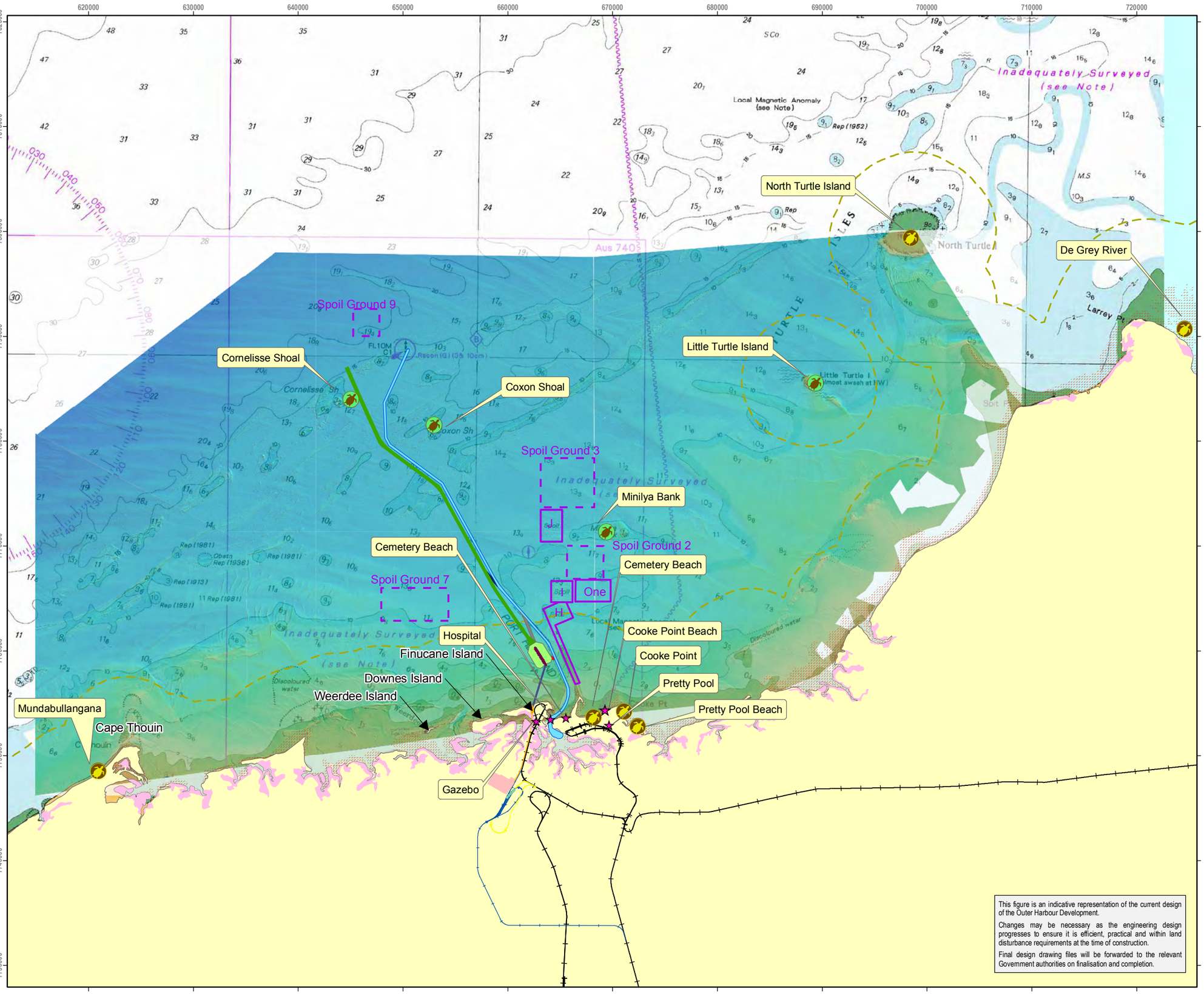

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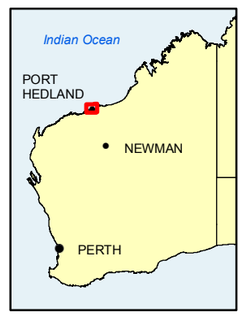
Legend

- Turtle Habitat Areas
- Potential/Unconfirmed Turtle Habitat
- Light Monitoring Locations
- Foreshore Flat
- Mangrove
- Spoil Ground (Existing)
- Spoil Ground (Proposed)
- Proposed Infrastructure Corridor
- Proposed Stockyards
- Proposed Car Dumper
- Proposed Jetty
- Proposed Wharf
- Proposed Goldsworthy Rail Loop
- Proposed Western Spur Railway
- Existing Railway
- State/Commonwealth Jurisdiction Boundary
- Proposed Tug Access Channel
- Proposed Departure Channel
- Proposed Berth Pockets and Swing Basins
- Proposed Link Channel
- Proposed Crossover Channel
- Existing Shipping Channel



0 5 10
kilometres

Scale =1:355,000 at A3
Datum: GDA94
Projection: MGA94 Zone 50

This figure is an indicative representation of the current design of the Outer Harbour Development.

Changes may be necessary as the engineering design progresses to ensure it is efficient, practical and within land disturbance requirements at the time of construction.

Final design drawing files will be forwarded to the relevant Government authorities on finalisation and completion.

Source:
Bathymetry: Tenix LiDAR (Nov 2007, April 2008)
Channel: 112-SK-00500 (FAST JV 01/11/2008)
Channel: Navy Hydrographer, AUS00740
Seafarer Chart: Australian Hydrographyic Office, AUS00740

Topography: GEODATA Topo 250K V3

Figure 4-6 Marine Turtle Habitats and Light Monitoring Locations

670000
690000
710000
7780000
7760000
Spoil Ground 3
J
Spoil Ground 2
I
One
H
PORT
HEDLAND
This figure is an indicative representation of the current design of the Outer Harbour Development.
Changes may be necessary as the engineering design progresses to ensure it is efficient, practical and within land disturbance requirements at the time of construction.
Final design drawing files will be forwarded to the relevant Government authorities on finalisation and completion.

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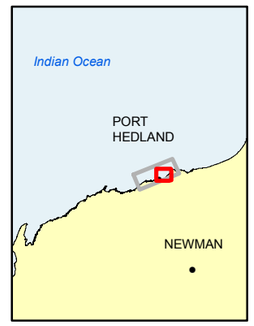
Legend

- Turtle 1 (Tag 89759_1)
- Turtle 1 (Tag 89759_2)
- Turtle 2 (Tag 89760)
- Turtle 3 (Tag 89761_1)
- Turtle 3 (Tag 89761_2)
- Turtle 4 (Tag 89762)
- Marine Turtle Study Area (Pendoley Environmental, 2009)
- Spoil Ground (Existing)
- Spoil Ground (Proposed)
- Proposed Infrastructure Corridor
- Proposed Stockyards
- Proposed Car Dumper
- Proposed Jetty
- Proposed Wharf
- Existing Railway
- Proposed Tug Access Channel
- Proposed Departure Channel
- Proposed Berth Pockets and Swing Basins
- Proposed Link Channel
- Proposed Crossover Channel
- Existing Shipping Channel



0 2.5 5
kilometres
Scale = 1:165,000 at A3
Datum: GDA94
Projection: MGA94 Zone 50

Source:
Channel: 112-SK-00500 (FAST JV 01/11/2008)
Channel: Navy Hydrographer, AUS00740
Imagery: Landsat (2005)
Topography: GEODATA Topo 250K V3
© Commonwealth of Australia (GA), 2006
Turtle Data: Fastloc

Figure 4-7 Internesting Movements of Four Flatback Turtles Tracked from Cemetery Beach, Port Hedland

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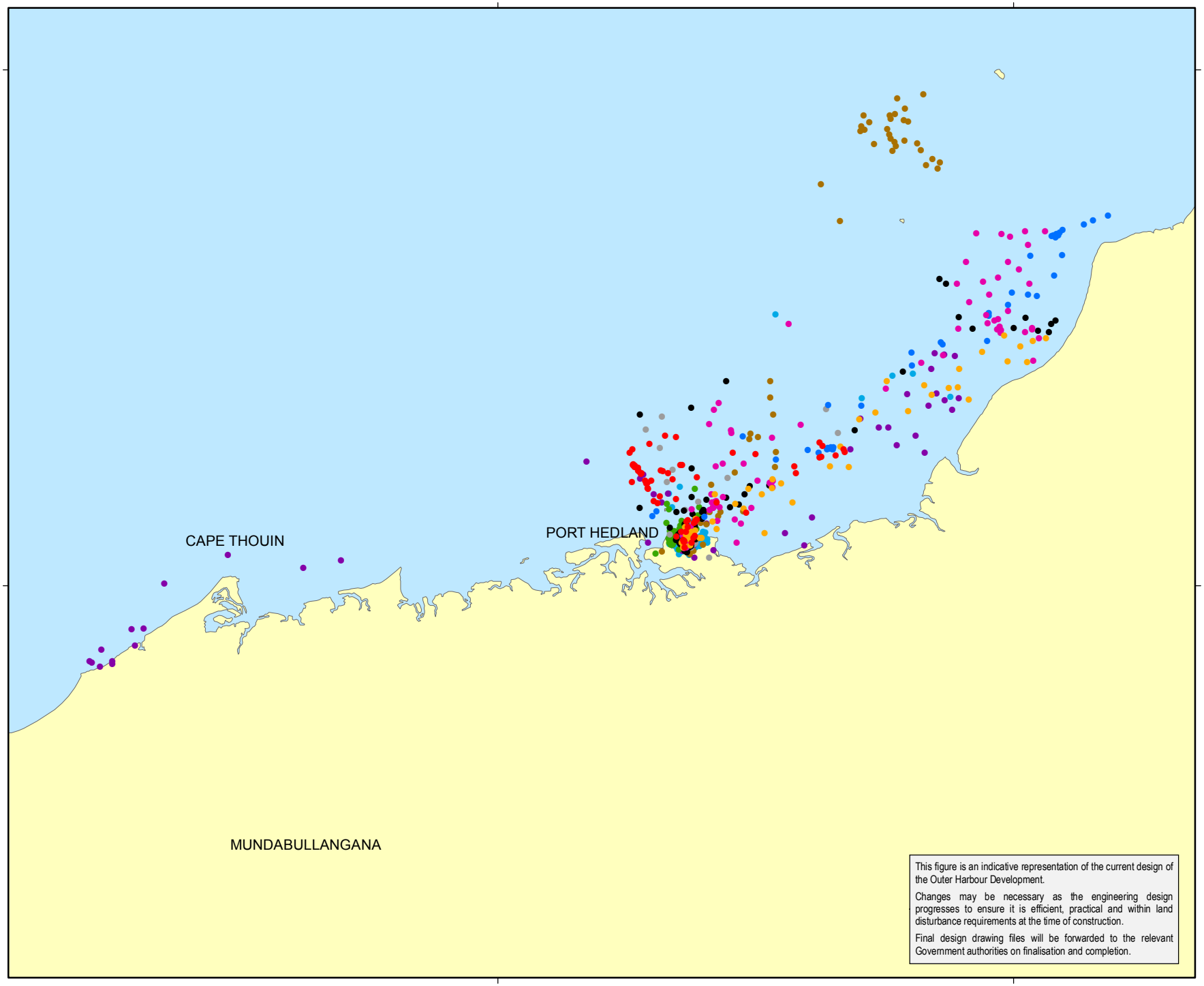

Figure 4-8 Internesting locations for flatback turtles 2008/09 to 2010/11

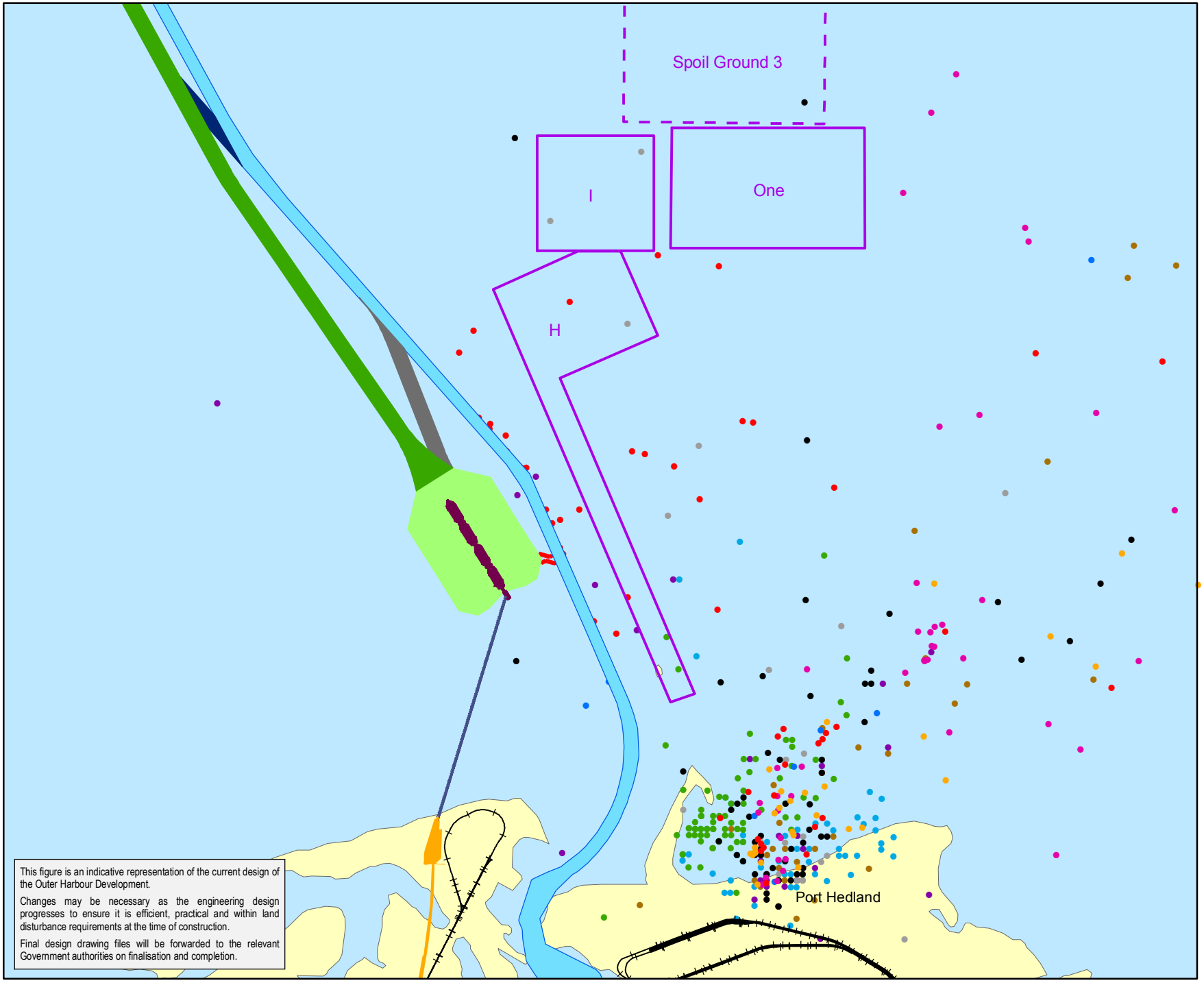

Figure 4-9 Interesting locations for flatback turtles 2008/09 to 2010/11 in proximity to the proposed project

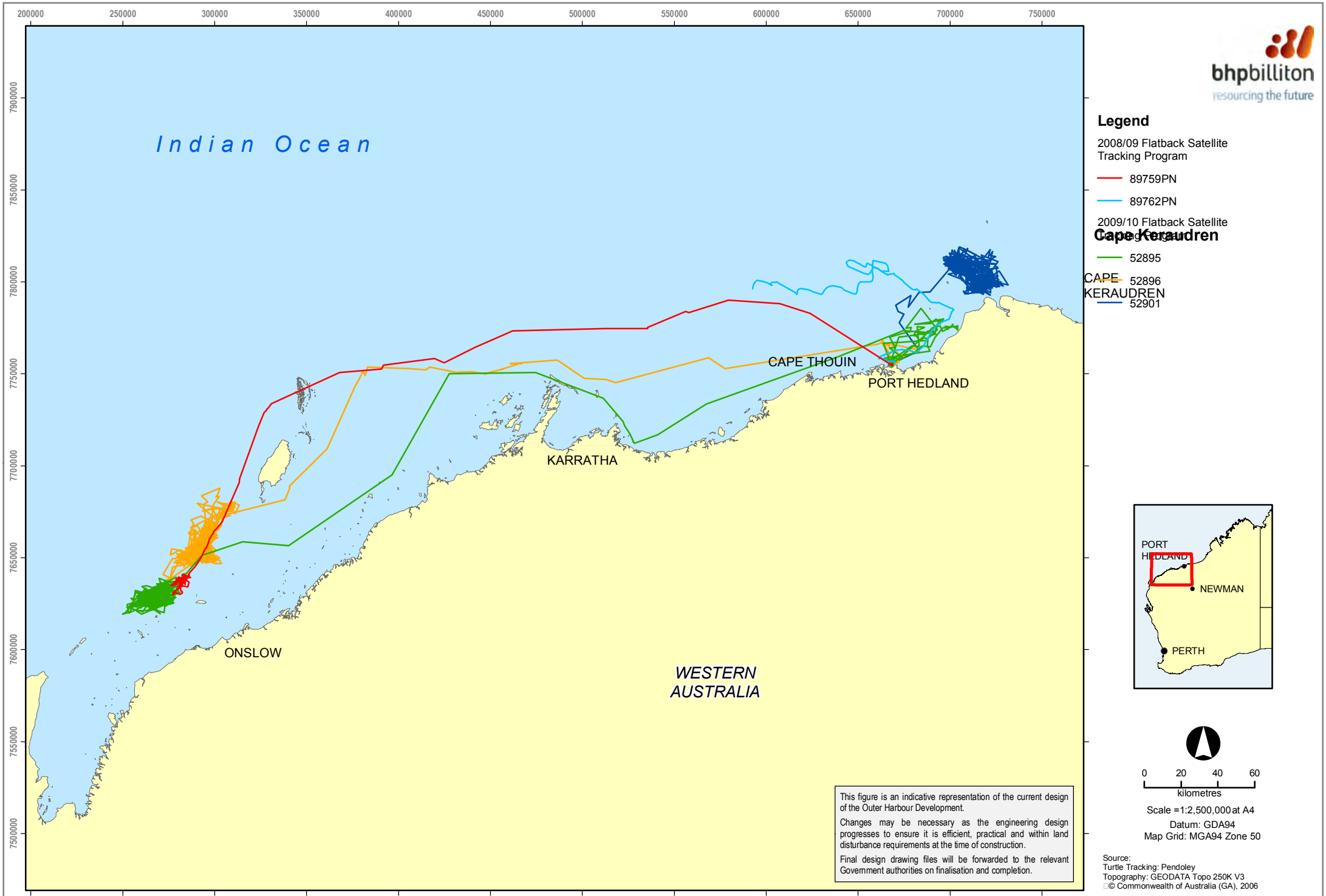

Figure 4-10 Post nesting migrations of all turtles headed south from Port Hedland in 2008/09 and 2009/10

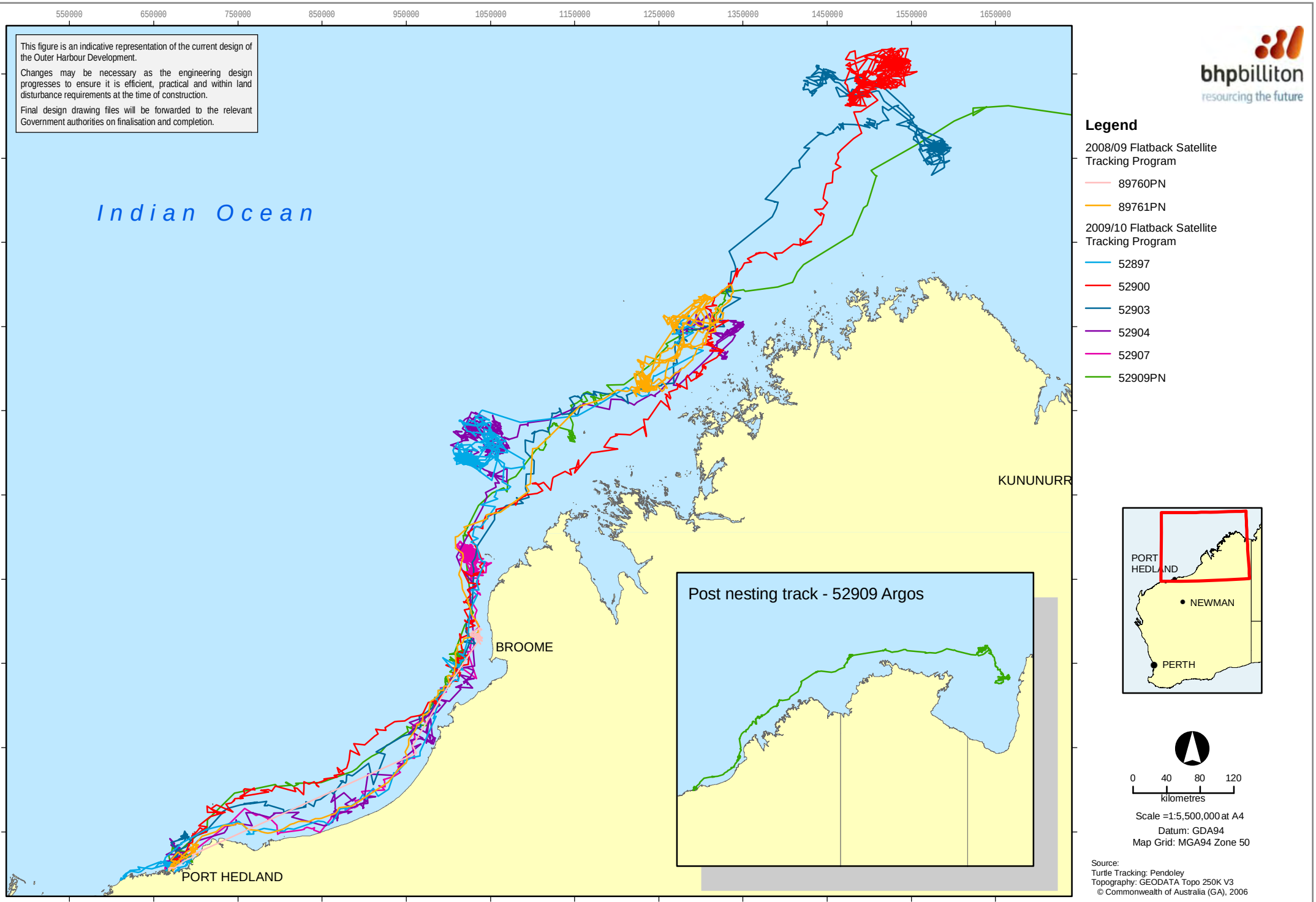

Figure 4-11 Post-nesting migrations of all turtles headed north from Port Hedland in 2008/09 and 2009/10

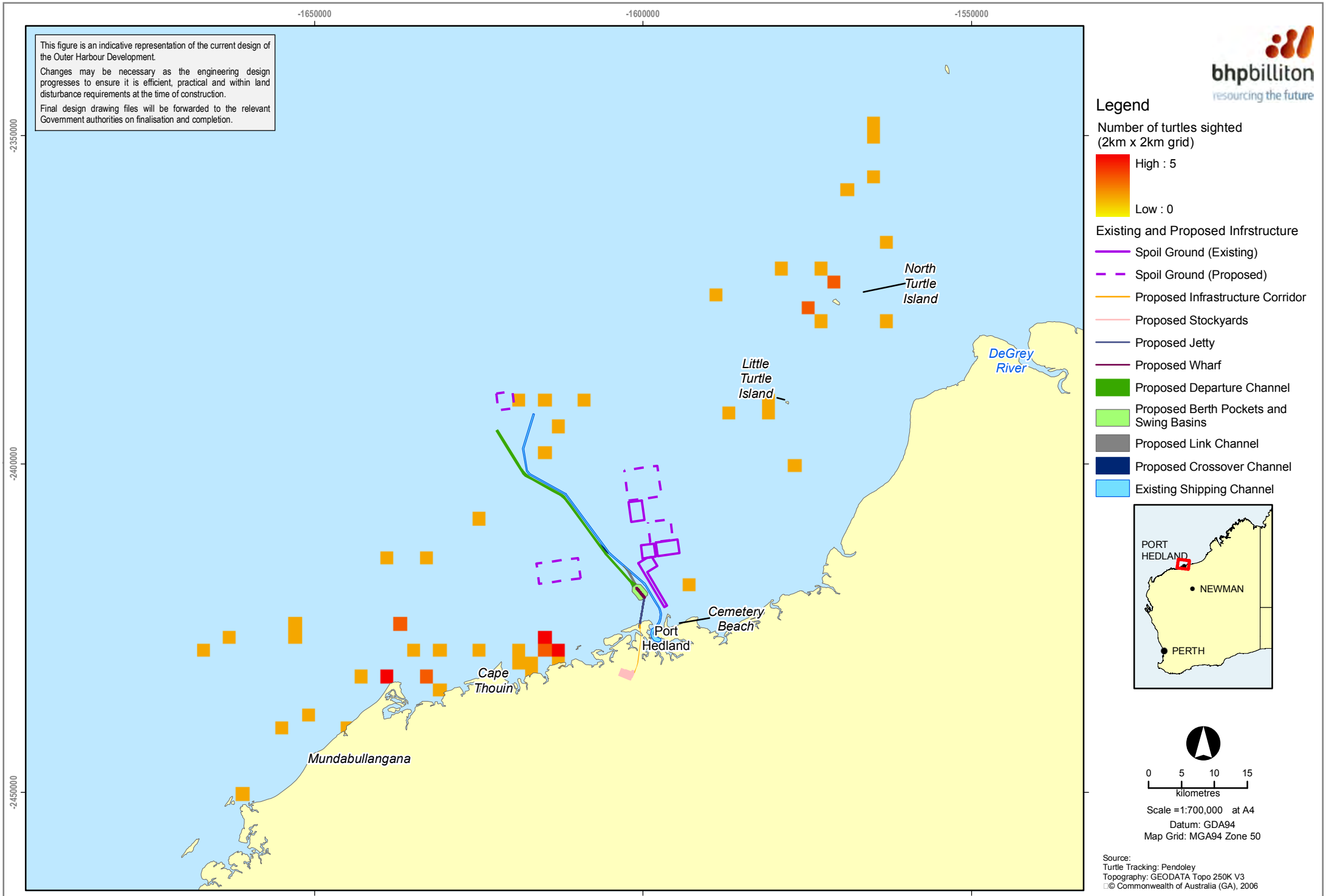

Figure 6.23 In-Water Marine Turtle Sightings Offshore from Port Hedland (Summer 2008 Aerial Survey)

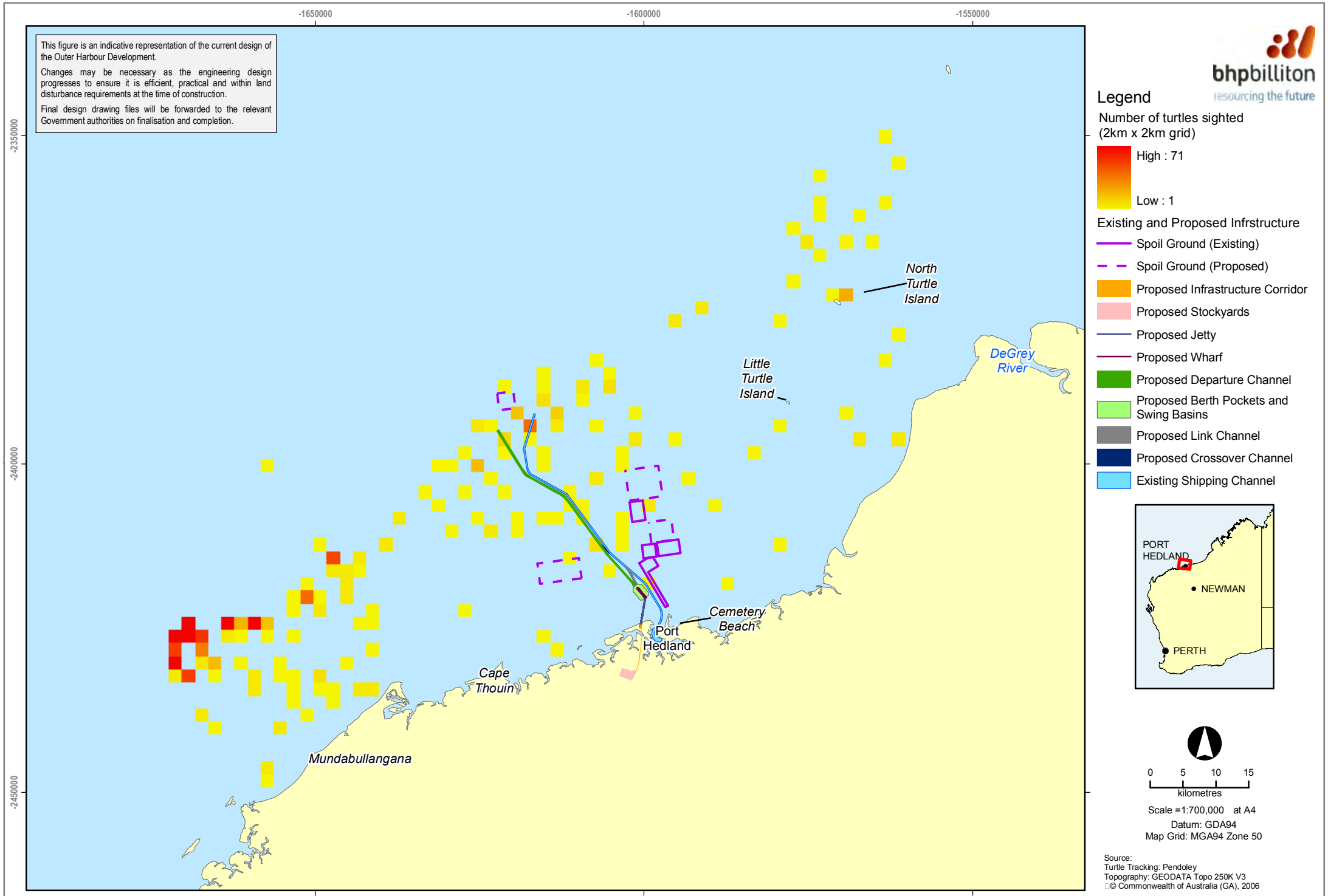

Figure 6.24 In-Water Marine Turtle Sightings Offshore from Port Hedland (Summer 2010 Aerial Survey)

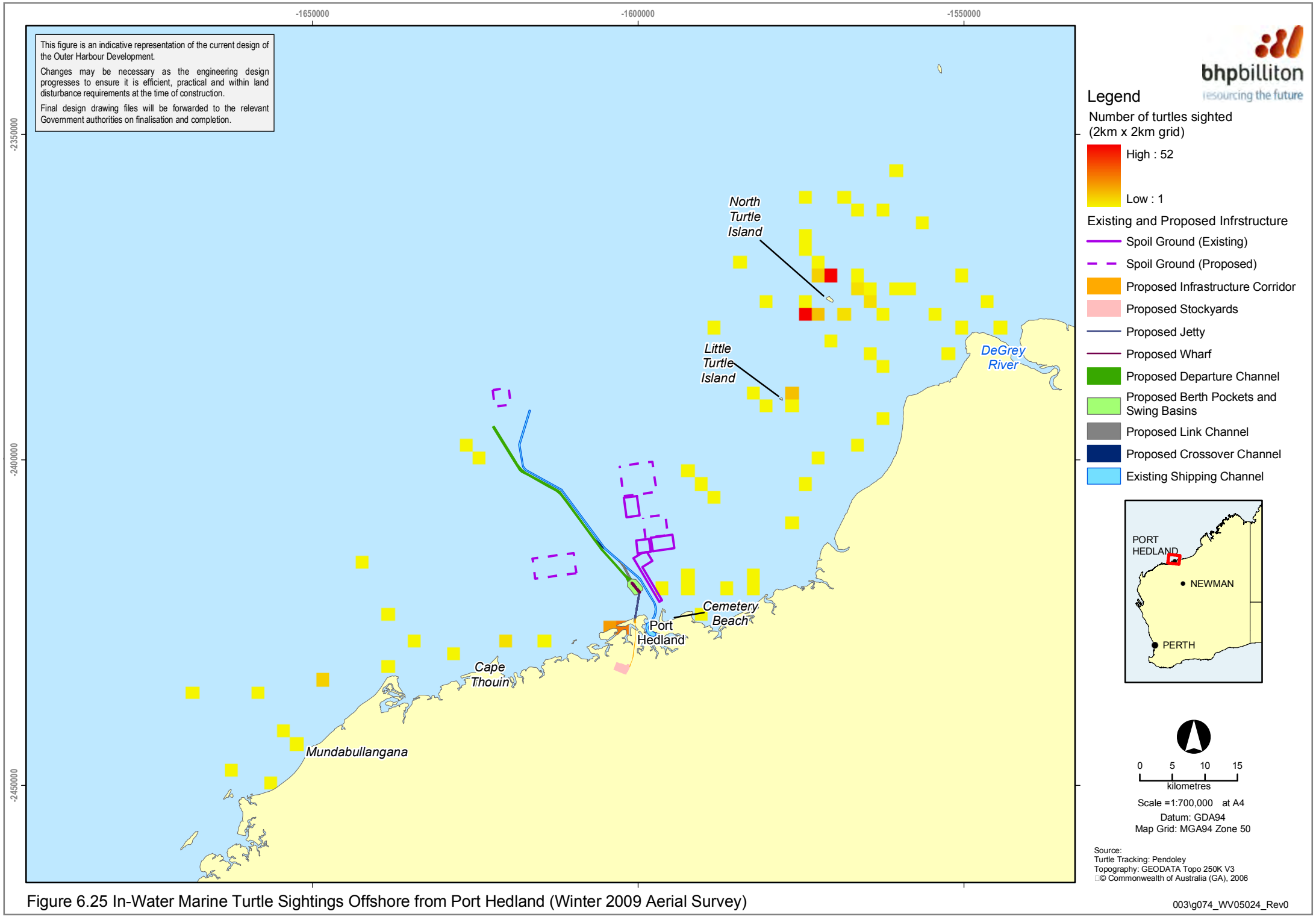

Figure 6.25 In-Water Marine Turtle Sightings Offshore from Port Hedland (Winter 2009 Aerial Survey)

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Marine Mammals

There are 11 species of marine mammals known or likely to occur in the Project area. All are listed in the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) as threatened, migratory or marine species (DEWHA 2008). These are:

- Humpback Whale (*Megaptera novaeangliae*);
- Blue Whale (*Balaenoptera musculus*);
- Antarctic Minke Whale (*Balaenoptera bonaerensis*);
- Bryde's Whale (*Balaenoptera edeni*);
- Fin Whale (*Balaenoptera physalus*);
- Sperm Whale (*Physeter macrocephalus*);
- Indo-Pacific Humpback Dolphin (*Sousa chinensis*);
- Spotted or Indo-Pacific Bottlenose Dolphin; Arafura/Timor Sea populations (*Tursiops* sp.);
- Killer Whale (*Orcinus orca*);
- Australian Snubfin Dolphin (*Orcaella heinsohni*); and
- Dugong (*Dugong dugon*).

The Humpback Whale, Indo-Pacific Humpback Dolphin (hereafter Humpback Dolphin), spotted or Indo-Pacific Bottlenose Dolphin (hereafter Bottlenose Dolphin) and the Dugong are known to occur in waters off Port Hedland (Prince et al. 2001). It is likely that during the project construction, individuals of these species will pass close to where pile driving and dredging will occur. The Australian Snubfin Dolphin (hereafter Snubfin Dolphin) has been reported in the Port Hedland regions as unconfirmed incidental sightings (Salgado-Kent *et al*. 2009) and off Dampier (Paton 2008). Therefore only these five listed species are considered in the DSDMMP.

In contrast, the other listed species are expected to rarely venture into shallow water sections of the study area and thus are unlikely to be affected by construction (including pile driving or dredging) activities. These species are not considered further in this DSDMMP. Nevertheless, the proposed management actions will be effective for all marine mammal species that venture into the project area during construction and operational phases.

Humpback Whale (*Megaptera novaeangliae*)

During winter months, humpback whales migrate from their Antarctic summer feeding grounds to their sub-tropical winter calving grounds. The major calving area for humpback whales in Western Australia is off the Kimberley coast (DEH 2006). 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. However, 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 2007; Jenner et al. 2001). According to Jenner et al. (2001) and Prince (2001), migrating humpback whales remain well offshore, typically in waters equal to or exceeding 20 m[6]. Nevertheless, individual animals or pods do venture closer to shore. During boat-based field work off Port Hedland in August 2009, anecdotal observations made by the SKM personnel noted humpback whales in water depths of about 13 m (G Paccani, SKM pers comm.).

[6] With respect to the proposed 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.

Humpback Dolphin (*Sousa chinensis*)

Indo-Pacific Humpback Dolphins have not been studied in the Pilbara region, and therefore their abundance and biology in the Port Hedland area remains unclear. Prince *et al*. (2001) reported small numbers of dolphins including *Sousa chinensis* during a one-off aerial survey in the Pilbara. According to Jefferson (2000), this species usually occurs close to the coast, generally in depths of less than 20 m. They have been reported from both clear and turbid water environments, and in a variety of coastal habitats, from coastal lagoons and enclosed bays with mangrove stands and seagrass beds through to open coastal waters with coral reefs (Corkeron *et al*. 1997). Humpback Dolphins are known to move seasonally, but resident populations have been described in some areas (Ross *et al*. 1994). This species is known to feed on fish, cephalopods and crustaceans.

Bottlenose Dolphin (*Tursiops aduncus*)

Bottlenose Dolphins have not been studied in the Pilbara region; however studies to reduce by-catch of this species in the Pilbara Trawl Fishery have been undertaken (Stephenson et al. 2006). Prince et al. (2001) reported that the Pilbara supports small numbers of dolphins, with *Tursiops* being the most abundant. The taxonomic status of this species in the Pilbara remains unclear (Hammond et al. 2008). Stephenson et al. (2006) reported specimens of *Tursiops truncatus* being caught by trawlers in the Pilbara. However, the Pilbara specimens may be *Tursiops aduncus* (Hammond et al. 2008). *T. aduncus* feeds on a wide variety of schooling, demersal and reef fish, as well as cephalopods (Hammond et al. 2008).

Snubfin Dolphin (*Orcaella heinsohni*)

Previously reported in Australia as the Irrawaddy Dolphin (*Orcaella breviostris*), the Australian population was re-named the Snub-fin Dolphin (*Orcaella heinsohni*) by Beasley *et al*. (2005). Until recently, it was unclear if this species was found in the Pilbara region (Prince *et al*. 2001; Parra et al. 2002; Beasley et al. 2005; DEWHA). However, Paton (2008) reported this species from waters off Dampier. Based on research in Queensland, this species is primarily found in shallow waters (less than 20 m deep), close to the coast, close to river and creek mouths and in the proximity of seagrass beds (Parra et al. 2002). Fish appear to be the primary food. According to Parra (2006) this species may be transient, with large home ranges.

Dugong (*Dugong dugon*)

Dugongs are usually found in large numbers only in shallow waters supporting extensive seagrass meadows. In Australia, they are found from the Queensland/New South Wales border in the east to Shark Bay on the Western Australian coast. Based on an aerial survey in 2000, Prince et al. (2001) estimated a population of 2,046 (±376 SE) in Pilbara waters, with an average density of 0.1 Dugong per km². This compares with a density of 0.71 (±0.12SE) dugong per km² in Shark Bay, Western Australia (Marsh et al. 1994). A recent aerial survey by Pendoley (2009b), focusing on turtles but also recording mammals, reported six to eight dugongs near Little Turtle Island. The observers could not determine if the animals were feeding, resting or travelling; but confirmed that no feeding scars (tracks) were observed anywhere in, or adjacent to, the study area.

The most extensive seagrass meadows found in the study area were in an embayment on the landward side of Weerdee Island and were low-density beds of seagrass, predominantly *Halophila ovalis*, approximately 86 ha in area. A single dugong was spotted there in August 2008 during related field investigations (Peter Morrison, SKM pers. comm.). Dugong feeding scars were not recorded in these seagrass beds during dives conducted in August 2009 (Kurt Wiegle, SKM pers. comm.).

Table 4.11 presents a summary of information relating to the types of habitats utilised by these marine mammals in the study area and the timing of their occurrence.

Table 4.11 Summary of Marine Mammal Habitat usage within and adjacent to the Proposed Outer Harbour Development

Species	Habitat Type	Known and Predicted Activity	Occurrence in Project Area	Reference relevant to study area
Humpback whale	Shelf waters off Western Australia, but mainly in water > 20 m in depth. Individuals (adults with calves) will come closer to shore	Migration	July to October. Northbound peak period: Late June–Early Aug. Southbound peak period: Late August–Mid October	Jenner *et al*. (2001); Prince *at al*. 2001; DEH (2005)
Humpback dolphin	Coastal lagoons and enclosed bays with mangrove stands and seagrass beds through to open coastal waters	Transient and feeding	All year	Jenner *et al*. (2001); Prince *at al*. (2001)
Bottlenose Dolphin	Inshore and offshore marine environments	Transient and feeding	All year	Jenner *et al*. (2001); Prince *at al*. (2001)
Snubfin Dolphin	Coastal, shallow waters and brackish estuaries<20 m in depth	Transient and feeding	All year	IUCN website[7]
Dugong	Shelf waters – presumably shallow waters (<10 m deep) where seagrasses are abundant	Transient and feeding	All year	Jenner *et al*. (2001); Prince *at al*. (2001)

4.4.2.1 Invasive Marine Species

Invasive marine species (IMS) are organisms that have been introduced into a region beyond their natural range, have the ability to survive in their new environment; and negatively impact that environment or other species. The ability of the population to subsequently spread by natural and/or human-mediated means (for example by 'port hopping' translocations) poses a potential risk to ecological and socio-economic values in the area. Once established, eradication 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 recognised as an "at risk" port in Australia for the introduction and establishment of marine pest species (C. Astbury, *pers. comm*.). This is largely based on the level of activity that occurs in the port environment and is primarily related to vessel mediated incursions. These incursions take one of two common pathways, ballast water or biofouling (external fouling and internal seawater system fouling).

Considering the level of commercial activity that occurs in Port Hedland the number of known IMS and cryptogenic[8] species is lower than expected (CSIRO 1999). The species present in Port Hedland Inner Harbour are either well known cosmopolitan, common fouling species or species with less obvious impacts or inconspicuous by nature. 'Cosmopolitan' species are species known to have a wide global distribution where part or all of their distribution may be considered cryptogenic.

Table 4.12 provides a summary of known IMS confirmed within Port Hedland (Huisman et al. 2008). There have been no introduced species recorded at the site of the proposed Outer Harbour Development. The proposed development is over 4 km outside the existing harbour and is not presently used for any shipping activities including anchoring or loading, so there is a very low likelihood of any IMS being present in the area due to the lack of suitable habitat which would permit successful establishment of a viable population.

[7] http://www.iucnredlist.org/details/136315/0
[8] 'Cryptogenic' means the status as an introduced or native species cannot be definitely or demonstrably categorised.

Table 4.12 Existing invasive marine species within Port Hedland

Species	Common name/ Species type	Distribution
Beania mirabilis (Johnston 1840)	Bryozoan	A widespread inconspicuous species, occurring throughout warm-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 vidocici (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 location 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.

Further detail on IMS in the Port Hedland region is provided in **Section 6** of the PER/EIS and **Appendix B5** of the PER/EIS.

5 SEDIMENT PLUME MODELLING AND IMPACT ASSESSMENT

Benthic Primary Producers (BPP) in the vicinity of proposed dredging and disposal may be impacted directly (direct removal by dredging, smothering from spoil disposal) or indirectly (light reduction from suspended particles, sedimentation). This section considers the potential indirect impacts.

5.1 SEDIMENT PLUME MODELLING

Modelling of the construction dredging and disposal activities of the proposed Outer Harbour Development predicted that heavier sediment particles and a proportion of finer sediments will deposit around the dredging and disposal operations while finer sediments will deposit as thin layers, for short durations, over a wider area.

The model predicted smaller sediment particles (silts and clays) as being susceptible to the prevailing levels of shear stress arising from tidal currents, causing sediment plumes to migrate and disperse close the seabed (half a metre to a metre and a half above the bottom). In addition, daily cycles of settlement and resuspension of sediment are likely to occur due to the strong tides and influence of waves, with flooding and ebbing tides spreading the particles and plume in an onshore-offshore direction. Over seasons, a net migration of finer particles to the east and northeast in summer months and west in winter months was predicted.

Evaluation of sediment plume behaviour associated with dredge spoil disposal predicted a greater net drift of spoil material into areas up to 10 to 15 km closer to shore from disposal area boundaries, a response to the onshore steering of tidal currents with proximity to land. In addition, heavier sediment particles will be distributed during storm events in disposal areas located in shallower waters, resulting in trapped fines being resuspended. This will likely occur for several years after completion of construction disposal, and will be a function of the frequency of local storm events.

A full account of the sediment plume modelling and the outputs is provided in **Appendix A15** of the PER/EIS.

5.2 BENTHIC HABITAT IMPACT ASSESSMENT

Marine habitats extend from above the high water mark on land through to the subtidal environment within the proposed Outer Harbour Development area. Specifically, the following categories of habitat types and their occurrence within proposed Outer Harbour Development relevant to the DSDMMP are:

- **coastal intertidal habitats**: marine habitats occurring between the highest and lowest astronomical tidal boundaries and including the habitat types of platform reef and tidal flat;
- **State subtidal habitats**: marine habitats occurring offshore of the lowest astronomical tidal boundary within State waters and including the habitat types of hard and soft substrate; and
- **Commonwealth subtidal habitats**: marine habitats occurring offshore of the lowest astronomical tidal boundary, offshore of the State jurisdiction boundary, and including the habitat types of hard and soft substrate.

Division of subtidal habitats between State and Commonwealth marine waters has been made to meet the requirements of the differing assessment guidances applicable. Specifically, Environmental Assessment Guideline (EAG) No. 3, *Environmental Assessment Guidelines for Protection of Benthic Primary Producer Habitat in Western Australia's Marine Environment* (EPA 2009), and EAG No. 7, *Marine Dredging Proposals* (EPA, 2010) are directly relevant to this DSDMMP. In addition, impacts to benthic habitats predicted or proposed to occur in Commonwealth marine areas are considered in context of the *Environment Protection (Sea Dumping) Act 1981*.

5.2.1 Definition of Impacts

EAG No. 7 (EPA 2010) focuses on the direct loss of benthic habitats and communities by removal or burial, and the indirect impacts on benthic habitats and communities from the effects of sediments

introduced to the water column by the dredging. Specifically, EAG No. 7 defines direct and indirect impacts as follows:

- direct impacts are, for the most part, coincident with the footprint of infrastructure and the areas immediately around the infrastructure; and
- indirect impacts arise when the pressure imposed by dredging exceeds the biota's natural tolerance to that type of pressure. The severity of indirect impacts will range from irreversible ('loss') to readily-recoverable ('impact') effects.

BPPH loss assessments relating to direct loss of habitats and communities through removal due to construction of the marine infrastructure as proposed for the Outer Harbour Development have been assessed, in addition to and indirect losses due to sedimentation. In addition, indirect effects on benthic habitats and communities due to the effects of sediments introduced to the water column by dredging have been evaluated. A summary of the impact assessments to each of the benthic habitat categories is provided below.

5.2.2 Coastal Intertidal Habitats

For a detailed account of the impacts to coastal intertidal habitats, refer to **Appendix A10** of the PER/EIS. Provided here is a summary of the assessment process and the findings.

Local Assessment Units (LAUs) have been determined for coastal intertidal habitats within the proposed Outer Harbour Development area, and direct and indirect losses have been evaluated within each LAU. The proposed LAUs and their boundaries are presented in **Figure 5-1** and the total coastal intertidal areas encompassed by each unit are provided in **Table 5.1**. The Port Hedland Industrial LAU[9] is an existing LAU within the region and as such has been incorporated into the assessment framework as is.

Table 5.1 Proposed Local Assessment Units and their Boundaries for the Impact Assessment of Coastal Intertidal Benthic Habitats

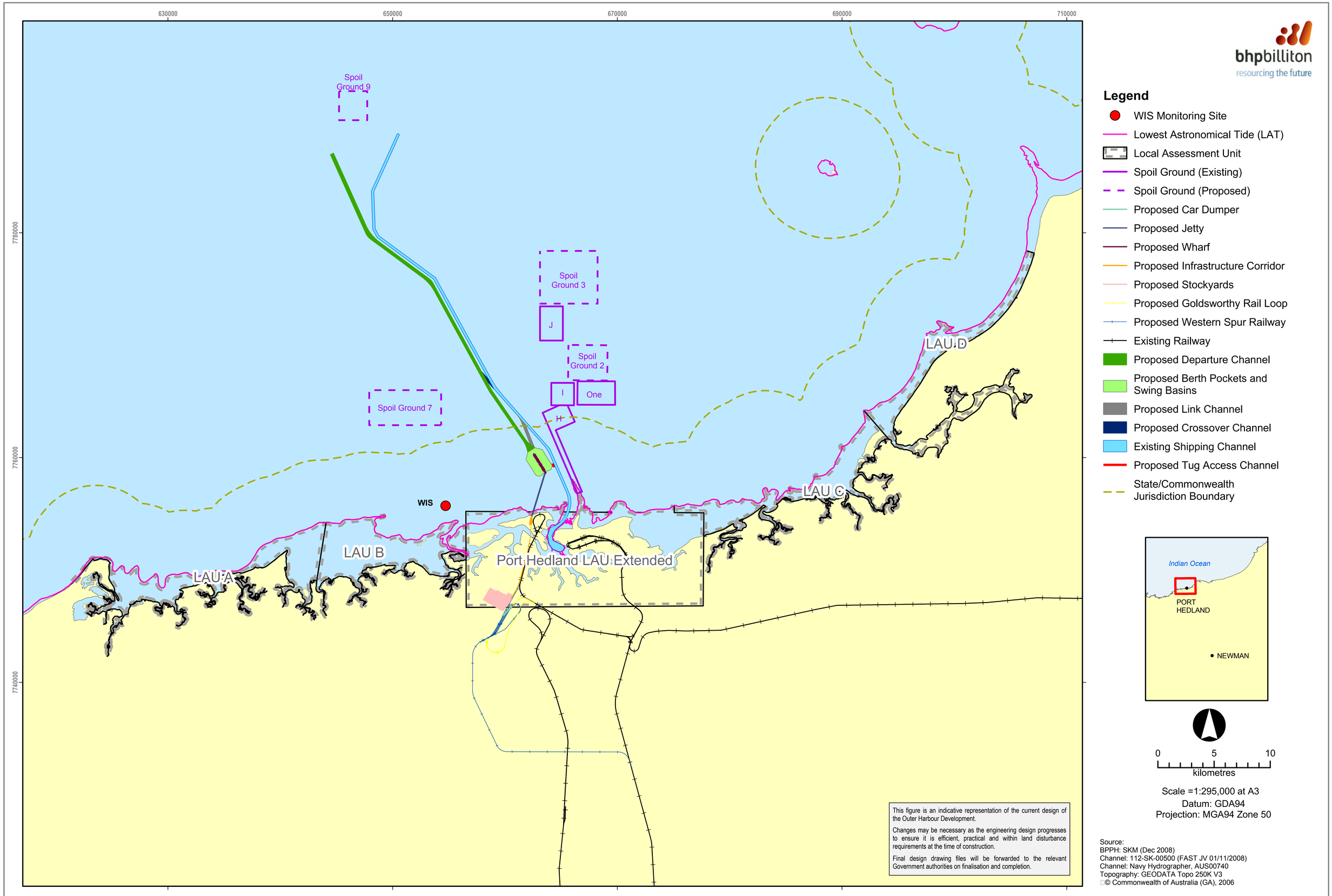
LAU	Area	
	ha	km^2
LAU A	4,876	48.76
LAU B	4,915	49.15
Port Hedland Industrial LAU	4,210	42.10
LAU C	4,143	41.43
LAU D	4,154	41.54

The losses for coastal intertidal BPPH within the Port Hedland Industrial LAU have been estimated as follows:

- historical losses: 69 ha; and
- direct losses: 1.7 ha due to construction of the jetty and abutment.

The total cumulative loss of coastal intertidal BPPH is 70.7 ha, with resultant percentage loss of 14.2% in the Port Hedland Industrial LAU. A summary of these loss components is provided in **Table 5.2**, and illustrated in **Figure 5-2** and **Figure 5-3**.

[9] Previously known as the Port Hedland Industrial Area Management Unit, as identified in EPA (2001).



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Legend

- WIS Monitoring Site
- Lowest Astronomical Tide (LAT)
- Local Assessment Unit
- Spoil Ground (Existing)
- Spoil Ground (Proposed)
- Proposed Car Dumper
- Proposed Jetty
- Proposed Wharf
- Proposed Infrastructure Corridor
- Proposed Stockyards
- Proposed Goldsworthy Rail Loop
- Proposed Western Spur Railway
- Existing Railway
- Proposed Departure Channel
- Proposed Berth Pockets and Swing Basins
- Proposed Link Channel
- Proposed Crossover Channel
- Existing Shipping Channel
- Proposed Tug Access Channel
- State/Commonwealth Jurisdiction Boundary

0 5 10
kilometres

Scale =1:295,000 at A3
Datum: GDA94
Projection: MGA94 Zone 50

Source:
BPPH: SKM (Dec 2008)
Channel: 112-SK-00500 (FAST JV 01/11/2008)
Channel: Navy Hydrographer, AUS00740
Topography: GEODATA Topo 250K V3

Figure 5-1 Local Assessment Unit Boundaries for Assessment of Impacts to Coastal Intertidal Benthic Habitats for the Proposed Outer Harbour Development

662000

664000

7754000

Finucane Island

This figure is an indicative representation of the current design of the Outer Harbour Development.

Changes may be necessary as the engineering design progresses to ensure it is efficient, practical and within land disturbance requirements at the time of construction.

Final design drawing files will be forwarded to the relevant Government authorities on finalisation and completion.

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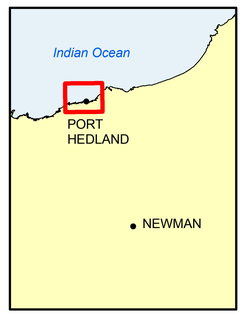
Legend

- Direct Loss
- LAT
- Local Assessment Unit
- Proposed Jetty
- Proposed Infrastructure Corridor
- Existing Railway
- Existing Shipping Channel
- Mixed Assemblage
- Sediment

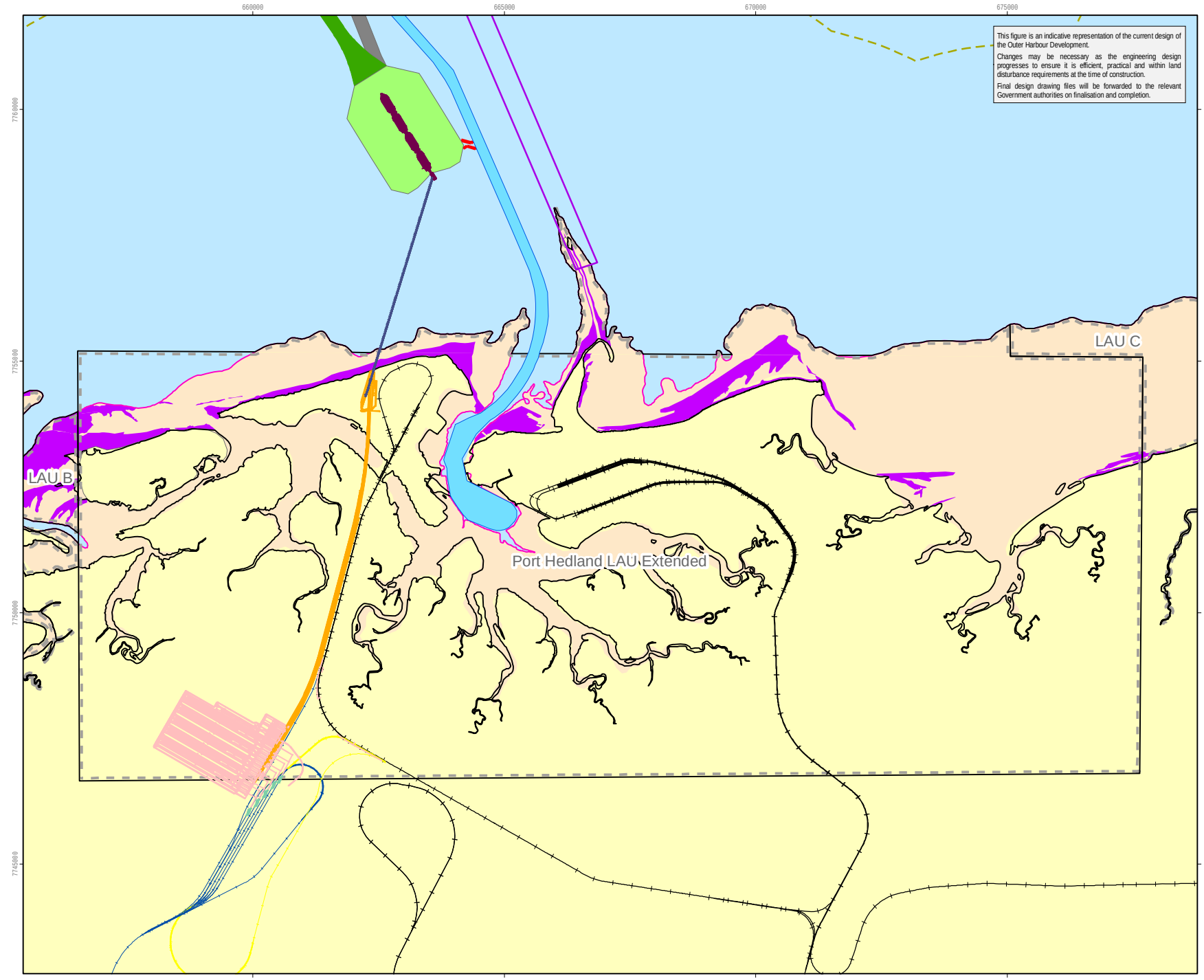


0 100 200 300 400 500
Metres

Scale =1:10,000 at A3
Datum: GDA94
Projection: MGA94 Zone 50

Source:
Assemblages: SKM (Feb, 2011)
Imagery: BHPBIO (Jun, 2010)
Channel: 112-SK-00500 (FAST JV 01/11/2008)
Channel: Navy Hydrographer, AUS00740
Topography: GEODATA Topo 250K V3

Figure 5-2 Direct Losses of Coastal Intertidal BPPH due to the Proposed Outer Harbour Development Jetty and Abutment



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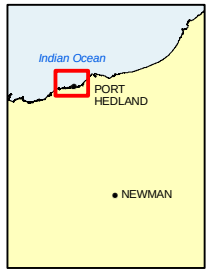
Legend

- Local Assessment Unit
- Lowest Astronomical Tide (LAT)
- Spoil Ground (Existing)
- Proposed Car Dumper
- Proposed Jetty
- Proposed Wharf
- Proposed Infrastructure Corridor
- Proposed Stockyards
- Proposed Goldsworthy Rail Loop
- Proposed Western Spur Railway
- Existing Railway
- Proposed Departure Channel
- Proposed Berth Pockets and Swing Basins
- Proposed Link Channel
- Existing Shipping Channel
- Proposed Tug Access Channel
- Mixed Assemblage
- Sediment
- State/Commonwealth Jurisdiction Boundary



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Scale =1:73,000 at A3

Datum: GDA94
Projection: MGA94 Zone 50

Source:
BPPH: SKM (Dec 2008)
Channel: 112-SK-00500 (FAST JV 01/11/2008)
Channel: Navy Hydrographer, AUS00740
Topography: GEODATA Topo 250K V3

Figure 5-3 Predicted Irreversible Losses of Coastal Intertidal BPPH due to Elevated Sedimentation Rates

Table 5.2 Total Cumulative Losses of Coastal Intertidal BPPH due to the Proposed Outer Harbour Development

LAU	Total Area of BPPH (ha)	Historical Loss (ha)	Direct Loss (ha)	Indirect Loss (ha)	Total Loss (ha)	Total Loss (%)	EPA Category and Loss Threshold
Port Hedland Industrial	498	69	1.7	0	70.7	14.2	E – 10%
Totals	**498**	**69**	**1.7**	**0**	**70.7**	**–**	**–**

5.2.3 State Subtidal Habitats

For a detailed account of the impacts to subtidal habitats in State waters, refer to **Appendix A10** of the PER/EIS. Provided here is a summary of the assessment process and the findings.

Local Assessment Units (LAUs) have been determined for State subtidal habitats within the proposed Outer Harbour Development area, and direct and indirect losses have been evaluated within each LAU. The proposed LAUs and their boundaries are presented in Figure 5-4 and the total subtidal habitat areas encompassed by each unit are provided in **Table 5.3**. The Port Hedland Industrial LAU[10] is an existing LAU within the region and as such has been incorporated into the assessment framework as is.

Table 5.3 Proposed Local Assessment Units and their Boundaries for the Impact Assessment of State Subtidal Habitats

LAU	Area	
	ha	km^2
1	4,289	42.89
2	4,941	49.41
3	3,580	35.80
4	3,653	36.53
5	4,411	44.11
6	4,767	47.67
7	4,651	46.51
8	5,680	56.80
Port Hedland Industrial LAU	898	8.98
9	4,642	46.42
10	4,438	44.38
11	4,793	47.93
12	4,821	48.21
13	4,429	44.29
14	4,264	42.64
15	4,149	41.49
16	4,109	41.09
17	2,372	23.72
18	6,800	68.00

The losses for State subtidal habitats due to the proposed Outer Harbour Development have been estimated as follows:

- historical losses: 4.17 ha;
- direct losses: 7.6 ha due to construction of the marine infrastructure; and
- indirect losses: 140.3 ha resulting from sedimentation.

The total cumulative loss of State subtidal habitat is 167.1 ha, with resultant percentage losses of 52.9% in LAU 8 and 2.2% in Port Hedland Industrial LAU. A summary of these loss components is provided in **Table 5.4**, and illustrated in **Figure 5-5** and **Figure 5-6**.

[10] Previously known as the Port Hedland Industrial Area Management Unit, as identified in EPA (2001).

650000

700000

7800000

7750000

Spoil Ground 9

Spoil Ground 3

J

Spoil Ground 2

I

One

Spoil Ground 7

H

1

2

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

WIS

Port Hedland LAU

This figure is an indicative representation of the current design of the Outer Harbour Development.

Changes may be necessary as the engineering design progresses to ensure it is efficient, practical and within land disturbance requirements at the time of construction.

Final design drawing files will be forwarded to the relevant Government authorities on finalisation and completion.

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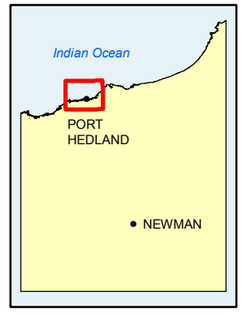
Legend

- WIS Monitoring Site
- Project Area
- Local Assessment Unit
- Lowest Astronomical Tide (LAT)
- Spoil Ground (Existing)
- Spoil Ground (Proposed)
- Proposed Car Dumper
- Proposed Jetty
- Proposed Wharf
- Proposed Infrastructure Corridor
- Proposed Stockyards
- Proposed Goldsworthy Rail Loop
- Proposed Western Spur Railway
- Existing Railway
- Proposed Departure Channel
- Proposed Berth Pockets and Swing Basins
- Proposed Link Channel
- Proposed Crossover Channel
- Existing Shipping Channel
- Proposed Tug Access Channel
- State/Commonwealth Jurisdiction Boundary

Habitat (SKM, Dec 2008)

- Hard Coral
- Soft Coral
- Macro Algae
- Invertebrates
- Sponge
- Hard Substrate
- Sediment



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Scale =1:320,000 at A3
Datum: GDA94
Projection: MGA94 Zone 50

Source:
BPPH: SKM (Dec 2008)
Channel: 112-SK-00500 (FAST JV 01/11/2008)
Channel: Navy Hydrographer, AUS00740
Topography: GEODATA Topo 250K V3

Figure 5-4 Local Assessment Unit Boundaries for Assessment of Impacts to State Subtidal Habitats for the Proposed Outer Harbour Development

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658000
660000
662000
664000
666000
668000
7762000
7760000
7758000
7756000
7754000

H

LAU 7

LAU 8

LAU 9

PORT HEDLAND LAU

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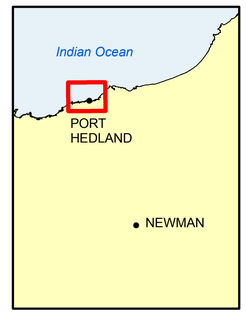
Legend

- Local Assessment Unit
- Lowest Astronomical Tide (LAT)
- Spoil Ground (Existing)
- Proposed Jetty
- Proposed Wharf
- Proposed Infrastructure Corridor
- Existing Railway
- Proposed Departure Channel
- Proposed Berth Pockets and Swing Basins
- Proposed Link Channel
- Existing Shipping Channel
- Proposed Tug Access Channel
- State/Commonwealth Jurisdiction Boundary

Habitat (SKM, Dec 2008)

- Hard Coral
- Soft Coral
- Macro Algae
- Invertebrates
- Sponge
- Hard Substrate
- Sediment



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Datum: GDA94
Projection: MGA94 Zone 50

This figure is an indicative representation of the current design of the Outer Harbour Development.

Changes may be necessary as the engineering design progresses to ensure it is efficient, practical and within land disturbance requirements at the time of construction.

Final design drawing files will be forwarded to the relevant Government authorities on finalisation and completion.

Source:
BPPH: SKM (Dec, 2008)
Imagery: BHPBIO (Jun, 2010)
Channel: 112-SK-00500 (FAST JV 01/11/2008)
Channel: Navy Hydrographer, AUS00740
Topography: GEODATA Topo 250K V3

Figure 5-5 Direct Losses of Subtidal Habitats in State Waters due to the Proposed Outer Harbour Development Marine Infrastructure Footprint

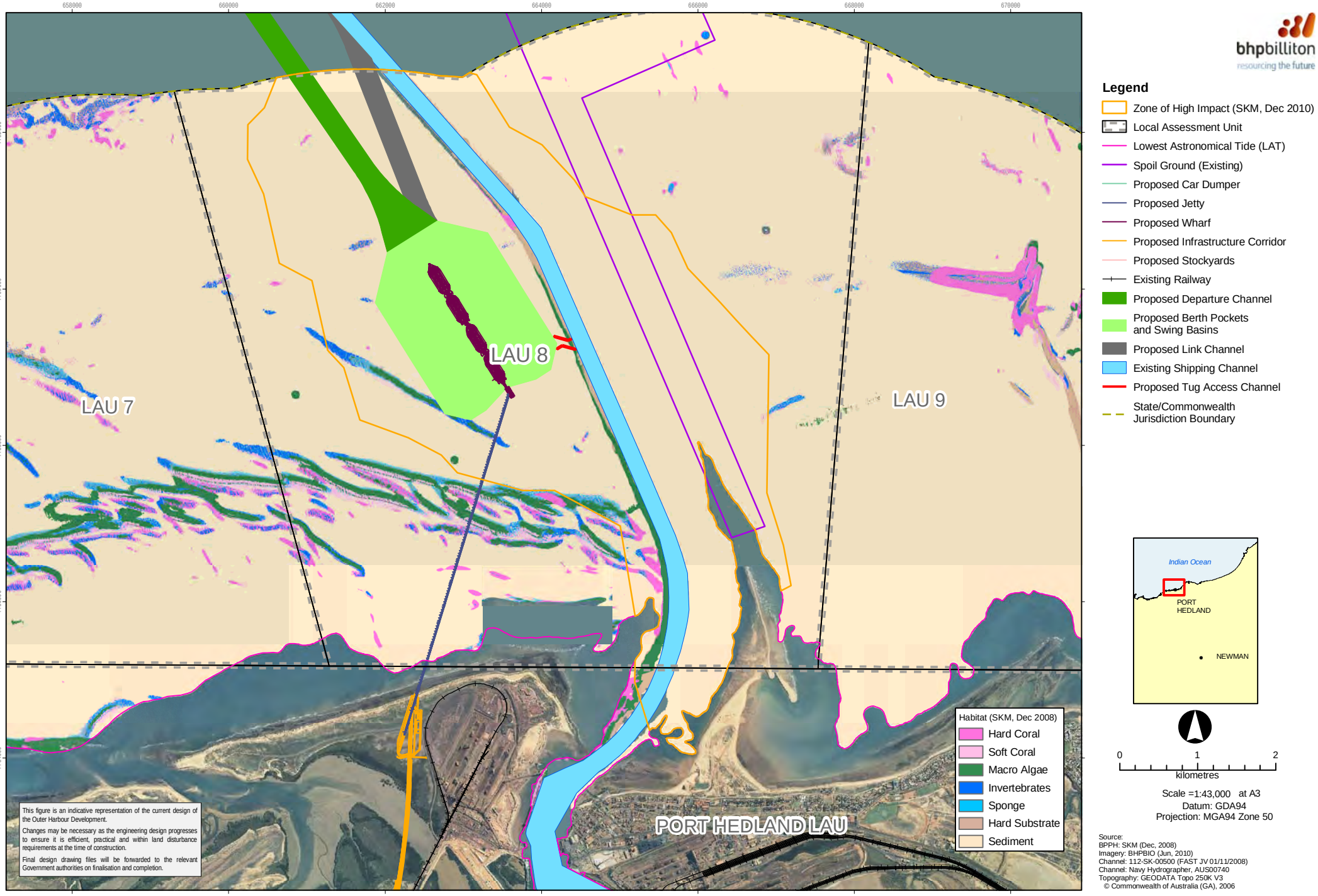


Figure 5-6 Predicted Irreversible Losses of Subtidal BPPH due to Elevated Sedimentation Rates

Table 5.4 Total Cumulative Losses of Subtidal Habitats in State Waters due to the Proposed Outer Harbour Development

LAU	Total Area of BPPH (ha)	Historical Loss (ha)	Direct Loss (ha)	Indirect Loss (ha)	Total Loss (ha)	Total Loss (%)	EPA Category and Loss Threshold
8	308.0	15.0	7.6	140.3	162.9	46.0	E – 10%
Port Hedland Industrial	190.07	4.17	–	–	4.17	2.2	E – 10%
Totals	**498.07**	**19.17**	**7.6**	**140.3**	**167.07**	**–**	**–**

5.2.4 Commonwealth Subtidal Habitats

Loss of benthic habitats within Commonwealth marine areas will occur due to direct removal during construction of the proposed marine infrastructure and from smothering in spoil disposal areas. Each of these benthic habitat loss aspects is considered below. In addition, assessment of potential impacts to coral spawning is provided.

Marine Infrastructure

Dredging of the channel will result in the removal of 64.2 ha of benthic habitat. The existing substrate in the areas of the proposed channel and turning basin is predominantly sand, although the footprint does intersect hard substrate in some areas, resulting in the loss of benthic habitat (**Figure 5-7**).

The greater proportion of benthic habitat affected by the proposed channel is at the very outer end of the channel. The majority of the proposed channel has been aligned to follow the deepest areas between the limestone ridgelines and thereby it has largely avoided hard substrate BPPH. The channel alignment has been located over areas mainly comprising bare sandy habitat. The channel does however intersect limestone substrate near the channel entrance. The benthic community at this location is a mosaic comprising hard and soft corals, sponges and macroalgae. These benthic organisms and the type of community they comprise are well represented throughout the Port Hedland region.

Spoil Disposal

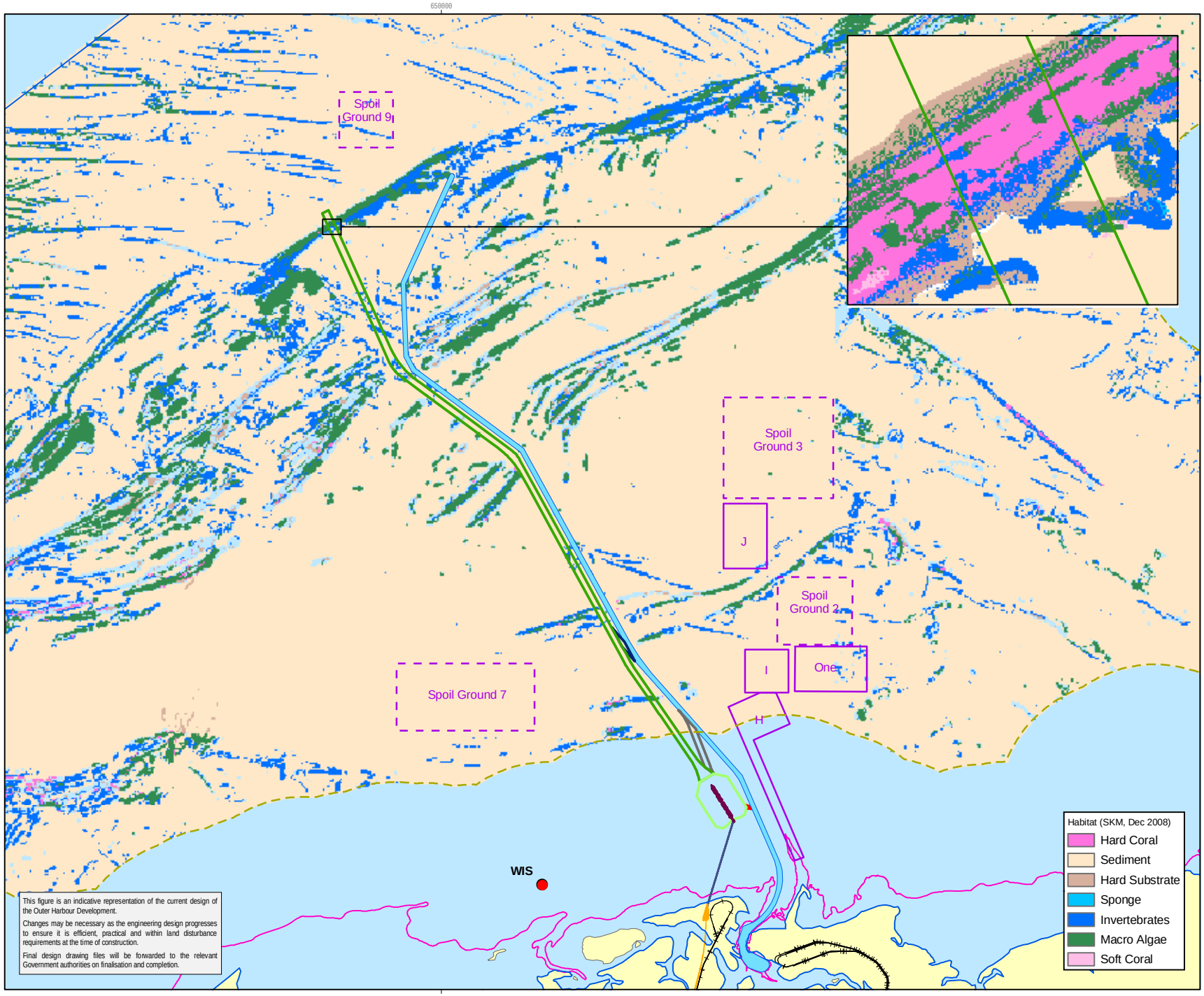
Smothering of the seabed resulting from dumping of dredged material into the disposal grounds will result in the loss of subtidal habitat. Loss of subtidal habitat supporting benthic communities due to spoil disposal has been minimised by the placement of the proposed spoil grounds on areas predominantly comprised of sandy substrate (**Table 5.5**). This is reflected in the very low total hard substrate areas that will be affected by spoil disposal: the total hard substrate area that will be smothered in Spoil Grounds 3 (18.5 ha), 7 (2 ha) and 9 (11.5 ha) amounts to 32 ha, or 0.63% of the total area (5,058.5 ha) proposed for spoil disposal.

Table 5.5 Areas (ha) and Proportions (%) of Substrate Types Present within the Proposed Outer Harbour Development Spoil Grounds

Substrate Type	Spoil Ground 2*	Spoil Ground 3	Spoil Ground 7	Spoil Ground 9
Total area	1,092.8	2,406.3 ha	2,002.3 ha	649.7 ha
Hard substrate	11.3	8.3 ha	0 ha	7.8 ha
	1.03%	0.4%	0%	1.2%
Sediment	1,081.5	2,398 ha	2,002.3 ha	641.7 ha
	98.97%	99.6%	100%	98.8%

Note: the proportions do not sum 100% due to a small amount of overlap attributable to the mosaic nature of benthic habitats.

** Spoil Ground 2 is proposed only for contingency and therefore the areas presented are for information only and not proposed as losses.*



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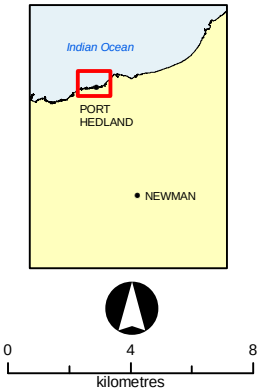
Legend

- WIS Monitoring Site
- Study Area
- Lowest Astronomical Tide (LAT)
- Proposed Infrastructure Corridor
- Proposed Stockyards
- Spoil Ground (Existing)
- Spoil Ground (Proposed)
- Proposed Jetty
- Proposed Wharf
- Existing Railway
- Proposed Departure Channel
- Proposed Berth Pockets and Swing Basins
- Proposed Link Channel
- Proposed Crossover Channel
- Existing Shipping Channel
- Proposed Tug Access Channel
- State/Commonwealth Jurisdiction Boundary



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kilometres

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Projection: MGA94 Zone 50

Source:
BPPH: SKM (Dec 2008)
Channel: 112-SK-00500 (FAST JV 01/11/2008)
Channel: Navy Hydrographer, AUS00740
Topography: GEODATA Topo 250K V3

Figure 5-7 Commonwealth Subtidal Habitats within the Proposed Outer Harbour Development Marine Infrastructure Footprint