NORTH STAR MAGNETITE PROJECT PUBLIC ENVIRONMENTAL REVIEW

August 2013

FMG

Fortescue
The New Force in Iron Ore

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Invitation to Make a Submission

The Environmental Protection Authority (EPA) invites people to make a submission on this proposal. Both electronic and hard copy submissions are most welcome.

FMG Iron Bridge Ltd, a majority owned subsidiary company of Fortescue Metals Group Ltd proposes to develop the North Star Magnetite Project (the Project) in the Pilbara region of Western Australia. The Project comprises three distinct components as follows:

- North Star mine area: approximately 1,230 kilometres (km) north-north east of Perth and 110 km south-south east of Port Hedland.
- Canning Basin borefield and water supply pipeline: The Canning Basin borefield is located approximately 160 km east of Port Hedland.
- Slurry pipeline and infrastructure corridor: connects the North Star mine area to facilities in Port Hedland.

The Project will include a new mine with one open pit, waste rock dump, tailings storage facility, low grade ore stockpile, process rejects waste landform, crushing and screening hub, magnetic separation processing plant, power station, roads, and other associated mine infrastructure. The Project will process up to 30 million tonnes of magnetite ore per year over a mine life of 45 years. The ore will undergo crushing, screening, and magnetic separation. Up to 15 million tonnes per annum (Mtpa) of product will be sent to Port Hedland for export as magnetite concentrate.

In accordance with the *Environmental Protection Act 1986* (EP Act), a Public Environmental Review (PER) has been prepared which describes this proposal and its likely effects on the environment. The PER is available for a public review period of 6 weeks from [date] closing on [date].

Comments from government agencies and from the public will help the EPA to prepare an assessment report in which it will make recommendations to government.

Why write a submission?

A submission is a way to provide information, express your opinion and put forward your suggested course of action – including any alternative approach. It is useful if you indicate any suggestions you have to improve the proposal.

All submissions received by the EPA will be acknowledged. Submissions will be treated as public documents unless provided and received in confidence, subject to the requirements of the *Freedom of Information Act, 1992* (FOI Act), and may be quoted in full or in part in the EPA's report.

Why not join a group?

If you prefer not to write your own comments, it may be worthwhile joining a group interested in making a submission on similar issues. Joint submissions may help to reduce the workload for an individual or group, as well as increase the pool of ideas and information. If you form a small group (up to 10 people) please indicate all the names of the participants. If your group is larger, please indicate how many people your submission represents.

Developing a submission

You may agree or disagree with, or comment on, the general issues discussed in the PER or the specific proposal. It helps if you give reasons for you conclusions, supported by relevant data. You may make an important contribution by suggesting ways to make the proposal more environmentally acceptable.

When making comments on specific elements of the PER:

- clearly state your point of view;
- indicate the source of your information or argument if this is applicable;
- suggest recommendations, safeguards or alternatives.

Points to keep in mind

By keeping the following points in mind, you will make it easier for your submission to be analysed:

- attempt to list points so that issues raised are clear. A summary of your submission is helpful;
- refer each point to the appropriate section, chapter or recommendation in the PER;
- if you discuss different sections in the PER, keep them distinct and separate, so there is no confusion as to which section you are considering;
- attach any factual information you may wish to provide and give details of the source. Make sure your information is accurate.

Remember to include:

- your name;
- address;
- date; and
- whether and the reason why you want your submission to be confidential.

Information in submissions will be deemed public information unless a request for confidentiality of the submission is made in writing and accepted by the EPA.

As a result, a copy of each submission will be provided to the proponent but the identity of private individuals will remain confidential to the EPA.

The closing date for submissions is: 21 October 2013

The EPA prefers submissions on PER documents to be made electronically on its consultation hub at https://consultation.epa.wa.gov.au.

Alternatively, submissions can be

- posted to: Chairman, Environmental Protection Authority, Locked Bag 33, CLOISTERS SQUARE WA 6850, Attention: Matt Spence; or
- delivered to the Environmental Protection Authority, Level 4, The Atrium, 168 St Georges Terrace, Perth, Attention: Matt Spence.

If you have any questions on how to make a submission, please ring the EPA assessment officer, Matt Spence on 6145 0819.

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This document was prepared on behalf of Fortescue Metals Group Limited by:

SINCLAIR KNIGHT MERZ
SKM

Approved by Fortescue:	Matt Dowling	Signature	17 July 2013

ABBREVIATIONS

Abbreviation	Meaning
%	Percent
°	Degrees Celsius
µm	Micron, micrometre
ABCC	Acid Base Characterisation Curve
AHD	Australian Height Datum
AMD	Acid metalliferous drainage
ANC	Acid Neutralising Capacity
ARI	Annual recurrence interval
AS	Australian Standard
ASLP	Australian Standard Leaching Protocol
Atlas	Atlas Iron
BHPB	BHP Billiton Iron Ore P/L
BIF	Banded Iron Formation
Cth	Commonwealth
DBNGP	Dampier-Bunbury Natural Gas Pipeline
DEC	Department of Environment and Conservation
DIA	Department of Indigenous Affairs
DMP	Department of Mines and Petroleum
DoH	Department of Health
DoW	Department of Water
DSD	Department of State Development
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities
DSO	Direct Shipped Ore
E/C	Electrical Conductivity
EIA	Environmental Impact Assessment
EIL	Environmental Investigation Level
EP Act	*Environmental Protection Act* 1986
EPA	Environmental Protection Authority
EPBC Act	*Environment Protection Biodiversity Conservation Act* 1999
Fe	iron
FMGIB	FMG Iron Bridge (Aust) Ltd
Fortescue	Fortescue Metals Group Ltd
GDP	Ground Disturbance Permit
GL	Gigalitre
GLpa	Gigalitres per annum
ha	hectare
Hematite Project	FMGIB Hematite Project
HPGR	High Pressure Grinding Roll

Abbreviation	Meaning
ICP	Inductively Coupled Plasma mass spectrometry
kL	Kilolitres
kL/day	Kilolitres per day
kL/month	Kilolitres per month
km	kilometres
kV	kilovolt
LGOS	Low Grade Ore Stockpile
LIMS	Low Intensity Magnetic Separation
litres/person/day	Litres per person per day
LoM	Life of Mine
m AHD	Metres with regard to Australian Height Datum
mFe	Magnetic iron
MLCM	Million Loose Cubic Metres
MLpa	Million litres per annum
mm	millimetre
Mm^3	Million cubic metres
Mt	Million tonnes
Mtpa	Million tonnes per annum
MW	Megawatt
N/A	Not Applicable
NAG	Net Acid Generating
NAPP	Net Acid Producing Potential
OEPA	Office of the Environmental Protection Authority
PAF	Potentially acid forming
PER	Public Environmental Review
pH	Acidity unit of measurement
PHPA	Port Hedland Port Authority
Project	North Star Magnetite Project
PRL	Process Reject Landform
Q	Quarter
RC	Reverse Circulation
ROM	Run of Mine
TJ	Terajoules
ToPH	Town of Port Hedland
tph	Tonnes per hour
TSF	Tailings Storage Facility
UHF	Ultrahigh frequency
w/w	Weight to water
WA	Western Australia

Abbreviation	Meaning
WRD	Waste Rock Dump
XRD	X-ray Diffraction

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Executive Summary

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EXECUTIVE SUMMARY

FMG Iron Bridge (Aust) Ltd (FMGIB) is proposing to develop the North Star Magnetite Project (the Project) in the Pilbara region of Western Australia. FMGIB is a majority owned subsidiary company of Fortescue Metals Group Ltd (Fortescue), who own and operate a number of mining and infrastructure projects in the Pilbara.

This document is a Public Environmental Review (PER) for the Project and has been prepared in accordance with State regulatory requirements. This document also satisfies the requirements for assessment under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) in accordance with the *Agreement Between the Commonwealth of Australia and the State of Western Australia Relating to Environmental Impact Assessment*.

Project Overview

The Project comprises three distinct components as follows:

- North Star mine area: approximately 1,230 kilometres (km) north-north east of Perth and 110 km south-south east of Port Hedland.
- Canning Basin borefield and water supply pipeline: The Canning Basin borefield is located approximately 160 km east of Port Hedland.
- Slurry pipeline and infrastructure corridor: connects the North Star mine area to facilities in Port Hedland. This PER seeks approval for the southern portion of this corridor between the North Star mine area and the boundary of the Port Hedland Port Authority lease area (Figure 1 and Appendix 2).

While preliminary planning for the location of these components and associated infrastructure has been undertaken, some flexibility is required to allow for minor changes during the detailed project design phase. To accommodate this, the Project area has been defined through the use of development envelopes that form a general development envelope within which Project infrastructure will be located. The development envelopes are identified as follows:

- Mining Development envelope: Open Pit, Tailings Storage Facility, Waste Rock Dump, Low Grade Ore Stockpile, Ore Processing Facility, Process Rejects Landform, Accommodation Camp and Power Station.
- Infrastructure Corridor Development envelope.
- Water Corridor Development envelope.
- Slurry Corridor Development envelope.

The Project will include a new mine with one open pit, waste rock dump, tailings storage facility, low grade ore stockpile, process rejects waste landform, crushing and screening hub, magnetic separation processing plant, power station, accommodation village, roads, and other associated mine infrastructure.

The Project will process up to 30 million tonnes of magnetite ore per year over a mine life of 45 years. The ore will undergo crushing, screening, and magnetic separation. Up to 15 million tonnes per annum (Mtpa) of product will be sent to Port Hedland for export as magnetite concentrate.

Power for the mine will be provided by an onsite gas fired power station with electricity distributed around the site via overhead 33 kV transmission lines.

Water requirements for construction of the Project will be met using existing licenced bores in Fortescue's Special Rail Lease for its Mainline Railway, or other bore locations as required. Ongoing operational water demand will be met though construction of the Canning Basin Borefield and Water Supply Pipeline.

Key Characteristics

The key characteristics of the proposal are shown in the Table ES1 below.

Table ES1: Summary of Key Project Characteristics

<table>
<tr><th colspan="4">General</th></tr>
<tr><td>Proposal Title</td><td colspan="3">North Star Magnetite Project</td></tr>
<tr><td>Proponent Name</td><td colspan="3">FMG Iron Bridge (Aust) Ltd</td></tr>
<tr><td>Short Description</td><td colspan="3">The proposal is for the development of the North Star Magnetite Deposit and includes:
• Open cut mine pit.
• Waste rock dump (WRD).
• Tailings storage facility (TSF).
• Ore stockpiles.
• Processing plant.
• Slurry, water return and gas pipelines.
• 120 megawatt (MW) gas fired power station.
• Roads and borrow pits.
• Water processing, ponds and reticulation.
• Bulk fuel storage.
• Workshops and maintenance facilities.
• Explosives and chemical storage.
• Borefield at the West Canning Basin and a 190 km water supply pipeline for the project's operational water supply requirements.</td></tr>
<tr><th>Physical Elements</th><th>Location</th><th colspan="2">Proposed Extent Authorised</th></tr>
<tr><td></td><td></td><td><u>Maximum Clearing</u></td><td><u>Development</u></td></tr>
<tr><td>Mining Development envelope</td><td>Figure 1</td><td>3493 ha</td><td>4970 ha</td></tr>
<tr><td>Infrastructure Corridor Development envelope</td><td>Figure 1</td><td>447 ha</td><td>4,171 ha</td></tr>
<tr><td>Slurry Corridor Development envelope</td><td>Figure 1</td><td>315 ha</td><td>2,235 ha</td></tr>
<tr><td rowspan="2">Water Corridor Development envelope</td><td rowspan="2">Figure 1</td><td>886 ha</td><td>28,696 ha</td></tr>
<tr><td colspan="2">Extraction of up to 14 GLpa from the Canning Basin.</td></tr>
</table>

General		
Operational Elements	**Location**	**Proposed Extent Authorised**
Dewatering Requirements	-	Up to 0.5 Gigalitres per annum (GLpa) caused by incident rainfall and seepage using in-pit sumps.
Power	Mining Development envelope Canning Basin Borefield	Mine area: 120 MW to be supplied by an on-site gas fired power station. Borefield and pumping stations: 8 MW gas fired power station.
Gas Supply	Slurry Corridor Development envelope	Gas will be supplied to the power station via a buried steel pipeline at a rate of 20 TJ/day.
Overburden/ Waste Rock	Mining Development envelope	Disposal of up 945 million tonnes.
Ore Processing (waste)	Mining Development envelope	Disposal of up 540 Mt of wet tailings. Disposal of up 180 Mt of dry rejects.

Justification for the Proposal

The projected long term demand for iron ore is considered unlikely to decline with sustained long-term growth forecasts for emerging economies such as China and India. In spite of fluctuations in the global market, in 2010 to 2011 export of iron ore from Western Australia to China increased and accounted for approximately 68% of total iron ore exports from the state, with a total value of approximately $39 billion (DMP, 2011a).

While the iron content of magnetite ore in the ground is generally around 20% to 30%, once the ore has undergone processing to produce a concentrate, iron content is often higher than that found in hematite ores. Magnetite concentrate is also lower in impurities. The higher grade and lower impurities of magnetite concentrate increases the efficiency of steel making furnaces, thereby reducing the energy and cost required to produce steel. This has resulted in magnetite concentrate being a preferred source of iron for many steel makers, making up about 30% of global furnace feed.

Implementation of the Project provides the opportunity to contribute to the creation of employment and training opportunities for local and indigenous community members, royalties and taxation payments from the sale of iron ore, and supports the development of ancillary industries in Western Australia.

Stakeholder Consultation

Fortescue has undertaken stakeholder engagement in relation to a range of new development projects since 2011. Key stakeholders were identified through Fortescue's experience in the Pilbara and project managers have collaborated to support each other's stakeholder engagement through joint identification of stakeholders and integrated engagement activities. Fortescue also adopted previous recommendations from State government agencies on stakeholders that should be included in the program.

Key issues raised and questions posed during the stakeholder consultation process were:

- The extraction of water from Canning Basin and the potential impact on other current and future groundwater users and wetlands systems such as Eighty Mile Beach.
- Impacts of the project to flora and fauna species.
- Involvement of Indigenous groups in biological survey.
- Potential for acid mine drainage.
- Potential presence of asbestiform (fibrous) minerals.
- Impacts to stygofauna.
- Transport of the product to Port Hedland and impacts on other roads users and the general community.
- Source of water for construction activities.
- Rehabilitation and closure of the site.

The issues raised by stakeholders are addressed in this PER.

Key Environmental Factors

Key environmental factors relevant to the Project were identified through the scoping process undertaken for the Environmental Scoping Document and the outcomes of environmental studies and investigations undertaken to date. Key environmental factors addressed in this PER are:

- Flora and vegetation.
- Terrestrial fauna.
- Subterranean fauna.
- Hydrological processes.
- Offsets.

In accordance with the EPBC Act Referral Decision issued by the Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC), Matters of National Environmental Significance (MNES) of relevance to the Project are:

- Listed Threatened Species and Communities, in particular the Northern Quoll, Pilbara Leaf-nosed Bat and Pilbara Olive Python.

Impact Assessment Summary

FMGIB has completed a range of specialist biological, botanical, hydrological, hydrogeological and heritage investigations for the North Star Project in accordance with Regulatory guidelines.

These investigations have formed the basis for assessing the potential environmental impacts and risks associated with the Project. To manage the potential impacts and risks, FMGIB has developed design considerations, mitigation measures and environmental management commitments. These measures have been developed so that the Project will be constructed and operated in an environmentally and sustainably responsible manner.

A summary of the environmental factors, management objectives, potential impacts, proposed management strategies and predicted environmental outcomes for the Project are shown in Table ES2.

Residual Impacts and Offsets

Based on the assessment of residual risk in accordance with EPA Position Statement 9 (EPA, 2006b) and EPA Guidance Statement 19: Environmental Offsets (EPA, 2008c), the Project will result in the following significant residual impacts:

- Permanent loss of significant habitat for the Northern Quoll.
- Permanent loss of significant habitat for the Pilbara Leaf-nosed Bat, including one day roost cave.
- Permanent loss of significant habitat for Pilbara Olive Python.
- Loss of 5141 hectares of vegetation.

In consultation with the DEC and DSEWPaC, Fortescue has developed a Strategic Land Management Plan. The plan identifies the key threats to EPBC Act listed threatened species and communities impacted by Fortescue operations and outlines landscape scale management strategies to address these threats in an area of over 1,000,000 ha. Key management actions of the plan include:

- Feral herbivore control.
- Baiting for feral predators such as cats and foxes.
- Weed Management
- Fire management.

This plan will allow Fortescue to work in collaboration with other parties including the DEC, pastoralists, Rangelands NRMs and other mining proponents, to support implementation of consistent management approaches in an efficient and targeted manner. The area of land selected is large enough to offset residual impacts from this Project and includes habitat for the Northern Quoll, Pilbara Leaf-nosed Bat and Pilbara Olive Python. The North Star Magnetite Project will contribute funding to the Strategic Land Management Plan.

In addition, FMGIB will undertake to recreate roost caves for the Pilbara Leaf-nosed Bat to offset the loss of one day roost cave. FMGIB will also contribute to research into the habitat requirements of the Pilbara Leaf-nosed Bat.

Environmental Acceptability

FMGIB believe that the North Star Magnetite Project can be implemented in a manner which will meet the EPA's objectives. The avoidance and mitigation measures will ensure that environmental impacts are kept to the minimum necessary to implement the Project and have proposed an offset strategy to provide for the enhancement of environmental factors impacted by the Project. Fortescue has experience in managing the development and operation of similar projects in the Pilbara and will continue to demonstrate its commitment to environmental compliance in the implementation of the North Star Magnetite Project.

On the basis of the findings of this PER, the Project is considered environmentally acceptable if implemented in accordance with the management measures and offset commitments made within the document.

Table ES2: Summary of Impacts and Proposed Management Measures

Environmental Factor	EPA Objective	Relevant Guidance	Existing Environment	Potential Impacts	Management Strategies	Predicted Outcomes
Terrestrial Flora – Key Factor	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.	• National Strategy for the Conservation of Australia's Biological Diversity. • National Strategy for Ecologically Sustainable Development. • *Wildlife Conservation Act 1950* (WA). • *Environmental Protection Act 1986* (WA) and Environmental Protection (Clearing of Native Vegetation) Regulations 2005. • EPA Position Statement No.2: Environmental Protection of Native Vegetation in Western Australia (Environmental Protection Authority, 2000). • EPA Position Statement No 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA, 2002a). • EPA Position Statement No 5: Environmental Protection and Ecological Sustainability of the Rangelands in Western Australia (Environmental Protection Authority, 2004). • EPA Guidance Statement No.51: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia (EPA, 2004a).	A total of 33 vegetation communities have been mapped across the mine area and surrounds, while 24 have been mapped in the Water Corridor Development envelope and 36 have been mapped along the Slurry Corridor Development envelope. The diversity of vegetation communities present is typical of surveys in the Pilbara during favourable conditions (ecologia Environment, 2012a). No threatened ecological community or priority ecological community occur within 40 km of the Project area. Two vegetation communities in the mine area are considered to be potentially locally significant. Two vegetation communities occurring in the pipeline area of the Water Corridor Development envelope are considered to be locally significant and one vegetation community along the pipeline route is considered to be a groundwater dependent ecosystem. Four vegetation communities occurring in the Slurry Corridor Development envelope are considered to be of local conservation significance. No EPBC listed Threatened Flora species nor any State listed Threatened (Declared Rare Flora) species were recorded within the Project area. Eight Priority Flora species have been recorded within the mine area and surrounds with two recorded from Project development envelopes. Five flora species in the mine area represent range extensions of more than 100 km to the taxon's previously known distribution. Four Priority listed Flora taxa were recorded in the Water Corridor Development envelope. Two additional flora species recorded in the Water Corridor Development envelope represent range extensions to the taxon's known distribution. Five Priority listed Flora taxa have been recorded from the Slurry Corridor Development envelope. One Weed of National	• Direct loss of vegetation due to clearing. • Direct loss of flora of conservation significance. • Direct loss of vegetation outside of the project area. • Direct loss of vegetation outside of Project footprint. • Degradation of vegetation.	• Project infrastructure has been located away from known areas of conservation significant flora and/or vegetation as far as practicable. • Ground Disturbance Permits (GDPs) will be required prior to commencement of clearing activities. • Clearing and disturbance within the Special Rail Licence (LSA1) will be undertaken in compliance with the *Rail Corridor Disturbance Management Plan* (R-PL-EN-0012) and *Rail Route (Stage B) Environmental Management Plan* (R-PL-EN-0010. • Infrastructure has been located outside of watercourses as far as practicable. Diversions will be put in place as required. • Information in relation the environment of the Project area, including vegetation and flora of conservation significance, will be included in the induction programme for the Project. The induction programme will include information in relation to roles and responsibilities. All staff and contractors will be required to undertake the induction programme. Visitors will be escorted while on site. • Vehicles will be confined to defined roads and access tracks. • An AMD management Plan will be implemented. The objective of this plan will be to manage waste rock such that the WRD is a stable, non-polluting landform. • Perimeter drains will be constructed around TSF to manage seepage. • Water trucks will be used for dust suppression on haul roads, access tracks, the pit floor and high traffic areas. • The use of surfactants to increase dust suppression capability of applied water will be investigated. This investigation will take into consideration the potential adverse consequences that may result from the use of surfactants, such as coating of leaf surfaces and toxic effects on frogs, as well as benefits such as reduced dust emissions and more efficient use of water resources. • Progressive rehabilitation of disturbed areas will be undertaken during the life of the Project and an approved mine closure plan implemented post-closure. • Pipeline corridors will be reinstated and rehabilitated once construction activities are complete, with the exception of an access track for maintenance activities. The long term aim of rehabilitation will be to return disturbed areas to a condition similar to adjacent, undisturbed areas. • Undertake additional flora and vegetation surveys of final water supply pipeline route and water bore locations.	The proposed management measures will further reduce potential impacts to flora and vegetation. No clearing is required in vegetation communities FpAtCo (escarpment springs) and GaTw (Basalt Dyke). Clearing of locally significant vegetation communities in the Slurry Corridor and Water Corridor Development Envelopes will be avoided where practicable. Where avoidance is not possible, the amount of clearing required will be minimised through implementation of Fortescue's Ground Disturbance Permit procedure. Rehabilitation of the areas disturbed following completion of construction activities will minimise the impact of clearing on these vegetation communities. Clearing of *Goodenia nuda* is unlikely to reduce the local and regional representation of this species as there is high species abundance in recorded locations throughout the Pilbara region. Should the alignment of the mine access road require clearing of a small number of individuals, the impact of this on the species as a whole will be negligible. Clearing of *Pityrodia* sp. Marble Bar will slightly reduce the regional representation of this species with 10% of the known number of individuals located in areas to be cleared. However, as 90% of the known records will not be disturbed and are located at least 1.5 km from the boundary of development envelopes, the long term impact on this species as a whole is expected to be minor. Further survey effort in the region, associated with ongoing mineral exploration activities by Fortescue and others, is likely to locate more populations or occurrences of this species, thereby further reducing the significance of any impacts. There are no groundwater dependant ecosystems (GDE's) within the potential drawdown cone of the Canning Basin borefield. Construction of the slurry, natural gas and water supply pipelines will not result in long-term drawdown of the watertable in areas where GDE's are located. No impacts to GDE's are anticipated as a result of implementation of the Project.

Environmental Factor	EPA Objective	Relevant Guidance	Existing Environment	Potential Impacts	Management Strategies	Predicted Outcomes
			Significance (WONS) and one Declared Plant under the Agriculture and Related Resources Protection Act 1978 were identified in the Water Corridor Development envelope. Nine environmental weeds were recorded in the mine area, ten were recorded in the Water Corridor Development Envelope and eleven were recorded in the Slurry Corridor Development envelope.			
Terrestrial Fauna (including MNES) – Key Factor	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.	• EPA Position Statement No.2: Environmental Protection of Native Vegetation in Western Australia (Environmental Protection Authority, 2000). • EPA Position Statement No.3: Terrestrial Biological Surveys as an Element of Biodiversity Protection (WA) (EPA, 2002a). • EPA Guidance Statement No.56: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia (EPA, 2004b). • Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (DEC, 2010). • *Wildlife Conservation Act 1950* (WA). • *Environment Protection and Biodiversity Conservation Act 1999* (Cth). • Matters of National Environmental Significance, Significant Impact Guidelines 1.1 *Environment Protection and Biodiversity Conservation Act 1999.* • Significant Impact or referral guidelines for nationally listed species (Northern Quoll *Dasyurus hallucatus)* 2011. • Draft EPBC Act policy statement 3.21 Significant impact guidelines for 36 migratory shorebirds: Migratory Species. • Draft EPBC policy statement: Use of environmental offsets under the *Environment Protection and Biodiversity Conservation Act 1999* (2007).	A total of 18 fauna habitat types occur across the Project area. The most extensive habitats in the Project area are: • Mine area: Rocky Spinifex Hills. • Slurry Corridor Development envelope: Spinifex grasslands on low stony rises. • Water Supply Development envelope: Sandplain grassland and spinifex grassland. The Rocky Ridges, Breakaways and Rocky Gorges fauna habitats from the mine area are considered suitable habitat for the Northern Quoll and Pilbara Leaf-nosed Bat and, where this habitat is associated with water pools, the Pilbara Olive Python. The Granite Outcrops, Breakaways and Boulder Piles habitat in the Slurry Corridor Development envelope is considered to be of conservation value as it occupies small areas in any one location and supports fauna species which are otherwise uncommon in the surrounding area, such as the Northern Quoll (*Dasyurus hallucatus*), Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*) and Pilbara Olive Python (*Liasis olivaceus barroni*). Thirteen Migratory species were identified by the EPBC Act Protected Matters Search Tool with seven of these species having a medium to high likelihood of occurrence within the Project area. Seven threatened species were identified by the EPBC Act Protected Matters Search Tool with five of these species considered as having a medium	**Impacts to Vertebrate Fauna (including MNES)** • Direct loss of fauna habitat • Direct loss of significant fauna habitat • Direct loss of habitat outside of the Project area • Habitat fragmentation and degradation • Direct loss of or injury to fauna • Direct loss of or injury to WC Act, Priority Listed or Migratory fauna species • Introduction or attraction of feral fauna species • Changes in fauna behaviour **Impacts to SRE fauna** • Vegetation clearing has the potential to reduce suitable habitat and/or cause fragmentation which could lead to reduction of movement of SRE individuals, thereby result in a potential population decline. • Earthworks may also lead to the direct loss or injury to SREs through activities such as excavation and compacting. • Fire may result in the direct mortality of SREs and contribute to a reduction of suitable habitat by removing vegetation, leaf litter and also through fragmentation of habitat. • Dust from construction and operation of the Project may also cause changes in suitable habitat through vegetation degradation and lead to alteration of habitat structure.	• Information in relation to the environment of the Project area, including fauna and habitats, will be included in the induction programme for the Project. The induction programme will include information in relation to roles and responsibilities. All staff and contractors will be required to undertake the induction programme. • Internal GDPs will be required prior to commencement of activities. • Where pipelines are required to be placed on the surface, the pipe will be raised off the ground in order to minimise impacts to surface water flow and fauna movements. • Vehicles will be confined to defined roads and access tracks. • Personnel trained in fauna handling will be employed during trenching operations to clear open trench of fauna on a daily basis and prior to backfilling. • Injured fauna will be reported to the site environmental officer who will determine the appropriate course of action. • Fauna mortalities involving EPBC Act, WC Act or DEC Priority listed species will be reported to DEC and DSEWPaC as required. • Progressive rehabilitation will be undertaken where practicable. • Fire prevention regimes will be implemented. • A Construction Environmental Management Plan will be implemented for construction of pipelines. • Ongoing monitoring of the persistence of the Pilbara Leaf-nosed Bat population at the mine area.	Fauna habitats of the Project area are generally considered to be common and widespread in the region. Some habitat will be cleared during implementation of the proposal, though this will have a negligible impact on the regional representation of these habitats. Potentially active mounds of the Western Pebble Mound Mouse have been recorded in the western portion of the Infrastructure Corridor Development envelope on the eastern edge of the pit area (ecologia Environment, 2012e). This species has limited ability to move away from disturbance and clearing activities will impact the local population. As the species has been recorded across the Pilbara, suitable habitat exists outside of project development envelopes and several Pebble-mound Mouse mounds have been recorded outside of these envelopes, the regional impact to this species will be low. The Long-tailed Dunnart has been recorded during surveys of the Project area and surrounds, though it has not been recorded from within Project development envelopes. No impacts to this species are expected. Bird species recorded from near the Project area (Grey Falcon, Australian Bustard, Bush Stone-Curlew, Fork-tailed Swift, Oriental Plover and the Rainbow Bee-eater) do not rely on the habitats in the Project area and will move into nearby areas of suitable habitat. No impacts to these species are expected. In relation to the Slurry Corridor Development envelope and Water Corridor Development envelope, the impact on all recorded species of SREs is expected to be negligible due to the narrow width of the pipeline corridor, the temporary nature of the construction and the limited impacts expected to occur on potential habitat

Environmental Factor	EPA Objective	Relevant Guidance	Existing Environment	Potential Impacts	Management Strategies	Predicted Outcomes
		• Discussion paper: Use of environmental offsets under the *Environment Protection and Biodiversity Conservation Act 1999* (2007).	to high likelihood of occurrence within the Project area (refer to Section 112). The species identified from the search tool were: • Northern Quoll (*Dasyurus hallucatus*) - Endangered • Northern Marsupial Mole (*Notoryctes caurinus*) - Endangered • Crest-tailed Mulgara / Brush-tailed Mulgara (*Dasycercus cristicauda / D. blythii*) - Vulnerable • Greater Bilby (*Macrotis lagotis*) - Vulnerable • Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*) - Vulnerable • Pilbara Olive Python (*Liasis olivaceus barroni*) - Vulnerable • Great Desert Skink (*Liopholis kintorei*) - Vulnerable Three of these species (Northern Quoll, Pilbara Olive Python and Pilbara Leaf-nosed Bat) have been recorded in the mine area while two species (Northern Quoll and Greater Bilby) have been recorded (or unconfirmed secondary evidence identified) from the Slurry Corridor Development envelope. Unconfirmed diggings which resemble those of the Greater Bilby were recorded from the Water Corridor Development envelope. No evidence of the Great Desert Skink was observed in the Water Corridor Development envelope, which occurs in the western edge of this species known range.			within the borefield area. Within the mine area, some potential SRE species have been recorded from within areas required for the Pit TSF. Some individuals are likely to be lost during construction in these envelopes. However, none of the habitats in which the potential SREs were located are unique to the Project area and extend beyond the limits of the mapped area. As a result, impact to SRE's resulting from construction and operation of the Project are not significant in a regional context. **Northern Quoll** The clearing of suitable Northern Quoll denning habitat in the mine area may result in a temporary decline in the local Northern Quoll population; however, this is not expected to adversely impact the recovery of the species as a whole or result in a general decline of the species in the region. Populations of Northern Quoll have been recorded within a 50 km radius of the mine area and the species is considered to be highly mobile (ecologia Environment, 2012d). Approximately 900 ha of suitable habitat occurs within 30 km of the mine area and additional habitat occurs across the region (ecologia Environment, 2012d). Oakwood (2000) surmises that female home territories are likely inherited by female progeny. Of the four females captured during targeted surveys by ecologia Environment, three were captured at least two kilometres from proposed disturbance areas. The fourth location was within the area required for the pit. Targeting trapping will be undertaken at this location and any quolls captures will be relocated to suitable habitat outside of the Project area, where practicable. The overall impact on breeding potential for the area immediately surrounding the Project area is considered to be low. Implementation of the Project will result in a permanent loss of Northern Quoll breeding and foraging/dispersal habitat associated with the proposed open pit, TSF, WRD and potentially the LGOS should this material remain following closure of the site. Rehabilitation and mine closure activities will aim to provide additional habitat for the Northern Quoll where practicable, however it is likely that there will be some permanent loss of

Environmental Factor	EPA Objective	Relevant Guidance	Existing Environment	Potential Impacts	Management Strategies	Predicted Outcomes
						habitat. Measures to offset this residual impact are discussed in Section 14. **Mulgara** Potential impacts to the Mulgara, should it occur in the Project area, are associated with the construction of pipelines within the Slurry Corridor and Water Corridor Development Envelope, and construction and operation of the mine access road within the Infrastructure Corridor Development Envelope. Impacts related to construction of the pipelines will be short term and temporary. Extensive suitable habitat for the Mulgara exists outside of the Project area and clearing required for the project equates to less than 2% of the mapped extended of habitats suitable for the Mulgara. It is therefore predicted that no significant impacts to the Mulgara will occur as a result of implementation of the Project. **Greater Bilby** Potential impacts to the Greater Bilby, should it occur in the Project area, are associated with the construction of pipelines within the Slurry Corridor and Water Corridor Development Envelope, and construction and operation of the Mine Access Road within the Infrastructure Corridor Development Envelope. Impacts related to construction of the pipelines will be short term and temporary and as such are considered unlikely to significantly impact the Greater Bilby population. **Pilbara Leaf-nosed Bat** One Pilbara Leaf-nosed Bat day roost cave and some suitable foraging habitat will be removed as a result of the development of the mine area. Foraging habitat is well represented in the region. It is expected that suitable roost caves also occur in the wider Gorge Ranges which surround the Project area.. While there may be a decline in the local population, the impact on the Pilbara Leaf-nosed Bat at a regional and species level is expected to be low. **Pilbara Olive Python** Some clearing of Pilbara Olive Python habitat will be required in order to implement the Project. Rehabilitation

Environmental Factor	EPA Objective	Relevant Guidance	Existing Environment	Potential Impacts	Management Strategies	Predicted Outcomes
						and closure activities will aim to provide additional habitat for the Pilbara Olive Python where practicable, however it is likely that some loss of habitat will be permanent. Python habitat associated with the proposed open pit, TSF, WRD and potentially the LGOS (should this material remain following closure of the site) will be permanently lost. Of the 11 water pools in the vicinity of the mine area, there is potential that three may experience a degree of degradation as a result of impacts from the Project which may reduce their ability to provide suitable habitat for the Pilbara Olive Python. Monitoring will be undertaken to assess the level of impact in these pools and allow for implementation of additional management measures where required. While there may be a local loss of individuals as a result of implementing the Project, the regional impact to the Pilbara Olive Python is expected to be moderate to low due to this species being widely distributed throughout the Pilbara. Additionally, a large area of habitat is conserved within Karijini National Park (DSEWPaC, 2012k).
Subterranean Fauna – Key Factor	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.	• EPA Guidance Statement Number 54: Consideration of Subterranean Fauna in Groundwater and Caves during EIA in Western Australia (EPA, 2003). • EPA Guidance Statement Number 54a (Draft): Sampling Methods and Survey Considerations for Subterranean Fauna in Western Australia (EPA, 2007a). • EPA Discussion Paper: A review of subterranean fauna assessment in Western Australia (EPA, 2012). • Draft EPA Environmental Assessment Guideline (EAG) Consideration of subterranean fauna in environmental impact assessment in Western Australia (EPA, 2013)	There is evidence to suggest that the mine area is part of a wider, more or less continuous subterranean habitat. As there is no local water table, the risk to stygofauna is considered to be negligible within the mine area. In the mine area, 11 troglofauna species and 17 stygofauna species/haplotypes have been identified. The majority of these subterranean fauna species occur widely in the local and regional area. Five of the eleven troglofauna species collected have only been recorded from the outline of the pit shell. Of these, one is likely to be range restricted. No stygofauna species were recorded from within the pit area during the 2011 survey. Studies indicate that deeper sections of the North Star Banded Ironstone Formation do not contain cavities or support groundwater bodies and therefore do not provide habitat for stygofauna. The alluvial aquifer associated with the	• Impacts related to troglofauna are largely limited to the mine area with the main potential impact being direct loss of troglofauna species and habitat due to mining of the open pit. • There is a minimal risk that stygofauna habitat in the wider Project area may be degraded through leaks and spills from vehicles and equipment during bore construction and operation.	• GDPs will be required prior to commencement of activities. • Hydrocarbons and chemicals will be appropriately stored and bunded to minimise the potential for spillage. • Spill kits will be provided and maintained in all areas where hydrocarbons and chemicals are stored or used. • Drainage from areas likely to be contaminated with hydrocarbons or chemicals (such as workshops) will be captured and treated (for example through oil-water separators). • Water abstraction will be managed through a DoW approved Groundwater Operating Strategy.	Mining will directly impact those troglofauna species within the footprint of the open pit. However, as there is evidence that the geology of the mine area form part of a larger, continuous subterranean habitat, the impact from mining activities on the conservation status of individual troglofauna species or their regional representation is not considered significant. Dewatering of the proposed open pit will not be required, and given the paucity of records of stygofauna from the pit area and Water Corridor Development Envelope, the risk of impacts to stygofauna is considered to be very low. The maximum depth of excavation for the slurry, gas and water supply pipelines is expected to be 3 m. If subterranean fauna are present along the Slurry Corridor and Water Corridor Development Envelope, the small amount of disturbance required to construct the pipelines is unlikely to significantly impact these species with habitat likely to be found immediately adjacent to and below the excavated trench.

Environmental Factor	EPA Objective	Relevant Guidance	Existing Environment	Potential Impacts	Management Strategies	Predicted Outcomes
			Turner River provides a large area of suitable stygofauna habitat along with many other alluvial aquifers surrounding the mine area. Studies indicate there is a low likelihood of diverse and abundant stygofauna being present in the Canning Basin borefield area. One worm specimen was recorded during the Canning Basin borefield survey, but may not have originated from the Wallal aquifer. As the slurry, gas and water supply pipelines and the Canning Basin borefield area will involve low levels of disturbance to construct, it is expected that any potential disturbance to troglofauna will be insignificant.			
Hydrological Processes – Key Factor	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	• *Rights in Water and Irrigation Act 1914* (WA) • Environmental Protection (Unauthorised Discharges) Regulations 2004 • Australian and New Zealand Guidelines for Fresh and Marine Water Quality, 2000, Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) • Water and Rivers Commission 2000. Environmental Water Provisions Policy for Western Australia: Statewide Policy No. 5 (Waters and Rivers Commission, 2000) • Department of Water Stormwater Management Manual for Western Australia 2004-2007 (Department of Water, 2004) • Water Quality Protection Guidelines (Nos 1 – 11), Mining and Mineral Processing (WRC 1999) • Department of Water. Pilbara groundwater allocation plan 2012: For public comment (Department of Water, 2012b) • Department of Water. West Canning Basin groundwater allocation limit report	**Surface Water** Drainage lines in the region are ephemeral and generally only flow for short durations following rainfall events. Intermittent flows normally occur during the wet season with long periods of no flow during the dry season. The mine area lies within the catchment boundary of the Turner River and Strelley River while the Slurry Corridor Development Envelope is located wholly within the Turner River Catchment. As a result of the local topography which consists of a series of plateaus, hills, ridges and valleys, numerous ephemeral drainages are found across the proposed mine site. The bimodal topography suggests local scale groundwater systems are likely to occur in the weathered uplands and provide a water source for escarpment springs. Surveys of the mine area and surrounds identified 11 water pools. The Water Corridor Development Envelope crosses a number of ephemeral creeks and rivers, including the Strelley and De Grey Rivers. **Groundwater - Mine Area** Groundwater within the mine area is likely to be found within: • Weathered, fractured	**Surface Water** Changes to surface water flows including: • Minor decrease in runoff. • Decrease in water quality of surface runoff. • Reduction in catchment runoff from rainfall on open pit. • Detention effect of drainage crossings may attenuate the peak discharge rate. • Increased runoff coefficient from cleared/compacted areas (haul roads etc.) due to changes in infiltration properties. • Ponding upstream of roads and other obstructions. Impacts to water pools may result from increased dust levels and degradation of vegetation and soils through human visitation to the pools. Impacts may also occur as a result of dust emissions from vehicular traffic on the access road, though traffic levels are expected to be minimal once construction is complete. Clearing and earthworks associated with the implementation of the Project may expose a greater area of soil to erosion and as a result may increase the sediment load of surface water runoff. In particular, increased sediment loads may be associated with runoff from the proposed WRD, Process Rejects Landform, LGOS, and product stockpiles **Groundwater** Potential impacts to local and regional groundwater resources from construction	• Construct diversion structures (such as bunds or channels) to divert clean surface water flow around infrastructure areas, and maintain downstream flow regimes where practicable. • Surface water diversions will be constructed such that water enters the drainage line/creek at an appropriate location to minimise erosion and scouring. • Where practicable, diverted clean surface water flows will be directed into the drainage line to which they naturally flow. • Potentially contaminated water from workshop areas and vehicle washdown will be captured and treated through an oil water separator, meeting the requirements of DoW Water Quality Protection Note 68 – Mechanical equipment washdown. • Minimise the impacts of the WRD on water quality and quantity through stabilisation to prevent erosion. • The Process Rejects Landform will be progressively constructed to provide a safe, stable, non-polluting landform. • Toe drains and sediment traps will be installed around the perimeter of the WRD, TSF and Process Rejects Landform where required. • Waste rock identified as potentially acid will be managed in accordance with the AMD Management Plan. • Locate buildings and process infrastructure out of the 1 in 100 year floodplain or construct suitable protection through bunds or vertical separation. • Hydrocarbons and chemicals will be transported, stored and handled in accordance with the applicable legislation and Australian Standards, for example AS1940. • Undertake progressive rehabilitation of cleared areas not required for operations. • Roads will be designed for a 1 in 5 year	Creeks within the Project area are ephemeral, flowing for a period after heavy rainfall events and are dry for the remainder of the time. Some diversion of surface water will be necessary in order to separate clean surface water flows from potentially contaminated surface flows. However, the volume of water diverted is a small portion of that flowing from the catchments in which the Project lies and is unlikely to adversely impact downstream flows. In the case of the TSF, stream flows return to 40 – 60% of natural flows within 2 km of the TSF embankment wall, and 80% of natural flows within 10 km of the TSF embankment wall. The absence of or reduction in flows within 2 km of the TSF embankment wall will impact the health of vegetation in this area and is likely to result in the death of some vegetation, in particular, the Ap and ApTp vegetation communities which are associated with the creekline. These vegetation units are well represented in the region and the decline in the health of the vegetation due to reduced flows from the TSF catchment will not significantly impact on their regional status. Additionally, no EPBC Act, WC Act or Priority listed flora species have been recorded from the section of Lost Boys Creek impacted by reduced flows. There is not expected to be any significant change to surface water quality as a result of implementation of the Project. The management measures outlined above will assist in

Environmental Factor	EPA Objective	Relevant Guidance	Existing Environment	Potential Impacts	Management Strategies	Predicted Outcomes
		(Department of Water, 2011) • Department of Water. Pilbara Water in Mining 2009. (Department of Water, 2009) • Department of Water. Lower De Grey River: ecological values and issues 2010 (Department of Water, 2010) • Department of Water. Ecological water requirements of the lower De Grey River (Department of Water, 2012c) 2012 • Water Quality Protection Guidelines (Nos 1-11), Mining and Mineral Processing (WRC 1999) • Department of Water, Pilbara groundwater allocation plan 2012: For public comment (Department of Water, 2012b) • Department of Water. West Canning Basin groundwater allocation limit report (Department of Water, 2011b) • Department of Water. Pilbara regional water plan 2010-2030 (Department of Water, 2010a)	basement rock. • Superficial aquifers (unconsolidated sediments). Groundwater occurrence within the mine area is limited to small discrete groundwater bodies with limited connectivity. Groundwater is sometimes absent in high areas where the weathered and fractured zone is unsaturated or where the fractures are poorly developed. The mine area is located on a ridge of high ground, forming a surface water catchment boundary. Aquifer testing has identified strata with low or negligible available groundwater (maximum discharge measured at 61 m^3/d) and low permeability (hydraulic conductivity measured between 0.3 $\times 10^{-2}$ and 8.1$\times 10^{-2}$ m/d). The superficial aquifer present to the west has been used as a water supply for exploration purposes. The standing water levels within the ore body vary between 319.9 m AHD and 395.2 m AHD. **Canning Basin Borefield** The West Canning Basin comprises three main hydrostratigraphic units: • Broome Sandstone. • Jarlemai Siltstone. • Wallal Sandstone. The Wallal Sandstone ranges in thickness between 14 m and 355 m with thickness generally increasing from the south west to the north east. Groundwater of the Wallal Sandstone is generally fresh, though increases in salinity towards the coast. Groundwater flow in the Wallal Sandstone is generally to the north and north-west, while recharge of the aquifer occurs via rainfall infiltration south of the sub-crop of the Jarlemai Siltstone in the south and east. Hydraulic conductivity for the Wallal Sandstone may vary across the aquifer with values between 20 and 60 m per day recorded. The only current use of water in the Wallal aquifer is for stock bores.	and operation of the Project include: • A drawdown cone of depression caused by pumping of groundwater from bores at Canning Basin. • Environmentally hazardous leachates from the WRD or Process Rejects Landform resulting in contamination of groundwater resources at the mine area. • Reduced infiltration in hardstand areas, stockpile areas, WRD and TSF resulting in decreased recharge to local ground water resources at the mine area. • Contamination of groundwater from hydrocarbon spills and leaks. • Increased infiltration of water from wet tailings in the TSF valley may increase recharge to alluvial aquifer.	rainfall event. • Prior to undertaking clearing activities in the vicinity of Fig Pool, the area to be cleared will be clearly delineated on the ground and dust and erosion management measures put in place to limit the potential indirect impact of these activities on Fig Pool. • Access to pools will be restricted to authorised personnel only. • Information in relation to surface water features of the Project area will be included in the induction programme for the Project. This will include information regarding restriction of access to these areas. All staff, contractors and visitors will be required to undertake the induction programme. • The design of the Project will take into account the climate change scenario developed for Fortescue (Adaptive Futures, 2011). • Spill kits will be maintained at high risk areas and on service vehicles. • Staff and contractors will be trained in spill response and the use of spill kits. • Hydrocarbons and chemicals will be transported, stored and handled in accordance with the applicable legislation and Australian Standards, for example AS1940. • Waste rock material will be managed according to the AMD Management Plan. • Mine closure planning includes measures to close the open pit and management of any pit lake. • The Canning Basin borefield will be operated in accordance with a DoW approved Groundwater Operating Strategy.	minimising impacts such that they do not represent a significant risk to the environment.. While Fig Pool is unlikely to be directly impacted from construction and operation of the Project, there may be residual, indirect impacts during operations, particularly in relation to increased noise and dust levels. The management measures outlined above will assist in managing the impact to Fig Pool such that any residual impact is as low as reasonably practicable. As groundwater in the mine area exists only in fractured rock systems and the hydraulic conductivity of the surrounding rock is very low, mining of the proposed open pit is only likely to impact those resources which it directly intersects. Groundwater investigations indicate the volume of water likely to be intercepted is low and consequently, impacts to the quantity of groundwater available in the mine area are considered to be negligible. Potential for impacts to groundwater quality are considered to be highest in relation to potential environmentally harmful drainage (such as acidic, metalliferous or saline drainage) from the WRD, LGOS and Process Rejects Landform. These facilities will be constructed such that they are stable, non-polluting landforms and the risk of impacts to the environment is low. Presence of mine infrastructure may reduce recharge to local groundwater systems in the mine area. Due to the nature of these systems (i.e. fractured rock aquifers) and the absence of groundwater dependant flora communities, the potential impact from reduced infiltration is considered negligible. There are no groundwater dependant ecosystems (GDEs) within the potential drawdown cone of the Canning Basin borefield. Construction of the concentrate slurry, natural gas and water supply pipelines will not result in long-term drawdown of the watertable in areas where GDEs are located. No impacts to GDE's are anticipated as a result of implementation of the Project. Groundwater reduction in pressure head in relation to abstraction from the Canning Basin borefield for the Project is predicted to be in the order of 0.8 m at the Great Northern Highway. In isolation, this is unlikely

Environmental Factor	EPA Objective	Relevant Guidance	Existing Environment	Potential Impacts	Management Strategies	Predicted Outcomes
						to impact on stock water bores in the area. The Wallal aquifer in the area of investigation is confined and has limited connectivity to the overlying Broome aquifer. Mandora Marsh, approximately 100 km north-east of the borefield is fed by an ancient paleo-estuary and paleodrainage channel and is not connected to the Wallal Aquifer. Surface water features, including wetlands associated with Eighty Mile Beach, are fed by the Broome aquifer and will not be impacted through abstraction from the Wallal aquifer. Additionally, modelling has predicted that impacts due to abstraction are limited to a 25 km radius from the borefield. The nearest known surface water expressions are outside of this radius.

Greenhouse Gases - Relevant Factor	To minimise emissions to levels as low as practicable on an on-going basis and consider offsets to further reduce cumulative emissions.
	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
		• EPA Guidance Statement No. 12 Minimising Greenhouse Gas Emissions
		• Department of Climate Change: National Greenhouse and Energy Reporting Guidelines (2008)
		• National Greenhouse and Energy Reporting Act 2007
		• National Greenhouse and Reporting Regulations 2008
		• National Greenhouse and Energy Reporting (Measurement) Determination 2008
		• NGER (Measurement) Technical Guidelines
			Fleet
			It is estimated that over the life of the Project approximately 80,512 tonnes of greenhouse gasses (measured as CO2-equivalent) per annum will be generated from sources other than power generation. The major contributor to greenhouse gas emissions will be fuel consumption for the purposes of mine load and haul which will generate approximately 61,702 tonnes of CO2-equivalent (CO2-e) per annum.
			Power Station
			Greenhouse gas emissions for the 120 MW power station have been calculated for two scenarios with the turbines running on natural gas only or diesel only. Under the natural gas only scenario, it is expected that 374,709 tonnes CO2-e will be generated per annum while under the diesel only scenario, 548,344 tonnes CO2-e will be generated per annum.
			Total Emissions
			As the power station will run on natural gas as the main fuel, the total emissions for the Project are estimated to be 455,221 tonnes CO2-e per annum. This is approximately 1% of the net emissions for Western Australia in 2010 (Department of Climate Change and Energy Efficiency, 2012) and equates to 0.03 tonnes CO2-e per tonne of product.
				• GHG emissions will be produced during construction and operation of the Project. Main sources of GHG:
				  • combustion of gas for power generation.
				  • combustion of diesel for drilling and blasting.
				  • vehicle fuel consumption.
				• Land clearing associated with clearing and earthworks will contribute to GHG emissions.
				• Impacts related to GHG include the potential to contribute to climate change, including changes in global temperature, rainfall, and wind patterns, shifts in climate zones, and rising sea levels.
					• Adoption of a continuous improvement program to increase energy efficiencies and reduce greenhouse gas emissions throughout the lifetime of the Project.
					• Review and report on greenhouse gas abatement measures and identify opportunities to further reduce greenhouse gas emissions over time.
					• Carbon reduction through the use of efficient technologies for the mining, processing, power production and transport functions.
					• Greenhouse emissions data collection.
					• Consideration of carbon reduction technologies or carbon offsets programmes.
					• Identify and implement cleaner production initiatives to increase energy efficiency where practicable.
					• Regular maintenance and servicing of infrastructure and machinery.
					• Progressive rehabilitation of cleared areas not required.
						Greenhouse gas emissions from the Project will not significantly contribute to total emissions for Western Australia. Through the implementation of the management strategies it is anticipated that greenhouse gas emissions will be reduced over time.

Environmental Factor	EPA Objective	Relevant Guidance	Existing Environment	Potential Impacts	Management Strategies	Predicted Outcomes
			The reported greenhouse gas emissions for the Electricity sector for the 2012 reporting period was109.7 million tonnes (Department of Climate Change and Energy Efficiency, 2012). The estimated emissions from the Project equate to 0.41% of this. .			
Atmospheric Emissions – Relevant Factor	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	• National Environment Protection (Ambient Air Quality) Measure (NEPM) (NEPC, 2003). • Kwinana Environmental Protection Policy (EPP) (EPA, 1999). • Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (NSW DEC, 2005). • Air Quality and Air Pollution Modelling Guidance Notes (DoE 2006). • A guideline for the development and implementation of a dust management program (Draft) (DEC, 2008). • EPA Guidance Statement Number 18: Protection of Air Quality Impacts from Land Development Sites (EPA, 2000).	The nearest sensitive receptor to the mine area will be the accommodation camp, which is approximately 4.5 km west of the open pit and 2.3 km west of the power station. A series of natural ridges exist as a barrier between the accommodation camp and proposed operations. The Woodstock Aboriginal Community is approximately 30 km south of the mine area while Panorama Homestead is approximately 40 km to the north east. The closest sensitive receptor to the Canning Basin borefield is the Pardoo Roadhouse, approximately 15 km northwest. Wallal Downs Homestead is approximately 40 km east while Pardoo Homestead and Muccan Homestead are approximately 45 km to the west and south respectively.	• The construction and operation of the mine, processing plant, administration buildings and site infrastructure is likely to generate emissions to air from material handling, wheel generated dust and wind erosion of exposed surfaces. • Exacerbation of pre-existing respiratory problems in the workforce due to dust. • Reduced visibility due to increased dust. • Reduced amenity due to surface deposition. • Impacts to vegetation due to dust deposition.	• The Fortescue Mine and Rail Dust Management Plan (45-PL-EN-0030) will be implemented. • Dust collection systems (for example cyclones or bag houses) will be installed at appropriate locations throughout the dry processing plant to remove airborne dust. • Progressive rehabilitation will be undertaken to reduce the area susceptible to wind erosion. • Water trucks will be used for dust suppression on haul roads, access tracks, the pit floor and high traffic areas. • Dust management measures will be implemented on areas of the TSF which are shown to be drying out and generating dust. • Dispersive waste rock materials will be managed in line with the AMD Management Plan. • The Process Rejects Landform will be constructed to provide a safe, stable, non-polluting landform. • Revised modelling of the power station will be undertaken as part of the Works Approval Application process. • Air emissions monitoring will be undertaken as per the requirements of Works Approvals and Licensees issued under Part V of the EP Act.	• The mine area, power station and Canning Basin borefield are located in remote areas of the Pilbara with the nearest non-project related sensitive receptor located at least 15 km distant. Given this, no impacts on air quality at these receptors is anticipated. The only sensitive receptor within proximity of the mine area is the mine accommodation camp. A series of natural ridges approximately 380 m AHD are located between the camp and the active mining and processing area creating a natural barrier to dispersion of air emissions towards the accommodation camp. In addition, the proposed management measures will reduce dust generation from mining operations. As a result, it is expected that there will be no air quality related impacts at the mine accommodation camp. • Management measures are expected to minimise dust generation and keep deposition to levels that will not impact on vegetation health. Should monitoring show adverse impacts are occurring, an investigation into the cause will be undertaken, and additional management measures identified and put in place.
Noise – Relevant Factor	To protect the amenity of nearby residents from noise impacts resulting from activities associated with the proposal by ensuring the noise levels meet statutory requirements and acceptable standards.	• Australian Standard AS 2436-2010 Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites (2010). • Australian Standard AS 2187.2-2006 Explosives - Storage and Use Part 2 Use of Explosives 2006. • *Environmental Protection Act 1986* (WA). • Environmental Protection (Noise) Regulations 1997. • Environmental Protection	A noise level survey was undertaken at the proposed mine accommodation camp to establish baseline ambient noise levels of the project area. Data was collected over a ten day measurement period in March 2012 and shows background noise levels are in the order of 19-22 dBA overnight and 55 dBA during the day. The higher value during the day is likely due to general wind noise. No significant source of anthropogenic noise currently	Impacts from noise may be experienced during operations at the accommodation camp west of the mine and along the slurry and water supply pipelines during construction. Generally, the potential impacts from noise emissions related to the Project include: • Nuisance noise and loss of amenity at the mine accommodation camp. • Nuisance noise and loss of amenity at Whitehills residential community and Indee homestead. • Avoidance by fauna of areas of higher noise emissions. This may result in	• All construction and operational activities will be undertaken in accordance with the Environmental Protection (Noise) Regulations 1997. • Updated modelling will be undertaken as part of the Works Approval Application process required under Part V of the EP Act to account for the addition of the power station in the mine area. • Noise monitoring will be undertaken during mining operations to determine if assigned levels are being exceeded. • Noise attenuation will be fitted to plant and equipment where required. • A complaints procedure will be established for the duration of construction activities	The only sensitive receptor likely to be impacted by construction and operation of the mine area is the mine accommodation camp. Mining activities may exceed the night time assigned noise level by 2 dB, however, this will only potentially occur while the mine fleet is close to the surface with all equipment and plant operating at maximum output. Management measures will be adopted to avoid any actual exceedances. As mining extends beyond 10 m below ground level, noise and vibration emissions

Environmental Factor	EPA Objective	Relevant Guidance	Existing Environment	Potential Impacts	Management Strategies	Predicted Outcomes
		Bulletin No.2 – Port Hedland Dust and Noise (EPA, 2009). • EPA Guidance Statement No. 8 (Draft): Environmental Noise (EPA, 2007). • Department of State Development: Port Hedland Air Quality and Noise Management Plan – The Port Hedland Dust Management Taskforce Report (DSD, 2010). • State Planning Policy 5.4 Road and Rail Transport Noise and Freight Considerations in Land Use Planning (WAPC, 2009a). • Implementation Guidelines for State Planning Policy 5.4, (WAPC, 2009b).	exists in the project area. The nearest sensitive receptor to the mine area is the accommodation camp, which is approximately 4.5 km west of the open pit and 2.3 km west of the power station. The Woodstock Aboriginal Community is approximately 30 km south of the mine area while Panorama Homestead is approximately 40 km to the north east. The closest sensitive receptor to the Canning Basin borefield is the Pardoo Roadhouse, approximately 15 km north west. Wallal Downs Homestead is approximately 40 km east while Pardoo Homestead and Muccan Homestead are approximately 45 km to the west and south respectively.	reduced breeding or foraging habitat being available for certain species. • Disturbance to Pilbara Leaf-nosed Bats roosting in caves in proximity to the open pit, processing plant and power station resulting in bats abandoning these roosts.	associated with slurry pipeline, water supply pipeline and Canning Basin Borefield. Contact details will be made available to the general public and specifically residents of Whitehills residential community and homesteads within 15 km of the pipelines. • Noise complaints from local communities will be addressed in a timely manner and the outcomes recorded. • Equipment and machinery will be maintained to manufacturers specifications such that noise emissions are minimised. • Construction will be undertaken in accordance with the noise practices outlined in AS 2436-1981. • All employees and contractors will be provided with awareness training on their obligations and responsibilities in relation to noise and vibrations impacts.	emanating from the open pit are minimal. A limited number of receptors may be impacted during construction of the slurry pipeline, water supply pipeline and Canning Basin borefield. However, construction activities will only be undertaken during daytime hours when background noise and vibration levels are generally higher. Construction will also be of a short duration in any one location and as a result impacts to receptors are expected to be minimal. Once construction is completed noise and vibration impacts will be limited to pumping stations and are therefore considered to be negligible The impacts of noise and vibration on fauna is expected to be greatest closest to the operational areas of the mine and largely associated with early phases of extraction and processing of ore. Any fauna nearby may be impacted in the short term, however the management measures outlined above are expected to minimise and reduce the exposure to noise. Anecdotal evidence from mine sites suggests that many fauna species are likely to become habituated to disturbances such as noise and vibration.
Social – Relevant Factor	To ensure that aesthetic values are considered and measures are adopted to reduce visual impacts on the landscape as low as reasonably practicable. To ensure that existing and planned recreational uses are not compromised.	• Pilbara Cities: Departments for Regional Development and Lands (2010). • Pilbara's Port City Growth Plan.	Detailed information relating to the existing local and regional economy and local communities near the Project can be found in Section 12. The key findings are summarised below. The closest non-Aboriginal community to the Project is Whitehills rural estate in Port Hedland, located 2.5 km from the Slurry Corridor Development Envelope. The closest Aboriginal community to the Project is Warralong community, approximately 15 km east of the Water Corridor Development Envelope. The closest Aboriginal community to the mine area is the Woodstock community, approximately 30 km to the south. The closest homesteads to the Project are Mulyie, Ettrick and Warralong which are less than 15 km from the Water Corridor Development Envelope. The closest Homestead to the mine area is Panorama Homestead,	Pressure on local communities that may become evident as a result of the Project, includes: • Potential increase in anti-social behaviour. • Increased competition for access to community services, such as health services. • Additional traffic and/or airport congestion. • Increased competition for access to accommodation. • Increased cost of living. • Increased pressure on available airline capacity. The proposed Project will make a contribution to the regional and local economy through local sourcing of goods and services, contributing royalties, company tax payments and generating 800 permanent jobs. The Project will also contribute to Indigenous training and business opportunities in the Pilbara region. Increased local operational and contracting workforce can provide a stimulus for local business development	• Procurement of goods and services from local providers to stimulate greater economic diversity and enhance the capability of the area. • Use of the Pilbara Business Capability Register (ePilbara) and the industry capability network database (ICN) for identifying local contractors. • Use of Fortescue's Community Office in Port Hedland as a recipient of local supplier information either though expressions of interest submitted by interested parties or through research undertaken by Community Office staff. • A construction and operations accommodation camp to be developed in the Project mine area to reduce pressure on local accommodation supply and transport infrastructure. • Bus transport for construction and operational workers travelling between Port Hedland and Project areas. • Employment of local workers from the Port Hedland area, Aboriginal communities. • Continued support and funding of activities that foster economic development and sustainable communities, including the VTEC program, community grants program, investment in new housing in Port Hedland,	Positive and negative impacts on local and regional economies and communities may be associated with the construction and operation of the Project. Fortescue's ongoing commitment to working with local and regional authorities and local communities will increase the positive impacts from the Project and assist with alleviating any potential negative impacts.

Environmental Factor	EPA Objective	Relevant Guidance	Existing Environment	Potential Impacts	Management Strategies	Predicted Outcomes
			approximately 40 km to the east. The nearest major town to the Project, by road, is Port Hedland, which is currently experiencing increased pressure on social services and transport infrastructure due to industrial growth. Large population fluctuations in Port Hedland are associated with temporary workforces and it is considered to be the fastest growing population in Australia. Strategic development programs are being implemented for the Pilbara at a Federal, State and local government level to assist with the sustainable development of key infrastructure in the region. Fortescue is supporting the State Government's Pilbara Cities vision and strategic development of the Pilbara through its commitment to a residential workforce, local employment, training and employing Aboriginal people and providing opportunities for local businesses.	and support employment opportunities in non-mining sectors of the local economy. Fortescue contributes to the local economy through community programs and initiatives including Indigenous traineeships and local projects, and to date has contributed millions of dollars to the Town of Port Hedland through such programs. Opportunities for local employment and business development will be realised through construction and operation of the Project. Economic development in Port Hedland will lead to increased benefits to hospitality, retail, recreation sectors and small businesses. Indigenous employment and community development including education, training and traineeships will be provided by this Project to communities in the Pilbara region.	attracting and retaining health workers and providing funding for strategic road upgrades. • Maintain a complaints and feedback system from the community and address them in a timely manner.	
Cultural Heritage – Relevant Factor	To ensure that changes to the biophysical environment do not adversely affect historical and cultural associations and comply with relevant heritage legislation.	• *Aboriginal Heritage Act 1972* (WA) • *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* (Cth) • *Native Title Act 1993* (Cth) • EPA Guidance Statement Number 41: Assessment of Aboriginal Heritage (EPA, 2004)	Indigenous heritage sites have been identified within the Project footprint in the Mining, Infrastructure Corridor, Slurry Corridor and Water Corridor Development Envelope. No listed European heritage sites are located within 10 km of the Project area. The Project will traverse the Njamal, Warrarn and Kariyarra Native Title Claims.	Impacts related to heritage may result largely due to clearing and earthworks associated with construction and operation of the Project and include: • Damage to or demolition of identified Aboriginal heritage sites. • Damage to or demolition of unknown Aboriginal heritage sites uncovered as a result of Project activities. • Unauthorised access to heritage sites leading to degradation of these sites. • Changes in land use resulting in exclusion of Aboriginal people from areas of cultural significance.	• An agreement has been reached with the Njamal people, creating a production sharing agreement between Fortescue and the Njamal people. Under this agreement, provision for protection and management of cultural heritage is included. • The "Guideline for the Management of Aboriginal Cultural Heritage" is Fortescue's primary cultural heritage management document used by personnel when planning and undertaking any scope of works in Fortescue project areas. It details guidelines and procedures to assist with the day to day management and protection of Sites on Fortescue project areas; and ensures staff and contractor compliance with internal, statutory and community cultural heritage obligations. • Ground disturbing activity will only take place once a Ground Disturbance Permit (GDP) has been obtained. • GDP's include heritage protection conditions where Aboriginal Sites are present, and are only approved for areas that have been subject to ethnographic and archaeological surveys. • Location and design of project elements will avoid heritage sites wherever possible. In the event that preservation of sites is not possible, sites of cultural significance will be salvaged in consultation with the Njamal people and in accordance with a Section 18 Consent and Ministerial Conditions.	Damage, loss, or disturbance of sites/artefacts of Aboriginal heritage through physical disturbance of the land, or from the presence of construction / operations workforce will be minimised through the proposed management strategies. As a result, it is expected that there will be no significant impacts to the cultural heritage values of the Project area and surrounds.

Environmental Factor	EPA Objective	Relevant Guidance	Existing Environment	Potential Impacts	Management Strategies	Predicted Outcomes
					• Where disturbance of an Aboriginal heritage site is unavoidable, consultation with Aboriginal site owners will be undertaken and a Section 18 application under the *Aboriginal Heritage Act 1972* will be completed • Staff working in proximity to Aboriginal heritage sites will be advised of their locations prior to commencing work on the Project in order to avoid unintentional disturbance of these sites • Heritage monitors will be employed for all activities which require ground disturbance in proximity to cultural sites • Known cultural heritage sites in the Project area will be appropriately protected with buffer zones, fencing or flagging (or equivalent) to prevent inadvertent disturbance of areas of significance • If additional heritage sites are uncovered during construction, work in the area will cease immediately until the authenticity and significance of the site is determined in line with Fortescue's Heritage Management Guidelines • Community complaints, incidents and non-compliance procedures will be established for the duration of the Project • Information in relation to the environment of the Project area, including cultural heritage, will be included in the induction programme for the Project. The induction programmed will include information in relation to roles and responsibilities. All staff and contractors will be required to undertake the induction programme. Visitors will be escorted while on site.	

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Section 1
Introduction

Fortescue
The New Force in Iron Ore

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1. INTRODUCTION

FMG Iron Bridge (Aust) Ltd (FMGIB) is proposing to develop the North Star Magnetite Project (the Project) in the Pilbara region of Western Australia. FMGIB is a majority owned subsidiary company of Fortescue Metals Group Ltd (Fortescue), who own and operate a number of mining and infrastructure projects in the Pilbara.

The Project was referred to the Western Australia Environmental Protection Authority (EPA) under Section 38 of the *Environmental Protection Act 1986* (WA) (EP Act) on 2 October 2012. The EPA determined the Project required assessment under Part IV of the EP Act and set the level of assessment at Public Environmental Review (PER) on 5 November 2012. The Project was also referred under Section 68 of the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) to the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) on 3 December 2012. DSEWPaC determined the Project was a controlled on 21 January 2013.

This document is the PER for the Project and has been prepared in accordance with the Environmental Impact Assessment Administrative Procedures 2010 (Western Australian Government, 2010). This document also satisfies the requirements for assessment under the EPBC Act in accordance with the *Agreement Between the Commonwealth of Australia and the State of Western Australia Relating to Environmental Impact Assessment*.

1.1 Proposal Overview

The Project comprises three distinct components as follows:

- North Star mine area: approximately 1,230 kilometres (km) north-north east of Perth and 110 km south-south east of Port Hedland.
- Canning Basin borefield and water supply pipeline: The Canning Basin borefield is located approximately 160 km east of Port Hedland.
- Slurry pipeline and infrastructure corridor: connects the North Star mine area to facilities in Port Hedland. This PER seeks approval for the southern portion of this corridor between the North Star mine area and the boundary of the Port Hedland Port Authority lease area (Figure 1 and Appendix 2).

While preliminary planning for the location of these components and associated infrastructure has been undertaken, some flexibility is required to allow for minor changes during the detailed project design phase. To accommodate this, the Project area has been defined through the use of development envelopes within which Project infrastructure will be located (Table 3 and Figure 1). The area of disturbance within the Project Development Envelope is described in Section 4.

Table 3: Project Development Envelopes

Development Envelope	Envelope Area (ha)	Contained Infrastructure
Mining Development Envelope	4970	Open pit Safety bunds RoM pads Waste rock dumps Tailings Storage Facilities Low grade ore stockpiles Process Rejects landform Fuel tanks Crushing circuits Processing plants Process related infrastructure Explosives magazines and Explosives storage facilities Water pipelines Water storage dams Evaporation ponds Concentrate slurry pipelines Power station Natural gas pipeline Minor workshops and warehouses Administration buildings Accommodation buildings Water treatment facilities Potable water storage tanks Sewage treatment facilities Recreational facilities Access and Haul roads
Infrastructure Corridor Development Envelope	4,171	Mine access road Concentrate slurry pipelines Natural gas pipeline corridor Administration buildings Related infrastructure
Slurry Corridor Development Envelope	2,235	Concentrate slurry pipelines Natural gas pipeline corridor Related infrastructure
Water Corridor Development Envelope	28,696	Canning Basin borefield Water supply pipeline Power generators Pumping stations Access tracks Related infrastructure

The Project includes a new mine with one mine pit, one waste rock dump (WRD), tailings storage facilities (TSF), one low grade ore stockpile (LGOS), crushing and screening hub, magnetic separation processing plant, roads and other associated mine infrastructure (Figure 2). The Project is premised on a maximum of 30 million tonnes (Mt) Run of Mine (ROM) feed of magnetite ore with a mine life of 45 years. After processing and beneficiation, up to 15 million tonnes per annum (Mtpa) of product will be sent to Port Hedland for export as magnetite concentrate.

Power for the mine will be provided by an onsite gas fired power station with electricity distributed around the site via overhead 33 kilovolt (kV) transmission lines.

Water requirements for construction of the Project will be met using existing licenced bores in Fortescue's Special Rail Lease for the Mainline Railway, or other borefields if required. Ongoing operational water demand will be met though construction of the Canning Basin Borefield and Water Supply Pipeline.

Further details on the Project are provided in Section 4.

1.2 Identification of Proponent

The Proponent for the Project is FMG Iron Bridge (Aust) Ltd (FMGIB). The contact person for the Project is:

Sean McGunnigle
Manager, Environmental Approvals
Fortescue Metals Group Limited
Level 2, 87 Adelaide Terrace
East Perth WA 6004
Phone: (08) 6218 8888
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1.3 Purpose of Document

The purpose of this document is to present the environmental factors of key significance relevant to the Project, the findings of environmental studies/investigations carried out to assess potential environmental impacts and the management framework to be implemented to achieve acceptable environmental outcomes. The document covers the following key considerations, aligned with current EPA Guidance on PER form and content (EPA, 2012c) as follows:

- Description of the key components of the proposal.
- Outline of the existing legislative, ecological and environmental context relevant to the proposal.
- Identification of potential environmental impacts associated with the proposal.
- The proposed management and mitigation measures to reduce potential impacts.
- Overall summary table of environmental factors relevant to the proposal, potential impacts and management and mitigation measures.

This document has been prepared in accordance with the requirements of the EPA prepared Environmental Scoping Document (ESD), approved on 21 February 2013. For ease of reference, the sections of this PER which address the requirements of the ESD are provided in Table 4.

Table 4: ESD Requirements Addressed in the PER

ESD Requirement	Relevant Section of PER
General	
Separate section identifying MNES – how matters have been addressed and any offsets proposed to address MNES.	Sections 8, 11, 14.5
Key Proposal Characteristics table informed by environmental factors.	Table 6
All technical reports, modelling and referenced documents (not currently in the public domain) used in the preparation of the PER should be included as appendices to the document.	Appendices 2 to 10
Detailed assessment of each of the preliminary key environmental factors identified, namely: • Flora and vegetation; • Terrestrial fauna; • Subterranean fauna; • Hydrological processes; and • Offsets.	Sections 6 to Section 14.5
Flora and Vegetation	
Detailed description of the clearing associated with the proposal, including from direct impacts, and the indirect impacts of groundwater drawdown and operations.	Section 7.9
Figures showing the extent of clearing or loss of vegetation and conservation significant flora species from direct or indirect impacts.	Figures
Level 2 flora and vegetation surveys conducted in areas that are likely to be directly or indirectly disturbed as a result of the proposal in accordance with Guidance Statement 51. Follow up or targeted surveys may be required.	Section 7.1
Analysis of the extent of clearing and conservation status of vegetation and/or flora species to be cleared, including quantifying impacts to vegetation types and/or conservation significant species, including threatened and/or priority ecological communities, declared rare flora, priority flora and new flora species, to be cleared to assist in determination of the significance of impacts.	Section 7.9
Baseline mapping of weed affected areas in any area likely to be directly or indirectly impacted by the proposal.	Section 7.6, Figure 17 to Figure 19, Appendix 7
Discussion of the potential for indirect impacts to flora and vegetation, including impacts to groundwater depending vegetation as a result of dewatering activities.	Section 7.9
Discussion using current predictions of potential for climate change to increase the direct and indirect impacts to flora and vegetation identified above.	Section 7.9
Discussion of proposed management, monitoring and mitigation methods to be implemented.	Sections 7.10, 14.
Terrestrial Fauna	
Desktop study of information available to provide a comprehensive listing of fauna known or likely to occur in the habitat present, and identification of conservation significant fauna species likely to occur in the area.	Sections 8.2, 11.2, Appendices 8 to 10
Where previous surveys are not available, or are not of acceptable quality in accordance with Guidance Statement 56, Level 1 survey and mapping of habitats within areas to be cleared should be conducted in accordance with Guidance Statement 56.	Section 8.1, Figure 20 to Figure 22, Appendices 8 to 10
Identification and mapping of important, rare or unusual habitat types.	Sections 8.2, 11.5 , Figure 20 to Figure 22, Appendices 8 to 10
Analysis of the extent of clearing, including percentages of habitat types to be cleared, to assist in determination of significance of impacts.	Sections 8.10, 11.8
Where the desktop study and habitat analysis indicates that it is appropriate, conduct targeted Level 2 surveys for conservation significant vertebrate species that are known to or likely to occupy habitats in the project area.	Section 8.1, Appendices 8 to 10

ESD Requirement	Relevant Section of PER
Conduct targeted Short Range Endemic survey and habitat mapping.	Section 8.6, Figure 23 to Figure 25, Appendix 9
Discussion of potential impacts to Fauna as a result of the proposal, with particular regard to Matters of National Environmental Significance (MNES), and provision of quantitative data on impacts of the proposal to species of conservation significance.	Sections 8.10, 11.8
Where vegetation to be cleared provides habitat for EPBC listed species, the PER should also provide an assessment of habitat quality in terms of site condition and context and species stocking rate, as described in the EPBC Act Offsets Assessment Guide.	Section 11.5
Discussion using current predictions of potential for climate change to increase the direct and indirect impacts to Fauna and Habitat identified above.	Section 8.10.12
Discussion of proposed management, monitoring and mitigation methods to be implemented.	Sections 8.11, 14
Subterranean Fauna	
Where previous surveys are not available, or are not of acceptable quality in accordance with Guidance Statement 54, surveys within areas to be impacted and in surrounding areas should be conducted in accordance with Guidance Statement 54 and Guidance Statement 54a. The EPA is currently reviewing the guidance on subterranean fauna.	Section 9.1, Appendix 10
The results of the subterranean fauna surveys should be presented and a discussion of potential for impacts to subterranean fauna provided.	Sections 9.1, 9.2, 9.3, 9.6
Discussion of proposed management, monitoring and mitigation methods to be implemented.	Sections 9.7, 14
Hydrological Processes	
Provide a detailed description of the design and location of the proposal with the potential to impact surface water or groundwater.	Section 10
Characterise baseline hydrological and hydrogeological regimes and water quality.	Section 10.1, 10.2
Assess groundwater drawdown associated with the proposal and analyse and discuss any impacts to groundwater expected as a result of the proposal.	Section 10.5
Assess impacts to existing and potential users of the proposed abstraction of water from the West Canning Basin.	Sections 10.5
Assess surface water impacts associated with the proposal and analyse and discuss any impacts to surface water expected as a result of the proposal.	Section 10.5
Predictive assessments of the hydrodynamics and hydrochemistry of any pit water over time showing potential interactions of pit water with local and regional groundwater and surface water during mining and following mine closure. This should include predictions, based on waste characterisation investigations, of the water quality of any water accumulating in the pits following large rainfall events.	Section 10.5
Discussion using current predictions of potential for climate change to increase the direct and indirect impacts to groundwater and surface water identified above.	Section 10.5
Discussion of proposed management, monitoring and mitigation to prevent any further contamination as a result of implementing the proposal.	Section 10.6, 14
Offsets	
Examination of residual impacts and, if required, development of draft program of environmental offsets.	Section 14.5
Identification of residual impacts with regard to MNES and an assessment of the significance of the impacts.	Section 14.5
Inclusion in the PER of the completed Environmental Offsets Reporting Form and any offsets required and proposed.	Section 14.5
Other Environmental Issues	
Dust impacts on vegetation and flora should be addressed in the environment review document through an assessment of the indirect impacts of the proposal on Flora and	Section 13

ESD Requirement	Relevant Section of PER
Vegetation.	
The environmental review document should assess any noise impacts from the proposal on fauna as part of the assessment of the impacts on terrestrial fauna.	Section 13

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Section 2
Project Rationale

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2. RATIONALE FOR THE PROPOSAL AND ALTERNATIVES CONSIDERED

2.1 Project Justification

In general, the majority of iron ore mined in Western Australia has previously been hematite which has higher iron content than unprocessed magnetite ore. The amount of this high quality hematite ore available in the world market is declining and this has led to the development of technologies to use magnetite ore as an alternative iron source (DMP, 2011a). Steel producers in China have successfully used magnetite ore to produce premium quality, low impurity steel products. Consequently, there is a new demand in the world market for magnetite ore, which has informed the commercial opportunity to pursue development of the Project.

In spite of fluctuations in the global market, in 2010 to 2011 export of iron ore from Western Australia to China increased and accounted for approximately 68% of total iron ore exports from the state, with a total value of approximately $39 billion (DMP, 2011a). Further, the projected long term demand for iron ore is considered unlikely to decline with sustained long-term growth forecasts for emerging economies such as China and India. China's urbanisation program will involve building city infrastructure for a population the equivalent of the United States over coming decades. The steel intensity of the Chinese economy is yet to reach levels eclipsed by the US, Japan, South Korea and Taiwan 40 years ago and would have to increase by 200% to surpass South Korea's steel intensity.

Implementation of the Project provides the opportunity to contribute to the creation of employment and training opportunities for local and Indigenous community members, royalties and taxation payments from the sale of iron ore and supports the development of ancillary industries in Western Australia. Australia's ongoing supply of iron ore is a critical component of China's urbanisation agenda improving the lives of hundreds of millions of people by building important infrastructure such as energy-efficient housing and subways for sustainable public transport.

2.2 Project Alternatives

A number of alternatives have been considered for discrete components of the Project including ore transportation, water supply and delivery, location of the waste rock dump (WRD), location of mine infrastructure and electrical power supply.

While the siting of much of the infrastructure directly associated with the mine is governed by the location of the magnetite iron ore deposit, FMGIB has endeavoured to minimise disturbance required for the mine area. The following alternatives have been considered as part of the planning process for the Project:

- A number of alternative locations for the waste rock dump. These locations included to the west of the open pit, north of the RoM pad and approximately where the Low

Grade Ore stockpile is located, and swapping the locations of the TSF and WRD. The current location taken forward into mine planning was considered to provide the best outcome in terms of haul distances from the open pit and integration into the surrounding landscape.

- Initial mine planning produced separate locations for the construction and operational accommodation village. This has since been revised with both construction and operational accommodation requirements integrated into a single location, minimising disturbance, reducing greenhouse gas emissions resulting from additional vehicle use and reduction of overall costs.

The following options for ore processing have been considered:

- During initial mine planning, two options for processing of the magnetite ore were considered. These were:
    - Dry grinding at the North Star mine with product shipped to wet processing facilities in China or the Middle East.
    - Full wet processing at the North Star mine. This is the option taken forward into detailed mine planning. Full wet processing at the mine will result in reduced dust emissions and reduced road/rail transport requirements as the wet concentrate can be sent to Port Hedland via a slurry pipeline.
- Several options for transportation of the ore concentrate from the mine to Port Hedland have been assessed. These were:
    - Trucking of concentrate filter cakes. Rejected due to impacts to road users, greenhouse gas emissions and costs of transport.
    - Construction of a rail spur line from the existing Fortescue rail line to transport concentrate filter cake via rail carriage to the existing Fortescue train unloading facilities at Port Hedland. Rejected due to costs to construct and impact to Fortescue's existing operations.
    - Pumping of concentrate slurry via a buried pipeline from the processing plant to a purpose built rail siding on the existing Fortescue rail line. Concentrate slurry would require dewatering to produce filter cakes suitable for loading into rail cars for transport to Fortescue's existing rail unloading facility. Rejected due to impacts to Fortescue's existing operation.
    - Pumping of concentrate slurry via a buried pipeline from the processing plant to a purpose built port facility in Port Hedland. This is the option which has been taken forward into detailed mine planning.

The following options for water supply have been considered:

- The Lalla Rookh borefield (approximately 10 km north of the mine area) was initially investigated but found to be unable to sustain water supply at the required volumes.
- The Canning Basin Borefield has been identified as the preferred option to provide the required volume of water for the life of the mine. No other groundwater resources

capable of sustaining the yield required for the Project have been identified within 100 km of the mine area.

- The option of obtaining water from existing Fortescue operations was investigated. Specifically, Christmas Creek Mine has a surplus of water. This option was rejected as the available water is saline and not suitable for use as either process or potable water without treatment via a desalination plant, resulting in a higher energy demand for the Project and additional environmental impacts associated with disposal of hypersaline waste water. Obtaining water from Christmas Creek Mine would also require a longer water supply pipeline than the Canning Basin option, resulting in a larger disturbance footprint for the Project.

  Surplus water at Christmas Creek Mine is re-injected into the local aquifer, which assists in maintenance of the environmental values of the area, in particular the Fortescue Marsh. Removing this water from the local system may result in unintended environmental consequences at Christmas Creek Mine.

- FMGIB investigated the option of purchasing water from the Water Corporation. This option was rejected due to uncertainty about the security of supply. Demand for water in Port Hedland and surrounds is forecast to increase, with demand predicted to reach 21 GL/year by 2016 and 33.5 GL/year by 2031 (Department of Water, 2012b). Currently, the Water Corporation is able to draw 20.5 GL/year from existing sources. To support the increase in demand, additional water resources will need to be located, assessed and developed. FMGIB considered this represented a risk to the ability to obtain a long term, secure source of water for the Project.

  This option would also require construction of a water supply pipeline from Port Hedland to the mine area. This option is therefore unlikely to result in a significant reduction in potential environmental impacts as a result of the Project.

- Two broad routes have been considered for the water supply pipeline. The water supply pipeline route taken forward into detailed mine planning has been selected after consultation with key stakeholders including native title holders and pastoralists. The final alignment within this corridor will take into account cultural, pastoral and environmental areas of interest.

The following options for power supply have been considered:

- A gas fired power station to be located within the Boodarie Industrial Estate with transmission lines to the Project mine area. With a nominal power output of 200MW, this power station would service the energy requirements of both the Project and Fortescue’s Port expansion to 155 Mtpa and would feed the North West Integrated System. However, the State Government would not consent to providing land in the Boodarie Estate.

- A smaller 120MW power station to be located at the Project mine area. The power station will be fuelled by natural gas, supplied via a dedicated gas pipeline. This is the option taken forward in the proposal.

2.2.1 No Development Option

In the scenario of a 'no development option', there would be no potential environmental impacts associated with the Project. However, there would also be loss of benefits at a local, regional, national and international level, such as:

- Infrastructure proposed by the Project will include a concentrate supply pipeline thereby minimising additional rail and road traffic originating from the Project in the Port Hedland area and along the Great Northern Highway.
- Development of water related infrastructure in the Canning Basin may provide a source of fresh water for Port Hedland. After filtration of the concentrate at Port Hedland, approximately 3 to 4 GLpa of fresh water will be generated. This water could be sold to third parties. At this time, water will be returned to the mine area via a return water pipeline.

Section 3
Principle Legislation

Fortescue
The New Force in Iron Ore

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3. PRINCIPLE LEGISLATION

Implementation of the Project will require compliance with Australian legislation, regulations and guidelines as listed in this section.

3.1 Commonwealth Legislation

The Project has been declared a controlled action by the Federal Minister for Environment and will be assessed by the Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) according to the terms of the Bilateral Agreement between the Commonwealth of Australia and the State of Western Australia. The bilateral agreement is authorised under Section 45 of the *Environment Protection and Biodiversity Conservation Act 1999*. Under the terms of the bilateral agreement, the EPA will provide its assessment report and any other assessment documentation, including this PER, to DSEWPaC upon completion of its assessment. DSEWPaC considers impacts from the Project to Matters of National Environmental Significance (MNES). For this Project MNES are the Northern Quoll, Pilbara Leaf-nosed Bat and Pilbara Olive Python.

Other relevant Commonwealth legislation relevant to the Project includes:

- *Aboriginal and Torres Strait Islander Heritage Protection Act 1984*
- *Australian Heritage Council Act 2003*
- *Native Title Act 1993*
- *National Greenhouse and Energy Reporting Act 2007*

3.2 Western Australian Legislation

3.2.1 Regulation of Key Factors

Implementation of the Project has the potential to cause impacts to a range of environmental factors as identified by the EPA in its Environmental Scoping Document. These potential impacts, and the State and Commonwealth legislation that regulate these impacts are documented in Table 5. This table highlights the duplication and overlap in regulatory responsibility for impacts to environmental factors and suggests that final responsibility for regulating these impacts reside with a single agency to remove duplication.

Table 5: Regulation of Environmental Factors

Environmental Factor	Potential Impacts	Applicable Legislation	Responsible Agency	Final Responsibility*
Flora and Vegetation	Clearing of Vegetation Direct loss of flora of conservation significance Direct loss of vegetation outside of the project area Degradation of vegetation	EP Act WC Act Environmental Protection (Clearing of Native Vegetation) Regulations 2004 *Agriculture and Related Resources Protection Act 1976*	Department of Environment and Conservation (DEC), or Department of Mines and Petroleum (DMP) under delegation) DAFWA	EPA
Terrestrial Fauna	Direct loss of fauna habitat Direct loss of fauna species Degradation of fauna habitat Change in fauna behaviour Light spill Vibration Noise Dust	WC Act EPBC Act	DEC SEWPAC (Matters of NES)	EPA
Subterranean Fauna	Loss of habitat Direct loss of species Degradation of habitat	WC Act	DEC	EPA
Hydrological Processes	Changes to surface water flows Degradation of surface water pools Drawdown on groundwater Contamination of Groundwater	*Rights in Water and Irrigation Act 1914* (Licensing of Groundwater abstraction) EP Act (Works Approval for TSF) *Contaminated Sites Act 2003*	Department of Water DEC	DoW
Greenhouse Gases	Potential to contribute to climate change	*National Greenhouse and Energy Reporting Act 2007*	Department of Climate Change and Energy Efficiency	Department of Climate Change and Energy Efficiency
Atmospheric Emissions	Dust Other emissions (CO, PM10, VOCs)	Environmental Protection (Unauthorised Discharges) Regulations 2004 EP Act	DEC	EPA
Noise	Nuisance and loss of amenity (impacts to fauna addressed above)	EP Act Environmental Protection (Noise) Regulations 1997	DEC	EPA
Heritage	Loss of Aboriginal Heritage sites Degradation of Aboriginal Heritage	*Aboriginal Heritage Act 1972* *Aboriginal and Torres Strait*	Department of Indigenous Affairs DSEWPaC Attorney General;	Department of Indigenous Affairs DSEWPaC Attorney General;

Environmental Factor	Potential Impacts	Applicable Legislation	Responsible Agency	Final Responsibility*
	sites Loss or degradation of other sites of heritage significance.	*Islander Heritage Protection Act 1984* *Native Title Act 1993* *Heritage of Western Australia Act 1990*	Department of Families, Housing, Community Services and Indigenous Affairs Heritage Council of Western Australia	Department of Families, Housing, Community Services and Indigenous Affairs Heritage Council of Western Australia
Health and Safety	Health risk to staff and visitors	*Mining Act 1978* *Mines Safety and Inspection Act 1994* (and Regulations) *Occupational Health and Safety Act 1984* *Health Act 1911* *Dangerous Goods Safety Act 2004* (and Regulations)	DMP Dept of Health Department of Commerce	DMP Dept of Health Department of Commerce
Rehabilitation and Closure	Ongoing impacts to surrounding environment post closure	Mining Act	DMP	DMP

* Agency responsible for the regulation of impacts to environmental factors to remove duplication and overlap of secondary approvals. Conditions endorsed by the Minister to comply with relevant Acts and Regulations that are audited by the EPA will remove this regulatory overlap. For instance, a condition for the management of impacts to fauna species would remove the requirement for similar conditions by DSEWPAC.

3.3 Other Applicable Legislation

Other legislation relevant to the Project may include:

- *Main Roads Act 1930*
- *Bush Fires Act 1954*
- *Land Administration Act 1997*
- *Local Government Act 1995*
- *Railway and Port (The Pilbara Infrastructure Pty Ltd) State Agreement Act 2004*
- *Railway and Port (The Pilbara Infrastructure Pty Ltd) Agreement Variation 2010*
- *Road Traffic Act 1974*
- *Soil and Land Conservation Act 1976*
- *Town Planning and Development Act 1928*

3.4 Guidelines, Standards and Policies

Guidelines and procedures relevant, or potentially relevant, to the Project include:

- A guideline for the development and implementation of a dust management program (DEC, 2008)
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000)
- Australian Standard AS 2436-2010 Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites (2010)
- Best Practice Environmental Management in Mining Series (Environment Australia, 2002)
- Biodiversity Management – Leading Practice Sustainability Development Program for the Mining Industry (2007)
- Department of Water Pilbara Region Water Plan 2010-2030 (Department of Water, 2010)
- Department of Water Pilbara Water in Mining Guideline (Department of Water, 2009)
- Department of Water Stormwater Management Manual for Western Australia 2004-2007 (Department of Water, 2004)
- Enduring Value – The Australian Minerals Industry Framework for Sustainable Development (Minerals Council of Australia, 2005)
- Environmental Impact Assessment Administrative Procedures (EPA, 2012b)
- Environmental Protection Bulletin No. 1 – Environmental Offsets (EPA, 2008b)
- Environmental Protection Bulletin No.2 – Port Hedland Dust and Noise (EPA, 2009a)
- EPA Discussion Paper: A review of subterranean fauna assessment in Western Australia (2012a)
- EPA Guidance Statement Number 12: Minimising Greenhouse Gases (EPA, 2002b)
- EPA Guidance Statement Number 18: Protection of Air Quality Impacts from Land Development Sites (EPA, 2000a)
- EPA Guidance Statement Number 19: Environmental Offsets (EPA, 2008c)
- EPA Guidance Statement Number 20: Sampling of Short Range Endemic Fauna for EIA in Western Australia (EPA, 2009b)
- EPA Guidance Statement Number 33: Environmental Guidance for Planning and Development (EPA, 2008d)
- EPA Guidance Statement Number 41: Assessment of Aboriginal Heritage (EPA, 2004a)
- EPA Guidance Statement Number 51: Terrestrial Fauna and Vegetation Surveys for EIA in Western Australia (EPA, 2004a)

- EPA Guidance Statement Number 54: Consideration of Subterranean Fauna in Groundwater and Caves during EIA in Western Australia (EPA, 2003c)
- EPA Guidance Statement Number 54a (Draft): Sampling Methods and Survey Considerations for Subterranean Fauna in Western Australia (EPA, 2007a)
- EPA Guidance Statement Number 55: Implementing Best Practice in Proposals Submitted to the EIA process (EPA, 2003b)
- EPA Guidance Statement Number 56: Terrestrial Fauna Surveys for EIA in Western Australia (EPA, 2004b)
- EPA Guidance Statement Number 6: Rehabilitation of Terrestrial Ecosystems (EPA, 2006a)
- EPA Guidance Statement Number 8 (Draft): Environmental Noise (EPA, 2007b)
- EPA Position Statement 2: Environmental Protection of Native Vegetation in Western Australia (EPA, 2000b)
- EPA Position Statement Number 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA, 2002a)
- EPA Position Statement Number 5: Environmental Protection and Ecological Sustainability of the Rangelands in Western Australia (EPA, 2004e)
- EPA Position Statement Number 7: Principles of Environmental Protection (EPA, 2004c)
- EPA Position Statement Number 8: Environmental Protection in Natural Resource Management (EPA, 2004c)
- EPA Position Statement Number 9: Environmental Offsets (EPA, 2006b)
- Guidelines for Mining Proposals in Western Australia (DMP, 2006)
- Guidelines on the Safe Design and Operating Standards for Tailings Storage (DME, 1999)
- Joint (DMP and EPA) Guidelines for Preparing Mine Closure Plans (2011b)
- Mine Rehabilitation, Leading Practice Sustainable Development Program for the Mining Industry (Department of Industry Tourism and Resources, 2006)
- Mine Void Water Resource Issues in Western Australia – Hydrogeological Record Series Report No. HG 3 (Water and Rivers Commission, 2003) National Environment Protection (Ambient Air Quality) Measure (NEPC, 2003) National Strategy for the Conservation of Australia's Biological Diversity Guidelines for Preparing Mine Closure Plans
- Planning for Integrated Mine Closure: Toolkit (International Council on Mining and Metals, 2008)
- Policy Statement on Water Sharing (Water and Rivers Commission, 2000a)
- State Planning Policy 5.4 Road and Rail Transport Noise and Freight Considerations in Land Use Planning (Department of Planning, 2009)

- Statewide Policy No. 5 Environmental Water Provisions Policy for Western Australia (Water and Rivers Commission, 2000b)
- Strategic Framework for Mine Closure (ANZMEC, 2010)
- Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (EPA and DEC, 2010)
- Visual Landscape Planning in Western Australia: A Manual for Evaluation, Assessment, Siting and Design (Department of Planning, 2008)
- Waste Classification and Waste Definitions 1996 (as amended 2009) (DEC, 2009)

Section 4
Project Description

Fortescue
The New Force in Iron Ore

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4. PROJECT DESCRIPTION

The Project will consist of three distinct components as described in Section 1.1. Table 6 summarises the key characteristics of the Project. The main area of disturbance will be the mine area, which will include development of an open pit and construction of a WRD, TSF, processing facilities, accommodation camp, and ancillary and support facilities (Figure 2). The Project has an overall ground disturbance of approximately 5,141 hectares (ha) inclusive of all infrastructure.

Table 6: Summary of Key Project Characteristics

General			
Proposal Title	North Star Magnetite Project		
Proponent Name	FMG Iron Bridge (Aust) Ltd		
Short Description	The proposal is for the development of the North Star Magnetite Deposit and includes: • Open cut mine pit. • Waste rock dump (WRD). • Tailings storage facility (TSF). • Ore stockpiles. • Processing plant. • Slurry, water return and gas pipelines. • 120 megawatt (MW) gas fired power station. • Roads and borrow pits. • Water processing, ponds and reticulation. • Bulk fuel storage. • Workshops and maintenance facilities. • Explosives and chemical storage. • Borefield at the West Canning Basin and a 190 km water supply pipeline for the project's operational water supply requirements.		
Physical Elements	**Location**	**Proposed Extent Authorised**	
		Maximum Clearing	**Development Envelope Area**
Mining Development Envelope	Figure 1	3493 ha	4,970 ha
Infrastructure Corridor Development Envelope	Figure 1	447 ha	4,171 ha
Slurry Corridor Development Envelope	Figure 1	315 ha	2,235 ha
Water Corridor Development Envelope	Figure 1	886 ha	28,696 ha
		Extraction of up to 14 GLpa from the Canning Basin.	

General		
Operational Elements	**Location**	**Proposed Extent Authorised**
Dewatering Requirements	-	Up to 0.5 Gigalitres per annum (GLpa) caused by incident rainfall and seepage using in-pit sumps.
Power	Mining Development Envelope Canning Basin Borefield	Mine area: 120 MW to be supplied by an on-site gas fired power station. Borefield and pumping stations: 8 MW gas fired power station.
Gas Supply	Slurry Corridor Development Envelope	Gas will be supplied to the power station via a buried steel pipeline at a rate of 20 TJ/day.
Overburden/ Waste Rock	Mining Development Envelope	Disposal of up 945 million tonnes.
Ore Processing (waste)	Mining Development Envelope	Disposal of up 540 Mt of wet tailings. Disposal of up 180 Mt of dry rejects.

4.1 Project Tenure

The mine pit, WRD and TSF are situated on Unallocated Crown Land while the processing plant, accommodation camp, administration facilities and workshops are located on the Wallareenya Pastoral Lease. Access to the site from Port Hedland is via the Great Northern Highway and local roads.

The concentrate slurry pipeline and infrastructure corridor are located on Wallareenya Pastoral Lease (3114/1266), Kangan Pastoral Lease (3114/1188), Indee Pastoral Lease (3114/1197) and Boodarie Pastoral Lease (3114/618).

The Canning Basin borefield will be located on Unallocated Crown Land, Wallal Downs Pastoral Lease (3114/1079) and Pardoo Pastoral Lease (3114/718). The water supply pipeline will traverse the Pardoo Pastoral Lease, De Grey Pastoral Lease (3114/1142), Muccan Pastoral Lease (3114/1233), Coongan Pastoral Lease (3114/1061), Strelley Pastoral Lease (3114/1281) and Unallocated Crown Land.

The Project is located within the mining tenure granted to FMG Magnetite Pty Ltd (or currently pending) under the *Mining Act 1978* as shown in Table 7.

Table 7: Tenure of the Project Area

Lease	Purpose	Status
M45/1226	Mining Development Envelope	Live
L45/325	Mining Development Envelope	Live

Lease	Purpose	Status
L45/293	Infrastructure Corridor Development Envelope	Pending
L45/294	Infrastructure Corridor Development Envelope	Pending
L45/272	Water Corridor Development Envelope	Live
L45/289	Water Corridor Development Envelope	Live
L45/290	Water Corridor Development Envelope	Live
L45/291	Water Corridor Development Envelope	Live
L45/292	Water Corridor Development Envelope	Live
L45/320	Water Corridor Development Envelope	Pending
L45/331	Water Corridor Development Envelope	Pending
L45/317	Slurry Corridor Development Envelope	Pending
L45/318	Slurry Corridor Development Envelope	Pending
L45/319	Slurry Corridor Development Envelope	Pending

4.2 Project Ore Inventory

The North Star resource estimate currently stands at approximately 2.1 billion tonnes of magnetite (Table 8). Approximately 30 Mtpa of ore will be mined from the Project, producing an average of 15 Mtpa of concentrate.

Table 8: Project Ore Inventory

	Unit	Quantity
Total Tonnes Ore	Mt	1,350
RoM Feed (ore)	Mtpa	30
Waste Rock from Pit	Mt	913
Total Extraction Rate (waste and ore)	Mtpa	107
Process waste (dry rejects and wet tailings)	Mtpa	14
Product (magnetite concentrate)	Mtpa	15

4.3 Mining Method

The Project will extract up to 107 Mtpa of ore and waste rock to produce up to 30 Mtpa of ore (RoM feed). The ore mining methodology employed for the Project will involve conventional drill and blast, followed by hydraulic excavation and haulage to processing facilities and stockpiles by off road haul trucks.

4.3.1 Pre-Stripping

Establishment of the Project area requires basic preparatory works including vegetation clearing and soil stripping. Topsoil and vegetation will be removed during pre-stripping and stockpiled in areas away from drainage channels. Topsoil management is described in Section 4.5.

4.3.2 Mine Pit Configuration

The Project involves the development of a single open pit which will be approximately 4.5 km in length and 1 km in width.

Benches at hilltop level will be free-dug where possible, exposing hard rock for drill and blast. The first blast bench will have a height of between five metres (m) and 12.5 m depending upon terrain, with the following benches being up to 12.5 m in height.

The design parameters for the open pit are:

- Bench Slopes 70°.
- Bench Height 12.5 m.
- Berm width 17.7 m.
- Inter-ramp angle 29°.
- Ramp width 40 m.
- Ramp Grade 10 percent (%).

Grade control will be undertaken using a combination of reverse circulation (RC) drilling and blast hole sampling, or similar, in advance of mining, to establish ore blocks. The mining method and open pit design parameters will be reviewed regularly and optimised during operations.

The waste rock stockpile and ore stockpiles have been located outside of the potential zone of instability of the open pit.

4.3.3 Drilling and Blasting

All areas will be drilled and blasted utilising modern blasting techniques. The number of blasts will be minimised within the constraints of maintaining a continuous supply of broken rock for the mining operations.

4.3.4 Mining Equipment

Table 9 provides the indicative mining fleet for the Project. Standby units, including those for the dump tracks and the bulldozer may also be site based.

Table 9: Indicative Mining Fleet

Type	Make / Model	Quantity
Shovel	RH400 equivalent	4
Haul Truck	Caterpillar 797 equivalent	48
Drill	To be determined	28
Dozer	Caterpillar D11 equivalent	14
Grader	Caterpillar 24H equivalent	8
Water Cart	Caterpillar 785 equivalent	8
Excavator	To be determined	1
Rockbreaker	To be determined	1

There will be a number of smaller vehicles and equipment required onsite in addition to the mining fleet, such as forklifts, light vehicles, service vehicles and generator-driven lighting plants.

4.3.5 Dewatering

Minimal mine pit dewatering will be required. In-pit sumps may be required to collect any incidental rainfall or seepage during mining activities.

A levee bank will be constructed around the open pit to provide flood protection for a 1 in 100 year Average Recurrence Interval (ARI).

Calculations of the direct rainfall volumes entering the mine pit for a 1 in 5 year ARI and a 1 in 100 year ARI indicate that at the final pit limit, the mine pit would not be inundated with volumes that will cause significant disturbance to mining activities. Any dewatering from the open pit will be utilised in processing or dust suppression.

4.4 Waste Rock Management

Up to 945 Mt of waste rock (386 Million Loose Cubic Metres (MLCM)) will be mined throughout the life of the Project. Waste rock will be used initially for bulk earthworks, then stored in the WRD (Plate 1), or used for rock armouring of other built landforms.

The maximum height of the WRD will be 140 m above natural ground level and will be designed to blend with the natural landscape. The surrounding ridgelines are approximately 130 to 140 m above the valley floor. At its closest point, the WRD will be 125 m from the pit edge and will have the following conceptual design parameters:

- Lift height 20 m.
- Berm width 29.5 m.
- Final face angle 20°.
- Overall slope angle 15°.

Waste rock will consist of relatively competent material with a low soil size fraction.

The WRD is to provide a safe, stable, non-polluting waste rock landform. The WRD will provide a facility for the long-term disposal of waste material which will include potential acid forming (PAF) waste rock. Current estimates using the geological block model indicate that 20 to 60 Mm^3 of PAF waste rock will be disposed. Early in the mine life (nominally 0 to 10 years), only small percentages of the total material mined are predicted to be PAF. More significant quantities of PAF material are expected to be mined after this period, when increased volume of the Hanging Wall material is mined. AMD test work continues and more data and test material will become available. Updated estimates of PAF material volume will be provided in the Mining Proposal for the Project.

The WRD will be capped with inert waste rock to reduce the ingress of water and oxygen, and the outer slopes will be profiled to provide slope stability for long-term closure. The disposal of PAF material within the dump will be carefully planned to reduce the volume and concentration of AMD produced. One option currently being investigated for AMD management is to co-dispose the fine dry process rejects and PAF waste rock together, as geochemical testing indicates that the fine dry reject material has acid neutralising capabilities. This may further reduce the risks associated with the placement of PAF material and the generation of AMD. A total of approximately 180 Mt of fine dry waste will be available. Combined rejects and PAF waste rock leach tests are ongoing to confirm the feasibility of this placement option.

Geochemical and AMD characterisation of the waste rock is ongoing, and includes static and kinetic leach column testing. Geochemical characterisation of the waste rock will be undertaken prior to its deposition to determine its acid-forming and elemental composition.

Plate 1: Northern Portion of the Proposed Waste Rock Dump Location

4.5 Topsoil Management

Topsoil depth is expected to vary across the site with some areas having little to no available topsoil (see Section 6.4.4). Where sufficient material exists, topsoil will be pushed to the edge of the clearing area and stored loose in a bund up to 2 m high. To assist with stabilisation and control of erosion, stony and gravelly soils or a layer of cleared vegetation will be placed over topsoil stockpiles, where practicable.

The waste rock stockpile and ore stockpiles will be located outside of the potential zone of instability of the mine pit.

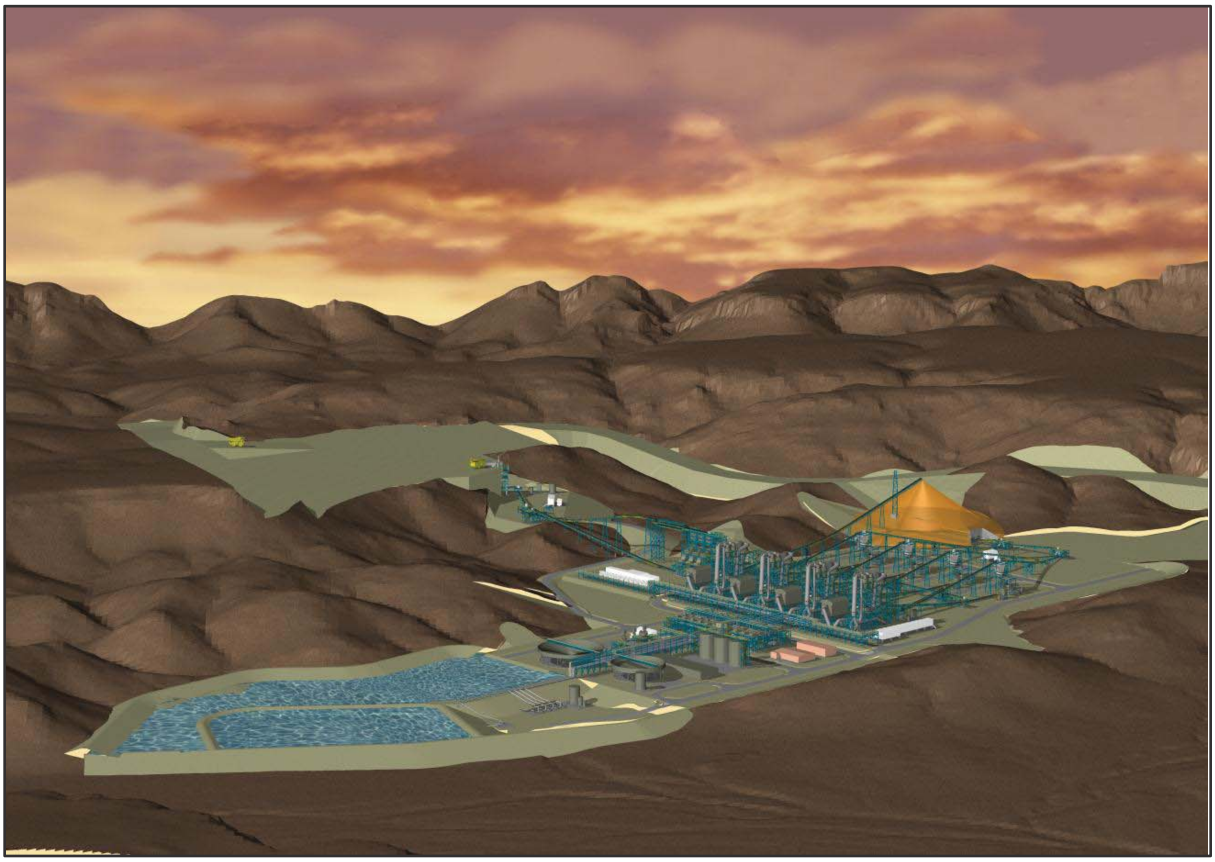
4.6 Ore Processing

Mined ore will be crushed, screened and stockpiled before being reclaimed and processed as shown conceptually in Plate 2. A conceptual process flow diagram illustrating the crushing, screening and stockpiling process is provided in Figure 3 and includes the following elements:

- ROM pad.
- Primary Crushing.
- Secondary Crushing.
- Stockpile and Reclaim.

- High Pressure Grinding Roll (HPGR) Grinding and Air Classification.
- Coarse Cobbing.
- Low Intensity Magnetic Separation (LIMS).
- Tertiary grinding.
- Concentrate Filtration.
- Tailings Thickening.

Plate 2: Conceptual View of the Proposed Processing Plant



4.6.1 Ore Stockpiling and Management

Mined ore will be transported via off-highway haul trucks to the ROM facility, where it will be either direct tipped into the primary gyratory crusher or stockpiled prior to processing.

Trafficked areas around these stockpiles will be watered by water carts on a regular basis.

No dust suppression is required for the ROM ore stockpiles, as they will consist of blasted ore with limited fines. Should dust become evident at these stockpiles, the Project's dust management requirements will be revisited.

During mining, some low grade ore will be stockpiled adjacent to the processing area for feed to the processing plant during the last 10 years of operation. Up to 230 Mt will be stored within a low grade stockpile over the life of the Project. All low grade ore will be processed over the life of mine and the stockpile area rehabilitated.

4.6.2 Crushing

ROM ore with a nominal size of 600 millimetres (mm) is fed to a primary gyratory crusher via haul truck at a maximum rate of 30 Mtpa. Ore is crushed such that 80% of the material has a diameter of 130-170 mm, then fed to a secondary circuit of three cone crushers and screens that reduce the ore to a diameter less than 28 mm to 40 mm. This ore is then transferred to the primary stockpile.

4.6.3 Grinding and Air Classification

Ore is recovered from the primary stockpile via apron feeders and is delivered via conveyors to one of four High Pressure Grinding Roll (HPGR) and air classification circuits via surge bins. Each grinding and air classification circuit contains a single two metre diameter roll and eight vibrating screens capable of grinding 3,000 tonnes per hour to a diameter of less than 150 micron (µm).

Discharge from the HPGR is fed to air classification which operates in closed circuit with the HPGR. The HPGR discharge is separated into three streams, being:

- Greater than three millimetre (mm) particles which are returned to the HPGR feed bins.
- 3 mm to >150 µm particles are directed to the Coarse Cobbing circuit (see below).
- Less than 150 µm particles are further split into oversize (150 µm to 50 µm) and undersize (less than 50 µm) with the oversize reporting to Coarse LIMS, and undersize recovered by baghouse prior to being slurried to 25% weight to water (w/w) and reporting to fine wet LIMS.

4.6.4 Coarse Cobbing

The Coarse Cobbing circuit is fully integrated with the HPGR/air classifier system. The less than 3 mm to 150 µm fraction of the HPGR discharge is separated by the first dynamic stage of the air-classifier and transferred to four lines of six ore bins using a belt feeder. The feeder distributes less than three millimetre ore evenly to each of the bins thereby ensuring consistent feed and particle size distribution to each of the 24 single drum dry magnetic separators. Crushed ore discharges from the ore bins by means of drum feeders and is passed over a single stage dry LIMS drum. The magnetic and non-magnetic fractions discharge by means of chutes with non-magnetic rejects reporting to the dry tailings conveyor and magnetics fraction transported to the HPGR feed bin via a recycle/return conveyor for further size reduction. The

Cobbing Circuit rejects are approximately 20% by mass at a magnetic iron (mFe) loss of approximately 1% of final product.

Reject from the coarse cobbing circuit is transferred by conveyor to a temporary stockpile prior to disposal in the dry process rejects stockpile.

4.6.5 LIMS Magnetic Separation

Output from the HPGR/air classification circuit is slurried with water and fed to one of two wet LIMS circuits. The coarse (between 150 and 50 µm) material is slurried to 35% weight to water and sent to one of four banks of four single drum LIMS units. Concentrate from these units is fed to one of three tertiary (vertical tower) mills, and tailings sent to a tailings thickener prior to disposal in the tailings storage facility.

Fine (less than 50 µm) material from the HPGR/air classifier circuit is slurried to 25% w/w and sent to one of four banks of four triple-drum LIMS units. Concentrate from this circuit reports to the concentrate filtration facility. Tailings from this circuit reports to the tailings thickener for disposal in the tailings storage facility.

4.6.6 Tertiary Grinding

Slurry from the four concentrate slurry tanks is combined into the Tertiary Grinding Distributor before gravitating to the three Vertical Tower Mills. Discharge from the Tower Mills is combined in the Tertiary Cyclone Pump Box and pumped to the Tertiary Classification Cyclones. Additional process water, if required, is added into the pump box for control of solids concentration to the cyclones.

Cyclone underflow (oversize) gravitates to the Tertiary Grinding Mill Distributor and is evenly distributed back to the three tower mills for regrinding; cyclone overflow (fine) particles gravitate to the Tertiary Cyclone Overflow Tanks.

4.6.7 Product Transport

Concentrate from the LIMS circuits is combined in a single thickener, and pumped at a nominal wet solid content of 62% w/w via a buried steel pipeline to a filtration plant located at Port Hedland. This material has a particle size of 34-25 µm and iron content of 68%. On arrival at Port Hedland, the concentrate is subject to pressure filters where it is dewatered to produce a final product concentrate cake at 8% w/w residual moisture.

4.7 Tailings Management

The coarse cobbing and LIMS processes will generate both dry and wet wastes respectively. The dry waste from the coarse cobbing circuit will have an average particle size of 3 mm. This material will either be:

- Transferred to the WRD for co-disposal with overburden with mine waste from the proposed open pit. Co-disposal will be achieved via either radial stacking and dozing, or trucking and blending on the tipping face. Early investigations indicate that the coarse waste may be beneficial for acid-neutralisation and could be placed preferentially for this purpose if required; or
- Placed within a separate waste landform within the Mining Development Envelope.

Over the life of the Project, it is expected that approximately 180 Mt of dry waste will be produced.

The wet LIMS waste will be slurried with particle size 28 µm and moisture content of 35%. This slurry will be transferred to a dedicated TSF (Plate 3). The facility will be located in a wide valley, located to the north of the proposed North Star open pit and WRD (Figure 2).

Tailings will be contained by the valley sidewalls and staged perimeter embankments, to be constructed along the lower, western perimeter of the valley. The embankments for the TSF will comprise cross-valley impoundments, raised in a downstream direction. Construction of the embankments for the TSF will be staged to defer capital expenditure and to utilise suitable waste rock as it becomes available from the mining operations. The TSF will be designed to cope with a 1 in 100, 72 hour rainfall event.

The TSF will occupy a final plan area of approximately 1300 ha. The facility will have a total storage capacity of 419 Mm^3 (540 Mt) of tailings. Tailings within the TSF are expected to reach a maximum design height of 77 m.

Prior to commissioning the process plant, waste rock sourced from the mine pre-stripping operations will be placed to form construction materials required for the starter embankment for the TSF. This starter embankment will accommodate approximately the first two years of tailings generated by the Project. As the tailings beach advances into the valley basin, the level of the tailings adjacent to the embankments will increase. The embankments will be raised progressively in a downstream direction over the life of mine, ahead of the tailings beach level.

Supernatant water from the tailings will be recovered from a decant access ramp located against the northern perimeter of TSF. Water will be decanted from the TSF using pumps mounted on a floating pontoon. Recovered water will be returned to the processing plant for reuse.

Plate 3: Proposed Tailings Storage Facility Location Looking North

4.8 Slurry Pipeline

Magnetite concentrate will be pumped via a buried pipeline to a filtration plant at Port Hedland for dewatering and stockpiling prior to export. The slurry pipeline will be approximately 140 km long and will be constructed from steel pipe, 600 mm in diameter, buried underground.

The pipeline will operate on a continuous 24 hour, 7 days a week schedule; however, occasional maintenance will require the pipeline to be flushed for inspection or repair. Storage locations for pipeline flushing and maintenance will be included in the design.

This PER seeks approval for the component of pipeline between the mine and the Port Hedland Port Authority management area boundary (Figure 1 and Appendix 1). The remainder of the pipeline will be the subject of a separate, future approval application.

4.9 Services and Utilities

The construction of the Project is anticipated to take 18 months. Infrastructure associated with the construction of the FMGIB Hematite Project (Hematite Project) will be utilised where possible. The construction workforce will initially be housed at the Hematite Project camp and the existing exploration camp. Should the Hematite Project not proceed, a fly camp will be constructed in order to house construction personnel ahead of construction of the construction camp.

Pioneering works will include earthworks and roadworks. Partial completion of the pioneering works will allow the following activities to commence:

- Construction of the construction accommodation camp.
- Construction of the mine operations centre and contractors' area.
- Establishment of the heavy mining equipment workshop.
- Mobilisation of heavy mining equipment.

4.9.1 Accommodation Camp

A camp for up to 2000 persons will be constructed for the construction workforce. Further discussion on the Project workforce is provided in Section 4.10.

The camp will be designed and constructed in accordance with Fortescue specifications, relevant Australian Standards, Building Code of Australia, and Shire statutory requirements. The camp will include, but is not limited to:

- Up to 2,000 rooms (scaled back to approximately 800 rooms during operations) with ensuites.
- Dry mess and kitchen.
- Wet mess and outdoor area.
- Gymnasium.
- Recreation room.
- Multi sports court.
- Primary first aid facility (including provision of an ambulance).
- Laundry facilities.
- Camp management office.
- Telephony and Internet room.
- Ice rooms.
- Power station.
- Potable water treatment infrastructure.
- Wastewater treatment infrastructure.

- Communications infrastructure.
- Fire pump set (package diesel, electric and jockey pump, fire water tank and associated fire water pump.
- Car parks and landscaped areas using native species. The landscaped areas will be irrigated with effluent from the wastewater treatment plant.
- Other related infrastructure.

All buildings and structures will be designed for wind loads in accordance with Australian Standard (AS) 1170.2.

4.9.2 Mine Operations Centre

The Mine Operations Centre will serve as the co-ordination centre for mining operations. The Mine Operations Centre will provide office facilities for site-based employees and will consist of transportable buildings.

The mine operations centre will consist of the following facilities:

- Administration Buildings: A number of transportable buildings for offices, communications equipment room, meeting room, reception area and a crib room.
- Stores: The stores will likely comprise several shipping containers.
- Secondary First Aid Facility.
- Ablution Block: Containing male and female ablutions. Sewage from the ablutions will be stored in a purpose built tank and either pump-out by truck for off-site disposal, or connected to the Camp waste water treatment system.
- Parking Facility for Light Vehicles: Will be designed for reverse parking and will contain windrows to check the rear tyres.

Potable water will be reticulated to the Mine Operations Centre office buildings and amenities from the camp treatment plant. Storage tanks will be used to ensure adequate back-up supply in case of service disruption.

4.9.3 Mining Fleet Facilities

The mining fleet will be operated and managed by specialist contractors. These facilities may include:

- Fuel Storage and Refuelling Area.
- Workshop and Washdown Area.
- Parking and Laydown Area.

- Power Supply.

4.9.4 Fuel Storage and Refuelling Area

The mining and haulage fleet will be the largest consumer of diesel fuel on site. To reduce the requirement to move the mining fleet long distances, a fuel storage and refuelling facility will be constructed close to the heavy vehicle maintenance and “go line”, where the fleet is parked during shift change.

Fuel at this facility will be stored in a single large vertical tank with a capacity of approximately 4,000 kilolitres (kL). This volume will allow continuity of fleet operation for 10 days if fuel supply from Port Hedland is interrupted. Fuel storage areas will be fully concrete lined and provided with appropriate bunding and fire suppression systems compliant to relevant legislation and Australian Standards. A lined refuelling pad will be provided adjacent to the fuel storage tank.

Fuel from this facility will be transferred to other lower volume use areas by service trucks.

A contracted fuel supplier will transport diesel fuel to site on a regular basis by tanker road train deliveries.

4.9.5 Workshop and Washdown Area

A workshop and washdown area will be established for the maintenance of mining plant and equipment. The washdown area will be designed to incorporate a collection sump to collect and store runoff that is potentially contaminated with hydrocarbons. Any potentially contaminated water will be treated on site to a level suitable for use as process water, for dust suppression or disposal to local creeks.

4.9.6 Parking and Laydown Area

The parking and laydown area will primarily be used for heavy vehicles and the storage of spares and waste materials to be transported offsite. Designated parking areas will provide a forward facing ‘go-line’ to avoid reversing manoeuvres, and windrows to check vehicle movements while parked. This area will be wetted and rolled to create a trafficable hardstand surface prior to use to minimise dust emissions.

4.9.7 Power Station

Power will be supplied to the mine area via an onsite 120 MW power station located adjacent to the Processing Plant in the Mining Development Envelope. The power station will consist of three gas turbines. The power station will operate on a 24 hour, 7 day a week basis.

All generators will be designed to operate on either diesel or natural gas (dual fuel) to allow for potential supply chain interruptions. It is envisaged that all generators will operate on natural gas except in times of gas supply interruption.

The gas turbines will be operated on an open-cycle basis to reduce initial capital purchase and installation costs, but will be installed with air inlet chillers to improve operating efficiency.

The turbines will feed suitable transformers and switchyard prior to reticulation to operations. This yard will be designed as a single integrated facility containing all generators, administrative and control buildings and service workshops.

Gas Supply

Gas for the power station will be required to be delivered at a rate of 20 terajoules (TJ) per day. This volume of gas can be provided via the existing Dampier-Bunbury Natural Gas Pipeline (DBNGP) and Epic Energy. A gas lateral will need to be built from the existing Epic pipeline to the power station metering and pressure regulation facility. The power station facility includes a diesel storage tank for use in the event that gas is not available.

4.9.8 Ancillary Infrastructure

The construction and operation of the power station will necessitate the construction of associated ancillary infrastructure including:

- Water pipeline.
- Evaporation pond.
- Minor workshop and warehouse.
- Ablution and administration buildings.
- Fencing and firebreaks.
- Telecommunications cables.
- Access roads and car parks.

4.9.9 Wastewater Management

All camp sewage and wastewater will be treated in a wastewater treatment plant. The wastewater treatment plant will consist of an aerobic treatment unit constructed and operated in accordance with Western Australian Department of Health and local government regulations. Treated effluent will be disposed of at a spray irrigated evaporation area and will meet quality standards described in the *Guidelines for the Non-potable Uses of Recycled Water in Western Australia 2011* and any other relevant statutory requirements (Department of Health, 2011).

At an average domestic water consumption of 350 litres/person/day and an operational workforce roster that allows for approximately 600 people on site at any one time, an estimated disposal volume of 210 kL per day is anticipated. This quantity exceeds the threshold for a Category 54 prescribed premises under Schedule 1 of the Environmental Protection Regulations 1987 (maximum rate to be less than 100 kL/day). During construction, a total of 2,000 rooms will be provided at the camp. Should the camp be full, up to 700 kL of domestic wastewater per day is anticipated.

The quantity of wastewater from ablutions at the mine site is expected to be significantly less than the accommodation village. The mine site facilities and administration buildings do not include shower, laundry or kitchen wastewater. Disposal of mine site and administration building ablution wastewater will be by either conventional septic tank and leach drain or alternative systems which dispose wastewater to an irrigation area located within the Mining Development Envelope.

4.9.10 Explosives Magazine

The explosives magazine has been located in a designated area within the Mining Development Envelope, 1 km away from the mine bund wall. The transport, storage and use of explosives will be subcontracted to a licensed service provider. Ammonium nitrate based explosives will be stored separately to detonators, ripcords and any other site-stored explosives. All explosives material and equipment will be stored in a magazine compliant with the *Dangerous Goods Safety Act 2004* (WA) and the *Mines Safety Inspections Act 1994 (WA).*

4.9.11 Water Production Bores and Pipelines

The project water demand is described in Section 4.12.1. Water supply for the Project has been designed to meet the Project's peak water demand of approximately 14 GLpa.

Water supply for the purpose of mine and road construction, mine operations and camp supply will be provided by bores located within the Canning Basin. These bores will be powered by an 8 MW gas fired power station.

Delivery to the mine area will be via buried pipeline approximately 190 km long and 650 mm in diameter, constructed with steel pipe. A section of the pipeline (approximately 14 km) close to the mine may not be buried in its entirety due to ground conditions. Where pipelines are required to be placed on the surface, the pipe will be raised off the ground in order to minimise impacts to surface water flow and fauna movements.

Potable water for camp use will be treated using either a packaged reverse osmosis plant or ultraviolet treatment. Should a reverse osmosis plant be used, FMGIB will investigate disposal options for the small volumes of brine that would be produced, including dilution and reuse for operations or dust suppression water stream.

4.9.12 Waste Management

Wastes produced will be those routinely produced at mining facilities and will include general refuse, medical waste, non-metal scrap (for example containers, pallets, wood, plastic and concrete), office and administrative waste, putrescibles waste, sewage, tyres, batteries and wastewater.

Solid wastes will be segregated prior to disposal within a licensed shire facility or on-site landfill in the Mining Development Envelope. Contracts will be put in place to remove high-value recyclable material from site. Waste storage will be designed to minimise wildlife access, with closed lids on any putrescibles and crib waste collection and storage vessels.

A contaminated soils treatment area will be constructed in the Mining Development Envelope to prevent contamination of soils and water.

4.10 Workforce

The construction workforce of approximately 2,000 persons will consist primarily of contractor employees, supplemented by FMGIB personnel. Due to the remote location of the mine site, all personnel will be fly in / fly out from Port Hedland and transported to and from site by road.

During operations, contractors will be employed for mining, crushing and screening, and product transport. Where possible, local contractors and employees will be used, depending on availability and the skills required. A number of FMGIB staff will also be onsite, primarily in management and technical roles. A permanent workforce of approximately 800 people will be required for mining and processing operations. All personnel (staff and contractors) will be accommodated on site in the Mining Development Envelope.

In addition to the permanent workforce, external providers will be required to supply maintenance and service personnel on an as-needed basis. These additional requirements are outlined in Table 10.

Table 10: Camp Accommodation Requirements During Operations

Category	Number of People
Permanent Workforce (mining and processing operations)	800
Accommodation Camp Contract Staff	20
Short-term Contract Staff (maintenance and service personnel)	40
Visitors	40
Total	**900**

Blasting will mostly be restricted to day shift operations as a safety precaution. Other mining and transport activities including load and haul from the mine pit and process plant operation are expected to operate 24 hours a day, 7 days a week.

4.11 Haulage and Access Roads

4.11.1 Site Access

The distance from Port Hedland to North Star by road is 145 km each way and will comprise the following access roads:

- The North Star access road to Great Northern Highway (38.5 km) which will utilise 1.5 km of the existing Wittenoom Road and existing level crossings at the BHP Billiton Newman rail mainline. An at-grade crossing will be constructed on Fortescue's rail mainline. This road will be nominally 20 m wide with berms, shoulders and drains extending to a total of 30 m, where required.
- Great Northern Highway to Port Hedland (106 km).

The North Star access road will be constructed for access to the Great Northern Highway and will be suitable for Class 1, 2 or 3 traffic. A 20 m wide constructed road will be required to allow for access of heavy haulage trucks and light vehicles. The total disturbance width of the road will be 30 m to allow for road berms, shoulders and drains. The access road basis of drainage design will satisfy a 1-in-5-year ARI rain event.

The North Star mine access and haulage road will be located within Miscellaneous Licences L45/276 and L45/293, issued to FMG Magnetite Pty Ltd, a wholly owned subsidiary of Fortescue Metals Group Ltd.

4.11.2 Access Ramp

An access ramp will be constructed between the mine pit and ROM facility to provide access for load and haul of material from the mine pit to the primary crusher, ROM or low grade stockpile. Design of the access ramp will be in accordance with the relevant Fortescue specifications and Australian Standards.

4.11.3 Miscellaneous Roads and Tracks

A number of mine access roads and tracks will be required to provide access to the various facilities including the camp, explosives magazine and borefields. With the possible exception of the mine access road, all roads and access tracks are planned to be unsealed and constructed with local material.

Roads will be formed by avoiding large trees or significant vegetation where possible, followed by stripping groundcover vegetation and topsoil and stockpiling it in windrows adjacent to the roads or designated stockpile areas. A grader will then form the road and create an additional windrow to protect stockpiled soil from potential disturbance. Passive drainage will be created through construction of each minor access road. Significant drainage requirements (for example culverts) are not anticipated but may be required in low areas subject to inundation or at watercourse crossings.

4.12 Resource Requirements and Regional Infrastructure

4.12.1 Water Usage

Due to the distance of the Project from existing water distribution assets, FMGIB proposes to construct a borefield in the Canning Basin and transport water to the mine via a buried water supply pipeline.

A summary of the Project's water demands during construction and operation is presented in Table 11 and Table 12 below. The average demand during construction is estimated to be approximately 216,000 kL/month. The average demand during operations is estimated to be approximately 1,066,000 kL/month.

Table 11: Mine Area Construction Groundwater Demands

Demand Item	Average Monthly Demand (kL)	Annual Abstraction (kL)	Demand Duration (months)
Earthworks	72,000	864,000	18
Road	72,000	864,000	18
Camp	28,000	336,000	18
Other	44,000	528,000	18
Construction Total	**216,000**	**2,592,000**	**18**

Table 12: Mine Area Operations Groundwater Demand Details

Demand Item	Average Monthly Demand (kL)	Annual Abstraction (kL)	Demand Duration (year)
Dust Suppression Mine	72,000	864,000	45
Dust Suppression Road	72,000	864,000	45
Processing Plant	850,000	10,200,000	45
Washdown/Infrastructure	44,000	528,000	45
Camp	28,000	336,000	45
Operations Total	**1,066,000**	**12,792,000**	**45**

Commercial dust suppression products (for example, Dustmag) will be examined to ascertain their effectiveness at the site in minimising water that is required for haulage route dust suppression.

Water extracted from the production bores in the Canning Basin will be delivered to site via a buried pipeline. The water will be contained in a lined storage dam in the mine area with a capacity of 162,000 kL. This will provide up to four days storage assuming a peak daily demand of up to 40,000 kL/day.

The storage dam is expected to be constructed using mining waste material. The dam will either be landscaped to allow fauna egress or have specific fauna egress points installed.

Water extracted for potable purposes will be piped to the camp where it will be treated to meet the minimum requirements of the Australian Drinking Water Guidelines (NHMRC, 2011). The treated water will be stored in a tank with five days storage capacity for camp demand. Potable water demands for other facilities within the Project area will either be reticulated from the camp or provided through separate treatment facilities and storage tanks at the source of demand.

4.12.2 Energy Usage

As power distribution assets are not located within a reasonable distance of the Project area, FMGIB proposes to construct a 120 MW dual fuel power station adjacent to the processing plant. Power will be reticulation throughout site via overhead 33 kV power lines.

Anticipated power requirements are:

- Process Plant – up to 70 MW.
- Mining Infrastructure – up to 20 MW.
- Camp – (up to 2,000) persons – 20 MW.

Backup generators capable of supplying power during unplanned outages will be installed at the camp, workshops and administration areas.

All electrical installations in the Project area will conform to Fortescue Specifications, Australian Standards, Western Australia Electrical Requirements, and the *Mines Safety and Inspection Act 1995* and associated Regulations.

Fuel Usage and Hydrocarbons

It is estimated that up to 30 million litres per annum (MLpa) of diesel will be required for the Project which includes:

- Mine Load and Haul – up to 23 MLpa.
- Drill and Blast – up to 3 MLpa.
- Support Fleet – up to 2 MLpa.
- Light Vehicle Fleet and Sundry Use – up to 2 MLpa.

Site tank storage will be up to 4.7 ML based on 10 day supply storage. It is expected that several tanks will be located at different geographical locations, primarily:

- 4 ML tank at the mining and workshop area.
- 11 x 55 kL tanks at the administration, camp and light vehicle workshops areas.

These tanks will be fitted with overfill alarms and visual indicators of an internal wall rupture (by dip tube) and protected from vehicle strikes with windrows or bollards. A lined refuelling pad will be provided adjacent to the fuel storage tanks, with at least one of the tanks consisting of an on-board bowser for dispensing fuel to light vehicles and a fast fill for refuelling heavy earth-moving equipment. A contracted fuel supplier will transport diesel fuel to site on a regular basis by tanker road train deliveries.

A range of lubricating oils will also be required. Bulk storage tanks of 20 kL for each oil grade will be required. These will similarly be either self bunded tanks or tanks located in an appropriate bunded compound that is compliant with legislative requirements and Australian Standards. An additional oil tank of 20 kL will be utilised to collect waste oil for offsite disposal.

A licence to store dangerous goods will be submitted to the Department of Mines and Petroleum when exact storage capacities and locations are finalised.

4.12.3 Communications

Communications will be via closed channel Ultra-high frequency (UHF). Telephone and mobile phone will be provided via fibre optic cable from existing Fortescue's fibre optic cable laid alongside the Fortescue rail mainline.

4.13 Project Timing

Subject to statutory approvals, FMGIB proposes to commence construction activities in Quarter (Q) 3, 2013 and commence ore processing in 2015. Table 13 provides an indicative timeline of milestones for the Project.

Table 13: Project Timeline

Project Activity	Timing
Commence construction at North Star	Q1, 2014
Commence ore processing at North Star	Q1, 2016
End of mining at North Star	2058
Complete Mine Closure and rehabilitation	2058-60

Section 5
Stakeholder Consultation

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5. STAKEHOLDER CONSULTATION

Stakeholder consultation on the Project has formed part of an ongoing extensive stakeholder engagement programme for Fortescue projects undergoing environmental approvals. The overarching objectives of the program are:

- To disclose the Project to all interested parties with sufficient detail such that they are able to raise issues and concerns and obtain feedback at the project development stage.
- To establish relationships with key stakeholders that enable ongoing dialogue through implementation and regulation of the Project.

5.1 Stakeholder Engagement Process

Fortescue has undertaken stakeholder engagement in relation to a range of projects since 2011. Key stakeholders were identified through Fortescue's experience in the Pilbara and project managers have collaborated to support each other's stakeholder engagement through joint identification of stakeholders and integrated engagement activities. Fortescue also adopted previous recommendations from State government agencies on stakeholders that should be included in the program. Key stakeholders identified to date are detailed in Table 14.

Table 14: Key Stakeholders for the North Star Project

Government Agencies	Community and Surrounding Land Users	Pastoral and Mining Companies
Department of Sustainability Environment Water Population and Communities (DSEWPaC)	Njamal People (Traditional Owners)	Atlas Iron (Atlas)
Office of the Environmental Protection Authority (OEPA)	Newman Community Consultative Group	BHP Billiton Iron Ore P/L (BHPB)
Department of Environment and Conservation (DEC)	Port Hedland Chamber of Commerce and Industry	Wallareenya Pastoral Station
Department of Mines and Petroleum (DMP)	Care for Hedland	Kangan Pastoral Station
Department of State Development (DSD)	Conservation Council of WA	Wallal Pastoral Station
Department of Water (DoW)	World Wide Fund for Nature	Pardoo Pastoral Station
Department of Health (DoH)	Pilbara Wildlife Carer's Association	Muccan Pastoral Station
Department of Indigenous Affairs (DIA)	Kings Park and Botanic Gardens	Indee Pastoral Station
Department of Transport WA	Wildflower Society	Boodarie Pastoral Station
Main Roads WA	Warrarn People	Coongan Pastoral Station
Shire of East Pilbara		De Grey Pastoral Station
Town of Port Hedland (ToPH)		Strelley Pastoral Station
Pastoral Lands Board		
Port Hedland Port Authority		

In addition to ongoing one-on-one telephone and email liaison, Fortescue employed the following modes of engagement in the development of the Project:

- Face-to-face meetings
- Site visits
- Direct mail
- Group emails
- Teleconferencing
- Telephone contact

Integrated engagement ensured efficient use of stakeholders' available time and resources by avoiding multiple briefings for multiple projects.

5.2 Stakeholder Comments and Proponent Responses

The consultation activities undertaken to date and the issues raised are summarised in Table 15. In addition, Fortescue also engaged in ongoing and ad hoc interactions with stakeholders on a one-to-one basis.

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Table 15: Stakeholder Engagement Activities Undertaken to Date

Date	Location	Stakeholder Group(s)	Consultation Method	Issues Raised	Response to Issues/Concern
12-Jan-11	West Perth	Port Hedland Port Authority	Meeting and brief presentation on North Star	Impact of trucking on Utah Road, possibility of trucking direct to Finucane Island.	Design of Project has taken these issues into account. Shipping and export from a proposed outer harbour are not considered in this PER.
19-Oct-11	Paraburdoo	Shire of Ashburton	Presentation	No issues raised.	No response required.
15-Nov-11	Karratha	Department of Water	Meeting/information session	No issues raised.	No response required.
30-Nov-11	Canberra	DSEWPaC	Presentation	No issues raised.	No response required.
8-Dec-11	Teleconference	DSEWPaC	Teleconference	No issues raised.	No response required.
14-Dec-11	Port Hedland	Town of Port Hedland	Presentation	Trucking of ore. Additional Infrastructure in Port Hedland.	Ore will be slurried to Port Hedland. Shipping and export from a proposed outer harbour are not considered in this PER.
14-Dec-11		DSEWPaC	Teleconference	No issues raised.	No response required.
16-Dec-11	Newman	Shire of East Pilbara	Council Meeting - Presentation	Presentation on North Star project.	No response required.
10 Jan 12	Port Hedland	Main Roads	Meeting	Presentation on North Star project.	No response required.
10 Jan 12	Port Hedland	Port Hedland Port Authority	Meeting	Presentation on North Star Project.	No response required.
11-Jan-12		DSEWPaC	Teleconference	Update on Projects.	No response required.
8-Feb-12		DSEWPaC	Teleconference	Update on Projects.	No response required.
14 - 15 Feb 12	North Star	Regulatory Agencies	Site Visit	Dust management. What flora and fauna studies planned. Community opinion on trucking of ore to Port Hedland. Tailings Management.	Flora and fauna studies have been completed. Dust management strategies will be included within the PER. Consultation with community, local government, Main Roads will occur.
22-Feb-12		DSEWPaC	Teleconference	Update on Projects.	No response required.

Date	Location	Stakeholder Group(s)	Consultation Method	Issues Raised	Response to Issues/Concern
7-Mar-12		DSEWPaC	Teleconference	Update on Projects.	No response required.
14-Mar-12		DSEWPaC	Teleconference	Update on Projects.	No response required.
28-Mar-12		DSEWPaC	Teleconference	Update on Projects.	No response required.
4 April 2012	Port Hedland	Main industrial road users in Port Hedland	Meeting	Impact on Utah point road from projects, including North Star, impact to other users.	No response required.
23-May-12	Canberra	DSEWPaC	Meeting and Presentation	Update on Projects.	No response required.
14 June 2012	De Grey Station	De Grey Station	Meeting	Briefing on Project. De Grey Pastoral Station voiced concern about current pipeline route.	Agreed to revisit the issue with more information.
29 July 2012	Pardoo Station	Pardoo Station	Meeting	Impact of Fortescue's extraction at Canning Basin on Pardoo's extraction plans.	Agreed to a 1m drawdown at Great Northern Highway, Operating Strategy will be sent to the DoW.
24 Aug 12	De Grey Station	De Grey Station	Meeting	Pipeline route and impacts to sensitive areas.	Will support realignment to avoid sensitive area.
24-25 Aug-12	North Star	Njamal People	Meeting and Site Visit.	Native Title Agreement Signing and Site Inspection Njamal requested that follow up site visits occur to allow traditional owners opportunity to identify flora and fauna species of 'cultural significance' to be included where possible in mine planning and closure.	Follow up site visits to occur.
24 September 2012	Pastoral Stations	De Grey, Wallal, Pardoo, Strelley, Muccan, Kangan, Wallareenya, Indee, Boodarie and Coongan Station De Grey Pastoral Station	Letter inviting comment on Project.	No comments.	No response required.

Date	Location	Stakeholder Group(s)	Consultation Method	Issues Raised	Response to Issues/Concern
24 September 2012	Whole Project	Wildflower Society of WA, Port Hedland Chamber of Commerce and Industry, Town of Port Hedland, Care for Hedland, World Wide Fund for Nature, Newman Consultative Community Group, Shire of East Pilbara, Botanic Parks and Gardens Board, Pilbara Wildlife Carer's Association, Conservation Council of WA, Main Roads WA, Port Hedland Port Authority	Letter inviting comment on Project.	Shire of East Pilbara – requested tenement numbers Botanical Gardens and Parks Board – requested copy of the PER.	Copy of PER will be made available.
17 October 2012	De Grey Station	De Grey Station	Meeting	Pipeline alignment and environmental survey of new alignment. Populations of *Callotropis* near De Grey River.	Fortescue will ensure De Grey are informed about any future environmental surveys. Final pipeline alignment will take account of De Grey's concerns. Weed management plan will be enacted.
15 November 2012	Fortescue Office	Njamal Native Title Working Group	Meeting	Greater involvement in environmental survey and mine closure.	Fortescue will engage with Njamal prior to future survey work.
21 November 2012	Whole Project	Care for Hedland, Conservation Council of WA, WWF, Pilbara Wildlife Carers Association, Botanic Gardens and Parks Board, Wildflower Society of WA	Letter inviting groups to presentation on the Project	No issues raised.	No response required
21 November 2012	Whole Project	DMP, DoW, DSD, DEC, EPA	Letter inviting agencies to presentation on the Project	No issues raised.	No response required.
27 November 2012	Fortescue Office	DSEWPAC	Meeting	General queries on species of National Environmental Significance found at the mine.	Northern Quoll, Pilbara Leaf-nosed Bat and Pilbara Olive Python are discussed in this PER.

Date	Location	Stakeholder Group(s)	Consultation Method	Issues Raised	Response to Issues/Concern
3 December 2012	Fortescue Office	DMP, DoW, DSD	Meeting	General queries regarding progress of Waste rock geotechnical studies, AMD studies, mine closure strategies, potential for stygofauna/troglofauna, surface water features, groundwater at mine area, what links to Glacier Valley and the hematite project, TSF design.	Information is provided in this PER. Greater details will be provided in the mining proposal to be submitted to DMP.
7 December 2012	Kings Park	Botanic Gardens and Parks Board	Meeting	Difficulties with spinifex and rehabilitation, recreating soils from 'growth mediums'. Use of Kings Park's expertise in seed management.	A mine closure plan will be developed for the Project, including rehabilitation trials using available growth mediums and local provenance seeds.
5 February 2013	DEC	DEC	Meeting	Impact of the project on *Pityrodia* sp. Marble Bar. Links between Canning Basin and GDE's. Surface water pools.	The impact of the project on *Pityrodia* sp. Marble Bar, potential for interaction between Canning Basin and GDE's and surface water pools are discussed in this PER.
8 February 2013	Newman	Shire of East Pilbara	Meeting	Alternative transport options for ore, impact of water extraction from Canning Basin, potential for water table at North Star.	Alternative transport options are discussed in this PER. The extraction of water from Canning Basin will not impact other users and will be managed in accordance with a DoW approved operating strategy. The mine pit will intersect with some small fractured rock aquifers.

Date	Location	Stakeholder Group(s)	Consultation Method	Issues Raised	Response to Issues/Concern
21 February 2013	Perth	EPA	Meeting	Depth of Pit. Potential for pit lake. Consultation conducted to date. Potential for AMD. Links to Outer Harbour Proposal. Offsets. Extraction of water from Canning Basin.	The PER will provide the results and analysis of studies undertaken to satisfy the EPA’s requirements. The Outer Harbour will be referred to the EPA as a separate proposal.

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5.3 Ongoing Consultation

FMGIB will continue to maintain established communication channels and stakeholder relations throughout the life of the Project. The engagement program established with stakeholders regarding the Project prior to its referral to the EPA will be continued as a normal part of Fortescue business practices. Ongoing consultation includes:

- Meeting with community groups, pastoral station owners, industry groups and non-government organisations.
- Site visits with Traditional Owners (Njamal People). This will be at the request of the Traditional Owners.
- Shopping centre information days at Port Hedland and South Hedland.
- Meetings and information sessions with regulatory agencies including:
  - EPA, DEC, DoW, DMP, DIA, DoH and DSD.
  - Regional offices of DoW and DEC.

Section 6
Physical Environment

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6. PHYSICAL ENVIRONMENTAL SETTING

This section details the physical environment in which the Project is located. The biological setting and the potential impacts posed by the Project are discussed in Section's 7, 8 and 9, whilst the hydrological setting is described in Section 10. Matters of National Environmental Significance are discussed in Section 11.

6.1 Climate

The Pilbara has an arid climate, characterised by hot, humid summers (wet season) and relatively cooler, drier winters (dry season). Rainfall is typically low and highly variable rainfall (both spatially and temporally), and evaporation rates are high.

The Pilbara is also subject to tropical cyclones during the wet season (November to April), with the coastal area between Port Hedland and Exmouth Gulf the most cyclone prone area in Australia (BoM, 2012).

The nearest Bureau of Meteorology (BoM) stations to the mine area are Marble Bar and Redmont (Site No. 004106 and 044043 respectively). For the Canning Basin borefield the closest Bureau station is Pardoo Station (Site No. 004028).

Temperatures are generally high, with average maximum monthly temperatures at Marble Bar ranging between 24.7°C in July to 40.1°C in December. Average maximum monthly temperatures at Redmont are generally one to two degrees cooler than those at Marble Bar. Average maximum monthly temperatures at Pardoo Station (Canning Basin) range from 28°C in July to 36.5°C in November. Average minimum monthly temperatures at Marble Bar range from 11.7°C in July to 26.1°C in January, with temperatures at Redmont roughly similar. Average minimum monthly temperatures at Pardoo Station range between 13°C in July and 25.8°C in January (Graph 1).

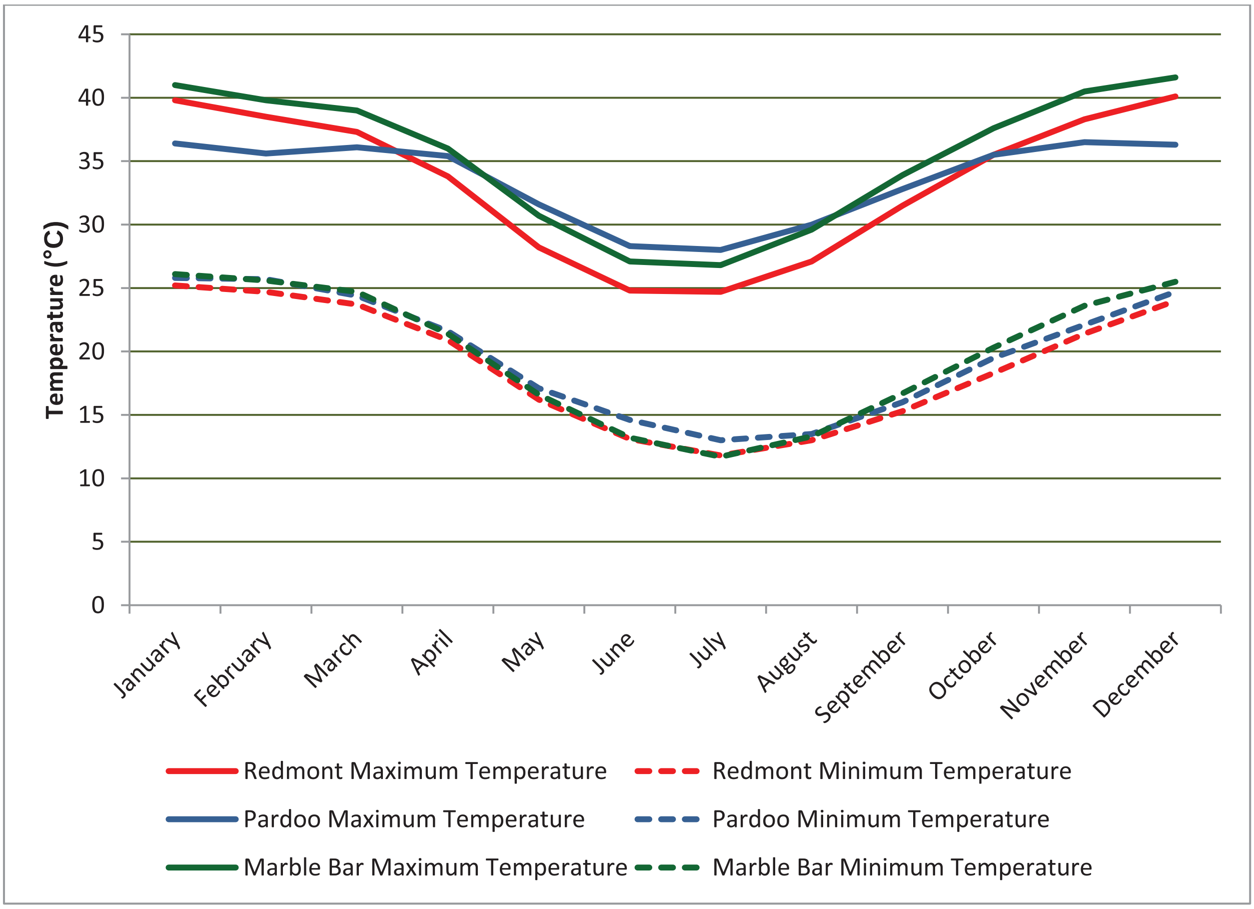
Rainfall events are variable and influenced by tropical cyclones and thunderstorms, which are common in the Pilbara region (approximately 20 to 30 occur per annum, with 15 to 20 storms occurring in coastal regions). Rainfall is generally localised and unpredictable with a bimodal rainfall distribution. From January to March, rains result from tropical storms producing sporadic thunderstorms. From May to June, extensive cold fronts move eastwards across the state occasionally reaching the Pilbara and producing only light rains.

Average annual rainfall for the Project area ranges from 304 mm in the Canning Basin area (Pardoo Site No. 004028) to 362 mm in the mine area (Redmont Site No. 004043) (BoM, 2011). Rainfall is highly variable however, with recorded annual rainfall varying between 18.2 mm and 815.7 mm (BoM, 2011). Both of these extremes were recorded at Pardoo.

The majority of rainfall occurs during January to March with very little rain recorded during September and October (BoM, 2011). Average monthly rainfall at Marble Bar ranges between a low of 0.9 mm in September to a high of 87.8 mm in February while average monthly rainfall at Redmont ranges from a low of 1.1 mm in September to a high of 67.1 mm in January. Average monthly rainfall at Pardoo Station ranges from a low of 0.7 mm in October to a high of 75.6 mm in February (Graph 2).

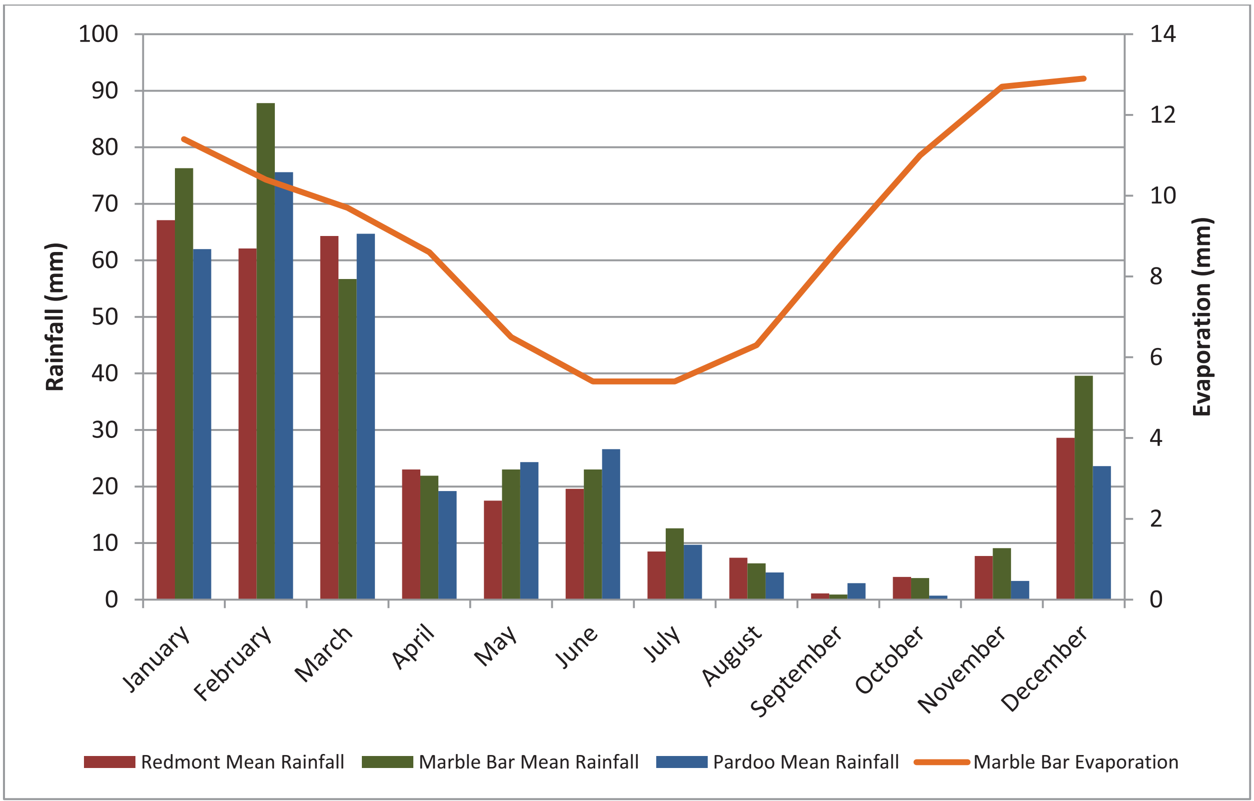
Evaporation greatly exceeds mean annual rainfall. Average pan evaporation rates along the coast are approximately 3,400 mm/year (Haig T. , 2008). Historical mean annual daily evaporation rates for the mine area are available from Marble Bar Comparison Site (Site 004020). This site recorded mean daily evaporation from 1968 until 1988. The site was closed in 2006 and replaced with the current Marble Bar site (004106), which no longer records evaporation rates. The average evaporation rate across the year was 9.1 mm per day (approximately 3,300 mm per year). High evaporation rates may limit rainfall recharge to groundwater, with the exception of high intensity rainfall events (WorleyParsons, 2012b).

Graph 1: Average Monthly Temperatures at Marble Bar and Redmont



Source: (BoM, 2011)

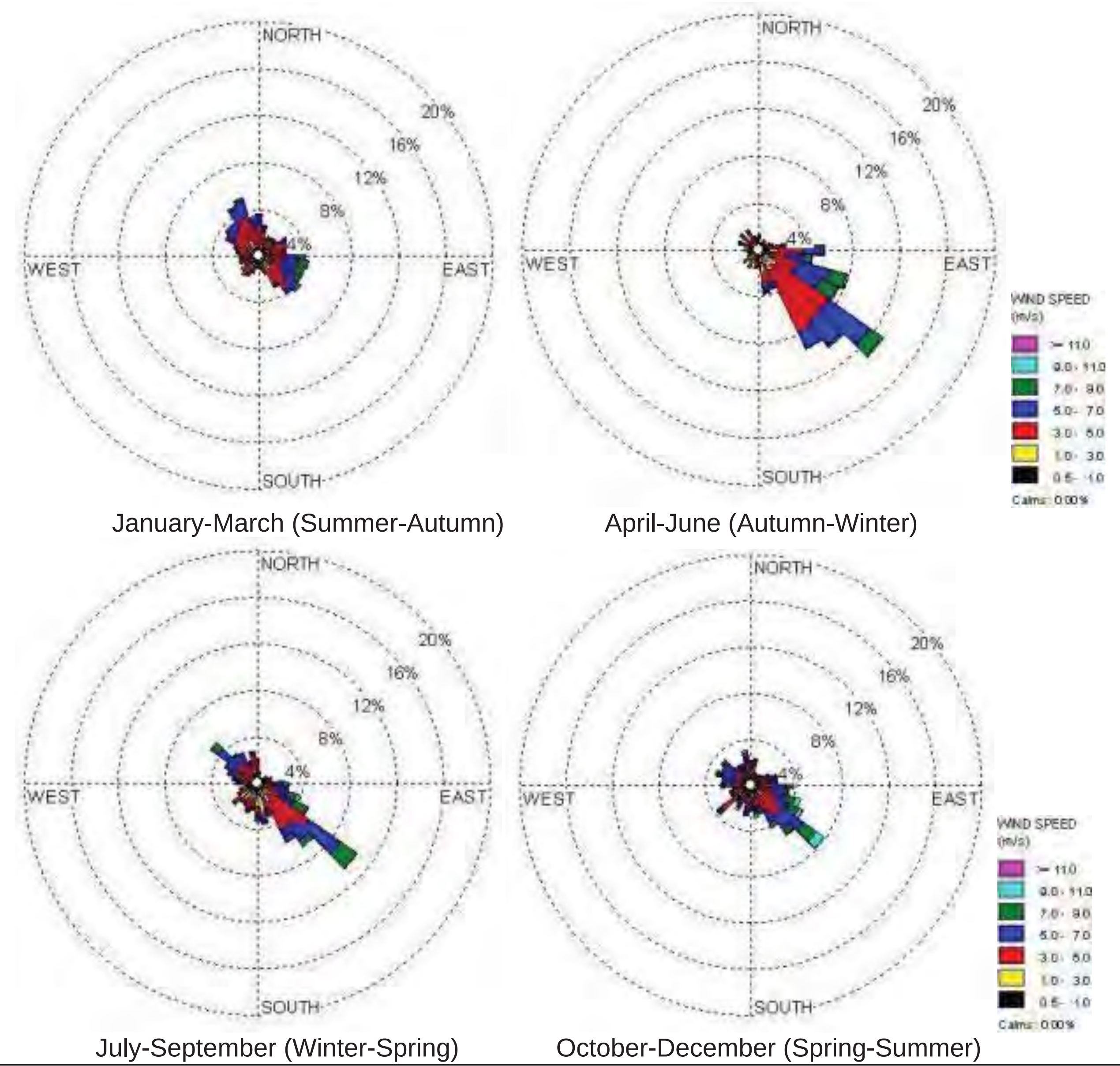
Graph 2: Average Monthly Rainfall and Evaporation for the Project



Source: (BoM, 2011)

Wind directions at Marble Bar are dominated by south-easterly winds between April and December, with varying wind speeds throughout the year (Graph 3).

Graph 3: Representative Local Wind Roses Near the North Star Mine Area (Marble Bar Site No. 004106)



January-March (Summer-Autumn) April-June (Autumn-Winter)

July-September (Winter-Spring) October-December (Spring-Summer)

Source: (BoM, 2011)

6.2 Geology

6.2.1 Regional Geology

The Project is situated within the North Pilbara terrane of the Pilbara Craton which is Archaean in age (2.5-3.5 billion years), and contains volcanic and volcaniclastic rocks of the Pilbara Super Group (greenstone belts) intruded by Archaean age felsic granitoids, to form dome and keel type structures. The area has generally been regionally metamorphosed to greenschist faces, and folded into sub vertical tight to isoclinal folds that have wrapped around granitoid contacts during regional transpressional deformation and now are parallel to the granite contacts. This regional deformation was also accompanied by strike slip and reverse faulting which has dislocated the main formations in the project area. The North Shaw 1:100,000 geological maps cover the project area and the regional geology is largely based on the work of Van Kranendonk (2000).

6.2.2 Local and Project Geology

The geology of the Project area has been described as part of the North Star Magnetite Project feasibility study. The main geological units within the project area are the Kangaroo Caves Formation (Western Shale Sequence), the Pincunah Hill Formation (hosting the magnetite mineralisation), and the Corboy Formation (Eastern Shale Sequence) (Figure 4). The project also includes part of the Paddy Market Formation, which outcrops in the northern part of the project area. These volcano-sedimentary rock units are aged c. 3238-3225 million years (Ma), and are wedged (dome and keel structure) between the Yule Granitoid Complex to the southwest (c. 3470-2927 Ma), and the Strelley Granitoid Complex to the east (c. 3238-3225 Ma).

The Kangaroo Caves Formation belongs to the Sulphur Springs Group, and forms the basal unit in the project area, consisting largely of andesitic to felsic volcanic rocks intruded by dacitic and rhyolitic sills. In the North Star project area, the Kangaroo Caves Formation consists of intercalated dark cherts, shales, minor banded iron formation, and fine grained tuffaceous / volcaniclastic lithologies. It is conformably overlain by the Pincunah Hill Formation. Evidence from field mapping suggests that the contact between the Kangaroo Caves and the Pincunah Hill Formations is a faulted contact through much of the North Star project area.

The Pincunah Hill Formation forms the lowest unit of the Gorge Creek Group and conformably overlies the Kangaroo Caves Formation. It is composed of thinly bedded banded iron formation, and bedded chert layers with minor intercalated ferruginous shale, and fine grained sedimentary and volcaniclastic rocks. This Formation is the host to the magnetite mineralisation at North Star. In general the formation dips at a high angle to the west and small scale folding is common. It consists of three main lithological units as follows:

- Western contact with the Western Shale Sequence. This is a 150 – 250 m wide zone forming the main magnetite orebody.
- Western Banded Ironstone Formation (BIF) which grades into a siltstone / sandstone clastic unit with some conglomerates and forms the footwall.
- Upper BIF which is gradational from the Western BIF and generally occurs outside the resource.

Conformably overlying the Pincunah Hill Formation, and forming the eastern contact, is the Corboy Formation, which is composed of quartzite, lithic sandstones, and pebble conglomerates, with minor volcaniclastic rocks.

In the northern most part of the project area is the Paddy Market Formation which lies conformably over the Corboy Formation, and is comprised of thinly bedded cherts, cherty banded iron formation, and ferruginous shales.

Structural relations indicate that the Kangaroo Caves, Pincunah Hill, and Corboy Formations are in fact overturned in the project area, and all dip steeply (75-85 degrees) to the west.

6.2.3 Asbestos

The geology at North Star does not support the formation of fibrous materials. This is explained below:

- Green and White asbestos are common in altered mafic igneous rocks. These rock types do not occur at North Star, which is characterised by sedimentary and acid/intermediate volcaniclastic rocks, which combined with low grade regional metamorphism, has produced a chert/siderite/stilpnomelane assemblage devoid of amphiboles.
- Blue Asbestos (Crocidolite) occurs where BIF has been metasomatically altered to riebeckite. No riebeckite has been observed during drilling at North Star.
- The chemical composition of riebeckite is almost identical to BIF, with the exception of the addition of approximately 2% Sodium (Na). Na is routinely analysed for all drill samples and assay results have not identified any anomalous areas of Na enrichment.
- Weakly elevated Na in the eastern footwall sequence is coincidental with minor amounts of plagioclase (Ca-Na feldspar) in the rock. This has been verified petrographically.
- Due to the very similar chemistry of riebeckite/crocidolite and BIF, crocidolite is almost always limited to BIF and therefore is very unlikely to occur in the hanging or footwall sequences.
- The overall metamorphic grade as defined by mineral assemblages identified by petrography is lower greenschist facies. The majority of asbestiform minerals are amphiboles which are rare in greenschist facies rocks.

A number of field and laboratory tests have been undertaken on samples from North Star for the presence of fibrous materials. The information below is a summary of all information collected to date.

- Respirable/inspirable dust sampling carried out during early drill programs did not detect any fibrous material.
- Visual logging of RC and Diamond drill holes has not detected any asbestiform material.
- Petrography has not detected any asbestiform material.

- Quantitative XRD on Davis Tube Recovery tailings samples have not detected any asbestiform material.

A composite sample prepared from left over RC drill chips from all North Star drilling programs has been created to undertake ore processing trials (LOM Sample). This sample is representative of the entire North Star orebody. A Scanning Electron Microscope laboratory test of this composite sample material did not find any evidence of fibrous materials within the sample.

Therefore, all available knowledge at North Star indicates there are no fibrous materials present within the orebody and waste material. Should asbestos fibres be encountered at any stage during operations, FMGIB will implement the Fibrous Material Management (Asbestos) HSES Procedure (200CO-00000-PR-SA-0008).

6.2.4 Geochemistry – Waste Rock and Tailings

High Level Geological Review

Geochemical assessment of the lithologies present within the proposed pit was undertaken in 2012. Initial geological interpretation suggested that the oxidised material near the surface of the deposit had a low risk of acidic, metalliferous or saline drainage and a low dispersion risk, the BIF and Footwall material had a low to medium risk of acidic, metalliferous or saline drainage while the Hanging Wall material had a medium to high risk of acidic drainage, medium risk of saline drainage and dispersion and a low to medium risk of metalliferous drainage (GHD, 2012). This high level geological review suggested that potentially acid forming (PAF) materials could be present in the wet tailings, dry rejects and waste rock originating from sub-economic grades of BIF, Hanging Wall and Footwall materials. To determine the actual potential for acidic, metalliferous or saline drainage from these materials, additional test work was conducted.

Waste Rock Assessment

Detailed geochemical testing was undertaken on 1,163 samples, representing the range of waste rock and ore likely to be encountered within the proposed pit (GHD, 2012). The following tests were carried out on these samples:

- Net Acid Generation (NAG).
- NAG liquor analysis.
- Acid Base Characterisation Curve (ABCC).
- X-ray Diffraction (XRD) (to determine mineralogy).
- ICP metals analysis.
- Australian Standard Leaching Protocol (ASLP) leach testing.
- Kinetic NAG.

Full details of the tests conducted and results are provided in the geochemical assessment report by GHD (2012) (Appendix 3). A summary of the findings is provided below.

Results from the NAG test work indicate that the BIF and Hanging Wall may contain PAF material. However, the ABCC test results showed that the BIF materials appeared to have moderate to high net acid consuming properties and consists of alkaline minerals likely to be easily liberated during oxidation. The results of the kinetic NAG testing confirmed these findings with sulphide oxidation reactions in the BIF material proceeding at a slow rate while sulphides in the hanging wall materials oxidised relatively quickly in a exothermic (heat producing) reaction (GHD, 2012).

Results of the metal analysis test work (XRD and ICP analysis) indicated that, relative to global abundance, metal concentrations are low for all materials. In respect to Ecological Investigation Levels (EILs) (DEC, 2010), manganese was elevated for all materials while nickel was elevated within the Footwall and Hanging Wall. Based on these results, the risk of metalliferous drainage was considered to be low (GHD, 2012).

ASLP leach testing confirmed the above findings with concentrations of metals generally very low and leachates generally having a pH greater than seven. A small number of samples were slightly acidic with pH between five and seven and showed elevated metals. These samples generally corresponded to material identified as PAF in NAG testing (GHD, 2012).

In summary, PAF material is likely to be encountered largely within the Hanging Wall. While the BIF does contain small amounts of PAF material, overall this lithology has been identified as net acid consuming (NAC) and any PAF material is likely to be offset by the larger volume of acid consuming materials generated during oxidation of the BIF.

Tailings and Dry Rejects Assessment

Representative samples of wet tailings and dry rejects were analysed for NAG, Net Acid Producing Potential (NAPP), total metals, ASLP leach test, NAG liquor, paste pH, ABCC and XRD. Full details of the tests conducted and results are provided in the geochemical assessment report by GHD (2012) (Appendix 3). A summary of the findings is provided below.

The results of the NAG and NAPP tests indicated that both materials are not acid forming (NAF) and in fact have acid neutralising capacity (ANC). The ABCC tests suggest that available ANC is approximately 30% of total ANC and that this is likely to be due to the presence of carbonate materials, which are not easily released (GHD, 2012). XRD analysis confirmed the presence of carbonates in the samples.

ASLP leach testing indicated these materials are relatively inert and not likely to produce saline or acidic drainages on contact with fresh water. NAG liquor analysis indicated that following complete oxidation, these materials will not release high levels of soluble metals and all metal concentrations were below ANZECC freshwater criteria (GHD, 2012).

Kinetic Testing

Additional kinetic testing is currently underway to determine the long term risk of acidic, metalliferous or saline drainage from lithologies present within the proposed pit. The samples for these column leach tests are representative of all main lithologies of the North Star pit shell, including footwall and hanging wall (hard rock waste units), oxide and BIF. Kinetic tests are also progressing on tailings material and a sample of PAF material combined with tailings to test the potential of co-disposal of these materials as a potential PAF management technique. Approximately six months of kinetic test results are available, however results are still trending. Results of these kinetic tests will be available for future Mining Proposal applications made under the *Mining Act 1978*.

Additional static and kinetic test work will be undertaken on new samples as they become available.

6.3 Topography

The Pilbara landscape is variable and shaped by the structure of the underlying geology with moderately high relief and a number of ranges, river valleys and peneplains (Van Vreeswyk, 2004).

The mine area lies largely within the Gorge Range on an eroded peneplain with remnants forming plateaus, hills and ridges within the landscape (Appendix 4) (GHD, 2011). The ore body is primarily situated beneath the North Star plateau, which is orientated in a north-south direction with a ridge to the northwest (Figure 5). The North Star plateau extends over 10 km and ranges in height from 80 to 120 m above the valley floor (GHD, 2011).

The topography of the Slurry Corridor Development Envelope can be described as gently undulating with a maximum relief of approximately 50 m AHD to 200 m AHD (Figure 6). The water supply pipeline and Canning Basin area is located on terrain that generally rises from the Canning Basin area towards the mine area with topography ranging from 70 m AHD to 300 m AHD (Figure 7).

6.4 Landscape

6.4.1 Biogeography

The Project is located across three bioregions as described by the Interim Biogeographic Regionalisation for Australia (IBRA) (Thackway & Cresswell, 1995), namely the Pilbara, Dampierland and Great Sandy Desert Bioregions (Table 16)

Table 16: IBRA Regions of the Project Area

Envelope	Bioregion	Subregion
Slurry Corridor Development Envelope	Pilbara	Chichester
		Roebourne
Water Corridor Development Envelope	Pilbara	Chichester
	Great Sandy Desert	McLarty
	Dampierland	Pindanland
Mining Development Envelope	Pilbara	Chichester
Infrastructure Corridor Development Envelope	Pilbara	Chichester

The Chichester subregion comprises plains which support a shrub steppe characterised by *Acacia inaequilatera* over *Triodia wiseana* hummock grasslands, while *Eucalyptus leucophloia* tree steppes occur on ranges. This subregion covers an area of approximately 9,044,560 ha (Kendrick & McKenzie, 2001).

The Roebourne subregion comprises coastal and sub-coastal plains which consist of grass savannah of mixed bunch and hummock grasses, and dwarf shrub steppe of *Acacia stellaticeps* or *A. pyrifolia* and *A. inaequilatera*. Uplands are dominated by *Triodia* hummock grasslands. Ephemeral drainage lines support *Eucalyptus victrix* or *Corymbia hamersleyana* woodlands. Samphire, *Sporobolus* and mangal occur on marine alluvial flats and river deltas (Kendrick & Stanley, 2001).

Small sections of the Water Corridor Development Envelope lie within the McLarty and Pindanland biogeographical subregions. McLarty mainly consists of tree steppe comprising open hummock grassland of *Triodia pungens* and *Triodia schinzii* with scattered trees of *Owenia reticulata* and Bloodwoods, and shrubs of *Acacia* spp, *Grevillea wickhamii* and *G. refracta* (ecologia Environment, 2012a). The Pindanland subregion comprises vegetation described primarily as pindan and characterises the coastal, semi-arid north-western margin of the Canning Basin (ecologia Environment, 2012a).

6.4.2 Major Landforms

Mine area

A landform assessment for the mine area was undertaken by GHD (2011). The dominant land units of the mine area and surrounds were identified to be:

- Hills.
- Plateaus.
- Ridges.
- Stony plains.
- Valleys.

- Drainage channels.

The dominant landforms of the mine area are the North Star/Glacier Valley Plateau, which constitutes the North Star orebody, and the West Star Plateau, approximately 500 m west of the North Star Plateau. Both plateaus are orientated north-south.

The North Star/Glacier Valley Plateau extends for approximately 10 km. The proposed open pit will be located along the northern five km of the plateau. The height of the plateau above the valley floor ranges from 80 to 120 m and the top of the plateau ranges in width from 500 to 1,000 m. The western margin is defined by cliffs and steep escarpments of outcropping rock, extending approximately 15 to 30 below the top of the plateau. Below these cliffs and escarpments, slopes tend to be moderate to very steep. The eastern edge of the plateau grades into a series of low hills ranging in height from 40 to 60 m (GHD, 2011).

The West Star plateau is similar in orientation and height to the North Star/Glacier Valley plateau but is much shorter, extending for approximately 3.5 km. The southern end of the West Star plateau is within the Mining Development Envelope. The top of the plateau ranges in width from 200 to 500 m. The West Star plateau does not exhibit the same cliff escarpment of the North Star/Glacier Valley Plateau. Upper slopes are generally very steep with outcropping rock while mid-slopes are concave and lower slopes convex (GHD, 2011).

Slurry Corridor Development Envelope

A Level 2 flora survey of the Fortescue rail line (including the area encompassed by the Slurry Corridor Development Envelope), was undertaken by Biota in 2003 (Biota, 2004a). This survey identified the following landforms:

- Sandplains.
- Stony plains.
- Hills.
- Drainage channels.
- Floodplains.
- Rocky outcrops.
- Granite boulders.
- Granite ridges.
- Quartz ridges.

Water Corridor Development Envelope

Level 1 flora and fauna surveys of the Water Corridor Development Envelope were undertaken by *ecologia* Environment in 2011 (ecologia Environment, 2012g). These surveys identified the following landforms:

- Low granite hills.
- Alluvial plains.
- Hills.
- Sandplains.
- Stony plains.
- Drainage channels.

6.4.3 Land Systems

A total of 16 Land Systems have been identified within the Project envelopes (Table 17 and Figure 8). The largest of these is the Nita land system, comprising 13,248 ha of the Project envelopes. The eastern portion of the water supply pipeline and the Canning Basin borefield will be located within this land system.

All land systems are well represented outside of the Project area, with less than 0.01% of their total Pilbara distribution located within the Project area.

Table 17: Representative Land Systems of the Project

Land System	Description of Land System	Approximate Area of Land System in the Project Area (ha)	Distribution in Pilbara Bioregion (km^2)
Boolaloo	Granite hills, domes and tor fields and sandy plains with shrubby spinifex grasslands	255	1,502
Boolgeeda	Stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands and mulga shrublands.	338	7,748
Callawa	Highly dissected low hills, mesas and gravelly plains of sandstone and conglomerate supporting soft and hard spinifex grasslands.	191	1,003
Capricorn	Hills and ridges of sandstone and dolomite supporting shrubby hard and soft spinifex grasslands.	5,409	5,296
Horseflat	Gilgaied clay plains supporting tussock grasslands and minor grassy snakewood shrublands.	176	1,261
Macroy	Stony plains and occasional tor fields based on granite supporting hard and soft spinifexes.	5,106	13,095
Mallina	Sandy surfaced alluvial planes on soft spinifex (and occasionally hard spinifex) grasslands.	2,141	2,557
Nita	Sandplains supporting shrubby soft spinifex grasslands with occasional trees.	13,248	11,250
Paradise	Alluvial plains supporting soft spinifex grasslands and tussock grasslands.	1,664	1,479

Land System	Description of Land System	Approximate Area of Land System in the Project Area (ha)	Distribution in Pilbara Bioregion (km^2)
Platform	Dissected slopes and raised plains supporting hard spinifex grasslands.	66	1,570
River	Active flood plains and major rivers supporting grassy eucalypt woodlands, tussock grasslands and soft spinifex grasslands.	1,159	4,088
Robe	Low limonite mesas and buttes supporting soft spinifex (and occasionally hard spinifex) grasslands.	148	865
Rocklea	Basalt hills, plateaux, lower slopes and minor stony plains supporting hard spinifex (and occasionally soft spinifex) grasslands.	2,380	22,993
Satirist	Stony plains and low rises supporting hard spinifex grasslands, and gilgai plains supporting tussock grasslands.	257	377
Talga	Hills and ridges of greenstone and chert and stony plains supporting hard and soft spinifex grasslands.	1,380	2,124
Uaroo	Broad sandy plains supporting shrubby hard and soft spinifex grasslands.	6,150	7,681

6.4.4 Soils

Soils in the mine area and surrounds are predominantly red and shallow with stony mantles (Van Vreeswyk, 2004). Topsoils range in depth from 0 to 15 cm, dependant on topography (valley flats and plains having the deepest topsoils). Soils are likely to be moderately to highly permeable due to the relatively high amount of rock in the profile (GHD, 2011). Lower flood plains have cracking and non-cracking clays. Duplex (texture-contrast) soils occur in localised areas.

A soil and landform assessment has been undertaken for the proposed mine area and surrounds in (GHD, 2011) (Appendix 4).This assessment determined that most soils in the mine area are covered with a stony mulch of iron rich material. Topsoil material is usually full of sub-angular to platy coarse fragments which hold limited moisture for plants. Subsoils are usually absent but when present are full of hard, weathered and unweathered rock. Soils have developed *in situ* from this parent material with softer rock types weathering more quickly, leaving harder, more resistant material behind (GHD, 2011).

Soils generally have a pH within the range 5.7 to 7.5, though in some areas soils were strongly alkaline, which may affect plant growth. Soils were generally low in macronutrients and deficient in copper and zinc. Levels of iron, manganese, arsenic, chromium and cobalt are naturally elevated (GHD, 2011).

Contaminated sites have not been recorded within the Project area and there is a low risk of encountering soil or groundwater contamination during construction of the Project given the previous and current land uses.

Soils within the Slurry Corridor and Water Corridor Development Envelopes have not been assessed. There is a risk that acid-sulfate soils may be encountered where pipelines cross waterlogged soils and sediments at major creek and river systems or otherwise low lying parts of the landscape. Fortescue commits to undertaking a risk assessment of the areas to be disturbed by trenching activities to determine where acid-sulfate soils may occur and to undertake tests of soils in these areas to identify where acid-sulfate soils may occur. Should acid sulphate soils be encountered they will be managed to ensure there is no release of harmful acidic leachates.

Section 7
Key Environmental Factor
Vegetation and Flora

Fortescue
The New Force in Iron Ore

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7. VEGETATION AND FLORA

The Project area is located in the Fortescue Botanical District and Canning Botanical District of the Eremaean Botanical Province, and the Dampierland Botanical District of the Northern Botanical Province as described by (Beard, 1990). The dominant Beard vegetation communities of the Project area are (ecologia Environment, 2012a,b):

- Shrub steppe characterised by *Acacia inaequilatera* over *Triodia wiseana* hummock grasslands.
- *Eucalyptus leucophloia* tree steppes.
- Grass savannah of mixed bunch and hummock grasses.
- Dwarf shrub steppe of *Acacia stellaticeps* or *A. pyrifolia* and *A. inaequilatera.*
- Tree steppe, grading to shrub steppe comprising open hummock grassland of *Triodia pungens* and *Triodia schinzii* with scattered trees of *Owenia reticulata* and Bloodwoods, and shrubs of *Acacia* spp, *Grevillea wickhamii* and *G. refracta.*
- *Eucalyptus microtheca* and *Lysiphyllum cunninghamii* tree savannahs over *Chrysopogon/Dichanthium* grassland with scattered forests of river gum and Cajeput along drainage lines.

7.1 Project Surveys

7.1.1 Mine Area

Level 2 flora and vegetation surveys have been undertaken in the proposed mine area over two seasons (ecologia Environment, 2012a). The southern section of the mine area was surveyed in April 2011 and again in August 2011. The northern section of the mine area was surveyed in July 2011 and September 2011. An additional Level 1 survey was undertaken in May 2012 in order to provide complete survey coverage of the mine area, in particular the Infrastructure Corridor Development Envelope.

A targeted regional flora survey for the Priority 1 listed *Pityrodia* sp. Marble Bar was undertaken in the mine area and suitable habitat during April 2012. Targeted surveys for other Priority listed flora species were not undertaken due to their known distribution, the location of populations in relation to proposed infrastructure, the type of disturbance involved (linear pipelines or roads) and the risk posed by the Project to their conservation.

The flora surveys for the mine area have been undertaken in accordance with EPA Position Statement 3 (EPA, 2002a) and EPA Guidance Statement 51 (EPA, 2004a). The reports prepared by *ecologia* Environment are provided in Appendix 7.

7.1.2 Water Corridor Development Envelope

A Level 1 flora and vegetation survey of the Water Corridor Development Envelope was undertaken in October 2011 (ecologia Environment, 2012b). This survey was undertaken in accordance with EPA Position Statement 3 (EPA, 2002a) and EPA Guidance Statement 51 (EPA, 2004a) and is provided in Appendix 7. Fortescue will undertake additional surveys within the Water Corridor Development Envelope when final alignments of the water supply pipeline and borefield are known.

7.1.3 Slurry Corridor Development Envelope

The Slurry Corridor Development Envelope is located within the Special Rail Licence (SRL), alongside the existing Stage A north-south railway. Surveys previously conducted in the vicinity of the SRL are therefore applicable to the Slurry Corridor Development Envelope area. The following surveys have been undertaken, which have informed the synthesis of current ecological knowledge relevant to this proposal:

- Vegetation and Flora Survey undertaken by Biota of the Fortescue Stage A rail corridor (Biota, 2004a).
- Vegetation and flora surveys undertaken by Coffey Environments for additional areas for borrow pits along the Fortescue railway (Coffey Environments, 2007).
- Surveys undertaken by ENV for the proposed BHPBIO's Outer Harbour Development (BHPBIO, 2011).
- Surveys undertaken by Biota for the Port Hedland Port Authority Utah Point Berth Project (Biota, 2007).
- Surveys undertaken by Biota for the Port Hedland Solar Saltfield Expansion Project (Biota, 2006).

7.2 Vegetation

7.2.1 Mine Area

During the 2011 flora and vegetation surveys, a total of 33 vegetation communities were described and mapped within the mine area and surrounds (Table 18 and Figure 14).

The three most widespread vegetation communities in the mine area were:

- *Tw4* (*Triodia* hummock grassland *Triodia wiseana* hummock grassland) – 13% of the total area mapped.

- *AaTw4* (*Triodia* hummock grassland *Acacia acradenia* and *Acacia inaequilatera* sparse mid shrubland over *Triodia wiseana* and *Triodia lanigera* hummock grassland) – 12% of the total area mapped.
- *Tw3* (*Triodia* hummock grassland *Triodia wiseana* and *Triodia basedowii* hummock grassland) – 12% of the total area mapped.

Approximately 57% of the vegetation within the mine area and surrounds was assessed as being in excellent condition, with 26% assessed as being in very good condition (ecologia Environment, 2012a). The remaining areas (17%) were considered to be in good to poor condition due to disturbances attributed to grazing of cattle and feral herbivores, weeds and previous mining activity. The majority of the mine area and surrounds has not been recently burnt, with approximately 55% burnt more than five years ago or undisturbed by fire (ecologia Environment, 2012a).

Table 18: Vegetation Communities of the Mine Area

Vegetation Community	Vegetation Description	Mapped Extent (ha)
AaTb	*Acacia* shrubland *A acradenia, Petalostylis labicheoides* and *Corchorus laniflorus* sparse shrubland, over *Triodia basedowii* sparse hummock grassland	158
AaTw1	*Acacia* sparse shrubland *A acradenia, Grevillea wickhamii* and *A orthocarpa* sparse mid shrubland, over *Triodia wiseana* sparse hummock grassland	77
AaTw2	*Triodia* hummock grassland *Acacia acradenia* open mid shrubland, over *T wiseana* hummock grassland	2,206
AaTw3	*Triodia* hummock grassland *Acacia acradenia, Acacia tumida* and *Grevillea wickhamii* open shrubland, over *T wiseana* hummock grassland	2,770
AaTw4	*Triodia* hummock grassland *Acacia acradenia* and *Acacia inaequilatera* sparse mid shrubland over *Triodia wiseana* and *T lanigera* hummock grassland	4,244
AiTb	*Triodia hummock* grassland *Acacia inaequilatera, Acacia acradenia* and *Grevillea wickhamii* sparse shrubland, over *T basedowii* and *T wiseana* hummock grassland	1,140
AoTb	*Acacia* shrubland *A orthocarpa* and *Indigofera monophylla* open shrubland, over *Triodia basedowii* open hummock grassland	158
AoTw	*Acacia* open shrubland *Acacia orthocarpa* open tall shrubland, over *Triodia wiseana* open hummock grassland	588
Ap	*Acacia* shrubland *A pyrifolia, Gossypium robinsonii* and *Tephrosia rosea* mid *shrubland*	316
ApTp	*Acacia* shrubland *A pyrifolia, A acradenia* and *Tephrosia rosea* mid shrubland, over *Triodia pungens* open hummock grassland	1,011
AsTl	*Triodia* hummock grassland *Acacia stellaticeps* sparse low shrubland, over *T longiceps* hummock grassland	53
At	*Acacia* shrubland *A tumida, Grevillea wickhamii* and *Indigofera monophylla* shrubland	444
AtEm	*Acacia* open shrubland *A tumida*, *A orthocarpa* and *Grevillea wickhamii* open shrubland, over *Eriachne mucronata* isolated tussock grasses	902
AtTw	*Acacia* open shrubland *A tumida* and *Grevillea wickhamii* open tall shrubland, over *Triodia wiseana* open hummock grassland	80

Vegetation Community	Vegetation Description	Mapped Extent (ha)
ChAbTp	*Corymbia* open woodland *C hamersleyana* open low woodland, over *Acacia bivenosa* mid shrubland, over *Triodia pungens* open hummock grassland	42
Cl	*Corchorus* shrubland *C laniflorus, Grevillea wickhamii* and *Solanum phlomoides* sparse shrubland	156
ElApEm	*Acacia* shrubland *Eucalyptus leucophloia* isolated low trees, over *A ptychophylla* and *Grevillea wickhamii* shrubland, over *Eriachne mucronata* isolated tussock grasses	871
ElApTw	*Triodia* hummock grassland *Eucalyptus leucophloia* isolated trees, over *Acacia ptychophylla* sparse shrubland, over *T wiseana* open hummock grassland	582
FpAtCo	*Ficus open* woodland *F platypoda* open woodland, over *Acacia tumida* and *Gossypium robinsonii* sparse tall shrubland, over *Cymbopogon obtectus* and *Eriachne mucronata* sparse tussock grassland	14
GaTw	*Triodia* hummock grassland *Gossypium australe* sparse mid shrubland, over *T wiseana* open hummock grassland	28
GwTe	*Triodia* hummock grassland *Grevillea wickhamii* sparse mid shrubland, over *T epactia* or *T schinzii* open hummock grassland	1,313
GwTp	*Triodia* hummock grassland *Grevillea wickhamii* sparse tall shrubland, over *T pungens* open hummock grassland	211
ImTs	*Triodia hummock* grassland *Indigofera monophylla* isolated low shrubs, over *T schinzii* open hummock grassland	110
Tl	*Triodia* hummock grassland *T lanigera* open hummock grassland	193
Tw1	*Triodia* hummock grassland *T wiseana* and *T schinzii* hummock grassland	195
Tw2	*Triodia* hummock grassland *T wiseana* open hummock grassland	1,964
Tw3	*Triodia* hummock grassland *T wiseana* and *T basedowii* hummock grassland	4,236
Tw4	*Triodia* hummock grassland *T wiseana* hummock grassland	4,549
EvCc	*Eucalyptus* open woodland ± *E victrix* ± *E camaldulensis* open mid woodland, over **Cenchrus ciliaris* tussock grassland	1,355
PfTp	*Pluchea* open shrubland *P ferdinandi-muelleri* open low shrubland, over *Triodia pungens* sparse hummock grassland	163
Tp	*Triodia* open hummock grassland *T pungens* open hummock grassland	1,501
ImTp	*Triodia* open hummock grassland *Indigofera monophylla* and *Solanum phlomoides* sparse shrubland, over *T pungens* and *T basedowii* open hummock grassland	2,557
SpTl	*Triodia* open hummock grassland *Solanum phlomoides* isolated low shrubs, over *T lanigera* open hummock grassland	670
Total		34,857

* Denotes weed species

Vegetation communities mapped in the mine area have been compared to those mapped by Biota (2004a) for the Fortescue rail line, Mattiske (2007) for the Panorama Copper-Zinc Project Sulphur Springs, and ecologia Environment (2011b) for the Brockman Rail corridor.

Multivariate analysis modelling was undertaken of vegetation communities located within 50 km of the mine area (ecologia Environment, 2012a). Analysis results show that a total of 12 vegetation communities mapped by Ecologia (2011a) are comparable to vegetation communities mapped by these other surveys (Table 19), thereby illustrating that these communities are widely represented in the region.

Table 19 Results of Multivariate Analysis of Vegetation Communities

Vegetation Community mapped by (ecologia Environment, 2012a)	Comparable Vegetation Community	Comments
EvCc,	Ac1, Ac2, Ac4, Ac6, Ac7 and Ac8 (Biota, 2004a) Alliances 1 and 2 (Mattiske, 2007) R7 and R8 (ecologia Environment, 2011b)	1355 ha of the mine survey area and 2830 ha of the Biota survey area 1355 ha of the mine survey area and 251 ha of the Brockman Rail Corridor survey area
AaTw[1], AaTw[2] and AaTw[3] AaTw[1] AaTw[3]	Cc12 (Biota, 2004a) Association 10 (Mattiske, 2007) Mattiske Association 11	These units are relatively common in both survey areas
AoTw	Aps3 (Biota, 2004a)	213 ha of the mine survey area and 1364 ha of Biota survey area
ChAbTp	Cc5 (Biota, 2004a) Association 6 (Mattiske, 2007) H2 and H3 (ecologia Environment, 2011b)	42 ha of the mine survey area and 794 ha of the Brockman Rail Corridor survey area.
At	Alliance 4 (Mattiske, 2007) R3 (ecologia Environment, 2011b)	444 ha of the mine survey area and 299 ha of the Brockman Rail Corridor survey area
ElApTw	Association 5 (Mattiske, 2007)	
Tw1, Tw2 and Tw3	Association 13 (Mattiske, 2007)	

Vegetation Community mapped by (ecologia Environment, 2012a)	Comparable Vegetation Community	Comments
ElApEm	H4 (ecologia Environment, 2011b)	891 ha of the mine survey area and 57 ha of the Brockman Rail Corridor survey area.

7.2.2 Water Corridor Development Envelope

Plate 4: Vegetation of the Water Corridor Development Envelope

a) Vegetation community AiTe

b) Vegetation community CzAtTe

Source: ecologia Environment (2012a)

A total of 24 vegetation communities were described and mapped within the Water Corridor Development Envelope survey area during the 2012 flora and fauna surveys (Table 20 and Figure 16). Three mosaic communities were also mapped with a total area of 4,480 ha. These areas represent mixtures of two vegetation communities which are either present in patches too small to be mapped or which could not be differentiated from the aerial photography. Plate 4 shows typical vegetation within the Water Corridor Development Envelope.

The most widespread vegetation community in the Water Corridor Development Envelope was *Acacia* shrubland *Corymbia zygophylla* open woodland over *Acacia tumida* var. *tumida* and *Acacia ancistrocarpa* shrubland over *Triodia epactia* hummock grassland (CzAtTe) which covers approximately 41% of the area surveyed.

Approximately 41% of vegetation within the survey area was assessed as being in excellent condition with 38% assessed as being in very good condition (ecologia Environment, 2012b). The remaining areas (21%) were considered to be in good to poor condition due to disturbances from grazing of cattle, weeds and previous mining activity. Approximately 37% of the survey area has been disturbed due to fire within the five years prior to 2011.

Table 20: Vegetation Communities of the Water Corridor Development Envelope

Vegetation Community	Vegetation Description	Mapped Extent (ha)
AaTb	*Acacia* shrubland *A ancistrocarpa* and *A inaequilatera* tall shrubland over *Triodia basedowii* hummock grassland	1,029
AaTe1	*Acacia* shrubland *A adsurgens*, *A ancistrocarpa* and *Otion simplicifolium* shrubland over *Aristida holathera* var. *holathera* tussock grasses and *Triodia epactia* hummock grasses	13,280
AaTe2	*Acacia* open shrubland *A ancistrocarpa* tall shrubland over *Triodia epactia* hummock grassland	2,495
AcTe	*Acacia* shrubland *A colei* tall shrubland over **Cenchrus ciliaris* tussock grasses and *Triodia epactia* hummock grasses	921
AiTw	*Triodia* hummock grassland *Acacia inaequilatera* tall shrubs over *T wiseana* hummock grassland	458
AgTp	*Triodia* hummock grassland *Acacia glaucocaesia* open tall shrubland over *T pungens* hummock grassland	865
AhTe	*Triodia* hummock grassland *Acacia hilliana* low open shrubland over *T epactia* hummock grassland	405
AiTe	*Triodia* hummock grassland *Acacia inaequilatera* tall shrubs over *T epactia* hummock grassland	882
AsTb	*Triodia* hummock grassland *Acacia stellaticeps* open low shrubland over *T basedowii* hummock grassland	160
AtCc	*Acacia* shrubland *A trachycarpa* shrubland over **Cenchrus ciliaris* tussock grassland	817
AtTp	*Acacia* shrubland A *tumida* var. *pilbarensis* shrubland over *Triodia pungens* hummock grassland	83
BcTe	*Triodia* hummock grassland *Bauhinia cunninghamii* open woodland over *Pluchea tetranthera* shrubs over **Cenchrus ciliaris* tussock grasses and *T epactia* hummock grassland	266
ChAaTe	*Acacia* shrubland *Corymbia hamersleyana* open woodland over *A ancistrocarpa* and *Acacia tumida* var. *Tumida* shrubland over *Triodia epactia hummock grassland*	422
ChAaTp	*Acacia* shrubland *Corymbia hamersleyana* open woodland over *A ancistrocarpa* shrubland over *Triodia pungens* hummock grassland	3,081
ChTe	*Triodia* hummock grassland *Corymbia hamersleyana* open woodland over *T epactia* hummock grassland	1,317
CzAtTe	*Acacia* shrubland *Corymbia zygophylla* open woodland over *A tumida* var. *tumida* and *A ancistrocarpa* shrubland over *Triodia epactia* hummock grassland	26,035
CzTe	*Triodia* hummock grassland *Corymbia zygophylla* open woodland over *T epactia* hummock grassland	320
EcMgCd	*Eucalyptus* open woodland *E camaldulensis* open woodland over *Melaleuca glomerata*, *Atalaya hemiglauca* and *M leucadendra* sparse tall shrubland over *Cyperus vaginatus* sedges and *Cynodon dactylon* grasses	652
Ep	*Eragrostis* tussock grassland *E parviflora* and *Panicum decompositum* tussock grassland	110
EvCc	*Cenchrus* open tussock grassland *Eucalyptus victrix* open woodland over **C ciliaris* open tussock grassland	185

Vegetation Community	Vegetation Description	Mapped Extent (ha)
PtTe	*Triodia hummock grassland Pluchea tetranthera* sparse low shrubland over *T epactia* hummock grassland	2,744
Tl	*Triodia* hummock grassland *T longiceps* and *T epactia* hummock grassland	280
Tp	*Triodia* hummock Grassland *T pungens* hummock grassland	707
VfTe	*Triodia* hummock grassland *Vachellia farnesiana* open shrubland over *T epactia* hummock grassland	511
Total		58,025

* Denotes weed species

On a broad scale, the vegetation of the Water Corridor Development Envelope survey area has been mapped into six vegetation associations (Table 21) (Shepherd, 2002). The most abundant within the Water Corridor Development Envelope are Associations 101 (*Acacia pachycarpa* shrub steppe over soft spinifex hummock grasslands) and 93 (shrub steppe of kanji, *Acacia inaequilatera*, over soft spinifex hummock grasslands), which occupy over 62% and 25% of the area respectively. The Water Corridor Development Envelope covers less than 1% of the known extent of these vegetation associations.

Table 21: Mapped Extent of the Vegetation Communities of the Water Corridor Development Envelope (survey area)

Beard Vegetation Association	Total Area (km^2)	Area mapped in survey of the Water Corridor Development Envelope (km^2)	Percent of the survey (%)	Percent of total Vegetation Association (%)
32	2,454	24.41	3.91	0.99
93	30,462	160.02	25.61	0.53
101	12,250	390.46	62.48	3.19
175	5,264	13.44	2.15	0.26
589	8,096	32.00	5.12	0.40
619	1,192	4.57	0.73	0.38

Source: (Shepherd, 2002)

7.2.3 Slurry Corridor Development Envelope

The Slurry Corridor Development Envelope is located within the area of the Fortescue special rail lease (SRL) which has been previously surveyed by Fortescue as discussed in Section 7.1.3. Whilst these surveys covered a more extensive area than that of the Slurry Corridor Development Envelope, the surveys have been used to identify a total of 36 vegetation communities intersected by Slurry Corridor Development Envelope (Table 22 and Figure 15).

The most widespread vegetation communities in the Slurry Corridor Development Envelope are:

- Apt13 (*Acacia ancistrocarpa* open shrubland to open heath over *Triodia lanigera* hummock grassland) – 22% of the total area mapped.

- Aps7 (*Acacia colei* high shrubland over *Triodia epactia, T. lanigera* mid-dense hummock grassland) – 10% of the total area mapped.
- Apt11 (*Acacia* spp. scattered tall shrubs over *A. stellaticeps* low open shrubland over *Triodia lanigera* hummock grassland) -10% of the total area mapped.

Table 22: Vegetation Communities of the Slurry Corridor Development Envelope

Vegetation Community	Vegetation Description	Mapped Extent (ha)
Ac1	*Eucalyptus camaldulensis, Melaleuca argentea* low woodland to low open woodland	13
Ac11	*Corymbia spp.* Scattered low trees over *Acacia tumida, A. Colei* open scrub over *Triodia epactia* hummock grassland	2
Ac12	*Corymbia hamersleyana* scattered low trees over *Acacia tumida* high shrubland over *Triodia lanigera, T. Epactia* mid-dense hummock grassland	1
Ac15	*Eucalyptus victrix* low open woodland to woodland over *Acacia colei* scattered tall shrubs to high open shrubland over *Triodia epactia* scattered hummock grasses and *Eriachne* spp. Tussock grasses	85
Ac19	*Corymbia hamersleyana* scattered low trees over *Acacia ampliceps, A. Tumida* high shrubland over *Triodia lanigera, T. epactia* mid-dense hummock grassland	16
Ac2	*Eucalyptus camaldulensis* scattered low trees over *Melaleuca argentea* low open forest over *Melaleuca linophylla, Acacia ampliceps* high shrubland	9
Ac21	*Acacia ampliceps* open scrub over *Triodia secunda* hummock grassland	7
Ac22	*Corymbia spp.* low open woodland over *Acacia acradenia, A. ancistrocarpa* open scrub over *Triodia epactia* open hummock grassland and *Chrysopogon fallax*, *Themeda triandra* tussock grassland	12
Ac24	*Acacia acradenia, A. colei* open scrub to high shrubland over *Triodia lanigera* mid-dense hummock grassland	1
Ac30	*Corymbia hamersleyana, C. Candida*low open woodland over *Acacia colei, A. Tumida* scattered tall shrubs over *Triodia epactia* hummock grassland and very open herbland	9
Ac8	*Eucalyptus victrix* scattered low trees over *Acacia trachycarpa* open scrub over *Triodia epactia* mid-dense hummock grassland or **Cenchrus ciliaris* open to closed tussock grassland	2
Ac8/Ac1 mosaic	*Eucalyptus victrix* scattered low trees over *Acacia trachycarpa* open scrub over *Triodia epactia* mid-dense hummock grassland or **Cenchrus ciliaris* open to closed tussock grassland / *Eucalyptus camaldulensis, Melaleuca argentea* low woodland to low open woodland	9
Ah1	*Acacia inaequilatera* scattered tall shrubs over *Triodia wiseana* hummock grassland to mid-dense hummock grassland	107
Ah2/Aps3 mosaic	*Acacia bivenosa, A. ancistrocarpa* open shrubland over *Triodia wiseana, T. lanigera* mid-dense hummock grassland / *Acacia orthocarpa* high open shrubland to high shrubland over *Triodia wiseana* mid-dense hummock grassland	119

Vegetation Community	Vegetation Description	Mapped Extent (ha)
Ah5	*Corymbia hamersleyana* scattered low trees over *Triodia* aff. *Basedowii* mid-dense to closed hummock grassland	16
Ah5a	*Acacia inaequilatera* scattered tall shrubs over *Triodia* aff. *lanigera* mid-dense hummock grassland	9
AiTb	*Triodia hummock* grassland *Acacia inaequilatera, Acacia acradenia* and *Grevillea wickhamii* sparse shrubland, over *Triodia basedowii* and *Triodia wiseana* hummock grassland	23
AoTb	*Acacia* shrubland *Acacia orthocarpa* and *Indigofera monophylla* open shrubland, over *Triodia basedowii* open hummock grassland	12
Aps2	*Acacia orthocarpa* high shrubland to open scrub over *Triodia lanigera* mid-dense hummock grassland	20
Aps6	*Acacia tumida* open shrubland to shrubland over *Triodia schinzii* hummock grassland	60
Aps7	*Acacia colei* high shrubland over *Triodia epactia, T. lanigera* mid-dense hummock grassland	243
Apt1	*Triodia epactia* , *T. secunda* mid-dense hummock grassland	20
Apt10	*Acacia stellaticeps* scattered shrubs to low shrubland over *Triodia epactia* dense hummock grassland	2
Apt11	*Acacia* spp. scattered tall shrubs over *A. stellaticeps* low open shrubland over *Triodia lanigera* hummock grassland	235
Apt12	*Acacia inaequilatera* scattered tall shrubs over *Triodia lanigera* mid-dense hummock grassland	36
Apt13	*Acacia ancistrocarpa* open shrubland to open heath over *Triodia lanigera* hummock grassland	500
Apt13/Ah1 mosaic	*Acacia ancistrocarpa* open shrubland to open heath over *Triodia lanigera* hummock grassland / *Acacia inaequilatera* scattered tall shrubs over *Triodia wiseana* hummock grassland to mid-dense hummock grassland	30
Apt15	*Acacia inaequilatera, A. ancistrocarpa* scattered tall shrubs over *Triodia epactia, T. lanigera* hummock grassland	132
Apt15/Aps7 mosaic	*Acacia inaequilatera, A. ancistrocarpa* scattered tall shrubs over *Triodia epactia, T. lanigera* hummock grassland / *Acacia colei* high shrubland over *Triodia epactia, T. lanigera* mid-dense hummock grassland	4
Apt16	*Acacia colei, A. tumida* high open shrubland over *Triodia epactia* hummock grassland	86
Apt18	*Acacia inaequilatera, A. ancistrocarpa* scattered tall shrubs over *Triodia basedowii* closed hummock grassland	17
Apt3	*Triodia epactia* hummock grassland to mid-dense hummock grassland	37
Apt4	*Triodia longiceps, T. epactia* mid-dense hummock grassland	203
Apt4/Apt1 mosaic	*Triodia longiceps, T. epactia* mid-dense hummock grassland / *Triodia epactia* , *T. secunda* mid-dense hummock grassland	76
Apt5	*Triodia angusta* mid-dense hummock grassland	56

Vegetation Community	Vegetation Description	Mapped Extent (ha)
Ar1/Ar2/Ar3/Ar4 mosaic	*Ficus brachypoda, Flueggea virosa* subsp. *melanthesoides*, *Terminalia canescens, Clerodendrum* spp. Scattered shrubs over *Triodia epactia* hummock grassland and **Cenchrus ciliaris* tussock grassland / *Acacia tumida* high shrubland to open scrub over *Triodia epactia* hummock grassland / *Trigopon loliiformis* dwarf open grassland / *bulbostylis burbidgeae* sedgeland	27
GwTp	*Triodia* hummock grassland *Grevillea wickhamii* sparse tall shrubland, over *Triodia pungens* open hummock grassland	1
ImTp	*Triodia* open hummock grassland *Indigofera monophylla* and *Solanum phlomoides* sparse shrubland, over *Triodia pungens* and *Triodia basedowii* open hummock grassland	23
Tp	*Triodia* open hummock grassland *Triodia pungens* open hummock grassland	64
Total		**2,324**

* Denotes weed species

7.3 Vegetation of Significance

7.3.1 Mine Area

Ecological communities are naturally occurring assemblages of flora and fauna associated with a particular type of habitat. At a national level, Threatened Ecological Communities (TECs) are protected under the EPBC Act, while at a State level, DEC maintains a list of TECs endorsed by the WA Minister for the Environment as well as a list of Priority Ecological Communities (PECs). PECs are possible TECs which have not met the survey criteria or are not adequately defined (DEC, 2007).

The surveys undertaken for the Project did not identify any TECs or PECs within 40 km of the mine area (ecologia Environment, 2012a).

In a local context, vegetation can be considered significant if it is locally uncommon or provides habitats of local significance. Vegetation communities FpAtCo (escarpment springs) and GaTw (basalt Dyke) were the least extensive of all vegetation communities mapped accounting for 0.4% and 0.8% of the mapped area respectively. FpAtCo was restricted to small patches where water cascades over escarpments from areas higher in the landscape. The combination of relatively high levels of moisture and a sheltered site provide conditions rarely found in the region (ecologia Environment, 2012a). GaTw was restricted to a basalt dyke located within the Infrastructure Corridor Development Envelope (Figure 14). These vegetation communities are potentially of local significance, but not of conservation significance, due to their locally restricted extent.

7.3.2 Water Corridor Development Envelope

No TECs or PECs were recorded within 50 km of the Water Corridor Development Envelope (ecologia Environment, 2012b).

The vegetation community Ep (*Eragrostis parviflora* and *Panicum decompositum* tussock grassland) (110 ha mapped) was considered to be of local significance as it is the only community dominated by tussock grasses present within the Water Corridor Development Envelope. The vegetation community AgTp (*Triodia* hummock grassland *Acacia glaucocaesia* open tall shrubland over *Triodia pungens* hummock grassland) (865 ha mapped) whilst not considered of conservation significance, was considered to be of local significance as it is dominated by the Priority 3 species *Acacia glaucocaesia* (ecologia Environment, 2012b).

One vegetation community has been identified as likely to be a groundwater dependent ecosystem *Eucalyptus camaldulensis* open woodland over *Melaleuca glomerata*, *Atalaya hemiglauca* and *Melaleuca leucadendra* sparse tall shrubland over *Cyperus vaginatus* sedges and *Cynodon dactylon* grasses (EcMgCd) (ecologia Environment, 2012b).

Eucalyptus victrix open woodland over *Cenchrus ciliaris* open tussock grassland (EvCc) may potentially be a groundwater dependent ecosystem (ecologia Environment, 2012b). Current knowledge in regards to *E victrix* suggests that this species is likely to be a facultative phreatophyte. It will preferentially draw water from the saturated soil zone above the watertable, but during periods of drought or otherwise limited water regimes, *E. victrix* is capable of drawing water from deeper in the soil profile and potentially from groundwater sources. (Froend, 2009). Global Groundwater (2011) suggests that the roots of *E. victrix* in the Mid-West region are typically shallower than 10 m, but can explore to depths of up to 20 m.

7.3.3 Slurry Corridor Development Envelope

No TEC or PEC have been recorded from within the Slurry Corridor Development Envelope (FMG, 2011a).

The Slurry Corridor Development Envelope is located within the SRL, alongside the existing Stage A North-South railway. Surveys previously conducted in the vicinity of the SRL (Biota, 2004a; Coffey Environments, 2007) identified four vegetation communities of significance (Ac21, Ac30, Apt5 and Ar6), as shown in Table 23.

It must be noted that the vegetation communities of local significance identified in the area from previous surveys comprised only a small portion of the total vegetation within the area. Approximately 48% of the mapped extent of Ac21 and 33% of Ac30 occurs within the SRL area (FMG, 2011a).

Vegetation community Ar6 was recorded during surveys as being locally restricted to quartz outcrops and ridges. However, this vegetation community is considered to be widespread and common within the Pilbara region (FMG, 2011a).

Apt5 is considered significant as it is dominated by an uncommon species, *Triodia angusta*. Although this vegetation community is uncommon, it is by no means rare or restricted to the area (FMG, 2011a). Although vegetation community Ac30 is a restricted and poorly known community, it is not likely to be restricted to the area (FMG, 2011a).

Table 23: Vegetation Communities of Significance in the Slurry Corridor Development Envelope

Vegetation Community	Vegetation Description	Reason for Significance
Ac21	*Acacia ampliceps* open scrub over *Triodia secunda* hummock grassland	This unit is considered to be restricted soak and drainage vegetation of the Abydos Plain. It was recorded from small flowlines south of the Chinnamon Creek and contained an unusual combination of *Acacia ampliceps* over *Triodia secunda*. This unit is likely to be restricted within the area.
Ac30	*Corymbia hamersleyana*, *Corymbia candida* low open woodland over *Acacia colei*, *Acacia tumida* scattered tall shrubs over *Triodia epactia* hummock grassland and very open herbland.	This unit is considered to be restricted soak and drainage vegetation of the Abydos Plain, and was recorded only from a small soak north of the East Turner River in the northern section of the survey corridor. It is considered uncommon as it had an isolated occurrence within the survey area.
Apt5	*Triodia angusta* mid-dense hummock grassland.	Apt5 was recorded from central portions of the Abydos Plain, and was dominated by a species not common within the area, *Triodia angusta*.
Ar6	*Acacia tumida*, *Grevillea wickhamii* scattered shrubs to open shrubland over *Triodia epactia* open hummock grassland to hummock grassland.	This unit occurs on quartz outcrops and ridges, with only a small number occurring south of Port Hedland. These quartz ridges have an extremely limited distribution within the rail corridor and the vegetation is in relatively good condition.

Source (FMG, 2011b)

7.4 Flora

7.4.1 Mine Area

A total of 472 vascular flora taxa were recorded from the mine area and surrounds during the 2011 surveys (ecologia Environment, 2012a). This consisted of 168 genera from 55 families. The most frequently recorded genera were *Acacia* (35 taxa) and *Ptilotus* (15 taxa). The most frequently recorded families were Fabaceae (peas;84 taxa), Poaceae (grasses; 74 taxa) and Malvaceae (hibiscus; 55 taxa).

The families and genera represented are considered typical of vegetation recorded within the Pilbara, with the exception of the relatively high representation of the family Cyperaceae. The unusually high diversity of sedge species such as *Cyperus hesperius* and *C. vaginatus* recorded in the mine area and surrounds in comparison to other areas of the Pilbara is a result of the relative abundance of semi-permanent and permanent water sources. The vegetation communities in which sedges were located were generally considered to be in excellent condition (ecologia Environment, 2012a).

7.4.2 Water Corridor Development Envelope

A total of 282 vascular flora taxa were recorded from the Water Corridor Development Envelope survey area during the 2011 survey (ecologia Environment, 2012b) representing 129 genera from 44 families. The most frequently recorded genera were *Acacia* (29 taxa) and *Eragrostis* (12 taxa). The most frequently recorded families were Fabacae (peas; 60 taxa) and Poaceae (grasses; 52 taxa).

The genera and families represented are considered typical of vegetation recorded within the Pilbara region.

7.4.3 Slurry Corridor Development Envelope

Based on the flora surveys of the SRL, a total of 762 taxa of flora, consisting of 218 genera from 69 families have been identified in the Slurry Corridor Development Envelope (FMG, 2004). The most frequently recorded families were Poaceae (grasses; 121 taxa), Papilionaceae (now Fabacae)(peas; 76 taxa), Malvaceae (hibiscus; 65 taxa) and Mimosaceae (wattles; 63 taxa) (FMG, 2004). The most commonly recorded genera were *Acacia* (61 taxa), *Sida* (29 taxa), *Tephrosia* (21 taxa), and *Cassia* and *Ptilotus* (19 taxa each) (FMG, 2004).

The genera and families represented are considered typical of the Pilbara region.

7.5 Flora of Conservation Significance

7.5.1 Mine Area

Extensive searches for conservation significant flora have been conducted in the mine area and surrounds (ecologia Environment, 2012a,c). No EPBC listed Threatened flora species nor any State listed Declared Rare Flora (Threatened) species have been recorded within the mine area and surrounds.

A search of the DEC Threatened Flora database indicated two Priority listed species may potentially occur within the mine area *Pityrodia* sp. Marble Bar (Priority 1) and *Gymanthera cunninghamii* (Priority 3). During the flora surveys of the mine area and surrounds, a total of eight Priority Flora taxa were recorded, two of which have previously been recorded in the mine area and surrounds (ecologia Environment, 2012a). A description and the location of these Priority Flora species is presented in Table 24 and Figure 14. Two Priority species were recorded within the Mining Development Envelope, *Pityrodia* sp. Marble Bar (Priority 1) (Plate 5) and *Goodenia nuda* (Priority 4), and are discussed below.

Of the eight Priority listed Flora taxa recorded during the flora and vegetation surveys, *Pityrodia* sp. Marble Bar, a Priority 1 taxon, appears to be the most restricted in distribution, with only two collections previously vouchered at the Western Australian Herbarium, representing an estimated 77 individuals. Surveys undertaken by *ecologia* Environment (2012a) for the mine area and surrounds identified a further 523 individuals of this species. These individuals were located both within the areas required for the TSF, Water Corridor and Waste Rock Dump and outside of Project development envelopes (Figure 14).

In addition to these records, surveys of Panorama Station (approximately 10 km east of the mine area) by Mattiske (2007) recorded 257 individuals from 15 locations of "*Pityrodia* sp Panorama". While specimens have yet to be lodged with the herbarium, *ecologia* Environment has confirmed that these records are the same species as *Pityrodia* sp. Marble Bar (ecologia Environment, 2012c).

The recently completed targeted survey for *Pityrodia* sp. Marble Bar has identified 1,521 *Pityrodia* sp. Marble Bar plants in total (including those identified previously in other surveys) (ecologia Environment, 2012c) (Figure 14). Of these, 980 individuals (64.4%) occur outside of the Mining Development Envelope (at 15 locations separated by at least 500 m), and 541 (35.6%) occur within the Mining Development Envelope (at 14 locations) (ecologia Environment, 2012c).

The Priority 4 listed species *Goodenia nuda* (Plate 5) was also recorded from 45 locations within the mine area and surrounds (ecologia Environment, 2012a). At least 28 records of *Goodenia nuda* have also been identified regionally with species abundance common at some of these locations (ecologia Environment, 2012a).

Five species recorded by Ecologia Environment (2012a) represent range extensions of more than 100 km to the taxon's previously known distribution. In some instances these species are likely to represent poorly collected taxa, given the relative paucity of records from the eastern portion of the Chichester sub-region. Table 25 shows the species identified as range extensions.

Plate 5: *Pityrodia* sp. Marble Bar (left) and *Goodenia nuda* (right)

Source: ecologia Environment (2012a)

Table 24: Priority Flora in the Vicinity of the Mine Area and Surrounds

Conservation Status	Species	Description	Number of Individuals recorded by ecologia Environment (2012a)	Located within Development Envelopes (Y/N)	Distribution
P1	*Abutilon pritzelianum*	A shrub ranging from 1 to 1.5 m high with yellow flowers	4	N	Karratha, Port Hedland, Whim Creek, Lake McLeod
P1	*Heliotropium muticum*	An open, spreading shrub with white flowers and very short but stiff, spiny hairs that grows up to 0.3 m tall	17	N	Karratha, Port Hedland
P1	*Pityrodia* sp. Marble Bar	A shrub to 2 m high with silver densely hairy leaves and pink flowers	523 (total of 1,521 recorded by *ecologia* Environment (2012c)	Y	Marble Bar
P2	*Euphorbia clementii*	An erect herb that grows to 0.6 metres (m) in height. This species favours gravely hillsides and stony grounds	21	N	Marble Bar, Port Hedland, Yandeyarra
P3	*Acacia glaucocaesia*	A dense, glabrous shrub or tree that ranges from 1.8 m to 6 m high with yellow flowers	16	N	Karratha, Port Hedland, Roebourne
P3	*Gymnanthera cunninghamii*	An erect multi stemmed shrub (pale tubercules on brown stem) to 1.5 m with pendulous foliage and milky sap and varnished leaves	13	N	Port Hedland, Boodarie Landing

Conservation Status	Species	Description	Number of Individuals recorded by ecologia Environment (2012a)	Located within Development Envelopes (Y/N)	Distribution
P4	*Goodenia nuda*	An erect to ascending herb that grows to 0.5 m high, with yellow flowers in April to August. This species appears to be widespread but uncommon and typically restricted to creeklines	553	Y	Port Hedland, Newman, Onslow
P4	*Ptilotus mollis*	A compact, perennial shrub with soft grey foliage. Up to 50cm in height	20	N	Port Hedland, Tom Price, Paraburdoo, Marble Bar

Table 25: Taxa with a Range Extension Greater Than 100km Located Within the Mine Area and Surrounds

Species	Approximate Extension	Number of Florabase Records
Acacia tumida var. *tumida*	250 km north northwestern extension	197
Isotoma petraea	100 km northern extension	153
Portulaca cyclophylla	100 km northern extension	18
Scaevola browniana subsp. *browniana*	100 km northern extension of southern population	32
Schoenoplectus lateriflorus	100 km northern extension	30

7.5.2 Water Corridor Development Envelope

No EPBC listed Threatened flora species nor any State listed Threatened flora species were recorded within the Water Corridor Development Envelope.

A search of the DEC Threatened Flora database indicates that 33 Priority listed flora taxa have the potential to occur in the Water Corridor Development Envelope (ecologia Environment, 2012b). During the flora survey, four Priority listed Flora taxa were recorded in the Water Corridor Development Envelope (Table 26 and Figure 16).

Two species recorded during the 2012 flora survey, *Sclerolaena densiflora* and *Goodenia scaevolina,* represent possible range extensions to their known distribution. *Sclerolaena densiflora* is the most northerly known record (170 km north of the nearest record); and *Goodenia scaevolina* is the first known record in the Great Sandy Desert bioregion (60 km east north-east from the nearest known record).

Table 26: Priority Flora within the Water Corridor Development Envelope

Conservation Status	Species	Description	Number of individuals recorded by ecologia Environment, (2012b)	Distribution
P1	*Heliotropium muticum*	An open, spreading shrub with white flowers and very short but stiff, spiny hairs that grows up to 0.3 m tall	16	Karratha, Port Hedland
P3	*Acacia glaucocaesia*	*Acacia glaucocaesia* is a dense, glabrous shrub or tree that ranges from 1.8 to 6 m high with yellow flowers.	124	Karratha, Port Headland, Roebourne
P3	*Keraudrenia katatona*	*Keraudrenia katatona* is an erect, compact multi-stemmed shrub to 1m tall with grey leaves and a purple flower.	1,111	Broome, Edgar Range, Wallal Downs, Canning Stock Route
P4	*Goodenia nuda*	An erect to ascending herb that grows to 0.5 m high, with yellow flowers in April to August. This species appears to be widespread but uncommon and typically restricted to creeklines	1	Port Hedland, Newman, Onslow

7.5.3 Slurry Corridor Development Envelope

No EPBC listed Threatened flora species nor any State listed Threatened flora species were recorded within the Slurry Corridor Development Envelope.

Five Priority listed Flora taxa have been previously recorded from the Slurry Corridor Development Envelope by Biota (2004a) (Table 27 and Figure 15).

Table 27: Priority Flora Within the Slurry Corridor Development Envelope

Conservation Status	Species	Description	Number of records by Biota (2004a) and ATA Environmental (2007)	Distribution
P2	*Euphorbia clementii*	An erect herb that grows to 0.6 metres (m) in height. This species favours gravely hillsides and stony grounds	2	Yarrie, Shay Gap, Port Hedland areas
P3	*Gymnanthera cunninghamii*	An erect multi stemmed shrub (pale tubercules on brown stem) to 1.5 m with pendulous foliage and milky sap and	4	Boodarie, 80 Mile Beach, Dampier Archipelago, Burrup Peninsula, Shaw River

Conservation Status	Species	Description	Number of records by Biota (2004a) and ATA Environmental (2007)	Distribution
		varnished leaves.		
P4	*Bulbostylis burbidgeae*	A tufted, erect to spreading annual grass, growing to 0.25 m. It is known to occur on granitic soils of granite outcrops or cliff bases	4	Abydos/Woodstock Reserve, Mount Eger Station, Hillside Station
P4	*Goodenia nuda*	An erect to ascending herb that grows to 0.5 m high, with yellow flowers in April to August. This species appears to be widespread but uncommon and typically restricted to creeklines	5	Port Hedland, Newman, Onslow

7.6 Introduced Flora

7.6.1 Mine Area

No Weeds of National Significance (WONS) or Declared Plants under the *Agriculture and Related Resources Protection Act 1978* (WA) were identified in the proposed mine area (ecologia Environment, 2012a).

Nine introduced flora species were recorded in the mine area (Figure 17). These were **Aerva javanica*, **Bidens bipinnata*, **Cenchrus ciliaris*, **Cucumis melo* subsp. *agrestis*, **Digitaria ciliaris*, **Indigofera blongifolia*, **Malvastrum americanum*, **Portulaca oleracea* and **Sonchus oleraceus* (ecologia Environment, 2012a).

7.6.2 Water Corridor Development Envelope

The 2011 flora survey of the Water Corridor Development Envelope identified one population of **Parkinsonia aculeata*, a WONS and a Declared Plant (Priority 1 for Western Australia and Priority 2 for Shire of East Pilbara). **Calotropis procera*, a Declared Plant, was also identified (Priority 1 for Western Australia and Priority 3 for Shire of East Pilbara) (ecologia Environment, 2012b).

Another eight introduced flora species were also recorded in the Water Corridor Development Envelope during the 2011 flora and vegetation survey (Figure 19). These were **Aerva javanica*, **Argemone ochroleuca*, **Cenchrus ciliaris*, **Chloris barbata*, **Cynodon dactylon*, **Portulaca oleracea*, **Solanum nigrum* and **Vachellia farnesiana*.

7.6.3 Slurry Corridor Development Envelope

No Weeds of National Significance (WONS) or Declared Plants under the *Agriculture and Related Resources Protection Act 1978* (WA) were identified in the Slurry Corridor Development Envelope (Biota, 2004a).

The Slurry Corridor Development Envelope occurs within the SRL and surveys completed for the SRL have identified that ten introduced flora species occur in the area (Biota, 2004a) (Figure 18). The introduced species are: **Cenchrus ciliaris*, **Chloris virgate*, **Setaria verticillata*, **Aerva javanica*, **Stylosanthes hamata*, **Malvastrum americanum*, **Datura leichhardtii*, **Solanum nigrum*, **Citrullus colocynthis* and **Bidens bipinnata*.

7.7 Management Objective

The EPA objective(s) relevant to the assessment and management of terrestrial flora are:

- 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.

7.8 Guidelines, Policies and Frameworks

Guidance on the assessment and management of impacts to terrestrial flora exists at a State and Commonwealth government level as shown in Table 28.

Table 28: State and Commonwealth Guidance for Assessment and Management of Flora

Document	Description
National Strategy for the Conservation of Australia's Biological Diversity	The strategy addresses the conservation of Australia's biological diversity by defining guiding principles.
National Strategy for Ecologically Sustainable Development	Provides broad strategic directions and framework for governments to direct policy and decision-making.
Wildlife Conservation Act 1950 (WA)	The Act provides for taxa of native flora to be protected based on their status.
Environmental Protection Act 1986 (WA) and Environmental Protection (Clearing of Native Vegetation) Regulations 2005	Protects native vegetation and identifies the 10 clearing principles that must be considered by the CEO prior to deciding to grant, or refuse, a permit to clear vegetation.
EPA Position Statement No.2: Environmental Protection of Native Vegetation in Western Australia (EPA, 2000b)	Provides an overview of the EPA position on the clearing of native vegetation in WA.
EPA Position Statement No 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA, 2002a)	Discusses the principles the EPA would apply when assessing proposals that may have an effect on biodiversity values in WA.
EPA Position Statement No 5: Environmental Protection and Ecological Sustainability of the Rangelands in Western Australia (EPA, 2004e)	Provides principles and environmental objectives for the rangelands environment.

Document	Description
EPA Guidance Statement No.51: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia (EPA, 2004a)	Provides guidance on standards and protocols for terrestrial flora and vegetation surveys undertaken for EIA in WA.

7.9 Potential Impacts

Potential impacts to vegetation and flora as a result of development of the North Star Project are discussed below. Key activities that impact on vegetation and flora include the clearing and earthworks associated with construction and operation of the mine and processing plant.

7.9.1 Direct Loss of Vegetation Due to Clearing

Development of the North Star Project will result in the clearing of approximately 5,141 ha of vegetation (Table 29). The majority of the clearing required (1,562.5 ha) affects vegetation communities SpTl, AoTw and AaTw2. These vegetation communities are described in Section 7.2. All three vegetation communities are well represented in the wider region and have been recorded during surveys of nearby areas (ecologia Environment, 2012a).

Some areas of the Slurry Corridor Development Envelope have been previously cleared. The alignment of infrastructure within this Development Envelope will use previously cleared areas where practicable. As the final alignment of infrastructure is not yet known, the totals in Table 30 represent an estimate only. The maximum possible total clearing represent the unlikely scenario where it is not possible to use any previously cleared areas.

While some vegetation communities appear likely to have a large proportion of their current extent cleared, this is an artefact of the extent of mapping undertaken in the area. All vegetation communities are considered to be well represented in the region (ecologia Environment, 2012a), as demonstrated in Section 7. 2, and therefore the actual extent of each vegetation community is likely to be much higher than that mapped during surveys of the Project area. As demonstrated by Table 29, some vegetation communities that occur within the Slurry Pipeline corridor have already been disturbed due to clearing for the construction of Fortescue's rail. However, the clearing resulting from the construction of the slurry pipeline is not significant even when considered in the context of vegetation that is already cleared, compared to the extent of the vegetation communities mapped.

The level of diversity recorded during surveys of the Project area is typical of surveys in the Pilbara during favourable conditions (ecologia Environment, 2012a).The clearing required for the Project will not significantly impact the extent of the vegetation communities to be disturbed.

Clearing of vegetation within the Water Corridor Development Envelope at the borefield area will be minimal and restricted to the power station, access roads, power lines and bores. Should any clearing be required within areas not previously surveyed, then a survey targeting conservation significant vegetation will be completed prior to the commencement of clearing.

Populations of conservation significant vegetation identified during these surveys will be avoided as far as practicable.

Direct disturbance associated with construction of the concentrate slurry pipeline and the water supply pipeline will be restricted to a narrow construction corridor. Once pipeline construction has been completed a maintenance track approximately 4 to 6 m wide will retained, with the remaining areas rehabilitated to the original condition as far as reasonably practicable, although re-growth will need to be maintained to ensure pipelines are not damaged by root growth. Due to the narrow width required for the construction ROW within the Slurry Corridor and Water Corridor Development Envelopes, clearing in these envelopes will not significantly impact the extent of the vegetation communities to be disturbed.

Table 29: Estimate of Vegetation Clearing Required

Vegetation Community	Mapped Extent (ha)	Estimated Area of Clearing Required (ha)	Area Previously Cleared (ha)	Maximum Possible Total Clearing (ha)[1]	% of Mapped Extent Remaining[2]
AaTb	1,187	10	0	10	99%
AaTe1	13,280	204	0	204	98%
AaTe2	2,495	37	0	37	99%
AaTw1	77	30	0	30	61%
AaTw2	**2,206**	**521**	**0**	**521**	**76%**
AaTw3	2,770	319	0	319	88%
AaTw4	4,244	326	3.17	329.17	92%
Ac1	13	1.5	0	1.5	88%
Ac11	2	0.5	0.17	0.67	67%
Ac12	1	0	0.05	0.05	95%
Ac15	85	0	0	0	100%
Ac19	16	0.5	0.76	1.26	92%
Ac2	9	0.5	0.05	0.55	94%
Ac21	7	1	4.28	5.28	25%
Ac22	12	1	2.44	3.44	71%
Ac24	1	0	0	0	100%
Ac30	9	1	0.13	1.13	87%
Ac8	2	0.5	0.07	0.57	72%
Ac8/Ac1 mosaic	9	1	2.13	3.13	65%
AcTe	921	19	0	19	98%
AgTp	865	8	0	8	99%
Ah1	107	14.5	16.48	30.98	71%
Ah2/Aps3 mosaic	119	72	13.04	85.04	29%
Ah5	16	1	0.74	1.74	89%
Ah5a	9	1	0.38	1.38	85%
AhTe	405	5.5	0	5.5	99%
AiTb	1,163	32	2.79	34.79	97%

Vegetation Community	Mapped Extent (ha)	Estimated Area of Clearing Required (ha)	Area Previously Cleared (ha)	Maximum Possible Total Clearing (ha)[1]	% of Mapped Extent Remaining[2]
AiTe	882	26.5	0	26.5	97%
AiTw	458	4	0	4	99%
AoTb	170	1	0.47	1.47	99%
AoTw	**588**	**446.5**	**0**	**446.5**	**24%**
Ap	316	41	0.4	41.4	87%
Aps2	20	5	4.13	9.13	54%
Aps6	60	5	2.69	7.69	87%
Aps7	243	34	29	63	74%
Apt1	20	4	4.37	8.37	58%
Apt10	2	0	0	0	100%
Apt11	235	19.5	19.79	39.29	83%
Apt12	36	4	7.53	11.53	68%
Apt13	500	46	53.41	99.41	80%
Apt13/Ah1 mosaic	30	7.5	15.08	22.58	25%
Apt15	132	22.5	10.4	32.9	75%
Apt15/Aps7 mosaic	4	0.5	0.12	0.62	85%
Apt16	86	9	4.9	13.9	84%
Apt18	17	0.5	0	0.5	97%
Apt3	37	4	1.43	5.43	85%
Apt4	203	35.5	14.19	49.69	76%
Apt4/Apt1 mosaic	76	15	6.95	21.95	71%
Apt5	56	8	7.71	15.71	72%
ApTp	1,011	171	0.47	171.47	83%
Ar1/Ar2/Ar3/Ar4 mosaic	27	4.5	2.02	6.52	76%
AsTb	160	2.5	0	2.5	98%
AsTl	53	12.5	0	12.5	76%
At	44	3.5	0	3.5	92%
AtCc	817	12	0	12	99%
AtEm	902	47	0	47	95%
AtTp	83	1	0	1	99%
AtTw	80	57	0	57	29%
BcTe	266	4	0	4	98%
ChAaTe	422	6	0	6	99%
ChAaTp	3,081	42	0	42	99%
ChAbTp	42	0	0	0	100%
ChTe	1,317	32	0	32	98%
Cl	156	0	0	0	100%
CzAtTe	26,035	335.5	0	335.5	99%

Vegetation Community	Mapped Extent (ha)	Estimated Area of Clearing Required (ha)	Area Previously Cleared (ha)	Maximum Possible Total Clearing (ha)[1]	% of Mapped Extent Remaining[2]
CzTe	320	5	0	5	98%
EcMgCd	652	8	0	8	99%
ElApEm	871	237	0	237	73%
ElApTw	582	3	1.31	4.31	99%
Ep	110	11	0	11	90%
EvCc	1,540	23	0	23	99%
FpAtCo	14	0	0	0	100%
GaTw	28	0	0	0	100%
GwTe	1,313	143	0	143	89%
GwTp	212	2	0.01	2.01	99%
ImTp	2,580	79	1.26	80.26	97%
ImTs	110	5	0	5	95%
PfTp	163	13	0	13	92%
PtTe	2,744	41	0	41	99%
SpTl	**670**	**595**	**0.34**	**595.34**	**11%**
Tl	473	106.5	0	106.5	77%
Tp	2,272	60	6.51	66.51	97%
Tw1	195	52	0.33	52.33	73%
Tw2	1,964	133	0.64	133.64	93%
Tw3	4,236	89.5	0	89.5	98%
Tw4	4,549	436	1.1	437.1	90%
VfTe	511	8.5	0	8.5	98%
Total	**95,206**	**5,141**	**252.56**	**5370.74**	**94%**

[1]Assuming no previously cleared areas are used; [2]Based on maximum possible clearing

7.9.2 Direct Loss of Flora of Conservation Significance

Table 30 demonstrates the potential impact of the project on flora of conservation significance.

Table 30: Priority Flora Species and Range Extensions Impacted by the Disturbance Associated with the Project

Species Recorded	Priority Status	Mine Area	Slurry Corridor Development Envelope	Water Corridor Development Envelope
Abutilon pritzelianum	Priority 1		Possibly Impacted	
Heliotropium muticum	Priority 1		Possibly Impacted	Not Impacted
Pityrodia sp. Marble Bar	Priority 1	Impacted		Possibly Impacted
Euphorbia clementii	Priority 2	Not Impacted		
Acacia glaucocaesia	Priority 3	Impacted		

Species Recorded	Priority Status	Mine Area	Slurry Corridor Development Envelope	Water Corridor Development Envelope
Gymnanthera cunninghamii	Priority 3		Possibly Impacted	
Keraudrenia katatona	Priority 3			Not Impacted
Bulbostylis burbidgeae	Priority 4		Possibly Impacted	Not Impacted
Goodenia nuda	Priority 4	Not Impacted		Possibly Impacted
Ptilotus mollis	Priority 4	Not Impacted		
Acacia tumida var. *tumida*	Range Extension	Impacted		
Eriachne melicacea	Range Extension	Not Impacted		
Goodenia scaevolina	Range Extension			Not Impacted
Isotoma petraea	Range Extension	Not Impacted		
Portulaca cyclophylla	Range Extension	Not Impacted		
Scaevola browniana subsp. *browniana*	Range Extension	Not Impacted		
Schoenoplectus laterifiorus	Range Extension	Not Impacted		
Sclerolaena densiflora	Range Extension			Not Impacted

While Table 30 identifies that a number of Priority Flora species within the Slurry Corridor and Water Corridor Development Envelope will be impacted, this is based on a worst case scenario. Final alignments for infrastructure within these envelopes will avoid Priority Flora where practicable, therefore reducing the risk of impacts to Priority flora in these envelopes.

Clearing of areas within the Water Corridor Development Envelope at the borefield area will be minimal and restricted to the power station, access roads, power lines and bores. Should any clearing be required within areas not previously surveyed, then a survey targeting conservation significant flora will be completed prior to the commencement of clearing. Populations of conservation significant flora identified during these surveys will be avoided as far as practicable.

During the 2011 flora survey, 523 individuals of the Priority 1 species *Pityrodia* sp Marble Bar were recorded from 75 locations in the mine area and surrounds. An additional regional survey targeting *Pityrodia* sp. Marble Bar was undertaken by *ecologia* Environment in April 2012 and identified a further 998 individuals (ecologia Environment, 2012c). This brings the total number of known records for this species to 1,521 individuals. Of these, 158 (10%) are located in areas to be cleared. This species is relatively abundant where present, suggesting the current lack of records is due to a lack of survey effort in the local region.

Pityrodia sp. Marble Bar appears to be strongly associated with the Capricorn Land System (ecologia Environment, 2012c). As a result, the spatial extent of this Land System can be used as an analogue for *Pityrodia* sp. Marble Bar habitat. The Capricorn Land System covers approximately 529,600 ha of the Pilbara bioregion, of which 2,686 ha (0.51%) will be disturbed for the Project.

The regional impact on this species will be minor, as only a small portion of the Capricorn Land System (potential habitat) will be disturbed and 90% of known records are located outside of development envelopes and will not be impacted by the Project. Further survey effort in the area, either by FMGIB or other parties, is likely to locate additional individuals and populations thereby reducing the significance of impacts resulting from the Project. Many areas of suitable habitat for this species remain unsurveyed, due to its inaccessibility.

A total of 81 individuals of the Priority 1 species *Abutilon pritzelianum* have been recorded from 16 locations in the Port Hedland area (ENV Australia, 2011). A further four individuals from four locations have been recorded from the mine area and surrounds (ecologia Environment, 2012a). Surveys of Atlas Iron's Boodarie Link Project have identified a further 2,209 individuals from 438 locations (Woodman Environmental Consulting, 2012). This brings the total number of individuals known in the vicinity of the Project area to 2,294.

One individual may be directly impacted through construction of the slurry pipeline. Based on this, there will be no significant impact to the species as a result of the Project.

Surveys of the Project area and surrounds by ecologia Environment (2012a; 2012e) in 2011 and 2012 recorded the Priority 1 species *Heliotropium muticum* from 13 locations. Estimates of exact number were difficult to make with only one individual positively identified at some locations. During a survey of the Port Hedland area for BHP Billiton Iron Ore, ENV Australia (2011) recorded 1,290 individuals of this species from 142 locations and a further 2,588 locations representing 5,831 individuals were recorded by Woodman Environmental Consulting (2012).

One location of *H. muticum* may be directly impacted by construction of infrastructure within the Slurry Corridor Development Envelope, this represents less than 1% of the known locations from the project area and surrounds. Based on this, there will be no significant impact to this species from the Project.

During the 2011 flora survey (ecologia Environment, 2012a), 16 individuals of the Priority 3 species *Acacia glaucocaesia* were recorded from six locations. These were mostly to the east of the mine area. A further 39 records are known from the Pilbara and Dampierland bioregions, the closest of which is located near the Shaw River, 35 km north east of the mine area (DEC, 2012). *Acacia glaucocaesia* inhabits red loam, sandy loam and clay soils and is generally associated with floodplains (ecologia Environment, 2012a).

One individual was recorded from the Mining Development Envelope and is likely to be impacted by the Project. Given that only 1 individual will be cleared due to construction of the Project together with the general lack of preferred habitat for this species (floodplain environments on red loam, sandy loam and clay soil) in the Project area, the impact to the species as a whole is not significant.

A total of 12 records of the Priority 4 species *Bulbostylis burbidgeae* were recorded from the Fortescue rail corridor by Biota (2004a). It was noted that this species forms dense stands comprising of hundreds of individuals and was usually found in sheltered habitats at the base of granite rockpiles. Construction of infrastructure within the Slurry Corridor Development Envelope may result in the clearing of two of these locations, though the final alignment of infrastructure within the Slurry Corridor Development Envelope will avoid Priority Flora species and the Granite Rockpiles habitat as far as practicable. A further 84 locations of this species have been recorded by Woodman Environmental Consulting (2012), bringing the total of known locations in the region to 96. Clearing of 2 locations will not significantly impact this species as a whole.

A total of 553 individuals of the Priority 4 species *Goodenia nuda* were recorded from the mine area and surrounds (ecologia Environment, 2012a). While none of these individuals were directly located in areas to be cleared, two populations of approximately 100 plants each were located in the Infrastructure Corridor Development Envelope, adjacent to the mine access road alignment. The final road alignment will avoid these populations as far as reasonably practicable.

At least 28 locations of *Goodenia nuda* have been identified regionally with the species relatively abundant at some of these locations (ecologia Environment, 2012a). Records indicate that *Goodenia nuda* has a distribution in the Pilbara covering approximately 175,000 km^2 (BHPBIO, 2011). Based on this, no significant impact to this species as a result of the Project is expected.

7.9.3 Direct Loss of Vegetation Outside of the Project Area

In the absence of appropriate controls and procedures, direct loss of vegetation outside of the Project development envelopes may occur as a result of:

- Hot work activities or vehicle exhausts causing fire.
- Over clearing or accidental clearing outside of defined areas to be cleared. Fortescue's internal Ground Disturbing Permit procedure will minimise the risk of this occurring.

7.9.4 Degradation of Vegetation

Degradation of vegetation may occur as a result of:

- Poor management of waste rock and tailings resulting in acid, metalliferous or saline drainage. This may lead to the degradation of vegetation through soil, surface water or groundwater contamination.
- Leaks from containment structures, pipes, vehicles or equipment leading to contamination of soils, surface water or groundwater.

- Spills of chemicals or hydrocarbons leading to contamination of soils, surface water or groundwater.
- Uncontrolled vehicle access leading to physical damage of vegetation and/or the introduction or spread of weeds.
- Creek crossed by roads leading to disruption of surface hydrology and causing drainage shadow effects or localised flooding if not designed to allow for continuation of surface water flow.
- Dust deposition on vegetation resulting from land clearing, blasting and excavation, construction activities, and operation of the processing plant.
- Inappropriate disposal of domestic waste, waste hydrocarbons and chemicals, construction waste or treated sewerage leading to contamination of soils, surface water or groundwater.
- Changes fire regimes and/or increased frequency of fires may alter the structure of the vegetation.
- Reduction in surface water flows to creeklines due to location of project infrastructure.

In relation to the project, dust deposition, changed fire regimes and changed surface water flows have the highest potential to cause degradation to vegetation communities. As the vegetation communities in the Project area are well represented in the region, vegetation degradation resulting from the above mentioned sources will not significantly impact the regional extent or status of these vegetation communities.

7.9.5 Effects of Climate Change

Fortescue has adapted a high impact climate change scenario for use during assessment and design of its projects (Adaptive Futures, 2011). This impact scenario also adopted by FMGIB, is shown in Table 31. The scenario adopted aligns with predictions by CSIRO and the Intergovernmental Panel on Climate Change.

This scenario predicts an increase of 10% in the intensity, frequency and duration of rainfall events by the year 2030. This is likely to result in an increase in the incidence of localised flooding and the velocity of surface water flows during these events.

Table 31: Adopted High Impact Scenarios for 2030

Variable	Coastal (Port Hedland)	Inland (Mines and Rail)
Mean sea level	+10 cm	NA
Mean sea level with variability	+6 cm	NA
Cyclone intensity	+10%	+10%
Storm surge	+10 cm on design level	NA
Temperature	+1.5°C	+2.0°C
Rainfall intensity (ARI ≥ 20yr)	+7.5%	+10%

Variable	Coastal (Port Hedland)	Inland (Mines and Rail)
Relative humidity	0	0
Potential evapotranspiration	+8%	+8%
Solar radiation	+2%	+2%
Mean wind speed	+5%	+5%

The Pilbara region is predicted to experience an increase in rainfall due to climate change. This may lead to improved conditions for introduction, establishment and spread of weed species. In particular, it has been noted that the environments suitable for buffel grass are likely to increase (Dunlop, et al., 2012) resulting in a spread of the weed into new areas. The additional fuel load created by the presence of introduced grass species may lead to an increase in the frequency of fires.

While the frequency of extreme rainfall events is predicted to increase, the length of dry periods between rainfall events is also expected to increase. This combined with increased temperatures and evapotranspiration rates may result in increased stress for some flora species, particularly those which rely on surface water flows. In particular, these stresses may result in a change in vegetation structure from tree steppe towards grasslands (Dunlop, et al., 2012). Increased temperatures and longer dry spells may also make revegetation of disturbed areas more challenging.

7.10 Proposed Management

The main potential impacts associated with vegetation and flora relate to clearing and earthworks required for construction and operation of the mine and associated landforms and infrastructure. In order to minimise these impacts, the following management measures are proposed:

- Project infrastructure has been located away from known areas of conservation significant flora and/or vegetation as far as practicable.
- Ground Disturbance Permits (GDPs) will be required prior to commencement of clearing activities.
- Clearing and disturbance within the Special Rail Licence (LSA1) will be undertaken in compliance with the *Rail Corridor Disturbance Management Plan* (R-PL-EN-0012) and *Rail Route (Stage B) Environmental Management Plan* (R-PL-EN-0010.
- Infrastructure has been located outside of watercourses as far as practicable. Diversions will be put in place as required.
- Information in relation the environment of the Project area, including vegetation and flora of conservation significance, will be included in the induction programme for the Project. The induction programme will include information in relation to roles and responsibilities. All staff and contractors will be required to undertake the induction programme. Visitors will be escorted while on site.

- Vehicles will be confined to defined roads and access tracks.
- An AMD Management Plan will be implemented. The objective of this plan will be to manage waste rock such that the WRD is a stable, non-polluting landform.
- Perimeter drains will be constructed around TSF to manage seepage.
- Water trucks will be used for dust suppression on haul roads, access tracks, the pit floor and high traffic areas.
- The use of surfactants to increase dust suppression capability of applied water will be investigated. This investigation will take into consideration the potential adverse consequences that may result from the use of surfactants, such as coating of leaf surfaces and toxic effects on frogs, as well as benefits such as reduced dust emissions and more efficient use of water resources.
- Progressive rehabilitation of disturbed areas will be undertaken during the life of the Project and an approved mine closure plan implemented post-closure.
- Pipeline corridors will be reinstated and rehabilitated once construction activities are complete, with the exception of an access track for maintenance activities. The long term aim of rehabilitation will be to return disturbed areas to a condition similar to adjacent, undisturbed areas.
- Undertake additional flora and vegetation surveys of final water supply pipeline route and water bore locations.

7.11 Predicted Environmental Outcome

The proposed management measures will further reduce potential impacts to flora and vegetation. The Project will result in the permanent loss of 5141 ha of native vegetation. However, progressive rehabilitation during mining and post-closure will attempt to restore functioning ecosystems in disturbed areas.

No clearing is required in vegetation communities FpAtCo (escarpment springs) and GaTw (Basalt Dyke). Clearing of locally significant vegetation communities in the Slurry Corridor and Water Corridor Development Envelope will be avoided where practicable. Where avoidance is not possible, the amount of clearing required will be minimised through implementation of Fortescue's Ground Disturbance Permit procedure. Rehabilitation of the areas disturbed following completion of construction activities will minimise the impact of clearing on these vegetation communities.

Clearing of *Goodenia nuda* is unlikely to reduce the local and regional representation of this species as there is high species abundance in recorded locations throughout the Pilbara region. Should the alignment of the mine access road require clearing of a small number of individuals, the impact of this on the species as a whole will be negligible, given its wide distribution across the Pilbara.

Clearing of *Pityrodia* sp. Marble Bar will slightly reduce the regional representation of this species with 10% of the known number of individuals located in areas to be cleared. However, as 90% of the known records will not be disturbed and are located more than 1.5 km from the boundary of development envelopes, the long term impact on this species as a whole is expected to be minor. Further survey effort in the region, associated with ongoing mineral exploration activities by Fortescue and others, is likely to locate additional populations of this species, thereby further reducing the significance of any impacts. Many areas of suitable habitat for *P*. sp. Marble Bar are inaccessible and have not yet been surveyed.

There are no groundwater dependant ecosystems (GDE's) within the potential drawdown cone of the Canning Basin borefield. Construction of the slurry, natural gas and water supply pipelines will not result in long-term drawdown of the watertable in areas where GDE's are located. No impacts to GDE's are anticipated as a result of implementation of the Project.

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Section 8
Key Environmental Factor
Terrestrial Fauna

Fortescue
The New Force in Iron Ore

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8. TERRESTRIAL FAUNA AND HABITAT

The vertebrate fauna of the Pilbara region is typified by arid adapted vertebrates with generally extensive regional distributions, diverse with elements including northern, tropical taxa as well as southern representatives, arid and semi-arid taxa and a range of endemic species (Doughty et. al., 2011). The Pilbara is home to one of the most diverse reptile assemblages in the world, many of which are endemic. These endemic species are associated with rock habitats and generally do not extend into the sandy deserts bordering the Pilbara (Doughty et. al., 2011). A study of the ecological values of the Abydos-Woodstock Reserve was undertaken by the Western Australian Museum between March 1988 and November 1990 (Berry, 1991). This study identified a total of 72 reptile species including five amphibians, 15 snakes, one turtle and 52 lizards (How, Dell, & Cooper, 1991).

A total of 18 small ground dwelling mammals are known to occur in the Pilbara. Surveys undertaken during the Pilbara biological survey recorded all 18 species, indicating that this fauna is relatively intact (Gibson & McKenzie, 2009) despite a number of processes (such as mining, pastoralism and changed fire regimes) which have been transforming both the economy and the landscape of the region. The Western Australian Museum study of the Abydos-Woodstock Reserve recorded a total of 25 native mammals. This included 14 species of ground dwelling mammals (How, Dell, & Cooper, 1991).

A total of 143 terrestrial bird species have been recorded from the Pilbara bioregion (Burbidge et al (2010). A total of 104 bird species are known from the Abydos-Woodstock Reserve with 92 of these recorded during the Western Australian Museum study (How, Dell, & Cooper, 1991).

Within the Project area, major fauna habitat types correspond to the major landform and vegetation communities.

8.1 Project Surveys

8.1.1 Mine Area

A Level 2 vertebrate fauna survey of the mine area was undertaken by *ecologia* Environment in March/April and October/November 2011. The survey was conducted in accordance with EPA Position Statement No 3 (EPA, 2002a), EPA Guidance Statement 56 (EPA, 2004b) and the Technical Guide - Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (EPA and DEC, 2010).

Subsequent to the Level 2 survey, a targeted conservation significant fauna survey of the mine area was undertaken by *ecologia* Environment in June 2011, specifically targeting the Northern Quoll, the Pilbara Leaf-nosed Bat and the Pilbara Olive Python. This survey was conducted in accordance with the referral guidelines for Northern Quoll (DSEWPaC, 2012a), and the survey guidelines for Australia's threatened reptiles (DSEWPaC, 2011d) and threatened mammals (DSEWPaC, 2011e).

In 2013, FMGIB commissioned a study to determine the potential impacts of blasting on the occupancy and structure of Pilbara Leaf-nosed Bat caves in the Project area and their ability to support bats post-mining. The study would provide recommendations to mitigate the impact of mining activities, particularly vibrations from blasting on the Pilbara Leaf-nosed Bat.

This study would be undertaken in two phases:

- Phase 1: Re-visit the Project area to determine the location of roost caves within the Project area.
- Phase 2: Study vibrations from an active mining area to determine impacts of blasting on the occupancy and structure of suitable roost caves in the Project area.

Upon completion of the study, FMGIB would be in a position to propose management measures to protect cave integrity, including the frequency and timing of blasts. Phase 1 was undertaken in April 2013 and the results are included in this Section.

A Level 1 vertebrate fauna and fauna habitat assessment was undertaken by *ecologia* Environment in May 2012 for the western portion of the Infrastructure Corridor Development Envelope. The survey was conducted in accordance with EPA Position Statement No 3 (EPA, 2002a), EPA Guidance Statement 56 (EPA, 2004b) and the Technical Guide - Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (EPA and DEC, 2010).

Reports detailing the findings of the fauna surveys undertaken for the Project are provided in Appendix 8.

8.1.2 Water Corridor Development Envelope

A Level 1 fauna survey of the Water Corridor Development Envelope was undertaken in October 2011, also by *ecologia* Environment. The survey was conducted in accordance with EPA Position Statement No 3 (EPA, 2002a), EPA Guidance Statement 56 (EPA, 2004b) and the Technical Guide - Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (EPA and DEC, 2010).

8.1.3 Slurry Corridor Development Envelope

While the Slurry Corridor Development Envelope was not specifically surveyed for this Project, a number of previous surveys have been undertaken within the Slurry Corridor Development Envelope and surrounding area, including:

- Hope Downs Iron Ore Project: Rail and Port (Biota, 2003a) (Biota, 2003b).
- Pilbara Iron Ore and Infrastructure Project: Stage A Port and North-South Railway (Biota, 2004b).

- Assessment of Conservation Significant Fauna for the Proposed Rail Corridor and Associated Borrow Pits (ATA Environmental, 2007)
- Outer Harbour Development Fauna Assessment (ENV, 2009a).
- Outer Harbour Development and Goldsworthy Rail Duplication Short Range Endemic Fauna Assessment (ENV, 2009b).
- Targeted Fauna Assessment of the Rail Duplication (Bamford Consulting Ecologists, 2010).

8.2 Vertebrate Fauna Habitat

8.2.1 Mine Area

Seven fauna habitats have been mapped and described from the mine area (Table 32 and Figure 20), with the most common being Rocky Spinifex Hills. This fauna habitat type is characterised by an open vegetation structure with small clumps of Spinifex and scattered low and mid-sized shrubs (ecologia Environment, 2012d).

Table 32: Fauna Habitat Types of the Mine Area

Habitat Type	Extent Mapped (ha)
Acacia shrubland on hard soil	458
Creekline	1,528
Granite Outcrop	51
Rocky Plains with Spinifex	5,555
Rocky ridges/ breakaway/ gorges	520
Rocky Spinifex Hills	23,843
Sandy Plains with Spinifex and Scattered Granites	2,889
Total	**34,844**

Analysis of the habitat types indicated that no single habitat supports a distinct or restricted fauna assemblage (ecologia Environment, 2012d). The following fauna habitats may support species of conservation significance within the mine area:

- Rocky Spinifex Hills (Western Pebble-mound Mouse and Long-tailed Dunnart).
- Rocky Ridges, Breakaway and Rocky Gorges (Northern Quoll, Pilbara Leaf-nosed Bat, Long-tailed Dunnart, Peregrine Falcons, Pilbara Olive Python).
- Sandy Plains with Spinifex and Scattered Granites (Greater Bilby, Brush-tailed Mulgara, Australian Bustard).
- Creeklines (Rainbow bee-eater, Bush Stone-Curlew).

The Rocky Ridges, Breakaways and Rocky Gorges has been identified as habitat of conservation significance due to its suitability as foraging, denning/roosting and/or breeding habitat for the Northern Quoll (Endangered), Pilbara Leaf-nosed Bat (Vulnerable) and Pilbara Olive Python (Vulnerable) (ecologia Environment, 2012d). This habitat is discussed further in Section 11 (Matters of National Environmental Significance).

8.2.2 Water Corridor Development Envelope

The 2011 fauna survey of the Water Corridor Development Envelope (ecologia Environment, 2012g) identified six fauna habitats (Table 33 and Figure 22). The most extensive fauna habitat was Sandplain shrubland and spinifex grassland, accounting for 65% of the total area surveyed within the Water Corridor Development Envelope.

Table 33: Fauna Habitats of the Water Corridor Development Envelope

Habitat Type	Mapped Extent (ha)
River system	1,257
Alluvial plain grassland	6,076
Spinifex grassland sandplains	8,911
Rocky spinifex hills	1,380
Sandplain shrubland and spinifex grassland	41,236
Stony spinifex grassland plains	4,803
Total	**63,663**

The habitats present within the Water Corridor Development Envelope do not support restricted vertebrate fauna assemblages and the habitats are well represented outside of the area surveyed. The following fauna habitats from the Water Corridor Development Envelope may support species of conservation significance:

- River System Habitat (Bush Stone-curlew, Rainbow Bee-eater and Pilbara Olive Python).
- Alluvial Plain Grassland (Rainbow Bee-eater and Oriental Plover).
- Spinifex Grassland Sandplains (Greater Bilby, Brush-tailed Mulgara and Rainbow Bee-eater).
- Rocky Spinifex Hills (Western Pebble Mound Mouse).
- Sandplain Shrubland and Spinifex Grasslands (Greater Bilby, Brush-tailed Mulgara, Australian Bustard and Rainbow Bee-eater).

All habitats are well represented outside of the Water Corridor Development Envelope and are not locally restricted. As such no habitats have been identified as being of significant conservation value.

8.2.3 Slurry Corridor Development Envelope

Four habitat types were identified along the Slurry Corridor Development Envelope (Table 34 and Figure 21). The most extensive habitat type in the area is Spinifex grasslands on low stony rises, which is well represented in the Pilbara region.

Table 34: Habitat Types of the Slurry Corridor Development Envelope

Habitat Type	Mapped Extent (ha)
Low trees/shrubs over Spinifex grasslands on sandplain	147
Granite outcrops, breakaways and boulder piles	274
Open riparian (Eucalypt) woodland	132
Spinifex grasslands on low stony rises	1,454
Tall shrublands	262
Low shrublands	62
Total	**2,331**

While the majority of habitats found along the Slurry Corridor Development Envelope are well represented in the region, the Granite outcrops, breakaways and boulder piles habitat occupies small areas in any one location and supports fauna species which are otherwise uncommon in the surrounding area (such as the Northern Quoll). As such this habitat has been identified as being of significant conservation value.

8.3 Terrestrial Vertebrate Fauna

8.3.1 Mine Area

The potential fauna assemblage of the mine area and surrounds comprises 47 native and 6 introduced mammals, 150 birds, 111 reptiles and 7 amphibians (ecologia Environment, 2012d). The Level 2 fauna survey recorded a total of 181 native vertebrate fauna species of the possible 315 species that may potentially occur within the region (ecologia Environment, 2012d). The recorded vertebrates comprised of 19 native mammal species, 3 introduced mammal species, 81 bird species, 75 reptile species, 6 amphibian species and four fish species (ecologia Environment, 2012d).

The 2011 survey undertaken by *ecologia* Environment (2012d) identified 16 reptile species which are closely associated with or restricted to rocky substrates, as reported by Doughty *et al* (2011). In particular, *Diplodactylys galaxias, D. savegei, Gehyra punctata, Egernia ebsisolus* and *Morethia ruficauda exquisita* are endemic to rocky ranges in the Pilbara, or extend slightly into the Gascoyne bioregion (Doughty *et al*, 2011).

Five fauna species listed under the *Wildlife Conservation Act 1950* (WC Act) and five DEC Priority listed species have been recorded within the mine area and surrounds. A further seven

WC Act listed or DEC Priority fauna species are considered likely to occur in the mine area and surrounds, as detailed in Table 29.

8.3.2 Water Corridor Development Envelope

The potential fauna assemblage of the Water Corridor Development Envelope comprises 37 mammals, 6 introduced mammals, 195 birds, 106 reptiles and 6 amphibians (ecologia Environment, 2012g). Based on database searches and the results of previous biological surveys in the surrounding region, 11 mammal, 36 bird and 3 reptile species of conservation significance potentially occur in the Water Corridor Development Envelope.

Diggings thought to be made by the Greater Bilby were recorded from the northern section of the Water Corridor Development Envelope, largely within the Sandplain shrubland and spinifex grassland habitat.

Three fauna species listed under the WC Act and three DEC Priority listed species have been recorded within the Water Corridor Development Envelope. A further 10 species are considered to have a medium to high likelihood of occurrence in the area based on local records and the habitats present (ecologia Environment, 2012g) (Table 29).

8.3.3 Slurry Corridor Development Envelope

The Slurry Corridor Development Envelope is located wholly within the SRL, alongside the existing Stage A north-south railway. Surveys previously conducted in the vicinity of the SRL identified 40 mammal species, 84 bird species, 58 reptile species and 6 amphibian species as potentially occurring in the area (Biota, 2004b).

Three fauna species listed under the WC Act and three DEC Priority listed species have been recorded within the Slurry Corridor Development Envelope. A further three WC Act listed or DEC Priority fauna species are considered likely to occur in the mine area and surrounds, as detailed in Table 29.

8.4 Fauna of Conservation Significance

A number of fauna species protected under the *Wildlife Conservation Act 1950* or listed on the DEC Priority List have been identified as having a high likelihood of occurrence or have been recorded during surveys of the Project area. These species are discussed further in this Chapter and are detailed in Table 35.

A number of fauna species protected under the EPBC Act have been identified as having a high likelihood of occurrence or have been recorded during surveys of the Project area and surrounds. These species are discussed in Section 11, and are detailed in Table 36. Migratory species are discussed in this section.

Table 35: Likelihood of Occurrence of Conservation Significant Fauna within the Project Area[1]

Species Common Name	Scientific Name	Conservation Status			Likelihood of Occurrence		
		EPBC	WC Act	DEC	Mine Area	Water Corridor Development Envelope	Slurry Corridor Development Envelope
Mammals							
Northern Quoll	*Dasyurus hallucatus*	EN	S1	EN	✓		✓
Greater Bilby	*Macrotis lagotis*	VU	S1	VU	•	▲	✓
Crest-tailed Mulgara / Brush-tailed Mulgara	*Dasycercus cristicauda / D blythii*	VU	S1	VU / P4	•	•	•
Pilbara Leaf-nosed Bat	*Rhinonicteris aurantia*	VU	S1	VU	✓		
Grey Falcon	*Falco hypoleucos*		S1	VU	✓	✓	
Spectacled Hare-wallaby	*Lagorchestes conspicillatus leichardti*			P3	•		
Ghost Bat	*Macroderma gigas*			P4	✓		
Long-tailed Dunnart	*Sminthopsis longicaudata*			P4	✓		
Western Pebble-mound Mouse	*Pseudomys chapmani*			P4	✓	•	✓
Birds							
Eastern Great Egret	*Ardea modesta*	Mi	S3		•	•	
Fork-tailed Swift	*Apus pacificus*	Mi	S3		✓		
Oriental Plover	*Charadrius veredus*	Mi	S3			✓	
Rainbow Bee-eater	*Merops ornatus*	Mi	S3		✓	•	✓
Grey Falcon	*Falco hypoleucos*		S1	VU	•	•	
Peregrine Falcon	*Falco peregrines*		S4		•	•	
Australian Bustard	*Ardeotis australis*			P4	✓	✓	✓
Bush Stone-curlew	*Burhinus grallarius*			P4	•	•	✓
Star Finch (Western)	*Neochmia ruficauda subclarescens*			P4	•	•	
Reptiles							
Pilbara Olive Python	*Liasis olivaceus barroni*	VU	S1	VU	✓		•
-	*Ramphotyphlops ganei*			P1	•		
-	*Lerista separanda*			P2		•	

- Note: ✓Recorded (ecologia Environment, 2012d,f; Biota, 2004b); ▲ Unconfirmed secondary evidence ; •Medium to High Likelihood of Occurrence.

[1] CR – Critically Endangered; EN – Endangered; VU – Vulnerable; Mi – Migratory; S1– Schedule 1; S2 – Schedule 2; S3 – Schedule 3; S4 – Schedule 4; P1–Priority 1; P2–Priority 2; P3–Priority 3; P4–Priority 4; P5 –Priority 5.

8.4.1 Species Listed Under the *Wildlife Conservation Act 1950* – Mine Area

Other than those species listed under both the WC Act and the EPBC Act, discussed in Section 11, no fauna species listed under the WC Act were recorded during surveys of the mine area. The Peregrine Falcon and Grey Falcon have been identified as having a high likelihood of occurrence in the area based on previous records and habitat types.

- **Grey Falcon** (*Falco hypoleucos*) (Schedule 1)

  This species is sparsely distributed across much of arid and semi-arid Australia, occurring in a variety of habitats in the north of WA, ranging from wooded drainage systems to open Spinifex plains (ecologia Environment, 2012d). Several records of previous sightings within and near the mine area were identified. A family of four birds were recorded by *ecologia* Environment (2012d) approximately two km south of the Infrastructure Corridor Development Envelope near the Turner River.

- **Peregrine Falcon** (*Falco peregrines*) (Schedule 4)

  The Peregrine Falcon is widely distributed in the region, typically inhabiting coastal cliffs, riverine gorges and wooded watercourses (ecologia Environment, 2012d). Three records exist within 100 km from the mine area, of which two recent records occur within 20 km of this area (ecologia Environment, 2012d). The surveyed mine area contains some suitable habitat along creek lines and cliff faces. No Peregrine Falcons were recorded during the survey by *ecologia* Environment (2012d).

8.4.2 Species Listed Under the *Wildlife Conservation Act 1950* – Water Corridor Development Envelope

While no fauna species listed under the WC Act were recorded during surveys of the Water Corridor Development Envelope, the Grey Falcon was recorded within 15 km of the boundary of this envelope and is therefore highly likely to occur within the Water Corridor Development Envelope (ecologia Environment, 2012g). The Peregrine Falcon is also considered to have a high likelihood of occurrence based on previous records and habitat types.

- **Grey Falcon** (*Falco hypoleucos*) (Schedule 1)

  Grey Falcons may utilise the majority of habitats within the Water Corridor Development Envelope, however the absence of large trees or cliffs limits their potential as hunting grounds. During the survey by *ecologia* Environment (ecologia Environment, 2012g), a group of five individuals was recorded approximately 13.8 km west of the Water Corridor Development Envelope. No individuals were recorded from within this envelope.

- **Peregrine Falcon** (*Falco peregrines*) (Schedule 4)

The Peregrine Falcon has been previously recorded in the area surrounding the Water Corridor Development Envelope, with suitable foraging habitat present but no potential breeding habitat in this area. This species was previously recorded within 15 to 40 km of the Water Corridor Development Envelope (ecologia Environment, 2012g).

8.4.3 Species Listed Under the *Wildlife Conservation Act 1950* – Slurry Corridor Development Envelope

Other than those species listed under both the WC Act and the EPBC Act, discussed in Section 11, no fauna species listed under the WC Act were recorded during surveys of the Slurry Corridor Development Envelope.

8.4.4 DEC Priority Listed Species – Mine Area

Four mammal, three bird and one reptile species listed on the DEC Priority fauna species list have been identified as either having a high likelihood of occurrence based on previous records and habitat types, or have been recorded during recent fauna surveys (ecologia Environment, 2012d, f; ENV, 2009a; ATA Environmental, 2007).

Mammals

- **Spectacled Hare-wallaby** (*Lagorchestes conspicillatus leichardti*) (Priority 3)

  This species has a fairly wide distribution throughout the Pilbara and Kimberley regions, although the majority of the records for the species are clustered in the area surrounding the mine area (a total of 102 individuals have been previously recorded within 20 km of this area); however more suitable habitat is available outside this area (ecologia Environment, 2012d). It inhabits grasslands, open forests, open woodlands, and tall shrublands, and shelters during the day under tussocks. This species was not recorded during the survey by *ecologia* Environment (2012d), despite searching in suitable habitat, including motion cameras.

- **Ghost Bat** (*Macroderma gigas*) (Priority 4)

  This bat, Australia’s only carnivorous bat, has a patchy but widespread distribution across northern Australia, with preferred roosting habitats in the Pilbara including caves and rockpiles. Ghost bats are generally found in similar habitat to the Pilbara Leaf-nosed Bat and often roost in caves also occupied by Pilbara Leaf-nosed Bats. They are known to forage in an area of approximately 60 ha, in a radius of approximately 2 km from the roost, and disperse widely during the non-breeding season (ecologia Environment, 2012d). Colonies range in size from a few to over 400 individuals. Suitable habitat exists outside of the mine area, with four maternity caves located to the east of this area. One maternity cave is located within 25 km of the mine area and three caves are located within 65 to75 km (Armstrong, 2000). Previous studies recorded 17 sightings within 100 km of the mine area and during the recent targeted survey (ecologia Environment, 2012d) a single individual was recorded, believed to be a transient or foraging individual. Ghost bats were recorded again during Phase 1 of the Pilbara Leaf-nosed Bat Vibration Study, utilising the same cave (Bat Call WA, 2013), most likely to predate on the Pilbara Leaf-nosed Bat and other bat species utilising the cave.

- **Long-tailed Dunnart** (*Sminthopsis longicaudata*) (Priority 4)

  The Long-tailed Dunnart (Plate 6) has scattered distributions across the arid zone of Australia, inhabiting rugged, rocky areas. Extensive suitable habitat occurs throughout the mine area, with open or Spinifex-dominated rocky areas preferred by the dunnarts; such habitat comprised the vast majority of this area of the mine area and surrounds. Database searches returned no previous records from within 40 km or previous surveys within 100 km of the surveyed mine area. The survey by *ecologia* Environment (2012d) recorded 11 individuals from three locations in the mine area and surrounds, none of which were within the Project development envelopes.

Plate 6: Long-tailed Dunnart

Source: ecologia Environment (2012d)

- **Western Pebble-mound Mouse** (*Pseudomys chapmani*) (Priority 4)

  This mouse is widely distributed, but patchy within the region, occurring across the central and southern Pilbara and extends into smaller ranges of the Little Sandy Desert (Start, 2008). Western Pebble-mound mice inhabit gently sloping hills of rocky ranges where the ground is stony and vegetated by Spinifex with a sparse overstorey of eucalypts and scattered shrubs of *Senna, Acacia* and *Ptilotus*. Mounds of small stones mark the past and present residencies of Pebble-mound Mice, usually located on spurs and lower slopes of rocky hills (ecologia Environment, 2012d). This species was recorded by *ecologia* Environment (2012d) through the presence of three active or recently active Pebble Mound-mouse mounds. There are also numerous literature and database records of this species nearby. Extensive suitable habitat is present in the region (ecologia Environment, 2012d).

Birds

- **Australian Bustard** (*Ardeotis australis*) (Priority 4)

  The Australian Bustard occurs across the majority of the country. It is a nomadic species, ranging over a large area, utilising a number of habitats including open or lightly wooded grasslands, plains and heathlands (ecologia Environment, 2012d). During the survey by *ecologia* Environment (2012d), nine individuals were recorded to the west of the mine area, generally in proximity to the Turner River.

- **Bush Stone-curlew** (*Burhinus grallarius*) (Priority 4)

  The Bush Stone-curlew is widely distributed within the region, with suitable habitat consisting of lightly wooded areas close to thickets or long grass. A study undertaken by Gates (2001) suggests this species occupies a home range of 26 – 64 ha (ecologia Environment, 2012d). The survey by *ecologia* Environment (2012d) recorded two individuals approximately four km south of the Infrastructure Corridor Development Envelope, along the Turner River.

- **Star Finch (Western subspecies)** (*Neochmia ruficauda subclarescens*) (Priority 4)

  The western subspecies of the Star Finch is patchily distributed across the Pilbara. They typically inhabit vegetation around watercourses, particularly thick reed beds (ecologia Environment, 2012d). Several records exist from previous surveys within 100 km of the mine area and the species is likely to occur along the length of the Turner River (ecologia Environment, 2012d). This species was not recorded during the survey by *ecologia* Environment (2012d).

Reptiles

- ***Ramphotyphlops ganei*** (Priority 1)

  Though little is known about this species of blind snake, its preferred habitat is thought to be subsoil habitats near moist gullies and gorges. It is thought they burrow into social insect colonies and feed on termites and ants (ecologia Environment, 2012d). This species has previously been recorded from a variety of habitats within the Pilbara region. The closest record to the mine area is approximately 15 km to the north. This species was not recorded during the survey by *ecologia* Environment (2012d).

8.4.5 DEC Priority Listed Species – Water Corridor Development Envelope

One mammal, three bird and one reptile species listed on the DEC Priority fauna species list have been identified as either having a high likelihood of occurrence based on previous records and habitat types, or have been recorded during recent fauna surveys.

Mammals

- **Western Pebble-mound Mouse** (*Pseudomys chapmani*) (Priority 4)

  Suitable habitat for the Western Pebble Mound Mouse within the Water Corridor Development Envelope consists of Rocky spinifex hills. This habitat is widespread in the region. While the database searches identified a record for the Western Pebble-mound Mouse within the Water Corridor Development Envelope this species was not recorded during the survey by *ecologia* Environment (2012g).

Birds

- **Australian Bustard** (*Ardeotis australis*) (Priority 4)

  The Australian Bustard would utilise the Sandplain shrubland and spinifex grasslands habitat within the Water Corridor Development Envelope. The survey undertaken by *ecologia* Environment (2012g) recorded 20 individuals at 12 sites along the Water Corridor Development Envelope. The majority of these records were towards the northern end.

- **Bush Stone-curlew** (*Burhinus grallarius*) (Priority 4)

  Suitable habitat for the Bush Stone-curlew within the Water Corridor Development Envelope consists of River system habitat. This species was not recorded during the survey by *ecologia* Environment however there are several records from the database searches within five km of the Water Corridor Development Envelope.

- **Star Finch (Western subspecies)** (*Neochmia ruficauda subclarescens*) (Priority 4)

  River system habitat comprises suitable habitat for the western subspecies of the Star Finch within the Water Corridor Development Envelope. This species was not recorded during the survey by *ecologia* Environment (2012g). The nearest regional records are approximately 17 km from the Water Corridor Development Envelope, along the De Grey River.

Reptiles

- ***Lerista separanda*** (Priority 2)

  Suitable habitat for this species in the Water Corridor Development Envelope consists of sandy soils such as those found in the Spinifex grassland sandplains habitat. This habitat is widespread in the Pilbara. The species was not recorded during the survey by *ecologia* Environment (2012g) and the nearest regional record is 12.5 km east of the Water Corridor Development Envelope.

8.4.6 DEC Priority Listed Species – Slurry Corridor Development Envelope

One mammal and two bird species listed on the DEC Priority fauna species list have been identified as either having a high likelihood of occurrence based on previous records and habitat types, or have been recorded during recent fauna surveys (ecologia Environment, 2012d) (ecologia Environment, 2012g) (ENV, 2009a).

Mammals

- **Western Pebble-mound Mouse** (*Pseudomys chapmani*) (Priority 4)

  Suitable habitat for the Western Pebble Mound Mouse within the Slurry Corridor Development Envelope consists of Spinifex grasslands on low stony rises. This habitat is widespread in the region. Active and recently active mounds of this species were recorded during the 2007 survey by ATA Environment.

Birds

- **Australian Bustard** (*Ardeotis australis*) (Priority 4)

  The Australian Bustard may utilise the Spinifex grasslands on low stony rises, and Low trees/shrubs over Spinifex grasslands on sandplain habitats within the Slurry Corridor Development Envelope. The surveys undertaken by Biota (2004b) and ATA Environmental (2007) recorded the presence of this species across the Slurry Corridor Development Envelope.

- **Bush Stone-curlew** (*Burhinus grallarius*) (Priority 4)

  Suitable habitat for the Bush Stone-curlew within the Slurry Corridor Development Envelope consists of Open riparian (Eucalypt) woodland. This species was not recorded during the surveys by Biota (2004b) or ATA Environmental (2007) within the Slurry Corridor Development Envelope.

8.5 Migratory Fauna

Thirteen migratory species have been identified in the Protected Matters Search Tool, with seven of these having a medium to high likelihood of occurring within the Project area (Table 36) and are discussed below.

Table 36: EPBC Listed Migratory (Mi) Species Relevant to the Project Area

Species	EPBC Act Status	Project Area	Likelihood of Occurrence
Apus pacificus (Fork-tailed Swift)	Mi Marine	Mine Area	**High** –this species is largely aerial and is commonly encountered in the Pilbara across a wide variety of habitats. It may overfly the Project area
		Water Corridor Development Envelope	**Medium** – as this species is largely aerial over a narrow linear corridor, there is less likelihood of encountering this species
		Slurry Corridor Development Envelope	**Medium** – as this species is largely aerial over a narrow linear corridor, there is less likelihood of encountering this species
Ardea modesta (Eastern Great Egret)	Mi Marine (as *Ardea alba)* Mi Wetland	Mine Area	**Low** – mine area does not provide preferred habitat for this species
		Water Corridor Development Envelope	**High** – suitable hunting habitat along major creek lines
		Slurry Corridor Development Envelope	**Medium** – may be found near the Turner River
Ardea ibis (Cattle Egret)	Mi Marine Mi Wetland	Mine Area	**Low** – area does not provide preferred habitat for this species
		Water Corridor Development Envelope	**Low** – area does not generally provide preferred habitat for this species except at the De Grey River crossing
		Slurry Corridor Development Envelope	**Low** – area does not generally provide preferred habitat for this species except at the Turner River
Charadrius leschenaultii (Greater Sand Plover, Large Sand Plover)	Mi Wetland	Water Corridor Development Envelope	**Low** – coastal species. Only likely to occasionally occur in Project area when conditions are suitable (i.e. after major floods)
Charadrius mongolus (Lesser Sand Plover, Mongolian Plover)	Mi Wetland	Water Corridor Development Envelope	**Low** – predominantly coastal species. Only likely to occasionally occur in Project area when conditions are suitable (i.e. after major floods)
Charadrius veredus (Oriental Plover, Oriental Dotterel)	Mi Wetland	Mine Area	**Medium** – recorded from the region
		Water Corridor Development Envelope	**High** – recorded during previous surveys. Extensive suitable habitat present
		Slurry Corridor Development Envelope	**Medium** – recorded from the region
Fregata ariel (Lesser Frigatebird, Least Frigatebird)	Mi Marine	Water Corridor Development Envelope	**Low** – species may overfly but is generally found closer to the coast
		Slurry Corridor Development Envelope	**Low** – species may overfly but is generally found closer to the coast
Glareola maldivarum (Oriental Pratincole)	Mi Wetland	Mine Area	**Low** – no records in the region
		Water Corridor Development Envelope	**High** – likely to be found along the De Grey River and known from 80 Mile Beach

Species	EPBC Act Status	Project Area	Likelihood of Occurrence
		Slurry Corridor Development Envelope	**Low** – no records in the region
Haliaeetus leucogaster (White-bellied Sea-Eagle)	Mi Terrestrial	Mine Area	**Low** – not recorded during fauna surveys
		Water Corridor Development Envelope	**Medium** – coastal species. Only likely to occasionally occur in Project area when conditions are suitable
		Slurry Corridor Development Envelope	**Medium** – may be seen along major rivers but unlikely to be impacted
Hirundo rustica (Barn swallow)	Mi Terrestrial	Mine Area	**Low** – normally recorded from coastal lowlands, near towns and cities
		Water Corridor Development Envelope	**Low** – normally recorded from coastal lowlands, near towns and cities
		Slurry Corridor Development Envelope	**Low** – normally recorded from coastal lowlands, near towns and cities
Merops ornatus (Rainbow Bee-eater)	Mi Terrestrial	Mine Area	**High** – recorded during site surveys
		Water Corridor Development Envelope	**High** – recorded during site surveys
		Slurry Corridor Development Envelope	**High** – recorded during site surveys
Plegadis falcinellus (Glossy Ibis)	Mi Marine	Water Corridor Development Envelope	**Medium** – some suitable habitat along major creeks in the Project area.
Pluvialis squatarola (Grey Plover)	Mi Wetland	Water Corridor Development Envelope	**Low** - coastal species. Only likely to occasionally occur in Project area when conditions are suitable (i.e. after major floods)

Fork-tailed Swift (*Apus pacificus*)

The Fork-tailed Swift is a medium sized Swift characterised by a long, deeply forked tail (DSEWPaC, 2012e). The species is a non-breeding visitor to all regions of Australia. In the Pilbara they typically arrive from overseas breeding areas during November. The Fork-tailed Swift is considered uncommon to moderately common near the north-west, west and south-east coasts of Western Australia, common in the Kimberley and rare or scarce elsewhere (ecologia Environment, 2012d).

Fork-tailed Swifts are a nomadic species and almost exclusively live in the air feeding on aerial insects. They are attracted to thunderstorms where large flocks can be observed (ecologia Environment, 2012d).

Fork-tailed Swifts were recorded from the mine area and surrounds during the survey by *ecologia* Environment (2012d).

Eastern Great Egret (*Ardea modesta*)

The Eastern Great Egret is a large bird with white feathers, a black or yellow bill and long reddish or black legs (DSEWPaC, 2012f). The species is widespread in Australia and found across a number of habitats including swamps and marshes; margins of rivers and lakes; damp or flooded grasslands, pastures or agricultural lands; reservoirs; sewage treatment ponds; drainage channels; salt pans and salt lakes; salt marshes; estuarine mudflats, tidal streams; mangrove swamps; coastal lagoons; and offshore reefs (DSEWPaC, 2012f).

The Eastern Great Egret is common to very common in the well-watered Kimberley flatlands, and scarce to moderately common elsewhere within its range (ecologia Environment, 2012d).

Surveys of the Project area have not recorded the presence of the Eastern Great Egret, however suitable habitat occurs along the proposed Water Corridor and Slurry Corridor Development Envelopes.

Oriental Plover (*Charadrius veredus*)

The Oriental Plover is a medium sized gregarious bird with long legs, usually occurring in small parties to flocks of 100 or more birds (DSEWPaC, 2012g). The species is a non-breeding visitor to Australia, with the majority of records from along the north-western coast, between Exmouth Gulf and Derby in Western Australia. Oriental Plovers are known to inhabit a range of habitats including estuarine mudflats and sandbanks, sandy or rocky ocean beaches or nearby reefs, near-coastal grasslands, semi-arid or arid grasslands and open areas that have been recently burnt.

A group of five birds was recorded during the survey of the Water Corridor Development Envelope by *ecologia* Environment (2012g), close to Pear Creek, which is a tributary of the De Grey River and is located approximately half way between the Mine area and the Canning Basin Borefield.

Oriental Pratincole (*Glareola maldivarum*)

The Oriental Pratincole is a medium sized tern-like shorebird with long pointed wings and a forked tail. The species is a non-breeding visitor to Australia, generally occurring north of 20°S latitude (DSEWPaC, 2012h). Preferred habitat of the Oriental Plover consists of sparsely vegetated plains, including samphire and short-grass flats, where it feeds largely on insects, often foraging at night (ecologia Environment, 2012d).

Surveys of the Project area have not recorded the presence of this species; however, suitable habitat occurs at the De Grey River.

White-bellied Sea-Eagle (*Haliaeetus leucogaster*)

The White-Bellied Sea-Eagle is a large bird of prey with long broad wings and a short wedge shaped tail. They are normally seen singularly or in pairs, though may sometimes gather where food is abundant (DSEWPaC, 2012i). The species generally occurs in coastal areas but can extend inland along major river systems. Habitats inhabited by the White Bellied Sea-Eagle are characterised by the presence of large areas of open water (larger rivers, swamps, lakes, the ocean) (DSEWPaC, 2012i).

Surveys of the Project area have not recorded the presence of the White-Bellied Sea-Eagle, however this species may overfly the northern extents of the Slurry Corridor and Water Corridor Development Envelopes.

Rainbow Bee-eater (*Merops ornatus*)

The Rainbow Bee-eater is a medium sized brightly coloured bird and is the only species of Bee-eater found in Australia (DSEWPaC, 2012j). In Western Australia, the species can occur as a resident, breeding visitor or non-breeding visitor (ecologia Environment, 2012g). The Rainbow Bee-eater is distributed across much of mainland Australia and occurs on several near-shore islands (DSEWPaC, 2012j). They are usually seen in pairs or small flocks (DSEWPaC, 2012j).

The Rainbow Bee-eater occurs mainly in open forests and woodlands, shrublands, and cleared or semi-cleared habitats, including farmland and urban areas. Rainbow Bee-eaters excavate nesting burrows in the banks of rivers, creeks or dams, in roadside cuttings, in the walls of gravel pits or quarries, in mounds of gravel, or in cliff-faces and as such are often seen around disturbed areas (DSEWPaC, 2012j).

Surveys of the Project area have recorded Rainbow Bee-eaters across the majority of the Project development envelopes.

Glossy Ibis (*Plegadis falcinellus*)

The Glossy Ibis is the smallest of the ibis species found in Australia. They are normally seen singularly, in pairs or in small flocks and are generally found along with other ibis species (DSEWPaC, 2012n). Preferred habitat for this species consists of shallows and adjacent flats of freshwater lake and swamps, but it is also found in river pools, flooded samphire and sewage ponds (ecologia Environment, 2012g).

Surveys of the Project area have not recorded the presence of the Glossy Ibis, however some creeklines and rivers which intersect the Project Development Envelopes may provide suitable habitat.

8.6 Short Range Endemic Invertebrates

The EPA defines Short Range Endemic (SRE) species as terrestrial or freshwater invertebrates with naturally small distributions of less than 10,000 ha (EPA, 2009b). These species also display a number of characteristic traits such as poor dispersal powers, low levels of fecundity, confinement to discontinuous habitats, or highly seasonal activity patterns (EPA, 2009b). Invertebrate groups which are known or considered likely to include SRE taxa include:

- Snails (Class: Gastopoda).
- Trapdoor spiders (Infraorder : Mygalomorphae).
- Pseudoscorpions (Order: Psudoscorpiones).
- Millipedes (Order: Diploda).
- Slaters (Order: Isopoda).
- Freshwater Crayfish (Order: Decapoda).

As they can be restricted to small spatial scales and in disjunct populations, these species are considered to be at greater risk of changes in conservation status, local population size or extinction than more widely distributed species (EPA, 2009b).

8.6.1 Project Surveys

Mine Area

A two phase SRE invertebrate fauna survey within the mine area was undertaken by *ecologia* Environment (Appendix 9). The first phase was undertaken between February and March 2011, with phase two between July and August 2011. This survey was consistent with EPA Guidance Statement 20 (EPA, 2009b).

Water Corridor Development Envelope

A SRE survey was conducted over the Water Corridor Development Envelope as part of the Level 1 fauna survey, undertaken during October 2011 by *ecologia* Environment (ecologia Environment, 2012g) (Appendix 8).

8.6.2 Short Range Endemic Invertebrate Habitat

Mine Area

Variability of habitats has been strongly linked with invertebrate diversity and species richness. Habitat parameters which determine their suitability for supporting SREs include moisture, shade, suitable microhabitat and geographical isolation. The overlying vegetation type provides a reasonable reflection of underlying soil, surface hydrology and position in the landscape, and therefore can be used as a surrogate of habitat parameters in respect to SREs.

Four broad vegetation associations, as defined by Beard (1975), have been identified in the SRE survey area. These were:

- Hummock grasslands, low tree steppe; snappy gum over *Triodia wiseana* (Association 82).
- Hummock grasslands, shrub steppe; kanji over soft spinifex (Association 93).

- Medium woodland; river gum (*Eucalyptus camaldulensis*) (Association 619).
- Hummock grasslands; shrub-steppe; kanji over soft spinifex and *Triodia brizoides* (Association 626).

The SRE survey sites were located within each of these vegetation associations and potential or unknown SRE species were recorded from two of these (Associations 82 and 93). The four vegetation associations found within the mine area and surrounds are not considered to be unique to the area, and therefore it is likely that the invertebrate assemblage found within the mine area extends well beyond the mine area (ecologia Environment, 2012f).

Water Corridor Development Envelope

Six habitat types were recorded from the Project Area:

- River system.
- Alluvial plain grassland.
- Spinifex grassland sandplains.
- Rocky spinifex hills.
- Sandplain shrubland and spinifex grasslands.
- Stony spinifex grassland plains.

Survey site locations were selected based on those habitats likely to support SREs in areas inside of the Project footprint. Sampling sites were selected based on the vegetation types and landforms and microhabitats in which SRE's are most likely to occur. These microhabitats are more likely to maintain higher moisture levels, thereby creating isolated 'island' habitats.

None of the habitats in which the unknown SREs were located are unique to the Water Corridor Development Envelope and extend beyond this area (ecologia Environment, 2012g). It can therefore be reasonably expected that SRE invertebrate species will not be restricted to the Water Corridor Development Envelope.

8.6.3 Short Range Endemic Invertebrate Fauna

Mine Area

Searches of the Western Australian Museum (WAM) databases, EPBC Act, WC Act, and DEC priority list identified a total of 21 invertebrate species which are recognized as SREs, potential SREs or unknown SREs that may potentially occur within the mine area. These included 7 Mygalomorph spiders, 4 scorpions, 7 pseudoscorpions and 3 millipede species. None of these listed species were recorded in the mine area during the 2011 survey (ecologia Environment, 2012f).

During the 2011 survey, a total of 45 invertebrate species were recorded (Figure 23). None of these species were listed under the EPBC Act, WC Act or DEC Priority list and no confirmed SRE species were recorded. Ten of the invertebrates species recorded were considered to be potential or unknown SREs. This included:

- Eight potential SRE species (spider *Aname* sp. Indet , spider *Karaops* sp., isopods *Buddelundia* sp. 11 and *Buddelundia* sp. 18, mollusc *Succinea* sp., millipede *Antichiropus* sp., and pseudoscorpions *Beierolpium* 'sp. 8/2' and *Beierolpium* 'sp. 8/4 lge').
- Two species with unknown SRE status (scorpion *Lychas* sp. Indet and snail *Rissooidea* sp.1).

Water Corridor Development Envelope

Searches of the Western Australian Museum (WAM) databases, EPBC Act, WC Act, and DEC priority list identified a total of 47 invertebrate species which may potentially occur in the vicinity of the Water Corridor Development Envelope, 11 of which were identified as likely, potential or unknown SRE species.

During the survey, 12 invertebrate species were collected (Figure 25), and their SRE status determined. Of the 12 species recorded, three (*Austrohorus* sp., *Beierolpium* sp. and *Beierolpium* 'sp. 8/4 small') were determined to be unknown SREs. Under the precautionary principle, all unknown and potential SREs should be treated as confirmed SREs.

The survey was conducted outside of the recommended period for SRE sampling, therefore the estimate of survey adequacy suggests that only a fraction of the diversity of SRE groups were sampled, and therefore it is probable that some SRE species inhabiting the Water Corridor Development Envelope were not collected. The survey efficiency was estimated at 30% of the total invertebrate assemblage, highlighted by the collection of only 12 invertebrate species out of the 47 expected to occur in the regional area.

8.7 Introduced Vertebrate Fauna

A total of five introduced fauna species have been recorded from the Project area.

Three introduced mammals, cattle (*Bos taurus*), camels (*Camelus dromedarius*) and secondary evidence of feral cats (*Felis catus*), were recorded from the mine area and surrounds (ecologia Environment, 2012d). These species are likely to occur in the area due to the presence of permanent water sources. Numbers of these animals may increase in times of drought as other water sources dry up.

During the 2011 fauna survey of the Water Corridor Development Envelope, evidence of four introduced mammals was recorded, specifically dog/dingo (*Canis lupus*), feral cat (*Felis catus*), camel (*Camelus dromedaries*) and cattle (*Bos taurus*) (ecologia Environment, 2012g).

Biota (2004b) recorded evidence of three introduced mammals along the Slurry Corridor Development Envelope. These were the house mouse (*Mus musculus*), camels (*Camelus dromedarius*) and cattle (*Bos taurus*).

8.8 Management Objective

The EPA objective(s) relevant to the assessment and management of terrestrial fauna are:

- 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.

8.9 Guidelines, Policies and Frameworks

Guidance on the assessment and management of impacts to terrestrial fauna exists at a State and Commonwealth government level (Table 37).

Table 37: State and Commonwealth Guidance for Assessment and Management of Fauna

Document	Description
EPA Position Statement No.2: Environmental Protection of Native Vegetation in Western Australia (EPA, 2000b)	Provides an overview of the EPA position on the clearing of native vegetation in WA
EPA Position Statement No.3: Terrestrial Biological Surveys as an Element of Biodiversity Protection (WA) (EPA, 2002a)	Discusses the principles the EPA would apply when assessing proposals that may have an effect on biodiversity values in WA.
EPA Guidance Statement No.56: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia (EPA, 2004b)	Provides guidance on standards and protocols for terrestrial fauna surveys required to assist in collecting sufficient data for decision-making associated with the protection of WA's terrestrial faunal biodiversity and its habitat
EPA Guidance Statement No.20 Sampling of Short Range Endemic Fauna for EIA in Western Australia (EPA, 2009b)	Provides guidance on standards and protocols for sampling Short Range Endemic invertebrate fauna for EIA in WA.
Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (EPA and DEC, 2010)	Provides advice on fauna sampling techniques and methodologies for different regions of the State and the analysis, interpretation and reporting requirements for EIA
Wildlife Conservation Act 1950 (WA)	The Act provides for taxa of native fauna to be protected based on their status including threat of extinction, are rare
Environment Protection and Biodiversity Conservation Act 1999 (Cth)	The Act provides for the protection of Matters of National Environmental Significance and threatened terrestrial fauna may be listed under the EPBC Act
Matters of National Environmental Significance, Significant Impact Guidelines 1.1, *Environment Protection and Biodiversity Conservation Act 1999*	Provides guidance on determining whether an action is likely to have a significant impact on a matter of national environmental significance protected by the EPBC Act
Significant Impact or referral guidelines for nationally listed species (Northern Quoll *Dasyurus hallucatus*) 2011	Provides guidance to proponents on the need to refer an action to which the EPBC Act applies.

8.10 Potential Impacts

Potential impacts to terrestrial fauna species and habitats as a result of development of the North Star Project are discussed below. The key impact to terrestrial fauna and habitats is the clearing and earthworks associated with construction and operation of the Project. Impacts to habitat for Matters of NES are discussed in Section 11.

8.10.1 Direct Loss of General Fauna Habitat

Development of the North Star Project will result in the clearing of about 5,141 ha of vertebrate fauna habitat (Table 38). The majority of the clearing (3,584 ha or about 70% of the total clearing) affects the Rocky Spinifex Hills habitat. This is the most common habitat of the Project area and is well represented in the wider region. This habitat has not been identified as being associated with conservation significant species. As 86% of the extent of this habitat currently mapped will not be cleared, no significant impacts to the Rocky Spinifex Hills habitat are predicted.

Habitats associated with the concentrate slurry pipeline, gas pipeline and water supply pipeline are well represented in the region. Only a small portion of the mapped extent of these habitats will be impacted. The maximum amount of clearing associated with construction of pipelines (14%) will be in Spinifex Grasslands on Low Stony Rises. Once pipeline construction has been completed, the right of way (ROW) will be reinstated to the original condition as far as practically possible, with re-growth maintained to protect the integrity of the pipelines. An access and maintenance track will also be retained. As the habitats in the Slurry Corridor and Water Corridor Development Envelope are well represented in the region, and at least 86% of their mapped extent will remain after clearing, there will be no significant impacts to fauna habitat in these envelopes.

Table 38: Estimate of Habitat Clearing Required

Habitat Type	Extent Mapped (ha)	Estimate of Clearing (ha)	% of Extent Mapped Remaining
Acacia Shrubland on Hard Soil	458	2.5	99%
Alluvial Plain Grassland	6,076	88.5	99%
Creekline	1,528	28	98%
Granite Outcrop	51	1	98%
Granite Outcrops, Breakaways and Boulder Piles	274	88	68%
Highly Disturbed		3	
Low Shrublands	62	14	77%
Low Trees/Shrubs Over Spinifex Grasslands on Sandplain	147	22	85%
River system	1,389	22	98%
Rocky plains with spinifex	5,555	87	98%
Rocky ridges/ breakaway/ gorges	520	95	82%

Rocky spinifex hills	**25,223**	**3,584**	**86%**
Sandplain shrubland and spinifex grassland	41,236	565.5	99%
Sandy plains with spinifex and scattered granites	2,889	74.5	97%
Spinifex grassland sandplains	8,911	150.5	98%
Spinifex grasslands on low stony rises	1,454	198	86%
Stony spinifex grassland plains	4,803	58	99%
Tall shrublands	262	32.5	88%
Total	**100,838**	**5,141**	**95%**

8.10.2 Direct Loss of Significant Fauna Habitat

The Rocky Ridges, Breakaways and Rocky Gorges habitat occurs along the edges of ridgelines, in particular occurring in association with the Gorge Range within which the mine area is located. Approximately 520 ha of this habitat have been delineated in the mine area (ecologia Environment, 2011a). Clearing activities will result in the loss of approximately 95 ha (18%) of this habitat in the mine area. The Rocky Ridges, Breakaways and Rocky Gorges habitat is associated with suitable habitat for Northern Quoll (*Dasyurus hallucatus*), the Pilbara Leaf-nosed Bat *(Rhinonicteris aurantia*) and Pilbara Olive Python (*Liasis olivaceus barroni*). This habitat also provides suitable denning habitat for the Northern Quoll and suitable roost caves for the Pilbara Leaf-nosed Bat, including a day roost cave which supports the population of bats at the mine area.

The Rocky Ridges, Breakaways and Rocky Gorges habitat is likely to be well represented in the wider region with ranges extending at least 70 km to the east and 45 km to the south of the mine area. Further survey effort in the area during future mineral exploration activities, either by FMGIB or other parties, is likely to increase the known extent of this habitat.

Clearing of the Rocky Ridges, Breakaways and Rocky Gorges habitat may have significant impacts on the Northern Quoll, the Pilbara Leaf-nosed Bat and Pilbara Olive Python as this habitat is associated with critical habitat for these species. The Project will result in the loss of breeding and denning habitat, which may lead to a long-term decrease in the size of a population of both the Northern Quoll and Pilbara Leaf-nosed Bat. Pilbara Olive Python are more likely to be associated with water pools, which are not impacted by the Project. This is discussed further in Section 11.

8.10.3 Direct Loss of Habitat Outside of the Project Area

In the absence of appropriate controls and procedures, direct loss of habitat outside of the Project area may occur as a result of:

- Hot work activities, incorrect disposal of cigarette butts or vehicle exhausts causing fire. Standard project work procedures will assist in minimising the risk of this occurring.

- Over clearing or accidental clearing outside of defined areas to be cleared. Fortescue's internal Ground Disturbing Permit procedure will assist in minimising the risk of this occurring.

8.10.4 Degradation of Habitat

Habitat degradation occurs through physical alteration of the habitat, such as changes to vegetation structure, changes to water regimes or availability and changes to the landscape and topography. The following mechanisms relevant to the Project may result in habitat degradation:

- Changes in vegetation structure due to soil contamination, introduction and/or spread of weeds.
- Changes fire regimes and/or increased frequency of fires which alter the structure of the vegetation.
- Dust deposition on vegetation resulting in decreased health and lowered carrying capacity of the habitat.
- Contamination of surface water flows and water pools through poor material handling and management.
- Reduction in surface water flows to creeklines due to location of project infrastructure.
- Uncontrolled vehicle access leading to physical damage of habitats.

Management measures will be put in place to minimise the potential for habitat degradation as a result of implementation of the project. Given that the habitats present within the Project area are well represented in the region, habitat degradation will not cause any significant changes to the extent or status of these habitats.

8.10.5 Fragmentation of Habitat

Vegetation clearing has the potential to result in fragmentation of fauna habitat reducing the connectivity of fauna populations. Fauna with large home ranges, such as ground dwelling mammals, are likely to be most at risk of habitat fragmentation.

Construction of the concentrate slurry pipeline, gas pipeline and water supply pipeline may result in fragmentation of fauna habitat. However, fragmentation is unlikely as pipeline corridors will be rehabilitated once construction is completed, with the exception of the maintenance tracks. The concentrate slurry and gas pipelines are adjacent to Fortescue's Mainline Railway and are therefore unlikely to increase the level of habitat fragmentation.

The mine pit has the potential to result in fragmentation of the ridge it occupies, thereby limiting dispersal of fauna north-south along the ridge.

8.10.6 Direct Loss of or Injury to Fauna

Direct loss of or injury to fauna may occur as a result of:

- Clearing and earthworks.
- Fire.
- Vehicle strikes.
- Entrapment in open trenches.
- Accidental ingestion of solid or liquid wastes, chemicals or fuels.
- Poor putrescible waste management resulting in increased predation due to attraction of carnivores and scavengers.
- Entrapment in water storage structures.
- Light spill resulting in disorientation of nocturnal fauna or attraction of fauna to areas where risk of injury or death is increased.

In most cases, the impact is likely to be localised and restricted to individuals and will not significantly impact on the regional status of fauna species which reside in the Project area.

Construction of the concentrate slurry, gas and water supply pipelines has the potential to result in the entrapment of fauna in open trenches resulting in death or injury through dehydration, hypothermia, drowning (where water is present in the open trench), or becoming buried during pipe laying and backfilling operations. Typically snakes, small reptiles and small mammals are more likely to become trapped, as larger reptiles (such as the Pilbara Rock Monitor) and mammals (such as the Northern Quoll) are generally able to climb out of excavated trenches. Kangaroos and cattle have been known to become trapped in open trenches either through becoming stuck between the walls of the trench or through injury due to falling into the trench. Large numbers of fauna, particularly small mammals and small reptiles, have been known to become trapped in open trenches (EPA, 2004f). This has the potential to have a significant impact on the regional representation of these animals. The implementation of appropriate management measures in relation to pipeline construction and trenching operations will reduce this impact to as low as reasonably practicable.

8.10.7 Reptiles Restricted to, or Associated with, Rocky Substrates

Studies undertaken by Doughty *et al* (2011) identified two groups of reptiles which are closely associated with rocky substrates such as ridges and breakaways. A total of 17 of these species were recorded from the mine area and surrounds by *ecologia* Environment (2012d) with five of these known to be endemic to the rocky ridges of the Pilbara, or extending slightly into the Gascoyne bioregion. Within the Project area, the Rocky Ridges, Breakaways and Rocky Gorges habitat is most likely to contain reptile species endemic to the rocky ridges of the Pilbara.

Development of the Project will result in the loss of 95 ha of the Rocky Ridges, Breakaways and Rocky Gorges habitat. This equates to 18% of the mapped extent of this habitat in the mine area and surrounds. This habitat is part of the Capricorn Land System, which is typified by ridges, hills and upper slopes with stony soils. The Rocklea, Talga and Granitic Land Systems occur within the Project area and surrounds and consist largely of ridges, hills and upper slopes, and are therefore likely to provide suitable habitat for endemic reptile species. Together these land systems cover a total of 34,433 km^2, of which 21,322.65 km^2 (2,132,265 ha) is estimated to be ridges, hills and upper slopes with stony or gravelly soils (Van Vreeswyk, 2004).

Few mines exist, or are planned, within a 75 km radius of the mine area. Currently operating mines are Atlas Iron's Wodgina and Mount Dove mines. These mines are located in the Platform and Uaroo Land Systems respectively and as such are unlikely to support reptile species endemic to the rocky ridges of the Pilbara. Atlas Iron also plans to expand their current operations through development of the Abydos, Mt Webber and McPhee Creek iron ore deposits. These developments will consist of a series of open pits and associated infrastructure. The Abydos project is located within the Capricorn Land System and has a proposed disturbance footprint of 437 ha, of which 129 ha are rocky ridges or rises. Mt Webber is located in the Talga and Capricorn Land System and has a proposed disturbance footprint of 756 ha, of which 532 ha are rocky ridges or rises. Mine planning has yet to be undertaken for McPhee Creek.

Other mineral developments in the area include Venturex Resources Sulphur Springs Copper-Zinc Project, located on the Rocklea and Capricorn Land System. This will be an underground operation and surface disturbance will be limited. Altura Resources are currently undertaking exploration at their Pilgangoora lithium deposit. This deposit is located in the Talga Land System to the north west of the North Star mine area.

No mines are currently planned to be developed in the Gorge Ranges to the south and east of the Project area. This is an area of approximately 85,000 ha which includes rugged rocky ridges, breakaways and gorges. Given the low number of mines currently in operation or known to be planned, and the large area of ranges that are not currently subject to development plans, it is unlikely that there will be significant impacts on reptile species endemic to the rocky ridges of this region of the Pilbara, either through this Project or through the cumulative impact of existing and planned projects.

8.10.8 Direct Loss of, or Injury to, WC Act, Priority Listed or Migratory Fauna Species

Potentially active mounds of the Western Pebble Mound Mouse (Priority 4) have been recorded in the western portion of the Infrastructure Corridor Development Envelope on the eastern edge of the area required for the open pit (ecologia Environment, 2012e). This species has limited ability to move away from disturbance and clearing activities will impact the local population. However, as the species has been recorded across the Pilbara, suitable habitat exists outside of project development envelopes and several Pebble-mound Mouse mounds have been recorded outside of these Development envelopes, the regional impact to this species will be low.

The Long-tailed Dunnart (Priority 4) has been recorded during surveys of the Project area and surrounds, though it has not been recorded from within Project development envelopes. No significant impacts to this species are expected.

A number of bird species have been recorded from near the Project area. These are the Grey Falcon (Schedule 1), Australian Bustard (Priority 4), Bush Stone-Curlew (Priority 4), Fork-tailed Swift (Migratory, Schedule 3), Oriental Plover (Migratory, Schedule3) and the Rainbow Bee-eater (Migratory, Schedule 3). While not directly recorded from Project development envelopes, these species may be at risk of road mortality, particularly along the mine access road. As records of these species are know from across the Pilbara, any resultant loss of individuals will not significantly impact the regional representation of these species.

The potential for a pit lake post closure is discussed in Section 10.5. In the event that a pit lake forms post closure, this has the potential to attract waterbirds, including migratory bird species. There are several pit lakes in the region surrounding the Project area and their presence does not appear to have any significant impact on the conservation significance of any bird species.

8.10.9 Introduction or Attraction of Feral Fauna Species

Feral fauna species may be introduced or attracted to the Project area through incorrect disposal or storage of organic waste or the presence of permanent and accessible water sources. Of the five species of feral fauna recorded from the Project area, two are listed on the Department of Agriculture and Food’s Declared Animal List under the *Agriculture and Related Resources Act 1976* (WA). These are the wild dog and feral camel. These are listed as category A5 meaning numbers are to be controlled or reduced.

Without appropriate management, the introduction or attraction of feral fauna species may indirectly impact on native fauna through increased rates of competition for resources and may ultimately result in reduced biodiversity.

8.10.10 Changes in Fauna Behaviour

Typical fauna behaviour may be modified by the physical presence of Project infrastructure, noise and vibration emissions, light spill, water storages, landfill, and vehicular and human traffic associated with construction and operation of the Project. These changes may be particularly noticeable around the mine area. Such changes in behaviour may result in the displacement of fauna from within the vicinity of the Project resulting in a localised decrease in fauna abundance. Displaced fauna are likely to relocate to areas of similar habitat outside of the impact zone of the above mentioned aspects.

The presence of water sources, landfill and light spill may also attract fauna to the Project area. In particular waterbirds may be attracted to permanent water sources. These may also act as focal points for fauna in general during periods of drought when natural water sources dry up. Scavenging fauna (such as wild dogs, crows and Northern Quoll) may be attracted to domestic waste storage and landfill while insectivorous fauna (such as birds and bats) may be attracted to light sources due to the concentration of insects in well-lit areas.

In the event that a pit lake forms post-closure, the presence of a large body of water may attract waterbirds, including some migratory species to the area. However, there already exist some large rivers in close proximity to the mine area, including the Turner and Strelley Rivers. Habitat or waterbirds and migratory bird species exists in these large Rivers, including some permanent waterholes. The existence of a pit lake is not expected to significantly alter the behaviour of water birds or migratory species, which are likely to be attracted to the area by the presence of permanent waterholes in large rivers.

8.10.11 Potential Impacts to SRE Fauna

The potential impacts to SREs relate primarily to vegetation clearing and earthworks associated with construction and operation of the Project. Vegetation clearing has the potential to reduce suitable habitat and/or cause fragmentation which could lead to reduction of movement of SRE individuals, thereby result in a potential population decline. Earthworks may also lead to the direct loss or injury to SREs through activities such as excavation and compacting.

Fire may result in the direct mortality of SREs and contribute to a reduction of suitable habitat by removing vegetation, leaf litter and also through fragmentation of habitat.

Dust from construction and operation of the Project may also cause changes in suitable habitat through vegetation degradation and lead to alteration of habitat structure.

8.10.12 Effects of Climate Change

As discussed in Section 7.9.5, Fortescue has developed scenarios for predicted climate change impacts by the year 2030. Under the scenarios developed, average temperatures are expected to increase by 2.0°C and the frequency, duration and intensity of extreme rainfall events is predicted to increase by 10%. This is in line with predictions made by CSIRO (Dunlop, et al., 2012) regarding climate change impacts to biodiversity across four biomes in Australia.

Climate change is predicted to result in an increased frequency of extreme rainfall events in the Pilbara. At the same time, the length of dry periods between these events is expected to increase. Average temperatures and evapotranspiration rates are also predicted to increase. This may result in a contraction of fauna species to the south where temperatures may be more suitable.

Changes in vegetation structure are likely to reduce the suitability of some habitats for various fauna species. For example, those species that prefer woodland habitats are likely to disappear from the area should climate change impacts result in structural changes in vegetation away from woodlands towards grasslands.

Changes to vegetation structure due to climate change may result in the contraction of existing habitats, particularly woodland and shrubland habitats. The extent of these habitats may be reduced to areas where water availability remains higher and temperatures remain lower than that generally experienced across the region, such as south facing valleys and gorges. These reduced areas of habitat may become refuges for fauna species.

A reduction in the extent of woodland and shrubland habitats may adversely impact on the known range of the Northern Quoll, as these habitats are associated with quoll denning habitat. However, the exact impact of climate change on the vegetation and habitats of the Pilbara is not clearly understood.

8.11 Proposed Management

The main potential impacts of concern in regards to fauna are related to clearing and earthworks required for construction and operation of the Project. In order to minimise these impacts, the following management measures are proposed:

- Information in relation to the environment of the Project area, including fauna and habitats, will be included in the induction programme for the Project. The induction programme will include information in relation to roles and responsibilities. All staff and contractors will be required to undertake the induction programme.
- Internal GDPs will be required prior to commencement of activities.
- Where pipelines are required to be placed on the surface, the pipe will be raised off the ground in order to minimise impacts to surface water flow and fauna movements.
- Vehicles will be confined to defined roads and access tracks.
- Personnel trained in fauna handling will be employed during trenching operations to clear open trench of fauna on a daily basis and prior to backfilling.
- Injured fauna will be reported to the site environmental officer who will determine the appropriate course of action.
- Fauna mortalities involving EPBC Act, WC Act or DEC Priority listed species will be reported to DEC and DSEWPaC as required.
- Progressive rehabilitation will be undertaken where practicable.
- Fire prevention regimes will be implemented.

8.12 Predicted Environmental Outcome

Fauna habitats of the Project area are generally considered to be common and widespread in the region. Some habitat will be cleared during implementation of the proposal, though this will have a negligible impact on the regional representation of these habitats.

Potentially active mounds of the Western Pebble Mound Mouse have been recorded in the western portion of the Infrastructure Corridor Development Envelope on the eastern edge of the area required for the open pit (ecologia Environment, 2012e). This species has limited ability to move away from disturbance and clearing activities will impact the local population. As the species has been recorded across the Pilbara, suitable habitat exists outside of project development envelopes and several Pebble-mound Mouse mounds have been recorded outside of these envelopes, the regional impact to this species will be low.

The Long-tailed Dunnart has been recorded during surveys of the Project area and surrounds, though it has not been recorded from within Project development envelope. No impacts to this species are expected.

Bird species recorded from near the Project area (Grey Falcon, Australian Bustard, Bush Stone-Curlew, Fork-tailed Swift, Oriental Plover and the Rainbow Bee-eater) do not rely on the habitats in the Project area and will move into nearby areas of suitable habitat. No impacts to these species are expected as a result of clearing activities. Should a pit lake be present after mining ceases, this may attract waterbirds and some migratory species to the area. However, it is likely that these species are already infrequent visitors to the area due to the presence of waterholes in large rivers near the mining area. Therefore, the presence of a pit lake is not likely to significantly impact the behaviour of any waterbird or migratory species.

In relation to the Slurry Corridor and Water Corridor Development Envelopes, the impact on all recorded species of SREs is expected to be negligible due to the narrow width of the pipeline corridor, the temporary nature of the construction and the limited impacts expected to occur on potential habitat within the borefield area.

Within the mine area, some potential SRE species have been recorded from within the area required for the open pit and TSF. Some individuals are likely to be lost during construction in these envelopes. However, none of the habitats in which the potential SREs were located are unique to the Project area and extend beyond the limits of the mapped area. As a result, impact to SRE’s resulting from construction and operation of the Project are not significant in a regional context.

Impacts to Matters of NES are discussed in Section 11.

Section 9
Key Environmental Factor
Subterranean Fauna

Fortescue
The New Force in Iron Ore

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9. SUBTERRANEAN FAUNA

9.1 Mine Area

A baseline survey of stygofauna and troglofauna was undertaken over two consecutive phases during the wet (March) and dry (June to July) seasons in 2011 (Subterranean Ecology, 2012a) (Appendix 10). The survey was undertaken in accordance with EPA Guidance Statement 54 (EPA, 2003c) and Draft Guidance Statement 54a (EPA, 2007a).

The survey confirmed the presence of troglofauna and stygofauna within the Project area with the occurrence of at least 17 stygofauna species/haplotypes and 11 troglofauna morpho-species (Subterranean Ecology, 2012a) (Figure 23).

9.1.1 Stygofauna

No stygofauna species/haplotypes were recorded from within the area required for the open pit during the 2011 survey by Subterranean Ecology (2012). Approximately 40% of stygofauna records were from the alluvial plains associated with the Turner River to the west of the mine area. A further 40% of stygofauna records were from Coppins Bore, approximately 20 km north west of the mine area (Subterranean Ecology, 2012a).

Deeper sections of the North Star Banded Ironstone Formation, where minor volumes of groundwater in fractured rock systems may be encountered, do not contain cavities and therefore do not provide habitat for stygofauna (Subterranean Ecology, 2012a). The alluvial aquifer associated with the Turner River provides a large area of suitable stygofauna habitat. Other alluvial aquifers in the region, such as that associated with Coppins Bore, Lost Boy's Creek and other creeks surrounding the mine area, are also likely to provide areas of suitable habitat for stygofauna.

9.1.2 Troglofauna

Six of the troglofauna morpho-species collected have only been recorded within the mine area (Subterranean Ecology, 2012a); however, this does not necessarily indicate that they are restricted to the mine area only. Based on current scientific understanding, only two of these may be range restricted, as listed below:

- *Curculionidae* sp. NS
- *Chthoniidae* sp. NS

The Curculionidae and Chthoniidae families to which these species belong are characterised by numerous subterranean species in the Pilbara which are considered to be of conservation interest due to low dispersal capabilities or being range restricted. It is therefore considered that the two species recorded during the survey (as described above) may be of conservation interest (Subterranean Ecology, 2012a).

Chthoniidae sp. NS was recorded within the infrastructure areas of the Project and not within the pit area (Subterranean Ecology, 2012a). *Curculionidae* sp. NS was found only within the proposed mine pit footprint (Subterranean Ecology, 2012a). However, given the extent of suitable habitat which occurs within the immediate vicinity, including the ridge immediately south of the proposed mine footprint, it is likely that this species will occur outside of the proposed pit.

9.2 Slurry Development Envelope

A subterranean fauna survey has been undertaken within Fortescue's rail corridor (Bennelongia, 2008). This survey was undertaken in accordance with EPA Guidance Statement 54 (EPA, 2003c) and Draft Guidance Statement 54a (EPA, 2007a). The survey was undertaken to determine whether extracting groundwater from bores within the rail corridor was impacting on the conservation status of the species in the local stygofauna communities.

The survey identified 41 species including amphipods, isopods, copepods, ostracods, mites and oligochaetes (Bennelongia, 2008). No species recorded were restricted to areas that experience groundwater drawdown, having been located in reference bores outside the zone of groundwater extraction or known from outside the study area from previous surveys. One species, *Parastenocaris* n. sp. B3, was previously unrecorded, but was located in an area that is not experiencing groundwater drawdown.

Subterranean fauna located within the Slurry Corridor Development Envelope and surrounds are depicted in Figure 24.

9.3 Water Corridor Development Envelope

A subterranean fauna survey of the proposed Canning Basin borefield and potential area of drawdown was conducted by Subterranean Ecology during February and March 2012 (Appendix 10). The survey was undertaken in accordance with EPA Guidance Statement 54 (EPA, 2003c) and Draft Guidance Statement 54a (EPA, 2007a)

The survey recorded one specimen of an aphanoneuran worm belonging to the family Aelosomatidae from a sub-artesian bore tapping the Wallal Sandstone aquifer in the Canning Basin Borefield area (Subterranean Ecology, 2012b). The integrity of the bore from which this specimen was collected was compromised due to age and general deterioration and as such, it remains uncertain if the this worm originated from the Wallal Aquifer or more superficial waters (Subterranean Ecology, 2012b).

Other surveys of the Wallal aquifer have recorded no or very few stygofauna. This, together with the results of this survey and the confined nature of the Wallal Aquifer indicates there is a low likelihood of diverse and abundant stygofauna being present (Subterranean Ecology, 2012b).

9.4 Management Objective

The EPA objective(s) relevant to the assessment and management of terrestrial fauna are:

- 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.

9.5 Guidelines, Policies and Frameworks

Guidance on the assessment and management of subterranean species exists at a State government level, as shown in Table 39.

Table 39: State Guidance for Assessment and Management of Subterranean Fauna

Document	Description
EPA Guidance Statement Number 54: Consideration of Subterranean Fauna in Groundwater and Caves during EIA in Western Australia (EPA, 2003a)	Guidance on the information the EPA will consider when assessing proposals where the protection of stygofauna is a relevant environmental factor
EPA Guidance Statement Number 54a (Draft): Sampling Methods and Survey Considerations for Subterranean Fauna in Western Australia (EPA, 2007a)	Outlines the EPA's position in relation to what are acceptable sampling efforts and methodologies for subterranean fauna.
EPA Discussion Paper: A review of subterranean fauna assessment in Western Australia (EPA, 2012a)	Summarises developments in subterranean fauna science and EPA assessment as well as providing options for future direction of subterranean fauna assessments
Draft EPA Environmental Assessment Guideline (EAG) Consideration of subterranean fauna in environmental impact assessment in Western Australia (EPA, 2013)	Addresses how subterranean fauna are considered in EIA in Western Australia and provides advice to proponents on the level of information and survey required and how to analyse the results as part of the EIA process. This document will supersede Guidance Statement 54 once made final.

9.6 Potential Impacts

9.6.1 Mine Area

As troglofauna are found within underground air filled cavities and caves, impacts related to these animals are largely associated with those activities that require excavation of rocky material, such as development of the open pit. Impacts may also arise from placement of infrastructure, particularly those items with a large footprint such as the TSF and WRD. Where infrastructure impedes movement of water, nutrients and detritus from the surface into subsurface cavities, voids and caves, subterranean fauna habitat will be degraded.

Excavation of the open pit will result in the loss of troglofauna habitat. A total of 6 troglofauna morpho-species were recorded from the footprint of the open pit. These were *Curculionidae* sp. NS, *Meenoplidae* sp NS, *Polyxenida* sp NS, *Blattidae* sp AB_NS, *Nocticola* sp S5_NS1 and *Nocticola* sp NS2. Of these, *Curculionidae* sp. NS, *Meenoplidae* sp NS and *Polyxenida* sp NS were not recorded outside of the footprint of the open pit. Meenoplidae and Polyxenida species are not normally range restricted and it is likely that they will occur in habitat outside of the open pit. Subterranean species from the Curculionidae family generally have lower dispersal capabilities with several potentially range restricted species known from the Pilbara (Subterranean Ecology, 2012a). *Curculionidae* sp. NS is therefore likely to be range restricted.

No troglofauna species have been recorded from the area required for the TSF. Three morpho-species have been recorded from the footprint of the WRD (*Symphyla* sp NS, *Anajapygidae* sp NS and *Symphyla* sp NS). These species have either also been recorded from areas outside of the Project development enelope or were recorded from the edge of the WRD and are therefore likely to also occur in adjacent areas outside of Project development envelope while those recorded individuals are likely to move to areas of higher quality habitat should the WRD result in degradation of troglofauna habitat due to reduced infiltration of water and nutrients.

As the geology the Project area and surrounds indicates that the mine area is part of a wider, more or less continuous subterranean habitat, it is likely that the troglofauna recorded by Subterranean Ecology (2012a) occurs outside of Project development envelopes. The loss of those individuals is therefore unlikely to significantly impact the morpho-species as a whole.

Groundwater in the mine area exists within fractured rock aquifers. As a result, mining of the proposed open pit is not expected to intersect large volumes of groundwater, though minor seepage may occur. Dewatering at the mine area will not be required and there will be no drawdown in surrounding groundwater resources. As no stygofauna species have been recorded in the footprint of the open pit no impacts to stygofauna are expected.

The potential for a pit lake post closure is discussed in Section 10.5. In the event that a pit lake exists post-closure, and as discussed in Section 10.5, water within the pit void is unlikely to migrate beyond the pit walls into surrounding country rock due the geology of the area. Therefore the presence of a pit lake is not expected to cause any changes to water quality in stygofauna habitat located in alluvial aquifers within the mine area.

9.6.2 Slurry Development Envelope

Impacts to stygofauna within the slurry corridor are limited to the extraction of water for construction. An assessment of stygofauna in the rail corridor concluded that groundwater extraction within the rail bores was having no detectable effect on stygofauna species abundance or diversity (Bennelongia, 2008).

Excavation of trenches for the slurry and gas pipelines is not expected to intersect large areas of competent rock and as such there will be no impact to troglofauna species or habitat.

9.6.3 Canning Basin Borefield

The depth and confined nature of the Wallal Aquifer along with the lack of records from surveys of the aquifer suggest a low likelihood of the presence of an abundant stygofauna community. The bore in which the aphanoneuran worm was collected by Subterranean Ecology (2012b) showed signs of damage and the worm may have colonised the bore from shallower aquifers rather than the Wallal Aquifer.

There is a minimal risk that stygofauna habitat in the wider Project area may be degraded through leaks and spills from vehicles and equipment during bore construction and operation. Due to the depth to groundwater in the mine area (between 319.9 m AHD and 395.2 m AHD) the risk of degradation of stygofauna habitat due to groundwater contamination is considered to be very low.

Excavation of trenches for the water supply pipeline is not anticipated to intersect the local watertable and impacts to subterranean fauna are therefore expected to be negligible.

9.7 Proposed Management

Potential impacts to subterranean fauna in the Project area will be minimised through implementation of the following management measures:

- GDPs will be required prior to commencement of activities.
- Hydrocarbons and chemicals will be appropriately stored and bunded to minimise the potential for spillage.
- Spill kits will be provided and maintained in all areas where hydrocarbons and chemicals are stored or used.
- Drainage from areas likely to be contaminated with hydrocarbons or chemicals (such as workshops) will be captured and treated (for example through oil-water separators).
- Water abstraction will be managed through a DoW approved Groundwater Operating Strategy.

9.8 Predicted Environmental Outcome

Mining is likely to have a direct on those troglofauna species within the footprint of the open pit, particularly those with limited means of dispersal (*Curculionidae* sp. NS). The troglofauna habitat at North Star is part of a larger contiguous geological unit (Subterranean Ecology, 2012a). Subterranean Ecology (2012a) note in their report that there are examples of Pilbara troglofauna with restricted ranges occurring within habitat that is part of a larger contiguous geological unit. It is important to note that survey efforts at North Star are in accordance with the EPA's Guidance Statements 54 and 54a (statistical analysis demonstrates 83% of expected troglofauna species present have been collected, this is very high). Notwithstanding this, subterranean fauna are cryptic by nature and are difficult to collect. Further sampling, even in the area where species have previously been located, may not be successful in recapturing the same species. It is possible therefore that the species *Curculionidae* sp. NS occurs outside of the pit footprint but survey efforts have not successfully located it. The Project is unlikely to have a significant impact on the conservation of troglofauna species.

As dewatering of the proposed open pit will not be required, and given the paucity of records of stygofauna from the open pit area and Water Corridor Development Envelope, specifically the borefield area, the risk of impacts to stygofauna is considered to be very low.

The maximum depth of excavation for the slurry, gas and water supply pipelines is expected to be 3 m. If subterranean fauna are present along the Slurry Corridor and Water Corridor Development Envelopes, the small amount of disturbance required to construct the pipelines is unlikely to significantly impact these species with habitat likely to be found immediately adjacent to and below the excavated trench.

Section 10
Key Environmental Factor
Hydrological Processes

Fortescue
The New Force in Iron Ore

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10. HYDROLOGICAL PROCESSES

Assessments of the hydrology and hydrogeology of the Project area and surrounds have been undertaken and are included in Appendix 5 (WorleyParsons, 2012a), (WorleyParsons, 2012b).

10.1 Surface Hydrology

10.1.1 Regional Hydrology

Drainage lines in the region are ephemeral and generally only flow for short durations following rainfall events (WorleyParsons, 2012a). Intermittent flows normally occur during the wet season with long periods of no flow during the dry season (WorleyParsons, 2012a).

The mine area lies on the catchment boundary of the Turner River and Strelley River (Figure 9). The Turner River has a catchment of 4,802 km^2 and is a major river of the Port Hedland Coast Catchment while the Strelley River has a catchment area of 2,805 km^2 and is a sub-catchment of the Shaw River (WorleyParsons, 2012a).

The Slurry Corridor Development Envelope is located wholly within the Turner River Catchment (Figure 10), while the Water Corridor Development Envelope traverses the Strelley River, Shaw River and De Grey River catchments, including the De Grey River Public Drinking Water Supply Area (Figure 11).

10.1.2 Local Hydrology

The local topography of the proposed mine area consists of a series of plateaus, hills, ridges and valleys ranging from approximately 220 m AHD to 420 m AHD. As a result, numerous ephemeral drainages are found across the site. The main drainage lines in the area are:

- Lost Boys Creek to the north of the proposed mine pit, within the area required for the TSF, which ultimately flows into the Turner River via Chinnamon Creek.
- An unnamed creek which roughly parallels the mine access road and flows into the Turner River just south of Pincunah Waterhole.

Several small drainages on the eastern edge of the mine area flow into Six Mile Creek which ultimately flows into East Strelley River.

The Slurry Corridor Development Envelope will cross the Turner River and Chinnamon Creek. The Water Corridor Development Envelope will cross the Shaw River, De Grey River and several other unnamed creeks along its length between the mine and the Canning Basin Borefield.

A number of water pools have been identified in the vicinity of the mine area. A total of 11 pools were located during the fauna surveys as detailed in Table 40 and shown on Figure 9. These pools are likely to represent a refuge for fauna in drier months (ecologia Environment, 2012a).

Table 40: Water Pools Located During the 2011 Fauna Survey

Pool Name	Easting (m) (MGA Zone 50)	Northing (m) (MGA Zone 50)
Northern Gorge 1	712735.56	7658183.47
Northern Gorge 2	713545.11	7658568.92
Echo Pool	714504.75	7655427.66
Fig Pool	711673.60	7650631.93
Cow Spring	711107.94	7648592.44
Site 12 Pool	716248.01	7649262.99
Gorge & Rockpool	713227.75	7644656.17
Camp Pool	712628.09	7655633.76
Central Creek Pool	704366.41	7646358.90
Dirty Water Pool	718242.60	7655602.97
Clean Water Pool	718614.74	7658052.80

10.2 Hydrogeology

10.2.1 Regional Hydrogeology

Groundwater in the Pilbara region occurs in various hydrogeological environments, the most important being; alluvial aquifers (unconsolidated sediments), consolidated sediments (sedimentary rock) and fractured aquifers (Department of Water, 2010). Although generally continuous throughout the region, the watertable is sometimes absent in high areas where the weathered and fractured zone is unsaturated or where the fractures are poorly developed.

There are small supplies of variable groundwater available throughout the region (less than 10 m^3/day). Groundwater is generally fresh, except away from the main rivers on the coastal plain where brackish to saline groundwater occurs (Van Vreeswyk, 2004).

The hydrogeological studies of the Project area (mine and borefield) are provided in Appendix 6, with key information of existing groundwater conditions summarised in the sub-sections below.

10.2.2 Mine Area Hydrogeology

A conceptual model of the Project area has been created for dewatering purposes (WorleyParsons, 2012b) and is shown on Figure 12. This indicates the presence in the Project area of unconsolidated alluvial deposits (alluvial aquifer) to the north-east of the ore body, a weathered zone of basement rock (potential fractured aquifer) and a south west - north east trending fault (another potential source of groundwater).

The main recharge process to groundwater is likely to be from infiltration during rainfall events (WorleyParsons, 2012b). As the Project area is situated on top of a ridge, the up-gradient surface water catchment that could contribute to groundwater recharge is negligible.

Although the presence of an alluvial aquifer overlying the ore body has not been identified during investigations to date, the superficial aquifer present to the west has been used as a water supply for exploration purposes. The other nearest supply bores are located 3 km north (Gusboy Bore) and north east (Packer Bore) of the ore body. The yield of these production bores is estimated to be between 0.5 and 2 L/s (WorleyParsons, 2012b).

The standing water levels measured within bores in and around the Project indicate that groundwater levels are highly variable, varying between 319.9 m AHD and 395.2 m AHD within an area of 2 km^2 (WorleyParsons, 2012b).

The groundwater levels in the neighbouring production bores (Gusboy Bore and Packer Bore) and their respective monitoring bores (GVW07 and GVW06) are lower, ranging from 297.1 m AHD (GVW06) to 226.4 m AHD (Packer Bore).

The most significant groundwater body in the Project area, which was encountered during investigations, occurred in the upper weathered zone along the fault which trends south west to north east across the northern part of the ore body (WorleyParsons, 2012b).

Aquifer testing has been conducted in and around the Project area (WorleyParsons, 2012b) and this indicates that the hydraulic conductivity (permeability) and specific yield of the ore body and the surrounding country rock (basement rock) are likely to be low. The investigation works included packer testing of four bores within the centre of the ore body footprint, together with test pumping of a bore (NS0128) situated within the fault zone in the northern part of the ore body. The results of these pump tests suggest that pit inflows are likely to be very low. The effective porosity of most of the lithologies present is also considered to be negligible.

10.2.3 West Canning Basin Hydrogeology

The West Canning Basin is located 80 km east of Port Hedland (Figure 1). As previously outlined in Section 4, a borefield will be constructed within the Canning – Pardoo sub-area of the Canning – Kimberley groundwater area, which will draw water from the Canning - Wallal aquifer in order to supply both potable and process water required for the Project.

The West Canning Basin comprises three main hydrostratigraphic units (Figure 13) as detailed below in order of depth:

- Broome Sandstone (aquifer of early Cretaceous age).
- Jarlemai Siltstone (aquitard of late Jurassic age).
- Wallal Sandstone (aquifer of middle to late Jurassic age) (FMG, 2012).

As shown on Figure 13, the Wallal Sandstone is overlain and confined for much of its extent by the Jarlemai Siltstone aquitard with the Broome Sandstone situated atop this. The Wallal Sandstone ranges in thickness between 14 m and 355 m with thickness generally increasing from the south west to the north east (Aquaterra, 2009). Depth to groundwater within the borefield area has been measured at between 39.7 and 44.5 metres below ground level (FMG, 2012).

Work undertaken by Leech (1979) estimated a uniform hydraulic conductivity for the Wallal Sandstone at 20 m per day, however more recent investigations have indicated this may vary across the aquifer with values between 20 and 60 m per day recorded during work undertaken by Moly Mines and Atlas Iron (Aquaterra, 2009).

Groundwater flow in the Wallal Sandstone is generally to the north and north-west, while recharge of the aquifer occurs via rainfall infiltration south of the sub-crop of the Jarlemai Siltstone in the south and east (FMG, 2012).

Groundwater of the Wallal Sandstone is generally fresh, increasing in salinity towards the coast. Concentrations of Total Dissolved Solids (TDS) range from 250 milligrams per litre (mg/L) to 2,000 mg/L (Aquaterra, 2009). Investigations undertaken within the proposed borefield area indicate water is fresh with TDS ranging from 254 mg/L to 285 mg/L. Groundwater is currently only used for stock watering, though there are plans by the owners of Pardoo and Wallal Pastoral Leases to irrigate pasture for cattle and the Water Corporation has expressed an interest in developing the West Canning Basin in order to deliver up to 10 Gigalitres per annum (GLpa) to existing clients (FMG, 2012).

Within the proposed borefield area and surrounds, the Canning – Wallal aquifer is a confined system with no natural discharge to the ground surface (FMG, 2012). The closest surface seepages to the proposed borefield are located on the coastal plain near Pardoo Station Homestead, approximately 75 km from the proposed borefield (FMG, 2012). The temperature of the water suggests it has either been directly discharged from the Broome Sandstone or contains a component of upward leakage from the Wallal Sandstone through the Jarlemai Siltstone. Groundwater modelling undertaken in 2012 (FMG, 2012) suggests that these surface water expressions will not be impacted as a result of abstraction from the proposed borefield. All abstraction will occur in the Wallal Sandstone and, due to the high specific storage of the aquifer, drawdown is expected to be restricted to within 25 km of the borefield.

10.3 Management Objective

The EPA objective(s) relevant to the assessment and management of surface water are:

- 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 environmental values or the health, welfare or amenity of people and land uses by meeting statutory requirements and acceptable standards.

10.4 Guidelines, Policies and Frameworks

Guidance on the assessment and management of surface water exists at a State and Commonwealth government level (Table 41).

Table 41: State and Commonwealth Guidance for Assessment and Management of Surface Waters

Document	Description
Rights in Water and Irrigation Act 1914 (WA)	Provides for the regulation, management, use and protection of water resources.
Environmental Protection (Unauthorised Discharges) Regulations 2004	Prohibits discharge of certain harmful materials and wastes into the environment.
Australian and New Zealand Guidelines for Fresh and Marine Water Quality, 2000, Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ)	Outlines the principles and assessment framework for protecting and managing the environmental values supported by the water resource.
Water and Rivers Commission 2000. Environmental Water Provisions Policy for Western Australia: Statewide Policy No. 5 (WRC 2000)	Describes the principles and processes to be applied by the Commission when considering allocation and review of water use rights.
Department of Water Stormwater Management Manual for Western Australia 2004-2007 (Department of Water, 2004)	Provides policies and planning principles and best practice advice.
Water Quality Protection Guidelines (Nos 1 – 11), Mining and Mineral Processing (WRC 1999)	A set of guidelines developed jointly between DoW, Department of Mines and Petroleum (DMP) and EPA for protecting the quality of water resources in areas where mining and mineral processing occur.
Department of Water. Pilbara groundwater allocation plan 2012: For public comment (Department of Water, 2012b)	This plan sets out how the DOW will manage groundwater in the Pilbara through allocation limits, water licensing and ongoing monitoring and evaluation.
Department of Water. West Canning Basin groundwater allocation limit report (Department of Water, 2011)	Background information and method used to set an allocation limit for the De Grey and Yule alluvial aquifers.
Department of Water. Pilbara regional water plan 2010-2030 (Department of Water, 2010a)	Guides water resource management over the long term (to the year 2030) across the state.
Department of Water. Pilbara Water in Mining 2009. (Department of Water, 2009)	Provides advice on the water management issues that need to be considered by mining projects in the Pilbara region.
Department of Water. Lower De Grey River: ecological values and issues 2010 (DEC, 2010)	Description and conceptualisation of groundwater dependent ecosystems in the lower De Grey River area and management objectives. Prepared to assist with the development of ecological water requirements and water allocation plan.
Department of Water. Ecological water requirements of the lower De Grey River (Department of Water, 2012c)	Ecological water requirements (EWRs) are the water regimes required to maintain dependent ecosystems at a low level of risk. This document sets the EWR for the lower De Grey River.

10.5 Potential Impacts

10.5.1 Flooding Potential

Worley Parsons (2012a) undertook 100 year annual recurrence interval flood modelling for the Turner River and un-named tributary that runs roughly parallel to the proposed Mine Access and Haul Road. This modelling indicates that whilst the Mine Access and Haul Road is not within the floodplain, parts of the Camp and Ore Processing areas are within the floodplain. Susceptible areas of the mine footprint will require bunding and flood diversion structures. Peak flow rates at the Turner River of 785 m^3/s to 1,050 m^3/s are expected for a 1 in 10 year flood event with flows in the range of 1,840 m^3/s to 5,110 m^3/s expected for a 1 in 100 year event.

10.5.2 Changes to Surface Water Flows

The physical presence of Project related infrastructure has the potential to cause changes to the flow of surface water around the Project area. WorleyParsons (2012a) assessed the potential impacts to surface water flow, in the absence of management and mitigation measures, in the nine sub-catchments of the mine area (Figure 3 of Appendix 4). The findings of this assessment are summarised in Table 42.

The Mine Access and Haul Road crosses a number of minor streams and the Turner River. The Turner River supports vegetation community EvCc, which may be partially dependent on surface or sub-surface water flows (WorleyParsons, 2012a). WorleyParsons (2012a) anticipates changes to flow both upstream and downstream of creek crossings will be minor and localised.

The proposed TSF will completely fill the upper catchment of Lost Boys Creek, a minor tributary of Turner River. This will effectively cut off flow upstream of the TSF embankment wall and the downstream creek, prior to its confluence with the next tributary. WorleyParsons (2012a) modelled the predicted flows in Lost Boys Creek and concluded that flows recover to 80% of natural flows within 10 km of the TSF embankment wall and accordingly there is unlikely to be any observable impact on the flows entering Turner River. Flows recover to 40 – 60% of pre-development flows within 2 km of the TSF wall while flows within 1 km of the TSF wall will be below 20% of natural flows. This changed flow regime will impact on the health of vegetation in 2 km the TSF wall, particularly where vegetation includes large trees such as *Eucalyptus* or *Corymbia* species.

Table 42: Potential Impacts to Surface Water Flows

Catchment	Contained Infrastructure	Potential Impacts on Flow
M1	Stockpile	• Minor decrease in runoff. • Decrease in water quality of surface runoff.
M2	Open pit	• Reduction in catchment runoff from rainfall on open pit. • Detention effect of drainage crossings may attenuate the peak discharge rate. • Increased runoff from cleared/compacted areas. • Decrease in water quality of surface runoff. • Increased runoff coefficient from cleared/compacted areas (haul roads etc.) due to changes in infiltration properties.
M3	Stockpile	• Minor decrease in runoff. • Decrease in water quality of surface runoff.
M4	Processing plant	• Ponding upstream of roads and other obstructions. • Increased runoff from cleared/compacted areas. • Decrease in water quality of surface runoff.
M5	Minor roads and sundry infrastructure	• Minor changes to flow rates. • Decrease in water quality of surface runoff.
M6	Minor roads and sundry infrastructure	• Minor changes to flow rates. • Decrease in water quality of surface runoff.
M7	Admin area	• Increased runoff from Cleared/compacted areas. • Decrease in water quality of surface runoff.
M8	Waste rock dump	• Minor decrease in runoff • Decrease in water quality of surface runoff.
TSF	Tailings Storage Facility	• No runoff from the site

Source: Worley Parsons (2012a)

10.5.3 Deterioration of Surface Water Quality

The transportation, storage, handling and disposal of fuels, chemicals or waste materials has the potential to result in contamination of surface water flows thereby resulting in decreased water quality. Potential contamination sources include runoff from refuelling stations and workshops, product loading facilities, vehicle yards, stockpiles, and spills and leaks from hydrocarbon and chemical storages and waste water treatment facilities. Facilities with the highest risk of contamination of surface waters are considered to be the workshop and fuel storage area.

Some waste rock to be excavated from the proposed open pit has been identified as being potentially acid forming. Without appropriate management, this material may result in acidic or otherwise environmentally harmful discharges which may flow into surface waters thereby resulting in a decrease in water quality. There is also a potential for any seepage from the TSF to enter surface water systems, thereby reducing surface water quality.

10.5.4 Erosion and Sedimentation

The Project area is located within an actively eroding region (GHD, 2011) and as such sediment loads are expected to be naturally high. Clearing and earthworks associated with the implementation of the Project may expose a greater area of soil to erosion and as a result may increase the sediment load of surface water runoff. In particular, increased sediment loads may be associated with runoff from the proposed WRD, Process Rejects Landform, LGOS, and product stockpiles.

10.5.5 Impacts to Water Pools

WorleyParsons (2012a) undertook a desktop assessment of the potential impact of the Project on the water pools identified during baseline flora and fauna surveys of the Project area and surrounds by *ecologia* Environment in 2011. This assessment found that two of the 11 pools may potentially be impacted by implementation of the Project (Table 43). These were Site 12 Pool and Central Creek Pool.

Site 12 Pool is located to the east of the Project, downstream of the proposed WRD. The WRD effectively fills part of the catchment of this pool and therefore will reduce the volume of water flowing to the pool. Runoff from the WRD is also likely to have an increased sediment load. However, this constitutes only a portion of the catchment area draining into the pool and flows from the WRD will be diluted by flows from the remainder of the catchment and any impacts are expected to be minor. Additionally, *ecologia* Environment (2012a) observed that the flow of water through this pool, and presence of vegetation such as sedges, suggests that the pool is spring fed and is therefore not reliant on surface water flows.

Central Creek Pool is an ephemeral pool located on the edge of the Infrastructure Corridor Development Envelope and downstream of the area required for Ore Processing area and the Process Rejects Landform. Infrastructure which may impact on this pool is located in the headwaters of the catchment and occupy only a small portion of the total catchment for this pool. As such, any increase in sediment load or contamination of water flows will be well diluted prior to reaching the pool.

Table 43: Potential Impacts to Surface Water Pools

Water Pools	River Catchment	Potential Impacts on Water Pools
Fig Pool	Turner River	No potential impacts expected as no Project infrastructure is located upstream of this pool.
Cow Spring	Turner River	No potential impacts expected as no Project infrastructure is located upstream of this pool.
Gorge and Rock Pool	Turner River	No potential impacts expected as no Project infrastructure is located upstream of this pool.
Central Creek Pool	Turner River	Located downstream of the project area. Since these infrastructure areas constitute only a small portion of the catchment draining into the water pool, the impact on the water pool is expected to be minor.

Water Pools	River Catchment	Potential Impacts on Water Pools
Northern Gorge 1	Strelley River	No potential impacts expected as no Project infrastructure is located upstream of this pool.
Northern Gorge 2	Strelley River	No potential impacts expected as no Project infrastructure is located upstream of this pool.
Echo Pool	Strelley River	No potential impacts expected as no Project infrastructure is located upstream of this pool.
Site 12 Pool	Strelley River	Part of the waste dump at the top edge of the catchment may affect the runoff characteristics (volume and quality). Since this area constitutes a small portion of the catchment area draining into the water pool, the impact on the water pool is expected to be minor.
Camp Pool	Strelley River	No potential impacts expected as no Project infrastructure is located upstream of this pool.
Dirty Water Pool	Strelley River	No potential impacts expected as no Project infrastructure is located upstream of this pool.

Source: Worley Parsons (2012a)

While impacts to Fig Pool resulting from changes to the pools surface catchment are not expected, this pool may be impacted during construction of the access road to the TSF, and water and tailings pipelines. Potential impacts to Fig Pool include increased dust levels, disruption to fauna from increased noise and vibration levels, and degradation of vegetation and soils through human visitation to the pool. Impacts may also occur as a result of dust emissions from vehicular traffic on the access road, though traffic levels are expected to be minimal once construction is complete.

Vegetation associated with Fig Pool is not expected to be cleared and management measures will be put in place to minimise the risk of accidental clearing.

The bimodal topography of the mine area indicates that local scale groundwater systems may occur in the weathered uplands (Equinox Environmental, 2012). These local systems are likely to provide the water source for springs along the escarpment, which in turn feed a number of water pools identified by *ecologia* Environment (2012a) during the 2011 baseline surveys. Development activities which impact on these local groundwater systems may in turn impact water levels in these pools. Those pools closest to the Project development envelopes may be impacted due to changes in groundwater flow. These are Fig Pool, Cow Spring and Site 12 Pool.

The source of water in these pools (that is if they are groundwater fed or surface water fed) is not yet fully understood and further investigations will be undertaken to determine this prior to commencement of operations below the surrounding topography. FMGIB have installed water loggers at Site 12 and Fig Pool to begin capturing baseline data for use within a detailed investigation.

As Fig Pool is located on uplands which are not occupied by Project infrastructure, the groundwater system which feeds the spring above this pool is unlikely to be impacted.

Should it be shown that Site 12 Pool is a surface expression of groundwater, the presence of the WRD to the west of this pool may result in decreased infiltration and recharge of the local groundwater system which may in turn impact on water levels in the pool. Acidic or otherwise environmentally harmful seepage from the WRD may also result in contamination of the local groundwater system which may result in a decrease in the water quality of the pool.

10.5.6 Impacts to Groundwater Systems

Potential impacts to local and regional groundwater resources from construction and operation of the Project include:

- A drawdown cone of depression caused by dewatering and/or pumping of groundwater from existing bores in the rail corridor.
- Environmentally hazardous leachates from the WRD or Process Rejects Landform resulting in contamination of groundwater resources.
- Reduced infiltration in hardstand areas, stockpile areas, WRD and TSF resulting in decreased recharge to local groundwater resources.
- Contamination of groundwater from hydrocarbon spills and leaks.
- Increased infiltration of water from wet tailings in the TSF valley may increase recharge to alluvial aquifer.

10.5.7 Pit Lake Hydrodynamics

At completion of mining, the open pit will be approximately 350 m deep. The rocks surrounding the open pit contain small volumes of groundwater in fractured rock systems from a depth of approximately 105 m. These systems are not continuous within the rock which hosts the magnetite ore (WorleyParsons, 2012b). Fractured rock systems, such as those within the mine area and surrounds, display extreme spatial variability in hydraulic connectivity with high flow pathways provided mainly by fracture zones (WorleyParsons, 2012b). Due to the low porosity and permeability of the host rocks in the mine area, flow of groundwater through pore spaces in the rock is negligible. The main potential source of groundwater inflows to the open pit is the southwest – northeast fault in the northern portion of the pit. Calculations by WorleyParsons (2012b) suggest that pit water inflows will be less than 20 litres per second (L/s) after 40 years of mining.

WorleyParsons (2013) undertook modelling of the open pit to determine the potential for a pit lake to form post closure (Appendix 7). Three scenarios were examined as follows:

- **Scenario 1:** No groundwater inflow and 100% evaporation. This scenario represents the minimum inflow and maximum outflow and will determine the minimum water level of any potential pit lake.

- **Scenario 2:** Groundwater inflow of 20 L/s and 70% evaporation. This represents the maximum expected groundwater inflow calculated by WorleyParsons (2012b). A factor of 70% for evaporation is commonly used to convert pan evaporation to evaporation from an open water body (WorleyParsons, 2013). This is considered to be the most likely scenario.
- **Scenario 3:** Groundwater inflow at 64 L/s and 70% evaporation. This represents the maximum possible inflow calculated by WorleyParsons (2012b).

Each scenario was modelled using the WSIBal water balance model and the model run for a simulation period of 1000 years. In general, the models all show the pit lake rapidly rising until equilibrium is reached where inflows are equal to outflows. Scenario 1 reaches equilibrium at -74 mAHD (approximately 474 m below the top of the open pit and a depth of 126 m) while Scenario 2 reached equilibrium at 18 mAHD (approximately 382 m below the top of the open pit and a depth of 218 m) and Scenario 3 reached equilibrium at 102 mAHD (approximately 298 m below the top of the open pit and a depth of 302 m).

As the permeability and porosity of the rocks within which the open pit is situated is very low, it is unlikely that water captured by the pit will migrate outside of the open pit. The general lack of connectivity expected in the fractured rock groundwater systems in the mine area will also limit any movement of water outside of the open pit.

Water inflows to the open pit will be monitored during the life of the operation. The model will be updated periodically with recorded inflow data to verify the accuracy of the model and provide up to date information for mine closure planning. Should results from revised modelling undertaken as the Project approaches the end of its life indicate pit lake formation remains likely, FMGIB will investigate options for reducing the risk of pit lake formation, such as backfilling the open pit.

10.5.8 Pit Lake Hydrochemistry

It is recognised that where pit lakes are present, water quality is likely to deteriorate over time. Johnson and Wright (2003) describe the evolution of water quality in pit lakes. Final water quality is dependent on factors such as oxygen status, pH, hydrogeological flow, chemical composition of rock walls, biological activity and hydrothermal inputs. Concentration of all constituents of a pit lake increases due to evapo-concentration (Johnson & Wright, 2003). Where evaporation exceeds precipitation, this can lead to an increase in total dissolved solids, producing saline to hypersaline water. Where pit walls contain acid forming materials, water quality also deteriorates as acidity increases.

The dominant ions within the groundwater in the vicinity of the open pit were determined to be chloride, magnesium and bicarbonate (WorleyParsons, 2013). Electrical conductivity values range from 1,030 microsiemens per centimetre (µm/cm) to 2,760 µm/cm. WorleyParsons (2013) modelled the effect of evapo-concentration on the salts and minerals present in the water of the pit lake. A worst case scenario was assumed, in which the water in the pit lake is dominated by groundwater similar in quality to that found in monitoring bore GVW07, located in the vicinity of the Project mine area. The modelling looked at the potential for salts to precipitate in the pit lake over time.

Modelling showed that calcium/magnesium salts are likely to precipitate over the life of the pit lake while sulphate and sodium chloride minerals are not likely to precipitate due to evapo-concentration. The greatest impact to water quality is likely to be increased salinity with Scenario 2 increasing at an annual rate of 13.5 mg/L and Scenario 3 increasing at an annual rate of 19.7 mg/L. WorleyParsons (2013) predicts that salinity of the pit lake will remain within the ANZECC/ARMCANZ (2000) guidelines for livestock drinking water quality for within approximately 150 years of pit lake formation for all scenarios. Scenario 3 exceeds the guidelines after approximately 150 years, while Scenario 2 exceeds the guidelines after approximately 300 years. Modelling further indicates that calcium and magnesium are unlikely to exceed the guideline for any of the three scenarios. Sulphate may exceed the guideline in a similar patter to that shown by salinity.

Predicting water quality over long periods of time is difficult as the hydrogeological, limnological and biological/biochemical processes need to be well understood. This is often not well understood during early mine planning. Most pit lakes in WA are too young to validate pit lake water quality modelling (Johnson & Wright, 2003). There are some case studies however, including the ex-BHP mine at Mount Goldsworthy that can be used as a comparison.

Mount Goldsworthy was operational between 1966 and 1982 and is useful as a guide to pit water quality as it has been well studied since closure and occurs in similar climactic conditions to the Project. However, it should be noted that mining at Mount Goldsworthy occurred below water table and mining required an active dewatering campaign.

The final pit void has dimensions of 1200m x 500m with a depth of about 200m (Sivapalan M. , 2005). The mine extended 177m below the pre-mining water table at the time mining ceased.

Since 1982, water levels at Mount Goldsworthy open pit have almost returned to pre-mining levels. However, water quality sampling shows that salinity within the pit has increased from 2,500 mg/L TDS in 1982 to 5,500 mg/L in 1996. This increase in TDS is due to evaporation, which acts to concentrate substances within the pit water over time as described by Johnson & Wright (2003)

The potential for acid forming materials to be present in the walls of the open pit is still being characterised, however modelling demonstrates that PAF materials do occur in the hanging wall waste material (approximately 16% of the waste is currently modelled as PAF). Further geochemical testing during mining operations will provide a clearer understanding of the potential for PAF material to be present in the pit wall post-mining. Any PAF material that is present in the pit wall at closure has the potential to increase the acidity of water within the pit. However, as described above, it is not anticipated that any water within the pit will migrate beyond the pit walls due to the hard, tight geology of the host country rock. Any PAF material present in the pit wall at closure will be managed according to the North Star mine closure plan and AMD management plan.

10.5.9 Impacts to the Wallal Aquifer

Detailed investigations to identify and characterise the major aquifer units in the Canning Basin have been undertaken by Fortescue with the results imported into a detailed model in order to simulate a variety of abstraction scenarios (FMG, 2012). The scenarios simulated in the model are as follows:

- **Predictive case 1**: Abstraction from the Project borefield only with pumping rates commencing at 7 GLpa for 4 years, then 15 GLpa for 10 years and finally 20 GLpa for 10 years.
- **Supplementary scenario 1**: Abstraction from the Project borefield and concurrent abstraction from the proposed Water Corporation borefield (currently at a conceptual stage only). Project abstraction rates would commence at 13 GLpa for 5 years then rising to 20 GLpa for 15 years while Water Corporation abstraction rates would be consistent at 10 GLpa for 35 years.
- **Supplementary scenario 2**: As for Scenario 1 but with additional abstraction by Pardoo Station and Wallal Station. Abstraction rates for both Pardoo Station and Wallal Station commence at 2 GLpa in 2013. Abstraction for Pardoo Station increases to 10 GLpa by 2017 while for Wallal Station, abstraction increases to 8 GLpa by 2016.

The modelling undertaken by Fortescue (2012) predicts the maximum reduction in pressure head in the Wallal aquifer due to extraction for the Project (Predictive case 1) to be 0.8 m (at the Great Northern Highway) after 24 years. Under supplementary scenario 1, the predicted reduction in pressure head at the Great Northern Highway is 3.5 m after 32 years, while under supplementary scenario 2, the predicted reduction in pressure head is 5.9 m after 35 years. Ecological surveys of the Water Corridor Development Envelope have not recorded the presence of any Groundwater Dependent Ecosystems in the vicinity of the borefield which could be impacted by this reduction in pressure head. Additionally, Fortescue (2012) identified several surface water seepages in the vicinity of Pardoo Station, however these are over 75 km from the borefield and well beyond the potential zone of impact.

A key concern of the Department of Water has been the ability of the West Canning Basin to support abstraction for the Project in addition to that approved for Pardoo and Wallal Station, and that planned by the Water Corporation for supply to Port Hedland. The modelling undertaken by Fortescue (2012) predicts that sufficient water is available for a combined total abstraction by all parties of 1,367 GL over the period 2014 to 2050. The storage of the Wallal aquifer has been estimated to be 54,900 GL (Haig T. , 2009).

10.5.10 Effects of Climate Change

The design of any flood protection/diversion and stormwater management structures will need to take into account the predicted increase in rainfall intensity, frequency and duration, as discussed previously in Sections 7.9.5 and 8.10.12. If this is not accounted for, there is an increased risk of contaminated stormwater entering creek systems and other surface water features.

An increase in the intensity of rainfall events is also likely to result in an increase in the velocity of surface water (overland) flows. This may result in increased erosion from cleared or disturbed areas. This may also adversely impact the success of slope stabilisation works and revegetation of created landforms, such as the WRD and LGOS, through increased erosion and associated loss of growth medium/topsoil.

Increased rainfall may result in increased recharge to local groundwater systems. However, this needs to be balanced by expected increases in evaporation rates.

10.6 Proposed Management

10.6.1 Surface Water

Implementation of the Project may result in impacts to surface water through changes to the flow regime and reduction in water quality. In order to manage and mitigate potential impacts to surface water in the Project area, the following management actions will be put in place:

- Construct diversion structures (such as bunds or channels) to divert clean surface water flow around infrastructure areas, and maintain downstream flow regimes where practicable.
- Surface water diversions will be constructed such that water enters the drainage line/creek at an appropriate location to minimise erosion and scouring.
- Where practicable, diverted clean surface water flows will be directed into the drainage line to which they naturally flow.
- Potentially contaminated water from workshop areas and vehicle washdown will be captured and treated through an oil water separator, meeting the requirements of DoW Water Quality Protection Note 68 – Mechanical equipment washdown.
- Minimise the impacts of the WRD on water quality and quantity through stabilisation to prevent erosion.
- The Process Rejects Landform will be progressively constructed to provide a safe, stable, non-polluting landform.
- Toe drains and sediment traps will be installed around the perimeter of the WRD, TSF and Process Rejects Landform where required.

- Waste rock identified as potentially acid will be managed in accordance with the AMD Management Plan.
- Locate buildings and process infrastructure out of the 1 in 100 year floodplain or construct suitable protection through bunds or vertical separation.
- Hydrocarbons and chemicals will be transported, stored and handled in accordance with the applicable legislation and Australian Standards, for example AS1940.
- Undertake progressive rehabilitation of cleared areas not required for operations.
- Roads will be designed for a 1 in 5 year rainfall event.
- Prior to undertaking clearing activities in the vicinity of Fig Pool, the area to be cleared will be clearly delineated on the ground and dust and erosion management measures put in place to limit the potential indirect impact of these activities on Fig Pool.
- Additional hydrological studies will be undertaken on the pools, with the exception of Central Creek Pool as this pool is ephemeral and only present following significant rainfall events. Surface water loggers have been installed at Site 12 Pool and Fig Pool to capture baseline data. The remaining pools will be used as reference sites.
- Access to pools will be restricted to authorised personnel only.
- Information in relation to surface water features of the Project area will be included in the induction programme for the Project. This will include information regarding restriction of access to these areas. All staff, contractors and visitors will be required to undertake the induction programme.
- The design of the Project will take into account the climate change scenario developed for Fortescue (Adaptive Futures, 2011).

10.6.2 Groundwater

Management measures to minimise potentially adverse impacts on groundwater resources from the Project include:

- Spill kits will be maintained at high risk areas and on service vehicles.
- Staff and contractors will be trained in spill response and the use of spill kits.
- Hydrocarbons and chemicals will be transported, stored and handled in accordance with the applicable legislation and Australian Standards, for example AS1940.
- Waste rock material will be managed according to the AMD Management Plan.
- Mine closure planning includes measures to close the open pit and management of the pit lake.

- Should results from revised modelling undertaken as the Project approaches the end of its life indicate pit lake formation remains likely, FMGIB will investigate options for reducing this likelihood such as partially backfilling the open pit.
- Investigate opportunity to backfill open pit during operations.
- The Canning Basin borefield will be operated in accordance with a DoW approved Groundwater Operating Strategy.

10.7 Predicted Environmental Outcome

Creeks within the Project area are ephemeral, flowing for a period after heavy rainfall events and are dry for the remainder of the time. Some diversion of surface water will be necessary in order to separate clean surface water flows from potentially contaminated surface flows. However, the volume of water diverted is a small portion of that flowing from the catchments in which the Project lies and is unlikely to adversely impact downstream flows. In the case of the TSF, stream flows return to 40 – 60% of natural flows within 2 km of the TSF embankment wall, and 80% of natural flows within 10 km of the TSF embankment wall. The absence of, or reduction in flows within, 2 km of the TSF embankment wall will impact the health of vegetation in this area and is likely to result in the degradation of some vegetation, in particular, the Ap and ApTp vegetation communities which are associated with the creekline. These vegetation units are well represented in the region and the decline in the health of the vegetation due to reduced flows from the TSF catchment will not significantly impact on their regional status. Additionally, no EPBC Act, WC Act or Priority listed flora species have been recorded from the section of Lost Boys Creek impacted by reduced flows.

There is not expected to be any significant change to surface water quality as a result of implementation of the Project. The management measures outlined above will assist in minimising impacts such that they do not represent a significant risk to the environment.

While Fig Pool is unlikely to be directly impacted from construction and operation of the Project, there may be residual, indirect impacts during operations, particularly in relation to increased noise and dust levels. The management measures outlined above will assist in managing the impact to Fig Pool such that any residual impact is as low as reasonably practicable.

As groundwater in the mine area exists only in fractured rock systems and the hydraulic conductivity of the surrounding rock is very low, mining of the proposed open pit is only likely to impact those resources which it directly intersects. Groundwater investigations indicate the volume of water likely to be intercepted is low and consequently, impacts to the quantity of groundwater available in the mine area are considered to be negligible. Modelling shows that a pit lake may form post-mining. However, should a pit lake form, the geology of the host country rock will preclude the migration of pit water into surrounding geology and any groundwater present. Therefore the presence of a pit lake is unlikely to have a significant impact on groundwater present within the local area. FMGIB will continue to work towards preventing pit lake formation, including updating modelling as mining progresses and potential for backfill.

Potential for impacts to groundwater quality are considered to be highest in relation to potential environmentally harmful drainage (such as acidic, metalliferous or saline drainage) from the WRD, LGOS and Process Rejects Landform. These facilities will be constructed such that they are stable, non-polluting landforms and the risk of impacts to the environment is low.

Presence of mine infrastructure may reduce recharge to local groundwater systems in the mine area. Due to the nature of these systems (i.e. fractured rock aquifers) and the absence of groundwater dependent communities, the potential impact from reduced infiltration is considered negligible.

There are no groundwater dependant ecosystems (GDEs) within the potential drawdown cone of the Canning Basin borefield. Construction of the concentrate slurry, natural gas and water supply pipelines will not result in long-term drawdown of the watertable in areas where GDEs are located. No impacts to GDE's are anticipated as a result of implementation of the Project.

Groundwater reduction in pressure head in relation to abstraction from the Canning Basin borefield for the Project is predicted to be in the order of 0.8 m at the Great Northern Highway. In isolation, this is unlikely to impact on stock water bores in the area.

The Wallal aquifer in the area of investigation is confined and has limited connectivity to the overlying Broome aquifer. Freshwater springs at the Mandora Marsh, approximately 100 km north-east of the borefield are fed by an ancient paleo-estuary and paleodrainage channel and is not connected to the Wallal Aquifer. Freshwater springs at Eighty Mile Beach are fed by the Broome aquifer and will not be impacted through abstraction from the Wallal aquifer as these two aquifers are not connected. Additionally, modelling has predicted that impacts due to abstraction are limited to a 25 km radius from the borefield. The nearest known surface water expressions are outside of this radius.

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Section 11
Matters of National Environmental Significance

Fortescue
The New Force in Iron Ore

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11. MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE CONTROLLING PROVISIONS

The EPBC Act provides for the protection of nationally and internationally significant flora, fauna, ecological communities and heritage places.

Under the EPBC Act, the following are Matters of National Environmental Significance (MNES):

- World heritage properties.
- National heritage places.
- Wetlands of international importance (listed under the Ramsar Convention).
- Listed threatened species and ecological communities.
- Migratory species protected under international agreements.
- Commonwealth marine areas.
- The Great Barrier Reef Marine Park.
- Nuclear actions (including uranium mines).

The Project was referred to DSEWPaC on 3 December 2012. On 21 January 2013, the Federal Minister for Sustainability, Environment, Water, Populations and Communities determined the Project to be a controlled action with the controlling provisions being listed threatened species and communities. The threatened species of specific concern were advised to be Northern Quoll (*Dasyurus hallucatus*), Pilbara Leaf-nosed Bat (*Rhinonocteris aurantius*) and Pilbara Olive Python (*Liasis olivaceus barroni*).

11.1 Eighty Mile Beach RAMSAR Site

The Eighty Mile Beach RAMSAR site consists of Eighty Mile Beach (the beach) from Cape Keraudren to Cape Missiessy and Mandora Salt Marsh (DSEWPaC, 2011e).

The beach is a 220 km linear stretch characterised by extensive intertidal mudflats comprised of fine silt and clay. On the landward side of the mudflats is a narrow strip of sandy beach, consisting of coarse quartz sand, bounded by coastal dunes. The width of the beach and mudflats ranges from one to four km (Hale & Butcher, 2009). At the landward extent of the mudflats is a narrow strip of coarse quartz sand bounded by coastal dunes to the east. More than 472,000 migratory waders have been counted on the mudflats during the September to November period, with the site being one of the three most important for migratory shorebirds in Australia (CALM, 2003). Eighty Mile Beach is a significant tourism destination with primary activities being fishing, four-wheel driving and shell collecting. Access to the beach is generally via Eighty Mile Beach Caravan Park (Hale & Butcher, 2009)

A number of freshwater springs are known along the length of the beach. These are fed by the Broome aquifer. These freshwater wetlands are important to biodiversity in the arid area, providing habitat and drinking water in an otherwise dry environment.

Mandora Salt Marsh has formed over thousands of years upon what was the lower reaches and mouth of a palaeo-river and palaeo-estuary system (Graham, 1999). The main features are two large lakes which are inundated following heavy cyclonic rains. The western lake (Walyarta) is a claypan that starts close to the Great Northern Highway and extends east approximately 30 km. The eastern lake, separated from Walyarta by a calcrete ridge, is a broad, braided drainage line with islands of vegetation and small salt/clay pans (Graham, 1999). Mandora Soak contains peat deposits estimated to be about 7 000 years old.

The major hydrological values of the RAMSAR site occur in Mandora Salt Marsh, where the Eil Eil Springs, Grant Spring and Salt Creek are discharge sites for groundwater. These hydrological features are fed by the paleodrainage river. The permanence of these freshwater wetlands makes them extremely important to biodiversity in the area. Salt Creek contains one of only two inland mangrove communities in Australia (DSEWPaC, 2011e).

The Canning Basin Borefield is located approximately 100 km south west of the Mandora Marsh and more than 20 km south of Eighty Mile Beach at its closest proximity.

11.2 Threatened Fauna

A search of the Project area using the EPBC Act Protected Matters Search Tool identified seven threatened fauna species as potentially occurring in the Project area (Table 44). Four of these have a medium to high likelihood of occurrence. In addition, the Northern Marsupial Mole (*Notoryctes caurinus*) was identified from a NatureMap search as having a low likelihood of occurring near the Canning Basin borefield (ecologia Environment, 2012d).

Table 44: EPBC Act Listed Threatened Species Potentially Occurring in the Project Area

Species	EPBC Status	Project Area	Likelihood of Occurrence
Mammals			
Dasyurus hallucatus (Northern Quoll)	EN	Mine Area	**High** – recorded from surveys
		Slurry Corridor Development Envelope	**High** – known records from Slurry corridor Development Envelope
		Water Corridor Development Envelope	**Medium** – Species is likely to pass through but no denning habitat exists in the water corridor Development Envelope
Notoryctes caurinus (Karkarratul, Northern Marsupial Mole)	EN	Mine Area	**Low** – no habitat present within mine area
		Slurry Corridor Development Envelope	**Low** – no habitat present within slurry corridor Development Envelope
		Water Corridor Development Envelope	**Low** – Very little suitable habitat present within the Project area
Dasycercus cristicauda / D. blythii (Crest-tailed Mulgara / Brush-tailed Mulgara)	VU	Mine Area	**Low** – Little suitable habitat exists within the Project area
		Slurry Corridor Development Envelope	
		Water Corridor Development Envelope	
Macrotis lagotis (Greater Bilby)	VU	Mine Area	**Medium** – Not recorded during surveys of the area but suitable habitat exist and has been recorded nearby (historical)
		Slurry Corridor Development Envelope	**High** – previous records from suitable habitat across the Development Envelope
		Water Corridor Development Envelope	**High** – potential diggings recorded during site survey. Extensive suitable habitat present in proposed borefield area
Rhinonicteris aurantia (Pilbara form) (Pilbara Leaf-nosed Bat)	VU	Mine Area	**High** – Recorded from site surveys
		Slurry Corridor Development Envelope	**Low** – may forage across the Development Envelope but unlikely to be impacted
		Water Corridor Development Envelope	**Medium** – some suitable wet season roost habitat recorded
Reptiles			
Liasis olivaceus barroni (Pilbara Olive Python)	VU	Mine Area	**High** – recorded from site surveys
		Slurry Corridor Development Envelope	**Low** – Development Envelope does not cross preferred habitat
		Water Corridor Development Envelope	**Medium** – Some suitable habitat along watercourses and rocky areas

Species	EPBC Status	Project Area	Likelihood of Occurrence
Liopholis kintorei (Great Desert Skink, Tjakura, Warrarna, Mulyamiji)	VU	Water Corridor Development Envelope	**Low** – preferred habitat not found within the borefield or pipeline route. The Project is at the western edge of the species' known range

Note: EN – Endangered; VU – Vulnerable

A targeted conservation significant fauna survey of the mine area and surrounds was undertaken by *ecologia* Environment in July 2011. This survey was undertaken in accordance with EPA Guidance Statement 56 (EPA, 2004b), Technical Guide - Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (EPA and DEC, 2010), referral guideline for the Northern Quoll (DSEWPaC, 2011b), and survey guidelines for Australia's threatened reptiles (DSEWPaC, 2011d), mammals (DSEWPaC, 2011e) and bats (DEWHA, 2010). The survey confirmed the presence of the Northern Quoll, Pilbara Leaf-nosed Bat and Pilbara Olive Python in the mine area and surrounds.

In addition to the targeted survey above, FMGIB commissioned a study to determine the potential impacts of blasting on the occupancy and structure of bat caves in the Project area and their ability to support bats post-mining. The study would provide recommendations to mitigate the impact of mining activities, particularly vibrations, from blasting on the Pilbara Leaf-nosed Bat.

This study would be undertaken in two phases:

- Phase 1: Re-visit the Project area to determine the location of roost caves within the Project area.
- Phase 2: Study vibrations from an active mining area to determine impacts of blasting on the occupancy and structure of suitable roost caves in the Project area.

Upon completion of the study, FMGIB would be in a position to propose management measures to protect cave integrity, including the frequency and timing of blasts.

Phase 1 was undertaken in April 2013 and the results are provided in this Section.

The Greater Bilby was not included in the targeted fauna surveys as a limited amount of habitat occurs within the mine area and no evidence of their presence was observed during the Level 2 fauna survey, despite focussed searching within areas of suitable habitat.

11.3 Site Context and Condition

The eastern portion of the mine area consists of rocky hills and rocky outcrops while the rest of the Project area is generally flat to undulating plains (ecologia Environment, 2013). In a broad context, the vegetation of the Project area can be described as a mosaic of *Triodia* hummock grasslands and *Acacia* open shrublands (ecologia Environment, 2013). Drainage lines in the Project area support *Corymbia* and *Eucalyptus* open woodlands. Vegetation associated with gorges, water pools and dykes is of particular significance due to this vegetation being uncommon in the local area, supporting conservation significant flora and fauna species.

ecologia Environment assessed the condition of vegetation in the mine area and Water Corridor Development Envelope as part of the flora and vegetation surveys undertaken in 2011. The majority of vegetation was assessed as being in excellent or very good condition (2012a; 2012b). Table 45 details this assessment in relation to the fauna habitats present. Vegetation condition was assessed using a modified version of the vegetation condition scale described by Trudgen (1991).

A variety of habitats are present across the Project area. These are described in detail in Section 8.2. In summary, there are a variety of habitats across the Project area ranging from grasslands on sandy and alluvial plains to acacia shrubland, riparian woodlands, rocky spinifex hills and rocky ridges, breakaways and gorges. Threatened fauna species are not dependent on any one species within certain habitats, but instead rely on particular habitat types and vegetation components (ecologia Environment, 2013).

The most relevant habitat features for the Northern Quoll, Pilbara Olive Python and Pilbara Leaf-nosed Bat are the rocky gorges, cliffs and gullies associated mainly with the Rocky Ridges, Breakaways and Gorges habitat (ecologia Environment, 2013). In relation to the Mulgara and Greater Bilby, relevant habitat features consist of sandy plains and presence of long unburnt spinifex (ecologia Environment, 2013).

Table 45: Condition of Habitats

Habitat	Total Habitat Area (ha)	Condition	Area (ha)	% of Total Habitat Area
Sandy plains with spinifex and shrubs	42,655.92	Excellent	38,702.04	90.73%
		Very Good	3,953.88	9.27%
Acacia shrubland on hard soil	26.88	Excellent	26.88	100.00%
Alluvial plain grasslands	5,079.82	Excellent	1,485.36	29.24%
		Good	44.05	0.87%
		Poor	3,550.41	69.89%
Creekline	285.33	Excellent	252.78	88.59%
		Good	32.55	11.41%
Granite outcrop	4.07	Excellent	4.07	100.00%
River system	1,279.40	Excellent	57.73	4.51%
		Good	1,221.67	95.49%
Rocky ridge/breakaway/gorge	227.52	Excellent	227.52	100.00%
Sandy plains with spinifex and scattered granites	823.29	Excellent	823.29	100.00%
Stony spinifex grassland plain	15,902.48	Excellent	15,844.78	99.64%
		Very Good	31.49	0.20%
		Very Poor	26.21	0.16%

Source: *ecologia* Environment (2013)

11.4 Species Profiles

11.4.1 Northern Quoll (*Dasyurus hallucatus*) - Endangered

Profile and Habitat

The Northern Quoll is the smallest of the four quoll species found in Australia. In the Pilbara Bioregion, records are scattered across the four sub-regions (Hamersley, Fortescue Plains, Chichester and Roebourne Plains) though the majority of recent records have come from the Chichester sub-region (Hill & Ward, 2010). The Northern Quoll appears to show an affinity with the Rocklea, Macroy and Robe land systems (DSEWPaC, 2012a) as a large portion of the known records come from these land systems. The Project area is close to the centre of the species' distribution in the Pilbara (Hill & Ward, 2010).

Northern Quolls are short-lived with males generally living for a year and the oldest female recorded from the wild being three years of age (Threatened Species Scientific Committee, 2005). While males and females have similar sized home ranges outside of the breeding season, home ranges of the males expand significantly during the breeding season and can overlap several other ranges, both male and female. Oakwood (2002) suggests that female home ranges are in the order of 35 ha while male home ranges can be greater than 100 ha during the breading season.

The Northern Quoll occupies a diversity of habitats, but habitat generally encompasses some rocky area for denning with surrounding vegetated habitats used for foraging and dispersal (Threatened Species Scientific Committee, 2005). The targeted survey undertaken by *ecologia* Environment (2010) mapped a total of 900.7 ha of suitable and potential habitat in the area surrounding the envelopes that make up the mine area. Of this, approximately 295 ha was classified as critical denning habitat, comprising mainly of rocky slopes, ridges and gorges. An additional 606 ha was classified as potential denning/foraging habitat.

An assessment of the quality of identified Northern Quoll habitat was undertaken by *ecologia* Environment (2013). The assessment used a modified version of the vegetation condition scale described by Trudgen (1991). The majority of potentially suitable Northern Quoll habitat has been assessed to be in excellent to good condition.

Plate 7: Northern Quoll Capture Site

Denning habitat for the Northern Quoll is generally associated with the rocky ridge running north – south through the mine area. This ridge extends at least eight km outside of Project development envelope. Similar ridges occur to the east of the mine area. The mine area lies within a larger landscape which has not been extensively cleared and as such the native vegetation remains intact. Areas between ridges provide foraging and dispersal habitat for the Northern Quoll effectively connecting denning habitat located on these ridges.

Threatening Processes

There are a number of threats to Northern Quolls which either directly, or in combination with each other, are thought to be contributing to the decline of the species. The known and perceived threats to this species have been identified as (DSEWPaC, 2012c):

- Removal, degradation and fragmentation of habitat as a result of development actions and/or agricultural activities.
- Lethal toxic ingestion of Cane Toads.
- Inappropriate and/or changed fire regimes causing direct loss of Northern Quolls or indirect loss through reduction in suitable habitat.
- Weeds which out-compete native grasses and increase the risk of fire causing direct loss of Northern Quolls or indirect loss through reduction in suitable habitat.
- Predation by feral animals (such as cats and foxes).
- Road mortality.

Within the context of this Project scope and location, the key threatening processes for the Northern Quoll are the potential for habitat loss or fragmentation, habitat degradation, inappropriate fire regimes, predation by feral animals and road mortality.

Survey Results

A total of 20 individual Northern Quolls were captured during the targeted survey (ecologia Environment, 2011a). Four of these were female, indicating a permanent breeding population (Hill & Ward, 2010). Two female quolls were captured approximately 9.5 km north east of the Project while a third female was captured approximately 3.5 km to the south. All three of these females were captured outside the area of disturbance. The fourth female was captured close to the northern extent of the North Star plateau and within the area required for the open pit. This individual was captured on three separate occasions with all captures within 250 m of each other and within a discrete area of mapped habitat, 22 ha in extent. As the home range of female quolls is generally regarded to be about 35 ha (Oakwood M. , 2002), it is considered likely that this female will remain within the area of mapped habitat in which it was captured and is unlikely to move into habitat mapped further south along the ridgeline. Additionally, it is likely that this home range will be inherited by a daughter of this quoll (Oakwood M. , 2002).

Captures of male quolls were distributed across the majority of trapping sites. The location of all Northern Quoll captures in proximity to the mining and processing areas is shown on Figure 20 and includes records where the same individual was re-captured multiple times. Areas where female quolls have been captured are considered to be of higher value to the local population as these areas represent critical breeding habitat.

Secondary evidence of Northern Quolls were found during the survey of the Stage A railway (which corresponds with the Slurry Corridor Development Envelope), however no individuals were observed (Biota, 2004b). The 2012 survey of the Water Corridor Development Envelope did not record the presence (either through direct observation or secondary evidence) of Northern Quoll and no suitable denning habitat was mapped (ecologia Environment, 2012b).

In addition to the 23 individuals recorded from the mine area and surrounds, Northern Quolls have been recorded to the west of the Infrastructure Corridor Development Envelope and north of the mine area. This indicates that a large population may be present in the area. The presence of four female quolls indicates the population is likely to permanently reside in the area. Given the reduction in the distribution of the Northern Quoll across Australia, the presence of good quality habitat in and surrounding the mine area, and the presence of female quolls, the site may be important to the Northern Quoll population as a whole (ecologia Environment, 2013).

Plate 8: A Northern Quoll captured during Surveys and Prior to its Release

Suitable habitat for Northern Quoll is well represented in the wider region. The majority of records were from the Capricorn Land System, which extends north east and south east of the Project area. A total of 5,296 km^2 of this land system has been mapped across the Pilbara by Van Vreeswyk *et al* (2004). Additionally, the Project area is located on the north western edge of a series of ranges which extend at least 70 km to the east and 45 km south of the Project area. These ranges are expected to provide additional suitable denning, foraging and dispersal habitat for the Northern Quoll. Outback Ecology (2011) undertook a review of surveys conducted within 150 km of Atlas Iron's Abydos Direct Shipping Ore project, which is located approximately 14.5 km north east of the Project area. This review found that, of the 14 surveys undertaken, 11 recorded the presence of Northern Quoll, mostly in rocky ridges, gorges, granite outcrops and watercourses (Outback Ecology, 2011). Outback Ecology (2011) recorded a total of 11 Northern Quolls from the 172 ha Abydos study area, including three females. This indicates that the Northern Quoll is well represented in the local region and is likely to be found in areas of habitat similar to that found surrounding the Project area as shown in Figure 20.

11.4.2 Karkarratul, Northern Marsupial Mole (*Notoryctes caurinus*) - Endangered

Profile and Habitat

The Northern Marsupial Mole is a blind marsupial which lives underground and grows to a maximum length of 16 cm with a tail length of 2.6 cm. It has no external ears and is covered with long, silky golden-brown fur with a horny shield on its snout.

The preferred habitat for the Northern Marsupial Mole includes longitudinal sand dunes, interdunal flats and may include the sandy soils along river flats (ecologia Environment, 2012g).

Threatening Processes

The known and perceived threats to this species have been identified as:

- Competition and/or predation by feral species (such as feral cats and foxes).
- Inappropriate and/or changed fire regimes.

Survey Results

Previous records indicate that the Northern Marsupial Mole has been recorded within 30 km of the Water Corridor Development Envelope in the Canning Basin borefield area (ecologia Environment, 2012g). Recent field surveys undertaken in October 2011 indicate that very little suitable habitat is present within the Water Corridor Development Envelope and the Northern Marsupial Mole was not expected to occur in this area. Further, no Northern Marsupial Mole individuals or other signs of habitation were recorded during recent surveys (ecologia Environment, 2012g).

11.4.3 Mulgara (Dasycercus cristicauda and D. blythii) - Vulnerable

Profile and Habitat

There has been confusion regarding the taxonomy of the Mulgara, with a single species being recognised for the majority of the last 30 years. In 2005 the Mulgara was recognised as two distinct species (*Dasycercus cristicaudata* – Crest-tailed Mulgara and *Dasycercus blythi* – Brush-tailed Mulgara) based on genetic and morphological attributes (Woolley, 2005).

Since previous records did not distinguish between the two species there is some ambiguity over their exact distributions, however recent research indicates that the Crest-tailed Mulgara appears to be restricted to sand ridges with Spinifex understorey while the Brush-tailed Mulgara typically inhabits sandy plains and gibber plains with moderately dense Spinifex with 'runways' between clumps (Pavey *et. al.*, 2011). This revision of the species has not been formally recognised in the EPBC Act to date and as such, the two species are discussed together.

Threatening Processes

The known and perceived threats to this species have been identified as (ecologia Environment, 2012d):

- Habitat loss and modification of native vegetation due to livestock farming and grazing.
- Loss and/or fragmentation of habitat and/or sub-populations due to ecosystem/community stress.
- Human intrusions and disturbance as a result of recreational activities and/or development.

- Invasive non-native species causing competition for habitat and/or habitat degradation (for example rabbits and camels).
- Predation by invasive non-native species (such as feral cats and foxes).
- Inappropriate prescribed regimes and/or vegetation management to control fire regimes.
- Species stresses caused by low numbers of individuals.

Survey Results

Using habitat preference as a basis, it is considered unlikely that *Dasycercus cristicauda* will occur within the Project area or surrounds due to a lack of sand dunes and sand ridges. Should this species occur in the Project area it would most likely be found in the borefield area of the Water Corridor Development Envelope. *D. cristicauda* was not recorded during surveys by *ecologia* Environment (ecologia Environment, 2012g).

Secondary evidence of Mulgaras has been recorded from the Slurry Corridor Development Envelope (Biota, 2004b; ATA Environmental, 2007), particularly in the northern section. Based on the habitat present (spinifex grasslands on sandplain), these records are likely to be Brush-tailed Mulgara (*Dasycercus blythi*). Suitable habitat for *D. blythi* occurs along the Water Corridor and Slurry Corridor Development Envelopes as well as in the western portion of the Infrastructure Corridor Development Envelope. This habitat consists of Low trees/shrubs over spinifex grasslands on sandplain, Spinifex grasslands on low stony rises, Spinifex grassland sandplains, and Sandplain shrubland and spinifex grasslands.

11.4.4 Greater Bilby (*Macrotis lagotis*) - Vulnerable

Profile and Habitat

The Greater Bilby is a rabbit sized bandicoot with large ears, long, soft, blue-grey fur over most of the body, and white to cream fur on the belly. The Greater Bilby was formerly found over 70% of mainland Australia but is now restricted to less than 20% of its original distribution. In the Pilbara bioregion the majority of records are from the Chichester sub-region. A variety of habitats on soft soils are preferred by the Greater Bilby, including spinifex grasslands, acacia shrublands, open woodlands and cracking clays (ecologia Environment, 2012d).

Threatening Processes

The known and perceived threats to this species have been identified as:

- Habitat modification resulting from changed fire regimes
- Predation by foxes and feral cats and, potentially, dingoes.
- Disease, trapping and distribution of poison baits which are used for rabbit control.

- Clearing of habitat for livestock farming and grazing leading to habitat fragmentation and/or degradation, habitat loss and habitat modification.
- Mining and quarrying leading to habitat destruction and/or modification due to mining activities.
- Competition and disruption of habitat by rabbits, dogs, cats and cattle.
- Development and/or maintenance of highways, railway tracks, gas pipelines.
- Vehicle related mortality.

Within the context of this Project scope and location, the key threatening processes for the Greater Bilby are the potential for habitat loss or fragmentation, habitat degradation, predation by feral animals, changed fire regimes and road mortality.

Survey Results

The 2012 survey of the Water Supply Corridor Development Envelope by *ecologia* Environment recorded signs of potential Greater Bilby diggings at the De Grey River and within the area of the borefield (Plate 9). These diggings have not been verified as belonging to the Greater Bilby. Previous surveys of the area encompassing the Slurry Corridor Development Envelope have recorded a number of locations where secondary evidence of Greater Bilby activity (burrows, diggings and scats) were found. No Greater Bilby individuals or other signs were recorded during the survey of the mine area by *ecologia* Environment, though suitable Greater Bilby habitat (Sandy Plains with Spinifex and Scattered Granites), has been mapped along the western and eastern portions of the Infrastructure Corridor Development Envelope (ecologia Environment, 2012d) (ecologia Environment, 2012e).

Plate 9: Potential Greater Bilby digging identified in the Water Corridor Development Envelope

11.4.5 Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*) - Vulnerable

Profile and Habitat

The Pilbara Leaf-nosed Bat is a medium sized bat with short, orange fur and fleshy noseleaf structure surrounding the nostrils. The species roosts in caves and disused mines with stable, warm and humid microclimates (DSEWPaC, 2012b). They are unlikely to roost in shallow caves due to the lack of humidity in these caves (Hill & Ward, 2010). Foraging habitat is varied and has been observed in *Triodia* hummock grasslands, along creek lines with *Eucalyptus camaldulensis,* amongst granite boulders and over pools and low shrubs in ironstone gorges (DSEWPaC, 2012b). Habitat for the Pilbara Leaf-nosed Bat in the Project area is generally in good to excellent condition.

Threatening Processes

The known and perceived threats to this species have been identified as (DSEWPaC, 2012b):

- Habitat shifting and alteration related to habitat loss, modification and/or degradation.
- Ecosystem and community stresses due to restricted geographical distribution.

- Disturbance of roost caves due to mine blasting and excavations.
- Human intrusions of roost caves, particularly where bats are captured.
- Vehicle related mortality.

Within the context of this Project scope and location, the key threatening processes for the Pilbara Leaf-nosed Bat are the potential for habitat loss or fragmentation, habitat degradation, disturbances due to mine development (such as noise, vibration and artificial lighting), human intrusions into roost caves and road mortality.

Survey Results

A targeted survey undertaken of the mine area and surrounds mapped approximately 713 ha of terrain which may contain suitable potential roost habitat for the Pilbara Leaf-nosed Bat (ecologia Environment, 2011a). Of this, 418.6 ha are classed as potential wet season roost habitat and are located along the Turner River to the west of the Project area. The remaining 294.4 ha are potential dry season roost habitat and is generally found along cliffs associated with ridgelines and in gorges.

Pilbara Leaf-nosed Bats were recorded during the 2011 survey from 18 locations of the mine area and surrounds (Figure 20). Based on the location and patterns of echolocation calls, four of these were considered to represent potential roost caves with three of these considered to be potential dry season roost caves (Plate 10). The other potential roost cave is likely used only during the wet season (Hill & Ward, 2010). The survey results indicated that western cliff edges and rocky gorges with pools may provide roost habitat for this species (Hill & Ward, 2010). The number of locations from which calls were recorded and the presence of potential dry season roost caves indicate that the mine area and surrounds are likely to provide an important refuge for the species.

Plate 10: Potential Roost Cave in the Mine Area

During Phase 1 of the Bat Vibration Study, bat activity was detected at all but one site indicating the widespread presence of the species across the survey area (Bat Call WA, 2013). In particular, one cave recorded high levels of activity with over 500 calls recorded over 4 nights. The pattern of calls recorded indicated that the bats were active for the whole night, with peak of activity between sunset and midnight. This pattern of activity is typical of late wet season when the young bats are fully independent (Bat Call WA, 2013).

The results indicate that the cave is used as a roost cave during the day and that the population is in excess of 200 bats (Bat Call WA, 2013). Video recordings made at the cave entrance confirm the departure of bats from the cave after sunset. The timing and distribution of bat calls across the survey area demonstrate that bats disperse from a single roost to forage before returning to the roost before sunrise. The population at the Project area is one of 10 known sites supporting the presence of the species in the East Pilbara region (Bat Call WA, 2013). The day roost cave is located within the open pit footprint.

Activity levels at other potential roost caves were medium to low. The pattern of calls at these caves demonstrated a use of the cave spread across the night, and is typical of bats foraging away from their roost cave.

Plate 11: Pilbara Leaf-nosed Bat leaving day roost cave

The surveys of the Slurry Corridor and Water Corridor Development Envelopes did not record the presence of Pilbara Leaf-nosed Bats or suitable dry season roost habitat. It was noted that suitable wet season habitat occurs in relation to major river systems along the Water Corridor Development Envelope (ecologia Environment, 2012b).

Regional Occurrence

Surveys undertaken between 2002 and 2007 by the DEC as part of the Pilbara Biological Survey indicate that the Pilbara Leaf-nosed Bat is more common than previously thought. Additional roost caves are likely to be found throughout the Pilbara, based on recordings of foraging individuals remote from known roosts (McKenzie & Bullen, 2009).

A large colony of 50 to 100 Pilbara Leaf-nosed Bats has previously been recorded at the Lalla Rookh Mine approximately 10 km north east of the mine area (DSEWPaC, 2012b). More recent survey data from Lalla Rookh suggest the population is approximately 1500 bats (Bat Call WA, 2013).

Within the Abydos area, the species has been recorded from five locations at cliff faces, along ironstone ridges and at watering points (Coffey Environments, 2012). The Pilbara Leaf-nosed

Bat was found in two additional locations in the Abydos area during December 2010 as part of an ongoing monitoring program (Outback Ecology, 2011).

The mine area is part of an extensive series of ranges and the landforms of the mine area are therefore not considered unique in the region. While these ranges have not been extensively surveyed, it is expected that suitable roost habitat will occur across the area in similar land systems and landforms as found in the Project area.

11.4.6 Pilbara Olive Python (*Liasis olivaceus barroni*) - Vulnerable

Profile and Habitat

The Pilbara Olive Python is a sub-species of the Olive Python and occurs in the ranges of the Pilbara region (DSEWPaC, 2012c). The species is considered to be stable with sizable populations at some known sites (Pearson, 1993), though few (74) regional records exist (ecologia Environment, 2012d).

The Pilbara Olive Python inhabits watercourses and areas of permanent water in rocky gorges or gullies (Pearson, 1993). Individuals have also been seen feeding at the entrance to bat roost caves. The species has generally been recorded from the McKay, Rocklea and Newman Land Systems; however, the 2011 Level 2 survey by *ecologia* Environment recorded a number of individuals from the Capricorn Land System.

An assessment of Pilbara Olive Python habitat within the mine area and surrounds undertaken by *ecologia* Environment (2013) found that overall, habitat was in good to excellent condition with the quality of habitat reflected by the number of Pilbara Olive Python records from the 2011 surveys.

Threatening Processes

The known and perceived threats to this species have been identified as (DSEWPaC, 2012c):

- Habitat loss or fragmentation.
- Altered fire regimes.
- Predation by foxes or cats.
- Vehicle related mortality.

Within the context of this project scope and location all of the above threats are relevant to the Pilbara Olive Python.

Survey Results

The species has previously been recorded within 36 km south of the Water Corridor Development Envelope (ecologia Environment, 2012d) and within 100 km of the Infrastructure

Corridor Development Envelope (ecologia Environment, 2012e). Recent surveys of the Slurry Corridor and Water Corridor Development Envelope did not record the presence of the Pilbara Olive Python (ecologia Environment, 2012d), (ecologia Environment, 2012e), (ecologia Environment, 2012g). However, the species is known to prefer water courses (ecologia Environment, 2012d) and it is therefore likely to occur along major river systems such as the De Grey, Turner and Shaw Rivers.

In the proposed North Star mine area and surrounds, a total of approximately 1,045 ha of potentially suitable Pilbara Olive Python habitat was mapped during the 2011 targeted survey by *ecologia* Environment. Of this, the majority (418.6 ha, 40%) is associated with the Turner River. The habitat along the Turner River is considered critical habitat for Pilbara Olive Python (ecologia Environment, 2011a). Small areas of critical habitat also occur in association with water pools in rocky gorges. Some critical habitat has been identified along the edge of the rocky ridge west of the proposed open pit and associated with a creekline to the east of the mine infrastructure area. The remaining 613 ha has been classified as 'Potential' habitat or 'Inaccessible'. Pilbara Olive Python Habitat is displayed in Figure 20.

A total of six Pilbara Olive Pythons were recorded during the 2011 surveys of the mine area and surrounds. An additional three observations of secondary evidence (skin, scats or remains) were recorded during the targeted survey, for example the remains shown in Plate 11. All sightings of live pythons were at locations where surface water was present. Individual pythons were recorded at Fig Pool, Cow Spring and near Dirty Water Pool while three individuals were recorded at Site 12 Pool as shown in Figure 20. The relatively high number of Pilbara Olive Pythons recorded suggests that the mine area and surrounds may be important to this species (ecologia Environment, 2013).

Plate 12: Pilbara Olive Python Remains

11.4.7 Great Desert Skink, Tjakura, Warrarna, Mulyamiji (*Liopholis kintorei*) – Vulnerable

Profile and Habitat

The Great Desert Skink is a large burrowing lizard that can grow up to 44 cm long and has a reddish-tan smooth skin, with creamy-lemony flanks and yellow belly scales. The species has been recorded from widely scattered localities across the western deserts region and generally occurs on red sandplains and sand ridges (DSEWPaC, 2012d). Suitable vegetation for the Great Desert Skink usually consists of hummock grassland (*Triodia basedowii, T. pungens* and *T. schinzii*), with some scattered shrubs and occasional trees (e.g. *Acacia* spp., *Eucalyptus* spp., *Hakea* spp., *Grevillea* spp. and *Allocasuarina decaisneana*) (DSEWPaC, 2012d). The population at Patjarr in WA occurs on a gravelly undulating plain with scattered Black Gidgee (*Acacia pruinocarpa*) or Mulga (*A. aneura*) over *Triodia basedowii* and low shrubs.

The species constructs large burrows up to 10 cm in diameter with multiple entrances. They may move up to 100 m from their burrow when foraging and up to 10 km to colonise new areas.

Threatening Processes

The known and perceived threats to this species have been identified as:

- Habitat loss or fragmentation.
- Feral predation by foxes or cats.
- Changed fire regimes affecting habitat suitability.
- Competition and disruption of habitat by rabbits.

Survey Results

Based on preferred habitat, known distribution and lack of survey records, this species has a low likelihood of occurrence within the Project area. The Project is at the western edge of the species' known range and the preferred habitat for the Great Desert Skink was not found within the Water Corridor Development Envelope and none of the species were recorded (ecologia Environment, 2012g).

11.5 Significant Fauna Habitats

The following habitats have been identified as being of significance in relation to MNES:

- Rocky Ridges, Breakaways and Gorges - provides critical habitat for the Northern Quoll and the Pilbara Leaf-nosed Bat. Where this habitat coincides with permanent or long term pools it is also considered critical habitat for the Pilbara Olive Python (ecologia Environment, 2012d).

- Granite Outcrops, Breakaways and Boulder Piles – may provide foraging habitat for Northern Quoll (ecologia Environment, 2012d; Bamford Consulting Ecologists, 2010).

The Rocky Ridges, Breakaways and Rocky Gorges habitat provides denning habitat for the Northern Quoll, roost caves and foraging habitat for the Pilbara Leaf-nosed Bat and rock faces and permanent water pools for the Pilbara Olive Python to forage, shed their skin and mate. The habitat occurs along the edges of ridgelines, in particular occurring in association with the Gorge Range within which the mine area is located. Studies undertaken by *ecologia* Environment (2012d) have mapped 591.8 ha of this habitat in the vicinity of the mine area (Figure 20). Three potential dry roost caves for the Pilbara Leaf-nosed Bat were identified in this habitat during the 2011 surveys by *ecologia* Environment. It is now understood that the Pilbara Leaf-nosed Bat population at the mine area occurs in a day roost cave located within the mine footprint, with other caves within the mapped habitat extent utilised during night feeding for resting.

The Granite Outcrops, Breakaways and Boulder Piles are an uncommon habitat and patchy in distribution. In relation to the Project, this habitat occurs along the Slurry Corridor Development Envelope and the Infrastructure Corridor Development Envelope. This habitat may provide suitable foraging habitat for the Northern Quoll. 400 ha of this habitat have been mapped during surveys of the Project area and surrounds (Bamford Consulting Ecologists, 2010; *ecologia* Environment, 2012d).

11.6 Management Objective

The objectives of the EPBC Act are to:

- Provide for the protection of the environment, especially for MNES.
- Conserve Australian biodiversity.
- Promote ecologically sustainable development through the conservation and ecologically sustainable use of natural resources.
- Enhance the protection and management of important natural and cultural places.
- Control the international movement of wildlife, wildlife specimens and products made or derived from wildlife.

11.7 Guidelines, Policies and Frameworks

Guidance on the assessment and management of MNES exists at a Federal government level, as shown in Table 46.

Table 46: Commonwealth Guidance for Assessment and Management of MNES.

Document	Description
Environment Protection and Biodiversity Conservation	Provides guidance for the preparation and evaluation of noise impact assessment. The Act aims to prevent

Document	Description
Act 1999 (Cth)	significant impacts occurring to Matters of National Environmental Significance.
Matters of National Environmental Significance: Impact Guidelines 1.1 *Environment Protection and Biodiversity Conservation Act 1999* (2009)	Provides overarching guidance for the assessment of proposed actions to determine whether the action is likely to have significant impacts on a matter protected under national environmental law.
Matters of National Environmental Significance: Impact Guidelines 1.2 Actions on, or impacting upon, Commonwealth land and Actions by Commonwealth Agencies (2010)	This guideline helps to determine whether or not to submit a referral to the DSEWPaC and whether approval is required under the EPBC Act.
Environment Protection and Biodiversity Conservation Act 1999 referral guidelines for the endangered northern quoll *Dasyurus hallucatus* (2011)	This guideline helps to determine whether or not to submit a referral to the DSEWPaC and whether approval is required under the EPBC Act for actions that may impact the Northern Quoll.
Draft EPBC policy statement: Use of environmental offsets under the Environment Protection and Biodiversity Conservation Act 1999 (2007)	The purpose of this draft policy statement is to outline the Australian Government's position on the use of environmental offsets under the EPBC Act. The aim is to ensure the consistent, transparent and equitable use of environmental offsets under the Act.
Discussion paper: Use of environmental offsets under the *Environment Protection and Biodiversity Conservation Act 1999* (2007)	The purpose of this paper is to facilitate the development of a public policy and internal guidance for the application of environmental offsets under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

11.8 Potential Impacts

The mine area represents the highest risk of impact to MNES, particularly in relation to EPBC Act listed Threatened Fauna Species. Impacts to MNES in relation to construction of the Slurry Corridor Development Envelope, and the Water Corridor Development Envelope are considered to be minor and temporary and therefore do not constitute a significant impact in accordance with the MNES Impact Guidelines (DEWHA, 2009).

Threatening processes in relation to EPBC Act listed Threatened Fauna Species that either occur in the Project area or have a high likelihood of occurrence are identified in Table 47.

Table 47: Threatening Processes for EPBC Act Listed Fauna Recorded in the Project Area

Species	EPBC Act Status	Threatening Processes						
		Habitat Loss / Fragmentation	Habitat Degradation	Weeds	Inappropriate Fire Regimes	Feral Predators and herbivores	Road Mortality	Rehabilitation of Old Mine Workings
Northern Quoll (*Dasyurus hallucatus*)	Endangered	✓	✓	✓	✓	✓	✓	
Crest-tailed Mulgara / Brush-tailed Mulgara (*Dasycercus cristicauda / D blythii)*	Vulnerable	✓	✓		✓	✓	✓	
Greater Bilby (*Macrotis lagotis*)	Vulnerable	✓	✓		✓	✓	✓	
Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*	Vulnerable	✓	✓				✓	✓

Species	EPBC Act	Threatening Processes						
(Pilbara form))								
Pilbara Olive Python (*Liasis olivaceus barroni*)	Vulnerable	✓	✓		✓	✓	✓	

Source: DSEWPaC, (2012k)

Potential impacts to MNES species and habitats as a result of the development of the Project are discussed below.

11.8.1 Direct Loss of the Rocky Ridges, Breakaways and Rock Gorges Habitat

Clearing activities will result in the loss of about 95 ha of the Rocky Ridges, Breakaways and Rocky Gorges habitat. This habitat has been identified as being of conservation significance as it is critical denning habitat for the Northern Quoll and roosting habitat for the Pilbara Leaf-nosed Bat, including one day roost cave. Where this habitat coincides with surface water pools it is also considered suitable habitat for the Pilbara Olive Python. A total of approximately 520 ha of this habitat have been mapped in the vicinity of the Project area by *ecologia* Environment (2012d). The Rocky Ridges, Breakaways and Rocky Gorges habitat is likely to be well represented in the wider region with ranges extending at least 70 km to the east and 45 km to the south of the mine area.

11.8.2 Degradation of Surface Water Pools

The water pools in the mine area and surrounds may provide habitat for the Pilbara Olive Python, particularly where these pools are adjacent to cliffs or gorges. Three of the pools identified by *ecologia* Environment (2012d) may be indirectly impacted by construction and operation of the Project. These are Fig Pool, Site 12 Pool and Cow Spring. Pilbara Olive Pythons have been recorded from each of these three pools during surveys of the mine area and surrounds by *ecologia* Environment (2012d). Northern Quoll has also been recorded from near Fig Pool and Site 12 Pool.

None of these pools are expected to be directly impacted as a result of the Project, though a number of indirect impacts may occur. Fig Pool and Cow Spring may be indirectly impacted from:

- Decline in vegetation health due to increased dust levels as a result of construction of nearby infrastructure.
- Decreased vegetation health due to increased dust levels as a result of fugitive emissions from the LGOS and access tracks during operations.
- Degradation of these pools (such as reduce water quality, damage to vegetation or pool margins, and introduction of weed species) resulting from unauthorised access to these pools.

- Decreased health of vegetation associated with the pools and reduction in water quality, which may ultimately reduce the ability of these pools to support the Pilbara Olive Python and Northern Quoll.
- Noise and vibration emissions during construction and operation of the Project may also result in avoidance of these pools by Northern Quoll and Pilbara Olive Python.

As Fig Pool appears to contain water for much of the year, the pool is likely to act as a watering point for local fauna including the Pilbara Olive Python and Northern Quoll. As such, there is an increased risk of vehicle collisions with fauna moving to/from the pool where the TSF access road passes the pool.

A number of cattle tracks have been recorded from Cow Spring indicating this pool is used as a water source by cattle from Wallareenya Station (ecologia Environment, 2012d). Exclusion of Cattle from the Project area may result in an improvement in the condition of Cow Spring and its ability to support Pilbara Olive Python and Northern Quoll.

Site 12 Pool may be impacted as a result of:

- Reduced water level in the pool due to a reduction in surface water inflows resulting from construction of the WRD.
- Reduced water level in the pool due to decreased infiltration to the local groundwater system as a result of construction of the WRD.
- Decrease in water quality of the pool resulting from acidic or otherwise environmentally harmful seepages from the WRD to surface or ground waters.
- The above impacts may have flow on effects in relation to decreased health of vegetation associated with the pool and illness or death of fauna as a result of ingesting contaminated water from the pool. Pilbara Olive Pythons may be particularly susceptible to illness, injury or death from contaminated waters as they are likely to spend part of the time submerged in the pool.

Full details of impacts to surface water pools are provided in Section 10.5.

11.8.3 Potential Impacts to Eighty Mile Beach RAMSAR Site

The Wallal aquifer in the area of investigation is confined and has limited connectivity to the overlying Broome aquifer. Mandora Marsh, approximately 100 km north-east of the borefield is fed by an ancient paleo-estuary and paleodrainage channel and is not connected to the Wallal Aquifer. Surface water features, including wetlands associated with Eighty Mile Beach, are fed by the Broome aquifer and will not be impacted through abstraction from the Wallal aquifer. Additionally, modelling has predicted that impacts due to abstraction are limited to a 25 km radius from the borefield. The nearest known surface water expressions are outside of this radius.

11.8.4 Potential Impacts to the Northern Quoll (*Dasyurus hallucatus*)

Habitat Loss or Fragmentation

The Northern Quoll was recorded in the mine area and surrounds with additional records of secondary evidence (scats) recorded from the Slurry Corridor Development Envelope and surrounds. Within the Slurry Corridor Development Envelope, scats were recorded from the Granite Rockpiles on the Abydos Plain habitat while in the mine area this species is largely associated with the Rocky Ridges, Breakaways and Rocky Gorges habitat and the Creekline habitat. A total of approximately 1,175 ha of potential suitable Northern Quoll habitat have been mapped across the Project area and surrounds. This includes:

- Approximately 295 ha of suitable critical denning habitat within the mine area and surrounds (*ecologia* Environment 2012d).
- Approximately 606 ha of potential foraging and dispersal habitat within the mine area and surrounds (*ecologia* Environment 2012d).
- Approximately 274 ha of Granite Rockpiles on the Abydos Plain habitat suitable for foraging along the Slurry Corridor and surrounds (Biota, 2004b).

The linear nature of the natural gas pipeline, slurry pipeline, and return water pipeline will enable alignment to avoid the Granite Rockpiles on the Abydos Plain habitat where practicable, thereby limiting the amount of clearing required. Additionally, construction activities will be short lived and the corridor will be reinstated and rehabilitated once trenching activities are completed, aside from the maintenance access track and controlling regrowth to maintain pipeline integrity. The loss of small amounts of the Granite Rockpiles on the Abydos Plain habitat will not result in a significant impact to the Northern Quoll population(s).

Construction and operation of the Project will require clearing of Northern Quoll habitat identified in the mine area. This consists of both suitable denning and foraging/dispersal habitat. Development of the proposed open pit will result in the clearing of up to 44 ha (5% of the mapped extent) of suitable habitat. As a pit void will remain once the mine is closed, this area of habitat will be permanently lost. Additionally, development of the TSF and WRD will result in clearing of approximately 39 ha (4% of the mapped extent) of suitable denning habitat. Where practicable, rehabilitation will aim to provide habitat for EPBC Act protected species, including the Northern Quoll.

Four female quoll were captured during these surveys including three from outside of the Project development envelopes (both to the north and south). The fourth female was captured within the northern extent of the area required for the open pit. This indicates that a permanent and viable population exists in the mine area and surrounds. Home ranges of female quolls are generally regarded to be about 35 ha (Oakwood 2002). Given the small home range of females in comparison to those of males, the possibility exists that the loss of denning habitat will have a greater impact on female quolls than males as they may be less likely to be able to find suitable breeding habitat in the nearby area.

Vegetation clearing has the potential to result in fragmentation of Northern Quoll habitat, particularly where valley floors between ridges are cleared. Fragmentation may restrict Northern Quoll movement and require quolls to divert around Project infrastructure to access alternative foraging and denning habitat. It is not clear what impact the disruption of male quoll movement in a north – south direction due to habitat fragmentation would have on the genetic mixing of the local northern and southern groups as their genetics has not been studied.

Habitat Degradation

Northern Quoll habitat within and surrounding Project development envelopes is likely to experience elevated levels of dust deposition during construction and operation of the Project. Modelling undertaken by Sinclair Knight Merz (2011) indicates that rates of dust deposition are likely to be higher in the immediate vicinity and north-west of the proposed open pit and processing plant with dust deposition rates in the order of 10 g/m^2/month. While it is commonly accepted that vegetation in the Pilbara is adapted to a naturally dusty environment, prolonged exposure to high levels of dust deposition may adversely impact on the health of vegetation leading to degradation of habitat.

Inappropriate Fire Regimes

Without appropriate project controls and management measures, the Project has the potential to increase the frequency of fires in the vicinity of the mine area. This may result in a decline in the population of Northern Quolls in the area through a reduction of foraging habitat or reduction in cover resulting in increased predation of quolls. Fires may be caused by:

- Sparks from hot work such as welding or grinding.
- Inappropriate disposal of cigarette butts.
- Sparks or radiated heat from vehicle exhausts igniting flammable vegetative matter or other materials.

Appropriate management controls, such as requiring a spotter for all hot work activities and provision of fire fighting equipment, will be put in place such that the risk of fire resulting from Project related activities is minimised.

Feral Predators

Feral predators may impact Northern Quoll populations through increased direct predation and competition for prey and/or denning sites. The main feral predator of concern is the feral cat (Hill & Ward, 2010). The 2011 survey of the mine area recorded evidence of feral cats (ecologia Environment, 2012d) in the survey area. Feral cats may be attracted to the mine area through the presence of permanent water and alternative food sources such as kitchen wastes. Prey species may also be attracted to the mine area through the presence of permanent water and alternative food sources which may also attract feral cats.

Other Threatening Processes

Suitable foraging or dispersal habitat for the Northern Quoll exists along the proposed access road within the Infrastructure Corridor Development Envelope. This increases the potential risk of Northern Quolls being struck by vehicles on the access road as they move through the area.

The introduction of Gamba Grass (*Andropogon gayanus*), Para Grass (*Urochloa mutica*), Olive Hymenachne (*Hymenachne amplexicaulis*), Mission Grass (*Pennisetum polystachion*) and Annual Mission Grass (*Pennisetum pedicellatum*) has been identified as a key threatening process under the EPBC Act (DSEWPaC, 2012m). None of these grasses have been recorded from the Project or surrounds.

Assessment Against DSEWPaC Significant Impact Guidelines

Potential impacts to the Northern Quoll have been assessed against the Significant Impact Guidelines (DEWHA, 2009) as shown in Table 48.

Table 48: Assessment of DSEWPaC Significant Impact Guidelines for the Northern Quoll

Significant Impact Criteria – Endangered Species	Significant Impact (Yes/No)
Lead to a long-term decrease in the size of a population	Possible. Clearing of the Rocky Ridges, Breakaways and Rocky Gorges habitat may result in a temporary decline in the local population.
Reduce the area of occupancy of the species	Possible, localised in extent. Significant effect at species/population level unlikely. The physical presence of the Project has the potential to result in avoidance of the area. A total of 95 ha of Rocky Ridges, Breakaways and Rocky Gorges habitat will be permanently lost. This will reduce the occupancy of the species in the local area. Extensive suitable habitat exists to the east and south of the mine area. This includes 2,132,265 ha of rocky ranges. No developments are planned within this area.
Fragment an existing population into two or more populations	No.
Adversely affect habitat critical to the survival of a species	No.
Disrupt the breeding cycle of a population	Possible. Clearing of the Rocky Ridges, Breakaways and Rocky Gorges habitat may reduce the availability of suitable denning habitat
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Possible. Localised in extent. 95 ha of Rocky Ridges, Breakaways and Rocky Gorges habitat will be permanently lost. This may result in a temporary reduction in the local population. Given extensive suitable habitat exists to the east and south of the mine area, there is unlikely to be a decline in the species as a whole
Result in invasive species that are harmful to a critically endangered or endangered species becoming	No.

Significant Impact Criteria – Endangered Species	Significant Impact (Yes/No)
established in the endangered or critically endangered species' habitat	
Introduce disease that may cause the species to decline	No.
Interfere with the recovery of the species	No.

11.8.5 Potential Impacts to the Crest-tailed Mulgara / Brush-tailed Mulgara (*Dasycercus cristicauda / D blythii)*

Habitat Loss or Fragmentation

Secondary evidence of Mulgara has been recorded from the Slurry Corridor Development Envelope (Biota, 2004b; ATA Environmental, 2007), particularly in the northern section. Suitable habitat for the Mulgara occurs along the Slurry Corridor, Water Corridor and Infrastructure Corridor Development Envelopes and consists of:

- Low trees/shrubs over spinifex grasslands on sandplain (Slurry Corridor Development Envelope)
- Spinifex grasslands on low stony rises (Slurry Corridor Development Envelope)
- Sandplains with spinifex and scattered granites (Infrastructure Corridor Development Envelope)
- Spinifex grassland sandplains (Water Corridor Development Envelope)
- Sandplain shrubland and spinifex grasslands (Water Corridor Development Envelope)

Approximately 54,637 ha of these habitats have been mapped in the project area and surrounds.

Clearing of Mulgara habitat will be associated with linear infrastructure such as the pipelines and mine access road. The linear nature of this infrastructure will enable alignment to minimise potential impacts. During construction only small sections of the pipeline corridor will consist of open trench at any one time, with backfilling and reinstatement/rehabilitation following on progressively as pipe laying is completed. As such, impact is considered to be temporary and localised to immediate works. A maximum of 74.5 ha of potential Mulgara habitat in the Infrastructure Corridor Development Envelope, 222 ha in the Slurry Corridor Development Envelope and 716 ha in the Water Corridor Development Envelope is expected to be impacted during construction of the pipelines. This equates to less than 2% of the mapped extent of habitats suitable for the Mulgara and as such does not represent a significant impact.

Small sections of the pipelines may remain above ground where the terrain is not suitable for trenching. Where pipes are located above the ground, they will be elevated to allow for continuation of the natural surface water flow regime and movement of fauna. The potential for fragmentation of this habitat is therefore considered to be very low. The Slurry Corridor Development Envelope has already been impacted through construction of the Mainline Railway. Construction of the slurry and natural gas pipelines will not increase the level of fragmentation in this Envelope.

Habitat Degradation

The potential for degradation of Mulgara habitat is considered to be very low as suitable habitat is extensive in the region. Reinstatement and rehabilitation of the pipeline corridors will aim to return the corridors to the pre-existing landform and vegetation community as far as reasonably practicable. Management measures will be put in place to minimise the risk of degradation from hydrocarbon spills, waste products (including hydrostatic test water) and unauthorised access outside of the construction corridor.

Feral Predators and Herbivores

Feral predators may impact Mulgara populations through increased direct predation and competition for prey. In relation to the Project, the main feral predator of concern is the feral cat, though domestic dogs may also be of concern in the vicinity of towns, such as Port Hedland. The 2011 fauna survey of the mine area recorded evidence of feral cats (ecologia Environment, 2012d) in the survey area. Feral cats may be attracted to the mine area through the presence of permanent water and alternative food sources such as kitchen wastes. Prey species may also be attracted to the mine area through the presence of permanent water and alternative food sources which may also attract feral cats. As there is no suitable habitat for the Mulgara in the mine area, there is no risk of increased predation due to attraction of feral predators.

The presence of rabbits may also impact on Mulgara populations as they compete for burrows. No rabbits have been recorded during surveys of the Project area.

Road Mortality

There is some risk of road mortality (as a result of vehicle strike) to the Mulgara along the western end of the Infrastructure Corridor Development Envelope. While no Mulgaras have been recorded from this Development Envelope, suitable habitat does exist and there is a medium likelihood of this species occurring in the area. The likelihood of road mortality is considered low and as extensive suitable habitat occurs in the area and records of Mulgaras are spread across the Pilbara, there will be no impact to Mulgaras at a regional or species level.

Inappropriate Fire Regimes

Increased fire frequency can modify the structure of vegetation and results in reduced cover for Mulgaras, thereby increasing the risk of predation, either by native or introduced predators. Increased fire frequencies may also lead to a reduction in the number of prey animals as food sources for these animals are also reduced. Through these mechanisms, frequent fires in areas of Mulgara habitat can decrease their number and lead to a localised decline of the species.

The highest risk areas for fires are associated with the mine area. As there is no Mulgara habitat within the mine area and surrounds, the risk of impacts to the species, either in a local or regional context is negligible.

Assessment Against DSEWPaC Significant Impact Guidelines

Potential impacts to the Mulgara have been assessed against the Significant Impact Guidelines (DEWHA, 2009) as shown in Table 49.

Table 49: Assessment of DSEWPaC Significant Impact Guidelines for the Mulgara

Significant Impact Criteria – Vulnerable Species	Significant Impact (Yes/No)
Lead to a long-term decrease in the size of an important population of a species	No.
Reduce the area of occupancy of an important population	No. The Crest-tailed Mulgara appears to be restricted to sand ridges with Spinifex understorey. This habitat does not occur in the Project area. The Brush-tailed Mulgara prefers sandy plains and gibber plains with moderately dense Spinifex with 'runways' between clumps. Less than 2% of this habitat will be cleared.
Fragment an existing important population into two or more populations	No.
Adversely affect habitat critical to the survival of a species	No. Less than 2% of mulgara habitat will be cleared. None of this has been identified as critical habitat.
Disrupt the breeding cycle of an important population	No. The final alignment of linear infrastructure will avoid burrows where practicable.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	No. Less than 2% of mulgara habitat will be cleared.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	No
Introduce disease that may cause the species to decline	No
Interfere substantially with the recovery of the species	No

11.8.6 Potential Impacts to the Greater Bilby (*Macrotis lagotis*)

Habitat Loss or Fragmentation

Unverified diggings which display similarities to those characteristic of the Greater Bilby were recorded from the Water Corridor Development Envelope (ecologia Environment, 2012g). Habitat occurring in the Water Corridor Development Envelope, Slurry Corridor Development

Envelope and the western end of the Infrastructure Corridor Development Envelope (*ecologia* Environment (2012g); Biota, 2004b) was also considered suitable to support populations of Greater Bilby. Within the Project area (Water Corridor and Slurry Corridor) preferred habitat of the Greater Bilby consists of sandy and sandy-loam soils with spinifex. This habitat is considered to be widespread in the region (ecologia Environment, 2012g).

Clearing of potential Greater Bilby habitat will mainly be associated with the construction of pipelines and the Canning Basin Borefield. During construction only small sections of the pipeline corridor will consist of open trench at any one time, with backfilling and reinstatement/rehabilitation following on progressively as pipe laying is completed. As such, impact is considered to be temporary and localised to immediate works. A maximum of 112 ha of potential Greater Bilby habitat in the Slurry Corridor Development Envelope and 470 ha in the Water Corridor Development Envelope is expected to be impacted during construction of the pipelines.

Small sections of the pipelines may remain above ground where the terrain is not suitable for trenching. Where pipes are located above the ground, they will be elevated to allow for continuation of the natural surface water flow regime and movement of fauna. The potential for fragmentation of this habitat is therefore considered to be very low.

Habitat Degradation

The potential for degradation of Greater Bilby habitat is considered to be very low. Reinstatement and rehabilitation of the pipeline corridors will aim to return the corridors to the pre-existing landform and vegetation community as far as reasonably practicable. Management measures will be put in place to minimise the risk of degradation from hydrocarbon spills, waste products (including hydrostatic test water) and unauthorised access outside of the construction corridor.

Inappropriate Fire Regimes

Increased fire frequency can modify the structure of vegetation and results in reduced cover for the Greater Bilby, increasing the risk of predation by both feral and native predators. Increased fire frequencies may also lead to a reduction in the number of available food sources, reducing the carrying capacity of the area and thereby leading to a local decline in the population.

The highest risk areas for fires are associated with the mine area. As there is no Greater Bilby habitat within the mine area and surrounds, the risk of impacts to this species, either in a local or regional context is negligible.

Feral Predators

Predation of the Greater Bilby by feral cat and dingo/wild dog is considered to be a major threatening process for the species (Pavey, 2006). Secondary evidence of the feral cat and wild dog/dingo has been recorded from surveys of the Water Corridor Development Envelope, Slurry Corridor Development Envelope and surrounds (Biota, 2004b; ecologia Environment, 2012g).

Due to the short duration required for construction of infrastructure contained within these envelopes, Project related activities are considered unlikely to result in the attraction of feral predators in areas where the Greater Bilby is likely to occur. The maintenance access track may allow predators to move more freely across the region, however given the open nature of the existing vegetation, this is not considered to constitute a significant change.

Road Mortality

There is some risk of road mortality (as a result of vehicle strike) to the Greater Bilby along the western end of the mine access road in the Infrastructure Corridor Development Envelope. While no Greater Bilbies have been recorded from this Envelope, suitable habitat does exist and there is a medium likelihood of this species occurring in the area.

Assessment Against DSEWPaC Significant Impact Guidelines

Potential impacts to the Greater Bilby have been assessed against the Significant Impact Guidelines (DEWHA, 2009) as shown in Table 50.

Table 50: Assessment of DSEWPaC Significant Impact Guidelines for the Greater Bilby

Significant Impact Criteria – Vulnerable Species	Significant Impact (Yes/No)
Lead to a long-term decrease in the size of an important population of a species	No. The project will not result in large areas of Greater Bilby habitat being cleared. The final alignment of linear infrastructure will avoid burrows where practicable.
Reduce the area of occupancy of an important population	No. Habitat for the Greater Bilby is associated with linear infrastructure, namely in the Slurry Corridor Development Envelope, Water Corridor Development Envelope and Infrastructure Corridor Development Envelope. The project will not result in large areas of Greater Bilby habitat being cleared.
Fragment an existing important population into two or more populations	No.
Adversely affect habitat critical to the survival of a species	No. The project will not result in large areas of Greater Bilby habitat being cleared. Of the areas to be cleared, none has been identified as critical habitat for the Greater Bilby.
Disrupt the breeding cycle of an important population	No. The final alignment of linear infrastructure will avoid burrows where practicable.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	No. The project will not result in large areas of Greater Bilby habitat being cleared.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	No.
Introduce disease that may cause the species to decline	No.

Significant Impact Criteria – Vulnerable Species	Significant Impact (Yes/No)
Interfere substantially with the recovery of the species	No.

11.8.7 Potential Impacts to the Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)

Habitat Loss

The Pilbara Leaf-nosed Bat has been recorded from the mine area and surrounds (*ecologia* Environment, (2012d), including three potential dry season roost caves. One of these caves has since been confirmed as a day roost (Bat Call WA, 2013). Development of the open pit will result in the removal of this cave. Pit excavations may come within 50 m of a second cave potentially resulting in disturbance of roosting bats due to noise and vibration emissions, particularly where blasting occurs in the southern end of the pit. The remaining cave is at least 500 m from any areas proposed to be developed and is therefore considered unlikely to be disturbed.

The day roost cave within the footprint of the open pit is one of few known natural cave roosts in the Eastern Pilbara (Bat Call WA, 2013). The results from the Phase 1 survey suggest that this is the only cave that Pilbara Leaf-nosed Bats are using for roosting during the day within a range of at least 8-10 km (Bat Call WA, 2013). The cave is therefore significant habitat for the species. The loss of this habitat through mining represents a significant impact.

The caves in the Project area and surrounds are formed over centuries by the percolation of rainfall through the permeable layer of oxide material which lies above the magnetite deposit. This water meets the harder, impermeable Banded Iron Formation (BIF), at which point it begins to seep sideways before seeping out of the ridge face. The passage of water through the oxide layer dissolves minerals and softer material and over time creates preferential flow paths. Occasionally cavities that trap humidity occur through slumping and cave falls. These small channels and cavities provide the type of cave that is preferred by the Pilbara Leaf-nosed Bat.

It is uncertain whether other caves in areas mapped as suitable bat habitat may be suitable as day roosts, despite the preferential use of the day roost identified during the survey. It is known that more Rocky Ridges, Breakaways and Rocky Gorges habitat has been mapped outside of the Project area, which is host to many shelters and crevices, and that the wider Gorge Ranges which surround the Project area is also likely to provide suitable roosting habitat. The same action of percolating water through softer rock type occurs along the ridge line at North Star and the surrounding hills and it is possible that caves suitable as bat habitat occur elsewhere along the ridge and the wider area.

It is known that Pilbara Leaf-nosed Bats will occupy man-made cave structures such as abandoned mine adits (Bat Call WA, 2013). It would appear that Pilbara Leaf-nosed Bats are capable of finding alternative habitat should disturbance to their day roost cave occur, such as after a cave in. Considering the narrow window of opportunity the bats have in terms of desiccation during daylight hours, the bats appear to be able to find new day roost caves quickly after such events. Additional study in this area is considered important to better understand the habitat requirements of the species.

The loss of the day roost cave at North Star is a significant impact. However, it is possible that other suitable roost caves occur in adjacent habitat within their current home range.

A large colony of 50 to 100 Pilbara Leaf-nosed Bats has been previously recorded at the Lalla Rookh Mine approximately 10 km to the north east of the mine area (DSEWPaC, 2012b). More recent survey data at Lalla Rookh suggests abandoned mine hosts a population of approximately 1500 bats (Bat Call WA, 2013). The land system in which these roost caves are located is the Capricorn Land System. This is the main Land System present in the mine area and extends to the east in association with Ranges in the region (Figure 8).

Foraging habitat of the Pilbara Leaf-nosed Bat is diverse and it is expected that bats will forage across all habitats in the mine area. Given that these habitats are well represented outside of the Project area, the required clearing will not significantly impact on the ability of the Pilbara Leaf-nosed Bat to forage in the area should they persist after mining commences. Studies undertaken by BHP Billiton Iron Ore (2005) at the Goldsworthy mine demonstrate that Pilbara Leaf-nosed bats continue to forage near mine areas, despite blasting occurring within the open pit and the presence of mine related infrastructure.

Mine and Infrastructure Development

The Pilbara Leaf-nosed Bat is sensitive to disturbances within or in close proximity to roost caves and is known to abandon roost caves when disturbed. Displaced bats are susceptible to death through dehydration, particularly during the dry season. Disturbances may be associated with human entry of roost caves and capture for monitoring programs, as well as increased lighting and/or increased noise or vibration from Project activities. Blasting in proximity to roost caves is likely to cause Pilbara Leaf-nosed Bat to abandon the roost (DSEWPaC, 2012l). However, blasting in open cut mines has been shown to have no impact on foraging of Pilbara Leaf-nosed Bats in nearby habitat (BHP Billiton Iron Ore, 2005).

Studies at roosts have demonstrated that artificially increased light levels may delay the timing of bat emergence (Downs *et. al.*, 2003, Duverge, 2000) and disturb their use of commuting routes (Stone *et. al.*, 2009), both of which will reduce the time available for foraging.

Road Mortality

Pilbara Leaf-nosed bats are known to forage close to the ground and may also be more susceptible to vehicle strikes between dusk and dawn.

Pilbara Leaf-nosed Bat Species and Population

Pilbara Leaf-nosed Bats have been located sporadically from the Eastern Pilbara, Chichester and Hamersley Ranges and Barlee Range in the western Pilbara (DSEWPAC, 2013). In particular the species has been recorded where suitable habitat is located in close proximity to permanent pools, usually within 5 km flying distance (Bat Call WA, 2013). Location records demonstrate that the species appears to be widespread across the Pilbara, although these records appear to show a divide between bats located in the Eastern Pilbara and those located in the Central and Western Pilbara (Department of Environment and Conservation, 2007), most likely due to a lack of suitable habitat within the Fortescue River valley and Fortescue Marsh.

Population numbers at other known roosts range from a few individuals to many hundreds. Bat Call WA (2013) state that some populations number in the thousands. The closest population to the Project area is at the Lalla Rookh abandoned mine, where the population is estimated at approximately 1500. Bat Call WA (2013) suggests that the population of the mine area is an average sized population. This is considered an important population given it is one of 10 known populations in the Eastern Pilbara region.

Assessment Against DSEWPaC Significant Impact Guidelines

The DSEWPaC (2009) Significant Impact Guidelines 1.1 provides guidance on where an action is likely to have a significant impact on a species. These are discussed in Table 51.

Table 51: Assessment of DSEWPaC Significant Impact Guidelines for the Pilbara Leaf-nosed Bat

Guidance Statement	Potential Impact	Significance
Lead to long term decrease in the size of a population of the species	The removal of the cave may result in the disappearance of the species in the local area, should the population be unable to find another suitable day roost.	Significant Impact
Reduce the area of occupancy of an important population	The removal of the cave may reduce the occupancy of an important population should the population be unable to find another suitable day roost.	Significant Impact
Fragment an existing important population into two or more populations	This is unlikely to occur.	N/A
Adversely affect habitat critical to the survival of the species	The day roost cave is important for the continuing presence of the species in the local area but is not critical to the survival of the species as the species is located across the Pilbara including areas in the vicinity of the Project and including areas within conservation estate (Barlee Range).	Not Significant
Disrupt the breeding cycle of an important population	The removal of the cave may disrupt the breeding cycle of an important population depending on when disturbance occurs.	May be significant
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Removing the day roost cave will destroy habitat for the species, however, other habitat has been mapped in the local area and other populations are known to occur in the vicinity of the Project area. There may be a permanent loss of	Not significant

Guidance Statement	Potential Impact	Significance
	approximately 200 individuals but this is not likely to cause the species to decline.	
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat.	This is unlikely to occur.	N/A
Introduce disease that may cause the species to decline	This is unlikely to occur	N/A
Interfere substantially with the recovery of the species	There is no evidence that the species is currently in decline or requires management to recover at a species level	N/A

Therefore the Project is likely to have a significant impact on the Pilbara Leaf-nosed Bat population at the mine area, but is not likely to have a significant impact on the Pilbara Leaf-nosed Bat at a species level.

11.8.8 Potential Impacts to the Pilbara Olive Python (*Liasis olivaceus barroni*)

Habitat Loss or Fragmentation

Pilbara Olive Pythons have been recorded from across the Project area and adjacent areas. Critical habitat for the Pilbara Olive Python in the Project area consists of semi-permanent water pools in rocky gorges and watercourses with thick vegetation. This habitat may occur within the following broader habitats mapped by *ecologia* Environment (2012d):

- Rocky Ridges, Breakaways and Gorges.
- Granite Outcrops.
- Creekline.

Within the mine area and surrounds, 432 ha of habitat considered critical for Pilbara Olive Python has been mapped (*ecologia* Environment (2012d), the majority of which is Creekline habitat associated with the Turner River. A further 532 ha of habitat considered suitable, but not critical, for Pilbara Olive Python has been mapped in the mine area and surrounds (*ecologia* Environment 2012d).

Construction and operation of the Project will require clearing of some areas of Pilbara Olive Python habitat. This consists of:

- Approximately 3 ha (less than 1% of the mapped extent) will be cleared in order to construct the road crossing at the Turner River. This may increase the potential for road mortality of Pilbara Olive Pythons in this area.

- Development of the proposed open pit will clear a maximum of 44 ha (5% of the mapped extent) of Pilbara Olive Python habitat. As the final pit void will remain once the mine is closed, this area of habitat will be permanently lost.
- Development of the TSF and WRD will result in clearing of approximately 53 ha (5% of the mapped extent) of Pilbara Olive Python habitat.

Eleven surface water pools have been recorded in the vicinity of the mine area (Figure 9). These pools, where associated with gorges or cliffs are likely to provide habitat for the Pilbara Olive Python. No direct impacts to the pools are expected as a result of construction and operation of the Project, although, Fig Pool, Cow Spring and Site 12 Pool may be indirectly impacted. Degradation of these pools and their associated vegetation may reduce their ability to support Pilbara Olive Python which may lead to a decline in the local population. A detailed discussion on potential impacts to surface water pools is provided in Section 10.5.

There is potential for movement of Pilbara Olive Python between water pools to be impeded by Project infrastructure. In particular, the presence of the proposed open pit, processing plant and LGOS may impede movement between Fig Pool or Cow Spring and Site 12 Pool or Gorge and Rockpool. Construction of the water supply pipeline may also temporarily impede movement across the Water Corridor Development Envelope. Once construction in the Water Corridor Development Envelope is complete it is expected that any impedance to fauna movement will be removed.

Inappropriate Fire Regimes

Increased fire frequency can modify the structure of vegetation and results in reduced cover for the Pilbara Olive Python, thereby increasing the risk of predation, either by native or introduced predators. Increased fire frequencies may also lead to a reduction in the number of prey animals as food sources for these animals are also reduced. Through these mechanisms, frequent fires in areas of Pilbara Olive Python habitat can decrease their numbers and lead to a localised decline of the species.

The highest risk areas for fires are associated with the mine area. Frequent fires, particularly in relation to vegetation associated with water pools and gorges, are likely to reduce the number of Pilbara Olive Pythons in the mine area and surrounds. Management measures will be put in place to minimise the risk of fires associated with the Project. The potential for impacts to the Pilbara Olive Python is therefore considered to be low.

Feral Predators

Feral predators may impact Pilbara Olive Python populations through direct predation and competition for prey. The main feral predator of concern is the feral cat (Threatened Species Scientific Committee, 2008). Feral cats may actively hunt Pilbara Olive Pythons, particularly juveniles and this combined with competition for prey species (such as quolls and rock-wallabies) may lead to a decline in the Pilbara Olive Python population where these feral predators are present.

The 2011 survey of the mine area recorded evidence of feral cats (ecologia Environment, 2012d) in the survey area. Feral cats may be attracted to the mine area through the presence of permanent water and alternative food sources if waste is incorrectly disposed.

Other Threatening Processes

Pilbara Olive Python may be particularly vulnerable to vehicle strikes as roads are often preferred basking spots for snakes. Suitable habitat for the Pilbara Olive Python occurs within 2 km on either side of the access road.

Pilbara Olive Python has also been known to benefit from additional water sources associated with mining, such as water storage ponds (Hill & Ward, 2010).

Noise and vibration emissions resulting from blasting in the proposed open pit may cause Pilbara Olive Pythons to relocate to areas of suitable habitat further from noise and vibration sources. However, pythons are expected to move back into areas previously occupied once mining and processing operations cease.

Assessment Against DSEWPaC Significant Impact Guidelines

Potential impacts to the Pilbara Olive Python have been assessed against the Significant Impact Guidelines (DEWHA, 2009) as shown in Table 52.

Table 52: Assessment of DSEWPaC Significant Impact Guidelines for the Pilbara Olive Python

Significant Impact Criteria – Vulnerable Species	Pilbara Olive Python
Lead to a long-term decrease in the size of an important population of a species	Possible. Clearing of the Rocky Ridges, Breakaways and Rocky Gorges habitat and potential impacts to water pools may result in a temporary decline in the local population. The importance of this population is not currently known, however the species is considered to be stable in Western Australia stable with sizable populations at some known sites (Pearson, 1993).
Reduce the area of occupancy of an important population	Possible, localised in extent. Significant effect at species/population level unlikely. The physical presence of the Project has the potential to result in avoidance of the area. Disturbance to water pools may result in Pilbara Olive Pythons avoiding these areas. A total of 95 ha of Rocky Ridges, Breakaways and Rocky Gorges habitat will be permanently lost. This will reduce the occupancy of the species in the local area. As noted above, the importance of this population to the species as a whole is not known.
Fragment an existing important population into two or more populations	No.

Significant Impact Criteria – Vulnerable Species	Pilbara Olive Python
Adversely affect habitat critical to the survival of a species	No. A large area of critical habitat has been mapped along the Turner River. A small amount of clearing in this habitat is required for the access road, though this is unlikely to adversely affect the survival of the species.
Disrupt the breeding cycle of an important population	No.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	No. The species is considered to be stable in Western Australia stable with sizable populations at some known sites (Pearson, 1993).
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	No.
Introduce disease that may cause the species to decline	No.
Interfere substantially with the recovery of the species	No. The species is considered to be stable in Western Australia stable with sizable populations at some known sites (Pearson, 1993).

11.9 Proposed Management

In order to minimise adverse impacts to MNES, the following management measures are proposed:

- Internal GDPs will be required prior to commencement of activities.
- Where pipelines are required to be placed on the surface, the pipe will be raised of the ground in order to minimise impacts to surface water flow and fauna movements.
- Information on EPBC Act, WC Act or Priority listed fauna species will be included in the staff and contractor induction program for the Project.
- Investigations will be undertaken in relation to potential roost caves for the Pilbara Leaf-nosed Bat to determine the closest distance at which works can occur without causing damage to the cave structure. This will form the basis for buffer zones established around these caves.
- Buffer zones around identified potential roost caves for the Pilbara Leaf-nosed Bat will be maintained and enforced. No works will be undertaken within these buffer zones.
- The *EPBC Listed Threatened Fauna Management Plan* (NS-PL-EN-0003) will be implemented for the Project. The aim of the plan is to manage the potential impacts on EPBC listed threatened fauna species resulting from the Project. It also provides an annual fauna monitoring programme that will be used to monitor and measure the success of management measures in protecting EPBC listed threatened fauna species. This plan has been previously approved by DSEWPaC for the North Star Hematite Project and will be updated as required for this Project.

- Injured EPBC Act, WC Act or DEC Priority listed fauna will be reported to the site environmental officer who will determine the appropriate course of action.
- Fauna mortalities involving EPBC Act, WC Act or DEC Priority listed species will be reported to DEC and DSEWPaC.
- Records of all sightings of EPBC Act, WC Act or DEC Priority listed fauna in the Project area will be taken.
- Progressive rehabilitation will be undertaken where practicable.
- A Construction Environmental Management Plan will be implemented for construction of pipelines.
- Where relocation of vertebrate fauna of conservation significance is required, FMGIB will implement a methodology for trapping, temporary holding, transport and relocation of species in consultation with the DEC.
- Where practicable, directional lighting will be used to minimise any increase in light levels as a result of project activities at the nearest potential roost caves.
- Vehicle speed limits will be enforced for all Project roads and tracks. Off road driving will be prohibited unless authorised or in emergency situations.
- Driving at dawn, dusk or night will be minimised as far as practicable.
- All machinery, vehicles and plant arriving on site will inspected for signs of invasive species and will be required to be free of vegetative matter and soil/mud.
- Fire prevention regimes will be implemented.

11.10 Predicted Environmental Outcomes

Development within the Water Corridor Development Envelope and Slurry Corridor Development Envelope is unlikely to have a significant impact on Threatened fauna species as these components are minor and temporary and can be designed, planned and managed to avoid significant impacts. None of the habitats in which the protected fauna species were located were unique to the Project area and they extended beyond the limits of the mapped area (ecologia Environment, 2012g).

11.10.1 Northern Quoll

The clearing of suitable Northern Quoll denning habitat in the mine area may result in a temporary decline in the local Northern Quoll population; however, this is not expected to adversely impact the species as a whole or result in a general decline of the species in the region. The Northern Quoll is known to occur within a 50 km radius of the mine area and is considered to be highly mobile (ecologia Environment, 2012d). Approximately 900 ha of suitable habitat have been identified within 30 km of the mine area and additional (unidentified) habitat occurs across the region (ecologia Environment, 2012d).

An active and viable Northern Quoll population exists in the mine area and surrounds. Oakwood (2000) surmises that female home territories are likely inherited by one of her daughters. Of the four females captured during targeted surveys by *ecologia* Environment, three were captured at least two kilometres from proposed disturbance areas. The fourth location was within the area required for the open pit. Targeting trapping will be undertaken at this location and any quolls captured will be relocated to suitable habitat outside of the Project area, where practicable. The overall impact on breeding potential for the area immediately surrounding the Project area is considered to be low.

Implementation of the Project will result in a permanent loss of Northern Quoll denning and foraging/dispersal habitat associated with the proposed open pit, TSF, WRD and potentially the LGOS should this material remain following closure of the site. Rehabilitation and mine closure activities will aim to provide additional habitat for the Northern Quoll where practicable, however it is likely that there will be some permanent loss of habitat. Measures to offset this residual impact are discussed in Section 14.5.

11.10.2 Crest-tailed Mulgara / Brush-tailed Mulgara (*Dasycercus cristicauda / D blythii)*

Potential impacts to the Mulgara, should it occur in the Project area, are associated with the construction of pipelines within the Slurry Corridor Development Envelope and Water Corridor Development Envelope, and construction and operation of the mine access road within the Infrastructure Corridor Development Envelope. Impacts related to construction of the pipelines will be short term and temporary. Extensive suitable habitat for the Mulgara exists outside of the Project area and clearing required for the project equates to less than 2% of the mapped extended of habitats suitable for the Mulgara. It is therefore predicted that no significant impacts to the Mulgara will occur as a result of implementation of the Project.

11.10.3 Greater Bilby

Potential impacts to the Greater Bilby, should it occur in the Project area, are associated with the construction of pipelines within the Slurry Corridor Development Envelope and Water Corridor Development Envelope, and construction and operation of the Mine Access Road within the Infrastructure Corridor Development Envelope. Impacts related to construction of the pipelines will be short term and temporary and as such are considered unlikely to significantly impact the Greater Bilby.

11.10.4 Pilbara Leaf-nosed Bat

Development of the open pit will result in the removal of the Pilbara Leaf-nosed Bat day roost cave. It is known that the species is subject to rapid dehydration and death within a day if removed from a day roost (Bat Call WA, 2013). The Project is therefore likely to result in a significant decline of the Pilbara Leaf-nosed Bat population within the Project area. Avoiding the day roost cave is not possible as the cave is located in the middle of the footprint of the open pit.

The Pilbara Leaf-nosed Bat's ability to find new day roost caves should disturbance to their preferred roost cave occur is not well understood. It is known that the species is able to colonise new man-made habitat such as old abandoned underground mines. It is not known whether the species range has extended into the East Pilbara due to the presence of these abandoned mines or whether they use these preferentially to natural roost caves. However, their ability to utilise man-made habitat suggests that the Pilbara Leaf-nosed Bat is able to find new habitat either during foraging or after an event which renders their preferred roost cave unusable, such as a natural cave-in.

Additional roosting and foraging habitat is found outside of the Project's disturbance area and it is possible that upon commencement of mining, the bats will abandon the roost cave and seek an alternative roost cave. Bat Call WA (2013) note that all known bat roost caves occur in close proximity to permanent water and it should be noted that the water pools at North Star will remain post mining. This increases the likelihood that the population will attempt to remain within the area post disturbance, provided a suitable cave is available.

It is predicted that the Project will likely lead to a significant decline, and possible loss of, the Pilbara Leaf-nosed Bat population within the Project area. However, it is possible that the population may persist at North Star post-disturbance if other suitable caves are available within their home range.

11.10.5 Pilbara Olive Python

Some clearing of Pilbara Olive Python habitat will be required in order to implement the Project. Rehabilitation and closure activities will aim to provide additional habitat for the Pilbara Olive Python where practicable, however it is likely that some loss of habitat will be permanent. Python habitat associated with the proposed open pit, TSF, WRD and potentially the LGOS (should this material remain following closure of the site) will be permanently lost.

Of the 11 water pools in the vicinity of the mine area, there is potential that three may experience a degree of degradation as a result of impacts from the Project which may reduce their ability to provide suitable habitat for the Pilbara Olive Python. Monitoring will be undertaken to assess the level of impact in these pools and allow for implementation of additional management measures where required.

While there may be a local loss of individuals as a result of implementing the Project, the regional impact to the Pilbara Olive Python is expected to be moderate to low due to this species being widely distributed throughout the Pilbara. Additionally, a large area of habitat is conserved within Karijini National Park (DSEWPaC, 2012k). Measures to offset local residual impacts are discussed in Section 14.5.

Section 12
Social Environment

Fortescue
The New Force in Iron Ore

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12. SOCIAL ENVIRONMENT

The majority of the Project infrastructure relevant to this proposal is located in the Shire of East Pilbara, while the remaining infrastructure (namely a portion of the Slurry Corridor Development Envelope and Infrastructure Corridor Development Envelope) is located in the Town of Port Hedland. Port Hedland is the nearest major town by road.

The Woodstock Aboriginal community is located approximately 30 km south of the Project mine area and the Warralong Aboriginal community is approximately 15 km east of the water supply pipeline. The Project may provide potential employment opportunities for these communities.

The nearest homestead to the North Star mine area is the Panorama Homestead, located approximately 40 km north east. Mulyie Homestead, Ettrick Homestead and Warralong Homestead are located less than 15 km from the water supply pipeline. Boodarie, Indee and Wallareenya homesteads are all located within 20 km of the proposed slurry pipeline and infrastructure corridor.

The Project is not located in areas commonly used for recreational purposes.

12.1 Strategic Development of the Pilbara

The Western Australian Government's Pilbara Cities Vision, launched in 2010, focuses on strategic development of the Pilbara region including health, energy, water, housing, and community development. The Vision aims to develop a network of sustainable, attractive towns throughout the region.

The Spotlight on the Pilbara Project provides a practical framework for use in regional strategic management and policy development via information supplied by the Australian Bureau of Statistic (ABS), the Regional Development Commission and the WA Department of Regional Development and Lands.

State and local governments have established plans to facilitate the sustainable development of the Pilbara. The Town of Port Hedland has implemented the following plans to provide strategic guidance for land use and development within the town municipality:

- Town Planning Scheme No. 5.
- South Hedland Town Centre Development Plan.
- Local Planning Strategy No. 1 – Land Use Master Plan.
- Pilbara's Port City Growth Plan.
- Residential Land Rationalisation Plan (February 2011).
- Parks Improvement Program.

The Shire of East Pilbara also has the following plans which assist the effective implementation of State Planning Strategy, regional plans and policies relevant to the Shire:

- Town Planning Scheme No. 4 and amendments.
- Local Planning Policy No. 1 East Newman.
- Local Planning Policy No. 5 Newman Revitalisation Strategy.

The Transient Workforce Accommodation Proposal 2011 by the Town of Port Hedland seeks to construct a temporary 1,200 person accommodation village at the Port Hedland International Airport to alleviate pressure on accommodation for FIFO workers (Town of Port Hedland, 2011). The Development of Precinct 3 (2011) at the Port Hedland International Airport also proposes the development of a 6,000 bed accommodation village for FIFO workers and additional commercial and retail facilities.

The Port Hedland Airport Upgrade Project involves a new terminal with a full range of facilities; runway, taxiway and apron upgrades; a new hangar, various parking improvements including a multi-storey car park and other development associated with the Airport Master Plan. The aim is to upgrade airport facilities to service one million passengers annually (Town of Port Hedland, 2010).

12.2 Social Services and Infrastructure

Regional infrastructure and social services have come under increasing pressure from the significant developments within Port Hedland and the Pilbara region. Greater pressures occur due to the influx of people associated with FIFO populations who use existing infrastructure and services. FIFO populations do not necessarily contribute to the provision or maintenance of these local services through rates.

Health services in Port Hedland include the Hedland Health Campus, the Royal Flying Doctor Service, the Pilbara Community and Aged Services, Port Hedland Community Health Centre, South Hedland Community Health Centre, the Pilbara Mental Health and Drug Service and several Aboriginal Controlled Health Services. Dental services in Port Hedland are predominantly publicly provided with the addition of a number of private dentists. Major causes of hospital admissions in Port Hedland relate to injury, poisoning and complications of pregnancy (Department of Regional Development, 2012).

Primary schools in Port Hedland outnumber secondary schools, with five primary and only one secondary school within the town (BHPBIO, 2011). There is one Technical and Further Education College (TAFE) with two campuses in the Port Hedland region. Retention of secondary students in Year 12 in 2008 was about 50% (Department of Regional Development, 2012). Further, less than 51% of TAFE students due to complete apprenticeships or traineeships between 2002 and 2008 actually completed their course (Department of Regional Development, 2012).

The public housing stock in Port Hedland has dropped from 787 dwellings in 2000 to 2001 to a low of 719 dwellings in 2008-2009. With the price of rental accommodation in Port Hedland high compared to metropolitan regions, low and medium income families not involved in the higher paying resource related industries are placing extreme pressure on the public housing stock. While the stock of public housing dwellings decreases, the number of individuals and families on the waiting list has increased to a high of 361 in 2008-09 (Department of Regional Development, 2012).

12.2.1 Tourism

Tourism is recognised as an important form of economic diversification for the Pilbara region (Kelly, 2005). Tourism has a large economic potential, particularly with respect to Indigenous cultural and nature-based tourism.

Major tourist attractions in the Pilbara include the gorges within Karijini National Park (approximately 135 km southwest of the Project), the Dampier Archipelago approximately 260 km north west of the Project), Chichester Millstream National Park approximately 130 km west of the Project), Mungaroona Range Nature Reserve (Approximately 75 km south west of the Project) and the historic settlement of Marble Bar (approximately 75 km directly east of the Project, or 330 km via major roads). Port Hedland offers tourism and recreational opportunities including parks, sporting grounds, boat-launching areas, inshore and offshore fishing and access to tourist attractions such as Karijini National Park.

12.2.2 Demographics

The population of the Pilbara region was approximately 45,000 in 2010 (ABS, 2011). The majority of the Pilbara's residents are located in the towns of Port Hedland, Karratha, Newman, Tom Price, Paraburdoo, Roebourne, Wickham, Dampier, Onslow and Marble Bar.

The Pilbara region has a higher proportion of males than females, compared to the State average. In general, the age profiles for the local communities in the Pilbara reflect the State average, however there are exceptions, with less individuals aged over 65 years and more under the age of 15 years (ABS, 2011).

The total population of the Shire of East Pilbara is 10,500 (Shire of East Pilbara, 2012). The population of Port Hedland is approximately 18,650 persons, of which approximately 3,500 are FIFO workers (Western Australia Planning Commission, April 2011).The population dynamics of Port Hedland are heavily influenced by the resource industry and it is considered to be the fastest growing population in Western Australia (ABS, 2011). Population fluxes occur as a result of temporary workforces during construction, industry investment decisions and long term permanent workforce requirements for operation of new industries. There are also a higher proportion of Indigenous individuals living in Port Hedland and the Pilbara region when compared to the State average (ABS, 2011).

12.3 Fortescue's Support of Strategic Development and Communities

As part of previous projects, Fortescue has contributed to community services and facilities, regional development and local procurement of goods and services (FMG, 2008).

Fortescue is supporting the Pilbara Cities Vision and strategic development of the Pilbara through its commitment to a residential workforce, providing opportunities for local businesses, local employment, training and employment of Aboriginal people.

Fortescue has committed to awarding contracts to a total value of $1 billion to Aboriginal contractors by 2013. Since 2010, Fortescue has awarded contracts to Aboriginal contractors including Joint Ventures (JVs), to the value of more than $618 million.

Training and employment of Aboriginal people is undertaken through the Fortescue funded Vocational Training and Employment Centre (VTEC) in South Hedland and Roebourne (FMG, 2011b). Training programs include driver training and licence support, mobile plant operator courses, industrial skills and administrative training, financial management and health/wellbeing courses and support – all designed to prepare students for successful employment. Since the establishment of VTEC in 2006, Fortescue has provided training and employment opportunities and support to over 1000 Aboriginal people. Working in tandem with VTEC, Fortescue successfully achieved its Summit 300 target to prepare 300 Aboriginal people from across the Pilbara for employment with Fortescue or associated contractors. At the end of December 2012, 420 Aboriginal people were employed by Fortescue, representing 11.2% of the company's total workforce, and more than 350 Aboriginal people were employed by contractors at that time.

Fortescue is also funding $3 million worth of community initiatives in Port Hedland, as well as funding a community grants program in the Town of Port Hedland and Shire of East Pilbara to support local projects. Fortescue has supported the economy of Port Hedland through its local expenditure of approximately $84.28 million from June 2010 to June 2011.

The following activities have been undertaken by Fortescue to support strategic development and communities in the Pilbara region:

- Investing almost $100 million on the construction of new houses in Port Hedland and has budgeted for a five year housing construction program
- Contributing funds to enable the upgrade of 36 km of road in the Shire of East Pilbara
- Helping a children's charity to build a house in Port Hedland, with the profit from the sale to be used by Variety WA towards its programs for local children
- Establishing a world class iron ore metallurgical testing plant at Newman that will help increase local employment opportunities and local community business opportunities
- Supporting a government housing initiative to attract and retain more doctors to Port Hedland

- Facilitating and sponsoring the establishment and operation of Scotty's Training Cafe at Port Hedland. This will act as a community meeting point and provide a vocational training environment for workers in hospitality.

Fortescue recognises that for the Pilbara to generate wealth and opportunities for Australians for many years, it must host long term, fully sustainable and high quality living communities.

12.4 Heritage

12.4.1 Native Title

The Project will traverse the Njamal, Warrarn People and Kariyarra Native Title Claims. In December 2011, Fortescue signed a land access agreement with the Njamal Native Title holders. The land access agreement provides certainty of tenure for part of the land covered by the Project and creates a production sharing agreement with the Njamal People who will become co-owners and joint operators of a proposed separate magnetite mine. The agreement provides unique commercial opportunities and a base for economic self-determination for the Njamal as well as putting in place exclusion zones to protect sites of cultural importance. Additionally, the agreement incorporates a detailed section on environmental management which prescribes that Fortescue must consult with the Njamal Elders on environmental management and, wherever possible and appropriate, incorporate Njamal traditional environmental management practice and procedure into the development of environmental management plans.

Fortescue have also negotiated land access agreements with the Kariyarra and Warrarn Native Title claimants.

12.4.2 Aboriginal Heritage

Heritage surveys of the mine area have been completed, with additional surveys for the water supply pipeline planned for 2013. These surveys involve anthropologists, archaeologists and representatives from the Traditional Owners. The surveys are consistent with the requirements and expectations for heritage surveys as defined in the EPA Guidance Statement Number 41: Assessment of Aboriginal Heritage (EPA, 2004c) and the *Aboriginal Heritage Act 1972.*

A search of the Department of Indigenous Affairs Aboriginal Heritage Inquiry System for the Project returned a number of registered and lodged sites. The results of the search are provided in Appendix 11 (DIA, 2012a) (DIA, 2012b). The identified sites are largely artefact scatters or grinding patches. Sites 29189, 29794 are identified as quarries while sites 809 and 23898 are identified as meeting places or camps. These sites are located in the vicinity of the Slurry Corridor Development Envelope. Additionally, the Turner River has been identified as a heritage place with generalised cultural importance to the local Aboriginal people, but is not a Registered Site.

Woodstock Abydos is located approximately 30 km south of the Project and is a protected area under the *Aboriginal Heritage Act 1972*. More than 500 Aboriginal sites within the Woodstock Abydos Protected Area are listed with the Department of Indigenous Affairs (DIA).

Indigenous heritage sites identified in the vicinity of the Project are shown on Figure 26.

12.4.3 European Heritage

In Western Australia, the *Heritage of Western Australia Act 1990* provides for the conservation of places identified to have significance to the cultural heritage of the State. Under the Act, places identified as meeting the criteria outlined in Section 47 are placed onto the State Register of Heritage Places. Places of Commonwealth heritage significance are protected under Part 15 of the EPBC Act and include World Heritage properties, National Heritage places and Commonwealth Heritage places.

Searches of the following databases were undertaken to identify cultural heritage values relevant to the Project:

- inHerit: searchable, online database of the Western Australian Register of Heritage Places.
- Heritage registers maintained by the Town of Port Hedland and Shire of East Pilbara.
- Australian Heritage Database: searchable, online database of places on the following lists:
  - World Heritage List.
  - National Heritage List.
  - Commonwealth Heritage List.
  - Register of the National Estate.
  - List of Overseas Places of Historic Significance to Australia

Database searches for the Shire of East Pilbara and Town of Port Hedland identified a number of sites of heritage significance. None of these sites are within 10 km of the Project area.

The nearest National Heritage Place is the Dampier Archipelago (including the Burrup Peninsula) which is approximately 200 km from Port Hedland. Mulyie Station Homestead is listed as an indicative place on the Register of the National Estate and is located near the De Grey River, 14 km south of Goldsworthy and approximately 6 km north-west of the water supply pipeline.

12.5 Management Objective

The EPA objective(s) relevant to the assessment and management of the community and cultural heritage are to ensure that:

- Risk from the proposal is as low as reasonably achievable and complies with acceptable standards and EPA criteria.
- The aesthetic values are considered and measures are adopted to reduce visual impacts on the landscape as low as reasonably practicable.
- Existing and planned recreational uses are not compromised.
- To ensure that changes to the biophysical environment do not adversely affect historical and cultural associations and comply with relevant heritage legislation.

Fortescue's overall objective is to create self-empowerment within communities by encouraging innovative partnerships and initiatives that build the capacity of the local communities. Fortescue contributes to the economic growth of communities, working with local suppliers and focussing on local employment.

12.6 Guidelines, Policies and Frameworks

Guidelines, policies and frameworks to assist with impact assessment are shown in Table 53.

Table 53: Guidelines, Policies and Framework for Local and Regional Economies and Local Communities

Document	Description
Pilbara Cities: Departments for Regional Development and Lands (2010)	Provides for the delivery of initiatives associated with health, energy, waste, water and community development for communities in the Pilbara region.
Pilbara's Port City Growth Plan	A growth plan to determine future planning and development in Port Hedland
Aboriginal Heritage Act 1972 (WA)	An Act to make provision for the preservation on behalf of the community of places and objects customarily used by or traditional to the original inhabitants of Australia or their descendants.
Aboriginal and Torres Strait Islander Heritage Protection Act 1984 (Cth)	An Act to preserve and protect places, areas and objects of particular significance to Aboriginals, and for related purposes
Native Title Act 1993 (Cth)	An Act for the advancement and protection of Aboriginal peoples and Torres Strait Islanders, and is intended to further advance the process of reconciliation among all Australians.
EPA Guidance Statement Number 41: Assessment of Aboriginal Heritage	Considers Aboriginal Heritage in the Environmental Approvals process when heritage values are linked to the environment.

12.7 Potential Impacts

12.7.1 Local and Regional Economy and Local Communities

The proposed Project will make a contribution to the regional and local economy through local sourcing of goods and services, contributing royalties, company tax payments and generating employment opportunities for local residents. The Project will also contribute to Indigenous training and business opportunities in the Pilbara region.

Increased local operational and contracting workforce can provide a stimulus for local business development and support employment opportunities in non-mining sectors of the local economy. Fortescue contributes to the local economy through community programs and initiatives including Indigenous traineeships and local projects, and to date has contributed millions of dollars to the Town of Port Hedland through such programs.

Opportunities for local employment and business development will be realised through construction and operation of the Project. Economic development in Port Hedland will lead to increased benefits to hospitality, retail, recreation sectors and small businesses. Indigenous employment and community development including education, training and traineeships will be provided by this Project to communities in the Pilbara region.

Pressure on local communities that may become evident as a result of the Project, includes:

- Potential increase in anti-social behaviour.
- Increased competition for access to community services, such as health services.
- Additional traffic and/or airport congestion.
- Increased competition for access to accommodation.
- Increased cost of living.
- Increased pressure on available airline capacity.

12.7.2 Heritage

Impacts related to heritage may result largely due to clearing and earthworks associated with construction and operation of the Project and include:

- Damage to or demolition of identified Aboriginal heritage sites.
- Damage to or demolition of unknown Aboriginal heritage sites uncovered as a result of Project activities.
- Unauthorised access to heritage sites leading to degradation of these sites.

- Changes in land use resulting in exclusion of Aboriginal people from areas of cultural significance.

12.8 Proposed Management

12.8.1 Local and Regional Economy and Local Communities

Management measures to enhance positive benefits and minimise negative impacts of the Project include:

- Procurement of goods and services from local providers to stimulate greater economic diversity and enhance the capability of the area.
- Use of the Pilbara Business Capability Register (ePilbara) and the industry capability network database (ICN) for identifying local contractors.
- Use of Fortescue's Community Office in Port Hedland as a recipient of local supplier information either though expressions of interest submitted by interested parties or through research undertaken by Community Office staff.
- A construction and operations accommodation camp to be developed in the Project mine area to reduce pressure on local accommodation supply and transport infrastructure.
- Bus transport for construction workers travelling between Port Hedland and Project construction areas.
- Bus transport for the operational workforce between Port Hedland and the mine area.
- Employment of local workers from the Port Hedland area, including Warralong and Woodstock Aboriginal communities.
- Continued support and funding of activities that foster economic development and sustainable communities, including the VTEC program, community grants program, investment in new housing in Port Hedland, attracting and retaining health workers and providing funding for strategic road upgrades.
- Maintain a complaints and feedback system from the community and address them with feedback in a timely manner.

12.8.2 Heritage

Potential impacts to cultural heritage in the Project area will be minimised through implementation of the following management measures:

- An agreement has been reached with the Njamal people, creating a production sharing agreement between Fortescue and the Njamal people. Under this agreement, provision for protection and management of cultural heritage is included.

- The "Guideline for the Management of Aboriginal Cultural Heritage" is Fortescue's primary cultural heritage management document used by personnel when planning and undertaking any scope of works in Fortescue project areas. It details guidelines and procedures to assist with the day to day management and protection of Sites on Fortescue project areas; and ensures staff and contractor compliance with internal, statutory and community cultural heritage obligations.
- Ground disturbing activity will only take place once a Ground Disturbance Permit (GDP) has been obtained. GDPs include heritage protection conditions where Aboriginal Sites are present, and are only approved for areas that have been subject to ethnographic and archaeological surveys.
- Location and design of project elements will avoid heritage sites wherever possible. In the event that preservation of sites is not possible, sites of cultural significance will be salvaged in consultation with the Njamal people and in accordance with a Section 18 Consent and Ministerial Conditions.
- Where disturbance of an Aboriginal heritage site is unavoidable, consultation with Aboriginal site owners will be undertaken and a Section 18 application under the *Aboriginal Heritage Act 1972* will be completed.
- Staff working in proximity to Aboriginal heritage sites will be advised of their locations prior to commencing work on the Project in order to avoid unintentional disturbance of these sites.
- Heritage monitors will be employed for all activities which require ground disturbance in proximity to cultural sites.
- Known cultural heritage sites in the Project area will be appropriately protected with buffer zones, fencing or flagging (or equivalent) to prevent inadvertent disturbance of areas of significance.
- If additional heritage sites are uncovered during construction, work in the area will cease immediately until the authenticity and significance of the site is determined in line with Fortescue's Heritage Management Plan.
- Community complaints, incidents and non-compliance procedures will be established for the duration of the Project.
- Information in relation to the environment of the Project area, including cultural heritage, will be included in the induction programme for the Project. The induction programme will include information in relation to roles and responsibilities. All staff, contractors and visitors will be required to undertake the induction programme.

12.9 Predicted Outcome

Positive and negative impacts on local and regional economies and communities may be associated with the construction and operation of the Project. Fortescue's ongoing commitment to working with local and regional authorities and local communities will increase the positive impacts from the Project and assist with alleviating any potential negative impacts.

Damage, loss, or disturbance of sites/artefacts of Aboriginal heritage through physical disturbance of the land, or from the presence of construction/operations workforce will be minimised through the proposed management strategies. As a result, it is expected that there will be no significant impacts to the cultural heritage values of the Project area and surrounds.

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Section 13
Other Relevant Factors

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13. OTHER RELEVANT FACTORS

Other factors relevant to development and operation of the Project, but not considered to be key, are:

- Air Quality.
- Heritage.
- Amenity.
- Human health.
- Rehabilitation and closure

These factors can be readily managed under other regulatory processes to meet the EPA's objectives and are discussed in brief in this Section.

Rehabilitation and Closure will be discussed in Section 14.2.

13.1 Air Quality and Human Health

13.1.1 Greenhouse Gases

Fleet

It is estimated that over the life of the Project approximately 80,512 tonnes of greenhouse gasses (measured as CO_2-equivalent) per annum will be generated from sources other than power generation. The major contributor to greenhouse gas emissions will be fuel consumption for the purposes of mine load and haul which will generate approximately 61,702 tonnes of CO_2-equivalent (CO_2-e) per annum.

Power Station

Greenhouse gas emissions for the 120 MW power station have been calculated for two scenarios with the turbines running on natural gas only or diesel only. Under the natural gas only scenario, it is expected that 374,709 tonnes CO_2-e will be generated per annum while under the diesel only scenario, 548,344 tonnes CO_2-e will be generated per annum.

Total Emissions

As the power station will run on natural gas as the main fuel, the total emissions for the Project are estimated to be 455,221 tonnes CO_2-e per annum. This is approximately 1% of the net emissions for Western Australia in 2010 (Department of Climate Change and Energy Efficiency, 2012) and equates to 0.03 tonnes CO_2-e per tonne of product.

The reported greenhouse gas emissions for the Electricity sector for the 2012 reporting period was109.7 million tonnes (Department of Climate Change and Energy Efficiency, 2012). The estimated emissions from the Project equate to 0.41% of this.

13.1.2 Dust and Other Atmospheric Emissions

The proposed extraction, handling and processing of ore has the potential to cause emissions to air, predominately in the form of particulate matter (dust). The principal health effect of dust relevant to North Star is the exacerbation of pre-existing respiratory problems in the workforce. Health impacts are more specific to fine particulate sizes, typically 10 micrometres and smaller; referred to as PM_{10} and $PM_{2.5}$. Dust can also reduce visibility and negatively affect amenity values when significant surface deposition occurs. Vegetation can also be impacted by significant amounts of dust deposition, though it is recognised that Pilbara vegetation is well adapted to the naturally dusty environment of the area (Coffey Environments, 2011).

The Project includes a 120 MW power station at the mine and an 8 MW power station located at the Canning Basin borefield. Atmospheric emissions from power generation include oxides of nitrogen (NO_X), sulphur dioxide (SO_2), carbon monoxide (CO), ozone (O_3), PM_{10} and volatile organic compounds (VOCs).

The nearest sensitive receptor to the mine area is the accommodation camp, which is approximately 4.5 km west of the open pit and 2.3 km west of the power station. A series of natural ridges exist as a barrier between the accommodation camp and proposed operations.

The Woodstock Aboriginal Community is approximately 30 km south of the mine area while Panorama Homestead is approximately 40 km to the north-east. The closest sensitive receptor to the Canning Basin borefield is the Pardoo Roadhouse, approximately 15 km north-west. Wallal Downs Homestead is approximately 40 km east while Pardoo Homestead and Muccan Homestead are approximately 45 km to the west and south respectively.

Representative samples of the material to be mined from the open pit have been analysed for the presence of fibrous minerals, such as asbestos. The samples were analysed using a scanning electron microscope fitted with an energy dispersive spectrometer. No fibres were observed in any samples, indicating that fibrous minerals are not present within the open pit.

13.1.3 Management Objective

The EPA objective(s) relevant to the assessment and management of greenhouse gas emissions are:

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

- 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 EPA objective relevant to the assessment and management of dust is:

- To ensure that emissions do not adversely affect environmental values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.

13.1.4 Guidelines, Policies and Frameworks

Guidance on the assessment and management of greenhouse gas emissions exists at a State and Commonwealth government level (Table 54).

Table 54: State and Commonwealth Guidance for Assessment and Management of Greenhouse Gases

Document	Description
EPA Guidance Statement No. 12 Minimising Greenhouse Gas Emissions	Provides guidance on the process for the assessment of greenhouse gas emissions.
Department of Climate Change: National Greenhouse and Energy Reporting Guidelines (2008)	Provides assistance to corporations to understand their obligations under the *National Greenhouse and Energy Reporting Act 2007*
National Greenhouse and Energy Reporting Act 2007	Introduced a single national reporting framework for the reporting and dissemination of information related to greenhouse gas emissions, greenhouse gas projects, energy consumption and energy production of corporations
National Greenhouse and Reporting Regulations 2008	Provides the necessary details that allow compliance with, and administration of, the *National Greenhouse and Energy Reporting Act 2007*
National Greenhouse and Energy Reporting (Measurement) Determination 2008	Rules for the estimation of emissions by companies are specified by the National Greenhouse and Energy Reporting (Measurement) Determination 2008.
NGER (Measurement) Technical Guidelines	Technical information on fuel sources and activity data

Guidance on the assessment and management of dust exists at a State and Commonwealth government level (Table 55).

Table 55: State and Commonwealth Guidance for Assessment and Management of Atmospheric Emissions

Document	Description
National Environment Protection (Ambient Air Quality) Measure (NEPM) (NEPC, 2003)	Provides standards for Ambient Air Quality nationally. For this assessment the PM_{10} and $PM_{2.5}$ standards are applied ($PM_{2.5}$ is a guidance standard only).
Kwinana Environmental Protection Policy (EPP) (EPA, 1999)	Provides standards for the assessment of total suspended particulate (TSP) within the Kwinana Industrial Area south of Perth. Often used by EPA as guidance for the assessment of TSP impacts outside of the Policy area.
Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (NSW DEC, 2005)	Provides standards for Ambient Air Quality in NSW. These standards are often referenced by the EPA when assessing impact due to dust deposition.

Document	Description
Air Quality and Air Pollution Modelling Guidance Notes (DoE 2006)	Provides guidance on expectations of the DEC when assessing air quality modelling.
A guideline for the development and implementation of a dust management program (Draft) (DEC, 2008)	Provides guidelines for the management of dust generated from a range of sources including mining activities, through the development and implementation of dust management programs.
EPA Guidance Statement Number 18: Protection of Air Quality Impacts from Land Development Sites (EPA, 2000a)	Provides guidance on the control of dust and smoke form land development sites. The guidance and its application are used by the EPA to prevent air quality impacts due to dust and smoke from land development sites.

13.1.5 Potential Impacts

Greenhouse Gas

Greenhouse gas emissions will be produced during construction and operation of the Project with main sources being the combustion of gas for power generation and combustion of diesel for drilling and blasting, and vehicle fuel consumption. In addition land clearing associated with clearing and earthworks will contribute to emissions.

Impacts related to greenhouse gas emissions include the potential to contribute to the result of climate change, including changes in global temperature, rainfall, and wind patterns, shifts in climate zones, and rising sea levels. The greenhouse gas emissions predicted from the Project do not represent a significant contribution to the total emissions for the State or the energy sector. Project related emissions are 1% of Western Australia’s total greenhouse gas emissions and 0.41% of total emissions for the energy sector.

Dust and Other Atmospheric Emissions

The construction and operation of the mine, processing plant, administration buildings and site infrastructure is likely to generate emissions to air from material handling, wheel generated dust and wind erosion of exposed surfaces.

Dust generated by construction activities are expected to be short term (minutes to days), and orders of magnitude smaller compared to dust emissions expected from normal mining operations. With the application of standard construction dust management measures, dust emissions from construction are unlikely to result in a significant impact.

To predict potential impacts of dust generated from mining operations at North Star, dispersion modelling was undertaken using the Victoria EPA AUSPLUME Gaussian plume dispersion model (SKM 2012). Emissions of TSP, PM_{10}, $PM_{2.5}$ and dust deposition, calculated using National Pollutant Inventory (NPI) emission factors, were modelled and assessed against NEPM, Kwinana EPP and NSW DEC standards at the only identified human receptor near the project area – the mine accommodation camp located west of the mine. This modelling included dust generated from the TSF and product stockpiles, blasting and excavation within the open pit, materials transfer activities at the processing plant and dust generated as a result of vehicle movements along the haul and access roads.

Modelling has predicted the following impacts as a result of mining:

- Dust concentrations attributable to mining and processing operations are unlikely to exceed ambient air criteria, though the added influence of background dust could result in exceedances, particularly for PM_{10}.
- As the deposition criteria assesses against the increase to existing levels (i.e. independent of background) the model predicts it is unlikely dust deposition will exceed assessment criteria.
- High dust concentrations were predicted on days with easterlies blowing for most hours and during temperature inversion conditions (that is, a stable atmosphere with light winds).

In addition, FMGIB is investigating the option of co-disposing of dry process rejects with PAF waste material. This would encapsulate this material within the waste rock dump, thereby minimising dust levels further. However, this has not been included in the dust modelling undertaken to date.

Electricity for the Project was planned to be provided by a 200 MW Power Station located in Port Hedland with power provided to site via high voltage power lines. Air emissions modelling was undertaken for this scenario, however, this has since been revised and a 120 MW power station will be situated at the mine area with a small 8 MW power station located at the Canning Basin borefield.

Due to its relatively small size and the absence of significant receptors nearby, the 8 MW power station at the borefield will not represent a significant risk to the environment or human health.

Dispersion modelling was undertaken for the 200 MW Port Hedland scenario using the US EPA AERMOD model with TAPM generated meteorology (ENVIRON Australia, 2012). Emissions of oxides of nitrogen (NO_X), sulphur dioxide (SO_2), carbon monoxide (CO), ozone (O_3), PM_{10} and volatile organic compounds (VOCs) were sourced from equipment manufacturer specifications and modelled and assessed against NEPM standards.

The wider outcomes from the Port Hedland scenario can be considered for a 120 MW power station at the mine area:

- Using 100% diesel fuel for a 200 MW power station, the predicted maximum across the Port Hedland model domain did not exceed assessment criteria, except for PM_{10} which was only exceeded within 2.5 km of the power station site.
- Using 100% natural gas to fuel a 200 MW power station resulted in no exceedances of assessment criteria for any modelled substance across the Port Hedland model domain.

- Reducing the power output from 200 MW to 120 MW will further reduce emissions and the predicted impact in the model domain.

Revised modelling of the 120 MW power station at the mine site will be undertaken as part of a Works Approval Application required under Part V of the EP Act. The influence of more complex terrain in the mine area, as well as the application of local meteorology will be incorporated into the domain model for the purpose of Part V approval. However, even accounting for the potential influence of the mine area’s topography and climate, it is not likely air quality at the accommodation camp will be significantly impacted by the operation of a 120 MW power station at the mine.

13.1.6 Proposed Management

Greenhouse Gas

Greenhouse gas emissions from the Project area will be minimised through the implementation of the following management measures:

- Adoption of a continuous improvement program to increase energy efficiencies and reduce greenhouse gas emissions throughout the lifetime of the Project.
- Review and report on greenhouse gas abatement measures and identify opportunities to further reduce greenhouse gas emissions over time.
- Carbon reduction through the use of efficient technologies for the mining, processing, power production and transport functions.
- Greenhouse emissions data collection.
- Consideration of carbon reduction technologies or carbon offsets programmes.
- Identify and implement cleaner production initiatives to increase energy efficiency where practicable.
- Regular maintenance and servicing of infrastructure and machinery.
- Progressive rehabilitation of cleared areas not required.

Dust and Other Atmospheric Emissions

Atmospheric emissions will be minimised through implementation of the following management measures:

- The *Fortescue Mine and Rail Dust Management Plan* (45-PL-EN-0030) will be implemented.
- Dust collection systems (for example cyclones or bag houses) will be installed at appropriate locations throughout the dry processing plant to remove airborne dust.

- Progressive rehabilitation will be undertaken to reduce the area susceptible to wind erosion.
- Water trucks will be used for dust suppression on haul roads, access tracks, the pit floor and high traffic areas.
- Dust management measures will be implemented on areas of the TSF which are shown to be drying out and generating dust.
- Dispersive waste rock materials will be managed in line with the AMD Management Plan.
- The Process Rejects Landform will be constructed to provide a safe, stable, non-polluting landform.
- Revised modelling of the power station and dust generation from the TSF and Process Rejects Landform will be undertaken as part of the Works Approval Application process.
- Air emissions monitoring will be undertaken as per the requirements of Works Approvals and Licensees issued under Part V of the EP Act.

13.1.7 Predicted Environmental Outcome

Greenhouse Gas

Greenhouse gas emissions from the Project will not significantly contribute to total emissions for Western Australia. Through the implementation of the management strategies it is anticipated that greenhouse gas emissions will be reduced over time.

Dust and Other Atmospheric Emissions

The only sensitive receptor within proximity of the mine area is the mine accommodation camp. A series of natural ridges approximately 380 m AHD are located between the camp and the active mining and processing area creating a natural barrier to dispersion of air emissions towards the accommodation camp. In addition, the proposed management measures will reduce dust generation from mining operations. As a result, it is expected that there will be no air quality related impacts at the mine accommodation camp.

Dust deposition on vegetation is expected to be greatest closest to the operational areas and northwest of the mine. The management measures outlined above are expected to minimise dust generation and keep deposition to levels that will not impact on vegetation health. Should monitoring show adverse impacts are occurring, an investigation into the cause will be undertaken, and additional management measures identified and put in place. Impacts of dust on vegetation is also discussed in Sections 7.9 and 8.10.

The mine area, power station and Canning Basin borefield are located in remote areas of the Pilbara with the nearest non-project related sensitive receptor located at least 15 km distant. Given this, no impacts on air quality at these receptors is anticipated.

13.2 Amenity – Noise and Vibration

13.2.1 Description of Factor

A noise level survey was undertaken at the proposed mine accommodation camp to establish baseline ambient noise levels of the project area. Data was collected over a ten day measurement period in March 2012 and shows background noise levels are in the order of 19-22 dBA overnight and 55 dBA during the day. The higher value during the day is likely due to general wind noise. No significant source of anthropogenic noise currently exists in the project area.

The nearest sensitive receptor to the mine area is the accommodation camp, which is approximately 4.5 km west of the open pit and 2.3 km west of the power station.

The Woodstock Aboriginal Community is approximately 30 km south of the mine area while Panorama Homestead is approximately 40 km to the north east. The closest sensitive receptor to the Canning Basin borefield is the Pardoo Roadhouse, approximately 15 km north west. Wallal Downs Homestead is approximately 40 km east while Pardoo Homestead and Muccan Homestead are approximately 45 km to the west and south respectively.

13.2.2 Management Objective

The EPA objective relevant to the assessment and management of noise is:

- To protect the amenity of nearby residents from noise impacts resulting from activities associated with the proposal by ensuring the noise levels meet statutory requirements and acceptable standards.

13.2.3 Guidelines, Policies and Frameworks

Guidance on the assessment and management of noise exists at a State government level (Table 56).

Table 56: State and Commonwealth Guidance for Assessment and Management of Noise Emissions

Document	Description
Australian Standard AS 2436-2010 Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites (2010)	This standard provides guidance in noise and vibration control, investigation and identification of sources, measurements of sound and vibration. It guides planning and assessment of control measures for construction, demolition and maintenance sites.
Australian Standard AS 2187.2-2006 Explosives - Storage and Use Part 2 Use of Explosives 2006)	This standard provides guidance and formulas for the calculation of noise and vibration as a result of blasting activities.
Environmental Protection Act 1986 (WA) and Environmental Protection (Noise) Regulations 1997	This Act provides for a number of controls relating to biodiversity including the establishment, functions and powers of the Environmental Protection Authority (EPA), including Environmental Impact Assessment (EIA) for proposals or strategic proposals that have the potential to cause significant impact on the environment. These Regulations set assigned noise levels which represent acceptable levels. They outline methods for noise assessment and control, providing a standard for industry.
Environmental Protection Bulletin No.2 – Port Hedland Dust and Noise (EPA, 2009a)	Provides a general outline of the view of the EPA regarding dust and noise in Port Hedland
EPA Guidance Statement No. 8 (Draft): Environmental Noise (EPA, 2007b)	Provides guidance for the preparation and evaluation of noise impact assessment.
Department of State Development: Port Hedland Air Quality and Noise Management Plan – The Port Hedland Dust Management Taskforce Report (DSD, 2010)	Provides a management plan for ongoing air quality and noise management in Port Hedland.
State Planning Policy 5.4 Road and Rail Transport Noise and Freight Considerations in Land Use Planning (WAPC, 2009a)	Policy aims to protect people from unreasonable levels of transport noise, protect major freight and transport corridors from urban encroachment, and facilitate the development and operation of an efficient freight network.
Implementation Guidelines for State Planning Policy 5.4 (WAPC, 2009b)	Guide the implementation of the State Planning policy 5.4

13.2.4 Potential Impacts

Impacts from noise may be experienced during operations at the accommodation camp west of the mine and along the slurry and water supply pipelines during construction. Sound emissions from stationary and mobile plant during construction and operation were modelled with the SoundPLAN software package using the CONCAWE method. Model predictions were assessed against the Western Australia Environmental Protection (Noise) Regulations 1997.

The predicted noise impact at the mine accommodation camp shows initial mining activities (mining at ground level) will exceed the assigned noise level by 2 dBA overnight. Daytime noise levels are not predicted to have a significant impact at the mine accommodation camp. As the mining extends below ground level, predicted noise levels will be below the assigned levels at all times.

It is noted the model assumed a conservative (worst case) operational load. Specifically the model simulated all plant would be operating at maximum load at any given hour (24/7) with all equipment located on the surface. Once open pit development extends more than 10 m below the surface, noise emissions from the pit will reduce due to the pit wall acting as a noise bund. However it is highly unlikely that all plant and equipment will be operating at full capacity upon commencement of mining. Pre-stripping of overburden and some mining of early ore will likely commence before the process plant is operational. Mining will have progressed below the surface before the plant becomes fully operational.

The construction of the slurry pipeline between the mine and Port Hedland may result in some noise impact to Whitehills residential community on the outskirts of South Hedland and the Indee Homestead located approximately 2.5 km from the slurry pipeline corridor. These receptors may experience some noise impacts during construction of the slurry pipeline, however these will be temporary and short term. Additionally, construction of the slurry pipeline will only occur during daylight hours. As the slurry pipeline is located adjacent to the FMG rail line, construction noise is expected to fall within the noise levels currently experienced at these receptors due to existing rail traffic.

Electricity for the Project was originally planned to be provided by a 220 MW power station located in Port Hedland with power provided to site via high voltage power lines. Noise and vibration emissions modelling was undertaken for this scenario, however, this has since been revised and a 120 MW power station will be situated at the mine area with a small 8 MW power station located at the Canning Basin borefield.

Due to its relatively small size and the absence of significant receptors nearby, the 8 MW power station at the borefield will not represent a significant risk to the environment or human health or amenity.

Revised modelling of the 120 MW power station will be undertaken as part of the Works Approval Application process undertaken Part V of the EP Act.

The potential impacts from noise emissions related to the Project include:

- Nuisance noise and loss of amenity at the mine accommodation camp.
- Nuisance noise and loss of amenity at Whitehills residential community and Indee homestead.
- Avoidance by fauna of areas of higher noise emissions. This may result in reduced breeding or foraging habitat being available for certain species.
- Disturbance to Pilbara Leaf-nosed Bats roosting in caves in proximity to the open pit, processing plant and power station resulting in bats abandoning these roosts.

13.2.5 Proposed Management

The Project will comply with the Environmental Protection (Noise) Regulations 1997. Noise emissions will be minimised through implementation of the following management measures:

- All construction and operational activities will be undertaken in accordance with the Environmental Protection (Noise) Regulations 1997.
- Updated modelling will be undertaken as part of the Works Approval Application process required under Part V of the EP Act to account for the addition of the power station in the mine area.
- Noise monitoring will be undertaken during mining operations to determine if assigned levels are being exceeded.
- Noise attenuation will be fitted to plant and equipment where required.
- A complaints procedure will be established for the duration of construction activities associated with slurry pipeline, water supply pipeline and Canning Basin Borefield. Contact details will be made available to the general public and specifically residents of Whitehills residential community and homesteads within 15 km of the pipelines.
- Noise complaints from local communities will be addressed in a timely manner and the outcomes recorded.
- Equipment and machinery will be maintained to manufacturers specifications such that noise emissions are minimised.
- Construction will be undertaken in accordance with the noise practices outlined in AS 2436-1981.
- All employees and contractors will be provided with awareness training on their obligations and responsibilities in relation to noise and vibrations impacts.

13.2.6 Predicted Environmental Outcome

The only sensitive receptor likely to be impacted by construction and operation of the mine area is the mine accommodation camp.

Mining activities may exceed the night time assigned noise level by 2 dB if all plant and equipment is fully operational, as discussed in Section 13.2.4, this is a highly unlikely scenario. Management measures will be adopted to avoid any actual exceedances. As mining extends beyond 10 m below ground level, noise and vibration emissions emanating from the open pit are minimal.

Revised modelling will be required to confirm noise and vibration levels at the camp as a result of mining operations and the operating power station. Should revised modelling show assigned noise and vibration levels will be exceeded, additional mitigation measures will be implemented to reduce noise impacts at the camp.

A limited number of receptors may be impacted during construction of the slurry pipeline, water supply pipeline and Canning Basin borefield. However, construction activities will only be undertaken during daytime hours when background noise and vibration levels are generally higher. Construction will also be of a short duration in any one location and as a result impacts to receptors are expected to be minimal. Once construction is completed noise and vibration impacts will be limited to pumping stations and are therefore considered to be negligible.

The impacts of noise and vibration on fauna is expected to be greatest closest to the operational areas of the mine and largely associated with early phases of extraction and processing of ore. Any fauna nearby may be impacted in the short term, however the management measures outlined above are expected to minimise and reduce the exposure to noise. Anecdotal evidence from mine sites suggests that many fauna species are likely to become habituated to disturbances such as noise and vibration. Impacts to fauna from noise and vibration are discussed in Section 8.10 and Section 11.8.

Section 14
Residual Risk Management

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14. RESIDUAL RISK MANAGEMENT

The Principles of Environmental Protection are outlined in the EPA Position Statement No. 7 which requires Proponents to consider these principles in the design, management and closure of their proposals. A summary of FMGIB's approach to addressing these principles for the North Star Project is shown in Table 57.

Table 57: Principles of Environmental Protection

Principle	Relevance	Approach
Precautionary Principle	Yes	FMGIB recognises the importance of minimising environmental impacts as it is vital in ensuring the company's longevity, success, growth and positioning in the domestic and global markets. FMGIB aims to gain a level of achievement beyond legal obligations. This will be achieved by successful management of potential risks. Fortescue maintains an Environmental Management System (EMS) which will be applied to the Project. The key elements of the EMS include assessing environmental risk arising from environmental aspects with the intention of identifying issues early in the process to enable planning for avoidance and/or mitigation. Part of this process includes undertaking detailed site investigations of the biological and physical environs. Where these investigations identify significant conservation issues, management measures are incorporated into the Project design to avoid, where practicable, and/or minimise any potential impacts. As a result, this Project has been designed to minimise potential impacts to the key environmental values of the local flora, vegetation and fauna.
Principle of intergenerational equity	Yes	FMGIB's decision making processes incorporate sustainability principles and the implementation of new and better technologies where reasonable and feasible. Fortescue aims to inspire an ethic and attitude that strives for continuous improvement and ongoing learning. Fortescue encourages employees to engage in positive attitudes and behaviour concerning respect for the environment. Fortescue recognise sustainability cannot be achieved without the contribution and action of the entire team.
Principle of conservation of biological diversity and ecological integrity	Yes	Conservation of biological diversity and ecological integrity is fundamental to Fortescue's approach to environmental management and is a major environmental consideration for the Project. Biological investigations have been undertaken early in the project planning process to identify values of environmental significance required to be protected from disturbance. This Proposal has been designed to minimise potential impacts to the key environmental values of the surrounding flora and vegetation and Threatened fauna species. FMGIB has committed to restoring disturbed environments upon decommissioning, as well as ongoing rehabilitation of vegetation around the Project. The aim of all rehabilitation is to establish sustainable vegetation communities consistent with reconstructed landforms and surrounding vegetation.

Principle	Relevance	Approach
Principles relating to improved valuation and incentive mechanisms	Yes	FMGIB acknowledges the need for improved valuation, pricing and incentive mechanisms and endeavours to pursue these principles when and wherever possible. For example: • Environmental factors have played a major role in determining infrastructure locations. • The Proponent has put in place procedures that will minimise pollution-type impacts as far as practicable.
Principle of waste minimisation	Yes	In order of priority, FMGIB's approach to waste management is: • Avoid and reduce at source. • Reuse and recycle. • Treat and/or dispose. The Project includes an appropriately licensed landfill for the disposal of general domestic solid wastes. A comprehensive recycling program will be established on-site which will include the recycling of aluminium cans, scrap steel, plastic, batteries, light globes, fluorescent tubes, polyethylene pipe, office paper and cardboard.

14.1 Environmental Management Framework

In addition to implementing the requirements of specific environmental conditions set by regulatory authorities, FMGIB will minimise environmental impacts through:

- Implementing and maintaining the Fortescue Environmental Management System (EMS).
- Implementing the overarching Environmental Management Plan (EMP) for the Project. The EMP will act as the central repository for issue specific management plans such as the Dust Management Plan and Fauna Management Plan.
- Regularly reviewing the performance of the EMS, EMP and developing environmental improvement plans for priorities identified in the reviews.
- Continually updating mine plans and closure, progressively rehabilitating and measuring success.
- Training staff and contractors in environmental requirements.
- Providing adequate resources to make sure stakeholder views are sought, respected and considered.
- Reporting regularly to stakeholders on performance.
- Aligning with the Fortescue Environmental Policy.

FMGIB will abide by all relevant current and future statutory requirements.

14.2 Environmental Policy

The Fortescue Environment Policy communicates what Fortescue are committed to achieving:

- Fortescue is committed to maintaining sound environmental management practices and meeting our responsibilities.
- Fortescue recognise the importance of minimising environmental impacts as it is important in ensuring the company's longevity, success, growth and positioning in the domestic and global markets.
- Fortescue decision making processes will incorporate sustainability principles and the implementation of new and better technologies where feasible. Fortescue aims to inspire an ethic and attitude that strives for continuous improvement and ongoing learning.
- Fortescue encourage employees to engage in positive attitudes and behaviour concerning respect for the environment. Fortescue recognises sustainability cannot be achieved without the contribution and action of the entire team.

14.3 Environmental Management Plan

The proposed management of the key issues associated with the Project will be documented in an EMP to be implemented to manage specific environmental aspects of the Project. Implementation of the Project in accordance with the EMP will assist the Project in meeting all respective environmental obligations including internal objectives, legislation, regulations, and conditions of approval relating to operation of the Project.

The EMP will act as the central repository for issue specific management plans that describe the specific environmental objectives and targets for each environmental factor, the management measures to be applied to avoid and minimise the environmental impact of the Project, monitoring measures to measure the performance of management against the targets, and contingency measures to mitigate unavoidable or accidental impact.

The EMP will be regularly reviewed and revised where appropriate. Environmental Improvement Plans will be developed and implemented for priorities identified during the reviews.

14.4 Rehabilitation and Closure

Closure planning is an ongoing process which requires regular review and development throughout the life of the Project. Regular review of mine closure planning documentation will capture changes in legal obligations, community expectations, corporate requirements, industry practice, improvements in technical knowledge, and changes to the Project.

FMGIB will prepare a Mine Closure Plan (MCP) for the Project in accordance with the joint EPA/DMP *Guidelines for Preparing Mine Closure Plans* (2011b). This MCP will be prepared in support of the Mining Proposal to be submitted to the DMP.

This MCP will:

- Consolidate and document all previous work undertaken pertinent to closure planning and rehabilitation.
- Provide a framework of closure domains.
- Indicate the studies, trials, research, assessment and monitoring that are recommended/ required post approval.
- Develop objectives, criteria, post-mining land use(s) and closure issues.
- Identify risks that could influence successful closure and tenure relinquishment.
- Guide future closure planning works by identifying and prioritising tasks using a risk management approach.
- Calculate indicative closure costs for financial provisioning and determine the timeframes for implementation.
- Provide a pathway to relinquish the site(s) and tenures.

The following sections provide a summary of the MCP.

14.4.1 Post Closure Land Use

The Project is located on both Unallocated Crown Land and Pastoral Leases. Closure activities will aim to return the land to its pre-mining land use. That is, areas of Unallocated Crown Land will be returned to Unallocated Crown Land – Native Vegetation while areas within Pastoral Lease boundaries will be returned to a pastoral land use, namely livestock grazing.

14.4.2 Closure Domains

Planning for mine closure has identified six domains to enable clear and specific objectives and strategies to be identified. The domains have been developed such that areas where similar rehabilitation works and strategies are required are combined into one domain. This provides a structured and consistent approach to closure of the site. The domains identified for mine closure planning are:

- TSF.
- WRD, LGOS and Dry Process Rejects Landforms (DPR).
- Mine Pit Void.

- Processing Area and Support Infrastructure.
- Major Pipeline Infrastructure.

14.4.3 Closure Objectives

The overarching Project objective for closure is to create safe, stable and non-polluting landforms which support self-sustaining ecosystems appropriate to the final post-mining land use. Table 54 provides more specific objectives which support the overarching closure objective. Indicative completion criteria and measurement tools used to assess closure success of each domain are also summarised in Table 58.

Table 58: Closure Objectives, Completion Criteria and Measurement Tools

Aspect	Objective	Indicative Completion Criteria	Measurement Tools
Landforms	The landforms will be inherently safe and stable such that they do not present additional new hazards.	No hazards in rehabilitation areas that represent an unacceptable risk to key stakeholders.	Site inspections / audits for all listed completion criteria. Routine inspections. Photographic records and documentation.
	The rehabilitated landforms will have a form consistent with the general slope and configuration of surrounding landforms.	Slope angles and lengths consistent with regional landforms. In general, unarmoured slopes will not exceed 20 degrees slope.	
	The rehabilitated landforms will be constructed to encourage the establishment and sustainability of local native vegetation and fauna habitat consistent with surroundings.	Landform surfaces constructed with materials that provide suitable growth medium and are resilient to the natural processes of erosion, fire, drought and grazing by native animals.	
Water	Surface water flow patterns and quality will not significantly adversely impact on upstream or downstream environmental values or uses.	Surface water quality as measured at agreed locations is within agreed ranges.	Pre and post mining topographic survey of the catchment / catchment plan, (illustrating natural flow paths and drainage structures) will confirm the catchment delineation and connectivity. Site specific hydrologic report confirms completion criteria have been met.
	Groundwater flow patterns and quality will not significantly adversely impact on downstream	Groundwater quality as measured at agreed locations is within	Ground water level and quality monitoring results to identify the potential

Aspect	Objective	Indicative Completion Criteria	Measurement Tools
	environmental values or uses.	agreed ranges.	toxicity of groundwater on ecological communities.
	Surface and groundwater resources within the disturbed area will be of similar quality of surrounding water sources.	Water samples taken from the project area are consistent with water samples from the surrounding area for a period of no less than 12 months.	Site specific hydrologic report to confirm completion criteria have been met.
Environment	The rehabilitated landforms will be revegetated with local native species with landscape functional indices trending towards surroundings.	Analogue sites have been established for the purposes of Ecosystem Function Analysis. The composition of flora species in rehabilitation areas are representative of the range of flora from analogue sites. Foliar cover is within or consistently progressing towards the foliar cover on analogue sites. Demonstrated increasing trend in plant species diversity and structural complexity of vegetative cover.	Site inspections / audits for all listed completion criteria. Routine inspections. Photographic records and documentation.
	The revegetated landform will not introduce any new or additional weed or feral animal burden to the surrounding landscape.	Weed and feral animal burdens are consistent with or less than at analogue sites.	
	Recreate suitable habitat for fauna.	This objective will be achieved as a consequence of meeting the revegetation objectives. This specifically includes a demonstrated increasing trend in plant diversity and structural complexity of vegetative cover.	
Social	Access for management purposes as agreed with the post-closure land manager.	Preparation of a Site Access Plan in consultation with the post-closure land manager.	Routine inspections that indicate the agreed Site Access Plan is being implemented.
	Access to heritage sites maintained by agreement with Traditional owners and DMP.	Preparation of a Site Access Plan in consultation with the post-closure land manager.	

14.4.4 Key Closure Risks

Soils for Rehabilitation

Soils within the Project area are not deep and careful planning is essential so that this resource is managed to preserve the quality of soils and to reduce losses of material from erosion. A preliminary soil balance will be provided within the MCP.

Impacts to Surface Hydrology

The ore body is situated on an elevated ridge along the divide between the Shaw River and Turner River. Based on catchment and surface water flow modelling, it is predicted that the Project is unlikely to have any significant impacts on flows. Small sub-catchment changes can be expected; however these are confined to the upper reaches of the regional catchment and will have little impact on overall catchment surface hydrology.

A number of regional pools have been identified around the Project area. The mine is not expected to negatively impact on these pools as surface hydrology is not expected to be significantly altered. Monitoring of water levels and quality will be undertaken as part of the monitoring and maintenance programme for the Project to support these predictions.

Generation of Acid Metalliferous Drainage

A geochemical assessment was undertaken by GHD (2012). The assessment involved detailed analysis of the geology and mineralogy of the mine area and development of a 3D geochemical block model. In addition to the available assay data, geochemical testing was conducted on 1,170 samples to determine if waste or ore materials had the potential to cause acidic, metalliferous or saline drainage.

Results of the geochemical model indicate that approximately 6% of the pit volume is classed as Potentially Acid Forming (PAF) material, the majority of this material is contained within waste units and the Hanging Wall unit in particular (16% of waste is classified as PAF). This material is at risk of producing acid leachates, though samples tested indicate that metal contents are low and the risk of metalliferous drainage is not high.

The BIF contain a small proportion of material classified as PAF, but also contain a significant proportion of material classed as Net Acid Consuming (NAC). As a result, the tailings and dry process rejects are unlikely to present a high risk of producing acidic or metalliferous drainage.

Pit Lake Formation

The formation of a pit lake has been identified as a potential closure risk.

WorleyParsons (2013) undertook modelling of the open pit to determine the potential for a pit lake to form post closure. Three scenarios were modelled as described in Section 10.5.7. The modelling undertaken indicates that a pit lake will form post closure. Under the most likely scenario (Scenario 2), the surface of the lake will be approximately 382 m below the top of the pit and will be 218 m deep. Water quality is predicted to remain within the ANZECC/ARMCANZ (2000) guidelines for livestock drinking water quality for at least the first 150 years following closure. Salinity and sulphate concentrations may exceed the guidelines after 150 years for Scenario 3 and 300 years for Scenario 2.

14.4.5 Site Wide Closure Strategies

Construction of Vehicular Access Barriers

Vehicular access to areas such as the TSF, WRD, LGOS and mine pit void will be prevented by closing, ripping and revegetating access roads and tracks. Physical barriers, such as boulders, logs or bunds, will be placed to discourage use of these roads where required.

Access to some areas may be required for closure monitoring and maintenance. These will be maintained to a level of safety required for operational access roads. Once access is no longer required, these roads will be closed as described above.

Dust Management Plan

A Dust Management Plan will be implemented to reduce the risk of harm to people and the surrounding environment. The plan will identify people at risk, risk mitigation and measurement and monitoring requirements. Capping and progressive rehabilitation of surfaces will assist with the control of dust. The plan will be implemented during operations and will include active controls such as wetting of surfaces; however the plan will need to also investigate the exposure pathways and controls for closure. The Dust Management Plan will be a live document developed during project start-up and implemented throughout the mining operations, into closure

QA Construction Audits

After completion of closure earthworks, the final levels will be confirmed and signed off by a Registered Surveyor. Where levels or grades deviate significantly from designs, the work will be remediated to the satisfaction of a suitably qualified and experienced engineer. Where compaction of surfaces is specified in design, the degree of compaction will be checked by a suitably qualified contractor.

Health and Safety Audits

Upon completion of all landform earthworks including capping, the landform(s) will be subject to a risk-based Health and Safety audit by a suitably experienced and qualified Health and Safety Professional. Audit actions will be implemented as directed by the authorised auditor.

Construction of Passive Surface Water Infrastructure

Where surface water infrastructure is required (such as spillways and diversion drains), infrastructure that is robust for long-term closure and does not rely on active management (such as pumping) will be constructed. Drainage structures (such as culverts and channels) will be designed in accordance with Fortescue's Drainage Standard.

Water Management Plan

An integrated Water Management Plan (WMP) will be developed for the Project. This plan will be developed prior to the construction of the TSF. The WMP will generally document operational requirements but will be continued into closure, modified as required. The WMP will identify:

- The catchments and their interconnectivity.
- Key water infrastructure and its purpose.
- Locally significant water features.
- Target and trigger concentration levels for potential contamination such as pH, EC, metals, salinity and hydrocarbons. The trigger levels will be developed cognisant of local environmental values, along with state and local regulatory requirements.

Progressive Rehabilitation Plan

A Progressive Rehabilitation Plan will be developed to investigate how rehabilitation can be practically and progressively implemented across the Project area.

The Progressive Rehabilitation Plan will investigate where tailings deposition can be completed to the final height and thereby allow rehabilitation trials and activities to be undertaken whilst tailings deposition is ongoing in other areas. By trialling a range of cover types the preferred cap/cover solution(s) can be developed for the TSF.

The Progressive Rehabilitation Plan is to be developed in the first year of mining.

Target Ecosystem and Vegetation Selection

Further investigation will be conducted by a qualified professional into vegetation selection for re-vegetation of the landforms. Seeds will be collected locally and/or commercially sourced. Further investigations will be undertaken to confirm:

- Target species for re-vegetation. These should be based on the pre-disturbance vegetation types.
- The proposed cap design and specification of optimal topsoil and subsoil mix for revegetation, along with the requirements for any soil conditioning (e.g. fertiliser).
- Nutrient cycling for sustainability of vegetation.

- Investigations into vegetation selection will inform the Progressive Rehabilitation plan and be completed in the early life of mine.

Revegetation Strategy

Disturbed areas will be re-profiled (made stable) and revegetated. The revegetation strategy will incorporate:

- Selection and sourcing of appropriate flora species for the re-vegetation of the area.
- Design for erosion resistant surfaces.
- Rehabilitation trials.
- Monitoring and Maintenance: Rehabilitation monitoring and maintenance will be conducted in accordance with the Closure Monitoring and Maintenance Plan which includes:
  - Assessment of rehabilitation progress using EFA.
  - Physical site inspections to identify problem areas.
  - A weed prevention and control programme to prevent establishment and spread of weeds.
  - A feral animal control programme to prevent rehabilitation being destroyed by feral herbivores.

14.4.6 Domain Specific Closure Strategies

A summary of the closure strategies specific to each domain is provided in Table 59. Detailed information on these strategies will be provided in the MCP to be submitted with the Mining Proposal to the DMP.

Table 59: Domain Specific Closure Strategies

Domain	Category	Strategy
TSF	Health and Safety	Removal of redundant infrastructure
	Water	Flood mitigation investigation
	Landform Stability	Geotechnical investigations of TSF foundation
		Detailed cap designs
		Detailed spillway designs
WRD, LGOS and Dry Process Rejects Landforms	Water	PAF material deposition strategy
		AMD leachate management
	Landform Stability	Geotechnical investigations of WRD, LGOS, and DPR landforms foundations
		Detailed materials scheduling model
		Detailed cap designs
Mine Pit Void	Health and Safety	Construction of abandonment bunding
	Water	Water balance model to predict closure outcomes
		Contingency plan for pit lake development such as backfilling of the pit with waste rock to above predicted static water levels
	Pit Stability	Pit geotechnical design
	Environment	Geochemical characterisation of pit wall materials
Processing and Support Infrastructure	Health and Safety	Remediation of contaminated sites
		Removal of infrastructure
	Surface Stability	Surface re-shaping
		Burial of concrete slabs
	Environment	Plant disposal strategy
		Disposal of contaminated materials
Major Pipeline Infrastructure	Health and Safety	Removal of above ground infrastructure
	Surface Stability	Surface re-shaping

14.4.7 Financial Provisioning

As part of mine closure planning, a cost estimate to implement the closure strategies and rehabilitation requirements will be prepared. The cost estimate will include decommissioning and removal of infrastructure, required earthworks and revegetation. Where sufficient information exists, costs will be calculated based on quantities identified from current site layouts and estimated contractor rates. Where detailed costing cannot be made, a provisional sum will be allocated. Closure cost estimates will be reviewed on a regular basis so that they remain valid and reflect the true cost of undertaking the works required.

14.4.8 Monitoring, Maintenance and Reporting

As individual sites are rehabilitated and closure works completed, there will be a period of monitoring and maintenance to make sure the site has been made safe and to demonstrate to the regulatory bodies and key stakeholders that the post-mining operation is approaching a safe and sustainable state. The monitoring and maintenance programme will include monitoring of surface and groundwater, dust, rehabilitation performance, erosion and geotechnical stability and maintenance of all areas requiring attention.

Monitoring results must demonstrate that closure objectives and closure criteria have been met and that there are no ongoing impacts from the site, in order to successfully relinquish tenements post-closure. It is envisaged that monitoring and maintenance will continue for a minimum period of five years following closure, but may be extended depending on the outcomes of the monitoring and maintenance programme.

14.5 Summary of Proposed Environmental Control Instruments

FMGIB has identified the regulatory controls that will be applied to provide appropriate environmental management of the Project. The key controls include (but are not limited to):

- Any conditions of DEC Works Approval(s) (under Part V of the EP Act) for construction of works on prescribed premises.
- Any conditions of DEC Licence(s) (under Part V of the EP Act) for the operation of activities on prescribed premises.
- Any conditions of the DoW Licences and Permits for activities relating to the abstraction of groundwater (under the RIWI Act).
- Any conditions of approval of the Mining Proposal (under the *Mining Act 1978*).
- Any tenement conditions (under the *Mining Act 1978*).

14.6 Summary of Potential Impacts, Proposed Management Commitments and Environmental Outcomes

A summary of the potential impacts, proposed management commitments and environmental outcomes for each of the environmental factors assessed is presented in Table 60.

Table 60: Summary of Impacts and Proposed Management Measures

Environmental Factor	EPA Objective	Relevant Guidance	Existing Environment	Potential Impacts	Management Strategies	Predicted Outcomes
Terrestrial Flora – Key Factor	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.	• National Strategy for the Conservation of Australia's Biological Diversity. • National Strategy for Ecologically Sustainable Development. • *Wildlife Conservation Act 1950* (WA). • *Environmental Protection Act 1986* (WA) and Environmental Protection (Clearing of Native Vegetation) Regulations 2005. • EPA Position Statement No.2: Environmental Protection of Native Vegetation in Western Australia (Environmental Protection Authority, 2000). • EPA Position Statement No 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA, 2002a). • EPA Position Statement No 5: Environmental Protection and Ecological Sustainability of the Rangelands in Western Australia (Environmental Protection Authority, 2004). • EPA Guidance Statement No.51: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia (EPA, 2004a).	A total of 33 vegetation communities have been mapped across the mine area and surrounds, while 24 have been mapped in the Water Corridor Development Envelope and 36 have been mapped along the Slurry Corridor Development Envelope. The diversity of vegetation communities present is typical of surveys in the Pilbara during favourable conditions (ecologia Environment, 2012a). No threatened ecological community or priority ecological community occur within 40 km of the Project area. Two vegetation communities in the mine area are considered to be potentially locally significant. Two vegetation communities occurring in the pipeline area of the Water Corridor Development Envelope are considered to be locally significant and one vegetation community along the pipeline route is considered to be a groundwater dependent ecosystem. Four vegetation communities occurring in the Slurry Corridor Development Envelope are considered to be of local conservation significance. No EPBC listed Threatened Flora species nor any State listed Threatened (Declared Rare Flora) species were recorded within the Project area. Eight Priority Flora species have been recorded within the mine area and surrounds with two recorded from Project development envelopes. Five flora species in the mine area represent range extensions of more than 100 km to the taxon's previously known distribution. Four Priority listed Flora taxa were recorded in the Water Corridor Development Envelope. Two additional flora species recorded in the Water Corridor Development Envelope represent range extensions to the taxon's known distribution. Five Priority listed Flora taxa have been recorded from the Slurry Corridor Development Envelope. One Weed of National	• Direct loss of vegetation due to clearing. • Direct loss of flora of conservation significance. • Direct loss of vegetation outside of the project area. • Direct loss of vegetation outside of Project footprint. • Degradation of vegetation.	• Project infrastructure has been located away from known areas of conservation significant flora and/or vegetation as far as practicable. • Ground Disturbance Permits (GDPs) will be required prior to commencement of clearing activities. • Clearing and disturbance within the Special Rail Licence (LSA1) will be undertaken in compliance with the *Rail Corridor Disturbance Management Plan* (R-PL-EN-0012) and *Rail Route (Stage B) Environmental Management Plan* (R-PL-EN-0010. • Infrastructure has been located outside of watercourses as far as practicable. Diversions will be put in place as required. • Information in relation the environment of the Project area, including vegetation and flora of conservation significance, will be included in the induction programme for the Project. The induction programme will include information in relation to roles and responsibilities. All staff and contractors will be required to undertake the induction programme. Visitors will be escorted while on site. • Vehicles will be confined to defined roads and access tracks. • An AMD management Plan will be implemented. The objective of this plan will be to manage waste rock such that the WRD is a stable, non-polluting landform. • Perimeter drains will be constructed around TSF to manage seepage. • Water trucks will be used for dust suppression on haul roads, access tracks, the pit floor and high traffic areas. • The use of surfactants to increase dust suppression capability of applied water will be investigated. This investigation will take into consideration the potential adverse consequences that may result from the use of surfactants, such as coating of leaf surfaces and toxic effects on frogs, as well as benefits such as reduced dust emissions and more efficient use of water resources. • Progressive rehabilitation of disturbed areas will be undertaken during the life of the Project and an approved mine closure plan implemented post-closure. • Pipeline corridors will be reinstated and rehabilitated once construction activities are complete, with the exception of an access track for maintenance activities. The long term aim of rehabilitation will be to return disturbed areas to a condition similar to adjacent, undisturbed areas. • Undertake additional flora and vegetation surveys of final water supply pipeline route and water bore locations.	The proposed management measures will further reduce potential impacts to flora and vegetation. No clearing is required in vegetation communities FpAtCo (escarpment springs) and GaTw (Basalt Dyke). Clearing of locally significant vegetation communities in the Slurry Corridor Development Envelope and Water Corridor Development Envelope will be avoided where practicable. Where avoidance is not possible, the amount of clearing required will be minimised through implementation of Fortescue's Ground Disturbance Permit procedure. Rehabilitation of the areas disturbed following completion of construction activities will minimise the impact of clearing on these vegetation communities. Clearing of *Goodenia nuda* is unlikely to reduce the local and regional representation of this species as there is high species abundance in recorded locations throughout the Pilbara region. Should the alignment of the mine access road require clearing of a small number of individuals, the impact of this on the species as a whole will be negligible. Clearing of *Pityrodia* sp. Marble Bar will slightly reduce the regional representation of this species with 10% of the known number of individuals located in areas to be cleared. However, as 90% of the known records will not be disturbed and are located at least 1.5 km from the boundary of development envelopes, the long term impact on this species as a whole is expected to be minor. Further survey effort in the region, associated with ongoing mineral exploration activities by Fortescue and others, is likely to locate more populations or occurrences of this species, thereby further reducing the significance of any impacts. There are no groundwater dependant ecosystems (GDE's) within the potential drawdown cone of the Canning Basin borefield. Construction of the slurry, natural gas and water supply pipelines will not result in long-term drawdown of the watertable in areas where GDE's are located. No impacts to GDE's are anticipated as a result of implementation of the Project.

Environmental Factor	EPA Objective	Relevant Guidance	Existing Environment	Potential Impacts	Management Strategies	Predicted Outcomes
			Significance (WONS) and one Declared Plant under the Agriculture and Related Resources Protection Act 1978 were identified in the Water Corridor Development Envelope. Nine environmental weeds were recorded in the mine area, ten were recorded in the water corridor Development Envelope and eleven were recorded in the Slurry Corridor Development Envelope.			
Terrestrial Fauna (including MNES) – Key Factor	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.	• EPA Position Statement No.2: Environmental Protection of Native Vegetation in Western Australia (Environmental Protection Authority, 2000). • EPA Position Statement No.3: Terrestrial Biological Surveys as an Element of Biodiversity Protection (WA) (EPA, 2002a). • EPA Guidance Statement No.56: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia (EPA, 2004b). • Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (DEC, 2010). • *Wildlife Conservation Act 1950* (WA). • *Environment Protection and Biodiversity Conservation Act 1999* (Cth). • Matters of National Environmental Significance, Significant Impact Guidelines 1.1 *Environment Protection and Biodiversity Conservation Act 1999.* • Significant Impact or referral guidelines for nationally listed species (Northern Quoll *Dasyurus hallucatus)* 2011. • Draft EPBC Act policy statement 3.21 Significant impact guidelines for 36 migratory shorebirds: Migratory Species. • Draft EPBC policy statement: Use of environmental offsets under the *Environment Protection and Biodiversity Conservation Act 1999* (2007).	A total of 18 fauna habitat types occur across the Project area. The most extensive habitats in the Project area are: • Mine area: Rocky Spinifex Hills. • Slurry Corridor Development Envelope: Spinifex grasslands on low stony rises. • Water Supply Development Envelope: Sandplain grassland and spinifex grassland. The Rocky Ridges, Breakaways and Rocky Gorges fauna habitats from the mine area are considered suitable habitat for the Northern Quoll and Pilbara Leaf-nosed Bat and, where this habitat is associated with water pools, the Pilbara Olive Python. The Granite Outcrops, Breakaways and Boulder Piles habitat in the Slurry Corridor Development Envelope is considered to be of conservation value as it occupies small areas in any one location and supports fauna species which are otherwise uncommon in the surrounding area, such as the Northern Quoll (*Dasyurus hallucatus*), Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*) and Pilbara Olive Python (*Liasis olivaceus barroni*). Thirteen Migratory species were identified by the EPBC Act Protected Matters Search Tool with seven of these species having a medium to high likelihood of occurrence within the Project area. Seven threatened species were identified by the EPBC Act Protected Matters Search Tool with five of these species considered as having a medium	**Impacts to Vertebrate Fauna (including MNES)** • Direct loss of fauna habitat • Direct loss of significant fauna habitat • Direct loss of habitat outside of the Project area • Habitat fragmentation and degradation • Direct loss of or injury to fauna • Direct loss of or injury to WC Act, Priority Listed or Migratory fauna species • Introduction or attraction of feral fauna species • Changes in fauna behaviour **Impacts to SRE fauna** • Vegetation clearing has the potential to reduce suitable habitat and/or cause fragmentation which could lead to reduction of movement of SRE individuals, thereby result in a potential population decline. • Earthworks may also lead to the direct loss or injury to SREs through activities such as excavation and compacting. • Fire may result in the direct mortality of SREs and contribute to a reduction of suitable habitat by removing vegetation, leaf litter and also through fragmentation of habitat. • Dust from construction and operation of the Project may also cause changes in suitable habitat through vegetation degradation and lead to alteration of habitat structure.	• Information in relation to the environment of the Project area, including fauna and habitats, will be included in the induction programme for the Project. The induction programme will include information in relation to roles and responsibilities. All staff and contractors will be required to undertake the induction programme. • Internal GDPs will be required prior to commencement of activities. • Where pipelines are required to be placed on the surface, the pipe will be raised off the ground in order to minimise impacts to surface water flow and fauna movements. • Vehicles will be confined to defined roads and access tracks. • Personnel trained in fauna handling will be employed during trenching operations to clear open trench of fauna on a daily basis and prior to backfilling. • Injured fauna will be reported to the site environmental officer who will determine the appropriate course of action. • Fauna mortalities involving EPBC Act, WC Act or DEC Priority listed species will be reported to DEC and DSEWPaC as required. • Progressive rehabilitation will be undertaken where practicable. • Fire prevention regimes will be implemented. • A Construction Environmental Management Plan will be implemented for construction of pipelines. • Ongoing monitoring of the persistence of the Pilbara Leaf-nosed Bat population at the mine area.	Fauna habitats of the Project area are generally considered to be common and widespread in the region. Some habitat will be cleared during implementation of the proposal, though this will have a negligible impact on the regional representation of these habitats. Potentially active mounds of the Western Pebble Mound Mouse have been recorded in the western portion of the Infrastructure Corridor Development Envelope on the eastern edge of the pit area (ecologia Environment, 2012e). This species has limited ability to move away from disturbance and clearing activities will impact the local population. As the species has been recorded across the Pilbara, suitable habitat exists outside of project development envelopes and several Pebble-mound Mouse mounds have been recorded outside of these envelopes, the regional impact to this species will be low. The Long-tailed Dunnart has been recorded during surveys of the Project area and surrounds, though it has not been recorded from within Project development envelopes. No impacts to this species are expected. Bird species recorded from near the Project area (Grey Falcon, Australian Bustard, Bush Stone-Curlew, Fork-tailed Swift, Oriental Plover and the Rainbow Bee-eater) do not rely on the habitats in the Project area and will move into nearby areas of suitable habitat. No impacts to these species are expected. In relation to the Slurry Corridor Development Envelope and Water Corridor Development Envelope, the impact on all recorded species of SREs is expected to be negligible due to the narrow width of the pipeline corridor, the temporary nature of the construction and the limited impacts expected to occur on potential habitat within the borefield area.

Environmental Factor	EPA Objective	Relevant Guidance	Existing Environment	Potential Impacts	Management Strategies	Predicted Outcomes
		• Discussion paper: Use of environmental offsets under the *Environment Protection and Biodiversity Conservation Act 1999* (2007).	to high likelihood of occurrence within the Project area (refer to Section 112). The species identified from the search tool were: • Northern Quoll (*Dasyurus hallucatus*) - Endangered • Northern Marsupial Mole (*Notoryctes caurinus*) - Endangered • Crest-tailed Mulgara / Brush-tailed Mulgara (*Dasycercus cristicauda / D. blythii*) - Vulnerable • Greater Bilby (*Macrotis lagotis*) - Vulnerable • Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*) - Vulnerable • Pilbara Olive Python (*Liasis olivaceus barroni*) - Vulnerable • Great Desert Skink (*Liopholis kintorei*) - Vulnerable Three of these species (Northern Quoll, Pilbara Olive Python and Pilbara Leaf-nosed Bat) have been recorded in the mine area while two species (Northern Quoll and Greater Bilby) have been recorded (or unconfirmed secondary evidence identified) from the Slurry Corridor Development Envelope. Unconfirmed diggings which resemble those of the Greater Bilby were recorded from the Water Corridor Development Envelope. No evidence of the Great Desert Skink was observed in the Water Corridor Development Envelope, which occurs in the western edge of this species known range.			Within the mine area, some potential SRE species have been recorded from within areas required for the Pit TSF. Some individuals are likely to be lost during construction in these envelopes. However, none of the habitats in which the potential SREs were located are unique to the Project area and extend beyond the limits of the mapped area. As a result, impact to SRE's resulting from construction and operation of the Project are not significant in a regional context. **Northern Quoll** The clearing of suitable Northern Quoll denning habitat in the mine area may result in a temporary decline in the local Northern Quoll population; however, this is not expected to adversely impact the recovery of the species as a whole or result in a general decline of the species in the region. Populations of Northern Quoll have been recorded within a 50 km radius of the mine area and the species is considered to be highly mobile (ecologia Environment, 2012d). Approximately 900 ha of suitable habitat occurs within 30 km of the mine area and additional habitat occurs across the region (ecologia Environment, 2012d). Oakwood (2000) surmises that female home territories are likely inherited by female progeny. Of the four females captured during targeted surveys by ecologia Environment, three were captured at least two kilometres from proposed disturbance areas. The fourth location was within the area required for the pit. Targeting trapping will be undertaken at this location and any quolls captures will be relocated to suitable habitat outside of the Project area, where practicable. The overall impact on breeding potential for the area immediately surrounding the Project area is considered to be low. Implementation of the Project will result in a permanent loss of Northern Quoll breeding and foraging/dispersal habitat associated with the proposed open pit, TSF, WRD and potentially the LGOS should this material remain following closure of the site. Rehabilitation and mine closure activities will aim to provide additional habitat for the Northern Quoll where practicable, however it is likely that there will be some permanent loss of habitat. Measures to offset this

Environmental Factor	EPA Objective	Relevant Guidance	Existing Environment	Potential Impacts	Management Strategies	Predicted Outcomes
						residual impact are discussed in Section 14. **Mulgara** Potential impacts to the Mulgara, should it occur in the Project area, are associated with the construction of pipelines within the Slurry Corridor Development Envelope and Water Corridor Development Envelope, and construction and operation of the mine access road within the Infrastructure Corridor Development Envelope. Impacts related to construction of the pipelines will be short term and temporary. Extensive suitable habitat for the Mulgara exists outside of the Project area and clearing required for the project equates to less than 2% of the mapped extended of habitats suitable for the Mulgara. It is therefore predicted that no significant impacts to the Mulgara will occur as a result of implementation of the Project. **Greater Bilby** Potential impacts to the Greater Bilby, should it occur in the Project area, are associated with the construction of pipelines within the Slurry Corridor Development Envelope and Water Corridor Development Envelope, and construction and operation of the Mine Access Road within the Infrastructure Corridor Development Envelope. Impacts related to construction of the pipelines will be short term and temporary and as such are considered unlikely to significantly impact the Greater Bilby population. **Pilbara Leaf-nosed Bat** One Pilbara Leaf-nosed Bat day roost cave and some suitable foraging habitat will be removed as a result of the development of the mine area. Foraging habitat is well represented in the region. It is expected that suitable roost caves also occur in the wider Gorge Ranges which surround the Project area.. While there may be a decline in the local population, the impact on the Pilbara Leaf-nosed Bat at a regional and species level is expected to be low. **Pilbara Olive Python** Some clearing of Pilbara Olive Python habitat will be required in order to implement the Project. Rehabilitation

Environmental Factor	EPA Objective	Relevant Guidance	Existing Environment	Potential Impacts	Management Strategies	Predicted Outcomes
						and closure activities will aim to provide additional habitat for the Pilbara Olive Python where practicable, however it is likely that some loss of habitat will be permanent. Python habitat associated with the proposed open pit, TSF, WRD and potentially the LGOS (should this material remain following closure of the site) will be permanently lost. Of the 11 water pools in the vicinity of the mine area, there is potential that three may experience a degree of degradation as a result of impacts from the Project which may reduce their ability to provide suitable habitat for the Pilbara Olive Python. Monitoring will be undertaken to assess the level of impact in these pools and allow for implementation of additional management measures where required. While there may be a local loss of individuals as a result of implementing the Project, the regional impact to the Pilbara Olive Python is expected to be moderate to low due to this species being widely distributed throughout the Pilbara. Additionally, a large area of habitat is conserved within Karijini National Park (DSEWPaC, 2012k).
Subterranean Fauna – Key Factor	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.	• EPA Guidance Statement Number 54: Consideration of Subterranean Fauna in Groundwater and Caves during EIA in Western Australia (EPA, 2003). • EPA Guidance Statement Number 54a (Draft): Sampling Methods and Survey Considerations for Subterranean Fauna in Western Australia (EPA, 2007a). • EPA Discussion Paper: A review of subterranean fauna assessment in Western Australia (EPA, 2012). • Draft EPA Environmental Assessment Guideline (EAG) Consideration of subterranean fauna in environmental impact assessment in Western Australia (EPA, 2013)	There is evidence to suggest that the mine area is part of a wider, more or less continuous subterranean habitat. As there is no local water table, the risk to stygofauna is considered to be negligible within the mine area. In the mine area, 11 troglofauna species and 17 stygofauna species/haplotypes have been identified. The majority of these subterranean fauna species occur widely in the local and regional area. Five of the eleven troglofauna species collected have only been recorded from the outline of the pit shell. Of these, one is likely to be range restricted. No stygofauna species were recorded from within the pit area during the 2011 survey. Studies indicate that deeper sections of the North Star Banded Ironstone Formation do not contain cavities or support groundwater bodies and therefore do not provide habitat for stygofauna. The alluvial aquifer associated with the Turner River provides a large	• Impacts related to troglofauna are largely limited to the mine area with the main potential impact being direct loss of troglofauna species and habitat due to mining of the open pit. • There is a minimal risk that stygofauna habitat in the wider Project area may be degraded through leaks and spills from vehicles and equipment during bore construction and operation.	• GDPs will be required prior to commencement of activities. • Hydrocarbons and chemicals will be appropriately stored and bunded to minimise the potential for spillage. • Spill kits will be provided and maintained in all areas where hydrocarbons and chemicals are stored or used. • Drainage from areas likely to be contaminated with hydrocarbons or chemicals (such as workshops) will be captured and treated (for example through oil-water separators). • Water abstraction will be managed through a DoW approved Groundwater Operating Strategy.	Mining will directly impact those troglofauna species within the footprint of the open pit. However, as there is evidence that the geology of the mine area form part of a larger, continuous subterranean habitat, the impact from mining activities on the conservation status of individual troglofauna species or their regional representation is not considered significant. Dewatering of the proposed open pit will not be required, and given the paucity of records of stygofauna from the pit area and Water Corridor Development Envelope, the risk of impacts to stygofauna is considered to be very low. The maximum depth of excavation for the slurry, gas and water supply pipelines is expected to be 3 m. If subterranean fauna are present along the Slurry Corridor Development Envelope and Water Corridor Development Envelope, the small amount of disturbance required to construct the pipelines is unlikely to significantly impact these species with habitat likely to be found immediately adjacent to and below the excavated trench.

Environmental Factor	EPA Objective	Relevant Guidance	Existing Environment	Potential Impacts	Management Strategies	Predicted Outcomes
			area of suitable stygofauna habitat along with many other alluvial aquifers surrounding the mine area. Studies indicate there is a low likelihood of diverse and abundant stygofauna being present in the Canning Basin borefield area. One worm specimen was recorded during the Canning Basin borefield survey, but may not have originated from the Wallal aquifer. As the slurry, gas and water supply pipelines and the Canning Basin borefield area will involve low levels of disturbance to construct, it is expected that any potential disturbance to troglofauna will be insignificant.			
Hydrological Processes – Key Factor	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	• *Rights in Water and Irrigation Act 1914* (WA) • Environmental Protection (Unauthorised Discharges) Regulations 2004 • Australian and New Zealand Guidelines for Fresh and Marine Water Quality, 2000, Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) • Water and Rivers Commission 2000. Environmental Water Provisions Policy for Western Australia: Statewide Policy No. 5 (Waters and Rivers Commission, 2000) • Department of Water Stormwater Management Manual for Western Australia 2004-2007 (Department of Water, 2004) • Water Quality Protection Guidelines (Nos 1 – 11), Mining and Mineral Processing (WRC 1999) • Department of Water. Pilbara groundwater allocation plan 2012: For public comment (Department of Water, 2012b) • Department of Water. West Canning Basin groundwater allocation limit report (Department of Water, 2011)	**Surface Water** Drainage lines in the region are ephemeral and generally only flow for short durations following rainfall events. Intermittent flows normally occur during the wet season with long periods of no flow during the dry season. The mine area lies within the catchment boundary of the Turner River and Strelley River while the Slurry Corridor Development Envelope is located wholly within the Turner River Catchment. As a result of the local topography which consists of a series of plateaus, hills, ridges and valleys, numerous ephemeral drainages are found across the proposed mine site. The bimodal topography suggests local scale groundwater systems are likely to occur in the weathered uplands and provide a water source for escarpment springs. Surveys of the mine area and surrounds identified 11 water pools. The Water Corridor Development Envelope crosses a number of ephemeral creeks and rivers, including the Strelley and De Grey Rivers. **Groundwater - Mine Area** Groundwater within the mine area is likely to be found within: • Weathered, fractured	**Surface Water** Changes to surface water flows including: • Minor decrease in runoff. • Decrease in water quality of surface runoff. • Reduction in catchment runoff from rainfall on open pit. • Detention effect of drainage crossings may attenuate the peak discharge rate. • Increased runoff coefficient from cleared/compacted areas (haul roads etc.) due to changes in infiltration properties. • Ponding upstream of roads and other obstructions. Impacts to water pools may result from increased dust levels and degradation of vegetation and soils through human visitation to the pools. Impacts may also occur as a result of dust emissions from vehicular traffic on the access road, though traffic levels are expected to be minimal once construction is complete. Clearing and earthworks associated with the implementation of the Project may expose a greater area of soil to erosion and as a result may increase the sediment load of surface water runoff. In particular, increased sediment loads may be associated with runoff from the proposed WRD, Process Rejects Landform, LGOS, and product stockpiles **Groundwater** Potential impacts to local and regional groundwater resources from construction and operation of the Project include: • A drawdown cone of depression	• Construct diversion structures (such as bunds or channels) to divert clean surface water flow around infrastructure areas, and maintain downstream flow regimes where practicable. • Surface water diversions will be constructed such that water enters the drainage line/creek at an appropriate location to minimise erosion and scouring. • Where practicable, diverted clean surface water flows will be directed into the drainage line to which they naturally flow. • Potentially contaminated water from workshop areas and vehicle washdown will be captured and treated through an oil water separator, meeting the requirements of DoW Water Quality Protection Note 68 – Mechanical equipment washdown. • Minimise the impacts of the WRD on water quality and quantity through stabilisation to prevent erosion. • The Process Rejects Landform will be progressively constructed to provide a safe, stable, non-polluting landform. • Toe drains and sediment traps will be installed around the perimeter of the WRD, TSF and Process Rejects Landform where required. • Waste rock identified as potentially acid will be managed in accordance with the AMD Management Plan. • Locate buildings and process infrastructure out of the 1 in 100 year floodplain or construct suitable protection through bunds or vertical separation. • Hydrocarbons and chemicals will be transported, stored and handled in accordance with the applicable legislation and Australian Standards, for example AS1940. • Undertake progressive rehabilitation of cleared areas not required for operations. • Roads will be designed for a 1 in 5 year rainfall event.	Creeks within the Project area are ephemeral, flowing for a period after heavy rainfall events and are dry for the remainder of the time. Some diversion of surface water will be necessary in order to separate clean surface water flows from potentially contaminated surface flows. However, the volume of water diverted is a small portion of that flowing from the catchments in which the Project lies and is unlikely to adversely impact downstream flows. In the case of the TSF, stream flows return to 40 – 60% of natural flows within 2 km of the TSF embankment wall, and 80% of natural flows within 10 km of the TSF embankment wall. The absence of or reduction in flows within 2 km of the TSF embankment wall will impact the health of vegetation in this area and is likely to result in the death of some vegetation, in particular, the Ap and ApTp vegetation communities which are associated with the creekline. These vegetation units are well represented in the region and the decline in the health of the vegetation due to reduced flows from the TSF catchment will not significantly impact on their regional status. Additionally, no EPBC Act, WC Act or Priority listed flora species have been recorded from the section of Lost Boys Creek impacted by reduced flows. There is not expected to be any significant change to surface water quality as a result of implementation of the Project. The management measures outlined above will assist in minimising impacts such that they do

Environmental Factor	EPA Objective	Relevant Guidance	Existing Environment	Potential Impacts	Management Strategies	Predicted Outcomes
		• Department of Water. Pilbara Water in Mining 2009. (Department of Water, 2009) • Department of Water. Lower De Grey River: ecological values and issues 2010 (Department of Water, 2010) • Department of Water. Ecological water requirements of the lower De Grey River (Department of Water, 2012c) 2012 • Water Quality Protection Guidelines (Nos 1-11), Mining and Mineral Processing (WRC 1999) • Department of Water, Pilbara groundwater allocation plan 2012: For public comment (Department of Water, 2012b) • Department of Water. West Canning Basin groundwater allocation limit report (Department of Water, 2011b) • Department of Water. Pilbara regional water plan 2010-2030 (Department of Water, 2010a)	basement rock. • Superficial aquifers (unconsolidated sediments). Groundwater occurrence within the mine area is limited to small discrete groundwater bodies with limited connectivity. Groundwater is sometimes absent in high areas where the weathered and fractured zone is unsaturated or where the fractures are poorly developed. The mine area is located on a ridge of high ground, forming a surface water catchment boundary. Aquifer testing has identified strata with low or negligible available groundwater (maximum discharge measured at 61 m^3/d) and low permeability (hydraulic conductivity measured between 0.3 $x10^{-2}$ and $8.1x10^{-2}$ m/d). The superficial aquifer present to the west has been used as a water supply for exploration purposes. The standing water levels within the ore body vary between 319.9 m AHD and 395.2 m AHD. **Canning Basin Borefield** The West Canning Basin comprises three main hydrostratigraphic units: • Broome Sandstone. • Jarlemai Siltstone. • Wallal Sandstone. The Wallal Sandstone ranges in thickness between 14 m and 355 m with thickness generally increasing from the south west to the north east. Groundwater of the Wallal Sandstone is generally fresh, though increases in salinity towards the coast. Groundwater flow in the Wallal Sandstone is generally to the north and north-west, while recharge of the aquifer occurs via rainfall infiltration south of the sub-crop of the Jarlemai Siltstone in the south and east. Hydraulic conductivity for the Wallal Sandstone may vary across the aquifer with values between 20 and 60 m per day recorded. The only current use of water in the Wallal aquifer is for stock bores.	caused by pumping of groundwater from bores at Canning Basin. • Environmentally hazardous leachates from the WRD or Process Rejects Landform resulting in contamination of groundwater resources at the mine area. • Reduced infiltration in hardstand areas, stockpile areas, WRD and TSF resulting in decreased recharge to local ground water resources at the mine area. • Contamination of groundwater from hydrocarbon spills and leaks. • Increased infiltration of water from wet tailings in the TSF valley may increase recharge to alluvial aquifer.	• Prior to undertaking clearing activities in the vicinity of Fig Pool, the area to be cleared will be clearly delineated on the ground and dust and erosion management measures put in place to limit the potential indirect impact of these activities on Fig Pool. • Access to pools will be restricted to authorised personnel only. • Information in relation to surface water features of the Project area will be included in the induction programme for the Project. This will include information regarding restriction of access to these areas. All staff, contractors and visitors will be required to undertake the induction programme. • The design of the Project will take into account the climate change scenario developed for Fortescue (Adaptive Futures, 2011). • Spill kits will be maintained at high risk areas and on service vehicles. • Staff and contractors will be trained in spill response and the use of spill kits. • Hydrocarbons and chemicals will be transported, stored and handled in accordance with the applicable legislation and Australian Standards, for example AS1940. • Waste rock material will be managed according to the AMD Management Plan. • Mine closure planning includes measures to close the open pit and management of any pit lake. • The Canning Basin borefield will be operated in accordance with a DoW approved Groundwater Operating Strategy.	not represent a significant risk to the environment.. While Fig Pool is unlikely to be directly impacted from construction and operation of the Project, there may be residual, indirect impacts during operations, particularly in relation to increased noise and dust levels. The management measures outlined above will assist in managing the impact to Fig Pool such that any residual impact is as low as reasonably practicable. As groundwater in the mine area exists only in fractured rock systems and the hydraulic conductivity of the surrounding rock is very low, mining of the proposed open pit is only likely to impact those resources which it directly intersects. Groundwater investigations indicate the volume of water likely to be intercepted is low and consequently, impacts to the quantity of groundwater available in the mine area are considered to be negligible. Potential for impacts to groundwater quality are considered to be highest in relation to potential environmentally harmful drainage (such as acidic, metalliferous or saline drainage) from the WRD, LGOS and Process Rejects Landform. These facilities will be constructed such that they are stable, non-polluting landforms and the risk of impacts to the environment is low. Presence of mine infrastructure may reduce recharge to local groundwater systems in the mine area. Due to the nature of these systems (i.e. fractured rock aquifers) and the absence of groundwater dependant flora communities, the potential impact from reduced infiltration is considered negligible. There are no groundwater dependant ecosystems (GDEs) within the potential drawdown cone of the Canning Basin borefield. Construction of the concentrate slurry, natural gas and water supply pipelines will not result in long-term drawdown of the watertable in areas where GDEs are located. No impacts to GDE's are anticipated as a result of implementation of the Project. Groundwater reduction in pressure head in relation to abstraction from the Canning Basin borefield for the Project is predicted to be in the order of 0.8 m at the Great Northern Highway. In isolation, this is unlikely to impact on stock water bores in the

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						area. The Wallal aquifer in the area of investigation is confined and has limited connectivity to the overlying Broome aquifer. Mandora Marsh, approximately 100 km north-east of the borefield is fed by an ancient paleo-estuary and paleodrainage channel and is not connected to the Wallal Aquifer. Surface water features, including wetlands associated with Eighty Mile Beach, are fed by the Broome aquifer and will not be impacted through abstraction from the Wallal aquifer. Additionally, modelling has predicted that impacts due to abstraction are limited to a 25 km radius from the borefield. The nearest known surface water expressions are outside of this radius.

Greenhouse Gases - Relevant Factor	To minimise emissions to levels as low as practicable on an on-going basis and consider offsets to further reduce cumulative emissions.
	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
		• EPA Guidance Statement No. 12 Minimising Greenhouse Gas Emissions
		• Department of Climate Change: National Greenhouse and Energy Reporting Guidelines (2008)
		• National Greenhouse and Energy Reporting Act 2007
		• National Greenhouse and Reporting Regulations 2008
		• National Greenhouse and Energy Reporting (Measurement) Determination 2008
		• NGER (Measurement) Technical Guidelines
			Fleet
			It is estimated that over the life of the Project approximately 80,512 tonnes of greenhouse gasses (measured as CO2-equivalent) per annum will be generated from sources other than power generation. The major contributor to greenhouse gas emissions will be fuel consumption for the purposes of mine load and haul which will generate approximately 61,702 tonnes of CO2-equivalent (CO2-e) per annum.
			Power Station
			Greenhouse gas emissions for the 120 MW power station have been calculated for two scenarios with the turbines running on natural gas only or diesel only. Under the natural gas only scenario, it is expected that 374,709 tonnes CO2-e will be generated per annum while under the diesel only scenario, 548,344 tonnes CO2-e will be generated per annum.
			Total Emissions
			As the power station will run on natural gas as the main fuel, the total emissions for the Project are estimated to be 455,221 tonnes CO2-e per annum. This is approximately 1% of the net emissions for Western Australia in 2010 (Department of Climate Change and Energy Efficiency, 2012) and equates to 0.03 tonnes CO2-e per tonne of product.
			The reported greenhouse gas
				• GHG emissions will be produced during construction and operation of the Project. Main sources of GHG:
				  • combustion of gas for power generation.
				  • combustion of diesel for drilling and blasting.
				  • vehicle fuel consumption.
				• Land clearing associated with clearing and earthworks will contribute to GHG emissions.
				• Impacts related to GHG include the potential to contribute to climate change, including changes in global temperature, rainfall, and wind patterns, shifts in climate zones, and rising sea levels.
					• Adoption of a continuous improvement program to increase energy efficiencies and reduce greenhouse gas emissions throughout the lifetime of the Project.
					• Review and report on greenhouse gas abatement measures and identify opportunities to further reduce greenhouse gas emissions over time.
					• Carbon reduction through the use of efficient technologies for the mining, processing, power production and transport functions.
					• Greenhouse emissions data collection.
					• Consideration of carbon reduction technologies or carbon offsets programmes.
					• Identify and implement cleaner production initiatives to increase energy efficiency where practicable.
					• Regular maintenance and servicing of infrastructure and machinery.
					• Progressive rehabilitation of cleared areas not required.
						Greenhouse gas emissions from the Project will not significantly contribute to total emissions for Western Australia. Through the implementation of the management strategies it is anticipated that greenhouse gas emissions will be reduced over time.

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			emissions for the Electricity sector for the 2012 reporting period was109.7 million tonnes (Department of Climate Change and Energy Efficiency, 2012). The estimated emissions from the Project equate to 0.41% of this. .			
Atmospheric Emissions – Relevant Factor	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	• National Environment Protection (Ambient Air Quality) Measure (NEPM) (NEPC, 2003). • Kwinana Environmental Protection Policy (EPP) (EPA, 1999). • Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (NSW DEC, 2005). • Air Quality and Air Pollution Modelling Guidance Notes (DoE 2006). • A guideline for the development and implementation of a dust management program (Draft) (DEC, 2008). • EPA Guidance Statement Number 18: Protection of Air Quality Impacts from Land Development Sites (EPA, 2000).	The nearest sensitive receptor to the mine area will be the accommodation camp, which is approximately 4.5 km west of the open pit and 2.3 km west of the power station. A series of natural ridges exist as a barrier between the accommodation camp and proposed operations. The Woodstock Aboriginal Community is approximately 30 km south of the mine area while Panorama Homestead is approximately 40 km to the north east. The closest sensitive receptor to the Canning Basin borefield is the Pardoo Roadhouse, approximately 15 km northwest. Wallal Downs Homestead is approximately 40 km east while Pardoo Homestead and Muccan Homestead are approximately 45 km to the west and south respectively.	• The construction and operation of the mine, processing plant, administration buildings and site infrastructure is likely to generate emissions to air from material handling, wheel generated dust and wind erosion of exposed surfaces. • Exacerbation of pre-existing respiratory problems in the workforce due to dust. • Reduced visibility due to increased dust. • Reduced amenity due to surface deposition. • Impacts to vegetation due to dust deposition.	• The Fortescue Mine and Rail Dust Management Plan (45-PL-EN-0030) will be implemented. • Dust collection systems (for example cyclones or bag houses) will be installed at appropriate locations throughout the dry processing plant to remove airborne dust. • Progressive rehabilitation will be undertaken to reduce the area susceptible to wind erosion. • Water trucks will be used for dust suppression on haul roads, access tracks, the pit floor and high traffic areas. • Dust management measures will be implemented on areas of the TSF which are shown to be drying out and generating dust. • Dispersive waste rock materials will be managed in line with the AMD Management Plan. • The Process Rejects Landform will be constructed to provide a safe, stable, non-polluting landform. • Revised modelling of the power station will be undertaken as part of the Works Approval Application process. • Air emissions monitoring will be undertaken as per the requirements of Works Approvals and Licensees issued under Part V of the EP Act.	• The mine area, power station and Canning Basin borefield are located in remote areas of the Pilbara with the nearest non-project related sensitive receptor located at least 15 km distant. Given this, no impacts on air quality at these receptors is anticipated. The only sensitive receptor within proximity of the mine area is the mine accommodation camp. A series of natural ridges approximately 380 m AHD are located between the camp and the active mining and processing area creating a natural barrier to dispersion of air emissions towards the accommodation camp. In addition, the proposed management measures will reduce dust generation from mining operations. As a result, it is expected that there will be no air quality related impacts at the mine accommodation camp. • Management measures are expected to minimise dust generation and keep deposition to levels that will not impact on vegetation health. Should monitoring show adverse impacts are occurring, an investigation into the cause will be undertaken, and additional management measures identified and put in place.
Noise – Relevant Factor	To protect the amenity of nearby residents from noise impacts resulting from activities associated with the proposal by ensuring the noise levels meet statutory requirements and acceptable standards.	• Australian Standard AS 2436-2010 Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites (2010). • Australian Standard AS 2187.2-2006 Explosives - Storage and Use Part 2 Use of Explosives 2006. • *Environmental Protection Act 1986* (WA). • Environmental Protection (Noise) Regulations 1997. • Environmental Protection Bulletin No.2 – Port Hedland	A noise level survey was undertaken at the proposed mine accommodation camp to establish baseline ambient noise levels of the project area. Data was collected over a ten day measurement period in March 2012 and shows background noise levels are in the order of 19-22 dBA overnight and 55 dBA during the day. The higher value during the day is likely due to general wind noise. No significant source of anthropogenic noise currently exists in the project area. The nearest sensitive receptor	Impacts from noise may be experienced during operations at the accommodation camp west of the mine and along the slurry and water supply pipelines during construction. Generally, the potential impacts from noise emissions related to the Project include: • Nuisance noise and loss of amenity at the mine accommodation camp. • Nuisance noise and loss of amenity at Whitehills residential community and Indee homestead. • Avoidance by fauna of areas of higher noise emissions. This may result in reduced breeding or foraging habitat	• All construction and operational activities will be undertaken in accordance with the Environmental Protection (Noise) Regulations 1997. • Updated modelling will be undertaken as part of the Works Approval Application process required under Part V of the EP Act to account for the addition of the power station in the mine area. • Noise monitoring will be undertaken during mining operations to determine if assigned levels are being exceeded. • Noise attenuation will be fitted to plant and equipment where required. • A complaints procedure will be established for the duration of construction activities associated with slurry pipeline, water supply	The only sensitive receptor likely to be impacted by construction and operation of the mine area is the mine accommodation camp. Mining activities may exceed the night time assigned noise level by 2 dB, however, this will only potentially occur while the mine fleet is close to the surface with all equipment and plant operating at maximum output. Management measures will be adopted to avoid any actual exceedances. As mining extends beyond 10 m below ground level, noise and vibration emissions emanating from the open pit are

Environmental Factor	EPA Objective	Relevant Guidance	Existing Environment	Potential Impacts	Management Strategies	Predicted Outcomes
		Dust and Noise (EPA, 2009). • EPA Guidance Statement No. 8 (Draft): Environmental Noise (EPA, 2007). • Department of State Development: Port Hedland Air Quality and Noise Management Plan – The Port Hedland Dust Management Taskforce Report (DSD, 2010). • State Planning Policy 5.4 Road and Rail Transport Noise and Freight Considerations in Land Use Planning (WAPC, 2009a). • Implementation Guidelines for State Planning Policy 5.4, (WAPC, 2009b).	to the mine area is the accommodation camp, which is approximately 4.5 km west of the open pit and 2.3 km west of the power station. The Woodstock Aboriginal Community is approximately 30 km south of the mine area while Panorama Homestead is approximately 40 km to the north east. The closest sensitive receptor to the Canning Basin borefield is the Pardoo Roadhouse, approximately 15 km north west. Wallal Downs Homestead is approximately 40 km east while Pardoo Homestead and Muccan Homestead are approximately 45 km to the west and south respectively.	being available for certain species. • Disturbance to Pilbara Leaf-nosed Bats roosting in caves in proximity to the open pit, processing plant and power station resulting in bats abandoning these roosts.	pipeline and Canning Basin Borefield. Contact details will be made available to the general public and specifically residents of Whitehills residential community and homesteads within 15 km of the pipelines. • Noise complaints from local communities will be addressed in a timely manner and the outcomes recorded. • Equipment and machinery will be maintained to manufacturers specifications such that noise emissions are minimised. • Construction will be undertaken in accordance with the noise practices outlined in AS 2436-1981. • All employees and contractors will be provided with awareness training on their obligations and responsibilities in relation to noise and vibrations impacts.	minimal. A limited number of receptors may be impacted during construction of the slurry pipeline, water supply pipeline and Canning Basin borefield. However, construction activities will only be undertaken during daytime hours when background noise and vibration levels are generally higher. Construction will also be of a short duration in any one location and as a result impacts to receptors are expected to be minimal. Once construction is completed noise and vibration impacts will be limited to pumping stations and are therefore considered to be negligible The impacts of noise and vibration on fauna is expected to be greatest closest to the operational areas of the mine and largely associated with early phases of extraction and processing of ore. Any fauna nearby may be impacted in the short term, however the management measures outlined above are expected to minimise and reduce the exposure to noise. Anecdotal evidence from mine sites suggests that many fauna species are likely to become habituated to disturbances such as noise and vibration.
Social – Relevant Factor	To ensure that aesthetic values are considered and measures are adopted to reduce visual impacts on the landscape as low as reasonably practicable. To ensure that existing and planned recreational uses are not compromised.	• Pilbara Cities: Departments for Regional Development and Lands (2010). • Pilbara's Port City Growth Plan.	Detailed information relating to the existing local and regional economy and local communities near the Project can be found in Section 12. The key findings are summarised below. The closest non-Aboriginal community to the Project is Whitehills rural estate in Port Hedland, located 2.5 km from the Slurry Corridor Development Envelope. The closest Aboriginal community to the Project is Warralong community, approximately 15 km east of the Water Corridor Development Envelope. The closest Aboriginal community to the mine area is the Woodstock community, approximately 30 km to the south. The closest homesteads to the Project are Mulyie, Ettrick and Warralong which are less than 15 km from the Water Corridor Development Envelope. The closest Homestead to the mine area is Panorama Homestead, approximately 40 km to the east.	Pressure on local communities that may become evident as a result of the Project, includes: • Potential increase in anti-social behaviour. • Increased competition for access to community services, such as health services. • Additional traffic and/or airport congestion. • Increased competition for access to accommodation. • Increased cost of living. • Increased pressure on available airline capacity. The proposed Project will make a contribution to the regional and local economy through local sourcing of goods and services, contributing royalties, company tax payments and generating 800 permanent jobs. The Project will also contribute to Indigenous training and business opportunities in the Pilbara region. Increased local operational and contracting workforce can provide a stimulus for local business development and support employment opportunities in	• Procurement of goods and services from local providers to stimulate greater economic diversity and enhance the capability of the area. • Use of the Pilbara Business Capability Register (ePilbara) and the industry capability network database (ICN) for identifying local contractors. • Use of Fortescue's Community Office in Port Hedland as a recipient of local supplier information either though expressions of interest submitted by interested parties or through research undertaken by Community Office staff. • A construction and operations accommodation camp to be developed in the Project mine area to reduce pressure on local accommodation supply and transport infrastructure. • Bus transport for construction and operational workers travelling between Port Hedland and Project areas. • Employment of local workers from the Port Hedland area, Aboriginal communities. • Continued support and funding of activities that foster economic development and sustainable communities, including the VTEC program, community grants program, investment in new housing in Port Hedland, attracting and retaining health workers and	Positive and negative impacts on local and regional economies and communities may be associated with the construction and operation of the Project. Fortescue's ongoing commitment to working with local and regional authorities and local communities will increase the positive impacts from the Project and assist with alleviating any potential negative impacts.

Environmental Factor	EPA Objective	Relevant Guidance	Existing Environment	Potential Impacts	Management Strategies	Predicted Outcomes
			The nearest major town to the Project, by road, is Port Hedland, which is currently experiencing increased pressure on social services and transport infrastructure due to industrial growth. Large population fluctuations in Port Hedland are associated with temporary workforces and it is considered to be the fastest growing population in Australia. Strategic development programs are being implemented for the Pilbara at a Federal, State and local government level to assist with the sustainable development of key infrastructure in the region. Fortescue is supporting the State Government's Pilbara Cities vision and strategic development of the Pilbara through its commitment to a residential workforce, local employment, training and employing Aboriginal people and providing opportunities for local businesses.	non-mining sectors of the local economy. Fortescue contributes to the local economy through community programs and initiatives including Indigenous traineeships and local projects, and to date has contributed millions of dollars to the Town of Port Hedland through such programs. Opportunities for local employment and business development will be realised through construction and operation of the Project. Economic development in Port Hedland will lead to increased benefits to hospitality, retail, recreation sectors and small businesses. Indigenous employment and community development including education, training and traineeships will be provided by this Project to communities in the Pilbara region.	providing funding for strategic road upgrades. • Maintain a complaints and feedback system from the community and address them in a timely manner.	
Cultural Heritage – Relevant Factor	To ensure that changes to the biophysical environment do not adversely affect historical and cultural associations and comply with relevant heritage legislation.	• *Aboriginal Heritage Act 1972* (WA) • *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* (Cth) • *Native Title Act 1993* (Cth) • EPA Guidance Statement Number 41: Assessment of Aboriginal Heritage (EPA, 2004)	Indigenous heritage sites have been identified within the Project footprint in the Mining Development Envelope, Infrastructure Corridor Development Envelope, Slurry Corridor Development Envelope and Water Corridor Development Envelope. No listed European heritage sites are located within 10 km of the Project area. The Project will traverse the Njamal, Warrarn and Kariyarra Native Title Claims.	Impacts related to heritage may result largely due to clearing and earthworks associated with construction and operation of the Project and include: • Damage to or demolition of identified Aboriginal heritage sites. • Damage to or demolition of unknown Aboriginal heritage sites uncovered as a result of Project activities. • Unauthorised access to heritage sites leading to degradation of these sites. • Changes in land use resulting in exclusion of Aboriginal people from areas of cultural significance.	• An agreement has been reached with the Njamal people, creating a production sharing agreement between Fortescue and the Njamal people. Under this agreement, provision for protection and management of cultural heritage is included. • The "Guideline for the Management of Aboriginal Cultural Heritage" is Fortescue's primary cultural heritage management document used by personnel when planning and undertaking any scope of works in Fortescue project areas. It details guidelines and procedures to assist with the day to day management and protection of Sites on Fortescue project areas; and ensures staff and contractor compliance with internal, statutory and community cultural heritage obligations. • Ground disturbing activity will only take place once a Ground Disturbance Permit (GDP) has been obtained. • GDP's include heritage protection conditions where Aboriginal Sites are present, and are only approved for areas that have been subject to ethnographic and archaeological surveys. • Location and design of project elements will avoid heritage sites wherever possible. In the event that preservation of sites is not possible, sites of cultural significance will be salvaged in consultation with the Njamal people and in accordance with a Section 18 Consent and Ministerial Conditions. • Where disturbance of an Aboriginal heritage	Damage, loss, or disturbance of sites/artefacts of Aboriginal heritage through physical disturbance of the land, or from the presence of construction / operations workforce will be minimised through the proposed management strategies. As a result, it is expected that there will be no significant impacts to the cultural heritage values of the Project area and surrounds.

Environmental Factor	EPA Objective	Relevant Guidance	Existing Environment	Potential Impacts	Management Strategies	Predicted Outcomes
					site is unavoidable, consultation with Aboriginal site owners will be undertaken and a Section 18 application under the *Aboriginal Heritage Act 1972* will be completed • Staff working in proximity to Aboriginal heritage sites will be advised of their locations prior to commencing work on the Project in order to avoid unintentional disturbance of these sites • Heritage monitors will be employed for all activities which require ground disturbance in proximity to cultural sites • Known cultural heritage sites in the Project area will be appropriately protected with buffer zones, fencing or flagging (or equivalent) to prevent inadvertent disturbance of areas of significance • If additional heritage sites are uncovered during construction, work in the area will cease immediately until the authenticity and significance of the site is determined in line with Fortescue's Heritage Management Guidelines • Community complaints, incidents and non-compliance procedures will be established for the duration of the Project • Information in relation to the environment of the Project area, including cultural heritage, will be included in the induction programme for the Project. The induction programmed will include information in relation to roles and responsibilities. All staff and contractors will be required to undertake the induction programme. Visitors will be escorted while on site.	

14.7 Proposed Offsets

EPA Position Statement 9 *Environmental Offsets* (EPA, 2006b) makes it clear that environmental offsets may only be considered once all other reasonable attempts to mitigate adverse impacts have been exhausted.

Management and mitigation measures for environmental impacts resulting from the Project have been designed to take into consideration the hierarchy of impact mitigation (Schematic Map 1) as described in EPA's *Draft Environmental Assessment Guideline – Environmental Offsets* (EPA, 2012d).

Schematic Map 1: Impact Mitigation Hierarchy (EPA, 2006)

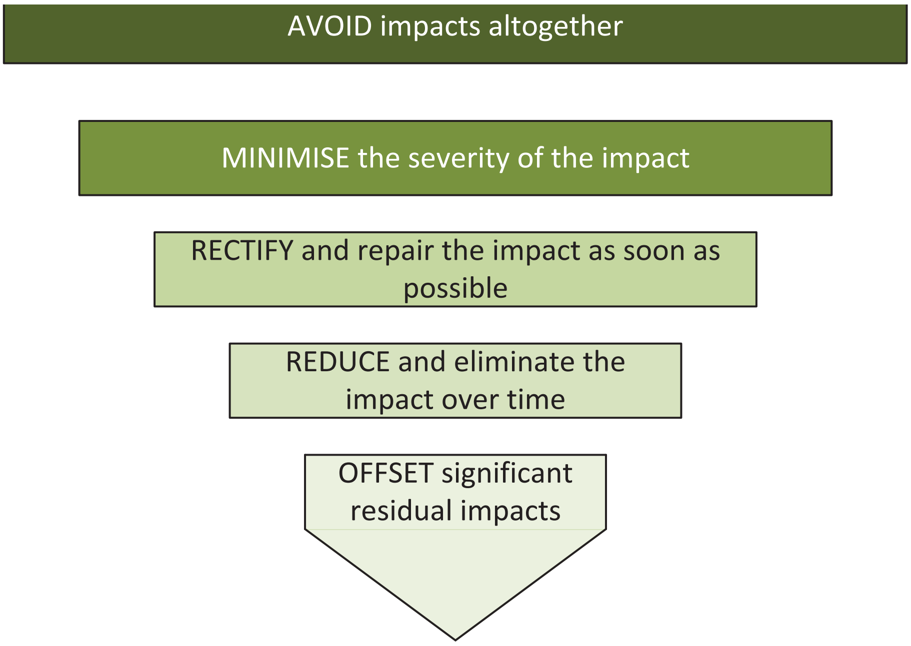

Table 60 above describes how avoidance, environmental management and mitigation and rehabilitation aim to reduce the impacts to key environmental factors as a result of the implementation of the Project. However it is expected that there will be residual impacts as a result of the Project.

14.7.1 Assessment of impacts against EPA Offset Guidance Material

EPA Position Statement 9 (EPA, 2006b) and EPA Guidance Statement 19: Environmental Offsets (EPA, 2008c) provide guidance to proponents on the approach needed to determine offset requirements for proposals. The definitions of critical and high value in EPA Position Statement 9 are as follows:

Critical Assets: represent the State's most important environmental assets that must be fully protected and conserved at all costs. Therefore the EPA in providing its advice will adopt a presumption against approval of project proposals where significant impacts affect 'critical *assets'. However where projects have been approved by the State Government (see Section 4) approval should be conditional on the:*

- *Consideration or demonstration (to the maximum extent possible) of onsite impact mitigation; and*
- *Development and implementation of an acceptable offsets package for significant, residual adverse impacts.*

High Value Assets: represents those environmental assets that are in good to excellent condition, are considered valuable by the community and/or government, but are not identified as 'critical assets'. Project proposals and offset activities for these assets may be referred to and assessed by the EPA on a case by case basis, but are otherwise considered relevant environmental government agencies.

The environmental aspects of the North Star Magnetite Project were assessed for their potential value as critical or high value assets as per the definitions provided within the EPA guidance material. Critical assets include:

- Northern Quoll populations and denning/breeding habitat.
- Pilbara Leaf-nosed Bat population, day roost cave and night roosting and foraging habitat.
- Pilbara Olive Python population and significant habitat.
- Priority listed flora and fauna species.
- Vegetation associated with a watercourse.

High Value assets include:

- West Canning Basin (Wallal Aquifer).
- Vegetation in good to excellent condition.

An assessment of the impact of the project to these environmental assets, the measures to avoid, mitigate and rectify these impacts and any significant residual impact is discussed in Table 61.

Table 61: EPA Environmental Offsets Reporting Form

Section A: Administrative information

1. Proposal or scheme name: North Star Magnetite Project

2. Summary of proposal or scheme:

The proposal is for the development of the North Star Magnetite Deposit and includes:

- One open cut mine pit.
- Waste rock dump (WRD).
- Tailings storage facility (TSF).
- Ore stockpiles.
- Processing plant.
- Slurry and gas pipelines.
- 120 megawatt (MW) gas fired power station.
- Roads and borrow pits.
- Water processing, ponds and reticulation.
- Bulk fuel storage.
- Workshops and maintenance facilities.
- Explosives and chemical storage.

It is also proposed to develop a borefield within the Canning Basin and a 190 km water supply pipeline for the Project's operational water supply requirements.

Section B: Type of environmental asset (s) – State whether Critical or High Value, describe the environmental values and attributes

Environmental assets that may be affected by the Proposal and could be considered 'critical assets' if significant impact occurs as defined in Position Statement 9 Environmental Offsets (EPA, 2006b) are:

Critical asset category (ii) Native Vegetation growing in, or in association with, an environment associated with a watercourse

- Vegetation associated with a watercourse (Section 7.2).

Critical asset category (iii) Declared Threatened Fauna

- Significant habitat for the Northern Quoll, Pilbara Leaf-nosed Bat and Pilbara Olive Python (Section 11.4 and 11.5).
- Significant population of Pilbara Leaf-nosed Bat (Section 11.4)

Critical asset category (iii) Priority species listed by the DEC

- Priority listed flora species (Section 7.3).

- Priority listed fauna species (Section 8.4)

Environmental assets that may be affected by the Proposal and could be considered 'high value' environmental assets as defined in EPA (2006b) are:

- West Canning Basin (Section 10.2.3).
- Vegetation is good to excellent condition (Section 7.2)

Section C: Significant impacts (describe the significant adverse environmental impacts related to the proposal or scheme before mitigation measures are applied)

Vegetation in association with a watercourse

- Clearing of up to 294 ha of vegetation associated with watercourses. This amounts to 7% of the mapped extent of these vegetation communities. Due to the paucity of surveys in the area the actual extent of vegetation communities is likely to be much larger than currently mapped at this scale.
- Reduction in surface water flows within 10km downstream of the TSF wall.

These impacts are not considered to be significant.

Fauna and Fauna Habitat, including EPBC Act Listed Species

- Clearing of up to 95 ha of Rocky ridges/ breakaway/ gorges habitat which has been identified as being significant habitat for the Northern Quoll, Pilbara Leaf-nosed Bat and Pilbara Olive Python. This amounts of 18% of the mapped extent of this habitat. Due to the paucity of surveys in the area the actual extent of vegetation communities is likely to be much larger than currently mapped at this scale.
- Loss of one day roost cave for the Pilbara Leaf-nosed Bat and possible loss of a colony of approximately 200 bats.
- Clearing of up to 112 ha of Pilbara Olive Python habitat. This amounts to 12% of the mapped extent of suitable habitat
- Degradation of water pools and their associated vegetation may reduce their ability to support Pilbara Olive Python which may lead to a decline in the local population.

These impacts are considered to be a significant impact.

Priority Flora and Fauna Species

- 158 individual *Pityrodia sp*. Marble Bar plants will be disturbed as a result of the Proposal. This is 10% of the known extent of this species.
- 1 individual *Acacia glaucocaesia* plant will be disturbed as a result of the proposal.

These impacts are not considered to be significant.

Groundwater Abstraction: West Canning Basin

- Reduction in pressure head of 0.8m at Great Northern Hwy due to extraction of 14GLpa from the Wallal Aquifer in the West Canning Basin

This is not considered to be a significant impact.

Vegetation in Good to Excellent Condition

- All vegetation to be cleared in Mining Development Envelope is in good to excellent condition.
- Approximately 845 ha (95%) of vegetation in good to excellent condition will be cleared within the Water Corridor Development Envelope.
- Approximately 437 ha (98%) of vegetation in good to excellent condition will be cleared within the Infrastructure Corridor Development Envelope.

- Vegetation condition mapping does not exist over large sections of the Slurry Corridor Development Envelope. Clearing within the Slurry Corridor Development Envelope (315 ha) will occur in close proximity to the existing Fortescue rail line. Vegetation may be disturbed by previous clearing activities and edge effects.

A total of 5141 ha of vegetation will be cleared as a result of the Project. Almost all clearing will occur within vegetation in good to excellent condition. However, the vegetation surrounding the Project clearing envelope has also been mapped as in good to excellent condition. Vegetation condition is likely to be similar within the region.

The clearing of 5141 ha of vegetation is a significant impact.

Section D: Mitigation measures (describe all measures to Avoid, Minimise, Rectify and Reduce)

Vegetation and Flora:

- Project infrastructure has been located away from known areas of conservation significant flora and/or vegetation as far as practicable.
- Ground Disturbance Permits (GDPs) will be required prior to commencement of clearing activities.
- Clearing and disturbance within the Special Rail Licence (LSA1) will be undertaken in compliance with the *Rail Corridor Disturbance Management Plan* (R-PL-EN-0012) and *Rail Route (Stage B) Environmental Management Plan* (R-PL-EN-0010).
- Infrastructure has been located outside of watercourses as far as practicable. Diversions will be put in place as required.
- Information in relation the environment of the Project area, including vegetation and flora of conservation significance, will be included in the induction programme for the Project. The induction programme will include information in relation to roles and responsibilities. All staff and, contractors and visitors will be required to undertake the induction programme. Visitors will be escorted while on site.
- An AMD management Plan will be implemented. The objective of this plan will be to manage waste rock such that the WRD is a stable, non-polluting landform.
- Vehicles will be confined to defined roads and access tracks.
- Water trucks will be used for dust suppression on haul roads, access tracks, the pit floor and high traffic areas.
- The use of surfactants to increase dust suppression capability of applied water will be investigated. This investigation will take into consideration the potential adverse consequences that may result from the use of surfactants, such as coating of leaf surfaces and toxic effects on frogs, as well as benefits such as reduced dust emissions and more efficient use of water resources.
- Progressive rehabilitation will be undertaken during operations and the area will be rehabilitated according to an approved mine closure plan post-closure.

Fauna and Habitat:

- Information in relation to the environment of the Project area, including fauna and habitats, will be included in the induction programme for the Project. The induction programme will include information in relation to roles and responsibilities. All staff and contractors will be required to undertake the induction programme.
- Internal GDPs will be required prior to commencement of activities.
- Where pipelines are required to be placed on the surface, the pipe will be raised of the ground in order to minimise impacts to surface water flow and fauna movements.
- Vehicles will be confined to defined roads and access tracks.
- Personnel trained in fauna handling will be employed during trenching operations to clear open trench of fauna on a daily basis and prior to backfilling.

- Injured fauna will be reported to the site environmental officer who will determine the appropriate course of action.
- Fauna mortalities involving EPBC Act, WC Act or DEC Priority listed species will be reported to DEC and DSEWPaC as required.
- Fire prevention regimes will be implemented.

EPBC Listed Threatened Species:

- Internal GDPs will be required prior to commencement of activities.
- Where pipelines are required to be placed on the surface, the pipe will be raised of the ground in order to minimise impacts to surface water flow and fauna movements.
- Vehicles will be confined to defined roads and access tracks.
- Records of all sightings of EPBC Act, WC Act or DEC Priority listed fauna in the Project area will be taken.
- Information on EPBC Act, WC Act or DEC Priority listed fauna of conservation significance will be included in the staff and contractor induction program for the Project.
- FMGIB will continue the Bat Vibration study to determine safe working distances from bat caves. When safe working distances are identified, this will be enforced at North Star and details provided to regulators.
- A monitoring program for Pilbara Leaf-nosed Bats, Pilbara Olive Python and the Northern Quoll will be undertaken in order to confirm the continued presence of the species in the area during the life of the Project.
- Injured EPBC Act, WC Act or DEC Priority listed fauna species will be reported to the site environmental officer who will determine the appropriate course of action.
- Fauna mortalities involving EPBC Act, WC Act or DEC Priority listed fauna species will be reported to DEC and DSEWPaC.
- Progressive rehabilitation will be undertaken where practicable.
- A Construction Environmental Management Plan will be implemented for construction of pipelines
- Where relocation of vertebrate fauna of conservation significance is required, FMGIB will implement a methodology for trapping, temporary holding, transport and relocation of species in consultation with the DEC.
- Where practicable, directional lighting will be used to minimise any increase in light levels as a result of project activities at the nearest potential roost caves.
- Vehicle speed limits will be enforced for all Project roads and tracks. Off road driving will be prohibited unless authorised or in emergency situations.
- Driving at dawn, dusk or night will be minimised as far as practicable.
- All machinery, vehicles and plant arriving on site will inspected for signs of invasive species and will be required to be free of vegetative matter and soil/mud.
- Fire prevention regimes will be implemented.

Hydrology:

- Information in relation surface water features of the Project area will be included in the induction programme for the Project. This will include information regarding restriction of access to these areas. All staff, contractors and visitors will be required to undertake the induction programme.
- The Canning Basin Borefield will be operated in accordance with a DoW approved Groundwater Operating Strategy.

Section E: Significant residual impacts (describe all the significant adverse residual impacts that remain after all mitigation attempts have been exhausted)

After the avoidance, mitigation and restoration measures outlined above, the following are considered to be significant residual impacts to environmental assets as a result of the Project.

- Permanent loss of 45 ha of Northern Quoll denning habitat associated with the open pit. The remainder of habitat cleared for the proposed open pit (465 ha) is considered to be foraging habitat.
- Loss of 45 ha of Pilbara Leaf-nosed Bat night roosts and foraging habitat associated with the open pit.
- Loss of one Pilbara Leaf-nosed Bat day roost cave and possible loss of a colony of approximately 200 bats.
- Permanent loss of 45 ha of Pilbara Olive Python habitat associated with the open pit.
- Permanent loss of 5141 hectares of native vegetation, the majority in good to excellent condition.

Significant residual impacts to other environmental assets are not expected.

Section F: Proposed offsets for each significant residual impact (identify direct and contributing offsets). Include a description of the land tenure and zoning / reservation status of the proposed offset site. Identify any encumbrances or other restrictions on the land that may impact the implementation of the proposed offset and provide evidence demonstrating how these issues have been resolved.

Direct and Contributing Offsets

Strategic Land Management Plan

The Strategic Land Management Plan has been prepared for Fortescue Projects in consultation with DEC and covers an area of 1,000,000 ha of land in the Pilbara and incorporates a mixture of tenures including Pastoral Leases, Mining Tenure, State Agreement Acts and Crown Land. The plan outlines a number of landscape scale management strategies to address threats to EPBC Act threatened fauna species including the Northern Quoll, Pilbara Leaf-nosed Bat and Pilbara Olive Python. These strategies include feral animal control, fire management and rehabilitation of degraded land. The plan requires a number of parties work collaboratively to achieve the desired outcomes. This approach will allow FMGIB to work with other parties including the DEC, pastoralists, Rangelands NRMs and other resources proponents, to support implementation of consistent management approaches in an efficient and targeted manner. The North Star Magnetite Project will contribute funding to the Strategic Land Management Plan. More details provided Section 14.5.

Pilbara Leaf-nosed Bat Research

A research programme will be undertaken to determine the habitat requirements of the Pilbara Leaf-nosed Bat, including cave formation, humidity and foraging requirements. The findings will be used to recreate Pilbara Leaf-nosed Habitat in the North Star area to allow bats to colonise and utilise new alternative roost caves. More details provided Section 14.5.

Section G: Spatial data relating to offset site/s (see *EPA Guidance Statement No. 19: environmental offsets- biodiversity*, Appendix 4)

Spatial data is held by Fortescue. Maps of the offset site are provided as part of the Strategic Land Management Plan.

Section H: Relevant data sources and evidence of consultation (consultation with agencies, relevant stakeholders, community and references to sources of data / information). Include details of specific environmental, technical or other relevant advice and information obtained to assist in the

formulation of the offset.

- Flora, vegetation and fauna surveys of the Project area, as outlined in Sections 7.1, 8.1.
- Hydrological investigations of the Project area, as outlined in Section 10.
- Native vegetation clearing principles in the EP Act 1986.
- EPA Position Statements 2 (protection of native vegetation), 4 (wetlands), and 9 (offsets).
- EPA Draft Guidance Statements 51 and 56 (flora and fauna studies) 19 (offsets) and 6 (rehabilitation).
- DSEWPaC significant Impact Guidelines 1.1 (MNES) and 3.2 (Northern Quoll).
- DSEWPaC survey guidelines or Australia’s threatened Bats and mammals.
- EPBC Act Environmental Offsets Policy.
- Consultation with DEC and DSEWPaC, as outlined in Section 5 of this PER.

14.8 Significant Residual Impacts and Offsets

As described in Table 61, the Project will result in the following significant residual impacts:

- Permanent loss of significant habitat for the Northern Quoll in the footprint of the proposed open pit.
- Permanent loss of significant habitat for the Pilbara Leaf-nosed Bat, including one day roost cave and possible loss of a colony of approximately 200 bats.
- Permanent loss of significant habitat for Pilbara Olive Python within the proposed open pit.
- The clearing of 5141 ha of vegetation, the majority of which is in good to excellent condition.

In consultation with the DEC and DSEWPaC, Fortescue has developed a Strategic Land Management Plan to meet the requirements of previous approval conditions issued under the EPBC Act. These approval conditions require the development of a Strategic Land Management Plan that maximises the benefits and minimises the threats to EPBC listed threatened fauna species in the Pilbara Region of Western Australia.

An area covering portions of the Hamersley and Fortescue subregions of the Pilbara has been selected for the implementation of strategic land management. This area includes areas of high conservation value such as Karijini National Park and the Fortescue Marsh, wetlands and riparian systems of national or subregional significance and EPBC listed species and their habitats.

Specifically, the Plan:

- Outlines the benefits of landscape scale management in the Pilbara
- Identifies and describes the area selected for landscape scale management
- Details how the Plan will contribute to other land management programs
- Identifies the threatening processes of EPBC listed fauna species in the Plan area
- Outlines options to manage the threatening processes

The objectives and deliverables of the plan are consistent with national initiatives being developed by the Australian government.

The key benefits of a landscape scale management approach include:

- A focus on managing and/or controlling specific threats to EPBC listed fauna species in the Pilbara, fire, feral animals and invasive weeds, on a large scale

- Implementation across a large area rather than just individual patches or populations of EPBC Act listed fauna species
- Allows for a consistent and coordinated approach to the implementation of offset programs rather than the management of small parcels of fragmented land in isolation, by teams that may not have specific expertise in conservation management
- The large land size and scale of the management actions will limit any impact to the conservation outcomes from mining and/or other alternative land uses
- The DEC, the key conservation management body in WA will be involved in the development and implementation of the plan
- Pastoral lease holders, managers and other stakeholders including those included in the ‘Care for our Country’ and Natural Resource Managers will be consulted and encouraged to participate in the coordinated program
- Implementation will include consideration of social benefits such as indigenous training and employment opportunities
- Traditional owners will be consulted to ensure cultural values are also considered and knowledge is incorporated into implementation

The plan identifies the key threats to EPBC Act listed threatened species and communities impacted by Fortescue operations and outlines landscape scale management strategies to address these threats in an area of over 1,000,000 ha. Key management actions of the plan include:

- Feral herbivore control.
- Baiting for feral predators such as cats and foxes.
- Weed Management
- Fire management.

This plan will allow Fortescue to work in collaboration with other parties including the DEC, pastoralists, Rangelands NRMs and other mining proponents, to support implementation of consistent management approaches in an efficient and targeted manner. The area of land selected is large enough to offset residual impacts from this Project and includes habitat for the Northern Quoll, Pilbara Leaf-nosed Bat and Pilbara Olive Python.

The North Star Magnetite Project will contribute funding to the implementation of the Strategic Land Management Plan.

In addition to the Strategic Land Management Plan, FMGIB proposes the following offsets in relation to the Pilbara Leaf-nosed Bat:

- FMGIB will monitor the population at North Star before and after disturbance occurs. This will provide additional information with regards to the population and will determine whether the population persists after mining commences. In addition, FMGIB will continue to search for other suitable bat caves in nearby habitat.

- FMGIB will study the roost cave before it is disturbed to determine its characteristics (temperature, humidity, size, length, cavity).
- FMGIB will work collaboratively with other proponents where they are required to offset impacts to the Pilbara Leaf-nosed Bat. This shared understanding and knowledge will be used to determine how best to manage the population at North Star pre and post-disturbance.
- FMGIB will re-create habitat based on the information currently available on habitat requirements and any data that is made available as a result of studies currently underway at other sites where the species is present. The results of re-creating habitat will be made publicly available for use in the protection and management of the species. An Artificial Roost Research Plan will be provided to the EPA and DSEWPAC for their approval which will include:
    - Provision for construction of artificial roost caves
    - Summary of research used to identify cave habitat requirements, including conditions within the existing roost cave at North Star
    - Design details of the artificial roost caves
    - Monitoring of the use of the artificial roost caves
    - Reporting of results
- FMGIB will submit this plan prior to the removal of the day roost cave.

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Section 15
Conclusions

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15. CONCLUSIONS

This PER document and all supporting documentation has been prepared in accordance with the guidelines published by the EPA and the Environmental Scoping Document (Appendix A).

The PER includes:

- A description of the Project
- A summary of all physical, biological and social factors of the existing environment
- The results from stakeholder consultation
- Discussion of the potential impacts of the Project to environmental factors
- Strategies and management measures to ensure environmental factors are protected and managed to ensure that the Project is environmentally acceptable.

15.1 Environmental Impacts and Mitigation

The key environmental factors identified for the Project are:

- Flora and Vegetation
- Terrestrial Fauna
- Subterranean Fauna
- Hydrological Processes
- Offsets

The potential environmental impacts from the Project are:

- Clearing of up to 294 ha of vegetation associated with watercourses. This amounts to 7% of the mapped extent of these vegetation communities. These vegetation communities are well represented outside of the Project Area.
- Reduction in surface water flows within 10km downstream of the TSF wall.
- Clearing of Rocky ridges/ breakaway/ gorges habitat which has been identified as being significant habitat for the Northern Quoll, Pilbara Leaf-nosed Bat and Pilbara Olive Python. Extensive areas of this habitat occur outside of the disturbance footprint for the Project.
- Loss of one day roost cave for the Pilbara Leaf-nosed Bat and the potential loss of a population of Pilbara Leaf-nosed Bat.
- Degradation of water pools and their associated vegetation may reduce their ability to support Pilbara Olive Python which may lead to a decline in the local population.

- Disturbance to approximately 10% of the known extent of *Pityrodia sp*. Marble Bar
- Reduction in pressure head of 0.8m at Great Northern Hwy due to extraction of 14GLpa from the Wallal Aquifer in the West Canning Basin. This is a minor reduction considering the large pressure head experienced by the Wallal Aquifer.
- The clearing of 5,141 ha of vegetation in good to excellent condition. However, the vegetation surrounding the Project clearing envelope has also been mapped as in good to excellent condition. Vegetation condition is likely to be similar within the region.

15.2 Environmental Management Framework

FMGIB operates under Fortescue's corporate Environmental Managements System (EMS). The EMS is consistent with *ISO 14001: 2004 – Environmental Management Systems – Requirements for guidance and use.* The EMS is guided by Fortescue's overarching environmental policy. Under the EMS:

- Fortescue understands environmental risks and obligation and manages them accordingly
- Work is undertaken in accordance with controls and designed to minimise environmental impacts. This includes outlining responsibility within the business for meeting environmental objectives, targets and obligations.
- Regular checks are undertaken to determine whether Fortescue is meeting its environmental objectives, targets and obligations and implements corrective actions where they are not met
- Senior staff review environmental performance and take action where required.

Management controls to be implemented as part of the Project include Construction Environmental Management Plan, Operational Environmental Management Plan, Surface Water Management Plan, Wallal Aquifer Operating Strategy and Mine Closure Plan.

15.3 Ongoing Stakeholder Consultation

FMGI is committed to ongoing stakeholder consultation with stakeholders throughout the life of the Project. This includes traditional owners, Shire of East Pilbara, Town of Port Hedland, the newly formed Department of Parks and Wildlife (ex DEC), OEPA, DSEWPaC DoW and DIA.

15.4 Environmental Acceptability of the Project

Fortescue has recent experience in managing the development, operation and environmental compliance of similar large scale mining projects. This experience provides Fortescue with the knowledge to implement the Project to achieve environmental objectives. The environmental impacts identified for this Project will be managed through implementing management plans, license and permits and the environmental conditions that will apply to this Project. The mine will be closed in accordance with an approved Mine Closure Plan with regard to the needs of relevant stakeholders.

The findings of this PER demonstrate that the Project is environmentally acceptable if implemented in accordance with proposed management measures and offsets.

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