Table 6.9 – Sponge and Soft Coral Cover in the Study Area

Area		Proximity to Port Hedland entrance	Sponges Cover (%)	Soft Coral Cover (%)	Bare Component (%)
Outer Ridgeline Systems	Outermost Ridgeline	37 km NW	2.9–11.6	0.0–3.1	>60
	Middle Ridgeline	31 km NW	3.6–9.6	0.2–1.8	>69
	Innermost Ridgeline	24 km NW	2.7–8.4	0.0–3.6	>67
Inner Ridge/Shoal Systems	Minilya Bank	19 km NE	6.4–9.8	0.0–6.0	>67
	Proposed Port Areas	4–6 km N	3.1–6.4	1.1–1.6	>79
	Weerdee Ridge	11 km W	1.8–12.2	0.0–7.1	11–75
	Cape Thouin Area	40 km W	7.8	1.1	>78
Islands	Weerdee Island	12 km W	minimal	minimal	12–66
	North Turtle Island	58 km NE	0.0–8.2	0.0–2.9	>81
	Little Turtle Island	40 km NE	2.9–9.6	<5	>69
Sand Plains	Eastern Shoreline	Inshore, from Port Hedland to Spit Point	0	0	100
	Potential Spoil Ground Locations[1]	Refer to **Figure 6.6**	minimal	minimal	100*
	Proposed Channel Footprint [2]	Refer to **Figure 6.6**	0	0	100**

Source: Summarised from SKM (2009k) (surveyed December 2007 to May 2008)
1 a series of potential spoil ground locations investigated for the proposed Outer Harbour Development
2 sites sampled at a proposed footprint which was subsequently realigned. Further investigations conducted within the current dredge footprint concluded the same results

The next closest location to the Outer Harbour Development which is considered an important bird area by DSEWPaC is the modified salt pans occupied by the Dampier Salt operations. The pans are approximately 5 km south-east of Port Hedland Harbour (DEWHA 2008a), and the data show that although this site produces higher numbers of migratory visitors, the numbers are still very small when compared with the sites further north such as Eighty Mile Beach and Roebuck Bay. The salt pans will not be impacted by the Outer Harbour Development.

6.6.5 Marine Reptiles

Marine reptiles that could potentially occur in the study area include turtles, sea snakes and the saltwater crocodile (*Crocodylus porosus*). Crocodiles, however, are uncommon in the Port Hedland area due to an absence of suitable breeding habitat as described below.

Marine Turtles

Marine turtles are air-breathing marine reptiles that are long-lived and slow maturing. All turtle species are protected under state and federal legislation and international treaties. Six species of turtle inhabit Western Australian waters of which four are reproductively active in the North-West Shelf region (Pendoley Environmental 2009c). These four turtle species are classified under the EPBC Act as vulnerable and are:

- Green Turtle (*Chelonia mydas*);
- Loggerhead Turtle (*Caretta caretta*);
- Flatback Turtle (*Natator depressus*); and
- Hawksbill Turtle (*Eretmochelys imbricata*) (CALM 2000).

The distribution of turtle species depends largely on their habitat requirements at different behavioural stages. Adult turtles occupy four main habitats corresponding to the four behavioural stages of foraging, mating, nesting and inter-nesting (Pendoley Environmental 2009a).

Timing and extent of the marine turtle breeding season, which includes mating, nesting and hatching, differs for individual species. Breeding seasons for the three species with most dependency on marine habitats in the Port Hedland region (Pendoley Environmental 2009c) are:

- Green Turtles: November to April with peak nesting in December to January;
- Flatback Turtles: November to March with peak nesting in December to January; and
- Hawksbill Turtles: August to April with peak nesting in October to November.

Research conducted for the proposed Outer Harbour Development has addressed those aspects of marine turtle biology that:

a) satisfy key monitoring areas for marine turtle populations as identified by the National Recovery Plan for Marine Turtles in Australia (Environment Australia 2003) and the Marine Turtle Recovery Plan

for Western Australia (DEC 2008c); and

b) provide relevant information regarding the potential interaction between marine turtles and the proposed Outer Harbour Development and appropriate management of those interactions.

An overview of the research activities undertaken in the study area is provided in **Figure 6.17**, and a summary of observations made to date is provided below.

Nesting Habitat

Marine turtle nesting populations are distributed widely across the Pilbara coastline and offshore Islands, though large populations are concentrated in only a few areas. Mundabullangana, located approximately 50 km west of Port Hedland, supports a regionally important Flatback Turtle rookery. This population is considered one of the largest nesting Flatback Turtle populations in the world (Pendoley Environmental 2009a). Eighty Mile Beach, approximately 280 km north-east of Port Hedland Harbour, is thought to support a similar size nesting population to Mundabullangana although this is not confirmed (Prince 1994). Surveys to confirm abundance at this rookery is scheduled for 2011/12 and 2012/13 reproductive seasons.

Small sandy beaches that occur along the coastline between Mundabullangana and the mouth of the De Grey River (approximately 70 km north-east of Port Hedland Harbour) may provide nesting habitat for marine turtles (Pendoley 2005). Aerial surveys of the coast to identify nesting habitat between Mundabullangana and the De Grey River (2008/09, 2009/10 and 2010/2011) found no nesting at a number of these beaches, including Finucane and Weerdee Islands, despite both locations providing potentially suitable nesting habitat. If nesting does occur at these locations it is likely to be infrequent. Observations at North Turtle Island recorded Flatback Turtle tracks and nests across the island (SKM 2009k; Pendoley Environmental 2009b). Nesting at Little Turtle Island has not been documented in surveys to date and it is unlikely nesting will occur, as most of the island is awash at high tide.

Flatback Turtles also nest at Cemetery Beach, Paradise Beach, Pretty Pool, Cooke Point and Downes Island (Prince 1994; Pendoley Environmental 2009b). Cemetery Beach is the closest nesting beach to the Outer Harbour Development, located approximately 5 km east-south-east of the proposed jetty and wharf (**Figure 6.17**), and also has the highest nesting density of the beaches in the vicinity of the Outer Harbour Development. Subsequent surveys focused on this location. A mark-recapture program was conducted over two months at the peak of nesting for two consecutive reproductive seasons (2009/10 and 2010/2011) at Cemetery Beach. Data from the first year show annual number of nesting *F*latback females at this site to be 188. Observations from this beach reveal a high level of public activity and low-level indigenous take of eggs. Predation by Varanid lizards also occurs (Pendoley Environmental 2010a) There is some movement of nesting females between Mundabullangana and Cemetery Beach (n=5 individuals) (Pendoley Environmental 2010).

Surveys to assess reproductive output and primary sex ratio were conducted during the 2010/2011 season. Preliminary findings from programs conducted during 2010/2011 show hatch success to be 35% and emergence success 27%. Beach (sand) and clutch temperatures were also monitored.

Inter-nesting Habitat and Behaviour

Inter-nesting habitat has been delineated using data from satellite tracking units attached to sixteen post-nesting Flatback Turtles (**Figure 6.19** and **Figure 6.20**) at Cemetery Beach, over three consecutive nesting seasons (2008/2009 to 2010/2011) (Pendoley Environmental 2009a/ in prep).

These data show inter-nesting turtles occupying habitat up to approximately 60 km offshore from Cemetery Beach between laying successive clutches of eggs (Pendoley Environmental 2009b). In some cases, animals spent periods of time in the existing shipping channel. There was no movement recorded west of the Channel; all inter-nesting tracks logged were to the east of the shipping channel (**Figure 6.20**). None of the data indicated animals were spending any time in the proposed development footprint. Two per cent of received locations showed turtles spending time within existing spoil disposal grounds. For further details on these studies refer to **Appendices B23, B24, B25 and B26**.

Flatback Turtles offshore from Cemetery Beach spent an average minimum of 31.5% of their time at the surface during inter-nesting, with a minimum of 68.5% of time spent diving (underwater). Seventy-five per cent of dives were less than 15 minutes duration. In the 2009/2010 survey, tracked Flatback Turtles spent an average of 34.4% of their dives resting on the seabed. For the remainder of the time they were mobile throughout the water column. They most frequently reside in water temperatures of 31°C (Pendoley Environmental in prep).

Migratory Pathways

Migratory pathways for animals tracked from Cemetery Beach in 2008/09 and 2009/10 are shown in **Figure 6.21** and **Figure 6.22**. Of a total of 13 tracks,

nine travelled north from Cemetery Beach, stopping at locations from the mouth of the De Grey River to the Gulf of Carpentaria. This latter track is the longest known migration of a Flatback Turtle (Pendoley Environmental in prep). Migrating animals travelled along the coastline until reaching the northernmost tip of Western Australia where some animals continued north, away from the coastline, to become parallel with Australia's northernmost latitudes. The remaining animals travelled south with three eventually occupying discrete areas located between the south-west of Barrow Island and to north of Serrurier Island.

In-water Distribution and Abundance

Marine turtle density inshore of the 20 m isobath off Port Hedland was assessed during aerial surveys in summer 2008 and 2010 (focussing on mating, inter-nesting and foraging turtles) and winter 2009 (focussing on foraging turtles) (**Figure 6.23** to **Figure 6.25**) (refer **Appendices B23** and **B24**). Density was calculated using a conversion factor extracted from Time-Depth-Recorder loggers attached to post-nesting turtles that measure the amount of time spent on the surface versus underwater. Marine turtle density in December 2008, April 2009 and January 2010 was 0.2, 0.8 and 2.5 turtles/km^2 respectively. The turtles were assumed to be mostly Green Turtles with smaller populations of Flatback, Hawksbill and Loggerhead Turtles.

Foraging Habitat

Data from satellite tracked animals show that tracked post-nesting turtles do not return to one location to forage. Foraging habitat was highly varied with few animals selecting the same area. Some animals appeared to have multiple foraging grounds, moving between areas either of a similar latitude or stopping en route before continuing north (**Figure 6.22**).

Aerial surveys documented foraging habitat at North Turtle Island and an area adjacent to the De Grey River mouth, approximately 70 km north-east of Port Hedland. Observations were not evenly distributed with density focused around the 20 m isobath in both summer (**Figure 6.23** and **Figure 6.24**) and winter (**Figure 6.25**).

Stable isotope analysis of gut samples collected during 2008/09 indicate Flatback Turtles are feeding on jellyfish and soft corals. Foraging groups of turtles may therefore be present where these food sources are identified. The same study indicated Green Turtles are foraging primarily on seagrasses and algae but they may also rely on higher order species for part of their diet. Further details of the Stable Isotope Study can be found in **Appendix B27.**

Consistent with this, aerial and boat surveys observed Green Turtles on the intertidal platform on North Turtle Island, approximately 58 km from Port Hedland (Pendoley Environmental 2009a). The surrounding area is expected to be suitable foraging habitat as it is colonised by macroalgae and corals (SKM 2009k). Offshore ridges including Minilya Bank, and Coxon and Cornelisse Shoals support a variety of sessile organisms including corals, macroalgae, sponges, hydroids and molluscs (SKM 2009k). Based on stable isotope analysis, assessment of available food sources and known marine turtle distribution in other areas where these food sources are available, these offshore ridges is likely to support foraging turtles (Pendoley Environmental in prep). Juvenile turtles are often observed closer to the coastline, adjacent to the beaches and mangrove root systems (Pendoley Environmental 2009a). During sampling and turtle surveys, juvenile Flatback and Green Turtles have been observed in the tidal creeks of Port Hedland Inner Harbour (J. Crozier, SKM, 2009, pers. comm.; J.R. Hanley, SKM, 2009, pers. comm.; Pendoley Environmental 2009a; Biota 2004). It is likely that these turtles forage on algae, mangroves and hard and soft corals found within area (SKM 2009k, 2009l). In addition, survey teams on Cemetery Beach frequently observe juvenile Green Turtles in the water immediately offshore (J. Oates, Pendoley Environmental 2009a, pers. comm.).

Sea Snakes

Twenty-two species of sea snakes are found in Western Australian waters and at least 16 of these have habitat ranges reported to occur in the Pilbara region (Storr *et al.* 2002). Sea snakes are found over a diverse range of water depths and types of seabed habitat (Berry 1986). The broad habitat types include shallow-water coral reef and seagrass habitats, deep-water soft bottom habitats away from reefs, intertidal mudflats and mangrove habitats in coastal areas, and surface water pelagic habitats – all of which occur within the marine study area. The 14 species that potentially occur within the study area where suitable habitat is present (Storr *et al.* 2002; Guinea 2007) are listed below:

- Black Ringed Snake (*Hydrelaps darwiniensis*);
- Brown-lined Sea Snake (*Aipysurus tenuis*);
- Dubois' Sea Snake (*Aipysurus duboisii*);
- Elegant Sea Snake[1] (*Hydrophis elegans*);
- Fine-spined Sea Snake[2] (*Hydrophis czeblukovi*);
- Horned Sea Snake (*Acalyptophis peronii*);

1 Also known as Bar-bellied Sea Snake
2 Also known as Geometrical Sea Snake

Table 6.10 – Seabird Species Recorded within the Study Area

Common name	Scientific name	EPBC listing
Lesser Frigate Bird	*Fregata ariel*	Migratory
Australian Pelican	*Pelecanus conspicillatus*	
White-Bellied Sea Eagle	*Haliaeetus leucogaster*	Migratory
Brahminy Kite	*Haliastur indus*	
Whistling kite	*Haliastur sphenurus*	
Osprey	*Pandion haliaetus*	Migratory
Silver Gull	*Larus novaehollandiae*	
Little Tern	*Sterna albifrons*	
Lesser Crested Tern	*Sterna bengalensis*	
Crested Tern	*Sterna bergii*	
Caspian Tern	*Sterna caspia*	
Whiskered Tern	*Sterna hybrida*	
Fairy Tern	*Sterna nereis*	
Gull-Billed Tern	*Sterna nilotica affinis*	

Table 6.11 – Shorebird Species Recorded within the Study Area

Common name	Scientific name	EPBC listing
Great Egret	*Ardea alba*	
White-Faced Heron	*Ardea novaehollandiae*	
Little Egret	*Ardea garzetta*	
Eastern Reef Egret	*Egretta sacra*	Migratory
Striated Heron	*Butorides striatus*	
Australian White Ibis	*Threskiomis molucca*	
Common Sandpiper	*Actitis hypoleucos*	Migratory
Ruddy Turnstone	*Arenaria interpres*	Migratory
Red Knot	*Calidris canutus*	Migratory
Curlew Sandpiper	*Calidis ferruginea*	Migratory
Red-Necked Stint	*Calidris ruficollis*	Migratory
Great Knot	*Calidris tenuirostris*	Migratory
Bar-tailed Godwit	*Limosa lapponica*	Migratory
Eastern Curlew	*Numenius madagascariensis*	Migratory
Whimbrel	*Numenius phaeopus*	Migratory
Grey-Tailed Tattler	*Tringa breviceps*	Migratory
Common Greenshank	*Tringa nebularia*	Migratory
Marsh Sandpiper	*Tringa stagnatillis*	Migratory
Terek Sandpiper	*Tringa cinereus*	Migratory
Sooty Oystercatcher	*Haematopus fuliginosus*	
Pied Oystercatcher	*Haematopus longirostris*	
Greater Sand Plover	*Charadrius leschenaultii*	Migratory
Lesser Sand Plover	*Charadrius mongolus*	Migratory
Red-Capped Plover	*Charadrius ruficapillus*	
Oriental Plover	*Charadrius veredus*	Migratory
Grey Plover	*Pluvialis squatarola*	Migratory

Table 6.12 – Seabird and Shorebird Species Expected in the Study Area

Common Name	Scientific Name	Broad habitat specialisation	Conservation code			A[1]	B	C	D	E	F	G
			EPBC	DEC	IUCN							
Phalacrocoracidae (Cormorants and Darters)												
Little Pied Cormorant	*Phalacrocorax melanoleucos*	Shorebird (Sh)			Least Concern (LC)				X		X	X
Little Black Cormorant	*Phalacrocorax sulcirostris*	Sh			LC				X			
Pied Cormorant	*Phalacrocorax varius*	Sh			LC		X		X		X	X
Fregatidae (Frigate Birds)												
Lesser Frigate Bird	*Fregata ariel*	Seabird (S)	Migratory or overfly (Mi)		LC						X	
Pelecanidae (Pelicans)												
Australian Pelican	*Pelecanus conspicillatus*	S			LC				X		X	X
Ardeidae (Herons and Bitterns)												
Great Egret	*Ardea alba*	Sh			LC						X	X
White-faced Heron	*Ardea novaehollandiae*	Sh			LC		X		X	X	X	X
Little Egret	*Egretta garzetta*	Sh			LC			X	X		X	X
Eastern Reef Egret	*Egretta sacra*	Sh	Mi		LC				X		X	X
Nankeen Night Egret	*Nycticorax calendonicus*	Sh			LC	X	X		X			
Threskiornithidae (Ibises and Spoonbills)												
Royal Spoonbill	*Platalea regia*	Sh			LC							
Glossy Ibis	*Plegadis falcinellus*	Sh	Mi		LC							
Australian White Ibis	*Threskiornis molucca*	Sh			LC			X	X		X	X
Straw-necked Ibis	*Threskiornis spinicollis*	Sh			LC	X			X			
Ciconiidae (Storks)												
Jabiru	*Ephippiorhynchus asiaticus*	Sh			Near Threatened (NT)							
Accipitridae (Kites, Hawks, and Eagles)												
White-bellied Sea Eagle	*Haliaeetus leucogaster*	S	Mi		LC		X				X	X
Brahminy Kite	*Haliastur sphenurus*	S			LC		X	X	X		X	X
Whistling Kite	*Haliastur sphenurus*	S			LC	X			X	X	X	X

Osprey	*Pandion haliaetus*	S	Mi		LC		X				X	
Rallidae (Waterhens)												
Buff-banded Rail	*Gallirallus philippensis*	Sh			LC	X						
Spotted Crake	*Porzana fluminea*	Sh			LC							
Scolopacidae (Sandpipers and Snipes)												
Common Sandpiper	*Actitis hypoleucos*	Sh	Mi		LC				X		X	
Ruddy Turnstone	*Arenaria interpres*	Sh	Mi		LC						X	X
Sharp-tailed Sandpiper	*Calidris acuminate*	Sh	Mi		LC	X						
Red Knot	*Calidris canutus*	Sh	Mi		LC						X	
Curlew Sandpiper	*Calidris ferruginea*	Sh	Mi		LC						X	
Pectoral Sandpiper	*Calidris melanotos*	Sh	Mi		LC							
Red-necked Stint	*Calidris ruficollis*	Sh	Mi		LC						X	
Long-toed Stint	*Calidris subminuta*	Sh	Mi		LC							
Great Knot	*Calidris tenuirostris*	Sh	Mi		LC		X				X	
Broad-billed Sandpiper	*Limicola falcinellus*	Sh	Mi		LC	X						
Bar-tailed Godwit	*Limosa lapponica*	Sh	Mi		LC						X	
Eastern Curlew	*Numenius madagascariensis*	Sh	Mi	Priority 4: Rare taxa (P4)	LC		X	X	X		X	
Whimbrel	*Numenius phaeopus*	Sh	Mi		LC		X	X	X		X	X
Grey-tailed Tattler	*Tringa brevipes*	Sh	Mi		LC				X		X	X
Wood Sandpiper	*Tringa glareola*	Sh	Mi		LC	X						
Common Greenshank	*Tringa nebularia*	Sh	Mi		LC		X				X	
Marsh Sandpiper	*Tringa stagnatilis*	Sh	Mi		LC	X						X
Terek Sandpiper	*Xenus cinereus*	Sh	Mi		LC		X				X	X
Haematopodidae (Oystercatchers)												
Sooty Oystercatcher	*Haematopus fuliginosus*	Sh			LC						X	X
Pied Oystercatcher	*Haematopus longirostris*	Sh			LC				X		X	X
Recurvirostridae (Stilts)												
Black-winged Stilt	*Himantopus himantopus*	Sh			LC				X	X		
Banded Stilt	*Cladorhynchus leucocephalus*	Sh			LC							

Red-necked Avocet	*Recurvirostra novaehollandiae*	Sh			LC	X						
Charadriidae (Plovers, Lapwings and Dotterels)												
Greater Sand Plover	*Charadrius leschenaultii*	Sh	Mi		LC		X				X	X
Lesser Sand Plover	*Charadrius mongolus*	Sh	Mi		LC						X	
Red-capped Plover	*Charadrius ruficapillus*	Sh			LC				X		X	
Oriental Plover	*Charadrius veredus*	Sh	Mi		LC		X				X	
Pacific Golden Plover	*Pluvialis fulva*	Sh	Mi		LC							
Grey Plover	*Pluvialis squatarola*	Sh	Mi		LC						X	
Glareolidae (Pratincoles and Old-world Shore Birds)												
White-winged Black Tern	*Chlidonias leucoptera*	S	Marine		LC	X						
Oriental Pratincole	*Glareola maldivarum*	S	Mi		LC	X						
Laridae (Gulls and Terns)												
Silver Gull	*Larus novaehollandiae*	S			LC		X		X		X	X
Little Tern	*Sterna albifrons*	S			LC			X			X	X
Lesser Crested Tern	*Sterna bengalensis*	S			LC	X					X	X
Crested Tern	*Sterna bergii*	S			LC	X			X		X	
Caspian Tern	*Sterna caspia*	S			LC	X			X		X	X
Common Tern	*Sterna hirundo*	S	Mi		LC	X						
Whiskered Tern	*Sterna hybrida*	S			LC	X					X	
Fairy Tern	*Sterna nereis*	S			LC						X	
Gull-billed Tern	*Sterna nilotica affinis*	S			LC		X		X		X	X
Apodidae (Swifts)												
Fork-tailed Swift	*Apus pacificus*	S	Mi		LC					X		

1 Information Sources:

Western Australian Museum Records
Within 50 km of Outer Harbour Development

Greater than 50 km from Outer Harbour Development

Current Study Area

A = Western Australian Museum Records
B = Hedland HBI Project – Boodarie Site – Flora, Vegetation and Vertebrate Fauna (Mattiske 1994)
C = A Flora and Fauna Assessment of RGP5 Spoil Areas A and H, Port Hedland Harbour (Biota 2008)
D = Hope Downs Environmental Review (Hope Downs 2002)
E = FMG Stage A Rail Corridor (Biota 2004)
F = Outer Harbour Development – Summer Survey (ENV)
G = Outer Harbour Development – Winter Survey (ENV)

Table 6.13 – Number of Birds Recorded during Shorebird Counts in the Port Hedland Region with inclusion of Eighty Mile Beach Data for Comparative Purposes

Area	Years Summer Counts	Years Winter Counts	No. Top 30 Species	Banded Stilt	Bar-tailed Godwit*	Black-fronted Dotterel	Black-tailed Godwit*	Black-winged Stilt	Broad-billed Sandpiper	Common Greenshank*	Common Sandpiper*	Curlew Sandpiper*	Double-banded Plover*	Eastern Curlew*	Great Knot*	Greater Sand plover*	Grey Plover	Grey-tailed Tattler*	Hooded Plover
Eighty Mile Beach	15	14	22	0	23023	0	21	6	40	897	2	1618	0	137	36568	11665	338	4222	0
Dampier Saltworks	5	1	19	86	250	0	40	97	61	59	1	842	0	15	109	126	31	28	0
Port Hedland	3	0	5	203	83	0	0	20	225	12	0	192	N/A	1	0	29	1	1	0
Finucane Island	3	2	4	0	8	0	0	0	0	11	0	3	0	1	47	3	1	7	0
Area	**Latham's Snipe***	**Lesser Sand plover***	**Marsh Sandpiper***	**Masked Lapwing**	**Oriental Plover***	**Pacific Golden Plover***	**Pectoral Sandpiper***	**Pied Oystercatcher**	**Red Knot***	**Red-capped Plover**	**Red-kneed Dotterel**	**Red-necked Avocet**	**Red-necked Stint***	**Ruddy Turnstone***	**Sanderling***	**Sharp-tailed Sandpiper***	**Sooty Oystercatcher**	**Terek Sandpiper***	**Whimbrel***
Eighty Mile Beach	0	65	80	0	12359	29	0	54	4429	1376	0	0	5992	199	269	41	1	3463	27
Dampier Saltworks	0	23	56	0	322	6	0	2	70	1169	0	112	4781	22	1	940	0	0	35
Port Hedland	0	2	1	0	18	1	0	0	0	15	0	14	1023	3	0	104	0	0	1
Finucane Island	0	0	0	0	6	0	0	2	2	2	0	0	17	11	0	0	3	10	8

Source: Birds Australia
** EPBC Act Listed Migratory Species (DEWHA website 2009)*

Table 6.14 – Behavioural Stages of North-West Shelf Turtles and Respective Habitat

Life Stage		Green Turtle	Flatback Turtle	Hawksbill Turtle	Loggerhead Turtle
Post-hatchling		Oceanic nursery/pelagic.	Coastal waters.	Oceanic nursery/pelagic.	Oceanic nursery/pelagic.
Adult	Mating	Offshore from nesting habitat.	Currently unknown in the Pilbara.	Offshore from nesting habitat.	Currently unknown in Western Australia.
	Foraging	Neritic[1] habitats associated with seagrass/ algal beds and mangrove habitat.	Currently unknown in the Pilbara.	Shallow reef, patch reef habitat.	Subtidal and intertidal coral and rocky reefs, seagrass meadows and deeper, soft-bottomed habitats of the continental shelf.
	Nesting	High energy, steeply sloped beaches. Deep well sorted medium grain size. Deep water approach.	Low-energy, narrow beaches. Moderate grain size. Low to moderate beach slope.	Shallow coarse sand and coral rubble associated with near shore coral reefs.	Sandy, wide, open beaches backed by low dunes and fronted by a flat sandy approach from the sea.
	Inter-nesting[2]	Shallow coastal waters within several km of the nesting beach.	Shallow near shore coastal waters within 5–10 km of nesting beach.	Shallow coastal waters within several km of the nesting beach.	Shallow coastal waters within several km of the nesting beach.

Source: Pendoley Environmental (2009c)
1 The neritic zone includes ocean waters from the low tide mark to a depth of about 200 m.
2 The period between laying successive clutches of eggs within a breeding season

- North-western Mangrove Snake[1] (*Ephalophis greyi*);
- Olive-headed Sea Snake (*Disteira major*);
- Olive Sea Snake[2] (*Aipysurus laevis*);
- Short-nosed Sea Snake (*Aipysurus apraefrontalis*);
- Spectacled Sea Snake (*Disteira kingii*);
- Spine-tailed Sea Snake (*Aipysurus eydouxii*);
- Stokes' Sea Snake (*Astrotia stokesii*);
- Turtle-headed Sea Snake (*Emydocephalus annulatus*);
- Yellow-bellied Sea Snake (*Pelamis platurus*); and
- two species without common names (*Hydrophis mcdowelli* and *Hydrophis ornatus*).

Of the sea snakes identified during offshore marine habitat surveys, the Olive Sea Snake (*Aipysurus laevis*) was commonly observed and anecdotally recorded throughout the project study area (J. Crozier, SKM, 2009, pers. Comm.). This species is generally found in shallow coastal and coral reef waters across northern Australia (DEWHA 2009b). Species such as the Olive Sea Snake (*Aipysurus laevis*) are generalists and feed primarily on fish and benthic invertebrates (Guinea 2007) and also feed on dead fish and have been known to take fish from baited hooks and feed on trawl discards.

1 Previously known as Southern Mud Snake (*Ephalophis greyae)*
2 Also known as Golden Sea Snake

6.6.6 Marine Mammals

Cetaceans

Whales and dolphins are warm-blooded, air-breathing mammals which use sound for hunting, navigation and communication. Some species are permanent residents in Australian waters while others such as the Humpback Whale (*Megaptera novaeangliae*) are transient and only present during seasonal migration (DEWHA 2007a). Twenty-three species of cetaceans have a habitat range overlapping the north-west Australian continental shelf (Carwardine 2005).

The Australian Whale Sanctuary provides protection for whales and dolphins within Australian Commonwealth waters. The Sanctuary extends from 3 to 200 nm from Australia's coast and territorial islands (DEWHA 2007b). It is an offence under Commonwealth law to kill, injure or interfere with a cetacean within the sanctuary zone.

Four whale species often occur on the shelf itself or in adjacent coastal waters. These are the Humpback Whale (*Megaptera novaeangliae*), Blue Whale (*Balaenoptera musculus*), Dwarf Minke Whale (*Balaenoptera acutorostrata*) and the Killer Whale (*Orcinus orca*).

The Humpback Whale occurs closest to the coast and appears to be the most abundant whale species in the region. The north-west coast of Australia supports one of the world's largest breeding and calving grounds for Humpback Whales (Jenner *et al*. 2001). During winter months, Humpback Whales migrate from their Antarctic summer feeding grounds to their sub-tropical winter calving grounds (**Figure 6.26**). The major calving area in Western Australia is off the Kimberley coast (DEH 2006) and each year large numbers migrate along the Western Australia coastline. The Group IV population of Humpback Whales that migrates along the Western Australian coast was estimated during the northward migration in 2008 to be approximately 21,750 animals (Hedley *et al.* 2009).

Habitat considered important (or critical) for supporting Humpback Whale populations are those areas utilised for feeding, calving, resting and migratory routes (DEH 2006). According to the Humpback Whale Recovery Plan 2005–2010 (DEH 2006), the Port Hedland area is not a known feeding, aggregation or major calving area. Humpback Whales migrate past Port Hedland on their way to and from calving areas off the Kimberley coast (Jenner *et al*. 2001). Off Port Hedland, the northbound peak period is late June to early August, while the southbound period is late August to mid-October (DEWHA 2007a; Jenner *et al*. 2001). According to Jenner *et al*. (2001) and Prince (2001), migrating whales remain well offshore, typically in waters equal to or exceeding 20 m[1] depth. Nevertheless, individual animals or pods do venture closer to shore. During boat-based field work off Port Hedland in August 2008, anecdotal observations noted Humpback Whales in water depths of about 13 m upto 30 km from shore (G. Paccani, SKM, 2009, pers. comm.).

Based on the habitat type and incidental sightings, three dolphin species are likely to be resident in the study area at least seasonally: the Indo Pacific Humpback Dolphin (*Sousa chinensis*), the Australian Snubfin Dolphin (*Orcaella heinsohni*) and the Bottlenose Dolphin (*Tursiops truncatus*) (Jenner & Thiele 2008). All three species are listed as data deficient under the International Union for Conservation of Nature (IUCN) Red List (IUCN 2008) and no publications exist for any cetacean surveys in the Port Hedland study area (Jenner & Thiele 2008). The Spotted Bottlenose Dolphin (*Tursiops aduncus*), which is listed as a migratory species under the EPBC Act, is also found in the study area although no resident populations are known to occur (Prince 2001).

Dugongs

Dugongs (*Dugong dugon*) are large marine, vertebrate [2]herbivores. In Western Australia, dugongs are found from Shark Bay (approximately half-way up the west coast of Western Australia) to the Northern Territory border.

Dugongs feed on seagrass and are usually found in shallow water (less than 5 m depth) in areas with extensive seagrass coverage. There is limited published evidence of seagrass presence in the Port Hedland region, although four seagrass species have been recorded previously (Walker & Prince 1987), three of which are considered important forage seagrasses for dugongs (Sheppard *et al.* 2007). Marine investigations undertaken for the Outer Harbour Development (refer to **Section 6.6.2**) located only sparse seagrass patches of limited spatial extent inshore of Weerdee Island, small, sparse patches offshore of Weerdee Island, in a shallow intertidal pool on the northeast margin of Finucane Island and at North Turtle Island (**Figure 6.15**).

Dugongs are known to be present in Pilbara inshore waters. Prince (2001) estimated in excess of 2,000 dugongs to be widely distributed from the northern end of Exmouth Gulf to Bedout Island, east of Port Hedland. This represents an average density of 1 dugong per 10 km^2. Port Hedland is not considered an important aggregation area for dugongs (Prince 2001) and the apparent lack of extensive seagrass meadows within the study area would suggest that it is not an important feeding area. The isolated area of seagrass found inshore of Weerdee Island may represent a potential dugong feeding or resting area, but is unlikely to support a large permanent population.

Dugongs have been sighted in the study area during the environmental studies undertaken for the Outer Harbour Development, and by other researchers working in the region. Several dugong sightings were made during surveys conducted to determine turtle numbers in the study area. Most sightings were of single individuals at locations close to shore, however a small pod of six to eight was sighted near Little Turtle Island during the summer of 2009 (Pendoley Environmental 2009a). Two sightings were recorded at a location approximately 20 km south-west from Cape Thouin, one sighting inshore of Weerdee Island and one at North Turtle Island.

1 With respect to the Outer Harbour Development, the 20 m bathymetric contour lies approximately 30 to 35 km from the end of the proposed wharf, while the end of the proposed channel is approximately 2 to 5 km from the nearest 20 m contour.

2 Herbivores are animals that eat only plants.

In April 2000, a single dugong was observed within the Port Hedland Inner Harbour during an aerial survey (Prince 2001) and in October 2008 a single dugong was observed in Oyster Inlet, an embayment 10 km to the west of Port Hedland Harbour (P. Morrison, SKM, 2008, pers. comm.). A single dugong was also observed from the shore of Finucane Island by DEWHA (now DSEWPaC) officers during an onsite visit with BHP Billiton Iron Ore personnel on 20 October 2009.

The small numbers of dugongs observed during previous studies and during the environmental investigations for the Outer Harbour Development suggest the study area is a dugong transitory pathway and does not support large numbers of feeding or resting dugongs.

Underwater Noise Levels Relative to Marine Mammals

Anthropogenic and natural noise can impede acoustic communication and other functions of marine biota. Relatively little is known about the effects of natural marine noise on marine animals in the oceans (NOAA 2004).

Noise in the marine environment is derived from a number of biological and physical sources. Marine noise sources include:

- naturally-occurring biological sounds produced by animals such as whales, dolphins and fish;
- naturally-occurring physical sounds such as waves, seismic activity, thunder and lightning; and
- noise associated with human activities such as shipping and construction.

Marine animals in the vicinity of the Outer Harbour Development that may be affected by anthropogenic noise emissions include turtles and mammals. Cetaceans are considered to be particularly sensitive to anthropogenic noise as it can impair their ability to echolocate, locate and capture food, detect predators and sense their biological and physical environment (which in the worst case may lead to disorientation and beaching).

An evaluation of the existing noise sources in the vicinity of the Outer Harbour Development was undertaken by Curtin University (Jenner & Thiele 2008). A CMST-DSTO sea noise logger was deployed on the seabed in 14 m CD depth of water, approximately 560 m east north-east of the PHPA Channel Marker 14 and 38 km north-east of the coast at Port Hedland harbour (**Figure 6.26**) from October 9 to 23, 2008, capturing a full spring-neap tidal cycle. The sea noise logger was set to record 5 minutes out of every 15 minutes, resulting in over 2,000 recordings. The main sources of noise identified from analysis of sea noise logger recordings included:

- vessels;
- Humpback Whale signals; and
- fish.

Vessel noise is likely to represent an increasingly large component of marine noise in the Port Hedland region. From 2004 to 2008, annual shipping traffic to Port Hedland Harbour increased from 773 to 1,027 vessels (PHPA 2008b).

Many marine noise sources can be highly seasonal, particularly those of a biological origin. The noise monitoring occurred when large pods of Humpback Whales were likely migrating southwards past Port Hedland. At a different time of year, Humpback Whale signals are unlikely to have been recorded, or would have contributed proportionately less to overall marine noise. Likewise, the physical sea noises recorded may not be an accurate reflection of this source's proportionate input at other times during the year. Increased natural noise levels are expected from wave action, thunder and lightning from storms and cyclonic activity during the summer months.

6.6.7 Fish

Fish species of the Port Hedland region have not been well surveyed although they are expected to include a sub-set of the fish recorded at the Dampier Archipelago, approximately 250 km to the west. Surveys of the Dampier Archipelago have recorded a total of 650 fish species consisting of a diverse 465 coral reef species, 116 mangrove-associated species, 106 species associated with soft bottom habitat and 67 pelagic species (Hutchins 2004). Although this survey was biased towards reef fishes, the survey also considered soft bottom and mangrove habitats as well as the pelagic environment. Hutchins found that species diversity was highest in areas of high topographic diversity, particularly along the northern perimeter of the archipelago. By comparison, the topography of the Port Hedland region consists of relatively low relief limestone ridgeline formations that support only sparse hard coral habitat, and consequently is expected to also support a less diverse suite of fish species.

A survey of fish assemblages within the Port Hedland Inner Harbour identified 106 species (Ecoscape 2004). The Inner Harbour area is a tidal creek system with mangroves and samphires present in intertidal habitats and some small patches of subtidal reef supporting low diversity, although

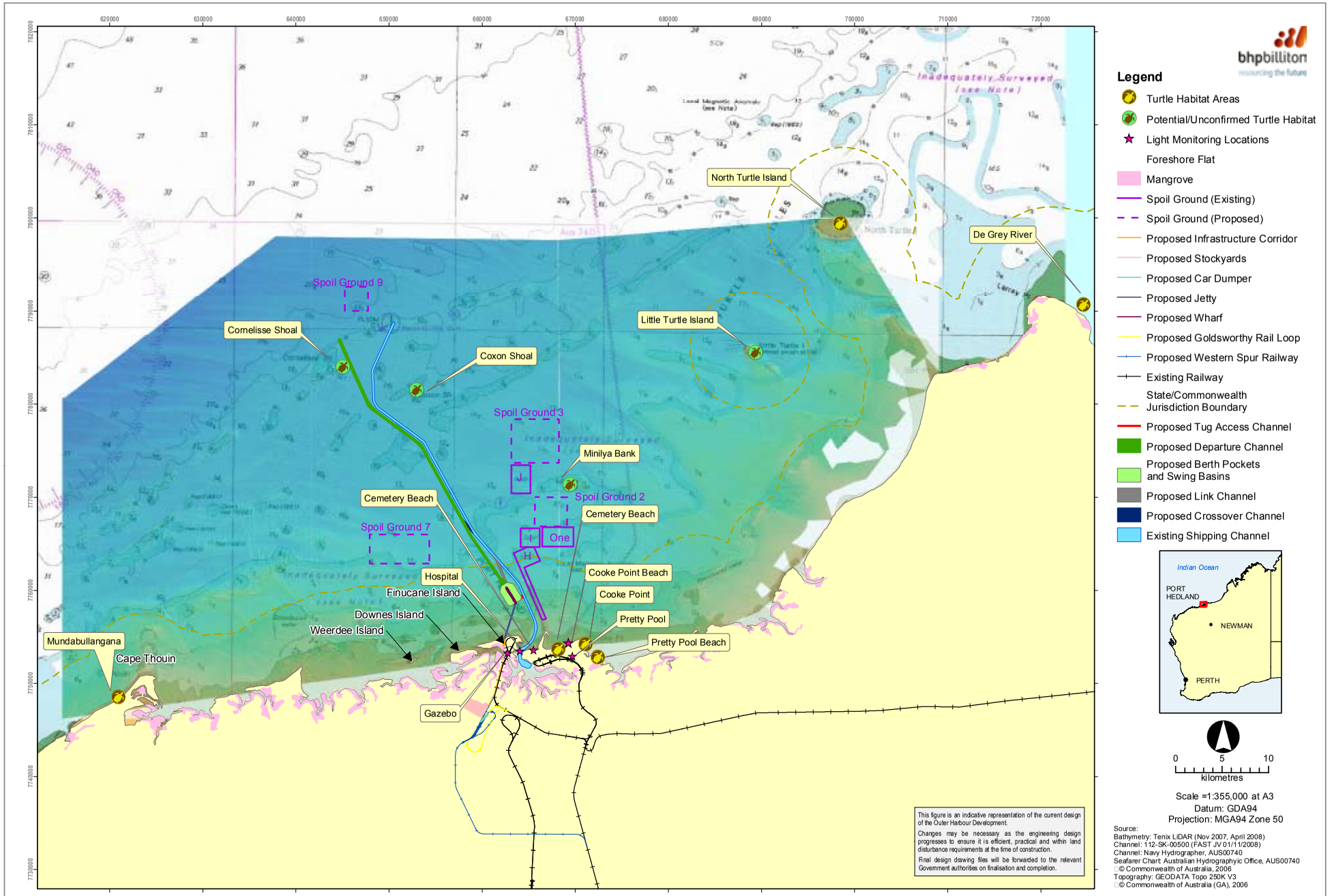

Figure 6.17 Marine Turtle Habitats and Light Monitoring Locations

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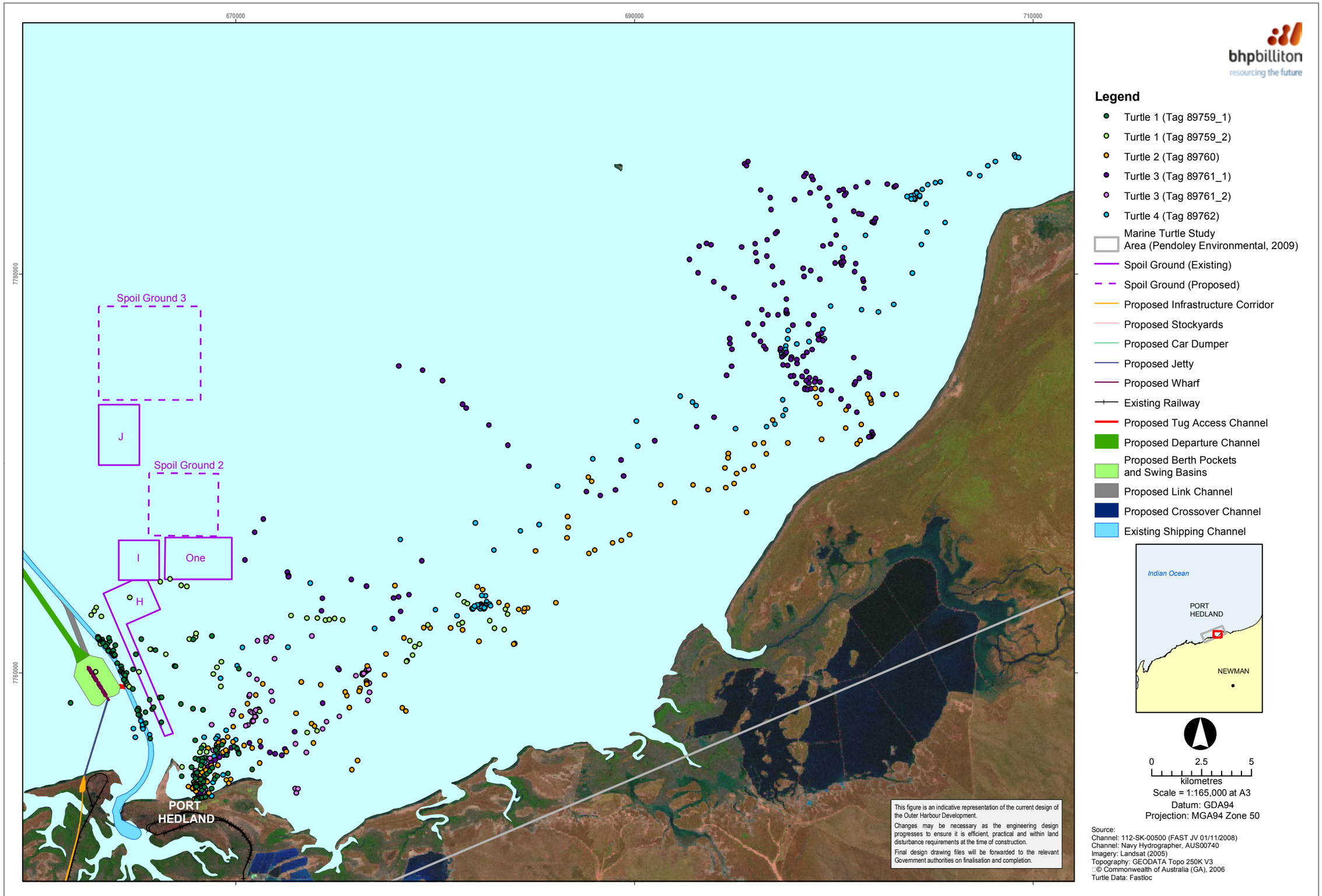

Figure 6.18 Internesting Movements of Four Flatback Turtles Tracked from Cemetery Beach, Port Hedland

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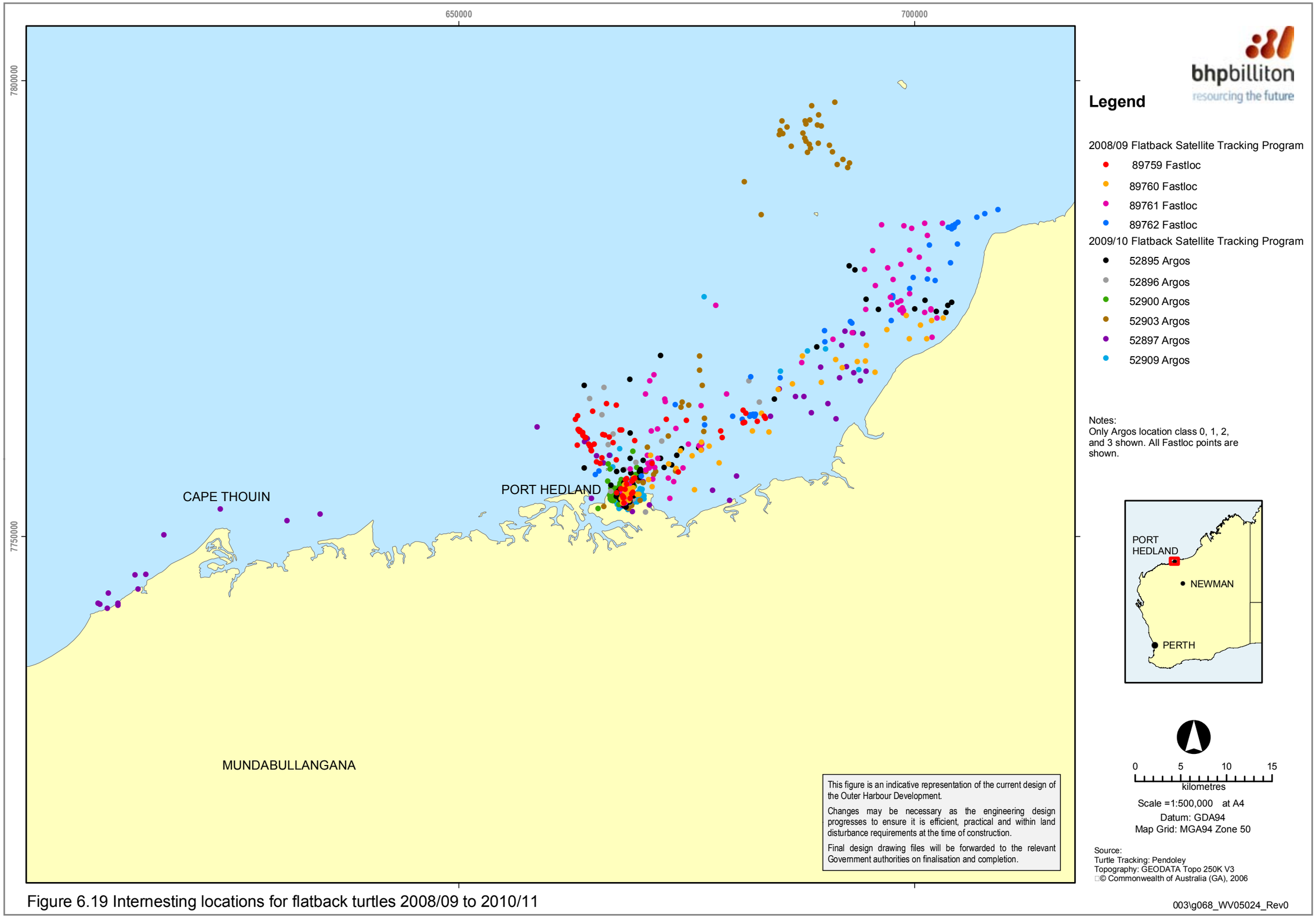

Figure 6.19 Internesting locations for flatback turtles 2008/09 to 2010/11

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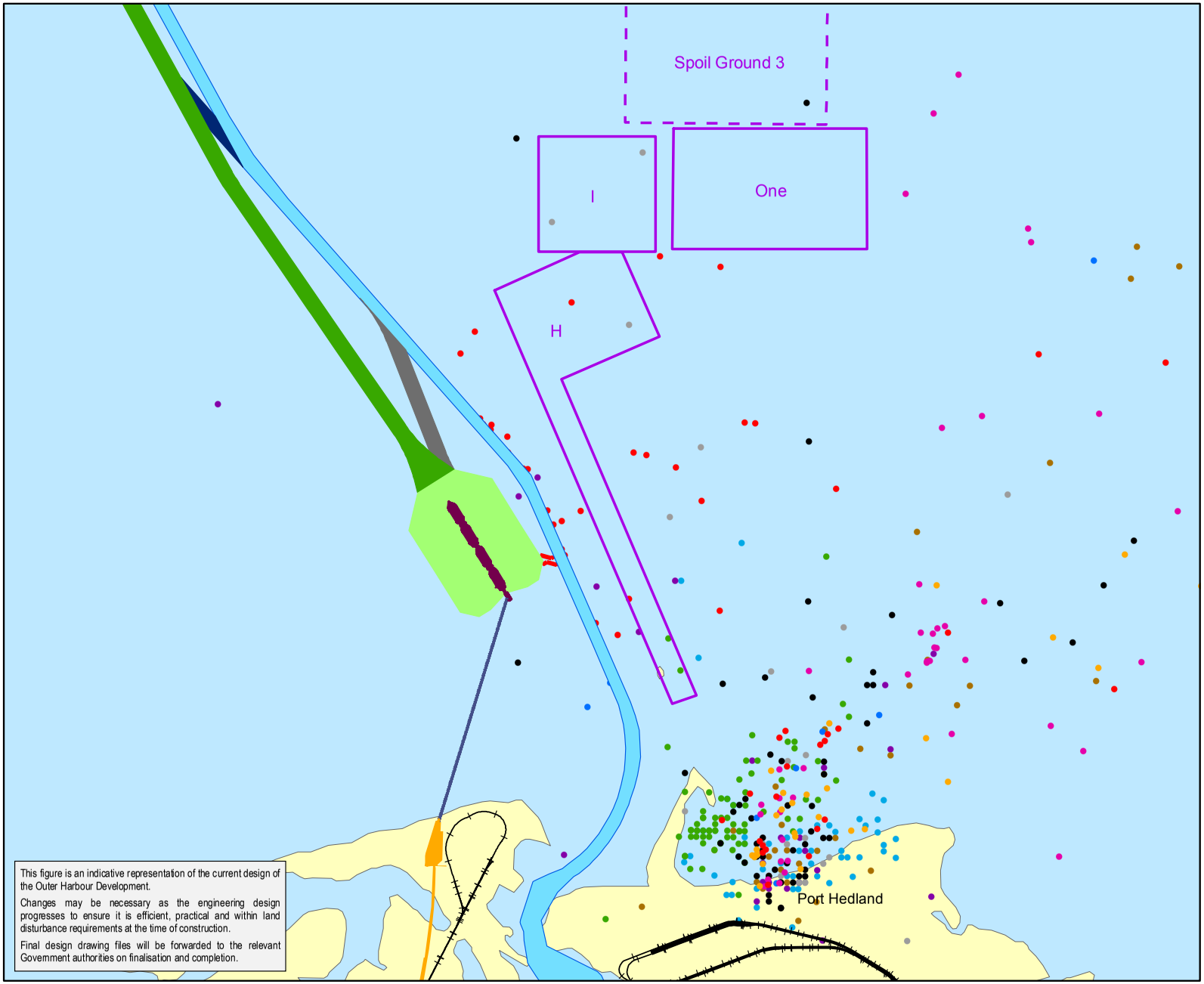

Figure 6.20 Internesting locations for flatback turtles 2008/09 to 2010/11 in proximity to the proposed project

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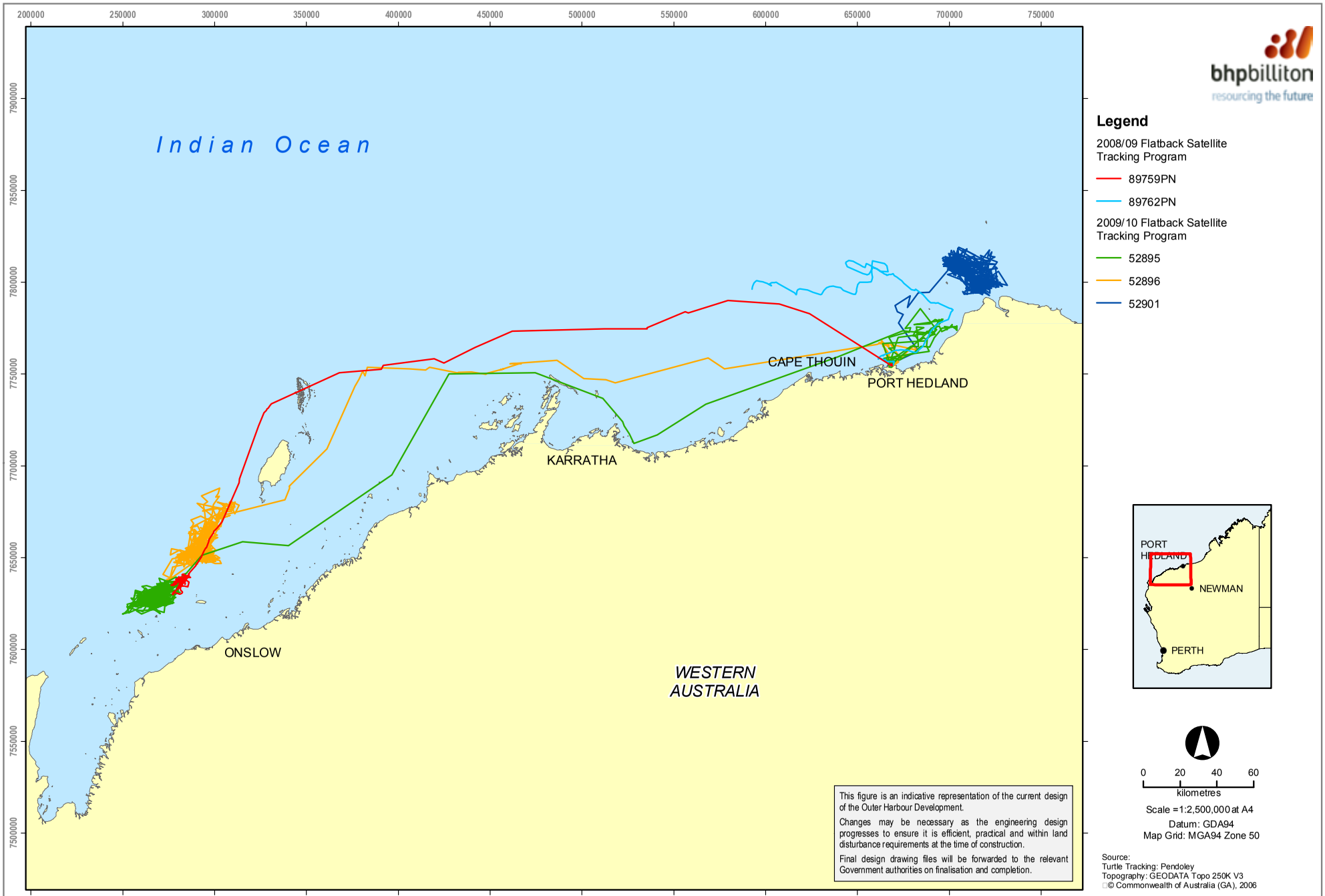

Figure 6.21 Post nesting migrations of all turtles headed south from Port Hedland in 2008/09 and 2009/10

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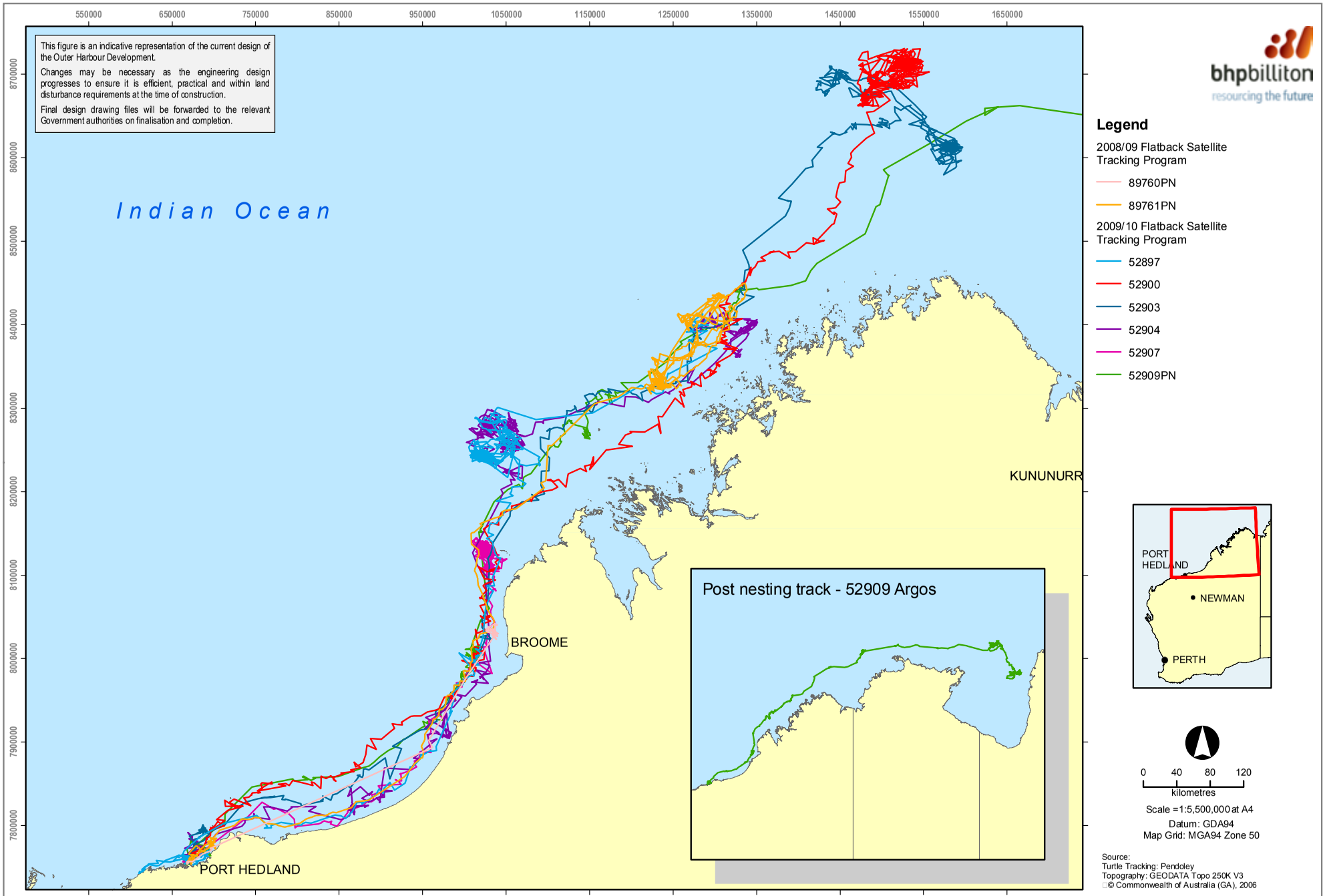

Figure 6.22 Post-nesting migrations of all turtles headed north from Port Hedland in 2008/09 and 2009/10

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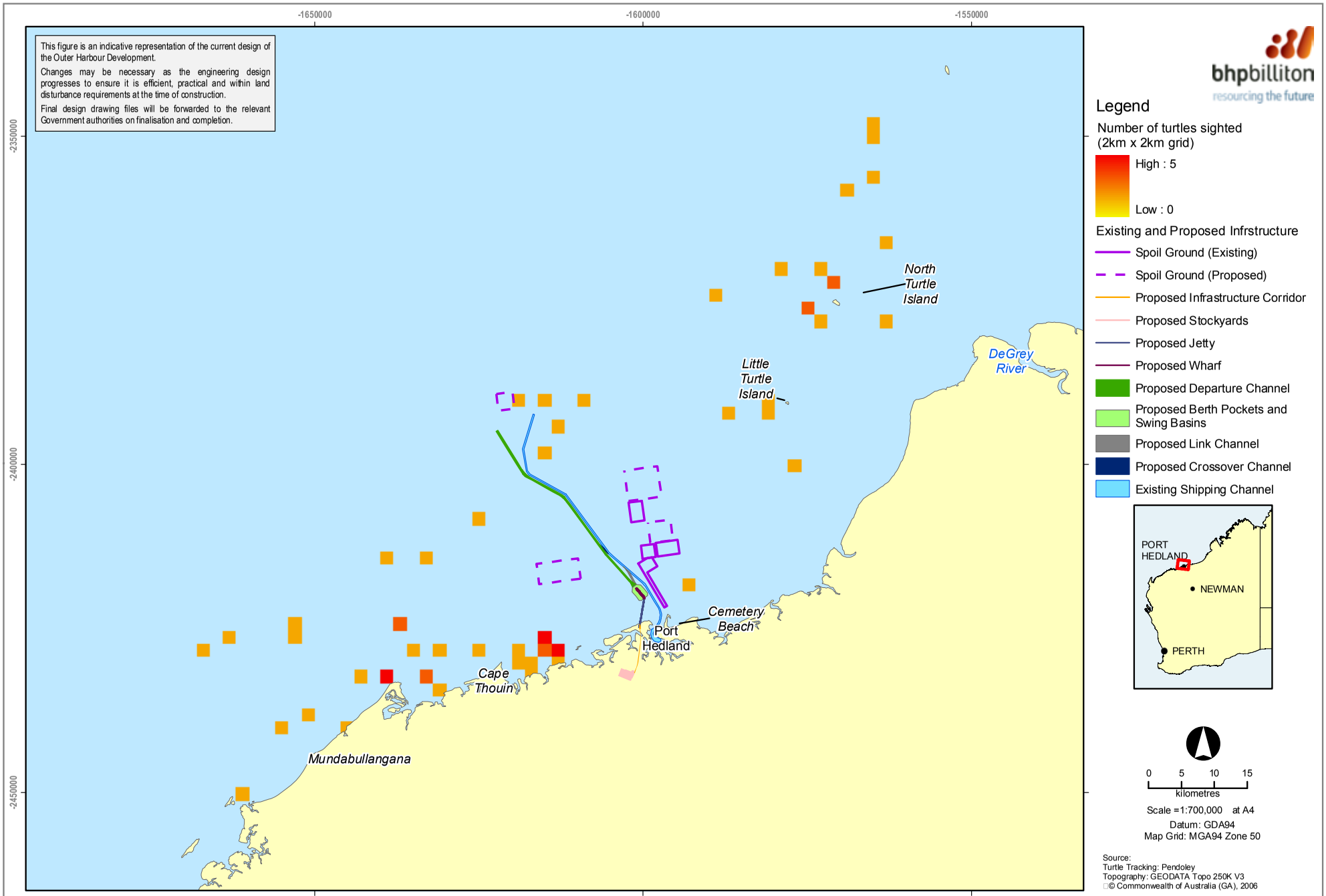

Figure 6.23 In-Water Marine Turtle Sightings Offshore from Port Hedland (Summer 2008 Aerial Survey)

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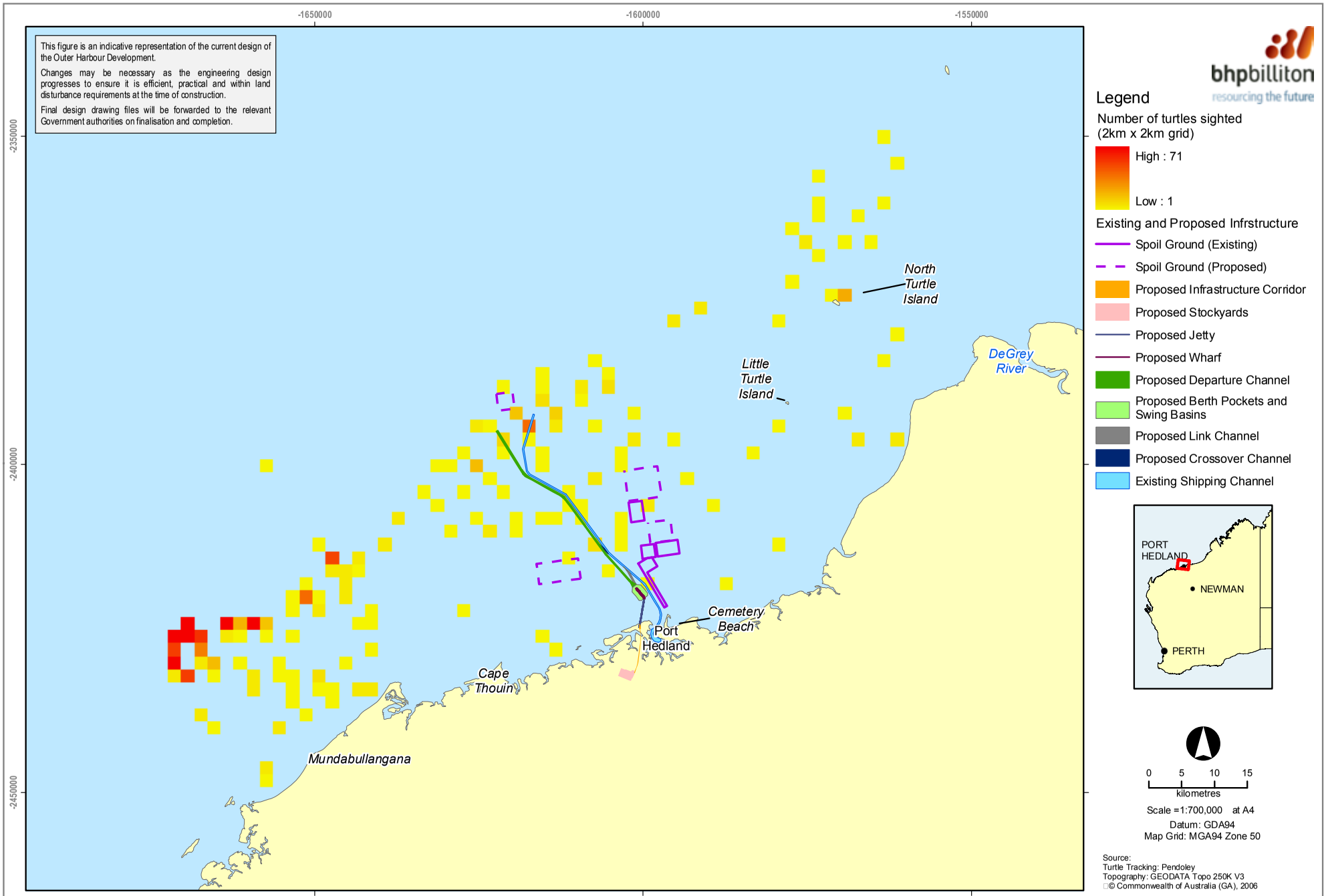

Figure 6.24 In-Water Marine Turtle Sightings Offshore from Port Hedland (Summer 2010 Aerial Survey)

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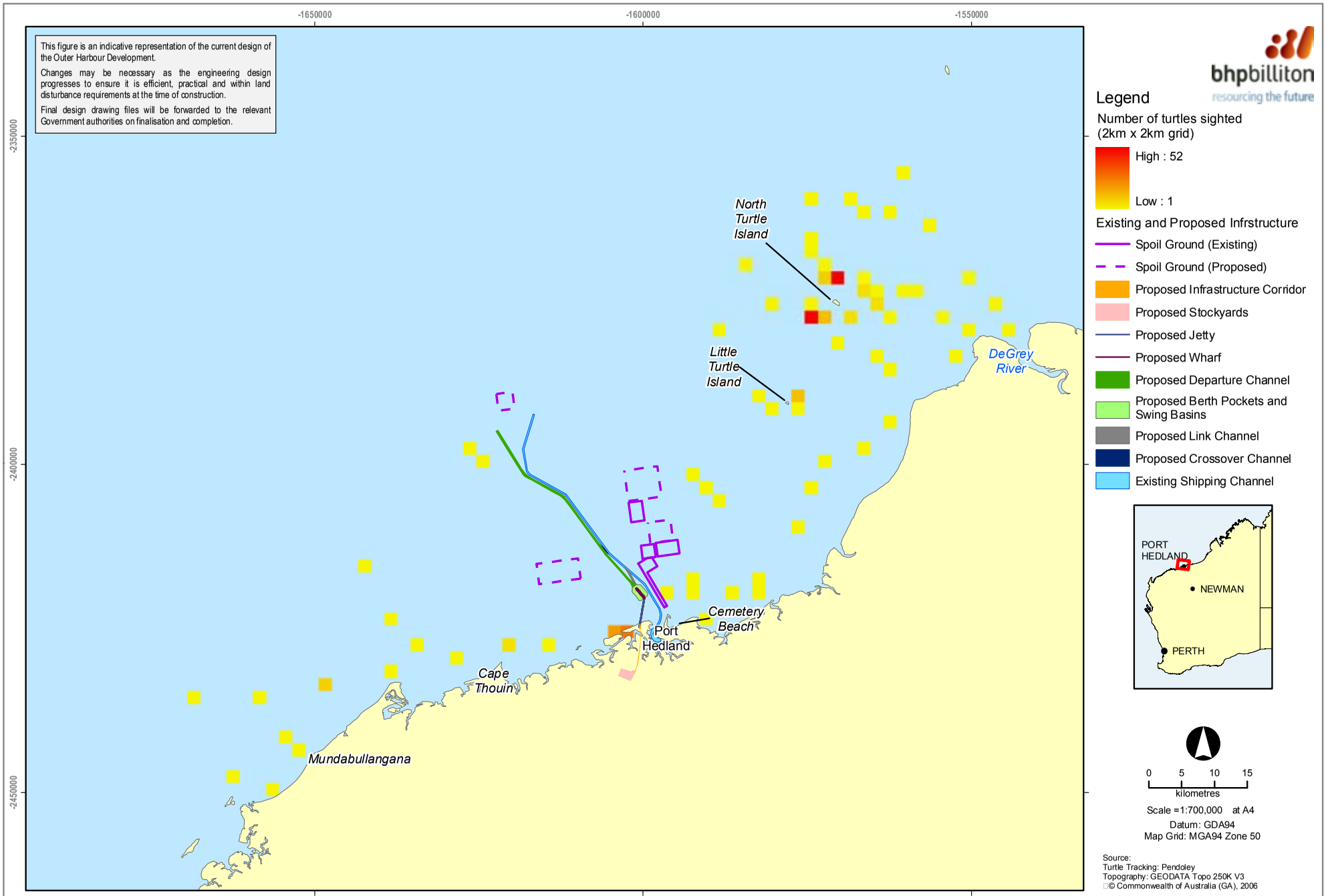

Figure 6.25 In-Water Marine Turtle Sightings Offshore from Port Hedland (Winter 2009 Aerial Survey)

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comprehensive, macroalgal cover. In addition, non-BPP organisms are also well represented in the Inner Harbour and include sponges and soft corals (BHP Billiton Iron Ore 2009d). The tidal creek system is likely to contain species that are resident, spending some or all of their lives in the creek system, and other species that enter with the incoming tide and exit with the outgoing tide.

Many of the locally-occurring species in the Port Hedland region are of commercial and recreational value and these are the species discussed in this section. Protected species of fish and sharks, i.e. the Whale Shark (*Rhincodon typus*) and Sawfish (*Pristis* spp.) are listed and discussed in **Sections 6.6.9** and **6.6.10**, respectively. Of the Sawfish, only the Green Sawfish (*Pristis zijsron*) is potentially present in high numbers in the Port Hedland region (D. Morgan pers. comm.).

Commercial Fisheries

Several commercial fisheries occur along the Western Australian north-west coastline and encompass the Port Hedland area. These fisheries are outlined in **Table 6.15**.

The Nickol Bay Prawn Fishery has operators that utilise fishing grounds within the Port Hedland area. The boundaries of the Nickol Bay Prawn Fishery encompass all the waters of the Indian Ocean and Nickol Bay between 116°45' east longitude and 120° east longitude on the landward side of the 200 m isobaths (DoF 2008). The main areas of fishing activity within this designated area are quite small, primarily around the De Grey River to the north-east of Port Hedland.

The Mackerel Fishery extends from Geraldton to the Western Australia-Northern Territory border and is divided into three management areas. The Outer Harbour Development occurs within the Pilbara management zone (114° to 121° east). Mackerels are pelagic fish, caught by trolling close to the surface around reefs, shoals and headlands (DoF 2008a, p.179). There is only one commercial mackerel fisherman operating from Port Hedland but mackerel are also targeted by recreational fishers within this area.

The Pearl Oyster Fishery, which targets the Silver-lipped Pearl Oyster (*Pinctada maxima*) comprises both wild-caught and hatchery-reared oysters. Diving for pearl oyster wild stock occurs mainly along Eighty Mile Beach, ideally in water depths less than 20 m CD, and also in the area around Exmouth Gulf. Since water clarity is an important factor in diver efficiency when harvesting pearl oyster, the turbid waters around Port Hedland are not as favourable for wild stock harvest. There is one oyster aquaculture licence (non-maxima pearl oyster) adjacent to Weerdee Island.

The Pilbara Demersal Finfish Fishery encompasses the Pilbara Trawl (Interim) Managed Fishery, the Pilbara Trap Managed Fishery, and a small line fishery component. These fisheries are found outside the marine development footprint in offshore waters; the Pilbara Trawl (Interim) Managed Fishery occurs seaward of a line following the 50 m isobath, and the Pilbara Trap Managed Fishery lies seaward of a line following the 30 m isobath at a distance of 16 km from the marine development footprint (DoF 2008).

Recreational Fisheries

Popular offshore recreational fishing spots include Cornelisse and Coxon Shoals and Minilya Bank. Although further offshore, Little Turtle and North Turtle Islands are also popular. Larger recreational boats are capable of going over 70 km offshore and some will fish in the same offshore areas as the commercial Mackerel Fishery operator.

The main species which are targeted offshore are members of the tropical snapper family (*Lutjanidae*), such as Red Emperor (*Lutjanus sebae*), adult Mangrove Jack (*Lutjanus argentimaculatus*), Crimson Snapper (*Lutjanus erythropterus*), Chinaman fish (*Symphorus nematophorus*), as well as Barcheek Coral Trout (*Plectropomus maculatus*), Yellowedge Coronation Trout (*Variola louti*), a variety of cods (*Serranidae* family), Red Throat Emperor (*Lethrinus miniatus*), Tuskfish (*Choerodon* spp.), Spangled Emperor (also known as Nor'west Snapper) (*Lethrinus nebulosus*), and assorted pelagic species such as Spanish Mackerel (*Scomberomorus commerson*), Grey Mackerel (*Scomberomorus semifasciatus*), Tuna (*Thunnus tonggol*), Cobia (*Rachycentron canadum*), Great Barracuda (*Sphyraena barracuda*), Wahoo (*Acanthocybium solandri*) and Sailfish (*Istiophorus platypterus*) (SKM 2009n).

Inshore fishing occurs in a variety of habitats, including coastal ridges, artificial spoil banks, mangroves, estuaries and creeks. Fishing is both shore- and boat-based. Popular recreational fishing spots within Port Hedland are the waters around Weerdee, Downes and Finucane Islands (see **Figure 6.11**), Spoil Bank (see **Figure 6.16**) and Cemetery Beach.

Many offshore reef species are also found in reefs and shoals within the inshore waters. Often juvenile species are found in these protected inshore waters and migrate offshore upon reaching maturity (SKM 2009n). Some snappers such as Golden Snapper (*Lutjanus johnii*) favour coastal areas, especially

near mangroves in estuaries, while the very popular Western Yellowfin Bream (*Acanthopagrus latus*) is found around coastal reefs and estuaries.

Pelagic species such as Mackerel are also found inshore around coastal reefs. Other species found in coastal waters are Giant Sea Catfish (*Arius thalassinus*), Golden Trevally (*Gnathanodon speciosus*) and Giant Trevally (*Caranx ignobillis*), which are also found in offshore waters (SKM 2009n).

Popular species found in estuarine areas include Barramundi (*Lates calcarifer*), Mud Crabs (*Scylla* spp.), Prawns (*Penaeus* spp.), Blue Threadfin (*Eleutheronema tetradactylum*), King Threadfin (*Polydactylus macrochir*), Mulloway (*Argyrosomus hololepidotus*), Mullet (family Muglidae) and Flathead (family Platycephalidae).

Goldenline Whiting (*Sillago analis*) are found in sandy areas near estuary mouths and inshore areas, while the Western Sooty Grunter (*Hephaestus jenkinsi*) are found in freshwater rivers and streams.

6.6.8 Invasive Marine Species

Invasive marine species (IMS) are organisms, introduced into a region beyond their natural range, that not only have the ability to survive in their new environment but also negatively impact that environment or other species within it. These introductions are often human-mediated, with some of the earliest introductions resulting from biofouling on wooden ships. If these introduced species are able to survive, reproduce and establish a foundation population, the ability of this population to subsequently spread by natural and/or human-mediated means (e.g. by 'port hopping' translocations) poses a potential risk to ecological and socio-economic values in the area. Once established, eradication of even localised populations is often impossible, limiting management options to ongoing control or impact minimisation. Eradication, control and impact minimisation have all proved to be expensive management alternatives.

Port Hedland is currently recognised as an "at risk" port within Australia for the introduction and establishment of marine pest species (C. Astbury, SKM, 2008, pers. comm.). This assessment is largely based on the level of activity that occurs within the port environment and is primarily related to vessel mediated incursions. These incursions take one of two common pathways: ballast water or biofouling. The latter includes external fouling and internal seawater system fouling. These two processes are historically responsible for many of the IMS introductions around the world. Considering the level of commercial activity that occurs within Port Hedland, the number of known IMS and cryptogenic species is lower than expected (CSIRO 1999). A summary of known IMS confirmed within the Port Hedland Inner Harbour is provided in **Table 6.16**. 'Cosmopolitan' species are those species known to have a global distribution where part or all of their distribution may be considered to be cryptogenic. 'Cryptogenic' means the status as an introduced or native species cannot be definitely or demonstrably categorised. The species that are known to be present within the Port Hedland Inner Harbour are either well-known cosmopolitan, common fouling species, or species with less obvious impacts or that are inconspicuous by nature.

There have been no introduced species recorded at the site of the Outer Harbour Development. Given that the project is located more than 4 km beyond the existing Inner Harbour operation and is not presently used for any shipping activities including anchoring or loading, there is a very low likelihood of any IMS being present in the area.

In Western Australia, IMS are managed through the *Quarantine Act 1908* (CTH)*, Fisheries Act 1952* (CTH), Australian Ballast Water Requirements, Australian Biofouling Management Protocol and Guidelines, *Biosecurity and Agriculture Management Act 2007, Fish Resources Management Act 1994*, *Pearling Act 1990, Port Authorities Act 1999* and associated regulations and subsidiary legislation that are currently being developed.

6.6.9 Marine Fauna of Conservation Significance

The WC Act provides for the protection of native fauna, with species considered as needing special protection listed under various categories. The Wildlife Conservation (Specially Protected Fauna) Notice 2008 (2) lists fauna that are rare, likely to become extinct (Schedule 1) and other 'specially' protected species (Schedule 4) in Western Australia (DEC 2008a) (refer to **Appendix B28**).

The DEC also has a 'Priority' list for monitoring fauna species, ranging from P1 to P5; with P1 indicating the greatest need for monitoring before the species can be listed as threatened fauna (DEC 2008b).

Table 6.17 lists the species of conservation significance (excluding migratory seabirds and shorebirds) that may potentially occur or have been recorded within the study area. In addition to these species 31 shorebird and seabird species listed as 'migratory' under the EPBC Act may potentially occur within the Project area (see **Section 10.4.5**).

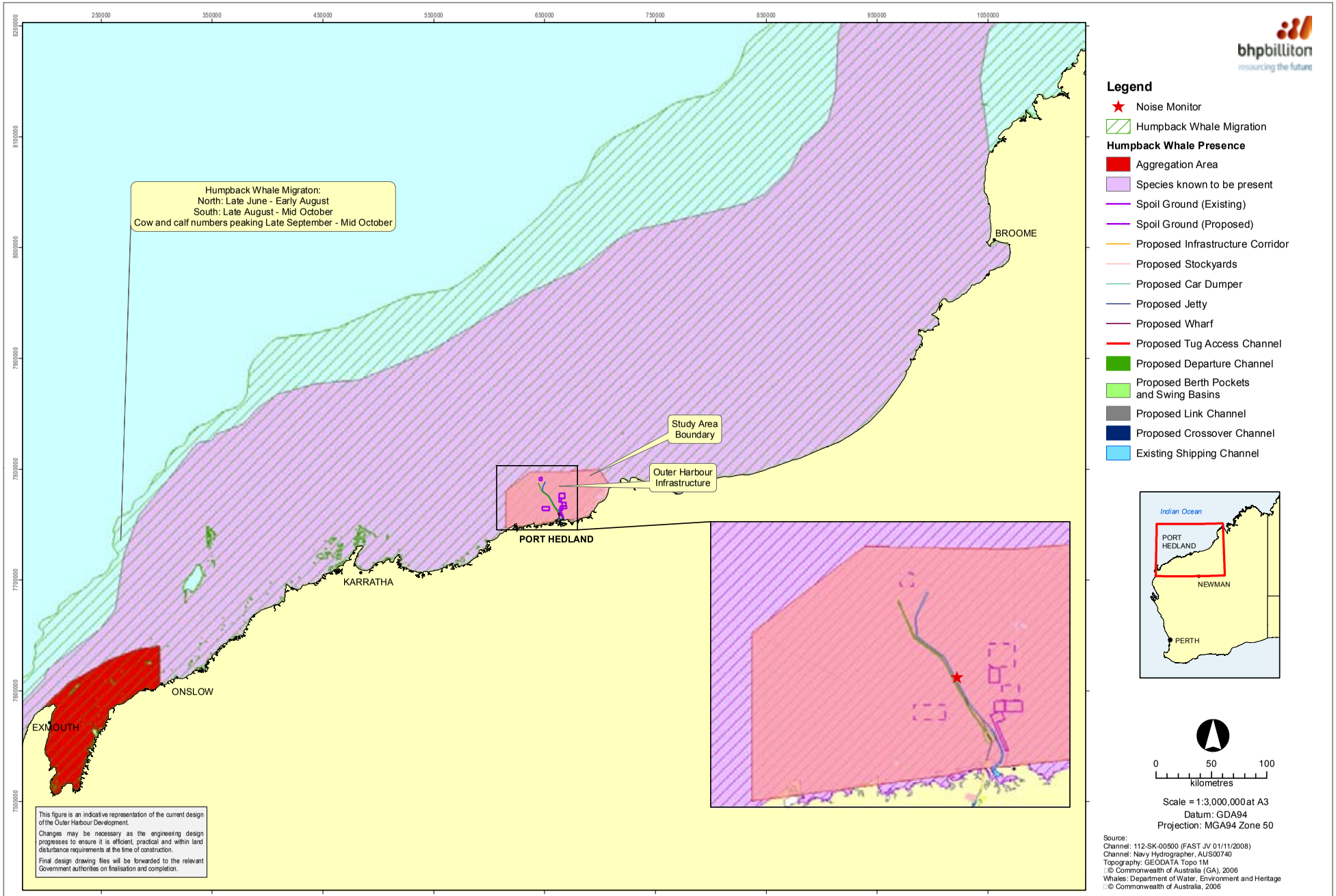

Figure 6.26 Humpback Whale Migration Route and Aggregation Areas

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6.6.10 Matters of National Environmental Significance

The EPBC Act provides protection for Matters of National Environmental Significance throughout Australia. For marine fauna, relevant Matters of National Environmental Significance are "nationally listed threatened species" and "listed migratory species". Threatened marine fauna may be listed under the EPBC Act in any one of the following categories: critically endangered, endangered, vulnerable, or conservation dependant. The list of migratory species is derived from those species listed on relevant international conventions or agreements.

The Commonwealth marine area is also a Matter of National Environmental Significance and any fauna species found within the Commonwealth marine area are considered to be a component of this matter, and therefore need to be considered.

Additionally, the EPBC Act provides further protection for cetaceans and "listed marine species" in Commonwealth waters. It should be noted that cetaceans and "listed marine species" are not Matters of National Environmental Significance unless also specifically included on the threatened species and/or migratory species lists.

The Outer Harbour Development constitutes a 'controlled action' under the EPBC Act due to the potential significant impacts on the following marine Matters of National Environmental Significance:

- **Listed threatened species and ecological communities**: a search of the EPBC Act protected matters search tool (DEWHA 2009) on the 23 of January 2009 found ten threatened marine species including two species of mammal, two species of birds, five species of turtles and one shark within the proposed Outer Harbour Development area. A list detailing these species is provided in **Appendix B28**.
- **Migratory species protected under international agreements**: a search of the EPBC Act protected matters search tool (DEWHA 2009) on the 23 of January 2009 found 32 species of migratory fauna. A list detailing these species is provided in **Appendix B28**.
- **Commonwealth marine areas**: although dredge spoil disposal for the Outer Harbour Development will occur within Commonwealth marine waters, it is not believed that the activities will have a significant impact on the environment (refer to **Section 10**).

Detailed here are those species identified under the EPBC Act as critically endangered, endangered, vulnerable or migratory. A complete list of all species found defined under the EPBC Act is provided in **Appendix B28**. The information provided relates to the marine development footprint of the proposed Outer Harbour Development, including the marine infrastructure which spans State and Commonwealth Marine Areas, and the proposed Spoil Disposal Grounds which are located in Commonwealth Marine Areas only.

6.6.10.1 Marine Reptiles

Potentially occurring marine affiliated reptiles listed under the EPBC Act include:

- three Endangered reptiles;
  - Loggerhead Turtle (*Caretta caretta*);
  - Olive Ridley Turtle (*Lepidochelys olivacea*); and
  - Leathery Turtle (*Dermochelys coriacea*), recently upgraded to endangered;
- three Vulnerable reptiles;
  - Green Turtle (*Chelonia mydas*);
  - Hawksbill Turtle (*Eretmochelys imbricata*); and
  - Flatback Turtle (*Natator depressus*).

Marine turtle nesting populations are distributed widely across the Pilbara coastline and offshore Islands though large populations are concentrated in a few areas. Small sandy beaches occur along the coastline between Mundabullangana and the mouth of the De Grey River (approximately 70 km north-east of Port Hedland Harbour) which may provide nesting habitat for marine turtles (Pendoley 2005). Aerial surveys of the coast to identify nesting habitat between Mundabullangana and the De Grey

Table 6.15 – Main Commercial Fisheries in the Port Hedland Area

Commercial Fishery	Key Species
Nickol Bay Prawn	Banana Prawns
Mackerel	Spanish Mackerel
Pearl Oyster	Silver-lipped Pearl Oyster
Pilbara Demersal Finfish (including Pilbara Trap and Pilbara Trawl (interim) fisheries	Bluespot emperor, Threadfin bream, Flagfish, Crimson snapper, Red emperor, Saddletail snapper, Goldband snapper, Spangled emperor and Rankin cod

River (2008/09, 2009/10 and 2010/2011) found no nesting at a number of these beaches, including either Finucane or Weerdee Islands, despite both locations providing what may be suitable nesting habitat. If nesting does occur at these locations it is likely sparse. Observations at North Turtle Island recorded Flatback turtle tracks and nests across the island (SKM 2009k; Pendoley Environmental 2009b). Nesting at Little Turtle Island has not been documented and is unlikely as most of the island is awash at high tide. Flatback turtles also nest at Cemetery Beach, Paradise Beach, Pretty Pool, Cooke Point and Downes Island (Prince 1994, Pendoley Environmental 2009b).

Data collected during field surveys, show internesting turtles occupying habitat up to 60 km offshore from Cemetery Beach between laying successive clutches of eggs (Pendoley Environmental 2009b). In some cases animals spent periods of time in the existing shipping channel. There was no movement recorded west of the shipping channel; all internesting tracks logged were to the east of the shipping channel. No locations were received that indicated animals spending any time in the proposed development area.

6.6.10.2 Marine Mammals

Potentially occurring marine mammals listed under the EPBC Act include:

- one Endangered mammal, Blue Whale (*Balaenoptera musculus*);
- one Vulnerable mammal, Humpback Whale (*Megaptera novaeangliae*); and
- three Migratory mammals, Dugong (*Dugong dugon*), Australian Snubfin Dolphin (*Orcaella brevirostri*), and the Indo-Pacific Humpback Dolphin (*Sousa chinensis*).

Of the large cetaceans found off the Pilbara coast, Humpback Whales undertake regular migration offshore from the Pilbara. Each year, Humpback Whales (*Megaptera novaengliae*) migrate from Southern Ocean summer feeding grounds to sub-tropical winter calving grounds. However, the Port Hedland area is not a known calving or aggregation area (NHT 2005). Humpback Whales migrate past Port Hedland on their way to and from calving areas off the Kimberley coast (Jenner *et al*. 2001). Off Port Hedland, the northbound peak period is late June to early August, while the southbound period is late August to mid-October (DEWHA 2007a; Jenner *et al*. 2001). According to Jenner *et al*. (2001) and Prince (2001), migrating whales remain well offshore, typically in waters equal to or exceeding 20 m[1] depth. Nevertheless, individual animals or pods do venture closer to shore. During boat-based field work off Port Hedland in August 2008, anecdotal observations noted Humpback Whales in water depths of about 13 m (G. Paccani, SKM, 2009, pers. comm.).

Prince (2001) suggested that large cetaceans off the Pilbara coast are unlikely to be found in waters less than 20 m deep and are therefore not expected in the vicinity of dredging footprint or spoil grounds. Prince (2001) reported that Pilbara coastal waters support small populations of dolphins, with the majority beings Bottlenose (*Tursiops* sp.) and Humpbacked Dolphins (*Sousa* spp.).

Dugongs (*Dugong dugon*) are known in Pilbara inshore waters. Prince (2001) estimated in excess of 2,000 dugongs to be widely distributed from the northern end of Exmouth Gulf to Bedout Island, east of Port Hedland. This represents an average density of 1 dugong per 10 km^2. During an aerial survey in April 2000, a single dugong was observed within the Port Hedland harbour (Prince 2001). However, from aerial surveys completed by James Cook University from 1984 to 2001, the density of dugongs within the Port Hedland area was found to be "low density" (Prince 2001). Port Hedland is not considered an important aggregation area for dugongs due to the lack of extensive seagrass meadows within the study area for feeding (Prince 2001), and this is supported by benthic habitat investigations undertaken for the proposed Outer Harbour Development.

6.6.10.3 Fish

A variety of fish are known to occur in the Port Hedland region. Within the study area, 106 species of fish have been identified (Ecoscape 2004).

Potentially occurring sharks listed under the EPBC Act include:

- the Whale Shark (*Rhincodon typus*), listed as Vulnerable;
- the Freshwater Sawfish (*Pristis microdon*), listed as Vulnerable;
- the Dwarf Sawfish (*Pristis clavata*), listed as Vulnerable; and
- the Green Sawfish (*Pristis zijsron*), listed as Vulnerable.

The *Protected Matters Search Tool* lists the Whale Shark (*Rhincodon typus*) as potentially occurring within the study area. Seasonal aggregations of the Whale Shark are thought to be linked to localised seasonal 'pulses' of food productivity (DEH 2005). There are no known feeding, breeding or aggregation

1 With respect to the Outer Harbour Development, the 20 m bathymetric contour lies approximately 30 to 35 km from the end of the proposed wharf, while the end of the proposed channel is approximately 2 to 5 km from the nearest 20 m contour.

sites of this species within or in close proximity to the study area (Environment Australia 2002b; DoF 2005). This species is likely to be an infrequent visitor to the area and is more likely to remain in deep water off the Pilbara coastline (i.e. greater than 20 m depth). Dredging activities are not considered to be a key threatening process to this species (Environment Australia 2002b; 2002c).

In their review of endangered sawfish and river sharks in Western Australia Morgan *et al.* (2010), did not identify any catches of the Freshwater Sawfish in close proximity to the project area, with the closest catches being at Cape Keraudren to the north-west. The Freshwater Sawfish is not normally found in the sea off Australia (DEWHA 2009d) and is generally restricted to brackish or fresh waters. As Port Hedland harbour has no riverine source, and since a riverine source is necessary for the life-cycle of Freshwater Sawfish, it is unlikely the Freshwater Sawfish would occur within the study area (D. Morgan, pers. comm.).

While the Dwarf Sawfish is listed under the EPBC Act as a "species that may occur within the area", it is generally restricted to northern Australia from Cairns to the Kimberley coast (DEWHA 2009d). D. Morgan (pers. comm.) has reaffirmed this, and believes that of the Sawfish species, the Green Sawfish is the species of interest in the area.

The Green Sawfish is listed under the EPBC Act as a "species that may occur within the area". The Green Sawfish is the most commonly distributed species of sawfish in Western Australian waters, occurring in areas with a muddy substrate and frequently found in shallow water. It commonly inhabits marine inshore waters, estuaries, lagoons. Most sawfish move into marine waters during or after the wet season and enter estuarine or fresher waters to breed (Stirrat *et al*. 2006). Morgan *et al*. (2010) found that the Green Sawfish has been recorded in Western Australian waters from Exmouth to the Northern Territory border, with the majority of capture locations between Karratha and One Arm Point. Pupping of juvenile Green Sawfish occurs in tidal creeks, but it is not known which tidal creeks in the Pilbara region are important pupping areas (i.e. nursery areas) and whether these creeks occur in the vicinity of Port Hedland.

6.6.10.4 Shorebirds and Seabirds

Potentially occurring shorebirds and seabirds birds listed under the EPBC Act include:

- one Endangered bird, Southern Giant Petrel (*Macronectes giganteus*);
- two Vulnerable birds, Australian Lesser Noddy (*Anous tenuirostris melanops*) and Australian Painted Snipe (*Rostratula benghalensis australis*); and
- thirty one (31) Migratory species.

None of the mangrove passerines discussed in **Section 6.6.2** is listed under the EPBC Act as a Matter of National Environmental Significance.

The Southern Giant Petrel (*Macronectes giganteus*), listed as Endangered, is a seabird that inhabits oceans and coastal bays where it tends to follow ships and scavenge (Simpson & Day 2004). This bird may forage within the study area during non-breeding season (winter).

The Australian Lesser Noddy (*Anous tenuirostris*), listed as Vulnerable, inhabits oceans and coastal islands (Simpson & Day 2004). This bird possibly feeds within the study area.

The Australian Painted Snipe (*Rostratula benghalensis*), listed as Vulnerable, tends to inhabit coastal and inland marshes with moderate cover (Simpson & Day 2004). This bird may feed within the tidal flats present within the study area.

Of the migratory listed shorebirds and seabirds that may potentially occur in the study area, three seabirds and 18 shorebirds were recorded during terrestrial fauna surveys (ENV 2009e, 2009f) (refer to **Appendices B15, B16** and **B17** for further detail). EPBC Act Policy Statement 3.21 outlines the criteria used in determining the importance of an area for shorebird species. According to these guidelines, an area that supports an ecologically significant proportion of a population (generally defined as 0.1% of the flyway population of a species), or at least 2000 shorebird individuals, or at least 15 different shorebird species, is considered important habitat.

6.7 Marine Management Frameworks

6.7.1 State and Commonwealth Marine Protected Areas

There are no existing or proposed State or Commonwealth marine protected areas in the marine study area. The closest existing State marine parks are the Montebello Marine Conservation Reserve located west of Dampier (approximately 300 km from the existing Port Hedland shipping channel) and the Rowley Shoals Marine Park located north of Port Hedland (approximately 265 km from the existing Port Hedland shipping channel). The proposed Dampier Archipelago Marine Park is situated in the Dampier region, 225 km west of Port Hedland. The closest Commonwealth Marine Parks include

Ningaloo Marine Park west of Exmouth and the Mermaid Reef Marine National Nature Reserve, north of the Rowley Shoals Marine Park.

In addition to the above protected and proposed areas, the Marine Parks and Reserves Selection Working Group 1994 (MPRSWG 1994) has included "Candidate Areas" at North Turtle Island and Bedout Island. There are also further "Candidate Areas Subject to Survey" located from Cape Lambert to Cowrie Beach approximately 50 to 220 km west and from Cape Keraudren to Eighty Mile Beach approximately 80 to 300 km east of the project area.

6.7.2 Pilbara Coastal Water Quality Consultation Outcomes

The Pilbara Coastal Water Quality Consultation Outcomes: Environmental Values and Environmental Quality Objectives (DoE 2006b) defines key environmental values and environmental quality objectives (EQO) that act as a guideline for the management of coastal water quality for the Pilbara region, including the Port Hedland area (**Table 6.19**).

6.7.3 The North-West Marine Bioregional Plan

Port Hedland is located within the North-West Province (DEWHA 2008), a vast bioregion between North-West Cape and Cape Bougainville. The bioregional profile provides a description of the North-West region's ecological characteristics, conservation values, the process by which new Marine Protected Areas will be identified and the current human activities that occur there.

The following conservation values have been identified within the bioregion:

- important rookeries and critical nesting and inter-nesting habitat for Flatback Turtles;

Table 6.16 – Known Introduced Marine Species in Port Hedland Inner Harbour

Species (and authority)	Common Name	Comment
Beania mirabilis (Johnston 1840)	Bryozoan	A widespread inconspicuous species, occurring throughout warm temperate seas.
Bulgula neritina (Linnaeus 1758)	Bryozoan	Distribution worldwide, in warm water ports and harbours. Common fouling species.
Bulgula stolonifera (Ryland 1960)	Bryozoan	Similar fouling species to *B neritina,* with lower tolerances to warmer waters.
Tricellaria inopinata (Hondt and Occhipinti 1985)	Bryozoan	Cosmopolitan species, previously overlooked in many cases due to the existence of similar closely related taxa.
Synnotum aegyptiacum (Audouin 1826)	Bryozoan	Cosmopolitan bryozoans distributed throughout warm waters. Distribution in Australia is from Vic to NSW and recorded in Port Hedland (West Australian Marine voucher specimen (WAM) 30551).
Savignyella lafontii (Audouin 1826)	Bryozoan	Widely distributed in warmer waters (WAM 30556; 32310).
Amathia distans (Busk 1886)	Bryozoan	Cosmopolitan species known to occur at various locations in warmer waters around Australia including Port Hedland.
Amathia vidovici (Heller 1867)	Bryozoan	Cosmopolitan species recorded in Port Hedland (WAM 30629).
Bowerbankia gracilis (Leidy 1855)	Bryozoan	Cosmopolitan species known to occur from South Australia recorded in Port Hedland (WAM 30552).
Zoobotryon verticillatum (Della Chiaje 1828)	Bryozoan	Cosmopolitan species, known in Australia from various locations from South Australia, NSW to Port Hedland.
Amphibalanus amphitrite (Darwin 1854)	Barnacle	Cosmopolitan species, recorded from WA, SA, Vic, NSW, Qld and the NT.
Amphibalanus reticulates (Utinomi 1967)	Barnacle	Cosmopolitan fouling species.
Megabalanus rosa (Pilsbry 1916)	Barnacle	Known to occur at various locations around Australia often associated with international shipping locations.
Megabalanus tintinnabulum (Linnaeus 1758)	Barnacle	Cosmopolitan species, well established throughout Australia, distribution associated with shipping activities.
Gymnangium gracilicaule (Jaderholm 1903)	Hydroid	Widely distributed in the tropical and subtropical Indian Ocean and Indo-West Pacific.
Antennella secundaria (Gmelin 1791)	Hydroid	Cosmopolitan in temperate and tropical seas, widely distributed throughout Australia.

Source: Huisman et.al. (2008).

Table 6.17 – Marine Fauna of Conservation Significance Potentially Occurring with the Project Area

Species	Conservation status		Likelihood of occurrence
	EPBC Act	State	
Loggerhead Turtle (*Caretta caretta*)	Endangered	Schedule 1[1]	Species or species habitat may occur
Olive Ridley Turtle (*Lepidochelys olivacea*)	Endangered	Schedule 1	Species or species habitat may occur
Leathery Turtle (*Dermochelys coriacea*)	Endangered	Schedule 1	Species or species habitat may occur
Blue Whale (*Balaenoptera musculus*);	Endangered	Schedule 1	Species or species habitat may occur
Southern Giant Petrel (*Macronectes giganteus*)	Endangered	Schedule 1	May forage within the Project area during non-breeding season
Flatback Turtle (*Natator depressus*)	Vulnerable	Schedule 1	Recorded within the Project area
Green Turtle (*Chelonia mydas*)	Vulnerable	Schedule 1	Recorded within the Project area
Hawksbill Turtle (*Eretmochelys imbricata*)	Vulnerable	Schedule 1	Species or species habitat may occur
Humpback Whale (*Megaptera novaeangliae*)	Vulnerable	Schedule 1	Recorded within the Project area
Whale Shark (*Rhincodon typus*)	Vulnerable	Not listed	Likely to be an infrequent visitor to the area and is more likely to remain in deep water off the Pilbara coastline
Green Sawfish (*Pristis zijsron*)	Vulnerable	Schedule 1	Species or species habitat may occur
Australian Lesser Noddy (*Anous tenuirostris melanops*)	Vulnerable	Schedule 1	Species or species habitat may occur
Australian Painted Snipe (*Rostratula benghalensis australis*)	Vulnerable	Schedule 1	Species or species habitat may occur
Dwarf Sawfish (*Pristis clavata*)	Vulnerable	Priority 1[2]	Unlikely to occur in the Project area
Freshwater Sawfish (*Pristis microdon*),	Vulnerable	Priority 3[3]	Unlikely to occur in the Project area
Australian Snubfin Dolphin (*Orcaella brevirostri*)	Migratory	Priority 4[4]	Likely to occur within Project area
Indo-Pacific Humpback Dolphin (*Sousa chinensis*)	Migratory	Priority 4	Incidental sightings have been documented in the region (Salgado-Kent *et al.* 2009)
Eastern Curlew (*Numenius madagascariensis*)	Migratory	Priority 4	Recorded within the tidal flats present within the Project area but is unlikely to be specifically reliant on this habitat
Dugong (*Dugong dugon*)	Migratory	Schedule 4[5]	Recorded within the project area
Saltwater Crocodile *(Crocodylus porosus)*	Marine	Schedule 4	Sighted in the Inner Harbour

1 Schedule 1 – Fauna that is rare or is likely to become extinct
2 Priority 1 – Taxa which are known from one or a few (generally <5) populations which are under threat
3 Priority 3 – Taxa which are known from several populations, and the taxa are not believed to be under immediate threat
4 Priority 4 - Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors
5 Schedule 4 - Other specially protected fauna

- high species richness (but relatively low endemicity);
- home to globally significant populations of internationally threatened species;
- biological productivity follows boom and bust cycles, and is sporadic and significantly geographically dispersed; and
- coral reefs in the region are of especially high species diversity. Reefs to the south of Ashmore Reef are mostly composed of scleractinian corals (i.e. hard corals).

A number of exceptions to the above conservation values apply for the marine environment in the vicinity of the proposed Outer Harbour Development, namely:

- there is a low diversity of coral species, and no endemic species of coral were reported. Many of the corals observed were small, suggesting appreciable population turnover rates; and
- although dugongs and whales are known to occur in the area, habitat required to support localised feeding and breeding activities were not identified, resulting in most of these animals being either transitory or dependent on areas outside the footprint of the proposed Outer Harbour Development.

While the Pilbara region contains some significant environmental values, such as endangered and vulnerable species, typically these values are either distributed widely throughout the entire province or they occur in areas that are not in the vicinity of the proposed Outer Harbour Development. An exception is the presence of populations of four turtle species within the immediate vicinity of the proposed Outer Harbour Development, which are also represented in areas beyond the Port Hedland region (refer **Section 6.6.5**).

6.8 Historical dredging and disposal in the Port Hedland region

Port Hedland has been an operating port since the late 1800s, when a jetty was created to service the pastoral industry of the eastern Pilbara. Prior to 1965, the harbour was crescent-shaped and had a maximum depth of 9 m at its widest point near the southern end (HDMS 2002).

With the development of the iron ore industry, the natural bathymetry of the harbour was altered by dredging and the provision of an approach channel, commencing in 1965. Much of the development at Port Hedland at that time took place inside the harbour within the area of the tidal creek system and impacts outside the mouth of the creek system were limited to the disposal of spoil nearshore on an area known as 'Spoil Bank' (**Figure 6.27**).

Between 1965 and 1984, approximately 1.2 million cubic metres (Mm^3) of dredged material was removed from the harbour and deposited in two offshore spoil grounds east of the harbour mouth, forming the Spoil Bank (HDMS 2002; HGM 1997). It is likely that the Spoil Bank area would once have had patches of corals growing on rocky bommies similar to that found on the seaward shoreline of Finucane Island (**Section 6.6**).

To facilitate access to the Port by larger iron ore vessels, an approach or shipping channel was deepened by 2.5 m in 1986. Dredging of this channel was limited to the first 17 km from the entrance in the shallower regions whereas the offshore portion of the channel was simply a navigational channel. Dredge spoil (13 Mm^3) from the channel development was placed in Spoil Grounds I and J.

Since that time, modifications have included:

- deepening of the harbour turning basin and berth pockets;
- deepening of an approach or shipping channel to the harbour;
- reclamation of East Creek to accommodate developments at Nelson Point;
- reclamation of Finucane Island to accommodate developments at Finucane Island; and
- construction of iron ore, salt and general cargo berths.

These subsequent modifications significantly altered the seaward section of the tidal creek system by deepening the turning basin to 14 m and some berth pockets up to 19 m. In addition to the deepening, berths were established along much of the foreshore area of Finucane Island and Nelson Point.

Dredge spoil from much of the harbour development was placed into either reclamation areas or used as fill at Finucane Island and at Nelson Point to accommodate the shore-based development associated with the port expansion. However, large quantities were also placed offshore at spoil grounds H, I and J and at Spoil Bank.

Maintenance dredging of the harbour and shipping channel is required every three to four years to remove a build up of sediment (PHPA 2008). Capital dredging for new projects has also occurred at Utah, Harriet, Anderson and Nelson Points (**Figure 6.27**). Dredge spoil from these activities has either been used for land reclamation or sea dumped at the large spoil grounds outside the harbour or a combination of reclamation and sea dumping. More recently, dredge spoil has been disposed of at offshore Spoil Grounds H and I, whereas Spoil Ground J has not been used since the channel deepening in 1986. Spoil Ground One has been utilised by BHP Billiton Iron Ore's RGP6 Nelson Point dredging project. Extensive dredging and spoil disposal activities have been undertaken in the offshore Port Hedland environment. During the past 25 years approximately 30 Mm^3 of dredged material has been removed from the shipping channel and harbour (**Table 6.20**). Dredging of the main shipping channel required the removal of a significant volume of material that required an extended period of dredging and disposal (e.g. more than 12 months). Although a formal impact assessment was not prepared for deepening of the shipping channel, the spatial extent and duration over which the dredging occurred generated sustained, highly turbid conditions in the offshore environment, potentially resulting in impacts to BPP communities present at the time.

Despite dredging and other activities that have occurred in the offshore marine environment, sensitive BPPs, such as hard corals, exist (as described in **Section 6.6**). Their presence indicates a tolerance to high turbidity events such as those associated with dredging and disposal activities, that dredging and disposal activities have limited impact on sensitive BPPs, or that BPPs have the ability to recover after natural conditions return.

6.9 Summary

The marine study area is located near the centre of the North-West Province, an extensive marine bioregion that extends from North-West Cape to Cape Bougainville. The elements of the study area's existing marine environment that are considered to be relevant to the proposed Outer Harbour Development are summarised below:

Mangroves: Seven species of mangrove have been recorded from within the Port Hedland Industrial Area Management Unit. These species are well represented within the Management Unit, and all species are found elsewhere in the Pilbara region; none are listed as threatened under the EPBC Act or the WC Act.

Cyanobacterial Mats: These occur seasonally, during wet seasons when rainfall is adequate. Mats have a lower diversity in the Pilbara region, with between only one and three genera present, compared with the seven or more species in other regions. Within the disturbance envelope, just 0.25 ha of cyanobacterial mat was found in January 2009, and recurrence of mats in this area has not been observed.

Subtidal Benthic Primary Producers: The majority of the surveyed area (over 85%) is bare and sandy with no BPPs and is not considered to be capable of supporting BPPs. Three per cent of the total survey area was predominantly macroalgae and 1.3% of the total survey area was mixed macroalgae and sparse hard coral.

Seagrass: Field investigations recorded sporadic observations of four seagrass species in the Port Hedland area. These were the pioneer or opportunistic species *Thalassia hemprichii*, *Halodule uninervis*, *Halophila ovalis* and *Halophila decipiens*.

Hard Coral: The species richness of coral taxa at all sites surveyed in the region is low in comparison to other studies carried out in the Pilbara region and no corals considered of conservation significance or unique to the region have been identified.

Marine Fauna: The area contains some significant ecosystem functions and environmental values such as endangered and vulnerable species, but these values are mostly either distributed widely throughout the entire province and appear to be interconnected within it, or they occur in, or utilise, areas which do not lie near Port Hedland. The exception is the presence within the area of populations of the four turtle species discussed in **Section 6.6.5**, which are well represented beyond the Port Hedland region.

Table 6.18 – Migratory Shorebirds and Seabirds present or likely to be present within the Study Area

Common Name	Scientific Name	Likelihood of occurrence
Shorebirds		
Eastern Reef Egret	*Egretta sacra*	This species was recorded in the Project area
Glossy Ibis	*Plegadis falcinellus*	Species or species habitat may occur within area
Common Sandpiper	*Actitis hypoleucos*	This species was recorded in the Project area
Ruddy Turnstone	*Arenaria interpres*	This species was recorded in the Project area
Sharp-tailed Sandpiper	*Calidris acuminate*	Species or species habitat may occur within area
Red Knot	*Calidris canutus*	This species was recorded in the Project area
Curlew Sandpiper	*Calidris ferruginea*	This species was recorded in the Project area
Pectoral Sandpiper	*Calidris melanotos*	Species or species habitat may occur within area
Red-necked Stint	*Calidris ruficollis*	This species was recorded in the Project area
Long-toed Stint	*Calidris subminuta*	Species or species habitat may occur within area
Great Knot	*Calidris tenuirostris*	This species was recorded in the Project area
Broad-billed Sandpiper	*Limicola falcinellus*	Species or species habitat may occur within area
Bar-tailed Godwit	*Limosa lapponica*	This species was recorded in the Project area
Eastern Curlew	*Numenius madagascariensis*	This species was recorded in the Project area
Whimbrel	*Numenius phaeopus*	This species was recorded in the Project area
Grey-tailed Tattler	*Tringa brevipes*	This species was recorded in the Project area
Wood Sandpiper	*Tringa glareola*	Species or species habitat may occur within area
Common Greenshank	*Tringa nebularia*	This species was recorded in the Project area
Marsh Sandpiper	*Tringa stagnatilis*	This species was recorded in the Project area
Terek Sandpiper	*Xenus cinereus*	This species was recorded in the Project area
Greater Sand Plover	*Charadrius leschenaultii*	This species was recorded in the Project area
Lesser Sand Plover	*Charadrius mongolus*	This species was recorded in the Project area
Oriental Plover	*Charadrius veredus*	This species was recorded in the Project area
Pacific Golden Plover	*Pluvialis fulva*	Species or species habitat may occur within area
Grey Plover	*Pluvialis squatarola*	This species was recorded in the Project area
Seabirds		
Lesser Frigate Bird	*Fregata ariel*	This species was recorded in the Project area
White-bellied Sea Eagle	*Haliaeetus leucogaster*	This species was recorded in the Project area
Osprey	*Pandion haliaetus*	This species was recorded in the Project area
Oriental Pratincole	*Glareola maldivarum*	Species or species habitat may occur within area
Common Tern	*Sterna hirundo*	Species or species habitat may occur within area
Fork-tailed Swift	*Apus pacificus*	Species or species habitat may occur within area

Table 6.19 – Environmental Values and Environmental Quality Objectives of the Port Hedland Area

Environmental Values	Environmental Quality Objectives
Ecosystem Health (ecological value)	Maintain ecosystem integrity This means maintaining the structure (e.g. the variety and quantity of life forms) and functions (e.g. the food chains and nutrient cycles) of marine ecosystems.
Recreational and Aesthetics (social use value)	Water quality is safe for recreational activities in the water (e.g. swimming). Water quality is safe for recreational activities on the water (e.g. boating). Aesthetic values of the marine environment are protected.
Cultural and Spiritual (social use value)	Cultural and spiritual values of the marine environment are protected.
Fishing and Aquaculture (social use value)	Seafood (caught or grown) is of a quality safe for eating. Water quality is suitable for aquaculture purposes.
Industrial Water Supply (social use value)	Water quality is suitable for industrial supply purposes.

Source: Pilbara Coastal Water Quality Consultation Outcomes: Environmental Values and Environmental Quality Objectives (DoE 2006b)

Table 6.20 – Volumes of Material Previously Dredged and Disposed in the Offshore Port Hedland Environment

Year	Dredge Volume (Mm^3)	Proponent	Type of Dredging	Location of Dredging	Location of Disposal	Source
1965 –84	1.2	PHPA	Capital and Maintenance	Harbour	Possibly Spoil Bank	GHD 2008
1985	7	PHPA	Capital and Maintenance	Harbour	Reclamation and Spoil Ground H	PHPA 2008
1986	13.6	Mt. Newman Mining	Capital	Shipping Channel and Harbour	Reclamation and Spoil Grounds I & J	Reference not Provided[1]
1990	0.35	PHPA	Maintenance	Shipping Channel and Harbour	Spoil Ground I	PHPA 2008
1993	0.2	PHPA	Maintenance	Shipping Channel and Inner Harbour	Spoil Ground I	PHPA 2008
1997	0.5	PHPA	Maintenance	Shipping Channel and Harbour	Spoil Ground I	PHPA 2008
2001	0.5	PHPA	Maintenance	Shipping Channel and Harbour	Spoil Ground I	PHPA 2008
2004	0.55	PHPA	Maintenance	Shipping Channel and Harbour	Spoil Ground I	PHPA 2008
2007	0.825	PHPA	Maintenance	Shipping Channel and Harbour	Spoil Ground I	PHPA 2008
2008	3.4	FMG	Capital	Anderson Point	Reclamation	FMG 2007
2009	6	BHP Billiton Iron Ore	Capital	Harriet Point (RGP5)	Reclamation and offshore disposal	BHP Billiton Iron Ore 2008
2010	2.7	BHP Billiton Iron Ore	Capital	Nelson Point (RGP6)	Reclamation and offshore disposal	BHP Billiton Iron Ore 2009

Source: GHD (2007)
1 PHPA was contacted on this dredging activity and although they confirmed the dredged volume, they did not provide a reference for the activity

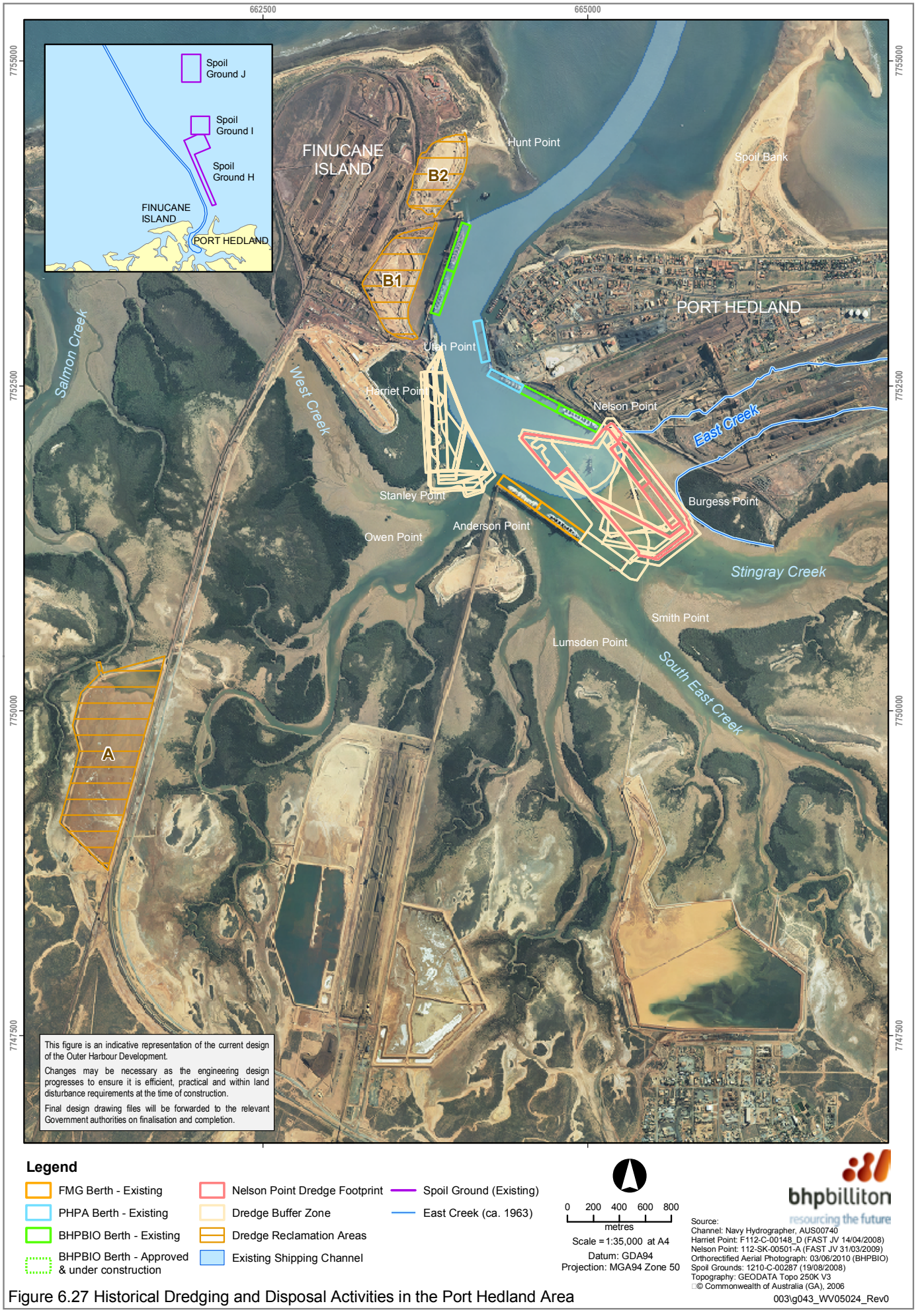

Figure 6.27 Historical Dredging and Disposal Activities in the Port Hedland Area