THUNDERBIRD MINERAL SANDS PROJECT

PRELIMINARY PORT ENVIRONMENTAL MANAGEMENT PLAN

PREPARED FOR:

SHEFFIELD RESOURCES LTD

SheffieldResources
LIMITED

JANUARY 2017

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THUNDERBIRD MINERAL SANDS PROJECT

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EXECUTIVE SUMMARY

This Preliminary Port Environmental Management Plan (Port EMP) is submitted in accordance with the Public Environmental Review (PER) document for the Thunderbird Mineral Sands Project which will be developed by Sheffield Resources Limited (Sheffield). This Port EMP is designed to be adaptive and will be updated over the life of the project (40+ years) as further information about environmental factors in the project area and surrounding marine areas, and effectiveness of implemented management measures, is obtained.

Prior to commencement of mining Sheffield will update this plan in consultation with the OEPA. As such this plan remains a working document.

Table 1 presents the purpose of this Port EMP in the context of relevant EPA objectives. Table 2 presents the environmental criteria to measure achievement of environmental objectives through implementation of this Port EMP.

Table 1: Purpose and Objective of this Port EMP

Title of Proposal	Thunderbird Mineral Sands Project
Proponent	Sheffield Resources Limited
Purpose of this Condition EMP	The purpose of this Port Management Plan is to provide a framework to ensure that impacts on Derby Port attributable to the Thunderbird Mineral Sands Project are minimised and impacts do not conflict with the EPA objectives for amenity, marine environmental quality and marine fauna.
EPA's environmental objective for key environmental factors	
Amenity	*To ensure that impacts to amenity are reduced as low as reasonably practicable.*
Marine Environmental Quality	*To maintain the quality of water, sediment and biota so that the environmental values, both ecological and social, are protected.*
Marine Fauna	*To maintain the diversity, geographic distribution and viability of fauna at the species and population levels.*

Table 2: Management Objectives and Targets

Project Management Objectives	Management Targets
Amenity	
Minimise loss of amenity to sensitive receptors in the town of Derby as a result of dust.	No public complaints relating to dust impacts at sensitive locations in Derby town.
Minimise loss of amenity to sensitive receptors as a result of environmental noise generated at the Derby Port Development Envelope.	No exceedance of environmental noise levels at residences in Derby town as stipulated in *Environmental Protection (Noise) Regulations 1997.*
Minimise loss of amenity to sensitive receptors as a result of traffic noise generated by road trains travelling through the town of Derby.	No exceedance of traffic noise limits at sensitive receptors in Loch Street (using Western Australian Planning Commission State Planning Policy 5.4 "*Road and Rail Transport Noise and Freight Considerations in Land Use Planning, 2009*").

Project Management Objectives	Management Targets
Marine Environmental Quality	
Minimise impacts through turbidity generated by installation of moorings	Moorings are only installed in places that have been used previously by other projects.
Minimise dust or spillage of product escaping to the marine environment.	No significant incidents of dust or spillage entering the marine environment requiring remediation.
Minimise chance of hydrocarbon spill during vessel refuelling.	No significant spill of hydrocarbons entering the marine environment requiring remediation.
No net change to marine environment through radiation impacts.	No spills of significantly radioactive product to marine environment requiring remediation.
Marine Fauna	
Minimise disorientation of migratory birds caused by installation of additional lighting at the Derby Port Development Envelope.	Additional lighting to be installed to the minimum level required for safe operations on a 24 hour basis.
Minimise disorientation of migratory birds and sea turtles caused by lighting on vessels.	Lighting installed to the minimum level required for safe operations and navigation on a 24 hour basis.
Minimise impacts to marine fauna as a result of vessel strike.	No deaths of animals of conservation significant species as a result of vessel strike.
Minimise impacts to marine fauna as a result of entanglement or ingestion of solid waste or marine debris.	No deaths of animals of conservation significant species as a result of project-related solid waste or marine debris.

Corporate Endorsement

I hereby certify that to the best of my knowledge, the Condition EMP provisions within this Preliminary Port Environmental Management Plan are true and correct and address the amenity, marine environmental quality and marine fauna environmental factors identified in the Scoping Document for the Thunderbird Mineral Sands Project.

Name: _____ Signed: _____

Designation: _____ Date: _____

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1. CONTEXT, SCOPE AND RATIONALE

1.1 PROPOSAL

The Thunderbird Mineral Sands Project (the project) is a greenfield project and will comprise:

- Mining of heavy mineral sands over a 40 plus year period from the Thunderbird deposit. The initial rate of mining will allow excavation of a nominal 7.5 million tonnes per annum (Mtpa) of ore for the first four to five years, before increasing to a nominal 15 Mtpa of ore for the remainder of the project life.
- Onsite primary and secondary processing of ore to produce a range of saleable mineral sands products (ilmenite, primary zircon, zircon concentrate, titano-magnetite and HiTi88 Leucoxene). Construction of processing facilities will be staged with production doubled to 15 Mtpa after approximately year five.
- Abstraction and reinjection of groundwater from the Broome Sandstone Aquifer to allow mining and supply ore processing needs.
- Development of infrastructure to support the project including power generation facilities, accommodation village, administration and maintenance buildings, internal roads, communications infrastructure, and waste storage and disposal facilities.
- Upgrade and extension of the existing pastoral road (Mt Jowlaenga Road) from the Great Northern Highway to form a 30 km Site Access Road.
- Transport of mineral sands products from the Mine Site via the Site Access Road and Great Northern Highway to Derby or Broome Ports for storage prior to export.
- Export of bulk mineral sands products from Derby Port via King Sound and packaged mineral product from Port of Broome to international customers.

Construction of the project is scheduled to commence in Quarter 3 2017, with mining and production scheduled to commence in early 2019. The project is proposed to be fully operational in early 2019 with the first export of product anticipated by end of 2019.

1.2 LOCATION

The project is located on the Dampier Peninsula within the west Kimberley region of Western Australia (Figure 1). The project comprises two geographically separate locations, namely the Mine Site Development Envelope (including the Site Access Road) and the Derby Port Development Envelope (Figure 2). Derby Port is an operational port and has been previously used for export of mineral products. Historic mineral exports from the port ceased in 2008. The port is currently used by several aquaculture, pearling, fishing and tourism operators.

The Mine Site Development Envelope is located approximately 75 km west southwest of Derby and 95 km northeast of Broome. It is accessed from the Great Northern Highway via a proposed 30 km long Site Access Road.

This Preliminary Port Environmental Management Plan (Port EMP) applies to the Derby Port Development Envelope and impacts that may occur in the marine environment as a result of transhipment and shipping activities.

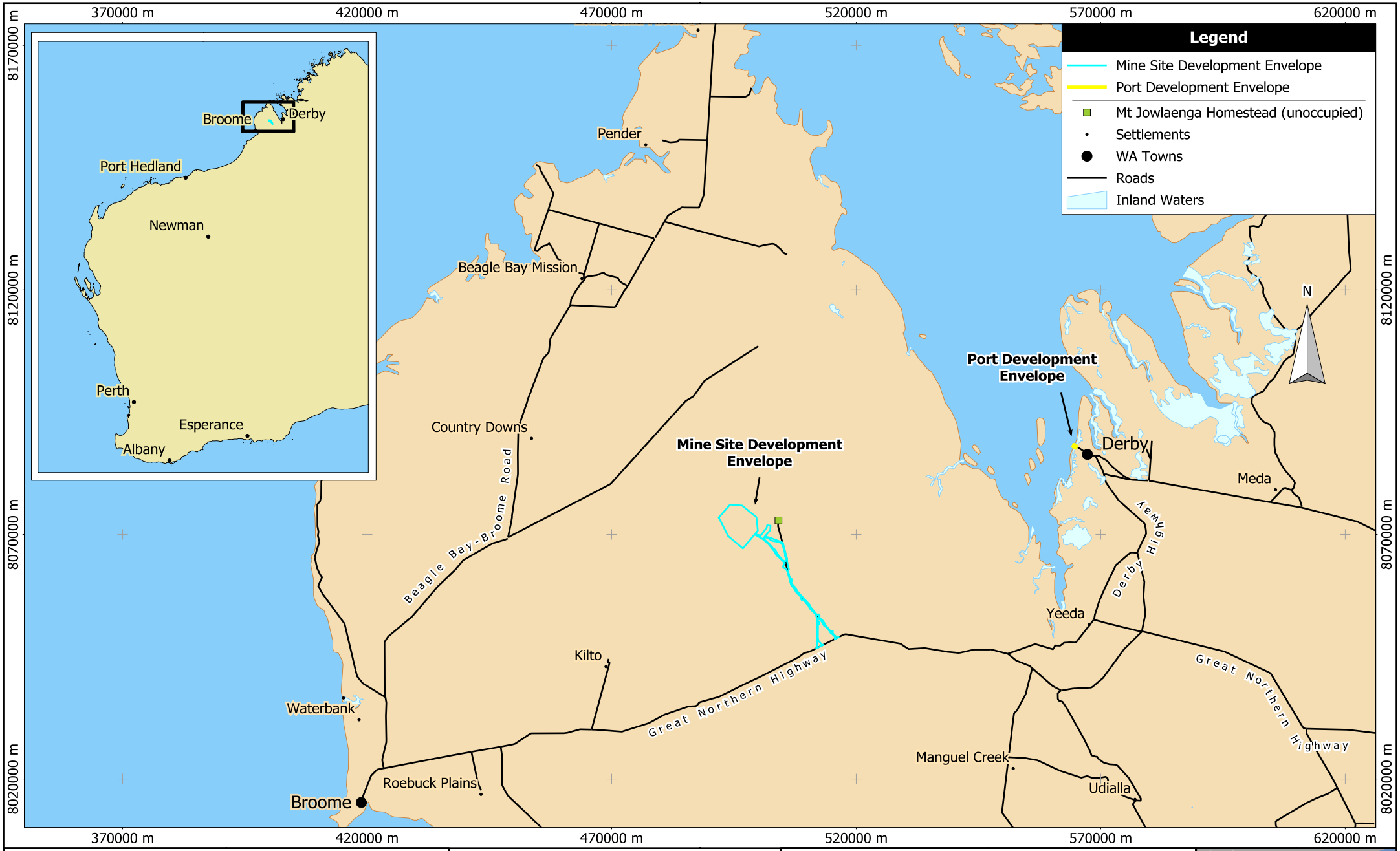
Outside of the Derby Port Development Envelope, there are three vessel zones as used previously by Lennard Shelf Pty Ltd that will be utilised by the project.

The three vessel zones (Figure 3) comprise:

- **Pilot Boarding Point:** In order to navigate the islands, headlands and shoals of King Sound, the ocean going vessel will be boarded by a pilot. The pilot will navigate the ocean going vessel to the sea transfer point within the port limits.
- **Sea Transfer Point:** The sea transfer point is where the ocean going vessel will be moored to be loaded from the transhipment vessel. It is located in King Sound in around 20 metres of water (at low tide), 17.3 nautical miles (nm) from Point Torment and within the Port of Derby limits.
- **Wharf Mooring Zone:** The wharf mooring zone will be where the transhipment vessels and tug boats are accommodated on fixed moorings when not in use or while waiting to approach the wharf at a higher tide. The existing mooring zone is ~6 nm north west of Derby wharf.

With respect to the factor of amenity, this Port EMP takes into account the Derby Port Development Envelope and sensitive receptors within the Derby township.

For the factors of marine environmental quality and marine fauna, the Port EMP provides management measures for potential impacts that may occur within the Derby Port Development Envelope, in the three vessel zones and the vessel transport routes between these zones.



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0 40 km

Sheffield Resources Limited
Thunderbird Mineral Sands Project

Figure 1

Project Location

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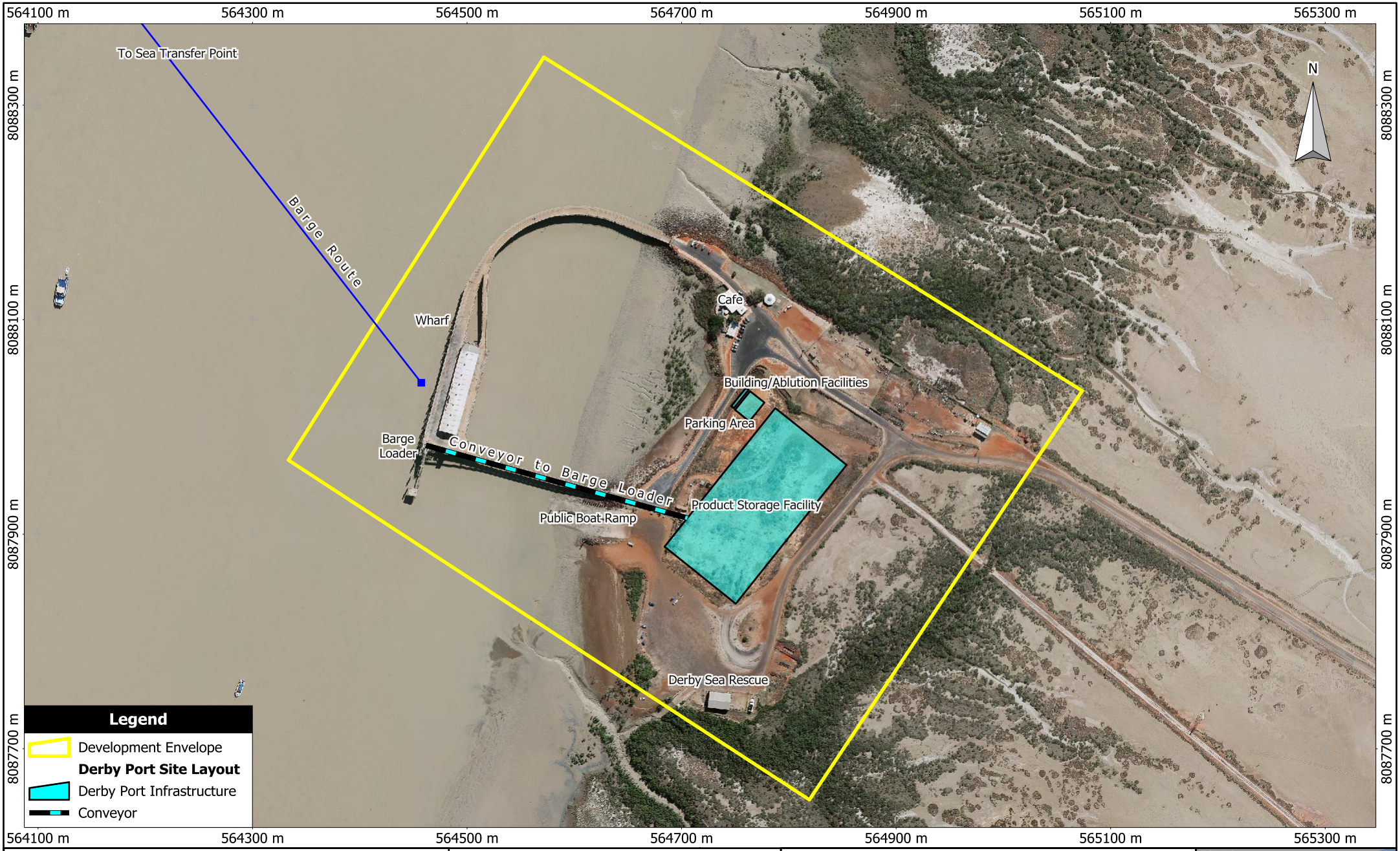

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0 100 m

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Figure 2

Derby Port Development Envelope

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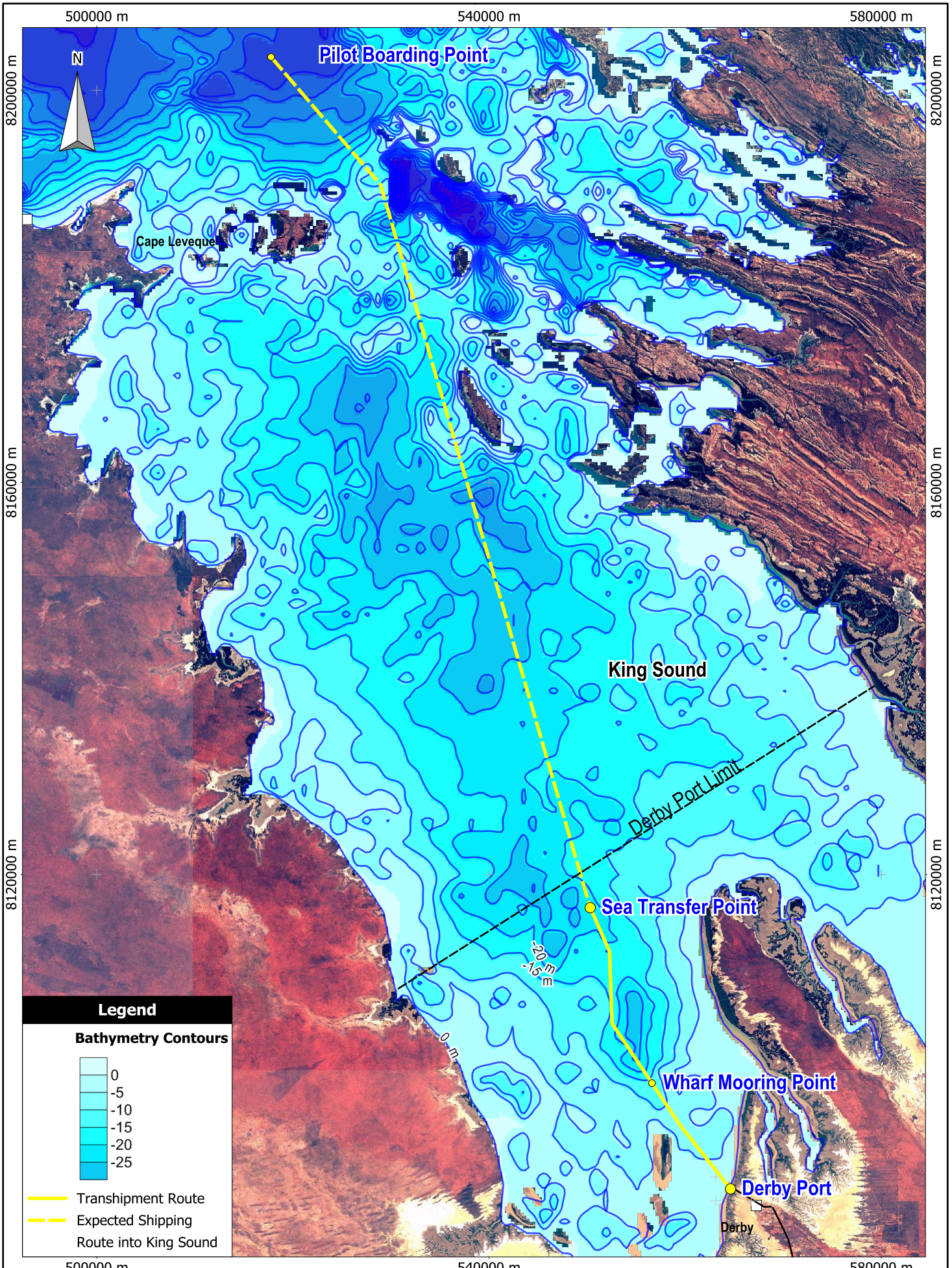
W:\Sheffield Resources\PER\Drawings\PER Derby Port.map 11/11/2016 F15 Derby Port Development Envelope A4L



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Satellite Image:2016 Copernicus Sentinel Data
Grid: MGA94(51)

0 10 km

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Figure 3

Derby Port Mooring and Anchor Points

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1.3 KEY ENVIRONMENTAL FACTORS AND POTENTIAL IMPACTS

Within this Port EMP there are two key environmental factors to be addressed. They are:

- Amenity.
- Marine Environmental Quality.

During preparation of the Environmental Scoping Document, the Department of Environment and Energy (DoEE) raised particular concern regarding several marine fauna species of conservation significance. The species of concern to DoEE were:

- Humpback Whale (*Megaptera novaeangliae*) – listed as Vulnerable under the *EPBC Act*.
- Dwarf Sawfish (*Pristis clavata*) – listed as Vulnerable under the *EPBC Act.*
- *Green Sawfish (Pristis zijsron) – listed as Vulnerable under the EPBC Act*.
- Largetooth Sawfish (*Pristis pristis*) – listed as Vulnerable under the *EPBC Act*.
- Northern River Shark (*Glyphis garricki*) – listed as Endangered under the *EPBC Act*.

These species were not listed as part of the *EPBC Act* 'Controlled Action' decision. However, since the species were of concern to DoEE, in addition to the key environmental factors listed above, this preliminary Port EMP will also address the "Other Environmental Factor" of Marine Fauna.

These factors are addressed in the following sections below.

1.3.1 Potential Impacts to Amenity

The following aspects of this proposal have the potential to affect amenity within the Derby Port Development Envelope and sensitive receptors in the town of Derby:

- **Dust emissions causing a decrease in amenity for sensitive receptors** - Airborne dust loadings from product transport and loading/unloading operations at the Derby Port. Airborne particles can cause amenity impacts by settling on surfaces (such as washing hung out to dry, cars, roofs) causing soiling and discolouration.
- **Noise emissions causing a decrease in amenity for sensitive receptors** - Decreased amenity for sensitive receptors due to environmental noise through operations in the Derby Port Development Envelope and for sensitive receptors in the town of Derby due to traffic noise caused by road trains.

1.3.2 Potential Impacts to Marine Environmental Quality

The following aspects of this proposal have the potential to affect Marine Environmental Quality within the Derby Port Development Envelope, the vessel zones and vessel transport routes:

- **Installation of mooring points increasing turbidity** - Installation of mooring points within the Derby Port limits at the wharf mooring zone and the sea transfer point. This could cause an increase in turbidity during construction through disturbance of the sea floor. Some minor localised turbidity will also be generated during operations by mooring lines dragging on the seafloor in lower tides.
- **Product dust or spillage causing marine pollution** - Dust or spillage of product from transfer and transhipment causing marine water and sediment pollution.
- **Hydrocarbon spill causing marine water and sediment pollution** - Impact through spillage of hydrocarbons. This may be caused through refuelling of tugs, or if used, motorised transhipment vessels.
- **Radiation impacting the marine environment** – Impact through spillage or dust of products containing radioactive components entering the marine environment.

1.3.3 Potential Impacts to Marine Fauna

The following aspects of this proposal have the potential to affect Marine Fauna within the Derby Port Development Envelope, the vessel zones and vessel transport routes:

- **Noise from construction and operational activities in Derby Port Development Envelope impacting birds or terrestrial fauna** – Noise from construction/upgrade of export facilities and operation of export facilities causes disturbance to birds or terrestrial fauna.
- **Light from construction and operational activities at Derby Port Development Envelope impacting birds or terrestrial fauna** – Light from construction/upgrade of export facilities and operation of export facilities causes disorientation to birds or terrestrial fauna.
- **Additional shipping and transhipment impacting marine fauna** – these could be direct or indirect through:
  - Vessel strike.
  - Noise.
  - Light.
  - Hydrocarbon spill.
  - Solid waste/marine debris.

1.4 REQUIREMENTS OF THE CONDITION

Specifically, this Port EMP is submitted with the PER to satisfy the EPA that Sheffield has taken into consideration the environmental objectives set for amenity, marine environmental quality and marine fauna. The Port EMP will demonstrate that Sheffield is committed to undertaking a project that meets these objectives. This will occur through the application of management and monitoring measures as detailed in this EMP.

1.5 RATIONALE AND APPROACH IN MEETING THE ENVIRONMENTAL OBJECTIVE

Results of baseline surveys, literature reviews and a number of assumptions and uncertainties are used in developing the management approach for meeting the environmental objectives stated in Section 2.1. The identified management actions, management targets and proposed review and revision of management actions are aligned with the overall management approach.

1.5.1 Amenity Baseline Information

Product will be transported from the Mine Site to Derby Port using a fleet of five quad road trains. Up to 10 return truck journeys (20 truck movements) per day will occur between the Mine Site and Derby Port, operating 24 hours per day 7 days per week. Approximately 6 km of the transport route is located in residential/commercial areas within Derby, with the remaining 144 km located in unpopulated areas.

The Great Northern Highway forms the longest portion of the transport route to Derby Port (75 km). It is also the main road link between Perth and the Kimberley Region and is the only sealed road connecting Perth with the Northern Territory. As a result, it is used extensively by heavy vehicles.

Loch Street is a continuation of the Derby Highway and is zoned as a 'major highway' according to Derby Town Planning Scheme 5 (SDWK 2003). Derby Highway transitions into Loch Street in the Derby town centre as it passes through residential and commercial areas. Loch Street transitions into Jetty Road to the north west of Derby township, at the intersection with Elder Street. The proposed transport route is shown in Figure 3.

1.5.1.1 Vehicle Movements

Existing heavy vehicle movements within the Town of Derby, along Derby Highway and Loch Street, account for between 10% and 18% of all vehicle movements in Derby (MRWA 2015). Approximately 2,220 vehicle movements per day, of which 421 were heavy vehicle movements, occurred along Loch Street east of Ashley Street in 2013/2014.

Current and historic daily vehicle movements around Derby and the percentage of these that are heavy vehicle movements are shown in Table 3.

Table 3: Current and Historic Daily Vehicle Movements Around Derby

Road	Location	Total Vehicle Movements / Heavy Vehicle (HV) Movements / % HV				
		2009/10	2010/11	2011/12	2012/13	2013/14
Derby Highway	North of Great Northern Highway	440 / 73 (16.6%)	400 / 55 (13.7%)	560 / 92 (16.5%)	-	580 / 82 (14.1%)
	South of Russ Street	1,640 / 179 (10.9%)	1,980 / 182 (9.2%)	2,330 / 284 (12.2%)	3,000 / 330 (11.0%)	-
	North of Russ Street	-	-	-	-	2,220 / 240 (10.8%)
Loch Street	East of Ashley Street	4,350 / 409 (9.4%)	3,970 / 409 (10.3%)	-	5,350 / 942 (17.6%)	4,050 / 421 (10.4%)

Source: MRWA 2015, '-' No data available. 2014/2015 data not available.

Historically, the Great Northern Highway, Derby Highway, Loch Street, and Jetty Road have been used to transport lead and zinc metal concentrates from the Lennard Shelf Operations, located east of Fitzroy Crossing, to Derby Port. While the Lennard Shelf Lead and Zinc Operations were operational (1997 - 2008), up to 500,000 tonnes per annum of lead and zinc concentrates were transported along the transport route from east of Fitzroy Crossing to Derby Port (MBS 2009).

1.5.1.2 Dust

As there are no significant emissions sources within the Derby region, air quality is expected to be good. Existing dust emissions are typically attributed to dust generation from unsealed roads, deposited dust on sealed roads that is remobilised by traffic and occasionally by smoke from bushfires (Atmospheric Solutions 2016).

The Derby Port and conveyor system have been unused for export activities since 2008 and no other industrial activities exist in the region. As such, background and cumulative emissions are expected to be negligible (Atmospheric Solutions 2016). However, conservative background concentrations of the average ambient dust concentrations found in northwest Western Australia have been used during project design to ensure the worst-case scenario is considered. These are 40 µg/m^3 for total suspended particulates, 20 µg/m^3 for particulate matter 10 microns and below, and 7 µg/m^3 for particulate matter 2.5 microns and below averaged over 24 hours. These concentrations are based on a number of studies on ambient monitoring of the Kimberley and Pilbara areas, which both experience a higher level of activity than Derby and as such are seen to be a conservative choice in lieu of local data (Atmospheric Solutions 2016).

1.5.1.3 Noise

A noise assessment was undertaken for the Derby Port Development Envelope and surrounds (WSP Parsons Brinckerhoff 2016b), in which continuous unattended noise monitoring was conducted simultaneously for seven days between 24 and 31 May 2016 at the Main Roads Western Australia offices on Woodhouse Street and the Derby Shire Offices on Loch Street to understand the existing background noise environment. The noise loggers were used to continuously measure ambient noise, which included all noise sources present at the time (Table 4).

Additionally, operator attended monitoring was undertaken at the Jetty Cafe, Fishing Club, Derby Shire Office and Spinifex Hotel in order to understand the composition of the current noise environment and to supplement the unattended noise monitoring data, results of which are presented in (Table 5). All noise measurements were obtained over a sufficient duration to provide a representation of the typical noise emissions.

Table 4: Derby Background Unattended Noise Monitoring Results

Location	Period	L_{A90} (dB)	L_{A10} (dB)	L_{A1} (dB)
Main Roads Office	Night	28	43	50
	Day	41	54	59
	Evening	40	47	55
Shire Office	Night	31	41	51
	Day	38	56	64
	Evening	38	47	59

Table 5: Derby Background Attended Noise Monitoring Results

Location	Time	L_{A90} (dB)	L_{A10} (dB)	L_{Amax} (dB)	Comments
Jetty Cafe	3:05 PM	38	53	72	Cars visiting café and jetty Bird noise
	7:25 PM	34	45	57	Cars visiting café and jetty
Spinifex Hotel	3:35 PM	34	47	72	Occasional bird and traffic
Shire Offices	4:30 PM	43	60	69	Traffic Loch Street Bird noise Plant noise shire offices
	7:50 PM	37	43	65	Traffic Loch Street
Fishing Club	8:05 PM	37	40	69	Insect noise dominant Domestic condenser unit Traffic
	10:00 PM	40	42	45	Insect noise dominant Domestic condenser unit One vehicle pass by

1.5.1.4 Visual Amenity

The wharf is a popular place for fishing and dining at the Jetty Cafe. With respect to visual amenity at the Derby Port, there are several buildings of single storey currently existing. The site is zoned for industry and includes the wharf, conveyor and existing buildings on the wharf.

1.5.2 Marine Environmental Quality - Baseline Information

Derby is located at the head of King Sound, which is a large embayment (approximately 130 km long and 40 km wide). The Buccaneer Archipelago lies between the opening of King Sound and the open ocean. The Fitzroy River, one of Australia's largest river systems, flows into King Sound and affects the water quality, notably by significantly increasing turbidity levels.

In the dry season, the water of King Sound is vertically well mixed in both temperature and salinity. High evaporation levels cause the maximum salinity to occur in the upper reaches of the Sound (Wolanski and Spagnol

2003). King Sound is a highly dynamic environment and has one of the world's largest tidal ranges of almost 12 m. Tides are semi-diurnal with a full tidal cycle of approximately 12.5 hours.

The factor of Marine Environmental Quality concerns sediment, water and biota. Baseline information and assumptions for each of these are discussed below.

1.5.2.1 Sediments of the Derby Port Development Envelope

Terrestrial sediments in the Derby Port Development Envelope are relevant to Marine Environmental Quality because of the potential for terrestrial contaminants to leach into the marine environment. The Derby Port Development Envelope has a history of contaminated sites due to the former storage and export of lead and zinc concentrates from the Lenard Shelf Lead and Zinc Operations. Following remediation works, validation sampling and reporting was undertaken at the site in 2012. While some residual lead and zinc concentrations exceeded the respective EILs but remained within discrete locations across the site, the risk to the surrounding environment was assessed as low. The site was deemed to be remediated to a level appropriate for its intended land use (industrial/commercial), with minimal risk to the surrounding environment as a result of residual soil contamination (MBS 2012). Due to the absence of any groundwater data beneath the site, the site remains classified as 'Possibly Contaminated – Investigation Required'.

Given the history of the Port area, a detailed inspection was undertaken by senior geochemists during June 2016 including a site visit to collect representative samples of soils, basement clays, and marine sediment. These samples were analysed for potential contaminants of concern and potential presence of acid sulfate soils (ASS). A summary of the findings are reported below.

Terrestrial Sediments

Residual low level zinc concentrations remain in some of the imported Pindan soils across the Port area, however these levels are significantly below industrial health investigation levels (HILs). The maximum concentration of zinc (360 mg/kg^{-1}) was equal to the site specific calculated National Environmental Protection Measure (NEPM) added contaminant level for this sandy soil type and would be at or below the EIL for the site depending on background concentrations (NEPC 2013). This is consistent with the previous site history and validation report (MBS 2012).

Concentrations of lead were correlated with zinc and were consistent with previous site use of exporting lead/zinc sulfide mineral concentrates, however no samples were found to exceed the industrial EILs or HILs for lead.

Examination of subsoil basement clays in accessible parts of the Port area indicated a slight presence of sulfidic material in an otherwise alkaline clay matrix, which was insufficient for classification as ASS materials.

Overall the assessment of all samples taken in and adjacent to the proposed Derby facility for analysis of metals and metalloids indicated concentrations considered either representative of the region or reflective of a Port facility with prior history of (in particular) lead and zinc exports. Further assessment of the soils and sediments within the lease area which may be disturbed in minor volumes by construction of a product storage facility indicated no significant risk of ASS.

Marine Sediments

Results indicate some elevation of zinc and lead above background levels adjacent to culverts that drain from the port area. These elevated concentrations were attributed to previous site history and road run off. The zinc concentration is above the lower interim sediment quality guideline (ISQG-Low) of 200 mg/kg, but below the calculated NEPM added contaminant level of 1,200 mg/kg (based on an assigned land use of recreational/public open space) (NEPC 2013).

All samples of clay/silt sediment including inshore marine, mudflats, and basement clays were in the range of 22 to 31 mg/kg for nickel, which marginally exceeds the ISQG-Low of 21 mg/kg. This strongly suggests a natural

enrichment of nickel in the estuarine silt/clay resulting from erosion of the nickel rich geology within the Kimberley hinterland.

Copper concentrations in two marine sediment samples DMS1 (90 mg/kg) and DMS2 (66 mg/kg) were above the ISQG-Low of 65 mg/kg, and significantly higher than other clay/silt based samples (23 to 35 mg/kg). Both these locations are used for boat launching and marginally elevated copper levels may be the result of copper anti-fouling paint from boat hulls.

No ISQG exceedances for arsenic, cadmium, chromium, silver or mercury were recorded. Selenium concentrations were all below the level of reporting. Uranium concentrations in silt/clay dominant sediment samples were consistently between 2.4 to 5.2 mg/kg, which similar to the average crustal abundance (2.7 mg/kg). Samples of sandier substrate at DS1 and DMS7 had lower concentrations (0.81 and 0.75 mg/kg respectively).

No significant disturbance of marine sediment and hence opportunity for oxidation and metals/metalloids release is expected as the wharf is already constructed.

1.5.2.2 Marine Water Quality

As part of the Derby Storage Facility Baseline Contamination Assessment (MBS 2016), marine water samples were collected near the boat ramp at the site known as DER BR1. Water samples were analysed for dissolved metals and general parameters such as pH, electrical conductivity, and total dissolved solids.

Estuarine tidal water sampled at the public boat ramp located to the immediate west of the proposed storage facility indicate no results above the ANZECC and ARMCANZ (2000) EIL trigger values with dissolved metals and metalloids very low, and mostly below laboratory limits of reporting (including for lead, zinc, copper and nickel). As expected for the silt laden waters of this estuary area, the turbidity (62 nephelometric turbidity units) and suspended solids (89 mg/L) were very high. Other general parameters of salt content and salt composition are consistent with typical seawater. Dissolved uranium was observed at a concentration of 0.0035 mg/L, which is consistent with the value reported by Miyake et al. (1966; cited in MBS 2016) of 0.0033 mg/L for seawaters of the western north Pacific.

In a study by McAlpine *et al.* (2012) outside of King Sound, it was concluded that the waters are usually clear and that the marine waters of the Kimberley are generally of very high quality. The concentrations of metals across the region were relatively low at the time of sampling and met the guideline trigger values from ANZECC and ARMCANZ (2000) for a very high level of ecological protection. The nearest survey site to the proposed project infrastructure was in the Sunday Strait. The total suspended solids on the surface and bottom at this site were 1 and 2 mg/L respectively. The study also indicated that cobalt may be naturally elevated in some Kimberley coastal waters.

1.5.2.3 Marine Biota

Marine biota may include any living organism in the marine environment. Given the limited scope and potential impact of this project, it is considered only necessary to discuss benthic habitats and communities and marine fauna. A brief discussion of known benthic communities and habitats is included below and baseline marine fauna is addressed in Section 1.5.3.

Benthic communities and habitats occur on the seabed within which algae, seagrass, mangroves, corals, or mixtures of these groups are prominent components (EPA 2009).

Mangrove forests (mangals) in the Kimberley region display a very high degree of intactness (EPA 2009). Mangals are the most important benthic primary producers in the wider Derby Port area. At Derby Port, vegetation surrounding the proposed storage facility is dominated by mangals that lie in a 500 m wide band between the open water of King Sound and extensive saline mudflats.

Approximately 165 km^2 of intertidal mangal habitat occurs within King Sound. In general, around the coastline of King Sound, *Avicennia* dominates the seaward zone, *Rhizophora* the middle zone and *Ceriops* the landward zone. Inland of the intertidal mangals are extensive saline mud flats which are bare and vary from two to four kilometres in width. They are inundated at high spring tide and after heavy rainfall. Where these mud flats extend above the level of the spring high tides, they form grassy or samphire flats (Semeniuk, 1980).

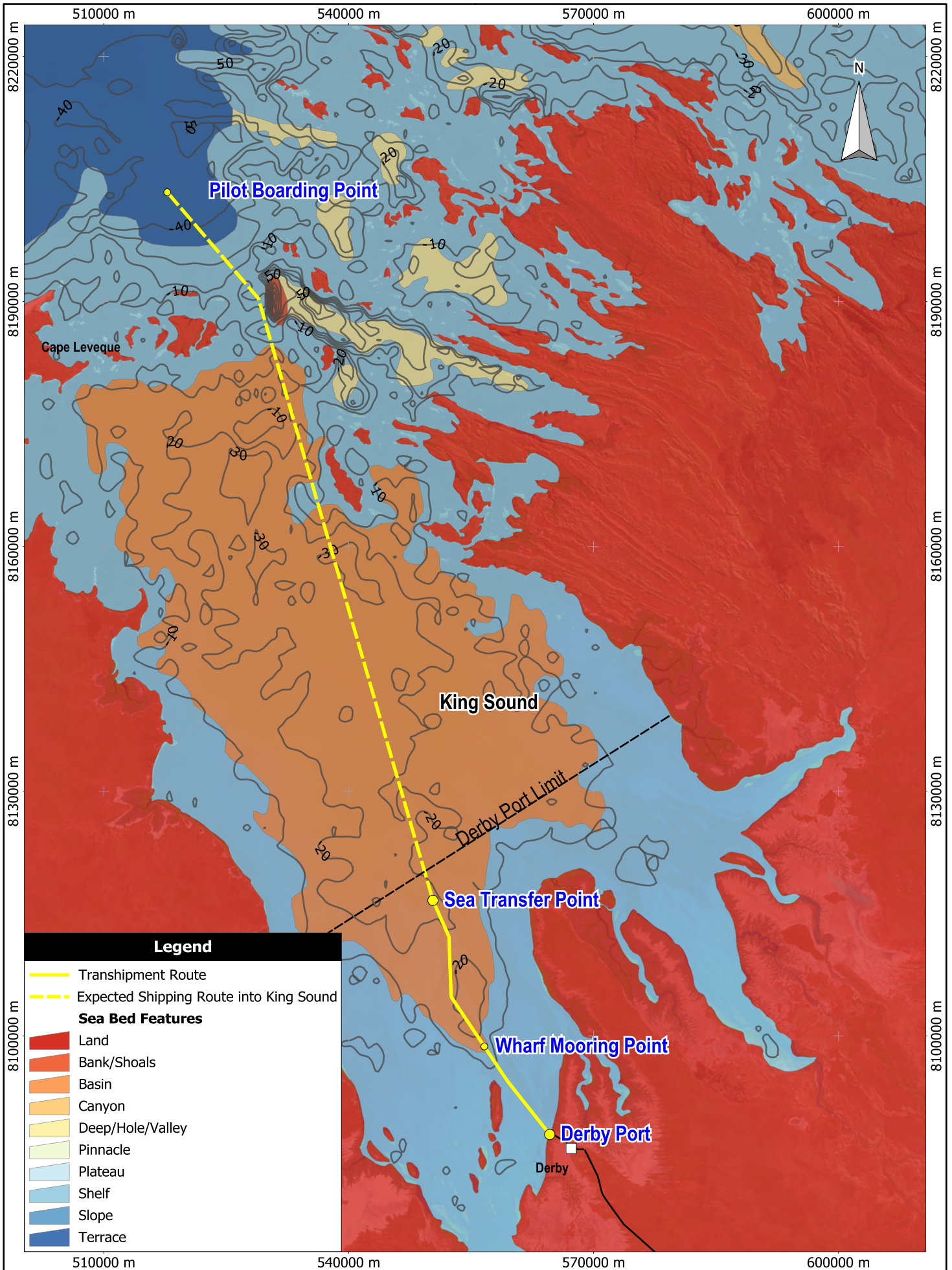
Eleven mangrove species are known to occur around King Sound, none of which are conservation significant.

1.5.2.4 Other Benthic Communities

Seagrasses require high levels of light penetration in order to conduct photosynthesis. High turbidity is known to impede access to light and therefore the growth of seagrasses in tropical waters (Chartrand *et al*. 2012). In colder waters of Australia, seagrasses are known to occasionally inhabit waters as deep as 45 m. In northern Australia where environments can be extreme, this depth limit is likely to be less. Studies show that large tidal movements, natural turbidity, oceanic swells, or freshwater runoff in the wet season reduce the diversity and extent of seagrasses (Green and Short 2003). Inshore areas of King Sound are not likely to support seagrasses, as they experience extremely high turbidity levels and large tidal movements. At the pilot boarding point, although the water is less turbid, the water is 40 m - 50 m deep. This depth affects light attenuation, and combined with the extreme tidal fluctuations is likely to prohibit the growth of seagrasses at this point. Figure 4 shows the seafloor, relative depths of the water in King Sound and the pilot boarding point.

Coral reefs are known to be a diverse and important form of benthic primary producer habitat. Coral reefs usually develop in clear, nutrient poor, shallow waters in tropical oceans. The zooxanthellae algae within the coral polyps require sunlight for photosynthesis to occur. In areas where the water is exceptionally clear, corals have been known to occasionally grow to a depth of 60 m (WA Museum 2016). However, it is noted that the most productive growing depths for coral reefs is 18 m - 27 m (Coral Reef Systems 2016). The high turbidity inside King Sound precludes the growth of corals. The 40 m – 50 m depth at the pilot boarding point prevents the growth of significant amounts of coral at this point (Figure 4).

At Cone Bay (to the east of the entrance to King Sound), the Department of Fisheries (2013) found minimal seagrasses and corals grow on mostly bare, sandy, fine to coarse sediments. It is thought that the scarcity of benthic primary producers in this area is due to the lack of hard substrate and the lack of available light due to the relatively high levels of turbidity (DoF 2013). The seafloor at the pilot boarding point may be broadly similar to Cone Bay, and although seagrasses and corals are unlikely to be present, benthic invertebrate and burrowing organism habitat could potentially be present.



Scale: 1:600000
Original Size: A4
Aerial Photo Date: 2016
Aerial Photo Source: Copernicus Sentinel Data
Grid: MGA94(51)
0 10 km

Sheffield Resources
Thunderbird Mineral
Sands Project

Figure 4

Seafloor Features

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1.5.2.5 Product Radiation Assessment

Bulk product (Ilmenite) will be exported through Derby Port. Packaged products (Zircon and HiTi88 Leucoxene) will be exported via the Port of Broome.

Radiation studies were undertaken by Radiation Professionals as part of the Feasibility Study measured the radiation concentrations of ore, mine wastes, process wastes and final products. All final products to be exported in bulk via Derby Port will have low radioactivity (<1 Bq/g) and as such are not defined as radioactive substances under the *Radiation Safety Management Act 1975* administered by the Radiological Council of Western Australia. This is outlined in the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) C*ode of Practice and Safety Guide for Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing* (ARPANSA 2005). Predicted concentrations of total activity for the two individual ilmenite products to be exported in bulk through Derby Port are 0.59 Bq/g and 0.50 Bq/g for Ilmenite and Ilmenite LTR450 respectively as thorium (Radiation Professionals 2016). Even if undiluted by other low activity port sediment, the ilmenite and ilmenite LTR450 products are insufficiently radioactive to trigger a Tier 2 environmental screening criteria of 10 µGy/h using the ERICA software assessment (ARPANSA 2015) for marine biota. As such there is no considered need for further assessment of risk to marine organisms from normal handling of these products through Derby Port.

Final products to be exported in packaged form through the Port of Broome will exceed the 1 Bq/g definition of a radioactive substance and as such they will be subject to management under the *Radiation Safety Management Act*.

All final products produced at the Mine Site will be exempt from transport regulations as radiation concentrations do not exceed the 10 Bq/g transport limit for Naturally Occurring Radioactive Materials (NORM).

The Department of Mines and Petroleum (DMP) is responsible for regulating the mining and processing of radioactive materials with this responsibility formalised in a Memorandum of Understanding (MOU) between DMP and the Radiological Council dated December 2012. Sheffield will produce a Radiation Management Plan, Radiation Waste Management Plan and Radiation Transport Management Plan as required by DMP to address employee occupational exposures.

1.5.3 Marine Fauna - Baseline Information

1.5.3.1 Threatened, Migratory and Marine Species

Several marine fauna species are listed as Threatened or Migratory under the *EPBC Act*, Vulnerable or Endangered under the *WC Act* or listed as a Priority species by DPaW. These species have been termed 'conservation significant' species.

A summary of Marine and Migratory fauna of conservation significance with the potential to occur within and around the Derby Port Development Envelope or the transhipment route is provided in Table 6. Of the 20 conservation significant species identified in the searches, there are four birds, seven reptiles, six sharks and three mammals. Important habitat for these species is illustrated in Figure 5.

In addition to the threatened marine fauna listed in Table 6, there are seven species of migratory fauna protected under an international agreement known as the Bonn Convention. These species may occasionally pass by King Sound or the vessel transport routes (Table 7). None of these species are listed as threatened under the *EPBC Act* or *WC Act*. Given the habitat preferences and the wide ranging nature of these migratory marine fauna species, they are unlikely to be encountered on a regular basis, with the exception of the Indo-Pacific Bottlenose Dolphin.

Table 6: Threatened Marine and Migratory Fauna – King Sound

Species	Conservation Status			Habitat	Likelihood of Occurrence	Recorded
	EPBC Act	*WC Act*	DPaW			
Birds						
Australian Painted Snipe *Rostratula australis**	E	T(E*)	-	Cryptic and scarce species generally inhabiting ephemeral, seasonal or temporary wetlands. Records for western part of Dampier Peninsula, but most records are in eastern Australia (Birdlife International, 2016).	Medium – possible	No
Curlew Sandpiper *Calidris ferruginea*	CE, M	T(V)	-	Occurs around the coast on intertidal mudflats in sheltered coastal areas, such as estuaries, bays (DoE 2016).	High – Recorded previously, non-breeding.	Yes (Birdlife International, 2016)
Eastern Curlew *Numenius madagascariensis*	CE, M	T(V)		Primarily has coastal distribution in non-breeding range. Roosts on sandy spits and islets, especially on dry beach sand near the high-water mark (DoE 2016).	High – Recorded previously, non-breeding.	Yes (Birdlife International, 2016)
Lesser Sand Plover *Charadrius mongolus*	-	T(E)	-	Feeds mostly on extensive, freshly-exposed areas of intertidal sandflats and mudflats in estuaries or beaches. Roost near foraging areas, on beaches, banks and spits (DoE 2016).	High – Recorded previously, non-breeding.	Yes (Birdlife International, 2016)
Reptiles						
Flatback Turtle *Natator depressus*	V, M	T(V)	-	Recorded from King Sound and known to feed in shallow, turbid waters. Unpublished account of nesting at Point Torment (R.I. Prince, pers. comm. cited in SWOT, 2009). Not expected to be a major nesting site.	High – often found in turbid waters	Yes (NatureMap, 2016; DPaW search 2016). Recorded outside of Port Limits on eastern side of King Sound.
Green Turtle *Chelonia mydas*	V, M	T(V)	-	Pelagic for first 5-10 years and then prefers shallow benthic foraging habitats such as coral and rocky reef habitat or inshore seagrass beds. Neither of these habitats occurs in King Sound. Uncommon in King Sound, but common at offshore islands of the Kimberley (DoE 2016).	Medium – outside King Sound.	Yes (NatureMap, 2016). Sighted near Port.

Species	Conservation Status			Habitat	Likelihood of Occurrence	Recorded
	EPBC Act	*WC Act*	DPaW			
Hawksbill Turtle *Eretmochelys imbricata*	V, M	T(V)	-	Nesting occurs in the Dampier Archipelago and foraging may occur throughout the region in coral and/or rocky reef habitat (Limpus, 2009a).	Low – suitable habitat not found.	No
Leatherback Turtle *Dermochelys coriacea*	E, M	T(V)	-	A pelagic species rarely nesting in Australia. Very wide-ranging in its distribution, but preferring open ocean habitats (Limpus, 2009b), although one record exists near One Arm Point.	Low – prefers open ocean	No
Loggerhead Turtle *Caretta caretta*	E, M	T(E)	-	No breeding in area and no critical feeding habitats. Foraging may occur in a wide range of habitats including rocky and coral reef, seagrasses and estuaries (DSEWPC, 2012).	Medium – rarely found inside King Sound	Yes (DPaW search 2016). Recorded near Point Torment.
Olive Ridley Turtle *Lepidochelys olivacea*	E, M	T (E)		The least common turtle in the area. Rarely nests in WA near Camden Sound (DPaW, 2016), mostly nests in Northern Territory. Forages on invertebrates from soft bottoms (DSEWPC, 2012b).	Low – uncommon in Australia.	Yes (NatureMap, 2016). Two records near One Arm Point, no sightings inside King Sound.
Short-nosed Seasnake *Aipysurus apraefrontalis*	CE	T(CE)	-	Significant habitats are not near the King Sound area (DSEWPaC, 2012).	Low – prefers coral reefs	No
Sharks						
Dwarf Sawfish *Pristis clavata*	V, M	-	P1	Known to inhabit the area of the Fitzroy estuary and King Sound (Thorburn *et al.* 2007a).	Medium – in King Sound but uncommon	Yes (Thorburn *et al.* 2007a)
Great White Shark *Carcharodon carcharias*	V, M	T(V)	-	Oceanic, temperate waters (DSEWPC, 2013)	Low – habitat not suitable.	No
Green Sawfish *Pristis zijsron*	V, M	T(V)	-	May inhabit King Sound and estuarine or brackish locations nearby (DoE 2015).	Medium – in King Sound but uncommon	Yes (DoE 2015)
Largetooth Sawfish *Pristis pristis*	V, M	-	P3	Uses the freshwaters of the Fitzroy River and some tributaries as a nursery and moves into estuarine and marine habitats when it matures (Thorburn *et al.* 2007b).	Medium – in King Sound but uncommon	Yes (Thorburn *et al*. 2007b)

Species	Conservation Status			Habitat	Likelihood of Occurrence	Recorded
	EPBC Act	*WC Act*	DPaW			
Northern River Shark *Glyphis garricki*	E	-	P1	Known to occur in King Sound and estuarine and freshwater habitats (DoE, 2015).	Medium – in King Sound but uncommon	Yes (DoE 2015)
Whale Shark *Rhincodon typus*	V, M	Schedule 7	-	Oceanic, associated with coral reefs (DEH 2005).	Low – habitat not suitable.	No
Mammals						
Humpback Whale *Megaptera novaeangliae*	V, M	Schedule 6	-	Prefers oceanic waters around the 200 m isobath (Jenner *et al*. 2001)	High – waters outside King Sound	Yes (Jenner *et al*. 2001)
Australian Humpback Dolphin *Sousa sahulensis*	M	-	P4	Shallow estuarine, river mouth and coastal waters of less than 10 metres depth, including turbid waters (Hanf *et al*. 2015).	High – known from King Sound	Yes (Brown *et al.,* 2016)
Snubfin Dolphin *Orcaella heinsohni*	M	-	P4	Shallow estuarine, river mouth and coastal waters (Allen *et al.* 2012).	High – known from King Sound	Yes (Brown *et al.,* 2016)

Legend:
T – Threatened; V – Vulnerable; E – Endangered; CE – Critically endangered; M – Migratory; P – Priority list; '-' No classification.

** Rostratula australis is listed as Endangered under the WC Act as Rostratula benghalensis australis.*

Table 7: Migratory Marine Fauna Protected Under Bonn Convention

Scientific Name	Common Name	Likely Occurrence
Balaenoptera edeni	Bryde's Whale	Potential to occasionally occur in the ocean-going vessel route. Found Australia-wide (DoE 2016).
Crocodylus porosus	Salt-water Crocodile	Likely to occasionally occur near Derby Port. Found in the ocean and most major river systems of the Kimberley (DoE 2016).
Dugong dugon	Dugong	Unlikely to occur as suitable habitat (seagrass beds) are not present (DoE 2016).
Manta alfredi	Reef Manta Ray	Unlikely to occur. Prefers coral or rocky reef habitats (IUCN 2016).
Manta birostris	Giant Manta Ray	Unlikely to occur. Prefers coral reef and offshore oceanic habitats (IUCN 2016).
Orcinus orca	Killer Whale	Potential to occasionally occur in the ocean-going vessel route. Mostly prefers oceanic habitats, often close to seal colonies (DoE 2016).
Tursiops aduncus	Indo-Pacific Bottlenose Dolphin	Confirmed as occurring in coastal areas near the mouth of King Sound (Brown *et al.* 2016).

1.5.3.2 Marine and Migratory Birds

Marine birds are birds that spend most of their lives at sea, coming to land to breed, with several species known to breed in the region (DSEWPC 2012a). Migratory shorebirds can also be found in the region, as many nest in the northern hemisphere summer in Siberia and Alaska and migrate to Australia in the Australian winter and spring, to return north in March and April. The migration occurs within the East Asian – Australasian Flyway, which is one of ten migratory bird flyways recognised worldwide (Bamford *et al*. 2008; DSEWPC 2012a).

In addition to the conservation significant birds listed in Table 6, there are 36 species of migratory birds protected under international agreements[1] that may overfly the Derby Port area, some of which may breed near the port and transhipment route (Table 8). None of the birds identified are listed as threatened under the *EPBC Act* or *WC Act*.

Most habitats of particular importance to conservation significant bird species are found on offshore islands and further west near 80 Mile Beach and Roebuck Bay. The closest areas of significance to the Derby Port Development Envelope are the Lacepede Islands, Adele Island and North-east and North-west Twin Islands. In addition, the Derby Sewage Ponds are listed as an area of international importance for the Little Curlew. Figure 5 shows the proximity of the Derby Port Development Envelope to these significant bird habitats.

[1] International agreements include Japan-Australian Migratory Bird Agreement, China-Australia Migratory Bird Agreement, and Republic of Korea-Australia Migratory Bird Agreement.

Table 8: Migratory Birds Protected Under International Agreement

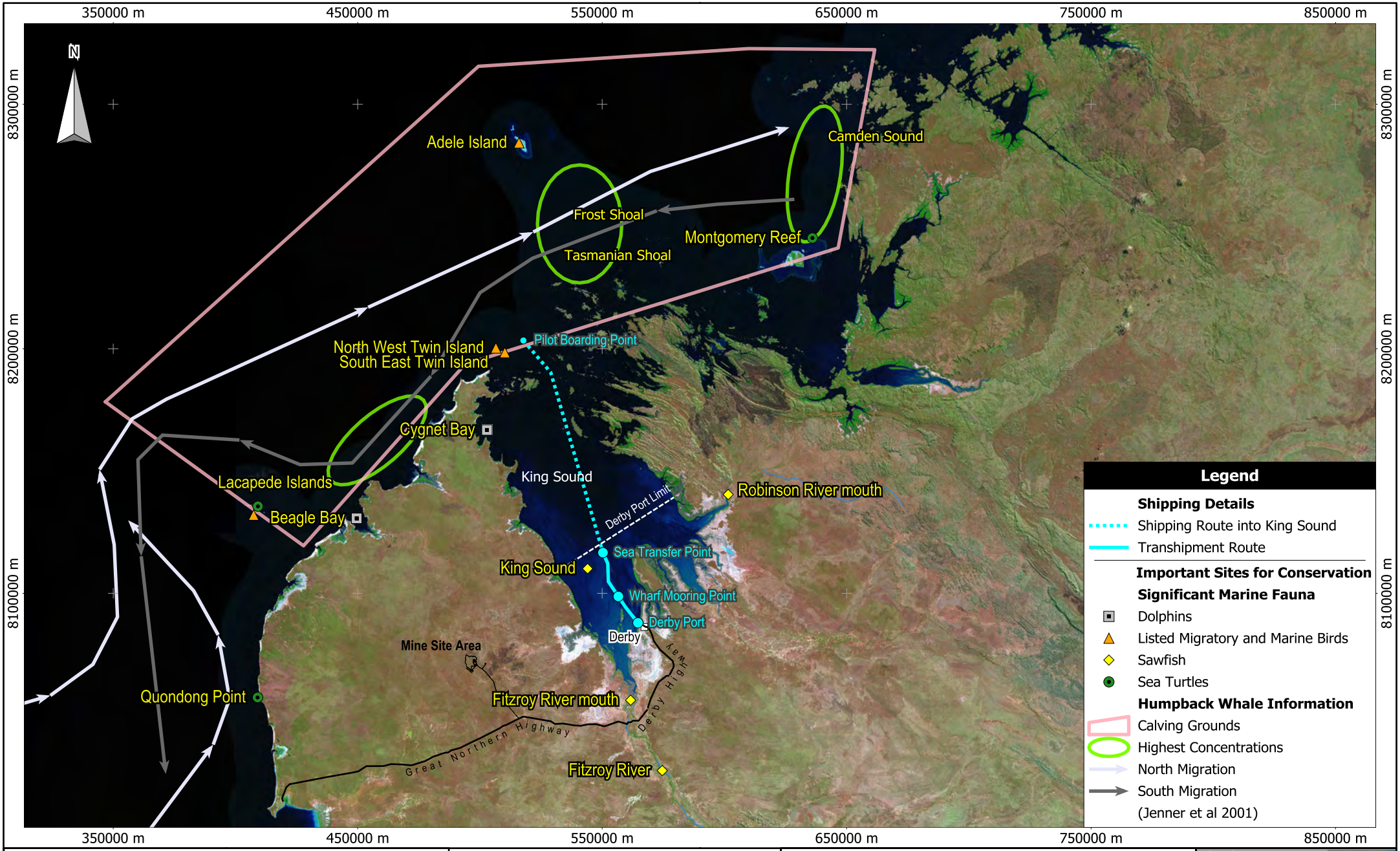
Scientific Name	Common Name	Recorded Near Derby Port	Potentially Occurring Near Derby Port
Actitis hypoleucos	Common Sandpiper	Yes	Yes
Anous stolidus subsp. ileatus	Common Noddy	-	Yes
Apus pacificus subsp. pacificus	Fork-tailed Swift	Yes	Yes
Ardea alba	Great Egret	-	Yes
Ardea ibis	Cattle Egret	Yes	Yes
Ardea modesta	White-necked Heron	Yes	Yes
Ardea sacra subsp. sacra	Eastern Reef Egret	Yes	Yes
Arenaria interpres interpres	Ruddy Turnstone	Yes	-
Calidris acuminata	Sharp-tailed Sandpiper	Yes	-
Calidris alba	Sanderling	Yes	Yes
Calidris ruficollis	Red-necked Stint	Yes	Yes
Calonectris leucomelas	Streaked Shearwater	-	Yes
Cecropis daurica	Red-rumped Swallow	-	Yes
Charadrius leschenaultii	Greater Sand Plover	Yes	Yes
Charadrius veredus	Oriental Plover	-	Yes
Cuculatus opatus	Oriental Cuckoo	Yes	Yes
Fregata ariel	Lesser Frigatebird	-	Yes
Glareola maldivarum	Oriental Pratincole	Yes	Yes
Haliaeetus leucogaster	White-bellied Sea-Eagle	Yes	Yes
Hirundo rustica	Barn Swallow	Yes	Yes
Limosa lapponica	Bar-tailed Godwit	Yes	Yes
Limosa limosa	Black-tailed Godwit	Yes	Yes
Numenius minutus	Little Curlew	Yes	Yes
Numenius phaeopus	Whimbrel	Yes	Yes
Merops ornatus	Rainbow Bee-eater	Yes	Yes
Motacilla cinerea	Grey Wagtail	-	Yes
Motacilla flava	Yellow Wagtail	Yes	Yes
Pandion haliaetus	Osprey	Yes	Yes
Plegadis falcinellus	Glossy Ibis	Yes	Yes
Pluvialis fulva	Pacific Golden Plover	Yes	Yes
Pluvialis squatarola	Grey Plover	Yes	Yes
Sternula albifrons	Little Tern	-	Yes
Sterna dougallii subsp. gracilis	Roseate Tern	-	Yes
Tringa glareola	Wood Sandpiper	Yes	Yes
Tringa nebularia	Common Greenshank	Yes	Yes
Tringa stagnatilis	Little Greenshank	Yes	-

1.5.3.3 Humpback Whale

The Humpback Whale is known to occur in significant numbers in the Kimberley region. Whales migrating up the west coast of Australia belong to a distinct population (Group IV population) to those occurring on the east coast of Australia (Group V population). The total number of whales in the Group IV population is estimated to be 21,750 (Hedley *et al*. 2008), although only a small proportion of these pass the mouth of King Sound each year between the months of July and November on their south/north migration to calving grounds. Humpback Whales do not use King Sound as a calving ground and the area is not part of the whale migration path.

Humpback whale calving grounds occur from Broome to north of Camden Sound, with the greatest concentration of calving whales found near Camden Sound (Jenner *et al*. 2001). Camden Sound is considered the most important Humpback calving site in the southern hemisphere, and the State and Commonwealth waters in the area are protected by marine reserves. Both include habitat protection areas in recognition of the importance of the area to whales (DPaW 2013; DoEE 2016).

The Group IV population mostly favours a fixed migration route known as the 'whale highway', which tends to follow the series of shelf-edge canyons that occurs off the west coast. Most whales appear to prefer the 20 m depth contour (Hedley *et al*. 2008; SoE 2011). Most whales on their north and south-bound migration pass to the west of the Lacepede Islands to avoid the shoals inshore and a substantial number also pass further offshore (Double *et al*. 2010). When heading north from the Lacepede Islands, most whales remain offshore, pass the mouth of King Sound, and aggregate at the Frost and Tasmanian Shoals. These shoals are most likely used as staging grounds where whales wait for the right tidal conditions to proceed to or from Camden Sound. Figure 5 shows the areas of highest concentration of whales and main migration routes used by Humpback Whales in the region (Jenner *et al.* 2001).



Scale: 1:2000000
Original Size: A4
Image: Geoscience Australia LS7 Mosaic 2007
Grid: MGA94(51)

0 50 km

Sheffield Resources
Thunderbird Mineral Sands Project

Figure 5

Important Habitat for Conservation Significant Marine Fauna

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W:\Sheffield Resources\PER\Drawings\PER Derby Port.map 21/12/2016 F42 Important Habitat for Conservation Significant Marine Fauna Map Layout

1.5.3.4 Sawfish and Sharks

Sawfish are shark-like rays, and three species are known to occur in the King Sound area: Dwarf Sawfish (*Pristis clavata),* Green Sawfish (*P. zijsron)* and Largetooth Sawfish *(P. pristis).* All of these Sawfish are considered Vulnerable under the *EPBC Act*, with breeding likely to occur in the area (DoE 2015). The Dwarf Sawfish is also listed as Priority 1 and the Largetooth Sawfish as Priority 3 by DPaW. The Green Sawfish is listed as Vulnerable under the *WC Act*. All three species of Sawfish and the Northern River Shark are also totally protected under the *Fish Resources Management Act 1994*.

The main threats to the Sawfish are associated with bycatch from commercial fishing using nets and entanglement in marine debris. The barbed rostrum and inshore and estuarine habitat preferences of the Sawfish mean they are sometimes caught as bycatch by fishers targeting Barramundi or King Salmon, however the impact of recreational fishers on the species is currently unquantified (DoE 2015). Habitat modification caused by developments in the Sawfish species' range may also represent a threat, but to date these have been of lesser concern than fishing (DoE 2015). Threats to Sawfish also include the shark-fin trade, which is known to occur within Australian waters, and collection of the rostrums as curios.

Dwarf Sawfish

The Dwarf Sawfish is found in tropical waters of Australia from south of Port Hedland to eastern Cape York Peninsula (DoE 2015). It prefers habitats of 2-3 m depth in coastal and estuarine waters and does not use any purely freshwater habitats. Thorburn *et al.* (2007a) studied Dwarf Sawfish in King Sound and several of the Sound's river estuaries. They determined that estuarine, and possibly brackish habitats in the Fitzroy River, are used as nursery areas and juveniles may stay in these areas until three years of age. Stevens *et al.* (2008) found the Dwarf Sawfish had limited daily movements and a range of only a few square kilometres. Its movements are influenced by the tides, with high tide being spent resting in inundated mangroves and on a moving tide they are active, presumably feeding.

Green Sawfish

The Green Sawfish was historically found throughout the Indian Ocean to South Africa and Indonesia, however the species' range is now considered to be much reduced. In Australia, the species currently occurs from Shark Bay in Western Australia to the Whitsundays in Queensland and it utilises marine and estuarine waters but not freshwater (Harry *et al.* 2011; Stevens *et al.* 2005). In a recent paper by Morgan *et al.* (2015), a large influx of Green Sawfish pups was reported for the Ashburton Estuary in the Pilbara. The authors speculate this may be the most important nursery area for the species globally. As with the Dwarf Sawfish, Stevens *et al.* (2008) found the movements of the Green Sawfish to be tidally influenced. The Green Sawfish swim towards the mangroves on the incoming tide and away from the mangroves on the outgoing tide. The species is thought to be long lived, reaching maturity at around nine years of age, and reaching 95% of its maximum size at 24 years of age (Stevens *et al.* 2005). It is a species of low fecundity, which contributes to its Vulnerable status under the *WC Act*.

Largetooth Sawfish

The Largetooth Sawfish, previously known as the Freshwater Sawfish (*Pristis microdon)*, is the largest of the three species of Sawfish found in the Kimberley (DoE 2015a). Its range in Australian waters is from Port Hedland in WA to Cooktown on the Cape York Peninsula in Queensland (DoE 2015). The freshwaters of the Fitzroy River are a nursery for this species, with immature fish remaining in the river until up to five years of age. This is the only species of Sawfish to utilise purely freshwater habitats and it has been found up to 400 km inland (DoE 2015a). Mapping of potential habitat of the species shows juveniles may occur in the wet season in the Fraser River and Fraser River South, the headwaters of which are around 4 km from the Mine Site. As the fish matures, it is found in estuarine and marine habitats including King Sound (Thorburn *et al*. 2007b). It has a worldwide distribution, although Australia may be the last viable population stronghold (DoE 2015).

Northern River Shark

The Northern River Shark (*Glyphis garricki*) is known from King Sound in the west to the Northern Territory, west of the Gulf of Carpentaria and may potentially use King Sound as a pupping ground (DoE 2015). The Northern River Shark is found only in Australia and Papua New Guinea. Juveniles may occupy freshwater habitats and adults are found in estuarine and marine habitats (Pillans *et al.* 2009). Males of the species are thought to mature at 14 years of age, and females at 17 years. Life expectancy is predicted to be more than 25 years (Stevens *et al.* 2005). Threats to the shark include commercial gill-net fishing, with the shark being recorded in the bycatch in the Kimberley Gillnet and Barramundi Fishery and recreational fishing (Fletcher and Santoro 2015). Habitat modification, such as restriction of tidal flow or damming of preferred rivers is also of concern for the species.

1.5.3.5 Inshore Dolphins

In the vicinity of King Sound, there are three species of dolphin of conservation significance that may occur: Australian Humpback Dolphin (*Sousa sahulensis*; listed as Migratory and a Cetacean under the *EPBC Act* and as Priority 4 by DPaW), Snubfin Dolphin (*Orcaella heinsohni;* listed as Migratory and a Cetatean under the *EPBC Act* and as Priority 4 by DPaW) and Indo-Pacific Bottlenose Dolphin (*Tursiops aduncus*; listed as Migratory and a Cetacean under the *EPBC Act*).

The Australian Humpback Dolphin is known to occur in coastal waters of WA as far south as Shark Bay, and is endemic to Australia and New Guinea. The species is poorly studied; however the available data indicate that the local populations may be quite distinct from one another and that these populations are discontinuously distributed, exhibiting site fidelity (Parra *et al*. 2004; Parra *et al*., 2006). The species is thought to prefer shallow estuarine, river mouth and coastal waters of less than 10 m depth. Brown *et al.* (2012) studied Australian Humpback Dolphins at North-west Cape and recorded animals in waters from 1.2 to 20 m deep and at ranges from 0.3 to 4.5 km off the coastline. Around one quarter of the individuals recorded were found in mixed groups with Indo-Pacific Bottlenose Dolphins. Australian Humpback Dolphins may be associated with intertidal areas including those around islands and can utilise a range of inshore habitats including turbid waters (Hanf *et al.* 2015; Allen *et al*. 2012). Accurate population numbers are not available but one estimate for total numbers in WA is less than 5,000 (Bejder *et al*. 2012).

The Snubfin Dolphin is endemic to Australian waters. Like the Australian Humpback Dolphin, information on the Snubfin Dolphin is scarce. The two species have some habitat overlap and the Snubfin Dolphin is known to live in shallow, coastal and estuarine waters. The species is known from King Sound with several records on the NatureMap search facility (DPaW 2016). The species has been recorded as far south as Exmouth Gulf, although it is more commonly recorded in Roebuck Bay, which is thought to be an important site for the species (Allen *et al*. 2012; Brown *et al.* 2016).

The Indo-Pacific Bottlenose Dolphin often associates with the Australian Humpback Dolphin and Snubfin Dolphin. Little is known of the species' abundance across northern Australia. The species was recently separated from Common Bottlenose Dolphins (*Tursiops truncatus*) and its range is considered fragmented (Allen *et al*. 2012; Brown *et al.* 2016).

Table 9 shows the relative abundance of the three species of dolphin of conservation significance that may occur in King Sound (Brown *et al*. 2016).

Table 9: Approximate Numbers of Dolphins at Kimberley Sites

Location	Snubfin Dolphin	Australian Humpback Dolphin	Indo-Pacific Bottlenose Dolphin
Cygnet Bay	54^	20^	60^
Cone Bay	20*	12*	0
Beagle Bay	2*	7*	184^
Roebuck Bay	133^	12*	9*

*Source: Brown et al. (2016). Key: ^ Highest count for estimated total population size at each site; * indicates insufficient data was gathered to determine population size. The number listed is the maximum number of individuals sighted on any of the repeated surveys.*

The abundance of the dolphin species varies markedly per site. Brown *et al*. (2016) noted that a fifth site, Inner Cambridge Gulf, which had highly turbid and estuarine conditions, showed the lowest abundance of any dolphin species. It was speculated that dolphins may avoid certain sites due to habitat and prey distribution, predation risk or social dynamics. Repeated sampling over various seasons at Cygnet Bay found that Snubfin Dolphins were resident in the area with almost no emigration to other populations. Australian Humpback and Indo Pacific Bottlenose Dolphins also showed site fidelity, but with movement of some individuals between Cygnet Bay and other areas. The study also found that some sites are far more important for one species than others.

1.5.3.6 Sea Turtles

Six of the seven species of sea turtle worldwide have the potential to occur in the region of the Project: the Flatback Turtle (*Natator depressus*), Green Turtle (*Chelonia mydas*), Hawksbill Turtle (*Eretmochelys imbricata*), Leatherback Turtle (*Dermochelys coriacea*), Loggerhead Turtle (*Caretta caretta*), and the Olive Ridley Turtle (*Lepidochelys olivacea*) (DSEWPC, 2012b). The Flatback, Green, and Hawksbill Turtles are listed under the *EPBC Act* as Vulnerable and Migratory. The Leatherback, Loggerhead, and Olive Ridley are listed as Endangered and Migratory under the *EPBC Act*.

DSEWPC (2012b) stated that in the North-west Marine Region, there are several areas of critical habitat for sea turtles based on their importance as foraging grounds or nesting and inter-nesting sites. None of these areas are in close proximity to King Sound, and the Sound is not considered critical habitat for sea turtles. Critical habitats for sea turtles are shown on Figure 5. Neither the Hawksbill Turtle, nor the Leatherback Turtle are known from in or around King Sound. Through the EPBC and DPaW search tools, the other four species have been recorded in or around King Sound. Records of each species and the likelihood of occurrence are shown in Table 6.

1.5.4 Key Assumptions and Uncertainties

The proposed Derby Port Development Envelope, King Sound and surrounds have been the subject of several investigations into amenity, marine environmental quality and marine fauna including targeted studies for amenity and marine water and sediment quality for the purpose of the PER. Other investigations into marine fauna have relied on information from scientific literature searches.

It is assumed that investigations and studies undertaken for the PER have adequately:

- Estimated the inputs into modelling completed to determine potential impacts on amenity, specifically for dust and noise parameters.
- Assessed the risk of contamination of the marine environment through disturbance of existing contaminated soils at Derby Port Development Envelope (MBS 2016).
- Through a search of the scientific literature, accurately assessed the likelihood of conservation significant marine fauna occurring in the Derby Port Development Envelope and vessel transport routes.

1.5.5 Management Approach

The management approaches discussed in this document are based and developed around the mitigation hierarchy of avoid, minimise, rehabilitate and off-set to ensure impacts to amenity, marine environmental quality and marine fauna have been avoided or reduced as far as practicable. The monitoring of environmental criteria in order to meet conditions will ensure the Thunderbird Mineral Sands Project meets its environmental objectives for the preliminary environmental factors.

Risks and management measures were identified and prioritised using information gained from baseline surveys, the scientific literature and other regional and local information within the public domain.

1.5.6 Rationale for Choice of Management Targets

With respect to amenity, baseline information has been gathered and scientific processes used to conduct modelling and predict impacts.

For marine environmental quality, baseline surveys have been completed and this knowledge has been combined with previous information from other projects at the Derby Port Development Envelope.

In relation to marine fauna, environmental criteria have been developed based upon baseline information gathered from current scientific knowledge and where uncertainty exists, the precautionary principle has been applied.

These environmental parameters have been translated into Environmental Risk criteria which are discussed below.

2. PRELIMINARY PORT ENVIRONMENTAL MANAGEMENT PLAN

This section identifies the legal provisions that Sheffield proposes to implement to ensure the protection of amenity, marine environmental quality and marine fauna. It identifies management actions that will be implemented to mitigate and manage potential risks to these factors, and management targets that will be used to measure the efficacy and performance of management actions. A monitoring framework for tracking performance against management targets is also included in this section, and proposed mechanisms for review and reporting.

2.1 PURPOSE

The purpose of this preliminary Port EMP is to provide a framework to ensure that impacts on Amenity, Marine Environmental Quality and Marine Fauna attributable to the project are minimised. This plan seeks to ensure that impacts do not conflict with the EPA objectives for these factors as listed below:

- Amenity - *To ensure that impacts to amenity are reduced as low as reasonably practicable.*
- Marine environmental quality - *To maintain the quality of water, sediment and biota so that the environmental values, both ecological and social, are protected.*
- Marine fauna - *To maintain the diversity, geographic distribution and viability of fauna at the species and population levels.*

2.2 MANAGEMENT ACTIONS TO BE IMPLEMENTED

Potential risks or impacts have been identified for each of the factors of amenity, marine environmental quality and marine fauna. Risk-based management actions have been proposed for each of these factors to achieve the relevant condition environmental objectives.

All of the residual potential impacts for the factors of amenity, marine environmental quality and marine fauna were assessed as "Low" during the formal impact assessment process. For this reason, no management actions have been prioritised over others.

2.2.1 Amenity Management Actions

Management actions were specifically developed to ensure the EPA's objective for amenity will be met. The actions in Table 10 will be implemented by Sheffield for the project.

2.2.2 Marine Environmental Quality Management Actions

Management actions were specifically developed to ensure the EPA's objective for marine environmental quality will be met. The actions in
Table 11 will be implemented by Sheffield.

2.2.3 Marine Fauna Management Actions

Management actions were specifically developed to ensure the EPA's objective for marine fauna will be met. The actions in Table 12 will be implemented by Sheffield.

Table 10: Risk-Based Management Actions to be Implemented for Amenity

Risk and/or Key Impacts	Management Actions	Timeframe / Project Phase
Dust emissions causing a decrease in amenity for sensitive receptors	• Bulk products will be transported to the Derby Port Development Envelope in covered containers. • Bulk product will be stored in a purpose built Product Storage Facility. This will include a drive through enclosed unloading area to ensure product is contained. • Transfer of product to barges will be via a covered conveyor. • Spillages of product on land will be cleaned up as required. Spilt product will either be returned to the Product Storage Facility or returned to the Mine Site for reprocessing or disposal.	Operations
Noise emissions causing a decrease in amenity for sensitive receptors	• Road trains will be maintained in good mechanical condition to minimise noise associated with their operation. • The use of engine brakes within the built-up area of Derby will only be permitted for emergency breaking. • Road train speed limits through the town of Derby will be determined in consultation with the Shire of Derby/West Kimberley, Main Roads WA and other stakeholders. • Sheffield will develop and implement a community feedback and complaints mechanism.	Operations

Table 11: Risk-Based Management Actions to be Implemented for Marine Environmental Quality

Risk and/or Key Impacts	Management Actions	Timeframe / Project Phase
Installation of mooring points affecting turbidity	• Sheffield will either upgrade or replace existing moorings installed at transhipment vessel and ship loading points within Derby Port limits.	Construction
Product dust or spillage causing marine pollution	• The Product Storage Facility will include a drive through enclosed unloading area to ensure product is contained within the facility during unloading activities. • Transfer of product to the barge will be via a covered conveyor to minimise escape of dust or spillage.	Operations
Hydrocarbon spill causing marine pollution	• Refuelling of marine vessels will be consistent with Port of Derby requirements. • Used oil or oil-soaked absorbents will be securely stored and disposed of at a licensed facility to reduce the chance of oil, fuel or any oily wastes being discharged into the marine environment. • Refuelling equipment will include an emergency shutdown valve and will be monitored at all times when in use. • Spills of oil, fuel or other hydrocarbons to water will be immediately reported to DoT.	Operations

Risk and/or Key Impacts	Management Actions	Timeframe / Project Phase
	• A spill kit located at Derby Port will be maintained in working order. • An appropriately sized and stocked marine spill kit will be located on each Sheffield owned or operated tug boat to address small scale spillages.	
Radiation impacting the marine environment	• Background radiation levels in soil, sediments and airborne dust will be measured prior to construction commencing. • Spillages of product on land will be cleaned up as required. Spilt product will either be returned to the Product Storage Facility or returned to the Mine Site for reprocessing or disposal.	Operations

Table 12: Risk-Based Management Actions to be Implemented for Marine Fauna

Risk and/or Key Impacts	Management Actions	Timeframe / Project Phase
Lighting from Port and vessels	• Lighting design will consider minimisation of attraction of wildlife. • Operators of the ocean going vessel will be made aware of potential lighting impacts to marine fauna and the advice of Environmental Assessment Guideline No. 5, Protecting Marine Turtles from Light Impacts (EPA 2010).	Construction/ Operations
Vessel strike	• If crew of Sheffield operated vessels sight cetaceans or sea turtles, these will be reported to other vessels to ensure they are informed and can take precautions in the area. • Captains of ocean going vessels will be informed to take extra care during the Humpback Whale migration season (July to November), adjust vessel speeds and have crew on watch as needed. • Sheffield operated vessels will reduce speed below 8 knots if whale sightings are within vessel movement areas. • Any wildlife strikes by Sheffield operated vessels will be reported through an incident reporting system and adaptive management practices implemented if necessary.	Operations
Solid waste/marine debris	• Employees and contractors operating Sheffield transhipment vessel and tug boat teams will be made aware of the importance of preventing the escape of solid waste. • Solid waste will be disposed of in appropriately covered receptacles at Derby Port and transferred to a licensed disposal facility.	Construction/ Operations

2.3 MANAGEMENT TARGETS AND MONITORING

To ensure management actions detailed in Section 2.2 are effective, a series of measurable management targets have been identified. If management targets are met then impacts on the environmental factors will be minimised and the EPA's environmental objective for Amenity, Marine Environmental Quality and Marine Fauna will be achieved.

A variety of records and reports collected during operations will be utilised to monitor performance against management targets. These will include incident reports and the results of routine inspections, which will be reviewed on a quarterly basis. Where required, additional monitoring surveys will also be undertaken to ensure specific targets are assessed. If targets are not achieved then appropriate corrective actions will be developed and implemented.

2.3.1 Amenity

Relevant records, reporting resources and the mechanisms for implementing monitoring relevant to management targets for amenity are provided in Table 13.

Table 13: Management Targets to Measure Efficacy of Amenity Management Actions

Management Objectives	Management Targets	Relevant Records and Reports	Monitoring
Minimise loss of amenity to sensitive receptors in the town of Derby as a result of dust	No public complaints relating to dust impacts at sensitive locations in Derby town.	• Register of public complaints. • Internal audits and inspections.	• Quarterly review of register of public complaints and inspection reporting.
Minimise loss of amenity to sensitive receptors as a result of environmental noise generated at the Derby Port Development Envelope	No exceedance of environmental noise levels at residences in Derby town as stipulated in *Environmental Protection (Noise) Regulations 1997.*	• Register of public complaints.	• Noise monitoring on quarterly basis at sensitive locations. • Necessity for monitoring to be reviewed after 2 years of operations. • Quarterly review of register of public complaints.
Minimise loss of amenity to sensitive receptors as a result of traffic noise generated by road trains travelling through the town of Derby	No exceedance of traffic noise limits at sensitive receptors in Loch Street (using Western Australian Planning Commission State Planning Policy 5.4 "*Road and Rail Transport Noise and Freight Considerations in Land Use Planning, 2009*").	• Register of public complaints.	• Noise monitoring on quarterly basis at sensitive locations. • Necessity for monitoring to be reviewed after 2 years of operations. • Quarterly review of register of public complaints.

2.3.2 Marine Environmental Quality

Relevant records, reporting resources and the mechanisms for implementing monitoring relevant to management targets for marine environmental quality are provided in Table 14

Table 14: Management Targets to Measure Efficacy of Marine Environmental Quality Management Actions

Management Objectives	Management Targets	Relevant Records and Reports	Monitoring
Minimise impacts through turbidity generated by installation of moorings	Moorings are only installed in places that have been used previously by other projects.	• Sheffield to consult with SDWK on previous locations of moorings. • Incident report will be completed if any vessel uses unauthorised moorings or anchoring.	• Quarterly review of any reported incidents.
Minimise dust or spillage of product escaping to the marine environment	No significant incidents of dust or spillage entering the marine environment requiring remediation.	• Incident reports. • Internal audit and inspections.	• Quarterly review of any reported incidents.
Minimise chance of hydrocarbon spill during vessel refuelling	No significant spill of hydrocarbons entering the marine environment requiring remediation.	• Incident reports. • Spill kit component stock replacement orders. • Internal audit and inspections.	• Quarterly review of any reported incidents.
No net change to marine environment through radiation impacts	No spills of significantly radioactive product to marine environment requiring remediation.	• Incident report. • Internal audit and inspections.	• Radiation Monitoring Program (soil, sediment and air samples).

2.3.3 Marine Fauna

Relevant records, reporting resources and the mechanisms for implementing monitoring relevant to management targets for marine fauna are provided in Table 15.

Table 15: Management Targets to Measure Efficacy of Marine Fauna Management Actions

Management Objectives	Management Targets	Relevant Records and Reports	Monitoring
Minimise disorientation of migratory birds caused by installation of additional lighting at the Derby Port Development Envelope.	Additional lighting to be installed to the minimum level required for safe operations on a 24 hour basis.	• Incident reports. • Internal audits and inspections.	• Quarterly review of any incident reports.
Minimise disorientation of migratory birds and sea turtles caused by lighting on vessels.	Lighting installed to the minimum level required for safe operations and navigation on a 24 hour basis	• Incident reports. • Internal audits and inspections.	• Quarterly review of any incident reports.
Minimise impacts to marine fauna as a result of vessel strike	No deaths of animals of conservation significant species as a result of vessel strike.	• Incident Reports. • Opportunistic observations.	• Quarterly review of incident reporting.
Minimise impacts to marine fauna as a result of entanglement or ingestion of solid waste or marine debris	No deaths of animals of conservation significant species as a result of project-related solid waste or marine debris.	• Incident reports. • Opportunistic observations. • Reports from the public. • Internal audits and inspections of solid waste management.	• Quarterly review of incident reporting. • Death of a conservation significant animal will result in an internal review of the solid waste management practices.

2.4 REPORTING

Sheffield will prepare Annual Environmental Reports (AERs) to be submitted to regulatory authorities. The format of these reports will be consistent with requirements stipulated by individual regulatory authorities.

A Compliance Assessment Report (CAR) will be submitted to the Office of the Environmental Protection Authority at an agreed date. The report will document compliance with conditions of approval including assessment of compliance with management plan requirements where management plans form part of approval conditions.

If a management target is exceeded (or not met), the CEO of the OEPA will be notified within 7 days of identification of the exceedance.

2.5 REVISION AND ADAPTIVE MANAGEMENT OF MANAGEMENT ACTIONS

This preliminary Port EMP will be reviewed and updated annually. Each review will be informed by the latest results of monitoring and reporting to ensure that the mechanisms for managing potential risks to amenity, marine environmental quality and marine fauna are current and fit for purpose.

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