B10 AIRPORT AND SURROUNDS MARINE ECOLOGY

CONTENTS

FIGURES

TABLES

APPENDICES (REFER SEPARATE APPENDICES DISK)

GLOSSARY

Abundance	Relative numbers of animals, for a species or community, in a given area or sample size.
Ambient	Existing background conditions of the immediate surrounds prior to the development of the assessed proposal.
Amphipod	Small crustacean of the Order Amphipoda.
Ascidian	A class of sea squirts, typically occurring as benthic fauna attached to substrate.
Attenuation	Gradual loss in the intensity of light as it travels through water.
Avifauna	Collective grouping or generic reference to birds.
Bathymetric	Underwater depth and topography of the seabed.
Benthic	Pertaining to the seafloor or seabed.
Biodiversity / diversity	Refers to the variety of organisms (taxa) within the communities included in this assessment (i.e. number of fish or invertebrate species etc.). Elsewhere, may refer to the variation for other scales life components, such as genetic diversity.
Biomass	Total mass of living organisms, or of a particular subset of organisms, or organisms within a given area (e.g. seagrass biomass).
Biota	All living organisms, plants and animals.
Buffer	A zone separating two regions.
Community	The biotic component of a habitat; grouping of populations of different species living together or sharing a habitat.
Composition	The biological components comprising a community, taking into account the different species present and/or their abundance.
Crustacean	A class of predominantly aquatic/marine organisms which generally have a hard shell (e.g. crabs, prawns, lobsters).
Density	In relation to biota (specifically seagrass), extent or numbers of an organisms within a given area.
Depauperate	Relatively devoid of biota, e.g. comparatively few obvious animals.
Dispersal	The movement or transport of animals and plants, particularly of juveniles and propagules, beyond their place of origin.
Distribution	The manner in which biota are spatially arranged; a species range or geographic extent.
Dredging	Excavation of subtidal bed sediments by mechanical means.
Echinoderm	From a phylum of marine animals with radial symmetry, includes starfish, sea urchins and sea cucumbers.
Ecological	Relating to the interactions between different organisms, or between organisms and their environment.
Ecosystem	Biotic and abiotic components of a broad environment functioning and interacting as an integrated system.
Epibenthic	Referring to organisms occurring on the surface of the seafloor or other substrata.
Epibiota	Organisms occurring on the surface of the seafloor or other substrata.
Epifauna	Fauna occurring on the surface of the seafloor or other substrata.
Epiflora	Flora occurring on the surface of the seafloor or other substrata.
Estuary	Semi-enclosed, tidal body of water (e.g. tidal reaches of a river, creek or similar).
Fauna	All of the animals found in an area.
Fisheries habitat	Natural and artificial habitats that support directly or indirectly the production, capture or culture of species interest to fisheries.
Flora	All of the plants found in an area.
Germination	Growth of a seedling from a seed (e.g. new seagrass plant).
Habitat	The environment in which a plant or animal lives.
Heterogenous	Consisting of different elements or parts.
Homogenous	Consisting of similar elements or parts.

Hydrographic	Associated with to mapping or describing the physical conditions characterising the ocean and other water bodies.
Indurated	Hardened or consolidated (with reference to indurated sands).
Infauna	Animals that live in the sediment.
Intertidal	The area along the coast below high tide and above low tide.
Invertebrate	Animals without backbones.
Larval	A juvenile form of animal, yet to undergo metamorphosis to adult form.
Macroalgae	Multicellular algae (seaweeds) that are visible to the human eye; green algae, red algae and brown algae.
Macroinvertebrate	Animals without backbones that are visible to the naked eye.
Mangrove	Salt tolerant trees which inhabit the intertidal zone on sheltered coastlines; their lower trunk and roots are periodically flooded by tides.
Megafauna	Animals that are large in size.
Microphytobenthos	Microscopic algae and cyanobacteria on the seabed.
Mitigation	Actions to alleviate, or reduce the severity of, disturbance.
Nutrients	Essential elements required by an organism for growth.
Pelagic	Pertaining to the water column.
Pest	A non-native species that has been introduced to a region and is considered problematic.
Photosynthetic	Undertakes the process carried out by plants, algae and some bacteria, whereby light energy is harvested by pigments (mostly chlorophyll) and utilised to convert carbon dioxide and water into organic molecules and oxygen.
Polychaete	Segmented marine worm from the Class Polychaeta.
Pore water	Water occurring between grains of sediment (i.e. interstitial).
Ramsar	Convention on Wetlands of International Importance Especially as Waterfowl Habitat, entered into force in 1975. A multilateral intergovernmental convention for the protection and management of internationally significant wetlands.
Richness	A measure of species/taxa diversity (e.g. the number of species present).
Rugosity	The degree of habitat complexity, taking into account changes in habitat height, slope and other physical characteristics. Indicative of amount of habitat available for colonisation, shelter, foraging etc.
Saltmarsh	An intertidal plant community complex dominated by herbs and low shrubs.
Seagrass	Flowering plant adapted to living wholly submerged in seawater.
Sedimentation	The deposition or accumulation of sediment.
Seed bank	Dormant plant seeds stored in in the environment (e.g. viable seagrass seeds in sediment).
Senescent season	The dormant season for seagrass (and other plant) species that display seasonal growth, leaves and other plant parts may be shed.
Sessile	Animals that cannot move, fixed in one place.
Spawning	Common reproductive process for marine animals; the release or deposition of eggs or offspring, often in large numbers.
Substrate	The benthic habitat surface or material (e.g. sand, rock).
Subtidal	The area below the level of the lowest low tide; below the intertidal zone.
Suspended solids	Small solid particles occurring in suspension within the water column.
Turbidity / turbid	Optical measure of light-absorbing materials in a water sample; surrogate measure of suspended solids.
Urchin	Sea urchin; globular, spiny animals of the echinoderm phylum.

MARINE ECOLOGY

10.1 INTRODUCTION

Consistent with the reporting structure for the EIS, the marine ecology assessment is presented in two parts, one for each study area. This chapter addresses marine environments in the vicinity of the airport, where the majority of construction and operational activities will occur. Chapter C4 – Marine Ecology provides the assessment for the Moreton Bay study area, where sand extraction operations are proposed to be undertaken.

10.1.1 Methodology and assumptions

10.1.1.1 Methodology

Nomenclature and terminology

For the purpose of this report the following terminology has been adopted:

- The term study area refers to all tidal waters within the nominated marine ecology study area. The marine ecology study area for the airport and surrounds covers an approximate 10 km length of coast from Maroochydore to Mount Coolum. It extends seaward to approximately 2 km offshore, and is bounded to the west by the Maroochy River and its tributaries, to approximately the upper tidal limit (**Figure 10.1a**)
- Pump-out site refers to the location where the dredge is proposed to be moored during construction for sand pumping operations (i.e. pumping sand from the dredge to the reclamation site), together with the pumping pipeline alignment where it lies in marine waters
- The pipeline assembly area refers to an approximate 0.5 km stretch of Marcoola Beach (south of the pipeline alignment) that will be used to assemble and disassemble the sand pumping pipeline during construction
- Tailwater discharge site refers to the location where the proposed northern perimeter drain discharges to Marcoola drain
- The surrounding area refers to the intertidal and subtidal waters adjacent to the study area.

Assessment approach

- Desk-top assessments and field surveys were undertaken to describe the existing ecological characteristics of marine habitats, flora and fauna in the study area and surrounds (**Table 10.1a**).

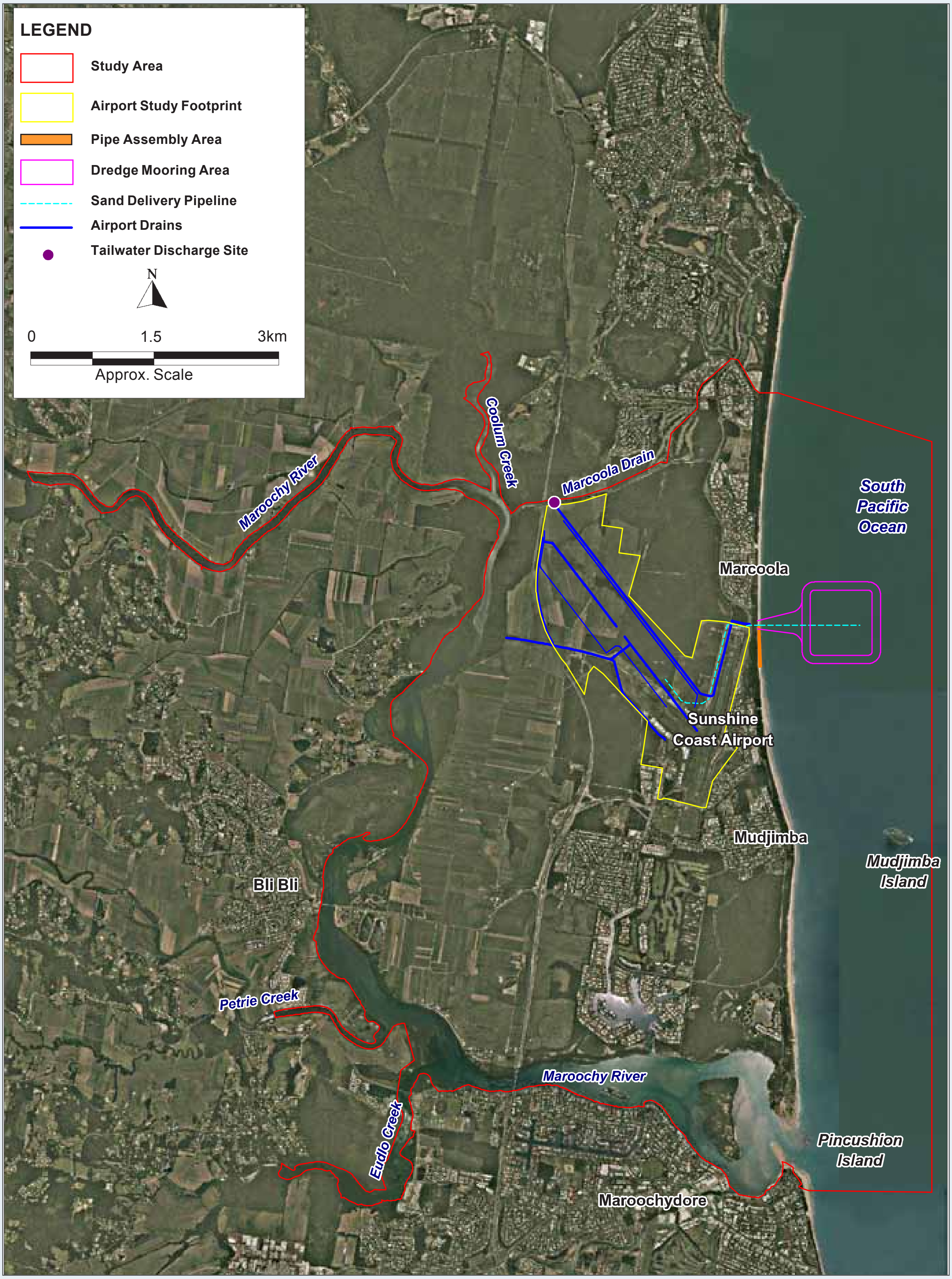
Key information sources reviewed during the desk-top assessments included:

- Aerial photography
- Results from public database searches for species and communities of conservation significance, namely the *Environment Protection and Biodiversity Conservation Act* (EPBC Act) Protected Matters Search Tool, and Department of Environment and Heritage Protection's (DEHP) Wildlife Online
- Existing vegetation mapping including Regional Ecosystem maps (DEHP 2012), historical marine vegetation maps (from Department of Agriculture, Fisheries and Forestry (DAFF) database), vegetation surveys undertaken as part of this EIS (refer Chapter B7 – Terrestrial Flora)
- Previous reports and databases describing the ecological and fisheries values of the study area and surrounds, particularly the CHRIS database (DAFF 2012).

Table 10.1a: Marine ecology components and assessment items

Component	Desk-top	Field surveys
Marine vegetation communities (seagrass, saltmarsh, mangroves)	• Existing mapping • Other existing data and reports	• Seabed habitat survey (video) for the pump-out site • Habitat survey at the tailwater discharge site
Unvegetated soft sediment marine habitats and epifauna communities	• Existing bathymetry mapping • Other existing data and reports	• Seabed habitat and epifauna community surveys (sonar and video) at the pump-out site • Habitat and benthic fauna survey at the tailwater discharge site
Reef habitats and communities	• Existing bathymetry mapping • Other existing data and reports	• Seabed habitat and epifauna community surveys (sonar and video) at the pump-out site
Fish communities and fishery values	• Commercial catch data	• Rapid fish survey at the tailwater discharge site
Marine mammals and reptiles	• Existing data and reports	• No field surveys included

Figure 10.1a: Marine ecology study area



Field surveys were undertaken by BMT WBM, providing up to date site-specific data for selected areas within, or adjacent to, the Project footprint. The methods utilised for sampling and subsequent data analyses are described below for:

- Seabed habitat mapping and epibiota surveys
- Estuarine vegetation validation
- Estuarine benthic fauna survey
- Estuarine fish survey.

Seabed habitat mapping and epibiota surveys

Seabed habitat and epibenthos community surveys were carried out using a combination of:

- Initial classification and mapping of substrate types using acoustic (sonar) based methods
- Visual survey of seabed habitats and communities using an underwater towed from the survey vessel.

Acoustic mapping survey effort over the marine ecology study area is shown in **Figure 10.1b**. Survey lines were spaced at 200 m in a grid formation over the pump-out site, with additional survey lines added opportunistically on the southern side of Mudjimba Island. Reef habitats surrounding Mudjimba Island were used to calibrate for “hard substrate”, as this area is known to contain reefs with hard coral.

Acoustic base mapping was conducted from the single hull survey vessel *Makira* with a Trimble Pro XRS differentially corrected GPS. The differential correction of the positioning data was conducted in real-time using the Australian Maritime Safety Authority (AMSA) radio beacon at Ningi to provide sub-metre accuracy within the study area. The dGPS antenna was affixed to the top of the acoustic sounding pole to maintain the integrity of all collected survey data.

The survey was completed on 31 November 2012. Weather during the period was calm to choppy, with wind speeds rarely exceeding 10 knots, and seas of less than 0.5 m at all times. Vessel speed while conducting acoustic surveys was maintained at approximately 5.5 knots. To minimise the potential for aeration of the transducer resulting from propeller induced turbulence, the sounding pole was positioned 1 m wide and forward, with the transducer in front of the propeller at a depth of 0.8 m below the waterline. The pole was clamped to a handrails and an entry ladder on Makira. This arrangement facilitated removal of the transducer from the water when the vessel was transiting to and from the study area, and a firm attachment point, free of turbulence for the transducer head.

Acoustic sounding and seabed classification was achieved using a 200 kHz single beam Hondex Model 7300 echo sounder (*Figure 10.1c*) with a sonar beam widths of 28 degrees. The echo sounder was interfaced to the Quester Tangent Corporation (QTC) View Series 5 (Version R2.10) system which consists of hydrographic survey hardware and software components (**Figure 10.1c**) tailored to acoustic seabed discrimination based upon the shape of acoustic sonar returns from the seabed.

The system records the characteristics of the reflected acoustic waveforms to generate habitat classifications, based upon the diversity of scattering and penetration of the acoustic signal from varying types of seabed. The process involves collection of acoustic data which are time stamped and geo-referenced using dGPS. The raw acoustic data were stored in real-time on a Toshiba Satellite Model U200 laptop computer running the QTC View Series 5 software.

Acoustic data analysis and mapping

The QTC suite of programs was used to process acoustic data (Locker and Wright 2003; Riegl and Purkis 2005; Preston et al. 2006). Raw data files were post-processed using the QTC IMPACT software package and all data were checked for correct time stamps, correct depths and correct signal strengths. Acoustic records from the marine ecology study area and the dredge extraction site were combined for the backscatter analysis using the QTC Impact seabed classification software. This allowed comparison of sediments (and eventually habitat classes) between the two areas.

In the QTC IMPACT software (version R3.40) the acoustic echoes were digitised and normalised to a range between 0 and 1, before being subjected to further analysis. These data were then reduced by generating Full Feature Vectors, referred to hereafter as acoustic records. Acoustic records were displayed on a bathymetry plot where the recorded depth was checked against the blanking (minimum recordable) depth and the maximum depths expected for the study area, based upon existing bathymetric information.

QTC IMPACT was used to classify acoustic signals (echograms) that returned from the seabed into statistically different acoustic classes. All acoustic records were subjected to Principal Components Analysis (PCA) to eliminate redundancies and noise. The first three principal components of each echo (called Q values) were retained, according to the theory that these typically describe 95 per cent of the information within each echo. Data points were then projected into pseudo three dimensional space along these three components, where they were then subjected to cluster analysis to determine echoes of similar signature. In clustering, the user determines the desirable number of clusters (seabed classes) and also chooses which clusters to split and how often. Clustering decisions are guided by three statistics offered by the software package.

For each individual signal, the following data were exported from QTC IMPACT: latitude and longitude; depth (uncorrected for tidal or wave states); three PCA axes (called Q axes); a class category; a class assignment confidence value and a class probability value, which both range from 0 to 100 per cent. These indices may be useful for further determining the overall ‘quality’ of individual data points and classes. Records with confidence less than 95 per cent were removed from the analysis. For the purposes of data presentation and interpolation, each dataset has been reduced to a three column matrix consisting of a single x, y and geo-referenced seabed class category z.

Figure 10.1b: Ecology nearshore sampling locations

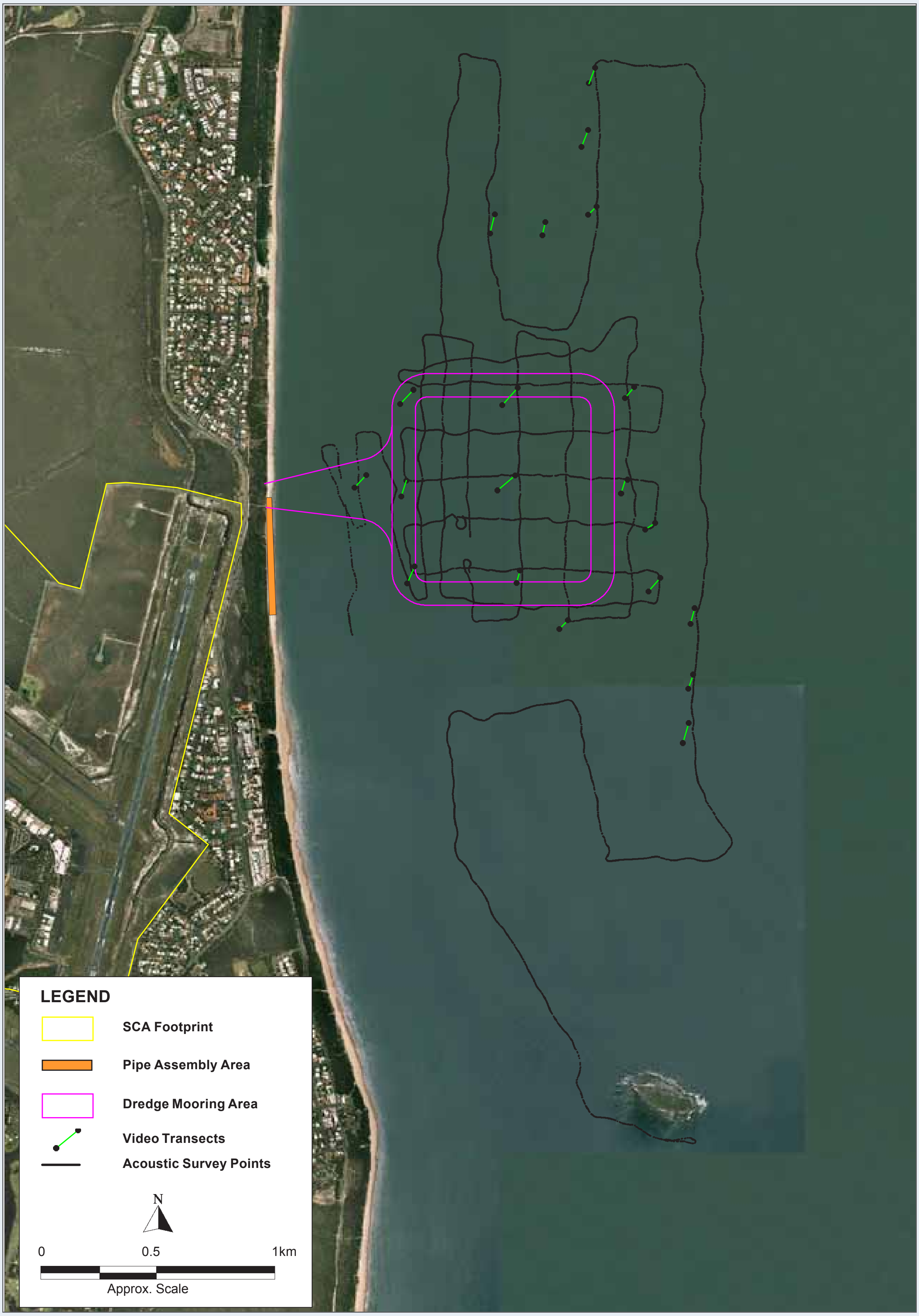
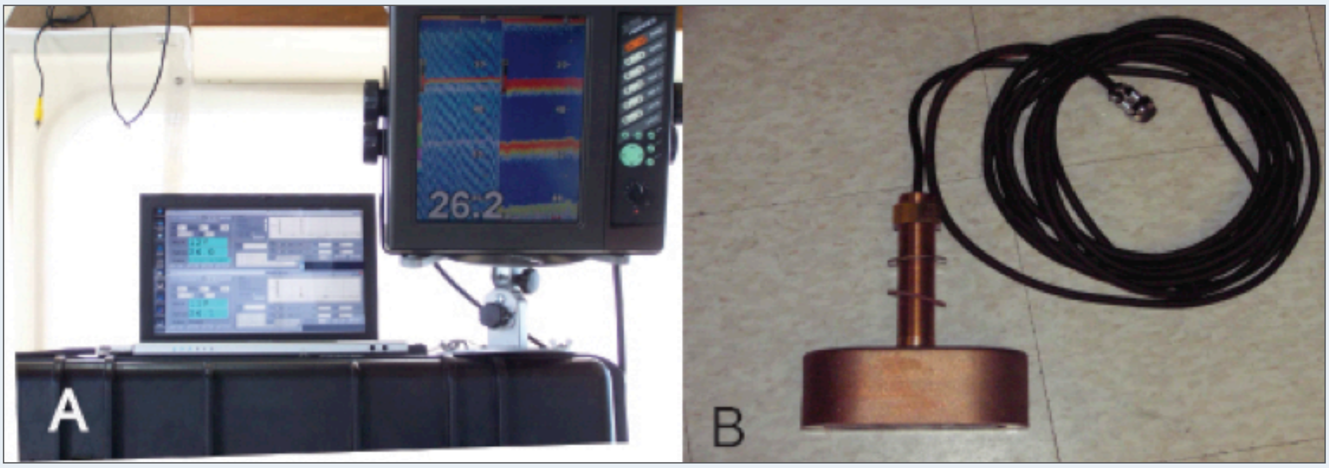


Figure 10.1c: Laptop and echo sounder (A); and the transducer head (B)



A natural neighbour interpolation with median values was used to create benthic habitat maps of the Project area using Vertical Mapper v3.1 through the MapInfo 10.0 platform. Mean values were used because habitat classes appeared to be serially ordinated, based on sediment grain size. That is, class 2 and 4 habitats were often separated by class 3 habitats. Sonar data were interpolated using 0.1m cell sizes and 0.1m aggregation distances. For video data interpolations, cell sizes were 6.4 m and aggregations distances were 4.8 m.

Assessment of sediments and epifauna, and validation of acoustic data

The acoustically derived habitat categories do not, in isolation, provide information on the nature of the actual seabed conditions. The final classification of benthic habitat types was undertaken by ground-truthing and validating acoustic habitat classes using video analysis and qualitative investigations of particle size.

Indirect methods were used to classify benthic habitats developed by acoustic categories. This involved the following process:

- Generation of acoustic habitat classifications on each transect line using Vertical Mapper
- Undertaking video analysis at representative sites located on acoustic transect lines
- Using geographic information systems (GIS) to overlay acoustic classes and video transects to check for correspondence or otherwise.

Video analysis

Seabed habitat communities of the marine ecology study area were assessed using an underwater video camera on 1 November 2012. Video ground-truthing surveys were used to characterise each acoustic habitat class and validate the results of the acoustic classification and mapping, as well as describe epibenthic fauna communities. The sites selected for video transects encompassed the range of habitats previously identified by the acoustic methods to be separate classes. The locations of these sites are shown in **Figure 10.1b**.

Video transects were recorded at 19 sites surrounding the pump-out site, and at two sites along the southern edge of Mudjimba Island. At each transect, an underwater camera system was deployed by the passively drifting vessel for 3-4 minutes in order to film at least 50 m of sea floor. Video footage was observed on a computer monitor in real-time and recorded to hard drive. A van Veen grab was used to sample the seabed at selected sites to confirm sediment type.

Once collected, the video file for each transect was reviewed, noting the following features:

- Substrate type (i.e. soft sediment, consolidated reef)
- Approximate sediment grain size (i.e. silt, sand, rubble)
- The presence, general composition and abundance (i.e. dominant groups) of visually obvious biota, including epibenthic fauna (i.e. hydrozoans, sponges, ascidians etc.), epibenthic macroalgae and seagrass
- Other relevant features influencing seabed habitats (i.e. topography, evidence of trawling activity).

Estuarine vegetation validation

Following a review of existing publicly available vegetation mapping and aerial photography, a preliminary map of the distribution and extent of marine vegetation was prepared. This preliminary map was then field validated to verify its spatial accuracy. Field surveys were undertaken in August 2012 and consisted of traversing the tailwater discharge site and surrounds to identify obvious inconsistencies in vegetation type and extent. Mid- and downstream reaches of the Maroochy estuary were broadly examined via vessel to identify and map any visually obvious seagrass beds. This consisted of navigating over the mid- and downstream reaches of the estuary at low tide, focusing on the shallower edges closer to shore, and mapping notable seagrass beds that were visible from the surface (i.e. on board the survey vessel). The preliminary estuarine vegetation map was then updated by digitising notable discrepancies to better reflect actual conditions.

Estuarine fish and benthic fauna survey

The broader marine fish habitat values of the study area were largely determined based on the seabed habitat mapping and epifauna community surveys described above. A once-off survey of estuarine fish and benthic infauna (invertebrates greater than 1 mm in size that live in or on estuarine soft sediments) was undertaken at Marcoola drain during August 2012 to characterise receiving environments of the proposed tailwater discharge. Field surveys included:

- Benthic fauna sampling – Five sites (refer **Figure 10.1d**) were sampled using a van Veen grab (~0.028 m^2 gape). At each site three replicate samples were collected and washed through a 1 mm mesh sieve. The fauna retained were preserved and transported to the laboratory for sorting and fauna identification and enumeration. Standard microscopy techniques were used to identify fauna to the lowest practical taxonomic level, typically to morpho-species.
- Fish sampling – Estuarine fish were surveyed at three sites in the vicinity of the tailwater discharge site (refer **Figure 10.1d**). In order to sample a range of different sized fish, a variety of nets and net mesh sizes were utilised, which were selected with respect to the habitat types and dimensions present at the times of the survey. These specifically included two seine nets (5 mm and 18 mm mesh) and three gill nets (40, 60 and 80 mm mesh). Each seine net was hauled twice at each site in a circular manner from the bank. Each gill net was deployed once at each site for a soak time of two hours. All captured fish were identified and counted, then released at the site of capture.

On the basis of the survey results, patterns in fish and invertebrate fauna community structure were quantified. Locations or habitats of high biodiversity or fisheries value are identified and described on the basis of these analyses. Patterns in benthic community similarity (Bray-Curtis similarities) were examined with non-metric multi-dimensional scaling ordinations (based on square-root transformed abundance data), using the software package Primer Version 6.

10.1.1.2 Assumptions and technical limitations

In terms of flora and fauna, this assessment focuses on conspicuous taxa present (or potentially present), especially those of conservation significance (i.e. protected by legislation), and those that are considered to be of high environmental value for other reasons, such as high fisheries value or directly support fauna of high conservation or fisheries value (i.e. as a key habitat or food source).

The description of the existing environment provided herein is based primarily on a combination of information that was available to the authors at the time of writing, together with the results of surveys conducted specifically for the Project. It is recognised that additional data and knowledge relevant to the Project may reside elsewhere (i.e. unpublished data, grey literature).

For the assessment of impacts to marine ecological values, the assessment is guided, in part, by the outcomes of technical assessments included elsewhere in this EIS. Thus, it is also bound by the limitations and assumptions of the relevant chapters, particularly the modelling predictions and advice presented for coastal processes and water quality chapters (refer Chapters B4 – Coastal Processes and B6 – Hydrology and Water Quality). Of primary relevance is the 33 week duration of simulated tailwater discharge modelling. The actual tailwater discharge program could be a shorter, to a minimum 14 week duration, depending on which dredge vessel is ultimately used. However, the 33 week program was selected for assessment purposes as it was considered to represent the worst case scenario in terms of assessing water quality effects relative to the relevant water quality objectives, which are based on an annual median concentration.

10.1.2 Policy context and legislative framework

The following is a summary of federal and state legislation that is relevant to marine ecological aspects of the Project.

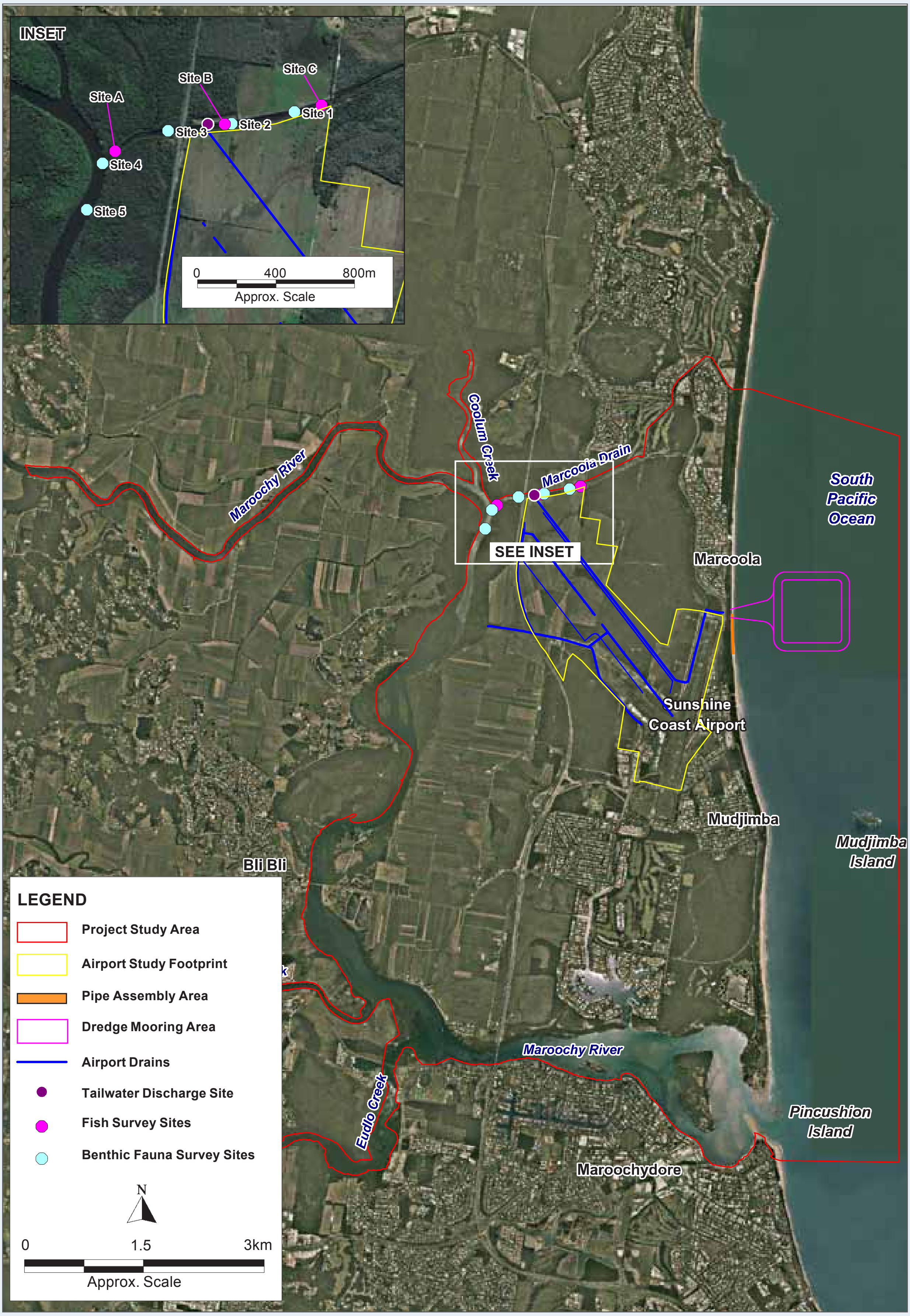
Federal:

- EPBC Act, which provides for the protection of matters of national environmental significance (MNES). MNES of relevance to the Project include:
  - Nationally threatened species and ecological communities (including marine turtles and mammals).
  - Migratory species (including dugong, whale shark and several threatened marine megafauna species).
  - Wetlands of international importance (i.e. Moreton Bay Ramsar site).

State:

- *Nature Conservation Act 1992*, which provides for the protection of state listed threatened and near threatened flora and fauna species, which in the context of this Project includes marine turtles, whales, dolphins and dugong
- *Fisheries Act 1994* provides for the use, conservation and enhancement of the community's fisheries resources and fish habitats. Of particular is the management of Fish Habitat Areas (including Maroochy River Fish Habitat Area) and the protection of fisheries habitats such as seagrass, mangroves and saltmarsh, and protection of fish stocks
- *Environment Protection Act 1994* (EP Act) provides for sustainable resource development while protecting ecological processes. The EP Act regulates environmentally relevant activities. The *Environmental Protection (Water) Policy 2009* aims to achieve the object of the EP Act in Queensland waters by establishing environmental values and water quality objectives

Figure 10.1d: Estuarine fish and benthic fauna sampling sites



- The *Queensland Coastal Plan* (Department of Environment and Resource Management (DERM), 2012) was prepared under the *Coastal Protection and Management Act 1995* in February 2012. The Coastal Plan consists of the State Policy for Coastal Management (SPCM), containing policies and guidance for coastal land managers on managing and maintaining coastal land. This policy has recently been replaced by the draft Coastal Management Plan (2013) which carries forward the policy outcomes from the State Policy for Coastal Management
- The Coastal Protection State Planning Regulatory Provision (the Coastal SPRP) took effect on April 2013. Previously, the Draft Coastal SPRP had suspended the operation of the State Planning Policy 3/11: Coastal Protection (Coastal SPP). The Coastal SPRP provides outcomes for development assessment in the coastal management district
- The single State Planning Policy (SPP) came into force December 2013, providing a single framework for considering a series of State Interests. The SPP is subordinate to the Coastal SPRP but must be considered in development assessment unless the provisions are adequately reflected in local planning schemes. Relevant State Interests include the biodiversity and the coastal environment.
- Sections and parts of the SPCM and Coastal SPRP that are relevant to marine ecology include:
  - Nature conservation, which covers biodiversity conservation, specifically conserving and managing a diverse range of habitats and biodiversity, the retention of native vegetation, and retention and management of riparian vegetation.
  - Areas of high ecological significance, which states development and development infrastructure to be located outside of, and not have an impact on High Ecological Significance areas, with some exceptions (note: development associated with an airport is an exception).

The relevance and consistency of the Project with the State Policy for Coastal Management and Coastal SPRP are outlined in Chapter A6 – Planning and Legislation and Chapter B2 – Land Use and Tenure.

10.2 EXISTING CONDITIONS

10.2.1 Introduction to marine habitats

The study area encompasses a range of marine and estuarine habitat types, including nearshore waters; estuarine waters; intertidal and subtidal soft sediment substrata; intertidal sandy beach; intertidal rocky outcrops along the coastline; and vegetated estuarine habitats, including seagrass, mangrove and saltmarsh communities. It also includes Mudjimba Island (also known as Old Woman Island) and associated rocky reef and intertidal shores.

These habitats are described in the following sections of this Environmental Impact Statement (EIS) in terms of their distribution, environmental values and current condition. Relevant marine protected areas are detailed, as are the major flora and fauna groups known to occur, with particular reference to those that are of key conservation, fisheries or other significance.

10.2.2 Marine protected areas

Marine protected areas within the bounds of the study area include the Maroochy River Fish Habitat Area (FHA) and a network of terrestrial-based conservation parks (**Figure 10.2a**). Fish Habitat Areas, which are managed under the Queensland *Fisheries Act 1994*, represent a form of multiple use marine protected area that limits certain activities that may affect fisheries habitat values. The Maroochy River FHA extends from the high water mark and covers estuarine waters of the Maroochy River and some of its tributaries, including Coolum, Petrie and Eudlo Creeks. It is split into areas of varying degrees of management, Management A and Management B. The Management A area is afforded the most intense protection, primarily excluding developments that are not required for fishing or safety purposes (i.e. private jetty, public bridge), and not permitting beach nourishment works. In the Maroochy River FHA, the location of the Management A area is largely aligned with that of the estuarine/fish habitats that are in best condition. Commencing approximately 1 km south of the Marcoola drain confluence, it extends downstream to the road bridge at Bli Bli. All other areas within the FHA are Management Level B.

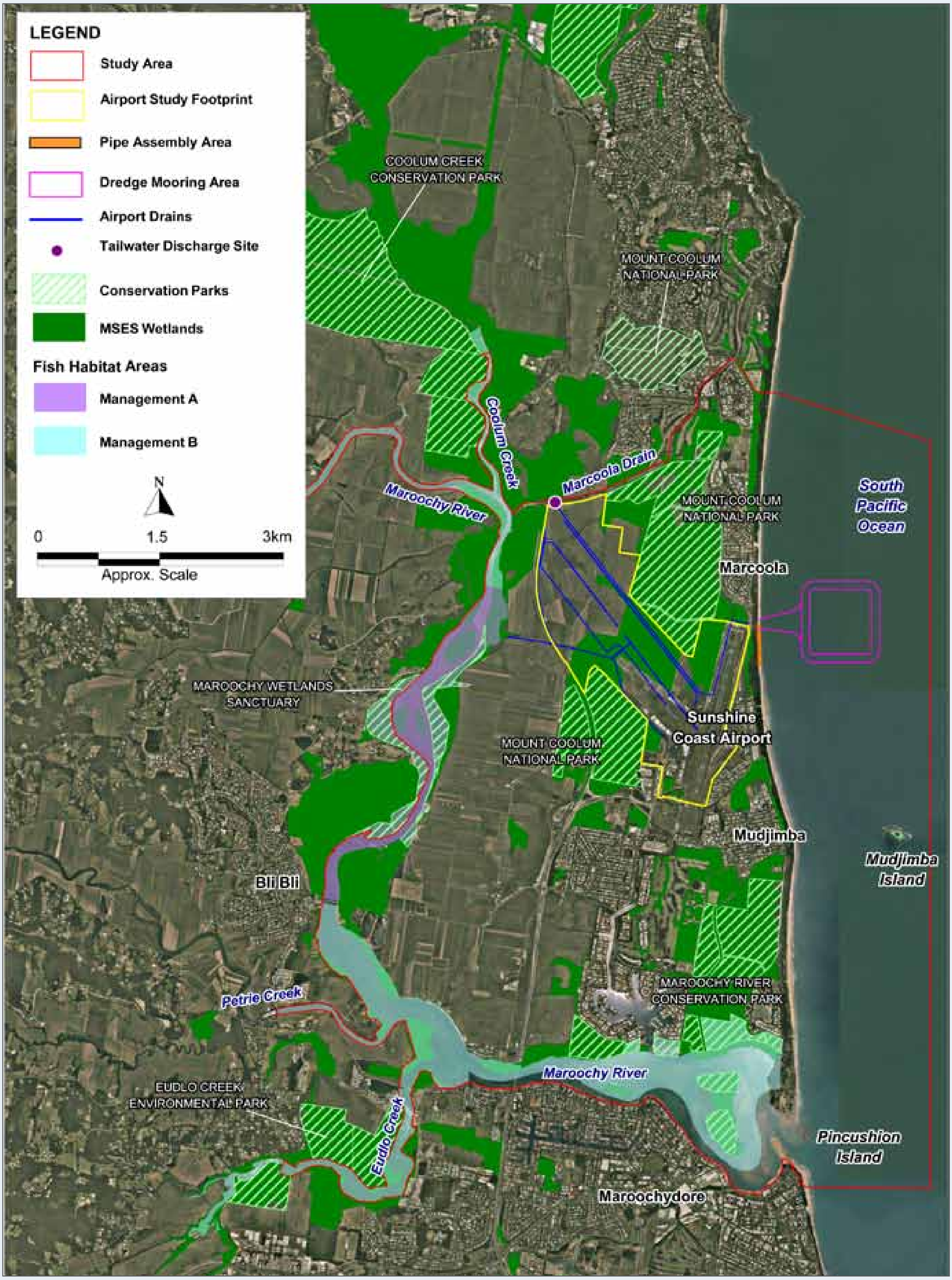
Conservation parks that include lands in or directly adjacent to intertidal areas of the study area include (**Figure 10.2a**):

- Maroochy River Conservation Park, including Mudjimba Island, parts of the north shore of the Maroochy River around Twin Waters and Mudjimba, as well as islands in the lower estuarine reaches of Maroochy River
- Eudlo Creek Environmental Park at Diddillibah
- Maroochy Wetlands Sanctuary at Bli Bli.

Note that most wetlands present in the study area are listed as MSES wetlands (Matters of State Environmental Significance) with a high conservation value, refer **Figure 10.2a**. While many of the wetlands mapped are freshwater (see Chapter B9 – Aquatic Ecology), significant areas of estuarine wetlands are also mapped in tidal areas, primarily encompassing the estuarine vegetation communities present (refer **Section 10.2.6** for further discussion).

The next nearest marine protected areas are Moreton Bay Marine Park and Moreton Bay Ramsar site, located approximately 20 km south of the study area. These two marine protected areas are within and adjacent to the Project's proposed dredging operations in Moreton Bay, and are therefore addressed in Volume C of this EIS.

Figure 10.2a: Locations of protected areas relevant to marine ecology



10.2.3 Seabed habitat

10.2.3.1 Acoustic mapping results

A total of 47,474 acoustic records (data points) were acquired for the combined dataset including the marine ecology study area and dredge extraction site. Based on five iterations per class and a maximum of 15 classes, cluster analyses revealed that the optimum number of seabed classes was six. Following the removal of anomalous data (i.e. records with confidence ratings less than 95 per cent), a total of 29,167 records remained from the combined dataset. This consisted of 18,172 records from the dredge extraction site, and 10,995 records from the marine ecology study area. PCA ordination of all acoustic records is shown in **Figure 10.2b**. In broad terms, data-points that are close together within each ordination (**Figure 10.2b**) are similar to each other, whereas data-points that are widely separated are dissimilar.

The data shows that class 1 (dark blue) and 2 (light blue) were the most similar classes, whereas class 1 and 5 (red) were the least similar to each other. Based on video observations and benthic grab observations, the acoustic habitat classes were mostly very similar to one another, and consisted largely of fine to medium sands with increasing fractions of coarse material present in higher classes (**Figure 10.2b**). Class 1 consisted of mostly fine sands, while class 2 consisted of fine to medium sands with shell grit. Class 3 contained fine to medium sands with occasional gravel. Video observations of class 3 sediments also suggested that these occasionally corresponded to flat patches of "coffee rock" (hardened Holocene sediments) with a thin sandy veneer. Class 4 habitats consisted of sand with some gravel and occasional rubble (cobble). Class 5 habitats consisted of sand with gravel and some rubble, and class 6 habitats consisted of high-relief areas, such as reefs which were found exclusively around Mudjimba Island.

10.2.3.2 Sediment distribution

Figure 10.2c shows patterns in the interpolated distribution of sediment classes in the marine ecology study area. The pump-out site was dominated by class 2 sediments, with occasional class 3 sediments becoming more common in the eastern part of the mooring area and less so in the western part of the pump-out site (**Figure 10.2c**). These sediments had moderate bed forms (sand ripples) consistent with regular wave action that the area experiences. The Class 3 sediments were often overlaying a platform of coffee rock, which was occasionally visible in small patches. Further west, near the western extent of the survey (i.e. closer to shore) was a patch of class 1 sediments corresponding to fine sands with irregular bed forms, which were mixed with class 2 sediments.

The greatest concentration of class 3 sediments occurred to the north of the pump-out site, and extended to the northernmost survey extent. These sediments also consisted of fine to medium sands with occasional gravel, often with well-developed bed forms.

The large area of class 3 sediments to the south of the survey area is considered to be only an interpolation anomaly where there was not survey effort, created due to averaging between higher classes (reef) surrounding Mudjimba Island and the large number of class 2 sediments dominated the rest of the survey area.

Class 6 habitat on the southern side of Mudjimba Island coincided with coral and boulder reef. Drop camera validation indicated that hard structure continued all the way down the reef slope, until the base of the reef slope where sandy sediment began again.

With the exception of Mudjimba Island and one site where coffee rock was observed (just west of the pump-out site), sediments appeared extremely homogeneous throughout the survey area. Distinctions between sediment classes have been based qualitatively on photos and video, rather than quantitatively through particle size distributional (PSD) analysis. This makes determination of subtle differences PSD among habitat classes more difficult, however; the subtleties of these differences are not necessarily biologically meaningful, in terms of their ability to support significant epibenthic communities. In other words, the acoustic classes describe sediments in more detail than necessary to adequately describe biological patterns (see **Section 10.2.4** for more detail).

10.2.4 Marine epibiota on unconsolidated substrata

10.2.4.1 Marine epifauna

Nearshore video surveys found that visually conspicuous epibenthic communities were extremely sparse within and surrounding the pump-out site. The highest fauna count was only four individuals (over transects up to 150 m in length) and numerous transects did not contain any individuals (**Figure 10.2d, Figure 10.2e-A**). Visible epibenthic fauna consisted of occasional swimmer crabs (**Figure 10.2e-C**), mole crabs (Hippoidea), sea cucumbers (holothurians), sea stars (asteroids) and bivalve molluscs. Although large epifauna were rarely sighted during video transects, grab samples frequently contained several small heart urchins (*Echinocardium cordatum* **Figure 10.2e-B**). The small size and burrowing nature of these animals means that they, and other small burrowers, were under-represented by video assessments.

While the results presented focus on epifauna in the vicinity of the pump-out site, dense epibenthic communities were also observed in association with consolidated substrata along the southern shore of Mudjimba Island, containing numerous corals, ascidians, molluscs and many other taxa. The reefal habitats are discussed more generally in **Section 10.2.5**.

10.2.4.2 Marine epiflora

No seagrass was observed within the pump-out site or nearshore pipeline alignment during the surveys conducted for this EIS. This was not unexpected, given the wave climate of the area. Several small patches of macroalgae

Figure 10.2b: Two-dimensional PCA ordination showing clusters of acoustic classes and representative screen grabs over these habitats

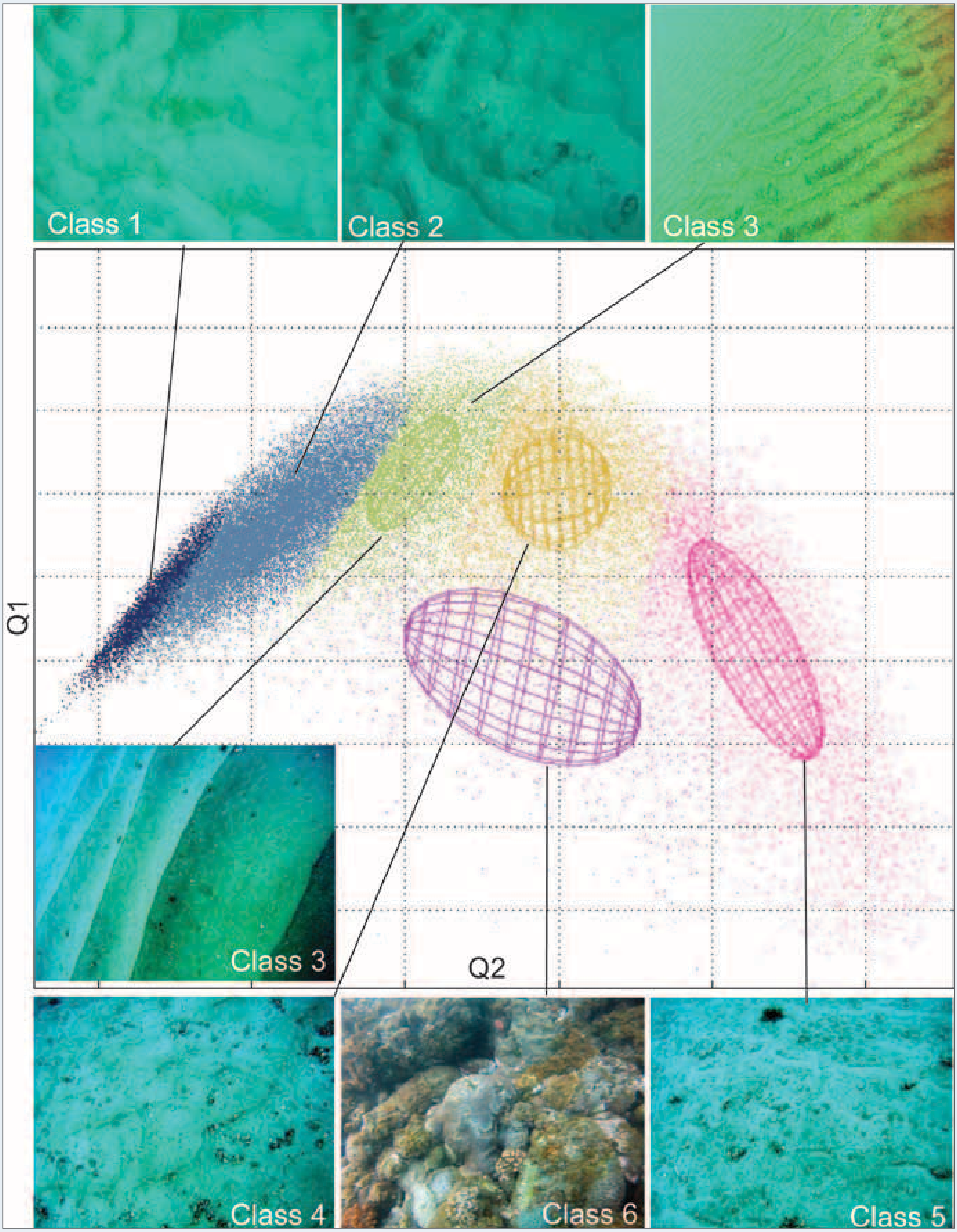


Figure 10.2c: Interpolated sediment classes

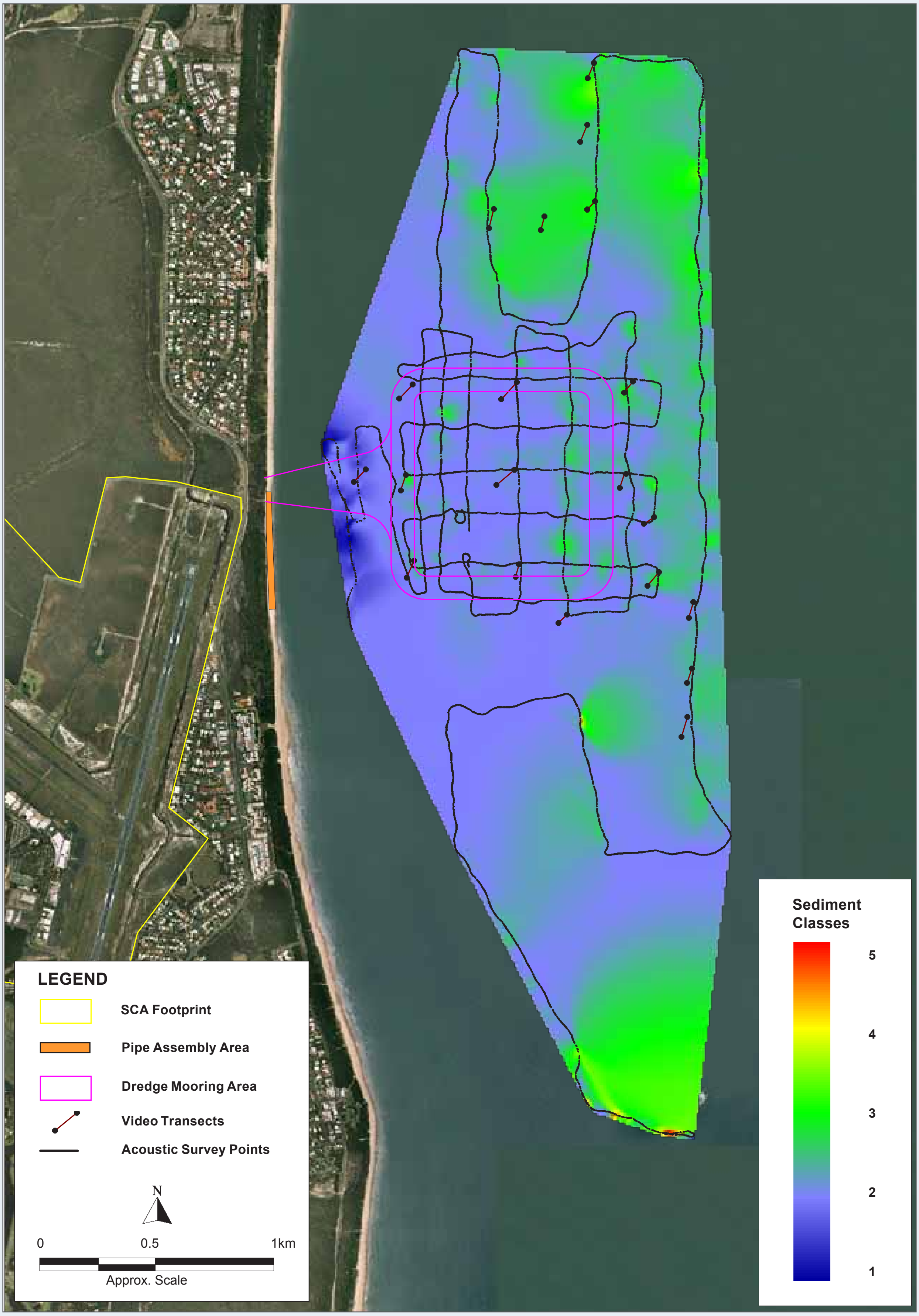


Figure 10.2d: Marine epifauna distribution

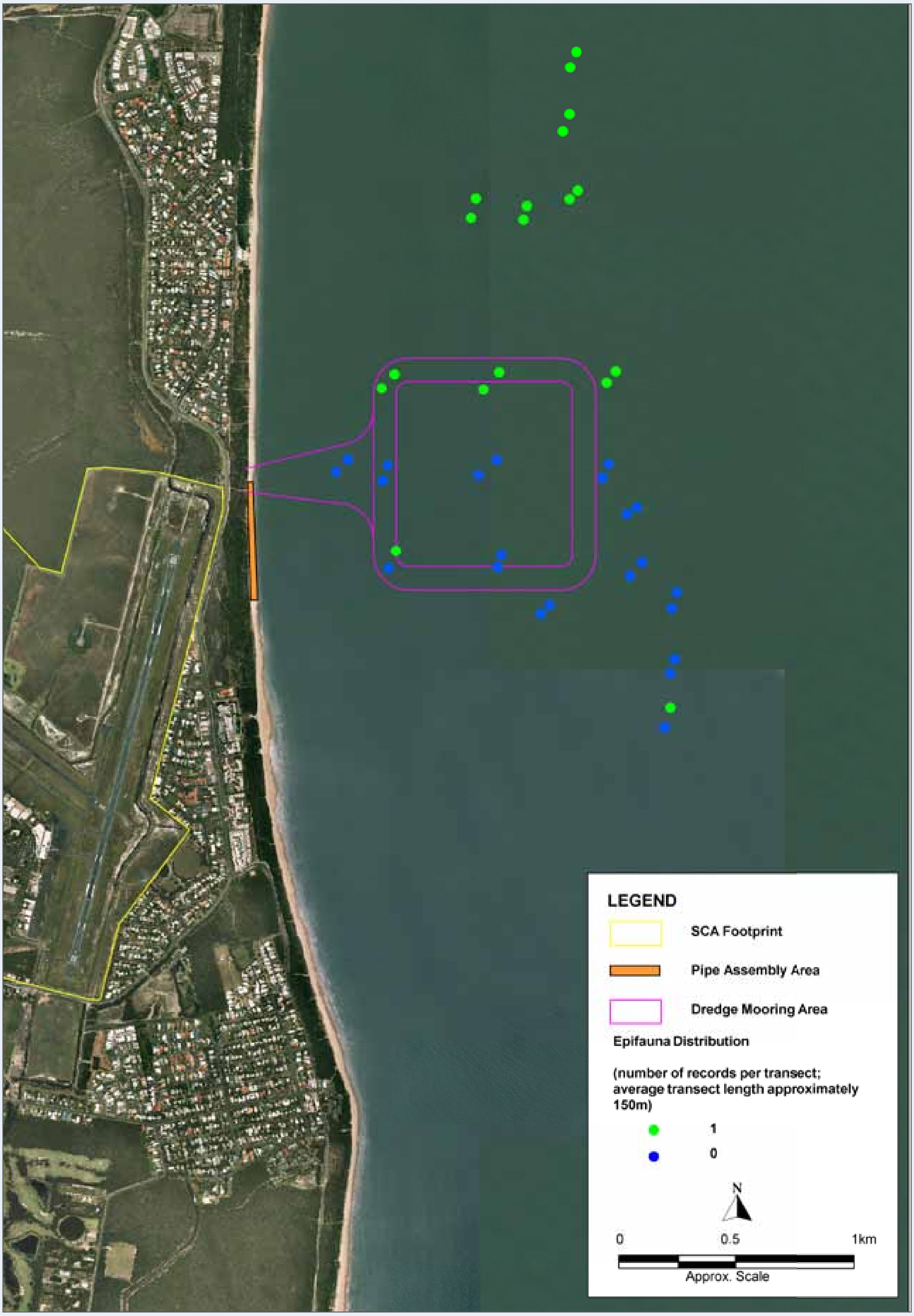


Figure 10.2e: (A) Bare sand with detritus and bedforms; (B) heart urchins Echinocardium cordatum; (C) small portunid (swimmer) crab; (D) Halimeda (top left) on sand over coffee rock; (E) Halimeda and Caulerpa sp.); (F) Sargassum

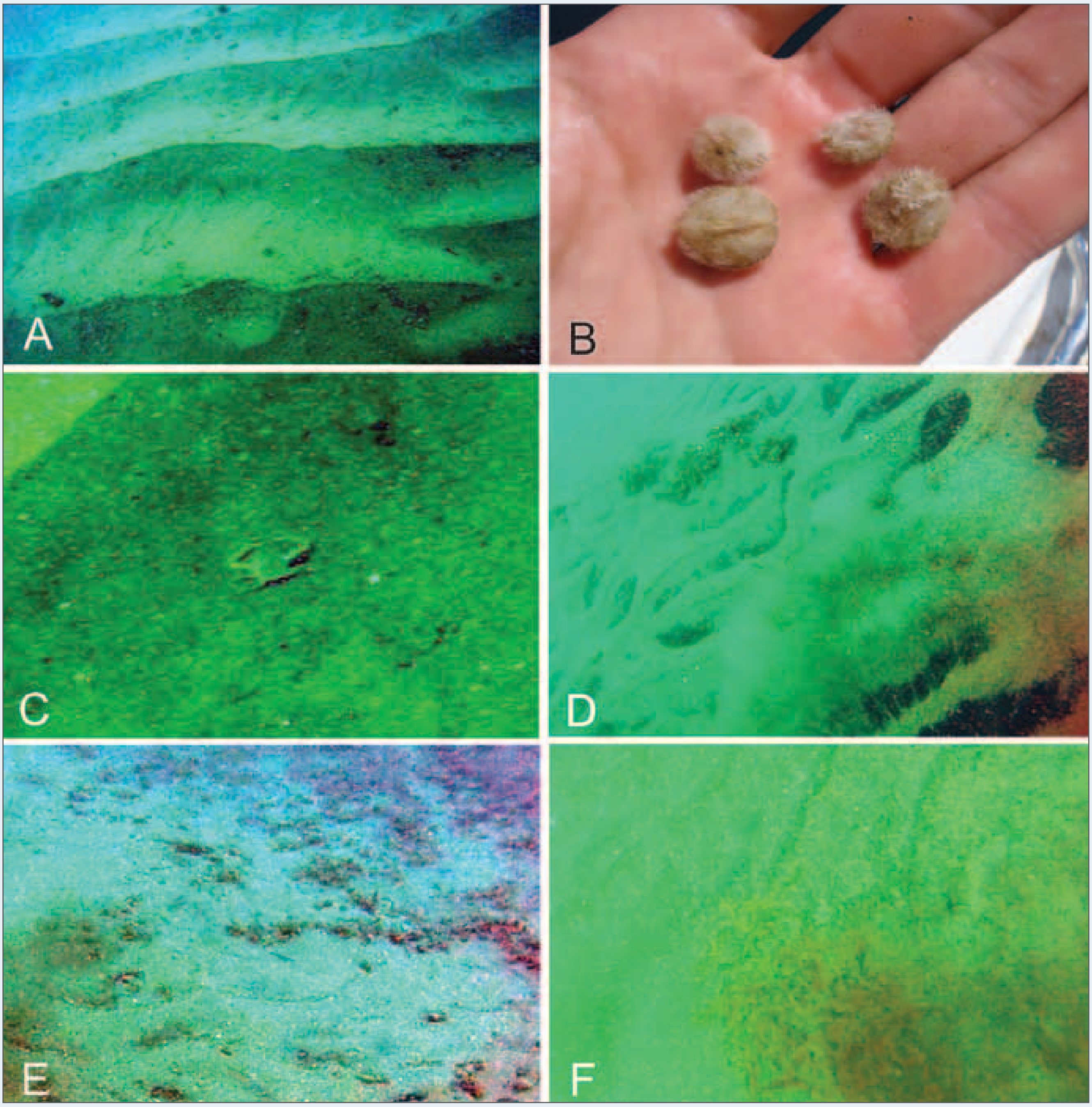
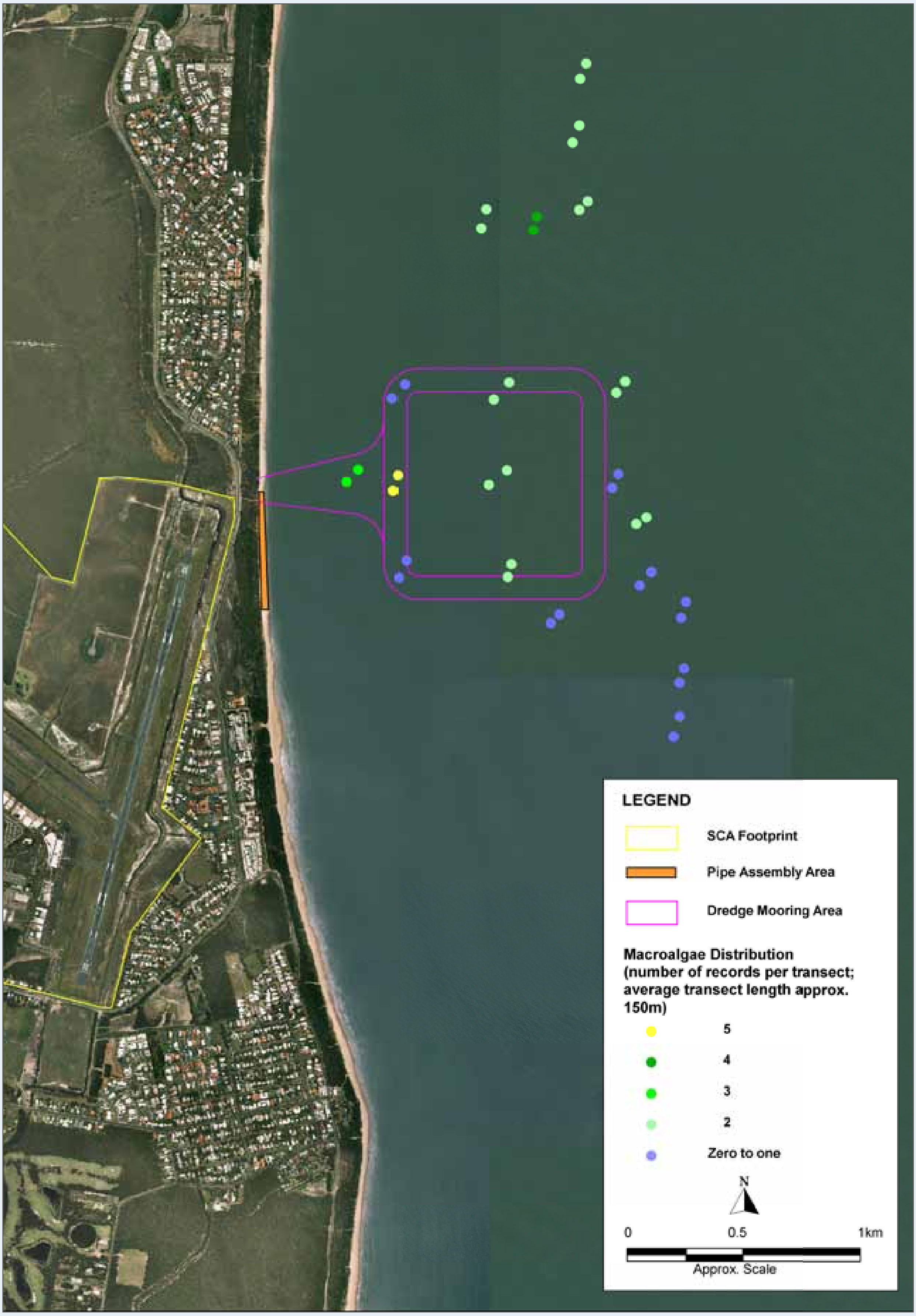


Figure 10.2f: Marine macroalgae distribution



were observed, mostly over coffee rock situated just west of the pump-out site, in the vicinity of the pumping pipeline alignment (**Figure 10.2f**). These consisted of the green calcifying algae *Halimeda* sp., *Caulerpa* c.f. *racemosa*, and *Sargassum* (**Figure 10.2e-D, E, F**). Several very small clumps of what appeared to be *Codium* were also occasionally observed, but these were unattached and likely to have originated elsewhere, such as Mudjimba Island or on other hard substrates nearby, beyond the surveyed area.

10.2.5 Reefs and hard substrata

Within the study area, the coastline is predominantly sandy with few rocky outcrops. Mudjimba Island, located approximately 1 km offshore from Mudjimba (**Figure 10.2g, Figure 10.2h**), represents the primary area of subtidal rocky reef and intertidal rocky reef habitats within this area. No other subtidal rocky reefs are known to occur within the study area, with the exception of the small areas of low-profile coffee rock that are exposed intermittently as the overlying sands shift.

Reef Check Australia undertakes annual monitoring of the fringing reef on the lee side of Mudjimba Island. A summary of the results for the last five years is provided below for benthic habitats and invertebrates **(Figure 10.2i**, Reef Check Australia 2012). Benthic habitat type has predominantly been comprised of rock, hard coral, with small soft coral, sponge and sand components. These findings are consistent with baseline surveys carried by Banks and Harriott (1995). Larger mobile invertebrate communities have shown considerable variation, but tended to be numerically dominated by sea urchins, gastropod molluscs, anemones and lobster. Fish communities recorded during this same time period were dominated by butterfly fish, sweetlip and, to a lesser degree, snapper, parrotfish and moray eels (Reef Check Australia 2012).

Mudjimba Island has a range of marine ecology values, including:

- It represents a structurally complex habitat and local centre of biodiversity in an otherwise comparatively simplified habitat landscape
- It provides refuge, rest and foraging grounds for numerous mobile marine fauna (i.e. sharks, pelagic fish, turtles).

The only other known subtidal reef system in the study area is Maroochy Reef, located approximately 700 m offshore of the Maroochy River mouth. Maroochy Reef contains relatively diverse and abundant hard and soft coral communities, but is dominated by brown algae and a range of sessile invertebrate species (Banks and Harriott 1995).

Onshore, intertidal rocky shores also occur at Pincushion Island at the Maroochy River mouth, and rocky outcrops on Mudjimba and Marcoola Beaches (**Figure 10.2g**). The area of these intertidal shores is small compared to that elsewhere on the Sunshine Coast, including those at Yaroomba and Mooloolabah, approximately 4 km to the north and south of the study area respectively. It is likely that the degree of exposure of the smaller rocky outcrops on the beaches varies over time, in response to sand accretion and erosion processes (i.e. greater area of habitat exposed after storm erosion events). Despite their dynamic nature and relatively small area, these coastal rocky shores still provide habitat that is not well represented elsewhere in the study area, and would have local biodiversity.

Note that an artificial reef occurs where the *Ex-HMAS Brisbane* was scuttled approximately 5 km east of Mudjimba Island (i.e. Ex-HMAS Brisbane Conservation Park). However, this reef is outside the bounds of the study area and is a restricted access area (i.e. dredge vessel not permitted to transit Conservation Park), and is therefore highly unlikely to be affected by the proposal. The extensive reef and coral communities of the Gneering Shoals are located to the south-east of the study area, well outside the potential influence of the Project (>7 km east of the Maroochy River mouth).

10.2.6 Estuarine vegetation communities

10.2.6.1 Seagrass

Seagrasses are protected under the *Fisheries Act 1994* as a ‘marine plant’ with fisheries significance. Historically, the Maroochy River once contained extensive seagrass areas but seagrass extent has declined in recent decades. The only notable seagrass beds observed in the main river channel during the present study were located near the Eudlo Creek confluence (refer **Figure 10.2j**). This bed had an estimated total area of 0.025 km^2 and was predominately comprised of *Zostera muelleri*. Surveys in the 1980’s (refer DAFF 2012) found this particular seagrass meadow extended upstream to the Paynter/Petrie Creek confluence but that it did not extend as far downstream as it does today.

Given the small size of this seagrass meadow, it is unlikely to contribute greatly to current ecosystem function and fisheries productivity at an estuary-wide scale (i.e. nutrient cycling, sediment stabilisation). Nevertheless, it does represent the last remaining significant seagrass meadow in the river, and is expected to provide the following local habitat values:

- Nursery and feeding habitat for fish and crustacean species of high fisheries value that prefer seagrass habitats at various stages of their life cycle (i.e. prawns, luderick)
- Potential food resources for green turtle *Chelonia mydas* (refer **Section 10.2.9**)
- Low tide foraging habitat for wader birds, many of which are protected under the EPBC Act as migratory species (refer Chapter B8 – Terrestrial Fauna).

No other seagrass is known to occur near the tailwater discharge site.

Figure 10.2g: Distribution of reefs and rocky shores

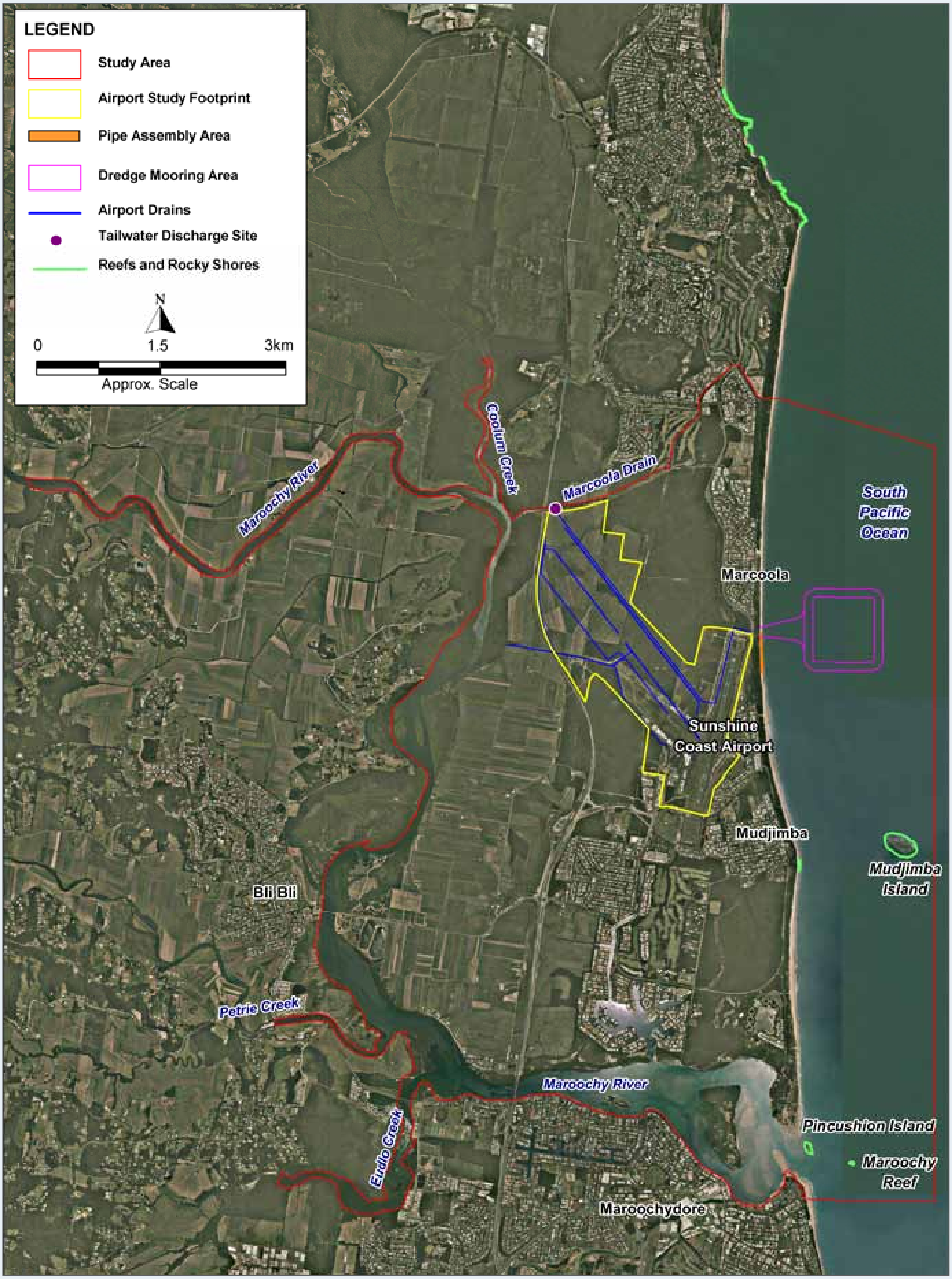
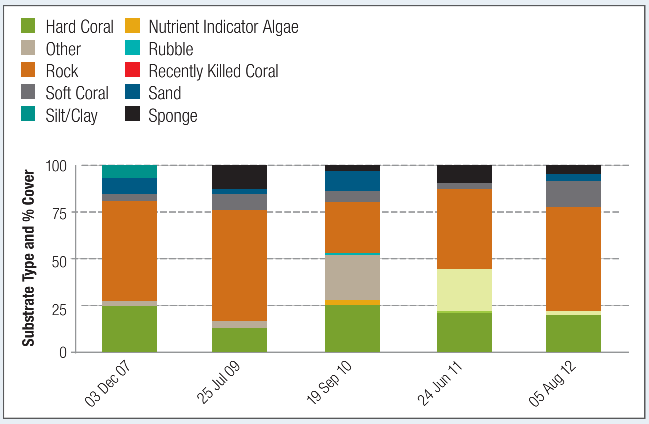
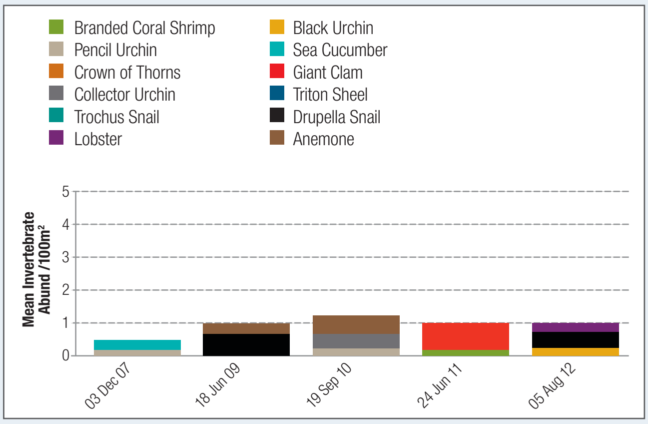


Figure 10.2h: Mudjimba Island viewed from pipeline corridor location on Marcoola Beach

Figure 10.2i: Benthic habitat and invertebrate data for Mudjimba Island, 2007-2012 (source: Reef Check Australia 2012)





10.2.6.2 Mangroves and saltmarsh

Mangroves and saltmarsh communities represent important primary producers in the study area, and also provide an important habitat for marine fauna, especially for fish (including species of fisheries significance, refer **Sections 10.2.8** and **10.2.10**) that depend on mangroves or saltmarsh as spawning, nursery, foraging and/or refuge habitat. Similar to seagrasses, mangroves and saltmarsh are also protected under the *Fisheries Act 1994* as a 'marine plant' with fisheries significance.

Mangrove and saltmarsh communities are the dominant vegetation type along the banks of the Maroochy estuary and its tributaries **(Figure 10.2g**). Based on mapping shown in **Figure 10.2g**, mangrove and saltmarsh vegetation have a total area of approximately 7.47 km^2 and 0.065 km^2, respectively, within the Maroochy estuary (including areas outside the study area). Mangroves, in particular, are notably extensive throughout the mid- to upper-estuary, from Bli Bli bridge to Coolum Creek.

Field surveys were carried out to assess mangrove and saltmarsh communities within the Marcoola drain and adjacent Maroochy River. The findings of this survey are summarised in **Table 10.2a**. Overall, patterns in community structure are representative of those found in the wider Maroochy estuary, and are consistent with surveys undertaken by Maroochy Waterwatch (2010). More detailed descriptions of the floristic characteristics of these mangrove and saltmarsh communities are provided in Chapter B7 – Terrestrial Flora.

On both sides of Marcoola drain, vegetation on the upper banks is generally modified and very narrow in width. Its lateral extent is restricted by the presence of unsealed access roads that run parallel, and close to the drain (**Figure 10.2k**). As a result, for much of the length of Marcoola drain (including the location of the proposed tailwater discharge and northern perimeter drain), the riparian vegetation consists of a narrow (<5 m) strip of mangroves that are bounded by band (1-2 trees wide) of *Casuarina* spp., then the access road (**Figure 10.2l**). Beyond this vegetation clearing has been extensive. Mangroves in the vicinity of the drain's confluence with the Maroochy River (west of the Sunshine Motorway) are an exception, where vegetation clearing is negligible, allowing for a wider and more intact mangal.

Throughout much of the mid-reaches of the Maroochy estuary mangroves have been retained, providing a reasonably diverse community that is in very good condition. Aside from their value as remnant vegetation, these mangroves are also of high conservation value for providing important fisheries habitat and essential habitat for the threatened water mouse *Xeromys myoides* (see Chapter B8 – Terrestrial Fauna).

In the upstream reaches of Marcoola drain, there is an unsealed access road crossing the drain, with three large culverts (directly adjacent to one another) enabling hydrological connectivity between the waterways reaches on either side (**Figure 10.2m, Figure 10.2n**). Near this point in the drain, there is a marked distinction in riparian vegetation type, whereby mangroves dominate downstream and *Casuarina* spp. begin to dominate upstream.

10.2.7 Estuarine and beach macrofauna

A snapshot survey of estuarine benthic macrofauna occurring in the vicinity of the tailwater discharge site was undertaken in August 2012. A total of 17 species were recorded across the five sites in Marcoola drain, and nearby reaches of the Maroochy River in the vicinity of the Marcoola drain confluence (**Table 10.2b**). These species were primarily comprised of various polychaete worms, crustaceans and molluscs.

Mean macroinvertebrate abundance ranged between approximately 40 and 80 individuals per sample (upstream Site 5 and mid-stream Site 3, respectively), while species richness ranged between approximately 3.0 and 6.3 species per sample (downstream Site 1 and mid-stream Site 3, respectively) (**Figure 10.2o**).

Table 10.2a: Mangrove and saltmarsh species observed in Marcoola drain and Maroochy estuary

Scientific name	Common name	Comments
Mangrove species		
Acrostichum speciosum	mangrove fern	Upper tidal zone, particularly upstream of the Sunshine Motorway bridge in Marcoola drain where the mangrove fringe is narrowest
Aegiceras corniculatum	river mangrove	Dominant mangrove species in parts of Marcoola drain where mangrove community is narrower
Excoecaria agallocha	blind-your-eye mangrove	Common throughout as isolated individuals towards landward edge
Rhizophora stylosa	red mangrove	Dominant on northern bank of the lower reaches of the Maroochy River
Avicennia marina	grey mangrove	Dominant canopy forming species throughout areas of most extensive mangroves (Maroochy River and Marcoola drain); mangrove species extending furthest upstream in Marcoola drain
Bruguiera gymnorrhiza	large-leafed orange mangrove	Common on landward edges of mangrove community in downstream reaches of Marcoola drain and mid-stream Maroochy River
Saltmarsh species		
Sporobolus virginicus	saltwater couch	Dominant saltmarsh species present throughout much of the study area
Sesuvium portulacastrum	sea purslane	Generally occurring as discrete patches on sandy shores or clay pans, or in a mixed mosaic with other saltmarsh species
Sarcocornia quinqueflora	beaded samphire	Often occurring in a mixed mosaic with other saltmarsh species
Suaeda australis	sea blight	As above
Phragmites australis	common reed	A few patches in Marcoola drain on waterway side of mangrove fringe

Figure 10.2j: Mangrove and saltmarsh vegetation extent

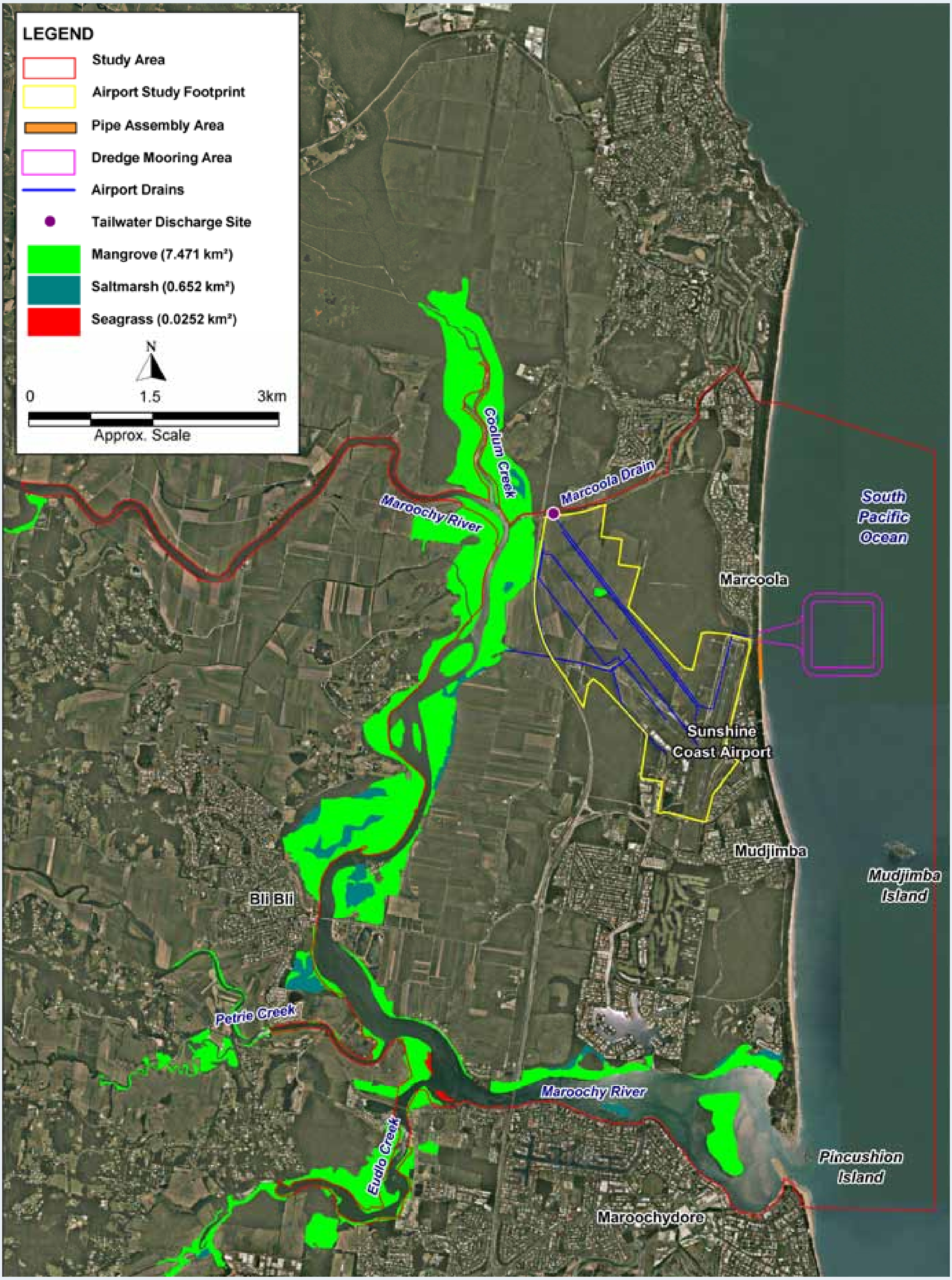


Figure 10.2k: Mangrove habitat (predominantly Avicennia marina) and the channel at downstream reaches of Marcoola drain

Figure 10.2l: Marine plant habitat typical of mid-stream reaches of Marcoola drain, comprising mixed mangroves (Avicennia marina and Aegiceras corniculatum) backed by strip of Casuarina spp. and with Phragmites australis in foreground

Figure 10.2m: Culverts mark the approximate ecotone in Marcoola drain, where mangroves begin to give way to Casuarina spp. as the dominant riparian vegetation

Figure 10.2n: Vegetation typical of upper freshwater-dominated reaches of Marcoola drain

Both macroinvertebrate abundance and species richness were greatest at Sites 3 and 4, which are located downstream of the proposed tailwater discharge site (i.e. Site 3 is immediately downstream of the Sunshine Motorway bridge and Site 4 at the confluence with Maroochy River – refer **Figure 10.1d**).

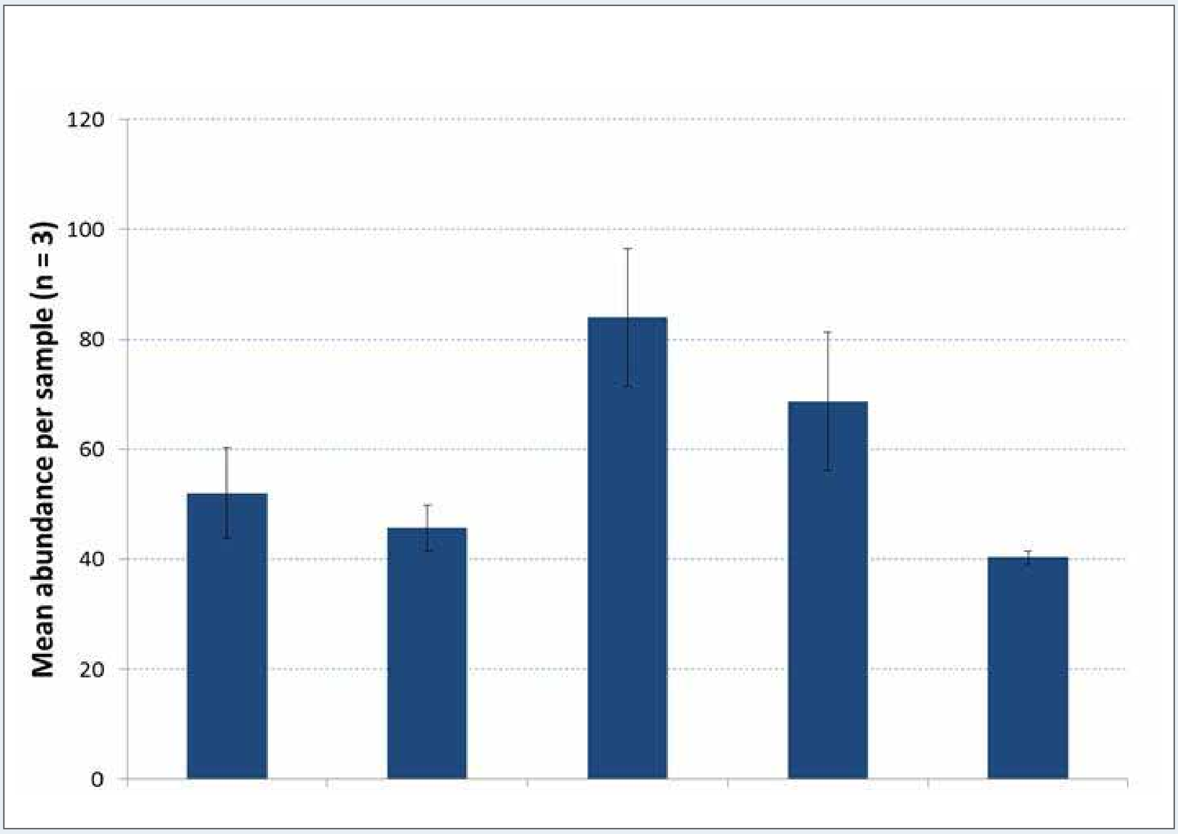
Despite the relatively short length of the drain over which samples were collected (approximately 1.4 km), the macroinvertebrate community shows a pronounced gradient from the upstream site (collected downstream of the culverts demarcating the division between tidal and freshwater dominated reaches) to the downstream site (collected in Maroochy River approximately 200 m downstream of Marcoola drain confluence). The community at the upstream sites (Sites 1 and 2, refer representative habitat shown in **Figure 10.2r**) was numerically dominated by amphipod crustaceans, while the downstream sites (Sites 4 and 5) were dominated by tanaid crustaceans (**Figure 10.2p**). Site 3, midstream between these two reaches represented a medium, to a degree, as it contained a significant proportion of both amphipod and tanaid crustaceans. Unlike other sites, Site 3 was numerically dominated by bivalve molluscs. A multivariate ordination (incorporating all species and their respective abundances) shown in **Figure 10.2q** again illustrates this gradient, whereby each of the five sites is distinct and a clear trend is obvious from the upstream to downstream sites. Fauna gradients such as this are characteristic of estuarine macroinvertebrate communities as fauna composition is strongly influenced by the abiotic gradients that naturally occur in these environments, particularly gradients in salinity, sediment grain size and sediment nutrient concentrations (Teske and Wooldridge 2003).

Table 10.2b: Macrofauna taxa recorded in the vicinity of the proposed tailwater discharge site

Phyllum	Class	Order	Family	Number of species	Relative abundance#
Annelida	Polychaeta	Phyllodocida	Nereididae	1	**
		Scolecida	Capitellidae	2	**
			Orbiniidae	1	*
		Spionida	Spionidae	1	*
		Sabellida	Sabellidae	1	**
Crustacea	Malacostraca	Decapoda	Hymenosomatidae	1	*
		Tanaidacea	Apseudidae	1	****
		Amphipoda	Corophidae	2	****
Mollusca	Bivalvia	Mytiloida	Mytilidae	1	*
			Unknown	1	****
	Gastropoda			2	*
Nemertea				1	*
Arthopoda	Insecta	Diptera	Chironomidae	2	*

*# Based on total number collected during field survey: * 1-10, ** 11-50, ***51-150, **** >150.*

Figure 10.2o: Mean (±S.E.) for taxonomic richness (upper plot) and mean abundance (lower plot) for macroinvertebrates within sub-tidal habitats in the study area



UPSTREAM *DOWNSTREAM*

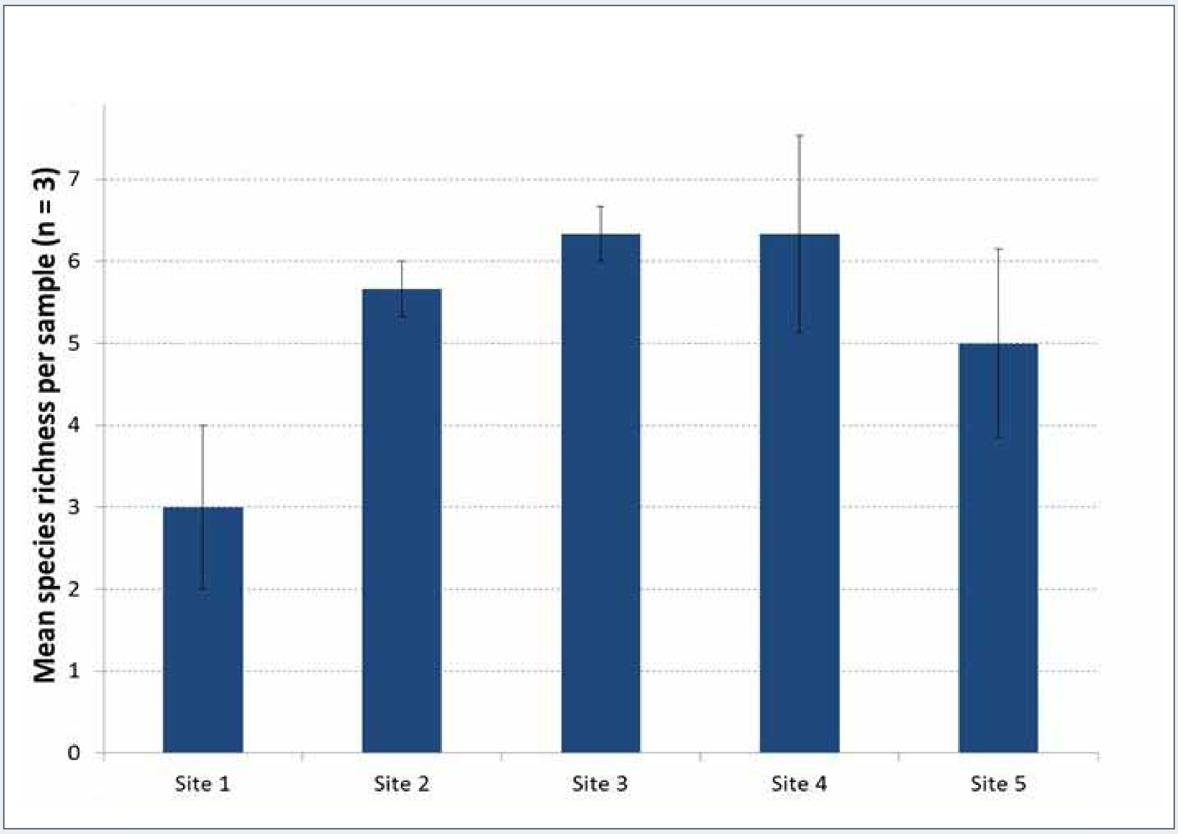


Figure 10.2p: Contribution of each fauna group to the total number of individuals collected in Marcoola drain

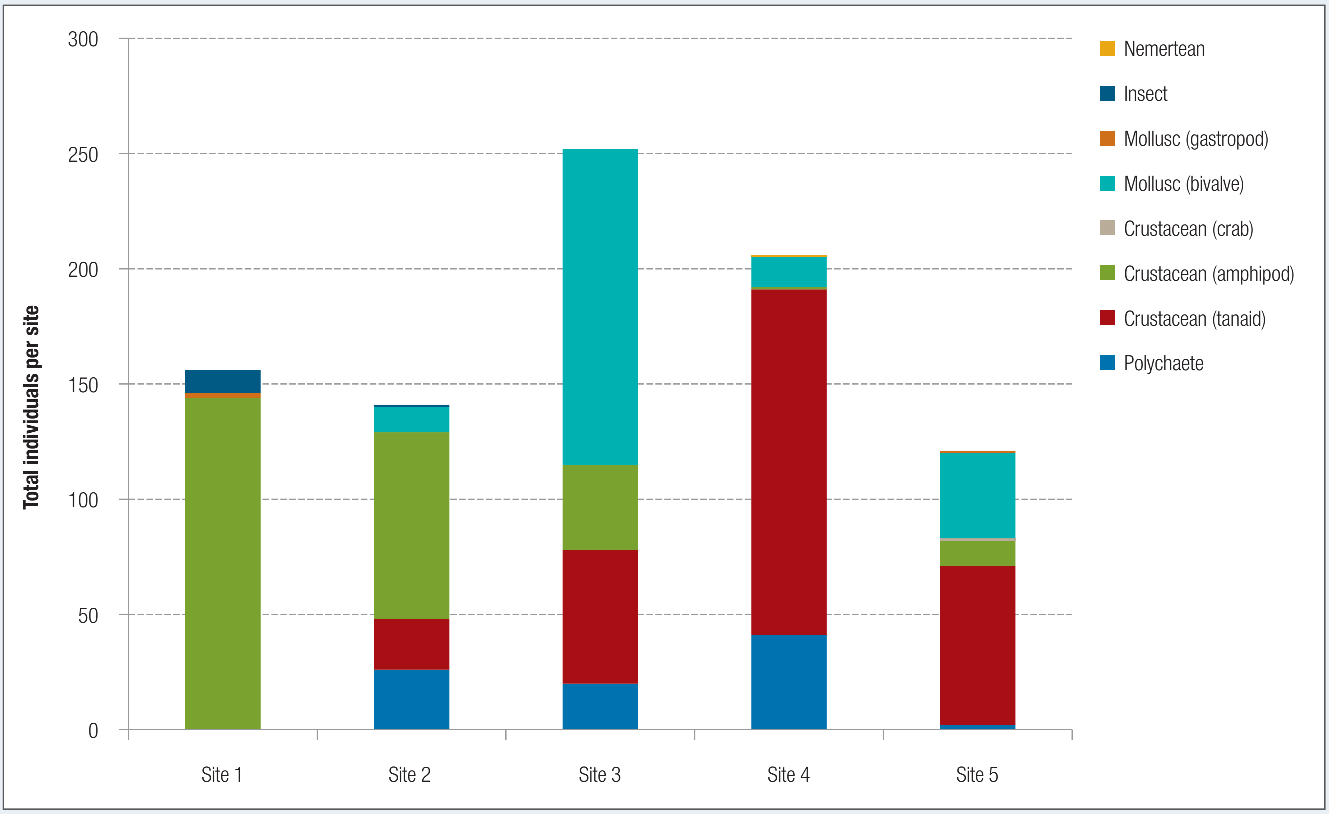


Figure 10.2q: n-MDS plot of infauna samples illustrating a community gradient between upstream and downstream reaches of Marcoola drain (each point represents a single sample and the relative distance between points indicates the degree of community similarity, i.e. close points have a more similar community)

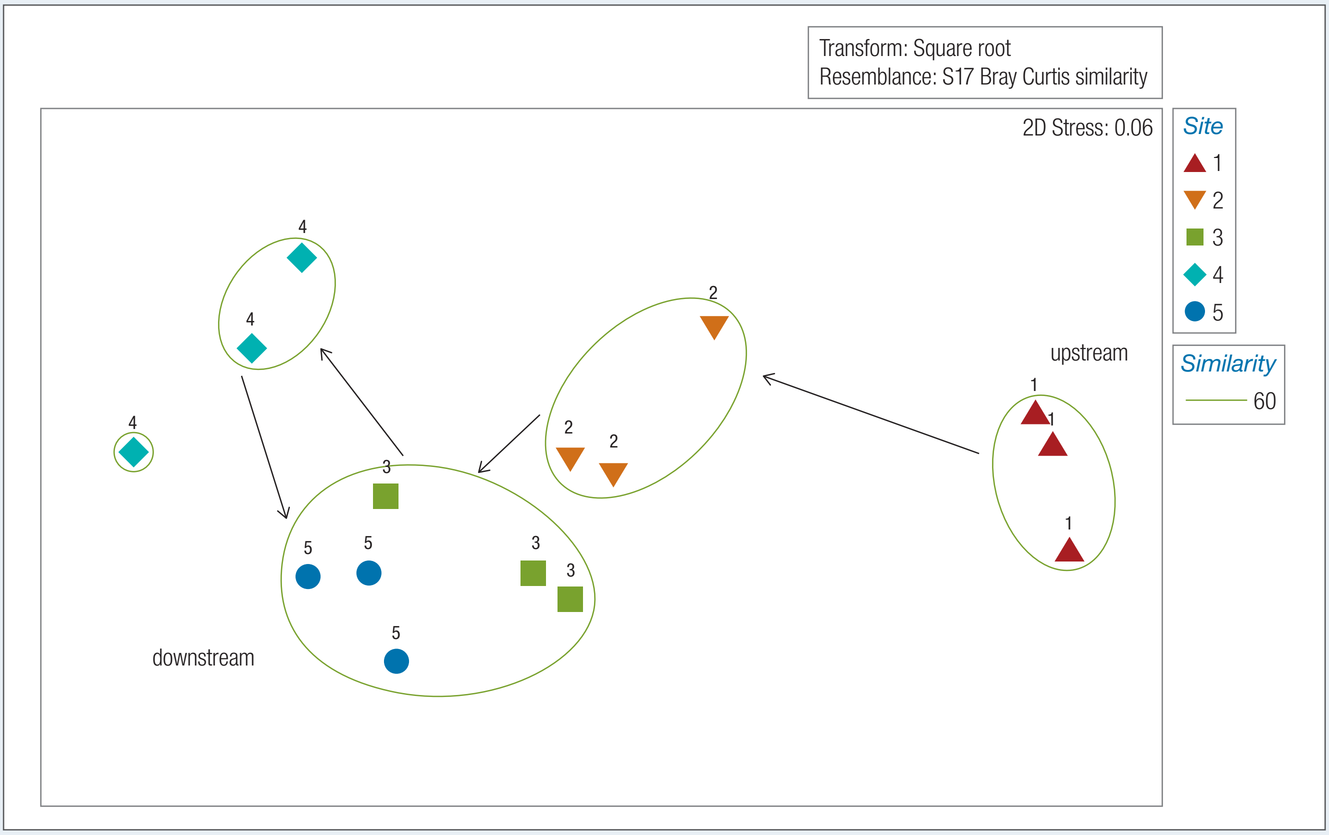


Figure 10.2r: View of Marcoola drain intertidal mud banks in proximity tailwater discharge site

Sections of Marcoola Beach in the vicinity of proposed beach works (pipeline assembly area; refer **Figure 10.2s**) also provide habitat for macrofauna. Marcoola Beach can broadly be classified as an example of an intermediate beach type, being characterised by a medium sand grain size, moderate wave heights and a medium to low grade profile (Jones and Short 1995). The wave energy of sandy beaches is rarely constant so they invariably oscillate from one intermediate state to another, in response to changes in surf conditions (Hacking 1997). Interactions of waves and tides with beach sediments create a very dynamic and constantly changing environment. As such, invertebrate fauna communities of such beaches are typically comprised of relatively robust species that can either tolerate (or recolonise relatively soon after) intermittent physical disturbances such as storm events.

Although no site specific invertebrate data are available for Marcoola Beach, it is likely that the invertebrate community is comparable to that of similar beaches elsewhere in the Sunshine Coast region (i.e. Schlacher et al. 2008). Dominant intertidal macroinvertebrate species are expected to include various crabs (i.e. ghost crabs *Ocypode* spp., sand bubbler crab *Scopimera inflata*), amphipods, isopods, polychaetes, gastropod (i.e. sand or moon snails *Polinices* spp. or similar) and bivalve molluscs (i.e. pipis *Plebidonax deltoides*), nemerteans and insect larvae. Note that intertidal sandy beach macroinvertebrate communities are typically less abundant and diverse that their estuarine counterparts. Distinct zonation across the shore is characteristic, such that species composition differs between the upper and lower tidal areas. Fauna communities in the subtidal surf zone would be expected to differ again to that of the intertidal beach.

10.2.8 Estuarine fish

A survey of estuarine fish occurring in the vicinity of the tailwater discharge site was undertaken in August 2012. It was a once-off survey providing a rapid indication of commonly occurring species, which should not necessarily be considered representative of other times (e.g. other seasons or reproductive periods). Six species were recorded across the three sites in Marcoola drain (**Table 10.2c**), four of which are of direct recreational and commercial fisheries value: mullet (*Mugil cephalus, Paramugil georgii, Liza argentea*) and yellow finned bream (*Acanthopagrus australis*). Estuarine waters elsewhere in the Maroochy River support numerous other species of direct fisheries significance, such as those listed in **Table 10.2d** (refer also **Figure 10.2t**). It would be expected that many of these species would use Marcoola drain from time to time.

Focusing on Marcoola drain, where estuarine fish are most likely to be directly subject to tailwater discharges, fish habitat values are limited due to the modified nature of this waterway, particularly when compared to the more intact and more extensive fish habitat available downstream in the Maroochy River Fish Habitat Area. Particular features of the estuarine reaches of Marcoola drain that limit its habitat value include the:

Figure 10.2s: Intertidal sandy beach habitat at pipeline assembly location during low tide, view looking south from pipeline corridor, June 2012

- Limited volume of water present in parts of the upper reaches during low tide, with some areas almost drying completely
- Limited extent of marine plants (i.e. foraging and nursery habitat) present along the drain, primarily restricted to a very narrow fringe on each bank (refer **Section 10.2.6**)
- Presence of culverts restricting fish passage or migration to upstream reaches.

Estuaries represent transition environments between marine and freshwater conditions. The inhabitant species are typically tolerant of varying conditions, often moving between estuarine and marine/freshwater habitats. Generally speaking, most of the fish species present in Marcoola drain would be relatively tolerant of flow changes that might be introduced by the Project, particularly given the changes in water volume that occur naturally with the tidal cycle on a daily basis. Rather than hydrology, it is more likely that the species present would be more sensitive to changes in salinity, with those less tolerant of salinities equivalent to seawater being excluded from the lower reaches of Marcoola drain during tailwater discharges. This would include those species more commonly associated with freshwater and brackish environments, such as the bullrout for example (refer **Figure 10.2t**).

Table 10.2c: Fish species recorded in the vicinity of the proposed tailwater discharge site

Scientific name	Common name	Relative abundance#	Local fisheries significance
Ambassis marianus	glassfish	****	✘
Mugil cephalus	seamullet	**	✔ Moderate
Acanthopagrus australis	yellowfinned bream	**	✔ High
Paramugil georgii	fantail mullet	**	✔
Gerres subfasciatus	common silverbiddy	****	✘
Liza argentea	goldspot mullet	***	✔ Low
Notesthes robusta	bullrout	*	✘
Tetractenos hamilotni	common toadfish	*	✘

*# Based on field survey observations: * 1-2, ** 3-10, *** 11-20, **** >20.*

Figure 10.2t: Examples of fish species present in Marcoola drain, clockwise from top left: yellowfinned bream (Acanthopagrus australis), fantail mullet (Paramugil georgii), bullrout (Notesthes robusta), common silverbiddy (Gerres subfasciatus)

Table 10.2d: Examples of additional fish species likely occurring in the broader Maroochy River estuary (source: Webley et al. 2008, Butcher et al. 2005)

Scientific name	**Common name**	Local fisheries significance
Herklotsichthys castelnaui	spotted herring, southern herring	✔ Low
Dasyatis fluviorum	estuary stingray	✘
Terapon jarbua	crescent perch	✘
Sillago analis	gold-lined whiting	✔ Moderate
Sillago ciliata	sand whiting	✔ High
Platycephalus fuscus	dusky flathead	✔ Moderate
Monodactylus argenteus	butter bream	✘
Leiognathus decorus	black-naped ponyfish	✘
Girella tricuspidata	luderick	✔ Moderate
Caranx sp.	trevally	✔ Moderate
Scomberoides lysan	queen fish	✔ Moderate
Pomatomus saltatrix	Tailor	✔ High
Lutjanus argentimaculatus	mangrove jack	✔ Moderate
Argyrosomus japonicus	mulloway	✔ Moderate
Scomberomorus quenslandicus	school mackerel	✔ Moderate
Epinephelus malabaricus	estuary cod	✔ Moderate
Hyporhamphus regularis	garfish	✔ Low

Note that previous reports undertaken prior to this EIS identified the study area as potential habitat for the EPBC and NC Act listed threatened species honey blue-eye (*Pseudomugil mellis*) and oxleyan pygmy perch (*Nannoperca oxleyana*). However, surveys undertaken for this EIS (refer also Chapter B9 – Aquatic Ecology), as well as prior surveys targeting these species on airport land during the initial advice stage of the EIS (BMT WBM 2010), did not detect either of these species. Given their greater affinity for freshwater and brackish habitats, these species are unlikely to occur in the marine study area, including the tide-dominated reaches of Marcoola drain.

10.2.9 Marine species of conservation significance

Public databases identify numerous marine species of conservation significance that likely inhabit the study area at various times. These include species of marine fish, mammals, reptiles and birds, as described below.

10.2.9.1 Marine fish

Five marine fish of conservation significance have been identified for the Project area (**Table 10.2e**), of which four are listed threatened species. Both the green sawfish *Pristis zijsron* and black rock cod *Epinephelus daemelii* have highly restricted distributions, to northern Queensland and New South Wales respectively, and are unlikely to occur in the Project area. The two threatened species most likely to occur are the whale shark *Rhincodon typus* and grey nurse shark *Carcharias taurus*. The whale shark (Vulnerable, EPBC Act) is a pelagic species that tends to prefer offshore tropical waters. This species is known to form seasonal feeding aggregations in the Coral Sea between November and December, although Ningaloo Reef is thought to present the only critical habitat in Australian waters (DSEWPAC 2012).

There are occasional records of this species along Queensland's inshore coasts, although it is thought to represent a transient visitor.

Most of the east coast population of grey nurse sharks (Critically Endangered – EPBC Act, Endangered – NC Act) spend much of its time in New South Wales, although they have been recorded as far north as Mackay. They undertake extensive movements along the east coast and locations known as 'aggregation sites' are thought to be the most critical habitat for this species. Known Queensland aggregation sites are located near Rainbow Beach, Moreton Island and Stradbroke Island. Mudjimba Island is not known to represent an aggregation site for this species, although it does provide rocky reef habitat that is utilised by grey nurse sharks as they move along the coast (i.e. from Moreton Bay to Wolf Rock). Grey nurse sharks have been observed at Mudjimba Island, but on rare occasions and in small numbers (Bennett and Bansemer 2004).

Note that the EPBC Protected Matters database also lists 36 sygnathids species (i.e. seahorses, pipehorses and pipefish) that are protected as Listed Marine species (i.e. non-threatened). Sygnathids are primarily associated with seagrass meadows and reef habitats, therefore the Project footprint is unlikely to represent an important habitat for these species.

10.2.9.2 Marine mammals

There are nine threatened and/or migratory marine mammal species that may occur within the study area (**Table 10.2f**). Threatened species are the key concern from a conservation perspective, which include three whales listed as Endangered or Vulnerable under the EPBC Act (blue whale *Balaenoptera musculus*, southern right whale *Eubalaena australis* and humpack whale *Megaptera novaeangliae*), as well as an additional two species listed as threatened or near threatened

Table 10.2e: Marine fish of conservation significance potentially occurring in study area

Scientific name	Common name	Status		Local occurrence / habitat
		EPBC Act	NC Act	
Rhincodon typus	whale shark	**Vulnerable** Migratory	Least concern	May occur oceanic pelagic waters as transient visitor; sighted as far south as the Gold Coast
Pristis zijsron	green sawfish, dindagubba, narrowsnout sawfish	**Vulnerable**	Least concern	Unlikely, tropical species with historic distribution to southern Qld and northern NSW estuaries. Present-day distribution thought to be only as far south as Cairns
Carcharias taurus	grey nurse shark	**Critically endangered**	**Endangered**	East coast population concentrated in southern Qld and throughout NSW; known aggregation sites critical, favours rocky reefs with gutter, overhangs and caves
Lamna nasus	porbeagle, mackerel shark	Migratory	Least concern	Species or species habitat may occur within area
Epinephelus daemelii	black rockcod	**Vulnerable**	Least concern	Primarily in NSW; may occur in southern Qld but records are rare

under the NC Act (dugong [*Dugong dugon]*, Indo-Pacific humpback dolphin [*Sousa chinensis]*). Each of these threatened species is discussed in further detail below in the context of the study area. Other EPBC listed mammals (i.e. listed marine species that are not threatened or migratory) that may occur in the area include minke whale (*Balaenoptera acutorostrata)*, short-beaked common dolphin (*Delphinus delphis)*, spotted dolphin *Stenella attenuate*, pygmy sperm whale)*Kogia breviceps)*, Risso's dolphin (*Grampus griseus)*, dusky dolphin (*Lagenorhynchus obscurus)*, spotted bottlenose dolphin (*Tursiops aduncus)*, and bottlenose dolphin (*Tursiops truncatus)*.

Blue whale, southern right whale and dugong are considered to be transient visitors to the coastal waters of the wider Sunshine Coast, and are unlikely to regularly occur in the vicinity of the study area. Although blue whales are not known to utilise Queensland waters for ecologically important activities, they may transit oceanic areas while migrating to tropical breeding areas (Curtis and Dennis 2012). Southern right whales generally occur offshore, but come in to shallow coastal waters to calve in winter. On the Queensland coast, small numbers have been observed inshore as far north as Hervey Bay (Curtis and Dennis 2012). Dugongs are more commonly associated with marine or estuarine areas that contain extensive beds; in South East Queensland (SEQ), this includes Moreton Bay, Pumicestone Passage and Hervey Bay.

The threatened (or near-threatened) marine mammals most likely to occur are the humpback whale and Indo-Pacific humpback dolphin. Humpback whales migrate relatively close to the coastline along parts of the Sunshine Coast during their winter migration, but are generally in deeper waters outside the bounds of the study area. For example, they are likely to be closer to shore when passing protruding headlands at Mooloolabah, Noosa, Double Island Point. Nevertheless, they may occur within the Project area from time to time, particularly if resting with a calf on their southern migration (late winter – early spring).

The near-threatened Indo-Pacific humpback dolphin is a tropical to sub-tropical species that extends as far south as the Queensland / New South Wales border, primarily inhabiting shallow coastal waters and estuaries. In SEQ known localities, and likely areas of highest numbers, occur south of the study area at Moreton Bay and Brisbane River, and to the north at Tin Can Bay and Great Sandy Straight (DSEWPAC 2013). Given its position between these localities, together with the recognised continuous nature of their distribution, it is likely that this species occurs in the study area from time to time.

Table 10.2f: Marine mammals of conservation significance potentially occurring in study area

Scientific name	Common name	Status		Local occurrence / habitat
		EPBC Act	NC Act	
Balaenoptera musculus	blue whale	**Endangered** Migratory, Other (marine)	Least concern	Unlikely, transient offshore
Eubalaena australis	southern right whale	**Endangered** Migratory, Other (marine)	Least concern	Generally offshore, though may calve in shallower coastal waters during winter
Megaptera novaeangliae	humpback whale	**Vulnerable** Migratory, Other (marine)	**Vulnerable**	Common whale during winter-spring migrations
Balaenoptera edeni	Bryde's whale	Migratory, Other (marine)	Least concern	Species may occur in marine waters
Dugong dugon	dugong	**Migratory, Other (marine)**	**Vulnerable**	Potential vagrant, significant populations Moreton and Hervey Bays
Lagenrhynchus obscurus	dusky dolphin	Migratory	Least concern	Species may occur in marine waters
Orcaella brevirostris	Irrawaddy dolphin	Migratory, Other (marine)	Least concern	Species may occur in marine waters
Orcinus orca	killer whale	Migratory, Other (marine)	Least concern	Species may occur in offshore marine waters
Sousa chinensis	Indo-Pacific humpback dolphin	Migratory, Other (marine)	**Near threatened**	Likely transient, significant populations Moreton Bay and Great Sandy Strait

10.2.9.3 Marine reptiles

Six species of sea turtles potentially utilise the study area, all of which are considered threatened under both the EPBC Act and NC Act as listed in **Table 10.2g**. Each of these species has been recorded in coastal nearshore waters of the wider Sunshine Coast area, and may forage in (especially in the vicinity of Mudjimba Island), or transit through, the study area. However, the loggerhead turtle (*Caretta caretta*, Endangered) and green turtle (*Chelonia mydas*, Vulnerable) are of the greatest significance in the context of the Project as they are relatively common and most likely to use coastal beaches within, or adjacent to, the study area as nesting habitat. Note that green turtles may also occur in the Maroochy estuary from time to time, potentially feeding on the seagrass present as this provides a key food source for this species.

Loggerhead turtles nest annually on Sunshine Coast beaches, typically numbering in the tens of individuals, primarily at Caloundra (Limpus 2008a). Green turtle nesting is rarer (Limpus 2008b). As it is estimated that approximately 500 female loggerheads nest along the full length of Australia's east coast, the Sunshine Coast population represents a small but important contribution to this endangered species' reproductive activity (Turtle Care 2012). Nesting season typically extends from November to February, although hatchlings may emerge as late as March. Each year the number of turtles nesting within the study area varies. Over the last three years a total of seven loggerhead turtle nests were recorded within the study area by local community monitoring volunteers. The locations of these nests are shown in **Figure 10.2u**.

Of these, up to two nests were located in the stretch of Marcoola Beach that is proposed to be utilised for pipeline assembly works. During the same period, additional nests were also recorded north of the study area at Coolum.

Similar to loggerhead turtles, the nesting season for green turtles in southern Queensland typically extends from November to March, with peak activity in January (Limpus 2008b). No green turtle nests have been recorded in the study area in recent years. In terms of other aspects of their ecology potentially affected by the proposal, the diets of loggerhead and green turtles differ markedly. Loggerhead turtles feed mainly on molluscs and crabs, although their diet also includes a wide range of other invertebrates (Curtis and Dennis 2012). In contrast, green turtles primarily feed on seagrass and algae (Curtis and Dennis 2012).

Note that the EPBC Protected Matters database also lists an additional nine sea snake species that are protected as Listed Marine species (i.e. non-threatened).

10.2.9.4 Sea birds

Most avifauna species of conservation significance are addressed elsewhere in this EIS (Chapter B8 – Terrestrial Fauna). This section applies only to sea birds, or marine birds, which in this EIS is defined as 'birds species that spend the majority of their life at sea' and includes species of albatross, petrels and shearwaters.

An estimated nine species of sea bird, which are listed as threatened and/or migratory species under the EPBC Act, may occur in the study area. These species are listed, along with their respective conservation status, in **Table 10.2h**. Four are also listed as threated species under the NC Act.

Table 10.2g: Marine reptiles of conservation significance potentially occurring in study area

Scientific name	Common name	Status		Local occurrence / habitat
		EPBC Act	NC Act	
Caretta caretta	loggerhead turtle	**Endangered** Migratory, Other (marine)	**Endangered**	Frequents marine waters of study area, known to nest on Marcoola Beach, and adjacent beaches, in low numbers
Chelonia mydas	green turtle	**Vulnerable** Migratory, Other (marine)	**Vulnerable**	Foraging, feeding or related behaviour known to occur within area; potentially nesting in the area
Dermochelys coriacea	leathery turtle, leatherback turtle	**Endangered** Migratory, Other (marine)	**Endangered**	Uncommon, may transit or forage in marine waters of study area
Eretmochelys imbricata	hawksbill turtle	**Vulnerable** Migratory, Other (marine)	**Vulnerable**	May transit or forage in marine waters of study area
Lepidochelys olivacea	olive Ridley turtle	**Endangered** Migratory, Other (marine)	**Endangered**	Uncommon, may transit or forage in marine waters of study area
Natator depressus	flatback turtle	**Vulnerable** Migratory, Other (marine)	**Vulnerable**	Uncommon, may transit or forage in marine waters of study area

Figure 10.2u: Sea turtle nesting sites recorded in the study area over the last three nesting seasons (data courtesy Turtle Care)

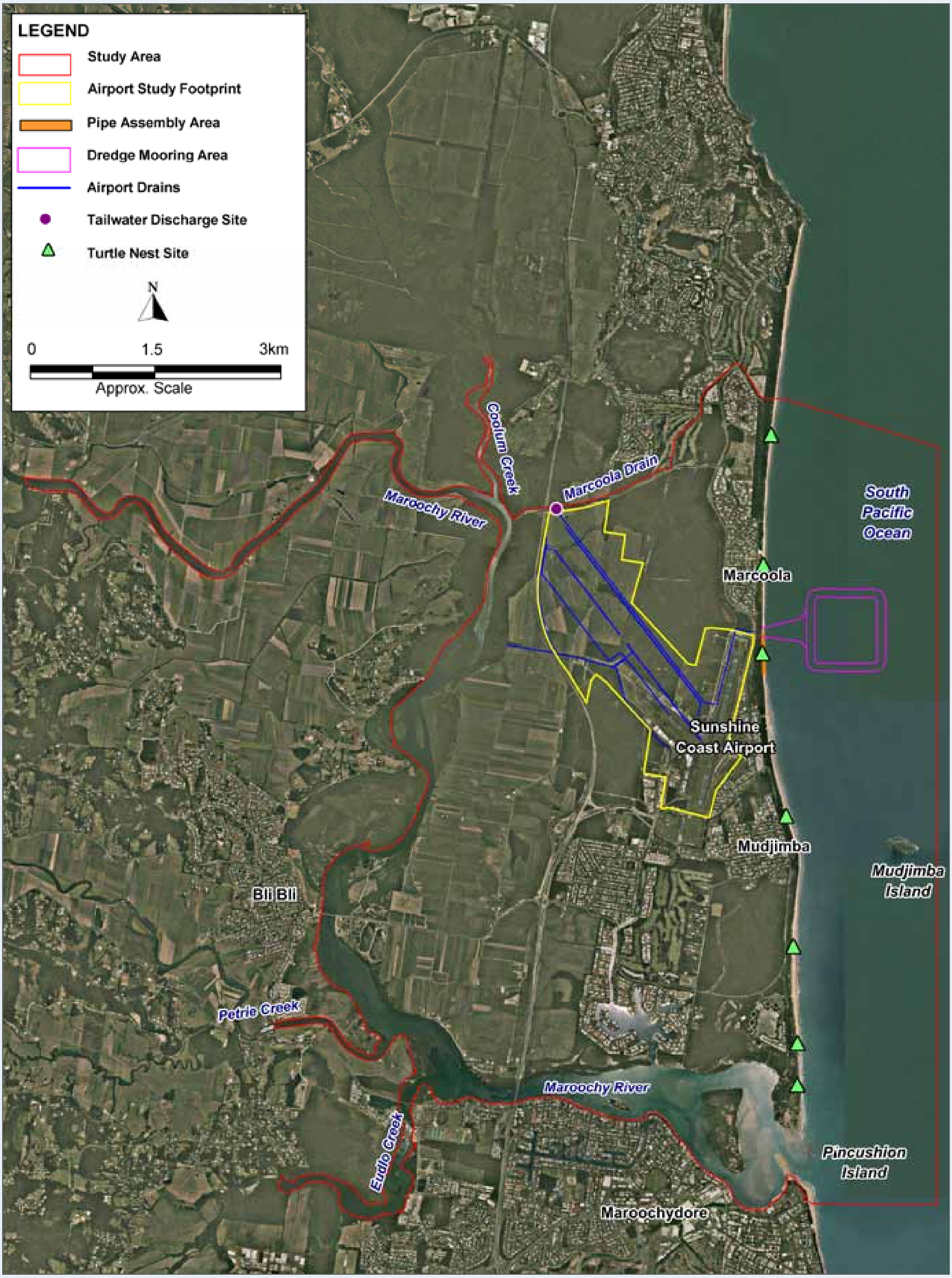


Table 10.2h: Sea birds of conservation significance potentially occurring in study area

Scientific name	Common name	Status		Local occurrence / habitat
		EPBC Act	NC Act	
Macronectes halli	northern giant-petrel	**Vulnerable,** Migratory, Other (marine)	**Vulnerable**	Rare, potential vagrants in small numbers
Macronectes giganteus	southern giant-petrel	**Endangered**	**Endangered**	Rare, potential vagrants in small numbers
Pterodroma neglecta neglecta	Kermadec petrel	**Vulnerable**	Least concern	Rare, potential vagrants in small numbers
Thalassarche melanophris impavida	Campbell albatross	**Vulnerable,** Migratory, Other (marine)	Least concern	Rare, potential vagrants in small numbers
Calonectris leucomelas	streaked shearwater	**Migratory,** Other (marine)	Least concern	Annual migration along coast
Diomedea exulans	wandering albatross	**Vulnerable**	**Vulnerable**	Rare, potential vagrants in small numbers
Diomedea exulans exulans (dabbenena)	Tristan albatross	**Endangered**	**Endangered**	Rare, potential vagrants in small numbers
Fregetta grallaria	white-bellied storm-petrel	**Vulnerable**	Least concern	Rare, potential vagrants in small numbers
Puffinus pacificus	wedge-tailed shearwater	Migratory, Other (marine)	Least concern	Annual migration along coast , significant colony nests on Mudjimba Islands during breeding season

Note that both the southern giant petrel (*Macronectes giganteus)* and the Tristan albatross (*Diomedea exulans exulans)* are assigned a higher conservation status, being listed as Endangered under both the EPBC Act and NC Act.

The albatross and petrel species are primarily Southern Ocean species, but may visit Queensland waters in small numbers as rare visitors or vagrants in winter and spring (Curtis and Dennis 2012). As such, while the study area and surrounding waters do not represent a significant habitat for these species, it is possible that they may transit the area or, on a rare occasion, use the coastal waters to rest or forage.

Wedge-tailed shearwaters (*Puffinus pacificus)* are not threatened, but transit the coastal waters of the Sunshine coast during the annual migration and also nest on Mudjimba Island in numbers. Dyer (2000) estimated approximately 2,700 burrows for the 1997/98 season with a breeding rate of approximately 37 per cent. He also states that Mudjimba Island supports one of only two colonies occurring on Queensland's mainland islands (note that breeding colonies also occur at offshore Queensland Islands such a Heron and Lady Elliot Islands, as well as in New South Wales).

10.2.10 Fisheries values

The study area contains habitats that are important in sustaining local fisheries, and those of the wider region. As described above, the Maroochy River provides a variety of habitats that support species (i.e. fish and crustaceans) of direct significance to recreational and commercial fisheries. Likewise beyond the estuary, oceanic waters, beach surf zones and Mudjimba support species of direct fisheries significance.

While the potential social values relating to commercial and recreational fisheries are addressed elsewhere in this EIS (Chapter B13 – Social Impact), this section provides an indication of the fisheries resource values of the study area and surrounds.

Commercial

Total commercial catch data was available for sites within the W36 grid over the years from 2006 to 2012, including the line, net, pot and trawl fisheries. These data are presented in **Figure 10.2v**, with the approximate location of the pump-out site shown as a small pink square at sites W36.7. Data from sites with less than 5 boats operating are not disclosed due to confidentiality reasons. Therefore, it should be noted that commercial catch from some sites and fisheries (especially those with less than 5 licences operating) would be higher than reported here. These data show relative differences among sites within the W36 grid in terms of commercial catch. The pump-out site is located in a site that contributed a moderate proportion of the total catch for grid W36 over this period (i.e. site W36.7 contributed approximately 80 tonnes, primarily consisting of mullet, eastern king prawn and spanner crab). By comparison, higher catches were recorded for the Maroochy River and at sites west of W36.7. For example, sites W36.6, W36.3, W36.8 and W36.13 each recorded a total of 100-200 tonnes from 2006 to 2012 **(Figure 10.2v)**.

For grid W36 between 2001 and 2005, total catches were dominated by mullet, spanner crab, eastern king prawns and blue swimmer crabs. Snapper, mackerel and whiting made minor contributions to total commercial catch in grid W36, along with a range of other species (**Figure 10.2w**). The catch contribution of these species varied markedly between the oceanic and estuarine sites in the vicinity of the study area. For instance, total catch for the Maroochy River site (W36.6) primarily consisted of mullet and, to a lesser degree whiting. By comparison, there was a much more even spread across the key species contributing to total catch at site W36.7, in the vicinity of the pump-out site (i.e. mullet, eastern king prawn, three spot crab, spanner crab and snapper).

The ten highest overall contributors to total commercial catch for grid W36 between 2006 and 2012 are shown in **Table 10.2i**. Mullet was the greatest contributor to total catch (1185 tonnes) during this period, followed by spanner crab (915), eastern king prawn (724) and blue swimmer crab (613). The next greatest contributor, snapper, recorded a substantially smaller total catch at 113 tonnes. In line with total catch, mullet resulted in the greatest catch per unit effort (342 kg per day), followed by spanner crab (182) and eastern king prawn (145).

While several aquaculture farms operate on non-tidal land adjacent to the Maroochy River, mainly near Bli Bli, minimal aquaculture operations are present within the estuary itself. A small aquaculture lease area is located in the main estuary channel near Bli Bli bridge, which is likely used for aquaculture of Sydney rock oysters.

Recreational

Recreational fishing activity focuses on Mudjimba Island for reef and pelagic species (i.e. snapper, pearl perch, red emperor, yellowtail kingfish, sweetlip, mackeral), and the Maroochy River for estuarine species. In the Maroochy estuary, sand banks, rockwalls, channel and holes support whiting, flathead, mangrove jack, trevally, mulloway and mud crabs. In winter, bream, mulloway, tailor and luderick are also targeted (Australian Fish Finder 2012). Sand crabs are likely targeted around the sand banks of the lower reaches towards the river mouth; and the Queensland Government's RFISH survey for 1997 (see Ozcoasts 2012) also ranked school mackerel, sea mullet, various shark and ray species, estuary cod, garfish, school prawns, eastern king prawns, and bay prawns as recreational catch for the Maroochy River. Marcoola Beach is likely fished for bream, flathead and whiting (Hooked In Paradise 2007).

By way of an indication of the intensity of recreational fishing within the study area, the RFISH survey estimated that recreational catch (harvest and released) for the Maroochy River in 1997 was 657,064 individuals (1.2 per cent of Queensland's total). Of this, the top four species caught were bream, whiting, flathead and tailor, accounting for an estimated 36 per cent, 29 per cent, 7 per cent and 5 per cent of the catch, respectively (Ozcoasts 2012). Refer to Chapter B13 – Social Impact for further discussion of fisheries related considerations.

Figure 10.2v: Total commercial catch (tonnes) reported for sites in grid W36 between 2006 and 2012 (source: DAFF 2013)

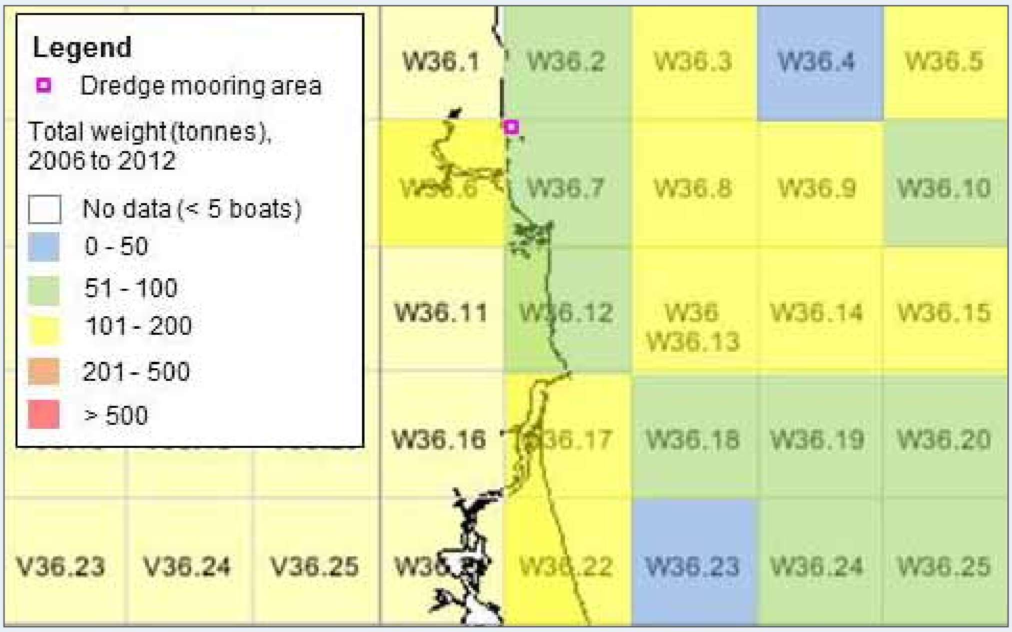


Figure 10.2w: Species contributions to total commercial catch at sites within grid W36 between 2006 and 2012 (source: DAFF 2013)

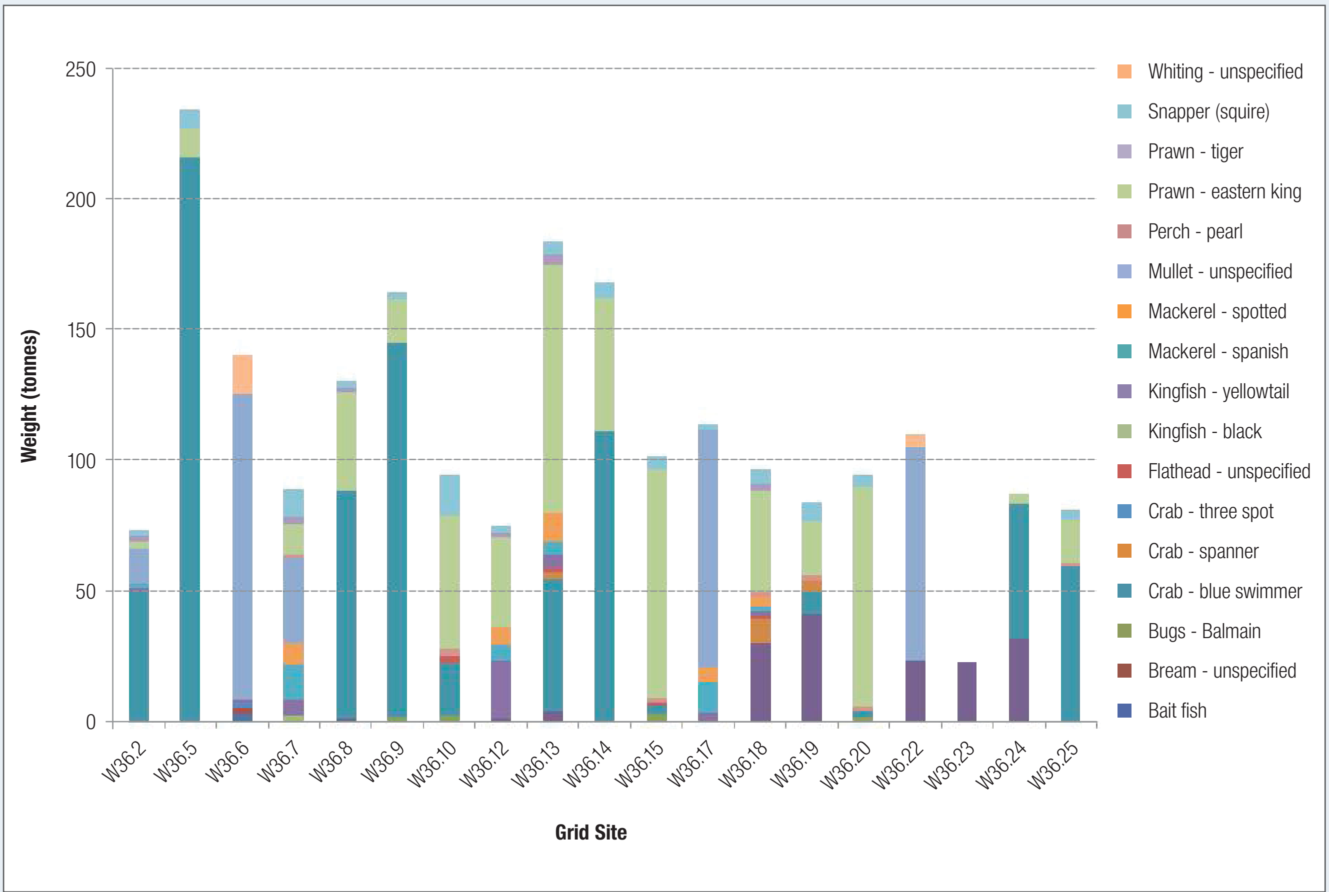


Table 10.2i: Top ten species contributing to total commercial catch between 2006 and 2012 in grid W36, and associated total licences, days fished and catch per unit effort (CPUE)

Species	Total Tonnes	Total Licences	Total Days Fished	CPUE (Kg/day)
Mullet – unspecified	1185.3	141	3467	342
Crab – spanner	915.4	175	5031	182
Prawn – eastern king	723.6	374	5003	145
Crab – blue swimmer	613.3	361	7760	79
Snapper (squire)	113.0	313	3347	34
Mackerel – school	110.0	145	2995	37
Mackerel – spanish	66.7	105	1599	42
Mackerel – spotted	63.2	177	1948	32
Whiting – unspecified	61.5	104	1956	31
Crab – three spot	58.6	194	3318	18

Table 10.3a: Impact significance criteria used for marine ecology assessment

Impact Significance/ Consequence	Description of Significance
Very High	This impact is considered critical to the decision making process as it would represent a major change to the ecological character of the marine environment of the study area. This level of impact would be indicated by: • Complete loss of any habitat type presently supported by the study area; or • Substantial effects on ecosystem structure or function, such that many species become locally extinct; or • Major regional-scale changes to the ecological character of Moreton Bay Marine Park, Moreton Bay Ramsar site, Fish Habitat Areas; or • Major impacts to populations to commonwealth or state listed threatened species, such that their capacity to reproduce and recover is significantly affected; and • Lead to impacts that are irreversible or otherwise long term (i.e. greater than decades).
High	The impact is considered important to the decision making process as it would cause a detectable change to the values that underpin the ecological character of the study area. A high level of impact would be indicated by : • Measurable impacts to key ecosystem structure or functions, large changes in abundance of many species at spatial scales measured in 10's of kilometres; or • Mortality of a small number of individuals of internationally/ nationally threatened species, but no detectable change in population status and the capacity of populations to recover; or • Measurable loss in fisheries production at the local spatial scale, but no impacts at regional scales; and • Lead to impacts that are medium term (measured in years) or longer.
Moderate	While important at a state, regional or local scale, these impacts are not likely to be critical decision making issues. Moderate impact significance would be indicated by: • Measurable but small changes to supporting ecosystem components (i.e. habitat extent, water quality) and functions (i.e. fisheries production, fauna reproduction/recruitment) at scales measured in kilometres, but no impact at broader scales; or • Small changes in abundance of many species, or large changes in some species, at scales measured in kilometres; or • Loss of important life history functions of threatened species, or species of high fisheries or other significance, but no detectable change in their population status at a local spatial scale (i.e. capacity to recover); and • Impacts that are medium term (years) or shorter.
Minor	Impacts are recognisable/detectable but acceptable. These impacts are unlikely to be of importance in the decision making process. Nevertheless, they are relevant in the consideration of standard mitigation measures. This would be indicated by: • Species of fisheries or conservation significance, or its habitat affected but no impact on local population status (i.e. stress or behavioural change to individuals); • Impacts tend to be short term or temporary and/or occur at local scale; • No effects to threatened species are expected, even at local spatial scales.
Negligible	Minimal change to the existing situation. This could include, for example, impacts at are below levels of detection, or impacts that are within the range of normal variation.

10.3 DESCRIPTION OF SIGNIFICANCE CRITERIA

A risk-based approach was adopted for assessing impacts to marine ecology values. This is based on the identification of potential impacting processes and characterising the significance and likelihood of environmental effects. This risk-assessment process is detailed in full in Chapter A8 – Environmental Impact Assessment Process of this EIS. While the terminology used here for the levels of impact significance and likelihood are consistent with that used elsewhere in the EIS, for the purposes of this impact assessment these categories have distinct definitions specific to marine ecology. Discipline-specific definitions used in the marine ecology impact assessment are provided below in **Tables 10.3a** to **10.3c** for:

- Impact Significance, which takes in account the overall degree of environmental effects in terms of intensity, geographic extent, anticipated duration and sensitivity of environmental receptors. Impact significance categories also take into account the legislative status of relevant matters of conservations concern, such as protected areas and threatened or migratory species.
- Duration of Impacts, which are incorporated into the impact significance.
- Likelihood of Impact, which assesses the probability of the impact occurring.

A qualitative risk rating is then calculated for each impacting process, determined from a combination of the relevant significance and likelihood scores, as shown in the risk matrix below (**Table 10.3d**).

10.4 ASSESSMENT OF POTENTIAL IMPACTS AND MITIGATION MEASURES

For the marine ecology values in the vicinity of the airport and surrounds, the primary impacting processes associated with the construction and operational phases of the development can be broadly grouped into the following:

- Direct disturbance of benthic habitats and biota within the Project footprint (i.e. pump-out site, pipeline alignment and pipeline assembly area, tailwater discharge site)
- Alterations to water or sediment quality and sedimentation, particularly those associated with tailwater and stormwater discharges
- Direct or indirect interactions between marine fauna and the vessels or mechanical plant, such as those relating to noise, vessel strike and use of artificial lighting.

The above processes may occur in various marine environments (i.e. ocean, beach and/or estuary) as a result of one or more construction or operational Project components. These interactions are summarised in **Table 10.4a**.

These primary impacting processes have the potential to result in individual and interactive environmental effects on marine ecology values. This section discusses the known or likely impacts, of both the construction and operational phases of the proposal, on marine flora, fauna and their habitats. Risk ratings for each impacting process were determined based on criteria set out in **Section 10.3**. Mitigation measures that will be incorporated into the Project to reduce the risk of impacts are also described. A summary of the results of the risk assessment and mitigations measures is provided in **Section 10.5**.

Table 10.3b: Categories used to define the duration of impacts

Relative duration of environmental effects	
Temporary	Days to months
Short term	Up to 1 year
Medium term	From 1 to 5 years
Long term	From 5 to 50 years
Permanent / irreversible	In Excess of 50 years

Table 10.3c: Categories used to define the likelihood of impacts

Likelihood of impacts (EIS categories)
Highly unlikely
Unlikely
Possible
Likely
Almost certain

Table 10.3d: Risk matrix

	Significance				
Likelihood	Negligible	Minor	Moderate	High	Very High
Highly Unlikely/ rare	Negligible	Negligible	Low	Medium	High
Unlikely	Negligible	Low	Low	Medium	High
Possible	Negligible	Low	Medium	Medium	High
Likely	Negligible	Medium	Medium	High	Extreme
Almost Certain	Low	Medium	High	Extreme	Extreme

Table 10.4a: Summary of processes associated with each Project component that may potentially affect marine environmental values

Project component	Relevant marine environment	Potential impacting processes		
		Direct disturbance – benthic habitats and biota	Water/ sediment quality alteration, sedimentation	Direct interactions with marine fauna
Construction				
Dredge mooring and pump-out	ocean	✓	✓ (spills only)	✓
Pipeline construction and placement	beach / ocean	✓	✓ (spills only)	✓
Tailwater discharge	estuary	✓	✓	-
Terrestrial vegetation clearing	estuary	-	✓	-
Operation				
Stormwater and flood runoff via perimeter drains	estuary	-	✓	-

10.4.1 Direct disturbance of benthic habitats and biota

10.4.1.1 Potential impacts

Habitats

Physical disturbance of marine benthic habitats will occur at various locations within the Project footprint during construction, in association with:

- Assembly of the sand pumping pipeline on Marcoola Beach and placement of the pipeline along the pipeline alignment from the upper beach (dunes) to the subtidal offshore mooring
- Disassembly of the above pipeline on completion of sand pumping activities
- Mooring placement and sand spillage during pumping
- Construction of the tailwater discharge outlet on the southern bank of Marcoola drain and possible localised bank and/or bed scour from tailwater discharges.

During the operational phase of the Project, local stormwater runoff from the Project footprint will be directed to Marcoola drain and the Maroochy River via constructed drains. The specific extent and duration of the above habitat disturbances are described below and summarised in **Table 10.4b**. Refer to Chapter A5 – Project Construction for further details regarding the specifications or proposed methodologies for each of these Project components. Note that associated biological implications are addressed in subsequent subsections.

Pipeline assembly and placement

In the pipeline assembly area on Marcoola Beach, the marine-based sand pumping pipeline will be coupled in two or three parts, then hauled by tug into a position that is perpendicular to the shoreline and placed on the seabed and across the beach. Note that the dune itself is generally above HAT and therefore addressed elsewhere in this EIS (refer Chapters B7 – Terrestrial Flora and B8, Terrestrial Fauna).

On completion of sand pumping activities, the pipeline will be manoeuvred back onto the beach and disassembled. Specific benthic habitat disturbance associated with these construction works include:

- Sand displacement and temporary habitat loss through beach re-profiling, disturbance from construction plant traffic (i.e. sand compaction, development of vehicle ruts); manoeuvring the assembled pipeline, compaction by the pipe(s) and loss of sand-water interface directly beneath the pipeline
- Once the pipeline is in place, it will provide a temporary barrier to local sediment transport processes (i.e. longshore movement of sand), which is predicted to result in increased sand accretion along the southern side of the pipeline, and a subsequent reduction in sand supply immediately adjacent to the northern side of the pipeline (see Chapter B4 – Coastal Processes).

These temporary disturbances peak at the start and end of the 4 week assembly/disassembly periods.

The affected areas are located in highly dynamic environments (i.e. surf beach, surf zone and nearshore) that are in a constant state of flux. The degree of physical disturbance resulting from the proposed works is negligible relative to natural erosion events. It is therefore expected that beach and nearshore habitats would recover to pre-disturbance levels within weeks to months of the completion of beach construction works.

- The placement of the pipeline on the seabed will temporarily provide hard substrate habitat in an otherwise relatively homogenous, soft substrate environment. Any beneficial impacts associated with the temporary creation of hard substrate habitat will be highly localised and temporary in nature. Marine pest risks are expected to be low, as discussed in **Section 10.4.4**.

Table 10.4b: Summary of the extent, timing and location of works involving direct physical disturbance of marine habitats

Project component	Project phase	Location	Estimated area of disturbance	Habitat type	Indicative timing
Assembly, placement and disassembly of sand pumping pipeline	Construction	Marcoola Beach and adjacent nearshore pipeline corridor	Approximate 500 m length of beach used for assembly, then dragged into position along corridor, some excavation and temporary modification of dune to accommodate pipe in corridor.	Intertidal sandy beach, subtidal soft sediments	Approximately 4 weeks to assemble and place pipeline; remaining in place during sand pumping activities (up to a maximum of 33 weeks), then disassembled over approximately 4 weeks on completion of sand pumping.
Mooring placement and sand spillage	Construction	Nearshore pump-out site	Various locations within an approximate 0.5 km^2 area	Subtidal soft sediments	During sand pumping activities (up to a maximum of 33 weeks)
Construction of tailwater discharge outlet	Construction	Marcoola drain, southern bank	Anticipate less than 20 m^2 of intertidal land	Intertidal estuarine soft sediments, mangrove vegetation	Prior to commencement of reclamation / sand pumping activities.
Tailwater induced scour	Construction	Marcoola drain, in vicinity of discharge outlet	Assume localised, immediately adjacent to discharge outlet	Intertidal estuarine soft sediments	During tailwater discharges throughout reclamation / sand pumping period.

Mooring placement and sand pumping spillage

Within the pump-out site, additional subtidal benthic habitat disturbance will result from:

- Burial of large anchor blocks required to keep the dredge mooring buoy in place
- Sand spillage from the end of the floating pipeline.

At this stage, it is assumed that up to three large concrete anchor blocks will be buried, resulting in disturbance of surficial sediments during burial, and again during retrieval on the completion of sand pumping operations. It is expected that the footprint will be measured in metres, rather than hundreds of metres. The magnitude and locations of sand spillage will be dependent on the dredge vessel that is contracted to undertake the dredging work, and its location at the time of spillage. It is expected that the maximum total spillage at a particular location could be in the order of one to two metres over the year (refer Chapter A5 – Project Construction).

Resuspension and dispersal by currents and surge will likely mobilise and spread some of this sand, while the remainder will be retained and deposit within the pump-out site, causing some burial of the seabed. If the accumulated deposits are excessive (i.e. causing a navigational hazard), they will be re-dredged. Such intervention should be avoided where possible from an ecological perspective, given the dynamic state of local sands, and the likelihood that spilled sand will eventually mobilise and integrate into the local sediment transport system (refer Chapter B4 – Coastal Processes). However, if re-dredging needs to occur, these disturbances to subtidal sediment will be temporary and small scale, with the rate of recovery influenced by natural sediment transport processes and climatic conditions.

Marcoola drain habitat disturbance

Small scale direct and indirect disturbance to estuarine habitats will occur in Marcoola drain as a result of the construction and operation of the tailwater (and northern perimeter drain) discharge outlet.

Construction works will involve the direct disturbance of intertidal soft sediments in the vicinity of the outlet structure, and the clearing of <10 m^2 of the narrow mangroves fringing Marcoola drain. These changes will be permanent, highly localised (measured in 10s of metres) and of low magnitude.

Furthermore, indirect impacts to habitats are expected to occur as a result of bed and bank scour. Scour and subsequent accretion could occur as a result of:

- Tailwater discharges during the construction phase – which are proposed to occur continuously into Marcoola drain throughout sand-pumping works for reclamation (estimated 14 to 33 week period, depending on ultimate size of dredger)
- Stormwater runoff during the operational phase – storm water runoff from the airport will be delivered to Marcoola drain via the northern perimeter drain, potentially resulting in bank scour near the outlet during peak flows.

It is expected that scour will be highly localised, restricted to the immediate vicinity of the outlet. No changes to bed sheer stress are expected in the lower and middle sections of the channel, or Maroochy River (refer Chapter B6 – Surface Water and Hydrology). The degree of scour will depend on the ultimate outlet design, the physical characteristics of the sediments present, and tidal phase when peak flows occur. The rate of bed or bank recovery following disturbance will be driven by both fluvial (upstream) and tidal inputs, as well as particulate deposits from perimeter drain flows.

Changes due to scour will be permanent, highly localised (measured in 10s of metres) and of low magnitude.

<u>Benthic fauna</u>

Marcoola Beach

Persistent or high frequency traffic on sandy beaches elsewhere in SEQ has previously be shown to cause reduced fauna diversity and abundance and direct mortality of species such as ghost crabs and pipis (Schlacher et al. 2007, 2008a,b, Schlacher and Thompson 2007). It is therefore expected that highly localised changes to beach invertebrate communities would occur within the works areas during pipeline assembly and disassembly on Marcoola Beach. Beach fauna have a range of opportunistic life history traits and/or behaviours that enable rapid recovery following disturbance (Jones and Short 1995, Hacking 1997, WBM 2005b). Therefore, any changes to beach communities resulting from the works will be temporary, with recovery expected in days to months of disturbance.

Marcoola drain

Highly localised effects to benthic fauna immediately downstream of the outlet are expected as a result of drain construction and operation. With the exception of the footprint of the tailwater discharge (northern perimeter drain) outlet on the bank of Marcoola drain, all other disturbances to benthic communities are temporary and will occur only during the construction phase of the Project. Therefore benthic fauna communities can be expected to recover in time. Recolonisation of benthic fauna to these disturbed areas may occur via several processes including:

- Passive recolonisation in subtidal areas, involving the passive settlement of resuspended organisms
- Larval settlement by planktonic organisms
- Post-colonisation invasion of the disturbed areas by adult and juvenile fauna from neighbouring undisturbed areas.

Therefore, impacts to benthic fauna are expected to be temporary and highly localised.

<u>Flora</u>

Marine benthic flora (i.e. macroalgae, seagrass) does not occur within the proposed disturbance areas, with the exception of small, isolated patches of macroalgae in the pump-out site (see **Section 10.2.4**). The occurrence of these subtidal macroalgae patches is considered ephemeral. This is due to it growing on low-profile coffee rock, which continually changes in its degree of exposure as surrounding sands shift. As such, potential impacts to macroalgae are considered negligible.

Being intertidal or shallow subtidal environments, all disturbed areas likely contain microphytobenthos (i.e. microscopic algae, cyanobacteria and similar photosynthetic biota) growing on the sediment surface) that will likewise be subject to some degree of temporary impact. However, the microphytobenthic communities fluctuate greatly and are considered relatively resilient to temporary physical disturbance, particularly where in grows in mobile sandy environments, and where the disturbance redistributes or resuspends these benthic algae (i.e. can rapidly settle and recolonise) (Underwood 2001, Seuront and Leterme 2006, Rossi et al. 2007).

The area of mangroves proposed to be removed at the tailwater discharge outlet on Marcoola drain is small and immediately adjoined by adjacent mangroves on both the upstream and downstream banks. While mangrove loss will be permanent within the immediate footprint of the outlet, if adjacent mangroves are disturbed through construction access, they would be expected to recover in time.

<u>Secondary effects</u>

The risk of potential indirect flow-on effects to other marine ecology components is considered to be negligible. The disturbance areas do not contain large or dense benthic flora, or structurally diverse habitats such as reefs or rocky shores, and the area of disturbed mangroves at the tailwater discharge outlet is small in comparison to the total area of mangroves present in Marcoola drain. Therefore these areas are unlikely to provide critical foraging, refuge or nursery functions for fish, with most fish foraging opportunistically as they transit the areas. The disturbance areas are also not known to represent significant habitats for listed threatened and/or migratory megafauna, with the exception of low numbers of turtles nesting on Marcoola Beach and their emergent hatchlings (see **Section 10.4.3** for specific impact assessment). No reef communities or other features of high biodiversity value occur in the proposed disturbance areas, although some low profile coffee rock is intermittently exposed.

None of the proposed disturbance locations (i.e. Project footprint) are within any protected areas, therefore potential impacts as a result of habitat or physical disturbance will not occur in marine protected areas in the vicinity of the airport and surrounds. Note that potential flow-on effects to shorebirds are addressed elsewhere in this EIS, (Chapter B8 – Terrestrial Fauna).

10.4.1.2 Mitigation

The following aspects have been incorporated into the design of the Project to minimise disturbances to benthic habitats during the construction phase of the Project, including:

- Placement of the temporary pipeline on the surface of the seabed, rather than buried, to minimise disturbances to surficial sediments during placement and retrieval
- Design of the tailwater discharge outlet to minimise local estuarine bed scour
- Selection of a dredger that minimises the potential for excessive spillage (where practicable in line with other constraint considerations) and implementation of appropriate management as specified in the Dredge Management Plan
- Ensure the duration of beach works, the number/type of plant used on the beach, the area of use and the extent of re-profiling works to accommodate pipeline assembly, are kept to a minimum
- Commitment to address excessive accumulation of beach sediment, if it occurs along the pipeline, to minimise interference with longshore sediment transport processes
- Minimise the area disturbed on Marcoola drain during construction of the tailwater discharge outlet, and brief relevant staff on marine plant status and best practice approach.

Specific Project design aspects and construction methodologies are fully described in Chapter A4 – Project Description and Chapter A5 – Project Construction.

Overall, physical disturbances to benthic habitats and inhabitant biota are considered to be low to negligible, given their largely temporary nature, the inherent capacity of these environments and their biotic communities to recover from temporary disturbances relatively quickly, and the very low possibility of effects to species of conservation significance.

10.4.2 Water or sediment quality alteration and sedimentation

10.4.2.1 Potential Impacts

The following impacting processes could lead to changes to water quality, sediment quality and quantity, and flow-on impacts to marine ecology:

- Tailwater discharges (construction) and stormwater runoff (construction/operational) from the airport site altering salinity and increasing pollutant loads into Marcoola drain and Maroochy River estuary (construction phase)
- Stormwater runoff from the construction footprint increasing sediment and nutrient loads into the Maroochy River estuary during construction
- Uncontrolled spills from the pump-out site, pipeline assembly area, or airport construction areas introducing hydro-carbons and other contaminants into the marine environment during construction.

Chapter B6 – Surface Water and Hydrology provides a detailed description of these impacting processes. The following describes potential implications from a marine ecology perspective.

<u>Tailwater and stormwater Inputs</u>

During the construction phase, tailwater discharges will result in temporary (less than one year duration) changes to water quality in Marcoola drain, primarily between the culverts at Finland Road and the confluence with the Maroochy River. Based on water quality modelling, the following temporary water quality changes are predicted in Marcoola drain (refer Chapter B6 – Surface Water and Hydrology for further details):

- The lower reach of Marcoola drain (i.e. downstream of the tail-water discharge point) is predicted to experience the greatest increase in turbidity and TSS. Annual median TSS concentration and turbidity level are predicted to increase here by approximately 25 per cent and 38 per cent, respectively
- Median salinity within the lower reach of Marcoola drain is predicted to increase from the existing 3.5 ppt (brackish) to 25 ppt over the course of the year (note, average seawater salinity is approximately 35 ppt)
- Annual median turbidity in the lower reach of Marcoola drain is predicted to exceed the WQO under both existing conditions and predicted discharge conditions, whereas the total suspended solid WQO is predicted to be achieved
- Only minor water quality changes are predicted to occur in the upper Marcoola drain (upstream of the culverts at Finland Road), with salinity and turbidity levels predicted to be within the range of natural variability observed under existing conditions.

Within the Maroochy River, water quality impacts due to tail-water discharges are predicted to be relatively minor and primarily consist of the following:

- Negligible changes to turbidity and TSS concentrations. Turbidity exceeds the WQO for both existing and discharge cases but no exceedences of the suspended sediment WQOs were predicted in the Maroochy River downstream of Marcoola drain, with the exception of a suspended sediment exceedence in a small region upstream of the Marcoola drain confluence.

- The tailwater discharge results in minor increases in salinity (with the exception of the lower estuary where predicted changes are negligible) although these changes are within the natural salinity variations observed at given sites.

For the Project's operational phase, stormwater discharged into Marcoola drain is likely to have minor impacts to water quality in the Maroochy River and surrounds in terms of changes in the future nutrient, sediment and contaminant concentrations (see Chapter B6 – Surface Water and Hydrology), and detectable impacts to marine ecology are not expected. However, runoff via the northern perimeter drain will cause a permanent change in the hydrology of Marcoola drain due to a greater catchment drainage area. Typically, flows are predicted to increase for all flow percentages, most notably during peak flow periods (Chapter B6 – Surface Water and Hydrology).

While Marcoola drain is a highly modified waterway, it provides various habitats for estuarine flora and fauna, and will continue to do so during construction. The predicted water quality changes, particularly the increase in salinity, are expected to result in temporary effects to benthos and fish community structure. While the flora and fauna present are typically tolerant of marine salinities, the predicted temporary increase in salinity will likely exclude species that prefer brackish to freshwater conditions, and favour marine species. Small areas of freshwater macrophytes and emergent vegetation that can tolerate brackish waters are present in Marcoola drain downstream of the culverts (i.e. *Phragmites australis*). These plants in the lower reaches will likely be susceptible if increased salinities persist over the duration of the works, but will likely resume this patchy downstream distribution on completion of the works, given the ongoing supply of propagules from upstream. Water quality related effects to mangroves are not expected, given that resident mangrove species are tolerant of marine water salinities, and the limited duration of tailwater discharges.

Some of the euryhaline invertebrate species recorded (i.e. chironomids) can tolerate marine salinities to a degree but exposure is usually intermittent and the prolonged duration of these conditions could result in a temporary community shift. The local benthic community is expected to be temporarily dominated by the species that are tolerant of marine salinity conditions. This would represent a temporary impact, and benthic communities would be expected to revert to a euryhaline-dominated community shortly after the completion of construction works.

Estuarine fish species are typically highly mobile and tolerant of a wide salinity range. Nonetheless, during the period that tailwater discharges increase the salinity in Marcoola drain, the species more commonly associated with brackish waters (i.e. bullrout) would likely remain in the upper reaches of Marcoola drain. The increased salinity and water volumes may provide a temporary opportunity for marine fish species to venture into Marcoola drain during construction.

Only minor changes to water quality are expected in Maroochy River, and it is not expected that such changes will result in major ecological changes. Perhaps the most sensitive species that would be most susceptible to the water quality changes are seagrasses, which are present in isolated areas of the mid-estuary (most extensive areas known are located approximated 8 km downstream of the Marcoola drain confluence). These seagrasses are not expected to be detectably impacted as a result of the Project. This is based on their distance downstream from the discharge, the minor change in magnitude of turbidity and TSS concentrations, the fact that these changes are within the range of natural variation, and the regular relief through semidiurnal tidal inputs (i.e. lower turbidity, refer Chapter B6 – Surface Water and Hydrology).

No detectable impacts are expected to Maroochy River Fish Habitat Area or the values it supports.

A suite of mitigation measures will be implemented to minimise tailwater effects, as listed in **Section 10.4.2.2** Key to this will be the implementation of the Dredge Management Plan as it relates to turbidity and suspended sediments (refer Chapter B6 – Surface Water and Hydrology and Chapter E4 – Dredge Management Plan). In the vicinity of the tailwater discharge site, reactive monitoring of sediment bed sedimentation (or scour) and associated benthic communities will identify excessive habitat or community effects that may need to be ameliorated. Overall, inputs from the tailwater discharge site are expected to have a low residual impact to the marine ecology values.

Runoff from the airport construction site

A number of hectares of terrestrial land will be cleared, or otherwise disturbed, by airport construction activities. Sediment erosion and water management controls will be required to ensure that construction activities do not result in unacceptable increases in sediment and nutrient loads entering the Maroochy River estuary.

Residual chemicals from past agricultural activities may also be mobilised, particularly considering the predominant past use for the surrounding cleared lands was sugar cane farming. Such inputs would most likely comprise pesticides and nutrients, which have the potential to pose a risk to estuarine water quality and potentially result in secondary effects to flora and fauna. Clearing, sediment erosion and water management practices will be employed, as outlined in the Chapter E3 – EMP. Through the implementation of these measures, this risk is considered to be minimal and potential water quality effects resulting from these works are expected to be a low risk.

Vessel or mechanically-derived spills

It is possible that chemical spills will occur from the dredger or beach-based machinery, presenting a risk for potential contaminants to be introduced to the marine habitats. These could include, for example, hydrocarbons or other potential toxicants used during operation. Spills could occur either within the beach works area, or in the vicinity of the dredge mooring (note that similar impacts at for the dredge while in transit or dredging in Moreton Bay are addressed in Volume C of this EIS).

In the event that a spill occurs, it presents a toxicity risk to marine flora and fauna. The significance of such an impact is highly variable, depending on factors such as:

- The type of material spilt and its chemical constituents
- The volume and/or load concentration of potential toxicants of concern entering the marine environment
- The location and timing of a spill, which can dictate the mixing potential (i.e. concentration reduction), extent of water quality effects, and the likelihood of sensitive receptors occurring in the affected area.

Spills of this nature are considered to be unlikely and are considered to represent a negligible risk to ecological values, given their localised extent or potentially undetectable effects in the event that they do occur, together with the implementation of the mitigation measures outlined below.

10.4.2.2 Mitigation

Mitigation of potential water quality effects focuses on the implementation of the EMP and DMP, which in turn concentrate on managing i) the turbidity and suspended sediment concentrations of discharged tailwaters to within acceptable limits, and ii) the management of spills and hazardous materials (refer Chapter E3 – EMP and E4 – DMP). Key aspects of these, for minimising potential water quality and associated biological effects to marine or estuarine biota include:

- Implementation of a reactive tailwater monitoring program and appropriate water quality mitigation measures as required (i.e. cease tailwater discharge if threshold exceeded)
- Tailwater discharge outlet designed to minimise bed scour at Marcoola drain
- During and after terrestrial clearing and ground disturbance, use of best practice procedures for erosion and sediment control to minimise risk of affecting nearby waterways
- To reduce spill risks, hazardous material handling procedures and emergency spill response procedures will be implemented, if required, as per DMP, and relevant staff will receive appropriate spill response training.

10.4.3 Direct interactions with marine megafauna

10.4.3.1 Potential impacts

Direct interactions between marine megafauna and the dredger or mechanical plant could potentially occur in relation to the following activities:

- Dredge mooring and pump-out
- Pipeline construction and placement.

During these activities, marine fauna could be affected by one or more of the following mechanisms, which are described in further detail below:

- Direct contact or obstruction of fauna passage
- Emissions of artificial noise from the vessels and dredge pump
- Emissions of artificial light during night works, either on the beach or nearshore vessels.

<u>Contact or obstruction</u>

When operating any kind of vessel in marine waters, there is a potential risk of fauna vessel strike, primarily for mobile megafauna that swim near the surface and/or frequent the surface to breath, such as whales, dolphins, dugongs and turtles. Interactions may also occur if the presence of a vessel obstructs fauna passage, which may occur if the presence of a vessel deters an animal from continuing along an intended path of passage, or is inclined to detour significantly around a vessel to reach an intended destination (i.e. avoidance behaviour – discussed further below with respect to potential noise effects).

Large vessels such as the dredger are slow-moving, which would provide marine fauna time to evade the approaching vessel. In this case, the dredger will be moving particularly slow as it will be approaching the mooring and/or manoeuvred by tug to maintain a relatively stationary position during pumping. The tug boat will be the vessel more commonly moving in and around the dredge mooring location. In addition to manoeuvring the dredger, it will be required to repeatedly tow the floating pipeline to the dredger for it to be coupled to the dredger's discharge point, and possibly also enforce compliance with approach limits if other vessels attempt to come close to the dredge or mooring. An additional vessel will also be used to drag the steel pipeline seaward for ocean placement. The close proximity of the mooring area to shore (less than 1 km) reduces the risk of larger megafauna, namely whales, coming in close proximity to the works area. Therefore the fauna most likely to enter the pump-out site are fish, dolphins and turtles. Overall, the likelihood of vessels striking or obstructing the passage of marine fauna is considered to be low.

Entrainment of fauna may potentially occur from the suction at the pump's water intake. However, this risk is very low as the intake will be in surface waters where larger fauna are highly mobile and would actively avoid the area.

Beach works during construction of the sand pumping pipeline potentially pose a risk of direct physical interactions with nesting turtles, turtle nests and hatchlings on Marcoola Beach. This risk will be negligible during the construction phase of the Project as all beach works will purposefully be timed to be undertaken outside of turtles nesting season.

<u>Noise</u>

The production and reception of particular sounds are important to many marine fauna species, particularly marine mammals. Both natural and anthropogenic sounds have the potential to interfere with various biological functions. During construction, sand pumping has the potential to adversely affect megafauna as it will form a source of underwater noise that will occur intermittently for the maximum ten month duration of sand pumping works. For example, depending on the size of the dredge, it is anticipated that it will discharge 2.0 to 3.5 times per day, with each discharge works taking approximately two hours at a time. Such noise may be generated by mechanical means (vessel engines, pumps, propellers and other machinery), or by water movements on vessel hulls. While vessel and pump generated noise is normally unlikely to occur at levels that could cause acute hearing damage to marine fauna, it may cause subtle but possibly more widespread increases to ambient noise levels. This may include for example, masking of biologically important sounds (i.e. vocalisations), interfere with dolphin sonar signals or alter fauna behaviour (i.e. noise avoidance).

Works on the beach, particularly pipe assembly, will also generate noise. This may not contribute significantly to underwater noise (and therefore megafauna effects), given the higher attenuation of noise in air. Nonetheless, together with beach construction vibrations and physical disturbance, will contribute to excluding and/or deterring fauna (i.e. crabs) from the pipeline assembly area for the duration of works.

Specific knowledge on the relative contributions of various noise sources to ambient noise levels is extremely limited, as is information on the effects of noise on marine megafauna in an Australian context. Further, specific underwater noise modelling has not been undertaken for this Project. Therefore, quantitative predictions about the extent of potential underwater noise impacts cannot be made.

The most likely impact of underwater noise from the pump and vessels will be the temporary avoidance of the pump-out site and immediate surrounds by mobile fauna. Noise generated by sand pumping activities will likely deter nesting turtles from nesting near the pump-out site. Nesting turtles will either nest at an alternative stretch of the beach, or possibly dispose of their eggs. Such impacts would be temporary, and given existing low intensity of nesting (expected to be no more than two individuals in close vicinity to the pump-out site), any such impacts are not expected to cause impacts to turtle populations.

It is also possible that underwater noise generated by the pump and vessels would deter whales and dolphins from using waters immediately adjacent to operational areas. Given that the waters directly adjacent to Marcoola Beach are not known to represent an important whale movement corridor or resting areas, major impacts to whale populations are not expected. Any such impacts to whales or dolphins (i.e. avoidance of area) are expected to be highly localised (measured in 100s of metres) and of a temporary nature.

As discussed below, mitigation measures will be implemented to further reduce the risk of underwater noise effects, as well as the risk of direct obstruction or contact with marine megafauna.

<u>Light emissions</u>

When vessels are operated at night in the pump-out site, they will utilise on-board lighting systems. It is anticipated that the dredge vessel would typically moor at this location for approximately two hours at a time, once or twice a night, during the maximum ten month duration of the sand pumping program. Buoys at the mooring and floating pipeline will be fitted with navigation lights. Lighting will also be used on Marcoola Beach when sand pumping occurs at night, and if security lighting required for the pipeline. Together, these sources will generate light emissions to the marine environment. Artificial lighting is not known to have a major effect on foraging or other behavioural patterns of dolphins, whales or sharks. Marine turtles are the marine megafauna species considered to be most vulnerable to artificial lighting effects as they may become disorientated during nesting and hatching (Witherington 1992). Throughout construction, no works will be undertaken on the beach during the local turtle nesting season (i.e. November to early March). Parts of the sand pumping operations may (depending on ultimate duration of sand pumping works) coincide with local turtle nesting. For hatchlings, this is considered to present negligible risk in terms of light effects as the seaward position of the vessels will not guide new hatchlings landward. Beach-bound nesting adults could potentially be confused and disorientated by Project-related lights when approaching shore during pumping operations: however, this is considered a low risk due to the more extensive road, residential and similar lighting on lands near Marcoola Beach; the low incidence of turtle nesting likely to occur; and the possibility that pumping noise emissions may already have deterred turtles form approaching this area.

Given the rare occurrence of threatened seabirds in the study area, the risk of artificial lighting affecting these fauna is considered negligible. While not specifically mentioned above, note that seabirds are not expected to be directly affected by other direct interactions, other than behavioural avoidance of the works area. Furthermore, direct interactions with the vessels, pump or beach plant are not expected to cause adverse impacts to the food resources for marine species of conservation significance. Overall, while megafauna interactions between the vessels, pumps and other machinery are typically unlikely (although noise-related avoidance behaviour is more likely), they are considered to represent a low risk, even with the implementation of the best practice mitigation below, since the fauna most likely to be affected are generally species of high conservation significance.

10.4.3.2 Mitigation

With respect to potential impacts to turtles on Marcoola Beach, all dredge pipeline construction works on Marcoola Beach will be undertaken during times that are outside turtle nesting season (i.e. November to March). Prior to the commencement of beach construction works, it is recommended that staff confirm with local turtle nest monitoring personnel (i.e. through SCC or direct with community groups) that any turtle nests occurring in the works area during the most recent nesting season are no longer active. With these measures in place, beach construction works will avoid interactions with nesting turtles, turtle nests and hatchlings.

While the pump-out site is not known or likely to support large numbers of marine megafauna, management strategies will be implemented throughout mooring and sand pumping operations to minimise the risk of interactions with the dredger and tug vessels. These management strategies will be set out as part of the Dredge Management Plan and will include:

- Implementing a Marine egafauna Management Plan
- Implementation of megafauna exclusion zones (i.e. maintaining a given buffer distance between vessels and megafauna) and associated reactive megafauna monitoring program (i.e. regular visual inspections of pump-out site)
- If visual monitoring for megafauna from either vessel detects megafauna within or headed towards exclusion zones, execute strategies to avoid interactions as required (i.e. stopping work if megafauna, especially whales, are within or near exclusion zones; halt vessel transit if potential to encroach on observed whales or their anticipated path)
- Where it does not conflict with security and safety requirements, lighting on the dredge vessel will aim for low wattage and/or directional light fixtures.

10.4.4 Other matters

The following provides commentary on other matters specifically raised in the Terms of Reference that are not considered in previous sections.

Marine pests

While marine pests, if present, could be transported from the dredger or tug vessels to the marine environment, the Project is not considered to pose a notable risk in terms of the potential of introducing marine pests to the Sunshine Coast. This is based on the following:

- The Project requires the use of a small number vessels (dredge and tug), which will remain in SEQ for the duration of the dredging and sand pumping campaign
- Appropriate measures will be in place prior to mobilisation of the dredge and tug vessels at the commencement of construction to reduce the potential for introducing marine pests via vessels (i.e. compliance with antifouling, hull cleaning and ballast treatment requirements)
- The Sunshine Coast is not currently known to support populations of marine pests of concern that could be dispersed by the dredger to waters elsewhere.

Fish spawning periods

Numerous fish and crustacean species may utilise the study area for spawning, or undertake migratory or other movements (i.e. between the upper and lower reaches of Maroochy River, between Maroochy River and oceanic waters). However, the timing of spawning varies between species.

For species of local fisheries significance, there is generally a broad window of peak spawning activity over the warmer spring and summer months (i.e. October to March), although some species may spawn or migrate at other times of year. No aspects of the Project proposed for marine habitats in the vicinity of airport are expected to create physical obstructions to fish passage. As discussed above (**Section 10.4.2**), predicted salinity increases in Marcoola drain may create a temporary chemical barrier to brackish/freshwater fish that utilise the drain from time to time, although none of this species are expected to be of direct fisheries significance. As tailwater discharges are proposed to occur continuously for a maximum of 33 weeks (depending on the chosen vessel), altering the commencement time of these works would not be expected reduce any related effects to fish passage or spawning.

10.5 SUMMARY AND CONCLUSIONS

A summary of the outcomes of the risk-based assessment for each primary impacting process is provided **Table 10.5a**.

Processes potentially impacting the marine ecology values of the study area include the:

- Direct disturbance of habitats and biota within the Project footprint (pump-out site, pipeline alignment and assembly areas, and tailwater discharge site)
- Alterations to water or sediment quality and sedimentation, particular those associated with tailwater and stormwater discharges
- Direct or indirect interactions between marine fauna and vessels within the pump-out site, or mechanical plant, such as those relating to direct contact, noise and artificial lighting.

Most of these processes primarily apply to the construction phase of the Project; however, stormwater runoff from the Project footprint will continue to be directed into Marcoola drain and the Maroochy river, via constructed drains, episodically for the life of the Project.

All of the above processes, if they occur, have the potential to result in effects to marine flora and/or fauna inhabiting the study area, which may be expressed by way of fauna behavioural change, changes in the structure (i.e. composition or abundance) or distribution of biotic communities, as well as (unlikely) flow-on effects to values in the surrounding waters if food sources or other habitat values, for example, are altered.

Overall, these potential impacts would initially have been considered to be a low to moderate risk to the marine ecology values of the study area. However, with the implementation of the recommended mitigation measures it is anticipated that this rating will reduce to a negligible to low level of impact, particularly considering the temporary nature of most potential effects.

Table 10.5a: Impact assessment summary table

Marine ecology	Initial assessment with mitigation inherent in the Preliminary Design in place				Residual assessment with additional mitigation in place (i.e. those actions recommended as part of the impact assessment phase)			
Primary impacting processes	**Mitigation inherent in the design**	**Significance of impact**	**Likelihood of impact**	**Risk rating**	**Additional mitigation measures proposed**	**Significance of impact**	**Likelihood of impact**	**Residual risk rating**
Construction								
Project component: Dredge mooring and pump-out								
Localised sedimentation from spillage of dredged material, associated benthic habitat and fauna alteration.	Contractor to clean up excess sand when it reaches a certain volume/area.	Minor	Possible	Low	None required	Minor	Possible	Low
Risk of vessel strike, passage obstruction, noise or artificial lighting effects to threatened (or otherwise protected) species	Implement DMP including visual checks from dredge vessel and implement strategies to avoid interactions.	Minor	Unlikely	Low	None required	Minor	Unlikely	Low
Spills from vessels affecting local water quality (i.e. introduce contaminants)	Implement DMP including hazardous material handling procedures and emergency response procedures. Spill response training for staff.	Minor	Highly unlikely	Negligible	None required	Minor	Highly unlikely	Negligible
Project component: Pipeline construction and placement								
Disturbance of nesting turtles, turtle nests and/or hatchlings (i.e. physical disturbance, avoidance, light)	Pipeline construction works on Marcoola Beach not to be undertaken during turtle nesting season (approximately late November to early March). Confirm with local community turtle monitoring groups that pipeline construction works are being undertaken outside local nesting period for that particular year.	Minor	Highly unlikely	Negligible	None required	Minor	Highly unlikely	Negligible
Temporary loss of surficial sediments and/or changes to benthic habitat on Marcoola Beach and adjacent subtidal pipeline alignment; accompanying changes in the structure of intertidal and subtidal benthic community.	Pipeline lain on top of seabed (rather than buried) to minimise physical disturbance of benthic habitats and associated communities. Minimise duration of pipeline installation and associated works. Pipeline completely removed on completion of construction works. Contractor to reprofile excessive sand accumulation if it reaches a certain volume/area.	Minor	Likely	Medium	None required	Minor	Likely	Medium

Marine ecology	Initial assessment with mitigation inherent in the Preliminary Design in place				Residual assessment with additional mitigation in place (i.e. those actions recommended as part of the impact assessment phase)			
Primary impacting processes	**Mitigation inherent in the design**	**Significance of impact**	**Likelihood of impact**	**Risk rating**	**Additional mitigation measures proposed**	**Significance of impact**	**Likelihood of impact**	**Residual risk rating**
Project component: Pipeline construction and placement								
Risk of spills from plant operation on beach introducing contaminants to intertidal sediments and/or waters.	Implement DMP which contains hazardous material handling procedures, i.e. there would be no vehicle refuelling allowed on the beach; emergency response procedures and spill response training for staff.	Negligible	Unlikely	Negligible	None required.	Negligible	Unlikely	Negligible
Project component: Tailwater discharge and northern perimeter drain								
Small scale (<10 m^2), permanent removal of estuarine vegetation (marine plants: mangroves) to construct discharge/ drain outlet on Marcoola drain.	Minimise area disturbed during construction (i.e. narrow access buffer, edge plants trimmed rather than removed where practicable). Brief staff on 'marine plant' status and best practice approach.	Minor	Possible	Low	None required	Minor	Possible	Low
Altered water quality and quantity in receiving environment of tailwater discharge (salinity, TSS, turbidity, sedimentation); risk of flow-on effects to estuarine flora and fauna, primarily in Marcoola drain.	Settlement pond incorporated into design in order to improve water quality prior to discharge. Implement reactive tailwater monitoring program. Cease discharge if turbidity compliance thresholds are exceeded.	Minor	Possible	Low	None required	Minor	Possible	Low
Physical disturbance or removal (scour) of estuarine bed in vicinity of discharge outlet on Marcoola drain, resultant modification of associated benthic assemblages.	Discharge outlet design and placement incorporates features to minimise local scour and bed disturbance.	Minor	unlikely	Low	None required	Minor	Unlikely	Low

Marine ecology	Initial assessment with mitigation inherent in the Preliminary Design in place				Residual assessment with additional mitigation in place (i.e. those actions recommended as part of the impact assessment phase)			
Primary impacting processes	**Mitigation inherent in the design**	**Significance of impact**	**Likelihood of impact**	**Risk rating**	**Additional mitigation measures proposed**	**Significance of impact**	**Likelihood of impact**	**Residual risk rating**
Project component: Terrestrial vegetation clearing								
Potential for terrestrial vegetation clearing to impact estuarine water quality of Maroochy River. Risk of flow-on effects to estuarine habitats and biota.	Limit terrestrial vegetation clearing to minimum requirements. Contain and/ or treat terrestrial run off during (and for a period after) vegetation clearing by implementing appropriate Erosion and Sediment Control Plan including, for example, use of appropriate geofabrics, especially adjacent to drains and waterways.	Moderate	Unlikely	Low	None required	Moderate	Unlikely	Low
Operational								
Project component: Stormwater runoff to estuarine waters during operational phase								
Changes to airport stormwater quantity and water quality regimes during the operations phase, including associated flow-on changes in receiving estuarine waterways.	Physical separation from waterways by approximately 150 m of vegetated overland flow.	Minor	Possible	Low	NA	Minor	Possible	Low

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