



Kimberley Technology Solutions Pty Ltd

Cockatoo Island Multi-User Supply Base Technical Study - Marine Flora and Fauna

June 2017

Executive summary

Kimberley Technology Solutions Pty Ltd is proposing to construct and operate the Cockatoo Island Multi-User Supply Base (the project) from Cockatoo Island, Western Australia. The project will involve the upgrade and development of infrastructure on Cockatoo Island, including an airfield, a wharf and an aftermarket subsea workshop as well as other related support infrastructure.

To support State and Commonwealth approval processes, a study was undertaken to describe the benthic communities and habitats (BCH) and marine fauna in the vicinity of the proposed wharf. The focus of the field survey was to characterise the BCH in the bay proposed for wharf development (Bay 1) and the two adjacent bays to the southeast (Bay 2 and Bay 3).

The survey identified that the estimated percentage of bare substrate in Bay 1 (67.3%) is substantially higher than in Bay 2 (47.2%) and Bay 3 (37.6%), likely due to Bay 1 having been impacted by nearby mining-related activities to the northwest.

Soft coral and hydroids are relatively minor contributors to the benthic community assemblage, although they represent a greater proportion of Bay 1 than the other two bays.

Habitat density observations (e.g. sparse, dense) for hard coral and macroalgae were used to estimate total coverage areas within each bay and over the entire survey area, which demonstrated that:

- The estimated hard coral area in Bay 1 of 0.2 ha is approximately 3% of this bay's surveyed area. The total estimated hard coral area of the three bays is 4.92 ha. The hard coral area in Bay 1 comprises only 4% of the total hard coral area across the three bays, presumably because of its proximity to past mining-related activities (and associated impacts). Construction and operation of the wharf facility will pose elevated environmental risks and impacts to only ~4% of the existing hard coral cover across the three bays (i.e. those in Bay 1); and
- The estimated macroalgal area in Bay 1 is 0.19 ha, representing 3% of this bay's surveyed area. This is a similar proportion to Bay 2 (5%) and Bay 3 (6%). The estimated macroalgae area in Bay 1 comprises 13% of the total macroalgae area across the three bays. A relatively small proportion (13%) of the total macroalgae area across the three bays will be at risk of impact by construction and operational activities of the wharf facility.

On the basis of observed benthic communities on the existing ship loader piles, it is anticipated that a similar community assemblage will colonise the proposed wharf infrastructure. Further, colonisation of the wharf structure by hard corals may occur, particularly along the eastern portion of Bay 1, where some hard corals currently occur.

There is the potential for threatened and listed marine fauna to occur near to the proposed wharf development that may be impacted during construction and operation of the facility. Preparation of construction and operation management plans with appropriate preventative controls and mitigation measures can reduce potential impacts and risks to marine fauna to acceptable levels.

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1. Introduction

1.1 Background

Kimberley Technology Solutions Pty Ltd is proposing to construct and operate the Cockatoo Island Multi-User Supply Base (the project) from Cockatoo Island, Western Australia. The project will involve the upgrade and development of infrastructure on Cockatoo Island, including an airfield, a wharf and an aftermarket subsea workshop as well as other related support infrastructure.

1.2 Study Objective and Scope

To support State and Commonwealth approval processes a study was undertaken to describe the benthic communities and habitats (BCH) and marine fauna in the vicinity of the proposed wharf through a:

- Desktop assessment of marine fauna;
- Desktop assessment of the BCH; and
- BCH field survey.

1.3 Limitations

This report has been prepared by GHD for Kimberley Technology Solutions Pty Ltd and may only be used and relied on by Kimberley Technology Solutions Pty Ltd for the purpose agreed between GHD and the Kimberley Technology Solutions Pty Ltd as set out in section 1 of this report. GHD otherwise disclaims responsibility to any person other than Kimberley Technology Solutions Pty Ltd arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and surveys undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

2. Methodology

2.1 Desktop Assessment

A desktop assessment of the marine environment was carried out prior to undertaking a marine survey. Existing marine survey reports and aerial photography of Cockatoo Island were reviewed to optimise planning and outcomes from the field study. The review included past marine surveys of the proximal area. Conservation significant marine species were identified that are listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the *Wildlife Conservation Act 1950*, and from the Department of Parks and Wildlife's NatureMap. Previous documented site visits and surveys, past approvals documents and other literature sources were also used.

2.2 Field Survey

A three day marine environment survey during 11-13 November 2016 was undertaken in the locale of the proposed wharf development. A digital underwater drop camera video system and a GPS-enabled tablet application were used.

2.2.1 Site Selection

Aerial imagery was used to select the survey area and to understand the level of similarity between the bay with the proposed wharf footprint and other proximal bays of Cockatoo Island. Aerial imagery could not be used to delineate habitat types because of poor water clarity.

2.2.2 Data Collection

During the survey the following data was collected at each site:

- Time and date of observation;
- Visual recording;
- Coordinates of observation;
- Dominant substrate (e.g. sand, silt etc.); and
- Benthic community type and coverage.

2.2.3 Data Analysis

Marine substrate and benthic community data were spatially mapped onto aerial imagery and recently acquired bathymetry. Contours from the marine habitat data were derived between sites through a natural neighbour interpolation. The coverage of benthic communities for the interpolation was classed as per Table 2-1 with the mid-value of the coverage intervals allocated to each site as per Table 2-1.

Table 2-1 Benthic coverage percentage bins

Coverage (Qualitative description)	Coverage Range (%)	Assigned Value (%)
None	0	0
Very Sparse	0 – 5	2.5
Sparse	5 – 25	15
Moderate	25 – 50	37.5
Dense	50 – 100	75

3. Results

3.1 Desktop Review

3.1.1 Overview of Cockatoo Island

Cockatoo Island is located approximately 7 km off the Western Australian coast within the Buccaneer Archipelago, approximately 130 km north-west of Derby (Figure 3-1). As described in MScience (2011), the Cockatoo Island climate is a dry sub-tropical environment, in an area of low wave energy with a large tidal range of 10 m. The large tidal range, steep cliffs and beach profile, and high ultraviolet radiation are the dominant factors that drive habitat distributions.

3.1.2 Marine Habitats

Bay 1, the location of the proposed wharf development (Bay 1 in Figure 3-1), has not been previously surveyed. This review is based on marine environment surveys primarily undertaken of the nearshore regions of Cockatoo Island to the northwest of Bay 1.

As described by the EPA (2016), benthic communities and habitats (BCH) are defined as “Functional ecological communities that inhabit the seabed and the areas of seabed that support these communities (e.g. high relief reef, platform reef, sand, silt and the depth they occur at). The communities may include light dependent taxa (e.g. algae, seagrass, corals, some sponges, mangroves) or animals that obtain their energy by consuming live or dead organisms (e.g. ascidians, sponges, soft corals)”.

Marine Substrates

In a 2013 survey (MScience, 2013) around the existing ship loader (approximately 400 m to the northwest of the proposed wharf development), the marine environment was characterised as a shallow nearshore flat of 10 to 30 m width that drops off at the seaward edge to 10-15 m below lowest astronomical tide (LAT). Uncolonised rocky substrates were common at the edges of the headland. Sand with some patches of mud was the dominant habitat. Areas of gravel and coral rubble were also noted on the outer flat and the slope.

Hard Coral

In a 2007 survey (MScience, 2007), two types of hard coral communities were noted; coral habitats of crests and upper reef slopes, and coral on reef flats (Figure 3-2).

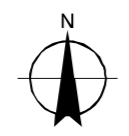
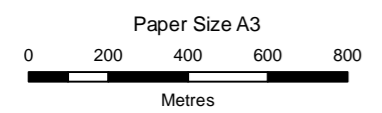
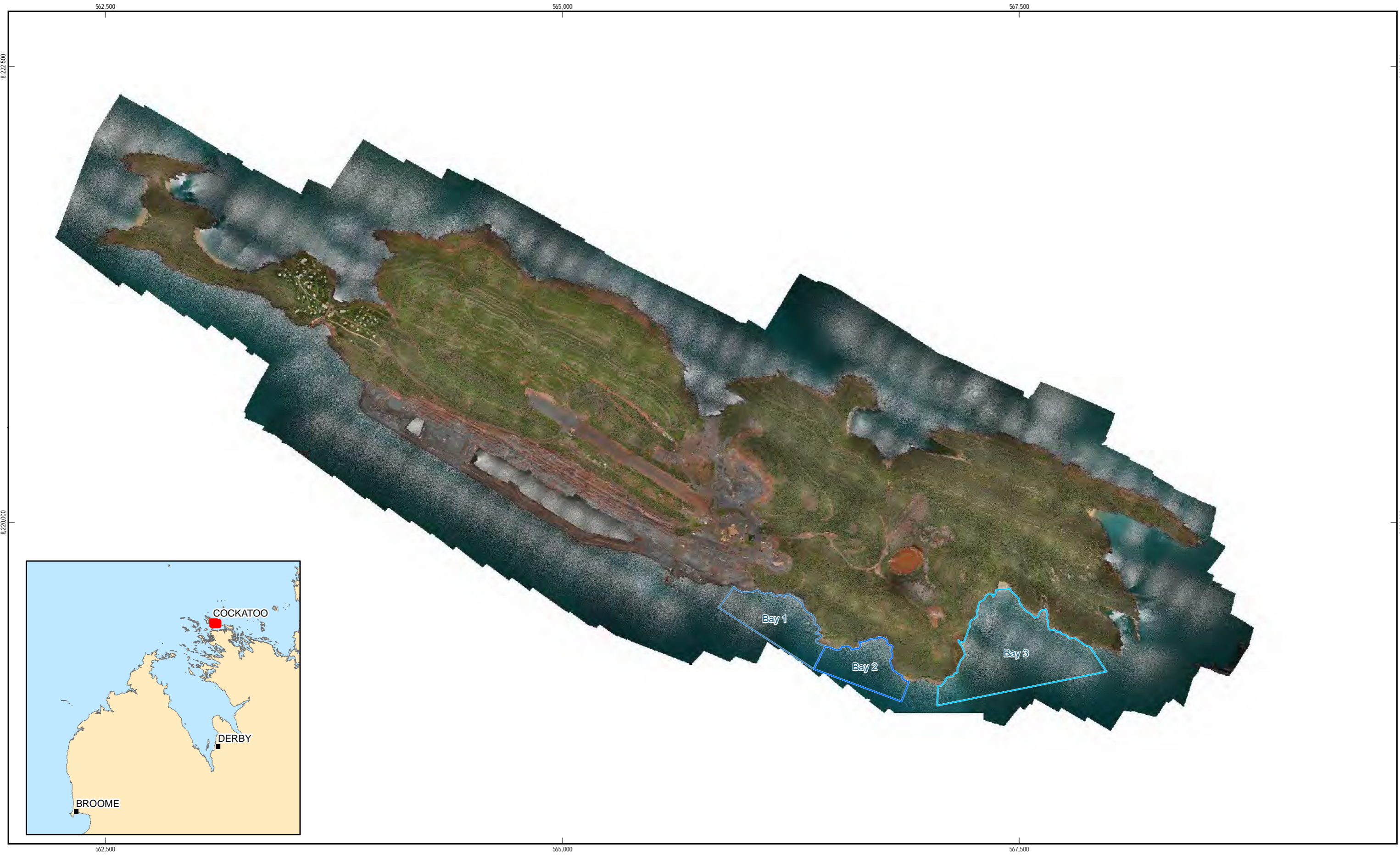
Hard coral colonised some areas of the coral rubble. Coral genera typically included *Acropora* and *Montipora* across a depth range of 1-5 m below LAT (MScience, 2013).

Macroalgae

MScience (2007) found substantial areas of moderately abundant macroalgae including *Sargassum* interspersed with *Padina*, and other brown, red and green algae around the perimeter of Cockatoo Island (Figure 3-2).

Non Benthic Primary Producer Habitats

Filter feeding invertebrates such as gorgonian soft coral sea whips, sponges and crinoids colonise some areas of the coral rubble (MScience, 2013).



Map Projection: Transverse Mercator
 Horizontal Datum: GDA 1994
 Grid: GDA 1994 MGA Zone 51



Kimberley Technology
 Solutions Pty Ltd
 Cockatoo Island Multi-User Supply Base

Job Number	61-35178
Revision	0
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Site Location

Figure 3-1

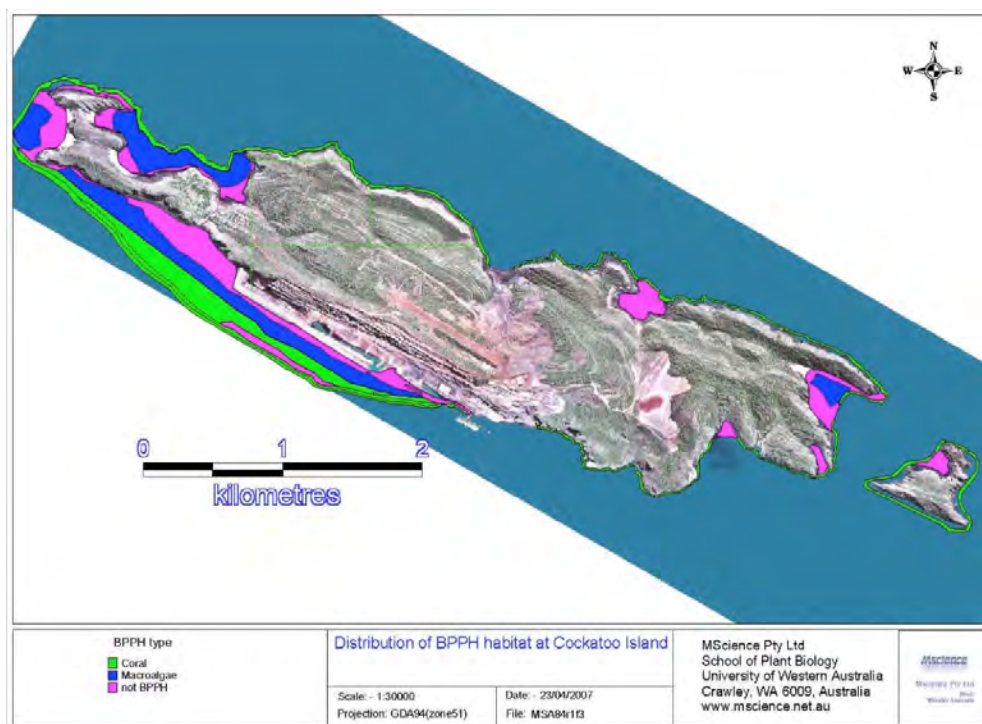


Figure 3-2 BPPH mapping of Cockatoo Island in 2007 (MScience, 2007)

3.1.3 Marine Water Quality

The large tidal regime has a large effect on the turbidity of in the region. Currents entrain and transport large amounts of suspended sediment (MScience, 2011) that in turn generates considerable turbidity (Wilson, 2014).

3.1.4 Marine Fauna

A search was undertaken with the online Protected Matters Search Tool (PMST), DPaW NatureMap records and Threatened and Priority Fauna Rankings for the Kimberley for marine waters within approximately 5 km of the proposed wharf development. This search area was used to identify the potential presence of any conservation significant marine fauna species proclaimed as Matters of National Environmental Significance (MNES) under the EPBC Act (the Protected Matters Report is provided in Appendix A) or as Specially Protected Fauna under the *Wildlife Conservation Act 1950*.

Marine Mammals

Nine species of protected or listed marine mammals may occur within or adjacent to the search area, of which one species of marine mammal is listed as Threatened (Table 3-1).

Humpback Whale

Humpback Whales occur throughout Australian waters with their distribution influenced by their migratory pathways and aggregation areas for resting, breeding and calving. Humpbacks arrive in the coastal waters of the Kimberley after summer to breed and calve before returning to the Antarctic after the winter season has passed. As shown in Figure 3-3, Humpback Whales are likely be in deeper waters of the Project area.

Table 3-1 Conservation significant marine mammals

Common name	Scientific name	EPBC listing			DPaW	Presence
		Listed threatened	Listed migratory	Other matters	Schedule /Ranking	
Whales						
Humpback Whale	<i>Megaptera novaeangliae</i>	VU	✓	✓	CD (D1)	B
Bryde's Whale	<i>Balaenoptera edeni</i>		✓	✓		M
Dolphins						
Common Dolphin, Short-beaked Common Dolphin	<i>Delphinus delphis</i>			✓		M
Irrawaddy Dolphin/Australian Snubfin	<i>Orcaella brevirostris</i>		✓	✓	P4	M
Indo-Pacific Humpback Dolphin	<i>Sousa chinensis</i>		✓	✓		B
Spotted Dolphin, Pantropical Spotted Dolphin	<i>Stenella attenuata</i>			✓		M
Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin (Arafura/Timor Sea populations)	<i>Tursiops aduncus</i>		✓	✓		L
Bottlenose Dolphin	<i>Tursiops truncatus s. str.</i>			✓		M
Sirrenians						
Dugong	<i>Dugong dugon</i>		✓	✓	SP	L

Note: 'B': Breeding known to occur within area.
 'L': Species or species habitat likely to occur within area.
 'M': Species or species habitat may occur within area.

'CD': Conservation dependant.
 'VU': Vulnerable.
 'SP': Specially protected.
 P1-P4: Priority 1 – 4.

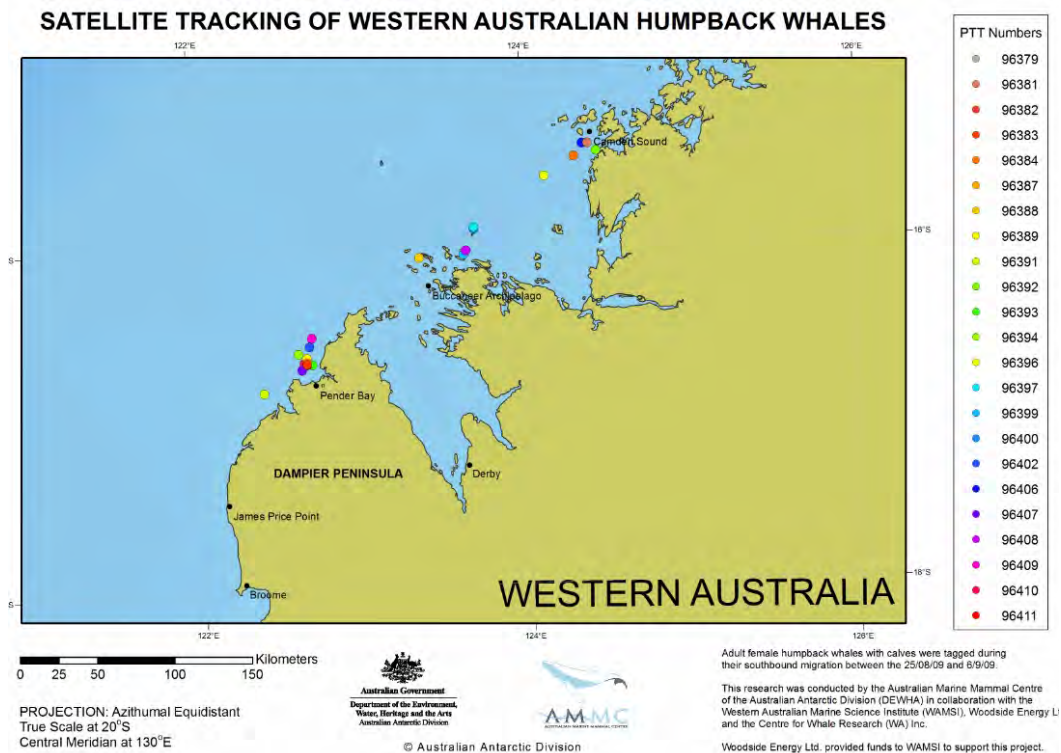


Figure 3-3 Satellite tracking of Humpback Whales in 2009 (Double et al., 2010)

Bryde's Whale

Byrde's Whales are the second smallest of the baleen whales. They inhabit tropical and warm temperate waters and generally travel alone or in pairs. This species appears to be limited to the 200 m depth contour, moving along the coast in response to the availability of suitable prey, while the offshore form is found in deeper waters (500 to 1,000 m) (Best 1977). Because of its small population, lack of sightings and preference for deeper water, it is unlikely to be encountered in the Project area.

Dolphins

Six species of dolphin listed under the EPBC Act were identified as potentially occurring in the Project area, with two listed as Migratory and four as 'other matters'.

Common Dolphins are recorded in all Australian waters and are not thought to be migratory. They are associated with high topographical relief of the ocean floor, drop-offs and upwelling areas; however, there are no known key areas for this species in Australia.

Redescription and genetic research has shown the Irrawaddy Dolphin to be renamed the Australian Snubfin Dolphin. This dolphin is primarily found in nearshore habitats, but has been recorded up to 23 km offshore. Beagle Bay and Pender Bay are important areas for the Australian Snubfin Dolphin (Department of the Environment and Energy, 2016a).

The Indo-Pacific Humpback Dolphin is primarily found in nearshore habitats, such as those associated with the Buccaneer Archipelago (Department of the Environment and Energy, 2016a). Indo-Pacific Humpback Dolphins typically occur in open waters around coasts and islands, generally in less than 20 m water depth (Parra *et al.*, 2002).

Little is known about the distribution of the Spotted Dolphin in the Kimberley region, although they have been recorded at the shelf edge and shelf slope area of the Browse Basin in large, high energy, mixed schools in association with tuna, seabirds and other pelagic cetaceans. Small groups of *Stenella* species have also been observed resting in nearshore areas of coast on the lee side of bays (Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC), 2012a).

The Bottlenose Dolphin is a cosmopolitan species found in all Australian waters in coastal, estuarine and pelagic settings. Bottlenose Dolphins have been observed during surveys by Jenner and Jenner (2009) between Cape Leveque (north of Broome) and Scott Reef in June, July, October and November 2008. The Spotted Bottlenose Dolphin is widely distributed in Indo-Pacific coastal waters, however there is limited information on the distribution and population of the Arafura/Timor sea population.

Due to shallow water preferences, the Irrawaddy/Australian Snubfin, the Indo-Pacific Humpback and the Bottlenose Dolphins are likely to be present all year round in the Project area. Due to its depth preferences, the Spotted Dolphin is unlikely to occur in the Project area.

Dugong

North-western Australia is thought to have one of the largest populations of Dugongs in the world and are largely sighted feeding in wide and shallow seagrass beds but also in estuarine streams (DSEWPaC, 2012b). Regional sightings pooled from 1996 to 2008 show some sightings around Cockatoo and Irvine Islands but notably less than that around the Dampier Peninsula, Derby and around the Walcott Inlet (Holley and Prince, 2011). Due to the Dugong's presence being largely correlated with seagrass beds, it is unlikely to be found within the Project area but is likely to be found in the wider coastal area.

Fish

Thirty-three species of protected or listed fish may occur within or adjacent to the Project area, of which five species are listed as Threatened (Table 3-2).

Table 3-2 Conservation significant fish

Common Name	Scientific Name	EPBC Listing			DPaW	Presence
		Listed Threatened	Listed migratory	Other matters	Schedule /Ranking	
Whale Shark	<i>Rhincodon typus</i>	VU	✓		SP	M
Great White Shark	<i>Carcharodon carcharias</i>		✓		VU	M
Green Sawfish	<i>Pristis zijsron</i>	VU	✓		VU	K
Largetooth Sawfish	<i>Pristis pristis</i>	VU	✓		P1	K
Dwarf Sawfish	<i>Pristis clavata</i>	VU	✓		P3	K
Reef Manta Ray	<i>Manta alfredi</i>		✓			K
Giant Manta Ray	<i>Manta birostris</i>		✓			M
Killer Whale, Orca	<i>Orcinus orca</i>		✓			M
Northern River Shark, New Guinea River Shark	<i>Glyphis garricki</i>	EN			P1	M
25 other species of pipefish and sea dragon				✓		M

Note: 'K': Species or species habitat known to occur within area.
'M': Species or species habitat may occur within area.

CD': Conservation dependant.
'VU': Vulnerable.
'SP': Specially protected.
P1-P4: Priority 1 – 4.

Whale Shark

Whale Sharks have a broad distribution in tropical and warm temperate seas, and feed on phytoplankton, macroalgae, zooplankton, krill and small nektonic life, such as small squid or vertebrates. The Whale Shark undertakes a well-known annual migration between March and June to aggregate in the Ningaloo Marine Park. This seasonal aggregation is believed to be linked to localised seasonal peaks of coral spawning that occurs around March/April each year (Woodside, 2011). Following this period, observers have recorded Whale Sharks migrating northwest to the Indian Ocean, or directly north to Sumatra and Java, or northeast passing within the region of Scott Reef and the Browse Basin and travelling along the 200 m contour (Figure 3-4), (Woodside, 2011). Due to the preference for deeper waters, the Whale Shark is unlikely to be found in the Project area.

Great White Shark

In Australian waters, Great White Sharks are widely but not evenly distributed, and sightings are considered uncommon to rare compared to most other large sharks (CITES, 2004). Great White Sharks can be found in areas close to inshore around rocky reefs, surf beaches and shallow coastal bays, and also in outer continental shelf and slope areas (Pogonoski *et al.*, 2002). It is unlikely that they would be present in the Project area.

Largetooth Sawfish

This species has been recorded in riverine and marine environments across northern Australia and is known to have occurred within most of the subtropical areas between Cape Keraudren in Western Australia and Princess Charlotte Bay in Queensland. It is known to occur up to 100 km offshore. The generally accepted model of movement and migration of Largetooth Sawfish in Australian waters is that young are born at the mouths of rivers and in estuaries and then migrate up river where they spend the first several years of life (Thorburn *et al.* 2004). As they reach maturity, they move out of the rivers and into the marine environment. Given this species known distribution, it is possible that they can occur in the Project area.

Green Sawfish

The Department of the Environment (2015) reports that Green Sawfish are distributed from the Whitsundays to Shark Bay. Individuals have been recorded from inshore coastal environments and estuaries to offshore deep waters (Stevens *et al.*, 2005). Given this species known distribution, it is possible that they can occur in the Project area.

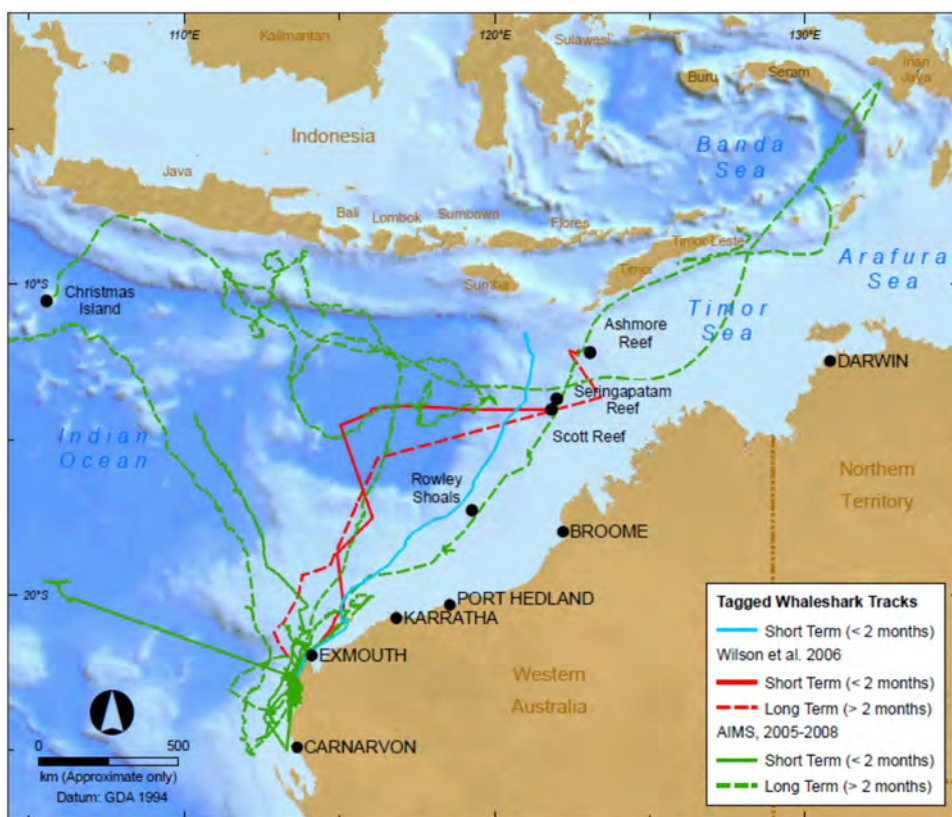


Figure 3-4 Satellite tracking of Whale Sharks from 2002 to 2008 (Woodside, 2011)

Dwarf Sawfish

The distribution of Dwarf Sawfish is considered to be restricted to northern Australia, ranging from northern Queensland to the Pilbara coastline. Sawfish generally inhabit shallow coastal waters and estuaries, which are utilised as nurseries for juveniles. Surveys have found most captures of Dwarf Sawfish occur over soft sediment environments (Department of the Environment, 2015). Given this species known distribution, it is possible that they could occur in the Project area.

Manta Rays

Manta Rays commonly occur throughout the majority of Australian coastlines. The Reef and Giant Manta Ray may be found in the Project area.

Killer Whales

Killer Whales are thought to be the most cosmopolitan of all cetaceans in Australasian waters and have been sighted along the Kimberley coast (Kimberley Society, 2010). Although not common, the Killer Whale may occur in the Project area.

Northern River Shark

The Department of the Environment (2015) reports that the Northern River Sharks utilise rivers, tidal sections of large tropical estuarine systems and macrotidal embayments, as well as inshore and offshore marine habitats. Given this species known distribution, it is possible that they could occur in the Project area.

Seahorses, Seadragons and Pipefish

Twenty-five species of Syngnathids have been identified that could occur in the Project area. Although uncommon, these species are expected to occur in shallow coastal areas. However as preferred habitat (seagrass) is likely to be sparse in the area, the occurrence of Syngnathids in the Project area is unlikely.

Marine Reptiles

Sixteen species of protected or listed marine reptiles potentially occur in the Project area, of which five species of marine reptiles are listed as Threatened (Table 3-3). Conservation significant marine reptiles are described below.

Table 3-3 Conservation significant marine reptiles

Common Name	Scientific Name	EPBC Listing			DPaW	Presence
		Listed Threatened	Listed Migratory	Other matters	Schedule/Ranking	
Turtles						
Loggerhead Turtle	<i>Caretta caretta</i>	✓	✓	✓	EN (D3)	K
Green Turtle	<i>Chelonia mydas</i>	✓	✓	✓	VU (D3)	C
Leatherback Turtle	<i>Dermochelys coriacea</i>	✓	✓	✓	VU (D3)	L
Flatback Turtle	<i>Natator depressus</i>	✓	✓	✓	VU (D3)	C
Hawksbill Turtle	<i>Eretmochelys imbricata</i>	✓	✓	✓	VU (D3)	L
Crocodiles						
Saltwater Crocodile	<i>Crocodylus porosus</i>		✓	✓	SP (D3)	L
Freshwater Crocodile	<i>Crocodylus johnstoni</i>			✓	SP (S3)	M
Sea snakes						
9 species of sea snake				✓		M

Note: 'C': Congregation or aggregation known to occur within area.

'K': Species or species habitat known to occur within area.

'L': Species or species habitat likely to occur within area.

'M': Species or species habitat may occur within area.

'EN': Endangered.

'VU': Vulnerable.

'SP': Specially protected.

Loggerhead Turtle

Loggerhead Turtles are globally distributed, occurring within coral, rocky reef, seagrass and muddy bay habitats throughout eastern, northern and western Australia (Department of the Environment and Energy, 2016b). Nesting is concentrated in southern Queensland and from Shark Bay to the North West Cape (Ningaloo) in WA, although foraging areas are more widely distributed. There has also been one reported nesting at Ashmore Reef (Guinea, 1995). Given the absence of important areas for feeding and nesting, it is unlikely that Loggerhead Turtles will be present in the Project area.

Green Turtle

Green Turtles are the most widespread and abundant turtle species in Western Australia waters, nesting from the Ningaloo coast to the Kimberley islands (Prince, 1994). There are two known migration pathways for Green Turtles from Scott Reef and Browse Island to the Australian mainland coast – either travelling north-east to the Bonaparte Archipelago and then following the coast to the Northern Territory; or travelling south to Cape Leveque and along the coast to the Pilbara (Figure 3-5) (Guinea, 2010). Satellite tracking has shown that Green Turtles nesting on Browse Island and Sandy Island (Scott Reef) feed between 200 km and 1000 km from their nesting beaches (Pendoley, 2005). In surveys by RPS (2010) from 2009-2010 in the Dampier Peninsula and Lacepede Islands, the majority of Green Turtles migrated north-east along the Kimberley coast in the post-nesting migration period (from approximately April). Given the known migration route and use of shallow benthic habitats for foraging, it is likely that Green Turtles could occur in the Project area.

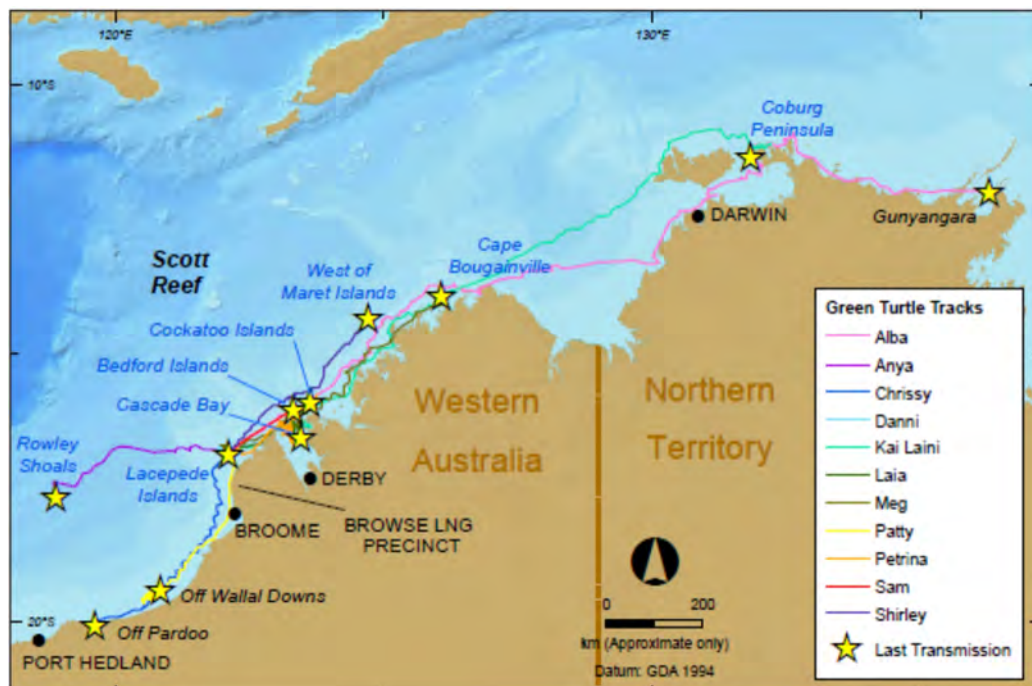


Figure 3-5 Post-nesting migration pathways of Green Turtles tagged at Lacepede Islands (2009-2010) (Woodside, 2011)

Leatherback Turtle

Leatherback Turtles are pelagic feeders, found in tropical, subtropical and temperate waters throughout the world. This species regularly forages over Australian continental shelf waters and has been reported in south-western WA waters (Department of the Environment and Energy, 2016b). There are no major nesting areas recorded in Australia, although there are scattered records in the NT, Queensland and NSW (Department of the Environment and Energy, 2016b). Given the absence of important areas for feeding and nesting, it is highly unlikely that Leatherback Turtles occur in the Project area.

Flatback Turtle

The Flatback Turtle is one of the two turtle species without a global distribution, found only in tropical waters of northern Australia, Papua New Guinea and Irian Jaya, with nesting confined to Australia (Limpus, 2007). The Kimberley region is an important nesting area, with significant nesting occurring on the Lacepede Islands. Studies of Flatback Turtles during the 2009-2010 nesting season on the Lacepede Islands tracked several individuals via satellite tags during the inter-nesting and post-nesting periods (RPS, 2010). Individuals were found to remain within 50 km of the islands during the inter-nesting period. During post-nesting migration, turtles stayed in shallow depths, travelling from 17 km to up to 1,005 km, mainly staying within WA waters, such as Adele Island, Lacepede Island and the Maret Islands (north-east of Derby) (Figure 3-6). Migration pathways of Flatback Turtles nesting in rookeries further south, such as Port Hedland, generally pass the Dampier Peninsula to probable foraging grounds in the Kimberley region (RPS, 2010). Given the known migration route and use of shallow benthic habitats for foraging, it is likely that Flatback Turtles could occur in the Project area.

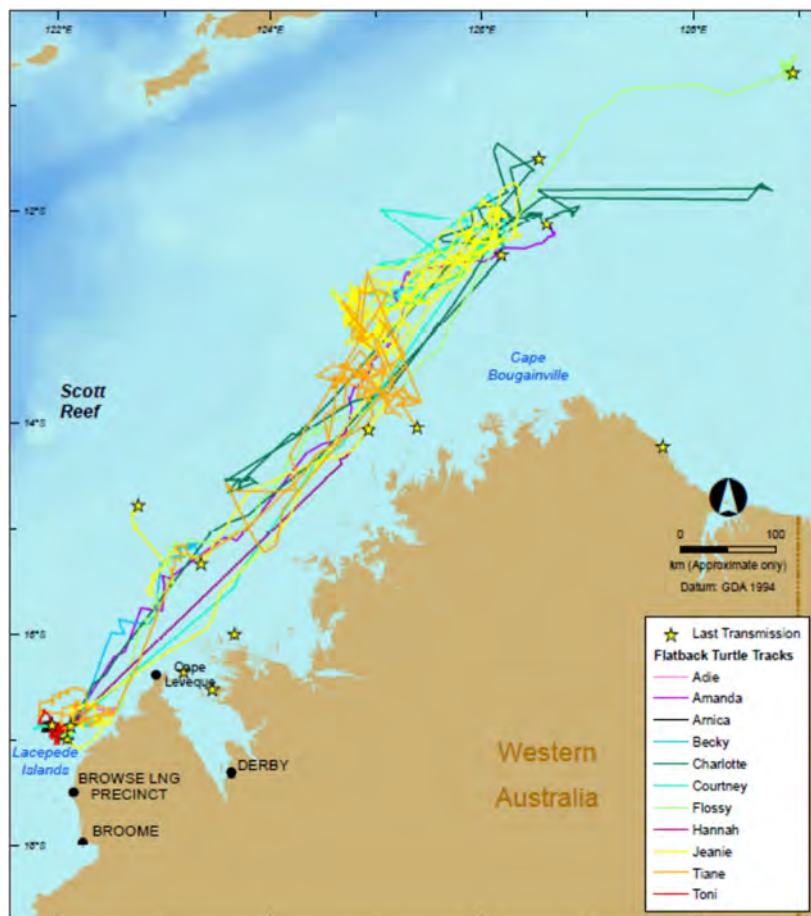


Figure 3-6 Post-nesting migration pathways of Flatback Turtles tagged at Lacepede Islands (2009-2010) (Woodside, 2011)

Hawksbill Turtle

The species has a global distribution throughout tropical, sub-tropical and temperate waters, with nesting largely concentrated on sub-tropical beaches (Marquez, 1990). Adults tend to forage in tropical tidal and sub-tidal coral and rock reef habitats where they primarily feed on sponges and algae (Department of the Environment and Energy, 2017). Key nesting and inter-nesting areas include the Dampier Archipelago, Barrow Island, Lowendal and Thevenard Islands, with areas of Ashmore Reef, Cartier Island and Sandy Island. Given this turtle's regional presence and use of reefs for foraging, it is likely that the Hawksbill Turtle could occur in the Project area.

Crocodiles

Saltwater and Freshwater Crocodiles are known to inhabit marine, coastal and riverine habitats from Port Hedland to Townsville (Department of Conservation and Land Management, 2004). Anecdotal observations from Cockatoo Island confirm that Saltwater Crocodiles occur infrequently near the Project area. Due to the lack of freshwater habitats in the Project area, the Freshwater Crocodile is unlikely to occur.

3.2 Field Survey

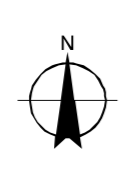
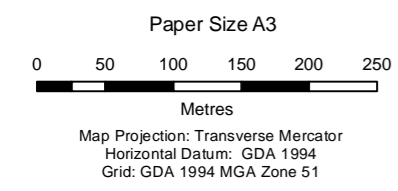
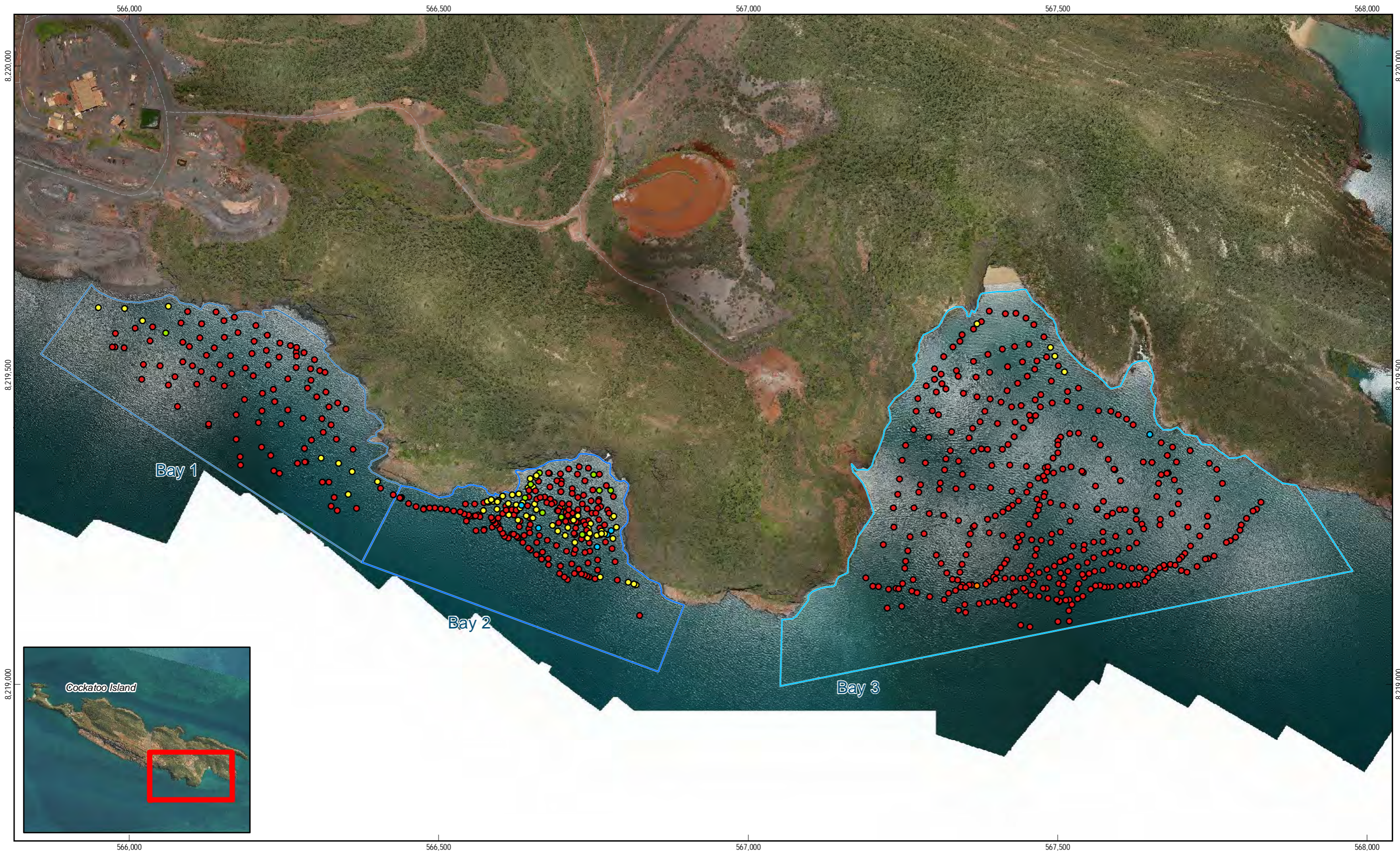
Seven hundred and twenty-three sites were surveyed across the three bays. The location and distribution of these sites are shown in Figure 3-7. Opportunistic surveys of the ship loader piles were also undertaken to characterise marine life colonisation of these metal structures.

3.2.1 Marine Substrate

The dominant substrate across the three bays was sand with fewer sites comprised of silt, gravel/pebbles, coral rubble and rocks. All three bays had similar substrate patterns with rocky habitats around the shoreline and sandy bottoms in the centre, though Bay 2 had a considerable greater proportion of rocky substrate (21%) than the other two bays (1-8%). A breakdown of the seabed substrate and its spatial distribution is shown in Table 3-4. Examples of substrate observations are illustrated in Plate 3-1.

Table 3-4 Substrate percentages within each of the three bays

Bay	Silt	Sand	Gravel/Pebbles	Coral Rubble	Rocky
Bay 1 (proposed wharf site)	0%	91%	1%	0%	8%
Bay 2	0%	71%	5%	3%	21%
Bay 3 (Copper Bay)	<1%	98%	0%	<1%	1%



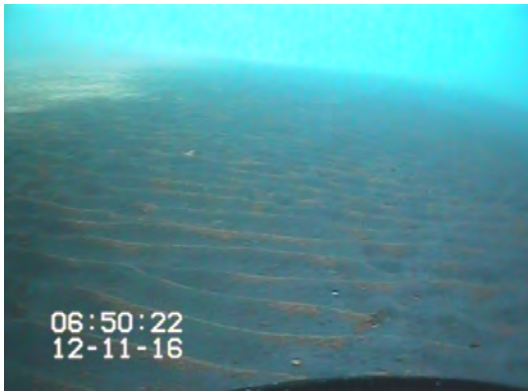
LEGEND
Substrate Type

● Pebbles	● Sand
● Coral rubble	● Silt
● Rocky	

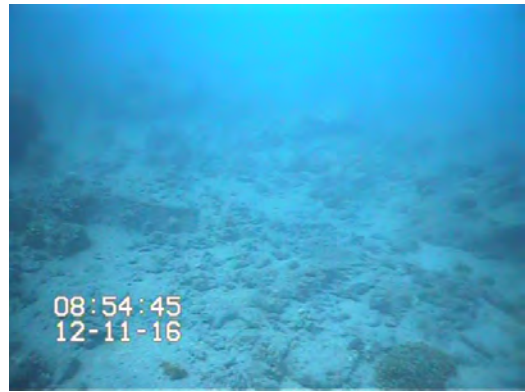


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Substrate Type Figure 3-7



a



b



c



d

Plate 3-1 Observations of dominant substrate types including a) sand, b) pebbles, c) coral rubble and d) rocky

3.2.2 Marine Habitats

Overview

All three bays had similar physical attributes with gently sloping sandy beaches from the shore to approximately 0 m LAT. Because of the large tidal range, much of this sandy area is likely to be exposed or very shallow at low spring tides. These areas were observed to be very sparsely colonised by hard coral and macroalgae (particularly *Chlorodesmis* spp “turtle weed”). Rocky environments were common in deeper waters around the headlands and were observed to be colonised only by turfing algae. As the depth increases, sandy habitats are more densely colonised by macroalgae and hard coral until approximately -5 m LAT. Thereafter, the slope profile steeply descends to -20 m LAT where generally only rippled sand was present with sparse hydroids and soft coral.

Bay 1 - Proposed Wharf Area

The survey area for Bay 1 was approximately 7.55 ha. Shallow (below 0 m LAT) sandy habitats extended from the shoreline for approximately 120 m and steeply descended thereafter to -20 m LAT. Of the 110 survey sites in this Bay, 67% were comprised of bare substrate (Table 3-5).

Macroalgae was observed at 21% of all sites with the majority comprised of very sparse to sparse coverage, and limited to shallower than -15 m LAT (Figure 3-8). While fine grain identification of algae was not possible through video analysis, macroalgae included *Caulerpa* spp. and *Chlorodesmis* spp.

Hard coral occurred at 15% of sites primarily at the south-eastern edge of the bay (Figure 3-9). Hard coral coverage was moderate to dense. Several sites outside of this south-eastern edge of the bay had very sparse hard coral cover. Most sites with hard corals were shallower than -5 to -10 m LAT. While fine grain identification of hard corals was not possible through video analysis, corals included:

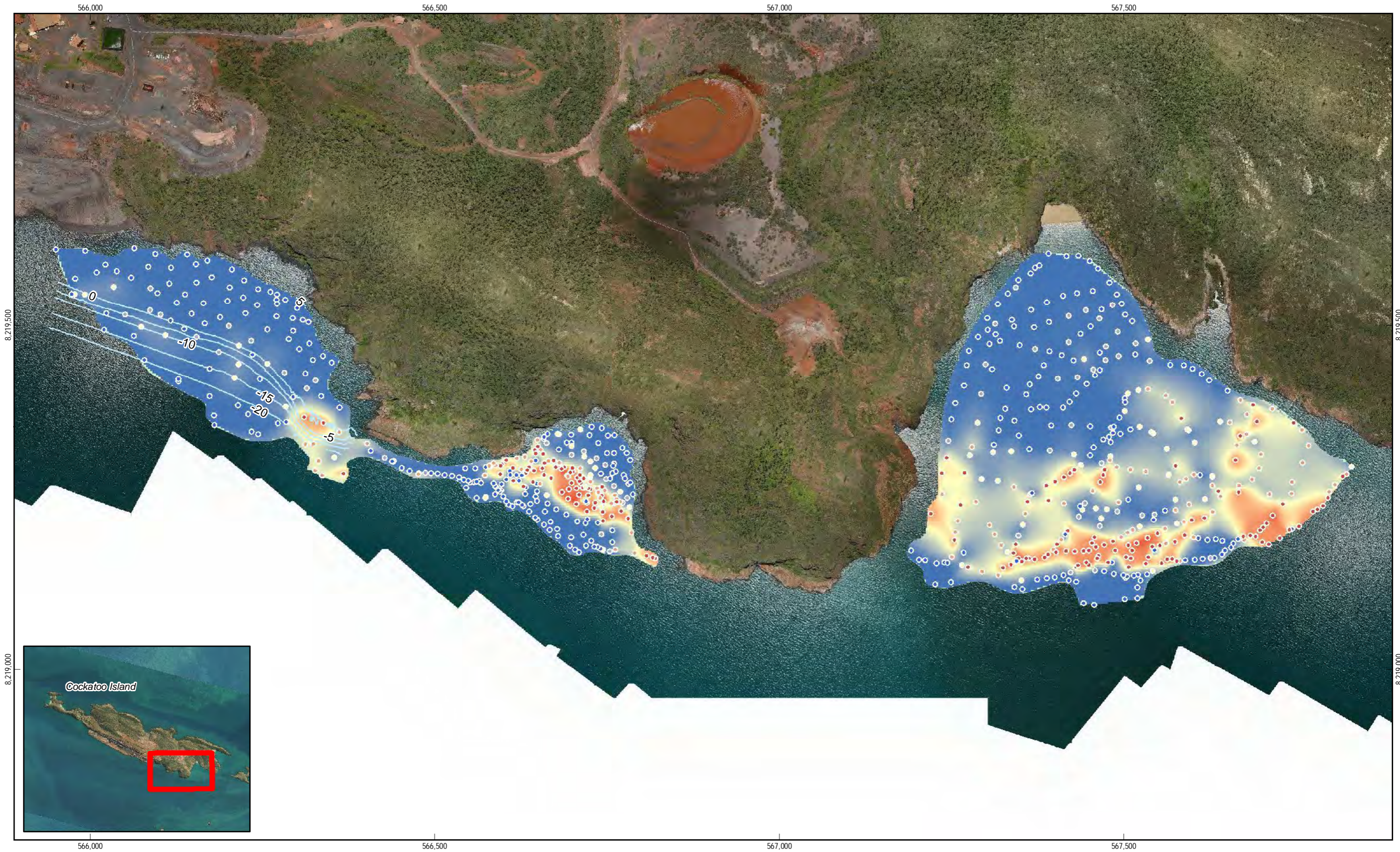
- Foliose forms of *Turbinaria*;
- Massive and sub-massive forms of *Porites*;
- Branching *Acropora*; and
- Other corals from the families Acroporidae, Faviidae and Pocilloporidae.

Soft coral and hydroids were observed at less than 10% of sites (Table 3-5). Video stills of sites at key areas throughout Bay 1 are shown in Figure 3-10.

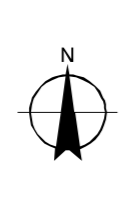
Table 3-5 Marine habitat types within Bay 1

Marine Habitat Types	Observations %	Marine Habitat	Observations %
Bare	67	Soft Coral	6
Macroalgae	21		
Dense	0	Dense	0
Moderate	4	Moderate	0
Sparse	65	Sparse	89
Very Sparse	30	Very Sparse	0
Hard Coral	15	Hydroids	8
Dense	13	Dense	0
Moderate	13	Moderate	11
Sparse	19	Sparse	89
Very Sparse	56	Very Sparse	0

Note: Multiple marine habitat types were observed at some sites and therefore the cumulative percentages are >100%.



Paper Size A3
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 Metres
 Map Projection: Transverse Mercator
 Horizontal Datum: GDA 1994
 Grid: GDA 1994 MGA Zone 51



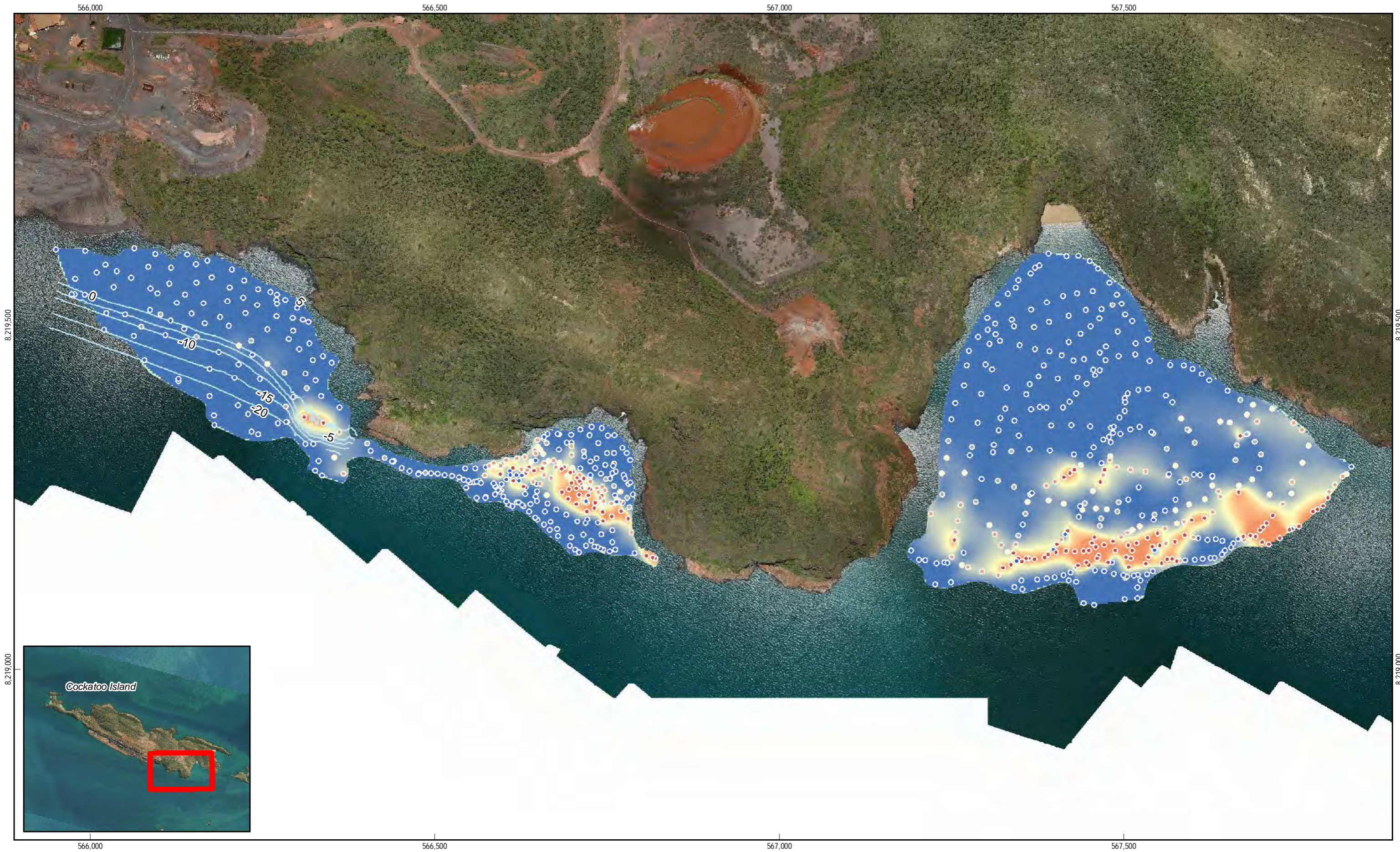
LEGEND
BCH Sampling Points
 BCH Cover (%)
 • 0
 • 0 - 5
 • 5 - 25
 • 25 - 50
 • 50 - 100
 — Bathymetry Contours (m LAT)

BCH Cover Interpolated
 %
 High : 100
 Low : 0

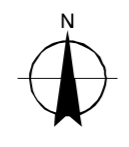


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Benthic Communities and Habitats Figure 3-8



Paper Size A3
 0 40 80 120 160 200
 Metres
 Map Projection: Transverse Mercator
 Horizontal Datum: GDA 1994
 Grid: GDA 1994 MGA Zone 51



LEGEND
Benthic Habitat Sampling Points
 Hard Coral Cover (%)

- 0
- 0 - 5
- 5 - 25
- 25 - 50
- 50 - 100
- Bathymetry Contours (m LAT)

Coral Cover Interpolated
 %
 High : 100
 Low : 0

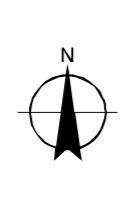
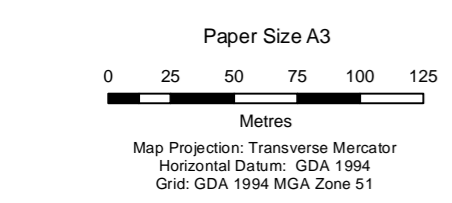
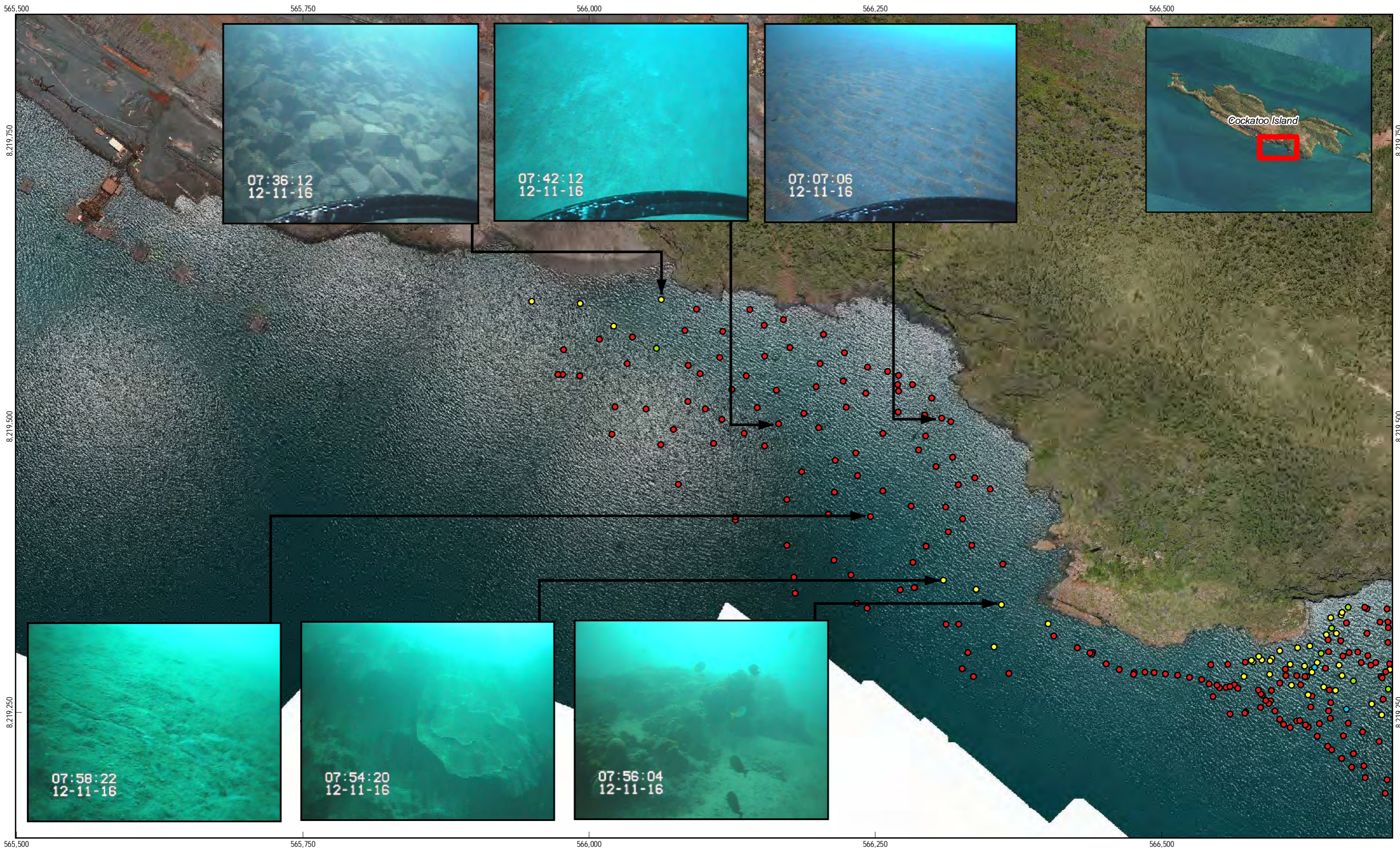


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Hard Coral Coverage

Figure 3-9



- LEGEND**
- Substrate Type**
- Rocky
 - Coral rubble
 - Pebbles
 - Sand
 - Silt



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Marine Habitat and Substrate Observations in Bay 1 **Figure 3-10**

Bay 2

The survey area for Bay 2 was approximately 3.47 ha. Shallow sandy habitats extended from the shoreline to approximately 360 m with a band of hard coral prior to the steep drop-off. Of the 235 sites in Bay 2, 47% had bare substrate (Table 3-6).

Macroalgae were observed at 30% of the Bay 2 sites. The majority of these sites had sparse coverage (Figure 3-8). While fine grain identification of macroalgae was not possible through video analysis, types included *Caulerpa* spp and *Chlorodesmis* spp.

Hard corals were observed at 43% of sites with the majority restricted to approximately a 50 m band width across the bay (Figure 3-9). Approximately 80% of all coral sites had moderate to dense coverage. While fine grain identification of hard corals was not possible through video analysis, corals included:

- Foliose forms of *Turbinaria*;
- Massive and sub-massive forms of *Porites*;
- *Fungia*;
- Branching *Acropora*; and
- Other corals from the families Acroporidae, Faviidae and Pocilloporidae.

Soft corals were observed at 1% of the Bay 2 sites (Table 3-6). Video stills of marine features of Bay 2 are shown in Plate 3-2.

Table 3-6 Marine habitat types within Bay 2

Marine Habitat Types	Observations %	Marine Habitat	Observations %
Bare	47	Soft Coral	1
Macroalgae	30		
Dense	3	Dense	0
Moderate	11	Moderate	0
Sparse	66	Sparse	50
Very Sparse	20	Very Sparse	50
Hard Coral	43	Hydroids	0
Dense	46	Dense	0
Moderate	32	Moderate	0
Sparse	14	Sparse	0
Very Sparse	9	Very Sparse	0

Note: Multiple marine habitat types were observed at some sites and therefore the total cumulative percentages are >100%.

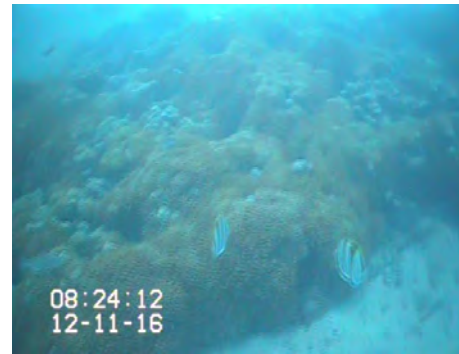
Bay 3 (Copper Bay)

The survey area for Bay 3 (Copper Bay) was approximately 19.64 ha. Shallow sandy habitats extend from the shoreline for approximately 400 m, then transition into a deeper band of hard coral before steeply descending down the drop-off. Of the 378 sites in Bay 3, 38% had bare substrate (Table 3-7).

Macroalgae were observed at 36% of the Bay 3 sites (Figure 3-8). The majority of these sites had sparse coverage. While fine grain identification of macroalgae was not possible through video analysis, types included *Caulerpa* spp and *Chlorodesmis* spp.



a



b



Plate 3-2 Observations of marine habitats at Bay 2 where a) and b) are areas of dense hard coral, and c) is of the steep drop-off with hard coral

Table 3-7 Marine habitat types within Bay 3 (Copper Bay)

Marine Habitat Type	Observations %	Marine Habitat	Observations %
Bare	38	Soft Coral	1
Macroalgae	36		
Dense	1	Dense	0
Moderate	22	Moderate	0
Sparse	47	Sparse	25
Very Sparse	31	Very Sparse	75
Hard Coral	49	Hydroids	<1
Dense	41	Dense	0
Moderate	22	Moderate	0
Sparse	21	Sparse	100
Very Sparse	15	Very Sparse	0

Note: Multiple marine habitat types were observed at some sites and therefore the total cumulative percentages are >100%.

Hard corals were observed at 49% of the bay's sites with the majority of corals restricted to approximately a 50 m wide band across the bay (Figure 3-9). Approximately 60% of all coral observations were moderate to dense coverage. While fine grain identification of hard corals was not possible through video analysis, corals included:

- Foliose forms of *Turbinaria*;
- Massive and sub-massive forms of *Porites*;
- *Fungia*;
- Branching *Acropora*; and
- Other corals from the families Acroporidae, Faviidae and Pocilloporidae.

Soft corals and hydroids were observed at less than 2% the bay's sites (Table 3-7). Video stills of marine features of Bay 3 are shown in Plate 3-3.

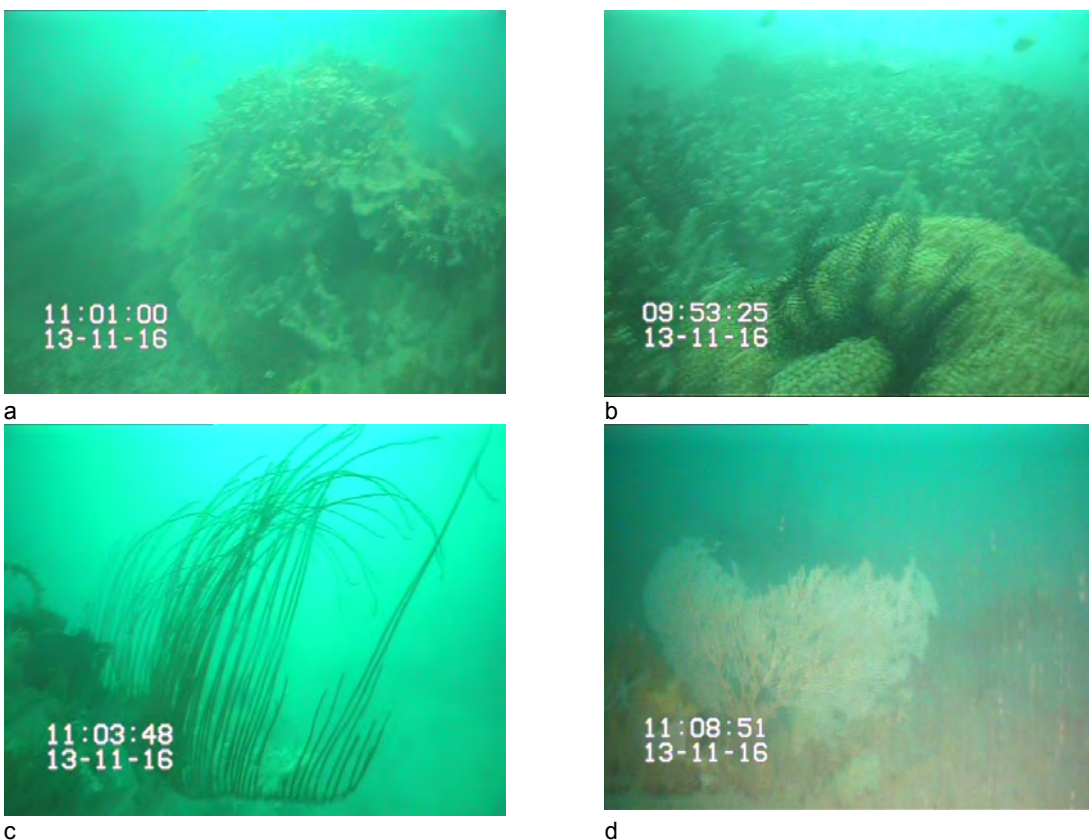


Plate 3-3 Observations of marine habitats at Bay 3 where a) and b) are areas of dense hard coral, and c) and d) are soft coral Gorgonians

3.2.3 Pile Survey

An opportunistic survey was undertaken to assess the marine environment near to and on the piles of the ship loader. Images of the ship loader pile environment are illustrated in Plate 3-4. At the seafloor, sparse soft corals, macroalgae and hydroids were noted. Deeper sections of the piles were colonised by hydroids and macroalgae, and shallower (and likely intertidal) portions were heavily encrusted by bivalves.

Shallow



Moderate Depth



Deep



Plate 3-4 Observations of the marine environment at the base of the ship loader piles and growth on the piles

4. Discussion

4.1 Marine Fauna

There is the potential for threatened and listed marine fauna to occur near to the proposed wharf development that may be impacted during construction and operation of the facility. Preparation of construction and operation management plans with appropriate controls and mitigation measures will reduce potential impacts and risks to marine fauna to acceptable levels.

4.2 Benthic Communities and Habitats

The focus of the field survey was to characterise the BCH in the bay proposed for wharf development (Bay 1) and the two adjacent bays to the southeast (Bay 2 and Bay 3).

The survey identified that the estimated percentage of bare substrate in Bay 1 (67.3%) is substantially higher than in Bay 2 (47.2%) and Bay 3 (37.6%), likely due to Bay 1 having been impacted by nearby mining-related activities to the northwest (Table 4-1, which summarises the percentage of each habitat category in Table 3-5, Table 3-6 and Table 3-7 accounting for sites with multiple habitat types).

Soft coral and hydroids are relatively minor contributors to the benthic community assemblage, although they represent a greater proportion of Bay 1 than the other two bays (Table 4-1).

Table 4-1 Summary of field survey marine habitat observations

Habitat Category	Bay 1 Observations	Bay 2 Observations	Bay 3 Observations
Bare	67.3%	47.2%	37.6%
Algae	10.9%	9.4%	13.8%
Hard Coral	9.1%	23.0%	27.0%
Hard Coral & Algae	3.6%	19.1%	20.6%
Hard Coral & Hydroids	0.9%	0.0%	0.0%
Hard Coral, Soft Coral & Algae	0.9%	0.4%	0.5%
Hard Coral, Sponges & Algae	0.0%	0.4%	0.0%
Hydroids	1.8%	0.0%	0.0%
Soft Coral & Algae	0.0%	0.4%	0.3%
Soft Coral, Algae & Hydroids	5.5%	0.0%	0.3%

The habitat density observations (e.g. sparse, dense) for hard coral and macroalgae were used to estimate total coverage areas within each bay and over the entire survey area on the basis of the values in Table 2-1, which demonstrates that (Table 4-2):

- The estimated hard coral area in Bay 1 of 0.2 ha is approximately 3% of this bay's surveyed area. The total estimated hard coral area of the three bays is 4.92 ha. The hard coral area in Bay 1 (0.2 ha) comprises only 4% of the total hard coral area across the three bays. Presumably, the lower percentage of hard coral area in Bay 1 is because of its proximity to past mining-related activities (and associated impacts). Construction and operation of the wharf facility will pose elevated environmental risks and impacts to only ~4% of the existing hard coral cover across the three bays (i.e. those in Bay 1); and

- The estimated macroalgal area in Bay 1 is 0.19 ha, representing 3% of this bay's surveyed area. This is a similar proportion to Bay 2 (5%) and Bay 3 (6%). Furthermore, the estimated macroalgae area in Bay 1 comprises 13% of the total macroalgae area across the three bays. A relatively small proportion (13%) of the total macroalgae area across the three bays will be at risk of impact by construction and operational activities of the wharf facility.

Table 4-2 Summary of Hard Coral and Macroalgae coverage areas

Parameter	Bay 1	Bay 2	Bay 3	Total
Total Surveyed Area (ha)	7.55	3.47	19.64	30.66
Hard Coral Area Calculations				
Calculated Hard Coral Coverage (ha)	0.20	0.72	4.00	4.92
% Hard Coral Cover	3%	21%	20%	16%
Macroalgae Area Calculations				
Calculated Algae Coverage (ha)	0.19	0.16	1.15	1.5
% Algae Cover	3%	5%	6%	5%

4.3 Wharf Colonisation

On the basis of the benthic communities on the existing ship loader piles, it is anticipated that a similar community assemblage will colonise the proposed wharf infrastructure. Further, colonisation of the wharf structure by hard corals may occur, particularly along the eastern portion of Bay 1 where some hard corals currently occur.

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Appendices

Appendix A – EPBC Act Protected Matters Report



EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about [Environment Assessments](#) and the EPBC Act including significance guidelines, forms and application process details.

Report created: 01/12/16 11:45:40

[Summary](#)

[Details](#)

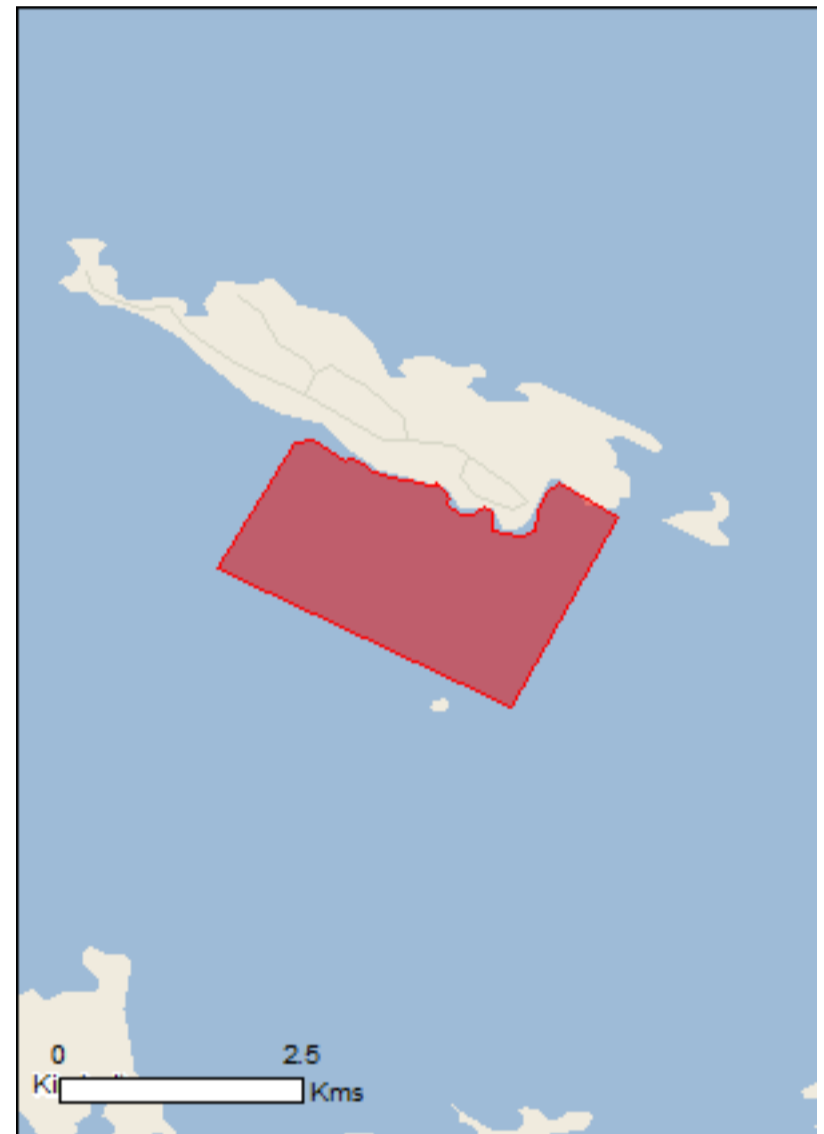
[Matters of NES](#)

[Other Matters Protected by the EPBC Act](#)

[Extra Information](#)

[Caveat](#)

[Acknowledgements](#)



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Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the [Administrative Guidelines on Significance](#).

World Heritage Properties:	None
National Heritage Places:	1
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	15
Listed Migratory Species:	32

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at <http://www.environment.gov.au/heritage>

A [permit](#) may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	62
Whales and Other Cetaceans:	11
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Commonwealth Reserves Marine:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	1
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

National Heritage Properties		[Resource Information]
Name	State	Status
Natural		
The West Kimberley	WA	Listed place

Listed Threatened Species		[Resource Information]
Name	Status	Type of Presence

Birds

Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
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Erythrotriorchis radiatus Red Goshawk [942]	Vulnerable	Species or species habitat may occur within area
--	------------	--

Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
---	-----------------------	--

Mammals

Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding known to occur within area
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Saccolaimus saccolaimus nudicluniatus Bare-rumped Sheath-tailed Bat, Bare-rumped Sheath-tail Bat [66889]	Critically Endangered	Species or species habitat may occur within area
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Reptiles

Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
---	------------	---

Chelonia mydas Green Turtle [1765]	Vulnerable	Congregation or aggregation known to occur within area
---	------------	--

Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
--	------------	--

Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat likely to occur within area
---	------------	--

Natator depressus Flatback Turtle [59257]	Vulnerable	Congregation or aggregation known to occur within area
--	------------	--

Sharks

Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area
--	------------	--

Name	Status	Type of Presence
Glyphis garricki Northern River Shark, New Guinea River Shark [82454]	Endangered	Species or species habitat may occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area

Listed Migratory Species

[[Resource Information](#)]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Foraging, feeding or related behaviour known to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Foraging, feeding or related behaviour likely to occur within area
Sula sula Red-footed Booby [1023]		Breeding known to occur within area
Migratory Marine Species		
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Congregation or aggregation known to occur within area
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
Dugong dugon Dugong [28]		Species or species habitat likely to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat likely to occur within area
Manta alfredi Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray [84994]		Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Manta birostris Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Congregation or aggregation known to occur within area
Orcaella brevirostris Irrawaddy Dolphin [45]		Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Breeding known to occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Cecropis daurica Red-rumped Swallow [80610]		Species or species habitat may occur within area
Cuculus optatus Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat may occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Migratory Wetlands Species		
Acrocephalus orientalis Oriental Reed-Warbler [59570]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area

Name	Threatened	Type of Presence
Pandion haliaetus Osprey [952]		Breeding known to occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [\[Resource Information \]](#)

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		

Acrocephalus orientalis Oriental Reed-Warbler [59570]		Species or species habitat may occur within area
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Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
---	--	--

Ardea alba Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
--	--	--

Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
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Cuculus saturatus Oriental Cuckoo, Himalayan Cuckoo [710]		Species or species habitat may occur within area
--	--	--

Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Foraging, feeding or related behaviour known to occur within area
---	--	---

Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Foraging, feeding or related behaviour likely to occur within area
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Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
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Hirundo daurica Red-rumped Swallow [59480]		Species or species habitat may occur within area
---	--	--

Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area
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Name	Threatened	Type of Presence
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Sula sula Red-footed Booby [1023]		Breeding known to occur within area
Fish		
Campichthys tricarinatus Three-keel Pipefish [66192]		Species or species habitat may occur within area
Choeroichthys brachysoma Pacific Short-bodied Pipefish, Short-bodied Pipefish [66194]		Species or species habitat may occur within area
Choeroichthys suillus Pig-snouted Pipefish [66198]		Species or species habitat may occur within area
Corythoichthys amplexus Fijian Banded Pipefish, Brown-banded Pipefish [66199]		Species or species habitat may occur within area
Corythoichthys flavofasciatus Reticulate Pipefish, Yellow-banded Pipefish, Network Pipefish [66200]		Species or species habitat may occur within area
Cosmocampus banneri Roughridge Pipefish [66206]		Species or species habitat may occur within area
Doryrhamphus excisus Bluestripe Pipefish, Indian Blue-stripe Pipefish, Pacific Blue-stripe Pipefish [66211]		Species or species habitat may occur within area
Doryrhamphus janssi Cleaner Pipefish, Janss' Pipefish [66212]		Species or species habitat may occur within area
Halicampus brocki Brock's Pipefish [66219]		Species or species habitat may occur within area
Halicampus grayi Mud Pipefish, Gray's Pipefish [66221]		Species or species habitat may occur within area
Halicampus spirostris Spiny-snout Pipefish [66225]		Species or species habitat may occur within area
Haliichthys taeniophorus Ribboned Pipehorse, Ribboned Seadragon [66226]		Species or species habitat may occur within area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within area
Hippocampus histrix Spiny Seahorse, Thorny Seahorse [66236]		Species or species

Name	Threatened	Type of Presence
Hippocampus kuda Spotted Seahorse, Yellow Seahorse [66237]		habitat may occur within area Species or species habitat may occur within area
Hippocampus planifrons Flat-face Seahorse [66238]		Species or species habitat may occur within area
Hippocampus spinosissimus Hedgehog Seahorse [66239]		Species or species habitat may occur within area
Micrognathus micronotopterus Tidepool Pipefish [66255]		Species or species habitat may occur within area
Solegnathus hardwickii Pallid Pipehorse, Hardwick's Pipehorse [66272]		Species or species habitat may occur within area
Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area
Solenostomus cyanopterus Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area
Solenostomus paegnius Rough-snout Ghost Pipefish [68425]		Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
Trachyrhamphus bicoarctatus Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area
Trachyrhamphus longirostris Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish [66281]		Species or species habitat may occur within area
Mammals		
Dugong dugon Dugong [28]		Species or species habitat likely to occur within area
Reptiles		
Acalyptophis peronii Horned Seasnake [1114]		Species or species habitat may occur within area
Aipysurus duboisii Dubois' Seasnake [1116]		Species or species habitat may occur within area
Aipysurus eydouxii Spine-tailed Seasnake [1117]		Species or species habitat may occur within area
Aipysurus laevis Olive Seasnake [1120]		Species or species habitat may occur within area
Astrotia stokesii Stokes' Seasnake [1122]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Congregation or aggregation known to occur within area
Crocodylus johnstoni Freshwater Crocodile, Johnston's Crocodile, Johnston's River Crocodile [1773]		Species or species habitat may occur within area
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
Disteira kingii Spectacled Seasnake [1123]		Species or species habitat may occur within area
Disteira major Olive-headed Seasnake [1124]		Species or species habitat may occur within area
Emydocephalus annulatus Turtle-headed Seasnake [1125]		Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat likely to occur within area
Hydrelaps darwiniensis Black-ringed Seasnake [1100]		Species or species habitat may occur within area
Hydrophis elegans Elegant Seasnake [1104]		Species or species habitat may occur within area
Hydrophis mcdowelli null [25926]		Species or species habitat may occur within area
Hydrophis ornatus Spotted Seasnake, Ornate Reef Seasnake [1111]		Species or species habitat may occur within area
Lapemis hardwickii Spine-bellied Seasnake [1113]		Species or species habitat may occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Congregation or aggregation known to occur within area
Pelamis platurus Yellow-bellied Seasnake [1091]		Species or species habitat may occur within area

Whales and other Cetaceans

[[Resource Information](#)]

Name	Status	Type of Presence
Mammals		
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area

Name	Status	Type of Presence
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding known to occur within area
Orcaella brevirostris Irrawaddy Dolphin [45]		Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Breeding known to occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area

Extra Information

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resources Audit, 2001.

Name	Status	Type of Presence
Plants		
Jatropha gossypifolia Cotton-leaved Physic-Nut, Bellyache Bush, Cotton-leaf Physic Nut, Cotton-leaf Jatropha, Black Physic Nut [7507]		Species or species habitat likely to occur within area

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-16.102924 123.619059,-16.102759 123.618973,-16.102759 123.618973,-16.103666 123.620089,-16.104161 123.620261,-16.104738 123.620175,-16.105645 123.621377,-16.10548 123.622492,-16.104903 123.623522,-16.105233 123.624209,-16.106965 123.624381,-16.107294 123.625325,-16.107377 123.627041,-16.106965 123.628329,-16.105233 123.628501,-16.103584 123.629101,-16.102677 123.63056,-16.10581 123.635882,-16.122714 123.625926,-16.110304 123.598846,-16.099089 123.60597,-16.098883 123.607644,-16.100862 123.610777,-16.100491 123.610991,-16.100697 123.611291,-16.101151 123.612407,-16.101687 123.613223,-16.102058 123.614253,-16.102264 123.614982,-16.102264 123.615454,-16.10247 123.615755,-16.102429 123.616184,-16.102553 123.616656,-16.102759 123.616999,-16.102677 123.617686,-16.102883 123.618201,-16.102924 123.619059

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

- [-Office of Environment and Heritage, New South Wales](#)
- [-Department of Environment and Primary Industries, Victoria](#)
- [-Department of Primary Industries, Parks, Water and Environment, Tasmania](#)
- [-Department of Environment, Water and Natural Resources, South Australia](#)
- [-Department of Land and Resource Management, Northern Territory](#)
- [-Department of Environmental and Heritage Protection, Queensland](#)
- [-Department of Parks and Wildlife, Western Australia](#)
- [-Environment and Planning Directorate, ACT](#)
- [-Birdlife Australia](#)
- [-Australian Bird and Bat Banding Scheme](#)
- [-Australian National Wildlife Collection](#)
- [-Natural history museums of Australia](#)
- [-Museum Victoria](#)
- [-Australian Museum](#)
- [-South Australian Museum](#)
- [-Queensland Museum](#)
- [-Online Zoological Collections of Australian Museums](#)
- [-Queensland Herbarium](#)
- [-National Herbarium of NSW](#)
- [-Royal Botanic Gardens and National Herbarium of Victoria](#)
- [-Tasmanian Herbarium](#)
- [-State Herbarium of South Australia](#)
- [-Northern Territory Herbarium](#)
- [-Western Australian Herbarium](#)
- [-Australian National Herbarium, Canberra](#)
- [-University of New England](#)
- [-Ocean Biogeographic Information System](#)
- [-Australian Government, Department of Defence Forestry Corporation, NSW](#)
- [-Geoscience Australia](#)
- [-CSIRO](#)
- [-Australian Tropical Herbarium, Cairns](#)
- [-eBird Australia](#)
- [-Australian Government – Australian Antarctic Data Centre](#)
- [-Museum and Art Gallery of the Northern Territory](#)
- [-Australian Government National Environmental Science Program](#)
- [-Australian Institute of Marine Science](#)
- [-Reef Life Survey Australia](#)
- [-American Museum of Natural History](#)
- [-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania](#)
- [-Tasmanian Museum and Art Gallery, Hobart, Tasmania](#)
- [-Other groups and individuals](#)

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the [Contact Us](#) page.

Appendix B – Survey Data

ID	Substrate	Habitat1	Hab1Covera	Habitat2	Hab2Covera	Habitat3	Hab3Covera	Comment_	Easting	Northing	Bay
1	Sand								566269.808846	8219536.455328	1
2	Sand								566260.829261	8219547.732486	1
3	Sand								566270.407859	8219544.213685	1
4	Sand								566282.678914	8219536.293169	1
5	Sand								566299.551494	8219524.583020	1
6	Sand								566308.255736	8219507.071167	1
7	Sand								566316.202925	8219503.983064	1
8	Sand								566293.138666	8219509.799176	1
9	Sand								566270.397739	8219530.721475	1
10	Sand								566243.313144	8219551.678944	1
11	Sand								566223.244143	8219564.355585	1
12	Sand								566205.039796	8219580.105583	1
13	Sand								566169.878528	8219593.149930	1
14	Sand								566140.572750	8219602.105946	1
15	Sand								566153.212197	8219588.022741	1
16	Sand								566175.673544	8219568.897229	1
17	Sand								566201.778059	8219554.550548	1
18	Sand								566221.978853	8219539.465675	1
19	Sand								566241.929262	8219528.832267	1
20	Sand								566269.984310	8219512.357668	1
21	Sand								566294.123077	8219491.585955	1
22	Sand								566317.704316	8219472.702092	1
23	Sand								566337.059014	8219454.876257	1
24	Sand								566350.252426	8219444.904568	1
25	Sand								566322.708451	8219448.722613	1
26	Sand								566303.271723	8219464.762167	1
27	Sand								566288.009532	8219479.113234	1
28	Sand								566256.586967	8219493.601284	1
29	Sand								566224.692462	8219516.544094	1
30	Sand								566198.545514	8219534.567144	1
31	Sand								566153.616448	8219561.107278	1
32	Sand								566117.042587	8219582.751137	1
33	Sand								566094.191859	8219602.213453	1
34	Rocky								566063.346488	8219610.733264	1
35	Sand								566083.658140	8219583.813514	1
36	Sand								566114.213894	8219560.104282	1
37	Sand								566137.434475	8219543.931872	1
38	Sand								566163.866652	8219531.278653	1
39	Sand								566187.929045	8219511.141603	1
40	Sand	Algae	Very sparse						566200.701457	8219498.627048	1
41	Sand	Algae	Very sparse	Hard coral	Very sparse				566233.256123	8219476.511981	1
42	Sand								566311.669400	8219429.431932	1
43	Sand	Algae	Very sparse						566326.400145	8219419.160734	1
44	Sand								566361.338427	8219379.534238	1
45	Sand								566334.538234	8219395.968339	1
46	Sand	Hard coral	Very sparse						566313.887177	8219407.658577	1
47	Sand	Hard coral	Very sparse						566281.362364	8219430.153503	1
48	Sand	Hard coral	Sparse						566256.582395	8219443.332788	1
49	Sand								566234.794048	8219456.800004	1
50	Sand	Hard coral	Sparse						566215.045921	8219470.060118	1
51	Sand								566165.547122	8219502.012299	1
52	Sand								566146.909080	8219516.395454	1
53	Sand								566125.095543	8219532.180218	1
54	Sand								566096.982533	8219546.053330	1
55	Sand	Algae	Very sparse						566086.937046	8219553.177990	1
56	Pebbles								566058.943348	8219568.190100	1
57	Sand								566038.023938	8219577.880483	1
58	Rocky								566021.684904	8219587.424355	1
59	Rocky								565992.393311	8219607.156531	1
60	Sand								566009.266855	8219576.026871	1
61	Sand	Algae	Sparse						566033.511688	8219554.866213	1
62	Sand	Algae	Very sparse						566086.435774	8219521.456819	1
63	Sand	Hard coral	Very sparse						566101.844379	8219514.920854	1
64	Sand								566116.007228	8219505.999176	1
65	Sand								566135.698060	8219493.819786	1
66	Sand	Hard coral	Very sparse						566153.547121	8219482.624892	1
67	Sand	Algae	Very sparse						566186.017232	8219460.209612	1
68	Sand	Algae	Sparse						566214.483397	8219442.356498	1
69	Sand								566245.969451	8219421.122263	1
70	Sand								566294.360450	8219394.886859	1
71	Rocky	Hard coral	Dense						566309.832342	8219365.512719	1
72	Rocky	Hard coral	Dense						566338.110239	8219357.431605	1
73	Rocky	Hard coral	Moderate						566360.523885	8219343.920070	1
74	Rocky	Algae	Moderate	Hard coral	Very sparse				566401.081548	8219327.304366	1
75	Sand								566439.839397	8219301.960489	2
76	Sand								566439.110445	8219300.780912	2
77	Sand	Hard coral	Very sparse						566476.092027	8219284.599946	2
78	Sand								566697.193895	8219340.162525	2
79	Sand	Algae	Sparse				short algae maybe caulerpa		566679.493190	8219340.741458	2
80	Sand	Algae	Sparse						566710.307649	8219348.133823	2
81	Sand								566727.339567	8219351.539281	2
82	Sand								566760.092255	8219339.745745	2
83	Sand								566771.243297	8219321.063000	2
84	Sand								566782.759775	8219303.592244	2
85	Pebbles								566778.177284	8219313.574959	2
86	Pebbles								566750.596942	8219338.918905	2
87	Sand								566724.169761	8219339.500281	2
88	Sand								566736.475980	8219328.553911	2
89	Sand								566749.122088	8219313.861947	2
90	Sand								566759.263553	8219298.484323	2

91 Sand					566773.439825	8219281.770673	2
92 Rocky					566780.279836	8219269.164892	2
93 Rocky					566783.284372	8219271.368305	2
94 Sand					566775.232054	8219276.781738	2
95 Sand					566761.889405	8219286.835222	2
96 Sand	Algae	Very sparse			566746.493969	8219296.472722	2
97 Sand	Algae	Very sparse			566734.198654	8219305.709980	2
98 Sand	Hard coral	Very sparse			566715.625044	8219316.444798	2
99 Sand					566697.970086	8219328.635189	2
100 Sand	Algae	Sparse			566677.583558	8219341.663483	2
101 Pebbles					566663.230517	8219341.797127	2
102 Sand					566679.705572	8219318.968463	2
103 Sand	Algae	Moderate			566710.655418	8219291.553183	2
104 Sand	Algae	Sparse	Hard coral	Very sparse	566724.442383	8219278.122641	2
105 Sand	Algae	Sparse	Hard coral	Moderate	566742.088591	8219264.835198	2
106 Sand	Algae	Moderate			566760.663165	8219252.658541	2
107 Coral rubble	Algae	Very sparse		coral rubble	566772.213172	8219242.156995	2
108 Rocky	Algae	Sparse	Hard coral	Very sparse	566781.765837	8219235.404128	2
109 Rocky	Algae	Sparse	Hard coral	Sparse	566763.464746	8219247.248008	2
110 Rocky	Hard coral	Moderate	Algae	Very sparse	566745.900536	8219259.939744	2
111 Rocky	Hard coral	Moderate	Algae	Very sparse	566725.063612	8219272.545410	2
112 Rocky	Hard coral	Dense	Algae	Sparse	566699.914472	8219287.275097	2
113 Sand	Algae	Sparse	Hard coral	Sparse	566680.352693	8219299.530219	2
114 Rocky	Hard coral	Sparse	Algae	Sparse	566653.078045	8219318.698545	2
115 Rocky	Hard coral	Moderate	Algae	Sparse	566644.247420	8219317.866027	2
116 Rocky	Hard coral	Dense	Algae	Sparse	566655.183611	8219291.150977	2
117 Pebbles	Hard coral	Moderate	Algae	Sparse	566667.876927	8219277.353145	2
118 Rocky	Hard coral	Dense	Algae	Sparse	566683.839077	8219257.055557	2
119 Rocky	Hard coral	Dense	Algae	Sparse	566692.708382	8219247.703336	2
120 Rocky	Hard coral	Dense	Algae	Sparse	566704.688032	8219240.192851	2
121 Rocky	Hard coral	Dense	Algae	Sparse	566720.327189	8219229.227208	2
122 Sand	Hard coral	Dense			566743.918873	8219215.217524	2
124 Sand	Hard coral	Moderate			566785.061586	8219198.322835	2
125 Sand	Hard coral	Dense			566780.088067	8219219.309955	2
126 Sand	Hard coral	Dense			566769.836942	8219229.665695	2
127 Sand	Hard coral	Dense			566760.945160	8219240.975972	2
128 Sand	Hard coral	Moderate			566734.433377	8219263.053313	2
129 Sand	Hard coral	Dense			566715.918424	8219276.688127	2
130 Sand	Hard coral	Dense			566705.950538	8219278.167425	2
131 Sand	Hard coral	Dense			566695.857766	8219285.469440	2
132 Sand	Hard coral	Dense			566687.237207	8219293.371736	2
133 Sand	Hard coral	Moderate	Algae	Sparse	566671.658647	8219302.600444	2
134 Sand	Hard coral	Sparse	Algae	Moderate	566656.548841	8219312.388159	2
135 Sand	Hard coral	Moderate	Algae	Sparse	566658.494641	8219299.227482	2
136 Sand	Hard coral	Moderate	Algae	Sparse	566674.798261	8219293.448053	2
137 Sand	Hard coral	Dense	Algae	Sparse	566691.780477	8219281.014461	2
138 Pebbles	Hard coral	Dense	Algae	Sparse	566698.208899	8219270.194632	2
139 Rocky	Hard coral	Dense	Algae	Sparse	566708.573618	8219253.188379	2
140 Sand	Hard coral	Dense			566720.199304	8219241.781355	2
141 Sand	Hard coral	Dense	Algae	Very sparse	566730.786166	8219234.590221	2
142 Sand	Hard coral	Dense	Algae	Very sparse	566743.194295	8219228.459346	2
143 Coral rubble	Hard coral	Dense	Algae	Very sparse	566756.344120	8219222.445947	2
144 Sand	Hard coral	Moderate		heavy voral rubble	566736.884292	8219257.219845	2
145 Sand	Hard coral	Dense	Algae	Sparse	566725.357145	8219261.718238	2
146 Coral rubble	Hard coral	Dense		coral rubble	566711.165498	8219270.422825	2
147 Sand	Hard coral	Dense	Algae	Sparse	566683.054196	8219291.096347	2
148 Sand	Hard coral	Sparse	Algae	Sparse	566664.141135	8219302.169542	2
149 Pebbles	Hard coral	Sparse	Algae	Moderate	566648.810878	8219323.363080	2
150 Sand	Hard coral	Very sparse	Algae	Very sparse	566661.567090	8219328.040783	2
151 Sand					566691.076511	8219328.836737	2
152 Sand	Algae	Sparse			566716.138194	8219308.734722	2
153 Sand	Algae	Sparse			566725.312573	8219301.848387	2
154 Sand	Algae	Sparse			566731.939214	8219291.741507	2
155 Sand					566740.130904	8219283.486475	2
156 Sand	Hard coral	Very sparse			566747.935730	8219276.377527	2
157 Sand	Hard coral	Very sparse			566759.312210	8219266.241496	2
158 Sand	Hard coral	Sparse			566768.065591	8219257.448204	2
159 Coral rubble	Hard coral	Very sparse		coral rubble	566778.627692	8219248.583185	2
160 Rocky					566787.028927	8219254.197574	2
161 Rocky	Hard coral	Moderate			566768.519628	8219243.156308	2
162 Rocky	Hard coral	Moderate			566755.815316	8219240.322212	2
163 Sand	Hard coral	Moderate			566743.213166	8219239.440321	2
164 Pebbles	Hard coral	Dense			566732.316544	8219242.039662	2
165 Sand	Hard coral	Dense			566721.744660	8219252.409248	2
166 Sand	Hard coral	Dense			566715.001932	8219263.582225	2
167 Sand	Hard coral	Dense			566709.015839	8219272.724782	2
168 Sand	Hard coral	Sparse	Algae	Moderate	566699.362430	8219292.160703	2
169 Sand	Algae	Very sparse			566697.859439	8219310.891777	2
170 Sand	Algae	Sparse			566698.141080	8219323.861283	2
171 Sand					566741.911753	8219349.627597	2
172 Pebbles					566759.526683	8219313.612916	2
173 Sand					566758.288275	8219295.432218	2
174 Sand					566756.718855	8219284.509367	2
175 Sand					566754.079908	8219276.506463	2
176 Rocky	Hard coral	Dense	Algae	Sparse	566741.834589	8219252.151298	2
177 Rocky	Hard coral	Sparse	Algae	Very sparse	566740.513589	8219236.135370	2
178 Sand	Algae	Very sparse			566741.086693	8219195.752838	2
179 Sand					566756.703263	8219184.418541	2
180 Sand					566757.041067	8219201.241285	2
181 Sand					566736.149180	8219212.709536	2
182 Sand					566718.460181	8219211.819040	2

183 Sand								566706.461532	8219214.845786	2
184 Sand								566690.371382	8219224.582985	2
185 Sand								566675.657509	8219232.677034	2
186 Sand								566663.052809	8219240.399620	2
187 Sand								566646.136350	8219250.996639	2
188 Sand								566631.469972	8219264.177336	2
189 Sand								566621.733549	8219273.852944	2
190 Sand								566608.526952	8219287.661554	2
191 Rocky	Hard coral	Dense	Algae	Sparse				566596.670706	8219297.120432	2
192 Rocky	Hard coral	Sparse	Algae	Sparse				566587.720389	8219295.585760	2
193 Rocky	Hard coral	Dense						566594.676954	8219283.175116	2
194 Rocky	Hard coral	Dense						566613.525085	8219273.597394	2
195 Rocky	Hard coral	Dense						566628.013147	8219265.087410	2
196 Sand								566647.517855	8219244.554333	2
197 Sand								566658.857681	8219229.362989	2
198 Sand								566667.608526	8219213.834710	2
199 Sand								566676.856684	8219203.043261	2
200 Sand								566697.003051	8219190.791867	2
201 Sand								566715.219871	8219194.719306	2
202 Sand								566720.769483	8219217.525743	2
203 Sand								566718.952435	8219243.779938	2
204 Sand	Hard coral	Moderate						566738.947142	8219249.176868	2
205 Sand	Hard coral	Dense						566722.231916	8219262.649569	2
206 Sand	Hard coral	Dense						566714.556431	8219263.633313	2
207 Sand	Hard coral	Dense						566705.154069	8219262.876350	2
208 Sand	Hard coral	Dense						566693.783215	8219261.330608	2
209 Coral rubble	Hard coral	Sparse				coral rubble		566661.845019	8219252.418658	2
210 Sand								566630.618670	8219254.352943	2
211 Sand								566618.387799	8219242.444524	2
212 Sand								566637.901358	8219240.195310	2
213 Sand								566647.814697	8219258.464166	2
214 Sand								566646.831638	8219269.350508	2
215 Sand	Hard coral	Dense						566643.560121	8219288.533040	2
216 Sand								566646.028632	8219302.688874	2
217 Rocky	Hard coral	Moderate						566648.114848	8219332.524718	2
218 Rocky								566657.247172	8219334.707752	2
219 Rocky								566657.949666	8219337.142976	2
220 Sand	Hard coral	Moderate	Algae	Sparse				566645.817705	8219313.143277	2
221 Pebbles	Hard coral	Sparse	Algae	Sparse				566639.633390	8219301.465489	2
222 Pebbles	Hard coral	Dense						566631.520059	8219287.275035	2
223 Pebbles	Hard coral	Moderate						566626.986758	8219281.134406	2
224 Sand								567390.144730	8219603.392039	3
225 Sand								567376.836694	8219586.221587	3
226 Sand								567364.117146	8219574.390677	3
227 Sand								567346.032825	8219564.945231	3
228 Sand								567331.146427	8219545.091509	3
229 Sand								567316.183177	8219529.832548	3
230 Sand								567301.214771	8219509.942141	3
231 Sand								567287.979180	8219482.579514	3
232 Sand								567274.267115	8219462.027106	3
233 Sand								567271.523941	8219441.509474	3
234 Sand								567267.284810	8219411.436892	3
235 Sand								567254.702132	8219385.978613	3
236 Sand								567249.135415	8219362.418305	3
237 Sand	Hard coral	Very sparse	Algae	Very sparse				567244.589047	8219331.539056	3
238 Sand	Hard coral	Sparse	Algae	Moderate				567242.103646	8219306.693515	3
239 Sand	Hard coral	Sparse	Algae	Moderate	Soft coral	Very sparse		567234.925128	8219284.738425	3
240 Sand	Hard coral	Very sparse	Algae	Moderate	Soft coral	Very sparse		567235.750366	8219253.693418	3
241 Sand	Hard coral	Moderate	Algae	Moderate				567218.995244	8219225.873206	3
242 Sand								567190.536501	8219172.029560	3
243 Sand								567239.104196	8219154.593412	3
244 Sand								567266.711556	8219168.809081	3
245 Sand	Hard coral	Moderate						567249.881236	8219162.505087	3
246 Sand	Hard coral	Dense						567253.711668	8219187.128979	3
247 Sand	Hard coral	Moderate						567254.905085	8219198.604259	3
248 Sand	Hard coral	Moderate						567258.312823	8219215.528327	3
249 Sand	Hard coral	Moderate	Algae	Sparse				567262.076402	8219238.699568	3
250 Sand	Algae	Moderate	Hard coral	Sparse				567268.178697	8219284.753264	3
251 Sand	Algae	Moderate	Hard coral	Very sparse				567278.925309	8219322.451949	3
252 Sand	Algae	Sparse						567286.832043	8219357.609433	3
253 Sand	Algae	Very sparse						567292.182462	8219399.050642	3
254 Sand	Algae	Very sparse						567298.224496	8219442.291033	3
255 Sand								567303.968913	8219472.630118	3
256 Sand	Algae	Very sparse						567312.390570	8219501.264791	3
257 Sand	Algae	Very sparse						567342.573154	8219554.404209	3
258 Rocky								567370.133548	8219582.834920	3
259 Sand								567415.751633	8219599.099169	3
260 Sand								567432.934856	8219600.005480	3
261 Sand								567449.427992	8219592.062224	3
262 Sand								567462.011047	8219581.357932	3
263 Sand								567478.176880	8219561.378118	3
264 Rocky								567489.134619	8219544.354934	3
265 Rocky								567496.124093	8219530.586865	3
266 Rocky								567511.298273	8219505.180372	3
267 Sand	Algae	Sparse						567534.204148	8219478.537067	3
268 Sand	Algae	Very sparse						567516.589872	8219473.015502	3
269 Sand	Algae	Very sparse						567491.570182	8219454.789553	3
270 Sand	Algae	Very sparse						567472.729544	8219448.643011	3
271 Sand	Algae	Very sparse						567454.718144	8219435.062025	3
272 Sand	Algae	Very sparse						567431.837658	8219423.337689	3
273 Sand	Algae	Very sparse						567403.190501	8219421.301212	3

274 Sand					567362.891991	8219413.453789	3
275 Sand					567329.067730	8219408.130944	3
276 Sand					567307.854384	8219435.742337	3
277 Sand					567313.403352	8219486.206070	3
278 Sand					567336.638373	8219507.210641	3
279 Sand					567364.561944	8219522.098182	3
280 Sand					567387.491577	8219532.970573	3
281 Sand					567411.021861	8219542.082281	3
282 Sand					567431.100129	8219546.062436	3
283 Sand					567453.892177	8219549.234115	3
284 Sand	Hard coral	Very sparse			567482.670655	8219528.854339	3
285 Sand					567467.091615	8219522.688639	3
286 Sand	Algae	Very sparse			567443.893661	8219521.422838	3
287 Sand	Algae	Very sparse			567419.204063	8219513.234704	3
288 Sand					567390.744492	8219504.359271	3
289 Sand					567368.801387	8219496.691923	3
290 Sand					567339.973860	8219498.070449	3
291 Sand					567301.478497	8219492.984804	3
292 Sand					567319.581957	8219477.119857	3
293 Sand					567347.954242	8219470.244862	3
294 Sand	Algae	Very sparse			567370.182777	8219464.572260	3
295 Sand					567391.299576	8219461.379057	3
296 Sand					567409.036040	8219456.145938	3
297 Sand					567426.257029	8219448.438351	3
298 Sand	Algae	Sparse			567441.671515	8219450.349276	3
299 Sand					567463.963856	8219459.761500	3
300 Sand	Algae	Very sparse			567473.449087	8219468.327882	3
301 Sand	Algae	Very sparse			567490.028616	8219489.859673	3
302 Sand					567501.338050	8219515.004580	3
303 Sand	Algae	Very sparse			567463.627107	8219509.385880	3
304 Sand					567451.138866	8219498.020651	3
305 Sand					567436.148895	8219486.865943	3
306 Sand	Algae	Very sparse			567418.912173	8219474.823875	3
307 Sand					567382.733472	8219441.509807	3
308 Sand					567375.042264	8219424.502983	3
309 Sand					567357.491967	8219398.444088	3
310 Sand					567326.804736	8219377.901065	3
311 Sand					567320.038183	8219364.246976	3
313 Sand	Algae	Sparse			567275.962518	8219310.570887	3
314 Sand	Algae	Sparse			567309.402308	8219314.967716	3
315 Sand	Hard coral	Very sparse	Algae	Sparse	567336.118467	8219316.221096	3
316 Sand					567362.314457	8219319.343685	3
317 Sand	Algae	Very sparse			567391.896336	8219317.579408	3
318 Sand	Algae	Sparse			567426.911076	8219311.804941	3
319 Sand	Algae	Very sparse			567466.613617	8219299.083861	3
320 Sand	Hard coral	Moderate			567489.006496	8219293.593123	3
321 Sand	Hard coral	Moderate			567508.673964	8219289.213221	3
322 Sand	Hard coral	Moderate			567530.781126	8219287.054862	3
323 Sand	Hard coral	Moderate			567563.744698	8219281.985224	3
324 Sand	Hard coral	Moderate			567589.069336	8219276.435676	3
325 Sand	Hard coral	Sparse	Algae	Sparse	567627.221345	8219266.709484	3
326 Sand	Hard coral	Dense			567665.584928	8219257.412116	3
327 Sand	Hard coral	Sparse	Algae	Sparse	567710.734893	8219254.264895	3
328 Sand	Hard coral	Moderate			567743.002599	8219271.629466	3
329 Sand	Hard coral	Sparse	Algae	Sparse	567758.515154	8219299.740842	3
330 Sand	Hard coral	Sparse	Algae	Sparse	567766.871831	8219324.429987	3
331 Sand	Hard coral	Moderate			567757.775710	8219347.460001	3
332 Sand	Hard coral	Moderate	Algae	Sparse	567745.407564	8219357.230827	3
333 Sand	Hard coral	Sparse	Algae	Sparse	567714.538806	8219377.606238	3
334 Sand	Hard coral	Sparse	Algae	Moderate	567686.194777	8219383.192892	3
335 Sand	Algae	Moderate	Hard coral	Very sparse	567667.866592	8219390.727143	3
336 Coral rubble					567649.565009	8219404.033944	3
337 Sand				coral rubble	567622.675864	8219419.090815	3
338 Sand					567611.970548	8219428.858412	3
339 Sand					567598.545905	8219435.922101	3
340 Sand					567586.231721	8219441.232822	3
341 Sand					567566.550016	8219442.161374	3
342 Sand	Algae	Very sparse			567536.835925	8219447.396206	3
343 Sand					567515.420871	8219457.349460	3
344 Sand					567464.513757	8219434.381260	3
345 Sand					567457.157343	8219426.610369	3
346 Sand					567445.196945	8219414.142945	3
347 Sand					567429.905683	8219400.035518	3
348 Sand					567420.411191	8219387.822262	3
349 Sand					567410.827090	8219379.547483	3
350 Sand					567387.008176	8219379.780563	3
351 Sand					567377.185767	8219380.455836	3
352 Sand					567364.676092	8219377.175323	3
353 Sand					567340.543650	8219360.498892	3
354 Sand					567317.512498	8219346.669365	3
355 Sand					567310.622104	8219325.694275	3
356 Sand					567347.011231	8219339.269207	3
357 Sand					567394.077167	8219353.534154	3
358 Sand	Algae	Very sparse			567423.114186	8219354.284461	3
359 Sand					567450.069591	8219352.164844	3
360 Sand	Algae	Very sparse			567480.460953	8219350.455069	3
361 Sand	Hard coral	Very sparse	Algae	Sparse	567541.710596	8219342.430315	3
362 Sand	Hard coral	Very sparse	Algae	Very sparse	567593.137772	8219346.681298	3
363 Sand	Hard coral	Sparse	Algae	Moderate	567679.139094	8219341.533880	3
364 Sand	Hard coral	Moderate	Algae	Moderate	567692.222533	8219359.269000	3
365 Sand	Hard coral	Sparse	Algae	Sparse	567677.760635	8219369.818688	3

366 Sand	Hard coral	Sparse	Algae	Sparse	567652.743527	8219358.246853	3
367 Sand	Hard coral	Sparse			567638.655134	8219359.232138	3
368 Sand					566543.343361	8219291.504839	2
369 Sand					566558.075102	8219291.670681	2
370 Sand					566573.298632	8219293.564339	2
371 Rocky	Hard coral	Dense			566579.999694	8219293.973673	2
372 Rocky	Hard coral	Moderate			566578.713565	8219295.382441	2
373 Rocky	Hard coral	Moderate			566585.133122	8219298.777693	2
374 Rocky	Hard coral	Dense			566612.535607	8219291.853060	2
375 Rocky	Hard coral	Moderate			566625.160494	8219290.201766	2
376 Rocky	Hard coral	Dense			566636.314667	8219293.224980	2
377 Rocky	Hard coral	Moderate			566629.782061	8219307.894698	2
378 Rocky	Hard coral	Moderate			566618.817487	8219306.294223	2
379 Rocky	Hard coral	Moderate	Algae	Sparse	566603.415628	8219303.790867	2
380 Rocky	Hard coral	Moderate	Algae	Sparse	566594.969490	8219295.062478	2
381 Rocky	Hard coral	Moderate			566572.319519	8219280.976651	2
382 Sand					566563.756689	8219273.749356	2
383 Sand					566556.375301	8219271.750910	2
384 Sand					566550.797247	8219271.397092	2
385 Sand					566545.052775	8219263.731670	2
386 Sand					566560.137523	8219248.589994	2
387 Sand					566573.703153	8219250.374362	2
388 Sand					566586.698797	8219254.094536	2
389 Sand					566595.486649	8219259.707927	2
390 Sand					566596.321494	8219268.794843	2
391 Sand					566603.369853	8219275.582359	2
392 Sand					566608.892423	8219281.779010	2
393 Sand					566618.180575	8219281.870815	2
394 Sand					566625.522251	8219281.337982	2
395 Rocky	Hard coral	Dense			566631.605358	8219284.852143	2
396 Sand					567201.949458	8219158.746058	3
397 Sand					567210.758923	8219157.908016	3
398 Sand					567227.314211	8219153.489837	3
399 Sand					567243.465560	8219154.570872	3
400 Sand	Hard coral	Sparse			567264.432948	8219150.989226	3
401 Sand	Hard coral	Moderate	Algae	Sparse	567273.351917	8219148.098827	3
402 Sand	Hard coral	Moderate	Algae	Very sparse	567293.483719	8219141.715376	3
403 Sand	Hard coral	Moderate			567316.835424	8219136.229275	3
404 Sand	Algae	Sparse	Soft coral	Very sparse	567350.406509	8219128.824012	3
405 Sand					567373.689002	8219129.881291	3
406 Sand					567387.430638	8219132.105315	3
407 Sand					567398.913310	8219133.524992	3
408 Sand					567411.446413	8219136.340707	3
409 Sand	Algae	Very sparse			567421.909395	8219140.610200	3
410 Sand	Hard coral	Dense	Algae	Sparse	567448.683287	8219150.923243	3
411 Sand	Hard coral	Dense			567429.719236	8219148.632235	3
412 Sand	Hard coral	Dense			567432.337295	8219150.314971	3
413 Sand	Hard coral	Dense			567462.449493	8219164.705293	3
414 Sand	Hard coral	Dense			567486.440024	8219172.325779	3
415 Sand	Hard coral	Dense			567505.349166	8219179.932275	3
416 Sand	Hard coral	Dense	Algae	Sparse	567517.450822	8219182.699515	3
417 Sand	Hard coral	Dense	Algae	Sparse	567533.662799	8219190.146490	3
418 Sand	Hard coral	Dense			567548.166319	8219196.741238	3
419 Sand	Hard coral	Moderate			567558.861577	8219204.096329	3
420 Sand	Hard coral	Sparse			567575.953219	8219211.274984	3
421 Sand	Hard coral	Moderate			567586.388194	8219213.966234	3
422 Sand	Hard coral	Dense			567597.738847	8219216.488744	3
423 Sand	Hard coral	Dense			567616.194209	8219219.658670	3
424 Sand	Hard coral	Moderate	Algae	Very sparse	567628.111574	8219228.582630	3
425 Sand	Hard coral	Moderate	Algae	Sparse	567636.450605	8219258.638924	3
426 Sand	Hard coral	Sparse	Algae	Very sparse	567627.473719	8219279.292017	3
427 Sand	Algae	Sparse	Hard coral	Very sparse	567601.971901	8219328.864261	3
428 Sand	Algae	Sparse	Hard coral	Very sparse	567591.350872	8219348.111904	3
429 Sand	Hard coral	Sparse	Algae	Moderate	567582.539709	8219363.550438	3
430 Sand	Algae	Moderate			567569.391969	8219387.101583	3
431 Sand	Algae	Moderate			567559.807613	8219396.821411	3
432 Sand	Algae	Moderate			567534.250088	8219406.119875	3
433 Sand	Algae	Sparse			567519.885293	8219405.319420	3
434 Sand	Algae	Sparse			567505.012661	8219399.890879	3
435 Sand					567500.624608	8219392.957223	3
436 Sand					567501.046650	8219386.989672	3
437 Sand	Algae	Sparse			567500.728385	8219374.418453	3
438 Sand					567492.997249	8219365.337884	3
439 Sand					567484.449822	8219351.600787	3
440 Sand					567483.421077	8219342.748550	3
441 Sand					567480.129068	8219329.334625	3
442 Sand	Hard coral	Sparse			567479.755785	8219309.254131	3
443 Sand	Hard coral	Moderate			567478.585117	8219303.534831	3
444 Sand	Hard coral	Dense			567471.449335	8219289.231116	3
445 Sand	Algae	Moderate	Hard coral	Moderate	567469.291276	8219281.746669	3
446 Sand	Hard coral	Dense	Algae	Sparse	567464.656377	8219271.578109	3
447 Sand	Hard coral	Sparse	Algae	Sparse	567454.208116	8219258.720638	3
448 Sand	Hard coral	Very sparse			567442.709532	8219241.039630	3
449 Sand	Hard coral	Sparse			567438.773606	8219231.552824	3
450 Sand	Algae	Very sparse			567433.510269	8219221.607411	3
451 Sand	Hard coral	Dense			567417.955904	8219200.666177	3
452 Sand					567414.392922	8219195.394814	3
453 Sand	Hard coral	Moderate			567408.276719	8219188.092131	3
454 Sand	Hard coral	Dense			567401.989133	8219180.662803	3
455 Sand	Hard coral	Moderate			567397.194182	8219173.529373	3
456 Sand	Hard coral	Dense	Algae	Very sparse	567389.064558	8219166.426456	3

457 Sand	Hard coral	Dense	Algae	Very sparse	567384.006977	8219161.972705	3
458 Sand	Hard coral	Dense			567361.244204	8219160.705431	3
459 Sand	Hard coral	Dense	Algae	Sparse	567346.431703	8219160.909188	3
460 Sand	Hard coral	Sparse			567330.514819	8219170.093240	3
461 Sand	Hard coral	Moderate			567321.233356	8219179.780727	3
462 Sand	Hard coral	Moderate			567311.946754	8219195.412286	3
463 Sand	Hard coral	Sparse	Algae	Sparse	567303.996173	8219209.004388	3
464 Sand	Algae	Moderate	Hard coral	Very sparse	567284.362062	8219243.051046	3
465 Sand	Algae	Sparse			567292.870224	8219276.115894	3
466 Sand	Algae	Sparse	Hard coral	Very sparse	567316.041387	8219273.346153	3
467 Sand	Algae	Moderate	Hard coral	Very sparse	567340.058777	8219264.613023	3
468 Sand	Algae	Moderate	Hard coral	Very sparse	567363.458506	8219253.824208	3
469 Sand	Algae	Moderate	Hard coral	Sparse	567389.656810	8219244.850278	3
470 Sand	Hard coral	Sparse	Algae	Sparse	567411.864766	8219240.696819	3
471 Sand					567435.542035	8219236.754622	3
472 Sand	Hard coral	Sparse			567458.281059	8219233.709468	3
473 Sand	Hard coral	Sparse			567474.354145	8219232.480318	3
474 Sand	Algae	Very sparse	Hard coral	Very sparse	567489.726027	8219229.267743	3
475 Sand	Algae	Very sparse			567525.680152	8219223.558527	3
476 Sand	Hard coral	Very sparse			567543.503563	8219224.682164	3
477 Sand					567558.779346	8219230.225494	3
478 Sand	Algae	Sparse			567573.843322	8219246.385617	3
479 Sand	Algae	Moderate			567580.208206	8219271.453396	3
480 Sand	Hard coral	Sparse	Algae	Moderate	567574.083998	8219295.313105	3
481 Sand	Algae	Sparse	Hard coral	Very sparse	567561.414008	8219320.079620	3
482 Sand	Algae	Sparse			567539.451267	8219344.406275	3
483 Sand	Algae	Sparse			567522.084063	8219351.478319	3
484 Sand					567508.733167	8219347.649197	3
485 Sand					567494.032201	8219341.827457	3
486 Sand					567477.416065	8219336.863376	3
487 Sand					567469.378562	8219333.088077	3
488 Sand					567455.463224	8219321.876625	3
489 Sand					567450.466088	8219310.398201	3
490 Sand	Hard coral	Sparse			567436.884029	8219296.228439	3
491 Sand	Hard coral	Dense			567427.594743	8219289.353972	3
492 Sand	Hard coral	Dense			567421.111518	8219284.438167	3
493 Sand	Hard coral	Dense			567412.032888	8219278.844403	3
494 Sand	Hard coral	Moderate	Algae	Sparse	567399.506563	8219272.451830	3
495 Sand	Hard coral	Moderate	Algae	Sparse	567386.941153	8219266.691692	3
496 Sand					567365.986396	8219255.737612	3
497 Sand	Algae	Moderate	Hard coral	Sparse	567359.357175	8219243.263050	3
498 Sand	Hard coral	Very sparse	Algae	Moderate	567356.587831	8219225.870640	3
499 Sand	Algae	Sparse			567352.285180	8219209.491402	3
500 Sand	Algae	Very sparse	Hard coral	Very sparse	567346.037445	8219193.514511	3
501 Sand	Hard coral	Moderate	Algae	Sparse	567342.612936	8219181.035649	3
502 Sand	Hard coral	Dense	Algae	Sparse	567339.260553	8219168.265286	3
503 Sand	Hard coral	Dense	Algae	Very sparse	567335.062200	8219151.585221	3
504 Sand					567340.296862	8219119.413254	3
505 Sand					567351.678542	8219116.354827	3
506 Sand					567225.436297	8219123.288342	3
507 Sand					567248.150338	8219126.141416	3
508 Sand					567343.917284	8219156.982417	3
509 Sand	Hard coral	Dense			567357.421186	8219160.724539	3
510 Sand	Hard coral	Dense			567324.198936	8219146.974063	3
511 Sand	Hard coral	Dense			567351.467008	8219156.266164	3
512 Silt	Hard coral	Dense			567369.901740	8219159.159857	3
513 Sand	Hard coral	Dense			567400.567273	8219169.717345	3
514 Sand	Hard coral	Dense			567415.082703	8219171.452178	3
515 Sand	Hard coral	Dense			567428.264977	8219170.877285	3
516 Sand	Hard coral	Dense			567440.689503	8219171.381443	3
517 Sand	Hard coral	Dense			567458.452458	8219177.228855	3
518 Sand	Hard coral	Dense			567470.433423	8219180.114493	3
519 Sand	Hard coral	Dense			567483.546039	8219185.319813	3
520 Sand	Hard coral	Moderate			567495.347651	8219190.781659	3
521 Sand	Hard coral	Sparse	Algae	Very sparse	567508.447802	8219199.478934	3
522 Sand	Hard coral	Sparse	Algae	Very sparse	567521.985719	8219206.786592	3
523 Sand					567542.398626	8219217.120819	3
524 Sand	Hard coral	Sparse	Algae	Sparse	567573.810262	8219230.902242	3
525 Sand	Hard coral	Sparse	Algae	Sparse	567594.060500	8219239.328707	3
526 Sand	Hard coral	Sparse	Algae	Very sparse	567616.824052	8219246.683603	3
527 Sand	Hard coral	Moderate	Algae	Very sparse	567639.405479	8219250.965654	3
528 Sand	Hard coral	Sparse	Algae	Sparse	567666.314835	8219266.438514	3
529 Sand	Hard coral	Sparse	Algae	Sparse	567685.497998	8219275.638843	3
530 Sand	Algae	Moderate			567695.537371	8219291.104378	3
531 Sand	Algae	Moderate	Hard coral	Very sparse	567697.740763	8219311.597807	3
532 Sand	Hard coral	Very sparse	Algae	Sparse	567689.230128	8219330.245362	3
533 Sand	Algae	Moderate	Hard coral	Very sparse	567676.780972	8219340.923486	3
534 Sand	Hard coral	Dense	Algae	Sparse	567667.831479	8219338.533798	3
535 Sand	Algae	Moderate	Hard coral	Very sparse	567663.268084	8219324.991085	3
536 Sand	Algae	Dense	Hard coral	Very sparse	567660.835550	8219303.570913	3
537 Sand	Algae	Sparse			567627.371217	8219280.735890	3
538 Sand					567609.451396	8219281.933857	3
539 Sand	Algae	Moderate			567600.858093	8219282.317901	3
540 Sand	Algae	Sparse			567564.565290	8219283.393144	3
541 Sand	Algae	Sparse			567520.631444	8219264.000893	3
542 Sand					567505.462572	8219246.200143	3
543 Sand	Hard coral	Very sparse	Algae	Moderate	567491.290239	8219242.454694	3
544 Sand	Algae	Sparse	Hard coral	Very sparse	567465.917716	8219218.894093	3
545 Sand	Hard coral	Very sparse			567464.233337	8219207.781675	3
546 Sand	Hard coral	Dense			567456.805811	8219191.299545	3
547 Sand	Hard coral	Dense			567452.790065	8219183.105425	3

548 Sand	Hard coral	Dense			567448.054773	8219172.140682	3
549 Sand	Hard coral	Dense			567444.713596	8219154.880880	3
550 Sand					567430.061938	8219127.216632	3
551 Sand					567441.040313	8219095.403102	3
552 Sand					567455.947831	8219092.479547	3
553 Sand					567543.469342	8219172.689805	3
554 Sand	Hard coral	Dense			567502.532770	8219162.362969	3
555 Sand	Hard coral	Moderate			567504.350252	8219198.346546	3
556 Sand	Hard coral	Sparse	Algae	Sparse	567511.933787	8219201.710273	3
557 Sand	Hard coral	Dense			567510.947481	8219171.765967	3
558 Sand	Hard coral	Dense			567509.440282	8219160.890857	3
559 Sand	Hard coral	Dense			567506.399189	8219147.942568	3
560 Sand					567501.995090	8219132.821099	3
561 Sand					567500.652559	8219101.172450	3
562 Sand					567518.965050	8219101.984888	3
563 Sand					567518.547027	8219118.562906	3
564 Sand					567503.625680	8219134.471709	3
565 Sand					567482.227701	8219154.600349	3
566 Sand	Hard coral	Dense			567476.544128	8219154.735720	3
567 Sand	Hard coral	Dense			567460.290685	8219160.493510	3
568 Sand					567419.069025	8219129.167574	3
569 Sand	Hard coral	Sparse	Algae	Sparse	567742.202182	8219255.316944	3
570 Sand	Hard coral	Moderate	Algae	Sparse	567729.850078	8219240.105536	3
571 Sand	Hard coral	Dense	Algae	Sparse	567715.261605	8219223.284150	3
572 Sand	Hard coral	Dense			567706.291866	8219211.362508	3
573 Sand	Hard coral	Dense			567701.195523	8219205.946661	3
574 Sand	Hard coral	Dense			567696.451451	8219201.468046	3
575 Sand	Hard coral	Dense			567682.804807	8219193.622550	3
576 Sand	Hard coral	Moderate			567673.902702	8219187.460500	3
577 Sand					567657.867619	8219182.487365	3
578 Sand					567642.207332	8219185.804239	3
579 Sand					567632.224328	8219188.686976	3
580 Sand					567620.194217	8219187.204646	3
581 Sand					567607.114209	8219189.744750	3
582 Sand	Hard coral	Moderate			567599.902412	8219191.392924	3
583 Sand	Hard coral	Dense			567587.340799	8219194.442210	3
584 Sand	Hard coral	Dense			567573.463962	8219184.724079	3
585 Sand	Hard coral	Moderate			567560.103168	8219182.309102	3
586 Sand	Hard coral	Dense			567551.019729	8219179.193343	3
587 Sand	Hard coral	Dense			567540.400042	8219177.885477	3
588 Sand	Hard coral	Dense			567534.517179	8219162.394262	3
589 Sand	Hard coral	Dense			567531.118764	8219153.235911	3
590 Sand					567523.189420	8219128.858724	3
591 Sand	Algae	Sparse			567829.281086	8219294.173188	3
592 Sand	Hard coral	Sparse	Algae	Sparse	567822.053559	8219283.134963	3
593 Sand	Hard coral	Moderate	Algae	Sparse	567816.331173	8219279.902043	3
594 Sand	Hard coral	Moderate			567805.348712	8219267.844810	3
595 Sand	Hard coral	Moderate			567797.061613	8219257.692973	3
596 Sand	Hard coral	Dense			567795.013012	8219248.753596	3
597 Sand	Hard coral	Dense			567788.197007	8219237.632968	3
598 Sand	Hard coral	Dense			567779.783687	8219232.236479	3
599 Sand	Hard coral	Dense			567773.393123	8219229.049906	3
600 Sand	Hard coral	Dense			567752.986820	8219206.975139	3
601 Sand					567743.140647	8219203.321606	3
602 Sand	Hard coral	Dense			567739.155254	8219202.146526	3
603 Sand	Hard coral	Dense			567725.456417	8219190.068033	3
604 Sand	Hard coral	Dense			567709.271289	8219180.904603	3
605 Sand	Hard coral	Dense			567699.941239	8219183.999324	3
606 Sand	Hard coral	Dense			567690.263009	8219192.130170	3
607 Sand	Hard coral	Dense			567672.271404	8219192.544859	3
608 Sand					567664.687254	8219188.392104	3
609 Sand					567654.529519	8219176.728632	3
610 Sand					567645.640468	8219171.938292	3
611 Sand					567641.648721	8219166.364011	3
612 Sand					567630.564762	8219161.266952	3
613 Sand	Algae	Very sparse			567624.702702	8219161.310681	3
614 Sand					567613.725767	8219159.758772	3
615 Sand					567601.916082	8219158.631492	3
616 Sand					567587.790387	8219157.870941	3
617 Sand	Hard coral	Moderate			567580.670947	8219157.048270	3
618 Sand	Hard coral	Dense			567575.735102	8219156.882739	3
619 Sand	Hard coral	Dense			567568.903242	8219159.781580	3
620 Sand	Hard coral	Dense			567561.838643	8219159.393901	3
621 Sand	Hard coral	Dense			567553.756201	8219153.756603	3
622 Sand	Algae	Sparse			567540.913902	8219141.950083	3
623 Sand					567532.882625	8219137.866924	3
624 Sand					567519.289244	8219136.883397	3
625 Sand					567513.587485	8219135.718970	3
626 Sand					567498.736801	8219136.249272	3
627 Sand					567484.372939	8219138.619939	3
628 Sand					567470.312629	8219142.337364	3
629 Sand	Algae	Very sparse			567457.030357	8219143.443608	3
630 Rocky	Hard coral	Dense			566819.296504	8219160.456502	2
631 Rocky	Hard coral	Dense			566815.415632	8219161.991131	2
632 Rocky	Hard coral	Dense			566806.411709	8219164.509256	2
633 Sand	Algae	Moderate			566789.082117	8219168.125578	2
634 Rocky	Algae	Moderate			566761.152056	8219173.211947	2
635 Sand	Algae	Very sparse			566752.989509	8219170.496932	2
636 Sand	Algae	Sparse			566743.747241	8219173.176052	2
637 Sand					566739.862780	8219174.701513	2
638 Sand					566735.426124	8219176.925500	2

639 Sand									566730.852105	8219177.945987	2
640 Sand									566726.598830	8219186.017610	2
641 Sand									566719.151799	8219178.822072	2
642 Sand									566708.457570	8219169.320554	2
643 Sand									566703.097261	8219173.208550	2
644 Sand									566695.443700	8219179.055892	2
645 Sand									566677.957940	8219192.938324	2
646 Sand									566666.309432	8219202.097936	2
647 Sand									566657.619824	8219209.554350	2
648 Sand									566648.672630	8219217.321159	2
649 Sand									566645.175524	8219220.224546	2
650 Sand									566636.222654	8219229.042243	2
651 Sand									566628.213428	8219236.962987	2
652 Sand									566625.864326	8219238.754848	2
653 Sand									566620.853601	8219242.715486	2
654 Sand									566612.481103	8219236.547686	2
655 Sand									566606.648139	8219239.139138	2
656 Sand									566603.484404	8219243.835359	2
657 Sand									566599.018263	8219251.072421	2
658 Sand									566593.720830	8219257.506293	2
659 Sand									566591.285772	8219260.327135	2
660 Sand									566588.224831	8219264.835062	2
661 Sand									566587.046521	8219265.966917	2
662 Sand									566584.850664	8219269.518936	2
663 Sand									566566.734970	8219270.755408	2
664 Sand									566559.872242	8219272.324763	2
665 Sand									566548.345613	8219273.469470	2
666 Sand									566541.503617	8219274.810098	2
667 Sand									566535.017744	8219278.415710	2
668 Sand									566524.381352	8219280.416791	2
669 Sand									566514.052524	8219282.181026	2
670 Sand									566503.561977	8219283.486613	2
671 Sand									566493.785873	8219284.725504	2
672 Sand	Algae	Very sparse	Hard coral	Very sparse					566485.685678	8219284.948951	2
673 Sand	Algae	Moderate	Soft coral	Very sparse					566475.745472	8219283.149986	2
674 Sand									566463.252973	8219287.326637	2
675 Sand									566451.600393	8219292.240195	2
676 Sand									566437.512433	8219301.633809	2
677 Sand	Hard coral	Very sparse							566426.551117	8219306.443789	1
678 Sand									566406.231092	8219316.742983	1
679 Sand	Algae	Sparse							566573.000000	8219249.000000	2
680 Sand	Algae	Sparse							566825.000000	8219111.000000	2
681 Rocky	Algae	Dense	Hard coral	Sparse					566763.000000	8219243.000000	2
682 Rocky	Algae	Dense	Sponges	Sparse	Hard Coral	Moderate			566744.000000	8219244.000000	2
683 Rocky	Hard coral	Sparse					Branching porites		566718.000000	8219265.000000	2
684 Sand	Algae	Sparse							566725.000000	8219282.000000	2
685 Sand	Hard coral	Moderate	Algae	Sparse			Porites		566710.000000	8219282.000000	2
686 Sand	Algae	Sparse	Hard coral	Sparse	Soft Coral	Sparse	Caulerpa, Turf Algae		566693.000000	8219280.000000	2
687 Rocky	Hard coral	Moderate	Algae	Sparse			Porites, Turf		566658.000000	8219282.000000	2
688 Rocky	Hard coral	Moderate	Algae	Sparse			Acropora, Fungia, Favia		566642.000000	8219272.000000	2
689 Rocky	Hard coral	Moderate					Acropora, Porites		566652.000000	8219269.000000	2
690 Coral rubble	Hard coral	Moderate	Algae	Sparse			Coral rubble, Fungia, Acropora, Turbinaria		566634.000000	8219289.000000	2
691 Rocky	Hard coral	Sparse					Gorgonian (sea whip)		566354.000000	8219307.000000	1
692 Sand	Hard coral	Moderate	Soft coral	Sparse	Algae	Sparse	Plate coral		566367.000000	8219284.000000	1
693 Sand	Algae	Sparse	Hydroids	Sparse	Soft Coral	Sparse			566336.000000	8219281.000000	1
694 Sand	Algae	Sparse	Hydroids	Sparse	Soft Coral	Sparse			566326.000000	8219288.000000	1
695 Sand	Algae	Sparse	Hydroids	Sparse	Soft Coral	Sparse			566331.000000	8219302.000000	1
696 Sand	Algae	Sparse	Hydroids	Sparse	Soft Coral	Sparse			566323.000000	8219327.000000	1
697 Sand	Algae	Sparse	Hydroids	Sparse	Soft Coral	Sparse			566312.000000	8219327.000000	1
698 Sand	Algae	Sparse	Hydroids	Sparse	Soft Coral	Sparse			566921.000000	8219351.000000	3
699 Sand	Algae	Sparse	Hydroids	Sparse	Soft Coral	Sparse	Acropora		566285.000000	8219359.000000	1
700 Sand	Hydroids	Sparse							566272.000000	8219357.000000	1
701 Sand	Hydroids	Moderate							566284.000000	8219359.000000	1
702 Sand	Bare								566234.000000	8219345.000000	1
703 Sand	Bare								566243.000000	8219341.000000	1
704 Sand	Bare								566180.000000	8219354.000000	1
705 Sand	Bare								566179.000000	8219368.000000	1
706 Rocky	Bare								565950.000000	8219609.000000	1
707 Sand	Bare								565978.000000	8219567.000000	1
708 Sand	Algae	Sparse							565992.000000	8219544.000000	1
709 Sand	Algae	Very sparse							566050.000000	8219515.000000	1
710 Sand	Algae	Sparse	Hard coral	Very sparse					566074.000000	8219497.000000	1
711 Sand	Algae	Sparse							566109.000000	8219485.000000	1
712 Sand	Bare								566173.000000	8219436.000000	1
713 Sand	Algae	Sparse							566209.000000	8219423.000000	1
714 Sand	Bare								566229.000000	8219370.000000	1
715 Sand	Algae	Sparse	Hard coral	Very sparse					566283.000000	8219381.000000	1
716 Sand	Bare								566214.000000	8219383.000000	1
717 Sand	Bare								566173.000000	8219396.000000	1
718 Sand	Bare								566128.000000	8219418.000000	1
719 Sand	Bare								566128.000000	8219421.000000	1
720 Sand	Bare								566078.000000	8219449.000000	1
721 Sand	Bare								566063.000000	8219484.000000	1
722 Sand	Bare								566023.000000	8219517.000000	1
723 Sand	Algae	Sparse							565977.000000	8219545.000000	1
724 Sand	Bare								565973.000000	8219545.000000	1
725 Sand	Bare								566020.000000	8219493.000000	1

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