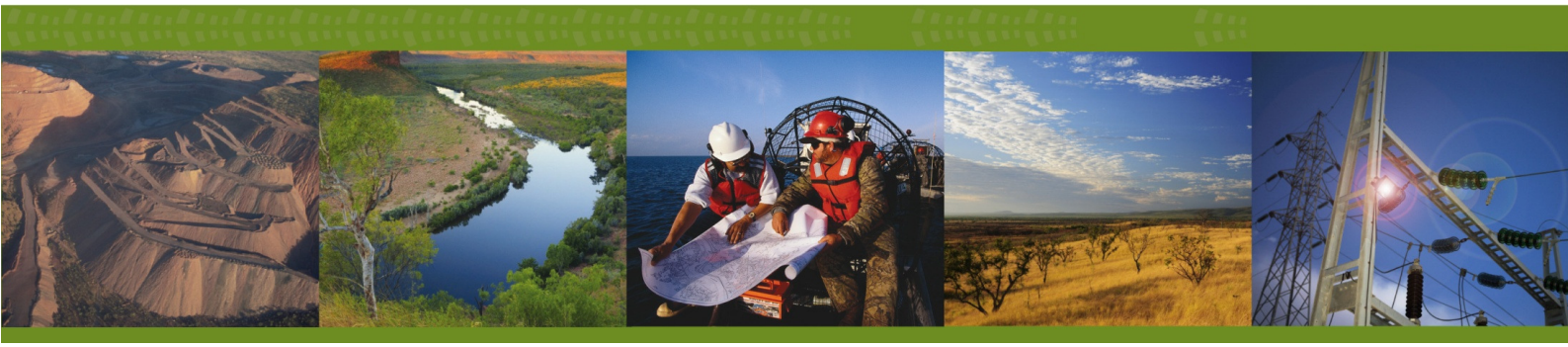

Buckland Project

Supporting Information for Environmental Referral

Prepared for
Iron Ore Holdings Limited
by Strategen

November 2012

STRATEGEN
environmental consultants

Buckland Project

Supporting Information for Environmental Referral

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November 2012

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Client: Iron Ore Holdings Limited

Report Version	Revision No.	Purpose	Strategen author/reviewer	Submitted to Client	
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Preliminary Draft Report	A1	Client comment	J Mitchell / NA	Electronic	30/07/12
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Preliminary Draft Report	C	Client comment	P Brand	Electronic	04/09/12
Preliminary Draft Report	D	Client comment	P Brand	Electronic	11/09/12
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Final Report	0	Issued for use: EPA assessment	P Brand / J Mitchell/ H Ventriss	Electronic & Hard Copy	15/11/12

Filename: IOH12073_01 R003 Rev 0 - 15 November 2012

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Appendices can be found on the CD-ROM enclosed within the cover of this document.

1. Introduction

1.1 Proposal background

Iron Ore Holdings Limited (IOH) proposes to develop the 'Buckland Project' (the Proposal), an iron ore mining project in the western Pilbara. The Proposal involves mining iron ore from three deposits; initially from above the watertable and then proceeding to below-watertable for two of the three deposits, processing the ore on-site and transporting the iron ore product by road to the customer delivery point.

The Proposal consists of two major elements:

1. Proposed mine area (pits, waste rock dumps, processing facilities and supporting infrastructure).
2. Proposed road to truck product to the customer delivery point.

The location and tenure of these elements are described below. The Proposal is described in detail in Section 2.

1.1.1 Exclusions

The Proposal does not include any activities beyond the customer delivery point.

1.1.2 Location

The mine area of the Proposal is located approximately 45 km south-southwest of Pannawonica along the Bungaroo Creek system (Figure 1). Four pits are proposed in three deposits, located within approximately seven kilometres of each other (Figure 2):

- Bungaroo South (west) – mining above and below watertable
- Bungaroo South (east) – mining above and below watertable
- Dragon – mining above watertable only.

Mine processing facilities and other associated mine infrastructure will be located near the Bungaroo South (west) pit area (Figure 2).

A haulage road approximately 170 km in length will be constructed for haulage of ore and use by other mine traffic. The road will be constructed in two stages and there are two options for each stage. These options are discussed in Section 2.4.5.

1.2 Purpose of document

The Proposal is to be referred to the Environmental Protection Authority (EPA) under section 38 of the *Environmental Protection Act 1986* (EP Act). The EP Act referral form is included as Appendix 1. The Proponent understands the Proposal meets the following criteria set out in the WA Government *Environmental Impact Assessment Administrative Procedures 2010*:

- the Proposal raises a limited number of significant environmental factors that can be readily managed, and for which there is an established condition-setting framework
- the Proposal is consistent with established environmental policy frameworks, guidelines and standards
- the Proponent can demonstrate that it has conducted (and will continue to conduct during the assessment period) appropriate and effective stakeholder consultation
- there is limited, or local, interest only in the proposal.

On this basis, the Proponent is proceeding on the early presumption that an Assessment on Proponent Information (API) will be a likely level of assessment.

The Proposal will be referred to the Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The purpose of this document is to provide information in support of the referral to assist the EPA reach a decision regarding the required level of assessment of the Proposal. The document is in the form of a preliminary environmental impact assessment (EIA) document, utilising project and study information currently available; with the intention that content is reviewed and amended to an appropriate level of detail in the following stages of the EIA process, as guided by the EPA and other relevant regulatory agencies.

To support the referrals, this document provides the following information to the extent of current availability:

- a description of the Proposal
- a summary of environmental studies completed and proposed
- preliminary closure measures
- management measures
- an offset strategy.

A table of legislation relevant to the Proposal is also provided in Appendix 3.

In the event the EPA decides an API level of assessment is appropriate for this Proposal, it is understood that the EPA would prepare and issue an environmental Scoping Guideline (API guideline) to the proponent. The proponent would then undertake an environmental review in accordance with the API guideline and prepare a report for submission to the EPA (API document) consistent with the guideline. The Proponent has prepared and appended a preliminary environmental Scoping Guideline, consistent with typical formats used for recent and similar proposals, which the EPA may choose to utilise and amend to suit its requirements (Appendix 4).

1.3 Proponent details

The Proponent is Iron Ore Holdings Limited (IOH). The key proponent contact details for the Proposal are:

Iron Ore Holdings

Mr Michael Klvac, Land Access and Approvals Manager
Level 1, 1 Altona Street
West Perth, WA, 6005
Phone: 9483 2000
Mobile: 0417 982 302

350000 400000 450000 500000

7700000 7650000 7600000 7550000

Point Samson
Dampier
Wickham
Karratha
Roebourne
Cape Preston
Delivery Point
Karratha
Maitland River
Munni Munni Creek
Hamersley Iron Ore Railway
Woodbrook
Jones River
Warambie
Pyramid
Balmoral
Mardie
Booyeema Pool Creek
Narrina Creek
George River
Robe River
Fortescue River
Portland River
Yarraloola
Warramboo Outstation
Warramboo Creek
Pannawonica
Robe River Railroad
Millstream Outcamp
Kanjenje
Yalleen
Yallalong
Deepdale
Mesa J
Peedamulla Outstation
Peedamulla
Kumina Creek
Red Hill
Red Hill Creek
Robe River Robe River
Caliwinga Creek
Cane River
Cane River

Western Australia
Perth

Legend

- Populated Places
- Homesteads
- Watercourse Lines

IOH Haul Road *(SKM, Oct 2012)*

- Stage 1 Alternate Route
- Stage 1 Preferred Route
- Stage 2 Alternate Route
- Stage 2 Preferred Route

Existing Roads

- Principal Road
- Secondary Road
- Minor Road
- Development Envelope
- RTIO Railway
- Buckland Project Mining M 47/1464
- Iron Ore Holdings Tenements *(DMP, Aug 2011)*
- Native Vegetation Area
- Built Up Area

Scale (A3): 1:700,000

Datum: Geocentric Datum of Australia 1994

Projection: Map Grid Australia, Zone 50

Sources: Topography: Geoscience Australia, GEODATA Topo 250KV3, © Commonwealth of Australia, 2006
Imagery: Bing Maps, WMS Service

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Figure 1: Regional location

Scale (A3): 1:450,000
Datum: Geocentric Datum of Australia 1994
Projection: Map Grid Australia, Zone 50

Sources: Topography: Geoscience Australia, GEODATA
Topo 250KV3, © Commonwealth of Australia, 2006

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400000 450000 7700000 7650000 7600000

Cape Preston
Maitland River
North West Coastal Highway
Fortescue River Road
Balmoral Road
Mardie
Mardie Road
Booyeema Pool Creek
Fortescue River
Portland River
Munni Creek
Karratha
Pannawonica
Exmouth
Yarraloola
Warramboo Outstation
Warramboo Creek
Mungarathoona Creek
Pannawonica Road
Pannawonica
Pannawonica Millstream Road
Robe River Railroad
Yalleen
Yallalong
Millstream Outcamp
Deepdale
Robe River
Bungaroo Creek
Kumina Creek
Proposed Bungaroo Water Reserve P1
Red Hill Road
Red Hill Creek
Proposed API Rail Line
Red Hill
Mount Stuart Red Hill Road
0 6 12 kilometres
N

Figure 2: Conceptual project layout - overview

Legend

- Populated Places
- Homesteads
- Proposed API Rail Line (API, June 2012)
- Watercourse Lines
- RTIO Railway
- Conceptual Mine Layout (Snowdens, Oct 2012)

IOH Haul Road *(SKM, Oct 2012)*
- Stage 1 Alternate Route
- Stage 1 Preferred Route
- Stage 2 Alternate Route
- Stage 2 Preferred Route

Roads
- Principal Road
- Secondary Road
- Minor Road

- Tenements (DMP, June 2012)
- Buckland Project Mining M 47/1464
- Proposed Bungaroo Water Reserve
- Proposed West Hamersley Conservation Park
- Native Vegetation Area
- Iron Ore Holdings Tenements (DMP, Aug 2011)

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1.4 Tenure and existing environmental approvals

The proposed mine pits are located on tenement M 47/1464. The Stage 1 preferred haul road will be located on tenements E 47/1279, E 47/1280, E 08/1294, E 08/1289, E 08/1686, AML 70/0248, E 08/1293, L 08/0076 and E 08/1826. The Stage 1 alternate haul road will be located on tenements E 08/1686, E 08/1196, M 08/0397, E 08/1453, E 08/1439, E 08/2137, E 08/1772 and E 08/1148. The Stage 2 preferred haul road will be located on tenements E 08/1624, E 08/0117, E 08/1451, E 08/1331, E 08/1585, E 08/2089, L 08/0074, E 47/2653, G 08/0063 and G 08/0074. The Stage 2 alternate haul road will be located on tenements E 08/0117, E 08/1451 and E 08/1585. The Proponent will apply for *Mining Act 1978* Miscellaneous Licences and General Purpose Leases to facilitate the approval of the associated infrastructure before construction of this infrastructure will commence. The Proponent has submitted Miscellaneous Licence and General Purpose Lease applications for the minesite and Stage 1 of the haul road, and anticipates that the licences and leases will be finalised by June 2013.

During the exploration program, IOH received a number of Programs of Work (POW) granted by Department of Mines and Petroleum (DMP) under the *Mining Act 1978* including:

1. **PoWE ID 20200**: for site preparation, access and drilling of exploration holes.
2. **PoWE ID 26050** for the drilling of holes and associated access tracks.
3. **PoWE ID 29353** for the drilling of holes and associated access tracks.
4. **PoWE ID 33372** for the drilling of holes and associated access tracks.
5. **PoWE ID 34442** for the drilling of holes and associated access tracks.
6. **PoWE ID 34852** for the drilling of holes and associated access tracks for water monitoring.
7. **PoWE ID 35263** for the drilling of holes and associated access tracks.

2. Proposal description

2.1 Summary

The Proposal is located in the western Pilbara region of Western Australia and involves mining, processing and delivery of ore to a customer delivery point for sale to a second party. Mining is expected to commence in late 2014 reaching the nominal initial production rate of 4 million tonnes per annum (Mtpa) within 6 months and then progressively increase to an estimated long-term production rate of 8 Mtpa.

Ore will be mined from multiple pisolitic channel iron deposits (CID) by conventional drill and blast techniques. During the first stage of mining, ore from above the watertable will be dry processed on site involving crushing and screening. The second stage involves mining of ore from below the watertable at Bungaroo South that will be wet-processed on site. Wet processing will require expansion of the processing facility for desliming and includes classification, thickeners, filters and low-grade fines storage facilities. Processed ore will be transported by road to the customer delivery point for transfer to a second party. Overburden and dry-processing waste will be stored in designated waste dumps, and wet-processing low-grade fines will be transported to appropriate storage facilities (Figure 3).

Mining below the watertable will be facilitated by dewatering of the aquifer exposed by the pits.

After exploring multiple customer delivery options, the Proponent determined the most feasible option is to deliver ore to a customer at a delivery point at Cape Preston, approximately 120 km northwest of the minesite, via a proposed approximately 170 km trucking route (Figure 2).

2.2 Key Proposal characteristics

The key characteristics relevant to the Proposal are listed in Table 1 and Table 2. Refer to Figure 2 and Figure 3 for the conceptual layout of the Proposal.

The maximum disturbance footprint will be approximately 1515 ha.

Table 1 Summary of the Proposal

Item	Description
Proposal title	Buckland Project
Proponent name	Iron Ore Holdings Limited
Short description	Mining and processing over 15-20 years at a nominal rate of 8 Mtpa of iron ore at the Bungaroo South and Dragon deposits with the ore transported by purpose-built and public roads to a customer delivery point near Cape Preston.

Table 2 Key Proposal characteristics

Element	Location	Proposed Extent Authorised
Physical elements		
Clearing	Figure 2 and Figure 3	Clearing of no more than 1515 ha of native vegetation within a 7350 ha development envelope.
Dewatering from Bungaroo South pits	Figure 3	Abstraction approximately 6.2 gigalitres per annum (GLpa).
Surplus water discharge	To be defined	Up to approximately 6.08 GLpa into Bungaroo Creek and aquifers downstream of mine
Operational elements		
Life of Mine	NA	Approximately 20 years

Element	Location	Proposed Extent Authorised
Ore processing (waste)	Figure 3	Disposal of no more than approximately 16 million tonnes per annum (Mtpa) up to a total of approximately 60 Mt as pit backfill and/or in waste dumps / low-grade fines storage facilities.
Water supply	To be defined	120 megalitres per annum (MLpa) for processing, dust suppression and potable water supply. To be sourced primarily from dewatering, supplemented by a borefield if and as required.
Power station	Figure 3 (in infrastructure area)	4 MW diesel–fuelled power station, expanding to 8 MW once below-watertable mining commences.
Wastewater treatment plant	Figure 3 (in infrastructure area)	Integrated ablution facilities will be linked to 'Biomax' or similar type plants with an approximate capacity of 15 kilolitres per day.
Landfill	Figure 3	500 tonnes per year estimated maximum capacity. To be licensed in accordance with the Environmental Protection (Rural Landfill) Regulations 2002.

2.3 Project schedule and life

Construction is anticipated to commence in Q3 2013 with the first truckload of ore occurring in Q1 2015 depending on receipt of all necessary approvals.

The Project is expected to have an operational life of approximately 15-20 years.

2.4 Mining operations

2.4.1 Mine design and methodology

The proposed mining operation will use conventional hydraulic excavators and trucks for the primary load and haul fleet. Primary ground will be broken using conventional drill and blast techniques.

448000

452000

7568000

7564000

Landfill

Mine Vehicles

Camp

Camp Access Road

Wet Plant

Gate House
Admin, Stores

Rom Pad

Dry
Processing
Plant

West Pit

Low
Grade
Fines

West Dump

East Pit

East Dump

East
Pit

East
Dump

Dragon
Dump

Dragon Pit

Legend

- Development Envelope
- Conceptual Mine Layout *(Snowdens, Oct 2012)*
- Tenements *(DMP, Aug 2011)*
- Iron Ore Holdings Tenements *(DMP Aug 2011)*

Scale (A3): 1:30,000

Datum: Geocentric Datum of Australia 1994

Projection: Map Grid Australia, Zone 50

Sources: Topography: Geoscience Australia, GEODATA Topo 250KV3, © Commonwealth of Australia, 2006
Imagery: IOH AAM Survey 2007

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Figure 3: Conceptual project layout - mine and suppport infrastructure area

2.4.2 Ore processing

During initial above watertable mining, processing of ore feedstock will be by conventional dry crushing and screening to produce a fines-only product for export. On commencement of mining below the watertable, wet processing will require expansion of the processing facility for desliming, including classification, thickeners, filters and the development of low-grade fines storage facilities. This transition will essentially be a simple 'add-on' upgrade of the existing dry processing system to minimise disruption to operations.

Run of mine (ROM) ore will be delivered to the ROM stockpile by the mining fleet (regular mine haul trucks) where it will be direct shipped or transferred to the crushing plant feed bin using a front-end loader. There will be three stages of crushing and screening to provide the required product size. Crushing and screening will be a series of primary, secondary and tertiary systems to achieve the final particle size. For above-watertable ore, sufficient water will be added to various stages of the crushing and screening process to suppress dust generated. Wet processing will decrease yield, but will improve product grade through removal of lighter fractions including silica, aluminium and phosphorous ('low-grade fines').

In terms of deliverable product, the moisture content of ore mined from above the watertable will be approximately 9%.

2.4.3 Overburden and process waste management

Where suitable, overburden will be used in the construction of other facilities and infrastructure, with the remainder placed in waste rock landforms and used in pit backfilling as pit development and staging allows.

Waste rock will be incorporated into waste rock landforms or in pit backfilling. Low-grade fines from wet processing will comprise relatively inert materials and initially be stored in a purpose-built facility designed to minimise leaching. Once excavation has progressed to a suitable stage, low-grade fines are proposed to be used for pit backfilling and contained within other waste rock material.

2.4.4 Surface and groundwater management

Surface water

The two Bungaroo South orebodies partially underlie Bungaroo Creek. The Proposal is to access as much of the resource as possible without significantly constricting the flow of the creek. The two Bungaroo South pits will consequently require bunding for flood protection (Figure 4). This approach will preclude some parts of the Bungaroo South iron ore deposits from future mining in order to preserve key environmental values associated with the creek and its banks.

The 100-year Annual Recurrence Interval (ARI) flow event peak, with freeboard, has been adopted for the bund design. Larger floods could overtop the bund and flow into the pit. Encroachment into the creek/floodplain will restrict flow (in significant flood events) and cause water levels to rise upstream.

All waste rock landforms will be subject to careful drainage design, such as bunding, contour drains and retention ponds as well as rock armouring to capture, contain and settle runoff to prevent excessive sediment being transported to waterways. Design parameters will be based on 100-year ARI flood events. Collected water will be re-used in the mining and processing operation as far as practicable.

Figure 4 Conceptual bunding of the pits

Groundwater

Below-watertable mining is only proposed for the Bungaroo South pits. Mining of Dragon pit will be above-watertable. Dewatering to allow mining below the watertable and to provide mine water supply will require abstraction of 6.2 gigalitres per annum (GLpa) from the CID aquifer and associated un-mineralised channel deposits (including alluvium), along with fractured zones within the Dales Gorge Formation (bedrock). Suitable options for disposal of excess dewater, such as subsurface irrigation/reinjection to replenish the Bungaroo Creek and aquifers downstream of the pit areas, are being explored in consultation with Department of Water (DoW) and the potential environmental impacts will be assessed.

For the above-watertable mining phase, minor in-pit drainage management will be required to remove stormwater from significant rainfall events (no groundwater inflows are expected). Stormwater runoff in excess of storage capacity and site requirements is anticipated to be a rare event. It will only be discharged to Bungaroo Creek following treatment in order to meet appropriate water quality requirements and in accordance with the site environmental licence.

2.4.5 Roads and haulage

A haulage road approximately 170 km in length will be constructed for haulage of ore and use by other mine traffic. The road will be constructed in two stages and there are two options for each stage:

1. Stage 1 will involve construction of the purpose built haul road from the mine processing area to North West Coastal Highway. There are two route options under consideration (Figure 2). The preferred route is located adjacent to the API West Pilbara Iron Ore Project (WPIOP) rail corridor (approved under Part IV of the EP Act – Statement No. 881). An alternate route is located to the west of, and branches from, the preferred route. Tenure of the land underlying the routes is discussed in more detail in Section 1.4.
2. Stage 2 will involve the construction of the purpose built haul road in a north-northeast direction from the North West Coastal Highway and Stage 1 haul road (preferred route) intersection to Cape Preston. The preferred route is located adjacent to the Dampier Bunbury Natural Gas Pipeline. An alternate route is located adjacent to North West Coastal Highway (Figure 2). Tenure of the land underlying the routes is discussed in more detail in Section 1.4.

The preferred Stage 1 road alignment has been chosen to minimise creek crossings and limit excavation work and is achieved by following the highest points of elevation through the range to North West Coastal Highway. The preferred alignment for Stage 2 follows the alignment of the existing Dampier Bunbury Natural Gas Pipeline parallel to the Cape Preston customer delivery point (Figure 2). The most significant waterway crossings will occur at the Robe and Fortescue Rivers. For these crossings, a low floodway option (designed to allow flooding to occur unimpeded) is being proposed by the road planners as an alternative to a bridge. This option will preclude traffic during peak flood periods.

A decision on the preferred road alignment will be made prior to submission of the API document.

Refer to Section 2.5.4 for discussion on water supply requirements for road construction and dust suppression.

Borrow pits

Borrow pits are proposed for the generation of road fill to facilitate construction of the road. The localities of these will be selected based on 'lowest environmental significance' criteria.

2.5 Project services and infrastructure

Mine infrastructure will include power, water, fuel and maintenance facilities, plus accommodation for the construction and operations workforce and operations personnel. At this stage of planning, support facilities, including on-site accommodation, workshops, warehousing and power generation, are proposed to be located in proximity to the processing plant to minimise power distribution and interconnecting road construction costs.

The Buckland Project centralised infrastructure will include:

- administration centre
- gate house and emergency response centre
- mine camp
- central power house and distributed supply
- warehousing and lay down areas
- maintenance facilities for mine and light vehicles
- maintenance facilities for haul trucks
- laboratory and core farm
- fuel storage and distribution
- integrated communications.

The following infrastructure will be situated at other locations convenient to the mining operations:

- explosive storage
- borefield
- landfill.

2.5.1 Stockpiles

Ore stockpiles will be designed to store an adequate volume of product to allow the mining and/or processing operation to run continuously. Ore stockpiles will be subject to watering treatment to minimise fugitive dust emissions to the environment.

A ROM stockpile will be located at the feed end of the processing plant and a product stockpile located at a post-processing point ready for loading onto trucks for transport to the customer delivery point. The product stockpile location is likely to be at an elevated location west of the Bungaroo West deposit, so that loaded road haul trucks have manageable grades to the top of the ranges heading west.

2.5.2 Administration

Administration and associated amenities are expected to comprise prefabricated modular buildings with power, communications and IT services connected as appropriate, as well as water and sewerage services. An ablution block will be located within this area.

2.5.3 Power generation and transmission

Power generation is required to support construction, ore processing and associated mining operation support infrastructure. Power will be generated via on-site diesel generator engines located within the Proposal development area. The total maximum power requirement and output will not exceed 8 MW. Gas powered electricity generation has been discounted due to the small size of the power station relative to other regional power stations, and the high cost to deliver a continuous supply of gas to the minesite.

A combination of overhead and underground power reticulation will distribute power to workshops, camp and administration facilities.

2.5.4 Water supply and wastewater treatment

Total water supply requirements (construction and operation) are expected to be up to 120 MLpa for processing, dust suppression and potable water supply.

Raw water for mining operations will be sourced from the dewatering of the two Bungaroo South deposits if required in advance of mining below the watertable from dewatering bores outside the pit near the Eastern Deposit. This may be pumped to provide a water supply while also allowing advanced dewatering. Water will be pumped to central storage tank for process and general use. Distribution will be via pumps and a steel and high-density polyethylene pipe network. The water supply will be sourced primarily from dewatering, supplemented by a borefield if and as required.

Water will be used for dust suppression during road construction and total water demand will be approximately 3 ML per day for the duration of the construction phase depending on the nature of the construction activities occurring in proximity to each borefield at the time. Water required for construction of the first stage of the transport road is expected to be supplied from the minesite borefield. Groundwater will be obtained from bores to be constructed approximately every 10 km along the second stage of the transport road to supply water for dust suppression activities during construction of this second stage of the road. Water from these bores will be abstracted sequentially as construction areas move progressively along the road alignment.

Potable water supplies will also be sourced from groundwater. Potable water will be treated with appropriate filtration and chemical conditioning to comply with the Australian Drinking Water Guidelines (NHMRC & NRMMC 2011) for camp use and distributed to the workshops, administration centre and processing plant. Use of standalone potable water tanks will be minimised to decrease the associated Health and Safety issues.

Fire and general purpose water will be reticulated in a common system. Detailed design will optimise piping, pumping and intermediate storage requirements.

Integrated ablution facilities will be linked to 'Biomax' type plants at major facilities for waste treatment. Other toilets, if required, will use a gravity fed septic system. Processed effluent will be disposed of through subsoil irrigation in a suitable area adjacent to the site (the final locations are to be determined based on geotechnical and environmental assessment).

Waste water from vehicle wash down will be re-used to water roads after the removal and appropriate disposal of oily waste.

2.5.5 Workforce and accommodation

A 100-person temporary camp will be built for initial construction, based on standard temporary 'early works facilities' and this will then be gradually expanded into a 236 room permanent facility (Figure 3). During operations of the early 4 Mtpa stages of the mine, this 236 room camp will house approximately 160 personnel at any one time. As production increases to 8 Mtpa, the camp will continue to be expanded to a peak of an estimated 322 rooms with approximately 215 personnel on site at any one time.

The Proponent will provide a level of preference to the employment of local Aboriginal community members and contracting businesses by developing an understanding of the Kuruma Marthudunera claim group capabilities and actively matching group members to positions vacant. This process has been agreed with by the Kuruma Marthudunera people and included in the Native Title agreement finalised in October 2012.

Employees sourced from elsewhere will be managed on a fly in-fly out basis. Personnel will fly to Karratha and then be transported via a bus service to the Proposal area. Potential airstrip locations suitable for jets in the Proposal area are extremely limited and not located on IOH lease areas and at this stage have been discounted as unviable options.

2.5.6 Warehousing and maintenance workshops

Storage will be provided using an approximately 500 m^2 shed for bulky items and sea containers for the remainder. An open air laydown area will be provided adjacent to the secure store for large non-perishable items.

Maintenance workshops will generally be made up from sea containers with domed covers as shown in Figure 5.

A vehicle wash down facility will be located at the mine vehicle maintenance workshop and will provide for both heavy and light vehicles. The facility will be a conventional arrangement based on water cannons on a drainage slab with a drive-in collection sump and oily water separator. Used water will be recycled for dust control on roads and sludge will be periodically removed.

Heavy vehicle tyre change facilities will be included within the mine vehicle and road train maintenance facilities.

Figure 5 Examples of dome-covered workshops

2.5.7 Laboratory and core shed

An area will be required for exploration, grade control and product specification analysis. The facility will have core cutting, crushing and screening equipment (in an undercover area) and an enclosed building to provide an office and house laboratory equipment. Sea containers and laydown areas will be used for sample storage.

2.5.8 Fuel supply and storage

Diesel fuel will be delivered by triple road train to a centralised fuel farm consisting of five, 110 kL self bunded tanks, providing two weeks operating capacity.

2.5.9 Refuse disposal/treatment

A fenced landfill site will be prepared to handle non-hazardous solid waste disposal (Figure 3). The site will be licensed under the provisions of the EP Act and Environmental Protection (Rural Landfill) Regulations 2002.

A long trench method will be used to dispose of putrescibles and non-recyclable waste with trenches being capped on a weekly basis. A 35 m buffer zone between trenches and the site boundary will be maintained, as will a firebreak around the facility.

Separate areas will be maintained to temporarily store and consolidate recyclables, tyres, hydrocarbons and hazardous waste prior to removal to appropriately licensed recycling or secure disposal facilities.

2.5.10 Telecommunications

A communications tower will be located centrally within the broader disturbance footprint to provide mobile phone and UHF radio coverage for all mine and exploration areas.

2.6 Design measures to avoid environmental impact

A number of design and process measures have already been applied to the Proposal to avoid environmental impacts on the environmental values within, downstream and down-gradient of the Proposal area, as outlined below.

2.6.1 Project footprint

The proposed mine pit boundaries and locations of associated infrastructure were developed to optimise resource recovery and operational costs while at the same time being cognizant of the need to avoid or limit the impact on key environmental features such as:

- Bungaroo Creek flows and downstream surface water and groundwater receptors
- potential significant flora and fauna values due to clearing and disturbance of habitat.

For this Proposal, the Proponent will not mine the full orebody as this would require major diversions of Bungaroo Creek and would significantly affect its natural ecological functions and values. The pit dimensions have consequently been designed to minimise the effect of the Proposal on Bungaroo Creek and downstream receptors while maximising resource recovery.

2.6.2 Surface water management

The Proponent developed a surface water management solution based on mining the maximum resource with minimum impact to creek flows. This is discussed in Section 2.4.4 in more detail; however, a number of other surface water management measures were considered for the protection of the mining areas from seasonal creek flow. These alternative design options included:

1. Pit bench channel and bund – this option would allow flood flows to be directed down a specially widened bench in the pit, and reduce creek flows via a larger dam across the pit on the upstream side which would act as a retardation basin.
2. Deep excavated channels – this option would divert upstream flows outside the potential pit footprints.
3. High level excavated channels with low flow – similar to the second alternate option but with the channels raised above the floodplain level to reduce excavation. A dam would therefore be required upstream of the pits, and flows stored until the water level reaches the spillway level. The dam would require a low-flow outlet or pipe onto a pit bench.

Use of dams for the protection of and access to, the entire orebody was dismissed, as this would have resulted in increased environmental impacts by significantly disturbing the creekline system and habitat including:

- prevention of creek flow along certain parts of Bungaroo Creek
- creation of surface water pools upstream of the dams resulting in loss of gully habitat due to rising and enduring water levels
- a decrease in downstream flow rates impacting downstream surface water receptors and users.

The Proponent has opted for a bunding approach in an attempt to maintain the natural ecological function and values of Bungaroo Creek and other tributaries as best as practicable while still being able to access the majority of the resource.

2.6.3 Maintenance of Northern Quoll habitat corridors

The Proponent has identified and extensively mapped Northern Quoll habitat throughout sections of tenement M 47/1464 and tenement E 47/1279. The design and placement of pit and surface water protection bunds, waste dumps and supporting infrastructure have been developed to ensure important creek flow habitat is preserved and other areas of habitat are avoided where possible to limit impacts to Northern Quoll habitat corridors within the Proposal area.

2.6.4 Backfill of pits

On closure, the pits will be up to 105 m in depth below the ground surface (53 m below watertable). These pit voids will be subject to groundwater inflows on cessation of dewatering and hold a significant amount of surface water resulting directly from rainfall events. To minimise the risk of groundwater contamination on closure and formation of large artificial surface water bodies due to stormwater inflow, the pits will be backfilled where the Mine Plan, backfill material availability and economic factors allow it.

2.6.5 Customer delivery point and delivery method options

A number of transport options including road and rail were considered for the delivery of ore to the proposed customer delivery point. One of these options included the construction and operation of a north-south haul road from the mine site to Pannawonica and then an east-west haul road to North West Coastal Highway. Key drivers such as topography, truck configurations, avoidance of existing infrastructure and significant surface water features, route length and access constraints were all considered in selection of the proposed delivery option.

3. Regional setting of the proposal

3.1 Physical environment

3.1.1 Climate

The Pilbara region has an arid tropical climate with two distinct seasons; a summer wet season and a winter dry season (Gentilli 1972). The region experiences very low rainfall, high evaporation rate and high daytime temperatures. The Pannawonica meteorological station (005069) is approximately 46 km from the Proposal area (SRK 2011). At this station, mean monthly maximum temperatures range from 41°C in January to 26.7°C in July, and mean monthly minimum temperatures range from 25.2°C in January/February to 12.6°C in July. Average annual rainfall at Pannawonica is approximately 406.3 mm (Bureau of Meteorology 2012). September to November is the driest period and January to March receives the most rainfall due to cyclonic activity. Southern cold fronts occasionally reach the Pilbara region resulting in light winter rains (RPS 2012a).

3.1.2 Geology and soils

Mineralisation

Two main mineralisation types are present in the Proposal area. The first is Channel Iron Deposits (CID) of the Robe Pisolite at the Bungaroo South pit area. The second mineralisation type occurs at Dragon and comprises martite-goethite enrichment in rocks of the lower part of the Dales Gorge Member of the Brockman Iron Formation.

Geology

Late Archaean to Early Proterozoic Hamersley Group rocks in the Proposal area are overlain by Cainozoic pisolitic CID of the Robe Pisolite and Cainozoic alluvial deposits.

Hamersley Group

The Proposal area is in the Hamersley Group, which comprises the following geological units (listed from oldest to youngest):

1. Wittenoom Formation (Bee Gorge Member): overall, the Wittenoom Formation is divided into three Members. The youngest is the Bee Gorge Member and in the Buckland area, only the Bee Gorge Member has been intersected by drilling. The Bee Gorge Member is dominated by thinly laminated graphitic argillite with subordinate carbonate, chert, volcaniclastic rock and iron formation. The distinctive graphitic shales of the Bee Gorge Member have commonly been intersected in the project area.
2. Mt Sylvia Formation: the Mount Sylvia formation is 30 m to 50 m thick and comprises shale, dolomitic shale and three prominent banded iron formation (BIF) layers. Two of these represent the top and base of the unit. The upper BIF band is the Bruno's band, which forms a very distinctive marker horizon in the area.
3. Mount MacRae Shale: the MacRae Shale is 60 m to 90 m thick and is dominated by shale and dolomitic shale with thinly bedded chert in the upper units.
4. Brockman Iron Formation - Dales Gorge Member: is an alternating assemblage of BIF macrobands and shale macrobands. These units persist throughout the entire Hamersley Province.

Cainozoic geology – Robe pisolite

Four main types of pisolitic (or CID) mineralisation have been identified in the Proposal area:

1. Weathered pisolite: various degrees of pisolite weathering ranging from broad overprinting of a clay matrix (with remnant pisolite fragments) to clay-filling of voids, cavities and fractures. Weathered pisolite tends to be haematitic and the abundance of clay distinguishes it from hardcap.

2. Reworked CID: comprises moderately to well preserved units of goethitic or haematitic CID, with well rounded, reworked CID clasts of up to 50 mm diameter. The pisolitic texture is partially to fully destroyed due to the weathering process and is generally high in impurities such as Al_2O_3 and SiO_2. This material type lies above the main CID zone.
3. Main CID: this material type is rich in ochreous and vitreous goethite with varying quantities of hematite. It forms a medium-hard to hard and very competent rock. Wood fragments are common and are usually replaced with ochreous goethite or ochreous hematite. In places, the pisolite becomes more strongly haematitic. There are some vughs and void spaces within the material.

Alluvium

Tertiary alluvial deposits typically comprise unconsolidated gravels with rounded to angular granule to boulder size BIF and chert fragments, maghemite nodules and detrital pisolites, in a clayey to silty matrix. Quaternary alluvium characteristically ranges from soil, to very fine clays and silts, to sand and gravel.

3.1.3 Topography

The region surrounding the Proposal area is characterised by mountainous areas, steep hills and flat plains (SRK 2011). The Proposal mine area is located within the Bungaroo Creek catchment where the main valley of Bungaroo Creek is incised into the Hamersley range and flows in a northwest direction. The width of the Bungaroo Creek valley varies from over 1 km wide at the upper end of the catchment to approximately 3 km wide at its lower extent (Old Yalleen Well). The upper catchment comprises relatively rugged topography with deeply incised watercourses while the main valley is relatively flat with adjacent ridges rising steeply above the valley floor (RPS 2012b).

3.1.4 Surface water and groundwater

Streamflow in the region is highly dynamic with the majority of flow occurring during the summer wet season following rainfall. Flow in smaller stream channels is ephemeral, while more significant river channels flow for weeks to months after major rainfall. Baseflow in creek systems is variable with no flow occurring in some years and relatively high flow in others (RPS 2012b).

Regionally, groundwater is associated with:

- unconsolidated alluvial aquifers in valleys
- calcrete and other chemically deposited rock aquifers (pisolitic limonitic)
- aquifers associated with fractured deposits of dolomite and banded iron formation (SRK 2011).

The region sees large variations in surface flow that leads to some groundwater level variation in shallow alluvial aquifers. Recharge to groundwater is most commonly provided by cyclonic rainfall events (RPS 2012b).

3.2 Biological environment

The Interim Biogeographic Regionalisation for Australia (IBRA) classifies Australia's landscapes into 89 large geographically distinct bioregions based on common climate, geology, landform, native vegetation and species information (SEWPaC 2012a). The Proposal area is mainly located in the Hamersley subregion of the Pilbara Biogeographic region. The Hamersley sub-region is a mountainous area of Proterozoic sedimentary ranges and plateaux, dissected by basalt, shale and dolerite gorges. Ranges within the sub-region typically feature snappy gum (*Eucalyptus leucophloia*) over *Triodia brizoides* on skeletal soils. Valley floors within the sub-region comprise low mulga woodlands over bunch grasses on fine textured soils (Kendrick 2003).

The Proponent has commenced a number of detailed biological studies for the Proposal. These studies include flora and vegetation, vertebrate and SRE fauna and subterranean fauna.

3.2.1 Vegetation and flora

The Proposal area occurs within the Fortescue and Roebourne Botanical Districts (Pilbara Region) of the Eremaean Province, dominated by tree and shrub-steppe communities. These are comprised predominately of eucalyptus and acacia species (Onshore 2012).

Historical systematic flora surveys of the Pilbara have been completed by Burbidge (1959) and Beard (1975). The original Beard mapping was further refined by Shepherd *et al* (2002). Within the Proposal area, two associations occur; the most common vegetation association being *Eucalyptus leucophloia* (snappy gum) and *Triodia wiseana* (hard spinifex) tree steppe occurring on hills (Onshore 2012).

While the remaining extent for each of the two vegetation associations is 100% of pre-European distribution, currently less than 10% of each association exists within reserves (Onshore 2012).

Findings of surveys undertaken in the Proposal area to date are discussed in Section 5.1 of this report.

3.2.2 Fauna

The Pilbara region is inhabited by a rich species assemblage of vertebrate and invertebrate fauna adapted to live in the harsh Pilbara climate. Many fauna species in the region are listed as threatened or priority species (Phoenix 2012a). Detrimental effects on the region's biodiversity have come from a range of threatening processes associated with pastoral and mining activities such as over-grazing and the introduction of exotic animals and plants, as well altered fire regimes (McKenzie *et al* 2009). There are presently 44 declared threatened fauna in the region consisting of 15 mammals, 16 birds, nine reptiles and four fish. One species is considered critically endangered, six are endangered and 28 are vulnerable (Phoenix 2012a). Thirty-four listed Priority species consisting of 10 mammals, eight birds, 15 reptiles and one fish also occur.

Vertebrate fauna

Four 'conservation significant' fauna species are considered to have potential to occur in the vicinity of the Proposal area, being the critically endangered Night Parrot (*Pezoporus occidentalis*) and the endangered:

- Northern Quoll (*Dasyurus hallucatus*),
- Northern Marsupial Mole (*Notoryctes caurinus)*
- Rufous Hare-wallaby (*Lagorchestes hirsutus*).

Bioregional vertebrate endemics are described in Phoenix 2012a (Appendix 2).

Short range endemic invertebrate fauna

Current knowledge of short range endemic (SRE) invertebrate species in Western Australia is relatively poor. SRE taxa that potentially occur in the Pilbara include the following groups (Phoenix 2012a):

- spiders and relatives (Arachnida)
  - spiders (Araneae), in particular trapdoor spiders (Mygalomorphae) and selected modern spiders (Araneomorphae) (here mainly Flat Rock Spiders, family Selenopidae)
  - harvestmen (Opiliones)
  - false scorpions (Pseudoscorpiones)
  - true scorpions (Scorpiones)
  - whip spiders (Schizomida) (although the majority of SREs in this order are troglobites

- multipedes (Myriapoda)
  - centipedes (Chilopoda), mainly the order Geophilomorpha and the Cryptopidae in the order Scolopendromorpha; other Scolopendromorpha are generally widespread and are not considered target taxa
  - millipedes (Diplopoda)
- crustaceans (Crustacea)
  - slaters (Isopoda)
- snails and relatives (Mollusca)
  - land snails (Gastropoda).

Subterranean fauna

The defining characteristic of subterranean fauna is that they spend all, or most, of their lifecycle underground and are morphologically adapted to the subterranean environment. Adaptations include pallid colouration, reduction or loss of eyes, elongate body, long slender appendages and well developed sensory setae (Bennelongia 2012).

Subterranean fauna have significant scientific value and a high proportion of subterranean species are short-range endemics (SREs), defined as species with ranges of <10,000 km^2 (Bennelongia 2012). The restricted ranges of most subterranean fauna species means they are particularly vulnerable to extinction from anthropogenic activities and, hence, are a focus for conservation. There are two types of subterranean fauna, stygofauna and troglofauna. Stygofauna occur in groundwater, whereas troglofauna are air-breathing and occur at depth in the various unsaturated soil and rock profiles above the watertable (Bennelongia 2012).

Studies have shown that calcrete and alluvial aquifers in the Pilbara and Yilgarn regions are inhabited by diverse stygofaunal communities. In Western Australia, subterranean fauna also inhabit palaeodrainage channels in inland deserts. In the arid zone, troglofauna are considered to be remnant of rainforest litter fauna (Rio Tinto 2008).

Investigations into troglofauna and stygofauna are continuing for the Proposal. Preliminary results are presented in Section 5.3.

3.3 Social environment

The Proposal is mostly located within the Shire of Ashburton (Pilbara Region), with the northern section of the haul road located in the Shire of Roebourne. Four towns are located in the Shire of Ashburton, Pannawonica (45 km north-north west) being the closest to the Proposal area.

Redhill is the closest station homestead to the Proposal; located approximately 40 km from the mine area of the Proposal and around 8 km from the nearest point of the proposed haul road. The nearest mine operation to the mine parts of the Proposal is the Rio Tinto Mesa J mine, approximately 40 km to the north-west.

The regional population fluctuates as large projects bring temporary workers to the area. Employment in the region is typically in the mining (24.9% of total employment), manufacturing and agriculture sectors (DLGRD 2006 in API Management Pty Ltd 2012).

3.3.1 Aboriginal and European heritage

A Native Title claim by the Kuruma Marthudunera claimant group (represented by Yamatji Marlpa Aboriginal Corporation) includes the mine area and a significant proportion of the proposed road. The claim covers a total area of approximately 15 759 km^2 in the region (SRK 2011). A Native Title Agreement has been reached between the Proponent and the Kuruma Marthudunera people. A Native Title claim by the Yaburara Mardudhunera includes the northern parts of the proposed road. A Native Title Agreement has also been reached between the Proponent and the Yaburara Mardudhunera people.

Aboriginal heritage sites have been identified in and around the Proposal area.

No significant European Heritage has been identified in or adjacent to the Proposal area.

3.3.2 Existing and surrounding land use

Land use in the Pilbara region consists predominately of mining, conservation, Unallocated Crown Land, Crown reserves, urban areas and pastoral activities. A large number of pastoral leases in the region are held by mining companies in order to secure access to land surrounding operations. The mine part of the Proposal sits within Unallocated Crown Land.

The Pilbara tourism industry is developing with a focus on conservation. A significant proportion of land in the Hamersley sub-region is reserved (14.1%), which includes the majority of the Karijini National Park (Onshore 2012).

The proposed mine is located within the boundaries of the proposed West Hamersley Range Conservation Park (Figure 2). The proposed conservation park was initially recommended in 2002 to ensure species and floristic communities recorded from summit (upland) habitats in the Hamersley Ranges are protected within the conservation estate (CALM 2002). The recommendation to create the conservation park acknowledges mineral prospectivity and existing *Mining Act 1978* tenure in the area. Consultation with Department of Environment and Conservation (DEC) indicates the prospective conservation park will be managed within a multiple-use framework that does not exclude mining activities.

Aquifers in the Bungaroo Creek valley, along with the Jimmawurrada Creek, have been identified as groundwater sources for the supply of bulk water into the West Pilbara Water Supply Scheme (DoW 2012). The borefield (Bungaroo Coastal Water Supply Borefield) is owned and operated by Rio Tinto Iron Ore (through Hamersley Iron).

DoW proposes to establish the Bungaroo Creek Water Reserve under the *Country Areas Water Supply Act 1947* to protect the water source for the Bungaroo Coastal Water Supply Borefield and the Bungaroo and Jimmawurrada Creek catchment areas that recharge the aquifer. DoW has recommended that the water reserve be managed for Priority 1 source protection, with 500 m wellhead protection zones established around all production bores, to help protect the source of water used for abstraction and potable supply. The proposed mine is located within the proposed water reserve boundary, which also encompasses the Rio Tinto Mesa J mine and prospective Bungaroo deposit (Figure 2).

4. Community and other stakeholder consultation program

The Proponent has undertaken a broad consultation program with key stakeholders with respect to the Proposal (Table 3). The Proponent is committed to continuing its engagement with stakeholders and to ensure consultation is ongoing throughout the environmental impact assessment (EIA) and approvals stages, and for the life of the mine. To date, the consultation strategy has centred on identifying and engaging with key government agencies at the federal, state and local level, as well as traditional owners and relevant neighbouring commercial interests. Most consultation has been in the form of face-to-face meetings with IOH representatives providing presentation material describing the Proposal and relevant matters such as available study results prior to receiving stakeholder feedback and advice and then reaching agreement on follow-up actions.

Advice from the Shire of Ashburton and other government agencies will assist the identification of any local stakeholders not already engaged, or other potential stakeholders, such as key community-based conservation groups. These will be approached and engaged through the EIA process where interest in the Proposal is indicated. Stakeholders which the Proponent have not consulted to date and which will be, or are likely to be, engaged include:

- conservation and non-government organisations, such as the Conservation Council WA and Wildflower Society
- the Shire of Roebourne
- Mineralogy
- any other relevant stakeholder as identified through ongoing development and implementation of the Proponent's consultation strategy.

Table 3 Consultation summary

Key stakeholder	Issues raised	Response
Government		
Dampier Port Authority (DPA)	DPA acknowledges that DoT would be leading discussions regarding the Cape Preston Port Development (subject to separate referral). DPA retain an interest in the port development proposal and would like to be included in development discussions going forward.	No specific issues of concern raised regarding the mine and road proposal – DPA to be kept up to date with Proposal developments and the impact of road capacity on Port throughput.
Department of Environment and Conservation (DEC)	Environmental studies undertaken and proposed, proposed 'West Hamersley Range Conservation Park' and any potential impacts, cumulative impact mining on Bungaroo Creek water supply (ensure DoW engaged).	Fauna survey approach reviewed to meet DEC advice. DoW engaged to discuss Bungaroo Creek water supply concerns (see below). DEC will be kept informed of Proposal developments as required during the EIA process.
Department of Mines and Petroleum (DMP)	Mining discussions and approval requirements; miscellaneous licence requirements and timing, closure planning requirements.	AMD studies scoped to assess potential for leaching of acid and metalliferous drainage. Soil and landform characterisation studies planned to inform rehabilitation and closure planning. Hydrological studies to ensure bunding and flood scenarios adequately addressed as part of mine and closure planning. Closure planning, to be undertaken as part of the Mining Proposal, will be in accordance with DMP/EPA guidance. In-principle agreement on key closure issues such as final land use and pit backfilling to be sought from relevant closure stakeholders. Various required licence applications lodged or being prepared.
Department of Premier and Cabinet– Native Title Branch	Native title.	Native Title Agreements have been reached between the Proponent and the Kuruma Marthudunera and Yaburara Mardudhunera peoples.

Key stakeholder	Issues raised	Response
Department of Resources, Energy and Tourism (RET) [Commonwealth]	Provided briefing in May 2012, being a high level overview of Proposal. Requested by RET to provide more detailed briefing closer to referral date. Follow-up detailed briefing provided in November 2012 outlining project specifics and referral detail.	RET generally supportive of the project and requested information regarding project economics.
Department of State Development (DSD)	Discussion and status of project, letter from the Premier of Western Australia supporting the Proposal.	No specific issues of concern raised regarding the mine and road proposal – DSD to be kept up to date with Proposal developments.
Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) [Commonwealth]	Provided briefing in May 2012, being a high level overview of Proposal. Requested by SEWPaC to provide more detailed briefing closer to referral date. Follow-up detailed briefing provided in November 2012 outlining project specifics and referral detail.	Northern Quoll key focus of fauna survey effort and will be a significant component of the Proposal EIA, including management planning and offsets strategies as required.
Department of Transport (DoT)	Planning, approval, environmental assessment requirements.	No specific issues of concern raised regarding the mine and road proposal – DoT to be kept up to date with Proposal developments.
Department of Water (DoW)	Potential impact on the Bungaroo Creek Water Reserve. Water licensing and approvals required for bores and road construction, potential for DoW to visit and inspect the minesite.	The Proponent has invited senior DoW personnel to visit and inspect the minesite. Hydrogeological investigations scoped to assess impact of dewatering and disposal of excess of dewater on Bungaroo Creek aquifers. AMD studies scoped to assess potential for leaching of acid and metalliferous drainage. Mine planning and management to address any potential contamination mechanisms and pathways, including hydrocarbon management and backfilling of pits to above watertable. DoW to be kept up to date with Proposal developments during the EIA process as required.
Environmental Protection Authority (EPA)	Discussion of initial plan to mine above the watertable and likely low level of assessment pending survey outcomes; future contact with the EPA. Later meeting discussed below-watertable mining and indication the Proposal likely to be assessed at API level. Staging of Environmental Management Plan approval, rehabilitation and closure options, water management.	Refer to the Environmental Factor, Offsets and Closure sections of this document for detail on the range of studies and strategies undertaken and planned to ensure the EIA of this Proposal meets the requirements of the EPA. Further detail will be provided as required during the scoping phase, as guided by the EPA.
Main Roads WA (MRWA)	Maximum fleet size MRWA would be comfortable with for a fleet of road trucks undertaking road haulage, variety of route options from the proposed mine to the customer delivery point.	No specific issues of concern raised regarding the mine and road proposal – MRWA to confirm road capacity allocation to IOH in November 2102.
Shire of Ashburton	Briefing provided to Shire council members in August 2012 –overview of project. Main questions were around timing of project development.	The Shire will be approached to further identify any other potential interested local stakeholders for inclusion in the ongoing consultation program. The Shire asked to be kept up to date with Proposal developments.
Heritage/Indigenous		
Kuruma Marthudunera (KM) and Yaburara Mardudhunera (YM) Claimant Groups	Native Title Agreements executed following successful negotiations.	The Proponent will ensure it honours its commitments detailed in the Native Title Agreements.
Commercial		

Key stakeholder	Issues raised	Response
API Aquila, Coz Iron, Rio Tinto, Red Hill Iron	Road alignments sent for these mining companies' consideration.	The companies have indicated no objections to the road alignment plans. The Proponent will maintain communication with these companies throughout the EIA, planning and construction/operations stages of the Proposal as required.
Dampier to Bunbury Natural Gas Pipeline (DBNGP)	Road alignments sent for DBNGP consideration.	DBNGP has indicated no objections to the road alignment plans. The Proponent will maintain communication with DBNGP throughout the EIA, planning and construction/operations stages of the Proposal as required.
Mardie Pastoral Station and Red Hill Pastoral Station	Road alignments sent for leaseholders' consideration.	Leaseholders have indicated no objections to the road alignment plans. The Proponent will maintain communication with these leaseholders throughout the EIA, planning and construction/operations stages of the Proposal as required.

5. Potential environmental impacts and management

This chapter provides a summary of the environmental factors potentially relevant to the assessment of impacts of this Proposal. The environmental factors have been separated into two groups:

1. Key factors: Those environmental factors of elevated significance, which require the most attention in the EIA process. The key factors include the following key factors, and are discussed in Sections 5.1 to 5.5:
    - flora and vegetation
    - terrestrial fauna
    - subterranean fauna
    - surface water
    - groundwater.
2. Other factors: Those environmental factors and issues of lesser importance that are recognised as potentially requiring consideration and management. Other factors or issues which have been identified include:
    - greenhouse gas
    - Aboriginal heritage
    - air quality (dust)
    - hazardous materials
    - acid and metalliferous drainage/soil and landform.

This list and division of factors and issues has been based on pre-referral consultation and guidance from regulatory agencies such EPA, DEC, DMP, DoW and SEWPaC, the results of relevant regional studies, as well the experience and advice of IOH personnel and the range of environmental consultants engaged to undertake environmental assessments and investigations of the Proposal.

The following sections describe and discuss these factors.

5.1 Vegetation and flora

5.1.1 Introduction

Studies/investigations

Completed

In April 2012, Onshore Environmental was commissioned to undertake a two-season Level 2 flora and vegetation survey. The first season survey was carried out in May/June 2012 at the Bungaroo South East and West deposits (approximately 600 ha), Dragon deposit (approximately 600 ha) and the infrastructure area (138 ha; Onshore 2012; Appendix 2).

Four previous surveys have been completed near the survey area by Malcolm Trudgen (1995) and Biota Environmental Sciences Pty Ltd (Biota; 2007a, 2007b and 2011). These studies are described in the Level 2 Flora and Vegetation Survey undertaken by Onshore (2012).

Planned

Flora and vegetation studies yet to be completed include:

- two season Level 2 survey for the first 40 km section of the Stage 1 road corridor closest to the minesite
- second season of the Level 2 flora and vegetation survey for the minesite survey area
- desktop assessment of the remainder of the road corridor.

EPA objective

Baseline studies and future management strategies will be developed and implemented to meet the following EPA objective for flora and vegetation:

- *to maintain the abundance, diversity, geographic distribution and productivity of flora at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.*

5.1.2 Description of factor

Vegetation

The first season flora and vegetation survey within the minesite was carried out within the Bungaroo South, Dragon and infrastructure survey areas. Within the minesite survey areas, nine vegetation associations were identified, as detailed in Onshore 2012) (Appendix 2, Table 4). The distribution of mapped vegetation associations is shown in Figure 6.

Table 4 Vegetation descriptions for associations mapped within the mine area of the Proposal

Vegetation association	ID	Description
Eucalyptus Open Woodland	1	*Eucalyptus victrix* Open Woodland over *Acacia pyrifolia*, *Gossypium robinsonii* Scattered Shrubs over *Tephrosia rosea* var. *glabrior* ms. *Pluchea dentex*, *Cleome viscosa* Low Open Shrubland
Terminalia Low Open Forest	2	*Terminalia canescens*, *Acacia pruinocarpa*, *Corymbia ferriticola* Low Open Forest over *Fluggea virosa* subsp. *melanthoides*, *Ventilago viminalis*, *Eremophila* cf. *latrobei* High Shrubland over *Dipteracanthus australasicus*, *Plumbago zeylanicum*, *Dicladanthera forrestii* Low Shrubland
Corymbia Low Woodland	3	Corymbia *ferriticola*, *Acacia pruinocarpa*, *Ficus brachypoda* Low Woodland over *Acacia tumida* var. *pilbarensis*, *Acacia monticola*, *Astrotricha hamptonii* High Open Shrubland over *Aristida burbidgei*, *Eriachne mucronata*, *Cymbopogon* ambiguous Very Open Tussock Grassland
Acacia High Shrubland	4a	*Corymbia hamersleyana*, Eucalyptus *leucophloia* Low Open Woodland over *Acacia tumida* var. *pilbarensis*, *Stylobasium spathulatum*, *Gossypium robinsonii* High Shrubland over *Tephrosia rosea* var. *glabrior* ms., *Pluchea dentex*, *Pterocaulon sphaeranthoides* Low Open Shrubland
Acacia High Shrubland	4b	*Corymbia hamersleyana*, *Eucalyptus leucophloia* Low Open Woodland over *Acacia monticola*, *Acacia tumida* var. *pilbarensis*, *Gossypium robinsonii* High Shrubland over *Triodia pungens* Open Hummock Grassland
Acacia Shrubland	5	*Grevillea pyramidalis* subsp. *leucadendron*, *Gossypium robinsonii*, *Acacia pyrifolia* High Open Shrubland over *Acacia pyrifolia*, *Indigofera* sp. Bungaroo Creek, *Stylobasium spathulatum* Shrubland over *Triodia pungens* Open Hummock Grassland
Triodia Closed Hummock Grassland	6	*Eucalyptus leucophloia* Low Open Woodland over *Triodia* wiseana Closed Hummock Grassland
Triodia Hummock Grassland	7a	*Eucalyptus leucophloia*, *Corymbia hamersleyana* Low Open Woodland over *Indigofera monophylla*, *Corchorus tectus*, *Triumfetta maconochieana* Low Shrubland over *Triodia wiseana*, *Triodia* sp. Robe River Hummock Grassland
Triodia Hummock Grassland	7b	*Acacia inaequilatera* High Open Shrubland over *Indigofera monophylla*, *Corchorus lasiocarpus*, Acacia *ptychophylla* Low Open Shrubland over *Triodia wiseana*, *Triodia* sp. Robe River Hummock Grassland

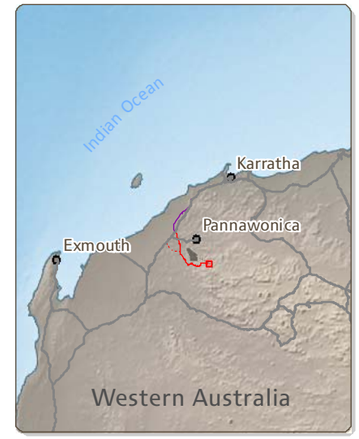
Source: Onshore 2012

448000

452000

7568000

7564000



Legend

- Development Envelope
- Conceptual Mine Layout *(Snowdens, Oct 2012)*
- Iron Ore Holdings Tenements *(DMP, Aug 2011)*

Note: For vegetation legend please see Figure 8

Scale (A3): 1:30,000
Datum: Geocentric Datum of Australia 1994
Projection: Map Grid Australia, Zone 50

Sources: Topography: Geoscience Australia, GEODATA Topo 250KV3, © Commonwealth of Australia, 2006
Imagery: IOH, AAM Survey 2007)

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Figure 6: Vegetation mapping in mine area

Legend

Vegetation Type at Dragon Location

Triodia Hummock Grassland
Acacia inaequilatera High Open Shrubland over *Indigofera monophylla/ Corchorus lasiocarpus/ Acacia ptychophylla*
Low Open Shrubland over *Triodia wiseana/ Triodia sp. Robe River* (M.E. Trudgen et al. MET 12367) Hummock Grassland.

Corymbia Low Woodland
Corymbia ferriticola/ Acacia pruinocarpa/ Ficus brachypoda Low Woodland over *Acacia tumida var. pilbarensis/ Acacia monticola/ Astrotricha hamptonii*
High Open Shrubland over *Aristida burbidgeae/ Eriachne mucronata/Cymbopogon ambiguus* Very Open Tuss*

Acacia High Shrubland
Corymbia hamersleyana/ Eucalyptus leucophloia Low Open Woodland over *Acacia monticola/ Acacia tumida var. pilbarensis/ Gossypium robinsonii*
High Shrubland over *Triodia pungens* Open Hummock Grassland.

Acacia High Shrubland
Corymbia hamersleyana/ Eucalyptus leucophloia Low Open Woodland over *Acacia tumida var. pilbarensis/ Stylobasium spathulatum/ Gossypium robinsonii*
High Shrubland over *Tephrosia rosea var. glabrior ms./ Pluchea dentex/ Pterocaulon sphaeranthoides**

Triodia Closed Hummock Grassland
Eucalyptus leucophloia Low Open Woodland over *Triodia wiseana* Closed Hummock Grassland.

Triodia Hummock Grassland
Eucalyptus leucophloia/ Corymbia hamersleyana Low Open Woodland over *Indigofera monophylla/ Corchorus 'thin leaf'/ Triumfetta maconochieana*
Low Shrubland over *Triodia wiseana/ Triodia sp. Robe River* (M.E. Trudgen et al. MET 12367) Hummock Grassland.

Eucalyptus Open Woodland
Eucalyptus victrix Open Woodland over *Acacia pyrifolia/ Gossypium robinsonii*
Scattered Shrubs over *Tephrosia rosea var. glabrior ms./ Pluchea dentex/ Cleome viscosa* Low Open Shrubland

Acacia Shrubland
Grevillea pyramidalis ssp. leucodendron/ Gossypium robinsonii/ Acacia pyrifolia High Open Shrubland over *Acacia pyrifolia/ Indigofera sp. Bungaroo Creek*
(S. van Leeuwen 4301), *Stylobasium spathulatum* Shrubland over *Triodia pungens* Open Hummock Grassland.

Terminalia Low Open Forest
Terminalia canescens/ Acacia pruinocarpa/ Corymbia ferriticola Low Open Forest over *Flueggea virosa ssp. melanthoides/ Ventilago viminalis/ Eremophila cf. latrobei*
High Shrubland over *Dipteracanthus australasicus/ Plumbago zeylanicum/ Dicladanthera**

Figure 7: Vegetation mapping legend

Vegetation condition

Vegetation condition within the minesite survey areas ranged from good to excellent (Onshore 2012). Drainage lines and floodplains tended to be in poorer condition due to impacts of stock grazing and weed species.

Flora

No Declared Rare Flora were indentified within the minesite survey areas. Four Priority Flora taxa were recorded in the survey area, at the Bungaroo South deposits:

- *Indigofera* sp. Bungaroo Creek (Priority 3)
- *Sida* sp. Barlee Range (Priority 3)
- *Rhynchosia bungarensis* (Priority 4)
- *Triodia* sp. Robe River (Priority 3).

All four Priority Flora species were recorded in the Bungaroo South survey area. *Triodia* sp. Robe River was the only Priority Flora species recorded in Dragon and infrastructure survey areas (Onshore 2012). The survey identified *Triodia* sp. Robe River at numerous locations typically as scattered individuals including on plateau slopes, minor drainage lines, ravines and gullies (Figure 8).

Seven introduced weed species were identified in the Bungaroo South survey area, with none recorded in the Dragon or Infrastructure survey areas.

Assessments indicate that the vegetation associations identified in the minesite survey areas are well distributed with low risk of significant impact as a result of the Proposal. There are no known conservation significant vegetation communities in the area and the risk to any riparian and groundwater-dependent vegetation is likely to be low (Onshore 2012).

Threatened and Priority Ecological communities (TECs and PECs) were assessed during the survey, confirming that there are no TECs within or adjacent to the minesite survey area. Similarly, no PECs were indentified in the minesite survey area; however, three PECs occur within 100 km of the mine area (Onshore 2012). These comprise:

1. *Triodia* sp. Robe River assemblages of mesas of the West Pilbara (Priority 3).
2. Invertebrate assemblages of Nyeetberry Pool (Priority 4).
3. Stygofaunal communities of the Western Fortescue Plains freshwater aquifer (Priority 4) (Onshore 2012).

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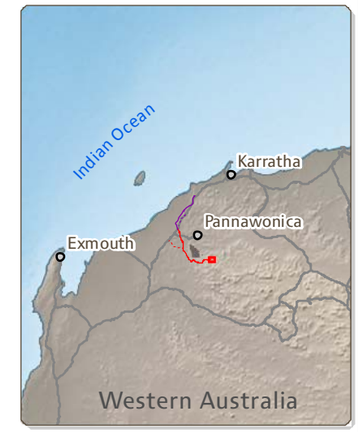

Legend

Priority Flora *(Onshore, Oct 2012)*

Genus

- *Indigofera* sp. Bungaroo Creek (Priority 3)
- *Sida* sp. Barlee Range (Priority 3)
- *Rhynchosia bungarensis* (Priority 4)
- *Triodia* sp. Robe River (Priority 3)
- Development Envelope
- Conceptual Mine Layout *(Snowdens, Oct 2012)*
- Iron Ore Holdings Tenements *(DMP, Aug 2011)*

Scale (A3): 1:26,000

Datum: Geocentric Datum of Australia 1994

Projection: Map Grid Australia, Zone 50

Sources: Topography: Geoscience Australia, GEODATA Topo 250KV3, © Commonwealth of Australia, 2006
Imagery: IOH, AAM Survey 2007

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Figure 8: Priority flora recorded in mine area

5.1.3 Key activities and their potential impacts

The key project activities identified as having the potential to impact on vegetation and flora are:

- **clearing of vegetation** may lead to loss of biodiversity, fragmentation of vegetation communities and soil erosion
- **earthworks** (including clearing and design and construction of landforms) may lead to dust smothering and changes to surface water flows
- **vehicle/machinery activity** may lead to weed infestation and/or pathogen infection, changes in surface and ground water quality, and fire outbreaks.

5.1.4 Management measures

Management of aspects of the proposal that have the potential to impact on flora and vegetation will be based on:

- adherence to clearing boundaries
- erosion protection
- dust control
- surface water management
- weed/hygiene management
- hydrocarbon management
- implementation of a fire management plan.

Management and monitoring actions for vegetation and flora will be further detailed in an Environmental Management Plan to be developed as part of the EIA for this Proposal.

5.2 Fauna

5.2.1 Introduction

Studies/investigations

Completed

Phoenix Environmental Sciences (Phoenix) carried out a Level 1 terrestrial vertebrate fauna and Level 2 short-range endemic invertebrate (SRE) survey for the Proposal (Phoenix 2012a; Appendix 2). The surveys covered two areas, encompassing the Bungaroo South and Dragon survey areas. The Level 1 vertebrate fauna survey was completed in May 2012 and the Level 2 SRE survey was carried out in May and July 2012. A targeted survey for several fauna species of conservation significance was then undertaken in July 2012 based on the observations and conclusions of the Level 1 terrestrial vertebrate fauna survey (Phoenix 2012b; Appendix 2).

A regional targeted Northern Quoll survey for the Proposal was then undertaken in August 2012 (Phoenix 2012b; Appendix 2) and a Level 1 terrestrial vertebrate fauna and SRE survey for the first 42 km of the proposed Stage 1 haul road for the Proposal was undertaken at the same time (Phoenix 2012c; Appendix 2).

Previous studies have been undertaken of the Robe River and Bungaroo Creek environments by Rio Tinto. This work relates to its Bungaroo Trial Mining Proposal (2005) and the Bungaroo Coastal Water Supply Borefield (2012).

Planned

Fauna studies yet to be completed include:

- desktop assessment of the second section of the proposed Stage 1 haul road corridor and the entire Stage 2 haul road corridor; this assessment will utilise data already collected in areas already surveyed by other Proponents that are in proximity to the Proposal area such as surveys conducted for the WPIOP rail corridor.

Any required further studies will be in accordance with EPA guidance (Position Statement No. 3, Guidance Statement No. 20 and Guidance Statement No. 56) and in consultation with Office of the Environmental Protection Authority and DEC.

EPA Objective

Management strategies will be developed and implemented to meet the following EPA objective for terrestrial fauna:

- *to maintain the abundance, diversity, geographic distribution and productivity of fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge*.

5.2.2 Description of factor (minesite)

The terrestrial fauna surveys for the minesite were carried out primarily within the Bungaroo South and Dragon survey areas. Some regional reference sites (regional survey area) were also used for the SRE survey (Phoenix 2012a).

Vertebrate terrestrial fauna

A desktop review identified 290 vertebrate fauna species with potential to occur in the survey areas, including 133 birds, 112 reptiles, 42 mammals and three amphibians. Of these species, 16 are listed under the *Wildlife Conservation Act 1950 (*WC Act) and a further nine are Priority species (Phoenix 2012a; Table 5). Not all vertebrate fauna species of conservation significance that have potential to occur in the survey area are likely to occur in the survey area (Phoenix 2012a). This is due to a lack of suitable habitat or ecological requirements.

Table 5 Species of conservation significance with potential to occur in survey area (minesite)

Species	Status
Northern Quoll (*Dasyurus hallucatus*)	Schedule 1 WC Act
Pilbara Olive Python (*Liasis olivaceus barroni*)	Schedule 1 WC Act
Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)	Schedule 1 WC Act
Bilby, Dalgyte *(Macrotis lagotis)*	Schedule 1 WC Act
Eastern Great Egret *(Ardea modesta)*	Schedule 3 WC Act
Oriental Pratincole (*Glareola maldivarum*)	Schedule 3 WC Act
Rainbow Bee-eater (*Merops ornatus*)	Schedule 3 WC Act
Cattle Egret *(Ardea ibis)*	Schedule 3 WC Act
White-bellied Sea-eagle (*Haliaeetus leucogaster)*	Schedule 3 WC Act
Little Curlew *(Numenius minutus)*	Schedule 3 WC Act
Common Sandpiper (*Actitis hypoleucos)*	Schedule 3 WC Act
Wood Sandpiper (*Tringa Glareola)*	Schedule 3 WC Act
Barn Swallow (*Hirundo rustica)*	Schedule 3 WC Act
Fork-tailed Swift (*Apus pacificus*)	Schedule 3 WC Act
Oriental Plover *(Charadrius veredus)*	Schedule 3 WC Act

Species	Status
Ramphotyphlops ganei	Priority 1 DEC list
Woma *(Aspidites ramsayi)*	Schedule 4 WC Act, Priority 1 DEC list (sw. pop)
Lined Soil-crevice Skink (*Notoscincus butleri*)	Priority 4 DEC list
Long-tailed Dunnart (*Sminthopsis longicaudata*)	Priority 4 DEC list
Ghost Bat (*Macroderma gigas*)	Priority 4 DEC list
Western Pebble-mound Mouse (*Pseudomys chapmani*)	Priority 4 DEC list
Grey Falcon (*Falco hypoleucos*)	Priority 4 DEC list
Australian Bustard (*Ardeotis australis*)	Priority 4 DEC list
Bush Stone –curlew (*Burhinus grallarius*)	Priority 4 DEC list
Star Finch (*Neochmia ruficauda subclarescens*)	Priority 4 DEC list

Source Phoenix 2012a

Bungaroo South survey area

Habitat types identified for terrestrial vertebrate fauna in the Bungaroo South survey area as follows:

- plateau of undulating spinifex grassland (78% of survey area)
- major creekline (11%)
- rocky foot slope and depositional material (9%)
- gully and rocky slope (2% of survey area).

The Level 1 survey identified 45 vertebrate species, including nine native mammals, 34 birds, and two introduced mammals. Key findings of the Bungaroo South survey include:

- potential occurrence of four Schedule 1 species as listed under the WC Act, being the Northern Quoll, Pilbara Olive Python, Pilbara Leaf-nosed Bat and Bilby
- identification of potential key habitat for conservation significant species including the Northern Quoll and Pilbara Olive Python.

The desktop review concluded the Bilby is unlikely to occur in the Proposal area.

Key findings of the targeted survey include:

- records (either by capture or scat collection) of Northern Quoll at six sites and identification of approximately 14.5 ha of denning/shelter habitat and 273 ha dispersal/foraging habitat in the survey area
- low level activity of Pilbara Leaf-nosed Bat in the survey area
- no critical habitat (i.e., permanent pools) for Pilbara Olive Python in the survey area.

The majority of the area surveyed consists of well-represented fauna habitat of relatively low-moderate value (Figure 9). Conservation significant species likely to occur in the survey area are unlikely to be highly dependent on the habitats within it. While no suitable permanent habitat for the Pilbara Olive Python such as permanent pools occurs within the survey area, some Pilbara Olive Python individuals may occasionally move through the survey area to reach permanent pools outside the survey area. The survey area may at times provide temporary habitat at one of two localities where temporary pools may form after large episodic rainfall events (Phoenix 2012a, 2012b). Recording of low-level activity of Pilbara Leaf-nosed Bat in the survey area indicates the species forages in the Proposal area; however, results strongly suggest a roost is not present in the Proposal area. Further discussion of Northern Quoll results is provided in the sub-section below.

Conservation significant species recorded are presented in Figure 10. These species and those of significance with the potential to occur in the survey area are further discussed in Phoenix (2012a).

Northern Quoll

Northern Quoll was not recorded from the survey area during the Level 1 survey; however, suitable denning/shelter and foraging/dispersal habitat was identified at several locations within the gully and rocky slope habitats (Phoenix 2012a).

The targeted Northern Quoll survey was undertaken in July 2012. Northern Quoll were recorded at five of the six trap and camera sites. In addition, two males were captured at two sites on a single ridgeline. The presence of males with overlapping ranges suggests females are also present. Scats were also found at one site unable to be further surveyed due to heritage access restrictions (Phoenix 2012b).

A regional undertaken in August 2012 involved 12 main trap (cage, Elliot and camera traps) sites and 16 additional camera trap sites across four creek systems. Nine individuals were captured during the survey with a total of 21 captures over 7 trap nights (1176 trap nights in total). The Northern Quoll were all captured at five of the 12 main trap sites, while Northern Quoll scats or photographic evidence were also recorded at another three main trap sites. The regional survey has provided strong evidence of significant movement up and down creek systems but no evidence of movement overland (Phoenix 2012b).

Dragon survey area

Habitat types were identified for terrestrial vertebrate fauna in the Dragon survey area as follows:

- plateau of undulating spinifex grassland (96% of survey area)
- plateau of undulating spinifex grassland (4% of survey area).

These provide limited habitat suitable for higher ranking conservation significant vertebrate fauna species. There is no habitat suitable for Northern Quoll, Pilbara Olive Python or Pilbara Leaf-nosed Bat. No sandy substrate exists for burrowing species such as the greater Bilby (Phoenix 2012a). Habitat suitable for a number of lesser-ranking conservation significant vertebrate fauna species does exist in the Dragon survey area (Figure 9) and these species are discussed in Phoenix (2012a).

The field survey identified that 45 vertebrate species potentially occur in the survey area. These include nine native mammals, 34 birds, and two introduced mammals. Key findings of the Dragon survey include:

- survey area may support up to four Priority 4 species
- survey area may support these species; however, there are no habitats of high value for fauna within the survey area
- no roosting or foraging habitat identified for the Pilbara Leaf-nosed Bat. Species presence is likely to be confined to transient individuals dispersing at dusk (Phoenix 2012a).

Short-range endemic invertebrates

Difficulties in the assessment of SRE distribution and likelihood of occurrence exist due to limited information on SREs in Western Australia. Currently, there is no accepted system to determine the likelihood that a species is an SRE. The uncertainty in categorising a specimen as SRE originates in a number of factors including:

- poor regional survey density: a regional fauna is simply not known well enough to assess the distribution of species
- lack of taxonomic resolution: many potential SRE taxa have never been taxonomically assessed and identification to species level is very difficult or impossible as species-specific character systems have not been defined
- problems of identification: SRE surveys often recover life stages of potential SRE taxa that cannot be confidently identified based on morphological characters, even if revisions exist.

To address this uncertainty, Phoenix (2012a, 2012c) has established three simple SRE categories to describe the probability of short-range endemism (Table 6).

Table 6 SRE categories reflecting survey, taxonomic and identification uncertainties

SRE category	Criteria	Typical representative
Confirmed	Confirmed or almost certainly SRE; taxonomy of the group is well known (but not necessarily published); group is well represented in collections, in particular from the region in question; high levels of endemism exists in documented species; inference is often possible from immature specimens.	*Antichiropus* (Paradoxosomatidae) millipedes; *Aops* scorpions (Urodacidae).
Likely	Taxonomically poorly resolved group; unusual morphology for the group (e.g. some form of troglomorphism); often singleton in survey and few, if any, regional records.	Opiliones, some araneomorph spiders in the genus *Karaops* (Selenopidae), some Pseudoscorpions (*Synsphyronus*) and slaters (Philosciidae).
Potential	Taxonomically poorly resolved group; often common in certain microhabitats in SRE surveys (i.e. litter dwellers), but no other regional records; congeners (= species in the same genus) often widespread.	Many mygalomorph spiders, some centipedes (Cryptopidae, Geophilomorpha).

Source Phoenix 2012a, 2012c

An SRE desktop review was conducted for the area covering the first 40 km of the proposed Stage 1 haul road and all of the minesite. The review found no instances of SREs within the survey area although this may be a result of no studies being done on these areas before. Database searches within approximately 100 km of the survey area identified 44 taxa that may include SREs (confirmed, likely or potential).

Bungaroo South survey area

Six sites were assessed in the Bungaroo South survey area representing the majority of available SRE invertebrate fauna habitat sites within the survey area. The field survey collected 576 individual specimens from the four SRE target groups being collected from the Bungaroo South and regional survey areas. Of these, 37% of specimens were collected from within the Bungaroo South survey area. While there were no confirmed SREs recorded from the Bungaroo South survey area, three taxa are considered likely SREs:

- crab spider *Karaops* sp. indet. (family Selenopidae)
- isopod Philosciidae 'pannawonica'
- land snail New genus cf. 'mt robinson' (Camaenidae).

Four taxa are considered potential SREs:

- centipede *Cryptops* sp. indet. (Cryptopidae)
- isopod *Buddelundia* '30' (Armadillidae)
- isopod *Buddelundia* '61' (Armadillidae)
- isopod *Buddelundia* sp. indet. (Armadillidae).

All taxa listed above have been identified outside of the survey area except the isopod Philosciidae 'pannawonica' (Figure 10). As species identification of three of the above taxa was not possible, specimens recorded within the Bungaroo South survey area may not be the same species as specimens recorded outside the survey area.

Most of the SRE taxa were recovered from the habitat type ‘gullies and rocky slope’ (ten SREs) and rocky foot slopes (six SREs). Two potential SREs were recorded in the habitat type ‘creekline’. This indicates that shade may be a factor in the distribution of SREs.

Detailed assessments of taxonomy and distribution are provided in Phoenix (2012a).

Dragon

The Dragon survey area represents a continuous, exposed landscape (of spinifex grassland plateau). This is unsuitable habitat for SRE invertebrates. Gully habitat is usually targeted as likely habitat for SREs, but is poorly represented in the Dragon survey area and did not provide the necessary features to support SRE invertebrate fauna. Given the likely paucity of suitable habitat, no survey sites were established for the Dragon area (Phoenix 2012a).

5.2.3 Description of factor (haul road)

The Level 1 haul road terrestrial vertebrate fauna and SRE survey area primarily comprises the first section of the proposed Stage 1 haul road corridor that commences near the headwaters of Bungaroo Creek. The survey corridor is 42 km long and 500 m wide, traversing the Buckland Hills from the Proposal mine and infrastructure area and terminating at the proposed API railway. In some instances, habitat outside the corridor was investigated where it was likely to be connected to habitat within the corridor (Phoenix 2012c).

Vertebrate terrestrial fauna

A desktop review identified 267 vertebrate fauna species with potential to occur in the survey area, including 123 birds, 96 reptiles, 45 mammals and three amphibians. Of these species, 24 are of conservation significance (Phoenix 2012c; Table 7).

Habitat types were identified for terrestrial fauna in the survey area as follows:

- rocky hills and plateaux of undulating spinifex grassland (81.6% of survey area)
- stony plains of sparse spinifex grasslands (13.4% of survey area)
- minor and major creeklines (4.78%)
- minor gullies (0.23%).

These habitats are expected to support conservation significant vertebrate fauna species. However, only a small proportion of the survey area is likely to be high value habitat. The survey recorded some potential Northern Quoll den and shelter habitat and recorded Pilbara Leaf-nosed Bat, with a small amount of potential foraging habitat available in the survey area for this species (Phoenix 2012c).

Phoenix (2012c) reports that of the 24 vertebrate fauna species of conservation significance that have the potential to occur in the survey area, 15 are considered likely to occur in the survey area due to lack of suitable habitat or known distributional data for the 9 other species.

Table 7 Species of conservation significance with potential to occur in survey area (haul road)

Species	Status
Northern Quoll (*Dasyurus hallucatus*)	Schedule 1 WC Act
Pilbara Olive Python (*Liasis olivaceus barroni*)	Schedule 1 WC Act
Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)	Schedule 1 WC Act
Bilby, Dalgyte *(Macrotis lagotis)*	Schedule 1 WC Act
Fork-tailed Swift (*Apus pacificus*)	Schedule 3 WC Act
Oriental Pratincole (*Glareola maldivarum*)	Schedule 3 WC Act
Rainbow Bee-eater (*Merops ornatus*)	Schedule 3 WC Act
Eastern Great Egret *(Ardea modesta)*	Schedule 3 WC Act
Cattle Egret *(Ardea ibis)*	Schedule 3 WC Act
White-bellied Sea-eagle (*Haliaeetus leucogaster)*	Schedule 3 WC Act
Little Curlew *(Numenius minutus)*	Schedule 3 WC Act
Barn Swallow (*Hirundo rustica)*	Schedule 3 WC Act
Oriental Plover *(Charadrius veredus)*	Schedule 3 WC Act

Species	Status
Ramphotyphlops ganei	Priority 1 DEC list
Woma *(Aspidites ramsayi)*	Priority 1 DEC list (sw. pop), Schedule 4 WC Act
Notoscincus butleri	Priority 4 DEC list
Long-tailed Dunnart (*Sminthopsis longicaudata*)	Priority 4 DEC list
Ghost Bat (*Macroderma gigas*)	Priority 4 DEC list
Western Pebble-mound Mouse (*Pseudomys chapmani*)	Priority 4 DEC list
Brush-tailed Mulgara (*Dasycercus blythi*)	Priority 4 DEC list
Grey Falcon (*Falco hypoleucos*)	Priority 4 DEC list
Australian Bustard (*Ardeotis australis*)	Priority 4 DEC list
Bush Stone –curlew (*Burhinus grallarius*)	Priority 4 DEC list
Star Finch (*Neochmia ruficauda subclarescens*)	Priority 4 DEC list

Source Phoenix 2012c

The field survey identified 17 vertebrate species including six reptiles, eight native mammals, two birds, and one introduced mammal. Key findings of the haul road survey include:

- one recorded mammal is listed as Schedule 1 under the WC Act (Pilbara Leaf-nosed Bat)
- one recorded mammal is listed under the DEC Priority fauna list (Western Pebble-mound Mouse)
- potential denning/shelter and connected foraging/dispersal habitat for Northern Quoll was recorded.

The majority of the survey area consists of well represented fauna habitat of relatively low-moderate value (Phoenix 2012c). While no suitable habitat for the Pilbara Olive Python exists (such as permanent pools) within the survey area, some Pilbara Olive Python individuals may occasionally move through the survey area to access permanent pools in the vicinity of the survey area where such pools occur (Phoenix 2012c).

Conservation significant species recorded or with the potential to occur in the survey area are further discussed in Phoenix (2012c, Appendix 2).

Short-range endemic invertebrates

The field survey resulted in 43 individual specimens from the four SRE target groups being collected. While there were no confirmed or likely SREs recorded from the survey area, four taxa are considered potential SREs:

- unidentified centipede in the genera *Mecistocephalus* (Mecistocephalidae)
- isopod *Buddelundia* '30' (Armadillidae)
- isopod *Buddelundia* '61' (Armadillidae)
- isopod *Buddelundia* '62' (Armadillidae).

Each of the SRE taxa identified above were recovered from the habitat type ‘gullies and rocky slope on minor creeklines’ or ‘rocky hills and plateaux’, indicative of shade being a factor in the distribution of SREs as discussed above. *Buddelundia* '62' was the only specimen found in the survey area but not identified in the desktop review (Phoenix 2012c). Where practicable, the Proponent is committed to avoiding the locality where *Buddelundia* '62' was recorded. If the area cannot be avoided, further work will be undertaken in an attempt to identify if its distribution extends outside the Proposal area.

Detailed assessment of SRE taxonomy and distribution is provided in Phoenix (2012c; Appendix 2).

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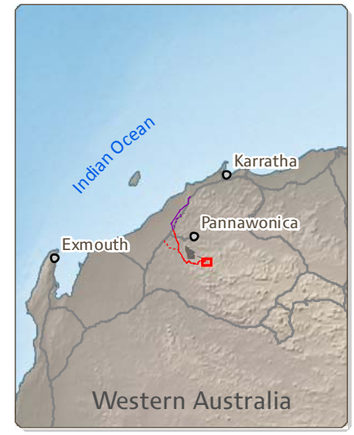

Legend

Pilbara Olive Python Habitat *(Phoenix, Oct 2012)*

- Permanent water pools suitable for Pilbara Olive Python
- Potential ephemeral water pools
- Development Envelope

General Vertebrate Fauna Habitats *(Phoenix, Oct 2012)*

- Gully and rocky slope
- Major Creek Line
- Minor Gully
- Plateau of undualting spinifex grassland (recently burnt)
- Plateau of undulating spinifex grassland
- Rocky foot slopes and depositional material
- Conceptual Mine Layout *(Snowdens, Oct 2012)*
- Iron Ore Holdings Tenements *(DMP, June 2012)*

Scale (A3): 1:40,000

Datum: Geocentric Datum of Australia 1994

Projection: Map Grid Australia, Zone 50

Sources: Topography: Geoscience Australia, GEODATA Topo 250KV3, © Commonwealth of Australia, 2006
Imagery: IOH AAM Survey 2007

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Figure 9: Potential terrestrial vertebrate fauna habitat in mine area

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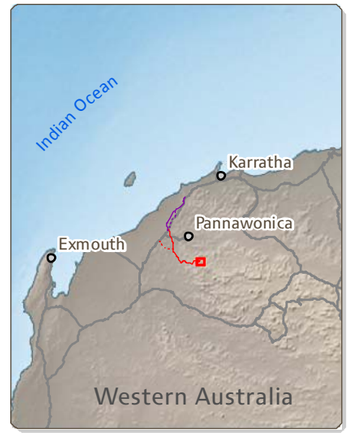

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SRE Invertebrate Records *(Phoenix, Oct 2012)*

- Buddelundia '30'
- Buddelundia '61'
- Buddelundia sp. indet.
- Cryptops sp. indet.
- Karaops sp. indet.
- New genus cf. 'Mt Robinson'
- Philosciidae 'Pannawonica'
- Rainbow Bee-eater *(Phoenix, Oct 2012)*

Northern Quoll

- Northern Quoll *(Phoenix, Oct 2012)*
- Northern Quoll (Targeted Survey) *(Phoenix, Oct 2012)*
- Northern Quoll Camera Trap Sites *(Phoenix, Oct 2012)*
- Northern Quoll Cage Trap Sites *(Phoenix, Oct 2012)*

Pilbara Leaf Nosed Bat Songmeter Locations *(Phoenix, Oct 2012)*

- Activity Recorded
- No Activity Recorded
- Development Envelope
- Iron Ore Holdings Tenements
- Conceptual Mine Layout *(Snowdens, Oct 2012)*

Scale (A3): 1:40,000

Datum: Geocentric Datum of Australia 1994

Projection: Map Grid Australia, Zone 50

Sources: Topography: Geoscience Australia, GEODATA Topo 250KV3, © Commonwealth of Australia, 2006
Imagery: IOH AAM Survey, 2007

File: 001\045_RevB (SP 02/11/2012)

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Figure 10: Conservation significant fauna survey effort and records in mine area

5.2.4 Key activities and their potential impacts

The key project activities identified as having the potential to impact on fauna are:

- **bunding for flood protection** of Bungaroo Creek and its tributaries to prevent flooding of the Bungaroo South east and west pits will constrict the waterway, which may alter flow regimes during high flow periods, which in turn may affect fauna and fauna habitat
- **modification of landforms** through the construction of pits, dumps, access and infrastructure may affect surface flows, which may in turn affect fauna and fauna habitat
- **vehicle/machinery activity** may lead to fauna injury or death
- **earthworks** (including clearing and trenching) may lead to loss of biodiversity, fauna entrapment (e.g. in trenches) and habitat loss/fragmentation
- **waste storage** may lead to an increase in abundance or distribution of feral fauna and native fauna reliance on human food wastes
- **night works** may lead to behavioural changes (e.g. due to light)
- **hydrocarbon and other hazardous material use**, storage and transport may lead to water/soil pollution.

5.2.5 Mitigation and management measures

Mitigation of potential impacts on fauna include:

- avoidance of disturbance to habitat such as some areas of Northern Quoll denning/shelter habitat and dispersal/foraging habitat for various species by proposing to access only part of the entire orebody.

Management of potential impacts on fauna will be centred on:

- incorporating surface water management into mine planning and design to maintain Bungaroo Creek flows without significantly impacting key fauna habitat (construction of bund to maximise fauna habitat values)
- reducing vehicle speeds and implementing a fauna management plan
- adherence to clearing boundaries
- responsible storage and management of waste
- use of directional or shielded lighting
- appropriate use and storage of hydrocarbons and other hazardous material.
- retention and maintenance of 50 m minimum buffer along creek embankment
- retention and maintenance of 50 m buffer along top of mesa for movement of fauna during wet periods
- local (site) feral animal control.

Management and monitoring actions for fauna will be further detailed in an Environmental Management Plan to be developed as part of the EIA for this Proposal.

5.3 Subterranean fauna

5.3.1 Introduction

Studies/investigations

Bennelongia Pty Ltd has undertaken troglofauna and stygofauna studies, with the first phase occurring from July to September 2012. The second phase commenced in October 2012 (Bennelongia 2012, Appendix 2). Further troglofauna and stygofauna sampling and molecular analysis is planned to ensure adequate data is captured to support the EIA, with further rounds of sampling likely to commence in early 2013. The Proponent is also considering use of habitat characterisation assessment based on local geologies to further support the impact assessment on subterranean fauna.

Troglofauna

Troglofauna samples have been collected from drill holes at 'impact sites' within, and at reference sites outside, the proposed pits at South Bungaroo West, East and Dragon (Table 8; Figure 11). All sampling includes use of traps and a scrape sub-sample to increase sampling effort. Troglofauna sampling effort at the Bungaroo South East Pit was 1.7% below the minimum effort recommended in EPA Guidance Statement No. 54A (EPA 2007) (59 as opposed to 60 samples). Sampling effort at the Bungaroo South West Pit was 3% below recommended levels (58 as opposed to 60 samples). Due to the limited number of drill holes available, 37 samples of the recommended 60 were able to be achieved at Dragon (Bennelongia 2012).

Table 8 Sample effort for troglofauna

	Round 1				Round 2*				
	Scrape	S Trap	D Trap	*Samples*	Scrape	S Trap*	D Trap*	***Samples***	**Total Samples**
South Bungaroo West Pit									
Impact	26	21	5	***26***	32	25	7	***32***	**58**
Reference	19	14	5	***19***	23	16	7	***23***	**42**
South Bungaroo East Pit									
Impact	32	24	8	***32***	27	19	8	***27***	**59**
Reference	13	8	5	***13***	15	14	1	***15***	**28**
Dragon									
Impact	13	10	3	***13***	24	16	8	***24***	**37**
Reference					21	16	5	***21***	**21**

*Round 2 trap retrieval is yet to occur - scheduled for December 2012

Stygofauna

Stygofauna sampling, conducted over two sample rounds, occurred from 17–20 July 2012 (Round 1) and from 4–5 October 2012 (Round 2) (Bennelongia 2012).

To date 29, 31 and one stygofauna samples have been collected from bores in the vicinity of the proposed pits at Bungaroo South West Pit, Bungaroo South East Pit and Dragon, respectively (Figure 11). Where the drawdown around the two pits in the Bungaroo South area is treated as a single impact area, stygofauna sampling effort reached the minimum effort recommended in EPA Guidance Statement 54A (EPA 2007). The single sample collected at Dragon will most likely represent a reference sample on the basis that the Dragon pit will not intersect the watertable (Bennelongia 2012).

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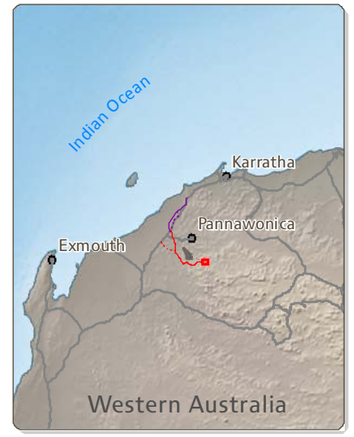

Legend

- Stygofauna Sample Sites *(Bennelongia, Oct 2012)*
- Troglofauna Sample Sites *(Bennelongia, Oct 2012)*
- Development Envelope
- Conceptual Mine Layout *(Snowdens, Oct 2012)*
- Iron Ore Holdings Tenements *(DMP, Aug 2011)*

Scale (A3): 1:25,000
Datum: Geocentric Datum of Australia 1994
Projection: Map Grid Australia, Zone 50

Sources: Topography: Geoscience Australia, GEODATA Topo 250KV3, © Commonwealth of Australia, 2006
Imagery: IOH AAM Survey, 2007

File: 001\050_RevB (HR 06/11/2012)

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Figure 11: Subterranean fauna sampling locations

Table 9 Sample effort for stygofauna

	Round 1	Round 2	**Total Samples**
South Bungaroo West Pit	15	14	**29**
South Bungaroo East Pit	15	16	**31**
Dragon		1	**1**

5.3.2 Description of factor

Morphological identification of specimens collected from the first phase of subterranean fauna sampling is complete; however, molecular identification is ongoing. Preliminary round one findings are as follows (Bennelongia 2012, Appendix 2):

Troglofauna comprised 78 specimens representing six Classes, twelve Orders and approximately 28 species (Table 10).

Table 10 Preliminary troglofauna findings

Class	Order	Species
Arachnids	Pseudoscorpionida	3
	Schizomida	Probably 5
	Araneae	Probably 1
Crustaceans	Isopoda	2
Centipedes	Geophilomorpha	1
Millipedes	Polydesmida	1
	Spirostreptida	1
Hexapods (Entognatha / Insecta)	Diplura	5
	Blattodea	Probably 1
	Hemiptera	3
	Coleoptera	2 to 4
	Diptera	1

Stygofauna comprised 971 specimens representing eight higher taxonomic levels and approximately at least 24 species (Table 11).

Table 11 Preliminary stygofauna findings

Taxonomic group	Species
Gastropoda	1
Oligochaeta	3
Acariformes	1
Ostracoda	At least 1 species
Copepoda	9
Syncarida	3
Amphipoda	5
Nematoda	1 (treated as one species)

Potential conservation significant subterranean fauna species

Troglofauna

From the first phase of sampling conducted to date, 11 of the 28 species of troglofauna collected are known only from the proposed mine pits. Apart from one species (*Curculionidae* Genus 2 sp. B14) all of the species are represented by one or two specimens (Bennelongia 2012, Appendix 2). About five (and up to 8 species) are of uncertain conservation status at present because of uncertain taxonomy - molecular analysis is underway for these species.

Currently there is presently little information from which to infer likely ranges of the potentially conservation significant species sampled in the Proposal area. The potentially conservation significant species sampled in the Proposal area are discussed further below (Bennelongia 2012):

Pseudoscorpionida (Atemnidae sp. B04 and *Tyrannochthonius* sp. B23)

Determining the range of pseudoscorpions can be difficult owing to the low abundance at which these species are typically collected. The Order is very species rich with most species having relatively small ranges. In the case of Atemnidae sp. B04, which occurs at East Pit and West Pit, this species is very likely to be present in the intervening area and is not restricted to the proposed impact footprint.

Schizomida (*Paradraculoides* sp. B05, *Paradraculoides* sp. B06 and *Draculoides* spp.)

Schizomids are probably the most studied troglofauna, in terms of distributions, in Western Australia and have variable ranges. Six species in the Robe Valley were reported to be each tightly restricted to single mesas (the largest only 989 ha), although *Draculoide*s *vinei* in the Cape Range had a linear range of about 50 km.

While no firm statements can be made about the ranges of the schizomid species that have been recorded at Bungaroo South and Dragon, *Paradraculoides* sp. B05 is likely to be represented in specimens trapped outside the proposed East Pit and currently identified only to genus level. The five specimens collected outside of the proposed West Pit provide a strong indication that schizomids (and other troglofauna) are not restricted to commercial grade mineralization.

Polydesmida (Dalodesmidae sp. B05)

Polydesmids are rarely encountered in Pilbara troglofauna surveys. Little can be said of the likely range of this species at present. The occurrence of more abundant species at the East Pit (e.g. the schizomids) may be the best guide to determining the likely range of this species.

Diplura (Anajapygidae sp. B04, Heterojapygidae sp. B02 and Japygidae sp. B30)

The limited information about the ranges of troglofaunal species of these families suggest these may sometimes have tightly restricted ranges and tend to occur in valley sediments rather than across ranges. Japygidae sp. B30 is more likely to occur beyond the impact areas because the related Japygidae sp. B17 is known from the lower Robe River catchment, with a linear range of 84 km. Most diplurans of the family Japygidae in the Pilbara appear to be relatively widespread.

Coleoptera (Curculionidae Genus 2 sp. B14)

Species of the family Curculionidae are usually recorded at low abundance and many species of the undescribed Genus 2 have already been collected in subterranean habitats of the Pilbara. When larger numbers of specimens are collected, some Genus 2 species have been observed to have considerable ranges. However, other information suggests many curculionids have restricted ranges. In the case of Curculionidae Genus 2 sp. B14, which occurs at East Pit and Dragon, this species is likely to be present in the intervening area and is not restricted to the proposed impact footprints.

Conclusion

The troglofaunal assemblage of the Proposal area appears moderately rich by Pilbara standards. The distribution of troglofauna in the reference areas at both the South Bungaroo West and East Pits indicates that the zone of commercial grade mineralization probably does not define the ranges of localised troglofauna species; however, for a number of species occurrence outside this zone remains to be demonstrated. Results at the Dragon deposit are more difficult to interpret because there have been no troglofauna collected from the reference bores. This may reflect a lack of troglofauna habitat beyond the proposed mine pit at Dragon but is more likely an artefact of sampling.

Stygofauna

Seven of the 24 species of stygofauna collected to date are known only from the sampling at the proposed mine pits (Bennelongia 2012). A further ten species are of uncertain conservation status at present because of uncertain identifications. This is typically because specimens are unsuitable for morphological identifications or, in the case of the Melitidae amphipods, the lack of a well developed taxonomic framework.

Existing information about likely ranges and conservation significance of the seven species is discussed below (Bennelongia 2012):

Acariformes (*Limnesia* sp. B04)

Members of this genus are commonly collected in surface waters in the Pilbara; however, stygal species are rare. The likely range of this species is not known, but most stygofaunal mites are widespread.

Gastropoda (Hydrobiidae sp. B05)

Species of the family Hydrobiidae are not commonly collected as stygofauna and appear to have localised ranges, although the taxonomy is poorly understood. Hydrobiidae sp. B05 is expected to have a relatively small range.

Copepoda (*Anzcyclops* sp. B03, nr *Dussartstenocaris* sp. B05 and nr *Kinnecaris* sp. B03)

Anzcyclops sp. B03, nr *Dussartstenocaris* sp. B05 and nr *Kinnecaris* sp. B03 are unlikely to have ranges as small as the scale of drawdown associated with mining at Bungaroo South; however, species of the genera *Anzcyclops, Dussartstenocaris* and *Kinnecaris* are rarely collected and have not been shown to occur beyond single catchments.

Syncarida (*Bathynella* sp. B09 and *Billibathynella* sp. B06)

Stygofaunal syncarid species are usually considered to have small ranges and, while there is evidence that ranges increase with sampling effort, DNA analysis is likely to lead to tighter species definitions and smaller ranges. *Bathynella* sp. B09 was collected in low numbers from a single bore and little can be inferred about its likely range. *Billibathynella* sp. B06 was recorded at both Bungaroo West and East Pits and was collected at some abundance, suggesting it occurs commonly in the area.

Conclusion

The Proposal area appears relatively depauperate by Pilbara standards, particularly for the Robe River catchment, although moderately rich by global standards. There are a number of species known only from the potential impact footprint and further taxonomic work may increase this number. A number of stygofauna species are expected to have ranges that reflect the limits of the Robe River catchment, or potentially even the smaller Bungaroo Creek Catchment. However, any species are not expected to be tightly restricted to the vicinity of the likely impact footprint.

5.3.3 Key potential aspects and impacts

The key project aspects identified as having the potential to impact on troglofauna are:

- **pit excavation** may lead to removal of potential troglofauna habitat (potential loss of individual fauna through the extraction of material or vibration)
- **waste rock and low-grade fines disposal** may lead to detrimental effects on underlying troglofauna habitat
- **hydrocarbon spills** may lead to surface and groundwater contamination that has the potential to degrade habitat for troglofauna
- **clearing of vegetation** may lead to a reduction of organic inputs.

Key project aspects identified as having the potential to impact on stygofauna are:

- **pit dewatering** may lead to drawdown and impact on stygofauna habitat
- **pit excavation** below groundwater level may remove stygofauna individuals and habitat
- **hydrocarbon spills** may lead to surface and groundwater contamination that has the potential to degrade habitat for stygofauna.

5.3.4 Mitigation and management measures

Mitigation of potential impacts on subterranean fauna include:

- avoidance of disturbance to some areas of troglofauna habitat by proposing to access only part of the entire orebody.

Management of potential impacts on subterranean fauna will be centred on:

- adherence to pit shell design, waste dump and low-grade fines storage facility boundaries
- appropriate dewatering management, minimising disturbance to stygofauna habitat by drawdown
- adherence to clearing boundaries
- appropriate use and storage of hydrocarbons and other hazardous material.

Management and monitoring actions for subterranean fauna will be further detailed in an Environmental Management Plan to be developed as part of the EIA for this Proposal.

5.4 Surface water

5.4.1 Introduction

Studies/investigations

Completed

A surface water assessment was carried out by RPS in July 2012 (RPS 2012a; Appendix 2). This consisted of a pre-feasibility study of surface water management options.

Planned

Hydrological studies of the Robe River and Fortescue River at the proposed river crossings will be undertaken in accordance with advice provided by DoW and/or DMP. DoW and DMP will continue to be consulted to confirm if further hydrological studies are required to support the EIA.

5.4.2 EPA objectives

Management strategies will be developed and implemented to meet the following EPA objectives for surface water.

- *to maintain the quantity of water so that existing and potential environmental values, including ecosystem maintenance, are protected*
- *to ensure that emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.*

5.4.3 Description of factor

The Bungaroo South deposits are located across Bungaroo Creek and its tributaries (RPS 2012a) (Figure 2). The proposed haul road alignment will involve two crossings of two significant ephemeral surface water features: the Robe River and Fortescue River.

Under the proposed water management strategy, Bungaroo Creek flow will be maintained and guided to the northern side of the pits through use of bunds, within the limits of the Bungaroo Creek valley. The Proposal requires bunding of parts of the creek system and some clearing of creek vegetation.

For road crossings at the Robe and Fortescue Rivers, a low floodway option – designed to allow flooding to occur unimpeded - is being proposed by the road planners as an alternative to a bridge. The Proponent will endeavour to ensure Robe River and Fortescue River flow regimes will not be significantly affected.

5.4.4 Key potential impacts

The following aspects of the mining and processing component of the Proposal may affect surface water values:

- **bunding for flood protection** of Bungaroo Creek and its tributaries to prevent flooding of the Bungaroo South east and west pits will constrict the waterway, which may alter flow regimes during high flow periods
- **modification of landforms** through the construction of pits, dumps, access and infrastructure may affect surface flows
- **discharge of surplus water** into ephemeral watercourses could modify the hydrological regime (quantity and quality) potentially affecting the planned Bungaroo Creek Water Reserve
- **spills of chemicals, hydrocarbons or wastes** within mining areas may cause contamination of surface water
- **runoff from disturbed areas and overburden dumps** may result in increased sediment transport to watercourses
- **presence of access road** between operational areas could lead to obstruction of surface water flow.

5.4.5 Management measures

Management of potential impacts on surface water will be centred on:

- incorporating surface water management into mine planning and design to maintain Bungaroo Creek flows without implementing major diversions
- appropriate reuse of excess surface water
- treating any excess water to appropriate standards prior to discharging into the environment
- appropriate management of chemical, hydrocarbons and wastes
- management of sediment to reduce mobilisation and use of treatment devices to reduce sediment loading.

Water management for the Proposal will be conducted under an Operating Strategy prepared in accordance with the *Pilbara Water in Mining Guideline* (DoW 2009) as an expected requirement of *Rights in Water and Irrigation Act 1914* licences to be obtained from DoW.

Management and monitoring actions for surface water will be further detailed in an Environmental Management Plan to be developed as part of the EIA for this Proposal.

5.5 Groundwater

5.5.1 Introduction

Studies/investigations

Completed

RPS was commissioned to undertake a prefeasibility-level dewatering assessment of the Bungaroo South deposits (east and west) (RPS 2012b). The RPS (2012) report provides a summary of previous groundwater investigations carried out in the area (Appendix 2).

Planned

Further groundwater modelling will be carried out to refine dewatering and drawdown estimates at the minesite and surrounds.

Assessment of the groundwater systems along the proposed haul road corridor will be undertaken to support groundwater extraction licence applications required for the construction of the haul road.

5.5.2 EPA objectives

Management strategies will be developed and implemented to meet the following EPA objectives for groundwater:

- *to maintain the quantity of water so that existing and potential environmental values, including ecosystem maintenance, are protected*
- *to ensure that emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.*

5.5.3 Description of factor

The main aquifer of interest at the mine is the channel iron deposit (CID) (i.e. ore-bearing rock) and the associated un-mineralised channel deposits (RPS 2012b). Limited monitoring undertaken by IOH indicates water quality is fresh (<700µ/cm) with a neutral to slightly acidic pH (RPS 2012b). These results accord with other testing undertaken in the regional aquifer for Rio Tinto Iron Ore and the Department of Water (RPS 2012b).

The CID infill of the palaeochannel on which the Proposal pits are centred acts as a semi-confined aquifer. Bedrock comprises Dales Gorge, Mt McRae and Mt Sylvia Shales – these locally fractured rock aquifers are interconnected and are believed to act as one aquifer. Overlying the CID is recently saturated alluvium that is expected to seep into both mine pits (RPS 2012b).

Aquifer testing has been carried out on mineral exploration (CID) and surrounding bedrock monitoring bores. Results suggest that both aquifers are relatively permeable. Average hydraulic conductivities have been estimated for the aquifers (RPS 2012b; Table 12).

Table 12 Average aquifer properties for Bungaroo South pits

Aquifer	Hydraulic conductivity (m/day)
CID Western Deposit	0.14
CID Eastern Deposit	1.7
Bedrock Western Deposit	2.1
Bedrock Eastern Deposit	0.67

Source RPS 2012b

The watertable sits approximately 10–20 m below current surface water drainage (RPS 2012b). The Proponent plans to mine the two Bungaroo South deposits using open pit methods to a depth of up to 105 m below ground level (53 m below watertable in the palaeochannel). Up to seventeen of the 20-year mine life will consist of below-watertable mining (RPS 2012b).

First-order estimates of dewatering requirements have been derived for three scenarios using simple analytical methods. This was assessed for mining below watertable over five years in the Western Deposit and 12 years in the Eastern Deposit. Estimates of dewatering requirements assume average climatic and aquifer conditions (RPS 2012b).

Drawdown effects were also assessed. Assumptions regarding hydrogeological properties have been made in order to achieve this (Table 13).

Table 13 Average hydraulic conductivities

	Aquifer	Hydraulic conductivity (m/d)
Eastern Deposit	CID	1.67
	Bedrock	0.64
Western Deposit	CID	0.13
	Bedrock	1.9

Source RPS 2012b

Dewatering of both Bungaroo South pits may be required from approximately year three. The Western Deposit has an overall lower dewatering requirement compared to the Eastern Deposit, which has higher dewatering requirements due to higher hydraulic conductivities and a larger cross section of the mine pit. Average dewatering requirements for the Western Deposit are calculated to be 19 L/s in the first year of mining below watertable and reaching 49 L/s five years later. The Eastern Deposit average dewatering requirements are calculated to be 97 L/s in the first three years of mining below watertable and reaching 145 L/s in the fifth year of mining, then a gradual decrease to 123 L/s due to later shallow pit extension to the east (RPS 2012b).

Dewatering of the two Bungaroo South pits would cause a gradual elongated cone of depression within the palaeochannel and its tributaries. This could extend approximately 3 km upstream from the mines over the life of the two pits. Downstream drawdown effects should be limited by the proposed return of excess water to the environment; however, the cone of depression in the bedrock aquifer (surrounding the CID) could reach up to approximately 12 km from the mine after five years although in practice natural flow barriers are expected to limit this (RPS 2012b).

Dewatering of both pits would be carried out by ex-pit bores within the CID and bedrock. Sump pumping would be needed initially, when the saturated alluvium is intersected, and also potentially following high rainfall events when inflows to the pit through the alluvium may increase (RPS 2012b).

The shallow alluvium is expected to contribute up to 91 L/s (Western Pit) and 227 L/s (Eastern Pit) until it is dewatered, after which time is expected to contribute seepage during and after rainfall significant enough to create flow in the creek (RPS 2012b).

Forty registered bores are listed within a 7 km radius of the Bungaroo South pits, all of which are related to investigations undertaken by Robe River Iron in 2002 and 2003 (RPS 2012b).

Bungaroo Creek Water Reserve

The Bungaroo Coastal Water Supply Borefield is being developed by Rio Tinto as part of its planned expansion of operations in the Pilbara. The borefield is located in the lower Bungaroo Valley and will have an annual capacity of 10 GL, from which bulk water will be supplied to Karratha, Dampier, Roebourne, Cape Lambert and Point Samson. The borefield consists of nine production bores within the Bungaroo Creek palaeochannel (RPS 2012b).

The Bungaroo Creek Water Reserve is planned to protect the water source and catchment areas that are responsible for aquifer recharge and the reserve boundary encompasses the deposits that are subject of the Proposal. DoW has recommended the water reserve be managed for Priority 1 source protection, with 500 m wellhead protection zones established around all production bores (RPS 2012b) (Section 3.3.2).

DoW indicates mining proposals within the proposed water reserve are compatible, with conditions (i.e., associated with EPA and/or DMP approvals), and should be guided by DoW water quality protection guidelines (DoW 2012).

Priority 1 (P1) classification areas are managed to ensure that there is no degradation of the drinking water source by preventing development of potentially harmful activities in these areas. The guiding principle is risk avoidance and this is the most stringent priority classification for drinking water sources (DoE 2004).

The Proponent will continue to consult DoW during the environmental impact assessment and approvals process to address potential impacts of the Proposal on the Bungaroo Creek Water Reserve.

5.5.4 Key potential impacts

The following aspects of the mining and processing component of the Proposal may affect groundwater values (with particular consideration of the Bungaroo Creek Water Reserve):

- **abstraction of groundwater** to dewater the mine pits and for mine and construction/processing water supply (when required to supplement water available from dewatering) may impact on groundwater quantity and levels
- **disposal of mine water** excess to water supply demand may impact on groundwater quality
- **contamination** from seepage from the low-grade fines storage facility, inappropriate management of solid and liquid wastes, inappropriate handling and storage of hydrocarbons and hazardous materials may impact on groundwater quality
- **disposal of effluent** from wastewater treatment plants may affect groundwater quality
- **excavation** of potential acid sulfate soil from below the watertable may affect groundwater quality.

5.5.5 Management measures

Management of potential impacts on groundwater will be centred on:

- limiting groundwater abstraction/dewatering to what is necessary for safe and efficient mining
- reuse of excess water or disposal with treatment if required
- identification and appropriate management of potential hazardous materials, including the prevention of leachate from low-grade fines storage facilities
- spill preparedness and appropriate spill response
- installation of effective wastewater treatment and disposal systems
- development of treatment programs to neutralise potential acid forming processes associated with excavation below the watertable.

Water management for the Proposal will be conducted under an Operating Strategy prepared in accordance with the *Pilbara Water in Mining Guideline* (DoW 2009) as an expected requirement of *Rights in Water and Irrigation Act 1914* licences to be obtained from DoW.

Management and monitoring actions for groundwater will be further detailed in an Environmental Management Plan to be developed as part of the EIA for this Proposal.

5.6 Other environmental factors and issues

5.6.1 Greenhouse gas emissions

Management strategies will be developed and implemented to meet the following EPA objective for greenhouse gas (GHG) emissions.

- *to minimise emissions to levels as low as practicable on an on-going basis and consider offsets to further reduce cumulative emissions*.

GHG emissions have been estimated for the proposed operations at 4 Mtpa (Stage 1) and 8 Mtpa (Stage 2) (Table 14). Emission sources considered include power generation and vehicles/machinery (road trains, light vehicle fleet and mining fleet).

Table 14 Estimated GHG emissions based on diesel fuel consumption for the Proposal

Capacity (Mtpa)	Annual fuel consumption (kL/yr)	Annual GHG emissions (t CO2-e/yr)
4	16,428	44,193
8	31,025	83,437

Source SKM 2012

The Proponent is committed to minimising emissions to levels as low as reasonably practicable on an ongoing basis through implementation of the following management actions:

- reporting GHG emissions in accordance with National Greenhouse and Energy Reporting (NGERS) requirements
- complying with the Australian *Clean Energy Act 2011* (carbon pricing system and emissions trading scheme).

Implementation of GHG and energy conservation measures would reduce emissions and provide a mechanism for continuous improvement in GHG emissions resulting from the Proposal.

5.6.2 Aboriginal heritage

Aboriginal heritage sites have been identified in and around the Proposal area. The Proponent remains in close consultation with the Kuruma Marthudunera (KM) and Yaburara Mardudhunera (YM) claimant groups to ensure project planning avoids heritage sites where possible and correct management measures are in place to minimise any potential impacts. A land use agreement was signed with the KM claimant group in October 2012 and the YM claimant group in November 2012.

The Proponent will also engage with the Department of Indigenous Affairs as required during the approvals process in accordance with the *Aboriginal Heritage Act 1972* (AH Act).

Management strategies will be developed and implemented to meet the following EPA objective for Aboriginal heritage:

- *to ensure that changes to the biophysical environment do not adversely affect historical and cultural associations and comply with relevant heritage legislation.*

Aboriginal heritage values will be addressed during planning and implementation of the Proposal by:

- avoiding disturbance to heritage sites where practical
- obtaining approval for any required disturbance to identified sites in accordance with s. 18 of the AH Act
- protecting all identified sites located near construction or operational areas that are not approved to be disturbed under s. 18 of the AH Act (e.g. through the installation of physical barriers)

- documenting the location of all protected sites in a Geographic Information System (GIS) database and on site plans
- working with the KM and YM people to ensure heritage values are maintained appropriately
- establishing heritage protocols and cultural awareness training for all employees.

Management actions for Aboriginal heritage will be further detailed in an Environmental Management Plan to be developed as part of the EIA for this Proposal.

5.6.3 Air quality (dust)

Management strategies will be developed and implemented to meet the following EPA objective for air quality.

- *to ensure that emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standard*s.

Dust will be generated as a result of the Proposal primarily through construction clearing and earthworks, blasting, materials handling, crushing and processing of ore and haulage and light traffic on unsealed roads.

Management measures to minimise dust will include:

- the application of water (or appropriate suppressants) to haul roads, working surfaces and stockpiles (as required)
- incorporation of dust controls in key infrastructure, such as water sprays at the ROM bin, and dust collectors at major dust generating centres (primary crusher, conveyor transfers)
- implementing and enforcing appropriate vehicle speed limits on site access roads.

Management and monitoring actions for air quality will be detailed in an Environmental Management Plan to be developed as part of the EIA for this Proposal.

5.6.4 Hazardous materials

Management strategies will be developed and implemented to meet the following EPA objectives for hazardous materials.

- *to maintain the integrity, ecological functions and environmental values of the soil and landform*
- *to ensure that emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards*.

The Proposal would involve the use of a number of hazardous materials such as fuels and lubricants. Inappropriate handling and/or storage of hazardous materials has the potential to result in discharges to the environment (i.e. contamination) and create health or safety hazards.

All hazardous material storage facilities will comply with the *Dangerous Goods Safety Act 2004* and associated Dangerous Goods Safety Regulations 2007, at a minimum.

Management and monitoring actions for hazardous materials will be further detailed in an Environmental Management Plan to be developed as part of the EIA for this Proposal.

5.6.5 Acid and metalliferous drainage/soil and landforms

Management strategies will be developed and implemented to meet the following EPA objectives for acid and metalliferous drainage (AMD) and soils and landforms.

- *to maintain the integrity, ecological functions and environmental values of the soil and landform*
- *to ensure that emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards*
- *to ensure that rehabilitation achieves an acceptable standard compatible with the intended land use, and consistent with appropriate criteria.*

A of review of existing data and statistical analysis of IOH supplied data (including X-ray Fluorescence [XRF]) data, drill logs, updated block models, planned drilling programs, geological information and maps) and site inspection has been undertaken (URS, unpublished), which forms the first stage in studies to be undertaken to support EIA and mine and closure planning.

Soils and landforms

Initial findings regarding soils and landforms in the Proposal area are as follows:

- three primary soil types were observed:
  - red loamy earths
  - stony soils
  - river bed soils (channels)
- areas with stony soils have large amounts of aggregates, are poorly developed and apedal and are unlikely to be suitable for capping material during land-forming and rehabilitation
- river bed soils are not present in significant quantities and are confined to drainage channels and are therefore unlikely to be a reliable resource for capping materials
- the red loamy earths appear to have a small proportion of aggregate and may be suitable as a capping material
- the carbon percentage of soils is expected to be low and careful supplementation of organic nutrient media may assist in revegetation
- soils in the Proposal area may be prone to accelerated wind and water erosion following the loss of vegetation and gravelly/stony mantle, along with disturbance from earth moving
- soils in the Proposal area are also likely to have varying dispersion characteristics and careful management of slopes and erosion barriers will be required
- soils from the red loamy earth soil unit may provide sufficient volume of soils with clay content suitable for construction of engineering surfaces
- better growing conditions are likely to be in areas containing red loamy soils.

Further studies

Future investigations to be undertaken to support soils and landforms assessment and rehabilitation and closure planning may include sampling for the following parameters at a suitable density across each identified landform targeting areas which will be disturbed by mining operations:

1. Soil profiling to include horizonation due to colour change and texture change, the presence of pans, ferricrete zones or non-ferricrete gravels, the nature of the horizon boundaries, texture, structure, colour and fabric.
2. In-situ field tests/observations from ground surface to varying depths to aid in soil classification of such parameters as roots (size, depth of penetration and abundance), dispersion and slaking, pH/EC, depth to free water and water repellence.
3. Soil sample testing of selected metals, nutrients, cations and anions, pH, salinity and total organic carbon.

Further work on the soil and landform assessment has been scoped and will be undertaken throughout project planning.

Management options

For the purposes of rehabilitation and closure, soil and landform management will be centred on:

- careful design of micro-relief features on the capping and topsoil
- positioning soils in areas where runoff is not predicted to flow at high velocities
- ripping soil surfaces
- progressive rehabilitation and monitoring.

The Proponent will also investigate options for addressing the limited topsoil availability within the Proposal area.

Management and monitoring related to soil and landforms will be detailed in a Mine Closure Plan to be developed as part of the Mining Proposal to be prepared under the *Mining Act 1978*.

Acid Mine Drainage

Preliminary data collected indicates low sulphur values and low acid generation risk across the Proposal area. A total of 3198 samples were assessed as part of AMD assessment. Three of the lithologies sampled were found to have greater than 10 kg of sulphuric acid per tonne, including the regolith-pisolite, sediment-chemical and sediment-clastic (SRK 2011). Preliminary results therefore indicate that the majority of waste will not be acid forming (<1% of samples tested). Preliminary investigations include no acid-neutralising capacity (ANC) data; therefore, cannot be classified as non-acid forming (NAF).

Based on preliminary results, the majority of materials are not expected to be problematic in terms of AMD; however, further detailed investigation including laboratory test work is required to determine the risk of AMD.

Further studies

Further investigations to be undertaken to support the preliminary AMD survey results include the following:

1. Ongoing desktop assessment, including a review of information including drill logs, updated block models, drilling programs, geological information and maps.
2. Geochemical static testing targeting key representative lithology/alteration types to obtain representative samples that reflect spatial area and depth of mining planned. Testing will enable characterisation of waste to determine the potential to generate both acidic and metalliferous drainage.

Further work on AMD and waste characterisation has been scoped and will be undertaken throughout project planning.

Management options

Management and monitoring actions for AMD will be detailed in a Mine Closure Plan to be developed as part of the Mining Proposal to be prepared under the *Mining Act 1978* (Section 7).

6. Offsets strategy

The Proponent is aware of the need to provide environmental offsets for possible significant residual environmental impacts to high value environmental assets remaining after on-site efforts to avoid, minimise and rectify impacts have been applied.

6.1 Relevant policy and guidance

6.1.1 State offsets policy and guidance

The Western Australian Environmental Protection Authority (EPA) is of the opinion that offsets should aim 'to counterbalance any significant residual environmental impacts and risks of a proposal' (EPA 2012). Environmental offsets represent the 'last line of defence' for the environment, ensuring that adverse impacts are counterbalanced by an environmental gain somewhere else (EPA 2006). Environmental offsets should be a component of the environmental impact assessment procedure, and the EPA expects proponents to put forward commitments for offsets as part of their Proposal.

The EPA has prepared two reference papers in relation to offsets: *EPA Guidance Statement No. 19 Guidance for the Assessment of Environmental Factors - Environmental Offsets – Biodiversity* (EPA 2008) and *Position Statement No. 9 Environmental Offsets* (EPA 2006). Both documents define a series of guiding principles for proponents to follow when developing an offsets package. Environmental offsets should also consider the *Draft Environmental Assessment Guideline for Environmental Offsets* (EPA 2012) and *WA Environmental Offsets Policy* (Government of Western Australia 2011).

6.1.2 Australian Government offsets policy

SEWPaC has released an EPBC Act Environmental Offsets Policy (EPBC Act Policy) (SEWPaC 2012b) that defines two types of offsets

- **direct offsets**: measures that have on-ground, tangible benefits that improve the viability of the protected matter
- **other compensatory measures**: any other measure that contributes to the overall conservation outcome of the protected matter.

Principles guiding the EPBC Act Policy are that offsets:

1. Deliver an overall conservation outcome.
2. Be efficient, effective, transparent, proportionate, scientifically robust and reasonable.
3. Be built around direct offsets but may include indirect (i.e. compensatory) offsets.
4. Be of a size and scale proportionate to the impacts being offset.
5. Be in proportion to the level of statutory protection that applies to the affected species or community.
6. Effectively manage the risks of the offset not succeeding.
7. Be able to be readily measured, monitored, audited and enforced.

6.2 Net conservation benefit

As part of the approval process, offsets will be developed in accordance with State and Australian Government guidance to address any significant residual impacts to biodiversity values associated with the Proposal. Potential residual impacts associated with the mining proposal have been identified at this stage to include localised impacts on Northern Quoll habitat; however, other potential residual impacts may be identified during future stages of the environmental impact assessment process.

A part of the EIA process, an offsets strategy will be developed and refined, and will include related mitigation strategies developed with input from the State and Australian agencies. The mitigation package will include accurate details regarding potential impact and the proposed offset measures to achieve a net conservation benefit for the area.

Examples of measures that may be considered for inclusion in an offsets package include support for:

- actions to protect existing good or better quality Northern Quoll habitat in the region (i.e. within the surrounding Bungaroo Creek system and proposed West Hamersley Range Conservation Park)
- Cane Toad control (in the Kimberley where the frontline of toad invasion is occurring) and related research
- relevant Northern Quoll research and/or education programs
- feral animal control in the vicinity of the Proposal
- Pilbara fire management and research
- local conservation efforts undertaken by Aboriginal and other landholder groups.

7. Mine closure

Amendments to the Western Australian *Mining Act 1978* in 2010 included the requirement for mine closure planning to be undertaken at the project planning stage. Mine Closure Plans are required to be included as a component of the Mining Proposal to be submitted to the Department of Mines and Petroleum (DMP) for approval (and/or to be submitted as an Appendix to an EIA document when seeking environmental approval from the EPA under Part IV of the EP Act).

These amendments were made to ensure closure planning is considered at project planning stages to enable the identification and management of closure and decommissioning risks. Accordingly, a Closure and Decommissioning Plan (Closure Plan) will be prepared to satisfy the requirements of the ANZMEC/MCA *Strategic Framework for Mine Closure* (ANZMEC/MCA 2000). This will be based on the methodology and approaches outlined in the DMP/EPA Guidelines for Preparing Mine Closure Plans (DMP and EPA 2011) and the Department of Industry, Tourism and Resources (DITR) *Leading Practice Sustainable Development in Mining* (DITR 2008) handbooks and the *Planning for Integrated Mine Closure: Toolkit* (ICMM 2008).

The EPA will generally not assess mine closure as part of its EIA of mining proposals where they are subject to the *Mining Act 1978* unless it considers there are particular issues that pose a high environmental risk. The EPA would consult with DMP before making any such decision. Unless the DMP indicates concern regarding potentially significant environmental impacts associated with closure, the Proponent understands from initial consultation with the EPA that a closure plan is unlikely to be required for assessment under an API level of assessment. Subsequently, assessment of the Closure Plan will be addressed under the *Mining Act 1978* through the Mining Proposal application and approval process.

The Closure Plan will be prepared with all available environmental and social information considered. The Closure Plan will be subject to review and amendments throughout the life of the Proposal and incorporate the following:

- planning of post-mining land use and development of closure objectives to ensure impacts on the post-mining landscape are minimised
- summary of legal obligations for closure of the project
- risk assessment to identify and evaluate potential closure issues and assess their significance
- details of closure data collected (based on existing data and any supporting environmental assessments)
- development of management strategies to manage closure issues
- determination of closure outcomes and goals (i.e. completion criteria)
- development of a rehabilitation strategy to be incorporated progressively throughout the project life
- development of a closure implementation program
- closure costing
- development of a monitoring and maintenance program on completion of decommissioning and closure
- summary of closure specific stakeholder consultation to date.

8. Conclusion

This section summarises the content discussed above regarding the key and other environmental factors and issues potentially relevant to the assessment of impacts of this Proposal (Table 15). It provides a summary of the potential impacts, proposed management measures to be addressed in detail during the anticipated EIA process as well as the further studies proposed to support the EIA.

Table 15 Preliminary summary of environmental factors, impact, management and proposed studies for the Buckland Project

Environmental factor	EPA objective(s)	Existing environment	Potential impacts	Proposed management	Proposed studies
Flora and vegetation	To maintain the abundance, diversity, geographic distribution and productivity of flora at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.	Nine vegetation associations were identified in the minesite survey area. Condition of vegetation within the survey area was in the range of good to excellent. No Declared Rare Flora were indentified within the survey area. Four Priority Flora taxa were recorded in the survey area. A total of seven introduced weed species were identified at Bungaroo South survey area, with none recorded in the Dragon or Infrastructure survey areas. Assessments indicate that habitats identified are well distributed with low risk of impacts as a result of the Proposal. At this stage there are no known conservation significant vegetation communities in the area and there is only a low impact risk to riparian and groundwater dependent vegetation. Threatened and Priority Ecological communities were assessed during the survey, confirming that there are no TECs within or adjacent to the minesite Proposal area. Similarly, no PECs were indentified in the minesite Proposal area; however, three PECs occur inside a 100 km radius. The surveys of vegetation and flora along the proposed haul road corridor are yet to be finalised.	Clearing of vegetation may lead to loss of biodiversity, fragmentation of vegetation communities and soil erosion. Earthworks (including clearing and design and construction of landforms) may lead to dust smothering and changes to surface water flows. Vehicle/machinery activity may lead to weed infestation and/or pathogen infection, changes in surface and ground water quality, and fire outbreaks.	IOH will implement the following key management measures in order to minimise potential impacts to the conservation-significant flora species identified within the Proposal area: • adherence to clearing boundaries • erosion protection • dust control • management of any surface water effects • weed/hygiene management • hydrocarbon management • implementation of a fire management plan.	Flora and vegetation studies yet to be completed include: • two season Level 2 survey for the first 40 km section of the Stage 1 road corridor closest to the minesite • second season of the Level 2 flora and vegetation survey for the minesite survey area • desktop assessment of the remainder of the road corridor.

Environmental factor	EPA objective(s)	Existing environment	Potential impacts	Proposed management	Proposed studies
Fauna	To maintain the abundance, diversity, geographic distribution and productivity of fauna at species and ecosystems levels through the avoidance or management of adverse impacts and improvement of knowledge.	Fauna surveys were conducted for Bungaroo South, Dragon and the haul road. The Bungaroo South field survey identified 45 vertebrate species. The majority of the area surveyed consists of well represented fauna habitat of relatively low-moderate value. Key findings for Bungaroo South include • potential occurrence of four Schedule 1 species as listed under the WC Act: • identification of potential key habitat for conservation significant species including the Northern Quoll and Pilbara Olive Python. The Dragon field survey identified 45 vertebrate species may occur in the survey area. Key findings include: • survey area may support up to four Priority 4 species • survey area may support these species; however, there are no habitats of high value for fauna within the survey area No SRE survey sites were established for the Dragon area Key findings of the haul road surveys include: • recorded mammals include the Pilbara Leaf-nosed Bat, DEC Priority Western Pebble Mouse • potential denning/shelter and connected foraging/dispersal habitat for Northern Quoll was recorded • 43 individual specimens from four SRE target groups were collected, of which four taxa are considered potential SREs.	While there were no confirmed or likely SREs recorded from the Bungaroo South survey area vehicle/machinery activity may lead to fauna injury or death. Earthworks (including clearing and trenching) may lead to loss of biodiversity, fauna entrapment (e.g. In trenches) and habitat loss/fragmentation. Waste storage may lead to an increase in abundance or distribution of feral fauna and native fauna reliance on human food wastes. Night works may lead to behavioural changes (e.g., due to light) Hydrocarbon and other hazardous material use, storage and transport may lead to water/soil pollution. Bunding for flood protection of Bungaroo Creek and its tributaries to prevent flooding of the Bungaroo South east and west pits will constrict the waterway, which may alter flow regimes during high flow periods, which in turn may affect fauna and fauna habitat. Modification of landforms through the construction of pits, dumps, access and infrastructure may affect surface flows, which may in turn affect fauna and fauna habitat	IOH will implement the following key management measures in order to minimise potential impacts to the conservation-significant fauna species identified within the Proposal area: • construction of bund to maximise fauna habitat values • reducing vehicle speeds and implementing a fauna management plan • responsible storage and management of waste • use of directional or shielded lighting • appropriate use and storage of hydrocarbons and other hazardous material. • retention and maintenance of 50 m minimum buffer along creek embankment • retention and maintenance of 50 m buffer along top of mesa for movement of fauna during wet periods • local (site) feral animal control.	Fauna studies yet to be completed include: • desktop assessment of the second section of the proposed Stage 1 haul road corridor and the entire Stage 2 haul road corridor.

Environmental factor	EPA objective(s)	Existing environment	Potential impacts	Proposed management	Proposed studies
Subterranean fauna	To maintain the abundance, diversity, geographic distribution and productivity of fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.	Preliminary results are indicative of a 'moderately rich' troglofauna assemblage. Further work remains to be carried out to determine if any specimens are restricted to pit areas, and to assess potential impacts of the Proposal on stygofauna. This information will be provided in the final impact assessment document.	Pit construction will lead to removal of potential troglofauna habitat (potential loss of individual fauna through the extraction of material or vibration). Hydrocarbon spills may lead to surface and groundwater contamination that has the potential to degrade habitat for troglofauna. Clearing of vegetation may lead to a reduction of organic inputs.	IOH will implement the following key management measures in order to minimise potential impacts to the conservation-significant subterranean fauna species identified within the Proposal area: • limiting the volume of resource mined such that subterranean habitat will remain • appropriate use and storage of hydrocarbons and other hazardous material.	Subterranean studies yet to be completed include: • further rounds of troglofauna and stygofauna sampling is likely to commence in early 2013 • habitat characterisation assessment based on local geologies (the use of this method is being assessed).
Surface water	To maintain the quantity of water so that existing and potential environmental values, including ecosystem maintenance, are protected To ensure that emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.	Stream flows in the region are highly dynamic with the majority of flow occurring during the summer months, following rainfall. Flow in smaller stream channels is ephemeral, while more significant river channels flow for weeks subsequent to major rainfall. Baseflow in creek systems is variable with no flow occurring in some years and relatively high flow in others (RPS 2012). The Bungaroo South deposit is located across Bungaroo Creek and its tributaries. .Under the proposed water management strategy, Bungaroo Creek flow will be maintained and guided to the northern side of the pits using minor bunds, within the limits of the Bungaroo Creek valley. The Proposal requires bunding of parts of the creek system and some clearing of creek vegetation.	Bunding for flood protection of the Bungaroo east and west pits will constrict Bungaroo Creek, which could potentially alter flow regimes Modification of landforms through the construction of pits, dumps, access and infrastructure may affect surface flows. Discharge of surplus water into ephemeral watercourses could modify the hydrological regime (quantity and quality) potentially affecting riparian vegetation and habitat. Spills of chemicals, hydrocarbons or wastes within mining areas may cause contamination of surface water. Runoff from disturbed areas and overburden dumps may result in increased sediment transport to watercourses.	IOH will implement the following key management measures in order to minimise potential impacts to surface water values identified within the Proposal area: • incorporating surface water management into mine planning and design • limiting extent of bund encroachment into watercourse to maintain flows • appropriate reuse of excess surface water • treating any excess water to appropriate standards prior to discharging into the environment • appropriate management of chemical, hydrocarbons and wastes • management of sediment to reduce mobilisation and use of treatment devices to reduce sediment loading.	Surface water studies yet to be completed include: • further refinement of surface water studies incorporating final mine designs • hydrological studies of the Robe River and Fortescue River at the proposed river crossings – to be undertaken in accordance with advice provided by DoW and/or DMP • DoW and DMP will continue to be consulted to confirm if further hydrological studies are required to support the EIA.

Environmental factor	EPA objective(s)	Existing environment	Potential impacts	Proposed management	Proposed studies
Groundwater	To maintain the quantity of water so that existing and potential environmental values, including ecosystem maintenance, are protected To ensure that emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.	Hydrogeology of the site; centred on the channel iron deposit (CID) infill of the Palaeochannel, which acts as a semi confined aquifer. Bedrock comprises Dales Gorge, Mt McRae and Mt Sylvia Shales. These locally fractured rock aquifers are interconnected and are believed to act as one aquifer. Overlying the CID is recent saturated alluvium that is expected to seep into both mines (RPS 2012b). Watertable sits approximately 15 metres below current surface water drainage and groundwater quality in the CID and surrounding bedrock is fresh. Testing results show electric conductivity to be less than 700 µ/cm and a neutral to slightly alkaline pH (RPS 2012b). The Bungaroo Coastal Water Supply Borefield is being developed by Rio Tinto as part of their planned expansion of operations in the Pilbara. The borefield is located in the lower Bungaroo Valley and will have an annual capacity of 10 GL, from which bulk water will be supplied to Karratha, Dampier, Roebourne, Cape Lambert and Point Samson. The borefield consists of nine production bores within the Bungaroo Creek Palaeochannel (RPS 2012b). Dept of Water is planning gazettal of a water reserve under the *Country Areas Water Supply Act 1947,* to protect the catchment areas that recharge the aquifers. The reserve boundary encompasses the deposits that are subject of the Proposal.	Below-watertable mining is proposed for the Bungaroo South pits. Abstraction of groundwater to dewater the mine pits and for mine and construction/processing water supply (when required to supplement water available from dewatering) may impact on groundwater quantity and levels (including the Bungaroo Coastal Water Supply Borefield Project. Disposal of dewatering effluent excess to water supply demand may impact on groundwater quality. Contamination from seepage from the waste fines facility, inappropriate management of solid and liquid wastes, inappropriate handling and storage of hydrocarbons and hazardous materials may impact on groundwater quality. Disposal of effluent from wastewater treatment plants may affect groundwater quality. Excavation of potential acid sulfate soil from below the watertable may impact on groundwater quality.	IOH will implement the following key management measures in order to minimise potential impacts to groundwater values identified within the Proposal area: • limiting groundwater abstraction/dewatering to what is necessary for safe and efficient mining • reuse of excess water or reinjection into the alluvial formations down-gradient of the mining area (with treatment if required) • identification and appropriate management of hazardous materials • spill preparedness and response • installation of effective wastewater treatment and disposal systems (Biomax) • development of treatment programs to neutralise potential acid forming processes associated with excavation below the watertable • waste fines facilities located, designed and managed to minimise short-term and long-term environmental issues.	Groundwater studies yet to be completed include: • groundwater modelling to refine dewatering and drawdown estimates at the minesite and surrounds • assessment of the groundwater systems along the proposed haul road corridor to facilitate the future groundwater extraction licence applications required for the construction of the haul road. .

Environmental factor	EPA objective(s)	Existing environment	Potential impacts	Proposed management	Proposed studies
Greenhouse gas	To minimise emissions to levels as low as practicable on an on-going basis and consider offsets to further reduce cumulative emissions.	N/A	Contribution to cumulative greenhouse gas emissions	The Proponent is committed to minimising emissions to levels as low as reasonably practicable on an ongoing basis through implementation of the following management actions: • report GHG emissions in accordance with NGERS • comply with the Australian Government Climate Change Plan (carbon pricing system and emissions trading scheme).	No further studies proposed.
Aboriginal heritage	To ensure that changes to the biophysical environment do not adversely affect historical and cultural associations and comply with relevant heritage legislation.	Aboriginal heritage sites have been identified in and around the Proposal area. A land use agreement was finalised with the Kuruma Marthudunera (KM) claimant group in October 2012 and the Yaburara Mardudhunera (YM) group in November 2012.	Disturbance of heritage sites.	Avoiding disturbance to heritage sites where practical Obtaining approval for any required disturbance to identified sites in accordance with s. 18 of the *Aboriginal Heritage Act 1972.* Protecting all identified sites located near construction or operational areas that are not approved to be disturbed under s. 18 of the *Aboriginal Heritage Act 1972* (e.g., through the installation of physical barriers). Documenting the location of all protected sites in a geographic information system (GIS) database and on site plans. Working with the Kuruma Marthudunera people to ensure heritage values are maintained appropriately in accordance with KM land access agreement Establishing heritage protocols and cultural awareness training for all employees.	Heritage surveys will be completed along the length of the haul road by the relevant claim groups.

Environmental factor	EPA objective(s)	Existing environment	Potential impacts	Proposed management	Proposed studies
Air quality (dust)	To ensure that emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.	Dust will be generated as a result of the Proposal primarily through construction clearing and earthworks, blasting, materials handling, crushing of ore, transport of ore via the conveyor system, and haulage and light traffic on unsealed roads.	Impacts of dust to residences and the environment are expected to be minimal.	The application of water (or appropriate suppressants) to haul roads, working surfaces and stockpiles (as required) Incorporation of dust controls in key infrastructure, such as water sprays at the ROM bin, and dust collectors at major dust generating centres (primary crusher, conveyor transfers). Implementing and enforcing appropriate vehicle speed limits on site access roads.	No further studies proposed.
Hazardous materials	To maintain the integrity, ecological functions and environmental values of the soil and landform, To ensure that emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.	The Proposal would involve the use of a number of hazardous materials such as fuels. Inappropriate handling and/or storage of hazardous materials has the potential to result in discharges to the environment (i.e., contamination) and creating health or safety hazards.	Contamination of soil and water	Hazardous material storage facilities will be managed in accordance the *Dangerous Goods Safety Act 2004* and associated Dangerous Goods Safety Regulations 2007. Accidental discharges of hazardous materials will be managed in accordance with the HSEQ Spill Response Procedure.	No further studies proposed.

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