NINGALOO MARINE RESEARCH CENTRE

ENVIRONMENTAL ASSESSMENT REPORT

PREPARED FOR:

MINDEROO

APRIL 2020

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MBS ENVIRONMENTAL

NINGALOO MARINE RESEARCH CENTRE
ENVIRONMENTAL ASSESSMENT REPORT

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1. INTRODUCTION

1.1 THE PROJECT

The Minderoo Foundation (Minderoo) is seeking to develop a state-of-the-art marine research facility at the Ningaloo Centre, Exmouth (the Project) (Plate 1).

Plate 1: Aerial View of Ningaloo Centre (Foreground) with Water Corporation Wastewater Ponds and Exmouth Gulf (top)

The proposed facility will deliver sophisticated aquarium and laboratory facilities to support and attract world class marine research to the Exmouth area. Dedicated spaces will be provided to researchers, students and industry partners on collaborative projects aimed at understanding and preserving our marine environments. Flourishing Oceans has received advice from leaders in the marine research fields, including the National Sea Simulator in Townsville, to ensure the facility is capable of supporting the quality of research proposed.

1.2 THE ENVIRONMENTAL ASSESSMENT REPORT (THIS DOCUMENT)

The objective of this Environmental Assessment Report (EAR) is to support the planning and environmental approvals processes for the Project. This document:

- Provides an overview of the Project.
- Provides an overview of the general environmental features of the Project area through a review of existing information and the outcome of desktop assessment.
- Discusses, at a high level, the potential environmental impacts associated with the Project.
- Provides a summary of the proposed environmental management framework.

2. OVERVIEW OF THE PROJECT

2.1 RESEARCH FACILITY

The intent is for the Project to support research that enables our oceans to withstand a changing climate and increasing human pressures and ensure it's healthy, resilient, free from pollution and with plentiful biomass of fished species. It is proposed that research related to climate change, reef restoration and adaptation, sexual reproduction in corals, coral holding and propagation and water quality and contaminants, will be undertaken. To complete the high-quality seawater experiments required of this facility a stable and consistent supply of high-quality seawater is essential.

2.2 SEAWATER SUPPLY

A consistent supply of high-quality seawater, with a low suspended solids load, low nutrient concentrations and consistent salinity and temperature, is required. All systems within the facility will work on full flow through (i.e. seawater is constantly flowing through the facility), which minimises water quality issues in experimental systems, with a turnover rate of between 1 to 24 volume/day (i.e. 1 to 24 times the facility storage volume flows through the facility each day), according to the experimental design(s).

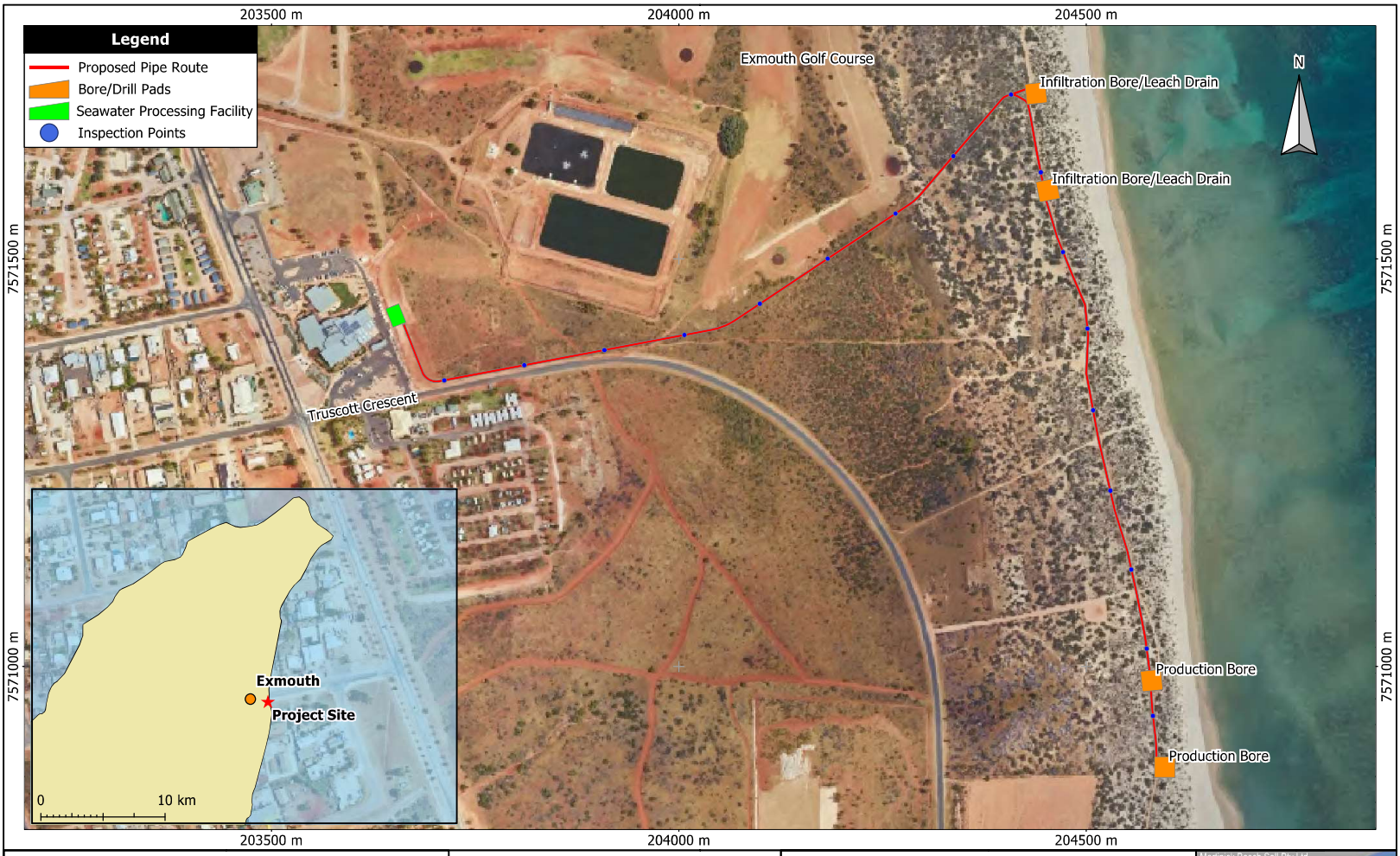
To supply the Project with seawater, two bores (Production bores) will be constructed within the seaward dunes southeast of the Ningaloo Centre and a seawater supply pipeline run north and then west between the bores and the Ningaloo Centre (Figure 1). The bores will have an internal diameter of approximately 205 mm and will be drilled to approximately 30 m below ground level (mbgl). It is anticipated that each production bore will operate 24 hours/day, 365 days/year, with an abstraction rate of 4-5 L/s (up to a maximum of 15 L/s). This equates to abstraction, from both bores, of on average of 160 ML/year (up to a maximum of 450 ML/year).

The pipeline connecting the bores to the facility will be constructed within a 6 m easement, running east along Truscott Crescent, then along the boundary of the golf course and into the dunes, before heading south along an existing pathway (Figure 1). The pipeline will consist of 3 x approx 150 mm diameter PVC pipes and will be buried 0.5 m to 1 m below the surface. Inspection points will be located at intervals to facilitate cleaning and maintenance of the pipeline.

2.3 WASTE STREAMS

Seawater leaving the facility, having circulated through the system, will be transported to two injection/infiltration bores, or leach drains (preferred disposal method to be confirmed following site investigations), for infiltration into the ground within the dunes to the east of the Ningaloo Centre (Figure 1). It is anticipated that discharge of up to 450 ML/year (of seawater which has passed through the facility) will occur.

No contaminants will be present within the discharge stream. Low doses of antiscalants or biocides may occasionally be introduced into the pipeline and these will be highly diluted prior to discharge. Low concentrations of nutrients are expected within the discharge stream (refer Section 5.6).



Scale: 1:6000 Original Size: A4 Air Photo Date: October 2019 Grid: Australia MGA94 (50) 0 — 200 m	Minderoo Foundation Ningaloo Aquaculture Laboratory Environmental Assessment Report	**Figure 1** **Location Plan**	Martinick Bosch Sell Pty Ltd 4 Cook St West Perth WA 6005 Australia t:+61 8 9226 3166 info@mbsenvironmental.com.au www.mbsenvironmental.com.au

W:\Minderoo\Ningaloo Centre\Approval Applications\EAR\GIS\Drawings\Mindaroo Pipe Route.map 8/04/2020 Location Plan

2.4 APPROVALS REQUIRED

Table 1 provides an overview of the approvals expected to be required to support the construction and operation of the Project. Further details on the key environmental approvals are provided in the sub-sections below.

Table 1: Overview of Project Approvals

Proposed Activity	Land tenure/access	Approval Required	Legislation (Regulatory Body)
Ground disturbance for bore pads/leach drains and seawater pipeline	Section 91	Grant of tenure	*Land Administration Act 1997* (Department of Planning Lands and Heritage [DPLH) *Environmental Protection Act 1986*; Native Vegetation Clearing Permit (Department of Water and Environmental Regulation [DWER)
Construction of water production bores	Section 91	26D licence	*Rights in Water & Irrigation (RIWI) Act 1914* (DWER)
Seawater abstraction	Section 91	5C licence	*Rights in Water & Irrigation (RIWI) Act 1914* (DWER)
Ningaloo Centre Upgrades (on Lot 300)	Lease from Shire of Exmouth	Development approval (obtained) Building permit	*Planning and Development Act 2005* (Shire of Exmouth)
Infrastructure Components on Crown Land (seawater pipeline, bore pads, power generation/supply, access tracks, connection to sewer)	Easement	Grant of tenure Development approval	*Land Administration Act 1997* (DPLH) *Planning and Development Act 2005* (Shire of Exmouth) *Health Act 1911* (Shire of Exmouth)

2.4.1 Planning

An application for a licence under s91 of the *Land Administration Act 1997* to provide tenure for the proposed bore pads, to support the proposed test drilling and pumping, was submitted to DPLH on 6 February 2020 (Case ID 2000667). The DPLH has sought comment from the Department of Mines, Industry Regulation and Safety (DMIRS) and DWER.

An application for development approval (DA) and Easement will subsequently be sought, from the Shire of Exmouth and DPLH respectively, for the permanent infrastructure (pipeline and the bores).

2.4.2 Water

A 26D licence is issued under the provisions of Section 26D of the *Rights in Water and Irrigation Act 1914* (RIWI Act) to construct or alter wells. A 26D licence is required to:

- Commence, construct, enlarge, deepen or alter an artesian well [26A(1)].
- Commence, construct, enlarge, deepen or alter any non-artesian well in a proclaimed groundwater area [26B (3) (a)].

A 26D application will be submitted to DWER for the development of test production (seawater abstraction) bores to the south east of the Ningaloo Centre.

A 5C (*RIWI Act*) licence allows the licence holder to take water from a watercourse, well, and or, underground source. A 5C licence will be sought from DWER for the operation of the production (seawater abstraction) bores.

2.4.3 Vegetation Clearing

A Native Vegetation Clearing Permit (NVCP) is required under the *Environmental Protection Act 1986* (EP Act), prior to undertaking clearing of native vegetation. The granting and administration of these permits are regulated under the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* (regulations). Unless the clearing has been approved under Part IV of the *EP Act* (covered through a Ministerial Statement), or falls under an exemption listed in the regulations, a NVCP is required.

No clearing is expected to be required for the proposed test drilling and pump testing, given the proposed use of the existing cleared areas (track). An NVCP application (Purpose Permit) for clearing associated with the proposed permanent seawater bores, pipeline and access track will be developed and submitted to DWER.

Referral of the Project under Section 38 of the EP Act is not proposed given the expected absence of significant environmental impacts (refer Section 5). The potential impacts associated with clearing and groundwater abstraction can be effectively regulated under other processes (Table 1).

3. STAKEHOLDER CONSULTATION

Extensive discussions and meetings have been held with a range of stakeholders (Table 2).

Table 2: Stakeholder Consultation for the Project

Stakeholder	Date	Issues/Topics Raised	Response/Outcome
DWER (EPA Services (Leanne Thompson) and Marine Ecosystems Branch (Fiona Webster)	13/9/2019	Initial overview of the Project and discussion of approvals processes.	General agreement that Project unlikely to require referral under s38 of the *EP Act*. Need to characterise wastewater discharge to demonstrate low risk of impact to marine environmental quality.
DWER (Yolandee Jones, Midwest Office)	31/3/2020	Initial overview of the Project and discussion of approvals processes.	DWER looking at landuse planning and potential implications of the Project. DWER aware that numerous future approvals will be required, including 5C licence. Requested that further information relating to the whole project, and proposed water abstraction, be provided. The Project intersects a potential contaminated site (Lot 1404) and the proposed management of disturbance in this area should be included in relevant documentation.
DPLH (Crown Land – Gascoyne team, Ken Buchan, Eileen Lemoine)	Ongoing	Project overview, request for s91 License.	Acknowledgement of forthcoming development approval (DA) on Crown Land and requirement for Easement for Infrastructure Components.
Shire of Exmouth (CEO and Council)	Ongoing	Project overview, discussion of planning approvals likely to be required.	Shire has already made a resolution of Council, consenting to the granting of an Easement for the proposed pipeline.

4. EXISTING ENVIRONMENT

4.1 PLANNING AND TENURE

The Project area traverses a number of Crown Land Lots, some of which are Reserves under Management Order to the Shire of Exmouth (or Reserves with no Management Order in place), and some of which are Unallocated Crown Land (UCL), as follows (refer Figure 2):

- Lot 300 – Civic and Community reserve.
- Lot 303 – Public Open Space reserve.
- Lot 1020 – Foreshore reserve.
- Lot 1403 – Special Use 4 zone (LPS 4 objectives are for tourism development) (UCL).
- Lot 1404 – Special Use 4 zone (as above) (UCL).
- Lot 1422 – Public Open Space reserve.

All Lots are subject to the Shire of Exmouth Local Planning Scheme No. 4 (LPS 4). There is no Regional Planning Scheme in place. The determining authority for an application for DA is the Shire of Exmouth (or the Kimberley Pilbara Gascoyne Joint Development Assessment Panel, depending on the cost of the works).

4.2 CLIMATE

The Project is located in a hot semi-arid climate with hot summers and mild winters. Climate data is available for the period since 1945, from the RAAF Learmonth Station located approximately 35 km south of the Project area. The annual mean maximum temperature is 31.9°C and the annual mean minimum temperature is 17.7°C. The mean annual rainfall was recorded at 260.7 mm (BoM 2017).

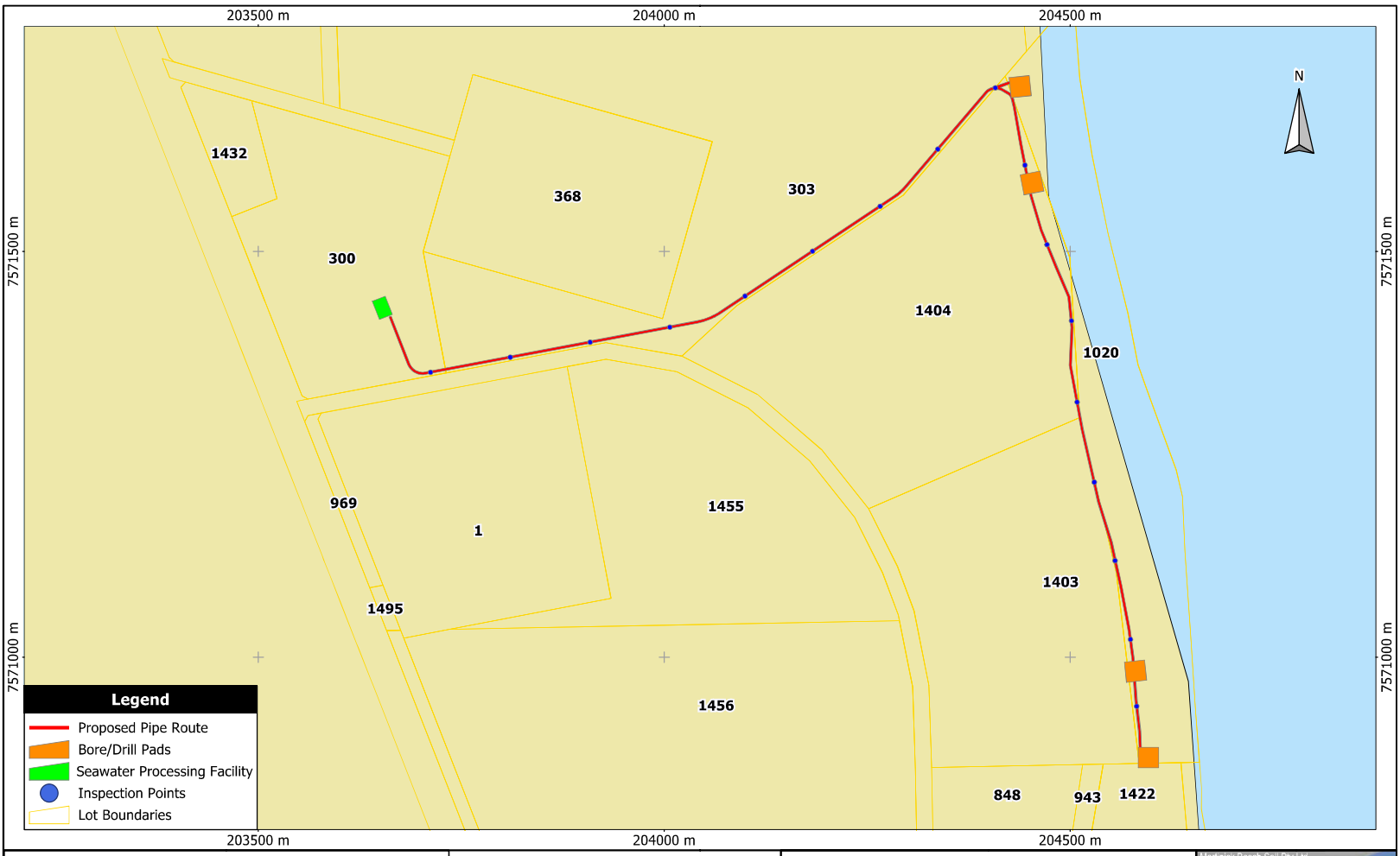


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Figure 2

Lots Intersected by the Project Area

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4.3 SOILS

The Australian Soil Resource Information System identified two soil units within the Project area, the Range System (204Le) and the Learmonth System (204Ra) (CSIRO 1991). The facility and a portion of the proposed pipeline occur within the Range System (204Ra), while the production bores and remainder of the pipeline occur within the Learmonth System (204Le).

These units are described below:

- Range System (204Ra) - Dissected limestone plateaux, hills and ridges with gorges and steep stony slopes supporting hard spinifex, sparse shrubs and eucalypts.
- Learmonth System (204Le) - Sandy outwash plains marginal to the Cape Range, supporting mainly soft spinifex hummock grasslands with scattered acacia shrubs.

4.4 TERRESTRIAL ENVIRONMENTAL FACTORS

4.4.1 Terrestrial Environmental Quality

4.4.1.1 Acid Sulfate Soils

The DWER Acid Sulfate Soil Risk Map: Pilbara Coastline (DWER-053) (DWER 2016) shows the Project area is located in an area with an extremely low probability of acid sulfate soils (ASS) occurring, progressing to a low probability of ASS occurring nearer the coast (Figure 3).

4.4.1.2 Contaminated Sites

Under the *Contaminated Sites Act 2003*, contaminated sites must be reported to DWER, investigated and, if necessary, remediated. A search of DWERs Contaminated Sites Database identified several one confirmed and one potential contaminated site within 5 km of the Ningaloo Centre. The closest registered site is located approximately 120 m to the west (Figure 4). An additional 'possibly contaminated' site is located on Lot 1404 On Plan 192085 and will be intersected by Project infrastructure (Figure 4). This site has been used as an uncontrolled landfill for an unknown period since the 1970s and it is understood that asbestos containing material and asbestos fibres may be present in the soil. The site is classified as 'Possibly contaminated - investigation required' (Appendix 2).

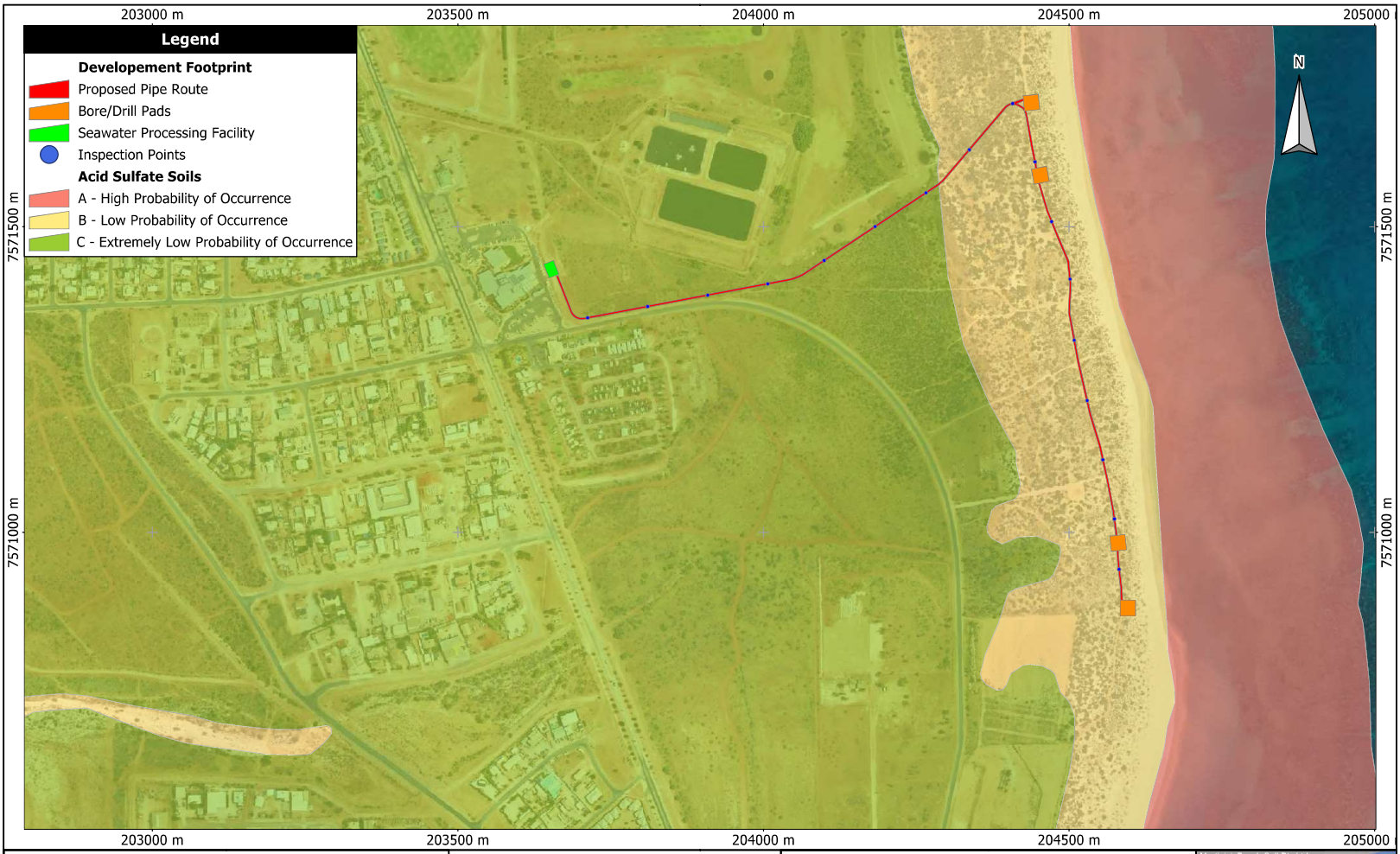

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Figure 3

Acid Sulfate Soils Risk Mapping in the Vicinity of the Project Area

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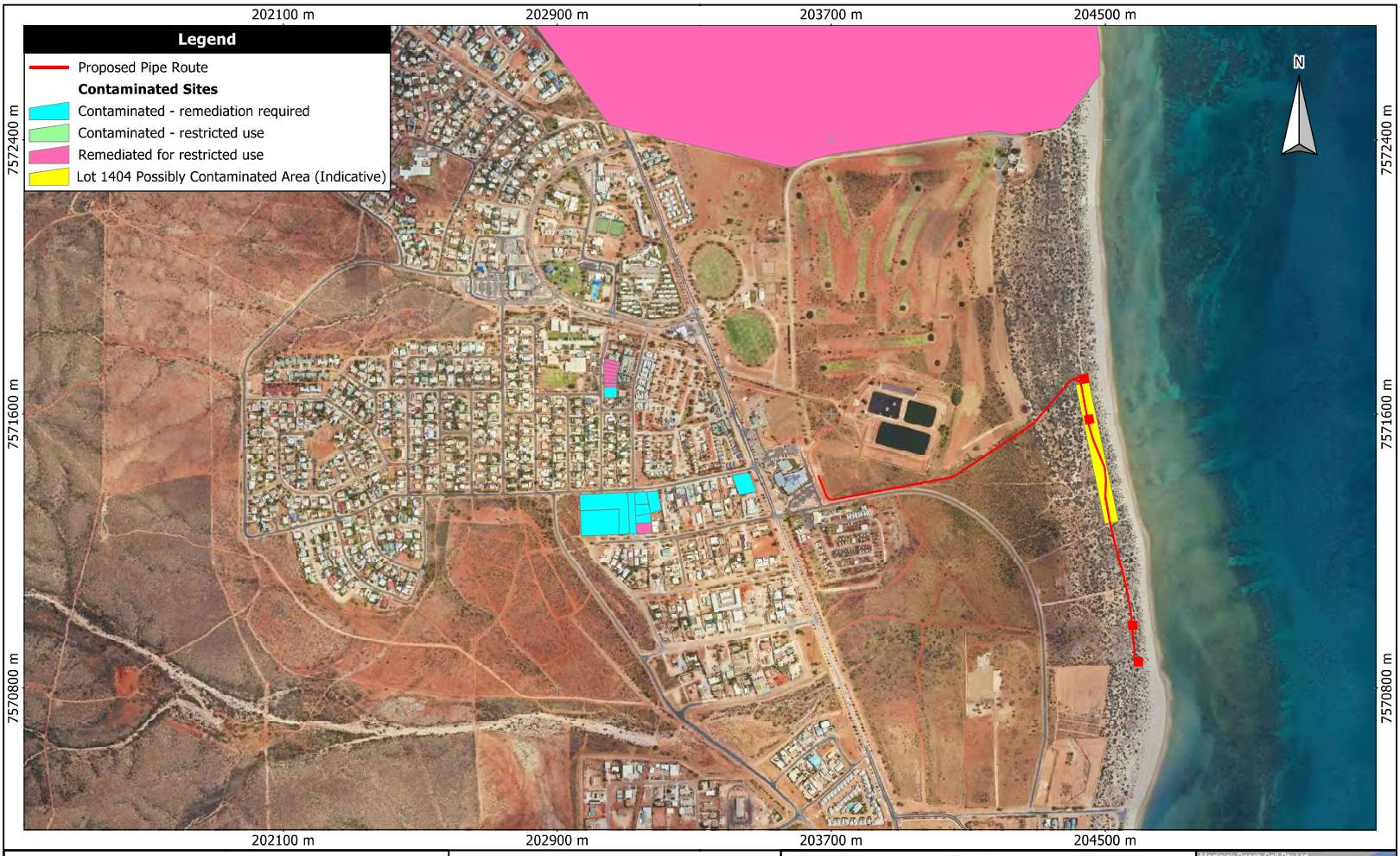

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Figure 4

Contaminated Sites in the Vicinity of the Project Area

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4.4.2 Flora and Vegetation

4.4.2.1 Regions and Land Systems

The Project is located in the Cape Range subregion of the Carnarvon Bioregion. The Carnarvon bioregion is composed of quaternary alluvial, aeolian, and marine sediments overlying Cretaceous strata. It is characterised by a mosaic of saline alluvial plains with samphire and saltbush low shrublands, Bowgada low woodland on sandy ridges and plains, Snakewood scrub on clay flats, and tree to shrub steppe over hummock grasslands on and between red sand dune fields. Limestone strata with *Acacia stuartii* or *A. bivenosa* shrubland outcrop in the north, where extensive tidal flats in sheltered embayment support Mangal (Kendrick and Mau 2002).

Land systems of the Western Australian rangelands have been mapped and described by the Department of Agriculture and Food WA (DAFWA 2012), providing comprehensive descriptions and maps of the biophysical resources of the region, together with an evaluation of the condition of the soils and vegetation throughout. Two land systems occur within the Project area, the Cardabia and Littoral systems:

- Cardabia System: Undulating sandy plains with linear dunes, minor limestone plains and low rises, supporting mainly soft spinifex hummock grasslands with scattered acacias and other shrubs.
- Littoral System: Bare coastal mudflats (unvegetated), samphire flats, sand islands, coastal dunes and beaches, supporting samphire low shrublands, sparse Acacia shrublands, and mangrove forests.

4.4.2.2 Vegetation Associations

Mapping of Pre-European vegetation within Western Australia was completed on a broad scale (1:1,000,000) by Beard (1975) and later re-assessed by Shepherd et al. (2001) with some larger vegetation units divided into smaller units. One broad vegetation type was identified and mapped over the Project area:

- Beard vegetation association 663: Hummock grasslands, shrub steppe; waterwood over soft spinifex.

A site inspection undertaken in February 2020, identified four broad vegetation units as described in Table 3. Selected photographs of the vegetation within the Project area, taken during the site inspection (February 2020), are provided in Table 4.

Table 3: Broad Vegetation Unit Descriptions

Unit Code	Broad Vegetation Description
AES	*Acacia* spp., *Exocarpos* sp. and *Scaevola* spp. Open Shrubland over *Enchylaena* sp. and *Rhagodia* sp. Low Sparse Chenopod Shrubland
ARG	*Acacia* spp. and *Rhagodia* spp. Open Shrubland over Tussock Grassland
ATG	*Acacia* spp. Open Shrubland over Tussock Grassland
CTG	Occasional *Acacia* spp. over Closed Tussock Grassland

It has been noted (EPA 1997) that the coastal dunes adjacent to Exmouth Marina, which is located approximately 1 km south of the proposed abstraction bores, form a distinct vegetation zone with a number of pioneer species such as *Spinifex longifolius*, *Salsola kali*, *Cakile maritima*, *Ipomea brasiliensis* and *Tetragonia decumbens* occurring in the foredune/primary dune and *Ptilotus* spp., *Atriplex isatidea*, *Olearia axillaris*, *Scaevola crassifolia* and *Euphorbia* sp. in the swales. .

Table 4: Photographs of Vegetation Within Project Area (February 2020)

Location	Photographs
Adjacent to Golf Course (West)	
Adjacent to Golf Course (East)	
Northern Bore Pad	
Pipeline Mid-point	
Southern Bore Pad	

4.4.2.3 Significant Flora Species

Searches of NatureMap (DBCA 2019, Appendix 3) and the EPBC Protected Matters Search Tool (PMST) (DoEE 2019, Appendix 4) did not identify any threatened ecological communities or species in proximity to the Project area.

Three Priority flora species were identified as potentially occurring within a 5 km buffer of the Project area and the preferred habitat for these species, and their status under the *Biodiversity Conservation Act 2018* (BC Act) and *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) are presented in Table 5.

The Threatened and Priority Flora Database (TPFL) and the WA Herbarium database (WAHerb) did not return any records for these species within 5 km of the Project area and none of these species were observed during a site inspection in February 2020. It is noted that the optimal time for survey in the Eremaean Botanical Province is 6-8 weeks post wet season (~March-June) with supplementary survey in the dry season (after winter rainfall if available), while the site inspection (not a botanical survey) was undertaken on 5 February 2020 with no rain recorded in Exmouth during the preceding 5 months. *Corchorus congener* (P3) has recently been found to be widespread to the south at Learmonth (Subsea 7 2019).

The TPFL and WAHerb returned records of *Tephrosia* sp. North West Cape (P2), located at 820 m, 1,200 m, 1,524 m and 1,600 m to the west of the Ningaloo Centre (DBCA 2020) (Table 5).

Table 5: Threatened and Priority Flora Potentially Occurring Within 5 km of the Project Area

Species	Cons. Status		Description	Preferred Habitat	Likelihood of Occurrence
	BC Act	EPBC Act			
Corchorus congener	P3	NA	Spreading shrub, to 0.6 m high. Fl. yellow, Apr to Jun or Aug to Nov.	Sand, red sandy loam with limestone. Sand dunes, plains.	Likely
Brachychiton obtusilobus	P4	NA	Tree, 3.5-6 m high. Fl. cream, Aug to Sep.	Skeletal soils. Rocky limestone ranges, gorges, occasionally sandplains.	Possible
Eremophila youngii subsp. *lepidota*	P4	NA	Dense, spreading shrub, (0.2-)1-3 m high. Fl. purple-red-pink, Jan or Mar or Jun or Aug to Sep.	Stony red sandy loam. Flats plains, floodplains, sometimes semi-saline, clay flats.	Possible
Tephrosia sp. North West Cape	P2	NA	Small, spreading shrub, c. 0.2 m tall × 0.7 m wide. FL. orange, 6–6.5 mm long, observed in May and July.	On current knowledge, known only from two locations on North West Cape, where it has been collected from orange-red to brown soil with limestone fragments, over limestone, growing with *Triodia*, *Acacia* and *Ipomea* (Butcher et al. 2017).	Possible

Note: 'P' denotes Priority species (listed by DBCA).

4.4.2.4 Weeds

The *EPBC Act* Protected Matter Database search (DoEE 2019) identified one weed species of national significance, *Cenchrus ciliaris* (Buffel grass), that may occur within 5 km of the Project area. The species is

widespread through the region and is a permitted organism under the West Australian *Biosecurity Management Act 2007*.

4.4.3 Terrestrial Fauna

A desktop search of NatureMap (DBCA 2019) and the PMST (DoEE 2019) was conducted within a 5 km buffer around the Project area to identify Threatened and Migratory species potentially present within the Project area. The PMST search identified 26 threatened species and 39 migratory species and the NatureMap searched identified 37 significant fauna species as potentially occurring within a 5 km radius of the Project area. These species are listed in Table 6.

Table 6: Significant Fauna Potentially Occurring Within 5 km of the Project Area

Common Name	Scientific Name	Conservation Status		
		BC Act	DBCA Listing	EPBC Listing
Birds				
Australian Fairy Wren	*Sternula nereis nereis*	-	-	VU
Barn Swallow	*Hirundo rustica*	IA	-	MI
Bar-tailed Godwit	*Limosa lapponica*	IA	-	MI
Bar-tailed Godwit (baueri)	*Limosa lapponica baueri*	-	-	VU
Bar-tailed Godwit (Northern Siberian)	*Limosa lapponica menzbieri*	VU	-	CR
Black-eared Cuckoo	*Chrysococcyx osculans*	-	-	MA
Caspian Tern	*Hydroprogne caspia*	IA	-	MI
Common Greenshank, Greenshank	*Tringa nebularia*	IA	-	MI
Common Noddy	*Anous stolidus*	IA	-	MI
Common Sandpiper	*Actitis hypoleucos*	IA	-	MI
Crested Tern	*Thalasseus bergii*	IA	-	MI
Curlew Sandpiper	*Calidris ferruginea*	VU	-	CR, MI
Eastern Curlew, Far Eastern Curlew	*Numenius madagascariensis*	VU	-	CR, MI
Fork-tailed Swift	*Apus pacificus*	IA	-	MI
Flesh-footed Shearwater	*Ardenna carneipes*	IA	-	MI
Great Egret	*Ardea alba*	-	-	MA
Cattle Egret	*Ardea ibis*	-	-	MA
Grey Plover	*Pluvialis squatarola*	IA	-	MI
Grey-tailed Tattler	*Tringa brevipes*	-	P4	-
Grey Wagtail	*Motacilla cinerea*	IA	-	MI

Common Name	Scientific Name	Conservation Status		
		BC Act	DBCA Listing	EPBC Listing
Lesser Frigatebird	*Fregata ariel*	IA	-	MI
Little Tern	*Sternula albifrons*	IA	-	MI
Long-toed Stint	*Calidris subminuta*	IA	-	MI
Night Parrot	*Pezoporus occidentalis*	EN	-	EN
Oriental Plover	*Charadrius veredus*	IA	-	MI
Oriental Pratincole	*Glareola maldivarum*	IA	-	MI
Osprey	*Pandion cristatus*	IA	-	MI
Pectoral Sandpiper	*Calidris melanotos*	IA	-	MI
Peregrine Falcon	*Falco peregrinus*	OS	-	-
Pin-tailed Snipe	*Gallinago stenura*	IA	-	MI
Rainbow Bee-eater	*Merops ornatus*	-	-	MA
Red Knot	*Calidris canutus*	EN	-	EN, MI
Red-necked Stint	*Calidris ruficollis*	IA	-	MI
Red-tailed Tropicbird	*Phaethon rubricauda*	-	P4	-
Ruddy Turnstone	*Arenaria interpres*	IA	-	MI
Sharp-tailed Sandpiper	*Calidris acuminata*	IA	-	MI
Southern Giant-Petrel	*Macronectes giganteus*	-	-	EN
Streaked Shearwater	*Calonectris leucomelas*	IA	-	MI
Whimbrel	*Numenius phaeopus*	IA	-	MI
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	-	-	MA
White-tailed Tropic Bird	*Phaethon lepturus*	IA	-	MI
Wood Sandpiper	*Tringa glareola*	IA	-	MI
Yellow Wagtail	*Motacilla flava*	IA	-	MI

Common Name	Scientific Name	Conservation Status		
		BC Act	DBCA Listing	EPBC Listing
Mammals				
Black-flanked Rock-wallaby	*Petrogale lateralis lateralis*	EN	-	EN
Northern Quoll	*Dasyurus hallucatus*	EN	-	EN
Pilbara Leaf-nosed Bat	*Rhinonicteris aurantia* (Pilbara form)	VU	-	VU
Potential SRE				
Northern Cape Range Draculoides	*Draculoides brooksi*	EN	-	-
Cameron's Cave Pseudoscorpion	*Indohya damocles*	CR	-	-
Cameron's Cave Millipede	*Stygiochiropus peculiaris*	CR	-	-

CR – Critically Endangered, EN – Endangered, VU – Vulnerable, MI – Migratory, MA – Marine, CD – Conservation dependent fauna
OS – Other specially protected fauna, P3 and P4 – Priority species
IA – Migratory birds protected under an international agreement

4.4.4 Inland Waters

4.4.4.1 Groundwater

Groundwater within the region generally flows eastwards, from Cape Range (source of groundwater recharge) towards Exmouth Gulf where it discharges (DoW 2011). Local groundwater flow patterns are likely to be significantly affected by karstic features.

In general, the unconfined aquifer in the region has a layer of fresh groundwater (less than 1,000 mg/L) varying in thickness from a few metres to several hundred metres thick in the karst limestone of the Cape Range. This fresh ground water overlies salt water (more than 35,000 mg/L) and there is transition zone between these with gradually increasing salinity with depth. The fresh water is thinnest at the coast, and in some areas is absent (EPA 1997). The location of the expected saline wedge and interface between fresh groundwater in the west and saline groundwater in the east is not accurately known. Test drilling of the proposed production bores will confirm the local geology, depth to groundwater and the salinity of the groundwater at different depths.

Groundwater salinity across the Exmouth Marina site, located approximately 1 km south of the Project area, was found to be in the range of 20,000 mg/L to 60,000 mg/L and the depth of the groundwater ranged from 2 m adjacent to the coast to approximately 6 m on the western boundary of the site (EPA 1997). Water quality data (DWER 2019a) indicate that the total dissolved solids (TDS) concentration within the surficial aquifer within the Project area is likely to be between 500 – 1,000 mg/L.

The Project area lies within the Gascoyne Groundwater Area, specifically the Exmouth Townsite Groundwater Sub-Area (DWER 2019b). No Public Drinking Water Source Areas (PDWSAs) are located in proximity to the site, with the Exmouth Water Reserve located 1.5 km west of the site (DWER 2019c, Figure 5).

The nearest third party production bores are located approximately 500 m south of the proposed production bores (Figure 5). A licence will be required for any groundwater abstraction. It is noted that the Project is proposing to abstract seawater rather than water from the surficial aquifer.

4.4.4.2 Surface Water

The Project is located at the eastern (or coastal) end of the Cape Range peninsula coastal 'floodplain'. The plain is relatively flat with numerous creeks and drainage lines which may flood during high rainfall events. The stormwater runoff is generally absorbed behind the coastal dunes within dissipation and infiltration areas prior to reaching Exmouth Gulf (EPA 1997).

On 22 March 1999, Tropical Cyclone Vance (Category 5 Cyclone) crossed the Exmouth coast. Approximately 150 mm of rain fell during the 10 hour period between 9am and 7pm on 22 March 1999. Based on this rainfall intensity (15 mm/hr), Tropical Cyclone Vance rainfall represented a 1 in 20 year average recurrence interval (ARI) event. Flooding in Exmouth occurred in the area between Murat Rd and the coast, the area in which the Project is proposed, due to a combination of storm surge and stormwater runoff. Flood debris along the eastern side of the coastal dunes indicates a peak flood level of approximately 4.5 mAHD. Aerial photography taken by the Department of Land Administration (DOLA) two days following the event show little ponding remaining, suggesting most water infiltrated or flowed out into the Gulf of Exmouth within 48 hours. Anecdotal evidence confirms most of this water had flowed out to the Gulf of Exmouth by 6pm on the day of the cyclone (JDA 2000).

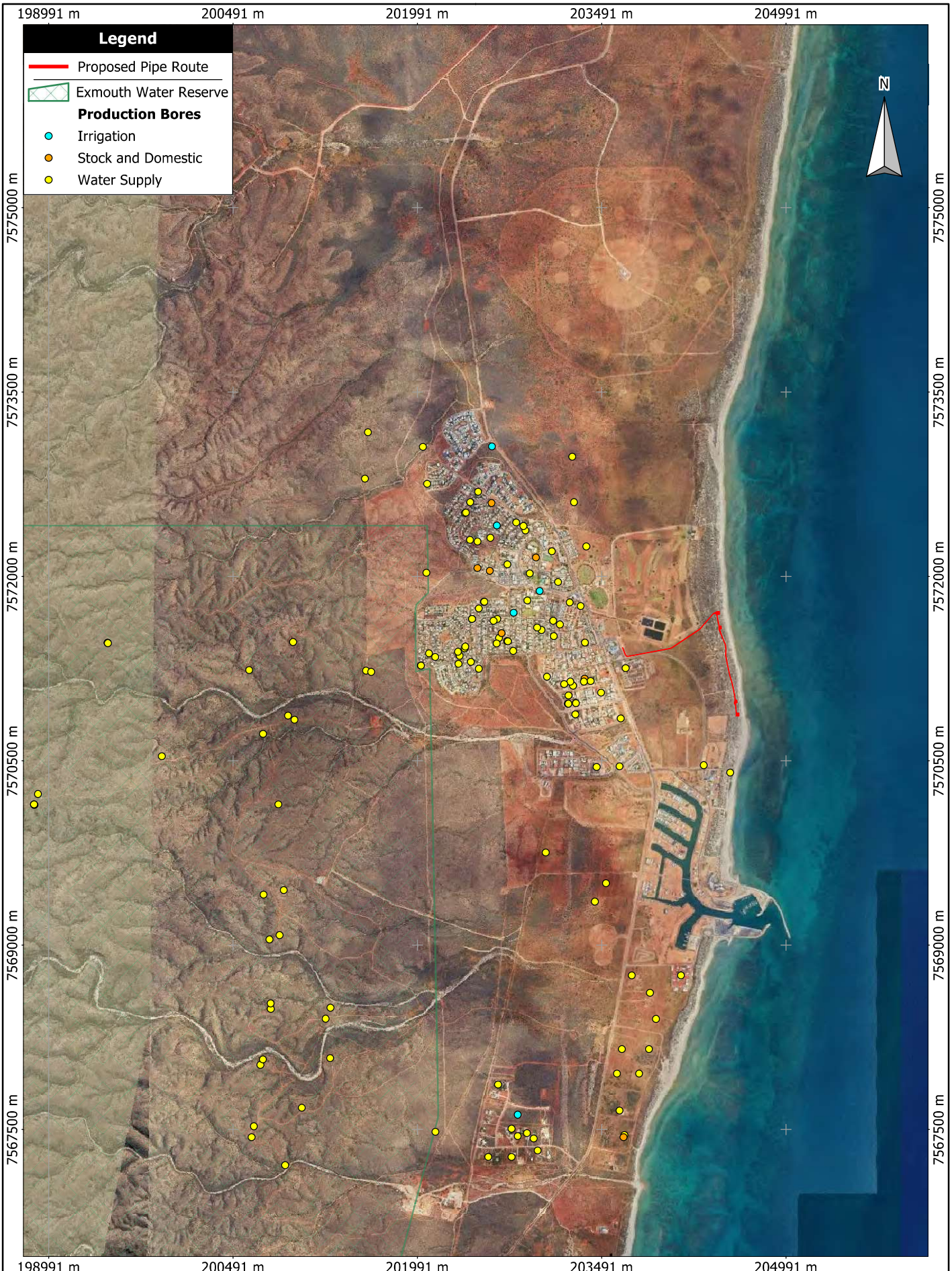

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Figure 5

The Exmouth Water Reserve and Licenced Production Bores in Relation to the Project Area

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4.4.5 Subterranean Fauna

A number of subterranean fauna studies have previously been undertaken within the region. The Cape Range coastline, specifically the Western Cape, located several kilometres to the west of the Project area, is a hotspot and key habitat for subterranean fauna due to the extensive limestone caves and karstic geologies found. A diverse relictual rainforest fauna of over 55 species of subterranean fauna have been documented and recorded (Humphreys 2000, 2004, 2008). Many of the subterranean species associated with Cape Range karstic habitat (aquatic, troglobitic) are protected under legislation. Two of Australia's four stygobitic vertebrate species, the stygofaunal fish blind gudgeon (*Milyeringa veritas*) and the blind cave eel (*Ophisternon candidum*) (Moore *et al.* 2018), are listed as vulnerable under the *EPBC Act*, and the blind shrimp (Stygiocaris stylifera) is listed as a Priority 4 species by the DBCA (Bennelongia 2017). These species are not known to occur in proximity to the Project area, and are considered unlikely to occur given the elevated salinity of groundwater immediately adjacent to the coast.

The Cameron's Cave Threatened Ecological Community (TEC) is located near the Exmouth Townsite, approximately 2.5 km south of the Ningaloo Centre. It comprises of various highly troglomorphic fauna including the pseudoscorpion *Indohya damocles* (Harvey 1993), the harvestman *Glennhuntia glennhunti* (Shear 2001), and the millipede *Stygiochiropus peculiaris* (Shear and Humphreys 1996).

4.5 MARINE ENVIRONMENTAL FACTORS

4.5.1 Benthic Communities and Habitats

Benthic habitats play important roles in maintaining the integrity of marine ecosystems and the supply of ecological services (EPA 2009).

Habitat mapping completed by Bancroft (2003) indicates that benthic habitat adjacent to the beach in proximity to the Project area is classified as 'soft sediment'. The Project area is located approximately 10 km south of the Bundegi Reef which has a rich coral and marine fauna community (EPA 1997).

4.5.2 Marine Environmental Quality

Previous regional studies have characterised Exmouth Gulf as having a naturally turbid state due to wind, waves and tidal currents causing resuspension of the fine sediments found throughout the gulf. Primary productivity within the region from phytoplankton biomass is relatively low and is limited by the availability of nitrogen within the system. Water temperatures range from 18° to 30°C (tropical) depending on season, with salinity ranges similar to oceanic measurements (34 to 36 PSU).

A sediment quality survey to determine background concentrations of a range of selected heavy metals and organic chemicals in the Pilbara marine waters from Exmouth Gulf to Port Hedland found the sediments from five sites within Exmouth Gulf to exhibit relatively low levels of contaminants (DEC 2006), as follows:

- Arsenic (7-19 mg/kg).
- Cobalt (0.5-27 mg/kg).
- Copper (0.5-2.1 mg/kg).
- Nickel (1.0-4.8 mg/kg).
- Lead (<1-3 mg/kg).
- Zinc (1.2-9.8 mg/kg).

The differences between sites were predominantly driven by the sediment particle size, with contaminants known to bind to fine (<63 µm) particles. The percentage of fines recorded within the samples varied from 0.5 to 11.3% (DEC 2006).

Water sampling within Exmouth Gulf in December 2016, at sites off Heron Point approximately 30 km south of the Project area, recorded nutrient levels generally below the tropical waters guideline (Table 7) (360 Environmental 2017). The bioavailable fractions of nitrogen (ammonia and oxides of nitrogen) and phosphorus (ortho-phosphate) were recorded at or below detection limits, indicating that the nutrients are not readily available for primary producer uptake.

Table 7: Water column Nutrient Concentrations off Heron Point (December 2016)

Analyte	Units	Guideline Value (Tropical Australia (ANZECC 2000))	Mean Value
Ammonia (as N)	µg/L	1-10	<3
Ortho-Phosphate	µg/L	NA	2.7
Nitrate & Nitrite (NOx)	µg/L	208	<2
Total Phosphorus (TP)	µg/L	15	14.7
Total Nitrogen (TN)	µg/L	100	96
Chlorophyll-a	µg/L	0.7-1.4	0.6

Note: where a range is provided, the lower values are typical of clear coral dominated waters (e.g. Great Barrier Reef), while higher values are typical of turbid microtidal systems (e.g. North West Shelf of Western Australia) (ANZECC & ARMCANZ 2000).

4.5.3 Marine Fauna

A desktop search of NatureMap (DBCA 2019) and the EPBC PMST (DoEE 2019) was conducted within a 5 km buffer around the Ningaloo Centre to identify Threatened and Migratory species potentially present within the marine area adjacent to the Project site. The PMST search identified 15 Threatened marine species, 18 Migratory species and 39 species listed as Marine. The NatureMap searched identified five significant fauna species as potentially occurring within a 5 km radius of the Project area. These species are detailed in Table 8.

Table 8: Significant Marine Fauna Potentially Occurring in Exmouth Gulf

Common Name	Scientific Name	Conservation Status		
		BC Act	DBCA Listing	EPBC Listing
Mammals				
Australian humpback dolphin	*Sousa sahulensis*		P4	
Bryde's Whale	*Balaenoptera edeni*			
Dugong	*Dugong dugon*	OS		MI
Humpback Whale	*Megaptera novaeangliae*	CD		VU, MI
Indo-Pacific Humpback Dolphin	*Sousa chinensis*			MI
Killer Whale	*Orcinus orca*			MI
Spotted Bottlenose Dolphin (Arafura/Timor Sea populations)	*Tursiops aduncus*			MI
Southern Right Whale	*Eubalaena australis*	VU		EN, MI
Reptiles				
Flatback Turtle	*Natator depressus*	VU		VU, MI
Green Turtle	*Chelonia mydas*	VU		VU, MI
Hawksbill Turtle	*Eretmochelys imbricata*	VU		VU, MI
Leatherback Turtle	*Dermochelys coriacea*	VU		EN, MI
Loggerhead Turtle	*Caretta caretta*	EN		EN, MI
Short-nosed Seasnake	*Aipysurus apraefrontalis*	CR		CR, MA
Horned Seasnake	*Acalyptophis peronii*			MA
Dubois' Seasnake	*Aipysurus duboisii*			MA
Spine-tailed Seasnake	*Aipysurus eydouxii*			MA
Olive Seasnake	*Aipysurus laevis*			MA
Stokes' Seasnake	*Astrotia stokesii*			MA

Common Name	Scientific Name	Conservation Status		
		BC Act	DBCA Listing	EPBC Listing
Spectacled Seasnake	*Disteira kingii*			MA
Olive-headed Seasnake	*Disteira major*			MA
Turtle-headed Seasnake	*Emydocephalus annulatus*			MA
North-western Mangrove Seasnake	*Ephalophis greyi*			MA
Elegant Seasnake	*Hydrophis elegans*			MA
Spotted Seasnake	*Hydrophis ornatus*			MA
Yellow-bellied Seasnake	*Pelamis platurus*			MA
Fish				
Blind Gudgeion	*Milyeringa veritas*	VU		VU
Blind Cave Eel	*Ophisternon candidum*	VU		VU
Spear-beaked Cave Shrimp	*Stygiocaris stylifera*		P4	
Grey Nurse Shark	*Carcharias taurus (west coast population)*	VU		VU
Great White Shark	*Carcharodon carcharias*	VU		VU, MI
Dwarf Sawfish	*Pristis clavata*		P1	VU, MI
Green Sawfish	*Pristis zijsron*	VU		VU, MI
Narrow Sawfish	*Anoxypristis cuspidata*	IA		MI
Whale Shark	*Rhincodon typus*	OS		VU, MI
Reef Manta Ray	*Manta alfredi*			MI
Giant Manta Ray	*Manta birostris*			MI
Braun's Pughead Pipefish	*Bulbonaricus brauni*			MA
Three-keel Pipefish	*Campichthys tricarinatus*			MA
Pacific Short-bodied Pipefish	*Choeroichthys brachysoma*			MA
Pig-snouted Pipefish	*Choeroichthys suillus*			MA

Common Name	Scientific Name	Conservation Status		
		BC Act	DBCA Listing	EPBC Listing
Cleaner Pipefish	*Doryrhamphus janssi*			MA
Flagtail Pipefish	*Doryrhamphus negrosensis*			MA
Ladder Pipefish	*Festucalex scalaris*			MA
Tiger Pipefish	*Filicampus tigris*			MA
Brock's Pipefish	*Halicampus brocki*			MA
Mud Pipefish	*Halicampus grayi*			MA
Glittering Pipefish	*Halicampus nitidus*			MA
Spiny-snout Pipefish	*Halicampus spinirostris*			MA
Ribboned Pipehorse	*Haliichthys taeniophorus*			MA
Beady Pipefish	*Hippichthys penicillus*			MA
Western Spiny Seahorse	*Hippocampus angustus*			MA
Spiny Seahorse	*Hippocampus histrix*			MA
Spotted Seahorse	*Hippocampus kuda*			MA
Flat-face Seahorse	*Hippocampus planifrons*			MA
Three-spot Seahorse	*Hippocampus trimaculatus*			MA
Tidepool Pipefish	*Micrognathus micronotopterus*			MA
Pallid Pipehorse	*Solegnathus hardwickii*			MA
Gunther's Pipehorse	*Solegnathus lettiensis*			MA
Robust Ghostpipefish	*Solenostomus cyanopterus*			MA
Double-end Pipehorse	*Syngnathoides biaculeatus*			MA
Bentstick Pipefish	*Trachyrhamphus bicoarctatus*			MA
Straightstick Pipefish	*Trachyrhamphus longirostris*			MA

CR – Critically Endangered, EN – Endangered, VU – Vulnerable, MI – Migratory, MA – Marine, CD – Conservation dependent fauna
OS – Other specially protected fauna, P3 and P4 – Priority species

4.6 SOCIAL SURROUNDS

4.6.1 Native Title

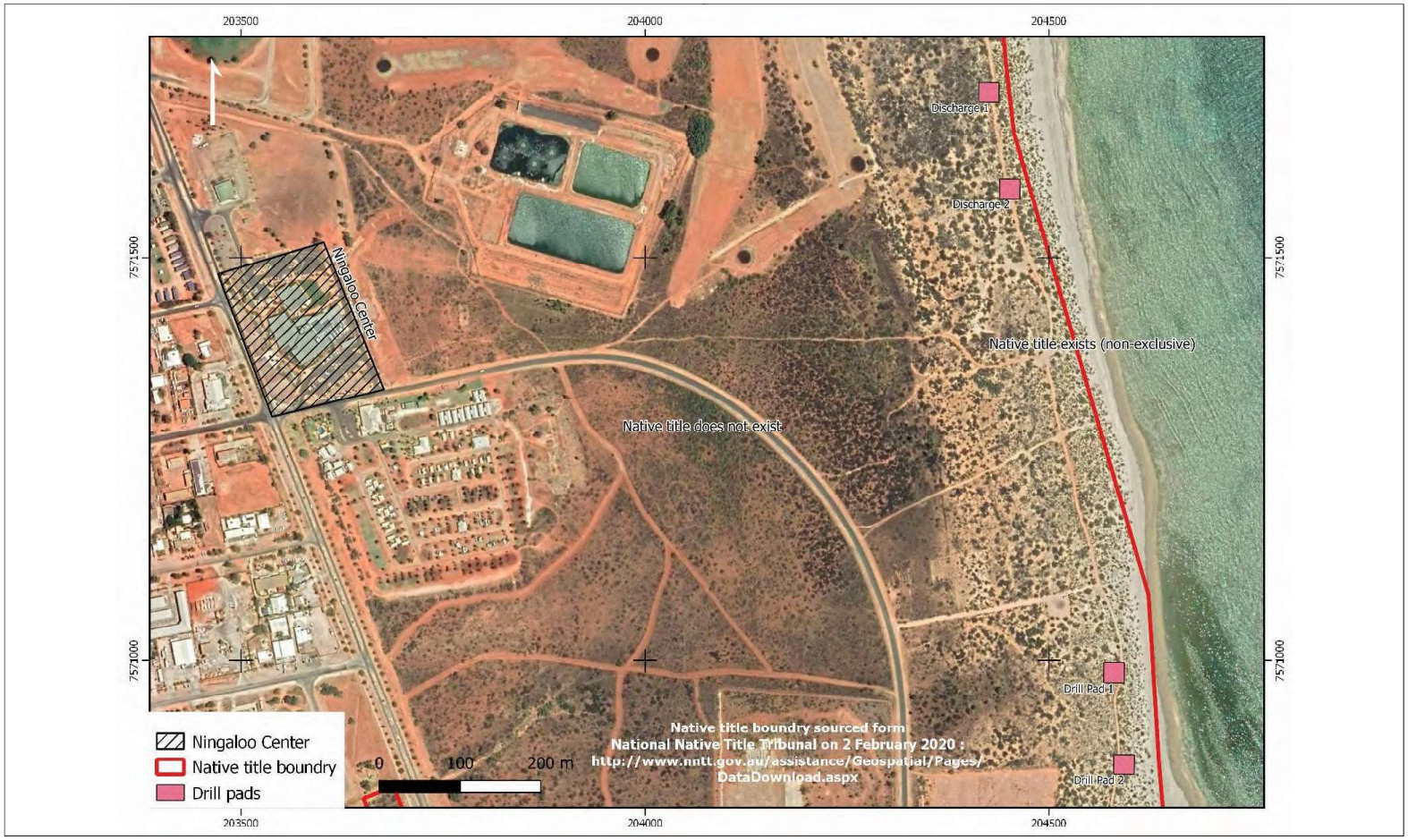
The *Native Title Act 1993* provides for the recognition and protection of native title rights of Aboriginal people who have maintained a traditional connection to their land and waterways since sovereignty. Native Title rights have been extinguished over land that has been subject to grants of land tenure, including land in freehold or leasehold from the Crown (DAA 2017). The Gnulli native claim covers parts of the region but does not intersect the Project area (Figure 6, NNTT 2020).

4.6.2 Aboriginal Heritage

In Western Australia, the *Aboriginal Heritage Act 1972* protects places and objects customarily used by, or traditional to, the original habitants of Australia. Desktop review of the Department of Aboriginal Affairs' (DAA) Aboriginal Heritage Inquiry System identified no registered heritage places within 5 km of the Project area but two lodged Aboriginal Heritage sites approximately 1 km north of the Project area (Table 9, Figure 7).

Table 9: Aboriginal Heritage Sites in Proximity to the Project Area

Object ID	Site ID	Site Type	Status
41	756	Ceremonial, Mythological, Engraving, Grinding patches / grooves	Registered
7105	6115	Skeletal material/Burial	Insufficient Information
7106	6116	Skeletal material/Burial	Insufficient Information
7276	6312	Artefacts / Scatter	Insufficient Information
17590	19838	Artefacts / Scatter, Midden / Scatter	Lodged
17591	19839	Artefacts / Scatter	Lodged



Scale: 1:15000 Original Size: A4 Data Source: NNTT 2020 Grid: MGA94(50)	Minderoo Foundation Ningaloo Aquaculture Laboratory Environmental Assessment Report	**Figure 6** **Status of Native Title in Proximity to the Project Area (NNTT 2020)**	Martinick Bosch Seil Pty Ltd 4 Cook St West Perth WA 6005 Australia t:+61 8 9226 3166 info@mbsenvironmental.com.au www.mbsenvironmental.com.au

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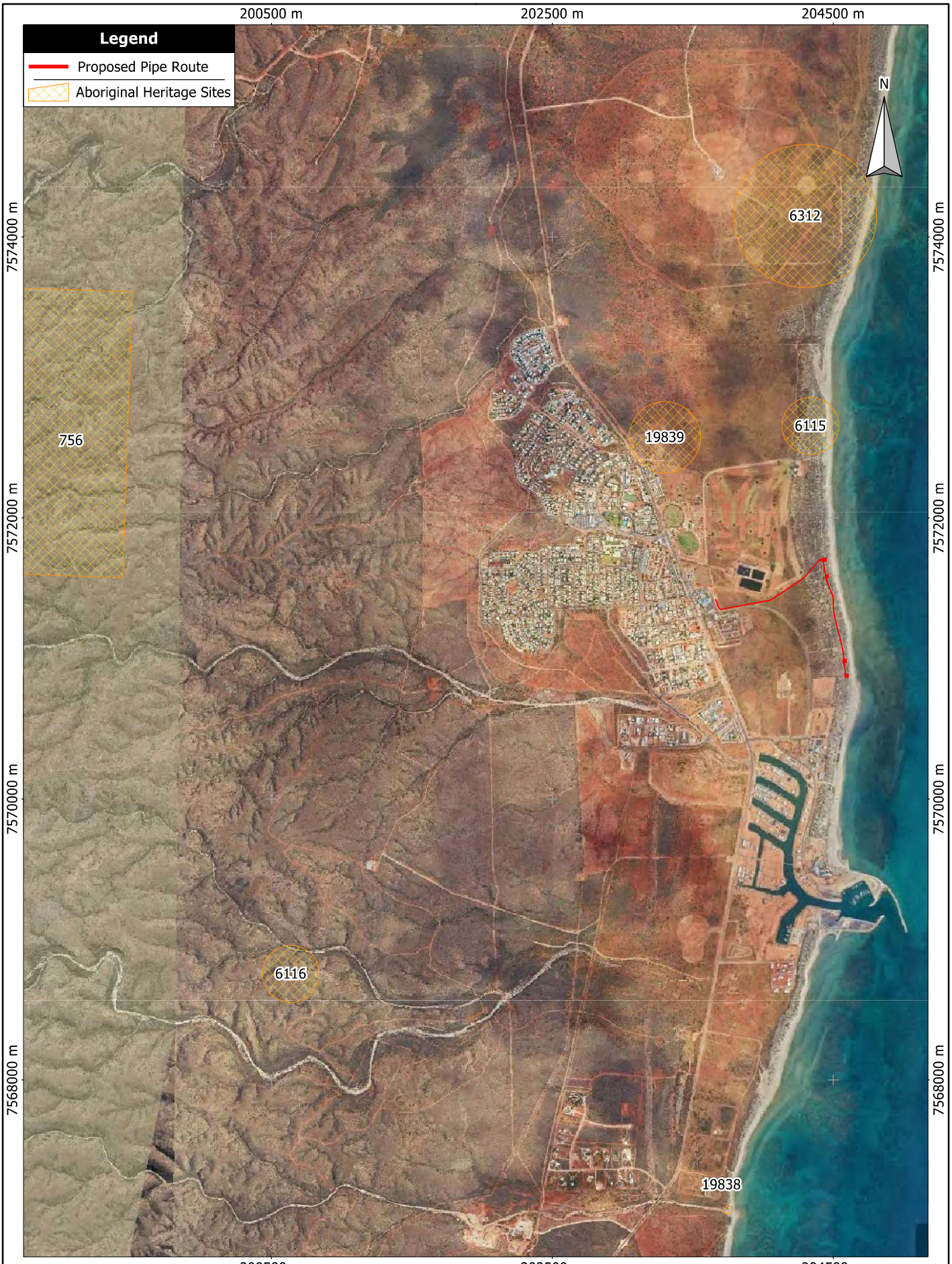

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Figure 7

Registered or Lodged Aboriginal Heritage Sites in Proximity tothe Project Area

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5. PRELIMINARY IMPACT ASSESSMENT

5.1 PRELIMINARY KEY ENVIRONMENTAL FACTORS

Based on the information in Section 4, the following environmental factors have been identified for preliminary assessment:

- Terrestrial Environmental Quality.
- Flora and Vegetation.
- Terrestrial Fauna.
- Inland Waters.
- Marine Environmental Quality.

The risk of impact to subterranean fauna is considered negligible given the targeting of marine water rather than freshwater or brackish water, the separation of the Project area from Cameron's Cave, the few species previously collected from the coastal plain in the region (Bennelongia 2018) and the minimal disturbance of potential subterranean fauna habitat (limestone).

The risk of impact to benthic communities and habitats is also considered negligible given the relatively small 'effluent' discharge volumes, and the absence of contaminants and low nutrient concentrations within the waste stream.

5.2 TERRESTRIAL ENVIRONMENTAL QUALITY

The proposed pipeline involves minimal excavation, to a maximum depth of 1 m, which will occur within an area with a low probability of ASS (Figure 3). Dewatering of the trench is not expected to be required as the land elevation adjacent to the pipeline route is approximately +5 m AHD. The proposed leach drains will also involve minimal excavation. The proposed bores will involve minimal disturbance and removal of soils.

The proposed pipeline and southern discharge bore/leach drain intersect the indicative location of a suspected contaminated site (Figure 4). Construction works in this area will be suitably managed to minimise the risk of exposure of workers to airborne asbestos (refer Section 6). In the event that contaminated material, including that containing asbestos or hydrocarbons, is excavated, this will not be returned to the ground following pipeline or bore/drain placement, but will be recovered for disposal at a licenced facility.

Overall the risk of a significant impact to terrestrial environmental quality is minor.

5.3 FLORA AND VEGETATION

Four broad vegetation units were described within the Project area following a site inspection in February 2020 (Table 3). Potential impacts to flora and vegetation, through clearing, will be addressed in more detail within the NVCP application. An indicative clearing area is presented in Figure 8. Approximately 0.4 ha of native vegetation is expected to be cleared for the construction of the bore pads/leach drains (pad size of 25 m x 25 m), pipeline easement (1 m in width) and access track (approximately 3 m in width).

Potential impacts to flora and vegetation as a result of clearing will be addressed within the NVCP application.

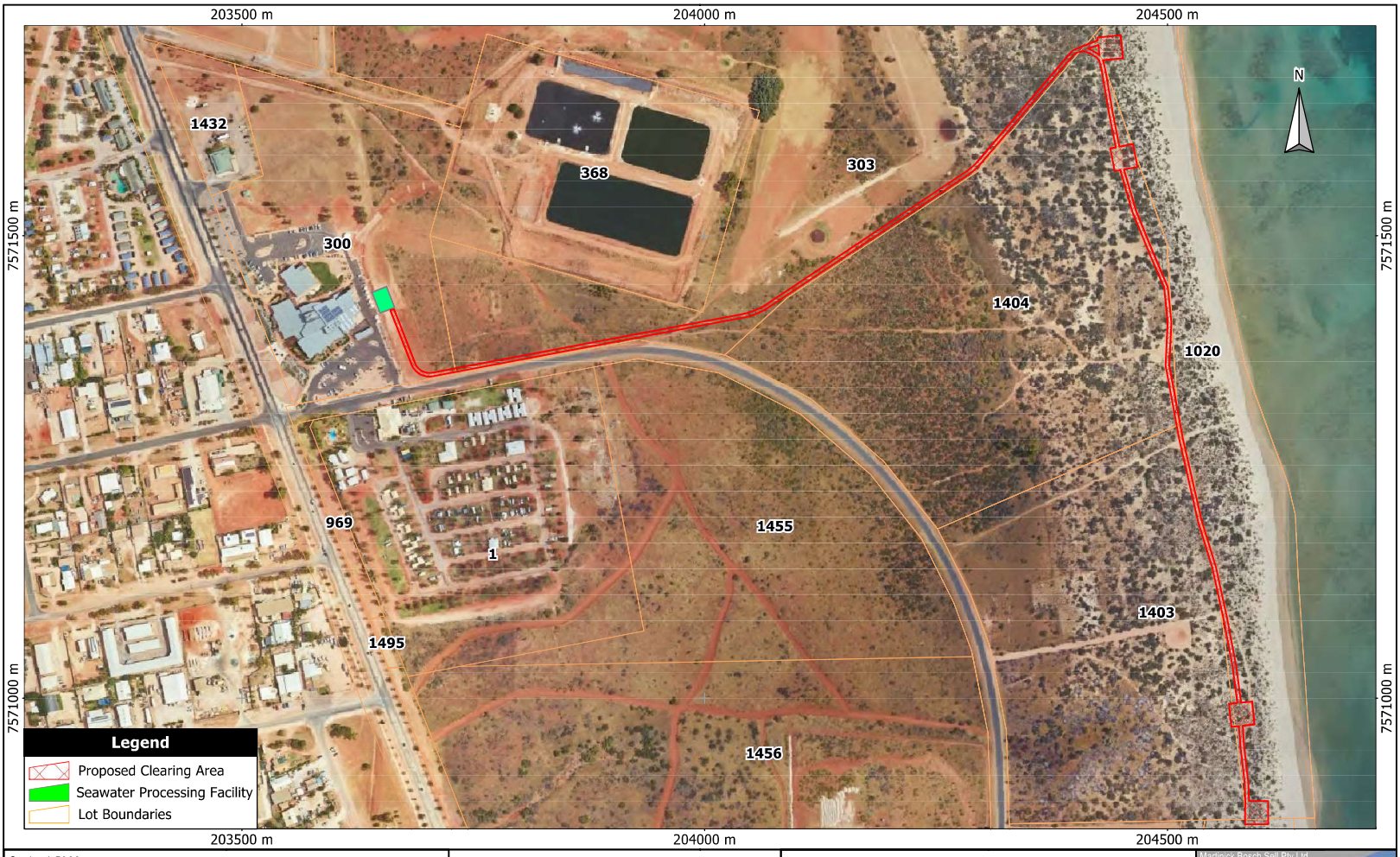

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Figure 8

Proposed Clearing Area

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5.4 TERRESTRIAL FAUNA

The likelihood of significant fauna species occurring within the Project area is assessed in Table 10. Given the absence of wetland or intertidal marine habitat within or immediately adjacent to the Project area, no impacts to shorebirds or marine species are expected. Several species may occur within or adjacent to the Project area, but they are generally species that exhibit a broad distribution, with the Project area unlikely to represent key habitat.

There is potential for smaller fauna to become trapped within the open trench during pipeline construction. The construction period will be relatively short (approximately six weeks) and the trench will be relatively small (approximately 1 m wide and 1 m deep). Trench management procedures will be outlined within a Construction Management Plan (CMP) (Section 6).

Given the low likelihood of occurrence of the majority of significant fauna species, absence of key habitat within the Project area, and minimal extent of clearing (refer Section 5.2), a significant impact on terrestrial fauna is not expected. Potential impacts to terrestrial fauna, through habitat loss, will be addressed within the NVCP application.

Table 10: Likelihood of Significant Fauna Potentially Occurring Within Project Area

Common Name	Scientific Name	Likelihood of Occurrence	Rationale/ Explanation
Barn Swallow	*Hirundo rustica*	Possible	The Barn Swallow is an uncommon to locally common summer visitor, mainly to coastal areas of north WA and south to Learmonth, inhabiting towns and wetlands (Johnstone & Storr 1998). There are no known records of the Barn Swallow in the Exmouth area.
Bar-tailed Godwit	*Limosa lapponica*	Unlikely	No roosting or foraging habitat within Project footprint.
Bar-tailed Godwit (baueri)	*Limosa lapponica baueri*	Unlikely	No roosting or foraging habitat within Project footprint.
Bar-tailed Godwit (Northern Siberian)	*Limosa lapponica menzbieri*	Unlikely	No roosting or foraging habitat within Project footprint.
Black-eared Cuckoo	*Chrysococcyx osculans*	Possible	This species is common in most areas of Australia except wet coastal forested areas, and prefers dry open forests, scrublands, mallee, mulga, lignum, saltbush and riverside thickets (Atlas of Living Australia 2020).
Australian Fairy Tern	*Sternula nereis nereis*	Unlikely	No roosting or foraging habitat within Project footprint.
Caspian Tern	*Hydroprogne caspia*	Unlikely	No roosting or foraging habitat within Project footprint.
Common Greenshank, Greenshank	*Tringa nebularia*	Unlikely	No roosting or foraging habitat within Project footprint.
Common Noddy	*Anous stolidus*	Unlikely	No roosting or foraging habitat within Project footprint.
Common Sandpiper	*Actitis hypoleucos*	Unlikely	No roosting or foraging habitat within Project footprint.
Crested Tern	*Thalasseus bergii*	Unlikely	No roosting or foraging habitat within Project footprint.
Curlew Sandpiper	*Calidris ferruginea*	Unlikely	No roosting or foraging habitat within Project footprint.
Eastern Curlew, Far Eastern Curlew	*Numenius madagascariensis*	Unlikely	No roosting or foraging habitat within Project footprint.
Fork-tailed Swift	*Apus pacificus*	Unlikely	The Fork-tailed Swift is a non-breeding visitor to all states and territories of Australia (Higgins 1999). It is a summer migrant to Australia usually during the months of October-April. The Fork-tailed Swift is an aerial species which forages high above the tree canopy and is mostly independent of terrestrial habitats. It occurs in flocks of up to 2,000 birds and is often seen accompanying Tree Martins and Masked Wood

Common Name	Scientific Name	Likelihood of Occurrence	Rationale/ Explanation
			swallows (Johnstone & Storr 1998). Given the absence of a tree canopy in the Project area and surrounds, this species is considered unlikely to occur.
Flesh-footed Shearwater	*Ardenna carneipes*	Unlikely	No roosting or foraging habitat within Project footprint
Great Egret	*Ardea alba*	Unlikely	No roosting or foraging habitat within Project footprint
Cattle Egret	*Ardea ibis*	Unlikely	No roosting or foraging habitat within Project footprint
Grey Plover	*Pluvialis squatarola*	Unlikely	No roosting or foraging habitat within Project footprint
Grey-tailed Tattler	*Tringa brevipes*	Unlikely	No roosting or foraging habitat within Project footprint
Grey Wagtail	*Motacilla cinerea*	Unlikely	This species inhabits fast-flowing mountain streams and rivers with riffles and exposed rocks or shoals, often in forested areas. It is also found in more lowland watercourses, even canals, where there are artificial waterfalls, weirs, millraces or lock gates. Outside of the breeding season it occupies a wider variety of habitats, including farmyards, sewage farms, forest tracks and even town centres (Tyler 2016). Given the absence of surface water features in the Project area and surrounds, this species is considered unlikely to occur.
Lesser Frigatebird	*Fregata ariel*	Unlikely	No roosting or foraging habitat within Project footprint
Little Tern	*Sternula albifrons*	Unlikely	No roosting or foraging habitat within Project footprint
Long-toed Stint	*Calidris subminuta*	Unlikely	No roosting or foraging habitat within Project footprint
Night Parrot	*Pezoporus occidentalis*	Unlikely	The DBCA threatened fauna database has no records of the Night Parrot in the Project area or surrounds. The Interim Night Parrot Survey Guidelines (May 2017) identify the broad habitat requirements of the Night Parrot (roosting and nesting together with foraging) as including areas of old-growth dense spinifex clumps (Triodia) (often >50 years unburnt, and especially hummocks that are ring forming) (DPaW 2017). The Project area does not contain dense old growth spinifex clumps and consequently the Night Parrot is considered unlikely to occur.
Oriental Plover	*Charadrius veredus*	Unlikely	No roosting or foraging habitat within Project footprint
Oriental Pratincole	*Glareola maldivarum*	Possible	This species is found in the warmer parts of south and east Asia, breeding from North Pakistan and the Kashmir region across into China and south west. They are migratory, wintering in India and Pakistan, Indonesia and Australasia.
Osprey	*Pandion cristatus*	Possible	The Osprey forages in marine/aquatic environments, therefore any loss of vegetation associated with the Project will not impact the foraging of this species. No

Common Name	Scientific Name	Likelihood of Occurrence	Rationale/ Explanation
			nests were observed during a site inspection (February 2020)
Pectoral Sandpiper	*Calidris melanotos*	Unlikely	No roosting or foraging habitat within Project footprint
Peregrine Falcon	*Falco peregrinus*	Unlikely	The Peregrine Falcon is found in most habitats, from rainforests to the arid zone, and at most altitudes, from the coast to alpine areas. It requires abundant prey and secure nest sites and prefers coastal and inland cliffs or open woodlands near water. Given the absence of cliffs and open woodlands in the Project area and surrounds, this species is considered unlikely to occur.
Pin-tailed Snipe	*Gallinago stenura*	Unlikely	The species distribution within Australia is not well understood. In Western Australia the species has been reported in the Pilbara, at Port Headland, Myaree Pool, Maitland River and near Karratha. During non-breeding period the Pin-tailed Snipe occurs most often in or at the edges of shallow freshwater swamps, ponds and lakes with emergent, sparse to dense cover of grass/sedge or other vegetation. The species is also found in drier, more open wetlands such as claypans in more arid parts of species' range. It is also commonly seen at sewage ponds; not normally in saline or inter-tidal wetlands (Higgins & Davies 1996). Given the absence of wetlands in the Project area and surrounds, this species is considered unlikely to occur.
Rainbow Bee-eater	*Merops ornatus*	Possible	This species is one of the most common and widespread birds in Australia with a distribution that covers the majority of Australia (Barrett et al. 2003). In WA this species can occur as a 'resident, breeding visitor, postnuptial nomad, passage migrant and winter visitor' (Johnstone & Storr 2004). The Project area does not contain any habitat that is of specific preference to the species, and not abundant across the wider region.
Red Knot	*Calidris canutus*	Unlikely	No roosting or foraging habitat within Project footprint.
Red-necked Stint	*Calidris ruficollis*	Unlikely	No roosting or foraging habitat within Project footprint.
Red-tailed Tropicbird	*Phaethon rubricauda*	Unlikely	No roosting or foraging habitat within Project footprint.
Ruddy Turnstone	*Arenaria interpres*	Unlikely	No roosting or foraging habitat within Project footprint.
Sharp-tailed Sandpiper	*Calidris acuminata*	Unlikely	No roosting or foraging habitat within Project footprint.
Southern Giant-Petrel	*Macronectes giganteus*	Unlikely	No roosting or foraging habitat within Project footprint.
Streaked	*Calonectris*	Unlikely	No roosting or foraging habitat within Project footprint.

Common Name	Scientific Name	Likelihood of Occurrence	Rationale/ Explanation
Shearwater	*leucomelas*		
Whimbrel	*Numenius phaeopus*	Unlikely	No roosting or foraging habitat within Project footprint.
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	Possible	The species forages in marine/aquatic environments, therefore any loss of vegetation associated with the Project will not impact the foraging habitats. No nests were observed during a site inspection (February 2020).
White-tailed Tropic Bird	*Phaethon lepturus*	Unlikely	No roosting or foraging habitat within Project footprint.
Wood Sandpiper	*Tringa glareola*	Unlikely	The Wood Sandpiper occurs in shallow, freshwater wetlands, usually where there is grass or aquatic plants protruding above the water, and often within trees and much fallen timber. Given the absence of wetland in the Project area and surrounds, this species is considered unlikely to occur.
Yellow Wagtail	*Motacilla flava*	Unlikely	Occurs in open areas near water.
Black-flanked Rock-wallaby	*Petrogale lateralis lateralis*	Unlikely	The DBCA threatened fauna database returned 18 records of the Black-flanked Rock-wallaby in the Exmouth area, all from nearby gorges. This habitat type is not present in the Project area.
Northern Quoll	*Dasyurus hallucatus*	Unlikely	The distributional boundaries of Northern Quoll are defined in the south by the Little Sandy Desert. Records from the Pilbara bioregion are scattered across the four subregions; namely the Hamersley, Fortescue Plains, Chichester and Roebourne Plains subregions with records extending as far south as Karinjini National Park (DAWE 2020). Given the Project area is at the southern limit of the species' known range, does not contain 'rocky hills' habitat and is within a population centre, this species is considered unlikely to occur.
Pilbara Leaf-nosed Bat	*Rhinonicteris aurantia (*Pilbara form)	Unlikely	The Pilbara Leaf-nosed Bat is dependent on caves and mines with very hot and humid roost sites (28-32˚C and 96-100% humidity) during the dry season (Armstrong 2000; Churchill 2008). Caves and mines, which have these specific characteristics, may occur within the region but not in proximity to the Project area.
Northern Cape Range Draculoides	*Draculoides brooksi*	Unlikely	No caves occur within or in proximity to the Project area.
Cameron's Cave Pseudoscorpion	*Indohya damocles*	Unlikely	No caves occur within or in proximity to the Project area.
Cameron's Cave Millipede	*Stygiochiropus peculiaris*	Unlikely	No caves occur within or in proximity to the Project area.

5.5 INLAND WATERS

The production bores will be targeting saline (marine) water, so no impact to the overlying brackish aquifer near the coast is expected. The nearest third party production bores are located approximately 500 m south of the proposed production bores (Figure 5).

The test drilling will also confirm the local geology and the characteristics of the local aquifers. Test pumping following the drilling of test bores will confirm the yield of the bores and the quality of the water obtained. A licence to abstract groundwater will then be sought from DWER under S5C of the *RIWI Act*.

5.6 MARINE ENVIRONMENTAL QUALITY

The '*Pilbara Coastal Water Quality Consultation Outcomes: Environmental Values and Environmental Quality Objectives*' (DoE 2006) recommends the Levels of Ecological Protection (LEPs), Environmental Values (EVs) and Environmental Quality Objectives (EQOs) for Pilbara waters, including Exmouth Gulf (Table 11).

Table 11: Environmental Values and Environmental Quality Objectives for the Marine Waters of Exmouth Gulf

Environmental Values	Environmental Quality Objectives (EQOs)
Ecosystem Health (ecological value)	EQO1: Maintain ecosystem integrity. This means maintaining the structure (e.g. the variety and quantity of life forms) and functions (e.g. the food chains and nutrient cycles) of marine ecosystems.
Fishing and Aquaculture (social use value)	EQO2: Seafood (caught or grown) is of a quality safe for eating EQO3: Water quality is suitable for aquaculture purposes.
Recreation and Aesthetics (social use value)	EQO4: Water quality is safe for primary contact recreation (e.g. swimming and diving) EQO5: Water quality is safe for secondary contact recreation (e.g. fishing and boating) EQO6: Aesthetic values of the marine environment are maintained
Cultural and Spiritual (social use value)	EQO7: Cultural and spiritual values of the marine environment are protected.

The waters immediately offshore from the Project site are designated a high level of ecological protection (DoE 2006). The Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ 2000) define a level of high ecological protection as meaning that small detectable changes in environmental quality (i.e. sediment or water quality) beyond limits of natural variation are acceptable as long as no resultant effect on biota occurs.

Table 12 presents the potential (worst case) nutrient concentrations in the discharge in comparison to background nutrient concentrations in Exmouth Gulf (as presented in Table 7). The actual nutrient concentrations in the discharge effluent are expected to be significantly lower given the lower nutrient concentrations in the intake water (from Exmouth Gulf) compared to Townsville.

Table 12: Expected Discharge Nutrient Concentrations in Relation to Background Values

Analyte	Units	Mean Background Value (Exmouth Gulf – Dec 2016)	Expected Discharge Value (Research Centre)*
Ammonia (as N)	µg/L	<3	6.7
Ortho-Phosphate	µg/L	2.7	7.1
Nitrate & Nitrite (NOx)	µg/L	<2	19.4
Total Phosphorus (TP)	µg/L	14.7	-
Total Nitrogen (TN)	µg/L	96	-
Chlorophyll-a	µg/L	0.6	NA

*Note: *Mean value from four measurements of effluent from SeaSim in Townsville, noting that the nutrient concentrations within the seawater drawn into the Townsville facility are significantly higher than those recorded in Exmouth Gulf.*

The temperature and salinity of the discharge is expected to be very close to the ambient values within Exmouth Gulf. No contaminants or potential contaminant will be present within the effluent stream.

Given the low discharge volumes (up to 25,920 L/d) and minor increase in nutrients load, with discharge into bores or leach drains within the dunes, no significant impact to marine environmental quality within the adjacent marine environment is expected. The EQOs will be met in the waters immediately adjacent to the infiltration bores or leach drains.

6. MANAGEMENT FRAMEWORK

A CMP will be prepared prior to the commencement of construction works. This will require endorsement by the Shire of Exmouth prior to the commencement of construction works, and will detail how the following will be managed:

- Clearing, including the preservation of cleared vegetation and topsoil and the rehabilitation of construction areas at the end of the construction phase.
- The potential disturbance of unknown Aboriginal heritage sites, with heritage monitors to be present during excavations within previously undisturbed areas.
- The potential disturbance of contaminated soils within Lot 1404 and resulting risks to human health.
- The spread or proliferation of weeds.
- Entrapment of fauna within pipeline trench during construction.
- Noise during construction impacting local amenity.
- Light during construction impacting local amenity.
- Dust during construction impacting local amenity.
- Continued beach access for the local community.
- Storage of materials, equipment and chemicals on the site during construction.

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