

# West Pilbara Iron Ore Project Stage 1

# Anketell Point Port Development Proposal

Ecosystem Research and Monitoring Program

December 2014





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API Management Pty Ltd

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Front cover image: North east tip of Dixon Island (lower right hand side) and tip of Anketell Point (top, centre), looking south west (image taken during autumn equinox high tide, March 2011, source API) Inside cover image: Flatback turtle on Delambre Island, January 2011 (Anna Vitenbergs)



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**APPENDIX 2** Mangrove photo-monitoring dataset (October 2012)



# 1. **INTRODUCTION**

## 1.1 **PROJECT OVERVIEW**

The Proposal is to establish and operate a multi-user deepwater port with iron ore stockpiling, transfer and ship loading facilities at Anketell Point in the Pilbara region of Western Australia. The Proposal includes a terrestrial infrastructure footprint of up to 1275 ha (including a western rail corridor) and a marine infrastructure footprint of 2,710 ha (comprising 508 ha marine infrastructure footprint and 2,202 ha marine dredge material disposal areas (DMDAs)). A disturbance envelope has been defined which describes the area in which the terrestrial and marine footprints will be located (Figure 1).

Marine components of the proposal include a dredged 15.2 km long and 200 m wide (widening to 300 m at the seaward end) shipping channel, four berth pockets, a 1,110 m long piled trestle jetty and wharf and a 3 km long, 200 m wide causeway running NNE off Anketell Point.

## 1.2 ENVIRONMENTAL APPROVAL

The WA State Minister for Environment; Water released Ministerial Statement 930 (MS930) granting approval of the Anketell Port proposal under the *Environmental Protection Act 1986*, on 30 January 2013. The Commonwealth Minister for Sustainability, Environment, Water, Population and Communities (the Minister) approved the Anketell Port proposal under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act), subject to conditions, on 15 May 2013 (EPBC2009/5120).





Figure 1 Overview of proposal envelope



## 1.3 PURPOSE OF THIS DOCUMENT

The EPBC Act approval requires the development of several plans and programs including an Ecosystem Research and Monitoring Program (Condition 22-25), to be submitted to the Minister within six months of the approval date.

This document addresses the requirement for API to prepare an Ecosystem Research and Monitoring Program (ERMP), and submit to the Minister for approval, as stipulated in Conditions 22 and 23 as follows:

- 22. To protect the Commonwealth marine area and listed threatened and migratory species, the person taking the action must develop and implement an Ecosystem Research and Monitoring Program<sup>1</sup> (ERMP) of the marine environment<sup>2</sup> of the Anketell Point region that can be used to monitor, manage and/or improve the regional marine environment. The ERMP must include, but not be limited to, monitoring surveys for the following:
  - a. Baseline state of the marine environment of the Anketell Point region;
  - b. Coastal processes including beach degradation and sedimentation;
  - c. Condition of listed threatened and migratory species populations, associated habitat and the Commonwealth marine area;
  - d. Behaviour of listed threatened and migratory species. This must include monitoring of potential important habitats, including resting, roosting, nesting and/or feeding areas. For listed migratory birds this must include, but not be limited to, monitoring programs at Dixon Island and the intertidal areas of Bouguer Passage;
  - e. Water quality;
  - f. Benthic habitat, including but not limited to, corals, seagrass, mangroves and benthic filter feeders; and
  - g. Implementation and reporting timeframes for each of the actions described above.
- 23. The ERMP must be submitted to the Minister for approval no later than six months from the date of this approval, unless otherwise approved by the Minister.

## 1.4 STRUCTURE OF THIS DOCUMENT

This document presents an overview of the baseline monitoring programmes completed to date, including a data summary (Section 2), and outlines the further work proposed to meet the requirements of Condition 22 of the EPBC Act approval, as presented in Table 1.

Condition No.	Subject	Relevant document	section	of
NA	Overview of baseline programmes and data summary			
	Sediment quality	Section 2.1		
	Coastal processes	Section 2.2		

#### Table 1 Conditions relating to the ERMP and the relevant section(s) of this document

<sup>&</sup>lt;sup>1</sup> If a condition of another approval held by the proponent requires monitoring programs or surveys relevant to condition 22, the proponent may include those monitoring programs or surveys as components of the ERMP.

<sup>&</sup>lt;sup>2</sup> Includes habitat where migratory bird species are known to occur.



Condition No.	Subject	Relevant document	section	of
	Condition of listed threatened and migratory species populations, associated habitat and the Commonwealth marine area	Section 2.3		
	Behaviour of listed threatened and migratory species	Section 2.4		
	Water quality	Section 2.5		
	Benthic habitat	Sections 2.6		
22	The ERMP must include, but not be limited to, moni	toring surveys fo	or the followi	ng:
а	Baseline state of the marine environment of the Anketell Point region	Section 3.2		
b	Coastal processes including beach degradation and sedimentation	Section 3.3		
С	Condition of listed threatened and migratory species populations, associated habitat and the Commonwealth marine area	Section 3.4		
d	Behaviour of listed threatened and migratory species. This must include monitoring of potential important habitats, including resting, roosting, nesting and/or feeding areas. For listed migratory birds this must include, but not be limited to, monitoring programs at Dixon Island and the intertidal areas of Bouguer Passage	Section 3.5		
е	Water quality	Section 3.6		
f	Benthic habitat, including but not limited to, corals, seagrass, mangroves and benthic filter feeders; and	Sections 3.7		
g	Implementation and reporting timeframes for each of the actions described above.	Section 4		



## 1.5 RELATED PROGRAMMES

A number of the required components of the ERMP may be fulfilled by the implementation of monitoring programmes required under the State approval (MS930), which is provided for under the footnote to Condition 22 (of the EPBC Act approval) (refer Section 1.3) as follows (conditions detailed below refer to the WA State approval, MS930):

#### State of the Marine Environment Surveys

• Monitoring of the state of the marine environment (State waters) before, during and post project implementation (State of the Marine Environment Surveys required under Condition 10).

#### Coastal processes

• Monitoring of beach profiles and examination of remote imagery (State of the Marine Environment Surveys required under Condition 10, Coastal Habitat Management Plan required under Condition 11).

<u>Condition of listed threatened and migratory species populations, associated habitat and the</u> <u>Commonwealth marine area</u>

- Monitoring of turtle populations (turtle nesting) and associated habitat (State of the Marine Environment Surveys required under Condition 10, Light Management Plan required under Condition 12, Project A required under Condition 20);
- Research into marine mammal populations (Project A required under Condition 20); and
- Monitoring of migratory bird populations at Anketell Point (Coastal Habitat Management Plan required under Condition 11).

#### Behaviour of listed threatened and migratory species

- Monitoring of turtle hatchling behaviour (Light Management Plan required under Condition 12, Marine Fauna Management Plan required under Condition 13);
- Research into the behaviour of marine mammals (Marine Fauna Management Plan required under Condition 13, Project B required under Condition 20); and
- Monitoring of the behaviour of migratory birds (Coastal Habitat Management Plan required under Condition 11).

#### Water quality

• Water quality monitoring before, during and after dredging (Dredge Environmental Management Plan required under Condition 8).

#### Benthic habitat

- Coral health monitoring (Dredge Environmental Management Plan required under Condition 8, State of the Marine Environment Surveys required under Condition 10,);
- Monitoring of filter feeder habitat within State waters (State of the Marine Environment Surveys required under Condition 10); and
- Mangrove health monitoring (State of the Marine Environment Surveys required under Condition 10, Coastal Habitat Management Plan required under Condition 11).

These programmes are discussed in more detail in latter sections of this document. The responsibility to implement a number of the projects required under Condition 20 of the State approval lies with the WA Department of Parks and Wildlife (DPaW) (formerly the Department of Environment and Conservation, DEC).



## 2. OVERVIEW OF BASELINE PROGRAMMES AND DATA SUMMARY

Numerous biotic and abiotic elements of the marine environment at Anketell Point were studied in detail between 2008 and 2012 to inform project design and support the environmental impact assessment (EIA) required under the State and Commonwealth approvals processes. Key baseline programmes addressing sediment quality, coastal processes, marine fauna, water quality and benthic habitats are discussed below.

## 2.1 SEDIMENT QUALITY

Physical characterisation of surface sediments has been undertaken as part of investigations across the dredge material disposal areas (DMDAs) and across the proposed seabed disturbance footprint. Inshore sediments were generally dominated by fine and medium sands, with a fines<sup>3</sup> content of < 10%. Further offshore medium sands dominated. Furthest offshore sediments were dominated by coarse and very coarse sands (WorleyParsons 2010).

The surface sediments (< 1 m) within the proposed dredge area were sampled for chemical analysis by manual coring, with the samples processed and analysed in accordance with the National Assessment Guidelines for Dredging (Commonwealth of Australia 2009). The sediments generally exhibited low concentrations of metals (antimony, arsenic, chromium, cobalt, copper, lead, manganese and zinc) and organotins, with the 95% upper confidence limit (95% UCL) concentrations below the screening levels presented in the National Assessment Guidelines for Dredging (Commonwealth of Australia 2009) (Oceanica 2010, 2011a).

## 2.2 COASTAL PROCESSES

Historic aerial photography of Dixon Island (1968–2009) was examined and it was found that there have been no significant changes in the morphology and shoreline of Anketell Point and Dixon Island in recent times (AECOM 2010a).

Seasonal monitoring of beach profiles in 2011 and 2012 has indicated that the Dixon Island and Anketell Point coasts exhibit minor seasonal variation. Some seasonal changes to the beach face of up to one metre have been recorded at the beaches on the northeast corner of Dixon Island, while the berm (where turtle nesting occurs) remained stable (Oceanica 2012a). This seasonal trend may be a response to seasonal shifts in the prevailing wind regime causing a net flux in sediments to the east during summer and towards the west during winter. The southern Dixon Island shoreline is fringed by mangroves and rock rubble which act to protect the beaches from oceanographic processes. These profiles are also sheltered from the open ocean by their location in Bouguer Passage.

The Anketell Point beach profiles did not change except for a single profile approximately 1 km west of the Anketell Point promontory which showed a landward retreat of the berm and an associated increase in the berm height by approximately 0.5 m. The mainland coast west of Anketell Point is less rocky than southern Dixon Island, but is protected by mangroves and sheltered from the open ocean. The profiles east of Anketell Point are sheltered from waves by Poverty Island to the east, the Anketell Point promontory to the west and Dixon Island to the north-west.

 $<sup>^3</sup>$  Particles of less than 63µm in diameter.



The beach sediments on Dixon Island and at Anketell Point were mainly medium to coarse grained sands. The Anketell Point samples were mainly comprised of medium sand (41-70%). No samples contained any clays or silts.

## 2.3 CONDITION OF LISTED THREATENED AND MIGRATORY SPECIES POPULATIONS, ASSOCIATED HABITAT AND THE COMMONWEALTH MARINE AREA

## 2.3.1 CONDITION OF LISTED THREATENED AND MIGRATORY SPECIES POPULATIONS AND ASSOCIATED HABITAT

## 2.3.1.1. MARINE TURTLES

API has completed multiple turtle nesting surveys during the peak hawksbill and flatback nesting periods (February 2008, January 2009, March 2009, April 2009, October 2009, October 2010, January 2011, February 2011, February 2012), to determine the relative importance of the beaches across the region (Figure 2). The combined information from these surveys provides a good understanding of the relative importance of beaches across the region to flatback and hawksbill turtles, and indicates that the beaches of Anketell Point, Cleaverville and Bezout Island are of minor importance when compared to Bells Beach and Dixon, Delambre and Legendre Islands.

Of the sites in proximity to Anketell Point (i.e. excluding Huay and Legendre islands), Delambre Island, Dixon Island and Bell's Beach exhibited the greatest abundance of nesting activity (Figure 3), tracks and nest emergences (Pendoley 2010, 2011).

A five day survey undertaken in February 2012, at the end of the flatback nesting season, confirmed the view (Pendoley 2010) that the Anketell Point and Bezout Island turtle nesting beaches are small, with sub-optimal conditions for turtle nesting. Rubble prevalent at Bezout Island was considered likely to prevent successful nesting in many cases, and the extensive intertidal rock platform and current anthropogenic disturbance at Anketell Point reduces the potential value of this beach as a nesting site. The exposure of the beach and steepness of the dunes at Anketell Point also suggests that the beach is vulnerable to erosion during storms, which would damage turtle nests (Oceanica 2012c).

Emergence success across the regional nesting beaches in 2010/11 varied from 27.5% (Bells Beach) to 82% (Dixon Island) to 87% (Delambre Island) (Pendoley 2011). Nests on Dixon Island are currently subject to extensive predation, including by foxes, which has been identified as a key threatening process to turtle populations in general (Commonwealth of Australia 2003) and specifically the flatback turtle (DEWHA 2008). Significant predation by *Perentie* (the goanna *Varanus giganteus*) has been recorded on Delambre Island (Pendoley 2011, Oceanica 2012c). The reasons for the low emergence success at Bells Beach are unknown, but may be related to high sand temperatures and the shallower clutch depth (Pendoley 2011).







Figure 2 Location of turtle nesting during 2008/09 and 2010/11 nesting seasons





# Figure 3 Relative abundance of nesting flatback turtles at regional beaches in (a) January 2011 and (b) January 2009 (Pendoley 2010, 2011)

#### 2.3.1.2. MARINE MAMMALS

Aerial surveys were completed between 13 August 2009 and 29 July 2010, to record the abundance of marine mammals in the waters off Anketell Point. A total of 702 Humpback whale pods containing 1069 individual whales were sighted (Table 2). Humpback whale sightings decreased significantly between 24 September 2009 until 17 July 2010 (CWR 2010). A number of other marine mammals were also recorded (Table 2).

Table 2	Abundance of marine mammals recorded during aerial surveys (2009	9-2010)
	5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	

Date	Humpbacks	Dolphins	Dugongs
13/8/09	172	19	0
22/8/09	191	14	1
08/9/09	120	0	0
24/9/09	131	143	0
06/10/09	52	0	0
18/10/09	65	80	1
03/11/09	15	45	0
19/11/09	0	0	0
06/12/09	0	5	0
04/1/10	0	46	0



Date	Humpbacks	Dolphins	Dugongs
17/1/10	0	56	0
05/2/10	0	58	0
02/3/10	0	144	7
22/3/10	0	58	0
13/4/10	0	57	2
01/5/10	0	101	6
21/5/10	0	210	3
04/6/10	0	0	0
17/6/10	7	124	0
07/7/10	5	0	0
17/7/10	186	59	13
29/7/10	125	62	3
Total	1069	1281	36

## 2.3.1.3. MIGRATORY BIRDS

The area surrounding Anketell Point was surveyed intensively between October 2008 and February 2012, with surveys during the breeding season (April to August/early September), southern migration (August-November), northern migration (March/April) and non-breeding season (early November to early March) allowing the stages of key use of the area to be determined. The abundance of the most common species (Grey-tailed Tattler, Greater Sand Plover, Bar-tailed Godwit and Great Knot) was greatest during the southern migration (October 2010) and the nonbreeding season (January 2011, February 2012). This follows the pattern in Grey-tailed Tattler abundance recorded during migratory wader surveys conducted on Barrow Island where numbers peaked during the non-breeding season, and decreased during the breeding season (Bamford 2005). The Grey-tailed Tattler was abundant within the Anketell Point area (>1% of global population) and was considered a key species during the impact assessment (API 2010, 2011). The Greater Sand Plover is considered another key species due to the relatively high numbers (1094 (Summer 2011), 692 (Summer 2012)) recorded across the region during the majority of surveys, which approached 1% of the flyway population. Migratory wader diversity (number of species) was greatest during the period comprising the northward migration (March/April) and the non-breeding season (November-March) (AECOM 2011).

## 2.3.2 COMMONWEALTH MARINE AREA

Commonwealth waters start at the outer edge of State waters, generally 3 nautical miles from the shore (territorial sea baseline), and extend to the outer boundary of Australia's exclusive economic zone, 200 nautical miles from the territorial sea baseline (Director of National Parks 2013). Parts of two of the three proposed DMDAs fall in the Commonwealth Marine Area. Habitat mapping, and data collected during the sampling of sediment for physical characterisation (AECOM 2010a, Oceanica 2011b), has identified a range of benthic habitat types within Commonwealth waters, including soft sediment, filter feeder habitat and macroalgae (Figure 4).





Figure 4 Distribution of benthic habitats across the project area (groundtruthing points included)



## 2.4 BEHAVIOUR OF LISTED THREATENED AND MIGRATORY SPECIES

## 2.4.1 MARINE TURTLES

The path taken by hatchlings immediately following emergence from the clutch as they head toward the ocean (hatchling orientation) indicates the direction of light cues and identifies any impacts from artificial light sources. Any deviation from the most direct route to the ocean leaves hatchlings vulnerable to predators, dehydration and ultimately death (Salmon 2003). Hatchling orientation data were collected from suitable emergence sites. Clear 'fan' patterns, not obscured by hatchling tracks from other hatched clutches or adult tracks, bird or other animal tracks, were assessed at all regional nesting beaches surveyed during the 2010/11 season.

The methods used to document hatchling emergence pattern indices follow those developed by Pendoley (2005), based on Witherington et al. (1996). Typically the angle of spread of the tracks increases under the influence of light (both natural and artificial) while lights behind, or at the end of the beach, will cause overall hatchling orientation to shift away from a direct line to the ocean. The spread of the hatchling tracks was measured using a sighting compass to record the bearing along the outside arms of each fan (excluding outliers). The bearing was taken at the point where the tracks cross the high tide line, or from the nest for tracks that were orientated parallel to the ocean. The bearing of outliers (max. of 3 per nest) was measured and recorded separately. An angle of spread was then calculated from these bearings. The orientation of the tracks relative to the most direct line to the ocean is termed the 'offset angle' and is determined by calculating the angle between the most direct line to the ocean and the bearing bisecting the angle of spread of all tracks observed (Pendoley 2011).

Mean spread angles (and offset angles) for flatback hatchlings at nesting beaches across the Anketell Point region in 2011 were as follows:

- Bells Beach 65.2° (9.9°);
- Dixon Island 71.8° (10.8°);
- Delambre Island (NE) 55.7° (13.5°);
- Delambre Island (SE) 64.3° (7.4°); and
- Delambre Island (SW) 43.1° (11.2°).

Two samples were obtained from hawksbill hatchings at Delambre Island (NE). The mean spread angle was  $73^{\circ}$  and the mean offset angle was  $4.8^{\circ}$ . An Analysis of Variance (ANOVA) analysis showed that there were no significant differences between beaches with respect to either spread (p > 0.05) or offset (p > 0.05) angles, indicating that at the time of the survey no impacts from artificial light were occurring.

#### 2.4.2 MARINE MAMMALS

A small majority (52%) of whales observed during aerial surveys completed between 13 August 2009 and 29 July 2010 (refer Section 2.3.1.2) were resting/milling rather than swimming. The peak of the resting/milling behaviour occurred in late July, during a transition period between the northern and southern migrations. These animals were more widely dispersed, although a discreet concentration was recorded approximately 20 km west of the proposed shipping channel, in Nickol Bay, in water depths averaging 10 m (CWR 2010).

An investigation into the patterns of usage of Nickol Bay by southerly migrating Humpback whales was undertaken over a 20 day period between August 23 and September 13, 2010, using systematic vessel surveys (line surveys). Behaviour types observed were categorised as either



Active or Passive depending on whether splashing-type behaviours were observed. The behaviour was recorded (i.e., breaching, pectoral fin slapping, trumpeting, etc.) and swim categories were assigned, based on the following general categories; resting, milling, migrating, speed fast, speed medium and speed slow.

A total of 432 whales in 272 pods, including 10 calves, were observed during the line transects. The locations of pods recorded along the inshore transect are shown in Figure 5. The majority of Humpback whale pods sighted were classified as Passive, although there was a higher proportion of Active pods sighted along the offshore transect. The large majority (60% and 47%) of pods were Migrating (swimming), rather than Milling or Resting, at Medium (ca. 3-4 knots) speeds (CWR 2011).



Figure 5 Location of Humpback whale pods sighted along inshore transect during the vessel-based line surveys (23 August to 13 September 2010) (source: CWR 2011)

A total of 56 behavioural follows were also conducted, for approximately 30 minute periods, to record details of the behaviours displayed. The proportion of surface time each pod displayed Active, Passive, and Neutral behaviour was used to calculate a 'Pod Activity Index' (PAI). A total of 127 Humpback whales from 56 pods, 23 which were cow/calf pods, were observed during the behavioural follows. The maximum PAI (indicating active behaviour) was 0.76 (obtained from animals between 8 and 10 nautical miles from Anketell Point) while the lowest PAI was -0.70 (obtained from animals between 10 and 12 nautical miles from Anketell Point) (CWR 2011).



Results of the photo-identification of 118 individuals (including 23 cow/calf pods) completed during the vessel-based studies show that whales in this population are not resting for extended periods (> 24 hours) in Nickol Bay (CWR 2011).

### 2.4.3 MIGRATORY BIRDS

Numbers of the Grey-tailed Tattler recorded from the Proposal area and surrounds exceeded the threshold of 1% of the flyway population during surveys conducted in October 2010 (low tide count 501 birds, high tide count 662 birds), January 2011 (low tide count 399 birds, high tide count 641 birds) and February 2012 (low tide count 770, high tide count 1004) (AECOM 2011, Western Wildlife 2012).

A number of Grey-tailed Tattler were recorded roosting within the proposal envelope (261 birds in October 2010, 380 birds in January 2011, 319 birds in February 2012) (Figure 6). Survey of the wider area in January 2011 and February 2012 revealed that sites beyond the project envelope also support significant numbers of Grey-tailed Tattler (Far West Mudflats (151 in 2011, 291 in 2012), Lambert Bay East (83 in 2011, 83 in 2012), Central Cossack (47 in 2011, 11 in 2012) and Dixon Island South-west (31 in 2011, 38 in 2012)).

## 2.5 WATER QUALITY

Baseline water quality surveys of the Anketell Point region were undertaken between November 2007 and July 2009 (AECOM 2010b). Monitoring of a number of physical parameters, including temperature, photosynthetically active radiation (PAR) and turbidity was also undertaken at the long-term water quality and coral health monitoring sites during 2011 and 2012 (GHD 2012). A summary of the data collected is provided below.

Trace metal concentrations were generally low, falling below the ANZECC/ARMCANZ (2000) guideline levels for 99% species protection. Zinc was the exception, with naturally occurring concentrations above guideline values (AECOM 2010b).

Total suspended solid (TSS) concentrations measured at the surface and bottom of the water column were generally low (<6 mg/L) except during and following high energy weather events, such as in February 2009 following Tropical Cyclone Dominic, when concentrations exceeded 15 mg/L (AECOM 2010b) and in early 2011, when water samples collected after a series of tropical cyclones exhibited elevated concentrations (7.0-49.5 mg/L) (GHD 2012).





Figure 6 Abundance of Grey-tailed Tattler recorded at high tide roosts between 2008 and 2012



## 2.6 BENTHIC HABITAT

## 2.6.1 SUB-TIDAL HABITATS

Over the period 2008 to 2012 a number of separate habitat mapping exercises were completed across the project area, as follows (refer also Figure 4):

A. Mapping over wider area (2008/2009) (AECOM 2010a)

- Groundtruth method: Towed video over ~100m transects.
- Mapping method: 'Heat maps' presenting all data, application of mapping thresholds and interpolation to produce final habitat distribution.
- B. Mapping adjacent to islands/mainland (2008) (MScience 2008)
  - Groundtruth method: Towed video over ~100m to ~1km transects.
  - Mapping method: Examination of aerial imagery, bathymetry and classified video data to determine habitat boundaries (which were 'manually' mapped in a GIS).
- C. Mapping within/adjacent to proposed dredge material disposal areas (DMDAs) 2 and 3 (Oceanica 2011b)
  - Groundtruth method: Towed video over ~50m to ~150m transects.
  - Mapping method: Application of mapping thresholds and interpolation to produce final habitat distribution.
- D. Mapping of intertidal/shallow subtidal habitats in Bouguer Passage/adjacent to Anketell Point (WorleyParsons 2011, Wilson 2011, Wilson and Fromont 2011)
  - Groundtruth method: Diver-operated video transects, towed video inspection, low tide inspection.
  - Mapping method: Application of mapping thresholds and manual digitisation of habitat features to produce final habitat distribution.
- E. Additional mapping at Bells Reef, Bezout Island, Dixon Island, Poverty Island and '3m Reef' (Oceanica 2011b, Oceanica 2012b)
  - Groundtruth method: Towed video over ~50m to ~500m transects.
  - Mapping method: Application of mapping thresholds, interpolation and manual digitisation of habitat features to produce final habitat distribution.

The majority of the seabed offshore of Anketell Point consists of unvegetated soft sediment, with small patches of ephemeral seagrass and turf algae sometimes occurring inshore. Large areas of filter feeder habitat occur offshore, principally north of Bezout Island, and east of Delambre Island, beyond the offshore extent of the proposed channel. Discrete areas of filter feeder habitat also occur within Bouguer Passage, adjacent to Poverty Island and at '3m Reef'. Areas of significant benthic primary producer habitat (BPPH), dominated by hard coral habitat, occur in shallow water adjacent to islands and shoals (Dixon, Bezout and Delambre islands and Bells Reef) (Figure 4).

Macroalgae dominated BPPH is found adjacent to Bezout and Delambre islands. The distribution of seagrass, predominantly *Halophila ovalis*, in the region is sparse and ephemeral, and is generally limited to depths shallower than -6 to -10 m (CD). This is consistent with the findings of previous surveys in the region (Bertolino, 2006; Semenuik et al. 1982; Wells and Walker, 2003; SKM 2008). The majority of the subtidal habitat groundtruthing surveys undertaken for the Proposal were conducted between July and September 2009 (AECOM 2010a), which captures the expected period of growth (Spring) while avoiding the cyclone season, during which widespread seagrass mortality can occur (as widely reported from Exmouth Gulf following cyclone Vance). Groundtruthing undertaken at different times, including during surveys in nearshore areas (November 2008), during the collection of sediment samples (November 2009 and May 2011) and towed video within Bouguer Passage (October 2010 and March 2011), has similarly not recorded significant areas of seagrass habitat. Although the distribution and extent of seagrass patches is likely to vary



seasonally and annually, a dense and extensive cover has not been recorded in the region at any time.

Intensive surveys of hard coral habitat at a number of sites (Figure 4) has been completed between January 2011 and May 2013. A summary of the mean cover of major benthic community groups along replicate 15 m transects at each of the coral habitat monitoring sites is presented in Table 3.

Table 3	Summary of mean benthic community composition recorded through the initial
	12 month monitoring period (GHD 2012)

	Mean community composition (%)						
Site location	Hard coral	Macroalgae	Soft coral	Sponge	Dead coral	Sand/rubble	
DIXW	45.9	35.1	0	0.4	0.1	17.3	
ELPR	27.3	47	0	0.1	0.1	24.7	
DINE*	25	31.3	0	0	0	38.4	
ANKR	19.3	20.8	0.6	0.6	0.2	57	
BELL	14.9	44.8	1.5	0.5	0	36.6	
BEZI	50.6	35.4	0.1	0.3	0.1	13.3	
DLIE	21.4	19.9	0.2	1.6	0	55.8	
DLIW	29.6	50	2.2	0.2	0	13.1	

Notes: \*data from single initial site survey (June 2012) (GHD 2012)

Variations in live coral cover of  $\sim 3\%$  were routinely recorded between quarterly surveys at each monitoring site. No consistent trend (i.e. declining or increasing) in coral cover was evident during the programme.

Between January and March 2013 a regional coral bleaching event occurred across the Northwest Shelf, with widespread bleaching of corals occurring across the Dampier Archipelago, the Montebello Islands, adjacent to Barrow and Veranus islands (Middlebrook, pers comm.) and at some of API's long-term monitoring sites. Analysis of the transect photographs captured in May 2013 at API's long-term coral monitoring sites suggests that bleaching of between 1% (inshore sites) and >10% (offshore sites) of corals within each site occurred due to this bleaching event. Photographs captured at Anketell Point (ANKR), Bezout Island (BEZI) and Delambre Island (DLIW) during the May 2013 monitoring event are presented in Appendix 1. The degree of mortality associated with this bleaching event is not known.

Survey of filter feeder habitat during the range of habitat mapping programmes has found this habitat to be generally characterised by limestone pavement, often with a thin veneer of sand, supporting a mixed assemblage of sponges, soft corals and at some locations macroalgae and occasional hard corals. A summary of the mean cover of major benthic community groups at each proposed monitoring site is presented in Table 4.



# Table 4Summary of mean benthic community composition recorded at each filter<br/>feeder monitoring site

Site location	Hard coral	Sponge	Soft coral	Turf algae	Macro- algae	Dominant substrate
		Mea	n commu	inity com	nposition	(Score <sup>1</sup> )
FF05	0	3	4	3	1	Coarse/medium sand
FF06	0	4	5	3	1	Coarse/medium sand
FF07	0	3	4	0	5	Coarse/medium sand
FF08	0	4	4	2	1	Coarse/medium sand
FF09	0	4	4	1	0	Coarse/medium sand
FF10	1	2	1	1	5	Coarse/medium sand
FF11	0	4	3	0	0	Coarse/medium sand

*Notes:* <sup>1</sup>*Data derived from adjacent towed video transect surveyed in August/September 2009, scores defined in Appendix B of AECOM (2010b) and range from 0 (absent) to 9 (90-100% coverage or very high abundance).* 

## 2.6.2 MANGROVES

Monitoring of mangrove health at a number of sites at Anketell Point and on Dixon Island commenced in May 2011 and continued on a seasonal basis until May 2012.

The mangrove community can be considered, for the purposes of monitoring, as consisting of a band of seaward *Avicennia marina*, followed by a zone of *Rhizophora stylosa* and then finishing with a landward zone of *A. marina*. Any changes to these communities would be expected to occur in the *A. marina* occurring at the extreme landward and/or seaward end and therefore monitoring sites have been established within these upper and lower bands (Figure 7).





Figure 7 Mangrove survey sites (monitored between May 2011 and May 2012)



A selection of data collected during the initial baseline monitoring survey (May 2011) is presented in Table 5.

	Canopy Density				Percentage of Alive/Dead			
Site location	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Quarter 1	Quarter 2	Quarter 3	Quarter 4
DI 3a	0	50- 55	55	0	< 5	< 10	< 10	0
DI 3b	15-20	55	55	0	20- 25	30	20- 25	< 5
DI 4a	0	80- 85	75- 80	50- 60	<25	<25	<25	25-30
DI 4b	70-75	75- 80	85- 90	65-70	25-30	25	<25	<25
DI 5a	0	60- 65	20	70 - 75	25- 30	20- 25	20- 25	15- 20
DI 5b	0	75- 80	45- 50	65-70	<10	< 5	20- 25	35
A3a	80	65	50- 55	20-25	<25	20	<25	20
A3b	30- 35	60	50	0	30- 35	10- 15	15	15
A4a	20	80-85	90	50	<5	10	< 5	5- 10
A4b	65- 70	90	75	0	25- 30	< 5	< 5	5
А5а	90- 95	45	0	55	25	<25	<25	20-25
A5b	0	35	75-80	60	0	<25	50- 55	25- 50
A6	45- 50	45- 50	45- 50	65-70	<25	<25	<5	<5

#### Table 5 Baseline canopy and branch health data (SKM 2011)



# 3. MONITORING SURVEYS

## 3.1 OVERVIEW

A number of the environmental monitoring programmes required under the State approval address the requirements of the ERMP (Table 1). Several of these programmes were commenced, and ran for periods of months to > 1 year between 2010 to 2012, to collect baseline data to support the final impact assessment and inform the development of the proposed construction phase monitoring programmes. To fulfil the requirements of the ERMP, as defined in EPBC2009/5120 Condition 22, a number of additional survey programmes are also proposed. A summary of the monitoring programmes proposed to fulfil the requirements of the ERMP is provided in Table 6.

Environmental Factor	Survey method	Parameters	Survey timing	Survey programme title (if covered under other programme)
Coastal Processe	es			
Coastal processes*	Beach profiles	Distance/elevation Sediment type	Baseline surveys completed (April 2011, October 2011, May 2012) Six monthly monitoring during construction.	State of the Marine Environment Surveys programme (required under MS930) Coastal Habitat Management Plan (CHMP)
Condition of List Commonwealth	ed Threatened and Marine Area	I Migratory Species	Populations, associated	I habitat and the
Marine Turtles				
Fauna abundance*	Survey of regional turtle nesting (Anketell Point, Bells Beach, Dixon and Delambre islands)	Track counts	Baseline surveys completed (2008 to 2012) Annually during peak flatback nesting period (October to December)	Project A (Schedule 4) of MS930
Habitat health (coral habitat)*	Diver survey of fixed transects & tagged colonies	Coral cover Coral health	Baseline data (>24 months) already captured Approximately monthly monitoring during construction phase.	State of the Marine Environment Surveys programme (required under MS930) Dredge Environmental Management Plan (DEMP)
Habitat health (filter feeder habitat)	Towed video transects	Fauna abundance Morphological groups	Sampling prior to construction, mid- construction and post- construction	State of the Marine Environment Surveys programme (required under MS930)
Marine Mammals	5			
Cetacean distribution and abundance*	Recording of cetacean (including inshore dolphins) distribution and abundance within Anketell Point area	Aerial and vessel- based surveys	Baseline surveys (aerial surveys) completed between August 2009 and July 2010. Project to run over 3 years, 'baseline', 'during' and 'post' implementation studies proposed.	Project A (Schedule 4) of MS930
Migratory Birds				
Fauna	High tide counts	Species abundance,	Baseline completed	СНМР

#### Table 6Summary of survey programmes proposed under the ERMP



Environmental Factor	Survey method	Parameters	Survey timing	Survey programme title (if covered under other programme)
abundance*		diversity and distribution	2008 to 2012. Bi-annually during October (southward migration) and January (non-breeding season)	
Commonwealth	Marine Area			
Sediment quality	Grab samples	Inorganic contaminants (metals), particle size distribution	Within 3 months following completion of dredging and disposal	NA
Behaviour of List	ted Threatened and	d Migratory Species	;	
Marine Turtles				
Turtle hatchling emergence*	Measurement of hatchling emergence	Fan angle Offset angle	Annually during flatback hatchling emergence (January/February)	Light Management Plan (LMP)
Marine Mammals	5			
Humpback whale behaviour*	Recording of whale behaviour during southern migration	Active and passive behaviours Spatial distribution	Baseline behavioural study completed between August and September 2010. Project to run over 3 years, 'during' and 'post' implementation studies proposed.	Project B (Schedule 4) of MS930
Migratory Birds				
Fauna abundance*	High tide counts Low tide counts	Species abundance, diversity and distribution	Baseline completed 2008 to 2012. Bi-annually during October (southward migration) and January (non-breeding season)	СНМР
Water quality				
Water quality*	Loggers	Turbidity Temperature	Baseline surveys completed (February 2011 to October 2012) Continuous logging to re-commence prior to construction	DEMP
	Water samples	Total Suspended Solids (TSS) Sediment particle size distribution (PSD)	Baseline surveys completed (February 2011 to March 2012) Repeat sampling prior to construction, mid- construction and post- construction	State of the Marine Environment Surveys programme (required under MS930)
Benthic habitat				
Habitat health (coral habitat)*	Diver survey of fixed transects & tagged colonies	Coral cover Coral health	Baseline data (>24 months) already captured Approximately monthly monitoring during construction phase.	State of the Marine Environment Surveys programme (required under MS930) DEMP
Habitat health (filter feeder	Towed video transects	Fauna abundance Morphological	Sampling prior to construction, mid-	State of the Marine Environment Surveys



Environmental Factor	Survey method	Parameters	Survey timing	Survey programme title (if covered under other programme)
habitat)		groups	construction and post- construction	programme (required under MS930)
Habitat health (seagrass habitat)	health ss Numerous surveys completed to date by a number of independent consult of API and Rio Tinto, have recorded only relatively small areas of low den seagrass cover in proximity to the proposal area (Figure 4), unlikely to foraging areas for listed threatened and migratory species. Dedicated se are therefore not proposed as part of the ERMP. Surveys of all habitat t seagrasses, will be completed under the State of Marine Environment Surve (required under MS930).			
	Towed video transects	Dominant taxa Percentage cover	Sampling prior to construction, mid- construction and post- construction	State of the Marine Environment Surveys programme (required under MS930)
Habitat health (mangrove habitat)*	Fixed quadrat surveys	Canopy cover Overall health Leaf colour	Baseline surveys completed (May 2011, November 2011, May 2012) Six monthly monitoring during construction.	State of the Marine Environment Surveys programme (required under MS930) CHMP

Notes: \*Baseline monitoring programme previously commenced.



## 3.2 BASELINE STATE OF THE MARINE ENVIRONMENT (CONDITION 22A)

The previously completed or proposed future surveys nominated to describe the baseline state of the marine environment are summarised below (Table 7). More detailed information on each programme is provided in the following sub-sections.

Environmental Factor	Survey method	Parameters	Survey timing	Collection of further baseline data proposed
Coastal processes*	Beach profiles	Distance/elevation Sediment type PSD	Baseline surveys completed (April 2011, October 2011, May 2012)	Additional baseline survey proposed within 3 months prior to project implementation
Turtle abundance*	Survey of regional turtle nesting (Anketell Point, Bells Beach, Dixon and Delambre islands)	Track counts	Baseline surveys completed (2008 to 2012)	No
Habitat health (coral habitat)*	Diver survey of fixed transects & tagged colonies	Coral cover Coral health	Baseline data already captured (2011-2013)	Additional baseline survey proposed within 3 months prior to project implementation
Habitat health (filter feeder habitat)	Towed video transects	Fauna abundance Morphological groups		Survey of subtidal filter feeder habitats to be completed within 3 months prior to project implementation
Marine mammal abundance*	Recording of cetacean distribution and abundance	Counts during aerial and vessel- based surveys	Baseline abundance surveys (aerial surveys) completed between August 2009 and July 2010. Vessel-based survey completed in August/September 2010	To be determined by DPaW
Migratory bird abundance*	High tide counts of migratory birds	Species abundance, diversity and distribution	Baseline completed 2008 to 2012.	No
Sediment quality*	Grab samples	Inorganic contaminants (metals), particle size distribution (PSD)	Baseline PSD data from proposed DMDAs previously collected (2010) Data on chemical composition of surface sediments (dredge footprint) previously collected (2009/2010).	No
Turtle hatchling emergence*	Measurement of hatchling emergence	Fan angle Offset angle	Baseline data collected (2011/2012)	No
Humpback whale behaviour*	Recording of whale behaviour during southern	Active and passive behaviours	Baseline behavioural study completed in August/September	No

 Table 7
 Summary of baseline state of the marine environment survey programme



Environmental Factor	Survey method	Parameters	Survey timing	Collection of further baseline data proposed
	migration	Spatial distribution	2010	
Water quality*	Loggers	Turbidity Temperature	Baseline surveys completed (February 2011 to October 2012)	No
	Water samples	Total Suspended Solids (TSS) Sediment particle size distribution (PSD)	Baseline surveys completed (February 2011 to March 2012)	Additional baseline survey proposed within 3 months prior to project implementation
Habitat health (mangrove habitat)*	Fixed quadrat surveys	Canopy cover Overall health Leaf colour	Baseline surveys completed (May 2011, November 2011, May 2012)	Additional baseline survey proposed within 3 months prior to project implementation

Notes: \*Baseline monitoring programme previously completed/commenced.



## 3.3 COASTAL PROCESSES (CONDITION 22B)

#### 3.3.1 COASTAL PROCESSES MONITORING SITES

A number of beach profiles have previously been surveyed along the north-east, east and southeast coasts of Dixon Island and east and west of Anketell Point (Figure 8), in autumn (April/May) and spring (October/November).



#### Figure 8 Baseline beach profile monitoring sites at Anketell Point and Dixon Island

## 3.3.2 COASTAL PROCESSES MONITORING METHODS

Profiles were established perpendicular to the coast and typically extended from wading depth to the swale of the primary dune. Significant inflection points and features were recorded including:

- Vegetation Line;
- Sand;
- Coral rubble
- Rock rubble;
- Rock platform;
- Storm debris line;
- High tide line;
- Water line;
- Wrack line;
- Upper swash limit; and
- Lower swash limit

The beach profiles will be measured using a Real Time Kinematic Global Positioning System (RTK GPS) with an estimated accuracy of  $\pm 0.05$  m vertical and  $\pm 0.12$  m horizontal (horizontal datum GDA94 MGA Zone 50, vertical datum Australian Height Datum (AHD)). Temporary benchmarks,



setup from a regional Standard Survey Mark, have been established on Dixon Island and at Anketell Point. Sediment samples will be collected from selected points and analysed for particle size distribution (PSD).

Beach profiles and sediment physical characteristics will be analysed to determine any proposalrelated changes and reconcile against predicted long-term effects of proposal infrastructure.

## 3.4 CONDITION OF LISTED THREATENED AND MIGRATORY SPECIES (CONDITION 22C)

### 3.4.1 MARINE TURTLES

Annual track counts (over  $a \ge 5$  day period) will be completed during the peak flatback nesting period (mid-December to end January) during the construction period and during the first year of operations. Counts will be completed at regional nesting beaches including at Anketell Point, Bells Beach and Dixon and Delambre islands. Specific survey details, such as the number of sites and the duration of the surveys, will be determined by the WA Department of Parks and Wildlife (DPaW) (formerly the Department of Environment and Conservation) under the governance arrangements for Project A.

#### 3.4.2 MARINE MAMMALS

The density and distribution of cetaceans, including the Indo-Pacific Humpback dolphin and other inshore dolphin species, and with a particular focus on Humpback whales, will be recorded during systematic vessel surveys, completed during the construction phase, including at the peak of the Humpback whale southern migration (August). It is expected that the survey design will be similar to that previously implemented during the baseline period (CWR 2011), with the survey completed along a number of pre-defined transects through the area adjacent to construction activities, but specific survey details such as the length and location of vessel transects and the duration of the surveys may vary. The objectives of the study will include (1) investigation of the occurrence of cetaceans, including inshore dolphins and Humpback whales, in the area surrounding Anketell Point, and (2) the completion of multi-year studies of the distribution, abundance and habitat preference of the inshore dolphin species present, and of Humpback whales. The specific survey design will be determined by DPaW under the governance arrangements for Project A, required under MS930.

The results of this programme will be used to inform the adaptive management of the Anketell Port construction programme.

## 3.4.3 MIGRATORY BIRDS

Survey of migratory waders will be completed through targeted on-ground counts of shorebird species at high tide roosts across the Anketell Point area, with the survey area divided up into the following sub-areas (to maintain consistency with the baseline survey methods): Cleaverville, Far West Mudflats, Mainland Mangroves, Dixon Island, Mudflats, Mainland and North East Island (Poverty Island) (AECOM 2011).

Counts will be timed to coincide with the expected maximum annual abundance of the dominant migratory species (October and January/February each year), and will be completed during the construction phase and for one year during the commissioning/operations phase. Counts are not proposed during the northern hemisphere breeding season as previous survey (July 2009) has indicated a very low usage of the survey area during this phase of the annual migration.



The data collected will include abundance estimates for each species at roosts within each sub-area to allow the determination of species diversity and the level of usage of the area during and following project implementation.

#### 3.4.4 COMMONWEALTH MARINE AREA

Sediment quality and physical characteristics (particle size distribution) will be monitored within the Commonwealth marine area, within and adjacent to two of the three dredge material disposal areas (DMDAs) (Figure 9) to confirm that no contamination of surface sediments (contaminant concentrations above screening levels, Commonwealth of Australia 2009), or significant change to physical characteristics of sediment outside the predicted zone of impact (500 m radius around DMDAs), have occurred. Grab samples will be collected to determine the surface ( $\leq$  10 cm) concentrations of inorganic contaminants (metals) and the sediment particle size (Table 8). Sampling will be completed during a pre-implementation survey within three months following the completion of dredging.

Analyte <sup>1</sup>	Limit of Reporting (mg/kg)	Screening level (mg/kg) <sup>2</sup>	Analysis method
Moisture content	1%	NA	Oven dried
Antimony	1.0	2.0	
Arsenic	1.0	20	
Nickel	1.0	21	Strong acid digest
Chromium	1.0	80	
Copper	1.0	65	
Particle size	0.01%	NA	Sieving (> 106 µm) Sedigraph/laser diffraction (106 – 2 µm)

Notes:

<sup>1</sup>Detected above the 1/10 screening level (Oceanica 2010)

<sup>2</sup>National Assessment Guidelines for Dredging (Commonwealth of Australia 2009)





Figure 9 Proposed sediment sampling sites



## 3.5 BEHAVIOUR OF LISTED THREATENED AND MIGRATORY SPECIES (CONDITION 22D)

#### 3.5.1 MARINE TURTLES

Monitoring of the mean spread angle and offset angle for emerging flatback hatchlings will be recorded annually in February at nesting beaches at Anketell Point (if nesting occurs), Dixon, Delambre and Legendre islands and Bells Beach, to determine whether any behavioural change occurs as a result of the implementation of the proposal. Monitoring will completed during the construction phase and once following the commencement of operations.

#### 3.5.2 MARINE MAMMALS

The behaviour of Humpback whales will be recorded during systematic vessel surveys, completed during the construction phase including at the peak of the Humpback whale southern migration (August). Specifically, Humpback whale distribution and behaviour patterns will be examined in relation to pile driving and other construction activities, including shipping movements, using passing mode (vessel does not deviate from trackline) line transects.

Behavioural follows of randomly selected whale pods will also be conducted, during ~30 minute periods, at varying distances from active pile driving and other construction activities. Sea noise levels will be recorded concurrently to establish received noise levels for the observed pods. Attempts to correlate behaviour patterns to received noise levels will be made. It is expected that the survey design will be similar to that previously implemented during the baseline period (CWR 2011), but specific survey details, such as the length and location of vessel transects and the duration of the surveys, will be determined by DPaW under the governance arrangements for Project B required under MS930.

The objectives of the study will include (1) investigation of the occurrence of active and passive behaviours within the observed whale pods in the area surrounding Anketell Point, and (2) data analysis to determine any links between the observed behaviour and the received underwater noise levels and/or proximity to construction activities.

The results of this study will be used to inform the adaptive management of the Anketell Port construction programme.

#### 3.5.3 MIGRATORY BIRDS

Survey of migratory waders will be completed through targeted on-ground counts of shorebird species at high tide roosts across the Anketell Point area, with the survey area divided up into the following sub-areas (to maintain consistency with the baseline survey methods): Cleaverville, Far West Mudflats, Mainland Mangroves, Dixon Island, Mudflats, Mainland and North East Island (Poverty Island) (AECOM 2011).

Counts will be timed to coincide with the expected maximum annual abundance of the dominant migratory species (October and January/February each year), and will be completed during the construction phase and for one year during the commissioning/operations phase. Counts are not proposed during the northern hemisphere breeding season as previous survey (July 2009) has indicated a very low usage of the survey area during this phase of the annual migration.

The data collected will include abundance estimates for each species at roosts within each sub-area to allow the determination of species diversity and the effects of the construction of the proposal on the roosting behaviour of migratory birds.



Low tide on-ground (or from a vessel) counts will also be completed to record the abundance of migratory birds foraging within the intertidal areas adjacent to Anketell Point, including in Bouguer Passage.

## 3.6 WATER QUALITY (CONDITION 22E)

#### 3.6.1 WATER QUALITY SURVEY SITES

A summary of the survey sites used for the baseline long-term coral health monitoring programme (and to be utilized through the construction phase), including location and approximate water depths, is provided in Table 10.

Site location	Water depth (MSL)	Easting	Northing
Dixon Island West (DIXW)	6.3	504931	7718814
Elephant Rock (Dixon Island) (ELPR)	5.7	507853	7720481
Dixon Island North East (DINE)	5.9	509150	7720700
Anketell 'Rock' (Anketell Point) (ANKR)	6.4	510625	7719725
Bell's Reef (BELL)	6.3	514906	7723849
Bezout Island (BEZI)	6.8	517847	7727150
Delambre Island East (DLIE)	8.8	509772	7737600
Delambre Island West (DLIW)	5.7	506891	7737172

#### Table 9 Long-term water quality monitoring site coordinates (GDA94, MGA50)

#### 3.6.2 SUMMARY OF WATER QUALITY SURVEY METHOD

At each monitoring site, a manual download Wetlabs ECO-NTU turbidity and temperature logger will be deployed 0.5m above the seabed for the duration of the marine works. These instruments were selected for their quality and reliability on the basis of past performance within the Pilbara. Each logger will be setup to collect data 'bursts' approximately every 15 minutes, and will be downloaded on an approximately monthly basis.

Duplicate grab water samples will be collected with a 5L van Dorn or Niskin bottle (or similar) from near-surface (1 m below) and near-bottom (1 m above) for analysis of particle size distribution (PSD) and total suspended sediment (TSS). TSS samples will be sent to the laboratory for filtration and analysis. PSD samples will be sent for analysis via laser diffraction. During each survey vertical profiles of temperature, conductivity, turbidity and PAR will also be captured with a probe.



## 3.7 BENTHIC HABITAT (CONDITIONS 22C AND 22F)

## 3.7.1 HARD CORAL HABITAT MONITORING SITES

A summary of the survey sites used for the long-term coral health monitoring programme (to be continued through the construction phase), including location and approximate water depths, is provided in Table 10 (refer Figure 4).

Table 10 Long-term coral health monitoring site coord	inates (GDA94, MGA50)
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Site location	Water depth (MSL)	Easting	Northing
Dixon Island West (DIXW)	6.3	504931	7718814
Elephant Rock (Dixon Island) (ELPR)	5.7	507853	7720481
Dixon Island North East (DINE)	5.9	509150	7720700
Anketell 'Rock' (Anketell Point) (ANKR)	6.4	510625	7719725
Bell's Reef (BELL)	6.3	514906	7723849
Bezout Island (BEZI)	6.8	517847	7727150
Delambre Island East (DLIE)	8.8	509772	7737600
Delambre Island West (DLIW)	5.7	506891	7737172

## 3.7.2 SUMMARY OF HARD CORAL HABITAT SURVEY METHOD

At each monitoring site, four permanently marked, 15 m transects, have been established within coral habitat.

Adapted from the approach of Brown et al. (2004) a diver will swim above the centreline of each transect, holding a digital still camera approximately 0.5 m above the seabed in order to obtain a series of overlapping photographs.

Fifteen images will be selected at random from each of the four transects (60 images per site) and assessed by plotting ~60 points over each frame in a 'stratified-random' distribution for subsequent assessment with Coral Point Count with Excel extensions (CPCe) to estimate benthic cover at each site.



## 3.7.3 PROPOSED FILTER FEEDER SURVEY SITES

A summary of the survey sites proposed under the State of Marine Environment Surveys programme (required under MS930), including location and approximate water depths, is provided in Table 11 (refer Figure 10).

To provide for the monitoring of habitat within the Commonwealth marine area, a number of additional monitoring sites are proposed under the ERMP (Table 11, Figure 11).

# Table 11 Proposed filter feeder habitat monitoring site (State waters) coordinates (GDA94, MGA50)

Site name	Location	Approximate water depth (CD)	Easting	Northing
FF05	State waters	-12	518917	7728779
FF06	State waters	-14	518345	7729814
FF07	State waters	-8	514453	7733051
FF08	State waters	-12	517362	7738761
FF09	State waters	-19	515946	7740064
FF10	State waters	-14	513406	7739422
FF11	State waters	-26	513433	7744516
FF_CMA_1	Commonwealth waters	17	518850	7738829
FF_CMA_2	Commonwealth waters	107	521083	7739261
FF_CMA_3	Commonwealth waters	11	522326	7738450
FF_CMA_4	Commonwealth waters	11	522031	7737333





Figure 10 Proposed filter feeder habitat survey sites (State waters)





Figure 11 Proposed filter feeder habitat survey sites (Commonwealth marine area)



### 3.7.4 PROPOSED FILTER FEEDER SURVEY METHODS

At each monitoring site, five randomly located 50 m transects, will be surveyed using towed video during each survey, within 250 m of a central point (Figure 12). The video camera will be towed at an angle of  $\sim 45^{\circ}$  approximately 0.5 m above the seabed in order to obtain high quality imagery.

To characterise the filter feeder community during each survey, the following counts will be made along each transect:

- Total large hard coral colonies (> 20 cm diameter)
- Total large sponges (> 10 cm in any plane), classified by major morphological group;
  - o erect,
  - o erect-branching,
  - o massive,
  - o hollow-massive, and
  - o encrusting.
- Total of large soft corals (> 20 cm in any plane) (including sea whips, gorgonians)



Figure 12 Conceptual subtidal filter feeder monitoring site arrangement



## 3.7.5 PROPOSED SEAGRASS SURVEY SITES

Under the 'Habitat Distribution' component of the State of Marine Environment Surveys programme (required under MS930) a number of towed video transects will be surveyed across previously mapped habitat boundaries to confirm the pre-construction extent, and characteristics, of major habitat units. Indicative towed video transect locations are presented in Figure 13 and include transects within the range of previously identified habitats, including seagrass habitat to the NE of Anketell Point and within a mixed habitat, including seagrass, in an area known as '3m Reef' (adjacent to filter feeder monitoring site 'FF07') (Figure 13). Sites established during the Pre-development survey will be used consistently during the subsequent surveys (Mid-term and Post-development surveys and as required during second Post-development survey).

## 3.7.6 PROPOSED SEAGRASS HABITAT SURVEY METHODS

Habitat groundtruthing will involve the capture of geo-referenced underwater video footage to confirm the extent and characteristics of benthic habitats, within 3 months prior to commencement of construction. The density and species composition of any seagrass habitat surveyed during the programme will be recorded.

Subsequent mid-term and post-development groundtruthing of benthic habitats will be completed to confirm any change in habitat characteristics or extent. Additional groundtruthing of benthic habitats may be completed during a second post-development survey, if required to evaluate whether the temporal nature of any impacts above the predictions are short-term and reversible.





Figure 13 Indicative towed video transect locations (proposed coral and filter feeder habitat monitoring sites shown for reference)



## 3.7.7 MANGROVE SURVEY SITES

The location of the survey sites, which are the same as those monitored as part of the long-term mangrove health monitoring programme which commenced in May 2011, is indicated in Figure 7. Surveys will be completed twice a year, in autumn (April/May) and spring (October/November).

#### 3.7.8 SUMMARY OF MANGROVE SURVEY METHOD

At each site permanent quadrats have been established to monitor a number of sediment and mangrove based characteristics. The quadrats measure 10 m by 10 m and include three,  $1 m^2$  permanent quadrats established at the seaward and backward edge of the mangroves where accessible.

Sediment based characteristics to be measured include:

- Pore water salinity (using simple permanent piezometers)
- Faunal burrow density (quadrat count of surface burrows)
- Pneumatophore density in the seaward and landward *A. marina* zone (quadrat count)
- Sediment height (using metal pegs) at 10 m quadrat corners and 1 m quadrat pegs

The mangrove characteristics to be measured at each site include:

- Overall health as being alive or dead
- Leaf colour recorded as green, yellow green and yellow (with quantitative proportions)
- Canopy density as being high, moderate and low
- Proportion of tree that is dead (categories of < 25%, 25-50%, 50-75% and >75%)
- Absence or presence of dead branches (and proportions if necessary).



## 4. IMPLEMENTATION AND REPORTING TIMEFRAMES (CONDITION 22G)

## 4.1 BASELINE STATE OF THE MARINE ENVIRONMENT OF THE ANKETELL POINT REGION

The results of the baseline state of marine environment monitoring surveys will be submitted to the Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) within three months following project implementation. This includes a summary of the results of studies completed prior to the pre-implementation phase (the three month period prior to project implementation during which additional surveys are proposed (Table 7)), as outlined in Table 12.

Environmental Factor	Survey method	Parameters	Survey timing	Reporting	
Coastal Processe	es				
Coastal processes*	Beach profiles	Distance/elevation Sediment type PSD	Baseline surveys completed (April 2011, October 2011, May 2012) Additional baseline survey proposed within 3 months prior to project implementation	Report providing summary of baseline surveys (2011-2012) and pre- implementation survey	
Condition of List Commonwealth	ed Threatened and Marine Area	I Migratory Species	Populations, associated	I habitat and the	
Marine Turtles					
Fauna abundance*	Survey of regional turtle nesting (Anketell Point, Bells Beach, Dixon and Delambre islands)	Track counts	Baseline surveys completed (2008 to 2012)	Report providing summary of baseline surveys (2010/2011)	
Habitat health (coral habitat)*	Diver survey of fixed transects & tagged colonies	Coral cover Coral health	Baseline data already captured (2011-2013) Additional baseline survey proposed within 3 months prior to project implementation	Report providing summary of baseline surveys (2011-2013) and pre- implementation survey	
Habitat health (filter feeder habitat)	Towed video transects	Fauna abundance Morphological groups	Survey of subtidal filter feeder habitats to be completed within 3 months prior to project implementation	Report providing summary of pre- implementation survey	
Marine Mammals					
Cetacean distribution and abundance*	Recording of cetacean (including inshore dolphins and the Humpback whale) distribution and abundance within Anketell Point area	Aerial and vessel- based surveys	Baseline abundance surveys (aerial surveys) completed between August 2009 and July 2010. Vessel-based survey completed in August/September 2010	Report providing summary of baseline surveys (2009-2010) (and additional pre- implementation survey if undertaken)	

Table 12	Summary of baseline	e reporting for each	monitoring program
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Environmental Factor	Survey method	Parameters	Survey timing	Reporting	
Migratory Birds					
Fauna abundance*	High tide counts	Species abundance, diversity and distribution	Baseline completed 2008 to 2012	Report providing summary of baseline surveys (2008-2012)	
Commonwealth	Marine Area				
Sediment quality*	Grab samples	Inorganic contaminants (metals), particle size distribution (PSD)	Baseline PSD data from proposed DMDAs previously collected (2010) Data on chemical composition of surface sediments (dredge footprint) previously collected (2009/2010).	Report providing summary of baseline surveys (2011, 2012)	
Behaviour of List	ted Threatened and	d Migratory Species	5		
Marine Turtles					
Turtle hatchling emergence*	Measurement of hatchling emergence	Fan angle Offset angle	Baseline data collected (2011/2012)	Report providing summary of baseline surveys (2011/2012)	
Marine Mammals	6				
Humpback whale behaviour*	Recording of whale behaviour during southern migration	Active and passive behaviours Spatial distribution	Baseline behavioural study completed in August/September 2010	Report providing summary of baseline study (2010)	
Migratory Birds					
Fauna abundance*	High tide counts Low tide counts	Species abundance, diversity and distribution	Baseline completed 2008 to 2012. Bi-annually during October (southward migration) and January (non-breeding season)	Report providing summary of baseline surveys (2008 to 2012)	
Water quality					
Water quality*	Loggers	Turbidity Temperature	Baseline surveys completed (February 2011 to October 2012)	Report providing summary of baseline surveys (2011-2012)	
	Water samples	Total Suspended Solids (TSS) Sediment particle size distribution (PSD)	Baseline surveys completed (February 2011 to March 2012) Additional baseline survey proposed within 3 months prior to project implementation	Report providing summary of baseline surveys (2011-2012) and pre- implementation survey	
Benthic habitat					
Habitat health (coral habitat)*	Diver survey of fixed transects & tagged colonies	Coral cover Coral health	Baseline data (>24 months) already captured Approximately monthly monitoring during construction phase.	Report providing summary of pre- implementation survey	
Habitat health (filter feeder habitat)	Towed video transects	Fauna abundance Morphological groups	Sampling prior to construction, mid- construction and post- construction	Report providing summary of pre- implementation survey	



Environmental Factor	Survey method	Parameters	Survey timing	Reporting
Habitat health (seagrass habitat)	Towed video transects	Dominant taxa Percentage cover	Sampling prior to construction, mid- construction and post- construction	Report providing summary of pre- implementation survey
Habitat health (mangrove habitat)*	Fixed quadrat surveys	Canopy cover Overall health Leaf colour	Baseline surveys completed (May 2011, November 2011, May 2012) Additional baseline survey proposed within 3 months prior to project implementation	Report providing summary of baseline surveys (2011-2012) and pre- implementation survey

Notes: \*Baseline monitoring programme previously commenced.



## 4.2 POST-IMPLEMENTATION MONITORING OF COASTAL PROCESSES, LISTED THREATENED AND MIGRATORY SPECIES, WATER QUALITY AND BENTHIC HABITAT

The results of all post-implementation monitoring will be submitted to DSEWPaC annually, within 3 months of the anniversary of project implementation, as outlined in Table 13.

#### Table 13 Summary of post-implementation reporting for each monitoring program

Environmental Factor	Survey method	Parameters	Survey timing	Reporting	
Coastal Processe	es				
Coastal processes	Beach profiles	Distance/elevation Sediment type PSD	Six monthly monitoring (autumn and spring) during construction.	Annual reporting covering spring and autumn surveys	
Condition of List Commonwealth	ed Threatened and Marine Area	I Migratory Species	Populations, associated	I habitat and the	
Marine Turtles					
Fauna abundance	Survey of regional turtle nesting (Anketell Point, Bells Beach, Dixon and Delambre islands)	Track counts	Annually during peak flatback nesting period (October to December)	Annual reporting covering full year of nesting activity	
Habitat health (coral habitat)	Diver survey of fixed transects & tagged colonies	Coral cover Coral health	Approximately monthly monitoring during construction phase.	Annual reporting covering full year of monthly (indicative) surveys	
Habitat health (filter feeder habitat)	Towed video transects	Fauna abundance Morphological groups	Sampling prior to construction, mid- construction and post- construction	Reporting of 'mid- term' and 'post- construction' monitoring within relevant annual report	
Marine Mammals	5				
Fauna abundance	Recording of cetacean abundance (including inshore dolphin species and the Humpback whale)	Counts during vessel-based surveys	Project to run over 3 years, 'during' and 'post' implementation studies proposed.	Reporting of 'during' and 'post' surveys within relevant annual report	
Migratory Birds					
Fauna abundance	High tide counts	Species abundance, diversity and distribution	Bi-annually during October (southward migration) and January (non-breeding season)	Annual reporting covering preceding October and January/February surveys	
Commonwealth Marine Area					
Sediment quality	Grab samples	Inorganic contaminants (metals), particle size distribution	Within 3 months following completion of dredging and disposal	Reporting of 'post- construction' survey within relevant annual report	
Behaviour of Listed Threatened and Migratory Species					
Marine Turtles					
Turtle hatchling emergence	Measurement of hatchling emergence	Fan angle Offset angle	Annually during flatback hatchling emergence	Annual reporting covering full year of nesting activity	



Environmental Factor	Survey method	Parameters	Survey timing	Reporting
			(January/February)	
Marine Mammals	5			
Humpback whale behaviour	Recording of whale behaviour during southern migration	Active and passive behaviours Spatial distribution	Project to run over 3 years, 'during' and 'post' implementation studies proposed.	Reporting of 'during' and 'post' surveys within relevant annual report
Migratory Birds				
Fauna abundance	High tide counts	Species abundance, diversity and distribution	Bi-annually during October (southward migration) and January (non-breeding season)	Annual reporting covering preceding October and January/February surveys
Water quality				
Water quality	Loggers	Turbidity Temperature	Continuous logging to re-commence prior to construction	Annual reporting covering full year of monthly (indicative) surveys
	Water samples	Total Suspended Solids (TSS) Sediment particle size distribution (PSD)	Repeat sampling prior to construction, mid- construction and post- construction	Reporting of 'mid- term' and 'post- construction' monitoring within relevant annual report
Benthic habitat				
Habitat health (coral habitat)	Diver survey of fixed transects & tagged colonies	Coral cover Coral health	Approximately monthly monitoring during construction phase.	Annual reporting covering full year of monthly (indicative) surveys
Habitat health (filter feeder habitat)	Towed video transects	Fauna abundance Morphological groups	Sampling prior to construction, mid- construction and post- construction	Reporting of 'mid- term' and 'post- construction' monitoring within relevant annual report
Habitat health (seagrass habitat)	Towed video transects	Dominant taxa Percentage cover	Sampling prior to construction, mid- construction and post- construction	Reporting of 'mid- term' and 'post- construction' monitoring within relevant annual report
Habitat health (mangrove habitat)	Fixed quadrat surveys	Canopy cover Overall health Leaf colour	Six monthly monitoring during construction.	Annual reporting covering preceding spring and autumn surveys



# 5. SUMMARY

To address the requirement for an Ecosystem Research and Monitoring Program (ERMP), as stipulated in EPBC 2009/5120 Conditions 22 and 23, API proposes to implement/fund the following survey programmes:

- State of the Marine Environment Surveys programme (required under MS930)
- Coastal Habitat Management Plan (CHMP) (required under MS930)
- Dredge Environmental Management Plan (DEMP) (required under MS930)
- Light Management Plan (LMP) (required under MS930)
- Project A (required under Schedule 4 of MS930)
- Project B (required under Schedule 4 of MS930), and
- Condition of Commonwealth Marine Area surveys independent programmes proposed to fulfil the requirements of Condition 22, as follows:
  - o Sediment quality; and
  - o Benthic habitat.



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## APPENDIX 1. SELECTED CORAL TRANSECT PHOTOGRAPHS (MAY 2013)





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# APPENDIX 2.

## MANGROVE PHOTO-MONITORING DATASET (OCTOBER 2012)















