from the single point of entry and provision of an environment and interpretive centre are also seen as an important component of limiting impacts.		
Strategies and Mitigation	- Develop and implement a Marine Mammal Management Plan in consultation with CALM and the local community, including but not limited to: - record of interactions; - records of entanglement, boat collisions and stranding; - response procedures. (CCMD, CALM, Environment Australia) (H-KMS) - Maintain records of the incidence of entanglement, boat collisions and stranding of cetacean and turtle species (CCMD, CALM, and Community). (M) - Ensure whale interaction activities do not impact wildlife, through education programs and liaison with charter operators. (CCMD, CALM) (L)		
Predicted Outcome	Impacts may occur in State controlled water resulting from opportunistic contact with dugong during snorkelling ecotourism activities. It is CCMD's view that State controls on commercial operators, research and public education will reduce foreseen impacts resulting from addition pressures brought about by implementation of the proposed action. Dugong, a listed migratory marine species, will be managed such that the action will not substantially modify, destroy or isolate an area of important habitat, nor seriously disrupt the lifecycle (breeding, feeding, migration or nesting behaviour) of migrating population (Controlling Provisions 20 and 20A).		
Performance measure	- Reported animal entanglements/year* - Reported animal-boat collisions/year* * as a proportion of fauna population	Desired trend	- Negative - Negative
Short-term target	To be developed prior to the operational phase of CCR.		
Long-term target	No significant disturbance to cetaceans in the park from human activities.		

4.5 Public Comment, Performance Assessment and Audit

The comparison of a set of repeated measurements, with a benchmark set or condition provides the basis for detecting change as a measure of both the effects of a particular pressure and efficacy of management responses. These performance measures have been described in the indicative SAMMP included as Appendix 5. Relevant comments in relation to the implementation, performance assessment and audit of the SAMMP are presented below.

4.5.1 Public Submissions on the Maud SAMMP

Following receipt of all necessary Commonwealth and State approvals for the proposed action to be implemented, the SAMMP will be finalised with relevant Agencies. Consistent with the MPRA requirements, the SAMMP will then be made publicly available for comment through a formal submission period. This will be an opportunity, provide information, and suggest alternatives and improvements to the Plan.

The draft SAMMP for the MSMA will be made available for a period of six weeks, and changes accommodated where consistent with agreed objectives and both the Commonwealth and State Ningaloo Marine Park Management Plans.

4.5.2 Duration of the Maud SAMMP

The SAMMP for the MSMA will be implemented, in the first instance, for a period of five years following the structural completion of the CCR. It is anticipated that this will occur not less than twelve years following implementation of the proposal. At this time, a workshop and review will be held to determine the need for and continuation of all or any aspects of the SAMMP and ongoing funding opportunities.

4.5.3 Annual Reports and Triennial Audits

The effectiveness of the SAMMP for the MSMA will be reviewed annually against the stated goals, short and long term measures, (i.e. outcome-based approach) and against progress regarding implementation of the key management strategies (i.e. activity-based approach), as presented in draft form in Appendix 5 of this PER document, and finalized in consultation with Environment Australia, CALM and relevant agencies.

The annual report will be prepared for submission to CALM and FWA.

A further formal audit and review process will be carried out by CALM every three years. The Triennial audit will include reports on the status of the key ecological values of the MSMA and an assessment of the effectiveness of current management strategies in the context of the SAMMP and the umbrella Ningaloo Marine Park Management Plans. The annual reports and triennial audits will further provide feedback to park managers.

Notwithstanding the best intentions of the majority of visitors and residents in the Coral Bay/Mauds Landing area, there will always be a need to monitor the level of compliance and, where users continue to undertake illegal activities, take action to stop inappropriate behaviour. This can only be achieved through the permanent presence of officers from regulatory agencies who have appropriate resources and equipment.

CALM and FWA have identified additional pressures on the NMP that will result from the implementation of the CCR proposal. The SAMMP is an initiative of CCMD that will assist statutory mechanisms of management within the MSMA and NMP generally.

To assist in managing these pressures, CCMD, on approval of the proposal, will enter into a binding agreement with CALM and FWA to provide additional resources for the NMP. This will go toward the provision of a permanent regulatory staff presence, office space/research facility, and capital items.

4.7 Environmental Risk Assessment

Det Norske Veritas (DNV) have been engaged by CCMD to undertake a Qualitative Risk Assessment of the proposed CCR to determine the level of risk to human life and the environment.

Public risk and safety was assessed using the Australian/New Zealand Standard AS/NZS 4360: 1999 "Risk Management". Terms and categorisations used in this document are the same as those in AS/NZS 4360.

The hazardous events associated with the proposed CCR facilities have been identified and then ranked according to the risk to human life, and environment separately. The significant environmental hazards identified by the risk assessment are:

- Cyclone damage to maritime;
- Ground & water pollution due to landfill;
- Environmental impact due to sewage; and
- Storm surge (ocean flooding).

Elements of risk management considered during this project included:

- Identification of risks for the proposed CCR facilities; what, why and how.
- Events can arise as a basis for further analysis.
- Analysis of the risks; analysis of risks in terms of likelihood and consequence in the context of existing and proposed controls.
- Assessment and prioritisation of risks; risks are ranked to identify management priorities.

A full listing of all assumptions and considerations is presented in the complete risk report found in Appendix 10.

When comparing the values in the risk matrix at the extremes, a value of "25" in the risk matrix (refer to Table 21) indicates a hazardous event that is expected to occur in most circumstances and that has potentially catastrophic consequences. A value of "1" in the risk matrix indicates a hazardous event that may occur but only under exceptional circumstances and has potentially insignificant consequences.

In other cases a value of "9" in the risk matrix indicates that the hazardous event should occur at some time but have moderate consequences. A value of "16" in the risk matrix indicates a hazardous event that will probably occur in most circumstances with potentially major consequences.

TABLE 21
RISK RANKING MATRIX

LIKELIHOOD CONSEQUENCE	RARE (1)	UNLIKELY (2)	POSSIBLE (3)	LIKELY (4)	ALMOST CERTAIN (5)
INSIGNIFICANT	1	2	3	4	5
MINOR	2	4	6	8	10
MODERATE	3	6	9	12	15
MAJOR	4	8	12	16	20
CATASTROPHIC	5	10	15	20	25

Table 22 presents a summary of risk ranking results for environmental hazards resulting from the implementation of the action.

TABLE 22
**SUMMARY OF RISK RANKING RESULTS FOR ENVIRONMENTAL
HAZARDS - PROPOSED CORAL COAST RESORT RISK RANKING**

HAZARD	RISK RANKING
Cyclones – Damage to Maritime	9
Landfill - Ground & Water Pollution	8
Sewage Effluent – Environmental Impact	8
Cyclones - Storm Surge (Ocean Flooding)	6
Airstrip - Soil Contamination	4
Beaches / Boat Channels – Damage to Coral Reef from Commercial, Recreational & Fishing Boats 2	2

The maximum environmental hazard ranking relates to potential damage resulting from a cyclone in the vicinity of the CCR. CCMD will provide a number of control measures to reduce the risk to human life and damage to maritime and the coral reef in the event of a cyclone. These include the construction of an inland marina designed for boats to moor in the area. Such an event would also cause significant damage to coral reef structures independent of the implementation of the proposal.

4.8 Environmental Management System

An environmental management system (EMS) is a structured approach to ensuring sound environmental management in industrial or other activities, including the

adoption of pollution prevention techniques and the mitigation of negative environmental impacts. Poor management is often the basic cause of poor environmental performance. Accordingly the adoption of measures that improve management can be viewed as positive in reducing environmental impacts.

The practical application of EMS has, until now, been mainly within large enterprises with a specific focus on industrial activities. A set of specifications and standards, under the umbrella of ISO 14000, has been developed as the proposed common international EMS framework.

4.8.1 Implementation of Environmental Management Systems for CCR

It is proposed that health; safety and environmental management plans for the CCR will comply with OHSAS 18001 and ISO 14001. This system will facilitate the management of the Occupational Health, Safety and environmental risks associated with the construction and operation of CCR. Management systems will include the organisational structure, planning activities, responsibilities, practices, procedures, processes and resources for developing, implementing, achieving, reviewing and maintaining the proposed Occupational Health, Safety and Environmental policy.

Relevant EMS plans and procedures will be developed by DNV in consultation with ATA Environmental and major consortium members.

Major consortium members, Brown and Root Services Pty Ltd and Clough Engineering Ltd, (resort construction) and Brown and Root Services Asia Pacific Pty Ltd (utilities and services provider, asset manager and facilities maintenance) each hold certification under ISO 9000 group of documents.

Other plans and procedures identified in the Management section of this report (section 4.4) and summarised in section 5.0 below will be incorporated within the ISO 14000 series documentation to ensure coverage of issues.

4.6 Implementation of the SAMMP for the MSMA

The SAMMP will be developed to provide support principally for CALM and FWA consistent with the management objectives of the NMP. The SAMMP describes the management plan for a small, though heavily impacted portion of the NMP. It cannot be viewed in isolation, but as an integral part of a suite of complementary management practices that occur within and adjacent to both the DIA, elsewhere within the NMP, and more broadly across all Western Australian waters.

A Natural Resources Management Agreement (NRMA) has formed the basis for the provision of this support, and is included in full in Appendix 7. The NRMA has been developed by CALM and FWA will be finalised in the event this project proceeds. It provides additional resources to Government agencies to redress current pressures in the Coral Bay area and those additional pressures that may result as a consequence of the implementation of this action.

The SAMMP details a range of strategies relating to the measurement of impacts as an input to the management of particular human activities in the MSMA and more widely in areas accessed from Mauds Landing/Bills Bay.

The effectiveness of these strategies will be dependent on the extent to which the users of the park abide by these restrictions. The education program is recognised as critical to achieving a high level of compliance as in most cases users will abide with controls where they are clearly aware of what they are and why they have been implemented.

A research and monitoring program is a key strategy in that it develops an understanding of the natural and social environment of the MSMA and monitors the state of the area's environment. This allows the early detection of detrimental changes and provides the trigger for management action to ameliorate potential impacts before they lead to undesirable changes in the MSMA and accordingly NMP values. Implementation and achievements against short and long-term objectives of the SAMMP will be subject to annual audit by CALM on advice from FWA.

A management hierarchy between CCMD and CALM as the lead agency within the NMP will need to be concluded prior implementation of the Maud SAMMP. It is anticipated the hierarchy will see the CCMD environmental manager report to the District Manager, CALM who has responsibility for the day to day management of the NMP.

It is acknowledged that the detection of human-induced changes requires an understanding of what is 'natural' as a benchmark. Much of this information does not exist within the proposed MSMA at present, or more broadly in the NMP. Similarly the management responses to changes have yet to be determined. Notwithstanding, pressures continue to grow within the NMP as a consequence of increasing visitation.

Accordingly, such research and monitoring programs need to focus on establishing the natural state of key ecological values and processes.

5. CONSOLIDATED LIST OF COMMITMENTS

A number of commitments have been presented in section 4.4 and made with a view to reducing environmental impacts. Commitments identified in the text to present do not reflect the full range of impacts addressed in the development of the action. All commitments made to address environmental pressures and social requirements are presented below.

1. The proponent will prepare and implement occupational health, safety and environmental management systems for the Coral Coast Resort that will comply with OHSAS 18001 and ISO 14001. The Systems will include but not be limited to:

- the organisational structure;
- planning activities;
- responsibilities;
- practices;
- procedures;
- processes; and
- identify resources.

for developing, implementing, achieving, reviewing and maintaining the proposed Occupational Health, Safety and Environmental policy. The Environmental Management System will be to the satisfaction of the Environmental Protection Authority. The System procedures, framework and procedures required for the construction phase of the project will be completed prior to construction commencing. The procedures relating to post-development management will be prepared in draft prior to the opening of the resort and marina and finalised following the first annual review.

2. The proponent will prepare and implement, in consultation with the Department of Conservation and Land Management and the Marine Parks and Reserves Authority, a Specific Area Marine Management Plan (SAMMP) for the Maud Specific Management Area, which will include but not be limited to:

- detailed habitat mapping of the Maud Specific Management Area;
- water and sediment quality including nutrients chlorophyll *a*, turbidity, and light extinction through the water column, nutrients; metals; indicators of microbiological contamination, tributyltin;
- development of management strategies and priorities for management;
- implementation of SAMMP with annual reporting and 5-year review from effective completion of the development;
- complete habitat mapping, especially of seagrass and pavement algal communities within the Development Impact Area;

- develop management strategies and priorities for management for ecotourism target species such as whales, whale sharks, manta rays, marine turtles and dugongs;
- construction impact marine monitoring program be developed as a component of the SAMMP with contingencies being prescribed;
- confirm earlier findings on fish species presence in Development Impact Area, and broader Maud Specific Management Area. Complete habitat mapping;
- develop management strategies and priorities for fish management in consultation with Department of Conservation and Land Management and Fisheries Western Australia (*see commitment 4*);
- coral monitoring will comprise a component of a broader program to identify the condition of habitat types within the likely area of direct influence, and as an indicator of the likely impacts of broader fishing/utilisation pressure as a consequence of the likely greater level of visitation resulting from the implementation of this proposal.
- monitor for and develop contingency measures in consultation with the Department of Conservation and Land Management and the CSIRO Centre for Research on Introduced Marine Pests for introduced marine pests to protect resident marine species.

The monitoring phase of the plan will commence prior to construction and continue for a minimum period of five years from the opening of the Coral Coast Resort, with review, both at the end of each year and at the end of the five-year period. The initial version of the Specific Area Marine Management Plan will be approved by the Marine Parks Management Authority prior to completion of Stage 1 of the project.

3. Prior to commencement of construction, the proponent will enter into a Natural Resources Management Agreement with Department of Conservation and Land Management and Fisheries Western Australia. This agreement will clearly define the scope and responsibilities of each of the parties to the agreement with regard to:
 - provision for baseline environmental research and ongoing monitoring programs;
 - provision of resources to Department of Conservation and Land Management and Fisheries Western Australia for management of the natural resources, commensurate with the management burden the development would create;
 - construction of a world class interpretation and environment centre in keeping with the standards of the overall development; and

- establishment of a propagated coral reef within the marina to reduce the impacts on the natural environment and provide opportunities for education and interpretation.
4. The proponent will, prior to commencing operation of the Coral Coast Resort, develop management strategies and priorities for fish management in consultation with Fisheries Western Australia, including:
- collection of major catch survey data to establish baseline fish stock data; and
 - development of relevant fishing quality indicators.

These strategies will be incorporated in the Specific Area Management Plan as they are developed.

5. The proponent will, prior to commencement of construction, develop and implement a Turtle Management Plan and Turtle Nesting Surveillance Program in consultation with Department of Conservation and Land Management and the local community. The plan will address but not be limited to the following matters:
- public education;
 - lighting controls;
 - maintenance of nesting habitat;
 - off road vehicle controls; and
 - litter.
6. The proponent will, prior to commencing operation, develop and implement a Marine Mammal Management Plan in consultation with Department of Conservation and Land Management and the local community, including but not limited to:
- record of interactions;
 - records of entanglement, boat collisions and strandings; and
 - response procedures.
7. The proponent will, prior to commencing construction develop and implement, in consultation with Department of Planning and Infrastructure and Department of Conservation and Land Management, a Shoreline Movement Management Plan. The plan will address but not be limited to the following matters:
- characterisation of sediment changes;
 - coastal (including sediment) accretion and erosion;
 - measurement of beach profiles;
 - accretion and erosion rates; and
 - identification of remedial actions.
8. The proponent will, prior to commencing operation, develop and implement, in consultation with Department of Conservation and Land Management and

Department of Planning and Infrastructure, a Foreshore Management Plan, including but not limited to:

- education and signage;
- the provision of paths, boardwalks and coastal facilities;
- formalisation of parking and recreation areas;
- installing protective measures and improvements;
- definition of dune preservation and fencing areas;
- rehabilitating foreshore areas; and
- contingency measures for foreshore stabilisation in the event of tropical cyclone damage.

The plan will be prepared to the satisfaction of the Environmental Protection Authority on the advice of the Department of Planning and Infrastructure.

9. The proponent will limit clearing of remnant vegetation to development areas only and protect areas that will not be directly impacted by the development to the satisfaction of the Environmental Protection Authority.
10. The proponent will develop and implement, in consultation with Department of Conservation and Land Management and Department of Environmental Protection, an Environmental Management Program. This Program will include but not be restricted to the following management plans:
 - Specific Area Marine Management Plan (SAMMP) (*see commitment 2*);
 - Terrestrial Flora and Fauna Management Plan (describing control of access to sensitive vegetated areas, beaches and lagoons and prohibition of cats and dogs at the Coral Coast Resort in line with normal National Park regulations);
 - Terrestrial Fauna Relocation Management Plan (if required) (*see commitment 32*);
 - Emergency Response Plan (*see commitment 14*);
 - Construction Management Plan (*see commitment 15*);
 - Nutrient and Irrigation Management Plan (*see commitment 17*);
 - Marina Water Quality and Sediment Management Plan (*see commitment 19*);
 - Turtle Management Plan (*see commitment 5*);
 - Marine Mammal Management Plan (*see commitment 6*);
 - Shoreline Movement Management Plan (*see commitment 7*);
 - Foreshore Management Plan (*see commitment 8*);
 - Revegetation and Landscaping Plan (*see commitment 11*);
 - Building and Landscaping Guidelines (*see commitment 29*);
 - Transport Management Plan (*see commitment 36*); and
 - National Threatened and Migratory Species Management Plan (*see commitment 42*).
11. The proponent will, prior to construction develop and implement, in consultation with Department of Conservation and Land Management and Department of Environmental Protection a Revegetation and Landscaping Plan including but not limited to:

- appropriate plant selection and practical planting areas;
- nursery and propagating methods of acceptable species;
- soil improvement and use of mulch;
- appropriate maintenance;
- installing protective measures and improvements;
- irrigation and water conservation; and
- revegetation and rebuilding damaged dunes.

The plan will be developed to the satisfaction of the Environmental Protection Authority on advice from the Department of Conservation and Land Management.

12. The proponent will design resort structures and buildings, to the approval of Department of Planning and Infrastructure and the Shire of Carnarvon, to meet 1 in 100 year return period storm events, with contingencies.
13. The proponent will design stormwater management systems, to the satisfaction of Department of Environmental Protection on advice from Department of Planning and Infrastructure and the Shire of Carnarvon to, as far as practicable, direct stormwater inland away from both the Coral Coast Resort and marina.
14. The proponent will, prior to commencing operation of the Coral Coast resort develop and implement an Emergency Response Plan, to the satisfaction of the Department of Environmental Protection on advice from the Police, Fire and Emergency Services WA and the Department of Planning and Infrastructure to address but not be limited to:
 - cyclone and flood warning and response;
 - tsunami warning and response;
 - emergency evacuation procedures;
 - fuel spillage;
 - fire and explosions;
 - collision between vessels;
 - sewage and chemical spills;
 - failure of containment at the WWTP; and
 - loss of containment at bulk hydrocarbon storage facilities (including boat bunkering).
15. The proponent will, prior to commencing construction, develop and implement a Construction Management Plan, including but not limited to the following elements:
 - dewatering management plan;
 - dredge management plan;
 - dust management procedures;
 - noise management procedures;
 - stormwater management; and
 - waste management.

The plan will be developed to the satisfaction of the Environmental Protection Authority on advice from the Department of Conservation and Land Management.

16. The proponent will construct all bulk fuel storage tanks in accordance with Australian Standard AS1940-1993 and the requirements of the Department of Mineral and Petroleum Resources to limit the potential impacts from hydrocarbon spillage during construction and operation.
17. The proponent will, prior to the operation of the Coral Coast Resort, develop and implement a Nutrient and Irrigation Management Plan which will include but not be limited to:
 - management strategies for limiting the use of nutrients and water and optimising the uptake of applied nutrients and water by plants;
 - recommendations for low nutrient/water requirement plants and grasses;
 - prescribing fertiliser and watering regime aimed at preventing the export of nutrients from the terrestrial environment to the marina environment; and
 - a procedure for an annual fertiliser application audit.

The plan will be developed to the satisfaction of the Environmental Protection Authority

18. The proponent will construct a boat sewage pump-out facility for use by boats moored in the marina.
19. The proponent will, prior to commencing the placement of breakwater materials develop and implement a Marina Water Quality and Sediment Management Plan that will include but not be limited to:
 - procedures for a Water Quality and Sediment Monitoring Program to allow comparison with the results from within the marina to those predicted in the nutrient modelling, and make appropriate adjustments on an annual basis; and
 - identification of specified procedures to be put in place to control, identify and manage marina water quality and sediment impacts including but not limited to:
 - education of boat users regarding the discharge of sullage/sewage and other wastes into the marine environment generally and the marina in particular;
 - exclusion of boats from the marina using antifouling paints containing tributyltin; and
 - controls over refuelling and maintenance of boats in the marina.

The plan will be developed to the satisfaction of Environmental Protection Authority of the advice of the Department of Planning and Infrastructure.

20. The proponent will develop, construct and operate, in consultation with the Department of Environmental Protection and the Shire of Carnarvon, the first cell of a managed landfill site in the services area. The identified site will have sufficient capacity for 20 years disposal.
21. The proponent will, prior to the operation of the Coral Coast Resort, design and install, in consultation with the Water Corporation and Shire of Carnarvon, reticulated sewerage and construct a waste water treatment plant to service the Mauds Landing Townsite, with provision for upgrading to accommodate the connection of Coral Bay.
22. The proponent will, prior to commencing construction, develop and implement, in consultation with Water & Rivers Commission, a Shallow Groundwater Monitoring Program and an Artesian Water Operating Strategy that will address but not be limited to:
 - the locations and design of monitoring bores bore locations;
 - the parameters and frequency of sampling;
 - a methodology for a review of the efficiency of use of artesian water;
 - identification of responsibilities for monitoring activities and reporting of results associated with the plan; and
 - contingency measures to be adopted in the event that significant impacts are identified in either the shallow or Birdrong aquifer.
23. The proponent will provide funding toward the construction and outfitting of an Environment and Interpretive Centre and for limestone substrate and propagation of a coral reef.
24. The proponent will engage contract an appropriately qualified and experienced archaeologist and consult with the Baiyungu community on any sites of significance uncovered during construction (*see commitment 25*).
25. The proponent will, prior to commencing construction, develop and implement, in consultation with the Baiyungu people the Aboriginal Affairs Department and WA Maritime Museum, a Site Heritage Protocol that will include but not be limited to:
 - induction of all employees and site contractors;
 - educational opportunities on aboriginal culture and heritage issues for all employees, visitors and residents;
 - protection of known sites of significance *any* sites of significance that may be uncovered during the life of the project and the conservation procedures for these sites;
 - responsibility under Aboriginal Affairs Act;
 - procedures to be implemented if an article or site is uncovered; and
 - maritime artefacts.
26. The proponent will, prior to construction, finalise and implement an agreement with the Baiyungu people relating to training, employment and self managed

business opportunities, including provision of funding for Cultural and Tourist Facilities.

27. The proponent will prior to construction, finalise a Native Title Agreement consistent with the requirements of the *Native Title Act 1999*.
28. The proponent will, on completion of the marina, relocate pylons from the former Mauds Jetty to a recreation area within the marina in consultation with Department of Planning and Infrastructure and Conservation and Land Management.
29. The proponent will, prior to completion of earthworks associated with the marina, develop and implement Building and Landscaping Guidelines to be required as conditions of sale and building approval in the development of the site, including but not limited to:
 - finished floor levels;
 - setbacks and height limitations;
 - building theme, design, construction materials and palette of colours;
 - fencing and outhouse design and materials;
 - landscape and water conservation guidelines;
 - nutrient minimisation and management; and
 - special precinct, universal use and vehicle/recreational vehicle provisions.

The guidelines will be to the satisfaction of the Environmental Protection Authority on advice from the Shire of Carnarvon.

30. The proponent will, prior to commencing operation of Coral Coast Resort, develop and implement Resort Management Agreement with Shire of Carnarvon that documents agreements on a range of matters including but not limited to:
 - the use of differential and specified area rating to ensure adequate funding exists to maintain infrastructure important for safeguarding the environment in the vicinity of the Coral Coast Resort;
 - long and short term management of the public infrastructure in the resort and marina;
 - environmental management commitments and coastal and waterways management; and
 - the formation and resourcing of a management committee to oversee the management of the Coral Coast Resort.
31. The proponent will develop and implement an Agreement with an experienced utility supplier to build, own and operate utility services, including but not limited to:
 - power, artesian water, potable water and landfill site;
 - wastewater treatment;
 - services area and light industrial sites;

- provision to connect Coral Bay, if requested; and
 - utilities management committee.
32. The proponent will undertake a terrestrial fauna survey of the development site prior to commencing ground-disturbing activities. Should sensitive or specially protected fauna be identified in the area proposed for disturbance the proponent will seek advice from the Department of Conservation and Land Management and develop and implement a Terrestrial Fauna Relocation Management Plan for the population's protection which will include but not be limited to:
- trapping procedures; and
 - procedures for relocating to other areas, prior to or on a 'as needs' basis during construction.
33. On completion of Stage 1 of the project, the proponent will prohibit the operation of quad bikes from businesses within the Coral Coast Resort to protect the nearby foredunes and beaches.
34. The proponent will support the recognition of the western area of Point Maud as a gazetted area under the *Control of Vehicles (Off-road Areas) Act 1978* to protect seabird resting and loafing areas.
35. Prior to completion of Stage 1 of the project, the proponent will develop a "Charter for Management" to identify responsibility for undertaking Coral Coast Resort management commitments, funding requirements and sources for the medium and longer term in consultation with all decision-makers and involved management agencies. The Charter of Management will be prepared to the satisfaction of all signatories including the Environmental Protection Authority and the Department of Environmental Protection.
36. The proponent will, prior to construction, develop and implement a Transport Management Plan in consultation with Main Roads Western Australia, the Shire of Carnarvon and the Shire of Exmouth to put in place funding arrangements and specified procedures to manage heavy haulage transport operations during the construction period of the Coral Coast Resort.
37. The proponent will, prior to completion of Stage 1 of the project, relocate the current airstrip to minimise the risk to both the residents and short-stay visitors to the Coral Coast Resort and surrounding areas posed by the operation of light aircraft.
38. The proponent will, prior to construction, in consultation with the Shire of Carnarvon and Main Roads Western Australia will design, the Coral Coast Resort and Services Area access roads to ensure that intersections are:
- at agreed locations; and
 - meet relevant safety design standards.
39. The proponent will, prior to construction, in consultation with the Shire of Carnarvon, the Shire of Exmouth and Main Roads Western Australia undertake

a road safety audit and implement the findings of the road safety audit to ensure all roads associated with the proposal are safe.

40. The proponent will, during construction, in consultation with the Shire of Carnarvon, the Shire of Exmouth and Main Roads Western Australia provide funding for additional road maintenance brought about by additional road wear that occurs as a direct result of the implementation of the proposal to ensure all roads impacted by the proposal remain safe.
41. The proponent will, prior to operation of the Coral Coast Resort:
 - Develop educational materials relating to limiting impacts on the proposed Yardie Creek Road.
 - Contribute limited funding toward the development of an EAMP for the proposed Yardie Creek Road.
- 42a. The proponent will, prior to construction (placement of breakwater materials), prepare a National Threatened and Migratory Species Management Plan to the satisfaction of Environment Australia, Department of Conservation and Land Management and the local community, to describe the impacts and the management responses to these impacts on listed threatened and migratory species.
- 42b. The proponent will, before commencing the operation of the Coral Coast Resort, implement the approved National Threatened and Migratory Species Management Plan.

6. COMMUNITY CONSULTATION

6.1 Introduction

An essential feature of any major development project is the need to consult and address relevant issues with the wider community. CCMD has recognised the importance of keeping the existing residents of the Coral Bay settlement, businesses, landowners, local authorities and interest groups fully informed about the proposed development of CCR since its inception. A targeted public consultation process has been undertaken to ensure these groups and individuals have the opportunity to comment on any aspect of the project. Community consultation has identified impacts and resulted in management measures altering the design, construction and operation strategies. The consultation has further provided opportunities for public awareness and comment.

A further formal public comment period has resulted as a result of the assessment of environmental impacts required under Western Australian environmental legislation.

The involvement of the community in developing the proposal has led to the modification of several aspects of the project to accommodate ideas and concerns of the public. The consultation process has proved to be effective in developing a more environmentally sound project with broader community acceptance.

Specifically, the consultation approach has involved the following opportunities for public awareness and discussion:

- stakeholder consultation meetings including local government, other government agencies and parliamentary members;
- liaison with the Shires of Carnarvon and Exmouth, Department of Environmental Protection, Environmental Protection Authority, Water & Rivers Commission, Ministry for Planning, FWA, Department of Conservation and Land Management, Department of Planning and Infrastructure (previously Department of Transport), and other relevant government agencies;
- discussions with the Baiyungu people;
- incorporation of the findings of, and discussion with, participants involved in the Gascoyne Coast Regional Strategy and Exmouth Learmonth Structure Plan;
- utilising the *North West Telegraph* and the *Northern Guardian* newspapers for media releases and articles discussing the project proposal;
- utilising the *North West Telegraph* and the *Northern Guardian* newspapers to advertise the public information and display event;
- community news announcements on ABC Radio Exmouth;

- posting information on the public information days on community noticeboards in Exmouth, Carnarvon and Coral Bay; and
- holding Public Information and Displays in Carnarvon, Coral Bay and Exmouth.

A summary of the issues raised during public consultation is provided in Table 23.

TABLE 23
COMMUNITY COMMENTS DURING INITIAL CONSULTATION
AUGUST 18 – 22, 2000

Comment Focus	Issue	Examples
Effect on sustainability of: • fish stocks • ecotourism • target species • Bills Bay area	Development will increase the number of people (including residential) using NMP. Increased damage may be due to • greater visitation (exceed 'carrying capacity')	• diver damage • increased boat use & anchor damage • impacts on fish stock due to greater fishing pressure • impacts of additional interaction on whale sharks, marine turtles, manta rays and marine mammals • increase potential for boat strikes (dugong, marine turtles) • potential increase in risk of turtle nest disturbance; • marine turtle disorientation due to light overspill; • interruption of manta ray feeding and other activities; • increased whale shark interaction
	• Water quality impacts	• nutrient rich urban discharges to marina & marine environment • boat fuelling • on-board sewage
Waste treatment	• Solid Waste	Comments that the current landfill site is unacceptable. Current landfill site is: • poorly managed; • has potential to contaminate shallow aquifer; • odorous; Consider composting similar to that adopted at Lord Howe Island.
	• Liquid Waste	Concern that proposed development will add to already elevated nutrient levels in Bills Bay area.
Substrate & foreshore	Development will alter circulation patterns and depositional characteristics on shoreline.	• accretion of sediments on W breakwater, with beach erosion on shoreline to E of channel entrance • increase turbidity/smothering due to construction impacts; and • difficulty in maintenance of channel
Storm surge	Development will not be able to withstand storm surge.	Needs to withstand a significant storm surge.
Beach access	Foreshore will become a 'private beach' and public access denied.	Denied access for local fisherman/ visitors wishing to make use of recreational vehicles.

Comment Focus	Issue	Examples
Coastal Road	Concern about access/management of access to Northern Coastal Road.	Opposing views expressed seeking: - assured access to track and all access point northward; and - formalisation of road and limited access only to coast.
Ineffective regulation and management	Fish-stocks will be further depleted. Safety of swimmers.	CALM, and to a lesser extent FWA, do not have the resources and legislative tools to manage even the existing level of development. Implementation will only make matters worse.
Provision of low cost accommodation	No low cost temporary and permanent accommodation.	Concerns expressed in relation to: - possible extension of existing poor quality employee accommodation at Coral Bay; and - seen as an 'upper end' resort with no provision for affordable employee/ family accommodation

The response of CCMD to these comments is presented below

6.2 Response to Public Comments

6.2.1 Summary

Comments in support of the proposal will not be further discussed. Responses are limited to issues raised that either have:

- the potential to have a significant adverse impact on the habitat, lifecycle (e.g. breeding, feeding, migration and the life expectancy) and spatial distribution of a number of species of NES; or
- where implementation may result in impacts on the Commonwealth portion of NMP.

A number of species of national environmental significance occur in these waters.

The following summary of issues and responses reflect the nature and intent of written and verbal comments made during the initial public consultation program. In response, references are drawn to relevant sections within the text.

A. Unsustainable use of area will cause the carrying capacity to be exceeded causing:

- depletion of fish stocks;
- change in behaviour of ecotourism target species;
- will impact directly on turtle breeding areas; and
- further pressure on the fragile coral species in Bills Bay.

Suggestions for better management included:

- recommendation to extend sanctuary zone to Bruboodjoo Point;

- a need for education of visitors to reduce environmental impacts;
- a need to manage construction timing impacts around the turtle-nesting season; and
- fish bag limits may need to be reviewed.

B. Waste Management

Suggestions for better management included:

- the need to provide adequate wastewater treatment facilities; and
- requirements to construct and operate a decent rubbish tip.

C. Substrate & Foreshore

- concern about waves, currents & resulting sedimentation caused by the breakwaters; and
- concerned about the maintenance of ongoing access to beaches.

Suggestion for better management included:

- stopping uncontrolled 4WD access to beach north of Mauds Landing.

D. Ineffective regulation and management

- CALM & FWA are currently ineffective and building the Coral Coast Resort will make it worse

E. Water quality management

- concern about nutrient management including fertilisers; and
- concern about maintaining adequate water circulation through the marina.

6.2.2 Responses to Comments Arising from Written or Verbal Submissions

A. Unsustainable use of area will cause the carrying capacity to be exceeded

Many written and public submissions raised the concern that implementation of the CCR proposal will result in the 'carrying capacity' of this section of the NMP to be exceeded. This was the single greatest issue of concern.

The matter of exceeding a harvesting rate or otherwise over-utilising a resource is not a function of the number of people visiting an area, but management of those people such that detrimental impacts are limited. Similarly, the management of a natural system or elements of that system under stress is not the responsibility of an individual regulatory agency or resort manager, but rather a combination of all users or responsible agencies for a common end result.

It can be demonstrated that the level of uncontrolled development that has occurred at Coral Bay has caused deleterious changes to the Bills Bay area due to inappropriate effluent disposal and boating pressure. Ecotourism opportunities continue to be

exploited without an understanding of the potential impacts on the target species. Concurrently, fishing pressure continues to increase without baseline catch and effort data for the area and biological information for select species being undertaken. As a result there is no measure to determine when the 'carrying capacity' is being approached and no management procedure in place to correct the imbalance.

Regardless of the implementation of this proposal, visitation numbers are increasing, and with it pressure on the marine fauna. Comments made during the initial community consultation indicate a general lack of confidence amongst the Coral Bay community in the ability of both CALM and FWA to manage the existing pressure on the Ningaloo Marine Tract. The implementation of this proposal will likely add to these pressures unless research on stresses and management plans are effected to protect target species and their support systems.

In recognition of these issues, CCMD, on approval of the proposal, will enter into a binding agreement with CALM and FWA to provide additional resources for NMP. This will go toward the provision of a permanent regulatory staff presence, office space/research facility and capital items. A draft of the Natural Resources Management Agreement is included as Appendix 7.

Based on 80% average peak occupancy, it is estimated that the total population at full development would be approximately 2025 persons comprising 1330 tourists and 695 residents and staff. In the short term, this may alleviate the overcrowding that presently occurs in Coral Bay during peak (school holiday) periods. The project will be implemented over a 10 to 12 year period, during which time tourist numbers will slowly increase. Baseline data on fish stocks, current pressures on target species and corresponding management strategies, and indicators of the health of the environment will be collected during the initial construction phase. During this initial (minimum two-year) period, there will not be any additional visitor numbers. As the increase in visitor numbers occurs during the operational phases of the CCR (see Table 3 for predicted project staging), additional pressures from increased visitation can be measured, new management strategies developed or existing strategies modified and these measures implemented. The SAMMP is integral in this process, and also provides an audit and reporting framework to ensure potential impacts arising from implementation of the development will be identified and addressed.

A commitment has also been made to include within the SAMMP strategies to address all potential impacts arising from the implementation of this beyond the specific management area, and including Commonwealth waters.

The potential impacts of greatest relevance to turtle populations at the Ningaloo Reef are vessel strikes, accidental entanglement ingestion of marine debris, and physical habitat degradation or destruction. Deliberate killing or injuring and incidental catch related to fishing for other target species are unlikely given the utilisation of the area and commitment of the Baiyungu Aboriginal people to conservation of turtles.

The potential for impacts on breeding turtles is acknowledged on the beaches of Bateman Bay. Records of nesting indicate Bateman Bay is predominantly used by Loggerhead turtles for nesting, and the principal area is approximately six kilometres from the proposed development site. Potential impacts will be addressed initially through design features of the CCR (such as limited footprint, lighting controls, water

quality and litter control), and managed through the implementation of an agreed Turtle Management Plan identified in the turtle management strategy (Appendix 8) addressing such issues and feral animal control and beach access.

This is consistent with management measures aimed at conserving turtles on the Great Barrier Reef (Dobbs 2001).

Swimming amongst the sensitive coral formations of Coral Bay remains one of the greatest single attractions of the area. However there continues to be clear evidence that boat operation, in particular large vessels, in Bills Bay continues to cause damage. Diver and swimmer safety is also a concern especially as the boat path passes within 50 m to 100 m from shore in one of the areas most frequented by visitors for this pursuit.

A number of recommendations have been made during the community consultation period to reduce impacts of the proposed CCR. There is a clear desire to manage manta ray interactions with a code of practice being proposed similar to that currently in place for whale sharks. Such management measures and others such as extension of the Sanctuary Zone to Bruboodjoo Point or further bag restrictions must be viewed as a part of a complementary suite of management practices. These include fisheries management, wildlife management and marine transport and safety measures that will be aided by data collected through the implementation of this proposal.

It is also anticipated that the implementation of the finalised SAMMP, together with the opportunities afforded by single point entry for boating and the education programs proposed to accompany this development will provide the management tools to minimise the potential impacts brought about by this proposal.

B. Waste Management

A number of correspondents reflected frustration at existing management facilities present at Coral Bay in particular the lack of active management of the landfill site and wastewater treatment facilities. In relation to the CCR development, a services area occupying approximately 62ha will be situated some 1.5km east of the existing Bills Bay and will comprise major utilities sites for power, water and effluent treatment as well as a landfill disposal site.

The services area has been sized so that it can also accommodate the service and waste disposal requirements of the existing Coral Bay settlement. Additionally, the utilities infrastructure will have the capability for expansion to service the needs of the Coral Bay settlement, should that be required. The Water Corporation has confirmed that the Services Area proposed by CCMD is also their preferred site for a wastewater treatment plant to service the Coral Bay settlement.

C. Substrate & Foreshore

Coastal stability and foreshore management is intrinsically linked. A number of correspondents identified the possibility of coastal erosion and foreshore loss as a matter of major concern. The Great Barrier Reef Marine Park Authority has noted that sand replenishment, may cause beach compaction, escarpments, and alter egg and hatchling survivorship (Great Barrier Reef Marine Park Authority 2001).

An extensive assessment of coastal processes and their potential impacts on shoreline stability at the Mauds Landing site has been undertaken by M. P. Rogers & Associates and is reproduced in full in Appendix 3.

The report concludes that longshore transport of sediment is anticipated to be negligible under the prevailing swell wave regime. During extreme cyclonic storms there is expected to be significant movements of sand along the southern shores of Bateman Bay towards Point Maud.

Calculations suggest that during a particularly severe storm, as much as 10,000 m³ of sand could be moved towards the breakwater site and the sand trapped on the northeastern side of the entrance breakwater. This would also result in the development of new beach alignments for a distance of 300 to 500m either side of the breakwaters. It is also anticipated that in the period following the cyclone, the swell will re-shape the beaches to pre-storm alignments. During the 2000/01 turtle nesting, five Loggerhead nests were identified on beaches within 500m of the proposed development site. The vast majority of turtle nests occur approximately 6km to the north (see Figure 7).

Notwithstanding, the natural dynamic nature of beaches, changing climate and predicted impacts on sea levels, increasing use of the coastal zone (regardless of the implementation of this action) requires monitoring and the development of contingency measures. If the development is approved, a Shoreline Movement Management Plan, consistent with the aims of sustainable development, will be developed to assess change and present contingency measures prior to the commencement of construction.

It is also recognised that uncontrolled recreational use of fragile coastal dunes and foreshore areas can lead to considerable erosion or damage to these features. Beaches north of the existing Coral Bay settlement are currently used for recreational pursuits including beach and foredune access by 4WD vehicles and motorcycles. This includes turtle nesting and hatching experiences.

In recognition of the sensitive nature of the coast and the increasing recreational use of the area, CCMD in consultation with CALM and MfP propose to develop a Foreshore Management Plan. The Shoreline Movement Management Plan and the Foreshore Management Plan are closely linked and will be developed in parallel.

Management of sensitive coastal dunes and foreshore will be integrated with marine resource management with a focus on protecting sensitive areas from inappropriate use. A recommendation coming from the community consultation was that uncontrolled 4WD access north of Mauds Landing should be stopped.

This is a matter for CALM to determine as the beach to 40m above the high water mark lies within the defined area of the NMP. CCMD will take direction from CALM in this matter.

D. Ineffective Regulation and Management

A view was put that CALM, and to a lesser extent FWA, do not have the resources and legislative tools to manage even the existing level of development and that

implementation of the proposal will only make matters worse. Accordingly fish-stocks will be further depleted and safety of swimmers further jeopardised.

CALM is the State Government agency responsible for the management of NMP. CALM advises that a seasonal ranger is deployed at Coral Bay and has indicated its intention to have a full-time presence when land is made available for staff housing and operation facilities. A proposal for this has been delayed due to an embargo on building development in Coral Bay.

Implementation of this proposal will provide a combination of infrastructure, land and resources available to CALM and FWA to establish a permanent and more effective presence within this portion of the NMP.

Notwithstanding the degree of regulatory enforcement, the effective management of the Ningaloo Reef relies on the cooperation and support of the community to be fully effective. To this end, the educational facilities and programs proposed as a key component of many of the initiatives that are proposed in this development will be important to win the support of the community and visitors.

E. Water Quality Management

A number of correspondents expressed concerns that acceptable water quality could not be achieved within the marina waterbody and accordingly within the southern portion of Bateman Bay.

Discussion in relation to water quality is presented in sections 3.1.8 and 4.4.4.

Ningaloo waters are recognised as being of a high quality with little natural input of deleterious materials. Some local contamination of nearshore marine waters has been identified in Bills Bay caused by sewage contamination of shallow groundwater.

The strategy to control nearshore marine water quality is linked to the control of construction impacts (eg. dewatering, dredge management), provision of services inland (Wastewater Treatment Plant (WWTP) and landfill), management of nutrients inputs to private gardens and public open spaces. Potentially contaminated storm water will be directed inland and away from the marina/ocean in all but the most extreme rainfall events.

As a result, it is anticipated a maximum of 62kg of DIN and 14kg of phosphorous will enter the marina water body and accordingly the nearshore waters of Bateman Bay annually.

Extensive water quality modelling both within the marina waterbody and Bateman Bay has been undertaken. Simulated nutrient concentrations within the marina channel discharging to Bateman Bay showed a diurnal cycle with the maximum concentrations never exceeding a 30% increase above background within the entrance channel (0.011mg/L and 0.005mg/L for DIN and phosphorus respectively) and accordingly reporting to Bateman Bay. This additional nutrient load would be indistinguishable after initial mixing with marine waters.

Within the marina waterbody the most important mechanisms that will contribute to water exchange are tidal variations and wind-induced currents. A predicted flushing period of up to 17 days is anticipated in the northeastern extremity of the marina waterbody, reducing to two days near the entrance channel. Notwithstanding, it is considered that the low inputs of nutrients and large volume (buffering capacity) of the marina waterway will maintain acceptable water quality at all times. The maximum predicted concentration at the northeastern most point of the marina waterbody for DIN and phosphorous will be 0.025mg/L and 0.007mg/L respectively, following a 'worst case' rainfall event. These values return to background levels within 14 days of the rainfall event.

6.2.3 Public Submissions to the Western Australian Public Environmental Review

The proponent's Public Environmental Review document was released for a period of 12 weeks in November 2000. The review period included an additional 2 weeks to account for the 2000 Christmas/New Year period.

Approximately 200 written submissions were received on the proponent's document. A further 3300 pro-forma submissions were received via email and approximately 1700 pro-formas were received by mail or fax.

At a general level, the key issues that have arisen from the submission process appear to relate primarily to the following:

- the impact of the 'foot print' of the proposal on the surrounding marine and terrestrial environments;
- the impacts associated with increased visitation and whether impacts are manageable in practice;
- concern as to whether the information provided on the environmental impacts is sufficient to ascertain whether management objectives (including draft management agreements with Government Agencies) can be met; and
- the context of the proposal within the NMP Plan (currently under review) and the State Coastal Environmental Protection Policy which the DEP understands is being developed by MfP.

7. CONCLUSIONS

This PER document provides information relating to the proposal to construct and operate a resort village that will provide a broad range of short stay and holiday accommodation at the Mauds Landing Townsite near Coral Bay in the Shire of Carnarvon, Western Australia. The document includes a description of the selected site, the characteristics of the proposal, and identifies potential impacts in species of NES. Relevant matters of NES as identified in the EPBC Act reported on in this document are nationally threatened species and communities and migratory species listed under international agreements.

Although the proposed action is being taken outside Commonwealth land, (the CCR is about 8km from Commonwealth waters) implementation of activities at Mauds Landing may impact on a Commonwealth marine area, specifically as it relates to increased boat usage, fishing and ecotourism activities within Commonwealth waters.

Accordingly an assessment of these potential impacts has also been undertaken, together with consideration of how implementation of the action may impact on the ecological support systems relevant to the species of NES. The PER document also identifies how these impacts may be managed and specifies further studies or monitoring that will enable performance to be measured.

Matters of NES relating to World Heritage Properties, RAMSAR wetlands, nuclear actions and direct impacts on Commonwealth land are not triggered.

Baseline data on the following listed threatened (LT) and listed migratory (LM) species has been presented:

- | | |
|--|---------------------|
| • Humpback Whale <i>Megaptera novaengliae</i> | LM, LT (Vulnerable) |
| • Dugong <i>Dugong dugon</i> | LM |
| • Loggerhead turtle <i>Caretta caretta</i> | LM, LT (Endangered) |
| • Green turtle <i>Chelonia mydas</i> | LM, LT (Vulnerable) |
| • Hawksbill turtle <i>Eretmochelys imbricata</i> | LM, LT (Vulnerable) |
| • Flatback turtle <i>Natator depressus</i> | LM, LT (Vulnerable) |
| • Whale shark <i>Rhincodon typus</i> | LM, LT (Vulnerable) |

Impacts on seabirds have also been considered.

Mauds Landing is the Western Australian Government's preferred site for this purpose. The CCR will be developed along principles consistent with State Cabinet requirements and the Gascoyne Coast Regional Strategy (Ministry For Planning 1996) and following consideration of a number of sites on the Gascoyne Coast. Being situated behind the secondary dunes on an area of coastline dominantly consisting of shallow sands on pavements, direct impacts on coral reef and shoreline reef platforms has been avoided. The inland marina will be located 3.5km from sensitive coral backreef communities important for turtle feeding and nesting, and about 2km from the nearest (sparse) perennial seagrass. Macroalgae occur over pavements adjacent to the proposed development, however these communities are depauperate and stunted relative to those present on the backreef and either side of Cardabia Passage.

TABLE 24
SUMMARY OF IMPACTS, EVALUATION AND PREDICTION OF OUTCOMES FOR THREATENED AND MIGRATORY MARINE SPECIES THAT ON THE BASIS OF THEIR KNOWN DISTRIBUTION MAY ON OCCASION BE OBSERVED IN THE NMP

	Impact of the Action	Evaluation	Predicted Outcome
Whale Sharks	Based on anticipated demand, and additional 71 boat trips annually, requiring one additional boat operating at 80% capacity will be required to meet demand over the period of the whale watching season. Possible impacts related the increased demand for whale shark interactions include pollution from fuel spillage, nutrient impacts resulting from sewage discharge from boats, litter impacts, and physical disturbance to wildlife resulting from boat activity or propeller strikes.	Only CALM authorised and Licensed operators can interact with humpback whales, although trailer drawn and moored private boats that will operate out of CCR can readily access waters used by whales. Based on predictions of visitation trends and resulting demands, implementation of the action would only result in one additional commercial boat trip daily. Due to the distance to interaction sites and reliance on spotter planes to locate whale sharks, contact is principally with Licensed commercial boats	Impacts may occur either in Commonwealth Marine area (Controlling Provisions 23 and 24A) or State controlled water. State controls on commercial operators, research and public education will reduce foreseen impacts resulting from addition pressures brought about by implementation of the action. It is CCMD's view that Whale sharks, a listed Threatened (Vulnerable) and Migratory marine species, will be managed such that the action will not substantially modify, destroy or isolate an area of important habitat, nor seriously disrupt the lifecycle (breeding, feeding, migration or nesting behaviour) of the threatened migrating population (Controlling Provisions 20 and 20A).
Dugongs	Based on anticipated demand, and additional 502 boat trips requiring up to two additional boats operating at 66% capacity will be required to meet demand over the year. Possible impacts related the increased demand ecotourism tours include pollution from fuel spillage, nutrient impacts resulting from sewage discharge from boats, litter impacts, and physical disturbance to dugong due to snorkelled activity, boat activity or propeller strikes.	The Baiyungu people have given an undertaking to assist in management of marine mammals in the area, which will reduce pressures from the indigenous hunting. In relation to entanglement, there is no commercial trawling in State or Commonwealth waters of the central portion of Ningaloo Reef, and limited recreational netting strongly regulated, requiring nets are only set in certain areas and cleared regularly. The possibility of vessel strikes and harassment may increase as a result of the operation of additional boats arising from the implementation of the proposed	Impacts may occur in State controlled water. State controls on commercial operators, research and public education will reduce foreseen impacts resulting from addition pressures brought about by implementation of the action. It is CCMD's view that Dugong, a listed migratory marine species, will be managed such that the action will not substantially modify, destroy or isolate an area of important habitat, nor seriously disrupt the lifecycle (breeding, feeding, migration or nesting behaviour) of migrating population (Controlling Provisions 20 and 20A).

	Impact of the Action	Evaluation	Predicted Outcome
		action. However this is mitigated by a reduction in larger commercial vessels and potentially private vessels passing along the sensitive backreef areas between Point Maud and the barrier reef. Increased demand for commercial snorkelling tours have been identified. Opportunities for improved education resulting from the single point of entry and provision of an environment and interpretive centre are also seen as an important component of limiting impacts.	
Humpback Whales	Based on anticipated demand, and additional 90 boat trips requiring one additional boat operating at 60% capacity will be required to meet demand over the period of the whale watching season. Possible impacts related the increased demand for whale watching include pollution from fuel spillage, nutrient impacts resulting from sewage discharge from boats, litter impacts, and physical disturbance to wildlife resulting from boat activity or propeller strikes.	Only CALM authorised and Licensed operators can interact with humpback whales, although trailer drawn and moored private boats that will operate out of CCR can readily access waters used by whales. Based on predictions of visitation trends and resulting demands, implementation of the action would only result in one additional commercial boat trip daily	Impacts may occur either in Commonwealth Marine area. (Controlling Provisions 23 and 24A) or State controlled waters. State controls on commercial operators, research and public education will reduce foreseen impacts resulting from addition pressures brought about by implementation of the action. It is CCMD's view that Humpback whales, a listed migratory marine species will be managed such that the action will not substantially modify, destroy or isolate an area of important habitat, nor seriously disrupt the lifecycle (breeding, feeding, migration or nesting behaviour) of migrating population (Controlling Provisions 20 and 20A). Similarly, it is considered by CCMD that additional pressures on the threatened and vulnerable humpback whales, based on the quantum of increase in interaction following implementation of the action will not be significant. Accordingly this will not reduce the area of occupancy of the species and seriously disrupt the lifecycle (breeding, feeding, migration or nesting behaviour (Controlling Provisions 18and 18A, 18(4) and 18(A)).

	Impact of the Action	Evaluation	Predicted Outcome
Loggerhead Green Flatback and Hawksbill turtle	The quantum of additional demands for boats is the same as for dugong. Turtle impacts principally occur within State controlled waters, and within the Ningaloo Reef. All aspects of turtle management will be described in a Turtle Management Plan to be developed in consultation the CALM and relevant experts. The impacts of feral animals, particularly foxes will be through direct control (baiting and trapping) and reduction in alternative food availability with the construction and operation of a managed landfill site. Landfill management will also reduce litter that could be ingested by turtles. The Baiyungu people have given an undertaking to assist in management of turtles in the area, which will reduce pressures from the indigenous harvest. In relation to incidental catch, there is no commercial trawling in State or Commonwealth waters of the central portion of Ningaloo Reef, and limited recreational netting is strongly regulated, requiring nets are only set in certain areas and cleared regularly. The possibility of vessel strikes and harassment may increase as a result of the operation of additional boats arising from the implementation of the proposed action.	Singley, the control of fox populations through construction of a managed landfill site and eradication programs will have the greatest impact on the success of turtle recruitment on Bateman Bay. The loss of 300 m of nesting habitat will result in females that otherwise nest in that specific location moving to alternative acceptable areas of the beach. Opportunities to reduce indigenous harvesting of turtles and turtle products will also be sought. The possibility of vessel strikes and harassment may increase as a result of the operation of additional boats arising from the implementation of the proposed action, however this is mitigated by a reduction in larger commercial vessels and potentially private vessels passing along the sensitive backreef areas important for turtle resting and feeding. Increased demand for commercial turtle nesting and hatching tours have been identified. Beach access from CCMD controlled lands will be managed. Further opportunities to control beach access from CALM controlled beaches and Cardabia land will be investigated. Opportunities for improved education resulting from the single point of entry and provision of an environment and interpretive centre are also seen as an important component of limiting impacts.	CCMD believe that there will be no impacts on Commonwealth Marine area (Controlling Provisions 23 and 24A). Mitigation measures and public education will reduce foreseen impacts resulting from addition pressures brought about by implementation of the action in State waters. It is CCMD's view that listed migratory marine species such as green and hawksbill turtles will be managed such that the action will not substantially modify, destroy or isolate an area of important habitat, nor seriously disrupt the lifecycle (breeding, feeding, migration or nesting behaviour) of the population (Controlling Provisions 20 and 20A). Similarly, it is considered by CCMD that additional pressures on the threatened and vulnerable loggerhead, green, flatback and hawksbill turtles, will be offset in part by redirection of boating activity away from sensitive backreef areas will not reduce the area of occupancy of the species and seriously disrupt the lifecycle (breeding, feeding, migration or nesting behaviour) of the population, particularly of loggerheads known to breed on Bateman Bay. (Controlling Provisions 18and 18A, 18(4) and 18(A)).

Table 24 presents a summary of impacts, evaluation and prediction of outcomes for Threatened or Migratory marine species that on the basis of their known distribution may on occasion be observed in the NMP and that the implementation of the controlled action may modify, destroy or isolate an area of important habitat of the species and/or seriously disrupt the lifecycle (breeding, feeding, migration or nesting behaviour) of an ecologically significant proportion of the population of the species.

The project has a number of direct and indirect benefits both to the environment and people of the region. Through development, the CCR will reduce further pressures from the Sanctuary Zone at Bills Bay including the removal of the majority of boating activity and the opportunity for connection to improved utilities, in particular deep sewerage. By providing (at full development) up to an additional 710 dedicated short stay accommodation units, overcrowding at the Coral Bay settlement will likely be reduced during peak periods, and the focus for development will be directed away from the lagoonal coral assemblages of Bills Bay.

The possible direct physical impacts of implementation of the proposal such as nutrient enrichment, increased turbidity, and groundwater pollution will be managed through the design, location, infrastructure and management programs identified in the project design. Planning for the CCR incorporates all service utilities including sewerage, power, solid waste landfill and reticulated water with the majority of utilities being located in a services area proposed for establishment 2km inland and approximately 3km from Mauds Landing. CCMD has also made a commitment to design utilities such as sewerage and power so that they can be upgraded to accommodate the requirements of the Coral Bay settlement. Should this occur, it is anticipated combined Coral Bay settlement and CCR physical environmental impacts will be reduced.

Nearshore and marina water quality management strategies are linked to the control of construction impacts (eg. dewatering, dredge management), provision of services inland (WWTP and landfill), the management of nutrients inputs to private gardens and public open spaces and to the direction of potentially contaminated storm water inland and away from the marina/ocean. Water quality modelling has been undertaken that indicates marina water will be indistinguishable from near shore oceanic waters immediately following mixing, largely as a consequence of low nutrient mass loading throughout the entire development.

Indirect impacts ('people pressure') will be managed through the implementation of monitoring and resultant management strategies in collaboration with government regulatory agencies. The CCR and marina waterways themselves will provide a range of features such as protected swimming beaches, constructed snorkeling reef, interpretive centre and entertainment that will provide an alternative to traditional recreational use of the NMP.

Discussions have been held with CALM in relation to the development of a Specific Area Marine Management Plan (SAMMP) consistent with the NMP Management Plan and the objectives of the Department of Conservation and Land Management in management of the area. Planning for the SAMMP is well advanced. It is proposed that the SAMMP will provide a detailed description of the ecological and social

values of the area surrounding the proposed development (including the existing Coral Bay area), management objectives, strategies and targets to be determined through a monitoring program to be implemented. Included in the SAMMP are descriptions and considerations in the management of the finfish and the ecosystem target species such as whale sharks, marine turtles, manta rays and marine mammals.

Implementation of this proposal will also provide an opportunity for regulatory authorities, notably CALM and FWA, to develop and institute more effective management controls on the Sanctuary Zone at Bills Bay and the greater Ningaloo Marine Tract as a consequence of a permanent on-site presence, better control of recreational fishing, adequate surveillance of recreational boats, greater control of marine safety, substantially safer boat access and management, and substantially improved boat handling and launching facilities. Single point access to visitors and the interpretive centre will provide educational opportunities. The development of a Resort Management Agreement and Building and Landscaping Agreement, on approval of the proposal, with the Shire of Carnarvon will ensure appropriate standards are maintained in construction of buildings and open areas.

CCMD is committed to ensuring the proposed CCR meets international standards for health, safety and the environment and committed to the development of management systems consistent with international benchmarks, such as OHSAS 18001 and ISO 14001 management systems. The design philosophies, which have been adopted for CCR, are in accordance with good practice and management systems will be implemented which would ensure that CCR improves on all environmental requirements.

On the basis of the specialist studies and other work associated with the preparation of this PER, it is concluded that the CCR development, if managed consistently with the strategy plan and commitments made in this PER, will result in minimal environmental impacts.

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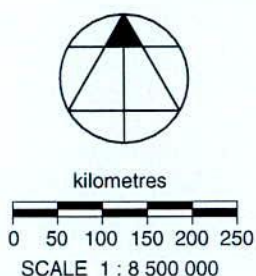
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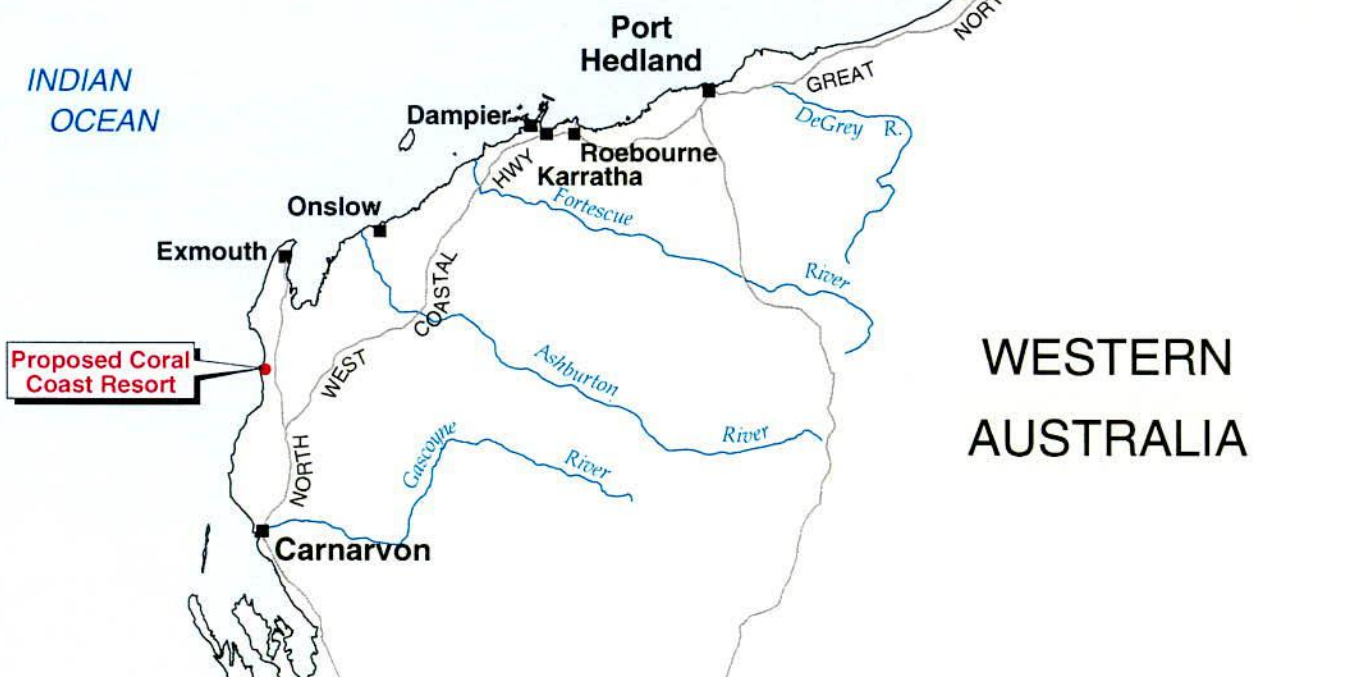
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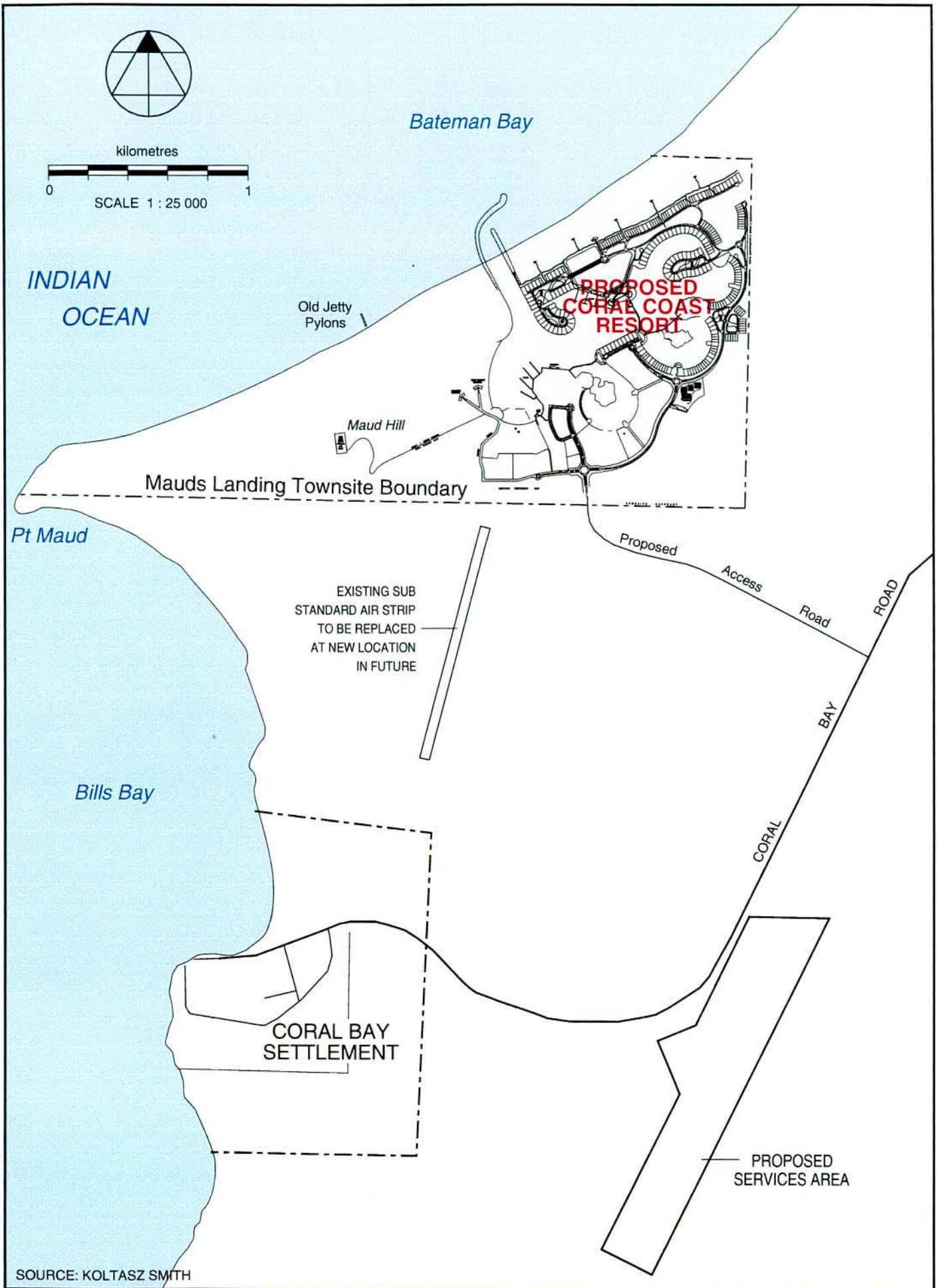
FIGURES



TIMOR SEA



WESTERN AUSTRALIA

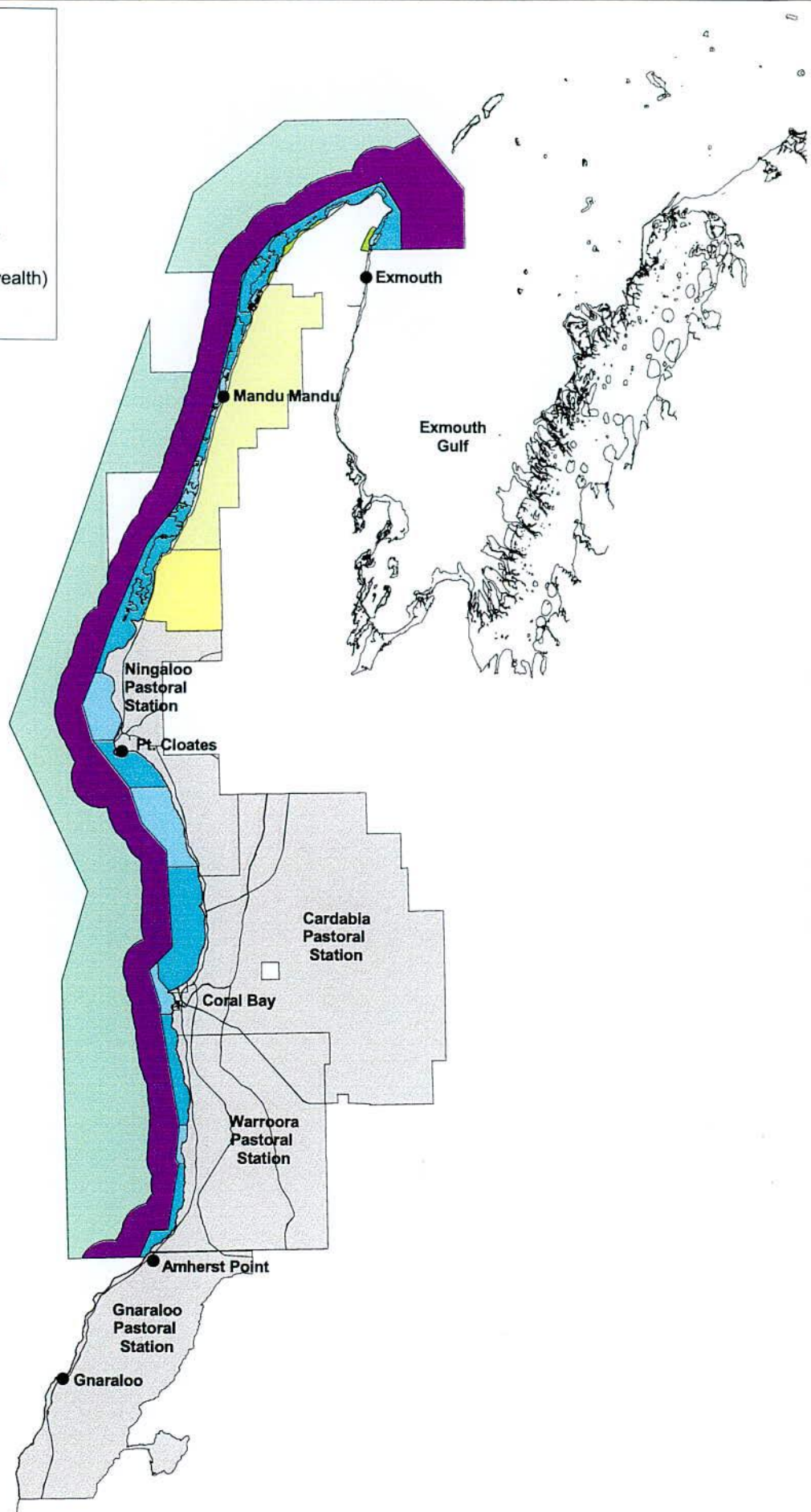


Legend

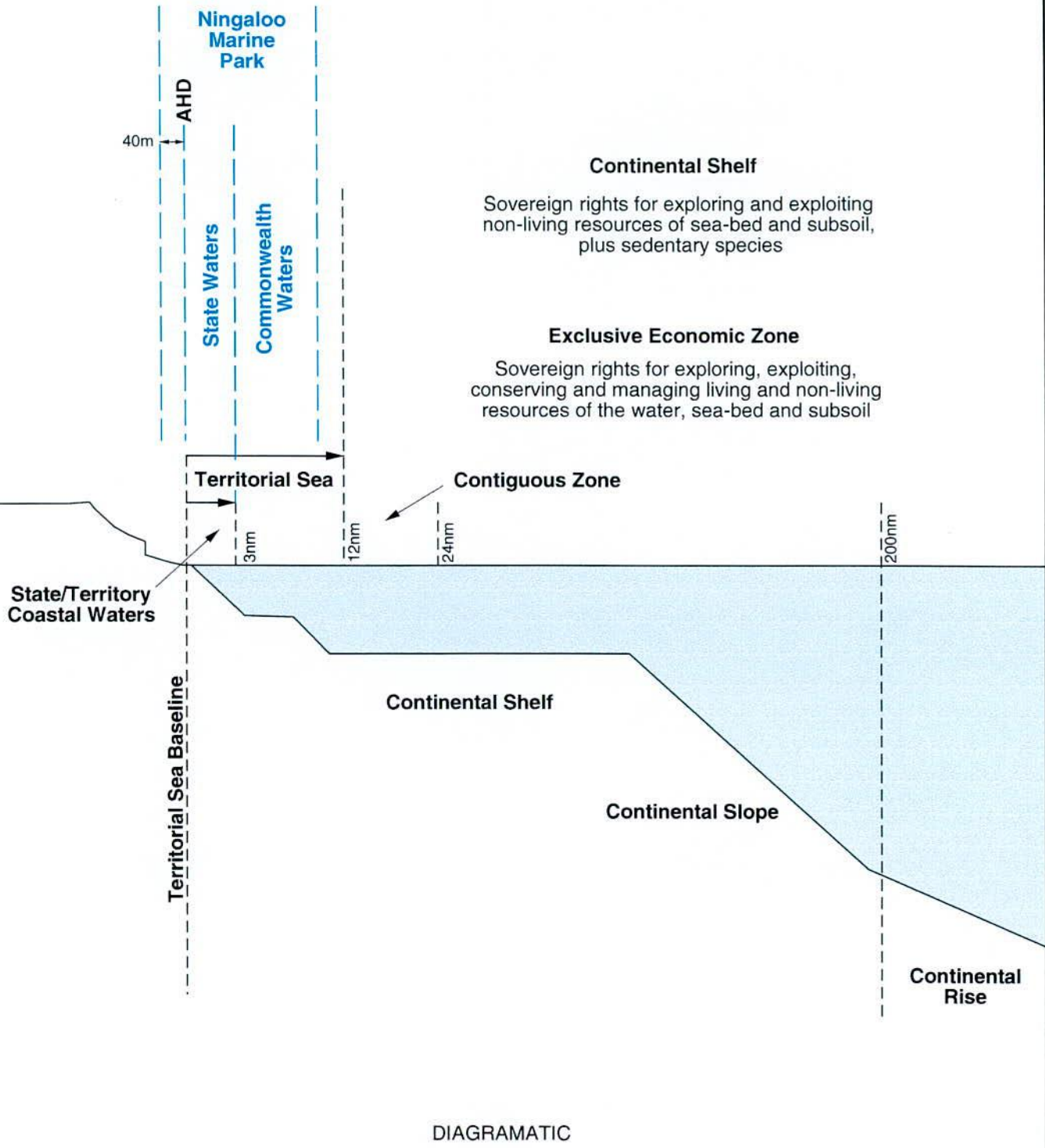
Ningaloo Marine Park

- Commonwealth Waters
- General Use Zone
- Recreation Zone
- Restricted Recreation Use
- Sanctuary Zone
- Cape Range National Park
- Coastal Park
- Boming Range (Commonwealth)
- Pastoral Lease

0 20 Kilometers



SOURCE: CARY et al, April 2000 (CALM)



SOURCE: Adapted from D.Gorden,2000

STRUCTURE PLAN

CORAL COAST RESORT

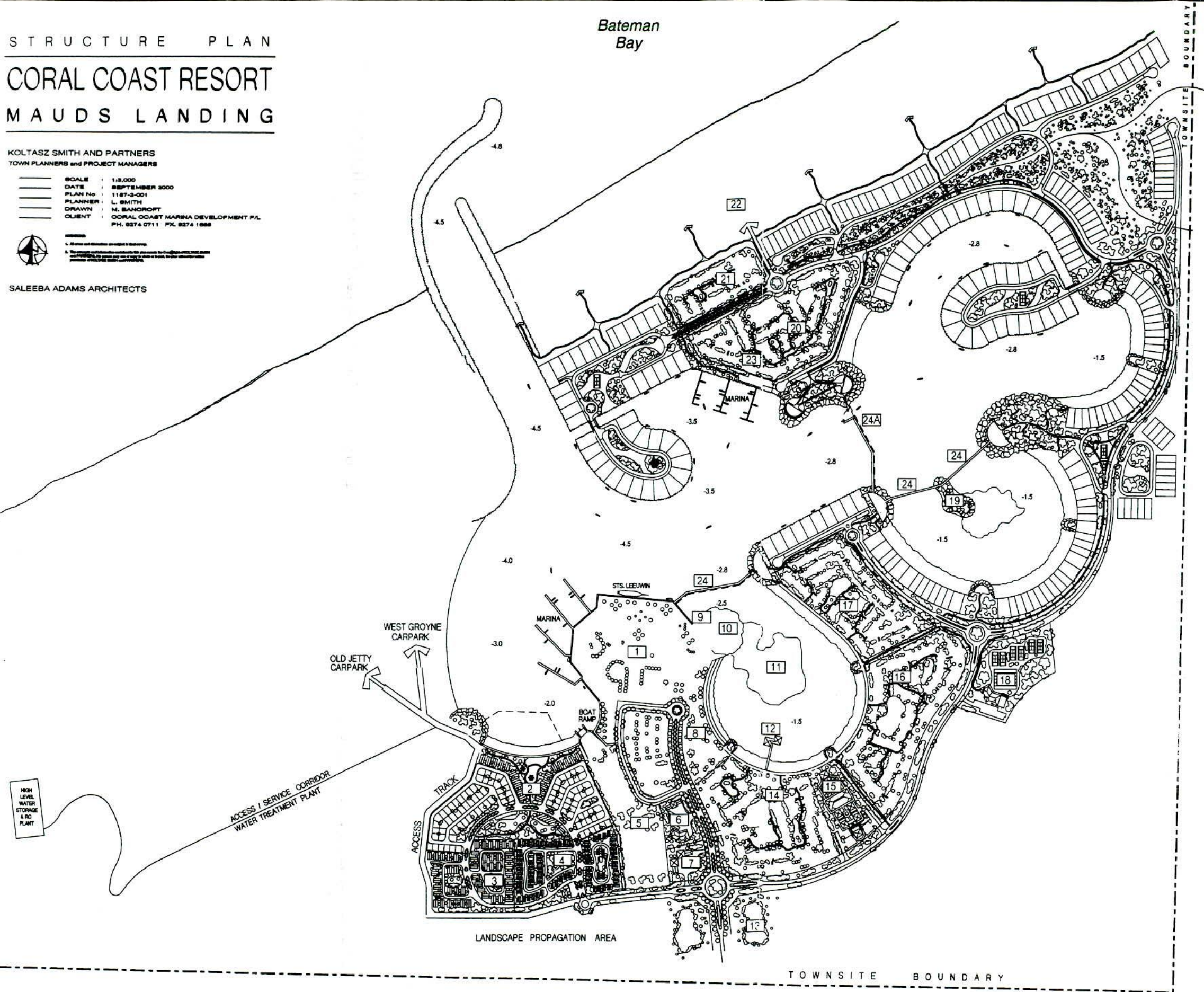
MAUDS LANDING

KOLTASZ SMITH AND PARTNERS
TOWN PLANNERS and PROJECT MANAGERS

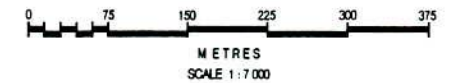
SCALE : 1:13,000
DATE : SEPTEMBER 2000
PLAN No : 1187-3-001
PLANNER : L. SMITH
DRAWN : M. BAKOROFF
CLIENT : CORAL COAST MARINA DEVELOPMENT P/L
PH. 9274 0711 FX. 9274 1888



SALEEBA ADAMS ARCHITECTS



- MARINA VILLAGE - RESORT 120 UNITS, RETAIL, FOOD & BEV. ETC 4.0ha 1
- CARAVAN AND CHALET PARK 100 BAYS / 20 CHALET 4.0ha 2
- STAFF VILLA HOUSING 50 UNITS 1.7ha 3
- STAFF AND CONSTRUCTION GROUP HOUSING 80 UNITS 2.1ha 4
- BOAT TRAILER PARKING 5
- COACH TERMINAL 6
- SERVICE STATION 7
- VILLAGE GREEN 8
- ENVIRONMENT AND INTERPRETIVE CENTRE 9
- CORAL GARDEN 10
- DIVE REEF 11
- RESTAURANT 12
- ARTESIAN BORE COOLING LAKES 13
- SERVICED APARTMENTS 130 UNITS 3.9ha 14
- BACK PACKERS 80 BEDS 1.0ha 15
- TIMESHARE 100 UNITS 3.6ha 16
- TOURIST TOWNHOUSES 80 UNITS 2.7ha 17
- SPORTS AND COMMUNITY CENTRE 1.6ha 18
- ISLAND AND SNORKELLING REEF 19
- TOURIST VILLAS 100 UNITS 4.0ha 20
- RESTAURANT 21
- BEACH PARKING PICNIC & BBQ 22
- CAFE / DELICATESSEN 23
- PEDESTRIAN BRIDGE 24
- PEDESTRIAN BRIDGE - SWING SECTION 24A
- SWIM NETS - -



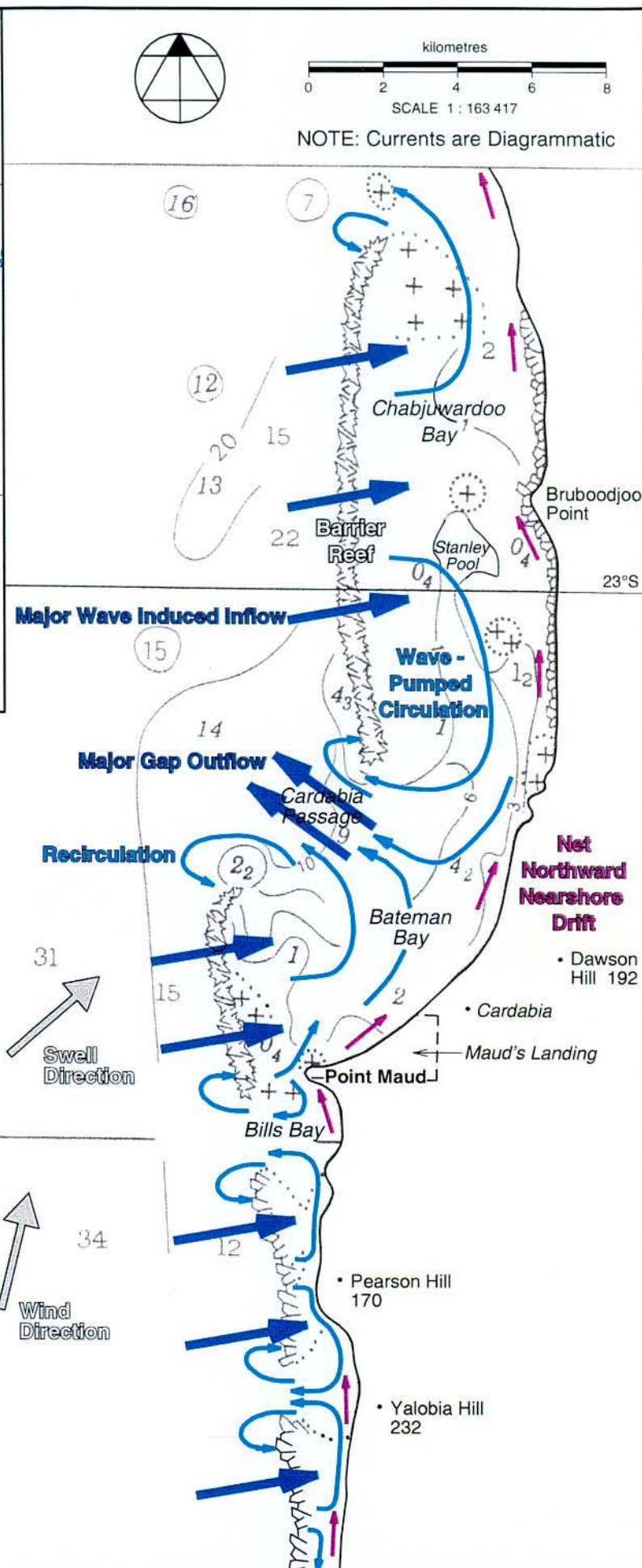
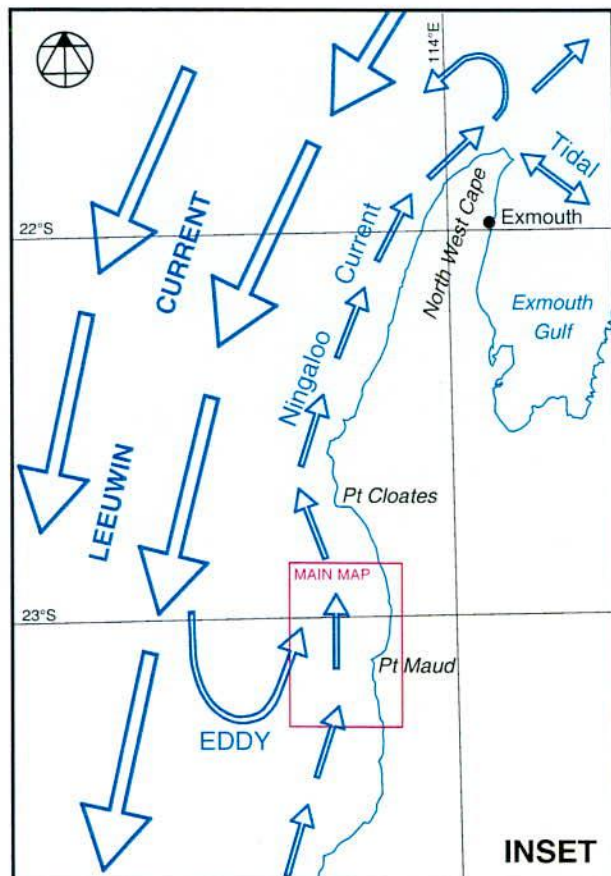
CORAL COAST RESORT
PUBLIC ENVIRONMENT REPORT
**CORAL COAST RESORT
STRUCTURE PLAN**

FIGURE 5

CHECKED: H VW 2-10-01

DRAWN: GLM 1-10-01

20057fed/21_94f6.dgn



**LEEUVIN
CURRENT**



**Ningaloo
Current**



SOURCES

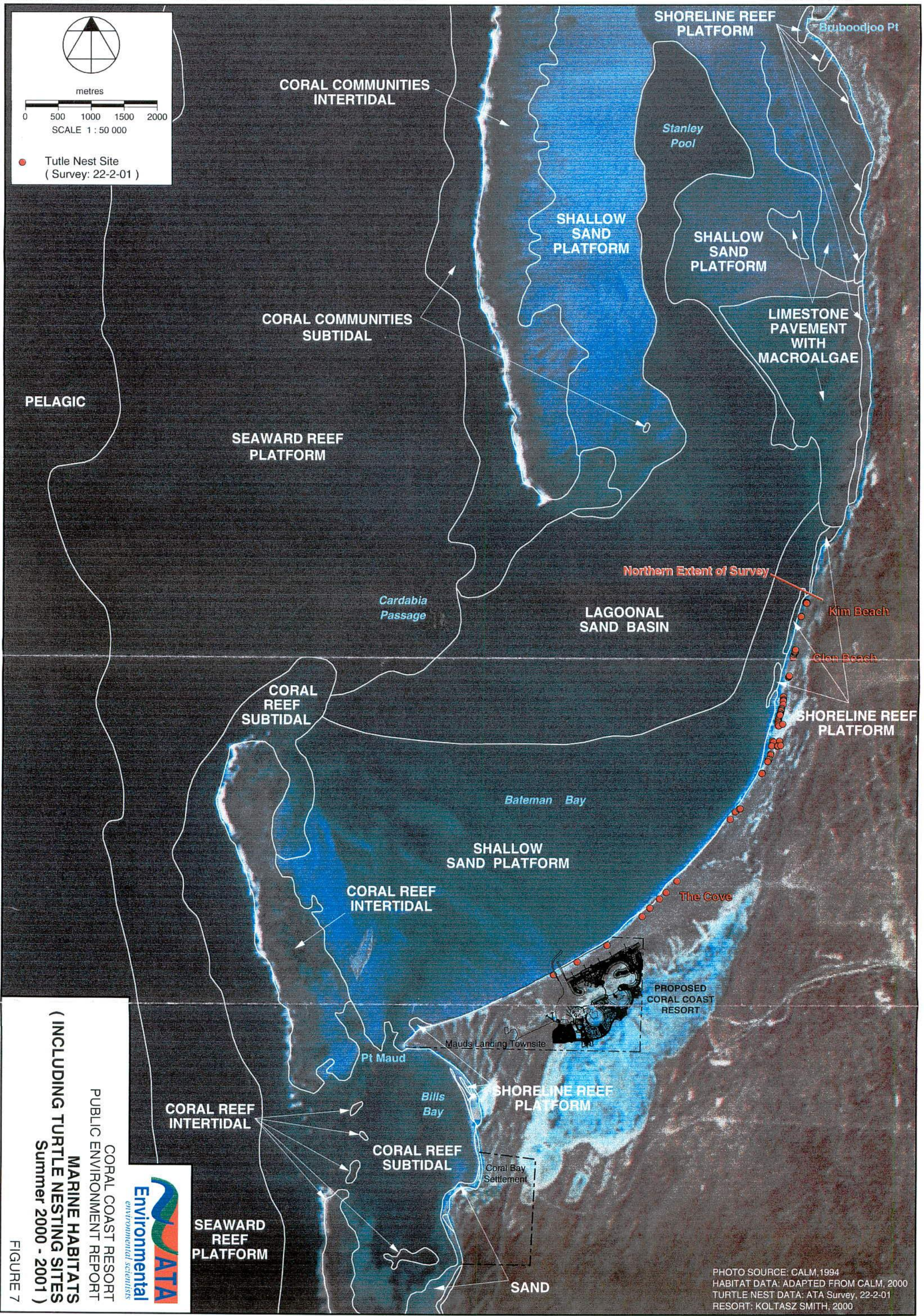
BASE: AUS 330 (Depths in fathoms)

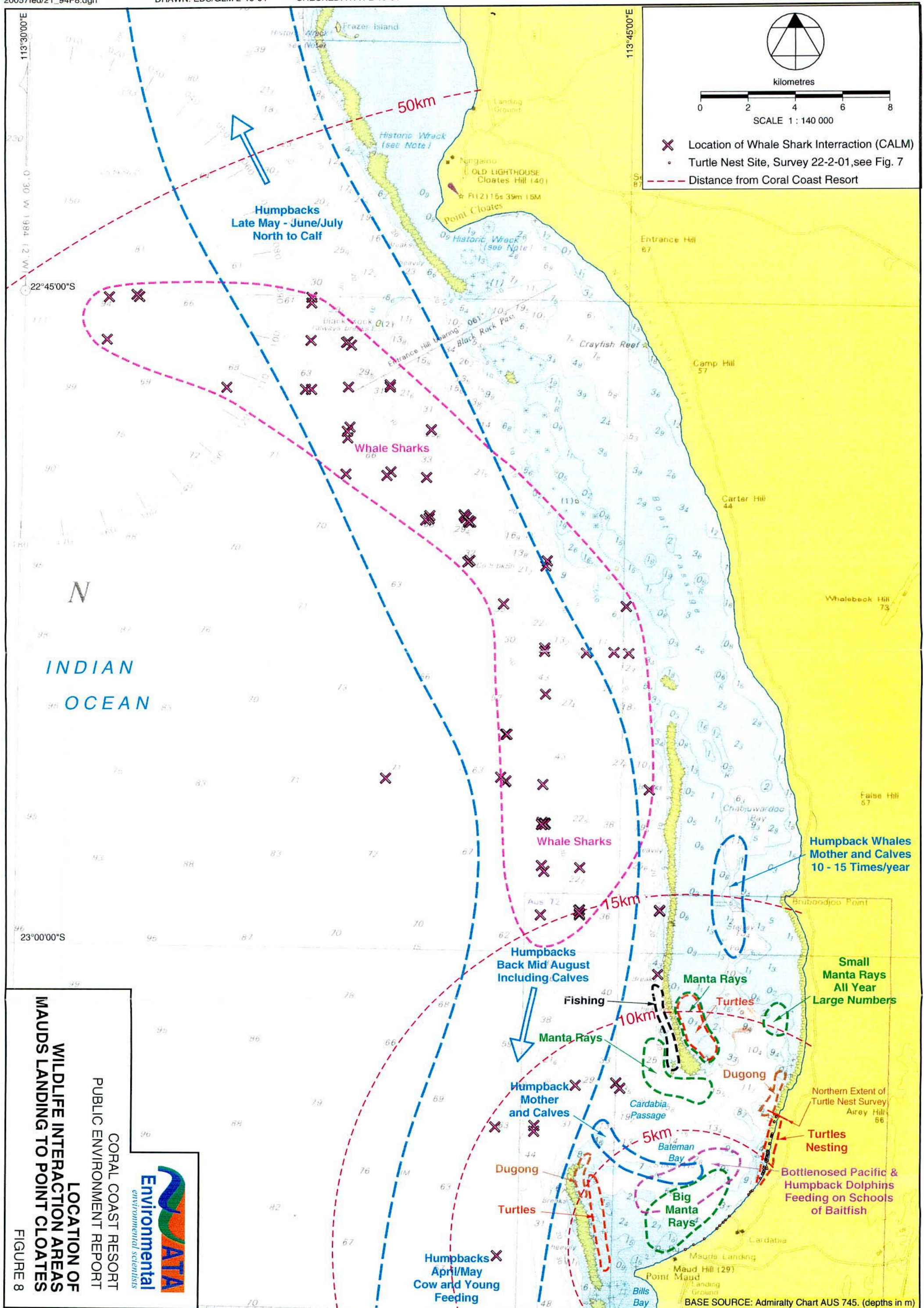
FLOW PATTERNS: Adapted from D'ADAMO
& SIMPSON, 2000

INSET: TAYLOR & PEARCE, 1999

CORAL COAST RESORT PUBLIC ENVIRONMENT REPORT MAJOR AND NEARSHORE WATER CURRENTS - NINGALOO REEF

FIGURE 6



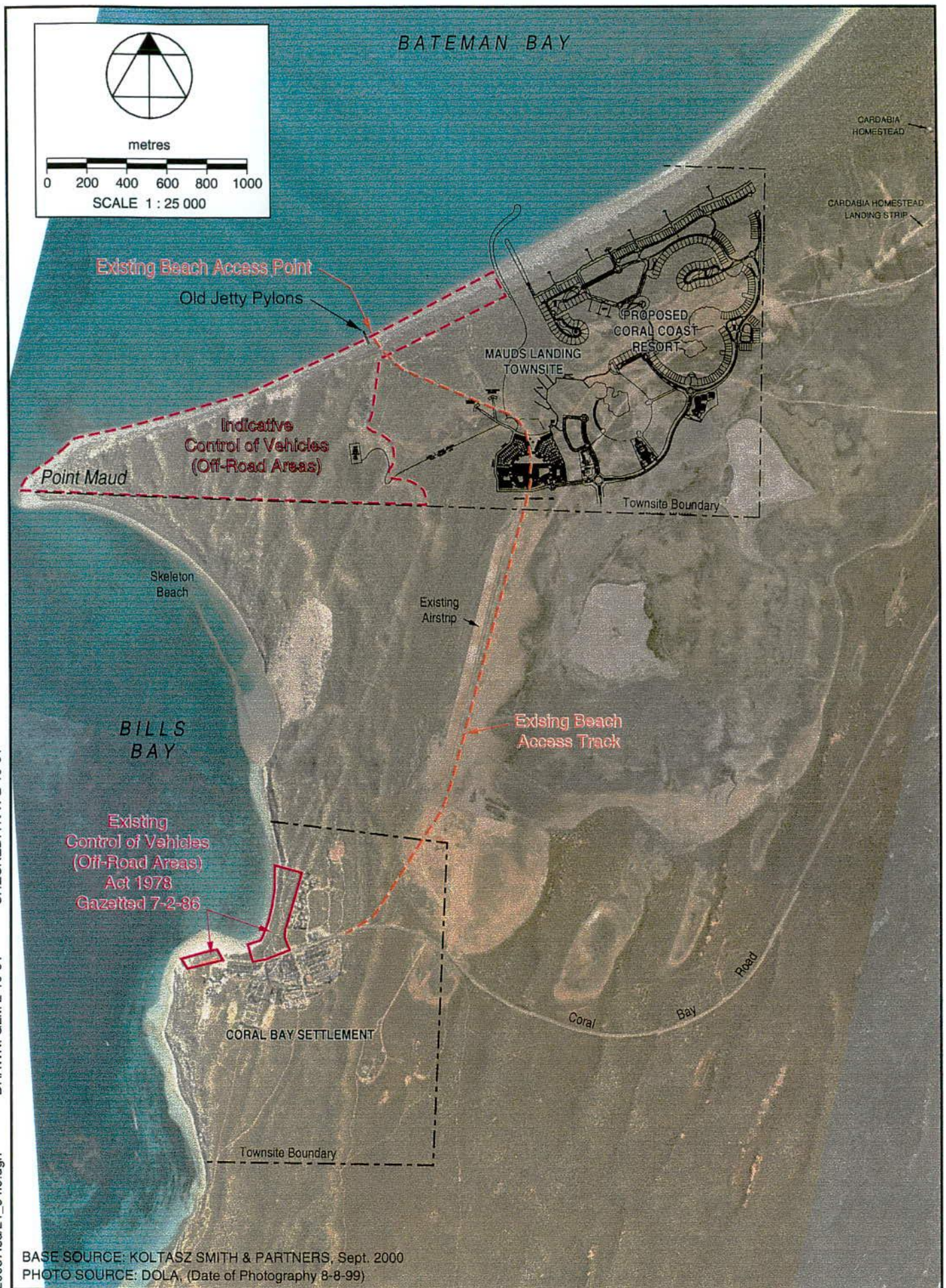


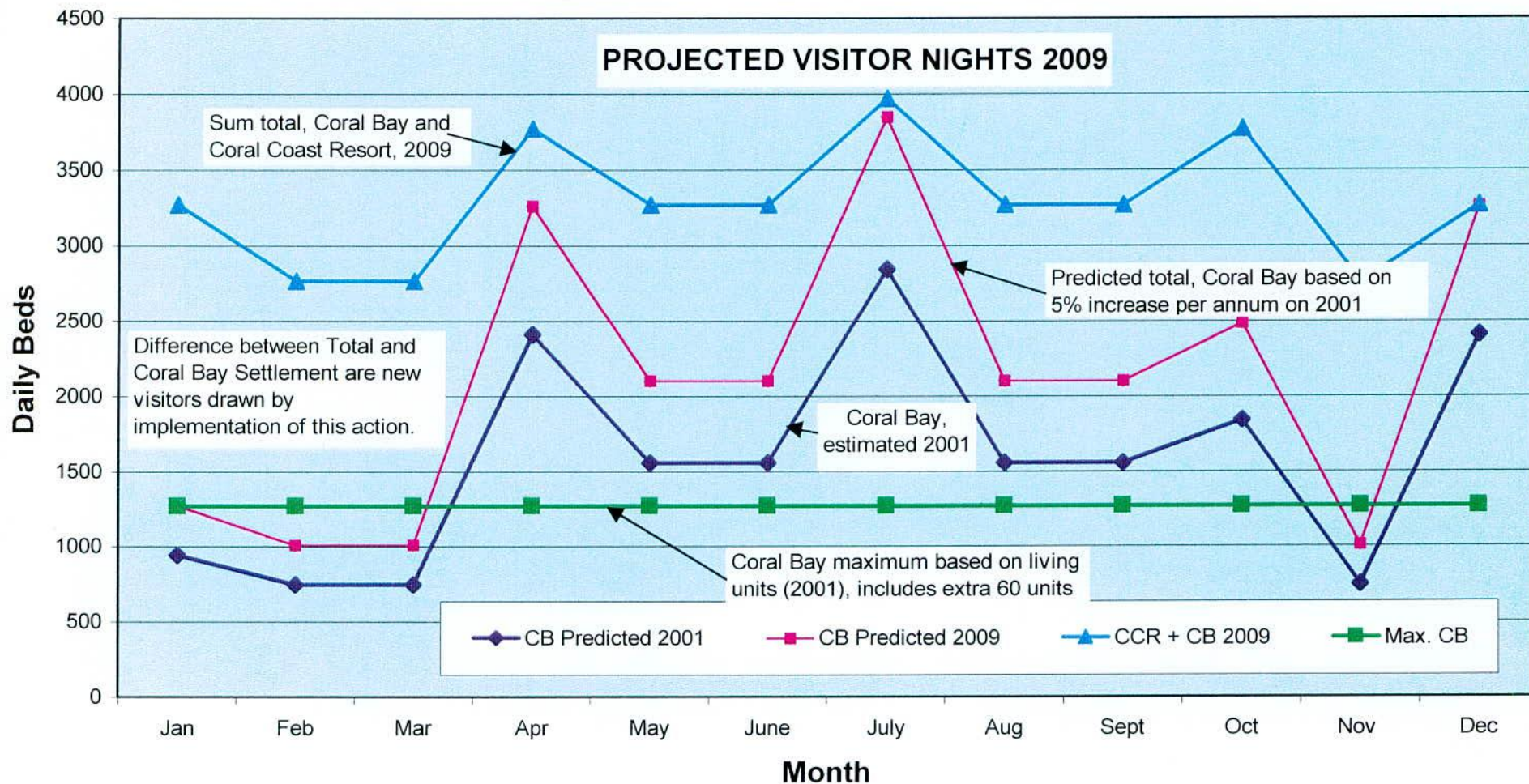
LOCATION OF
WILDLIFE INTERACTION AREAS
MAIDS LANDING TO POINT CLOATES

CORAL COAST RESORT
PUBLIC ENVIRONMENT REPORT

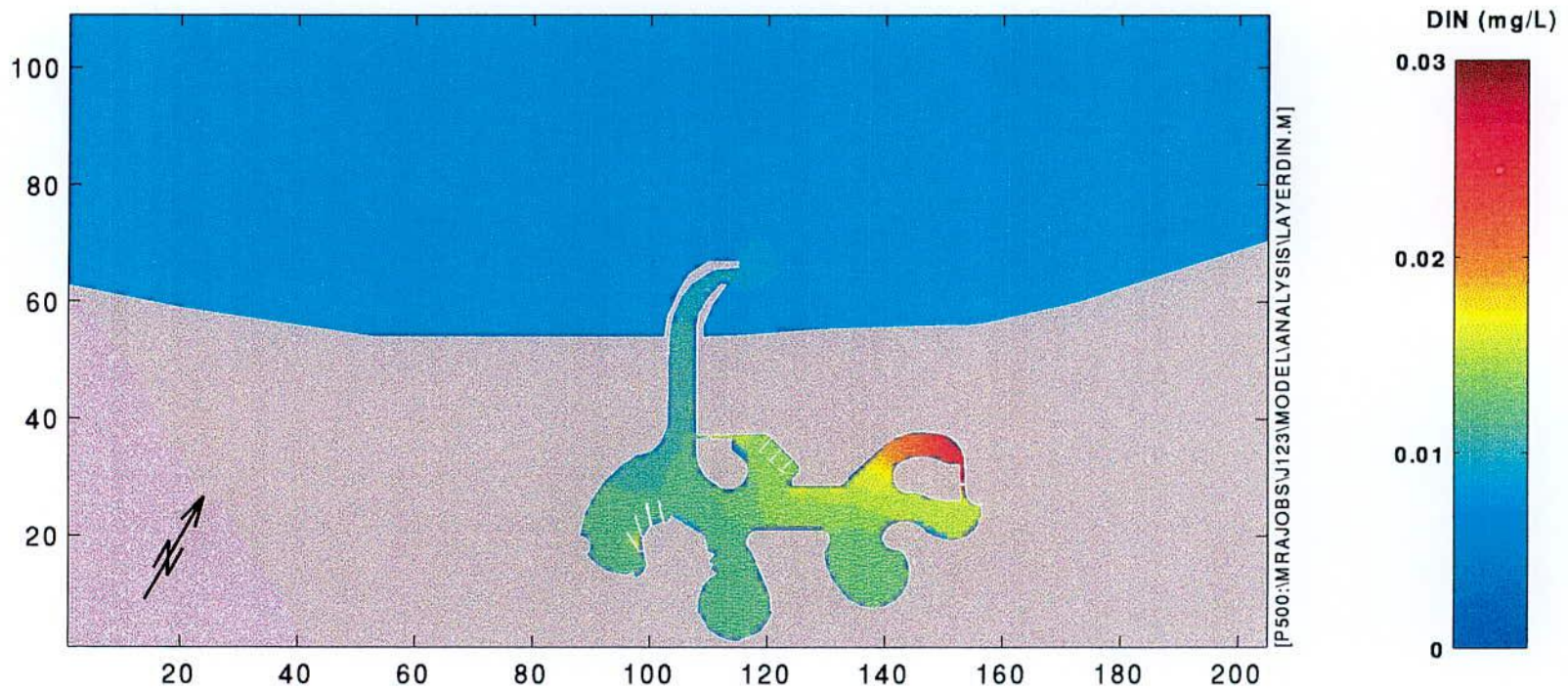


FIGURE 8





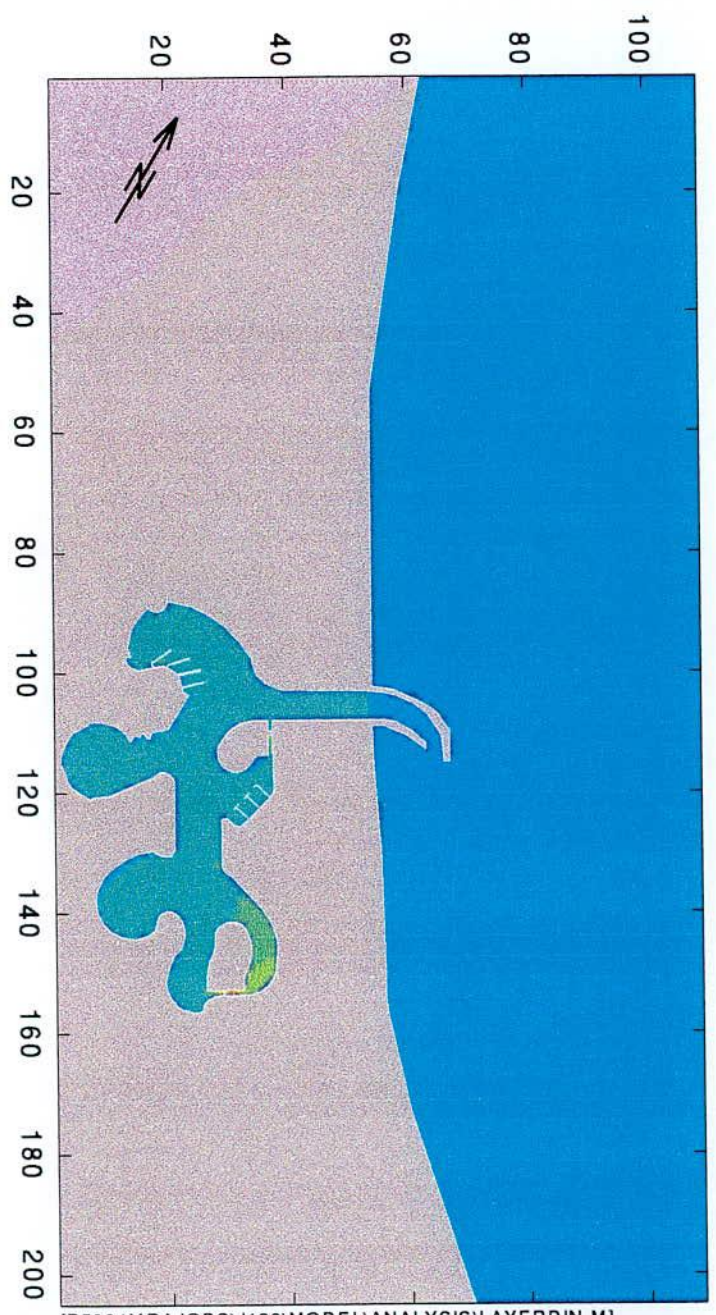
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PLOT TYPE: Spatial Distribution of Dissolved Inorganic Nitrogen
TIME: 00:00 11/04/1998 **LAYER:** Surface
SCALE: 1:25000 **GRID RESOLUTION:** 20 m by 20 m



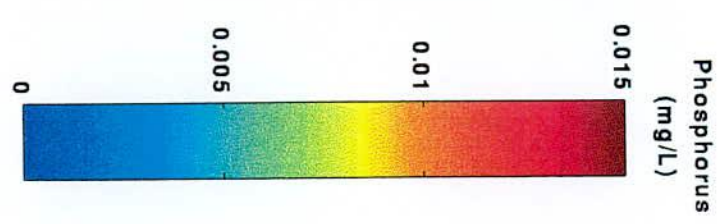


SOURCE: MP ROGERS & ASSOCIATES

TITLE: Coral Coast Resort - Summer Case
PLOT TYPE: Spatial Distribution of Phosphorus
TIME: 00:00 11/04/1998 **LAYER:** Surface
SCALE: 1:25000 **GRID RESOLUTION:** 20 m by 20 m

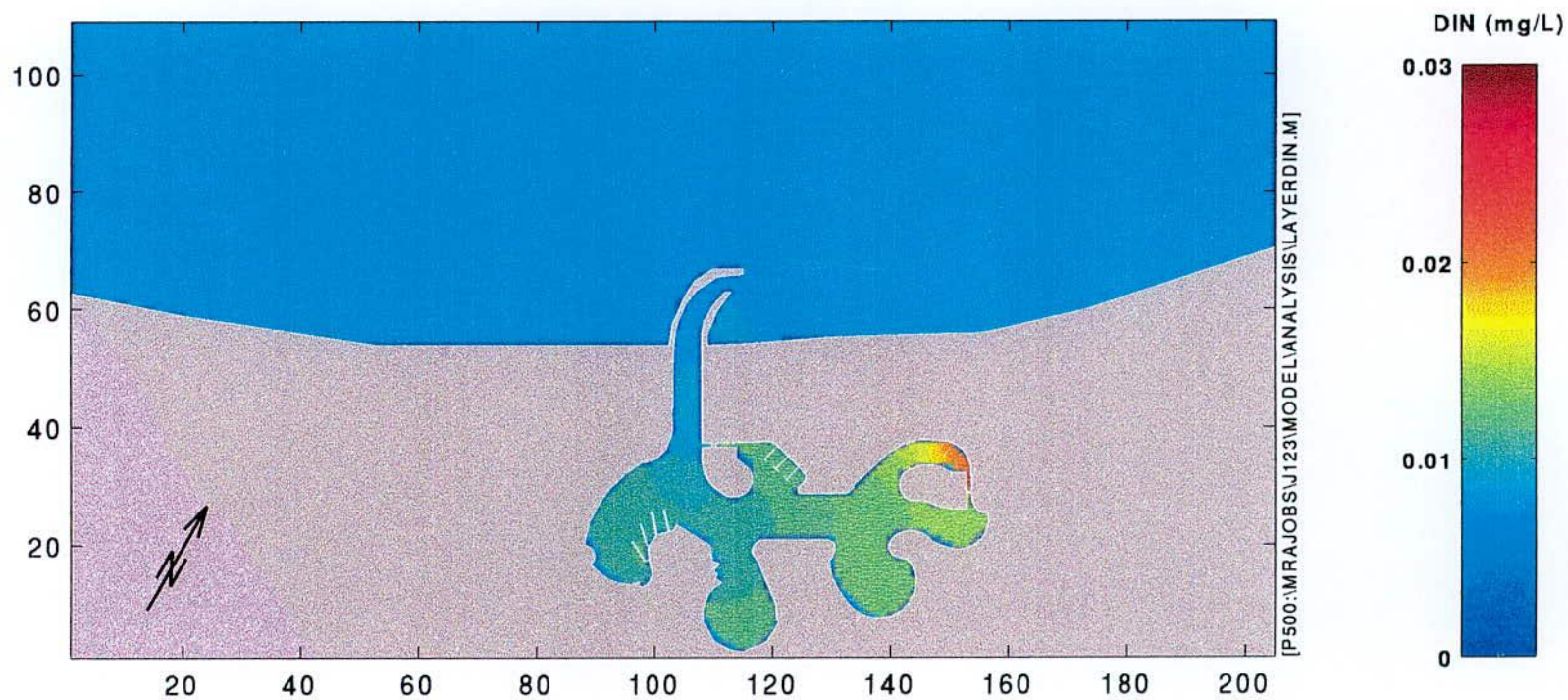


[P500:\MRAJOBS\J123\MODEL\ANALYSIS\LAYERDIN.M]

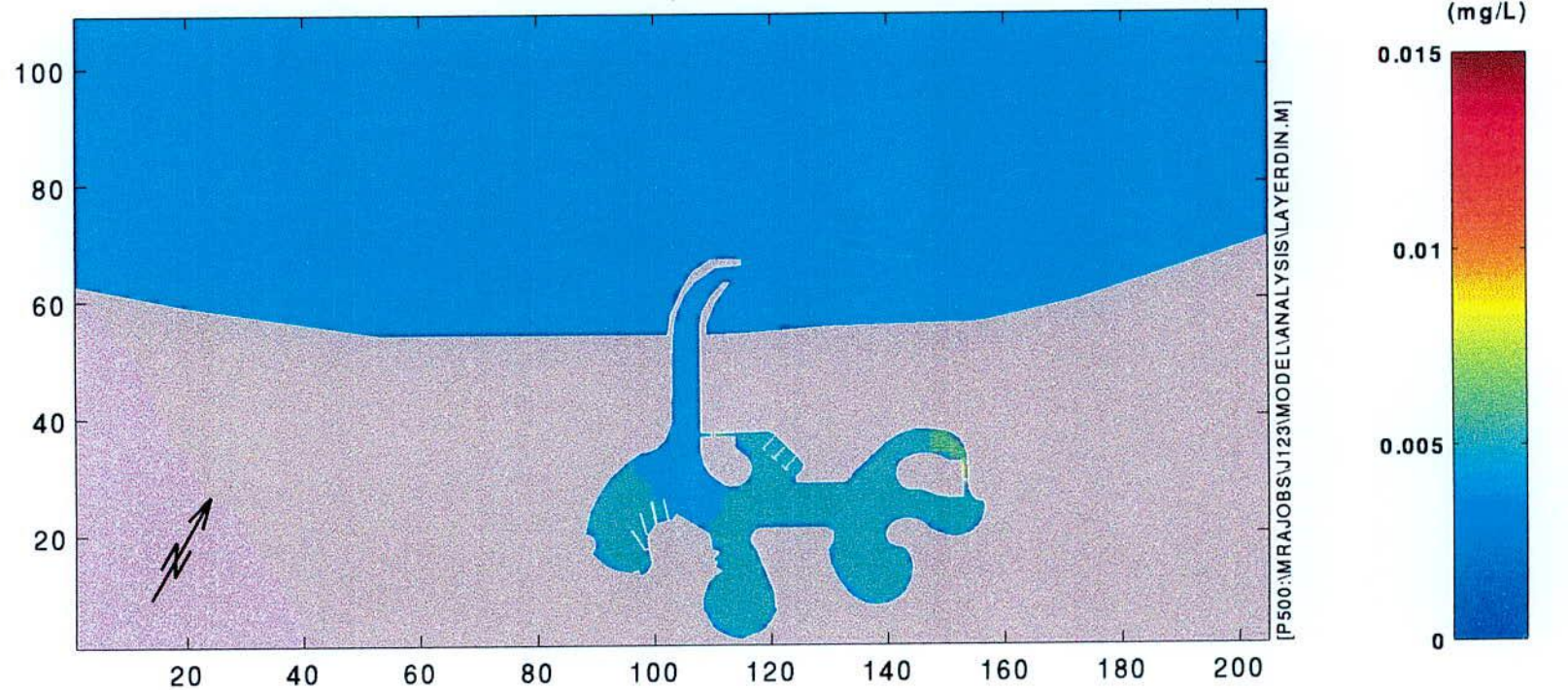


SOURCE: MP ROGERS & ASSOCIATES

TITLE: Coral Coast Resort – Winter Case
PLOT TYPE: Spatial Distribution of Dissolved Inorganic Nitrogen
TIME: 00:00 16/07/1998 **LAYER:** Surface
SCALE: 1:25000 **GRID RESOLUTION:** 20 m by 20 m



TITLE: Coral Coast Resort – Winter Case
PLOT TYPE: Spatial Distribution of Phosphorus
TIME: 00:00 16/07/1998 **LAYER:** Surface
SCALE: 1:25000 **GRID RESOLUTION:** 20 m by 20 m



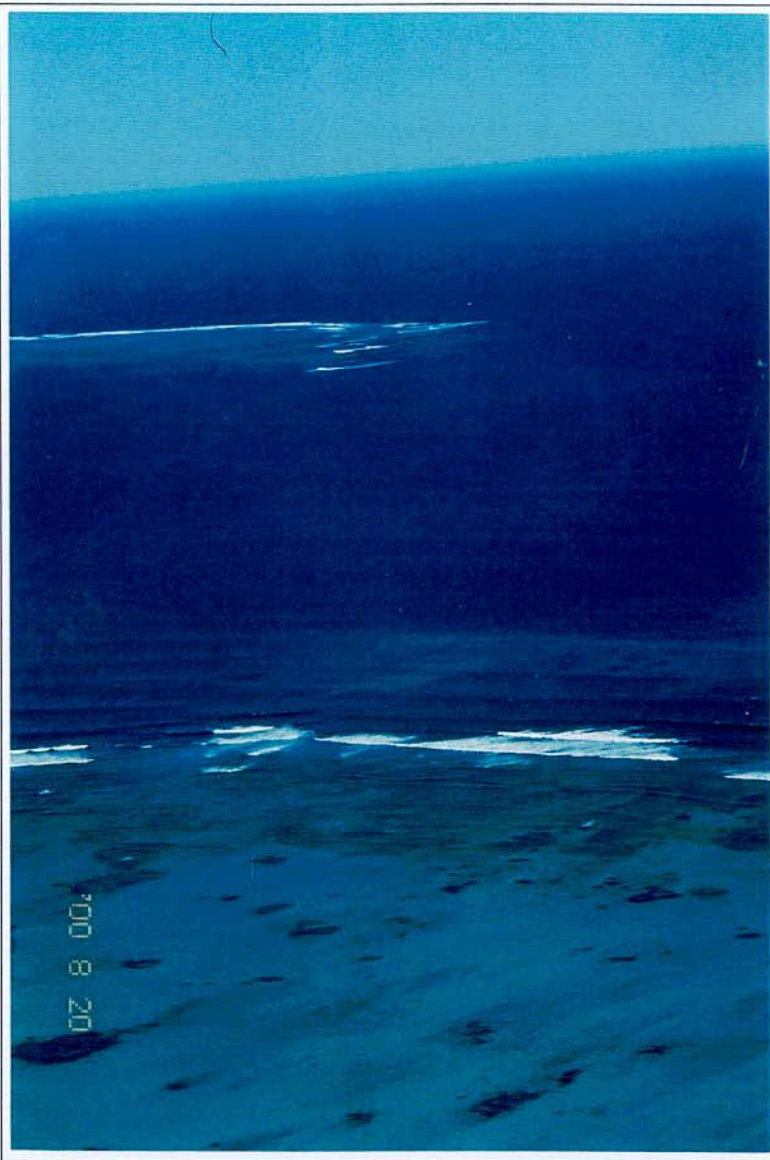


Plate 1 Cardabia Passage (aerial oblique looking southwest)



Plate 2 Boat moorings, Coral Bay Settlement

PLATES

CHECKED: HWV 2-10-01

DRAWN: GLM 2-10-00

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