Lumsden Point General Cargo Facility

Benthic Habitat Survey

301012-01660 – EN-REP-04

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PROJECT 301012-01660 - LUMSDEN POINT GENERAL CARGO FACILITY

REV	DESCRIPTION	ORIG	REVIEW	WORLEY-PARSONS APPROVAL	DATE	CUSTOMER APPROVAL	DATE
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B	Issued for client review	J Shakespeare	D Ryan	A Jacobs	03-Dec-12		
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0	Issued for use	N Wilson	H Houridis		12-Jul-12		
1	Issued for use	J Shakespeare	H Houridis		25-Sep-13		

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EXECUTIVE SUMMARY

The Port Hedland Port Authority (PHPA) plans to develop a General Cargo Facility at Lumsden Point. Two Handymax berths totalling 500 metres (m) in length will be developed. As part of this development, dredging of surface marine sediments to a depth of -13.5 m chart datum (CD) within the berth pocket and and -12 m CD in access channel will be undertaken. An area directly behind the berths will also be cleared to make way for a landbacked wharf.

The dredging and construction development will directly affect benthic substrate within the footprint. In accordance with the *Environment Protection Act 1986* (EP Act), all proposals that may result in disturbance to or loss of marine benthic primary producer habitat (BPPH) should adhere to the principals and guidelines recommended within the Environmental Protection Authority (EPA) *Environmental Assessment Guideline No. 3: Protection of benthic primary producer habitats in Western Australia's marine environment* (EPA 2009).

Drop video and still imagery were completed within the proposed disturbance footprint to describe and map subtidal and intertidal habitats. The BPPH was dominated by bare sediment within the proposed footprint area. Of the colonised BPPH, turfing algae and macroalgae dominated subtidal areas, while mangrove communities dominated intertidal and supratidal areas. Mangrove communities consisted of three species: *Avicennia marina*, *Rhizophora stylosa* and *Ceriops australis*. The most common mangrove species was *A. marina*, with large variations seen in vegetation density and canopy height. The total area of mangroves within the disturbance footprint is 13.88 ha (hectares).

It is expected that 22.22 ha of BPPH will be directly removed by this project excluding BPPH already accounted for in previous proposals. No unusual, unique or highly significant habitat complexes were identified within the dredge and construction footprint.

ACRONYMS

BHPBIO	BHP Billiton Iron Ore
BPP	benthic primary producer
BPPH	benthic primary producer habitat
CD	chart datum
DMMA	Dredge Material Management Area
OEPA	Office of the Environmental Protection Authority
GIS	geographic information system
MPB	microphytobenthos
PHPA	Port Hedland Port Authority

1. INTRODUCTION

1.1 Background

Port Hedland is located approximately 1,660 km north of Perth within Western Australia's Pilbara region. The Port of Port Hedland is defined as 'water within a radius of 10 nautical miles (nm) of Hunt Point Beacon (Beacon 47)' (PHPA 2001) and is managed by the PHPA under the *Port Authorities Act 1999* (WA). The port consists of a 20 nm dredged channel leading (inshore) to a dredged basin between Nelson Point and Finucane Island, where several intertidal creeks converge. The harbour has been highly modified by dredging activities and development and operation of port-related industry.

In line with expected growth in the iron ore export industry in the Pilbara region over the next few years, the PHPA has identified the need to develop a facility that will both alleviate trade growth pressures on Port Hedland port berths 1, 2 and 3 and accommodate potential marine supply trades supporting the offshore oil and gas and other industries.

The proposed Lumsden Point General Cargo Facility Project will be located opposite the existing inner harbour area, at the junction of South Creek and South East Creek. The site has present seabed levels ranging from 0.0 m CD to over -6.0 m CD. The site is sheltered from swell, but experiences strong tidal currents as a result of the high tidal range experienced in the region.

The marine habitats found in Port Hedland are characteristic of those found along the arid coastlines of the Pilbara. Recent benthic habitat surveys have been undertaken in the inner harbour for BHP Billiton Iron Ore's (BHPBIO) RGP5 and RGP6 developments and the PHPA's vessel mooring cyclone protection facility (SKM 2009; WorleyParsons 2011). These surveys identified five distinct mixed benthic primary producer (BPP) communities throughout the Port Hedland harbour, which included coral colonies in South East Creek, South West Creek and Stingray Creek.

1.2 Project overview

The proposed works will include:

- two Handymax berths totalling a length of 500 m;
- dredging of up to -13.5 m CD for the berth pocket;
- dredging of up to -12.0 m CD for the access channel;
- an area of land immediately backing a wharf behind the two berth areas;
- causeway access from land-based facilities to the wharf area; and
- disposal of dredge spoil onshore to an approved Dredge Material Management Area (DMMA).

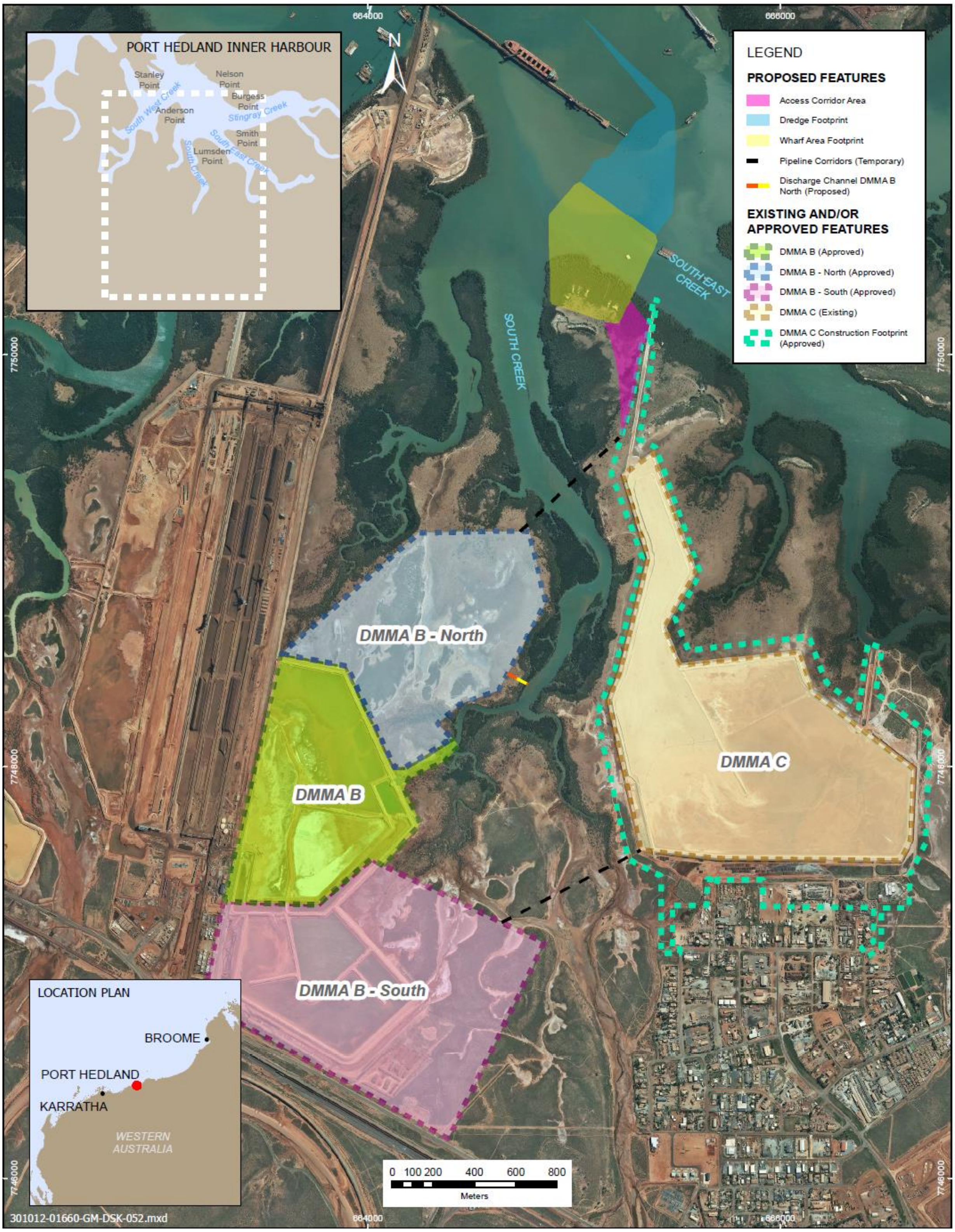

Figure 1: Proposed development footprint of the Lumsden Point General Cargo Facility

1.3 Environmental Assessment Guidelines

The EPA's *Environmental Assessment Guideline No. 3* defines BPPH as seabed communities within which algae (e.g. macroalgae, turf and benthic microalgae), seagrass, mangroves, corals or mixtures of these groups are prominent components (EPA 2009). The EPA recognises the fundamental ecological importance of BPPHs and the potential consequences of their loss. It is also acknowledged that almost all marine development proposals will result in the loss of some of these important habitats (EPA 2009).

For the purposes of this study, the following definitions were adopted:

- BPPs are primarily marine plants such as macroalgae, seagrasses, mangroves, turf algae and benthic microalgae, but also include the scleractinian corals (which gain a large proportion of their energy from internal symbiotic microalgae); and
- BPPHs are a combination of the BPPs and the substrata that can support them. BPPHs not only include areas of existing BPPs, but also areas that previously supported them or may be colonised by them in the future. Examples of BPPHs include coral reefs, seagrass meadows, mangrove forests, intertidal mud flats and seabed where macroalgal, coral or seagrass communities have grown and could grow.

Other benthic habitats such as those dominated by sessile organisms (e.g. sponges and ascidians) are recognised as being important, but the loss of or damage to these habitats would be treated separately in the environmental impact assessment process.

The dredging operations will directly affect benthic substrate within the proposed dredge footprint and may create a sediment plume that causes indirect effects on habitats near the dredging and disposal operations. Development of the wharf area and access corridor also has the potential to directly affect BPPs. In accordance with the *Environment Protection Act 1986* (EP Act), all proposals that may result in disturbance to or loss of marine BPPH should adhere to the principles and guidelines recommended within the EPA's *Environmental Assessment Guideline No. 3: Protection of benthic primary producer habitats in Western Australia's marine environment* (EPA 2009).

Figure 2 shows all BPP habitats within the Port Hedland Local Assessment Unit (LAU) as mapped in the previous South West Creek dredging survey (WorleyParsons 2012)[1].

[1] The EPA requires that spatial distribution of BPP and their habitats in the Port Hedland LAU are assessed before dredging and reclamation operations at Lumsden Point begin. The associated losses and their cumulative impacts are assessed separately in the EIA.

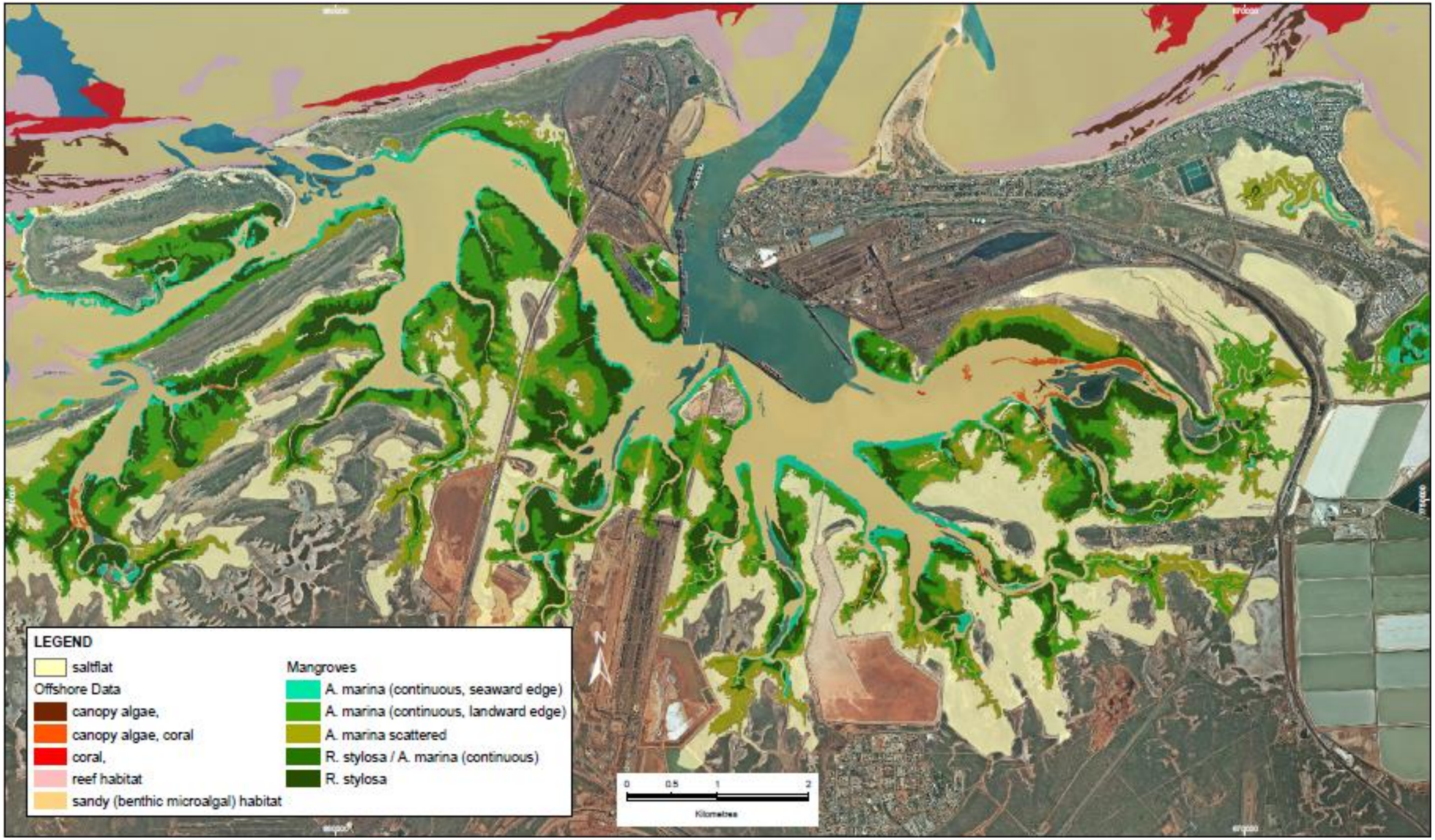

Figure 2: Benthic primary producer habitat of the Port Hedland LAU

1.4 Scope of work

This report presents the findings of a benthic habitat drop camera and still camera survey completed for the PHPA's proposed Lumsden Point General Cargo Facility project, combined with other recent drop camera imagery from the Port Hedland harbour, to create a high-resolution benthic habitat map for the subtidal and intertidal areas of the disturbance footprint. The report will also present findings from a mangrove and supratidal survey, which has been used to determine the distribution of mangrove and supratidal habitats within the disturbance footprint.

2. METHODS

2.1 Benthic subtidal and intertidal imaging

2.1.1 Data acquisition

A total of 150 points were surveyed using either still or video imagery within the disturbance footprint and surrounding area (Figure 3). Previous dredge areas were not sampled because it was assumed BPPH was not present or had been removed previously. Survey points were positioned using a random location generator in ArcGIS. Points were sampled by either drop video or still camera when exposed during low tides. The benthic habitat survey was completed between 15 and 16 November 2012 (56 points). The remaining 94 points are adopted from a previous benthic habitat survey undertaken between 26 and 29 September 2011 (WorleyParsons 2011).

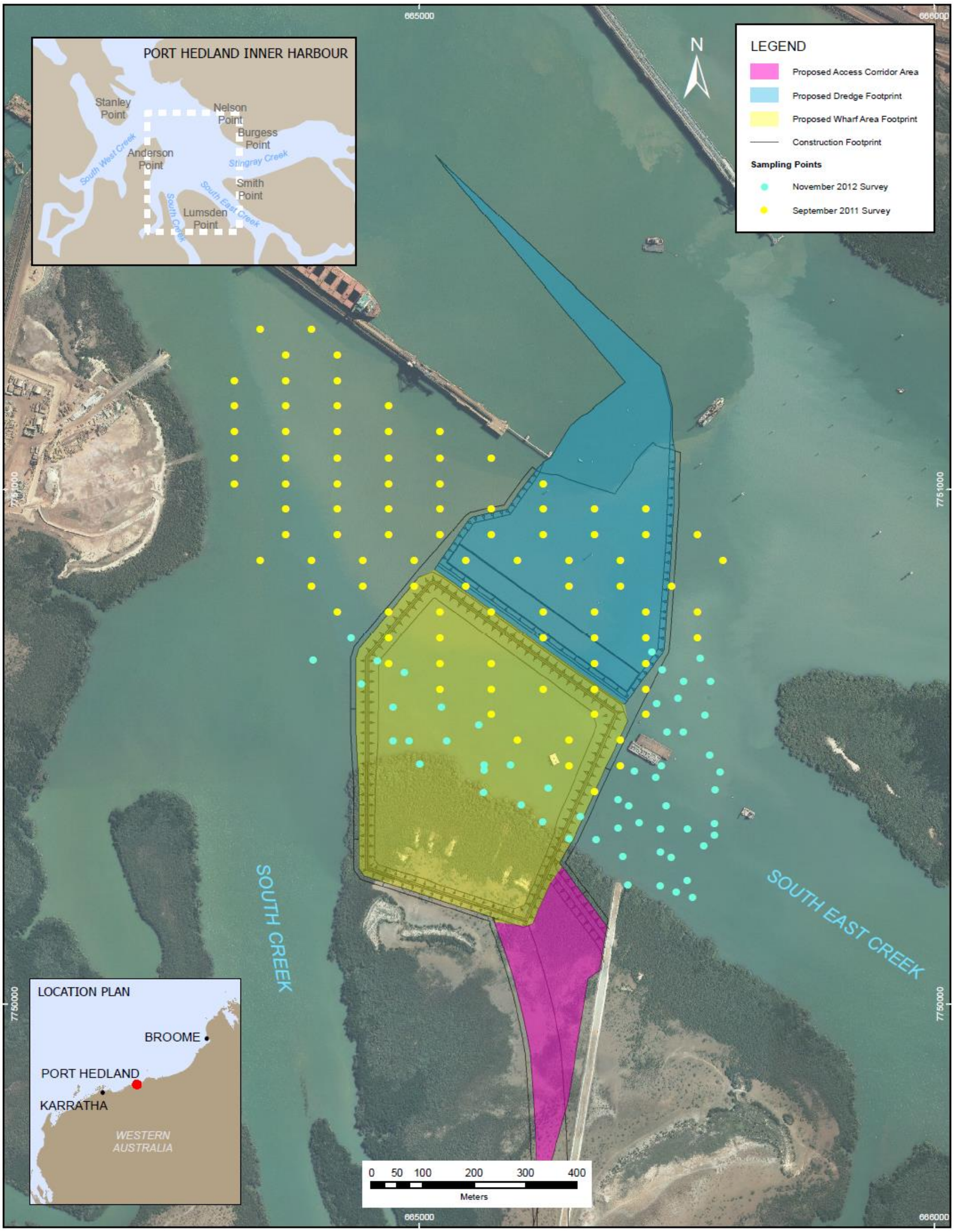

Figure 3: Position of benthic habitat survey points.

2.1.2 Image analysis and habitat classification

Each survey point was classified by a marine scientist to record key habitat types. Points were classified as supporting a benthic community type where more than 5% of the quadrat consisted of a type of biota. Where more than one biota type was present, data was recorded cumulatively. To maintain a consistent approach with other benthic habitat mapping exercises done in the Port Hedland harbour area, the PHPA's habitat classification scheme for the South West Creek project was applied to benthic habitat data collected for this study (WorleyParsons 2010). Habitat classes observed in this study included the following categories or combinations of categories:

- macroalgae;
- turfing algae;
- soft coral;
- coral;
- bare sediment; and
- pneumatophores.

2.2 Supratidal and mangrove surveys

Transects identified before mobilisation were traversed on foot across the proposed infrastructure footprint using a portable handheld GPS (Figure 4). Species composition, height, canopy cover and density were recorded along each transect. Where species density or composition changed, a GPS point was recorded and multiple photographs taken to support data analysis. Areas surrounding the DMMA B – North discharge channel as well as the north and south temporary pipelines were ground truthed in the terrestrial field survey undertaken on the 15th November 2012 (WorleyParsons 2013).

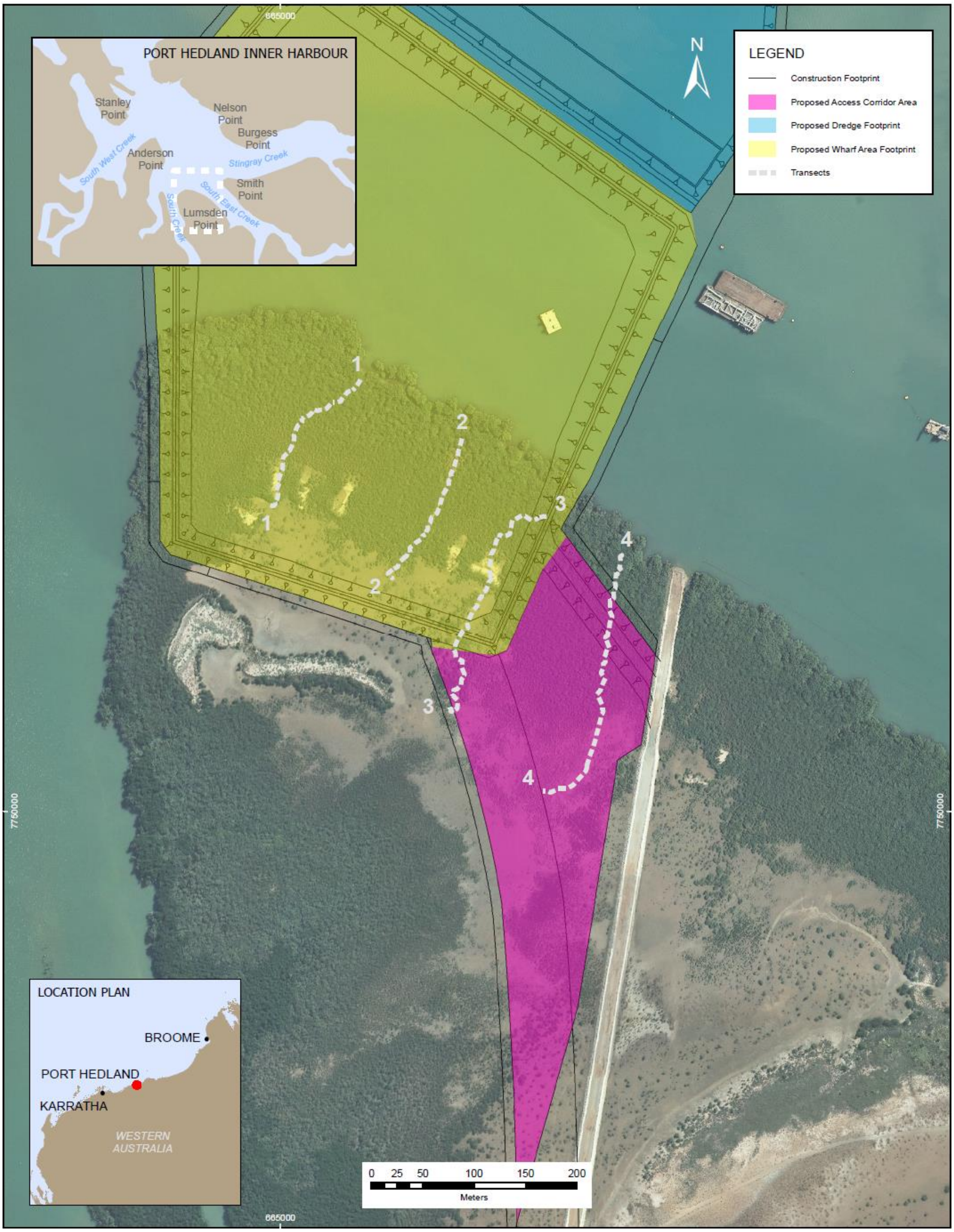

Figure 4: Position of supratidal and mangrove habitat survey transects.

2.2.1 Image analysis and habitat classification

Each transect and subsequent GPS point recorded was classified by a marine scientist to record key habitat types and changes in community composition. Variations in habitat composition were defined as a noticeable change in species type, species density, canopy cover and vegetation height. Habitat classes observed in this study included the following categories:

- *Avicennia marina* tree (density ≥ 50%);
- *Avicennia marina* tree (density < 50%);
- *Avicennia marina* shrub (density ≥ 50%);
- *Avicennia marina* shrub (density < 50%);
- *Avicennia marina* and *Rhizophora stylosa* tree (density ≥ 50%); and
- *Avicennia marina* and *Ceriops australis* shrub (density < 50%).

An arbitrary height of 2 m was used to differentiate between trees (≥ 2 m) and shrubs (< 2 m). While the term shrub in an ecological sense can describe a plant up to 6 m high, the term shrub in this context is solely used to denote a shorter vegetative structure from its taller counterpart.

2.3 Habitat map production

Habitat maps were created from the imaging data showing spatial distribution of the main intertidal, subtidal and supratidal environments within the disturbance footprint and fringing areas. Habitat polygon boundaries were interpolated around classified points using the nearest neighbour tool in ESRI ArcMap V10.1. The regional BPP map (Figure 2) had previously been collected via a range of mapping techniques including 41 sidescan sonar surveys, aerial photography, 231 ground truthing sites, 171 benthic habitat survey sites (WorleyParsons 2012). This data was classified in terms of potential biological habitat to create the BPPH map.

3. RESULTS

3.1 Wharf and dredge area

3.1.1 Non-mangrove intertidal and subtidal habitats

The wharf and dredge area covers a total area of 36.6 ha of which 30.31 ha (or 82.81%) was composed of bare substrate. Pneumatophores, which are related to the adjacent mangrove community, were abundant along the shoreline and comprised 0.70 ha (1.91%) within the wharf and dredge area. Macroalgae comprised 1.77 ha (4.84%) (*Sargassum* sp. and *Halimeda* sp.) and turfing algae 3.82 ha (10.44%) which were predominantly found along the western boundary of the dredge area.

Adjacent to the wharf and dredge area, benthic habitats were comprised of large patches of turfing algae. Soft coral communities were uncommon, with two small patches observed amongst the turfing algae to the north-west of the wharf and dredge area. No seagrass or hard coral communities were observed in or adjacent to the wharf and dredge area.

Distribution of benthic habitats is shown in Figure 5. The area of each habitat class within the wharf and dredge area is provided in Table 1.

Table 1: Area of benthic habitats within the (non-mangrove) disturbance footprint

Benthic habitat type	Coverage (ha)
Bare substrate	30.31
Macroalgae	1.77
Pneumatophores	0.70
Turfing algae	3.82
Total	**36.60**

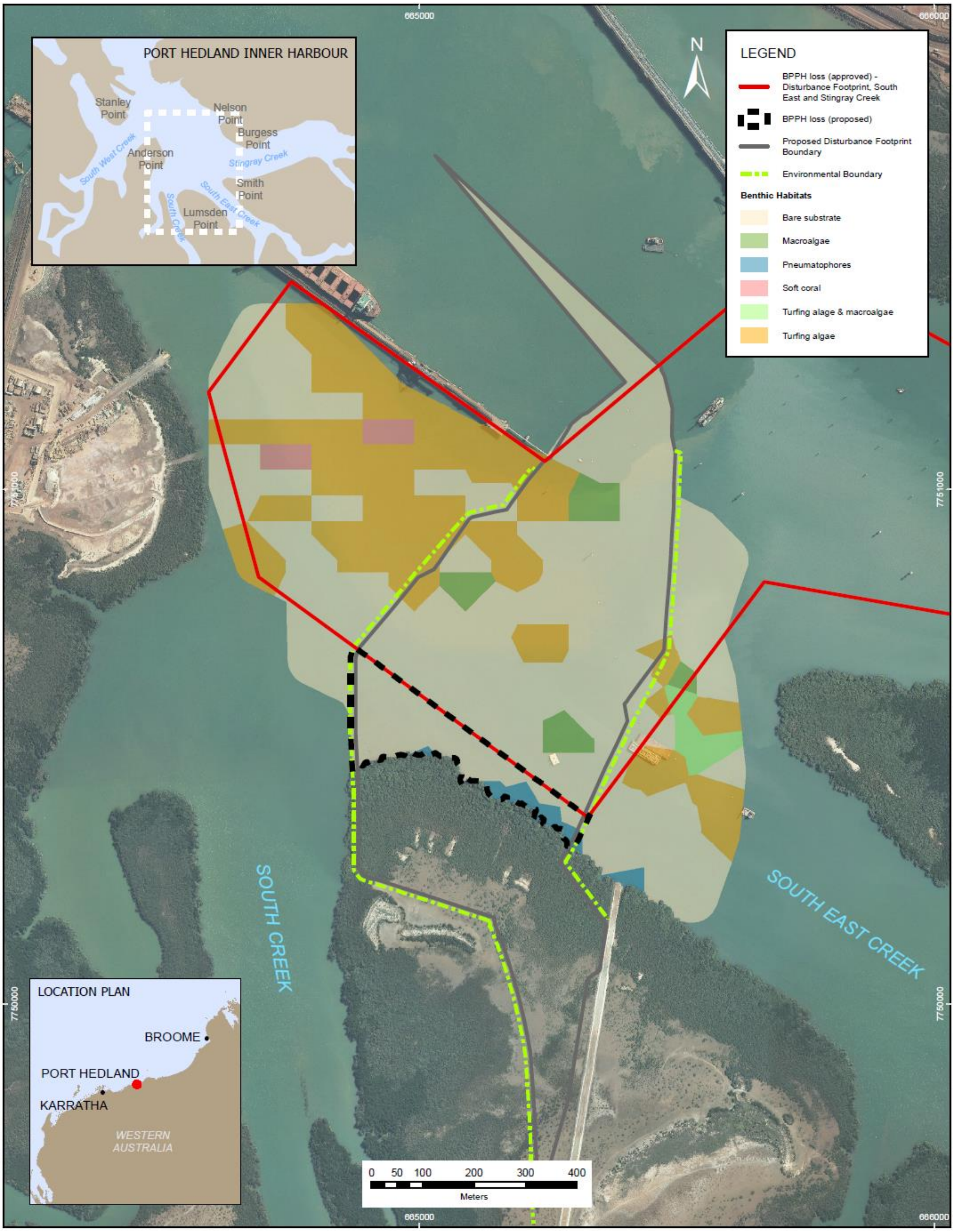

Figure 5: Non-mangrove intertidal and subtidal BPPH within the wharf and dredge area.

3.1.1 Mangrove Habitat

The supratidal and mangrove habitats identified within the wharf and dredge area comprised predominantly *A. marina* based vegetation complexes.

The different mangrove complexes were composed of trees and shrubs of varying densities as well as other less common species of mangroves such as *Ceriops australis*. The largest discrete mangrove community within the wharf and dredge area was mixed *A. marina* and *R. stylosa* (density ≥ 50%) which covered an area of 3.87 ha. Generally the presence of *R. stylosa* was only evident in the areas close to the waterline. *A. marina* trees (density ≥ 50%) and *A. marina* shrubs (density ≥ 50%) made up 2.09 ha and 1.63 ha respectively, and were seen to decrease in abundance with increasing distance from the waterline. *C. australis* was the least represented species, and was only found in conjunction with *A. marina* shrubs covering an area of 0.13 ha. Area of habitat composition is given in Table 2.

Table 2: Area of mangrove habitat composition within the wharf and dredge area footprint.

Mangrove habitat composition	Coverage (ha)
Avicennia marina tree (density ≥ 50%)	2.09
Avicennia marina tree (density < 50%)	0.33
Avicennia marina shrub (density ≥ 50%)	1.63
Avicennia marina shrub (density < 50%)	0.11
Avicennia marina and *Rhizophora stylosa* tree (density ≥ 50%)	3.87
Avicennia marina and *Ceriops australis* shrub (density < 50%)	0.13
Bare substrate	1.61

Vegetation density of mangrove habitat within the disturbance footprint was relatively high, with 7.59 ha being classed as having 50% density or greater. Bare substrate covered 1.61 ha but was predominantly found in the less frequently inundated areas, furthest away from the waterline. Vegetation with a density less than 50% made up the smallest proportion with coverage of 0.57 ha.

Distribution and area of mangrove habitat composition is shown in Figure 6. Area of habitat density is given in Table 3.

Table 3: Area of mangrove habitat density within the land based disturbance footprint.

Mangrove habitat density	Coverage (ha)
Vegetation density ≥ 50%	7.59
Vegetation density < 50%	0.57
Bare substrate	1.61

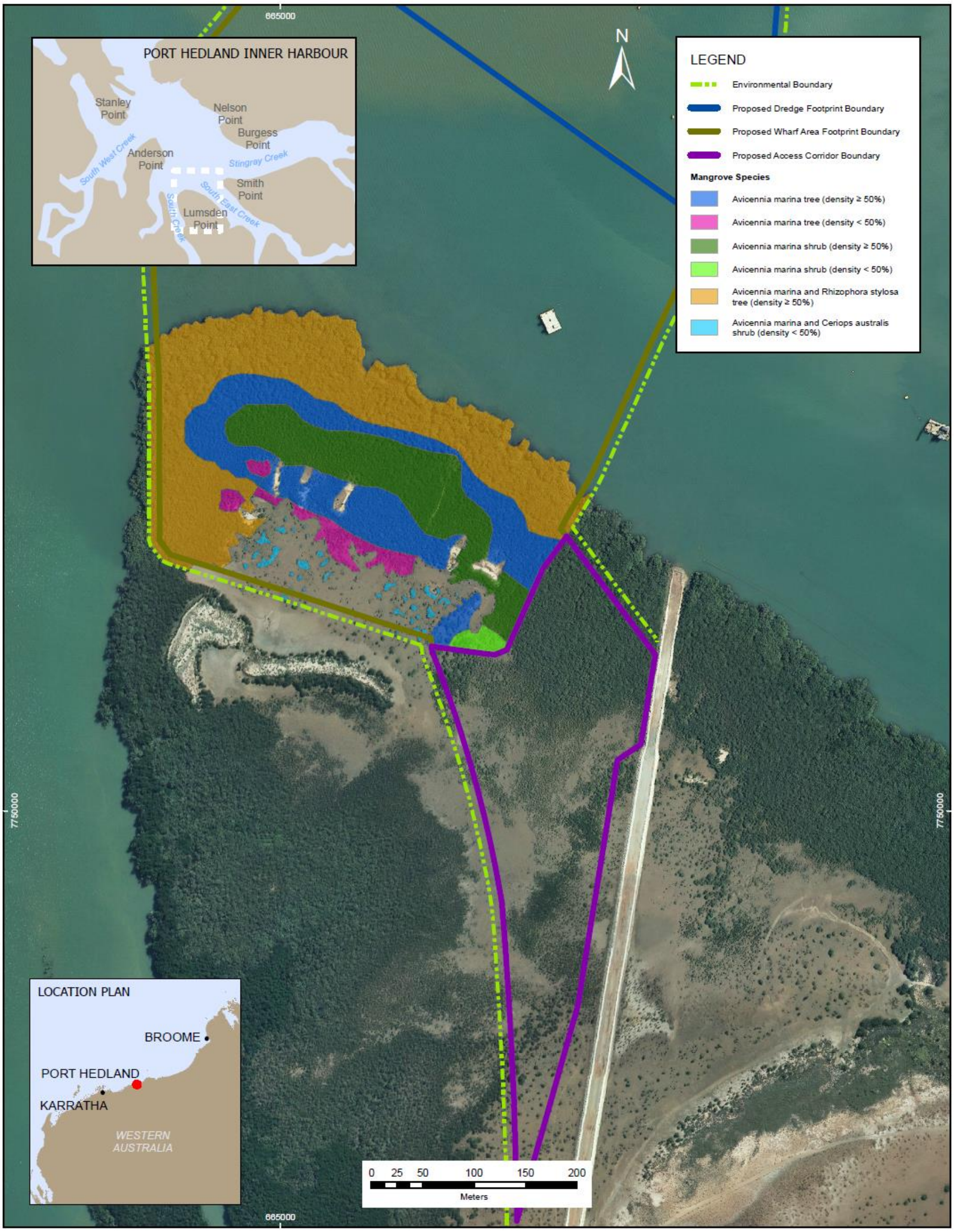

Figure 6: Mangrove habitat composition within the wharf area.

3.2 Access corridor

Most of the 8 ha within the access corridor footprint and fringing areas comprised of *A. marina* based vegetation complexes. The different habitat complexes were composed of trees and shrubs of varying densities. The largest discrete group within the disturbance footprint was the mixed *A. marina* and *C. australis* tree (density < 50%) group which made up an area of 1.56 ha. The presence of *R. stylosa* was only evident in a small area close to the waterline in conjunction with *A. marina* (0.46 ha). *A. marina* trees (density ≥ 50%) made up 0.73 ha and were seen to decrease in abundance with increasing distance from the waterline. There were no areas of *A. marina* trees where a density of less than 50% was observed. *A. marina* shrubs of both ≥ 50% and < 50% density comprised the remaining vegetated area with areas of 0.61 ha and 1.43 ha respectively.

Vegetation density of mangrove habitat within the access corridor was low, with only 1.8 ha (15.1%) being classed as having greater than 50% density. Vegetation with a density less than 50% covered an area of 2.99 ha. Bare substrate covered the greatest area with 1.82 ha and was predominately found in the less frequently inundated areas, furthest away from the waterline.

Distribution of mangrove habitat composition is shown in Figure 7. Area of each habitat class is given in Table 4 and area of habitat density is given in Table 5.

Table 4: Area of mangrove habitat composition within access corridor disturbance footprint.

Mangrove habitat composition	Coverage (ha)
Avicennia marina tree (density ≥ 50%)	0.73
Avicennia marina tree (density < 50%)	0.00
Avicennia marina shrub (density ≥ 50%)	0.61
Avicennia marina shrub (density < 50%)	1.43
Avicennia marina and *Rhizophora stylosa* tree (density ≥ 50%)	0.46
Avicennia marina and *Ceriops australis* shrub (density < 50%)	1.56
Bare substrate	1.82

Table 5: Area of mangrove habitat density within access corridor disturbance footprint.

Mangrove habitat density	Coverage (ha)
Vegetation density ≥ 50%	1.80
Vegetation density < 50%	2.99
Bare substrate	1.82

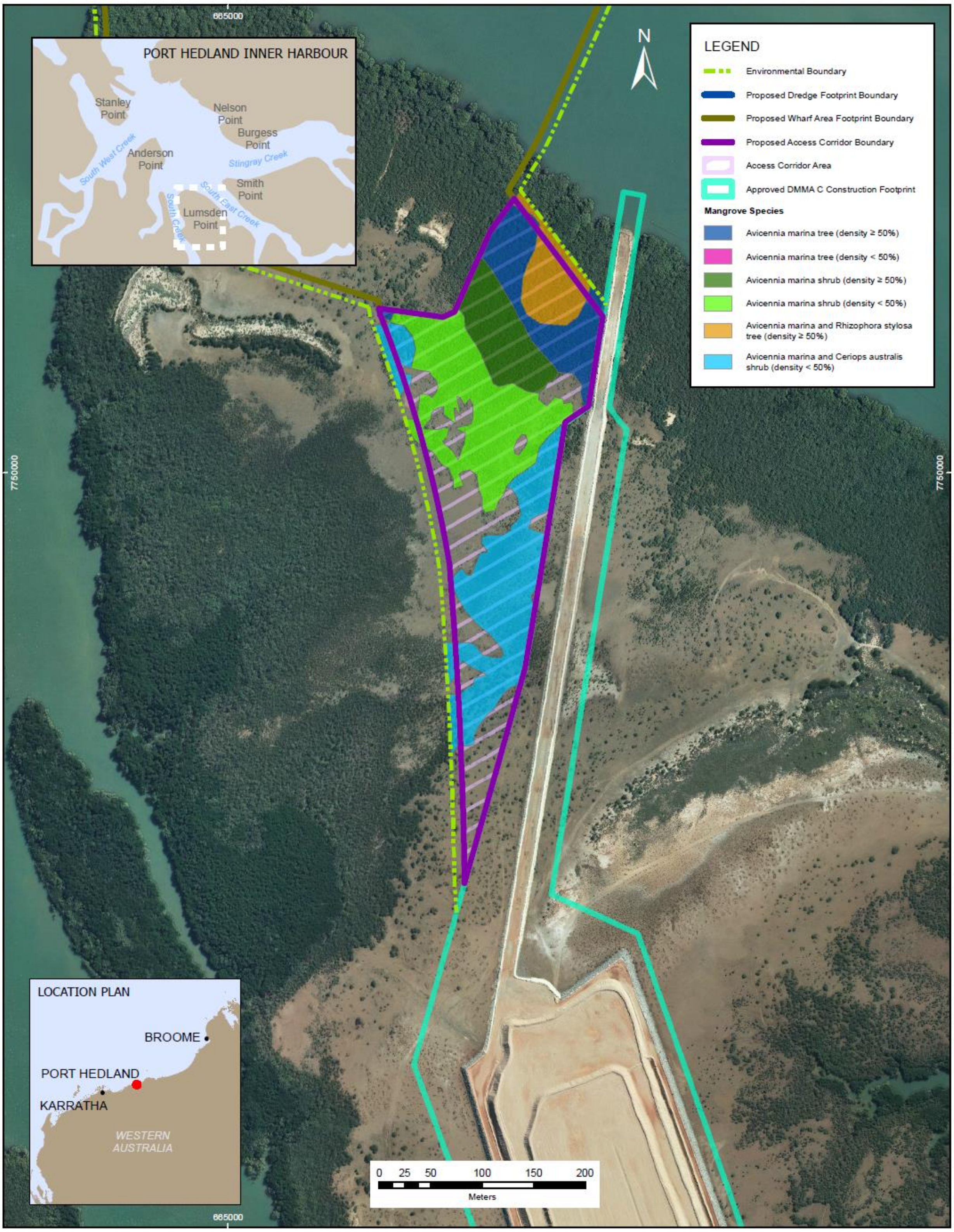

Figure 7: Composition of mangrove habitat within access corridor.

3.3 Discharge channel and temporary pipeline corridors

3.3.1 DMMA B – North discharge channel

Of the 0.11 ha within the discharge channel corridor disturbance footprint, over half (0.069 ha) was classified as intertidal bare substrate. Within the vegetated area, *A. marina* (0.022 ha) and *R. stylosa* (0.019 ha) vegetation complexes were present. The two vegetated habitat complexes were composed of trees with densities greater than 50%.

Distribution of mangrove habitat composition is shown in Figure 8. Area of each habitat class is given in Table 6 and area of habitat density is given in Table 7.

Table 6: Area of mangrove habitat composition within the DMMA B - North discharge channel corridor disturbance footprint.

Mangrove habitat composition	Coverage (ha)
Avicennia marina tree (density ≥ 50%)	0.022
Rhizophora stylosa tree (density ≥ 50%)	0.019
Bare substrate	0.069

Table 7: Area of mangrove habitat density within the DMMA B - North discharge channel corridor disturbance footprint.

Mangrove habitat density	Coverage (ha)
Vegetation density ≥ 50%	0.041
Vegetation density < 50%	0.000
Bare substrate	0.069

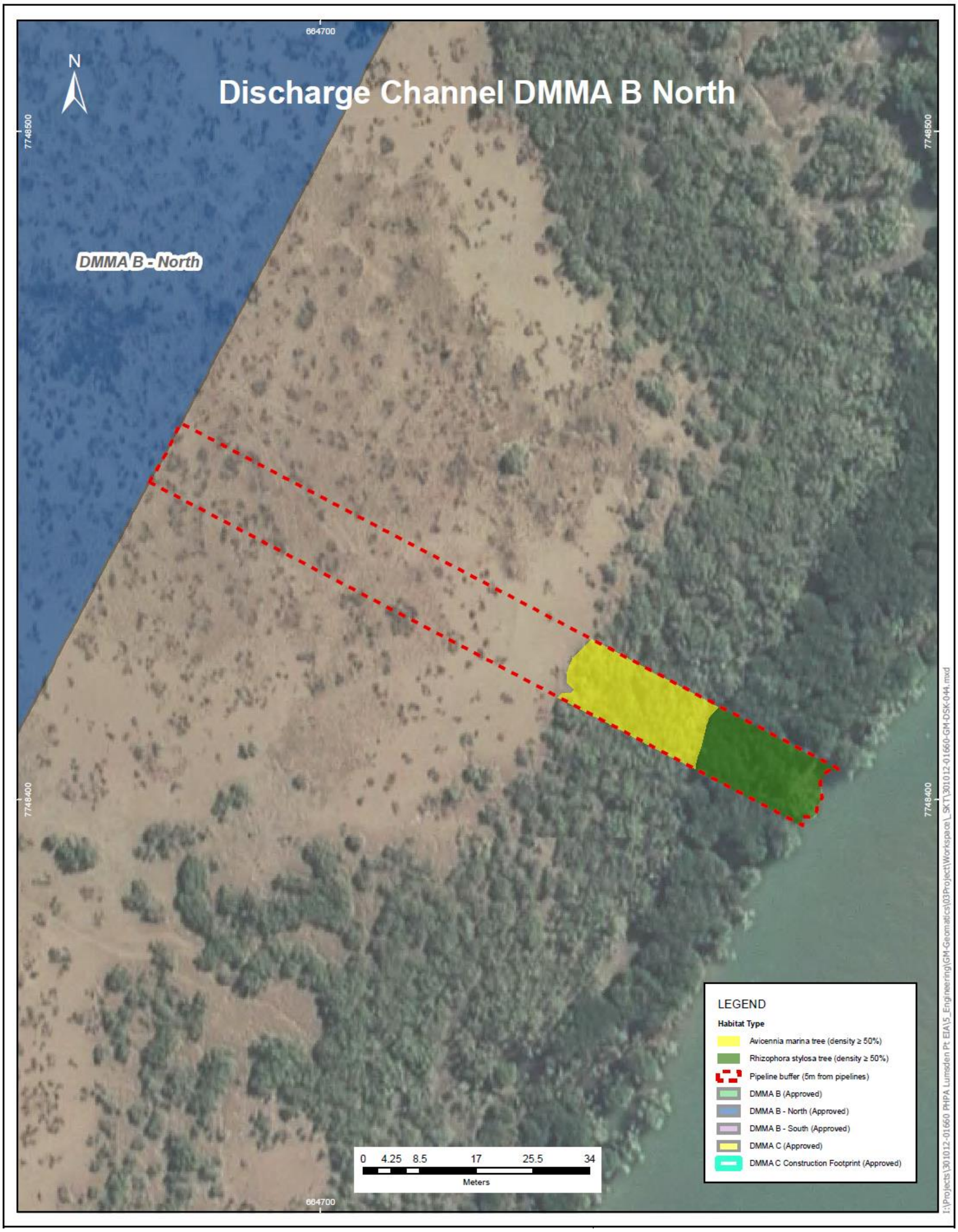

Figure 8: Composition and extent of mangrove habitat in the DMMA B - North discharge channel corridor.

3.3.1 Temporary pipeline corridor north

Of the 0.46 ha within the temporary pipeline corridor north disturbance footprint, over half (0.27 ha) was classified as intertidal bare substrate. Of the vegetated areas, *A. marina* (0.068 ha) and *R. stylosa* (0.123 ha) vegetation complexes were present. The two vegetated habitat complexes were composed of trees with densities greater than 50%.

Distribution of mangrove habitat composition is shown in Figure 9. Area of each habitat class is given in Table 8 and area of habitat density is given in Table 9.

Table 8: Area of mangrove habitat composition within the temporary pipeline corridor north disturbance footprint.

Mangrove habitat composition	Coverage (ha)
Avicennia marina tree (density ≥ 50%)	0.068
Rhizophora stylosa tree (density ≥ 50%)	0.123
Bare substrate	0.27

Table 9: Area of mangrove habitat density within the temporary pipeline corridor north disturbance footprint.

Mangrove habitat density	Coverage (ha)
Vegetation density ≥ 50%	0.191
Vegetation density < 50%	0
Bare substrate	0.27

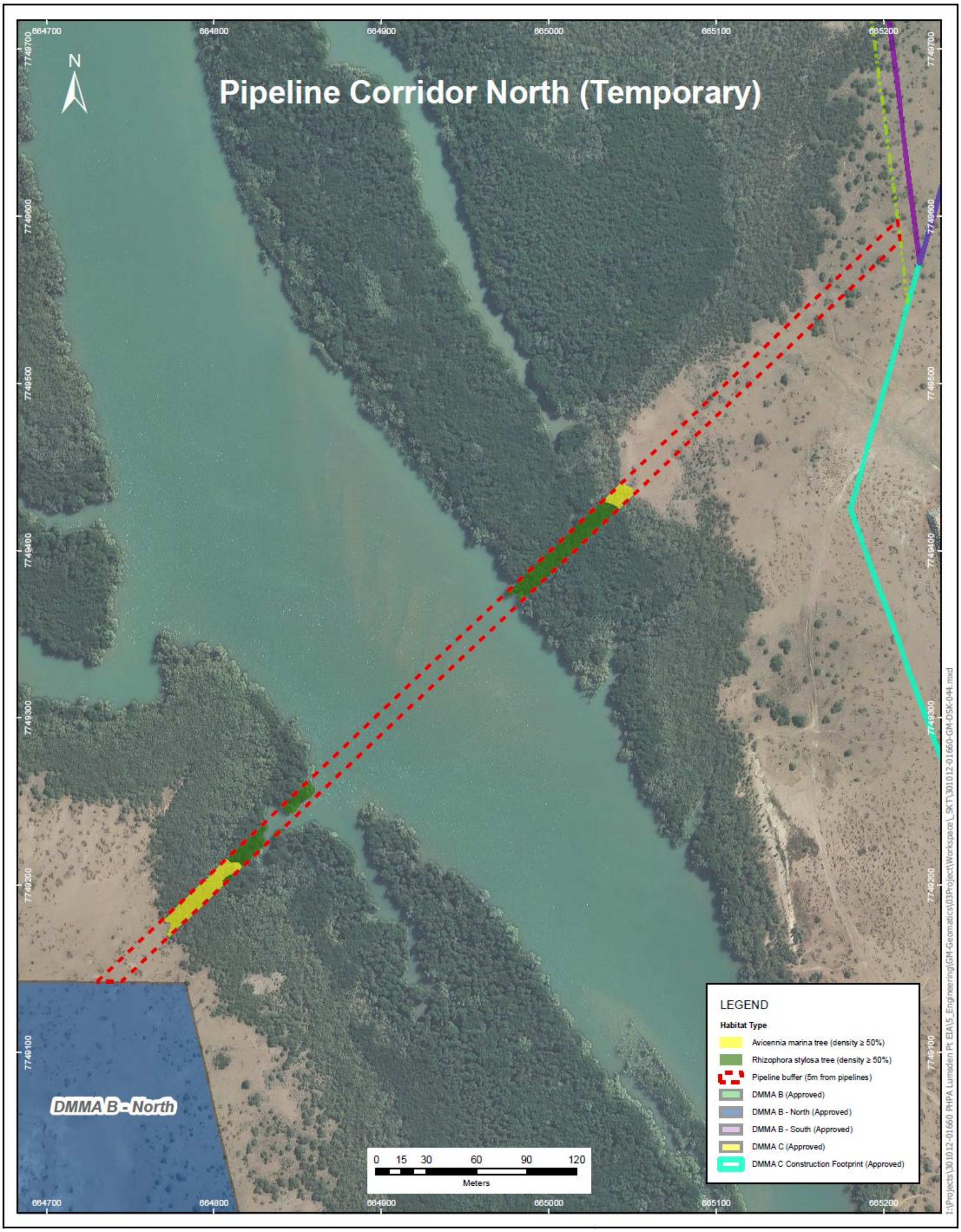

Figure 9: Composition and extent of mangrove habitat in the temporary DMMA B - North pipeline corridor.

3.3.1 Temporary pipeline corridor south

Of the 0.76 ha within the temporary pipeline corridor south disturbance footprint, 0.327 ha was classified as intertidal bare substrate. No mangroves were present in the footprint (Figure 10).

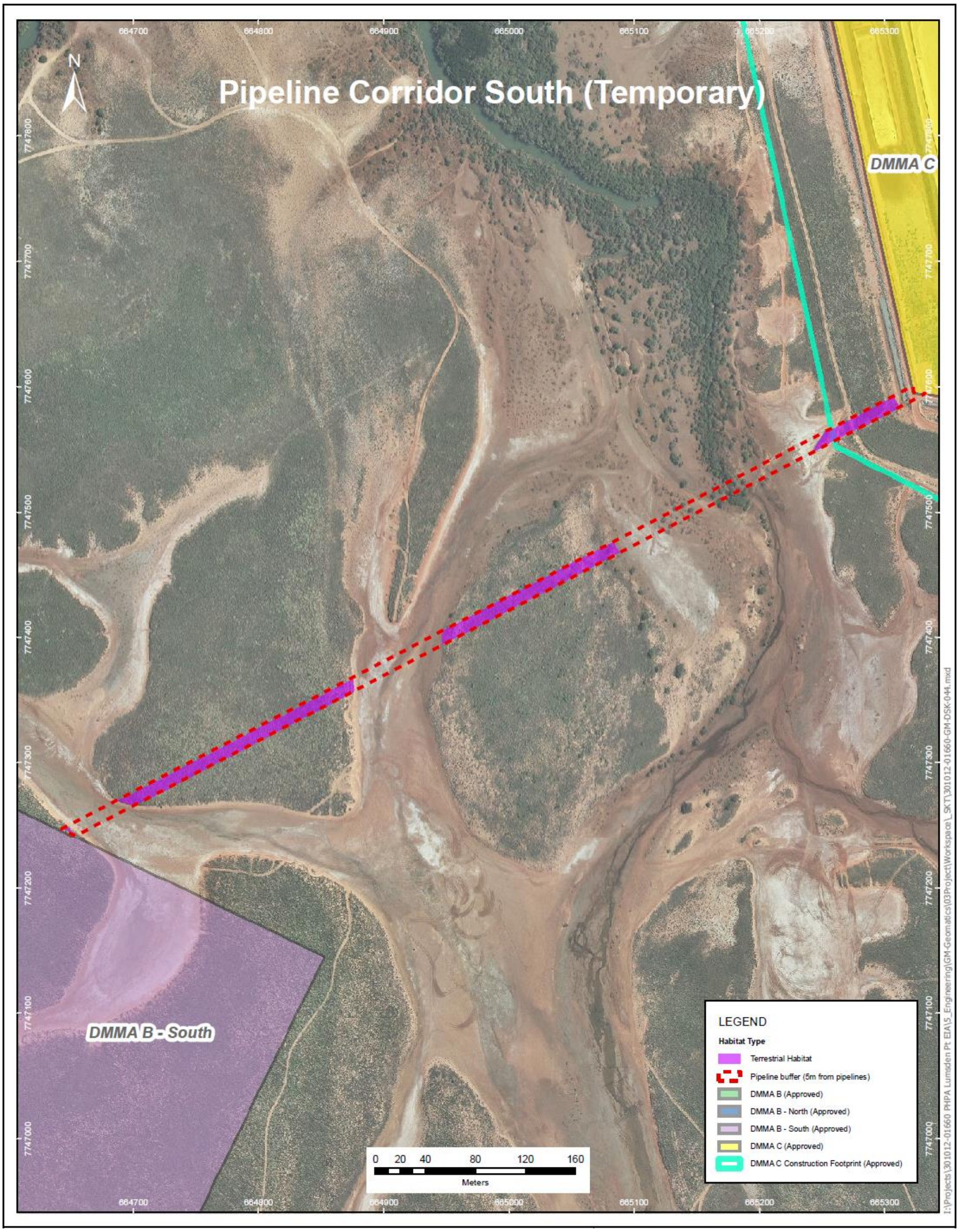

Figure 10: Extent of Habitats along the Temporary - South pipeline corridor.

4. DISCUSSION

The subtidal and non-mangrove intertidal benthic communities within the study area consisted of a mosaic of turfing algae and macroalgae, interspersed by large areas of bare substrate. These habitats are considered typical of those found at the mouths of the creek systems surrounding the inner port area, where bare substrate and turfing algae are generally the most dominant habitat types (WorleyParsons 2010; WorleyParsons 2011; WorleyParsons 2012). Turfing algae appeared to be more prevalent in the deeper subtidal areas, which are subject to less influence from tidal drying than the shallow banks at the mouths of creeks. These turfing algae communities are generally not diverse and are dominated by species that are fast growing and tolerant of the dynamic physical conditions within the harbour (WorleyParsons 2011). Such species are likely to rapidly recolonise suitable areas within the harbour following disturbance (WorleyParsons 2011). Furthermore, significant seasonal change in canopy algae coverage is known to occur in the Port Hedland harbour, with large algal blooms occurring in association with the wet season (WorleyParsons 2010).

Bare substrate is the most common benthic habitat in the entire disturbance footprint, consisting of unconsolidated muddy sands and gravels with widespread shell fragments. Bare sediment areas are characterised by various types of morphology, ranging from flat terrain and hummocky intertidal areas to areas of current-induced sand waves. In particular, the presence of sand wave areas suggests the substrate may be mobile, and that these areas are unsuitable for permanent macro-BPP colonisation (WorleyParsons 2010). Given the extent of subtidal muddy and sandy habitat within the Project area, and the relatively shallow bathymetry of the inner harbour, it is likely that the flatter bare sediments subject to less current stress would support microphytobenthos (MPB) communities. MPB generally consist of diatoms, dinoflagellates, cyanobacteria and other microscopic primary producers that colonise soft sediments. Although these sediments appear unvegetated, MPB is a known source of organic carbon production. MPB are also known to be an important source of organic carbon which contribute to the stability and health of Australian tropical estuarine systems (see Douglas (2005) for review).

MPB are ubiquitous and are likely to be present in all benthic habitats where sufficient light is present on the seabed. As such, aspects of the project most likely to affect MPB are dredging and reclamation which may result in temporary reduction of light to the seabed and increased sedimentation. As Port Hedland is subject to regular shipping movements and maintenance dredging, MPB communities that may be present are already subject to elevated levels of turbidity and sedimentation. MPB will be largely unaffected by the disturbance footprint as studies have shown that MPB communities have naturally high turnover rate (up to 50 times a year) (Harris *et al*. 1996) and are quite dynamic and capable of recovery after disturbance (Beardall and Light 1997). While no specific data was captured on the distribution of MPB in the Port Hedland harbour and more specifically the Lumsden Point disturbance footprint, the presence of MPB has been considered indirectly through the inclusion of bare substrate as a potential BPPH.

The mangrove community structure found within the disturbance footprint is comprised of three commonly occurring species of mangroves within the Port Hedland locality (seven species are present in the Pilbara region). The dominant species across the disturbance footprint was *Avicennia marina*, which was found in all vegetated areas. Tree density data showed that most of the 13.88 ha of the mangroves is dense, thickly grown vegetation. This trend coincides with vegetation complexes closer to the waterline showing greater density than those further away. There were no unusual or unique habitat complexes found, with all supratidal mangrove habitats within the disturbance footprint and fringing area considered typical of those found in the surrounding creek systems of Port Hedland.

The total maximum area of each BPPH type that stands to be lost from completion of the PHPA General Cargo Facility at Lumsden Point is summarised in Table 10. The majority of the dredge and land backed wharf disturbance footprint has previously been dredged or already approved for disturbance (Figure 5) and while these areas have been classified for mapping purposes they should be considered to contain no BPPH and thus has been excluded from the BPPH calculations The total maximum loss of BPPH is expected to be no greater than 22.22 ha, however 8.34 ha of this area comprises bare substrate. Of the colonised BPPH, mangroves (including pneumatophores) represent 13.88 ha of the entire disturbance footprint.

None of the 22.22 ha of BPPH is considered unique or rare within the Port Hedland locality and all types of BPP are well represented in neighbouring and adjacent areas within the Port Hedland LAU.

Table 10: Maximum BPPH loss from the Lumsden Point Project footprints.

Habitat Type	Footprint (ha)					
	Wharf area	Access corridor	North pipeline corridor	South pipeline corridor	DMMA B-North discharge channel	Total
Mangroves	8.86	4.79	0.19	0	0.04	**13.88**
Bare Substrate	5.85	1.82	0.27	0.33	0.07	**8.34**
Total BPPH	**14.71**	**6.61**	**0.46**	**0.33**	**0.11**	**22.22**

5. CONCLUSION

This primary objective of the study was to acquire baseline data on the distribution of benthic habitats within the proposed disturbance footprint, and to compile existing information to create a detailed habitat map of the benthic environment.

From the data collected, bare sediments were found to be the most dominant BPPH, with mangrove habitat representing the next most common habitat type. A total of 22.22 ha of BPPH is expected to be directly removed by the project. No unusual, unique or highly significant habitat complexes were identified within the dredge and construction footprint.

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