

Marine Habitat Assessment East Arm Wharf Expansion Project

Draft Technical Memo

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1. Background

To satisfy the 'Further Information Request' (NRETAS, 2011) in response to the Supplementary Environmental Impact Statement (EIS) for the East Arm Wharf (EAW) Development, Geo Oceans was commissioned by URS to update the marine habitat distribution maps in of Darwin Harbour. This project involved collating habitat data collected during projects commissioned by the Department of Lands and Planning (DLP) as part of the EAW EIS with existing habitat and marine species distribution data.

1.1. Objectives

1. Produce a marine habitat map quantifying the spatial area of the different marine habitats (i.e. hard coral, macroalgae, filter feeders, soft coral, seagrass) in the areas predicted to be influenced by the East Arm Wharf development.
2. Show MAGNT records for listed, threatened and/or migratory species under the EPBC Act 1999;
3. Determine which species found within the East Arm study area have not been recorded elsewhere within Darwin Harbour; and
4. Provide species lists for filter feeder and coral habitats in East Arm.

2. Marine Habitat and Construction Impact Predictions

2.1. BMT WBM Point Data Reclassification

The BMT WBM (2010) habitat maps were verified using towed video transect and benthic trawl methods to collect data of the benthic communities. The abundance of benthic fauna per transect was determined post field work by manually counting individuals or colonies (for colonial animals) during video playback. The habitat (community) classes were then classified using non-metric multidimensional scaling (nMDS) plots with PRIMER 6.1.6. to group communities that were similar. This resulted in 9 different habitat classes. Similarity percentage SIMPER routines were used to provide an empirical estimate of the types of taxa constituting each habitat class; defining the habitat type.

Geo Oceans reviewed the habitat classification data provided by BMT WBM (2010), including the data of the counts of each species (a summary of the data is listed in Appendix 2). The data indicated that the BMT WBM (2010) method of habitat classification was not consistent with the INPEX habitat classification method (Geo Oceans, 2010) and that there were inconsistencies in the data for some of the transect points. For example, the class 'Scleractinian Reef' (hard coral) class included counts of hard coral colonies ranging from 0 to 37 colonies and for the 'Moderate-High Density Sponge and Soft Coral Beds' class the counts of Soft Coral and Sponge ranged from 4 to 186 counts. The video transects classed as 'Scleractinian Reef' and 'Moderate-High Density Sponge and Soft Coral Beds' were reclassified by reanalysing the video footage from the transects. The video was reclassified using a qualitative estimate of percent cover of the biota classes,



similar to the method used for the INPEX EIS (INPEX 2011), across the entire transect.

The (BMT WBM, 2010) method of using nMDS ordinations to define habitat classes was different to the method used in the Geo Oceans (2010) report for the INPEX EIS (INPEX, 2010) which used estimates of biota percent cover to define habitat classifications; In the INPEX EIS the biota were identified down to a fine taxonomic level and grouped into broad habitat classes using a hierarchical habitat classification scheme (**Appendix 1**). The percent cover threshold decision rules for habitats present for hard coral, filter feeders and macroalgae habitat classes were greater than 10% cover; and for the seagrass habitat class were greater than 1% cover. The results of the reclassification for all of the BMT WBM transects are listed in Appendix 2.

2.2. BMT WBM Polygon Reclassification

The GIS shapefiles provided by BMT WBM only included the polygon boundaries and did not contain any attribute fields for habitat type. Geo Oceans added the 'Habitat_cl' field to the shapefile and classified this field with the 9 habitat classifications listed in section 3.1 of BMT WBM (2010) report. The polygons were manually classified using the figures 3-16, 3-17 and 3-18 from BMT WBM (2010) to identify the habitat types. This created a polygon shapefile that is assumed to have identical habitat classifications as the spatial data displayed in the maps in BMT WBM (2010).

The BMT WBM maps were produced using point-based interpolations, where class boundaries were estimated using a combination of substrate texture, bathymetry, position in the estuary and the identity of nearby points. However, because the points were reclassified (as described in section 2.1) all of the habitat polygons that intersected a video point that had been reclassified, was revised. These revised polygons were recreated by manual digitisation of the habitat boundaries by tracing the bathymetry contours created from the IX Survey (IX Survey, 2010) geotechnical data. The revised habitat boundaries and reclassified video data points are shown in Figure 1.

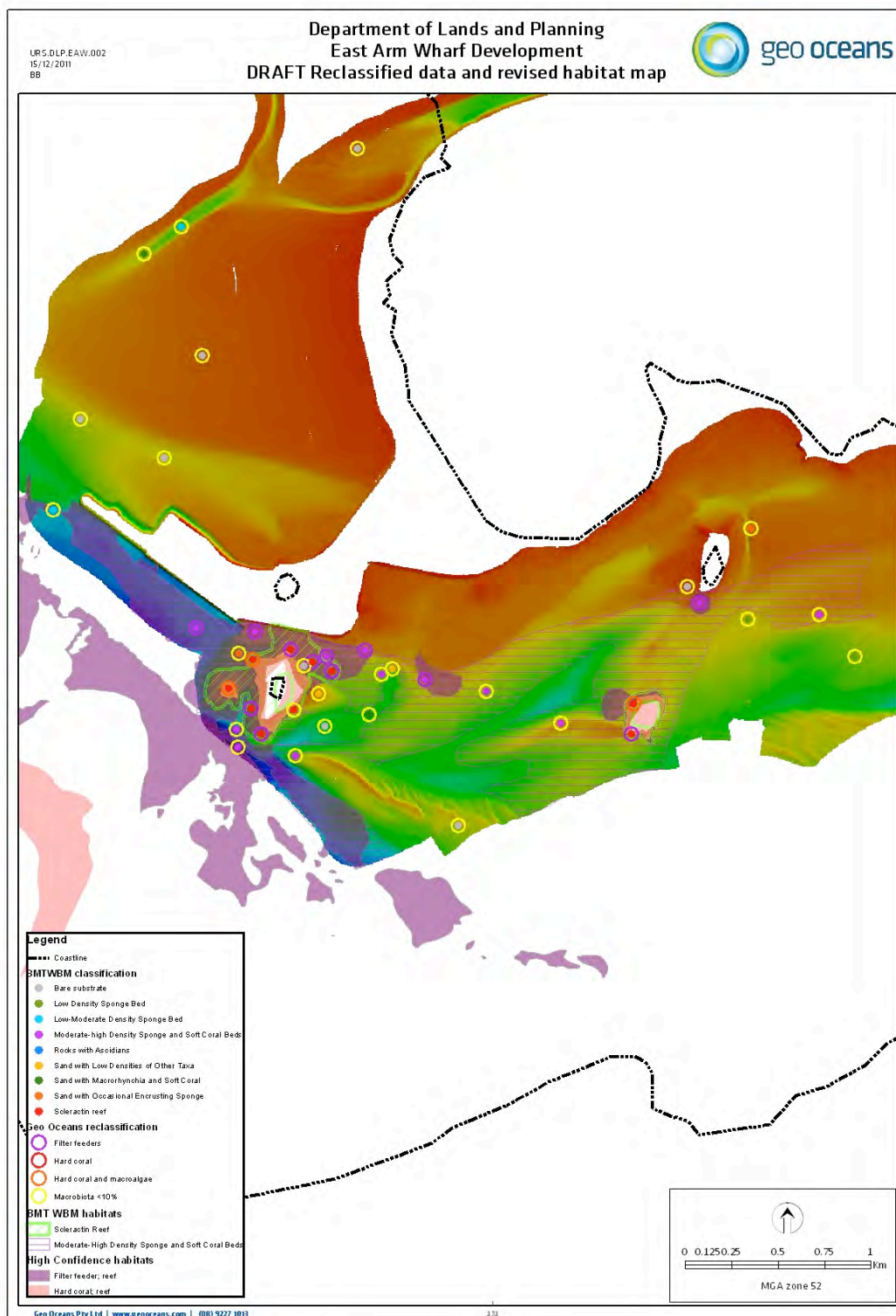


Figure 1 Revised habitat boundaries and reclassified points



2.3. Darwin Harbour Management Unit Benthic Habitat Map

The revised BMT WBM habitat map was combined with the INPEX habitat map (INPEX, 2011) to create a combined habitat map showing the distribution of the marine habitats in the Darwin Harbour Management Unit (MU) (Figure 2). The MU was defined in the INPEX EIS Supplement (INPEX, 2011).

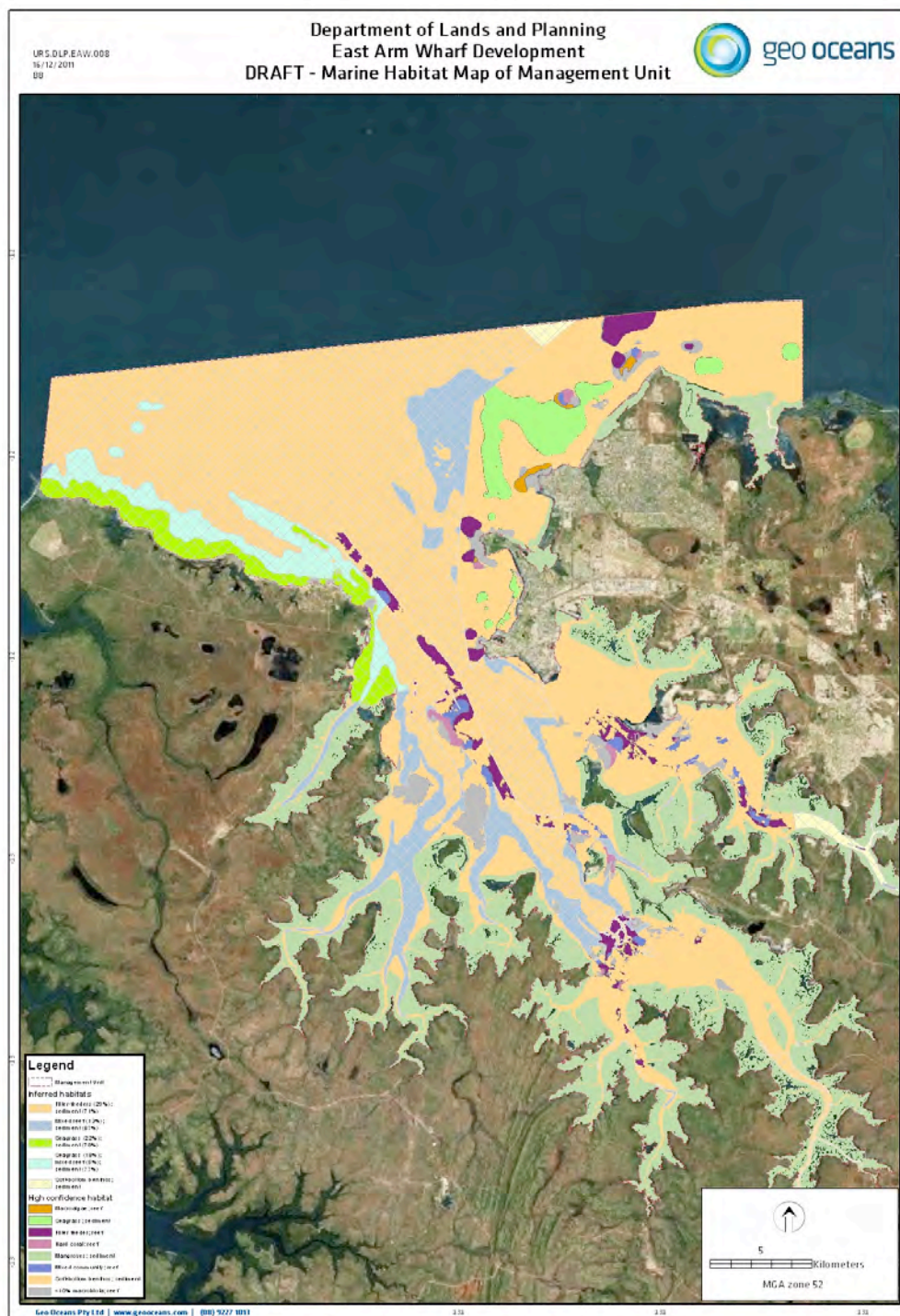


Figure 2 Marine Habitats within the Darwin Harbour Management Unit



2.4. Area Calculations

The proportion of each habitat type with the Zone of High Impact (ZoHI), Zone of Moderate Impact (ZoMI) and Zone of Influence (ZoI) as a proportion of the total habitat area in the MU was calculated using the 'clip' tool for polygons in Arc GIS software. The boundaries for the ZoI, ZoMI and ZoHI and the surrounding habitats are displayed in Figure 3. The habitat area calculations within these zones are listed in Table 1.

Table 1 Marine habitat calculations for the different zones influenced by the construction activities

Habitat	Total habitat in MU (Ha)	ZoI		ZoMI		ZoHI	
		ZoI (Ha)	% of total	ZoMI (Ha)	% of total	ZoHI (Ha)	% of total
Filter feeders; reef	8173	0	0%	0	0%	3.09	>1%
Hard coral; reef	433	0	0%	0	0%	0.02	>1%
Macroalgae; reef	234	0	0%	0	0%	0.01	0%
Macrobiota <10%; Reef	2337	0	0%	0	0%	23.43	1%
Seagrass; sediment	1735	0	0%	0	0%	0.00	0%
Mangrove: sediment	19657	0	0%	0	0%	0.33	0%
Sediment	40532	0.75	>1%	1	>1%	17.24	>1%

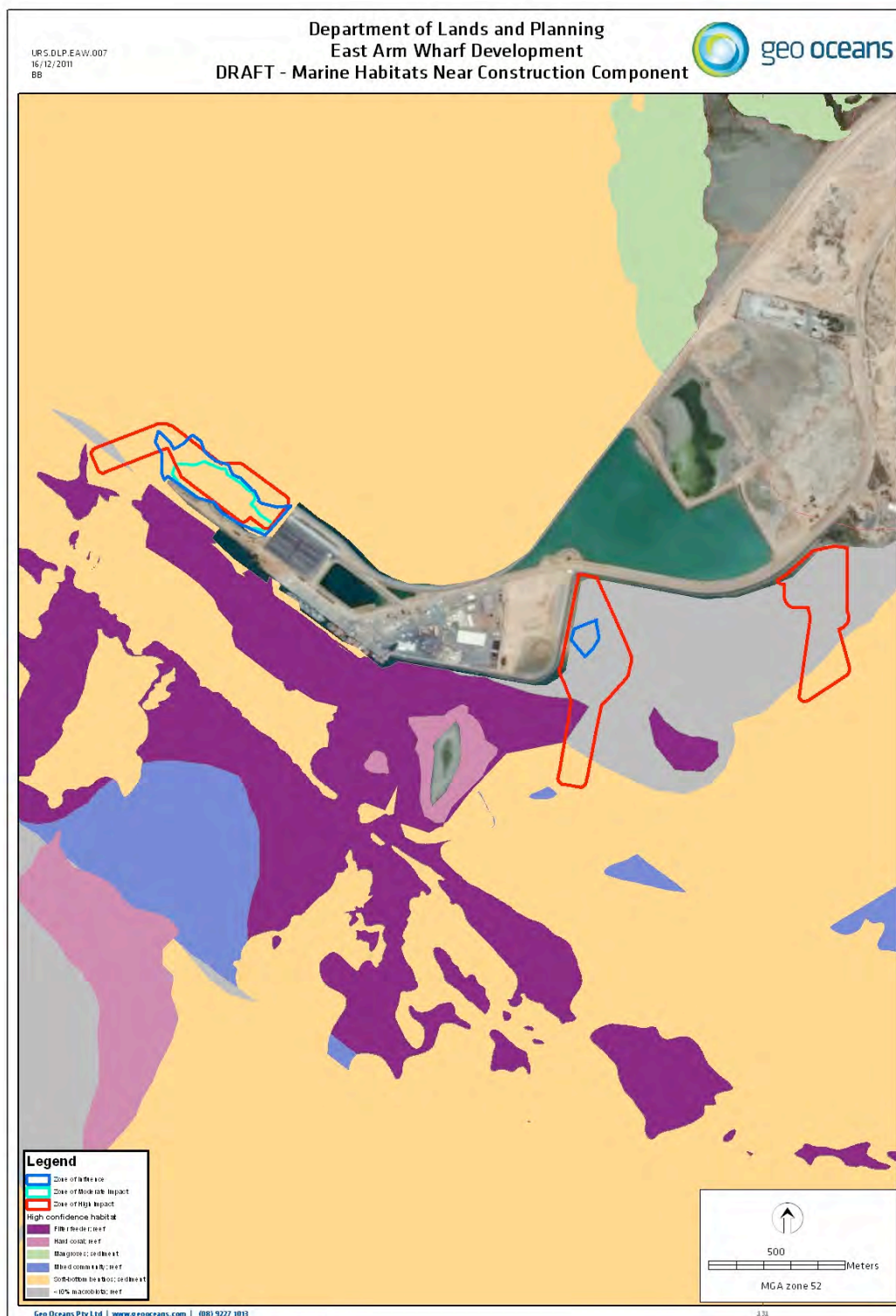


Figure 3 Marine habitats in the zones influenced by the construction activities



3. Species Lists and Distributions

Several datasets were provided to URS by MAGNT:

- Sighting records from within Darwin Harbour for species listed under the EPBC Act 1999
- Marine fauna specimen records from within Darwin Harbour (except fish)
- Fish specimen records from the immediate vicinity of East Arm Wharf

Additional data on hard corals present at four sites was extracted from a report by GHD (2006).

The sighting records for EPBC listed species (other than birds) were augmented with specimen records.

The list of species not recorded elsewhere in Darwin Harbor was generated. An 'intersect' within Arc GIS of the combined MAGNT fauna and (smaller) GHD (2006) datasets was used to generate two lists of species: one for those found within the East Arm study area; the other for species found within the rest of Darwin Harbor. A database query was used to generate a list of species in the East Arm list but not the rest of Darwin Harbor list. The resulting list was manually checked for inconsistencies (originating from the MAGNT extraction) that may have prevented matches and notes were added for possible exceptions relating to taxa not differentiated to species level.

The list of species for filter feeder and coral habitats in East Arm was generated from the MAGNT fauna specimen records, including the fish.

The EPBC listed species sighting in the Darwin Harbour management unit is displayed in Figure 4.

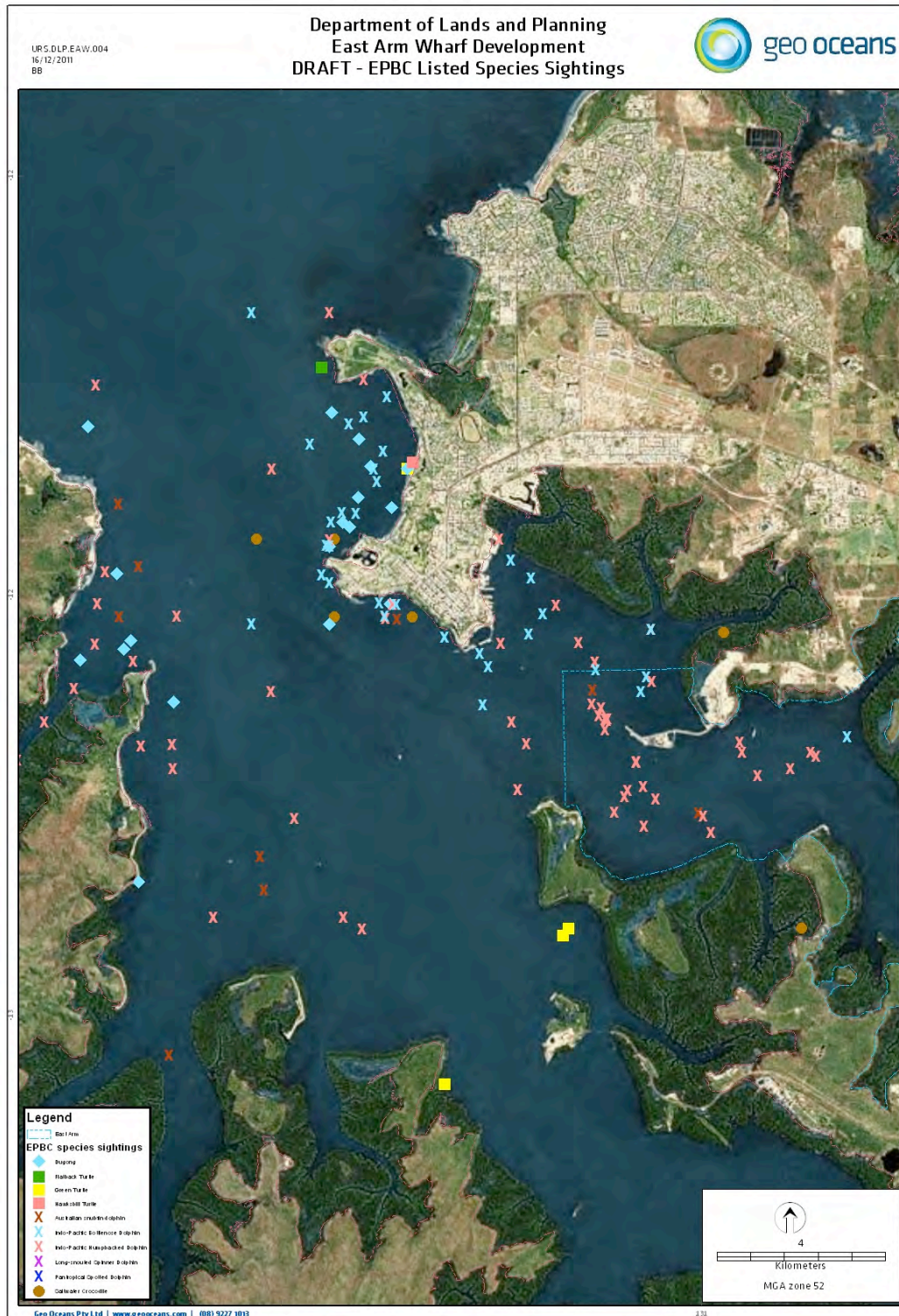


Figure 4 Sighting locations of EPBC listed species near East Arm (MAGNT data)



4. References

BMT WBM (2010) East Arm, Elizabeth River, Blackmore River and Middle Arm Marine Habitat Survey. Prepared for IX Survey. Unpublished Report. December 2010.

INPEX (2011) Ichthys Gas Field Development Project, Supplement to the Draft Environmental Impact Statement.

Geo Oceans (2011) Ichthys Gas Field Development Project: Benthic Habitat Mapping of the Darwin region - Methods of Data Collection, Collation, and Map Production. Ichthys Technical Appendix S6.

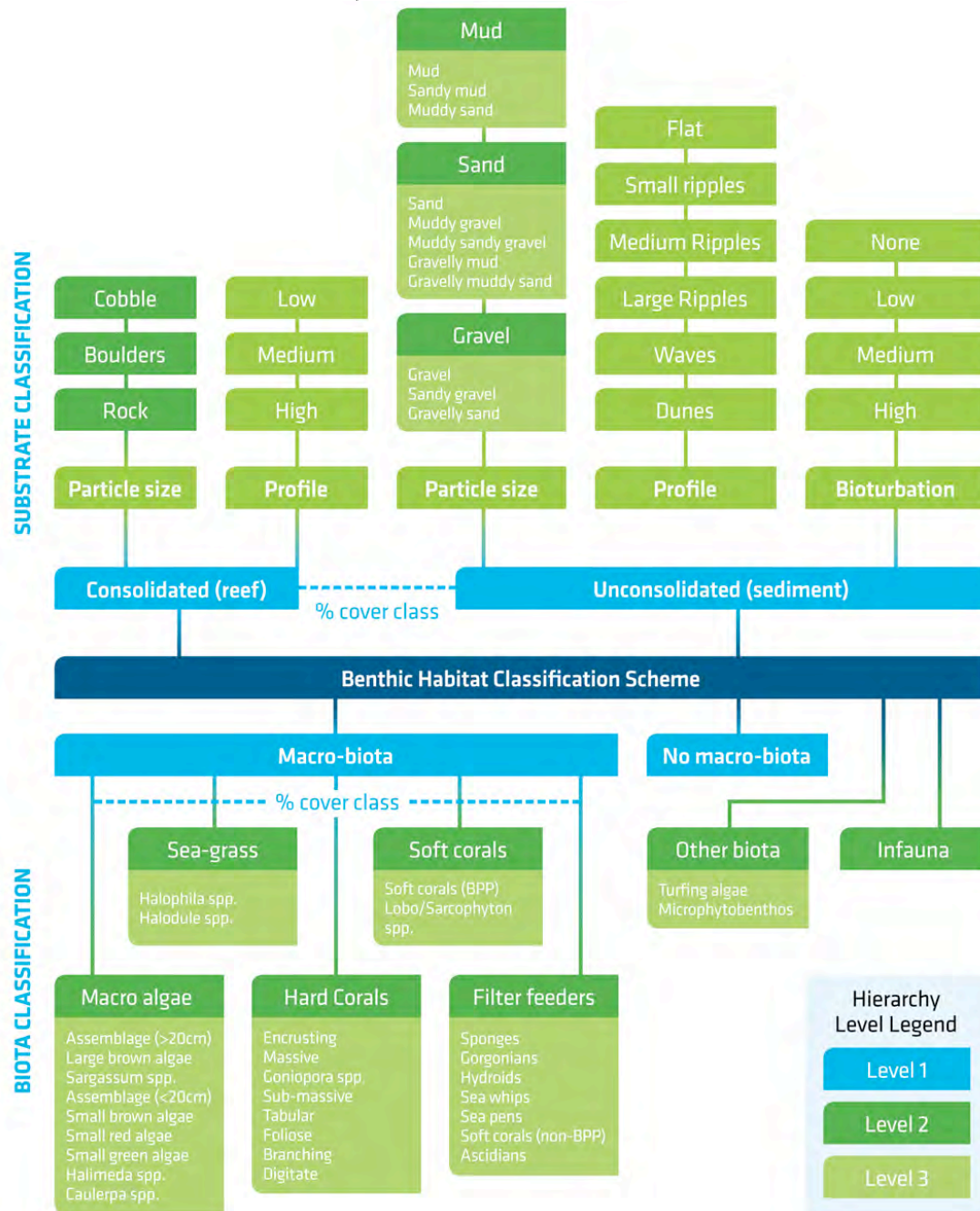
IX Survey (2010) Hydrographic Survey Report for Darwin Port Corporation for Provision of Hydrographic Services. Unpublished report

GHD (2006) Darwin Wharf Project. Coral Monitoring - 2006 Post Dredge Survey Report. Unpublished report.

NRETAS (2011) Further Information Request. Department of Natural Resources, Environment, the Arts and Sport. November 2011.



Appendix 1 Hierarchical habitat classification scheme used for the revised habitat classifications (adapted from INPEX, 2011)





Appendix 2 BMT WBM video transect biota (count) data and reclassification classes by Geo Oceans

Site	BMT WBM class	Geo Oceans reclass	Video checked	filter feeders	Hard Coral	Macroalgae	Misc. taxa
1	Scleractin reef	Hard coral and macroalgae	X	129	37	57	0
2	Scleractin reef	Hard coral and macroalgae	X	10	19	56	1
82	Scleractin reef	Filter feeders	X	19	6	21	6
118	Scleractin reef	Hard coral	X	32	19	33	3
120	Scleractin reef	Hard coral	X	29	14	40	16
149	Scleractin reef	Hard coral and macroalgae	X	21	32	88	0
8	Scleractin reef	Filter feeders	X	27	0	0	4
9	Scleractin reef	Macrobiota <10%	X	77	2	19	3
12	Scleractin reef	Filter feeders	X	146	5	0	0
3	Scleractin reef	Filter feeders	X	72	2	14	0
16	Scleractin reef	Filter feeders	X	162	1	0	2
17	Scleractin reef	Filter feeders	X	54	1	0	5
23	Scleractin reef	Filter feeders	X	69	0	1	0
41	Scleractin reef	Filter feeders	X	103	0	0	26
4	Moderate-high Density Sponge and Soft Coral Beds	Filter feeders	X	186	0	5	2
5	Moderate-high Density Sponge and Soft Coral Beds	Filter feeders	X	50	0	8	0
10	Moderate-high Density Sponge and Soft Coral Beds	Macrobiota <10%	X	38	0	0	3
11	Moderate-high Density Sponge and Soft Coral Beds	Macrobiota <10%	X	17	0	1	1
13	Moderate-high Density Sponge and Soft Coral Beds	Filter feeders	X	37	0	2	2
14	Moderate-high Density Sponge and Soft Coral Beds	Macrobiota <10%	X	6	0	0	1
18	Moderate-high Density Sponge and Soft Coral Beds	Macrobiota <10%	X	21	0	0	1001
20	Moderate-high Density Sponge and Soft Coral Beds	Filter feeders	X	138	0	0	40
21	Moderate-high Density Sponge and Soft Coral Beds	Macrobiota <10%	X	18	0	0	0
22	Moderate-high Density Sponge and Soft Coral Beds	Macrobiota <10%	X	8	0	0	0
25	Moderate-high Density Sponge and Soft Coral Beds	Filter feeders	X	66	0	25	0
28	Moderate-high Density Sponge and Soft Coral Beds	Macrobiota <10%	X	13	0	0	1
37	Moderate-high Density Sponge and Soft Coral Beds	Filter feeders	X	57	0	0	0
42	Moderate-high Density Sponge and Soft Coral Beds	Filter feeders	X	73	0	0	3
50	Moderate-high Density Sponge and Soft Coral Beds	Macrobiota <10%	X	26	0	0	0
54	Moderate-high Density Sponge and Soft Coral Beds	Macrobiota <10%	X	7	0	0	0
57	Moderate-high Density Sponge and Soft Coral Beds	Filter feeders	X	130	0	4	1
72	Moderate-high Density Sponge and Soft Coral Beds	Macrobiota <10%	X	4	0	0	0
79	Moderate-high Density Sponge and Soft Coral Beds	Macrobiota <10%	X	61	0	7	0
80	Moderate-high Density Sponge and Soft Coral Beds	Macrobiota <10%	X	19	0	3	1
84	Moderate-high Density Sponge and Soft Coral Beds	Filter feeders	X	34	0	0	0
85	Moderate-high Density Sponge and Soft Coral Beds	Filter feeders	X	98	0	0	0
86	Moderate-high Density Sponge and Soft Coral Beds	Filter feeders	X	48	0	0	3
87	Moderate-high Density Sponge and Soft Coral Beds	Filter feeders	X	97	0	0	28
90	Moderate-high Density Sponge and Soft Coral Beds	Filter feeders	X	89	0	6	2
93	Moderate-high Density Sponge and Soft Coral Beds	Filter feeders	X	147	0	9	17
94	Moderate-high Density Sponge and Soft Coral Beds	Filter feeders	X	46	0	0	1
96	Moderate-high Density Sponge and Soft Coral Beds	Filter feeders	X	38	0	0	0
97	Moderate-high Density Sponge and Soft Coral Beds	Filter feeders	X	41	0	0	1
124	Moderate-high Density Sponge and Soft Coral Beds	Filter feeders	X	65	0	0	3
125	Moderate-high Density Sponge and Soft Coral Beds	Macrobiota <10%	X	14	0	0	8
139	Moderate-high Density Sponge and Soft Coral Beds	Macrobiota <10%	X	19	0	0	6
143	Moderate-high Density Sponge and Soft Coral Beds	Macrobiota <10%	X	12	0	0	0
145	Moderate-high Density Sponge and Soft Coral Beds	Macrobiota <10%	X	23	0	0	2
146	Moderate-high Density Sponge and Soft Coral Beds	Filter feeders		61	0	0	25
30	Low-Moderate Density Sponge Bed	Macrobiota <10%		7	0	0	0



Site	BMT WBM class	Geo Oceans reclass	Video checked	filter feeders	Hard Coral	Macroalgae	Misc. taxa
33	Low-Moderate Density Sponge Bed	Macrobioda <10%		12	0	0	1
44	Low-Moderate Density Sponge Bed	Macrobioda <10%		7	0	1	0
47	Low-Moderate Density Sponge Bed	Macrobioda <10%		8	0	0	0
52	Low-Moderate Density Sponge Bed	Macrobioda <10%	X	20	0	0	0
53	Low-Moderate Density Sponge Bed	Macrobioda <10%		8	0	1	1
102	Low-Moderate Density Sponge Bed	Macrobioda <10%		10	0	0	5
117	Low-Moderate Density Sponge Bed	Macrobioda <10%	X	17	0	0	0
123	Low-Moderate Density Sponge Bed	Macrobioda <10%		8	0	0	0
138	Low-Moderate Density Sponge Bed	Macrobioda <10%	X	52	0	0	0
141	Low-Moderate Density Sponge Bed	Macrobioda <10%		11	0	0	6
147	Low-Moderate Density Sponge Bed	Macrobioda <10%		11	0	0	0
111	Rocks with Ascidians	Macrobioda <10%		0	0	0	3
127	Rocks with Ascidians	Macrobioda <10%	X	0	0	0	108
128	Rocks with Ascidians	Macrobioda <10%	X	0	0	0	500
26	Low Density Sponge Bed	Macrobioda <10%		2	0	0	0
29	Low Density Sponge Bed	Macrobioda <10%		10	0	0	0
48	Low Density Sponge Bed	Macrobioda <10%		7	0	0	0
55	Low Density Sponge Bed	Macrobioda <10%		2	0	0	0
58	Low Density Sponge Bed	Macrobioda <10%	X	28	0	0	0
61	Low Density Sponge Bed	Macrobioda <10%		6	0	0	0
88	Low Density Sponge Bed	Macrobioda <10%		5	0	0	0
121	Low Density Sponge Bed	Macrobioda <10%		8	0	0	4
135	Low Density Sponge Bed	Macrobioda <10%	X	18	0	0	0
148	Low Density Sponge Bed	Macrobioda <10%		6	0	0	0
38	Sand with Macrorhynchia and Soft Coral	Macrobioda <10%		3	0	0	0
43	Sand with Macrorhynchia and Soft Coral	Macrobioda <10%		15	0	10	0
46	Sand with Macrorhynchia and Soft Coral	Macrobioda <10%		1	0	0	0
56	Sand with Macrorhynchia and Soft Coral	Macrobioda <10%		11	0	0	0
70	Sand with Macrorhynchia and Soft Coral	Macrobioda <10%		7	0	0	1
71	Sand with Macrorhynchia and Soft Coral	Macrobioda <10%		6	0	0	0
73	Sand with Macrorhynchia and Soft Coral	Macrobioda <10%		11	0	0	0
74	Sand with Macrorhynchia and Soft Coral	Macrobioda <10%		1	0	0	0
75	Sand with Macrorhynchia and Soft Coral	Macrobioda <10%	X	48	0	0	0
76	Sand with Macrorhynchia and Soft Coral	Macrobioda <10%		3	0	0	0
77	Sand with Macrorhynchia and Soft Coral	Macrobioda <10%		27	0	0	0
81	Sand with Macrorhynchia and Soft Coral	Macrobioda <10%		5	0	0	1
83	Sand with Macrorhynchia and Soft Coral	Macrobioda <10%		3	0	0	1
89	Sand with Macrorhynchia and Soft Coral	Macrobioda <10%		13	0	0	0
91	Sand with Macrorhynchia and Soft Coral	Macrobioda <10%		14	0	0	5
92	Sand with Macrorhynchia and Soft Coral	Macrobioda <10%		1	0	0	0
98	Sand with Macrorhynchia and Soft Coral	Macrobioda <10%		9	0	0	0
100	Sand with Macrorhynchia and Soft Coral	Macrobioda <10%		5	0	0	0
101	Sand with Macrorhynchia and Soft Coral	Macrobioda <10%		4	0	0	0
103	Sand with Macrorhynchia and Soft Coral	Macrobioda <10%		2	0	0	0
106	Sand with Macrorhynchia and Soft Coral	Macrobioda <10%		8	0	0	8
109	Sand with Macrorhynchia and Soft Coral	Macrobioda <10%		6	0	0	1
114	Sand with Macrorhynchia and Soft Coral	Macrobioda <10%		12	0	0	9
122	Sand with Macrorhynchia and Soft Coral	Macrobioda <10%		19	0	0	2
129	Sand with Macrorhynchia and Soft Coral	Macrobioda <10%		0	0	0	0
130	Sand with Macrorhynchia and Soft Coral	Macrobioda <10%		21	0	1	6



site	BMT WBM class	Geo Oceans reclass	Video checked	filter feeders	Hard Coral	Macroalgae	Misc. taxa
133	Sand with Macrorhynchia and Soft Coral	Macrobiota <10%		4	0	0	0
136	Sand with Macrorhynchia and Soft Coral	Macrobiota <10%	X	38	0	0	7
144	Sand with Macrorhynchia and Soft Coral	Macrobiota <10%		6	0	0	0
152	Sand with Macrorhynchia and Soft Coral	Macrobiota <10%		4	0	0	0
27	Sand with Occasional Encrusting Sponge	Macrobiota <10%		1	0	0	0
36	Sand with Occasional Encrusting Sponge	Macrobiota <10%		3	0	0	0
68	Sand with Occasional Encrusting Sponge	Macrobiota <10%		2	0	0	0
7	Sand with Low Densities of Other Taxa	Macrobiota <10%		3	0	2	0
19	Sand with Low Densities of Other Taxa	Macrobiota <10%		1	0	1	0
49	Sand with Low Densities of Other Taxa	Macrobiota <10%		1	0	0	0
99	Sand with Low Densities of Other Taxa	Macrobiota <10%		3	0	0	1
105	Sand with Low Densities of Other Taxa	Macrobiota <10%		0	0	1	1
116	Sand with Low Densities of Other Taxa	Macrobiota <10%		2	0	0	0
142	Sand with Low Densities of Other Taxa	Macrobiota <10%		1	0	0	0
6	Bare substrate	Macrobiota <10%		0	0	0	0
15	Bare substrate	Macrobiota <10%		0	0	0	0
24	Bare substrate	Macrobiota <10%		0	0	0	0
31	Bare substrate	Macrobiota <10%		0	0	0	0
32	Bare substrate	Macrobiota <10%		0	0	0	0
34	Bare substrate	Macrobiota <10%		0	0	0	0
35	Bare substrate	Macrobiota <10%		0	0	0	0
39	Bare substrate	Macrobiota <10%		0	0	0	0
40	Bare substrate	Macrobiota <10%		0	0	0	0
45	Bare substrate	Macrobiota <10%		0	0	0	0
51	Bare substrate	Macrobiota <10%		0	0	0	0
59	Bare substrate	Macrobiota <10%		0	0	0	0
60	Bare substrate	Macrobiota <10%		0	0	0	0
62	Bare substrate	Macrobiota <10%		0	0	0	0
63	Bare substrate	Macrobiota <10%		0	0	0	0
64	Bare substrate	Macrobiota <10%		0	0	0	0
65	Bare substrate	Macrobiota <10%		0	0	0	0
66	Bare substrate	Macrobiota <10%		0	0	0	0
67	Bare substrate	Macrobiota <10%		0	0	0	0
69	Bare substrate	Macrobiota <10%		0	0	0	0
78	Bare substrate	Macrobiota <10%		0	0	0	0
95	Bare substrate	Macrobiota <10%		0	0	0	0
104	Bare substrate	Macrobiota <10%		0	0	0	0
107	Bare substrate	Macrobiota <10%		0	0	0	0
108	Bare substrate	Macrobiota <10%		0	0	0	0
110	Bare substrate	Macrobiota <10%		0	0	0	0
112	Bare substrate	Macrobiota <10%		0	0	0	0
113	Bare substrate	Macrobiota <10%		0	0	0	0
115	Bare substrate	Macrobiota <10%		0	0	0	0
119	Bare substrate	Macrobiota <10%		0	0	0	0
126	Bare substrate	Macrobiota <10%		0	0	0	0
131	Bare substrate	Macrobiota <10%		0	0	0	0
132	Bare substrate	Macrobiota <10%		0	0	0	0
134	Bare substrate	Macrobiota <10%		0	0	0	0
137	Bare substrate	Macrobiota <10%		0	0	0	0
140	Bare substrate	Macrobiota <10%		0	0	0	0
150	Bare substrate	Macrobiota <10%		0	0	0	0
151	Bare substrate	Macrobiota <10%		0	0	0	0