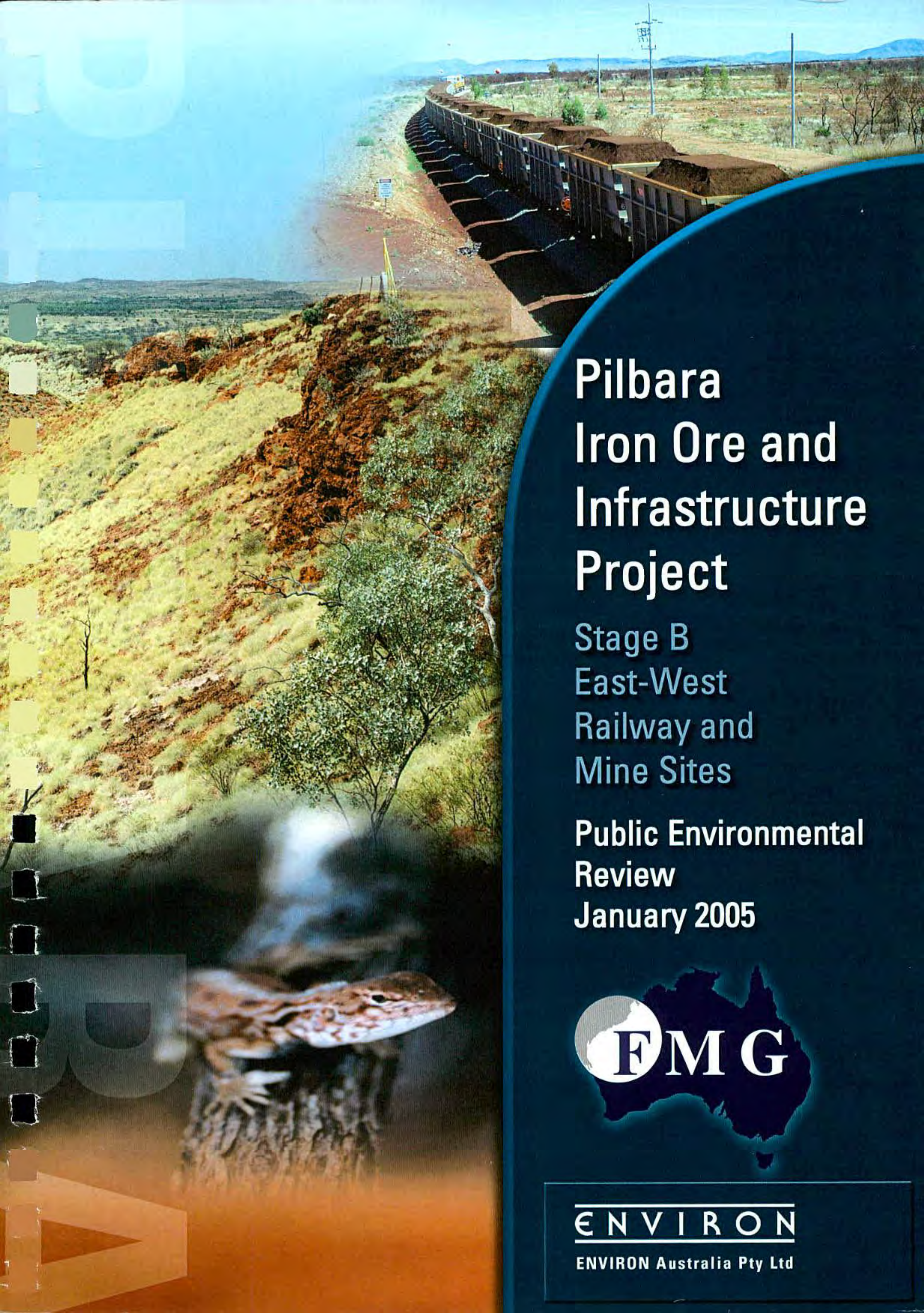

Pilbara Iron Ore and Infrastructure Project

Stage B
East-West Railway and Mine Sites

Public Environmental Review
January 2005

FMG

ENVIRON

ENVIRON Australia Pty Ltd

PUBLIC ENVIRONMENTAL REVIEW
Pilbara Iron Ore and Infrastructure Project: E-W Railway and Mine Sites (Stage B)

for

Fortescue Metals Group Limited

ENVIRON

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Attachment 1

Invitation to make a submission

The Environmental Protection Authority (EPA) invites people to make a submission on this proposal. If you are able to, electronic submissions emailed to the EPA Service Unit project officer would be most welcome.

Fortescue Metals Group Limited (FMG) proposes to develop four iron ore mines and associated infrastructure in the East Pilbara with a 160 km east-west railway to connect these mines to FMG's proposed north-south railway and port facility for export from Port Hedland. This document covers the assessment of the mine sites and the east-west railway only. (The north-south railway and port facility have been assessed separately as Stage A of the Pilbara Iron Ore and Infrastructure Project). In accordance with the *Environmental Protection 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 8 weeks from 17 January 2005 closing on 14 March 2005.

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*, 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 with 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 proposals. It helps if you give reasons for your 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 of 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: 14 March 2005

Submissions should ideally be emailed to

juliet.cole@environment.wa.gov.au

OR addressed to:

Environmental Protection Authority
PO Box K822
PERTH
WA 6842

OR

Westralia Square
141 St George's Terrace
PERTH WA 6000

Attention: Juliet Cole

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EXECUTIVE SUMMARY

E1. Background

The Pilbara region of Western Australia is a major centre for iron ore export to the world market. World steel production has recently undergone a significant expansion predominantly driven by production growth in China. The resultant outcome is a global demand for iron ore that exceeds supply, a situation which is forecast to continue. As a result, the Pilbara region is the focus of a new wave of major iron ore mining developments. However, access to rail and port infrastructure remains the limiting factor in the development of the Pilbara iron ore industry.

Fortescue Metals Group Limited (FMG) is proposing to develop the Pilbara Iron Ore and Infrastructure Project which will involve the development of FMG's own iron ore mines, and rail and port infrastructure which will not only support its mining developments, but also provide third-party access to other resources in the Pilbara region. For the purposes of environmental assessment and development, the Pilbara Iron Ore and Infrastructure Project has been separated into two stages:

- Stage A: Development of a port facility at Port Hedland and a railway stretching 345 km from Port Hedland, south to Mindy Mindy; and
- Stage B: Development of four iron ore mines in the Pilbara and a 160 km railway from the eastern-most mine site to connect to the Stage A north-south railway.

The Public Environmental Review document (PER) for Stage A was released on 20 September 2004 for an 8 week public review period which ended on 15 November 2004. This PER document is for assessment of Stage B of the Pilbara Iron Ore and Infrastructure Project.

E.2 Project Overview

FMG is proposing to develop four mining areas; three in the Chichester Ranges (Christmas Creek, Mt Lewin and Mt Nicholas mines), and one on the edge of the Hamersley Ranges (Mindy Mindy mine). The three mining areas in the Chichester Ranges will be linked to the north-south (Port Hedland to Mindy Mindy) railway proposed in Stage A, via a 160 km railway spur, which will run along the southern slopes of the Chichester Ranges. Access roads will also be constructed to link these Project areas.

The Project will involve the mining, beneficiation and transport of 45 million tonnes per annum (Mtpa) of iron ore to Port Hedland for shipment. The Proponent and owner of the Project is Fortescue Metals Group Limited. FMG holds 50 percent of the issued capital of Pilbara Iron Ore Pty Ltd, the joint venture company that holds the Mindy Mindy tenements. Key Project characteristics are outlined in Table E1.

Table E1. Railway and Mines Key Characteristics

Project Component	**Characteristic**
Project Life	20 years+
Mining Areas	
Ore produced	45 Mtpa
Target grade	55-65% Fe
Mt Nicholas	
Estimated resource	390 Mt
Ore type	Marra Mamba
Method of mining	Strip mining, with progressive backfilling of open pit
Total area of disturbance over LOM	2,757 ha
Total area of rehabilitation over LOM	2,757 ha [1]
Average size of working open pit	700 m long x 1,300 m wide [2] (possibly two starter pits will be developed)
Average pit depth	60 m
Overburden produced	67 Mt deposited to three starter overburden stockpiles in first year (199 ha), after which overburden is used to progressively backfill strip mining operations.
Dewatering requirements	2,850 MLpa. Dewatering water pumped to Beneficiation Plant for use in process.
Processing requirements	Beneficiation
Mt Lewin	
Estimated resource	200 Mt
Ore type	Marra Mamba
Method of mining	Strip mining, with progressive backfilling of open pit
Total area of disturbance over LOM	1,775 ha
Total area of rehabilitation over LOM	1,775 ha [1]
Average size of working open pit	1,500 m long x 2,000 m wide
Average pit depth	50 m
Overburden	82 Mtpa deposited to a starter overburden stockpile in first 2 years (200 ha), after which used to progressively backfill strip mining operations.
Dewatering requirements	520 MLpa. Dewatering water pumped to Beneficiation Plant.
Processing requirements	Beneficiation and Direct Shipped Ore (DSO)
Christmas Creek	
Estimated resource	1,000 Mt
Ore type	Marra Mamba
Method of mining	Strip mining, with progressive backfilling of open pit
Total area of disturbance over LOM	4,245 ha (Christmas Creek East) 4,100 ha (Christmas Creek West) 1,778 ha (Christmas Creek Central)
Total area of rehabilitation over LOM	10,123 ha [1]
Average size of working open pit	1,500 m long x 3,000 m wide [2]
Average pit depth	60 m
Overburden produced	112 Mtpa deposited to an overburden placement area in first 2 years (388 ha) after which used to progressively backfill strip mining operations.
Dewatering requirements	1,150 MLpa. Dewatering water pumped to Beneficiation Plant.
Processing requirements	Beneficiation and DSO

Project Component	**Characteristic**
Mine Site Infrastructure	
Mt Nicholas, Mt Lewin, Christmas Creek Mine Sites	• Semi-mobile primary crusher • Overland conveyors, haul road and/or rail to Beneficiation Plant • Haul roads and access tracks • Secondary crushers, screening plant and Beneficiation Plant • Iron ore product stockpile and train loading facilities • Mobile plant and machinery workshop • Construction of 132 kV transmission line to Newman with capacity upgrade at Newman or • 45 MW power station (to be provided and maintained by an external supplier) • Bulk hydrocarbon storage facility • Explosive and detonator and magazines • Accommodation and camp facilities • Administration and ancillary support facilities • Airstrip upgrade at Christmas Creek • Concrete batching plant (during construction) • 11 GLpa water supply from borefield, supplemented by mine dewatering.
Beneficiation Rejects at Christmas Creek	48 Mtpa rejects disposed of in the first 2 years to an above ground placement area located within the initial overburden placement areas, after which co-disposed in-pit with overburden.
Mindy Mindy	
Estimated resource	68 Mt
Ore type	Channel Iron Deposit
Method of mining	Strip mining, with progressive backfilling of open pit, DSO
Total area of disturbance over LOM	852 ha
Total area of rehabilitation over LOM	852 ha [1]
Average size of working open pit	1,300 m long x 500 m wide
Average pit depth	40 m
Overburden produced	20 Mtpa deposited to an overburden placement area in first 2 years (200 ha) after which used to progressively backfill strip mining operations.
Dewatering requirements	Dewatering water used for dust suppression (~0.4 GLpa).
Processing requirements	None. DSO only

Project Component	**Characteristic**
Mine Site Infrastructure	
Mindy Mindy Mine Site	• Crushing and screening plant • Sealed haul road or overland conveyor system from crushing/screening plant to rail loading facility • Administrative and maintenance hub • Iron ore product stockpiles and train loading facility • 4 MW power station (to be provided and maintained by an external supplier) or connection to 132 kV Newman-Yandi transmission line. • Mine dewatering pumps and pipeline • Airstrip upgrade at Mindy Mindy • Water for dust suppression from pit dewatering and potable water from dewatering or nearby alluvial deposits. • Accommodation village
Railway Infrastructure	• 160 km of rail track • Sidings, passing bays and loading loops • Train loader • Rail maintenance track • Temporary construction facilities
Area of railway disturbance [3]	1,600 ha
Railway operations	800 ha
Sewerage	Packaged treatment plant and/or septic systems
Personnel for Mines and Infrastructure	
Construction	800 personnel accommodated in on-site facilities
Operation	500 personnel accommodated in on-site facilities and/or local towns
Key:	
GL – gigalitres	*M – metre*
GLpa – gigalitres per annum	*Mm^3 – million cubic metres*
ha - hectare	*Mtpa – million tonnes per annum*
km – kilometre	*Mt – million tonnes*
MW – megawatts	

Notes: 1. If infrastructure such as roads are identified by relevant stakeholders as being required for post mining operations the rehabilitation figure may be lower.
2. At least two pits will be open at any one time.
3. Including railway construction corridor ~40m wide, access track, yards, temporary disturbance

Provided all project approvals are in place, construction of the Stage A Project is scheduled to commence in the first half of 2005, with the first shipment of ore in early 2007. Construction of Stage B is anticipated to commence in the second half of 2005 after receipt of environmental approvals.

FMG has signed a State Agreement with the Government of Western Australia which covers FMG's proposed railway and port facilities. The *Railway and Port (The Pilbara Infrastructure Pty Ltd) Agreement Act 2004* was ratified by Parliament in November 2004. This State

Agreement gives FMG the right to construct and operate its railway and will provide suitable tenure for the railway by the issuing of a Miscellaneous Licence under the *Mining Act 1978*. FMG is in the process of negotiating another State Agreement to cover the mining operations. This agreement is expected to be signed in the first quarter of 2005 with ratification by Parliament following soon thereafter. FMG will secure tenure for the mining aspects of the Project under the *Mining Act 1978* and this will be endorsed by the State Agreement when it becomes valid.

E3. Environmental Approvals for the Project

An Environmental Referral for the Pilbara Iron Ore and Infrastructure Project: East-West Railway and Mining operations, was submitted to the WA Environmental Protection Authority (EPA) on 7 April 2004. The EPA advertised the level of assessment for the Project as a Public Environmental Review (PER) on 3 May 2004. A Scoping Document outlining the proposed scope of works for the environmental impact assessment was also prepared and submitted to the EPA on 3 September and finalised on 16 November 2004 (Appendix A).

This PER document has been prepared according to Part IV Division 1 of the WA *Environmental Protection Act 1986* which is subject to 8 weeks public review. Guidelines for making a submission on the Project are outlined at the front of this document.

The stakeholder consultation process for the Project was initiated by FMG during the early development stages of the Project. A consultation strategy was prepared by FMG to facilitate effective communication with the regulators, local and wider community and other stakeholders, and to allow issues raised during the consultation process to be taken into consideration in the design and planning of this Project.

E4. Evaluation of Alternatives

Railway

The alignment of the proposed Stage B railway is constrained by the need to link to the Stage A railway, the location of the Fortescue Marsh floodplains to the south, the Chichester Ranges, the proposed mine sites described in this PER and potential future mine areas. The area between the Chichester Ranges and the Fortescue Marsh has areas of surface water sheetflow which support extensive Mulga groves. A number of alternative alignments along and through the Chichester Ranges were considered, some of which were east of Christmas Creek. Recognition of the importance of the Fortescue Marsh, and the potential impact of a linear disturbance corridor on sheetflow in the area, resulted in the railway being moved as far north as practicable to cross more defined drainage channels, rather than the diffuse drainage patterns further south. Constraints such as land tenure, access, cultural heritage, engineering issues, other environmental issues and operational efficiency resulted in the final alignment that was selected.

Mine Sites

Locations of the mine sites, in particular the pits, are dictated by the locations of the orebodies. However, within these areas, locations of the starter overburden stockpiles and rejects placement areas, the Beneficiation Plant and supporting infrastructure have been designed to take into consideration environmental and Aboriginal heritage constraints as well as engineering constraints.

Mining Method

As the ore is relatively close to the surface in the northern areas of the mineralised zone and gently dips to the south at Christmas Creek and Mt Lewin, the most appropriate mining method is considered to be open-cut mining. The options were to develop a large shallow open pit with large adjacent overburden stockpiles; or develop the pit progressively using strip mining, where a starter pit is opened (with overburden from the starter pit placed in smaller stockpiles), and then the open pit is progressively backfilled as the mining face progresses.

Strip mining was selected as the preferred option because it presents a cost effective method of progressively backfilling the pit with overburden and rejects during the life of the mine. The total ground disturbance required is minimised as large overburden stockpiles are not required external to the pits. Superior progressive rehabilitation practices can be utilised as topsoil can be removed ahead of mining and placed directly on final contoured backfilled areas, in one operation.

Processing Method

As a result of preliminary testwork, the beneficiation of iron ore by wet gravity separation was selected as the most economic process. Wet gravity separation is a well proven process already in use in the Pilbara. As it is an inert process, it does not require the use of harmful chemicals. Dry processing was investigated but did not produce the required grade and purity of ore and did not have the added advantage of controlling ore moisture content which is beneficial in dust management.

Transport Options

Alternatives considered for transport of ore were rail, road and overland conveyor. For long distances such as from the mines to the north-south railway (up to 160 km), road and conveyor were not considered economic, but for short distances these alternatives were considered feasible and have been retained as options for transport of ore from the mines to the Beneficiation Plant.

No Project Option

The "no project" option would result in the loss of opportunity to develop these iron ore resources and the loss of employment opportunities and economic benefit, particularly within local regional communities. As FMG will be an open-access infrastructure provider, the "no project" option would also result in the loss of opportunities for other companies to develop stranded resources and loss of potential for future developments in downstream processing of raw materials. The increasing global demand for iron ore would then be met through the development of other projects elsewhere, predominantly overseas, with the loss of the associated benefits to Western Australia.

E5. Existing Environment

Biophysical Environment

The Pilbara region of Western Australia is classified as arid-tropical, becoming more arid inland, with peak rainfall during the summer months about February and a smaller peak in winter. Climatic conditions in the Pilbara are influenced by tropical cyclone systems predominantly between January and March. Annual average rainfall for the Project area ranges from 312 mm at Newman to 328 mm at Nullagine.

The Project area occurs in the Pilbara Bioregion which has four main components. FMG's tenements cross three of these units:

- Chichester Range (PIL3) - Christmas Creek, Mt Lewin and Mt Nicholas mines;
- Fortescue Plains (PIL2) - east-west rail corridor; and
- Hamersley Range (PIL1) - Mindy Mindy mine.

Within the Newman area, the regional topography is dominated by the Hamersley Plateau in the south and the Chichester Ranges in the north, with the two features divided by the Fortescue Valley. The main drainage system is the Fortescue River, which flows north and then northwest into the Fortescue Marsh.

On the southern and northern flanks of the Fortescue Valley, numerous creeks discharge to the marsh. On the lower less steep valley flanks, rainfall runoff tends to flow overland rather than along defined courses. These water courses and sheetflow areas frequently support scrub and Mulga woodlands, particularly in the lower lying areas. The Fortescue River and other main channels entering the marshes typically support eucalypt woodland in their floodplains.

Portions of several pastoral stations within the Project area have been nominated for future conservation purposes when these pastoral leases come up for renewal in 2015. This includes the stations on which the Fortescue Marsh is located. The Fortescue Marsh is listed as a 'Nationally Important Wetland in *A Directory of Important Wetlands in Australia* which is located on the Australian Wetland database administered by the Department of Environment and Heritage. It is also listed as an Indicative Place on the Register of the National Estate (natural heritage) due to its importance for conservation of waterbirds.

The Project area occurs within the Fortescue Botanical District of the Eremaean Botanical Province as defined by Beard (1975). The vegetation of this province is typically open, and frequently dominated by spinifex, wattles and occasional eucalypts. Several vegetation types within the proposed mining areas have been identified as being of restricted occurrence or otherwise significant. In summary, those vegetation types of conservation significance in the Project are:

- Vegetation type Fa10 was considered to be of Very High conservation significance. This unit occurred between Mt Lewin and Mt Nicholas and comprised Mulga dominated vegetation of seasonally-wet broad drainage areas in excellent condition, and is considered likely to support flora species of restricted distribution in the region.
- Seven vegetation types of High conservation significance were identified (Fa1, Fa13, Fa18, Fa19, Fa20, Fa25 and Fa27). These were all Mulga-dominated vegetation types that occurred mainly on restricted Land Systems (particularly Washplain and Jamindie). These vegetation types were also in very good condition, and are also considered likely to support restricted flora taxa.

No Declared Rare Flora (DRF) species were recorded during the field survey of FMG's Stage B mining areas and none would be expected to occur in the habitats present. Several Priority flora were recorded during the survey of the FMG mine areas. These comprise:

- *Eremophila pilosa* (Priority 1);
- *Abutilon trudgenii* ms. (Priority 3);
- *Goodenia nuda* (Priority 3);
- *Hibiscus brachysiphonius* (Priority 3);
- *Sida* sp. Wittenoom (W.R. Barker 1962) (Priority 3); and
- *Themeda* sp. Hamersley Station (M.E.Trudgen 11431) (Priority 3).

Thirteen species of introduced flora were recorded from within the Project area. None of these are listed as a Declared Plant for the Pilbara under the *Agriculture and Related Resources Protection Act 1979.*

A fauna survey of the proposed Stage B areas was undertaken by Biota in June-July 2004.

Two species of Schedule fauna and four Priority listed species were recorded from the FMG Project area during the current survey. Those threatened fauna species that were found to occur in the Project area are:

- Mulgara, *Dasycercus cristicauda* (Schedule 1, 'vulnerable');
- Peregrine Falcon, *Falco peregrinus* (Schedule 4);
- Short-tailed Mouse, *Leggadina lakedownensis* (Priority 4);
- Pebble-mound Mouse, *Pseudomys chapmani* (Priority 4);
- Australian Bustard, *Ardeotis australis* (Priority 4).
- Long-tailed Dunnart *Sminthopsis longicaudata* (Priority 4)

Stygofauna are groundwater dwelling fauna and the initial stygofauna sampling programme recorded no stygofauna. However, given the widespread occurrence of stygofauna throughout the Pilbara it is expected that stygofauna will be encountered in groundwater in the Project areas. The mining areas within the Nammuldi Member of the Marra Mamba Iron Formation and gravel deposits in the alluvium formations found at Christmas Creek, Mt Nicholas, Mt Lewin and Mindy Mindy are expected to host stygofauna.

The Project lies within the Hamersley Basin where granitoid rocks of the Pilbara Craton are overlain throughout most of the Project area by sedimentary rocks. The lowest of sedimentary group is known as the Fortescue Group, which is itself overlain, in parts, by the Hamersley Group.

In low-lying areas, particularly along the Fortescue Marsh, Fortescue River and major creek systems, depth to groundwater is typically less than 10 m. Away from these surface water locations groundwater levels are typically at depths of 20 m or more. The available data set indicates that water levels in the alluvium on the plain are below the bed of the marsh, thus confirming the marsh as a predominantly surface water feature as opposed to a groundwater discharge area.

Social Environment

The estimated resident population of the Pilbara region was 39,676 in 2001 which constitutes around 2% of the State's population. The vast majority of Pilbara residents are located in the western third of the region, which includes the towns of Port Hedland/South Hedland, Karratha, Newman, Tom Price, Paraburdoo, Roebourne, Wickham, Dampier, Onslow and Marble Bar. The eastern portion of the region is largely desert, and home to a small number of indigenous people. The closest town to the Project area is Newman, which will provide accommodation and services for the Project.

The Chichester Range, the Fortescue Plain and the Hamersley Plateau are known to contain a rich diversity of Aboriginal sites. FMG has been able to avoid impacting significant Aboriginal sites to date as a result of the Aboriginal heritage surveys commissioned by Pilbara Native Title Services with the participation of the Aboriginal Traditional Owners. FMG has also considered the known potential for Aboriginal heritage sites in its selection of the preferred rail route. Heritage surveys are ongoing and will be completed prior to commencement of construction.

E6. Potential Impacts and Proposed Management

Whilst FMG's Pilbara Iron Ore and Infrastructure Project involves mining of a finite resource, and the use of fuel resources that will one day be depleted; the way in which the Project is constructed, operated and decommissioned can be undertaken in a manner which meets the Guiding Principles of the National Strategy for Ecologically Sustainable Development and the State Sustainability Strategy. In order to implement the principles of sustainability, FMG will develop a Sustainability Strategy which addresses contribution to global impacts such as greenhouse gas emissions and focuses on managing impacts across the triple bottom line of Social Capital, Economic Wealth and Environmental Assets.

FMG is in the process of developing and implementing an Environmental Management System (EMS) that will assist the company to be proactive in managing environmental issues and promoting environmental excellence. The EMS will be developed to be consistent with the ISO 14001 standard and will be integrated with Quality, Health & Safety, and other business management systems. A Draft EMP for construction and operation of the Project has been developed and is presented as Appendix B of this PER. Specific procedures for this EMP will be developed prior to construction, for the management of site-specific environmental issues.

Key issues that were raised during the consultation programme are briefly discussed below and in Table E2.

Surface Water Impacts

Concern was raised over the potential impacts of construction of a railway and access road without adequate or appropriate drainage structures. If this was the case, the infrastructure corridor could significantly interrupt the natural drainage patterns, in particular the sheetflow process, with consequences for downstream vegetation condition.

FMG has aligned the rail corridor as far north of the Fortescue Marsh as possible, without affecting the operation of mining areas, to cross drainage flowpaths higher in the catchment where they are more defined. A number of alternative railway lines were considered before the selection of the proposed rail alignment (Section 5.2).

FMG has investigated the impacts of existing railways in the Pilbara region and is currently working with its engineers and consultants to design drainage structures for the proposed railway and access road to maintain or re-establish surface water flow patterns as close as practicable to natural flows. This has included the conceptual design of the 'spreader ditch system' which improves upon current best practice in the Pilbara, and is currently being trialled by FMG (Section 6.1.4).

Three of the mine sites are located on the southern flanks of the Chichester Plateau in an area which drains towards the Fortescue Marsh to the south. The fourth mine site is in an area which drains towards Weeli Wolli Creek. Design, construction and operation of the open pits, ore stockpiles, overburden stockpiles, rejects placement area, access and haul roads, Beneficiation Plant and other infrastructure will account for natural surface hydrology conditions, including maintaining channel flows required downstream and redistribution of surface flows intercepted by these facilities.

All of the mines will require drainage diversion structures (Section 6.1.1). FMG and its consultants have designed the Project to minimise impacts on natural drainage flow patterns and downstream areas.

Groundwater Impacts

The proposed mines will require a supply of approximately 11 GLpa of water to be used primarily for ore beneficiation, but also for dust suppression and domestic purposes. Some of this water will be obtained from pit dewatering, with the remainder supplied from the water supply borefield located near Mt Nicholas.

In addition, 0.4 GLpa will be supplied to the Mindy Mindy mine from dewatering bores. This water will be used for dust suppression and ore moisture control (to prevent dust during transportation of ore and handling of ore at the Port). This will prevent the need for discharge of dewatering water to a nearby creek, as all the water will be utilised in the operations. Small quantities of potable water for Mindy Mindy will be supplied from dewatering or from nearby alluvial deposits.

Groundwater drawdown will occur in the vicinity of the water supply borefield and mines to be dewatered. Biota (2004f) reviewed potentially groundwater dependent (phreatophytic) vegetation types within the Project area and the groundwater conditions, and found the risks to such vegetation from groundwater drawdown to be low.

On closure, pits will be backfilled to above the water table to ensure no long-term groundwater impacts occur as a result of mining.

Mulga Groves

The Mulga (*Acacia aneura* and variants) grove communities at the footslopes of the Chichester ranges are considered the northern-most extent of Mulga in Western Australia. The Mulga in this area is on the Hillside and Roy Hill pastoral stations and the vegetation in the area has been grazed by cattle for nearly 100 years. The Mulga is partially dependent on surface water sheetflow and therefore has the potential to be adversely affected by changes to surface hydrology patterns as a result of the Project if managed inadequately.

As previously discussed, FMG has aligned the rail corridor to cross the drainage lines higher in the catchment where they are more defined. Appropriate drainage structures will also be designed to maintain sufficient support downstream Mulga communities. While watershadow is a historical issue which has previously impacted Mulga in the Pilbara, it is now accepted that it can be managed with correct hydrological engineering. Other potential impacts to Mulga include fire and weed invasion. These impacts will be managed by FMG through its Environmental Management Plan.

FMG is developing a Rehabilitation and Revegetation Management Plan for the mining areas that will focus on re-establishment of native vegetation communities after mining, to resemble as close as practicable the original Mulga communities.

Total disturbance to Mulga containing land systems for the Project area accounts for 2.7% within the Chichester footslopes unit, and 1.4% within the Fortescue Marsh unit (see Section 6.3.1).

Fortescue Marsh

The Fortescue Marsh, to the south of the proposed east-west rail line, is a 'Nationally Important Wetland' listed in *A Directory of Important Wetlands in Australia*, on the Australian Wetland database administered by the Federal Department of Environment and Heritage. Much of the Fortescue Marsh is being sought by CALM for exclusion from pastoral leases (during the review of pastoral leases that will occur when all leases expire in 2015) so that it can then be added to the conservation estate or be managed by conservation agreements. This, however, would require separate approval under the State Reservation Process (Section 6.13).

FMG has committed to avoid direct or indirect impacts on the critical values of the Fortescue Marsh. As such, FMG has located the Project as far north of the marshes as practicable (including realigning the proposed rail corridor), considering resource location, environmental values, transport requirements and engineering and heritage constraints. The proposed railway will be approximately 4 km at its closest point from the peak flood boundary of the Fortescue Marsh recognised by the Department of Environment and Heritage. The proposed mining areas will be 6.5 km from the marsh at the closest point.

FMG also conducted a risk assessment as part of this impact assessment to ensure all risks to the Marsh would be adequately managed (Section 6.2.7).

Vegetation Clearing

FMG's iron ore resources are relatively shallow and cover extensive areas. As such, strip mining is considered the most suitable mining method. This method allows one or more strips (or parallel pits) to be mined, whilst progressively placing overburden and beneficiation rejects as backfill in mined-out sections of the pits. This reduces the extent of the open working pit, reduces surface facilities for storage of overburden and rejects, and allows the pit to be progressively rehabilitated.

It is proposed to disturb approximately 1,600 ha in the construction of the east-west railway and supporting infrastructure, of which 800 ha will be rehabilitated. The construction corridor for the railway will generally be less than 40 m except where areas are required for the access track, temporary facilities (e.g. contractor laydown areas) and operating yards. Land clearing will be kept to a minimum for safe working practices, and sensitive vegetation communities and significant flora species will be avoided if practicable. No Declared Rare Flora are known to occur within the Project area.

FMG has developed a draft Rehabilitation and Revegetation Management Plan which outlines how FMG propose to re-establish the vegetation communities as close as practicable to those present prior to mining. This will include revegetation trials and ongoing research into revegetation methodology. The Plan will be frequently reviewed and updated to reflect trial results.

Threatened Fauna

The Project was referred to the Federal Department of Environment and Heritage (DEH) under the *EPBC Act 1999* on the basis of evidence of Mulgara (*Dasycercus cristicauda*) which is listed as Schedule 1, 'vulnerable' occurring within the Project area. The DEH determined that the proposal was not considered a 'controlled action' under Part 9 of the *EPBC Act 1999*.

FMG will minimise habitat disturbance and avoid where practicable, known populations of Mulgara or any other threatened fauna species that may occur within the Project area. FMG has committed to discussing potential 'off-sets' with CALM which may include funding towards taxonomic issues, or other relevant research such as CALM's Mulgara research programme.

Stygofauna

FMG has developed a Subterranean Fauna Management Plan, which includes a biannual sampling plan to be implemented for the first two years prior to Project commissioning. Depending on the outcomes of further sampling work, it is proposed to continue stygofauna monitoring throughout the life of the Project.

Table E2. Key Environmental Factors, Potential Impacts and Proposed Management for the Project

Environmental Factor	**EPA/Project Environmental Objective**	**Existing Environment**	**Potential Impacts**	**Environmental Management**	**Predicted Outcome**
INTEGRATION					
Biodiversity	To avoid adverse impacts on biological diversity, comprising the different plants and animals and the ecosystem they form, at the levels of genetic, species and ecosystem diversity. To avoid, minimise, mitigate and offset direct and indirect impacts on the critical values of the Mulga woodlands (Chichester Range footslopes) and the Fortescue Marsh.	The Project area occurs in the Pilbara Bioregion which has four main components. FMG's tenements cross three of these units: • Chichester Range - (Christmas Creek, Mt Lewin and Mt Nicholas mines); • Fortescue Plains (east-west rail corridor); and • Hamersley Range (Mindy Mindy mine). The total size of the Chichester Footslope Mulga Woodland is 1641 km^2 (based on Rangeland Mapping). The Fortescue Marsh is listed as a 'Nationally Important Wetland' and supports a rich diversity of migratory birds when in flood. The Fortescue Marsh is also listed as an 'Indicative Place' on the Register of the National Estate (natural heritage).	There are a number of significant flora and fauna species and vegetation communities that occur within the Project area, and may be affected by land clearing or construction or operational impacts. Large areas will be required to be cleared, however, these will be revegetated progressively throughout the life of mine to agreed completion criteria. Other potential impacts on biodiversity within and adjacent to the Project area are: • disruption to surface hydrology; • introduction and/or spread of weed species; • increased risk of fire; • coating vegetation in dust; and • groundwater drawdown.	FMG will implement prior to construction, the EMP which will have specific plans for the management of fauna, flora and vegetation, weeds, surface water, groundwater, dangerous goods, dust and fire. FMG has developed and will implement the Rehabilitation and Revegetation Management Plan to address the impact of clearing. The Subterranean Fauna Management Plan will also be implemented prior to commissioning of the Project.	No unacceptable impacts on the biological diversity of the Project area.

Environmental Factor	**EPA/Project Environmental Objective**	**Existing Environment**	**Potential Impacts**	**Environmental Management**	**Predicted Outcome**
Sustainability	To ensure, as far as practicable, that the proposal meets or is consistent with the sustainability principles in the *National Strategy for Ecologically Sustainable Development (Commonwealth 1992).* To assess the acceptability of large scale-clearing.	The Project area is currently used for pastoral activities and has been grazed for nearly 100 years. Resource projects are the main economic and employment generators in the Pilbara region.	Poor design and management of a development such as FMG's proposal could result in unacceptable economic, environmental and social impacts. Conversely, protection of the environment and social values needs to take into consideration economic constraints. Potential impacts are: • environmental – e.g. land clearing, interruption of surface water flow, groundwater drawdown, dust, noise, etc; • social – e.g. employment opportunities, restricted access to certain areas, increased pressure on local services and housing etc; • economic – e.g. royalties, procurement.	FMG will have an Environmental Management System (EMS) for the management of specific environmental and social issues, which will be integrated with other business, quality and safety systems. FMG will: • facilitate community involvement in company planning processes and decision making; • use a predominantly non-FIFO operational workforce; • develop a housing plan; • develop a Vocational Training and Education Centre (VTEC); • maintain a focus on regional capacity building. On completion of mining, FMG intend to leave the Project area in a state that resembles pre-mining conditions as closely as practicable.	The Project will be developed in a way which meets the needs of the present without compromising the ability of future generations to meet their own needs and assists the development of the Pilbara region in a sustainable manner.

Environmental Factor	**EPA/Project Environmental Objective**	**Existing Environment**	**Potential Impacts**	**Environmental Management**	**Predicted Outcome**
Future Conservation Estate	To avoid adversely affecting the conservation value of the portions of the pastoral stations proposed for conservation purposes.	Portions of several pastoral stations within the Project area have been nominated for future conservation purposes in 2015. This includes Mulga Downs, Hillside, Marillana and Roy Hill Stations on which the Fortescue Marsh is located. The Fortescue Marsh is listed as a 'Nationally Important Wetland' and as an Indicative Place' on the 'Register of the National Estate.' The Fortescue Marsh is approximately 4 km from the proposed railway and 6.5 km from the closest proposed mining area.	The key issues relating to the protection of future conservation values of the area include potential impacts to the Fortescue Marsh catchment area, impacts on migratory birds through noise, and impacts to Mulga groves. Also relevant are mine dewatering activities borefield operations, and the potential groundwater impacts.	FMG has conducted a risk assessment into the potential impacts of the Project on the Fortescue Marsh and developed appropriate management measures to ensure residual risk is low. Some direct clearing of Mulga will occur during construction of the railway and mining operations. The final location and design of the railway and mines has been selected to minimise these direct clearing impacts as far as practicable. Indirect impacts on Mulga, through disruption of sheet flow have been minimised by moving the railway as far north as practicable to cross more defined drainage channels, rather than the diffuse drainage patterns further south. Frequently spaced, small diameter culverts as well as spreader ditch systems to be installed where sheetflow dependent Mulga groves exist immediately downstream of the railway. Noise and vibration impacts are expected to be minimal due to the distance from the marshes and can be readily managed. FMG will implement a blast management strategy.	No unacceptable impacts on the Mulga woodlands or Fortescue Marsh within the areas proposed for future conservation.

Environmental Factor	**EPA/Project Environmental Objective**	**Existing Environment**	**Potential Impacts**	**Environmental Management**	**Predicted Outcome**
BIOPHYSICAL					
Terrestrial Flora – Vegetation Communities	Maintain the abundance, species diversity, geographic distribution and productivity of vegetation communities.	A total of 81 broad vegetation types were defined for the Project area. The vegetation types of conservation significance are: • Vegetation type Fa10 (Very High conservation significance). Mulga dominated seasonally-wet broad drainage areas; • Fa1, Fa13, Fa18, Fa19, Fa20, Fa25 and Fa27 (High conservation significance). Mulga-dominated on restricted Land Systems.	Approximately 17,107 ha will require clearing over the life of the Project, the majority of this will be progressively rehabilitated and revegetated. Other potential impacts on vegetation within the Project area are: • disruption to surface hydrology; • erosion; • introduction and/or spread of weed species • increased risk of fire • coating vegetation in dust • groundwater drawdown; and • unauthorised off-road driving;	FMG has designed the Project to avoid where practicable, significant vegetation communities. Vegetation clearing will be kept to the minimum necessary for safe construction and operations and clearing limits will be marked on all design drawings and pegged in the field. Off-road driving will be strictly prohibited. FMG has developed and will implement a Rehabilitation and Revegetation Management Plan. FMG will also implement prior to construction, an EMP which will have specific Plans for the management of surface water, groundwater, weeds, dust and fire. Monitoring of groundwater-dependent (phreatophytic) vegetation will be undertaken as part of the Borefield Management Plan. FMG will consider offsets to disturbance to Mulga groves in consultation with CALM.	Vegetation clearing and revegetation will be undertaken progressively throughout the life of the Project with all disturbed areas revegetated on closure of the Project. The Project will not threaten the conservation status of significant vegetation communities. The final project design will take into consideration the location of significant vegetation and where practicable avoid these areas (e.g. railway alignment and borrow pits).

Environmental Factor	**EPA/Project Environmental Objective**	**Existing Environment**	**Potential Impacts**	**Environmental Management**	**Predicted Outcome**
Terrestrial Flora – Declared Rare and Priority Flora; flora of conservation significance	Protect Declared Rare and Priority Flora, consistent with the provisions of the *Wildlife Conservation Act* 1950. Protect other flora species of conservation significance.	No DRF species were recorded during the field survey of Project area and none would be expected to occur in the habitats present. One Priority 1 flora and five Priority 3 flora were recorded: • *Eremophila pilosa* (Priority 1); • *Abutilon trudgenii* ms. *Goodenia nuda*; • *Hibiscus brachysiphonius*; • *Sida* sp. Wittenoom (W.R. Barker 1962); and • *Themeda* sp. Hamersley Station (M.E.Trudgen 11431).	These significant flora species could potentially occur within proposed areas of disturbance.	FMG will refine the Project design to avoid populations of significant flora where practicable. Clearing limits will be marked on all design drawings and pegged in the field prior to any clearing works commencing. FMG will investigate the use of significant flora species in revegetation practices.	The Project will not threaten the conservation status of significant flora present in the Project area.

Environmental Factor	EPA/Project Environmental Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
Terrestrial Fauna	Maintain the abundance, species diversity and geographical distribution of terrestrial fauna.	A wide range of fauna, including some threatened species were recorded from the Project area. None of the habitat types within the Project area are considered unique or significant at the bioregion scale. Several habitat types are significant on a local scale and support either apparently restricted suites of species or individual species of regional significance: • Fortescue basin flats (Fortescue Marsh); • cracking clay habitat units associated with the Chichester Range and foothills; and • major drainage systems.	Terrestrial fauna may be affected directly by earthworks, noise and blasting vibration, or indirectly due to modification of habitat. Land clearing will disturb some fauna habitats. Fauna habitats may also be affected by changes to surface hydrology, groundwater drawdown, fire or dust.	The detailed design of the Project will consider the location of significant fauna habitats and will avoid these where practicable. Vegetation protection measures above will be implemented to mitigate impacts on fauna habitat. Off-road driving will be strictly prohibited and speed-restrictions will apply on all project roads to minimise the risk of vehicle strikes. Staff will be made aware that all native fauna are protected. Firearms, traps and domestic pets will be prohibited on-site. FMG will also implement prior to construction, an EMP which will have specific plans for the management of surface water, groundwater, dangerous goods, dust and fire.	No unacceptable impacts on fauna populations. The Project will not threaten the conservation status of any significant fauna habitats.

Environmental Factor	**EPA/Project Environmental Objective**	**Existing Environment**	**Potential Impacts**	**Environmental Management**	**Predicted Outcome**
Terrestrial Fauna - Specially Protected (Threatened) Fauna	Protect Specially Protected (Threatened) Fauna, consistent with the provisions of the *Wildlife Conservation Act* 1950.	A number of significant fauna were recorded in the Project area: • Mulgara *Dasycercus cristicauda* (Schedule 1, 'vulnerable'); • Peregrine Falcon *Falco peregrinus* (Schedule 4); • Short-tailed Mouse *Leggadina lakedownensis* (Priority 4); • Pebble-mound Mouse *Pseudomys chapmani* (Priority 4); • Australian Bustard *Ardeotis australis* (Priority 4); • Long-tailed Dunnart *Sminthopsis longicaudata* (Priority 4).	Terrestrial fauna may be affected directly by earthworks, noise and blasting vibration, or indirectly due to modification of habitat. Land clearing will disturb some fauna habitats. Fauna habitats may also be affected by changes to surface hydrology, groundwater drawdown, fire or dust.	Site-specific surveys prior to construction of the Project will be carried out to identify any significant fauna species which may be present, with modification of the Project to avoid these species and their habitat where practicable. Off-sets will be considered in consultation with CALM (e.g. funding towards taxonomic work or research into threatened species).	The Project will not threaten the conservation status of significant fauna populations present in the Project area.
Stygofauna	Maintain the abundance, diversity and geographical distribution of subterranean fauna.	Preliminary sampling undertaken within the Project area did not record any stygofauna. However, given the widespread occurrence of stygofauna throughout the Pilbara, they are expected to be encountered in gravel deposits in the alluvium formations.	Abstraction of groundwater for the Project's water supply, and pit dewatering may impact stygofauna habitat.	FMG has commenced a detailed sampling programme which includes biannual sampling commencing in January 2005 and continuing until December 2006. Results of the sampling programme will be used to refine the Project design to avoid impacting significant populations of stygofauna where practicable. A long term stygofauna monitoring programme will be developed by January 2007 if stygofauna are located within the Project area and will include management strategies.	The Project will not threaten the conservation status of stygofauna populations present in the Project area.

Environmental Factor	EPA/Project Environmental Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
Water courses and wetlands	Maintain the integrity, functions and environmental values of watercourses and sheetflow.	The proposed Project area is located in the Upper Fortescue River Catchment which drains to the Fortescue Marsh. Numerous small ephemeral creeks pass through the Project area. The proposed railway corridor runs along the southern slopes of the Chichester Ranges which typically crosses perpendicular to the surface water flow directions. The railway corridor crosses areas of sheetflow which support vegetation which is partially dependent on sheetflow along the lower slopes of the plateau.	The main surface water impact will potentially be the interruption of existing surface water flow patterns and a potential reduction of surface water runoff volume and water quality to the downstream environment. Grove-intergrove Mulga communities, which are partially dependent on sheetflow runoff, may be impacted. Other potential impacts include erosion and sedimentation.	The final location of mine infrastructure will take into consideration surface water flows and will be placed to minimise impacts. Bunding will be constructed around the upstream end of the pits to divert surface water to existing adjacent or downstream flowpaths. In sheetflow areas diverted flows will be discharged over riprap pads to encourage flows to slow (to reduce the risk of erosion) and disperse. Selected irrigation of sheet-flow dependent vegetation downstream of working open pits, following significant runoff events. Progressive backfill and rehabilitation of mined-out pits will be undertaken according to the Rehabilitation and Revegetation Management Plan presented as a draft within this PER. Surface water collected from within the pits will be treated via sedimentation ponds, prior to external discharge or reuse within the mining operations.	Safe construction and operating conditions will be maintained. No adverse downstream surface water impacts, particularly in sheetflow zones.

Environmental Factor	EPA/Project Environmental Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
Water courses and wetlands (cont'd)				Frequently spaced culverts will be installed along the proposed railway at all defined drainage crossings and at appropriate intervals along sheetflow zones to withstand a 20 year ARI flood. Where sheetflow dependant vegetation exists, a downstream sheetflow redistribution system will be installed. In sheetflow areas, the railway access road will be installed on the downslope side of the railway formation to minimise the risk of erosion and associated sedimentation from the road material. This will also limit the potential for the road to impact on the water entering each of the culverts.	

Environmental Factor	EPA/Project Environmental Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
Water supply	Maintain (sufficient) quantity of groundwater so that existing and potential uses, including ecosystem maintenance, are protected.	Potential surface water supplies are ephemeral and therefore groundwater is required to supply the Project. A borefield near Mt Nicholas is proposed for water supply, supplemented by pit dewatering. The hydrogeology of the borefield reflects the hydrogeology of the Mt Nicholas and Mt Lewin mine sites. The aquifers targeted during the exploratory drilling programme are alluvial deposits.	Approximately 11 GLpa of water will be required for ore beneficiation and associated mining operations for the mines, with an additional 0.4 GLpa at Mindy Mindy for dust suppression and ore moisture control. Potential impacts of borefield abstraction may be: • effects on phreatophytic vegetation within the groundwater drawdown zone; • impacts on water quantity and quality in nearby station bores; • upconing of underlying saline water; • impacts on stygofauna habitat. Impacts on the Fortescue Marsh from borefield operation and pit dewatering are considered unlikely.	FMG has developed a Borefield Management Plan which will be implemented with development of the borefield. Temporary bores for construction will not be closer than 100 m from creek lines. A Borefield Management Plan will be implemented to monitor trends and calibrate the groundwater impact assessment model. Condition monitoring of phreatophytic vegetation will be undertaken in areas where groundwater levels have declined as a result of groundwater abstraction. Timely development of a contingency borefield will be undertaken if modelling and/or monitoring data predict unacceptable ecological impacts. If station bores are affected by abstraction for the Project, these will be deepened, or an alternative water supply provided from Project bores.	No unacceptable ecological impacts from operation of the Project's borefield. No unacceptable impact on station bores from operation of the Project's borefield.

Environmental Factor	**EPA/Project Environmental Objective**	**Existing Environment**	**Potential Impacts**	**Environmental Management**	**Predicted Outcome**
Rehabilitation	To ensure, as far as practicable, that rehabilitation achieves a stable and functioning landform which is consistent with the surrounding landscape and meets other environmental objectives including biodiversity.	Three of the mining areas are located in the Chichester Ranges and one mining area is located on the edge of the Hamersley Ranges. The east-west railway crosses the foothills of the Chichester Ranges and the plains of the Fortescue Valley. The predominant existing land use is pastoral.	Large areas of land will be progressively cleared (17,107 ha) which will require progressive rehabilitation over the life of the Project (20+ years).	FMG has developed a Rehabilitation and Revegetation Management Plan which will be implemented throughout the life of the Project. The mine sites will be progressively rehabilitated throughout the life of the mine Rehabilitation activities will include, but not be limited to: ▪ backfilling mined out pits; • ripping of compacted areas; • re-establishment of a stable landform that resembles the pre-mining landscape as closely as practicable; • reinstatement of surface drainage patterns; • replacement of topsoil (direct return where practicable) or alternative growth media; • spreading of vegetation debris; • additional seeding and planting if required; and • on-going monitoring.	Re-establishment of safe and stable, revegetated landforms that resemble the pre-mining landscape as close as practicable. Any remaining depressions will be free-draining where practicable and stable.

Environmental Factor	EPA/Project Environmental Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
Decommissioning	To ensure, as far as practicable, that decommissioning achieves a stable and functioning landform which is consistent with the surrounding landscape and meets other environmental objectives including biodiversity.	The predominant existing land use is pastoral.	Decommissioning will need to ensure that the Project area is left safe and stable and functional for the nominated land use to ensure no long-term hydrological, hydrogeological or ecological impacts.	Project closure will include the safe dismantling and removal of infrastructure, the appropriate disposal of waste materials, backfilling and/or contouring and site rehabilitation to return the environment to a safe stable landform. FMG has developed a Conceptual Closure Plan that will be revised at least every two years. Detailed closure procedures will be established in accordance with the applicable legislation and standards at the time of closure, and will be documented in the revised Final Closure Plan. Completion criteria will be developed in consultation with the relevant stakeholders and documented within the Closure Plan prior to final decommissioning.	No long-term adverse environmental or social impacts following closure.

Environmental Factor	**EPA/Project Environmental Objective**	**Existing Environment**	**Potential Impacts**	**Environmental Management**	**Predicted Outcome**
POLLUTION MANAGEMENT					
Air – Greenhouse Gases	Minimise greenhouse gas emissions for the Project and reduce emissions per unit product to as low as reasonably practicable, and mitigate greenhouse gas emissions in accordance with the *Framework Convention on Climate Change 1992*, and with established Commonwealth and State policies.	The Project area is currently used for pastoral activities and is largely vegetated by woodlands, shrublands and grasslands.	It is conservatively estimated that approximately 14.3 kgCO_{2e} will be emitted per tonne of ore shipped. This includes clearing impacts but does not take into account the positive effects of revegetation. Actual greenhouse emissions per tonne of ore shipped are predicted to be lower than this.	During construction and operation of the Project, FMG has committed to minimising land area and total amount of biomass cleared. Clearing will occur over the life of the Project (20 or more years) and cleared areas will be progressively rehabilitated as mining progresses. In designing the Project, FMG has where practicable selected the most energy efficient technology available. Once operational FMG will monitor greenhouse gas emissions and continue to improve energy efficiency and reduce greenhouse gas emissions. Renewable energy sources will be used where appropriate (e.g. solar panels for power in remote areas).	Minimisation of greenhouse gas emissions and offsets where practicable.

Environmental Factor	**EPA/Project Environmental Objective**	**Existing Environment**	**Potential Impacts**	**Environmental Management**	**Predicted Outcome**
Air – Particulate dust emissions during construction	Protect the surrounding land users such that dust and particulate emissions will not adversely impact upon their welfare and amenity or cause health problems.	The Project is in an arid area where background dust levels are relatively high. Existing anthropogenic sources of dust are mainly from traffic travelling on unsealed roads.	Dust from earthworks during construction may create a dust nuisance for workers and adjacent land users. Due to the remoteness of the sites, the potential for dust impacts on neighbours is expected to be low. Unsealed areas within the Project area may generate dust, smothering vegetation.	A Dust Management Plan will be prepared prior to the commencement of construction and operations and will include such measures as: • the use of water carts on high traffic areas; • progressive rehabilitation of disturbed areas; • minimisation of vegetation clearing; • optimisation of vehicle movements; • daily visual inspections of construction areas; and • regular vegetation inspections to assess ongoing dust impacts;	No unacceptable dust impacts during construction.
Air – Particulate dust emissions during operations	Ensure that particulate/dust emissions, from FMG's activities meet appropriate criteria and do not cause environmental or human health problems.	The Project is in an arid area where background dust levels are relatively high. Existing anthropogenic sources of dust are mainly from traffic travelling on unsealed roads.	Ore loading, conveying and stockpiling, has the potential to create a dust nuisance for workers and adjacent land users. Due to the remoteness of the sites, the potential for dust impacts on neighbours is expected to be low. Unsealed areas within the Project area may generate dust, smothering vegetation.	A Dust Management Plan will be prepared prior to the commencement of construction and operations and will include such measures as: • the incorporation of dust control measures into project design; • the use of water carts on high traffic areas; • progressive rehabilitation of disturbed areas; • optimisation of vehicle movements; • daily visual inspections to ensure dust control management measures are effective; • regular vegetation surveys to assess ongoing dust impacts; and • ambient dust monitoring where appropriate.	No unacceptable dust impacts during operation.

Environmental Factor	EPA/Project Environmental Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
Water Quality -Surface water	Maintain or improve the quality of surface water to ensure that existing and potential uses, including ecosystem maintenance are protected, consistent with the *Australian and New Zealand Water Quality Guidelines (ANZECC 2000).*	Creeks within the Project area are ephemeral only flowing after significant rainfall events and often have high sediment loads.	Surface water runoff or discharge of waste water from the Project area could contaminate, or increase sediments flowing into, nearby waterbodies.	Areas prone to erosion during construction and operation will be stabilised. Surface water collected from around the Project area (including pits) will be treated via a sedimentation pond, prior to external discharge or reuse within the mining operations. Surface waters from around the Beneficiation Plant and maintenance yards will be treated via an oil/water separator and sedimentation pond and used in the plant. Conduct surface water monitoring as detailed in the Construction Environmental Management Plan.	No adverse impacts on surface water quality downstream of the Project.
Water Quality -Groundwater	Maintain or improve the quality of groundwater to ensure that existing and potential uses, including ecosystem maintenance are protected, consistent with the *Australian and New Zealand Water Quality Guidelines (ANZECC 2000).*	Groundwater within the Project area ranges from fresh to saline. A number of station bores supply water for stock.	There is potential for spills or contaminated runoff from the Project area, to seep into the underlying groundwater. Where freshwater occurs over saline water in an aquifer, continued pumping of the overlying freshwater can result in a rise in the interface between fresh and saline water ('upconing'). This could affect water quality in nearby station bores, or require disposal of saline water from pit dewatering. The risk of saline water upconing into the pit is considered low.	FMG will have specific spill prevention and clean up procedures to reduce the risk of harm to the environment from spills. All hydrocarbons and chemicals will be stored in bunded facilities constructed to AS 1940. FMG will monitor water quality in Project bores and nearby station bores. FMG will provide alternative water supplies if impacts on water quality in station bores are unavoidable. Groundwater will be managed according to the Borefield Management Plan.	No unacceptable impacts on groundwater quality.

Environmental Factor	**EPA/Project Environmental Objective**	**Existing Environment**	**Potential Impacts**	**Environmental Management**	**Predicted Outcome**
Waste Management - Overburden - Rejects - General Waste	To ensure that disposal/ management of waste does not adversely affect environmental values, or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.	The Project area is predominantly used for pastoral activities.	Incorrect disposal of wastes can lead to contamination of soils, surface and ground water and/or air, and increase health risks.	Overburden and beneficiation rejects will, for the first two years of operations in an area, be placed in permanent off path storage areas which will later be contoured and rehabilitated according to the Rehabilitation and Revegetation Management Plan. Once sufficient mined-out pit areas become available, overburden and rejects will be used to backfill the pits, which will be contoured to resemble the pre-mining landform where practicable, and revegetated according to the Rehabilitation and Revegetation Management Plan. General waste management will be along the principles of: • avoid • re-use • recycle • energy recovery • treatment and/or disposal.	Appropriate management of waste generated by the Project with no risk to human health or adverse impacts on the environment.

Environmental Factor	EPA/Project Environmental Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
Contamination - Acid Mine Drainage	Minimise the risk to the environment resulting from potentially acid forming materials.	Geochemical tests have indicated that overburden sampled from the four mining deposits is relatively inert and unlikely to create Acid Mine Drainage (AMD) problems.	Although the Black-Shales are classified as Potentially-Acid Forming, open-pit mining will not mine the Black-Shales. Dewatering of the Black-Shales is not expected to occur and no AMD problems are likely to be encountered.	Should acid-generating materials potentially be encountered, these will be placed to minimise oxidation and subsequent transport of low pH drainage. If monitoring indicates that dewatering activities are likely to have an impact on the Black-Shales within the cone of groundwater depression, then additional modelling (such as oxygen diffused modelling) will be undertaken to determine the extent of the impact and how best to manage this.	No adverse impacts on the environment as a result of AMD.
Noise	Ensure noise impacts emanating from construction and operation activities comply with statutory requirements and acceptable (and appropriate) standards.	The Project area is relatively remote from residential settlements. There is an existing railway line (BHPBIO's) near Mindy Mindy.	The mining and rail areas are expected to be sufficiently remote to not impact on any nearby residences. Blasting impacts may initially have a minor impact on birds and other fauna using the Fortescue Marsh as a breeding ground if incorrectly managed.	Use low-noise equipment where practicable. Monitor blast noise near sensitive receptors to determine allowable blasting mass. Monitor the effects of blast noise on birdlife and other fauna using the Fortescue Marsh. Avoid blasting under worst-case meteorological conditions and design the mine to reduce potential noise impacts.	No unacceptable noise impacts on residences or birds on the Fortescue Marsh.

Environmental Factor	**EPA/Project Environmental Objective**	**Existing Environment**	**Potential Impacts**	**Environmental Management**	**Predicted Outcome**
SOCIAL SURROUNDS					
Heritage – Aboriginal culture and heritage	Ensure that the proposal complies with the requirements of the *Aboriginal Heritage Act* 1972. Ensure that changes to the biological and physical environment resulting from the Project do not adversely affect cultural associations with the area.	The Chichester Range, the Fortescue Plain and the Hamersley Plateau are known to contain a rich diversity of Aboriginal sites. The Project area impacts upon a number of native title claims: • Nyiyaparli (WC99/4-proposed east-west railway spur and Mt Nicholas, Mt Lewin, Christmas Creek and Mindy Mindy mines), • Palyku (WC99/16-east-west railway spur and Christmas Creek mine); and • Martu Idja Banyjima (WC98/62-east-west railway spur) native title claims (from east to west).	Sites of Aboriginal Heritage significance could potentially occur within the Project area. FMG has been able to avoid impacting any known Aboriginal sites to date, although it is acknowledged it may not be possible to avoid all sites.	FMG will complete heritage surveys prior to commencement of construction and will ensure that Aboriginal sites are located and recorded and where possible protected. FMG will implement a Cultural Heritage Management Plan which will provide for Aboriginal Monitors to oversee the construction of the Project within the relevant native title claims to ensure that no known Aboriginal sites are inadvertently impacted and to ensure that changes to the physical environment do not affect Aboriginal heritage and culture.	No unacceptable impacts on the Aboriginal cultural values of the Project area.
Heritage – European heritage	Comply with statutory requirements in relation to areas of cultural or historical significance.	No sites of European Heritage significance are known to occur in or near the Project area.	It is not expected that any sites of European heritage significance will be affected by the Project.	No specific management measures required.	No impact on sites of European Heritage value.

Environmental Factor	**EPA/Project Environmental Objective**	**Existing Environment**	**Potential Impacts**	**Environmental Management**	**Predicted Outcome**
Economic and Social Impacts	To ensure a net benefit to the local community potentially affected by the Project.	FMG's Stage B Project is located within the Shires of East Pilbara and Ashburton, which have a population of 6,786 and 6,888 respectively.	The Project activities that have the potential to give rise to socio-economic impacts at the planning and pre-construction stage include project approvals and negotiations, public communications about the Project procurement and changes to land tenure. Project activities that have the potential to give rise to impacts at the construction and operational stage include: • payment of royalties and taxes; • procurement; • mobilisation of the workforce; • construction of temporary work camps; • accommodation in residential areas; • earthworks and blasting activities; • general construction activities; • power use and water use; and • creation of an area around activities that excludes the public.	FMG will: • facilitate community involvement in company planning processes and decision making; • use a predominantly non-FIFO operational workforce; • develop a housing plan to ensure quality and equitable housing for employees whilst minimising negative impacts on existing communities; • develop a Vocational Training and Education Centre (VTEC); • maintain a focus on regional capacity building.	No unacceptable socio-economic impacts on the local and wider community. Support of local businesses and training and employment opportunities throughout the life of the Project.

E7. Conclusions

The proposed Project has been designed to minimise the environmental impacts associated with the construction and operation of the proposed east-west railway and four mine sites. In particular FMG is aware of the significance of the Fortescue Marsh and has completed a risk-based assessment of potential impacts on the marsh which has identified management measures that will be implemented by FMG to ensure that all identified environmental risks to the marsh are low. The conservation significance of selected vegetation communities (such as Mulga communities occurring in groves) and threatened fauna species has also been given priority and the design of the Project incorporated management and mitigative measures to reduce impacts as far as practicable.

FMG has made a number of formal commitments with respect to this Project to demonstrate its commitment to constructing and operating in an environmentally responsible manner. The formal commitments will be implemented to the satisfaction of the Environmental Protection Authority.

PUBLIC ENVIRONMENTAL REVIEW
Pilbara Iron Ore and Infrastructure Project: East-West Railway and Mine Sites (Stage B)

for

Fortescue Metals Group Limited

1. INTRODUCTION

1.1 BACKGROUND

The Pilbara region of Western Australia is a major centre for iron ore export to the world market. Many of the regional towns and communities are predominantly mining orientated and rely on this industry for their survival and prosperity. The number of mining operations and supporting rail network has progressively expanded to serve demand.

Consolidation of the iron ore industry in WA has seen the rail networks now owned by two companies; BHP Billiton Iron Ore (BHPBIO) and Hamersley Iron (HI) (part of the Rio Tinto Group). The Pilbara region is currently the focus of a new wave of major iron ore mining developments, in response to growing international demand for steel. However, third party access to rail and port infrastructure remains the limiting factor in the development of the Pilbara iron ore industry.

Fortescue Metals Group Limited's (FMG's) Pilbara Iron Ore and Infrastructure Project will involve the development of FMG's own iron ore mines, and rail and port infrastructure which will not only support its mining developments, but also provide third-party access to other stranded resources in the Pilbara region. For the purposes of environmental assessment and development, the Pilbara Iron Ore and Infrastructure Project has been separated into two stages:

- Stage A: Development of a port facility at Port Hedland and a railway running 345 km from Port Hedland, south to the Mindy Mindy mine site; and
- Stage B: Development of four iron ore mines in the Pilbara and a 160 km railway from the eastern-most mine site to connect to the Stage A north-south railway.

The Public Environmental Review document (PER) for Stage A was released on 20 September 2004 for an 8 week public review period which ended on 15 November 2004.

This PER document is for the assessment of Stage B of the Pilbara Iron Ore and Infrastructure Project.

1.2 PROJECT OVERVIEW

FMG holds a large number of tenements for exploration and development of iron ore deposits in the Western, Central and Eastern Pilbara region of Western Australia, for its Pilbara Iron Ore and Infrastructure Project: Mining operations and east-west railway (Stage B) (The Project). FMG has currently identified four key mining areas, three in the Chichester Ranges; (Christmas Creek, Mt Lewin and Mt Nicholas); and Mindy Mindy further south on the edge of the Hamersley Ranges. The Christmas Creek, Mt Lewin and Mt Nicholas mining areas will be linked to the Port Hedland to Mindy Mindy railway (assessed as part of Stage A of the Pilbara Iron Ore and Infrastructure Project) via a 160 km railway spur. This east-west railway will run along the southern slopes of the Chichester Ranges (Figure 1). Access roads will also be constructed to link these Project areas.

The Project is planned to initially mine and transport 45 million tonnes per annum (Mtpa) of iron ore, from the three FMG owned resources and from the Mindy Mindy Joint Venture resource. FMG holds 50 percent of the issued capital of Pilbara Iron Ore Pty Ltd, the joint venture company that holds the Mindy Mindy tenements. It is FMG's intention that the railways and port facilities will be made accessible to other parties, and function as an open-access transport system. Third party use would be based on a fee for use at commercially competitive rates.

The project is being assessed in stages: Stage A involves the construction and operation of a Port and north-south railway that FMG will make available to third parties; Stage B which comprises the development of the iron ore mining operations that will utilise the Stage A infrastructure. The Stage A, Port and North South Railway Public Environmental Review (PER) was submitted to the EPA in September 2004. The Stage A and B PERs for the Pilbara Iron Ore and Infrastructure Project are being assessed separately to allow timely commencement of construction of the infrastructure component. The Stage B mining operations discussed in this PER will utilise the Stage A infrastructure, which is included in Stage A PER. Interrelationships between the two projects are explained in Section 1.6. The Stage A PER is available on FMG's website: www.fmgl.com.au

FMG has signed a State Agreement with the Government of Western Australia which covers FMG's proposed railway and port facilities. This agreement was ratified by Parliament on 26 November 2004. This State Agreement gives FMG the right to construct and operate its railway and will provide suitable tenure for the railway by issuing a Miscellaneous Licence under the *Mining Act 1978*. FMG is also negotiating another State Agreement to cover the mining operations; this agreement is expected to be signed in the first quarter of 2005 with ratification by Parliament following soon thereafter. FMG will be securing tenure for the mining aspects of the Project under the *Mining Act 1978* and this will be endorsed by the State Agreement when it becomes valid.

1.3 PURPOSE OF THIS DOCUMENT

An Environmental Referral for the Pilbara Iron Ore and Infrastructure Project: East-West Railway and Mining operations, was submitted to the WA Environmental Protection Authority (EPA) on 7 April 2004. The EPA advertised the level of assessment for the Project as a Public Environmental Review (PER) on 3 May 2004. A Scoping Document outlining the proposed scope of works for the environmental impact assessment was also prepared and submitted to the EPA on 3 September and finalised on 16 November 2004.

This PER document has been prepared according to Part IV Division 1 of the WA *Environmental Protection Act 1986* for proposals of local or regional significance that raise a number of significant environmental factors, some of which are considered complex and require detailed assessment. The EPA considers that such proposals should be subject to a formal public review period, which in the case of this Project was set at eight weeks, and environmental conditions under Part IV of the Act to ensure that the Project is implemented and managed in an environmentally acceptable manner.

1.4 THE PROPONENT

The Proponent and owner of the Pilbara Iron Ore and Infrastructure Project is Fortescue Metals Group Limited. The address is:

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The relevant contacts are:

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1.5 COMMUNITY CONSULTATION PROCESS

The stakeholder consultation process for the Project was initiated by FMG during the early development stages of the Project. The consultation strategy was prepared to facilitate effective communication with the regulators, local and wider community and other stakeholders, and to allow issues raised during the consultation process to be taken into consideration in the design and planning of this Project. Detail on the community consultation process, consultation undertaken to date, and how FMG has responded to issues raised by the community, is presented is Section 7.

1.6 TIMING AND STAGING OF PROJECT

To expedite the environmental assessment process and allow timely commencement of construction of the infrastructure component, FMG has undertaken the Environmental Impact Assessment of the Pilbara Iron Ore and Infrastructure Project in two stages. The following synopsis describing interrelationships and how the two stages overlap is provided.

1.6.1 Technical Interrelationships

There are several areas where technical issues regarding mining (Stage B Project) are related to environmental issues at the Port (Stage A Project). These have been considered and discussed in this PER and are summarised below.

The characteristics of the ore to be mined (such as particle size distribution and moisture content) and the beneficiation process to be used in the Stage B Project will influence how dust is managed for both stages of the Project (particularly at the port facility). Refer to Section 6.6 for management of dust during construction and operation of the proposed mines and railway. Management of dust at the port is addressed in Section 6.3.7 and Appendix F of the Stage A Public Environmental Review (FMG, 2004).

Locomotive diesel fuel consumption and the consequential greenhouse gas impacts were assessed as part of the Stage A Project and are therefore not included in greenhouse gas emission calculations for the Stage B Project. However, Section 6.8 of this report includes a discussion of the overall greenhouse emissions for the Project (both Stage A and Stage B).

1.6.2 Timing Overlaps

Both the Stage A and Stage B Projects have been set at a Public Environment Review (PER) level of assessment with an eight week public comment period. Whilst the public comment periods will not overlap (Stage A public review period ended 15 November 2004), the EPA will be assessing both projects concurrently.

Provided all project approvals are in place, construction of the Stage A Project is scheduled to commence in the first half of 2005, with the first shipment of ore in the fourth quarter of 2006 or early in 2007. Construction of Stage B is anticipated to commence in the second half of 2005 on receipt of environmental approvals.

The key constraints to the Project timing are:

- granting of environmental approvals;
- granting of appropriate tenure;
- availability of construction materials, supplies, plant and equipment; and
- efficiency of construction and commissioning phases (dependent on equipment and personnel availability, weather, environmental constraints, etc.).

FMG is cognisant of the fact that approval for Stage A does not guarantee approval of Stage B or any subsequent stages that are part of an independent Environmental Impact Assessment (EIA) process.

2. PROJECT JUSTIFICATION

2.1 PROJECT BACKGROUND

World steel production has recently undergone a significant expansion predominantly driven by growth in China. The outcome is a global demand for iron ore that exceeds supply, a situation that is forecast to continue. As a result, the Pilbara region is the focus of a new wave of major iron ore mining developments. Hamersley Iron (HI), which is part of the Rio Tinto group, opened its Yandicoogina mine in 1999, which included an extension of its rail line from Marandoo and a link to the HI main line network to Dampier. BHP Billiton Iron Ore's (BHPBIO's) adjacent Yandicoogina operation has been subject to capacity upgrades since 1992, and provides the rail spur linkage to BHPBIO's main line network to Port Hedland. New projects in this area include Rio Tinto's West Angelas and BHPBIO's Mining Area C (MAC).

Current infrastructure utilisation in the Pilbara (controlled exclusively by BHPBIO and HI/Rio Tinto) is restricting the development of the Western Australian iron ore industry to its full potential. To date, no third parties have been able to gain access to this infrastructure, although specific provision has been made by Government within State Agreements with these companies. The Hope Downs (Hancock/Kumba) project has received environmental approval to construct its own mine, railway and port facility, but is still attempting to negotiate access to BHPBIO's existing rail and port infrastructure. However, there is currently no true multi-user agreement for third party use of existing or proposed rail and port infrastructure that will stimulate resource development across the Pilbara.

2.2 STATE AND NATIONAL BENEFITS

FMG proposes to develop the iron ore deposits around the Christmas Creek, Mt Lewin, Mt Nicholas and Mindy Mindy resource areas (Figure 2), and to provide an east-west railway that will join the north-south railway being assessed under Stage A of the Project. FMG proposes that its port and railway infrastructure will be multi-user and will be made available at commercially competitive rates and time slots to other users.

The development of the Project will provide a number of significant benefits including:

- multi-user infrastructure that will facilitate the development of other third party stranded mineral resources and offer open access at competitive commercial rates. Initially at least, it is perceived that such third party projects will be for mining/mineral processing and not public access. Such access would remove the need for third parties to construct their own infrastructure and avoid the cumulative environmental impacts resulting from this;

- creation of significant direct and indirect employment opportunities through materials purchase, construction, operation and support services;
- a total expenditure of approximately A$1.85 billion for Stage A and Stage B;
- income to Government through taxes and royalties; and
- improved regional community support through local employment opportunities. FMG will seek to locate the majority of its operational workforce within the regional centres of Newman and Port Hedland.

2.3 NO DEVELOPMENT OPTION

The "no project" option would result in the loss of opportunity to develop these iron ore resources, loss of employment opportunities and economic benefit, particularly within local regional communities and loss of potential for future third party mines. The increasing global demand for iron ore would then be met through the development of projects elsewhere, predominantly overseas, with the loss of the associated benefits to Western Australia.

3. ENVIRONMENTAL APPROVALS PROCESS

3.1 RELEVANT LEGISLATION AND POLICIES

The *Environmental Protection Act 1986* is the principal statute relevant to environmental protection in Western Australia. The Act makes provision for the establishment of the Environmental Protection Authority (EPA), for the prevention, control and abatement of pollution and for the conservation, preservation, protection, enhancement and management of the environment. The Act also provides for the control and licensing of potentially polluting activities and land clearing, and is the Act under which the WA State environmental approvals process operates.

Other state environmental and related legislation relevant to the Project includes the following:

- *Aboriginal Heritage Act 1972*
- *Agriculture and Related Resources Protection Act 1976*
- *Bush Fires Act 1954*
- *Conservation and Land Management Act 1984*
- *Contaminated Sites Act 2003*
- *Explosives and Dangerous Goods Act 1961*[1]
- *Dangerous Goods (Transport) Act 1998*[1]
- *Land Administration Act 1997*
- *Occupational Safety and Health Act 1984*
- *Private Railways (Level Crossings) Act 1966*
- *Rail Safety Act 1998*
- *Rights in Water and Irrigation Act 1914*
- *Soil and Land Conservation Act 1945*
- *Town Planning & Development Act 1928*
- *Wildlife Conservation Act 1950*

Commonwealth legislation of relevance to the Project includes the following:

- *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act 1999)*
- *Native Title Act 1993*

Under the *EPBC Act 1999* an action requires approval from the Federal Minister for Environment and Heritage if the action has, will have, or is likely to have, a significant impact on a matter of national environmental significance such as:

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[1] The *Dangerous Goods Safety Act 2004* will soon replace the *Explosives and Dangerous Goods Act 1961* and the *Dangerous Goods (Transport) Act 1998.*

- World Heritage properties;
- National Heritage places;
- Ramsar wetlands of international importance;
- Listed threatened species and communities;
- Migratory species protected under international agreements;
- Nuclear actions; or
- The Commonwealth marine environment.

Stage B of the Project was referred to the Federal Department of Environment and Heritage (DEH) on 1 December 2004 due to the possibility of listed rare fauna species occurring within the Project area (Section 4.5.3.2). The DEH has assessed the referral and a decision has been made that the project is not a 'controlled action' under Part 9 of the *EPBC Act 1999* (Appendix C).

3.2 KEY DECISION MAKING AUTHORITIES

The key Decision Making Authorities (DMAs) involved in the environmental assessment of FMG's Project are the State EPA and the Department of Environment (DoE) which provides advice to the EPA.

Consultation with the Department of Conservation and Land Management (CALM) on the assessment of potential impacts on biodiversity has been ongoing. Similarly, consultation regarding the assessment of potential impacts on water resources continues with the Water and Rivers Commission (WRC) section of the DoE.

If Project tenure is issued under the *Mining Act 1978*, approvals from the Department of Industry and Resources (DoIR) will be required once formal approvals under the *Environmental Protection Act* have been obtained. FMG has been granted a State Agreement for the proposed port and railways (both Stage A and Stage B railways), and is currently involved in discussions with the State Government with regards to another State Agreement for development of the mines. If this is granted, *Land Act* tenure would require compliance with the *Land Administration Act 1997* administered by the Department for Planning and Infrastructure (DPI).

Other DMAs involved in the Project approvals include:

- Department of Indigenous Affairs (DIA);
- Department of Land Information (DLI);
- Department of Agriculture (AgWA); and
- Shires of East Pilbara and Ashburton.

3.3 APPROVALS PROCESS

It has been determined by the EPA that the Project requires formal assessment at the PER level. The process for submission and assessment of a PER is as follows:

1. The Proponent refers the proposal to the EPA to set the level of assessment;
2. The EPA determines the level of assessment as a PER and advertises this decision and the length of the public review period, subject to appeal;
3. The Proponent prepares an Environmental Scoping Document outlining the scope of works for the PER assessment;
4. The EPA agrees to the Environmental Scoping Document as a basis for the PER;
5. A draft PER is prepared by the Proponent and submitted to the EPA Service Unit for comment;
6. The final draft of the PER is submitted to the EPA for authorisation to release as a public document;
7. The PER *(this document)* is released for a public review period of 8 weeks;
8. Any submissions received by the EPA at the end of the review period are provided to the Proponent, for the Proponent to summarise and respond;
9. The EPA undertakes an assessment of the proposal;
10. The EPA 'Report and Recommendations' is published;
11. A two week statutory appeal period commences at the time of release of the EPA's Report and Recommendations;
12. The Minister determines any appeals on the EPA's Report and Recommendations, and consults with the key Decision Making Authorities to seek agreement on whether or not, and in what manner the proposal may be implemented; and
13. The Minister issues a Statement as to whether or not the Project can be implemented.

This PER is intended to allow the public to review the potential environmental impacts of the Project and proposed management measures. Guidelines for making a submission are presented in the front of this document.

If approval for a project is obtained under Part IV of the *Environmental Protection Act 1986*, licensing of construction and operations is required under Part V of the Act. This requires a Works Approval Application to be submitted to the DoE prior to commencement of construction, and an Application for Licence to Operate submitted to the DoE, for the mining components of the Project, prior to commencement of commissioning. Parts of the Project will be constructed on tenure granted under the *Mining Act 1978*, and if this is the case, then a Notice of Intent will also be required to be submitted to the DoIR for approval, before construction can commence.

3.4 LAND USE ZONING

The Project area is located on the following pastoral leases (from west to east; Figure 3):

- Mulga Downs;
- Hillside;
- Marillana;
- Roy Hill;
- Bonney Downs;
- Noreena Downs; and
- Balfour Downs.

The southern tenements of Mindy Mindy are located on unallocated crown land, and two stock routes (reserved crown land) also pass through the Project area (Figure 3).

All pastoral leases in Western Australia issued under the now repealed *Land Act 1933* expire on 30 June 2015. Portions of numerous pastoral leases in the Pilbara have been nominated by CALM to be released to the conservation estate or to be set aside for conservation management within the pastoral leases under conservation agreements, when the pastoral leases are renewed. Four such pastoral lease exclusion zones have been proposed on pastoral stations in the vicinity of FMG's proposed Project area: Marillana, Roy Hill, Mulga Downs and Hillside. These exclusion areas are currently being negotiated by CALM with the Pastoral Lessees and the results of the negotiations will be kept confidential between the negotiating parties, until agreement has been reached and approved (or not) by the State Minister for Planning and Infrastructure. If the exclusion zones are agreed and approved by the State Minister, a further approval process will be required to be sought for the areas to be included in the conservation estate or conservation agreements are reached with the pastoral lessees. At this stage it is not certain whether FMG's Project area will overlap the final exclusion zones negotiated, or whether these will be approved by the Minister for Planning and Infrastructure.

FMG is cognisant of the potential impacts of the Stage B Project on the proposed future conservation areas, and have investigated these in detail in Section 6.13.

4. EXISTING ENVIRONMENT

4.1 CLIMATE

The Pilbara region of Western Australia is classified as arid-tropical, becoming more arid inland. Climatic data provided by the Bureau of Meteorology (www.bom.gov.au) for Nullagine and Newman, the two closest weather stations to FMG's mining areas, indicate that peak rainfall occurs in the summer months with a smaller peak in June (Table 1). Climatic conditions in the Pilbara are influenced by tropical cyclone systems predominantly between January and March. These cyclones normally develop over the ocean north of Australia and follow a south-westerly course parallel to the northwest coast. However, at some point, two thirds of these cyclones change direction and head southeast, crossing the coast and moving inland, bringing heavy rainfall. Rainfall during May and June is generally a result of cold fronts moving across the south of the State, which occasionally extend into the Pilbara.

Annual average rainfall for the Pilbara ranges from 180 mm to over 400 mm (Beard, 1975) with the Bureau of Meteorology data indicating an annual average of 328 mm at Nullagine and 312 mm at Newman. Average maximum summer temperatures are generally between 34°C and 40°C and winter maximum temperatures generally between 22°C and 31°C. In this climate, annual evaporation rates greatly exceed the mean annual rainfall. The local climate is influenced to some degree by the topography with rainfall highest around the Hamersley Ranges (Beard, 1975).

Table 1. Climatic data for Nullagine and Newman

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Nullagine[1]													
Mean Daily Max. Temp (°C)	39.4	38.3	36.7	33.1	27.9	24.1	24.0	26.8	31.3	35.0	38.3	39.7	32.9
Mean Daily Min. Temp (°C)	24.2	23.7	21.9	17.2	12.4	8.8	7.5	9.3	12.8	16.9	21.1	23.3	16.6
Mean 9am Rel. Hum. (%)	43	46	40	40	50	53	49	41	31	28	27	30	40
Mean 3pm Rel. Hum. (%)	28	28	26	27	33	34	31	26	19	18	18	19	26
Mean monthly rainfall (mm)	70.4	66.9	49.2	22.2	20.4	24.3	11.2	6.8	1.6	4.1	12.4	28.0	327.5
Highest monthly rainfall (mm)	298.5	222.8	255.4	183.8	156.7	185.1	91.0	76.6	36.1	80.8	95.5	263.3	
Highest recorded daily rainfall (mm)	144.8	105.2	135.0	153.2	73.7	95.8	73.7	50.0	30.0	37.6	54.9	147.3	
Mean 3pm wind speed (kph)	10.1	9.6	8.6	8.3	9.0	8.9	10.0	10.8	10.5	11.6	10.5	9.2	9.8
Newman[2]													
Mean Daily Max. Temp (°C)	38.8	37.2	35.8	31.6	26.2	22.4	22.2	24.8	29.4	33.6	36.5	38.5	31.3
Mean Daily Min. Temp (°C)	25.3	24.4	22.5	18.5	13.3	9.6	8	10.2	13.7	18	21.5	24.1	17.3
Mean 9am Rel. Hum. (%)	35	41	37	41	49	56	50	43	30	25	24	30	39
Mean 3pm Rel. Hum. (%)	22	26	23	26	32	34	29	24	17	14	14	19	24
Mean monthly rainfall (mm)	51	80	39	25	23	25	13	11	4	4	10	27	312
Highest monthly rainfall (mm)	226	286	199	212	119	156	64	96	43	23	63	140	
Highest recorded daily rainfall (mm)	142	151	108	72	47	101	29	36	31	17	57	63	151
Mean 3pm wind speed (kph)	10.1	10.7	8.8	7.7	7.9	8.3	9.3	9.2	10.2	11	10.2	9.6	9.4

Source: Bureau of Meteorology (www.bom.gov.au)

1. Data for Nullagine from 1897 to 2004
2. Data for Newman from 1965 to 2004

Nullagine experiences greater extremes of temperature than Newman. Although average annual rainfall is similar for both stations, Newman's rainfall exceeds that of Nullagine's during the winter months and in February, and Nullagine receives more rainfall than Newman in January and March.

At Newman winds are predominantly easterly in summer, east-southeasterly in autumn and variable during the winter, moving around to southwesterly in spring. Annual average wind speed at Newman is 9.4 kph measured at 3 pm (www.bom.gov.au).

4.2 GEOMORPHOLOGY

4.2.1 Topography

Within the Newman area, the regional topography is dominated by the Hamersley Plateau in the south and the Chichester Ranges in the north, with the two features divided by the Fortescue Valley. The main drainage is the Fortescue River, which flows northwards on Ethel Creek Station and then flows northwest on Roy Hill Station into the Fortescue Marsh.

The topography of the Project areas and proposed railway can best be described as gently undulating, with a maximum relief from the Fortescue valley (400 – 450 mRL) to the Chichester Ranges (500 – 600 mRL) of approximately 50 m to 200 m. The Chichester Ranges and the major drainage system of the Fortescue valley to the south are aligned west-northwest, while the Mt Nicholas topography has north-northeast trend.

Christmas Creek, Mt Lewin and Mt Nicholas Mining Areas

The topography of these Project areas is influenced by the eastern end of the Chichester Ranges. The area is hilly to undulating, sloping south-southwest towards the Fortescue River Valley, containing the Fortescue Marsh (also known as Roy Hill Marshes). Elevations of the Project areas are between 440 mRL and 500 mRL at Christmas Creek, 430 mRL and 460 mRL at Mt Lewin, 470 mRL and 485 mRL at Mt Nicholas.

Plate 1. Photo showing changes in topography within the Chichester Range.

Mindy Mindy Mining Area

The Mindy Mindy tenements are located in an undulating hilly landscape, straddling two catchment areas, with Weeli Wolli Creek to the west and Coondiner Creek to the east. Drainage flows northwest towards the Weeli Wolli Creek and east to Coondiner Creek before heading north out to the Fortescue Marsh. The average elevation of the Mindy Mindy Project area is between 480 mRL and 590 mRL.

East - West Railway Corridor

The proposed east-west railway line follows the contour of the southern foothills of the Chichester Ranges (Figures 4, 5 and 6). The railway line extends from the Mt Nicholas mining area in a westerly direction and joins the proposed Stage A railway from Port Hedland to Mindy Mindy railway. This area slopes gently to the southwest towards the Fortescue Valley. Elevation along the railway corridor ranges from 470 mRL to 500 mRL and the mean gradient will be approximately 0.33 percent.

4.2.2 Land Systems

Christmas Creek, Mt Lewin and Mt Nicholas Mining Areas

Land systems at Christmas Creek are dominated by the Newman Land System (Rugged jaspilite plateaux, ridges and mountains supporting hard Spinifex grasslands) and the McKay Land System (Hills, ridges, plateaux remnants; and breakaways of metasedimentary and sedimentary rocks supporting hard spinifex grasslands) and Jamindie Land System (Stony hardpan plains and rises supporting groved Mulga shrublands, occasionally with Spinifex understorey).

The Mt Lewin mining area is characterised by the McKay Land System and the Jamindie Land System.

The Mt Nicholas area is characterised by the McKay Land System, which approximately follows where the orebody is located and the Divide Land System (Sandplains and occasional dunes supporting shrubby hard Spinifex grasslands).

Mindy Mindy Mining Area

At Mindy Mindy, the area is predominantly in the Newman Land System (rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands) and some Rocklea Land System (Basalt hills, plateaux, lower slopes and minor stony plains supporting hard spinifex and occasionally soft spinifex grasslands).

East – West Railway

The main land systems along the proposed east-west rail line as described by Payne *et al.* (2002) are the:

- Jamindie Land System; and
- Turee Land System - Stony alluvial plains with gilgaied and non-gilgaied surfaces supporting tussock grasslands and grassy shrublands.

This is interspersed with the:

- Christmas Land System to the west - Stony alluvial plains supporting snakewood and Mulga shrublands with sparse tussock grasses;
- Brockman Land System - Alluvial plains with cracking clay soils supporting tussock grasslands; and
- Washplain Land Systems - Hardpan plains supporting groved Mulga shrublands; at the eastern end of the rail corridor.

The Divide Land System occurs where the rail line terminates at Mt Nicholas.

4.2.3 Project Geology

4.2.3.1 Regional Geology

The geological stratigraphy in the Pilbara region of Western Australia is relatively continuous, with similar geological processes occurring across the region which have resulted in the enrichment of the iron deposits. The Project lies within the Hamersley Basin where granitoid rocks of the Pilbara Craton (2800 – 3500 Million years old), are overlain throughout most of the Project area by sedimentary rocks. The lowest of the sedimentary group is known as the Fortescue Group, which is itself overlain, in parts, by the Hamersley Group. These sedimentary formations were originally formed in horizontal layers, but over time, tectonic movement has resulted in folding of the rocks and several major geological faults have developed. Weathering processes have resulted in erosion of some of these rocks into alluvium and colluvium. These eroded rocks include gravels, sands and clays, which have been deposited in the lower lying areas, including ancient river channels.

The regional geology of Mt Nicholas and Mt Lewin areas is shown in Figure 7 and the regional geology of the Christmas Creek and Mindy Mindy area is shown in Figure 8.

4.2.3.2 Project Area

FMG's Mt Nicholas, Mt Lewin and Christmas Creek deposits are located in the Chichester Ranges and the Mindy Mindy deposit is located on the edge of the Hamersley Ranges. The mineralogy of the ore units of the Chichester deposits is dominated by iron oxides (greater than 55%) with the minerals present being goethite, hematite and to a lesser extent martite together with ochreous goethite and hematite. Other minerals present are kaolinite (representing alumina, less than 5%) and free plus matrix quartz (representing silica, less than 10%). Other remaining minerals within the ore unit average less than 1% of the total measured material and include apatite (representing phosphorous, average of 0.05%) and sulphates (measured as elemental sulphur, average of 0.04%). Mined material will also contain up to 10% contained water. All of FMG's ore bodies are considered to contain non-reactive mineralogy due to the geological conditions under which they have been formed.

Mt Nicholas

The iron ore at Mt Nicholas lies within the Hamersley Group, which has been sub-divided into different formations. The lowest is the Marra Mamba Iron Formation, which has been further divided into different members, of which the Nammuldi Member is the most predominant outcropping member in the region, and contains the iron ore mineralisation targeted for mining. The Marra Mamba Formation overlies the Jeerinah Formation, which is the top formation in the Fortescue Group.

At Mt Nicholas, the Nammuldi Member is iron enriched and resistant to erosion. This forms a line of hills which reflects the geology of the region. These hills strike predominately south-north, and dip to the west (approximately 10°), with the geology being folded in the northern part of the tenement (an antiform), such that the strike changes to east-west and dips to the south (steeper dipping). To the west of the hills which encompass Mt Nicholas, the Nammuldi member, which is enriched to a certain extent, is concealed beneath layers of sands, clays and gravels (alluvium and colluvium), which are the weathered remnants of the surrounding rocks. To the east of the Mt Nicholas hills the rocks have been eroded away and the underlying Jeerinah formation is now exposed at the surface. The iron ore targeted for mining therefore is preserved in a strip, which runs in a general north-south direction (changing to east-west).

Mt Lewin

Geologically, the Mt Lewin mine is very similar to that at Mt Nicholas. As with Mt Nicholas the iron ore is located in the Nammuldi Member of the Marra Mamba Formation. This again is iron enriched and forms a line of low lying outcropping hills, which generally strike in an east west direction although they are folded and changes in trend quite often. The units dip gently to the south around 10°, with flatter dips to the west. These are covered to the south by alluvium and colluvium which can conceal iron mineralisation beneath cover. There are large regional faults recognised throughout the Mt Lewin region, and these interrupt the trend of the hills, and are commonly signified by reasonably sized creek beds.

Christmas Creek

The geology at Christmas Creek is also similar to that at Mt Lewin and Mt Nicholas, however there are some subtle differences. As at Mt Lewin, the Marra Mamba Formation at Christmas Creek strikes generally east-west and dips in a southeasterly direction, but the gradient is shallower (around 5°), so the formation appears at the surface as a broader outcrop than at Mt Lewin. The hills surrounding Christmas Creek are flatter and more topographically incised than those at Mt Lewin or Mt Nicholas, with small creeks dissecting the Marra Mamba geology and eroding this formation away to expose Jeerinah formation in small gullies.

Mindy Mindy

The mineralogy of the Mindy Mindy ore deposit is dominated by goethite, and to a lesser extent hematite, with minor ochreous goethite. Other mineral present are kaolinite (representing alumina, less than 5%) and free plus matrix quartz (representing silica, less than 10%). The remaining minerals are all units that average less than 1% of the total mined material, including apatite (representing phosphorous, average of 0.07%) and sulphates (measured as elemental sulphur, average of 0.02%). As with the Chichester deposits, contained water is expected to make up to 10% of the material mined.

The geological setting of Mindy Mindy differs from the other three sites. The ore is located in an ancient riverbed system associated with the current-day Mindy Mindy Creek. Iron ore mineralisation in such Channel Iron Deposits (CID) results from chemical precipitation of iron forming pisoliths, which are cemented together through diagenetic processes. At Mindy Mindy, this ancient channel passes through the Weeli Wolli Formation of the Hamersley Group for most of its length, with the most northerly section passing through the Brockman Iron Formation. Unlike many CID deposits in the Pilbara where the CID's occurrence is indicated by mesas formed by erosion of the surrounding rocks, the Mindy Mindy deposit lies below the surrounding topography (covered by alluvium and colluvium).

Borefield

The proposed process water supply borefield is situated in a 60 km long arc along the foot slopes of Mt Lewin and Mt Nicholas. The geology of the borefield area consists of gently dipping Marra Mamba Iron Formation, overlain by a sequence of clays, silts, sands and gravels. The Marra Mamba and dolomite dips gently in two directions; at Mt Lewin it dips in a southerly direction, whereas at Mt Nicholas the dip is to the northwest. The surface of the Marra Mamba consists of a weathered saprock, generally 10 m thick. Below this weathered surface, the Marra Mamba is typically represented by unweathered cherts, shales and banded iron formation (BIF).

Further south and also associated with lineaments, there are occasional high permeability zones of deeper fractured/karstic, transitionally weathered Marra Mamba Iron Formation including mineralised Nammuldi Member, typically at 80 m to 120 m depth. Secondary permeability is developed locally, but is uncommon suggesting that any voids have been mostly in-filled with overlying sediments.

There are several alluvial fans within the northern part of the proposed borefield. Further south there is a series of faults, but it is likely that any voids associated with these features have been in-filled with overlying sediments.

Asbestiform Minerals

Although the Hamersley range geological sequence is noted for occurrence of asbestiform (or asbestos) minerals there has been no identification of such minerals in any of the FMG active exploration projects to date (in excess of 2,000 drill holes).

crocidolite (or riebeckite) is the most common asbestiform mineral recognised in the Hamersley region. These are fibrous members of the amphibole group, which are common rock forming minerals in igneous or metamorphic terrains. It is postulated that there are no recognised asbestiform minerals within the FMG Project areas as suitable rock geochemistry or metamorphic conditions have not been present for the formation of crocidolite or riebeckite to occur. The geological processes of iron enrichment can act to replace these minerals with iron, therefore destroying their fibrous nature. As FMG is targeting the iron enriched areas, the possibility of intersecting these minerals is reduced. The likelihood of asbestiform minerals occurring within the proposed mining areas is therefore considered to be low and this is supported by current drilling statistics.

FMG will continue to test for the presence of asbestos in its ore as a matter of course during the feasibility studies for Stage B of the Project. If an area is found to contain asbestos minerals, FMG will develop a management plan in consultation with relevant government agencies (such as the Department of Health) and will not mine a particular area if concentrations of asbestiform minerals are unacceptable. If asbestos is encountered accidentally (e.g. during drilling), FMG has strict Occupational Health and Safety procedures that must be followed to ensure there is no health risk to FMG's own employees or the wider public.

4.3 SURFACE WATER

4.3.1 Regional Hydrology

The hydrology of the region is discussed in more detail in a separate report by Aquaterra (Appendix F) and is briefly summarised below.

The proposed FMG mining areas and Stage B railway corridor are located in the vicinity of the Fortescue Marsh in the Upper Fortescue River Catchment (Figure 9). In common with other areas in the Pilbara Region, the Fortescue Valley is subjected to localised thunderstorm and cyclonic rainfall events. Typically these events occur during the period December to April and can produce very large runoff events. The period May to November typically has relatively low rainfall and significant runoff events during this time are not common. Due to the low rainfall and brief wet season, most watercourses flow, if at all, for only brief periods. However surface water does remain available all year in some river pools, waterholes and springs.

The Goodiadarrie Hills, located on the valley floor around 60 km east from the town of Wittenoom, effectively cuts the Fortescue River into two separate river systems. West from the Goodiadarrie Hills, the Lower Fortescue River Catchment drains to the coast, whereas east from the hills the Fortescue Marsh receives drainage from the Upper Fortescue River Catchment. The alluvial outwash fan from the Weeli Wolli Creek system abutting the Goodiadarrie Hills is believed to be partially responsible for this obstruction to the Fortescue River and forming the Fortescue Marsh.

The Fortescue Marsh is an extensive intermittent wetland occupying an area around 100 km long by approximately 10 km wide located on the floor of the Fortescue Valley. The marshes have an elevation around 400 m above sea level. To the north, the Chichester Plateau rises to over 500 m above sea level, whereas to the south the Hamersley Range rises to over 1,000 m above sea level. Following significant rainfall events, runoff from the approximately 31,000 km^2 Upper Fortescue River Catchment drains to the marshes. For the smaller runoff events, isolated pools form on the marshes opposite the main drainage inlets, whereas for the larger events the whole marsh area floods.

On the southern and northern flanks of the Fortescue Valley, numerous creeks discharge to the marsh. Runoff from rainfall on the valley sides initially drains down gradient as overland flow before concentrating in a defined flow channel. In this process, surface retention, vegetation, seepage and other mechanisms absorb water from the runoff stream. In steep areas, the runoff processes are rather rapid with relatively low losses and defined drainage channels are typically in close proximity. In the lower slope areas, the runoff processes are rather slow with relatively higher losses and a greater distance between defined drainage channels.

Where defined drainage channels from the steeper slopes enter the lower slope areas, the channels typically have a reduced discharge capacity and in many instances become less well defined and braided or may completely disperse in flat areas. In these reducing slope channels, runoff tends to overspill the main channel flow zones and spread over a wider front. In some lower slope areas, vegetation communities (such as Mulga woodlands) have developed areas which are dependent on seepage water provided by the overland flow process. In these areas, the overland flow process has been termed sheetflow. Conversely, the Fortescue River, Weeli Wolli Creek and other main channels entering the marshes typically support eucalypt woodlands on their banks and floodplains.

Published topographical mapping indicates that bed levels in the Fortescue Marsh predominantly lie between 400 m and 405 m above sea level and that a flood level in the Marsh would need to be around 415 m above sea level to overspill westwards past the Goodiadarrie Hills. No published flood level data are available for the marshes. Enquires with BHPBIO indicate that flood levels have never overtopped their railway crossing over the marshes which is at approximately 415 mRL, although large floods in the early 1970's are reported to have caused inundation up to the existing railway track level (*pers. comm.* G. Liddell, BHPBIO).

At the eastern end of the marshes, an indication of flood levels can be obtained from the Roy Hill streamflow gauging station data (S708008) established on the Upper Fortescue River. This gauging station used to monitor streamflows entering the marshes, was located downstream from the Roy Hill Homestead and was operating from September 1973 to September 1986. This station was established to monitor streamflows entering the marsh from the upper Fortescue River. At the gauging station, the main flow channel bed level was around 405.5 m above sea level and during the 13 years of record, the maximum recorded streamflow level was 408.75 m above sea level (February 1980). The corresponding peak flood storage level in the downstream marsh would have been less than this gauge level.

Surface water runoff to the marsh is of low salinity and turbidity, though the runoff turbidity increases significantly during periods of flooding (WRC, 2000). Following a significant flood event that flooded the whole marsh area, the ponded water could be over 4 m deep in the lower elevation marsh areas. Water stored on the marsh slowly dissipates through the processes of seepage and evaporation and the aerial extent of the marsh decreases, becoming a series of pools, until the surface water completely dries up. During the evaporation process, the water salinity levels increase and as the ponded area recedes, traces of surface salt can be seen. As the ponds evaporate, increasingly more saline water is thought to seep into the valley floor alluvial deposits.

4.3.2 Project Hydrology

The surface hydrology of the proposed mining and railway areas were investigated by Aquaterra (2004a) (Appendix F).

Mining Areas

The Fortescue Marsh, an extensive intermittent wetland, receives runoff from the Upper Fortescue River Catchment, as previously described (Section 4.3.1). The marsh has an elevation around 400 m above sea level (ASL), whereas to the north, the Chichester Plateau rises to over 500 m ASL, and to the south, the Hamersley Range rises to over 1,000 m ASL. The proposed mine developments have pit perimeter levels at Mt Lewin and Christmas Creek of around 430 - 500 m ASL and at Mt Nicholas and Mindy Mindy of around 500 m above sea level. Hence all the pit development areas are located well above any potential flood storage level in the marshes.

The proposed Mt Nicholas mine pit is located parallel to a north-south ridge and natural drainage is generally to the west. Several small creeks pass through the proposed pit area which have relatively steep gradients (typically 10 m to 20 m per kilometre) adjacent to the main ridge and have upslope local catchment lengths varying up to around 4 km. Away from the main ridge, natural drainage gradients are relatively flat.

The proposed Mt Lewin mine is located along the southern flank of the east-west running Chichester Plateau adjacent to Kondy Creek and comprises several pits and associated ore and overburden stockpiles, facilities and access/haul roads. Kondy Creek with a catchment area around 270 km^2 above the proposed mine development area drains into the Fortescue River, which in turn drains to the Fortescue Marsh. During peak flood events, Kondy Creek would carry a significant discharge and flow over a relatively wide shallow floodplain. One of the Mt Lewin pits is partially located in the western floodplain of Kondy Creek, whereas the other pits are away from the floodplain. Numerous small creeks pass through the proposed pit development areas. These creeks have relatively steep slopes in the higher rocky ridge areas and relatively flat slopes away from the ridge.

The proposed Christmas Creek mine development comprises a series of pits located along the southern flank of the east-west running Chichester Plateau. These pits are predominantly located on the western side of Christmas Creek, which has a catchment area of around 225 km^2 above the proposed mine development area. During peak flood events, Christmas Creek would carry a significant discharge and over the lower slopes of the plateau, creek flows would spread over the relatively wide shallow floodplain. One of the proposed pits abuts the western floodplain of Christmas Creek, whereas the other pits are away from the floodplain. In common with the other proposed pit areas, numerous small creeks discharge southwards through the proposed pit development area. These creeks have relatively steep slopes in the higher rocky ridge areas and relatively flat slopes away from the ridge.

The proposed Mindy Mindy pit development is located south of the Fortescue Marsh on the northern flank of the Hamersley Ranges. The proposed pit follows a northwest-southeast trending valley located between the Weeli Wolli Creek and Mindy Mindy Creek systems. The pit valley has a total catchment of 24 km^2 and drains towards Weeli Wolli Creek at an average slope of 5 m per kilometre. Numerous small creeks drain into the pit valley from the surrounding ridges. The mine development area also includes ore and overburden stockpiles, facilities and access/haul roads.

Published topographical mapping indicates that no springs or pools are located in FMG's proposed mining areas.

Railway

The FMG proposed Stage B railway corridor runs along the southern slopes of the Chichester Ranges linking the Mt Nicholas mine site to the FMG Stage A Mindy Mindy to Port Hedland railway corridor (Figure 2). Along this route, the proposed Stage B railway connects with the Mt Lewin and Christmas Creek mine sites. Located predominantly on the lower slopes of the Chichester Plateau, the closest distance from the railway corridor centreline and boundary to the marsh is 4 km.

The corridor intersects numerous small creeks (Figures 4, 5 and 6). There are six main creek crossings of the FMG proposed Stage B railway corridor. The characteristics of these crossings are presented in Table 2. The creeks range from the Goman with a catchment area upstream of the railway corridor of about 30 km^2 to the Kulkinbah with an upstream area of about 770km^2. All of these creeks in this predominantly alluvial soil area, have gently sloping channel beds within the railway corridor zone, ranging from about 0.1 to 0.4 percent. The Goman Creek is the only watercourse with a well defined drainage channel compared with the other five main creeks which have braided channels with wide floodplains.

Table 2. Characteristics of the Main Creek Crossings of the FMG Proposed Stage B Railway Corridor

Creek	Catchment Area (km^2) $^{(1)}$	Average Slope (%) $^{(2)}$	Flowpath Characteristics $^{(3)}$
Goman	30	0.4	Defined channel around 50m wide
Sandy	80	0.3	Braided channels, wide floodplain
Christmas	250	0.2	Braided channels, wide floodplain
Kulbee	70	0.4	Braided channels, wide floodplain
Kulkinbah	770	0.1	Braided channels, wide floodplain
Kondy	280	0.2	Braided channels, wide floodplain

Notes

(1) Area upstream of railway corridor

(2) Channel slope through railway corridor

(3) Characteristics through railway corridor zone

Published topographical mapping indicates that no springs or pools are located along this railway corridor.

Starting from the Stage A railway corridor near the crest of the Chichester Plateau, at around 500 m above sea level, the proposed Stage B railway corridor initially proceeds in a southeast direction towards the marshes. This corridor route has been selected to gradually descend over a distance of 20 km to 25 km to the lower slopes of the plateau. Once on the lower slopes, the railway corridor is typically located between the 420 - 430 m ASL contours until the Kondy Creek floodplain after which the route slowly ascends to around 460 m ASL near the Mt Nicholas mine site. The railway corridor is located above any potential flood storage level in the marshes.

On the lower slopes of the plateau, the railway corridor crosses numerous small creeks. These southerly draining creeks typically have slopes between 5 m to 10 m per kilometre through the corridor area. For the larger Christmas, Kulkinbah and Kondy Creeks, the floodplain drainage slopes through the railway corridor are flatter at around 2 m per kilometre. These flatter slopes arise because of the more extensive alluvial fans developed from the larger capacity creek systems. East of the Kondy Creek floodplain, surface water runoff drains in a general westerly direction parallel to the railway corridor. This corridor section up to Mt Nicholas is relatively flat, with a natural gradient of around 2 m per kilometre, but without defined drainage flowpaths crossing the corridor. Conversely, in the higher elevation western portion of the railway corridor, rocky ground conditions occur and drainage slopes are significantly steeper with many steep gullies crossing the corridor.

Together with the numerous small creeks, the railway corridor crosses extensive areas of sheetflow along the lower slopes of the plateau. Catchments to these sheetflow areas are difficult to define, as they comprise a combination of the directly upgradient overland flow areas plus over spill from nearby main creek flow zones. Scrub and Mulga woodland communities have developed in large sections of the lower slope areas, which are reported to be partially dependent on seepage water provided by the sheetflow process. Of particular note are the grove-intergrove Mulga communities located west of Sandy Creek (Figure 10 and 11).

4.4 GROUNDWATER

4.4.1 Regional Hydrogeology

The hydrogeology of the region is discussed in more detail in a separate report by Aquaterra (Appendix G) and is briefly summarised below.

Regional groundwater levels were obtained from the DoE's AQWABASE system. These data were combined with groundwater measurements from the bores drilled for the Project and used to construct regional groundwater contour plots. Figures 12 and 13 show these contours as metres above reduced level (mRL) and metres below ground level (mbgl).

Throughout the region groundwater levels are a subdued reflection of topography so that groundwater levels are generally highest along topographic high points and lowest in valley locations. However, because groundwater gradients are generally shallower than topography, the depth to the water table is generally least in low-lying areas and greatest along the ridges. In low-lying areas, particularly along the Fortescue Marsh, Fortescue River and major creek systems, depth to water is typically less than 10 m. Groundwater levels in the vicinity of the Fortescue Marsh are generally below 400 mRL (5 mbgl). At locations away from these surface water locations groundwater levels are typically at depths of 20 m or more.

Maximum groundwater levels (approximately 500 mRL (40 mbgl)) were observed along the topographic highs associated with rocks of the Hamersley and Fortescue Groups. The Nammuldi Member which dips across the Hamersley Basin tends to be below the water table where it occurs in low-lying areas, and above the water table at higher elevations.

As with the geology, there are two distinctly different hydrogeological regimes within the Project area. The first is associated with the three mines located north of the Fortescue

River and Marsh (Mt Nicholas, Mt Lewin and Christmas Creek) and the borefield, and the second is associated with the Mindy Mindy area to the south.

In the three mines to the north of the Fortescue River there are two extensive aquifers; an alluvial aquifer within the Quaternary and an aquifer in the upper portion of the Marra Mamba formation where it is either mineralised or weathered. In the borefield, the Wittenoom Dolomite was encountered below the alluvium at bore sites west of Mt Nicholas.

Typically the alluvial aquifer is not saturated at the foot slopes. However, in areas along the foot slopes where creeks have incised into basement rocks, the alluvium can be saturated throughout much of its thickness. Away from the foot slopes, and towards the marsh, the basal 20 m of alluvium is saturated.

Fortescue Marsh

Information on the hydrogeology of the Fortescue Marsh has been obtained from:

- Water samples from the marsh: These showed that it contains sub-potable water (TDS) 7,500 mg/L) in spring, but that the water becomes more saline towards summer (TDS 10,000 mg/L in October) as water levels in the marsh decline.
- Nested piezometers installed in the area between Christmas Creek and the marsh: These indicate that, in this area, groundwater levels in both the alluvium and underlying basement material are 8 mbgl. Furthermore, regional water levels recorded in stock bores suggest groundwater levels along the Fortescue Valley are typically 5 m or more below ground level.
- Groundwater samples, taken from bores between Christmas Creek and the marsh: These indicate that the alluvium intercepted contains water with a similar water quality to that in the marsh. For instance, a sample from one bore approximately 2 km from the marsh was found to have TDS of 5,700 mg/L. However, at greater depths, the Marra Mamba Iron Formation was found to contain much higher salinities (e.g. another bore, also 2 km from the marsh, contained water with TDS of 120,000 mg/L).
- Anecdotal evidence suggesting that the marsh completely dries out during sustained dry periods, when salt crystals form on the surface of the bed (Gary Clark, *pers. comm.*, October 2004). In support of this, during September 2004, occasional salt deposits were observed on the flanks of the marsh.
- Unpublished data on groundwater levels along the Mt Newman railroad which indicate a groundwater catchment divide downstream of Christmas Creek.

The available data set indicates that water levels in the alluvium on the plain are below the bed of the marsh, thus confirming the marsh as a predominantly surface water feature as opposed to a groundwater discharge area. During flooding events salts deposited during previous drying episodes are redissolved, and the freshwater entering the marsh becomes moderately saline.

Following a flood event, a portion of the ponded surface water infiltrates causing water levels to rise beneath the marsh, ultimately to ground level (the marsh bed). Continual evaporation removes ponded surface water, after which the water table in the marsh bed sediments will decline to its former position under the combined processes of direct evaporation and radial groundwater flow. Under this concept, any change in groundwater level beneath the marsh will have no impact on the occurrence of surface water ponding, or on the rate of seepage from the marsh bed into the water table. It is conceivable however, that where the groundwater level is lowered significantly, an increased amount of water would be required to fully saturate the profile, which could reduce the duration of surface water ponding.

The alluvium and, to a lesser extent, Marra Mamba aquifers on the flanks of the valley are recharged with fresh water during rainfall events. Given there is a hydraulic gradient towards the marsh, this water will drain towards the marsh. As a result groundwater both below and close to the marsh is saline, whilst that further away is fresh.

A schematic diagram representing hydrological and hydrogeological processes of the marsh is presented in Figure 14.

4.4.2 Project Hydrogeology

The hydrogeology of the mining and borefield areas was investigated by Aquaterra and its report is provided as Appendix G.

Mt Nicholas

Investigations undertaken to date indicate the occurrence of two aquifers within the area of the proposed mine. Both aquifers drain from east to west, towards the Fortescue River.

The most extensive aquifer is associated with an alluvial sequence that extends southeast from the lower slopes of the Chichester Ranges (below 480 mRL) across to the Fortescue River channel. The alluvial deposits consist of clays, silts, sands and gravels and extend to depths of 70 m. Over most of the area, low permeability clays with occasional sand and gravel lenses dominate the alluvial sequence. In these areas, the permeability is typically low (0.1 m/d). At some locations however, higher proportions of sands and gravels occur within alluvial fans and, in these areas, permeability values of 0.5 m/d have been recorded. Mineralised sections of the Nammuldi Member form a second aquifer.

Geophysical studies indicate the presence of significant faulting across Mt Nicholas. In general, these faults trend in a northeast-southwest orientation. Drilling amongst these faults has indicated that there is little evidence of increased permeability along these features.

Groundwater levels across Mt Nicholas have been measured in mineral bores, and bores drilled for the hydrogeological investigation. The data shows that groundwater levels vary from approximately 410 mRL in the lower slopes at the southern end of the deposit, to 485 mRL along the eastern ridge, in the northern-most part of the mine. Contouring of the groundwater levels shows that the water table is generally flat in the southern part of the mine, but there is an east-west hydraulic gradient in the northern sections.

Figure 15 is a generalized cross-section of the Mt Nicholas mine, on which key hydrogeological features are shown.

During the hydrogeological investigations, water quality samples were taken from the bores that intercepted the water table. Groundwater in the region was found to be generally fresh, with TDS typically in the order of 1,000 mg/L.

Mt Lewin

Figure 16 shows a generalised cross-section across the Lewin deposit and illustrates groundwater levels and the main aquifers. Bore drilling at, and in the vicinity of the Mt Lewin mine has determined that, as with Mt Nicholas, there are two aquifers to consider. The first is the alluvium, which has been shown to consist mainly of clay and fine-grained material. The second is the mineralised Nammuldi Member. At Mt Lewin these aquifers dip in a south-easterly direction.

The Mt Lewin mine is bounded on the west by Kulkinbah Creek and is dissected by Kondy Creek. Both these creeks flow from northeast to southwest and into the Fortescue River. These creeks have been shown to be closely aligned to geological faults and have extensive alluvial fans associated with them. These fans consist of higher permeability material than the surrounding alluvial clays.

Groundwater levels have been obtained from approximately 40 bores in and around the proposed mine. The data show that groundwater levels at Mt Lewin range from 390 mRL to approximately 440 mRL in the north.

Water quality analysis showed that water in the ore body and in the alluvium was fresh, with TDS typically 2,000 mg/L.

Christmas Creek

There has been a programme of bore drilling, hydraulic testing and water sampling in the Christmas Creek area to determine the existing hydrogeology. In particular, studies have been undertaken to determine the relationship between the Fortescue Marsh and surrounding aquifers.

The investigation has shown that there are two aquifers in the vicinity of the Christmas Creek mine, and a third to the south, close to the Fortescue Marsh (Figure 17). The first aquifer is within the alluvial deposits that occur below 450 mRL, and which dip to the southwest, becoming increasingly thicker towards the Fortescue Marsh where the sequence was proven to be 60 m thick. These deposits consist mainly of fine-grained material, with occasional gravel lenses. Hydraulic tests have shown that the permeability of the alluvium is in the order of 1 m/d.

The second aquifer is the Nammuldi Member of the Marra Mamba Iron Formation. This dips in a southwesterly direction to a depth of approximately 100 m and has permeability in the order of 3 m/d.

In one bore, (F2), Wittenoom Dolomite was encountered at depth. This formation, which is part of the Hamersley Group, is an aquifer that occurs in other parts of the Pilbara.

Measurements have shown that to the north of the rail corridor the water table is generally below the base of the alluvium. However, on the rail corridor and to the south of it the proposed railway, the alluvium is partially saturated. Water samples have shown that groundwater in the alluvium is generally fresh with TDS typically 1,600 mg/L. The salinity of water in the alluvium increases towards the Fortescue Marsh, with a maximum value of 5,700 mg/L measured.

In the northern tenements, the Nammuldi Member is above the water table. Measurements in bores in the southern parts of the proposed mine show that the ore is partially or fully saturated with fresh groundwater, but that, below the ore zone, saline groundwater occurs. Drilling to the south of the proposed mine indicates that the Marra Mamba and Jeerinah Formations are saturated with saline water. Measurements of TDS in bores intercepting saline water were typically in the order of 160,000 mg/L.

Monitoring of groundwater levels in specially constructed bores close to the Fortescue Marsh indicate that the relatively fresh water in the alluvium and the saline water in the Marra Mamba and Jeerinah Formations have the same potentiometric head.

From the water samples taken, it is evident that the salinity of groundwater in the alluvium, Marra Mamba and Jeerinah formations increases towards the Fortescue Marsh. The highest recorded salinity in the Fortescue Marsh itself was in October 2004, when TDS was 9,000 mg/L, an order of magnitude lower than the hyper-saline groundwater in the underlying Marra Mamba and Jeerinah Formations, but similar to values in the alluvium.

Mindy Mindy

At Mindy Mindy, the alluvium forms a primary porosity aquifer where saturated. However, the alluvium is generally only saturated in the centre of the valley in the north-west of the site. The alluvium is likely to be in hydraulic continuity with the underlying CID.

As described in Section 4.2.3, a CID has been deposited within the palaeo-valley and is up to 34 m thick. The CID is typically goethitic and limonitic, and is pisolitic in parts. The CID is highly porous and vuggy with significant secondary permeability from joints and solution cavities. The upper surface of the CID has been weathered forming a Surface Weathered Profile (SWP). The SWP is likely to have a higher permeability than the unweathered CID due to greater degree of weathering enhancing the secondary porosity.

Basement rocks in the area comprise the Brockman Formation and the Weeli Wolli Formation of the Hamersley Group. The Weeli Wolli Formation forms the basement to most of the site. The Weeli Wolli Formation comprises BIF together with shale and dolerite. The Brockman Formation forms the basement in the north of the site and comprises banded iron formation with shale and chert. The Weeli Wolli Formation and Brockman Formation form fractured rock aquifers, with secondary porosity from fractures, ore-mineralisation, weathered horizons, joints and bedding planes. The Weeli Wolli and Brockman Formations are generally considered to form poor aquifers.

The depth to groundwater ranges from approximately 8 m below ground level (mbgl) to 50 mbgl. There is a groundwater divide in the south of the mine. Groundwater levels in the south of the mine at the groundwater divide have an elevation of approximately 487 mRL falling to approximately southeast to northwest north of the divide and northwest to southeast south of the divide (Figure 18).

Based on work in other parts of the Pilbara, groundwater in the CID is expected to have a salinity of between 1,000 mg/L and 2,000 mg/L (TDS).

Borefield

The hydrogeology of the borefield reflects the hydrogeology of the Mt Nicholas and Mt Lewin mine sites. The target aquifers during the exploratory drilling programme were the alluvial deposits, particularly where incised in basement rocks along creek beds, and the Wittenoom Dolomite. The alluvial aquifer is a sequence of clay, silts, sands and gravels, which is typically 50 m thick, and saturated in the basal 20 m. This aquifer is thicker along creek systems, where it extends to 113 m. The alluvium is generally of low permeability, but at some locations along river creeks, has moderate permeability (0.4 m/d).

The Wittenoom Dolomite was found to be generally weathered to a depth of 5 m, below which it was poorly fractured, but there were occasional voids, possibly associated with geological faulting. Where the dolomite is absent the alluvium lies on the Marra Mamba Iron Formation, which is generally weathered to a saprock across its surface to a depth of 10 m.

Groundwater levels throughout the borefield are typically 30 mbgl, equivalent to 420 mRL. Water levels dip towards the Fortescue River, where they are generally 400 mRL. Water in the alluvial aquifer is typically potable or sub-potable.

4.5 BIOLOGICAL ENVIRONMENT

4.5.1 Biogeography

The Interim Biogeographic Regionalisation for Australia (IBRA) recognises 85 bioregions (Thackway and Cresswell, 1995; Environment Australia, 2000). The Pilbara Bioregion has four main components, based on the physiographic work of Beard (1975), of which three are within the Stage B Project area (Figure 19).

Chichester Range (PIL3)

The Chichester Range subregion (referred to as the Chichester Plateau by Beard, 1975) comprises: "Archaean granite and basalt plains supporting shrub steppe characterised by *Acacia pyrifolia* over *Triodia pungens* hummock grasses. Snappy Gum tree steppes occur on ranges." The proposed Christmas Creek, Mt Lewin and Mt Nicholas mine sites occur along the southern edge of the Chichester Ranges.

Fortescue Plains (PIL2)

South of the Chichester Range, the east-west rail corridor runs along the boundary of the Fortescue Plains subregion and the Chichester Ranges. The Fortescue Plains (referred to by Beard (1975) as the Fortescue Valley) comprise: "Alluvial plains and river frontages. Salt marsh, Mulga-bunch grass, and short grass communities on alluvial plains. River Gum woodlands fringe the drainage lines. This is the northern limit of Mulga (*Acacia aneura*)."

Hamersley Range (PIL1)

The Hamersley subregion (referred to as the Hamersley Plateau by Beard, 1975) is described as "A mountainous area of Proterozoic sedimentary ranges and plateaux with Mulga low woodland over bunch grasses on fine textured soils and Snappy Gum over *Triodia brizoides* on skeletal sandy soils of the ranges." (IBRA Revision 5.1; Environment Australia, 2000). The proposed Mindy Mindy minesite occurs on the northern extent of the Hamersley Ranges, where it meets the Fortescue Plains.

With increasing survey work in the Pilbara, it is becoming apparent that this region is one of the centres of biodiversity in the State. The eastern portion of the Pilbara in particular is located in a transitional zone between the floras of the Eyrean (central desert) and southern Torresian (tropical) bioclimatic regions, and contains elements of both floristic regions (see van Leeuwen and Bromilow (2002) for more detail). In recognition of this high species diversity and the high levels of endemism in the region, the Pilbara has recently been nominated as one of 15 national biodiversity "hotspots" by the Federal Minister for the Environment and Heritage.

The Pilbara Bioregion is also listed as a high priority for funding for land purchase under the National Reserves System Co-operative Programme due to the limited representation of the area in conservation reserves. Portions of various pastoral leases in the region have been nominated for exclusion for public purposes in 2015, when the leases come up for renewal (Sections 3.4). Many of the nominating submissions are from CALM, with the intention of adding these areas to the existing conservation estate in order to provide a more comprehensive, adequate and representative reserve system.

The pastoral stations within FMG's Project area that have areas nominated for future conservation purposes are Mulga Downs, Hillside, Marillana and Roy Hill Stations. These areas have been identified for exclusion to protect the highly significant Fortescue Marsh, which is listed as a 'Nationally Important Wetland (DEH, 2004), based on the following criteria:

- It is a good example of a wetland type occurring within a biogeographic region in Australia;
- It is a wetland which plays an important ecological or hydrological role in the natural functioning of a major wetland system/complex;
- It is a wetland which is important as the habitat for animal taxa at a vulnerable stage in their life cycles, or provides a refuge when adverse conditions such as drought prevail; and
- The wetland is of outstanding historical or cultural significance.

Fortescue Marsh is also listed as an 'Indicative Place' on the Register of the National Estate (natural heritage) due to its importance for conservation of waterbirds.

The potential impacts of FMG's Project on future conservation areas are discussed in Section 6.13.

4.5.2 Flora and Vegetation

4.5.2.1 Regional Vegetation Communities

Beard (1975) mapped the vegetation of the Pilbara at a scale of 1:1,000,000. The Project area occurs within the Fortescue Botanical District of the Eremaean Botanical Province as defined by Beard. The vegetation of this province is typically open, and frequently dominated by spinifex, wattles and occasional eucalypts.

According to Beard's (1975) mapping, vegetation along the proposed east-west rail line is predominantly sparse low Mulga woodland discontinuous in scattered groups, with Coolibah (*Eucalyptus victrix*) trees scattered over various sedges and forbs near Mt Lewin. Where the rail spur terminates near Mt Nicholas, there are hummock grasslands, shrub steppe with *Eucalyptus gamophylla* over hard spinifex.

Vegetation at Christmas Creek is a mosaic of low woodland with Mulga in valleys and hummock grasslands, low open tree steppe with snappy gum (*Eucalyptus leucophloia*) over *Triodia wiseana*, and kanji (*Acacia pyrifolia*) over soft spinifex and *Triodia wiseana* hummock grasslands. Mt Lewin and Mt Nicholas are characterised by low Mulga woodland and shrub steppe with kanji over soft spinifex and *Triodia wiseana* hummock grasslands.

Mindy Mindy is characterised by low tree steppe with snappy gum over *Triodia wiseana* hummock grasslands.

4.5.2.2 Vegetation Types of the Project Area

Flora and vegetation assessments of the Project area were undertaken by Biota Environmental Sciences (2004a) (Appendix J) and the results are summarised below.

A total of 80 broad vegetation types were defined for the survey areas, each comprised of a wide range of structural and floristic variants. The broad units included:

- hummock grasslands of *Triodia* species with a variable shrub overstorey on low stony hills of the Chichester and Hamersley Ranges;
- tall shrublands of *Acacia* species, usually with an overstorey of *Corymbia*, in creeklines;
- open woodlands of Coolibah *Eucalyptus victrix* over tall shrublands of *Acacia* or *Melaleuca* spp. on river banks and beds;
- Mulga (*Acacia aneura* and associated taxa) woodlands and tall shrublands over spinifex or various grasses on the plains of the Fortescue Valley; and
- varied vegetation on cracking clays of the Fortescue Valley (ranging from tussock grasslands to herblands).

Maps of the distribution of these vegetation types and descriptions of the vegetation types are provided in Appendix J.

Of key interest are those vegetation communities which are dependent on groundwater for survival. These species are recognised as "phreatophytes" as they are dependent on the water directly available from the surface of the water table. Impacts on phreatophytic vegetation as a result of groundwater drawdown may include replacement of groundwater dependant vegetation with other community assemblages, loss of vegetation condition, particularly during drought periods or under heavy grazing pressure, or vegetation deaths.

Along the creeks there is the potential for phreatophytic vegetation woodland communities, including those containing River Red Gums *Eucalyptus camaldulensis*; Cadjeput *Melaleuca argentea*; and Coolibahs *Eucalyptus victrix*, which may act as a phreatophyte along creek systems. FMG assessed vegetation types within the cones of groundwater depression predicted to result from mine dewatering and borefield abstraction, using a combination of vegetation mapping by Biota and the Pilbara Rangelands Project Rangeland Mapping (Payne *et al*., 2002). Biota (2004f) conducted a review of these vegetation types and the groundwater drawdowns predicted for the Project and found the risks to such vegetation from groundwater drawdown to be low.

Refer to Sections 6.2.3 and 6.3 for further information on phreatophytic vegetation.

Vegetation of Conservation Significance

Biota (2004a) conducted an assessment of vegetation conservation significance using the following information:

- the Land Systems present within the study area, including their distribution through the Pilbara and area of extent;
- the vegetation types defined, including their area and frequency of occurrence within the study area, capacity to support rare or restricted flora, and condition (health); and
- the floristic groups identified by a floristic analysis (using statistical analysis software) within each vegetation type, to indicate the probable distribution of the vegetation units outside the study area.

Through this assessment, the following vegetation types of conservation significance were identified:

- Vegetation type Fa10 was considered to be of Very High conservation significance. This unit occurred between Mt Lewin and Mt Nicholas and comprised Mulga dominated vegetation of seasonally-wet broad drainage areas, which is an uncommon habitat in the area. It was strongly associated with the Washplain Land System, which has a restricted distribution in the Pilbara, with the study area being located at the northern edge of this range. This vegetation was in excellent condition, and is considered likely to support flora species of restricted distribution in the region.
- Seven vegetation types of High conservation significance were identified (Fa1, Fa13, Fa18, Fa19, Fa20, Fa25 and Fa27). These were all Mulga-dominated vegetation types that occurred mainly on restricted Land Systems (particularly Washplain and Jamindie). These vegetation types were also in very good condition, and considered likely to support restricted flora taxa.

Refer to Appendix J for a more detailed discussion on the conservation significance of each vegetation type. Potential impacts on these vegetation types are considered in Section 6.3.

4.5.2.3 Mulga Communities

The term 'Mulga' can be used to refer to the arid zone tree or large shrub *Acacia aneura* and its variants, or the vegetation communities where Mulga is the dominant overstorey species. Variation amongst Mulga occurs both within and between populations and often results in a very complex mosaic of mixed Mulga populations. The paper by Miller *et al.* (2002) goes into further detail on the possible genetic and biological factors responsible for this variation.

On hardpan plains Mulga can form groves across the direction of the slope with groves forming in areas of water run-on and intergroves forming in areas of water run-off. The groves trap surface water sheetflow and leaf litter, which in turn creates a more hospitable environment for seed germination and seedling establishment (Burnside *et al.*, 1995). These groves tend to have higher plant and animal diversity and accumulate higher levels of organic carbon and nitrogen than the intergroves (Tongway and Ludwig, 1990). Shading of the soil by established trees will also reduce soil temperatures during the hot summer months and reduce evaporation of moisture from the soil and leaf transpiration. Mulga can aestivate (remain dormant) when drought occurs and resume growth four days after water becomes available (Miller, *et al.*, 2002).

Land Systems containing Mulga communities in the Pilbara ranges are well defined by the Pilbara Ranges Project Rangeland Survey (Payne *et al.*, 2002). Collectively, Mulga in the vicinity of the Chichester Ranges represents the northern limit of Mulga in Western Australia. However, it should be recognised that approximately 121,145 ha of land systems containing Mulga communities exist north of FMG's Project area. These land systems are mapped as the Jamindie, Jurrawarrina, Laterite, Pindering, Spearhole, Warri and Washplain land systems (Payne *et al.*, 2002).

Potential impacts on Mulga from the Project and proposed management strategies are discussed in Section 6.3.1. Further analysis of the Mulga communities within the Project area are presented in Biota's report (Appendix J).

4.5.2.4 Terrestrial Flora

A total of 599 taxa of native vascular flora from 181 genera belonging to 54 families were recorded from the survey areas (see Appendix J). In addition, 13 introduced flora species (see Section 4.5.2.5). The families with the greatest number of taxa within the survey area were generally those that are predominant in the vegetation of the eastern Pilbara. The best represented families were:

- Poaceae (grass family) – 88 species
- Malvaceae (Hibiscus family) - 68 species
- Mimosaceae (wattle family) – 58 species
- Papilionaceae (pea family) – 46 species
- Amaranthaceae (mulla-mulla family) – 31 species
- Asteraceae (daisy family) – 31 species
- Caesalpiniaceae (Cassia family) – 30 species
- Chenopodiaceae (saltbush, bluebush family) – 25 species
- Euphorbiaceae (spurge family) – 20 species
- Goodeniaceae (fan-flower family) – 18 species

Some of the families (eg. the Amaranthaceae, Malvaceae and Poaceae) are more species rich in the Northern and Eremaean floras and poorer in the Southern flora, while others, such as the Mimosaceae, are abundant in all three. In contrast to the families that have many representatives, 16 families and 95 genera recorded during the survey were represented by only one taxon.

Flora of Conservation Significance

While all native flora are protected under the *Wildlife Conservation Act 1950-1979*, some species are assigned an additional level of conservation significance based on the number of known populations and the perceived threats to these populations (Table 3). Species of the highest conservation significance are designated Declared Rare Flora (DRF) (either extant or presumed extinct). Species that appear to be rare or threatened, but for which there is insufficient data to properly evaluate their conservation significance, are assigned to one of four Priority flora categories.

Table 3. Categories of Conservation Significance for Flora Species (Atkins 2004).

Declared Rare Flora - Extant Taxa. Taxa that have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction or otherwise in need of special protection.
Declared Rare Flora - Presumed Extinct. Taxa which have not been collected, or otherwise verified, over the past 50 years despite thorough searching, or of which all known wild populations have been destroyed more recently.
Priority 1 - Poorly Known Taxa. Taxa which are known from one or a few (generally <5) populations which are under threat.
Priority 2 - Poorly Known Taxa. Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under threat.
Priority 3 - Poorly Known Taxa. Taxa which are known from several populations, at least some of which are not believed to be under threat.
Priority 4 - Rare Taxa. Taxa which are considered to have been adequately surveyed and which whilst being rare, are not currently threatened by any identifiable factors.

In addition, some flora species are listed as triggers for Federal referral under the *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act 1999)*. In the

Pilbara, only the two DRF species (*Lepidium catapycnon* and *Thryptomene wittweri*) are currently listed under the *EPBC Act 1999*.

A search of CALM's Threatened (Declared Rare) and Priority Flora database and the Western Australian Herbarium Specimen database was commissioned for the area bounded by 20°00' - 23°00'S and 118°00' - 121°00'E. This search yielded 275 location records of 68 taxa. The search was of a very large area and only five records (of five taxa) were actually within 10 km of the proposed FMG Stage B rail corridor and mine areas (Appendix J):

- The DRF Hamersley Lepidium *Lepidium catapycnon* has been recorded approximately 7 km southeast of the Mindy Mindy mine area;
- *Eremophila spongiocarpa* ms. (Priority 1) has been recorded from the Fortescue Marsh west of the rail corridor. This species would not be expected to occur in habitats present within the Project area;
- *Helichrysum oligochaetum* (Priority 1) has been recorded from alluvial clayey plains habitat south of the rail corridor;
- *Myriocephalus scalpellus* (Priority 1) has been recorded from clayey plains habitat east of Mt Nicholas; and
- *Stylidium weeliwolli* (Priority 2) has been recorded along Weeli Creek, approximately 10 km north of the Mindy Mindy mine area. This species would not be expected to occur within the minor drainage lines in the Project area.

Significant Flora Recorded from the Project Area

No DRF species were recorded during the field survey of FMG's Stage B rail corridor and none would be expected to occur in the habitats present along the proposed rail corridor. Although the stony hills within the Mindy Mindy Project area would comprise suitable habitat for *Lepidium catapycnon*, this species has not been recorded from the 31 sites assessed in the area. There are thus no flora species of significance known from the Stage B rail corridor or mine areas that are listed under the *EPBC Act 1999*.

Plate 2. *Abutilon trudgenii* ms. (Priority 3)

Six Priority flora were recorded during the survey of the FMG rail corridor and mine areas. These comprise:

- *Eremophila pilosa* (Priority 1);
- *Abutilon trudgenii* ms. (Priority 3);

- *Goodenia nuda* (Priority 3);
- *Hibiscus brachysiphonius* (Priority 3);
- *Sida* sp. Wittenoom (W.R. Barker 1962) (Priority 3); and
- *Themeda* sp. Hamersley Station (M.E.Trudgen 11431) (Priority 3).

With the exception of *Eremophila pilosa*, all of the Priority flora species recorded from the FMG Stage B rail corridor and mine areas have also been recorded during the Hope Downs rail corridor surveys (Biota and Trudgen, 2002; Biota, 2004b and c) and/or FMG Stage A rail corridor survey (Biota 2004a). A more complete account of the regional distribution and status of these species is provided in Appendix J. The locations of these Priority flora populations are shown on Figure 20 and these will receive further consideration as part of project design and management (see Section 6.3.8).

In addition to formally listed DRF and Priority Flora, several other flora species of note were recorded from the FMG rail corridor. These are species that are poorly known, could not be identified to species level or are range extensions. An account of these species is presented in Appendix J.

4.5.2.5 Introduced Flora

Thirteen species of introduced flora were recorded from the Project area (Appendix J). None of these are listed as a Declared Plant for the Pilbara under the *Agriculture and Related Resources Protection Act 1979*. The 13 weed species recorded are largely common and widespread species of the Pilbara region:

- Ruby dock **Acetosa vesicaria;*
- Kapok **Aerva javanica;*
- Mexican poppy **Argemone ochroleuca* subsp. *Ochroleuca;*
- Beggar's ticks **Bidens bipinnate;*
- Buffel grass **Cenchrus ciliaris*;
- Birdwood grass **C. setigerus;*
- Feathertop Rhodes grass or Windmill grass **Chloris virgata;*
- The cucurbid **Citrullus colocynthis*;
- Awnless Barnyard Grass **Echinochloa colona* ;
- Spiked Malvastrum **Malvastrum americanum;*
- Whorled pigeon grass **Setaria verticillate;*
- Indian weed **Sigesbeckia orientalis and;*
- Common sowthistle **Sonchus oleraceus;*

Mesic habitats such as creek lines are particularly susceptible to weed invasion, and the majority of sites with significant weed invasion (both in terms of numbers of species and in the degree of cover) were located in such habitats. Mulga groving is also susceptible to ingress by weeds; groves within the study area frequently contained Beggars Ticks and Spiked Malvastrum, with the former sometimes at high densities.

Management of weeds within the proposed mining areas is discussed in Section 6.3.4.

4.5.3 Terrestrial Fauna

A fauna survey of the proposed Stage B rail corridor and the Mt Lewin, Mt Nicholas and Christmas Creek mine areas was undertaken by Biota in June-July 2004 (Appendix K). Fauna survey work of the Mindy Mindy mine areas was previously completed in March-April 2004 as part of the systematic survey work conducted for FMG's Stage A rail corridor (Biota 2004d), with the results considered in this document. The results of the fauna surveys are summarised below and presented in detail in Appendix K.

4.5.3.1 Fauna Habitats

Fauna habitat description is intended as a guide to the type and distribution of habitats generally recognised as occurring in a region. This provides a mechanism by which to describe the potential occurrence and predicted distribution of fauna species within the Project area. The units address the requirements of a broad range of vertebrate species that are responding to different elements of their environment. However it must be recognised that the habitat requirements of many species are not well understood and should be interpreted with caution. Fauna habitats are considered here in the context of vegetation types, landforms and soils.

The proposed FMG Stage B rail corridor and mine areas will affect three physiographic regions as defined by Beard (1975) (Section 4.5.1). Within these regions, the substrate of each fauna trapping site was described in terms of the major rock type and/or soil derived from rock. The data used to determine rock type and soils at each fauna site were digitised 1:500,000 and 1:250,000 geological coverage (Hickman and Lipple, 1978; Hickman and Gibson, 1982; GSWA, 1997; Thorne and Tyler, 1996). This coverage was intersected with the coordinates for the fauna survey sites. A geological description of the substrate at each fauna site was derived from both mapping scales, with each description field checked by reference to local features. This level of detailed description is provided in Biota (2004e) (Appendix K).

Significant Fauna Habitats

None of the habitat types within the FMG Stage B development areas appear to be unique or significant at the bioregion scale (cf. How *et al.*, 1991; Trudgen and Casson, 1998; Ecologia, 1998; Halpern Glick Maunsell and Biota 2000; Biota, 2002a). Several habitat types are significant on a local scale and support either apparently restricted suites of species or individual species that are, or may be, of regional significance. These include:

- Fortescue basin flats (Fortescue Marsh): Diverse clay based vegetation units and supporting an apparently restricted set of fauna;
- Cracking clay habitat units associated with the Chichester Range and foothills to the immediate north: Apparently restricted nature of several species occurring in these habitats; and
- Major drainage systems: Species rich and supporting a range of species not recorded from other habitats in the study corridor.

4.5.3.2 Fauna Recorded from the Project area

Herpetofauna

Forty-four species of herpetofauna (two frogs and 42 reptiles) were recorded from the proposed Stage B rail corridor and mine areas during the fauna surveys. The two frog species each represented a separate family: Hylidae (tree frogs; *Cyclorana mainii*) and Myobatrachidae (ground frogs; *Notaden nichollsi*). The reptiles comprised one freshwater tortoise (*Chelodina steindachneri*), eight species of gecko, six pygopodid species (legless lizards), five agamids (dragons), three varanids (monitor lizards), 14 skink species, four elapid snakes and a single blind snake species (*Ramphotyphlops ammodytes*) (see Appendix K). The capture rate for herpetofauna was relatively low due to the low ambient temperatures during the survey and it is likely that the assemblage is more diverse than suggested by the survey results. A comprehensive annotated list, including details of voucher specimens lodged with the WA Museum (WAM), is provided in Appendix K.

Plate 3. *Lophognathus longirostris*

Ground Mammals

The survey recorded 23 species of non-volant mammals, comprising one member of the family Tachyglossidae (echidnas), eight Dasyuridae (carnivorous marsupials), three Macropodidae (kangaroos and wallabies), five native and one introduced Muridae (murid rodents), two Equidae (horses and donkeys), one Camelidae (camels), one Felidae (cats) and one Canidae (dogs).

The Dasyuridae was the most species rich of the mammalian families with 29.2% of the total species richness and the second most numerically abundant (35 records or 20.1% of the total mammal records). One Dasyurid of conservation significance, the Mulgara *Dasycercus cristicauda* (Schedule 1; vulnerable), was recorded during the survey (Appendix K). No individuals were trapped, but the species' presence was confirmed from characteristic diggings, scats and tracks at the eastern end of the rail corridor where the sandier Divide Land System begins. The species has previously been recorded from the Abydos plain section of the FMG Stage A rail corridor (Biota, 2004d), in addition to other parts of the Hope Downs rail corridor (Biota, 2002b).

The survey also recorded three Priority 4 species including the infrequently captured Long-tailed Dunnart *Sminthopsis longicaudata,* the Short tailed Mouse *Leggadina lakedownensis* and the Western Pebble-Mound Mouse *Pseudomys chapmani.* A single specimen of the Long tailed Dunnart was collected from a stony *Triodia* hill slope on the last day of the trapping programme (Appendix K). This was the only new species added to the list of ground mammal taxa recorded during previous surveys completed in the locality (How *et al.*, 1991; Biota, 2002a, 2004d).

Bats

Nineteen species of bats occur in the Pilbara region and a summary of these species and their ecology is provided in Biota (2004d) (Appendix K) (compiled from the mammal database of the WAM; Churchill, 1998; McKenzie and Rolfe, 1996; Biota, 2001).

The bat species recorded during the fauna survey of the FMG Stage B rail corridor and mine areas were all recorded during earlier survey work along the Hope Downs rail corridor (Biota, 2002), FMG's Stage A rail corridor (Biota 2004d) or during other regional studies (e.g. McKenzie and Rolfe, 1996).

There are three bat species of conservation significance present in the Pilbara:

- Ghost Bat *Macroderma gigas* (CALM Priority 4);
- Orange Leaf-nosed Bat *Rhinonicteris aurantius* (Schedule 1); and
- Little Northwestern Freetail Bat *Mormopterus loriae* (CALM Priority 1; sometimes designated as subspecies *cobourgiana*).

The first two have previously been recorded in surveys near the FMG rail corridor, but no suitable habitat for *Rhinonicteris aurantius* was observed during the survey of the FMG Stage B development areas or those conducted previously for the proposed Hope Downs railway (Biota, 2002a). Recent survey work targeting *Rhinonicteris aurantius* in the Fortescue Basin did not record any specimens of this Schedule 1 species (K. Armstrong, *pers. comm.*). *Mormopterus loriae cobourgiana* is restricted to coastal habitats, particularly mangroves, and is not expected to occur in the development areas.

Avifauna

One hundred and five bird species were recorded during the surveys of the FMG Stage B rail corridor, mine sites and Mindy Mindy area (Appendix K), representing a total of 7,978 individuals. This total comprised 49 species of non-passerines and 56 species of passerines. The most species rich families were the Meliphagidae (Honeyeaters; 10 species), Accipitridae (Eagles; 9 species), Psittacidae (Parrots; 7 species), Acanthizidae (Thornbills and allies; 7 species), Falconidae (Falcons; 5 species) and Columbidae (Doves and pigeons; 5 species). Together these families accounted for 41% of the species recorded. The most abundant species were the Zebra Finch (2,190 individuals), Masked Woodswallow (420 individuals), Budgerigar (415 individuals), Variegated Fairy-wren (347 individuals), Singing Honeyeater (308 individuals) and Fork-tailed Swift (304 individuals) (see Appendix K). These six species accounted for almost 50% of all individuals recorded during the surveys.

The Peregrine Falcon *Falco peregrinus macropus* (Schedule 4) and the Australian Bustard (Priority 4) were the only avifauna of conservation significance recorded in the Project area.

Threatened Fauna

Native fauna species which are rare, threatened with extinction, or have high conservation value, are specially protected by law under the Western Australian *Wildlife Conservation Act 1950-1979.* In addition, many of these species are listed under the *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act 1999).* Extant species listed under the *EPBC Act 1999* may be classified as 'critically endangered', 'endangered', 'vulnerable' or 'conservation dependent'.

Migratory wader species are also protected under the *EPBC Act 1999.* This consists of those species identified under the following International Conventions:

- Japan-Australia Migratory Bird Agreement (JAMBA);
- China-Australia Migratory Bird Agreement (CAMBA); and
- Convention on the Conservation of Migratory Species of Wild Animals - (Bonn Convention).

Classification of rare and endangered fauna under the *Wildlife Conservation (Specially Protected Fauna) Notice 1998* recognises four distinct schedules of taxa:

- Schedule 1 taxa: Fauna which are rare or likely to become extinct and are declared to be fauna in need of special protection;
- Schedule 2 taxa: Fauna which are presumed to be extinct;

- Schedule 3 taxa: Birds which are subject to an agreement between the governments of Australia and Japan relating to the protection of migratory birds and birds in danger of extinction which are declared to be fauna in need of special protection; and
- Schedule 4 taxa: Fauna that are in need of special protection, other than for the reasons mentioned above.

In addition to the above classification, fauna are also recognised under four Priority levels:

- Priority One - Taxa with few, poorly known populations on threatened lands. Taxa which are known from few specimens or sight records from one or a few localities on lands not managed for conservation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
- Priority Two - Taxa with few, poorly known populations on conservation lands, or taxa with several, poorly known populations not on conservation lands. Taxa which are known from few specimens or sight records from one or a few localities on lands not under immediate threat of habitat destruction or degradation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
- Priority Three - Taxa with several, poorly known populations, some on conservation lands. Taxa which are known from few specimens or sight records from several localities, some of which are on lands not under immediate threat of habitat destruction or degradation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
- Priority Four - Taxa in need of monitoring. Taxa which are considered to have been adequately surveyed or for which sufficient knowledge is available and which are considered not currently threatened or in need of special protection, but could be if present circumstances change. These taxa are usually represented on conservation lands. Taxa which are declining significantly but are not yet threatened.

Threatened Fauna Species from the FMG Project area

Two species of Schedule fauna and four Priority listed species were recorded from the FMG Project areas during the current survey. Those threatened fauna species that were found to occur in the Project area are discussed below.

- Mulgara *Dasycercus cristicauda* (Schedule 1, 'vulnerable')

  The Mulgara is a medium sized (60-120 g) carnivorous marsupial occurring in suitable habitat across the arid zone of Western Australia. It is listed as Schedule 1 under the *Wildlife Conservation Notice 2003* and vulnerable under the *EPBC Act 1999* (a referral has been lodged under this legislation; see Section 3.1), and as

Schedule 1 under the *Wildlife Conservation Notice 2003.* Evidence (burrows, diggings, scats and tracks) of Mulgaras was recorded from the eastern end of the rail corridor where the sandier Divide Land System begins (Appendix K). All records were from sandy substrates vegetated with *Triodia* spp (spinifex) with a sparse overstorey of low shrubs. The species apparently prefers mature spinifex associations on sandy substrates. Populations are thought to contract to core habitat areas during harsh years and have also been documented as undergoing rapid expansions in response to good conditions (Woolley, 1995; Pearson, 1991). Although a listed Threatened species, the Mulgara appears to be moderately common in the region. A targeted survey completed to the north-west of the current proposal area recorded over 1,000 individual signs of Mulgara activity from 29 localities across 145 km in a north-south direction, and 75 km in an east-west direction (Biota, 2002b). Some of these populations were extensive, with activity stretching for several kilometres in a number of directions.

- Peregrine Falcon *Falco peregrinus* (Schedule 4)

Recorded three times during the FMG Stage B Project areas survey, from a variety of habitats. The habitat of this species comprises cliffs along coasts, rivers and ranges and wooded water courses (Johnstone and Storr, 1998). Storr (1984) suggests that most Pilbara records have come from hilly country.

- Short-tailed Mouse *Leggadina lakedownensis* (Priority 4)

This species was recorded 11 times during the survey of the FMG Stage B Project area, mostly from Mulga woodland and cracking clay tussock grassland habitats. Data available to date suggest that the main habitat for this species on the mainland comprises areas of cracking clay. The species has been recorded more frequently in recent surveys and is apparently more widely distributed in the region than initial records indicated.

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

This species was recorded from 11 individuals on stony slopes in the Mindy Mindy mine area (typical habitat for the species). The only suitable habitat for this species in the balance of the Stage B Project area was represented by the low hills south of the southern flank of the Chichester Range paralleled by the proposed rail corridor, where the species is also likely to occur.

- Australian Bustard *Ardeotis australis* (Priority 4)

This species was recorded four times in the mine areas. The Australian Bustard occurs over much of Western Australia, with the exception of the more heavily wooded southern portions of the state (Johnstone and Storr, 1998). Its wider distribution includes eastern Australia and New Guinea. This species prefers open or lightly wooded grassland including Triodia sandplains (Johnstone and Storr, 1998) and is considered scarce to common depending on season and habitat. It has an omnivorous diet and occurs in a relatively broad range of habitats but appears to have some preference for grasshoppers and is often attracted to recently burnt areas (Marchant and Higgins, 1993). This species breeds from March to September and the eggs are laid on bare, preferably stony, ground (Johnstone and Storr, 1998). This species was frequently recorded in the FMG Stage B study area, with a total of 16 individuals being sighted within the rail corridor and a further five individuals sighted in the eastern mine areas. This species is probably nomadic in the study area but is likely to be present most of the time.

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

  This species inhabits rocky, rugged habitat from the Pilbara and adjacent upper Gascoyne region in the west, to the central Northern Territory and South Australia. Records have come from plateaus near breakaways and screes and rugged boulder strewn screes. Only two individuals have been recorded from the Pilbara, the first from the bank of Caves Reek (near Mt Brockman) adjacent to a rugged scree, and the second during the current survey from spinifex hummock grassland on a low stony hillslope.

The FMG rail corridor survey (and the earlier Hope Downs survey) recorded eight undescribed fauna taxa or anomalies. These are discussed in Appendix K.

4.5.4 Stygofauna

Stygofauna are obligate, groundwater dwelling fauna. They are typically strongly adapted for the subterranean environment, with features such as lack of pigment, elongated appendages and reduced or absent eyes. Many of these fauna have primitive features which link them to geological periods when the Pilbara was covered with rainforest. They are therefore regarded as 'relict' fauna which have survived in the aquifer over geological timeframes.

The University of Western Australia carried out an initial stygofauna sampling programme within the Project area in September 2004 on behalf of FMG (Appendix L). The objective of the survey was to determine if stygofauna were present in the groundwater areas that will be affected by mine dewatering and water supply. Eleven bores were sampled (Figure 21); however no stygofauna were recorded. Given the widespread occurrence of stygofauna throughout the Pilbara the lack of any stygofauna in the samples was unexpected. It is considered likely that the absence of stygofauna in the bores is due to the fact that most of the bores were relatively new and it typically takes several months before stygofauna colonise new bores.

Stygofauna are known to be present in a variety of rock types including Karst (limestones), fissured rock (e.g. granite) and porous rock (e.g. gravel alluvium) (Marmonier *et al.*, 1993). Within the mining areas the Nammuldi Member of the Marra Mamba Iron Formation and gravel deposits in the alluvium formations found at Christmas Creek, Mt Nicholas, Mt Lewin and Mindy Mindy are expected to host stygofauna. In the proposed water supply borefield and predicted zone of impact, stygofauna habitats would be likely to occur in gravels within the alluviums of the Nammuldi Member (where mineralised and vuggy).

The study of stygofauna taxonomy and ecology is relatively recent, and as such identification to species level is not always possible, and the conservation status of numerous forms are unknown. The proposed Subterranean Fauna Management Plan, to be implemented prior to commencement of pit dewatering and borefield operation, is discussed in Section 6.5 and presented in Appendix M.

4.6 SOCIAL AND ECONOMIC ENVIRONMENT

The social setting within which the Project will be developed is described in Environmental Resources Management (2004) (Appendix H), and is summarised below.

4.6.1 Demographics

The estimated resident population of the Pilbara region was 39,676 in 2001 which is around 2% of the State's population. The vast majority of Pilbara residents are located in the western third of the region, which includes the towns of Port Hedland/South Hedland, Karratha, Newman, Tom Price, Paraburdoo, Roebourne, Wickham, Dampier, Onslow and Marble Bar. The eastern portion of the region is largely desert, and home to a small number of indigenous people.

Port Hedland/South Hedland is one of the largest towns in the Pilbara region and is a focus for major resources development in the region. Table 4 shows the key population characteristics for Western Australia, the Pilbara region and townsites relevant to this Project. The key conclusions to be drawn from Table 4 include:

- Port Hedland/South Hedland is the main centre of population in the region;
- The local communities adjacent to the Project have a higher proportion of males than females in the workforce compared with the State average. This is common in the Pilbara and reflects the gender distribution of resource-oriented employment in the region;
- Age profiles for the local communities generally reflect the State average with the exception that there are significantly less people aged over 65 years and significantly more under the age of 15 years and the median age is lower in Port Hedland and Newman;

- There is a significantly higher proportion of indigenous people living in Port Hedland and Newman than the State average; and
- Household sizes are significantly larger in Port Hedland and Newman than elsewhere in the State.

Table 4. Population characteristics of Western Australia, Pilbara and Local Communities, 2001

Characteristic	**State of W.A**	**Pilbara Region**	**Combined LGAs [1]**	**Port Hedland[2]**	**Newman[3]**
Total Population	1,851,252	39,676	19,855	13,099	3,535
Total Males (%)	50%	56%	57%	55%	54%
Total Females (%)	50%	44%	43%	45%	46%
Mean Household Size	2.6	2.9	3	3.6	3.4
Age Characteristics					
% Pop. aged < 15 yrs	21%	24%	24%	25%	28%
% Pop. aged > 15 yrs	79%	76%	76%	75%	72%
% Pop. aged > 65 yrs	11%	5%	4%	4%	3%
Median Age	34	31	32	30	30
Indigenous Population					
Total number	58,496	5,736	3,418	1,829	165
% of total population	3%	13%	17%	14%	5%

Source: ABS Basic Community Profiles, 2001

Notes:
1. Includes the combined Local Government areas (LGAs) for Port Hedland and Shire of East Pilbara.
2. Represents the Urban Centre Locality of Port Hedland as defined in the ABS Basic Community Profiles, 2001.
3. Represents the Urban Centre Locality of Newman as defined in the ABS Basic Community Profiles, 2001.

Population in the Pilbara decreased during the early to mid 1990s before stabilising in the mid to late 1990s during a period of resource investment. The population declined again as world demand for resources slowed in the wake of the Asian financial crisis. Census data for 2001 does not clearly show to what extent the current investment cycle has reversed the decline in resident population.

Table 5 shows population change between 1996 and 2001. In this time the population of regional Western Australia grew by 1.1% and the State population grew by 1.4%. During this period it is apparent that the population of Newman declined in response to BHPBIO's restructuring of their Pilbara operations. By 2001, the Shire of East Pilbara had lost 33.6%

of its 1991 population. FMG acknowledge that these figures have significantly increased in the past 12 months due to industry demand and are aware of the additional pressure on infrastructure and housing. FMG is working with the Pilbara Development Commission's Central Pilbara Co-ordinating Taskforce to address these issues in consultation with other industry members and government departments.

The population of Port Hedland decreased 0.1% from 1996 to 2001 and the population of East Pilbara decreased 14.6% from 1996 to 2001.

Table 5. Population Change between 1996 and 2001

Locality	1996	2001	% Change 1996 – 2001
East Pilbara (SLA)[1]	7,945	6,786	-14.6%
Port Hedland (SLA)[1]	13,116	13,099	-0.1%
Pilbara Region	44,798	42,747	-4.5%
Perth Metropolitan SD[2]	1,244,320	1,339,993	7.7%
Western Australia	1,726,095	1,851,252	7.3%

Source: ABS Census of Population & Housing, Basic Community Profile (Table B01), 1996 & 2001
Notes: 1. SLA – Statistical Local Area 2. SD – Statistical Division

4.6.2 Regional Development

Development within the Pilbara was driven by the discovery of vast deposits of iron ore in the region. Large-scale mining commenced in the 1960's, and to cater for this, a number of small company-owned mining towns were established in the Pilbara, including Dampier, Tom Price, Paraburdoo, Port Hedland, Newman, Wickham, Pannawonica, Goldsworthy and Shay Gap (now closed). These towns provided logistical support and living quarters for the miners, and were heavily dependent on the mining industry to sustain them. (In 1981 responsibility for the townsite of Newman was handed over from BHPBIO to the Shire of East Pilbara.)

In the 1970's and 1980's, discoveries of oil and natural gas were also made off the Pilbara coastline in the seas around Australia's North West Shelf. Development of these oil and gas resources caused the Pilbara's economy and population to grow dramatically.

Resource projects are the main economic and employment generators in the region. In 2001, nearly a quarter of Pilbara employment was in the mining sector. Resource projects naturally impact on the social profile and communities of the towns that support them. The cyclical nature of many of these resources projects (i.e. peak workforce during construction phase, and a much smaller workforce during operations) tends to lead to a corresponding fluctuating economy and transient population for the small towns that service these projects.

Further, many of these operations use a fly in-fly out (FIFO) regime from Perth which is not considered by the Pilbara Area Consultative Committee to benefit the towns in the region, and are of concern to the Pilbara Development Commission and some local governments. FIFO operations are associated with adverse social impacts on both the workers and their families such as alcoholism, depression, and stress (Environmental Resources Management, 2004; Appendix H).

4.6.3 Amenity, Cultural Assets

The region's main towns contain basic cultural and recreational facilities, and residents have access to a range of sporting and recreational activities that are supported by local, regional and state agencies. The region is culturally and environmentally diverse, and is well known for its heritage assets. There are a variety of natural attractions in the region, including the Karijini and Millstream/Chichester National Parks and the Dampier Archipelago.

4.6.4 Native Title

The Stage B Project area impacts upon the Nyiyaparli (WC99/4-proposed east-west railway spur and Mt Nicholas, Mt Lewin, Christmas Creek and Mindy Mindy mines), Palyku (WC99/16-east-west railway spur and Christmas Creek mine) and Martu Idja Banyjima (WC98/62-east-west railway spur) native title claims (from east to west). All of these native title claims are currently registered under the *Native Title Act 1993*. The native title claims collectively represent the Aboriginal Traditional Owners of the land over which FMG is proposing to construct the proposed east-west railway spur and mines.

FMG has signed Protocols with all of the above native title claimant groups and their Representative Body, the Pilbara Native Title Service (PNTS). The PNTS is a service division of the Yamatji Marlpa Barna Baba Maaja Aboriginal Corporation Inc, the Native Title Representative Body under the *Native Title Act 1993* for the Pilbara region. The Protocols have established the procedure by which Aboriginal heritage surveys and native title negotiations are being conducted between FMG, the affected native title claimant groups and the PNTS.

Information provided by PNTS is presented in Appendix I.

4.7 ABORIGINAL AND EUROPEAN HERITAGE

4.7.1 Aboriginal Heritage

The Chichester Range, the Fortescue Plain and the Hamersley Plateau lie within the Australian arid zone. A great deal of archaeological research has focused on the Australian arid and semi-arid zones in an attempt to determine the nature and timing of Aboriginal occupation of the area.

Today the arid zone covers some 4,600,000 km², or 60% of Australia. Its extent and severity have changed over the past 50,000 years or so, in response to climatic fluctuations, particularly during the height of the last glaciation at about 18,000 years Before Present (BP). Until about 15 years ago, archaeological evidence suggested a terminal Pleistocene-early Holocene date of 10,000 to 12,000 years ago for the settlement of the arid zone. However, recent excavations of rock shelters in the region have produced Pleistocene dates ranging from 18,000 BP to 26,000 BP and have consequently revealed that the initial (Pleistocene) Aboriginal occupation of the arid zone occurred at around 26,000 to 22,000 years BP at a time of increasingly dry climate which reached its nadir at around 18,000 BP. The increased aridity during the last glaciation caused reductions in the availability of water and food resources, which forced the abandonment of many arid areas until conditions improved in the mid-Holocene.

The development of settlement/subsistence models of the region by archaeologists suggest that the archaeological signature of semi-arid and arid regions would be characterised by:

- many small sites associated with ephemeral water sources;
- a smaller number of larger sites, adjacent to more permanent water; and
- special purpose, task specific sites, such as stone quarries, located where conditions permit, such as around outcrops of siliceous stone.

During the mid to late Holocene, a number of indicators of Aboriginal intensification have been identified by archaeologists. These include increased site usage, an increased rate of site establishment, the use of marginal environments, the introduction of new tools types, specialised seed grinding and water procurement, storage and conservation techniques, increased complexity of exchange programs and increasingly complex social and ceremonial organisation.

The Abydos Plain to the north of the Chichester Range contains an abundance of rock engravings. The valleys of the Chichester Range itself also contain rock engravings. Similar engravings are found elsewhere in the Pilbara notably on the Burrup Peninsula adjacent to the towns of Dampier and Karratha.

4.7.1.1 Aboriginal Mythology

All engravings, particularly those of human figures, as well as other designs are of current significance to the Aboriginal Traditional Owners, who believe that they represent the physical manifestations of the ancestral beings that roamed the earth before humans occupied the land.

There are natural features within the Chichester Range, the Fortescue Plain and the Hamersley Plateau such as the Fortescue Marsh, hills such as Mt Lewin, creeks, springs, claypans, rock holes and rock shelters which the Aboriginal Traditional Owners believe are also the physical manifestations of the ancestral beings. Stories and songs are told today about the travels and exploits of the ancestral beings along the Dreaming Tracks which represent the pathways travelled in the Dreaming.

4.7.1.2 European Impact

The Aboriginal Traditional Owners lived in relative isolation until European settlers took up pastoral leases in the region in the late 1900s. Pastoralists displaced and indentured Aboriginal people as seasonal labourers. Aboriginal men were employed as shepherds and station workers and women were engaged as 'domestics' at station homesteads. They received food and provisions in return for their services. Notwithstanding this impact, the Aboriginal Traditional Owners maintained their connection to country through ritual and hunting and gathering activities.

Ration camps were established by the Government around the turn of the century, in order to care for those Aboriginal people who were not in the employ of the stations. Increasingly poor conditions on the stations resulted in a series of strikes by the Aboriginal workers in the 1940s. The movement known as 'the Strike' was led by Aboriginal people mainly in the Port Hedland and Marble Bar areas.

The downturn in wool prices coupled with increased costs and land degradation resulted in the displacement of many Aboriginal people from the pastoral stations in the 1950s and 1960s. The Government introduced assimilation policies at this time. Many of the Aboriginal Traditional Owners moved off the stations, some forcibly, into the towns of Port Hedland, Marble Bar and Nullagine where they lived in camps and reserves on the outskirts of the towns. The Aboriginal Traditional Owners continued to maintain their connection to country through these difficult times.

Conditions in the camps and on the reserves were poor, with people living under sheets of corrugated iron. The Aboriginal Traditional Owners had limited employment opportunities. Despite the hardships, the sense of community remained strong. Mining was established in the region in the 1950s and 1960s, with gold, tin and asbestos being exploited. Many of the Aboriginal Traditional Owners worked 'yandeeying' tin in order to survive.

Prior to the advent of the *Native Title Act 1993,* the involvement of Aboriginal people in the protection of their cultural heritage in the region was minimal. Consultation with Aboriginal people was not an essential prerequisite for compliance with the *Aboriginal Heritage Act 1972,* and their involvement was a matter of negotiation. However, since native title claims were lodged post 1994, the Aboriginal Traditional Owners have been able to demand their right to be involved in the management and protection of their cultural heritage and to seek compensation for any loss of their native title rights and interests.

4.7.1.3 Aboriginal Heritage Surveys

Aboriginal heritage surveys (ethnographic and archaeological) of the proposed mines and east-west railway spur are being conducted with the affected native title claimant groups to ensure consultation with and the participation of the relevant Aboriginal Traditional Owners. These surveys include the use of archival research; a formal field survey for Aboriginal ethnographic and archaeological sites as well as consultation with the Aboriginal Traditional Owners as representatives of the affected native title claimant groups.

Aboriginal heritage surveys of the proposed and current exploration programme commenced in September 2003 and are ongoing. All surveys will be completed prior to the construction of the Project.

On the basis of previous Aboriginal ethnographic and archaeological surveys conducted in the region and consultation with the Aboriginal Traditional Owners, a number of different types of Aboriginal sites are expected to be encountered. Definitions of these sites are as follows:

> Artefact scatter refers to a location where a range of activities have occurred such as the manufacture and maintenance of tools and the processing of foods. Such sites will often contain a wider range of lithic materials than quarries and knapping floors;
>
> Ceremonial refers to a location where the Aboriginal Traditional Owners have practiced and/or continue to practice ceremonial activities;
>
> Gnamma hole/water source refers to a natural or artificial rock cavity, which holds water after rain or is linked to the water table;
>
> Grinding patches refers to patches of smoothed rock of varying size. In the Pilbara region these are believed to be seed grinding patches, elsewhere though they are linked to ceremonial practices. Grinding patches are frequently associated with engraving sites throughout the Pilbara;
>
> Midden refers to a location usually on the coast or adjacent to a creek which contains the remains of shellfish and bone;
>
> Modified tree refers to a tree, which has trunks and/or limbs that have been modified by the removal of bark and/or wood. Aboriginal people removed (and continue to remove) wood and bark for material items such as shields and baskets or to access native honey inside hollows in the tree;
>
> Mythological refers to a location which may be a natural feature such as a hill or waterhole which has a name, story and/or song about a particular ancestral being(s)

known to the Aboriginal Traditional Owners and which is of current significance to them;

Quarry refers to a location from which stone used to manufacture flaked or ground stone artefacts has been extracted;

Reduction area (or knapping floor) refers to a cluster of stone artefacts, which represent the remains of an episode (or episodes) of stone artefact manufacture. Artefacts within a knapping floor can usually be conjoined back together; and

Rock art refers to art placed on a rock surface that may be created by additive (such as painting or drawing) or subtractive (such as abrading or engraving) processes.

It is a requirement of the professional anthropological and archaeological organisations (Anthropological Society of Western Australia Inc. the Australian Anthropological Society Inc. and the Australian Association of Consulting Archaeologists Inc.) that Aboriginal Traditional Owners participate in Aboriginal heritage surveys. This ensures that the views of the Aboriginal Traditional Owners concerning ethnographic and archaeological sites are adequately represented and recorded during the conduct of surveys. The Aboriginal Traditional Owners that have participated in surveys to date were previously chosen by their respective native title Working Groups at formal meetings.

To date, FMG has commissioned the PNTS to undertake the following Aboriginal heritage surveys with regard to the proposed mines and east-west railway spur:

1. Preliminary ethnographic survey (by helicopter) of the proposed mines and the southern portion of the east-west railway corridor (Chichester Range to the proposed Mindy Mindy mine and the Mt Nicholas mines);

2. A consultation meeting with senior Traditional Owners to define the spatial boundaries of the Mankarlyirrkurra ethnographic site complex; and

3. Specific work programme clearance surveys (ethnographic and archaeological) of the proposed Mt Nicholas, Mt Lewin, and Christmas Creek mines, exploration drilling and hydrological drilling areas at Mt Nicholas, Christmas Creek, Mt Lewin and Mindy Mindy and plus various campsites, access tracks and laydown areas. These surveys are ongoing.

The results of the preliminary ethnographic survey and the subsequent consultation meeting with senior Traditional Owners, has revealed that there are several ethnographic sites of significance to the Aboriginal Traditional Owners which FMG has agreed to avoid and protect. These significant sites include the Mankarlyirrkurra ethnographic site complex, Kunjapininyha (Mt Lewin itself) and Millimpirinyha (the Fortescue Marsh).

The results of the ongoing work programme clearance surveys have revealed that there are a number of ethno-archaeological sites (mainly stone artefact scatters) in the region which are presently being avoided during FMG's exploratory drilling program.

4.7.2 European Heritage

A review of the databases of the Australian Heritage Commission (AHC), Heritage Council of Western Australia (HCWA), National Trust and the East Pilbara Shire Municipal Inventory indicated there were no sites of European Heritage significance within or near FMG's Project area. The nearest places of interest are two sites that are listed on the Shire of East Pilbara's Municipal Inventory, as shown on the Heritage Council's webpage (www.heritage.wa.gov.au). These are the Roy Hill Homestead, which was used as a former post office, general store and directional beacon, and the concrete road bridge over the Fortescue River on Roy Hill Station designed in 1929. The homestead is approximately 8.4 km from the rail corridor at its closest point, and the concrete road bridge is approximately 11 km.

5. THE PROJECT

5.1 KEY CHARACTERISTICS

The following table identifies the key characteristics of the Stage B east-west railway and mines.

Table 6. Railway and Mines Key Characteristics

Project Component	Characteristic
Project Life	20 years+
Mining Areas	
Ore produced	45 Mtpa
Target grade	55-65% Fe
Mt Nicholas	
Estimated resource	390 Mt
Ore type	Marra Mamba
Method of mining	Strip mining, with progressive backfilling of open pit
Total area of disturbance over LOM	2,757 ha
Total area of rehabilitation over LOM	2,757 ha [1]
Average size of working open pit	700 m long x 1,300 m wide [2] (possibly two starter pits will be developed)
Average pit depth	60 m
Overburden produced	67 Mt deposited to three starter overburden stockpiles in first year (199 ha), after which overburden is used to progressively backfill strip mining operations.
Dewatering requirements	2,850 MLpa. Dewatering water pumped to Beneficiation Plant for use in process.
Processing requirements	Beneficiation
Mt Lewin	
Estimated resource	200 Mt
Ore type	Marra Mamba
Method of mining	Strip mining, with progressive backfilling of open pit
Total area of disturbance over LOM	1,775 ha
Total area of rehabilitation over LOM	1,775 ha [1]
Average size of working open pit	1,500 m long x 2,000 m wide
Average pit depth	50 m
Overburden	82 Mtpa deposited to a starter overburden stockpile in first 2 years (200 ha), after which used to progressively backfill strip mining operations.
Dewatering requirements	520 MLpa. Dewatering water pumped to Beneficiation Plant.
Processing requirements	Beneficiation and Direct Shipped Ore (DSO)

Project Component	**Characteristic**
Christmas Creek	
Estimated resource	1,000 Mt
Ore type	Marra Mamba
Method of mining	Strip mining, with progressive backfilling of open pit
Total area of disturbance over LOM	4,245 ha (Christmas Creek East) 4,100 ha (Christmas Creek West) 1,778 ha (Christmas Creek Central)
Total area of rehabilitation over LOM	10,123 ha [1]
Average size of working open pit	1,500 m long x 3,000 m wide [2]
Average pit depth	60 m
Overburden produced	112 Mtpa deposited to an overburden placement area in first 2 years (388 ha) after which used to progressively backfill strip mining operations.
Dewatering requirements	1,150 MLpa. Dewatering water pumped to Beneficiation Plant.
Processing requirements	Beneficiation and DSO
Mine Site Infrastructure	• Semi-mobile primary crusher • Overland conveyors, haul road and/or rail to Beneficiation Plant • Haul roads and access tracks • Secondary crushers, screening plant and Beneficiation Plant • Iron ore product stockpile and train loading facilities • Mobile plant and machinery workshop • Construction of 132 kV transmission line to Newman with capacity upgrade at Newman or • 45 MW power station (to be provided and maintained by an external supplier) • Bulk hydrocarbon storage facility • Explosive and detonator, ammonia nitrate storage and magazine • Accommodation and camp facilities • Administration and ancillary support facilities • Airstrip upgrade at Christmas Creek • Concrete batching plant (during construction) • 11 GLpa water supply from borefield, supplemented by mine dewatering.
Mt Nicholas, Mt Lewin, Christmas Creek Mine Sites	
Beneficiation Rejects at Christmas Creek	48 Mtpa rejects disposed of in the first 2 years to an above ground placement area located within the initial overburden placement areas, after which co-disposed in-pit with overburden.

Project Component	**Characteristic**
Mindy Mindy	
Estimated resource	68 Mt
Ore type	Channel Iron Deposit
Method of mining	Strip mining, with progressive backfilling of open pit, DSO
Total area of disturbance over LOM	852 ha
Total area of rehabilitation over LOM	852 ha [1]
Average size of working open pit	1,300 m long x 500 m wide
Average pit depth	40 m
Overburden produced	20 Mtpa deposited to an overburden placement area in first 2 years (200 ha) after which used to progressively backfill strip mining operations.
Dewatering requirements	Dewatering water used for dust suppression (~0.4 GLpa)
Processing requirements	None. DSO only
Mine Site Infrastructure	
Mindy Mindy Mine Site	• Crushing and screening plant • Sealed haul road or overland conveyor system from crushing/screening plant to rail loading facility • Administrative and maintenance hub • Iron ore product stockpiles and train loading facility • 4 MW power station (to be provided and maintained by an external supplier) or connection to 132 kV Newman-Yandi transmission line. • Mine dewatering pumps and pipeline • Airstrip upgrade at Mindy Mindy • Water for dust suppression from pit dewatering and potable water from dewatering or nearby alluvial deposits. • Accommodation village
Railway Infrastructure	• 160 km of rail track • Sidings, passing bays and loading loops • Train loader • Rail maintenance track • Temporary construction facilities
Area of railway disturbance [3]	1,600 ha
Railway operations	800 ha
Sewerage	Package treatment plant and/or septic systems
Personnel for mines and infrastructure	
Construction	800 personnel accommodated in on-site facilities
Operation	500 personnel accommodated in on-site facilities and/or local towns
Key:	
GL – gigalitres	*M – metre*
GLpa – gigalitres per annum	*Mm^3 – million cubic metres*
ha – hectare	*Mtpa – million tonnes per annum*
km – kilometre	*Mt – million tonnes*
MW – megawatts	

Notes: 1. If infrastructure such as roads are identified by relevant stakeholders as being required for post mining operations the rehabilitation figure may be lower.

2. At least two pits will be open at any one time.
3. Including railway construction corridor ~40m wide, access track, yards, temporary disturbance

Provided project approval is obtained, it is planned to commence construction of Stage B during the second half of 2005 with commissioning scheduled for the fourth quarter of 2006, consequently, the first shipment of iron ore is expected by the fourth quarter of 2006 or early first quarter 2007.

5.2 EVALUATION OF ALTERNATIVES

5.2.1 Railway Corridor Alignment

The proposed Stage B railway which runs east-west, links FMG's mine sites to the north-south Stage A railway at the Chichester Ranges. The alignment of the proposed Stage B railway is constrained by:

- the need to link to the Stage A railway;
- the location of the Fortescue Marsh floodplains to the south;
- the Chichester Ranges;
- the proposed mine sites described in this PER; and
- access to future mines which are part of FMG's 50 year plan.

FMG evaluated a number of alternative rail routes before the company arrived at the preferred route presented in this PER. For the alternative routes, an Environmental Risk Assessment was undertaken which included:

- A desktop study to determine the amount of Mulga and other significant vegetation types directly impacted by each alternative rail route (including samphire communities).
- Evaluation of potential water shadow effects on downstream vegetation as a result of the rail alternatives.
- Evaluation of the broader environmental impacts from each rail route including overall land disturbance, greenhouse gas emissions and hydrology impacts.

An Engineering Assessment of the alternative rail routes was undertaken using general design constraints related to topography, alignment of the rail route relative to streams and engineering design constraints which included:

- maximum grade loaded and empty;
- minimum horizontal radius; and
- cut and fill requirements.

An investigation of the alternative rail routes was also undertaken which considered:

- tenure constraints;
- cultural heritage issues;
- access to FMG resources and potential customers;
- efficient transport of resources (including rail spurs and conveyor options); and
- economics.

The above investigations resulted in the selection of the rail route proposed in this PER (route 2). A report describing the rail alternative evaluation process and results is included as Appendix E and is summarised below.

5.2.2 Access to Christmas Creek, Mt Lewin and Mt Nicholas

FMG has identified several possible routes from the north-south rail line to Mt Nicholas via Christmas Creek and Mt Lewin. In discussion with stakeholders (mainly CALM), other routes have been proposed and considered.

Seven possible routes to Mt Nicholas are described and compared in this section (refer to Figure 22). All routes start somewhere along the Stage A north-south line. Routes 1-6 are the same to the east of Christmas Creek. The routes are as follows:

1. A route running close to the northern shoreline of Fortescue Marsh, as much as possible in the samphire zone, below mulga communities. This route leaves the north-south line at the eastern deviation. It requires a 5 km spur line to Christmas Creek.

2. A route 5-10 km further to the north, just below the Chichester Range. This route also leaves the north-south line at the eastern deviation. The intention is for the final route alignment to be as high as possible in the landscape, just below "headlands" in the breakaway that runs along the Chichester Range.

3. A route that leaves the north-south rail line approximately 30 km north of the eastern deviation. This route meets the gently sloping sediments to the south of the Chichester Range towards the eastern end of proposed future mining areas.

4. A route that traverses higher ground and meets the sediments to the south of the Chichester Range to the northeast of Warrie Camp.

5. A route ~40 km north that joins the gently sloping sediments to the north of Warrie Camp.

6. A route ~40 km north that joins the gently sloping sediments within the Christmas Creek area, passing over some parts of the area to be mined.

7. A route south of the Fortescue Marsh from Mindy Mindy to Roy Hill, and on to Mt Nicholas, with a spur line to Mt Nicholas. All ore from Mt Nicholas, Mt Lewin and Christmas Creek would be transported south to Mindy Mindy, before the journey north to Port Hedland.

When assessing the rail alternatives FMG set out to balance the large number of issues and constraints. The final selection is a compromise between a number of factors.

It is important to realise the scale of the proposed Pilbara Iron Ore and Infrastructure Project. The length of the proposed rail infrastructure in Stage B alone is of the order of 160 km. Given that the purpose of rail infrastructure is to provide access, an efficient route must pass close to where access is needed. Otherwise a significant length of other linear infrastructure (rail spurs, conveyors and roads) may be required later to reach the primary route.

5.2.2.1 Issues

A number of issues influence the choice between different potential rail routes. These include:

- resource issues;
- land access issues;
- engineering and cost issues; and
- environmental issues.

Resource issues

There are a number of issues relating to mineral resources, including:

- the requirement for rail to provide access to FMG's iron ore resources;
- the need for rail to provide access to stranded resources held by other companies (e.g. Hancock Prospecting, near Christmas Creek, and Hope Downs, near Mindy Mindy); and
- the need for rail not to be too far from possible future mines (e.g. in the area west of Christmas Creek on the Chichester Range), to ensure efficient transport from mines to the rail line.

Land access issues

Access issues include:

- the nature of underlying tenure (i.e. pastoral leases);
- the requirement that FMG infrastructure should not interfere with BHPBIO's infrastructure;
- the need to negotiate access to mining tenements held by others;
- the need to negotiate access with traditional owners; and
- the need to avoid or minimise impact on cultural heritage sites.

Engineering and cost issues

The engineering design of rail lines is driven by:

- the need to reduce length[2];
- grade (i.e. slope) requirements, specifically a maximum of 0.33% for travel towards the coast (loaded) and 1.5% for travel inland (empty); and
- curvature of rail lines, to allow fully loaded trains to travel at the maximum possible speed, and to reduce maintenance requirements on wheel bearings.

Other engineering issues include:

- the need for suitable foundations from a geotechnical point of view;
- the need to balance cut and fill;
- the desire to source additional fill, if required, from borrow areas within areas that will or may be mined;
- the desirability of crossing creeks and streams higher in the landscape to reduce the size and number of culverts and bridges, and also to reduce potential impact on downstream flows; and
- the need to avoid the possibility of the rail line being flooded, or washed out.

It has been proposed that conveyors or haul roads be used to provide access to some areas, rather than rail. Conveyors and haul roads also have a footprint, and conveyors require a parallel access road.

The net effect of all requirements is reflected in the capital costs for construction, cycle time and operating costs.

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[2] Length is the primary determinant of capital costs, ground disturbance, fuel consumption, travel time, cycle time, greenhouse gas emissions and labour costs. Cycle time is the time taken for a round trip of a train, including loading of a train at the mine, travel (loaded) to the port, unloading and return travel (empty) to the mine.

Environmental issues

Key environmental issues include:

- proximity to Fortescue Marsh (from the point of view of avoiding flooding of the rail line and also minimising impact on the hydrological regime of the marsh);
- other hydrological issues, such as the impact of linear infrastructure on sheet flow;
- total disturbance of native vegetation;
- disturbance to different vegetation types, in the context of relative abundance of different rangelands classifications, and the condition of the vegetation (i.e. previous impacts of fire, weeds and grazing);
- the spatial distribution of mulga groves and species endemic to the samphire zone around the Fortescue Marsh;
- the occurrence of Declared and Rare Flora; and
- the need to minimise greenhouse gas emissions.

Noise, dust and decommissioning issues are relatively independent of the precise rail route. However noise and dust issues may be greater for conveyors and haul roads providing access to possible future mining areas.

5.2.2.2 Comparison of alternative rail routes

Total disturbance can be summarised as:

- Route 2 has the least total disturbance, especially taking into account the impact of conveyors (or other forms of access to potential future mines, such as haul roads); and
- Routes 3 to 6 through the Chichester Range result in significantly more total disturbance.

Hydrological issues can be summarised as:

- Route 1 would be significantly more difficult than others from a water management point of view. Being low in the landscape, the embankment required for Route 1 would impede throughflow and require bigger culverts;
- Route 2, requires the most management of sheet flow into Mulga groves (along 44 km of rail), however all the rail routes require varying degrees of sheet flow management. FMG believes that this can be managed as described in Section 6.1.4;
- Routes 3 to 6 that have a complete second crossing of the Chichester Range are likely to have greater impacts on drainage within the Range, and will certainly require many diversion channels and culverts in areas of cut and fill, respectively; and
- Route 7 would effectively dam the Fortescue River upstream of Fortescue Marsh.

Impact on vegetation types can be summarised as:

- Route 1 has the greatest impact on mulga communities;
- Route 1 impacts a mulga containing land system which is very small, with only six occurrences (the Cowra Land system);
- Route 1 impacts the Marsh land system which contains Fortescue Marsh samphires and species which are known to be restricted to this area;
- Route 2 has the second greatest impact on mulga communities in total and the greatest impact on groved mulga, but disturbs only 0.14% of the Jamindie land system and 0.2% of such communities within the Chichester Footslopes mulga vegetation unit defined within the FMG Stage B PER;
- Routes 3 to 7 all have impacts on mulga communities;
- Route 7 impacts two mulga containing land systems that are restricted to the region (the Fan and Marillana land systems);
- Routes 5 and 6 impact two particularly small non-mulga land systems which may support restricted vegetation (Black and White Springs land systems) and also impacts the River land system which is restricted to the region;
- Route 7 impacts two small non-mulga land systems which may have restricted vegetation within them (Adrian and Narbung). It also impacts the Coolibah land system which is restricted to the Fortescue River floodplains and the Urandy land system which is restricted to the southern edge of the Fortescue Plains;
- Route 6 impacts the Bonney land system which has isolated occurrences in the Pilbara and due to isolation of pockets impacted route 6, may support distinct vegetation; and
- All routes impact the Turee land system (restricted to the region) to a similar extent, although the final alignment of the rail can be designed to take into account the location of cracking clay vegetation within the corridor.

The importance of vegetation condition and grazing history can be summarised as:

- Routes 1 and 2 were affected by fires to the west of the Christmas Creek area in 1999 and 2000;
- Significant weed invasion was found by FMG during its detailed surveys of route 2 and the proposed mines;
- Route 6 passes through a part of Hillside Pastoral Lease that was affected by a large fire in 1997;
- The vegetation crossed by all routes north of the Fortescue Marsh (routes 1 – 6) has been subject to more fires in the last 10 years than that crossed by route 7 (south of the Marsh);
- The area crossed by route 7 is also reported to be subject to weed invasion;
- Routes crossing higher elevations (routes 3 – 6) are likely to be subject to less weed invasion and grazing pressure in the elevated areas due to inaccessibility – therefore these areas may be more pristine; and

- The lowlands around Fortescue Marsh and the foothills of the Chichester Range have been grazed for about 100 years.

Greenhouse gas emissions can be summarised as:

- Overall greenhouse gas emissions during the life of the rail infrastructure will be dominated by the length (and to a lesser extent curvature, alignment and elevation) of the rail line and conveyors;
- Route 7 would increase fuel use and greenhouse gas emissions by about 35%; and
- Use of haul roads to transport ore from possible future mining areas would cause an increase in emissions during the mining of future mines.

5.2.2.3 Preferred Rail Route

During the process of considering alternatives, FMG has taken into account environmental, engineering and economic issues, and will continue to do so.

Since length of line is the primary determinant of capital and operating costs, as well as land disturbance and greenhouse gas emissions, length becomes a key parameter in any comparison. Other key parameters include proximity to currently known and future resources.

Through the *Railway and Port (The Pilbara Infrastructure Pty Ltd) Agreement Act 2004*, FMG now has an obligation to provide open access to its rail infrastructure, and to provide infrastructure that will provide access to stranded resources in the area.

The route that maximises access to resources while minimising overall environmental impact is Route 2 which is FMG's preferred route.

Rail route 2 between the north-south line and Mt Nicholas will require clearing of 306 ha of mulga groves. When compared with the total area of mulga in the Chichester Range and footslopes, this is 0.2% of the total mulga in this area.

The benefits of rail route 2 are that it:

- provides best access to FMG's known and potential resources;
- provides best access to potential stranded resources held by other parties;
- provides greater likelihood that materials for embankment construction can be sourced from likely mine areas;
- has operating costs per tonne (fuel, labour, wear and tear etc., but excluding depreciation of capital costs) that are almost as low as any other option;
- has the lowest capital costs (such costs influencing the costs that will be charged by TPI to all parties accessing the rail line);

- has the least total disturbance;
- affects areas of mulga and mulga groves, but often obliquely, so that water management may not be as difficult;
- has been affected by multiple fires, weed infestation and grazing (and is therefore not pristine, which must be considered in determining conservation value); and
- has greenhouse gas emissions for transport from all areas along the Chichester Range that are as low as any other option.

Each of the other routes have disadvantages such as:

- Route 1 would require a large embankment that would impede flows and present risks to the Fortescue Marsh, affects the largest area of mulga and mulga groves, and is prohibitively expensive;
- Route 3 requires a second crossing of the Chichester Range (with more cut and fill, hydrological impacts and cultural heritage risks), does not provide optimal access to possible future mining areas (it would require conveyors and/or roads), has larger total disturbance than Route 2 and results in significant capital expenditure (CAPEX) and operating expenditure (OPEX) increases;
- Route 4 requires a long second crossing of the Chichester Range (with more cut and fill, hydrological impacts and cultural heritage risks), does not provide optimal access to possible future mining areas (it would require conveyors and/or roads), has larger total disturbance than Route 2, requires an additional locomotive to accelerate a train up the Chichester Range from Christmas Creek and results in significant CAPEX and OPEX increases;
- Route 5 requires a second crossing of the Chichester Range (with more cut and fill, hydrological impacts and cultural heritage risks), does not provide optimal access to possible future mining areas (it would require conveyors and/or roads), has larger total disturbance than Route 2, disturbs additional significant vegetation types, and requires an additional locomotive to accelerate a train up the Chichester Range from Christmas Creek. It also split the Hillside Pastoral Lease in two and would adversely affect stock movement along a stock route and results in significant CAPEX and OPEX increases;
- Route 6 requires a second crossing of the Chichester Range (with more cut and fill, hydrological impacts and cultural heritage risks), does not provide optimal access to possible future mining areas (it would require conveyors and/or roads), has larger total disturbance than Route 2, disturbs additional significant vegetation types, and requires an additional locomotive to accelerate a train up the Chichester Range from Christmas Creek. It also split the Hillside Pastoral Lease in two and results in significant CAPEX and OPEX increases;
- Route 7 would add 35% to fuel use and greenhouse gas emissions for most of the project life, does not provide optimal access to possible future mining areas (it would require conveyors and/or roads), and has larger total disturbance than Route 2 and

disturbs additional significant vegetation types. The route would be very expensive, as embankments would effectively dam the Fortescue River floodplain; and

- Route 2 provides the best balance between project and engineering requirements and environmental management requirements, consistent with the policy outlined in Position Statement No.7 of the Environmental Protection Authority (2004).

A final rail alignment is currently being designed which reduces direct impact on Mulga by ensuring the final alignment traverses through non-Mulga areas or areas of less dense (or scattered) Mulga wherever possible. A conceptual alignment which in particular would move south out of Mulga groving at Christmas Creek and avoid a significant Mulga community at Kondy Creek is shown conceptually in Figure 11. To reflect these refinements FMG has reduced the east-west corridor from 2 km to 800 m in width, (apart from in the crossing through the Chichester Ranges and just east of this area, where a 2 km corridor is required for flexibility in crossing the elevated areas as shown in Figure 11).

As described above, indirect impacts on Mulga, through disruption of sheetflow have been minimised as far as possible, by the railway being moved as far north as practicable to cross more defined drainage channels. Any downstream impacts will be further minimised by regularly spaced, small diameter culverts which will allow sheetflow to pass underneath the rail embankment as well as spreader ditch systems to be installed where sheetflow dependent Mulga groves exist immediately downstream of the railway (see Section 6.1.4).

5.2.3 Mine Sites

5.2.3.1 Site Selection

Locations of the proposed mine sites, in particular the pits, are dictated by the locations of the orebodies. However, within these areas, locations of the permanent overburden placement areas, rejects placement area, processing plant and supporting infrastructure have been designed to take into consideration environmental and Aboriginal heritage constraints as well as engineering constraints.

One of the main constraints considered was surface hydrology. For example it was originally proposed to locate the starter overburden stockpiles as close as possible to the starter pit (without sterilising any future ore resources), to minimise haulage distance. However, at Christmas Creek and Mt Lewin this would have impacted on areas that have surface water sheetflows. As a result, these starter overburden stockpiles were located towards the northern end of the proposed pits to minimise the potential impacts on the existing drainage patterns. Similarly the initial rejects placement area at Christmas Creek was located at the northern extent of the proposed pit and contained within the starter overburden stockpiles to minimise impacts to surface water flows. These overburden and reject placement areas will be contoured so they are incorporated into the surrounding topography where practicable.

5.2.3.2 Mining Methods

Detail on the mining methods is presented in Section 5.3. As the ore is relatively close to the surface in the northern areas of the mineralised zone and gently dips to the south at Christmas Creek and Mt Lewin, the most appropriate mining method is considered to be open-cut mining using the strip method. The options were to develop a large shallow open pit with large adjacent overburden stockpiles; or develop the pit progressively using strip mining, where a starter pit is opened (with overburden from the starter pit placed in a smaller overburden stockpile), and then the open pit is progressively backfilled and rehabilitated as the mining face progresses.

Strip mining was selected, as it presents a cost effective method of progressively backfilling the pit with overburden during the life of the mine. The total ground disturbance required is minimised as large waste rock dumps are not required external to the pits. Superior progressive rehabilitation practices can be utilised as topsoil can be removed ahead of mining and placed directly on final contoured backfilled areas, in one operation.

Backfilling an open pit with overburden at the end of the life of the mine would not be feasible, and the remaining open voids and large overburden stockpiles would present a much greater mine closure issue. Mine voids tend to act as sinks for rainfall, surface water runoff and groundwater if the water table is intersected. This water can become hypersaline through evaporation in the arid Pilbara climate and may adversely impact the water quality of the local and regional groundwater. Hydrogeological issues are discussed in greater detail in Section 6.2. Geochemical processes such as Acid Rock Drainage (ARD) may also occur if reactive material is exposed in a pit void or overburden stockpile although this is not expected to be an issue for FMG's mining areas (see Section 6.9.2).

5.2.3.3 Processing Methods, Location and Ore Transport

As a result of preliminary testwork, the beneficiation of iron ore by a combination of wet gravity separation and dry separation was selected as the most economic approach to improve the iron content in the export ore. Dry processing was investigated but did not produce the required grade and purity of ore and did not enable ore moisture control for dust management. Wet gravity separation is a well proven process already in use for iron ore in the Pilbara and because it is an inert process, does not involve the use of any harmful chemicals or produce environmentally toxic tailings.

It is proposed to locate the processing plant at Christmas Creek as it minimises the amount of surface disturbance due to haulage systems, during the first 10 years of operations, when most of the product will come from Christmas Creek and Mt Lewin. The processing plant will be made up of relocatable modules which will allow the future relocation to Mt Nicholas, depending on customer iron ore specifications in the medium term future.

The Stage B Project requires a rail corridor extending to Mt Nicholas the eastern-most mine site. Mt Nicholas will be developed in the later stages of the Project and will require the future relocation of process plant modules to Mt Nicholas, with the ore then transported directly to Port Hedland by rail. As it is dependent on customer requirements, approval for any such plant relocation will be sought at the time of proposing the relocation, in accordance with environmental legal requirements at that time.

Ore from the Mindy Mindy mine site will not require processing, and can be Direct Shipped from site via the Stage A railway (with appropriate moisture control for dust management), after crushing and screening has been undertaken on site.

5.3 THE MINES

The proposed site layouts for the four mines along with contour information and indicative mineralisation are shown in Figures 23, 24, 25 and 26. Figure 27 shows the conceptual mining method to be employed for the project, which is discussed in further detail for each mine site in Sections 5.3.1 to 5.3.3.

5.3.1 Christmas Creek and Mt Lewin

5.3.1.1 Mining Methodology

The Christmas Creek and Mt Lewin Project areas consist of a number of iron ore deposits of varying grades and thicknesses, which is discussed in more detail in Section 4.2.3. Both areas extend along a distance of 25 km. The bedding that contains the material of economic worth is relatively flat lying with a gentle dip from north to south of between 2° and 5°. As the thickness of the overburden above the ore body increases, the economic viability of mining the ore is reduced. The economic distance from north to south varies from deposit to deposit but is generally about 6 km in the case of Christmas Creek. This economic distance reduces to the west of the Christmas Creek Project area.

In the northern section of the orebodies the iron ore is typically lying exposed on the surface (outcrop). As it proceeds south it becomes covered with 'detrital material' and also beddings of non economic material (overburden). All of the material above the orebody must be removed separately from the ore.

The proposed mining methodology for each of the Project areas is very similar. Initially the vegetation and topsoil will be removed from above the overburden and either stored for later use or transported directly to the rehabilitation area behind the mining area (refer to the Rehabilitation and Revegetation Plan in Appendix D). The overburden is then removed from above the ore body. As the mine faces advance, ore will be removed from the pits in haul trucks and will be tipped into a pit rim crusher. Following crushing the product will transported by overland conveyor, haul road or rail to the stockpiles ahead of the Beneficiation Plant.

5.3.1.2 Overburden Management

Overburden is the material overlying the ore body, excluding vegetation and topsoil. Topsoil and vegetation from pre-stripping operations will be used in progressive rehabilitation activities. The overburden will be used during rehabilitation of the mine to construct the post-mining landform. Over the life of the mine, the pits will be backfilled to at least above the water table. Refer to Section 5.3.7 for further detail.

During the start-up phase for a new pit (typically 1 to 2 years), it will be necessary to place the overburden in a permanent storage area that is not situated within the mine pit area. Further detail is provided in Sections 6.9.1 and 6.9.3.

Following the start-up phase, the overburden will be placed in the mined-out sections of the pit. The time between the commencement of mining in an area and the placement of overburden within the mine path will vary depending on the resource depth and thickness. It has been estimated that at Christmas Creek and Mt Lewin it will be two years. Based on current ore body information and mine path design, it has been estimated that the following amounts of overburden would be placed in defined areas off path:

- Christmas Creek 112 Mt of overburden placed in permanent storage areas covering 388 ha; and
- Mt Lewin 82 Mt of overburden placed in permanent storage areas covering 200 ha.

The final design and therefore height of the permanent off path storage areas will be based on the surrounding topography in the specific area. Where practicable local features will be incorporated into the design of these areas. The overburden storage areas will be rehabilitated and revegetated as part of FMG's standard procedures (refer to the Rehabilitation and Revegetation Management Plan in Appendix D).

5.3.1.3 Ore Removal

Christmas Creek and Mt Lewin ore will be mined as two products based on the target grade. The higher grade ore which meets the target grade will be crushed and screened and transported to Port Hedland for export. The ore which does not achieve the stated grade will be upgraded by the Beneficiation Plant. In any one pit, which may consist of three faces along the strike direction, the ore will be mined and transported in campaigns. Handling the ore in such a fashion improves the efficiency of the mine and operations can be more simply scheduled. If a face presents with both product types and the face is relatively low grade it may be necessary to stockpile one of the types of ore in pit until the next campaign producing that type of ore.

The mining sequence will be dictated largely by grade and output considerations. FMG is proposing to produce 45 Mtpa of ore at a target grade of 55% to 65% iron. Throughout an area that is economically viable to mine, the iron content will be both below and above the target grade. Therefore mining of these areas must be sequenced to ensure the final product is within the required specifications.

Depending on the type of ore, drilling and blasting may be required prior to excavation of the ore. If blasting is necessary, the density of drilling and type and strength of explosives to be used will be carefully estimated in order to minimise the impact of blasting on the size of the resultant material, noise and vibration impacts.

Ore will be loaded from the face by backhoe excavators typically operated from on top of the face being excavated. The backhoe excavators will load trucks which are located level with the operating face. The trucks then transport the ore to the crusher which may be in pit or on the pit edge (at the start up of each pit). All of the ore will be tipped into a receival bin prior to crushing. Following crushing the ore will be conveyed to stockpiles ahead of the Beneficiation Plant (Figure 28).

5.3.1.4 Dewatering and waste water control

At Christmas Creek and Mt Lewin the initial years of mining are conducted in dry ground conditions. As the faces progress in a southerly direction it is expected that groundwater will be encountered at approximately 400 mRL. The groundwater is relatively fresh with Total Dissolved Solids (TDS) in the range of 1,000 to 3,000 mg/L. Water will be drained ahead of the advancing mining faces via the use of dewatering bores. The dewatering water will either be used in the pit as a dust suppressant or pumped to the Beneficiation Plant to reduce borefield pumping requirements. Dewatering requirements are predicted to be on average over the life of mine 1,150 MLpa at Christmas Creek, and 520 MLpa at Mt Lewin.

Beneficiation Plant rejects and fine waste material will be returned to the mined out areas and mixed with the overburden generated by the advancing mine. The sediment will settle when the velocity of the mixture slows and the water which flows through the material will be collected in sumps. The sumps will consist of a wall which will be sealed with clayey material to facilitate water collection. The recovered water will be returned to the Beneficiation Plant dam for reuse or will be used for dust suppression in the operational area. This system will also serve to collect water from large rainfall events.

5.3.2 Mt Nicholas

5.3.2.1 Mining Methodology

The Mt Nicholas orebody extends for approximately 22 km in a general north-northeast to south-southwest direction. It dips to the west at approximately 5° to 10°. The orebody varies from 3 m thickness to approximately 10 m. At its deepest point the Mt Nicholas pit will be 72 m below the surface. The pit will extend from the eastern outcrop dipping undercover to the west with an average pit width of approximately 600 m.

Topsoil and overburden will be handled in a similar manner to the other mines. Initially the overburden will be placed in permanent stockpiles that are not within the mine path for up to one year. However, when a sufficient working area has been established the overburden will be placed within the mining area. During mining, the pit at Mt Nicholas will be backfilled to at least above the water table (refer to Section 5.3.7 for further detail). At Mt Nicholas, approximately 67 Mt of overburden will be placed in permanent storage areas covering 199 ha. These will be landscaped to blend with the surrounding topography and revegetated (refer to Sections 6.9.1 and 6.9.3 and the Rehabilitation and Revegetation Management Plan, Appendix D).

A single crushing plant will be located at the mine and the mine scheduling will be designed to minimise relocation of the crusher and the number to trucks required to deliver the ore to the crusher. Mt Nicholas will be mined along the orebody from a central location and the northern end of the orebody. The two faces will progress in a southerly direction along the orebody. A large loader will be used to feed the crusher. Following crushing and screening the ore will be transported overland to the Beneficiation Plant.

5.3.2.2 Ore Removal

Approximately 67 Mt of overburden will be removed and placed in permanent storage areas covering 199 ha.

The ore at Mt Nicholas will be mined in benches which may be up to 6 m high. Ore will be extracted using backhoe excavators discharging into trucks located on the bench below. Benches will generally be mined level and ore extracted as cleanly as possible away from the material above and below it. Trucks will then transport the ore to a pit rim crusher where the ore will be tipped into a bin and a plate feeder deposits the ore into the crusher. The crushed ore will be conveyed to the Beneficiation Plant for further crushing, screening and beneficiation.

5.3.2.3 Dewatering and waste water control

Groundwater levels across Mt Nicholas have been measured in mineral exploration drill holes, and bores drilled for the hydrogeological investigation. The data show that groundwater levels vary from approximately 410 mRL in the lower slopes at the southern end of the deposit, to 485 mRL along the eastern ridge, in the northern-most part of the mine. The water table is generally flat in the southern part of the mine, but there is an east-west hydraulic gradient in the northern sections.

During the hydrogeological investigations, water quality samples were taken from the bores that intercepted the water table. Groundwater in the region was found to be generally fresh, with total dissolved solids (TDS) typically in the order of 1,000 mg/L.

Dewatering requirements for Mt Nicholas are expected to be approximately 2,850 MLpa. At Mt Nicholas dewatering of the orebody will be conducted by drilling production bores ahead of the operation. This will result in a cone of depression in the water table into which the operating faces advance. To safeguard employees and equipment, weep holes (that is holes drilled horizontally ahead of an advancing face) will be drilled in all faces that exhibit the presence of water behind the face. These drill holes reduce the potential for a slip failure by reducing the head (pressure) of water behind the face.

Water drawn off in the dewatering bores will be pumped to dams that supply the Beneficiation Plant. Water from the weep holes will be collected in sumps at the base of the mine and either pumped to the water supply dams, or stored in water tanks and used for dust suppression on haul roads.

5.3.3 Mindy Mindy

5.3.3.1 Mining Methodology

The Mindy Mindy orebody extends for approximately 9 km in a general northwest, southeast direction. The ore is up to 34 m thick in most of the area but decreases to 15 m on the northern end. The Mindy Mindy deposit generally dips to the northwest at less than 0.5°.

Mining will commence at the southeastern end of the mining area, one third of the way along the deposit, and work up to the northwest for four years, then coming back to the southeastern end working northeast for the remaining two years. The southern area has been selected as the starting point as there is very little overburden associated with this ore and consequently it only requires pre-strip of the sides of the orebody. In addition, the southern orebody exhibits the greatest width of all areas and this allows for the most convenient start up arrangements. It has been estimated that approximately 20 Mt of overburden will be placed in permanent stockpiles away from the mine path, covering 122 ha. These areas will be landscaped to blend in with the surrounding topography and revegetated as part of FMG's standard procedures (refer to the Rehabilitation and

Revegetation Management Plan in Appendix D). As the face advances, overburden material will then be placed directly into the mined out portion of the pit. The pit will be backfilled to at least above the water table (refer to Section 5.3.7 for further information on backfilling).

Ore will be loaded with an excavator into trucks that will transport this ore to a storage area at the crushing and screening plant. Ore will then be crushed, screened, loaded into 300 t road trains and transported to the rail load out location where the side tipping trailers will discharge ore at the rail siding.

5.3.3.2 Overburden Management

As the orebody occurs near the surface, overburden stripping from the sides of the orebody only, will be required initially. Overburden will initially be placed in overburden placement areas covering approximately 122 ha, after which it will be used to backfill the pit.

5.3.3.3 Ore Removal

Ore will be removed from the pit using a 250 t backhoe excavator with a fleet of 140 t trucks and transported 400 m to the crushing and screening plant. Minimal drilling and blasting is envisaged however an allowance is made for a proportion of material being paddock blasted.

5.3.3.4 Dewatering and Waste Water Control

The water table at Mindy Mindy is located approximately 20 m below ground level. The orebody follows a sunken valley with all run-off draining into the mine catchment. It is expected that dewatering will be conducted by utilising a series of borehole pumps on the upstream side of the valley across the bed. Five pumps will be located across the deposit pumping from a depth of 65 m. These together with in pit pumps are considered adequate to keep the mining operation dry. Dewatering of the Mindy Mindy orebody will require the abstraction of an average of 0.4 GLpa over the life of the mine (six years). Dewatering water will be used for dust suppression and potable water supplies (if of suitable water quality). The dewatering water is expected to be relatively fresh with a TDS of between 1,000 and 2,000 mg/L.

5.3.4 Ore Transport from Mine

A portion of the ore is considered likely to be of such quality as to warrant direct shipment whilst a simple beneficiation process will treat the remaining ore to produce a product containing 55% to 65% iron, depending on the selected mining cut-off grade.

After direct ship ore is crushed and screened, it will be loaded into 300 t road trains, and transported to the rail loadout locations where side-tipping trailers discharge at the rail siding. Appropriate moisture content management will be applied to minimise dust generation at the Port.

Ore requiring beneficiation will be transported to the Beneficiation Plant by either conveyors, haul roads or rail. The environmental impacts of each of the transport operations will be investigated and the final option selected based on engineering constraints and environmental management considerations. Beneficiated ore will join DSO for transport by rail to Port Hedland.

5.3.5 Beneficiation Plant

Beneficiation of ore will not be required at Mindy Mindy. It is proposed to locate the Beneficiation Plant in the Christmas Creek Mine area, with later relocation to Mt Nicholas. This is in line with the mine scheduling (see Section 5.3.12) which results in Christmas Creek being mined for the first eight years and the other three mines being mined in combination for the remaining twelve years according to customer product requirements. As a result the plant will be relocated to Mt Nicholas once mining has been completed at Christmas Creek, where it may service both Mt Lewin and Mt Nicholas. The plant will be located in an area allocated for infrastructure at Mt Nicholas (see Figure 23). FMG will seek approval for the proposed management of any additional environmental impacts, under a separate environmental proposal at that time. A conceptual process flow diagram of the beneficiation process is shown in Figure 28.

5.3.5.1 Primary Crushing

Primary crushing will be conducted by semi-mobile crushing units. The modular design of these units will allow reuse and relocation of the equipment as necessary. Overland conveyors, haul roads or rail will convey the crushed ore to the central Beneficiation Plant.

5.3.5.2 Beneficiation

Figure 28 presents a conceptual process flow diagram for the Beneficiation Plant, the components of which are described in detail in Table 7.

At the Beneficiation Plant, ore will be crushed in a secondary crusher and screened before being processed using various wet gravimetric processes and other separation methods to reduce contamination and increase the ore grade to a marketable product. This process is completely inert and does not involve the use of bulk chemical additives and therefore will not result in the production of chemical pollutants.

The Beneficiation Plant will include:

- Primary crushed ore stockpile: The conveyor from the primary crusher will feed into a buffer stockpile through a stacker. Feeders will extract the ore from under the stockpile for delivery to the secondary screening and crushing plant.
- Secondary crushing and screening facilities: This facility will consist of screens and crushers connected by belt conveyors which will recycle the oversize ores from the screens to the secondary crushers, and back to the screens.
- Beneficiation modules: Modules will include dry screening, wet screening, jigs, cyclones and thickeners to treat a variety of ore types.

Table 7. Description of the Beneficiation Plant

Item	Process Unit	Description	Purpose
1	Wet Screening	4.88 x 8.54 m double deck wet Banana screen, upper 8 mm aperture, 1 mm lower aperture	Separate lumps (+8 -31.5 mm) and fines (-8 mm) into separate products for subsequent processing.
2	Coarse Jig	7 m wide pneumatically pulsed jig which uses compressed air to pulse a water column to produce stratification of +8 - 31.5mm feed particles	Gravity separation to concentrate higher specific gravity hematite and goethite ore minerals and to reject lower specific gravity gangue including shale, weathered BIF, quartz and porous composite particles of hematite, goethite, quartz and clay. Essential to decrease the SiO_2 and Al_2O_3 levels of the product to marketable levels
3	Coarse Jig Dewatering Screen	Vibrating screen with fixed aperture	Remove surface water from lump concentrate and return reclaimed water back to process circuit
4	Fines Jig	7 m wide pneumatically pulsed jig which uses compressed air to pulse a water column to produce stratification of –8 +1 mm feed particles	Gravity separation to concentrate higher specific gravity hematite and goethite ore minerals and to reject lower specific gravity gangue including shale, weathered BIF, quartz and porous composite particles of hematite, goethite, quartz and clay.
5	Fines Jig Dewatering Screen	Vibrating screen with fixed aperture	Remove surface water from -8 +1 mm fines concentrate and return reclaimed water back to process circuit
6	Hydrocyclone Size Classification 0.075mm	1.0 m diameter hydrocyclone which uses centrifugal forces acting on a water-iron ore slurry to accelerate the settling rate of particles	To separate the -1mm feed into coarser (-1.0 +0.075 mm) and fine (-0.075 mm) fractions for subsequent processing
7	+0.075mm Attrition Mill	Tower grinding mill consisting of a vertical stirred shaft with lifters, a counter-current flow of slurry and steel grinding balls to achieve a mild size reduction of the particles	To liberate quartz and clay gangue from composite particles that also contain hematite or goethite. Unless the quartz and clay gangue is liberated the product will be too low grade.
8	Hydroseparator	A column tank comprising upward flow of water and an opposing flow of solids introduced at the top, producing hindered settling of particles based on size and specific gravity	To separate lower specific gravity quartz and clays from the higher specific gravity hematite and goethite. The separation is essential to upgrade the iron ore concentrate.
9	Coarse Spirals	Banks of helical-shaped conduits in which slurry in fed from the top of the spiral. The particles are stratified due to centrifugal force and differential settling	Use gravity and water to concentrate the hematite and goethite ore minerals and to preferentially reject the lower specific gravity quartz and clay gangue as well as porous low

Item	Process Unit	Description	Purpose
		rates, then separated via ports with adjustable cutters at the lower section of the spiral.	grade particles. The separation is essential to upgrade the iron ore concentrate.
10	Desliming Hydrocyclones	0.250 m diameter hydrocyclones which uses centrifugal force on a water-iron ore slurry to accelerate the settling rate of particles. To separate the feed into -0.015 mm and +0.015 mm products	To use size classification to reject the clay-rich -0.015 mm size fraction from the iron ore concentrate and hence upgrade the product
11	-0.075 mm Attrition Mill	Tower grinding mill consisting of a vertical stirred shaft with lifters, a counter-current flow of slurry and steel grinding balls to achieve a mild size reduction of the particles	To liberate quartz and clay gangue from composite particles that also contain hematite or goethite. Unless the quartz and clay gangue is liberated the product will be too low grade.
12	LIMS/WHIMS /Fine Spirals	Low and Wet high intensity magnetic separators (LIMS, WHIMS). The LIMS is a permanent magnetic drum which is rotated in a slurry bath, magnetic minerals stick to the drum and are removed by a scraper as the drum rotates above the slurry level. Wash water is also applied consisting of a rotating carousel of vertical metal plates that are magnetised as they pass through an electromagnetic field. Slurry composed of iron ore and water are passed over the plates in the magnetic filed along with wash water, the paramagnetic minerals stick to the metal plates and the liberated non-magnetic quartz and clay pass by the plates and avoid being attracted. As the plates are rotated away from the electromagnetic field, the paramagnetic minerals are washed off the demagnetised plates into the final concentrate. Fine spirals – see Spirals above.	The LIMS separates magnetic minerals and returns them to the final fine ore concentrate. This step is essential to avoid fouling up of the plates in the subsequent WHIMS step. The WHIMS is essential to reject liberated fine quartz, clays and other non-magnetic gangue minerals. Some fine spirals are also used to clean up the concentrate by rejecting the lower specific gravity quartz and clay gangue or porous composite gangue-hematite/goethite particles.
13	Fines Filtration	Horizontal vacuum belt filter in which the concentrate slurry is pumped onto one end and a vacuum is applied to the whole belt length. As the belt is moved along the length of the unit the water is drawn down through the bed of solids which forms and the filtrate is recovered to the process water circuit whilst the solid filter cake is sent via conveyor to the fines product stockpile	The vacuum filtration is essential to recover water back to the process circuit and to dewater the concentrate so that it can be more easily transported by train to the port.
14	Paste Thickener	A large vertical column tank in which fine (<0.075) rejects in slurry form and flocculant are added to a central well, whilst a rake gently stirs the tank. Fine solids are agglomerated and settle to the bottom of the tank to form a thick paste which is then removed via an underflow pump and the clarified water is returned via a weir back to the circuit process water.	The paste thickener is essential to recover water back to the process circuit and to product a paste which can then be added on top of the coarse (+0.075mm) rejects belt for placement in the mine pit or solids containment area.

5.3.6 Rejects Management

The rejects from the Beneficiation Plant will consist of two streams of material. One reject stream is a solid material stream and the other is a slurry. It is estimated that on average 85% of the rejects will be solids (Table 8) and it is proposed to convey these initially to a surface reject placement area in the first two years and then to the mined-out pits for disposal with overburden from the mining operation. Dry waste will be returned to the pit via the conveyor system utilised for ore transport to the Beneficiation Plant, or dump truck if the haul distance is not large. The thickened slurry rejects will be added as a final component of the 'fill'. Water drained from the slurry after deposition will be collected in sumps and returned to the Beneficiation Plant for further use.

Table 8. Beneficiation Plant rejects volume, weight and % solids

Process Plant Rejects	Dry Solids Mass TPH	Dry Solids Nom Vol m³/hr	Liquor (Water) TPH	Wet Mass TPH	Wet Vol m³/hr	% Solids	% by Vol	Bulk/ Pulp SG	Max Solid/ Pulp TPH	Max Vol m³/hr
Lump	1808	904	201	2009	1004	90.0		2.0	2009	1004
Fine	1932	966	261	2193	1097	88.1		2.0	2193	1096
Slime - Pulp	403	134	173	576	308	70.0	43.8	1.9	576	307
Solid	3740	1870	462	4202	2101	89.0		2.0	4202	2101
Total Rejects	4143	1090	634	4777	1725	86.7	63.2	2.8	4777	1725

TPH = tonnes per hour

During the first two years of operation, the reject placement areas will be located at Christmas Creek, until co-disposal of rejects in-pit can commence. For every tonne of screened ore processed the beneficiation process generates approximately one tonne of rejects. The rejects placement area will have lifts of 2 m per year (maximum height of 4 m) and be incorporated into the Christmas Creek overburden placement area. Further detail is provided in Section 6.9.3. Studies are currently underway to investigate water recovery from the rejects to supplement plant supply and reduce borefield pumping demands.

5.3.7 Backfilling Pits

Overburden and rejects from the Beneficiation Plant will be used to infill the open cut pits created during the mining process. Initial calculations have been undertaken to determine the amount of material that will be available for infilling and therefore the extent of final void that will remain at any given area. Conservative estimates of the waste to ore strip ratio have been made based on available data. It should be noted that the strip ratio will vary with time and across the mines. However, it has been assumed that the initial strip ratio will be close to zero (as the ore is at the surface) and the final strip ratio will be approximately 2.8 units of waste to 1 unit of ore.

When material is removed during mining it expands as it is broken up and air spaces form between the particles (this is known as a bulking factor). The bulking factor will vary from material to material with wet sand expanding by approximately 20% and slate expanding by approximately 85% (Berkman, 1995).

To determine the material available for infilling the following assumptions have been made:

- A bulking factor of 65% for overburden based on data from Berkman (1995);
- A bulking factor of 35% for rejects being returned to the pit from the Beneficiation Plant based on data from Berkman (1995);
- The process plant has a yield of 65%;
- The stripping ratios (waste:ore) for years 1 to 6 are respectively: 0.5, 0.8, 1.0, 1.4, 2.0 and 2.8: 1;
- Reject material returning to pit is always 1.0 (ore mined) x 0.35 (rejects generated from the Beneficiation Plant) x 1.35 (bulking factor for rejects) = 0.47;
- Overburden from the first two years of operation will be placed in permanent storage areas not located within the mining area.

It is likely that each of the pits will have a life of approximately 6 years. Based on this pit life and the above assumptions the following can be determined. It should be noted that the information contained in Table 9 is a volume simulation and does not consider the total amount of material to be removed. The purpose is to show the relative amount of material that will be removed and available for infilling.

Table 9. Calculation of material available for backfilling of pits

Parameter	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Totals	% volume of material mined
Ore material Volume 'in situ'	1.0	1.0	1.0	1.0	1.0	1.0	-	-
Waste volume 'in situ'	0.5	0.8	1.0	1.4	2.0	2.8	-	-
Total 'in situ' relative volume to be mined	**1.5**	**1.8**	**2.0**	**2.4**	**3.0**	**3.8**	**14.5**	**100%**
Reject material volume returned to the pit	0.47	0.47	0.47	0.47	0.47	0.47	-	-
Waste material volume to go in pit	0.82	1.32	1.65	2.31	3.30	4.62	-	-
Total relative volume available for backfilling pits[1]	**1.29**	**1.79**	**2.12**	**2.78**	**3.77**	**5.09**	**13.76[1]**	**95%**
[1]Total of Years 3 to 6								

As can be seen in the table above, approximately 95% of the volume mined will be available for backfilling the pits (a combination of overburden and rejects). Therefore, the amount of material available for the infilling of the pit is almost sufficient to completely fill the void.

Where practicable the rejects and overburden from the next pit that is developed will be returned to the previous pit for infilling. Eventually as the final pit is completed a reasonably small depression will remain. This can be minimised by scaling back production operations in order to reduce operating area requirements on the pit floor and move the advancing overburden and rejects placement closer to the mining face. The final depression will be above the water table and will be designed to resemble the surrounding topography as close as practicable. It is unlikely that any significant consolidation will occur in the short term in the backfilled areas given the compaction caused by various types of mobile equipment traversing the area prior to the spreading of relocated topsoil.

5.3.8 Product Stockpiles and Train Loading

Chichester Deposits

The combined concentrate product from the Beneficiation Plant will be conveyed to the train loading yard stockpile.

This stockpile facility will consist of one or more stockpiles up to 1.5 km long, with a travelling, slewing and luffing stacker to stack the combined product. The stockpile will allow the free moisture to drain or evaporate over approximately 7 days. After draining, the product will contain 6% to 8% moisture.

The product stockpile will have capacity for approximately one week's production, which allows for dewatering of the processed ore, any blending of direct shipped ore and for irregularities in the rail delivery process.

The material will be reclaimed utilising a travelling, slewing and luffing reclaimer of a nominal 10,000 tph capacity. The reclaimer is a comparable machine to the machine at the port stockyard and will be automated. The reclaiming conveyor will feed into the train loading bin. The train loading bin mechanism will regulate the flow of product into the train wagons.

Mindy Mindy Deposit

As previously indicated, the ore is of direct ship quality and therefore only crushing and screening is required before stockpiling and transport to the rail loop by road haulage or conveying. The stockpiles will be similar to that proposed for the Chichester deposits except that reclaiming will be via front end loader.

5.3.8.1 Maintenance Workshops and Warehouse

Maintenance workshops will be built near to the Beneficiation Plant to service the mining fleet, crushing plant and Beneficiation Plant. A warehouse will be provided for spare parts.

Dangerous goods management will be one of the important criteria in designing of these facilities (Section 5.5.2).

5.3.9 Water Supply

Water required for the Project including beneficiation of the ore from the Chichester Deposits and dust suppression will require the development of a dedicated borefield. This borefield is proposed to be established near the Mt Nicholas mine and will supply water to the Project. The borefield will be supplemented by mine dewatering water.

The water requirement of the Chichester mines is estimated to be 11 GLpa. An additional 0.4 GLpa will be required at Mindy Mindy and sourced from pit dewatering. Investigations are currently underway to reduce this water requirement primarily by increasing the recovery of water from the reject streams and water harvesting from within the proposed mine pits and other runoff areas within the proposed mine site.

Figure 29 shows the various water uses and losses in the process. Moisture is lost from the Beneficiation Plant with both the product and reject streams (Figure 28), but the largest loss of water is due to evaporative losses based on the fact that evaporation for the region is approximately 3,700 mm/y/m^2.

Unlike the Chichester deposits water demand at Mindy Mindy is not high as ore will not require beneficiation and it is a smaller operation. Water supply for dust suppression, ore conditioning and potable water (if suitable water quality) will be supplied from the deposit. If water from the deposit is non-potable then potable water will be supplied from nearby alluvial deposits.

5.3.10 Power Supply

The power requirements for the mining, processing and support facilities will be provided by power stations that will be provided, operated and maintained by an external supplier. These providers will submit separate environmental proposals if gas pipelines and/or transmission lines are to be used.

Options for the Chichester Deposits include:

- A gas fired power station, in a N+1 configuration (see footnote [3]), using gas supplied from the existing Onslow to Kalgoorlie gas pipeline operated by Goldfields Gas Transmission Company. The gas will be supplied from a new line to be constructed with the take-off located near the existing Newman Power Station takeoff.

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[3] An N+1 configuration indicates sufficient power turbines for target power production plus one extra turbine for standby (in case of maintenance or failure of other turbines).

- The existing Newman Power Station via a 132 kV overhead power line to the Chichester minesite(s). Alinta has provided a proposal whereby they would provide and own the transmission line and associated substations with the point of supply being the 33 kV supply point at the minesite(s) HV substation.

Options for the Mindy Mindy Deposit include:

- a diesel fired power station in a (N+1) configuration;
- the existing Newman Power Station via a spur off the 132 kV Newman-Yandi transmission line to the Mindy Mindy minesite.

In addition to the provision of power to the minesite, an external communications link to Newman and radio base station communication systems and structures will be provided at each of the mine sites.

5.3.11 Construction Activities

Construction of the proposed mines development will follow the sequence and management measures outlined in Table 10.

Table 10. Sequence of Construction – Mines

Construction Activity	Description
Detailed Surveying	Engineering, environmental, community, archaeological and anthropological studies are used to determine areas which should be avoided or any special construction techniques or mitigation measures required. A detailed survey of the Project layout will be undertaken to identify and locate special management areas.
Clear and Grubbing	Front end loaders, graders, bulldozers and scrapers are used to progressively clear the mine pit, overburden and rejects storage, access roads and plant site footprint ready for construction to commence. During this process, sites of heritage significance and environmental sensitivity are fenced off, and topsoil and vegetation removed and stored separately for use during rehabilitation.
Temporary Facilities	Temporary facilities will include accommodation facilities, offices, laydown areas, ablution facilities, mobile workshops etc. Many of these facilities will be used repeatedly by the different contractors on site as the construction project progresses, and will be located in already disturbed areas where practicable.
Borrow Pits	Borrow pits will be required to supply suitable construction material to raise and develop the foundation of haul roads, stock yard, ore crushing, screening and handling facilities, administration buildings and product conveyor etc. Borrow pits will be preferably located in areas designated for pit and overburden stockpile locations and will be temporarily rehabilitated (to a stable land form that is erosion resistant) if not immediately required during mining.
Bulk Earthworks	Once initial clearing and grubbing has been completed, heavy earthmoving equipment such as graders, front end loaders, bulldozers, scrapers, dump trucks, water carts, compact rollers and loaders will be utilised in the construction of the foundation for the stockpiles, ore handling facilities, product conveyor and commencement of the mine pit.

Construction Activity	Description
Pit Preparation and Initial Mining	Overburden from the pits will also be used where practicable in site preparation works to minimise the need for additional borrow pits. In addition, initial pit development and ore extraction will commence to develop the Run of Mine (ROM) and ore stockpiles ready for plant commissioning and the first shipment of ore.
Rejects storage	Material removed during initial pit development and from suitable borrow pits will be used to construct the rejects placement area. Following the first two years of operation, rejects will be co-disposed of in-pit.
Plant Foundations	Plant foundations require the excavation of the footings and the placement of reinforced iron and concrete to form the foundations. Concrete will be sourced from a temporary batching plant located on site.
Structural Steel Erection	Independent construction crews/contractors will work on separate parts of the Beneficiation Plant, concurrently where possible. Structural steel erection comprises the construction of the primary and secondary crushing facilities, screens, Beneficiation Plant, overland conveyors, stacker and reclaimer beds, and train loader. Wherever structural erection can be prefabricated off-site this will be undertaken to speed the process of on-site erection and minimise on-site disturbance.
Machinery (i.e. Stackers and Reclaimer)	Similar to the structural erection of the support facilities, wherever practicable the ore handling machinery will be prefabricated off-site and then pieced together on-site to speed up the process of erection and minimise on-site disturbance.
Services	Power, lighting, communications and water services will be developed progressively throughout the mine site construction phase.
Administrative and Support Buildings	Administrative buildings, control rooms, accommodation facilities and support buildings such as amenities and ablution facilities will be constructed progressively. With the exception of the accommodation facilities the remaining facilities will be grouped and located as a central administrative hub, close to the centre of operations while maintaining a safe working distance from the pits.
Commissioning	Commissioning will comprise no-load commissioning of all machines, pumps, motors and support equipment without ore. Subsequently, load commissioning will be undertaken where all machinery and equipment is run under pressure/load.
Demobilisation, Clean-up, Rehabilitation and Monitoring.	Prior to departure the supervising engineers will retain a small team of construction equipment and contractors to undertake final rehabilitation works including: • demobilising construction equipment and temporary facilities; • removing overburden and undertaking rehabilitation of any disturbed areas not required as part of operations. The 'construction site' will then be handed to the mining contractors for active operations and further mine development.

5.3.12 Mine Scheduling

Figures 30 to 33 show the conceptual mining schedule for each of the mining operations. Briefly Christmas Creek will be mined for the first 8 years of production. The other three mining areas will be mined in combination over the following 12 year period, in order to produce the grade required by customers at that time. The mining sequence and schedule for each mining operation is as follows:

- Mount Nicholas will be mined along the ore body from a central location and the Northern end of the orebody. Two faces will progress in a southerly direction along the ore body. Its life will be 4 years.
- Mount Lewin will be mined from north to south opening up multiple pits across the deposit. Its life will be 4 years
- Christmas Creek will be mined from north to south opening up multiple faces across the deposit. Its life will be 8 years
- Mindy Mindy will be mined opening a face one third of the way along the deposit (at the southeastern end) working to the northwest for 4 years, then coming back to the southeastern end working northeast for the remaining 2 years. Its life will be 6 years

5.4 THE RAILWAY

5.4.1 Alignment

From the Mt Nicholas mine rail loading loop, it is proposed that the mainline track will head north-west along the southern side of Chichester Ranges for approximately 160 km. The rail will also pass the Mt Lewin and Christmas Creek mining areas. The rail alignment will be between the Fortescue River floodplain and Chichester's ridgeline and it will connect to the north-south railway (refer to the Stage A PER), where it crosses the Chichester Ranges. This portion of the track will include one siding to allow trains to pass.

The selected alignment crosses:

- one main road, the Nullagine-Marble Bar Road near Roy Hill;
- a number of minor road/tracks;
- numerous watercourses off the Chichester Ranges that feed the Fortescue River; and
- a floodplain near Mt Nicholas (Figures 4, 5 and 6).

A series of culverts will support the rail track across major surface drainage features, such as creeks and floodways. The more significant of these water courses will be monitored by a simple solar powered detection device that will allow for early warning of any significant water rise, and prevent trains from entering that section of the track. This early detection will allow for quick response to ensure the integrity of the railway is maintained and environmental impact is minimised.

The construction corridor will be generally less than 40 m wide, although additional areas will be required for the access track, yards, and temporary facilities (e.g. contractor laydown areas).

5.4.2 Borrow Pits and Quarries

Wherever practicable, fill material for the rail embankment will be sourced from material recovered from construction of the railway cuttings or proposed mine disturbance areas. If material cannot be sourced from these areas, a series of borrow pits will be required to supply suitable transition and sub-ballast material for the railway embankment and formation, and for bulk fill materials. The location of these borrow pits will be constrained by the availability of suitable construction material. It will not be possible to define the location of these borrow pits until geotechnical studies have been completed as part of detailed design. However, borrow pits will be located away from sensitive environments, such as significant vegetation, surface drainage and Aboriginal heritage sites. Where practicable they will be located within 2 km of the rail corridor. Preference will be given to using existing or old borrow pits where available. The borrow pits will be left as free-draining where practicable.

If required, borrow pits will be spaced out along the length of the rail corridor to minimise haulage distance and also concentrated disturbance. Vegetation surveys will be conducted prior to borrow pit emplacement. The location of borrow pits will be selected in consultation with CALM and DoIR.

Borrow pit locations will be selected based on the characteristics of the fill required and minimising disturbance to vegetation. Prior to the establishment of a borrow pit, topsoil will be stripped and stockpiled for use in rehabilitation. The borrow pits will be designed to encourage natural drainage and prevent the establishment of ponded water where practicable. The final slope of the re-contoured land will also be minimised to reduce the potential for water erosion and the pit floor will be deep ripped to reduce compaction. Once contoured, the stockpiled topsoil will be spread over the borrow pit. Refer to the Rehabilitation and Revegetation Management Plan (Appendix D) for additional information on borrow pit rehabilitation.

In summary, whilst it is not possible to define the location of borrow pits until geotechnical evaluation and detailed design has been completed. The following criteria will be applied during selection to minimise impact(s):

- If possible locate within areas to be disturbed such as proposed mine pits;
- Locate away from surface drainage channels;
- Locate away from Aboriginal Heritage sites;
- Conduct vegetation surveys to ensure they are located away from significant flora or vegetation;
- Locate away from significant fauna habitats;
- Determine final location in consultation with CALM;
- Seek approvals if required from DoIR.

5.4.3 Mine Terminal(s)

At the mine terminal(s), the empty train will pass around a balloon loop to the train loading facility where ore will be loaded into the ore wagons. Each wagon will be loaded with ore to a maximum of 126 t.

The mine balloon loop will be constructed with sufficient space to allow an empty train to arrive and commence loading while a loaded train has not yet departed. In addition a railway yard will be located on the inside of the loop. Whilst no regular maintenance of locomotives or rolling stock will be undertaken at the mine, the following facilities will be provided to ensure operational flexibility and safe running:

- track maintenance equipment siding capable of holding several pieces of track equipment and permitting minor servicing;
- a siding for the location of wagons requiring repair or overloaded cars; and
- a siding capable of storing two locomotives.

5.4.4 Rail Facilities

It is anticipated that rail movements will be controlled remotely from a train operations control centre in Port Hedland. The number of train movements along the railway will vary depending on the ramp up and scheduling of mining operations, demand by customers and use by third parties. However, at full capacity for the Project (i.e. 45 Mtpa) an average 5.1 iron ore trains per day will be required.

Facilities associated with the east-west railway will include rail loops, sidings, substations and communication systems at the mines. Water for both construction and operation of the railway will be provided from existing or new bores established near the rail corridor.

5.4.5 Locomotives and Rail Wagons

A fully laden train could weigh up to 35,600 t and be in the order of 2.6 km long, comprising three locomotives and 200 ore wagons, carrying 29,600 t of iron ore. Initially the operations are anticipated to comprise 200 to 220 ore wagons. Each ore wagon will be similar to those used by BHPBIO and capable of going through BHPBIO's twin cell dumpers.

Plate 4. Rail transport of ore in the Pilbara

5.4.6 Construction Activities

The railway will be constructed using specifically profiled concrete sleepers and a continuous welded rail. These will be bedded on a layer of ballast around 250 mm deep on the rail formation. Ballast material will be provided from local existing or new quarries. If new quarries are required, appropriate approvals will be sought. However, this work and the associated approvals may be undertaken separately by a contract ballast supplier.

Construction activities will follow the sequence and management measures as outlined in Table 11.

Table 11. Sequence of Construction – Railway

Construction Activity	Description
Detailed Surveying	Engineering, environmental, archaeological and anthropological surveys are used both in routing and to determine any special construction techniques or mitigation measures required. Once the rail route and design have been defined by the known constraints and with input from stakeholders, then the engineering aspects are finalised and a detailed survey is undertaken to identify project layout and constraints to be avoided.
Clear and Grubbing	Graders, bulldozers and scrapers are used to clear the rail corridor ready for construction to commence. During this process, sites of heritage significance and priority flora are fenced off, severed pastoral fences are repaired, and topsoil and vegetation are removed and stored separately for use during rehabilitation once the railway is completed.

Construction Activity	**Description**
Temporary Facilities	Temporary facilities such as construction facilities, water supply, mobile workshops, batching plants, etc. are established. Many of these facilities are established progressively with the active front of construction.
Bulk Earthworks and Rail Formation Construction	Once initial clearing and grubbing has been completed, a fleet of heavy earthmoving equipment such as graders, bulldozers, scrapers, dump trucks, water carts, compact rollers and loaders are utilised in the construction of the rail embankment and formation. Excavation and placement of suitable material must be undertaken in a specific manner to ensure the integrity of the rail formation is maintained and able to withstand the weight of the loaded rolling stock and weathering by the natural elements.
Culvert Construction	The location of culverts will be identified during the initial surveys of natural drainage systems. Placement of corrugated, galvanised iron culverts will be undertaken during the bulk earthworks stage. The culverts will be surrounded by concrete stabilised fill, placed at specific locations to enable uninterrupted water flow. Culverts will be protected both upstream and downstream with rock armour. Culverts will be designed to allow no rail formation over topping for peak flow Average Return Interval (ARI) events of 1 in 20 years. In the areas where grove and intergrove Mulgas are present, environmental culverts will be installed to maintain/re-establish the sheetflow necessary for Mulga to survive in good condition (refer to Section 6.1.4).
Blasting	In areas that have large amounts of rock, blasting will be used to break up the rocks. For this Project a detailed cut to fill model will be established to minimise the practicable extent of blasting required and also the need to source additional borrow material.
Borrow Pits and Quarries	A number of borrow pits will be required to supply suitable construction material. These will be opened and rehabilitated progressively to keep pace with the active front of rail formation earthworks. Similarly, if an existing quarry cannot be utilised to source ballast material then another quarry will need to be developed to supply this material.
Bridge Construction	Independent bridge construction crews will work on separate bridges at the same time to ensure their completion and integration with the rail formation being built. Bridge superstructure will be built off-site and transported to specific areas for assembly where more than one span is required. Bridges will be designed so that they shall not be overtopped by a 1 in 50 peak flow ARI event.
Site Rehabilitation	Site rehabilitation will be undertaken progressively wherever practicable (refer to Rehabilitation and Revegetation Management Plan, Appendix D). However, much of the rehabilitation works can only be undertaken towards the end of construction activities and once the bulk of disturbance has been completed. Disturbed areas will be used as temporary laydown areas for sleepers and culverts to help minimise the extent of disturbance.
Sleeper and Track Laying	Once the rail formation has sufficiently progressed, sleeper and track laying will commence. A train carrying lengths of pre-welded track, approximately 400 m in length will be used to transport the material to site. A track laying machine will lay the track which will then be automatically clipped into place on the sleepers. The track laying machine will then roll forward over the newly laid track and another length of track will be pulled off and clipped into place prior to welding the rail.
Ballast Laying	Ballast will be brought in via ballast trains and dumped over the recently laid track. Specialist train equipment such as rail tampers and regulators will be utilised to compact and form-up the ballast bed to around 200 mm - 250 mm around the rail sleepers and track.

Construction Activity	Description
Signals	Signals and communications will be incorporated into the track during and after construction, including signal lights at level crossings and switch pads.
Commissioning	Commissioning will comprise the running of light high-rail vehicles along the new railway, followed by a series of incrementally loaded trains until fully loaded trains are run and the rail track is opened for operations.
Demobilisation, Final Rehabilitation and Monitoring.	Prior to departure, the supervising engineers will retain a small team of construction equipment and contractors to undertake final rehabilitation works, completing any outstanding rehabilitation and repair work, demobilise construction facilities and temporary facilities along the rail corridor, remove overburden materials and repair pastoral fences etc. A construction facility will be retained and used as a maintenance facility for ongoing maintenance operations.

5.4.7 Sheetflow Maintenance

Grove and intergrove Mulga stands occur in areas on the southern slopes of the Chichester ranges between the range and the Fortescue Marsh. These Mulga groves are thought to rely partially on sheetflow to trap moisture for survival (Section 4.5.2.3). In consultation with CALM a number of drainage alternatives were considered and the environmental concepts shown in Figure 34 are proposed for the Project to redistribute surface water flows and minimise impacts on these Mulga communities.

These drainage redistribution systems will be spaced as required (at approximately 50 m to 100 m intervals) where the railway runs through the Mulga stands.

5.5 GENERAL

5.5.1 Ancillary Services

The mine sites and rail terminals will each have support facilities located on-site. Potable water will be provided from the borefield. At the accommodation facilities, control rooms and maintenance facilities, packaged sewerage treatment plants or septic systems will be installed.

The siting of temporary facilities required during construction will take into consideration the location of:

- significant flora populations or vegetation communities;
- significant fauna habitats or threatened fauna populations;
- sites of Aboriginal heritage significance;
- proximity to water supplies;
- topographic constraints and potential impacts on the surface hydrology of the site; and
- areas prone to flooding.

Existing areas of disturbance will be used, if practicable, to minimise the extent of clearing required for temporary facilities.

5.5.2 Dangerous Goods

There will be two types of dangerous goods on the mine sites:

- Hydrocarbons: including oils, greases, fuels (petrol and diesel), degreaser, and kerosene; and
- Explosives: Ammonium nitrate fuel oil (ANFO) and water proof emulsions used as the blasting agents.

They will all be stored and used in compliance with relevant legislation and standards (e.g. *Explosives and Dangerous Goods Act* 1961 (soon to be updated); Australian Standard AS 1940-1993 for the storage and handling of flammable and combustible liquids. Bulk hydrocarbons will be stored in bunds.

On each site where hydrocarbons are stored or used, spill kits will be available and spill response plans formulated. Hydrocarbon wastes from maintenance facilities will be collected and disposed of based on the waste management regulations. A bioremediation facility will be established on mine sites for the treatment of oily waste.

Approximately 40 MLpa of diesel will be required to run the locomotives. As train refuelling will be undertaken at the Port (as part of the Stage A Project), it is unlikely that operational activities will require the presence of any significant volume of dangerous or hazardous substances to be either stored or used on site, other than fuel for the mining fleet. All diesel storage vessels and facilities will be constructed and operated in compliance with relevant legislation and standards including the *Explosives and Dangerous Goods (Dangerous Goods Handling and Storage) Regulations* 1992.

An explosives storage facility will be constructed away from other infrastructure and in accordance with the relevant regulations.

5.5.3 Waste Management

Waste management at the mine sites and east-west railway will be along the principles of:

1. Avoid: Reduce the amount of waste generated at the site;
2. Re-use: Re-use waste products without substantially changing their form;
3. Recycle: Treat waste that is no longer useable in its present form and use it to produce new products;

4. Energy Recovery: Adopt management practices that recover and use energy generated from waste;
5. Treatment and/or Disposal: Adopt management practices that reduce the potential for environmental harm by appropriately disposing of waste or treating and disposing of waste.

Waste that cannot be reused or recycled will be disposed of in landfill facilities, in accordance with relevant legislation and standards.

An education programme will be delivered to the workforce to raise awareness of waste management to help reduce waste generation and encourage reuse and recycling.

5.5.4 Fire Management

Fires are part of the natural Pilbara landscape as a result of lightning strikes (particularly during summer) and Aboriginal land management practices. The spinifex grasslands and Mulga stands are particularly prone to wildfires. Severe damage to the environment can occur when the frequency of fires is too high, fires are too hot, or fires are lit with the intent of causing damage to the environment and property, or as a result of negligence.

Generally, the common causes of fires at mines are:

- Electricity: use or misuse of electricity on battery locomotives, power cables, trolley wires, motors, electric heaters and even light bulbs.
- Deliberate or accidental activities: Welding, burning, smoking, blasting operations, or accidental leakage of petroleum products on hot machinery.
- Spontaneous combustion: when ventilation is not sufficient to carry away the heat of oxidation, e.g. slow oxidation of a pile of oily rags, old timber, can generate enough heat for the material to spontaneously ignite.
- Friction: Such as caused by overheating of brake bands, clutches, transmission gear boxes and v-belt drives, on equipment, vehicles and conveyors.

Construction activities can increase the risk of fire, particularly if there are inadequate fire protection measures in place (such as buffer zones free of vegetation around welding areas) or the workforce does not take care to prevent fires. FMG will prepare and implement a Fire Management Plan that will include work procedures for all welding and grinding work, personnel fire hazard procedures, fire response vehicles on site and bushfire contingency for the life of the Project. FMG will use best practice rail grinding technologies and spark suppression systems to reduce fire risk. During operations, FMG will ensure locomotive engines are well maintained to reduce the risk of sparks from the engine exhaust.

The construction and operational workforce will undergo Environmental Awareness training that will include fire protection and prevention measures, such as safe operating and waste disposal practices and restricted clearing within high fire risk areas. Track maintenance crews will be trained in fire fighting, and maintenance machinery will have water and fire fighting equipment on board.

5.5.5 Workforce and Accommodation

5.5.5.1 Construction

Accommodation facilities will be built for the mine site construction workforce located adjacent to the proposed minesite or Beneficiation Plant. The facilities will be upgraded for the administration, operations and maintenance personnel as construction work is completed, to provide permanent contractor accommodation.

Permanent common use buildings will generally be constructed of higher grade materials whereas accommodation facilities will be transportable. The facilities will include their own sewage plant and the treated grey water will be utilised for garden watering and dust suppression, within health standard requirements.

The construction workforce for the rail will be accommodated in either the mine site construction facilities or temporary construction facilities along the railway. FMG will also consider using existing facilities if possible.

5.5.5.2 Operations

Operational personnel will be housed predominantly in Newman with daily transport to the different mine sites. Mine contractor personnel will be employed as fly-in/fly-out (FIFO) but will be encouraged to be based in Newman.

Operational staff for the rail will be accommodated at Port Hedland or Newman (refer to the Stage A PER).

5.5.6 Access and Stock Management

Access to the mining areas are as follows:

- For the Chichester deposits at Mt Nicholas and Mt Lewin is via the Newman-Balfour Downs unsealed road, maintained by the East Pilbara Shire, and then northwards along an upgraded/new pastoral track.
- For the western Chichester deposits at Christmas Creek, access is via the Newman-Marble Bar unsealed road, maintained by the East Pilbara Shire, and then westwards along an upgraded/new pastoral track;

- For the Hamersley deposit at Mindy Mindy, access is via the Roy Hill-Marble Bar unsealed road, maintained by the East Pilbara Shire, and then south-westwards along an upgraded/new pastoral track.

Some of these roads are subject to inundation for short periods in wet weather. The site access roads from Newman will be upgraded to enable access for personnel, equipment and materials to the mine sites. The roads not currently maintained by the East Pilbara Shire will be maintained by FMG.

Access roads will be constructed to enable access to the support infrastructure associated with the minesite and Beneficiation Plant such as the train loading facilities, high voltage substation, water supply and accommodation facilities. Access will also be available via the access road to be constructed alongside the railway line.

Three major types of roads will be constructed:

1. General traffic roads: these roads, including mine general traffic roads, will connect the site access road and the operational centres (e.g. Beneficiation Plant, administration building, and accommodation at the site). These roads will be unsealed and built to a minimum width of approximately 7 m.

2. Ore truck and mine access roads: these roads within the mine are to provide the safe passing of the ore trucks, and will be about 28 m wide. Roads without passing ore trucks will be about 12m wide. All these roads will be unsealed and dust generation will be controlled by water trucks and/or alternative dust suppressant measures.

3. Conveyor and train access tracks: these tracks will be used for maintenance vehicles to access to the rail line or conveyor. These will be unsealed and about 7m wide.

These roads have been designed to minimise disruption to overland surface water flow (Section 6.1). The locations of these roads are shown on Figures 23 to 26.

Air strips will be required to cater for daily plane flights for Contractor FIFO personnel and emergency evacuations. The existing airstrip at Christmas Creek will be used, and the existing Mt Lewin and Mt Nicholas airstrips will be upgraded for use by the Project. At Mindy Mindy FMG will either utilise the existing HI or BHPBIO strips, or construct a new airstrip adjacent to the proposed mine camp (within the current proposed infrastructure footprint).

During construction and operation of the mines public access to the Beneficiation Plant and railway and mine areas will be restricted.

Fences disturbed during construction of the railway will be reinstated on completion of construction unless another agreement with the land holder is reached. Public access will be restored except where the risk to the public would be unacceptable (e.g. within operational and maintenance areas) and level crossings constructed.

FMG will liaise with the affected land holders regarding impacts on land access and land use to reach an appropriate outcome. Management measures may include additional fencing and gates, cattle crossings and land use agreements. Any road crossing of the railway will be constructed and signalled in accordance with Australian safety standards.

The proposed increase in road traffic on the Newman to Nullagine road is not expected to create unacceptable road safety conditions or adversely impact pastoral land use, provided there is appropriate signage and regular road maintenance. FMG will maintain all access roads constructed for the Project in a safe condition, and will contribute to the Shire maintenance programme for public roads leading to the Project area. In maintaining these roads, FMG will ensure that adverse hydrological impacts do not result following grading (refer to Section 6.1).

5.5.7 Inspection, Maintenance and Monitoring

FMG will manage its mines and rail facilities to ensure there are no unacceptable impacts on the environment as a result of its operations. Ongoing monitoring and community consultation will enable FMG to evaluate and modify its management measures.

Inspection work (both aerial and ground patrolling) associated with the mines and railway will be conducted in accordance with all statutory requirements and the specific operator's inspection and maintenance programme developed for this Project. Inspection patrols will be scheduled on a regular basis and will be used to detect third party activity near the mine(s) or railway, potential erosion areas, monitor sheetflow management measures, weed germination or other conditions potentially requiring possible remedial measures.

Liaison with land holders will be maintained to ensure that they remain aware of the restrictions on working in the vicinity of the mine site(s) or railway and to gather early warning of any of their activities that may affect either the mine site(s) or the railway.

Routine maintenance of the rail access/maintenance road will consist of regular checks on track condition and repairs as required. Emergency repairs or replacements along the railway will be conducted in the unlikely event of a major breakdown of the system, such as railway damage or derailment.

Field operators will undertake regular route inspections and maintain ongoing liaison with the community, pastoralists, tenement holders and other stakeholders. They will respond to maintenance requirements such as track, ballast and formation repairs, erosion, noise, dust and weed control.

A comprehensive environmental monitoring programme will be developed in the Environmental Management Plan (EMP) and implemented prior to construction for all of the mine sites, Beneficiation Plant and railway on both Stage A and B. The draft Construction EMP is presented as Appendix B. The general strategy will be to delineate those areas in the Project area that are ecologically sensitive and minimise disturbance as far as practicable. Monitoring frequency will vary with the sensitivity of the environment and will be detailed in the EMP.

6. ENVIRONMENTAL IMPACT ASSESSMENT AND MANAGEMENT STRATEGIES

6.1 SURFACE WATER

The EPA objectives for the Project with regards to management of surface water are to:

- maintain the integrity, functions and environmental values of watercourses and sheetflow; and
- maintain or improve the quality of surface water to ensure that existing and potential uses, including ecosystem maintenance are protected consistent with the Australian and New Zealand Water Quality Guidelines (ANZECC, 2000).

The surface hydrology of the proposed mine sites and railway was investigated by Aquaterra and its report is presented as Appendix F.

6.1.1 Open Pit Areas

6.1.1.1 Potential Impacts

The proposed FMG mine developments could potentially alter the existing surface water flow patterns in the development areas including flooding characteristics; scour and siltation of the drainage channels; inundation of upstream areas and water starvation to downstream areas. In particular, the grove-intergrove Mulga communities, which are partially dependent on sheetflow runoff, may potentially be impacted. The mine developments could also result in a potential reduction of surface water runoff volume and quality in the downstream environment.

The four mine sites being developed by FMG are located in the Upper Fortescue River Catchment, as shown in Figure 9. All four mine development areas are located above potential flood storage level in the Fortescue Marsh. The proposed open pit mining areas are located on the lower flanks of the Chichester and Hamersley Ranges and their development will interrupt existing surface water flow patterns.

The potential impact of runoff water volume loss to the Fortescue Marsh, due to the proposed pit developments, is considered to be minor. This can be illustrated by a comparison of the area collectively intercepted by the pit development with the catchment area of approximately 31,000 km^2. During the mining phase, assuming that a quarter of the pits are open at any one time (a conservative estimate, as FMG will minimise its open areas), the open pit areas will represent approximately 0.1% of the total Marsh catchment area. Whilst this temporary reduction in catchment area does not represent a significant catchment loss to the Marsh in the context of natural seasonal variability of catchment yield to the Marsh, it is recognised that the proposed extent of open pit may result in localised hydrological impacts if not appropriately managed. However the proposed management measures including stream diversions and pit catchment management works, as shown in Figure 35, will ensure that any potential impacts can be managed effectively.

Due to the proposed pit locations, the upstream pit perimeters will typically be located in defined creek flow zones whereas their downstream perimeters will tend to be in sheetflow zones. Some of these sheetflow zones contain grove-intergrove Mulga communities immediately downstream from a pit development area. Such zones are located downstream of the proposed Christmas Creek and Mt Lewin mining areas and there is potential for these areas to be impacted by the loss of surface water flow.

Grove-intergrove Mulga communities are reported to be dependent on both direct rainfall and sheetflow for providing soil moisture and nutrients for stability and productivity (Anderson and Hodgkinson, 1997). To determine the extent that grove-intergrove Mulga communities are dependent on sheetflow and their potential to be impacted by interruption to sheetflow runoff from mining activities, assistance and advice was sought from both the Mulga Research Centre (Curtin University of Technology) and the Ecosystem Research Group (University of Western Australia). These research establishments have undertaken extensive investigations and are familiar with other research into various aspects of the Mulga communities. Work undertaken to date indicates that numerous factors affect the ecology of the grove-intergrove Mulga communities, and therefore quantitative data on the upstream catchment area required to sustain the communities cannot be determined adequately (refer to Section 6.1.4).

During a runoff event, the Pilbara creek systems discharge water with naturally high turbidity and sediment loads (WRC, 2000). In proximity to the pits, diverted flows may potentially increase their naturally high sediment and turbidity loadings. However, these potentially elevated levels will dissipate quickly with distance from the pit area. The closest mine pits to the Fortescue Marsh are those at Christmas Creek with a minimum separation distance of 6.5 km. The potential impact on runoff water quality draining to the Marsh from these external diversion works at Christmas Creek and other sites, in particular sediment loadings and turbidity, is also assessed as being minor due to the large distances between the pit development areas and the Fortescue Marsh and the naturally high turbidity and sediment loadings of the flows.

During the mining process, it is proposed that the pit areas at all four mine sites will be progressively backfilled above the water table. Upon completion of mining, if practicable, the pits will be backfilled to a level above the lowest elevation on the pit perimeter to ensure that the finished pit surface is continuously draining to this area. The backfilled pit surface will be finished with a layer of fine-grained material and material suitable for revegetation, such that surface water runoff from the backfilled pit area will drain to the downstream environment. Some portions of the pits may be preferentially backfilled during the mining process, to enable upstream (external) surface water runoff to pass through the pit area, rather than be diverted around the pit footprint, within engineering safety constraints.

6.1.1.2 Management Strategies

Surface water protection bunding will be constructed around the pit perimeters in stages, as the pits are developed. Where feasible, upstream surface water flows will be diverted around the pit development areas and directed into adjacent defined surface water pathways. Where adjacent water flow pathways are not present, diverted water will be directed around the pit areas to join existing downstream flow pathways.

Where sheetflow zones are located immediately downstream from the pit area, diverted surface water will be discharged over a riprap (rock fill) pad to encourage the flows to slow and disperse. The conceptual layout for diversion of runoff around the open pit areas is shown in Figure 35. Sheetflow dependent areas will be identified through surveys conducted prior to mining

Where diversion of upstream surface water runoff around the pit perimeter is not feasible due to topography, the surface water runoff will pond against external bunds and either be removed by pumping or allowed to dissipate by evaporation and seepage. Alternatively, the upstream surface water runoff will be allowed to discharge into the pit area (within engineering safety constraints). In-pit sumps and pumps will be designed to manage any external surface water entering the pit, together with in-pit stormwater volumes.

Management of interruption to surface water sheetflow in the mining areas may also include in-pit collected surface water runoff being irrigated over the downstream zone (depending on water quality) to support sheetflow dependent vegetation communities. However, as sheetflow only occurs following a major rainfall event, then this irrigation system will only be used following such an event.

The proposed irrigation system, as conceptually shown in Figure 35, will comprise a separate mobile pump feeding water to a moveable spreader pipework system. Irrigation will not be applied to grove-intergrove areas that are approved to be cleared by future mining activities except for trial purposes. Sediment basins will be used to treat in-pit water prior to any irrigation discharges to the downstream environment. With this treatment the potential increase in sediment loading to general runoff water quality in the downstream environment will be minimal.

To reduce water abstraction from the water supply bores, it is proposed that the in-pit water will also supplement process water.

Upon completion of mining, the rehabilitated backfilled pit area would drain to the natural downstream environment. The backfilled pit surface will be finished with a layer of fine-grained material and material suitable for revegetation, such that surface water runoff from the backfilled pit area will be able to drain to the downstream environment. With these management works, impacts to a grove-intergrove Mulga community located immediately downstream from a pit development area would be minimised.

6.1.2 Overburden Placement

6.1.2.1 Potential Impacts

During the initial mining phases, areas will be established to contain overburden from mining and rejects from the processing stream. However, as mining progresses and open pit space becomes available, overburden will be deposited in the pits. Generally, these initial overburden placement areas will be established in the higher elevation areas upstream from the open pits. In these areas of higher elevation, drainage is generally characterised by defined creeks, therefore the proposed overburden placement locations will avoid the lower elevation sheetflow zones. Additionally, as the immediate downstream area contains an open pit, the overburden placement areas have a reduced potential to impact the downstream environment.

The overburden placement areas will be bunded and upstream flows will be diverted to join existing downstream drainage lines, or dispersed to mimic sheetflow. Where diversion of upstream surface water runoff around the bund perimeter is not feasible, external runoff water will pond against the overburden placement areas and be dissipated by evaporation and seepage. In these locations, the overburden placement areas will likely form part of the surface water protection works for the downstream pit.

With the proposed management measures outlined below, the reduction in surface water runoff volume as a result of construction and operation of the overburden placement areas is considered minor and localised, as most external surface water will be redirected around the overburden placement areas and redistributed downstream. Internal runoff collected from the overburden placement area will be directed through sediment basin interceptors, to reduce sediment loadings and turbidity prior to discharge to the downstream environment. Any reduction in surface flow volume will be minor when compared with the overall catchment runoff.

6.1.2.2 Management Strategies

Surface water protection bunding will typically be constructed around the overburden placement perimeters. These protection works, comprising a combination of earth bunds and diversion channels, will prevent external surface water from entering the sediment prone overburden areas. Where feasible upstream surface water flows will be diverted around the overburden placement areas and directed into defined surface water pathways either adjacent or downstream from these areas. Where appropriate, riprap pads will be provided in key areas along the edges of the diversion bunding to slow and redistribute runoff. This is a similar concept to that shown for mine pit areas in Figure 35.

Surface water runoff will be drained from the top and batters of the overburden placement areas, to the downslope sides and then directed through sediment basins, to reduce sediment loadings and turbidity, prior to discharging to the downstream environment.

For long-term closure conditions, riprap pads will be provided, as appropriate, at the exit from the overburden placement areas to slow and redistribute runoff.

6.1.3 Beneficiation Plant

6.1.3.1 Potential Impacts

The Beneficiation Plant site will initially be developed at Christmas Creek mine, and later moved to Mt Nicholas mine site. These plant sites will be located in the general sheetflow zone downslope from the open pit areas and upslope from the railway.

It is considered that the Beneficiation Plant will have a minor impact on the surface water runoff volumes due to the relatively small area utilised for the Plant compared with the total catchment area of the Marsh and that surface water runoff will be diverted around the site. Surface water runoff internal to the Beneficiation Plant will be retained for use in the process.

The ore stockpiles are expected to have a minor and localised impact on the surface water runoff volumes and have only localised and minor impacts on the surface water runoff quality in the downstream environment, as perimeter bunding will divert surface flows away from the stockpiles, and internal drainage from these areas will be collected for use in the Beneficiation Plant.

6.1.3.2 Management Strategies

The Beneficiation Plant site has been selected to minimise impact arising from sheetflow interruptions to the downstream environment particularly the Mulga grove-intergrove areas. The plant site will be bunded as appropriate to prevent external surface water runoff entering the infrastructure area and to retain internal drainage. The internal drainage will be collected and reused in the process water circuit.

Ore stockpiles will be established at the Beneficiation Plant and at the train loading facilities in the rail corridor. These stockpiles will typically occupy relatively small areas and will be bunded to contain internal drainage and protected from any external surface water runoff. Water collected from within the bunded areas will be returned to the process water circuit.

Runoff from haul roads may be collected in sumps and reused where practicable.

6.1.4 Railway

6.1.4.1 Potential Impacts

The FMG east-west railway will be constructed along the north side of the Fortescue Marsh linking the Mt Nicholas mine site to the FMG Stage A railway corridor, as shown in Figure 9. This east-west route is around 160 km in length and links the Christmas Creek and Mt Lewin mine development areas. Located predominantly on the lower slopes of the Chichester Plateau, the railway corridor typically crosses perpendicular to the surface water flow directions although in some areas of sheetflow localised topography causes surface water to flow in directions other than north-south and in these areas the railway does not cross perpendicular to the sheetflow direction. The corridor crosses numerous small creeks (Section 4.3.2) but no major river systems, with the largest flowpath being Kulkinbah Creek draining a catchment area of around 770 km^2 above the railway corridor.

The railway construction, comprising predominantly cut and fill earthworks, could potentially interrupt the surface water drainage features that naturally cross the rail corridor. Inappropriate management of these features could alter existing natural drainage patterns including flooding characteristics; scour, erosion and siltation of the drainage channels; inundation of upstream areas and water starvation to downstream areas where sheetflow is modified.

Defined Flow Channels

Where the railway formation crosses defined flow channels culverts will be designed and installed to safely pass the 20 year ARI (Average Recurrence Interval) flood event. Although these culverts will partially constrict flood flows, they will not prevent runoff draining to the downstream environment. During a flood event, water levels upstream of the culverts may become elevated and pressurise the flow through the culverts generating a higher velocity discharge stream. Downstream from the culverts, the discharging water slows and reverts to natural flow conditions and water levels are not affected.

Where the railway formation is located such that topography would cause intercepted drainage pathways to flow along the upstream side of the formation for long distances, there is potential that large and erosive drainage discharges could develop.

Sheetflow Areas and Mulga

Along the flanks of the Chichester Ranges, the FMG east-west rail corridor passes through areas where partially sheetflow dependent grove-intergrove Mulga vegetation occurs. It is generally reported by CALM and others that in grove-intergrove mulga communities the runoff shadowing effect caused by a linear structure such as a road or railway has a detrimental effect on the community. These linear structures cause an interruption to sheetflow through the area and a subsequent reduction in the potential for soil moisture replenishment in the mulga grove areas. Most of these anecdotal observations in the Pilbara describe extensive areas of dead mulgas, some of which are located downslope from road and railway alignments. Observations also report extensive areas of healthy grove-intergrove mulgas located downslope from roads and railways.

The Ecosystem Research Group from the University of Western Australia has an on-going study investigating the impacts of linear structures on grove/intergrove mulga communities in the Pilbara (*pers. comm.* Dr Pauline Grierson). Although these investigations are yet to be completed, they have as yet not been able to fully quantify or even determine qualitatively the catchments required for mulga species. The studies at UWA have so far focused on detailed field surveys of mulga health, recruitment and carbon patterns across extensive rail lines in the Pilbara and they can not yet identify either clear patterns in mulga health or adverse effects directly resulting from infrastructure shadowing. Because of the often contradictory survey results, remote sensing and GIS are now being used to quantify both spatial extent of areas where mulga is showing signs of stress and to identify patterns of decline in association with rail lines, slope position and culvert placement.

Dr Grierson's personal opinion is that the importance of overland flow is still to be established and that there is likely to be a strong interaction among placement of roads and railways in alignment with natural breaks in the landscape, the infrastructure acting as fire breaks and the placement of culverts all interacting to influence Mulga condition (*pers. comm.* Grierson).

Downstream impacts or "water shadow" is reported to be related to the degree to which the Mulga is dependent on runoff from upslope (noting that such slopes are usually subtle). In typical grove-intergrove Mulga patterns, the Mulga in the grove is mainly dependent on runoff from the intergrove upslope (usually 20 m – 50 m in width). In such areas reports and observations suggest that road water shadows are generally less than 100 m wide. Railways should act in a similar manner to roads, however culverts and other measures can be employed to prevent sheet flow blockage (*pers. comm.* Dr. E. van Etten). If Mulga groves are generally dependent on runoff from the intergrove upslope, this suggests that water shadow would not extend far beyond one grove-intergrove stand of Mulga downstream of a surface flow barrier. However, FMG believe that downstream impacts from the rail will be minimal, due to the placement of culverts and sheetflow redistribution systems that will be installed (see Section 6.1.4).

FMG recognises the significance of the mulga and associated vegetation communities located in the general project area and believes that runoff shadow from their works could potentially have an effect on the downslope environment. As such, FMG will conduct operations and implement management measures to minimise the potential for impacts as described in detail later in this section.

The access road adjacent to the railway needs to be considered in conjunction with the railway formation for the potential to block the sheetflow pathways and to introduce sediments into the surface water runoff. To maintain the access road, regular grading will be required. Grading typically results in the formation of a loose earth windrow along the road verges. If the access road is located such that sheetflow collects against these windrows, this loose material will tend to be mobilised by the flows and redistributed downstream. Additionally, diverted water may pond over poorly graded sections in the road. Grading of roads may also lower the elevation of the road which may result in ponding, and may require the use of borrow pits to build up the road surface to its original elevation (see Section 5.4.2).

6.1.4.2 Management Strategies

The proposed alignment for the railway has been pushed further north into the footslopes of the Chichester Ranges, so that it intercepts more defined channels than to the south (see Section 5.2). However, because of the nature of the landscape in the footslopes of the Chichester Ranges, where defined channels are adjacent to gently sloping areas, the rail will still cross some sheetflow areas, despite its position in the footslopes. Culverts will be installed under the east-west railway at all drainage crossings and in the sheetflow areas at frequent intervals of at least 50 m to 100 m or wherever there is a depression. These culverts will be designed with erosion protection works, as appropriate, to neutralise the potential for adverse water flow impacts. Installation of the railway embankment with appropriate culverts will ensure that upslope surface water runoff drains to the Fortescue Marsh.

In proximity to the culverts, localised higher flow velocities occur and will require the installation of appropriate erosion protection. Methods to manage these potentially adverse factors to acceptable levels include limiting the upstream water levels by installing larger culverts, the provision of riprap or similar scour protection blankets and at some locations the provision of additional support earthworks.

Where the railway formation is located such that topography would cause intercepted drainage pathways to flow along the upstream side of the formation for long distances, there is potential that large and erosive drainage discharges could develop. In these areas, additional culverts will be installed under the railway formation at regular intervals together with small interceptor embankments to direct runoff into the culverts.

The railway access road will be constructed on the downstream side of the rail formation. Adjacent to the sheetflow culverts a shallow dip will be constructed in the access road using cement stabilised road base material. Graded windrow material will not be placed in this flow zone.

For the sheetflow redistribution system, as conceptually shown in Figure 34, a small ditch or similar structure will be constructed along the contour, using survey control, with a level outflow sill to uniformly distribute runoff to the downstream environment. Discharges to the redistribution system from a 300 mm diameter sheetflow culvert, would be relatively small (peak around 60 L/s) due to the culvert's limited flow capacity. Hence flow velocities through the redistribution system would be relatively low and non-erosive.

Prior to entering the system, runoff from the culvert will be discharged to a silt trap that will overflow to the redistribution system. A small riprap pad will be installed directly in-line with the redistribution system inlet, to restrict any potential for flows to breakout of the ditch before lateral redistribution. The final design layout for the redistribution system will be based on field trials that will be completed prior to construction. The operation of the redistribution system will be monitored and maintained with modifications made as considered appropriate to ensure its effectiveness over time. The Surface Water Management Plan will include measures to ensure that:

- sheetflow redistribution system levels are maintained;
- redistribution systems and culverts are maintained in operational order and free from blockage; and
- the redistribution systems are effective for the life of the Project.

FMG have conducted an initial onsite trial into management of surface water via a sheetflow redistribution system. Detail of this system is provided in a report by C. Muller (2004) (see attachment to Appendix F). The purpose of this trial was to:

- Improve the understanding of natural surface flows in mulga communities, including spread from a point discharge such as a culvert;
- Field trial alternative redistribution structures; and
- Investigate potential significance of subsurface flows from redistribution structures.

The two alternatives that were trialled were a spreader ditch and levee banks. The spreader ditches were constructed along the contour by a backhoe and were 0.5 m wide and 0.5 m deep. Levee banks were constructed using river shingle, with the intent that they create a permeable barrier that would slow and spread out the water, with water percolating across a wider area than with unimpeded flow.

The trial demonstrated that permeable levee banks offer promise to redistribute water effectively and cheaply. Close culvert spacing and overlapping levee banks could potentially virtually eliminate drainage shadow. During the trial some difficulties were experienced with the spreader ditches. This included cows damaging the ditch and parts of the ditch eroding and creating small drainage channels. Subsurface flow from the redistribution systems were shown to be minor.

On the "Grove/Intergrove" site the water spread laterally before reaching the grove. Prior to the trial, it was anticipated that the mulga grove would act similar to the levee, as an obstruction to spread the water. This proved not to be the case. The water spread out before reaching the grove, and there was much less spread within the grove itself. A possible explanation for this is that the grove has acted over the years as a silt trap and/or reduced sheet erosion and as a result is marginally higher than the surrounding land, resulting in the water spreading in the marginally lower areas immediately before the grove. The differences in levels are slight, and are less than the overall fall towards the grove. The density of sampling points in the survey carried out prior to the trial was insufficient to identify this small change over a large area evidenced by the water flow.

To build on the current level of understanding and the findings of the study, it was recommended that FMG consider the following further work:

- Conduct trials with a range of graded rock material from likely sources to determine optimum material for levee bank construction to provide the balance between spread and permeability. Such trials could include:
    - heavy sediment loads to provide accelerated siltation so as to investigate long term performance
    - varying widths of levee to determine the maximum width that will provide the desired permeability
    - assessment of the resistance to cattle damage
- Investigate the susceptibility to erosion/damage of the spreader levees under full discharge plus head for the design return period event for the railway line, and determine if gabions or similar are required at discharge points.
- Investigate the maximum effective length of spreader levee for a range of rainfall events, from the minimum that is expected to result in overland flow, to the maximum discharge event. This will assist in design of culvert spacing in areas where sheet flow is to be re-established.

FMG will undertake additional trials on the redistribution system prior to the construction of the railway. The purpose of these trials will be to add to the existing knowledge and will consider the inclusion of the above recommendations.

6.2 GROUNDWATER

The EPA objectives for the Project with regards to management of groundwater and Project water supply are to:

- maintain or improve the quality of groundwater to ensure that existing and potential uses including ecosystem maintenance are protected consistent with the Australian and New Zealand Water Quality Guidelines (ANZECC, 2000); and
- maintain sufficient quantity of groundwater so that existing and potential uses, including ecosystem maintenance, are protected.

The hydrogeological impacts of the Project were investigated by Aquaterra. The full report is presented as Appendix G.

The hydrogeology of the four mines and the water supply borefield was simulated in two numerical groundwater models. The first includes the features of the Fortescue Valley (i.e. the borefield, Christmas Creek, Mt Lewin and Mt Nicholas) the second model represents Mindy Mindy which lies south of the Fortescue Valley. Each of these models is summarised below (Section 6.2.1 and 6.2.2) and then the potential impacts of mine dewatering and borefield abstraction are discussed in Sections 6.2.3 to 6.2.10. The cones of depression resulting from mine dewatering and borefield abstraction are shown (overlaid on vegetation types) in Figures 36 to 39. Potential impacts on groundwater dependent vegetation are also discussed in Section 6.3.7.

The temporary abstraction of groundwater for the proposed east west railway construction was modelled using a lump parameter model. The potential impacts of abstraction for the railway are discussed in Section 6.2.11.

Finally, water efficiency, proposed further work and contingency strategies are discussed in Sections 6.2.12 to 6.2.14.

6.2.1 Christmas Creek, Mt Lewin and Mt Nicholas Mines and Borefield Groundwater Modeling

Pit dewatering will be required at the Christmas Creek, Mt Lewin and Mt Nicholas mines (the Chichester Mines) to enable mining of the lower lying parts of the ore bodies, which are below the current water table. The dewatering will occur via a series of bores and the abstracted water will supplement water to be provided from the water supply borefield.

Groundwater levels within the Project area have been modelled during the life of the Project assuming an annual water requirement of 11 GLpa from a combination of dewatering of the Chichester mines and the water supply borefield. For modelling purposes surface water storage within the pits was not considered to provide a reliable supply of water for the ore beneficiation process and therefore was not included in the model.

6.2.1.1 Model Results

The abstraction of groundwater either for dewatering or from the water supply borefield will result in a lowering of the groundwater table known as a cone of depression. Maps showing the predicted cones of depression during the life of the Project resulting from pit dewatering at Christmas Creek, Mt Lewin and Mt Nicholas mines and abstraction from the water supply borefield, are presented in Figure 36 (5 years), Figure 37 (20 years) and Figure 38 (30 years; 10 years post-decommissioning). Key features of the maps are:

- a cone of depression resulting from groundwater abstraction extending from the water supply borefield;
- in Mt Lewin and Mt Nicholas water levels are drawn down below the base of the pits (400 mRL) due to the cone of depression from the borefield;
- the cone of depression resulting from abstraction from the water supply borefield and dewatering of the Mt Lewin and Mt Nicholas pits extends to several creeks that flow into the Fortescue Valley (potential impacts on phreatophytic vegetation are discussed below in Section 6.2.3);
- groundwater levels in the southern extent of the Christmas Creek pits are reduced by 30 m, to a level of 380 mRL, which equates to the base of the pit (potential impacts of saline groundwater at Christmas Creek are discussed in Section 6.2.5);
- groundwater levels are drawn down by 1 m at a distance approximately half way between the Fortescue Marsh and the proposed Christmas Creek pits (potential impacts on the Marsh are discussed below in Section 6.2.7); and
- groundwater levels will be reduced in station bores in the vicinity of the proposed pits and water supply borefield (this is discussed in Section 6.2.8).

Groundwater abstraction will withdraw approximately 176 GL of groundwater over the life of the Project. The work undertaken to date indicates that abstraction from the water supply borefield is sustainable, within the context of potential impacts and management strategies discussed below and will not adversely affect existing and potential users, including ecosystem maintenance. However further work is proposed by FMG to verify the work to date, as outlined in Section 6.2.13.

6.2.2 Mindy Mindy Groundwater Modeling

Pit dewatering will also be required at the Mindy Mindy mine. Most of the water abstracted will be used for dust suppression, with the remainder used for domestic purposes at the mine site camp. There will be no additional water to discharge. Based on work in other parts of the Pilbara, groundwater in the CID is expected to have a salinity of between 1,000 and 2,000 mg/L as TDS.

In the conceptual model of Mindy Mindy, the Channel Iron Deposit (CID) aquifer, which is up to 34 m thick, has been deposited within the palaeo-channel. The direction of the palaeo-channel approximately mimics the present day drainage channel. The CID is expected to have a hydraulic conductivity of 10 m/day and a specific yield of 0.03, based on projects undertaken on similar deposits in the Pilbara.

The bedrock underlying and adjacent to the palaeo-channel is considered to be relatively impermeable. The bedrock comprises the Weeli Wolli Formation in the south and west of the area, and the Brockman Iron Formation in the north.

Recharge to the system is estimated to be equivalent to approximately 1% of annual rainfall to the entire catchment. Abstraction for water supply will commence at the start of mining although, for the first four years, the mined area will be above the current groundwater table and dewatering will not be required for mining purposes.

Groundwater flow occurs through the CID in a northwest direction within the Mindy Mindy palaeo-channel. This flow has been estimated to be $200m^3/d$. Further downstream, this water currently discharges into the sediments that in-fill the Weeli Wolli Creek. Throughflow in the Weeli Wolli Creek estimated at 10 ML/d discharges into the sediments of the Fortescue Valley.

6.2.2.1 Model Results

A map showing the predicted cones of depression from pit dewatering at Mindy Mindy are presented in Figure 39.

Dewatering rates are predicted to be an average of 0.4 GLpa. As a result of the abstraction, throughflow to the Weeli Wolli system will decline by 0.4 ML/d (400 m^3/d). This is equivalent to 4% of the estimated total through flow of the Weeli Wolli groundwater system. This is not expected to impact groundwater dependent vegetation or Weeli Wolli Springs as discussed below in Section 6.2.4.

6.2.3 Groundwater Dependent Vegetation

6.2.3.1 Potential Impacts

Along the creeks there is the potential for phreatophytic vegetation woodland communities, including those containing River Red Gums *Eucalyptus camaldulensis*; Cadjeput *Melaleuca argentea*; and Coolibahs *Eucalyptus victrix*, which may act as phreatophytes along creek systems. FMG assessed vegetation types within the cones of depression that will result from mine dewatering and the borefield, using a combination of vegetation mapping by Biota and the Pilbara Rangelands Project Rangeland Mapping (Payne *et al.*, 2002) (Section 6.3.7).

Expected groundwater drawdown contours from borefield operation are overlain on this mapping in Figures 36, 37, 38 and 39.

At Mt Nicholas there are not expected to be any impacts on phreatophytic species within the area of groundwater drawdown.

Plate 5. Riverine vegetation including phreatophytes within the project area

At Mt Lewin the majority of vegetation types are unlikely to have any dependence on the water table due to the depth to groundwater of approximately 15 - 25 mbgl. Where there is *Eucalyptus victrix* open woodland (a potential phreatophyte) groundwater drawdown contours predicted for the Project area range between 1 m and 5 m, with the current groundwater level at ~15 - 25 m below the surface. The current level of groundwater dependence is likely to be low to moderate dependent on the rooting depth of the *E. victrix* associated with this creek. It is expected that the vegetation within the area of 1-2 m of drawdown would be unaffected by the proposal. Some of the individual trees in the areas where the groundwater will be drawn down by up to 5 m may be stressed (Biota, 2004f) and a properly designed monitoring and management programme will be implemented.

At Christmas Creek the majority of vegetation types within the creek areas are unlikely to have any dependence on the water table due to the depth to groundwater of approximately 20 - 25 mbgl. Where *Eucalyptus victrix* occurs, current groundwater levels in this area are at approximately 20 – 25 m below surface, and this is likely to be at the limit of eucalypt rooting depth. Groundwater modelling indicates that drawdowns of only ~1 m are likely to occur in the area of this vegetation type. This is likely to be within the typical seasonal and long-term variations in water table depth that the trees experience under natural conditions, therefore it is unlikely that any significant impact would arise from this level of change (Biota, 2004f).

As outlined above, dewatering at Mindy Mindy will cause a decline approximately 4% in throughflow to the Weeli Wolli groundwater system. It is not anticipated that such a change will have a noticeable effect on vegetation along the Weeli Wolli Creek or downstream in the Fortescue Valley. An analysis of the drawdown curve at Mindy Mindy shows there is one potential phreatophytic vegetation community occurring within the predicted drawdown area. However, groundwater modelling indicates that a drawdown of only 0.5 m is likely to arise from groundwater abstraction. As with Christmas Creek, this drawdown is likely to be within the seasonal and long-term fluctuation range that the keystone tree species in this riverine vegetation type would experience under normal conditions (Biota, 2004f).

6.2.3.2 Management Strategies

Whilst there is a low risk of impacting phreatophytic vegetation FMG have developed a Vegetation Monitoring and Management Programme (as part of the Borefield Management Plan) to ensure that any impacts on potentially groundwater-dependent vegetation are adequately managed. This will focus on the potentially affected vegetation identified at Mt Lewin.

Management measures are likely to include:

- The construction of groundwater monitoring bores in the alluvial and basement aquifers along creeks with potentially affected vegetation, prior to commencement of groundwater abstraction, followed by monitoring of groundwater levels.

- Development of improved numerical groundwater models (see Section 6.2.13) and annual calibration of these models so that future drawdowns for the life of the project can be identified in a timely manner before potential impacts occur.

- Vegetation condition assessments in those areas where groundwater levels have declined as a result of groundwater abstraction. If groundwater monitoring and vegetation condition assessments indicate a decline in tree condition due to drawdown, irrigation systems will be considered to support selected vegetation.

The monitoring results will be reported in the Annual Environmental Report, which is submitted to the DoE and the DoIR. Results will also be submitted to the EPA and CALM as required. FMG will make the monitoring results publicly available if required.

If the groundwater monitoring, groundwater modelling or vegetation condition assessments show that the groundwater abstraction from the proposed water supply borefield is resulting in unacceptable impacts, an alternative borefield will be developed in a timely manner as described under Section 6.2.14.

6.2.4 Weeli Wolli Springs

6.2.4.1 Potential Impacts

The Weeli Wolli Springs are an important feature of the Weeli Wolli Creek system. They are located approximately 20 km upstream from the proposed Mindy Mindy mine and there will be no impact on the springs as a result of the Project.

6.2.4.2 Management Strategies

No specific management strategies are required for Weeli Wolli Springs.

6.2.5 Saline Water at Christmas Creek Mine

6.2.5.1 Potential Impacts

As discussed in Section 4.4.2, saline water underlies part of the Christmas Creek pit. When an aquifer contains an underlying layer of saline water, and is pumped by a well penetrating only the upper freshwater portion of the aquifer, a local rise of the interface below the bore occurs. This phenomenon is known as upconing. With continued pumping the interface rises to successively higher levels. Once it reaches above a critical level it can reach the base of the bore, resulting in abstraction of saline water.

Investigations to date show that saline water beneath Christmas Creek is approximately 90 m below ground level. The depth of the pit on completion will be approximately 60 m below ground level (i.e. 30 m above the saline aquifer). Analysis of the aquifer, the orebody and pumping rates (see Appendix G) indicates that the extent of upconing of saline water is likely to be in the order of 10 m. Given that the floor of the pit will be 30 m above the current level of the saline water, it can be expected that, with an additional 10 m of upconing, the saline water will still remain 20 m beneath the mine pit floor. This indicates that there is little risk of saline water upconing into the pit.

6.2.5.2 Management Strategies

Whilst the risk of saline water upconing occurring to the extent that saline water is abstracted is considered low, as part of the groundwater monitoring programme, regular water quality sampling will be undertaken from dewatering bores and from approximately 8 monitoring bores installed to the south of the pit. Field measurements will be taken monthly and EC and TDS measured. This will identify if saline upconing is occurring and whether the method of dewatering needs to be modified. In the unlikely event of saline water being abstracted it will require careful management. This may include mixing saline water with fresher water to make it useable by the beneficiation process, or developing contingency plans to return the water back to the aquifer.

In the unlikely event that saline groundwater was abstracted it would require careful management. Any pipelines transporting the saline water would be bunded to reduce the risk of accidental saline water release and subsequent vegetation loss. Pipelines would also be regularly inspected, and have pipeline pressure monitoring installed to detect possible leaks.

6.2.6 Stygofauna

6.2.6.1 Potential Impacts

Any saturated gravel deposits along the Fortescue River and other creeks have the potential to support stygofauna. These deposits may be dewatered by abstraction from the mine dewatering or water supply borefields. There is therefore potential for stygofauna communities to be affected by the borefield abstraction (see Section 6.5).

6.2.6.2 Management Strategies

FMG has developed a subterranean fauna management which is presented as Appendix M (Section 6.5). The plan includes a commitment to monitoring of groundwater levels for two years prior to the commencement of operations, and a long-term plan will be developed if stygofauna are located.

6.2.7 Fortescue Marsh

6.2.7.1 Potential Impacts

The potential impacts on the Fortescue Marsh from the dewatering and borefield water supply have been assessed based on the numerical groundwater modelling and a conceptual model for the Marsh presented in Figure 14. This conceptual model is based upon groundwater level data, water quality analysis, topographical surveys, plus observations and the experience of Aquaterra and other consultants in the Pilbara.

There are two potential impacts that have been considered as a result of changes to the hydrogeology of the Project area:

1. Surface water in the Marsh will form less frequently than it does at present.
2. The Marsh may dry out more quickly than at present.

The Marsh is considered to be a surface water feature which relies on rainfall. The Marsh therefore forms after significant rainfall events. Evaporation from the water table results in groundwater levels being maintained 5 m below the base of the Marsh for the majority of the time and groundwater does not contribute to the surface water within the Marsh. Therefore, changes in the hydrogeological regime will not result in the Marsh being filled less frequently than at present.

Figure 14 shows an unsaturated layer below the bed of the Marsh. The volume of water draining from the Marsh into this unsaturated layer is limited by the available storage within that unsaturated zone. If drawdowns from the dewatering and/or water supply borefield were to extend below the Marsh, then the available storage would increase and would have the potential to increase the volume of water draining from the Marsh. However groundwater modelling indicates that the cone of depression from the dewatering of Christmas Creek will not extend as far as the Fortescue Marsh, and therefore, the volume of the unsaturated zone will not be increased and the Marsh will not be affected by drawdowns from the dewatering or borefield.

Risk Assessment

Given the limited available data and importance of the Marsh, a risk assessment, which considered the potential impacts on the Marsh as a result of the proposed Project, was undertaken. The results of this risk assessment are presented as Appendix N (minRISK, October 2004).

As part of the risk assessment process, the potential impacts on the Marsh from pit dewatering, the borefield supply and saline water were listed and the risks assessed using a model based on AS/NZS 4360: 1999 "Risk Management" and utilising risk criteria specifically developed from the guidelines within HB 203: 2000 "Environmental Risk Management".

For the purposes of the risk assessment the Marsh was defined as the area within the Australian Nature Conservation Agency (ANCA) boundary. A list of potential impacts on the Marsh was developed and consequence and likelihood estimated for each; the results are summarised in Table 12 below. The potential impacts in Table 12 are listed from those presenting the highest risk to those presenting the lowest risk. Except where the consequences were considered to be insignificant, mitigation measures were developed. The inherent risk represents the potential risks without management measures applied, whilst the residual risk represents the risks after mitigation measures have been implemented.

The overall residual risk to the Fortescue Marsh ecosystem as a result of the proposed Project was found to be minimal when control measures were considered. The initial, uncontrolled (inherent) risk levels were found to be low in most instances; due to the geographical separation of the mining, railway and borefield facilities from the Fortescue Marsh resulting in an insignificant impact on the surface or groundwater flows. Modelling of the groundwater reserves predicts minimal drawdown on water table levels within the immediate Marsh area and within the current range of variations due to normal rainfall effects.

Environmental damage resulting from unexpected events (e.g. hydrocarbon spills) was assessed as a low risk, due to the improbability of the event (on the basis of the routine practices demonstrated regularly elsewhere) and the emergency response plans proposed to mitigate any impacts. Seepage or spillage from within the proposed mining and processing areas was determined to be outside the area of influence for the Marsh, and, additionally, was to be minimised through bunding, process controls or localised catchments.

FMG will continue to work with CALM throughout the life of the Project to ensure that that the Project does not adversely affect the conservation values of the Fortescue Marsh, and where opportunity arises, to enhance the conservation values of the proposed conservation area (Section 6.13).

Table 12. Inherent and Residual Risks to the Fortescue Marsh (minRISK, October 2004)

Activity	Issue	Potential Impact	Consequence	Likelihood	Inherent Risk Rating	Residual Consequence	Residual Likelihood	Residual Risk Rating
Borefield operation	Groundwater	Drawdown impacting on the drying cycle of the marsh.	Minor	Possible	M	Minor	Unlikely	L
Mine Dewatering	Groundwater	Aquifer drawdown impacting drying cycle.	Minor	Possible	M	Minor	Unlikely	L
Borefield operation	Groundwater	Drawdown affecting water levels in the marsh and therefore vegetation.	Minor	Unlikely	L	Minor	Rare	L
Borefield operation	Groundwater	Drawdown affecting vegetation in Fortescue River and increasing sedimentation within marsh.	Minor	Possible	M	Minor	Rare	L
Mine Dewatering	Groundwater	Drawdown affecting water levels in the marsh and therefore vegetation.	Minor	Unlikely	L	Minor	Rare	L
Borefield operation	Groundwater	Drawdown affecting Stygofauna.	Insignificant	Rare	L			NC*
Borefield operation	Groundwater	Drawdown affecting yields from stock bores within marsh boundary.	Insignificant	Rare	L			NC*
Mine Dewatering	Groundwater	Drawdown affecting Stygofauna.	Insignificant	Rare	L			NC*
Mine Dewatering	Groundwater	Drawdown affecting yields from stock bores within marsh boundary.	Insignificant	Rare	L			NC*
Mine Dewatering	Groundwater discharge	Effect of disposal of saline water produced during pit dewatering	Insignificant	Rare	L			NC*
Mine Dewatering	Groundwater discharge	Flora loss from pipeline failure releasing saline water	Insignificant	Rare	L			NC*
Mine Dewatering	Groundwater discharge	Introduction of an artificial semi-permanent source of surface water at Mindy Mindy	Insignificant	Rare	L			NC*

KEY
NC – residual risk not calculated as the consequence was determined to be insignificant.
Minor Consequence – first aid treatment, on-site release immediately contained, medium financial loss
Insignificant Consequence – no injuries, low financial loss, negligible environmental impact
Possible Likelihood – could occur
Unlikely Likelihood – could occur but not expected
Rare Likelihood – occurs only in exceptional circumstance
L – low risk, manage by routine procedures
M – moderate risk, management responsibility must be specified

The risk assessment identified a number of aspects of the Project that could pose a medium environmental risk to the Marsh. However, the risk assessment identified that the application of management measures resulted in the residual risks being low in all cases.

6.2.7.2 Management Strategies

A series of management and mitigation measures were developed as part of the Risk Assessment on the Marsh. These can be summarised as follows:

- FMG will install groundwater monitoring bores between the water supply borefield and the Marsh and implement a groundwater monitoring programme throughout the life of the operation. Data obtained will be used to update the numerical groundwater model which will then be used to predict if any adverse impacts are likely to occur. The model will be calibrated annually. Monitoring data will be reviewed and hydrological reports produced.

- FMG will also install groundwater monitoring bores between the pits to be dewatered and the Marsh and implement a groundwater monitoring programme. Similarly data obtained will be used to revise the numerical groundwater model which will be used to predict adverse impacts.

- FMG will develop a contingency plan for timely development of an alternative water supply borefield if the groundwater impacts model and/or monitoring data predict an adverse impact on the Marsh or vegetation. Several contingency supplies have been identified and are discussed in the Borefield Management Plan (Appendix G).

6.2.8 Station Bores

6.2.8.1 Potential Impacts

Where the cones of depression from the water supply borefield and dewatering extend to station bores, there is the potential that yields from those bores will be reduced.

6.2.8.2 Management Strategies

Before commencement of mining it is proposed that a more detailed survey of station bores be undertaken. The groundwater models will then be used to identify commissioned bores that may be affected by the Project.

Possible mitigation measures may include deepening of affected bores or, where this is not possible, provision of an alternative piped supply from the dewatering bores or water supply borefield.

Water quality samples will be taken from those bores in the vicinity of Christmas Creek prior to commencement of the Project. The results will be used to determine if the salinity of water in these bores is being affected by the dewatering of the Christmas Creek mine.

6.2.9 Excess Water from Dewatering

6.2.9.1 Potential Impacts

There is a need to consider the consequences of intercepting greater amounts of water during the mining process than predicted. Other mining operations in fractured rock in the Pilbara, have intercepted more water than anticipated and the permeability of the Marra Mamba in other parts of the Pilbara is known to be highly variable. It is possible (whilst thought unlikely) that higher rates of dewatering than those predicted from the modeling could be required.

6.2.9.2 Management Strategies

The water requirements from the ore Beneficiation Plant are large in comparison to the predicted dewatering requirements, but in the unlikely event that the rate of dewatering were to exceed the water requirements, initially, the abstraction from the borefield would be reduced accordingly. It would then be necessary to store and/or discharge the excess water. There are several possible disposal mechanisms including;

- using the water to irrigate any vegetation affected by the cone of depression;
- piping the water to one of the many creeks in the area;
- discharging into one of the worked pits; or
- allowing the water to soak away into the Marra Mamba at a point away from the unworked pits.

The mechanism chosen would depend upon a number of factors, including the volume of water to be discharged, the location of the excess water and whether there are any worked pits in the vicinity. The management strategy would be chosen in consultation with the DoE, based on information available at the time. If management involved a discharge to the environment then prior to such a discharge, a suitable monitoring program would be developed to the satisfaction of the DoE.

6.2.10 Mine Closure

6.2.10.1 Potential Impacts

The mine closure plan involves the backfilling of waste material into the pits including overburden and rejects from the beneficiation process. It is proposed that each of the mine pits will be back filled to above the water table. Sufficient material is available to achieve this as described in Section 5.3.7.

The rejects from the ore beneficiation process will be low permeability material, which, if placed along the hanging wall, will have the potential to partially "blind" the hanging wall material (alluvium and Marra Mamba) and reduce groundwater flow. This has the potential to result in "backing-up" of water in the pits, forcing groundwater levels towards the surface.

The hydrogeology of the Marsh suggests that evaporation from below ground level can occur to a depth of 5 m in the Project area. It is concluded therefore that if such backing-up of groundwater did occur, evaporation from the resulting shallow water table would prevent this water appearing at the ground surface as a pool. Whilst evaporation of the groundwater would result in increased salinity, constant groundwater throughflow would maintain this at relatively low levels.

6.2.10.2 Management Strategies

The potential for backing up of groundwater in the Christmas Creek pits (if rejects from the ore-beneficiation process blind the hanging wall material) will be prevented by disposing of rejects above the existing water table. The management of other impacts associated with Mine Closure are discussed separately under Section 6.12.3.

6.2.11 Railway

6.2.11.1 Potential Impacts

It is proposed to construct temporary bores along the rail corridor to supply water during construction of the railway. The modelling results indicate that groundwater drawdowns from each bore are unlikely to extend for more than 250 m out from the bore. Drawdowns in excess of 2 m are predicted to be confined to within 100 m of each bore and groundwater levels are expected to recover to 2 m of the original level within 6 weeks after cessation of pumping. As discussed in Section 4.4.1, the available data suggests that the Fortescue Marsh is a surface water feature, and the surface water which forms within it does not represent groundwater discharge. At its closest point, the railway is approximately 4 km from the Fortescue Marsh and it is therefore unlikely that abstraction from the railway construction bores will impact upon the Marsh.

Existing groundwater levels along the route of the east-west railway are typically 10 mbgl to 20 mbgl (Figure 13), which is deeper than Mulga and Spinifex roots are thought to penetrate and it is therefore expected that the drawdown described above would not have any effect on non-phreatophytic vegetation. Along the major creeks that cross the rail corridor in the Mt Lewin and Mt Nicholas areas there are likely to be phreatophytic species (eg. River Red Gums *Eucalyptus camaldulensis* or Cadjeputs *Melaleuca argentea*). Therefore bores located close to creeks may have short-term impacts on phreatophytic communities, but this is unlikely to result in vegetation deaths, unless plants are already subject to stress, resulting from, for instance, grazing or drought. Bores required for construction of the railway will be located away from areas supporting phreatophytic vegetation.

Given the generally fine-grained nature of the alluvial aquifer, it is unlikely that there are significant numbers of stygofauna in the aquifers along the proposed railway. Studies elsewhere in the Pilbara have shown that stygofauna populations can tolerate short to medium term fluctuations in groundwater levels. Typically, it is expected that short-term perturbation as described above would have a local population level impact on stygofauna (if present), but would be unlikely to have a significant effect at the taxon or conservation status level (i.e. unlikely to lead to extinction of any species).

6.2.11.2 Management Strategies

It has been shown that there is unlikely to be any long-term impact on vegetation from the temporary abstraction of water for the construction of the railway except where bores are situated close to phreatophytic species, such as may exist along creek lines. Furthermore, the most likely habitats for stygofauna are within coarse-grained alluvial deposits within these same creeks. It is proposed to construct temporary bores for construction of the rail corridor no closer than 100 m from any creeks, to mitigate against potential impacts to phreatophytic vegetation and stygofauna. The distance of 100m was selected because modelling indicated that at distances of greater than this the cone of depression would be less than 2 m and, based on discussions with ecologists, it was determined that a drawdown of 2 m for the short duration that the railway bores will be operated would present a low risk to groundwater dependant vegetation. At distances of less than 100 m the cone of depression would be greater than 2 m and vegetation was more likely to be stressed.

6.2.12 Water Efficiency

FMG is conscious of the need for water efficiency at its operations and will be investigating and implementing a number of measures to maximise water efficiency. The beneficiation process will be further investigated to minimise the amount of water required and the volume of wet rejects that are generated. Based on the current process it has been estimated that 15% of the rejects will be in a slurry form. Research into the ore that FMG will mine and the specification for the final product will continue with the aim of reducing the amount of material requiring wet beneficiation and recovery of water from the rejects stream for reuse.

FMG will aim to maximise the opportunities to recycle the water that is used in the ore Beneficiation Plant and other activities on haul roads as a dust suppressant. Where practicable sumps will be constructed to collect runoff from the haul roads, with the collected water pumped to a tank for reuse as a dust suppressant. Alternatives to using water for dust suppression on haul roads will also be investigated. Water is likely to be present in the mine pits from groundwater seepage and direct rainfall into the pits. This water will be collected in sumps and used either as a dust suppressant, in the Beneficiation Plant or to irrigate Mulga communities downstream of the pit during sheetflow events (provided the water quality is acceptable).

Water efficient devices will be incorporated into the design of accommodation facilities and effluent from the sewage treatment plant may be reused for operational purposes (within health standard requirements).

6.2.13 Further Work

In the course of any groundwater modelling it is necessary to make a series of assumptions based on local and regional data. These assumptions include:

- Estimates of recharge to each of the different aquifers
- The recharge mechanisms
- The permeability and storage coefficients of the different aquifers

For this project Aquaterra have used results from the groundwater investigations undertaken, knowledge obtained from other work in the Pilbara and published data for the area. FMG also discussed the assumptions made with other hydrogeologists with experience in the study area and on this basis the assumptions were found to be reasonable.

However, to further verify the findings to date, FMG propose to conduct additional work. The work program is designed to confirm the assumptions in the numerical groundwater models and validate the results presented in this PER. This includes the drilling of trial water supply bores in the location of the proposed borefield, and trial dewatering bores in the proposed Christmas Creek and Mount Lewin pits. Furthermore a temporary abstraction bore is to be installed close to the Fortescue Marsh to confirm that the marsh will not be affected by changes to the hydrogeology of the project area. Details of the proposed further work are given below. It is expected that all of this work will be completed by the end of the first Quarter 2005. FMG proposes to submit the results of this work to the EPA for review prior to its decision on the project.

Water Supply Borefield

Work that has commenced already consists of the drilling of approximately 12 additional exploratory bores in the area south of Mount Lewin on existing FMG tenements. Information obtained from these bores will be used to verify the thickness of the alluvial deposits in this area and the topography of the basement material. In addition 5 trial water supply bores and 10 monitoring bores will be drilled in the location of the borefield. The trial bores will intercept the alluvium and underlying formation (Marra Mamba or Wittenoom Dolomite). Each of the trial bores will be test pumped for an extended period of time using a submersible pump. The results will be analysed to verify aquifer parameters. This information will be used to validate the assumptions within the numerical groundwater model and to confirm the extent of the cone of depression from the borefield abstraction.

FMG also proposes to measure groundwater levels in station bores within the predicted cone of depression, to provide improved understanding of regional groundwater levels.

Dewatering Requirements

Further work is proposed to verify the assessment of dewatering requirements. This will involve the drilling of trial water bores in the hanging wall material of the proposed Mount Lewin and Christmas Creek pits. Monitoring bores will also be drilled to penetrate the hanging wall material. Each trial dewatering bore will be test pumped using a submersible pump. The results of this investigation will be used to improve the numerical groundwater model, providing more accurate estimates of both the dewatering requirements for the Chichester Mines and the extent of the cone of depression.

Fortescue Marsh

FMG proposes to install a temporary abstraction bore close to the Fortescue Marsh. This bore will be test pumped for an extended period of time and the impacts on nearby monitoring bores already installed in the area will be measured. The results will provide additional information on the hydrogeology of the Fortescue Marsh and, in particular, any impacts on the marsh from groundwater abstraction resulting from either dewatering of the proposed pits or abstraction from the water supply borefield

6.2.14 Contingency Strategies

6.2.14.1 Borefield Management Plan

FMG has developed a draft Borefield Management Plan which outlines the proposed monitoring strategies and management proposals during operation of the borefield (see Appendix G).

This management plan details the approach FMG will take to conduct ongoing groundwater monitoring. It also identifies how monitoring data will be managed, analysed, reported and used. The plan also lists a series of triggers which will be used to predict when unacceptable impacts may occur and so that preventative action can be taken. It also includes a Borefield Contingency Plan which describes six potential alternative locations for the borefield and describes the process which would lead to the development of such an alternative site. One such situation which will be considered as part of this contingency plan is if dewatering at a mine produced more water than predicted (see Section 6.2.9).

This management plan will be reviewed by, and revised in consultation with, the DoE (WRC).

6.2.14.2 Alternative Borefields

Groundwater studies to date indicate that the proposed borefield will be adequate for the mining proposal and impacts predicted from the project can be managed appropriately. However, FMG has recognised that further work is required to fully confirm this and has proposed a program of further work as outlined above.

As described above (Section 6.2.14.1) FMG have, as part of the Borefield Management Plan, identified six alternative borefields which will continue to be investigated as contingencies. Should the further work outlined above indicate that development of the current borefield proposed is unacceptable, FMG will then pursue a contingency borefield.

In the event that FMG is required to develop an alternative borefield, it understands and accepts that the DoE may trigger a formal assessment of this borefield. This will include field work and the development of additional numerical models which will be used to determine environmental impacts.

6.3 FLORA AND VEGETATION

The EPA's objectives with regards to flora and vegetation are to:

- avoid adverse impacts on biological diversity comprising the different plants and animals and the ecosystems they form, at the levels of genetic, species and ecosystem diversity;
- maintain the abundance, species diversity, geographic distribution and productivity of vegetation communities;
- protect Declared Rare and Priority Flora, consistent with the provisions of the *Wildlife Conservation Act 1950*; and
- protect other flora species of conservation significance.

The significance of an ecological impact is dependent on the status of conservation or reservation of the vegetation types and individual flora species potentially affected. It is also dependent on the intensity, nature and duration of the impact. The significant terrestrial vegetation and flora of the FMG rail corridor have been identified in Sections 4.5.2.2 and 4.5.3.2.

It is difficult to assess the conservation significance of the vegetation of the survey area given the lack of comparable data for the region. However, the vegetation types considered by this assessment to be of conservation significance are listed in Appendix J and discussed in Section 4.5.2.1. Briefly, these are:

- Vegetation type Fa10 was considered to be of Very High conservation significance. This unit occurred between Mt Lewin and Mt Nicholas and comprised Mulga dominated vegetation of seasonally-wet broad drainage areas, which is an uncommon habitat in the area. It was strongly associated with the Washplain Land System, which has a restricted distribution in the Pilbara, with the study area being located at the northern edge of this range. This vegetation was in excellent condition, and is considered likely to support flora species of restricted distribution in the region.

- Seven vegetation types of High conservation significance were identified (Fa1, Fa13, Fa18, Fa19, Fa20, Fa25 and Fa27). These were all Mulga-dominated vegetation types that occurred mainly on restricted Land Systems (particularly Washplain and Jamindie). These vegetation types were also in very good condition, and considered likely to support restricted flora taxa.

Potential impacts that the proposed development presents to vegetation are the same in nature irrespective of the conservation status of the vegetation affected. The significance of the impact is greater in the event that higher conservation significance vegetation types may be affected. The following potential impacts could result from the Project if appropriate management controls are not put in place.

6.3.1 Vegetation Clearing

6.3.1.1 Potential Impacts

Clearing of vegetation will be required for the proposed railway, for the mine pit areas, ore and overburden stockpiles and for establishment of infrastructure such as borrow pits, laydown areas, water bores, dams and access tracks. Cut and fill will be required where the proposed rail corridor traverses ridges and valleys, which would extend the limit of clearing beyond the immediate vicinity of the rail line. To estimate the representative impact of the clearing on a local scale, the nominal centre line of the rail corridor was buffered by 50 m on either side, representing a 40 m construction corridor plus additional areas for borrow pits, laydown areas and access roads located within FMG's 2 km wide surveyed corridor. This clearing envelope was combined with the conceptual mine pit and infrastructure layouts to arrive at a total clearing footprint for the proposal.

It is estimated that during the life of the mine (20+ years) approximately 2,757 ha will be disturbed at Mt Nicholas, 1,775 ha at Mt Lewin, 10,123 ha at Christmas Creek and 852 ha at Mindy Mindy. The majority of these areas will be progressively cleared and then rehabilitated once the area is no longer required. The railway will require an area of approximately 1,600 ha cleared, of which 800 ha will be rehabilitated on completion of construction of the railway. An indicative breakdown of the area of each vegetation type affected by the proposed railway and mine areas is provided in Appendix J.

Additional impacts on vegetation may result from other project-related activities including off-road driving and fire (see below). Spinifex (*Triodia* spp.) is particularly susceptible to physical damage from vehicle movements and may take extended periods to recover.

Direct impacts on Mulga through clearing have been calculated and placed in a regional context by reviewing Agriculture WA rangeland mapping (Payne *et al.*, 2002) and defining two regional management units that may be considered for assessment of impacts of the Project:

- The Fortescue Marsh surrounds, including all Mulga containing land systems within an approximate 12 km buffer around the perimeter of the Marsh, including both groved Mulga and other Mulga communities; and
- The Chichester Ranges footslopes, consisting primarily of groved Mulga systems and the thick band of Mulga fringing the Fortescue Marsh on its northern side (this unit is also a subset of the Fortescue Marsh surrounds).

Based on the rangeland mapping, the approximate size of the Chichester Ranges footslopes unit is 1,641 km^2, whilst the Fortescue Marsh surrounds is 3,204 km^2. There are arguments for the use of each management unit as follows:

1. The larger Fortescue Marsh unit is geomorphologically similar in structure given that it fringes the marsh and consists of flood plains on both sides, to the north flanking the Chichester Ranges and to the south flanking the Hamersley Ranges. Mulga groving exists both to the north and to the south of the marsh.
2. The smaller Chichester Ranges footslopes unit (a subset of the Fortescue unit above) is believed by CALM to be in better condition than the remainder of Fortescue unit. That is, whilst it has been grazed for nearly 100 years, it is believed by CALM to be less impacted by fire and weed infestation. FMG's flora surveys identified 13 weed species in this unit, and identified areas of significant weed invasion (both in terms of number of species and degree of cover) in creekline habitats and Mulga areas. FMG has also observed fire damage in Mulga groves in this unit and the 10

year fire scar history shows that the area has been subject to frequent fires (refer to Appendix E). While this has caused some degradation in this area (with the exception of areas substantially degraded by weeds) much of the vegetation remains in at least good condition (Biota, 2004a)

Table 13. Direct Impact on Mulga, as a Proportion of Chichester Ranges Mulga and Fortescue Marsh Mulga (based on Rangeland Mapping, Payne *et al.*, 2002)

Management Unit Sizes (based on CALM Rangeland Mapping)	
Unit	Km^2
Chichester Ranges Footslopes	1,641
Fortescue Marsh Surrounds	3,204

Direct Impacts on Mulga as a percentage of Management Units			
	Km^2	% of Chichester Footslope Unit	% of Fortescue Marsh Unit
EW Corridor (Route 2)	3.1	0.2	0.1
Christmas Creek Mine	35.2	2.1	1.1
Mt Lewin Mine	6.5	0.4	0.2
Total Mining	41.7	2.5	1.3
Total Project	49.5	2.7	1.4

Total disturbance to Mulga containing land systems for the Project area accounts for 2.7% within the Chichester footslopes unit, and 1.4% within the Fortescue Marsh unit.

6.3.1.2 Management Strategies

During the final design of the Project, further refinement will be undertaken having regard for the locations of significant vegetation types (particularly Mulga associations) and populations of Priority flora (Figures 10, 11 and 20), with the objective of avoiding these units where practicable (see Section 5.2 for evaluation of alternatives).

The flora and vegetation study area surveyed by Biota is larger than the proposed disturbance area. In particular, a 2 km rail corridor was surveyed, however FMG propose to only disturb a 40 m wide corridor. This is to allow FMG flexibility during final design to avoid significant flora and vegetation.

A final rail alignment is currently being designed which reduces direct impact on significant vegetation. For example, FMG believes it is possible to avoid vegetation type Fa10 associated with the washplain land system, by moving the rail corridor slightly south near Kondy Creek (as discussed in Section 5.2.2.3 and depicted in Figure 11).

Vegetation clearing for the rail corridor and all mine disturbance areas will be kept to the minimum necessary for safe construction and operations, particularly in areas adjacent to vegetation of higher conservation significance (see Section 4.5.2.2). Clearing limits will be marked on all design drawings and pegged in the field prior to any clearing works commencing. This will constitute a hold-point for the site supervisor to review and provide written approval prior to clearing works commencing.

A Rehabilitation and Revegetation Management Plan has been included in this PER (Appendix D). This plan includes use of provenance collected native seed if propagation from topsoil is not sufficient, characterisation and management of topsoil, and the respreading of cleared vegetation. Recovery monitoring will also be carried out, with any rehabilitation failure subject to additional treatment to a suitable standard;

The location of borrow pits and other materials sourcing sites are not known in detail at this stage of the Project. However, further detail on how they will be selected and managed is given in Section 5.4.2. Given that all biological surveys are based on representative sampling only, there will always be parts of the Project area that have not been adequately ground-truthed. It is therefore possible that borrow pits may ultimately be located in areas that have not been specifically surveyed. If this is the case, the location of these sites will be subject to targeted survey for any threatened flora species or vegetation types of conservation significance once identified, prior to clearing commencing. The location of materials sourcing sites will be revised as appropriate based on the findings of this work in liaison with the CALM regional office.

FMG will consider offsets to the disturbance of Mulga groves (such as further research into the ecology and/or taxonomy of Mulga in the East Pilbara) in consultation with CALM and academic experts.

6.3.2 Disruption to Surface Hydrology

6.3.2.1 Potential Impacts

The majority of the FMG Stage B rail corridor is located within broad areas of very gently sloping alluvial plains, which are subject to sheetflow. Mulga groves occur within this area and these are reliant to some extent on surface sheetflow. The interruption of such flow has the potential to cause degradation and Mulga mortality by either restriction of water input downstream of the rail formation or ponding upstream if not managed appropriately.

6.3.2.2 Management Strategies

Section 6.1 outlines the management strategies based on the potential hydrological impacts. The following briefly discusses those management strategies.

A redistribution system will be installed in areas that contain sensitive vegetation (primarily Mulga), to maintain sheetflow to ensure both upstream and downstream vegetation are not adversely affected. This is a particular consideration for the western two-thirds of the rail corridor, which passes through Mulga groving in the Fortescue Valley. This aspect of the drainage design will be finalised to the satisfaction of CALM and the DoE (see Section 6.1.4).

The drainage design for the railway will take into account local hydrological patterns that may have ecological significance. This will include adequate provision for drainage line habitats to ensure that back-water or flow restriction is reduced as far as practicable. This will be based on best practice drainage design (see Section 6.1.4).

6.3.3 Erosion

6.3.3.1 Potential Impacts

Clearing of vegetation has the potential to lead to increased rates of erosion. Susceptible substrates within the Project area include the cracking clays and the heavier soils underlying the Mulga communities of the Fortescue Valley. This is particularly important given the potential for increased siltation of the Fortescue Marsh downstream of the proposed Project developments.

6.3.3.2 Management Strategies

Management of erosion and silt loads in surface run-off from the rail and mine areas is outlined in Section 6.1. In addition off-road driving will be strictly prohibited in all parts of the Project area to reduce the potential for increased erosion along un-maintained tracks.

6.3.4 Introduction and/or Spread of Weed Species

6.3.4.1 Potential Impacts

Thirteen introduced flora species were recorded from the FMG rail corridor and mine areas, at least two of which are considered to be serious environmental weeds (Buffel grass **Cenchrus ciliaris* and Ruby dock **Acetosa vesicaria*; Section 4.5.2.5). Earthworks, topsoil and overburden transportation, vehicle movement and other factors have the potential to introduce additional weeds to the area and to spread existing populations of introduced flora within the development areas. Mesic habitats such as Mulga vegetation, creek lines and floodplains are particularly susceptible to weed invasion.

6.3.4.2 Management Strategies

Weed control measures will be implemented to ensure that new weed species are not introduced and that weed species identified within the development areas are not spread during the construction and operation of the Project. This may include targeted control of more aggressive weed species. A Weed Hygiene and Management Plan will be prepared to the satisfaction of CALM and the Agricultural Protection Board (APB) prior to construction commencing and implemented throughout the life of the Project.

Off-road driving will be strictly prohibited in all parts of the Project area, with all staff and contractors to be informed of this, and other general environmental issues, as part of an on-site induction programme.

6.3.5 Fire

6.3.5.1 Potential Impacts

The level of impact on vegetation associated with a potential increased fire frequency is dependent on the structure of the affected vegetation. The increased fire risk is primarily associated with welding and track grinding activities on the proposed railway and management measures will be in place to reduce these risks (see Section 5.5.4). The hummock grassland associations which dominate the stony hills of the mine areas are typically very flammable, but are also adapted to fire and recover relatively quickly. Increased frequency of fires can, however, lead to changes in floristic composition and a prevalence of early successional stages of the vegetation (the climax vegetation is prevented from developing; Biota and Trudgen, 2002). Mulga communities may be killed by hot fires, and the Mulga woodlands and tall shrublands that dominate the FMG Stage B rail corridor are susceptible to damage from fires, particularly if there is also strong grazing pressure or other stresses presented by modification to the existing hydrological regime.

6.3.5.2 Management Strategies

FMG will implement a Fire Management Plan and will address fire management as part of the EMP (see Appendix B) that will be prepared and implemented prior to construction of the Project. The objective of these management measures will be to reduce the risk of unplanned fires and provide contingency measures to minimise any impacts in the event that a fire is started. This will include measures to address normal construction activities including the use of heavy plant and equipment in dry vegetated areas, welding, grinding and other activities with the potential

Plate 6. Recently burnt *Acacia rhodophloia* tall open shrubland over *Eriachne mucronata* tussock grassland, annual grasses and herbs on small rocky knoll

to start fires.

Management of rail maintenance and the fire risk associated with track grinding and welding activities will be an important component of the Fire Management Plan. The compulsory use of spark shields will be specified into rail maintenance contracts, with vehicles equipped with fire fighting equipment to follow the track grinder in order to quickly stop any spot fires that may have started.

6.3.6 Dust

6.3.6.1 Potential Impacts

Dust generated during the construction, operation and maintenance of the proposed railway and mine areas has the potential to negatively affect surrounding vegetation, but this is considered to be a minor and localised impact (see Section 6.6).

6.3.6.2 Management Strategies

Standard dust suppression measures will be implemented across the Project area during construction and operation to minimise impacts on surrounding vegetation. These management strategies are further discussed in Section 6.6.

6.3.7 Groundwater Drawdown

6.3.7.1 Potential Impacts

Hydrogeological modelling undertaken for the Project indicates that existing groundwater levels within the three proposed pits in the Chichester Ranges will be drawn down by 30 m over the life of the mines to ensure dry mining activities. At Mindy Mindy dewatering will reduce groundwater levels by a maximum of 15 m. Groundwater drawdown contours are shown in Figures 36, 37, 38 and 39. Within the borefield, maximum drawdown is likely to be 15 m after 16 years. If these drawdowns occur in areas where groundwater dependent (phreatophytic) vegetation occur, then it is possible this will result in decline in vegetation condition.

Biota conducted a review of potentially phreatophytic vegetation within the area predicted to be affected by groundwater abstraction and found the risks to such vegetation from groundwater drawdown to be low (Biota, 2004f). The review conducted by Biota which discusses potential impacts and proposed monitoring and management measures for phreatophytic vegetation is included under Appendix J.

6.3.7.2 Management Strategies

As outlined in Section 6.2.3 FMG will implement measures to avoid impacting phreatophytic vegetation during pit dewatering and borefield operations. This will include a groundwater monitoring programme and revision of the numerical groundwater models, and vegetation condition monitoring if areas are identified where groundwater levels have declined as a result of groundwater abstraction.

6.3.8 Terrestrial Flora

6.3.8.1 Potential Impacts

The survey area supports a relatively rich mix of terrestrial flora given the size of the area and the relative uniformity of the habitats (see Section 4.5.2.2). Flora of conservation significance found during surveys of proposed Project areas included:

- *Eremophila pilosa* (Priority 1);
- *Abutilon trudgenii* ms. (Priority 3);
- *Goodenia nuda* (Priority 3);
- *Hibiscus brachysiphonius* (Priority 3);
- *Sida* sp. Wittenoom (W.R. Barker 1962) (Priority 3); and
- *Themeda* sp. Hamersley Station (M.E.Trudgen 11431) (Priority 3).

Potential impacts to significant flora arising from the proposed FMG rail and mines are similar to those outlined above and include:

- physical disturbance;
- disturbance to surface hydrology;
- introduction and/or spread of weed species;
- fire; and
- dust.

6.3.8.2 Management Strategies

The management strategies for these potential impacts are addressed in Sections 6.3.1 to 6.3.7.

6.4 TERRESTRIAL FAUNA

The EPA objectives with regards to fauna management are to:

- maintain the abundance, species diversity and geographical distribution of terrestrial fauna; and
- protect Specially Protected (Threatened) Fauna, consistent with the provisions of the *Wildlife Conservation Act 1950*.

Potential impacts on terrestrial fauna and management of those impacts arising from the construction and operation of the proposed Stage B railway and mine areas are essentially similar to potential impacts on vegetation (Section 6.3). From the perspective of fauna habitats, these are discussed below.

6.4.1 Direct Fauna Habitat Disturbance and Modification

6.4.1.1 Potential Impacts

One of the primary potential impacts associated with the proposed development arises from the clearing of fauna habitat necessary to establish the mines and railway, including pits, overburden stockpiles, infrastructure, the rail formation, access tracks and associated materials sourcing areas. A nominal breakdown of representative habitats expected to be disturbed by the proposed railway and mine areas is provided in Appendix K.

Several fauna habitats within the Project area have been identified as either spatially restricted or supporting populations of significant species or fauna communities (Section 4.5.3). In summary these comprise:

- Fortescue basin flats (Fortescue Marsh);
- cracking clay habitat units associated with the Chichester Range and foothills to the immediate north; and
- major drainage systems.

As with vegetation, all fauna habitats within the Project area may be affected by clearing activities for the development of the mines and the railway. However, were clearing impacts on habitat units of greater conservation importance, the disturbance are considered more significant. The final design of the rail alignment, mine infrastructure and any related ground disturbing activities will aim to minimise or avoid any impacts on these habitats where practicable. This particularly applies to the more discrete and isolated habitat units such as cracking clay formations.

Additional disturbance to vegetation may result from other project-related activities including off-road driving. Spinifex dominated habitat units are particularly susceptible to this type of physical damage and can take extended periods to recover. Given the reliance of several fauna species of conservation significance in these habitats (including the Schedule 1 species the Mulgara *Dasycercus cristicauda*), strict on-site management will be implemented to ensure that such activities are controlled.

6.4.1.2 Management Strategies

The detailed design of the final rail alignment and mine infrastructure disturbance areas will treat the location of restricted and potentially significant fauna habitats, particularly cracking clay units, as design constraints with the objective of minimising impacts on these areas or avoiding them as far as practicable.

Fauna habitat clearing will be kept to the minimum necessary for safe construction works and operations, particularly in the vicinity of significant fauna habitats, such as creek lines, Mulga groves and the Fortescue Marsh. Work area clearing limits will be identified on design documentation and pegged in the field prior to the commencement of any clearing activities. This will constitute a hold-point for the site supervisor to review and provide written approval prior to clearing works commencing.

Site-specific surveys of access tracks and associated railway infrastructure will be carried out if these areas have not been adequately surveyed as part of work for this PER. These surveys will be to identify any significant fauna habitats which may be present, with modification as necessary in liaison with CALM regional office.

A Rehabilitation and Revegetation Management Plan has been developed for all non-permanent disturbed areas. This will serve to restore some area of habitat lost or modified during construction activities and fauna habitat reconstruction measures will be included as part of this plan (refer to Appendix D for draft Rehabilitation and Revegetation Management Plan).

Off-road driving, with associated impacts on spinifex habitats in particular, will be prohibited by FMG staff and contractors.

Off-sets will be considered in consultation with CALM. These could include funding towards taxonomic issues, or other relevant research such as CALM's research programme on Mulgara (*Dasycercus cristicauda*).

6.4.2 Indirect Fauna Habitat Disturbance and Modification

6.4.2.1 Potential Impacts

Indirect modifications may also affect fauna habitat adjacent to the railway and in the areas adjoining the mine sites. These processes would generally be initiated by the construction activities and have the potential to continue during operations. Mechanisms in this category include changes to surface hydrology (Section 6.1), increased erosion, weed introduction/spread and changes to fire regimes (see Section 6.3).

Any changes to existing surface hydrology regimes could have affects on both upstream and downstream vegetation, with flow-on effects on fauna habitat and riverine and floodplain habitat dependent fauna species. The potential impact on Mulga woodland due to sheetflow modification is an example of this, and many avifauna in the region are dependent on this habitat type. Changes to surface flows could also result in increased scour and erosion, with similar consequences for fluvial fauna habitats. The Fortescue Marsh, which is downstream of the proposed Stage B railway for most of its length, would be a key receiving environment in this context. However, increased sedimentation to the Marsh as a result of the Project is unlikely due to the distance from the Project areas (Section 6.1.4).

The Fortescue Marsh is recognised as providing an important wetland habitat, particularly for inland water birds, when in flood. The majority of the bird species with regionally significant breeding populations utilising this area for breeding are vagrants such as the Australian Pelican *Pelecanus conspicillatus* (up to 700 breeding individuals recorded) and the Black Swan *Cygnus atratus* (up to 200 breeding individuals), in addition to several duck and heron species (Storr, 1984; DEH A Directory of Important Wetlands in Australia, 2004). Whilst most birds known to utilise the Marsh are not true migrants listed under the *EPBC Act 1999*, there is a single confirmed breeding record for the Great Egret (*Egretta alba*) from the Fortescue Marsh which is a migratory species listed under the *EPBC Act 1999* (Storr, 1984). Up to a dozen other migratory species listed under the *EPBC Act 1999* may utilise the Marsh when in flood, but this is likely to be a function of the relative timing of the birds migration movement and the extent of flooding in the Marsh. These species are not confirmed as utilising the Marsh as a regionally significant habitat (due to the lack of survey data), but are considered likely to occur. Potential species in this category include the Curlew Sandpiper (*Calidris ferruginea*), Pectoral Sandpiper (*Calidris melanotos*), Glossy Ibis (*Plegadis falcinellus*) and the Marsh Sandpiper (*Tringa stagnatilis*), all of which may be present in large numbers on occasions when water levels are suitable during their migration. Any downstream reductions in hydrological input, or increases in sediment loads due to project-induced scour and erosion, may impact on this regionally important wetland and water bird habitat. However, these risks have been assessed as low (see Section 6.1).

The spread or introduction of weeds is a potential risk associated with the construction of any linear infrastructure corridor and this can also have implications for fauna species. Changes to the floristic and structural nature of vegetation and fauna habitat can result in the habitat resource value of areas being diminished for native fauna. The replacement of spinifex hummock grasslands by Buffel grass that has occurred across large areas of the Pilbara is an example of such a shift. Mesic environments such as major creek lines are particularly susceptible to weed invasion and any consequent changes to fauna habitat. FMG will implement a Weed Hygiene and Management Plan as described under Proposed Management below.

6.4.2.2 Management Strategies

The detailed design of the railway will take into account local hydrological patterns to reduce potential impacts, particularly with respect to Mulga habitat. Further details on the management strategies for the potential hydrological impacts are detailed in Section 6.1.4.

Weed control measures will be implemented as outlined in Section 6.3.4. The Weed Hygiene and Management Plan will be prepared to the satisfaction of CALM and the APB prior to construction commencing.

6.4.3 Increased Fire Frequency

6.4.3.1 Potential Impacts

Construction works, track grinding and other maintenance activities for the proposed FMG Stage B railway and mine areas have the potential to increase fire frequency in adjacent areas. The consequences of this potential for increased fire frequency would depend on the affected fauna habitats and the fauna species present.

Open vegetation types such as samphire and Snakewood shrublands tend not to carry fires of any significant spatial scale. However, spinifex hummock grassland habitats tend to dominate much of the proposed corridor and these are highly flammable (Section 4.5.2.2). A number of significant fauna species identified from the corridor require mature spinifex as a component of their habitat and their persistence in the immediate locality could be affected if high fire frequencies continue to apply or are increased (Biota, 2002a; 2004d).

Fire is a natural part of vegetation, habitat and fauna ecological cycles in the Pilbara, with many bushfires started naturally by lightning strikes (Biota and Trudgen, 2002; Biota, 2002a). At a regional level, fire is a normal and to some extent necessary part of the Pilbara ecological landscape, particularly in relation to senescent vegetation and habitat units which may experience reduced fire frequencies compared to historical patterns. A number of management initiatives will be employed as part of the proposed rail to address the issues of fire regimes in the Project area (see Section 5.5.4). A Fire Management Plan will be developed as described under Proposed Management below.

6.4.3.2 Management Strategies

Prior to construction commencing, FMG will prepare and implement a Fire Management Plan as detailed in Section 6.3.5.

6.4.4 Noise and Blasting Impacts

6.4.4.1 Potential Impacts

Potential impacts of noise and vibration (from blasting at the mines) on fauna within the Project area and migratory birds utilising the Marsh has also been assessed. Although there is expected to be some impact on fauna species within the Project area from construction and operation noise, and blasting vibrations, studies indicate that fauna are quick to adapt to man-made noises if other threats are absent. The potential impacts of noise and blasting on migratory bird species using the Fortescue Marsh is discussed in Section 6.7.

6.4.4.2 Management Strategies

Despite the low risk of impact, FMG will develop a Noise and Vibration Management Plan prior to construction of the Project, in consultation with the DoE, to ensure any potential impacts are managed adequately (Section 6.7).

6.4.5 Light Impacts

6.4.5.1 Potential Impacts

Another potential impact to birds and insects inhabiting the Marsh is light overspill from mining operations. Incorrectly managed, this could result in the attraction of insects at night and attract predators that feed off the insects.

6.4.5.2 Management Strategies

FMG will manage this potential impact through a Light Overspill Management Plan (see Table 20 for detail).

6.4.6 Direct Loss of Individual Fauna

6.4.6.1 Potential Impacts

There will inevitably be some localised loss of individual fauna due to direct mortality arising from the construction of the railway and mine areas, including that which may occur during the clearing of habitat (Section 6.3.1). Ongoing impacts may also arise from more frequent vehicle movements, train movements and machinery operation down the rail corridor and during mining operations. It is unlikely, however, that the loss of individuals associated with these events would be significant enough to affect the conservation status of any of the species recorded from the region. However, impacts on significant species will be avoided where practicable.

6.4.6.2 Management Strategies

As part of the environmental induction, staff will be made aware that all native fauna are protected and that there are substantial penalties associated with unapproved disturbance to fauna. Firearms, traps and domestic pets will be prohibited on-site.

6.4.7 Restriction of Fauna Movement

6.4.7.1 Potential Impacts

The construction of the Stage B railway formation will result in a barrier to the movement of some fauna species and potential subdivision of populations situated along the rail alignment. The extent to which this would affect the various fauna occurring along the corridor is dependent on a range of factors including:

- how high the embankment may be or how deep the cut;
- how foreign the construction material may be (eg whether a rock ballast is being placed on a sandy, clay or rocky substrate); and
- the ordinary range, dispersal and effective population size of the species involved.

Ground mammals are perhaps most likely to be potentially affected, given their greater dispersal and generally larger home ranges compared to most herpetofauna present along the corridor (Biota 2002a; 2004d). Populations of species associated with riverine habitats are perhaps less likely to be potentially affected by this, given that culverts will be constructed at all significant drainage system crossings and within sheetflow areas. These culverts will provide pathways for small fauna during dry periods. The proposed railway would not present any significant barrier to avifauna and bats and some larger species of fauna may be able to cross over the rail embankment.

6.4.7.2 Management Strategies

Culverts will be required at regular intervals along the proposed Stage B railway to maintain surface water flows, and these will provide the main crossings for fauna near the rail corridor, in addition to level crossings and other stock crossings.

FMG will consider the design of the railway including embankment height, depth of cut and construction material, to minimise the barrier to fauna where possible. In addition FMG will consider the conservation significance of particular fauna habitats and where it may help alleviate the impact of creating a barrier to fauna, the use of underpasses and crossovers will be investigated.

6.5 STYGOFAUNA

The EPA objective for the Project is to:

- maintain the abundance, diversity and geographical distribution of subterranean fauna.

6.5.1.1 Potential Impacts

Within the mining areas the Nammuldi Member of the Marra Mamba Iron Formation and gravel deposits in the alluvium formations found at Christmas Creek, Mt Nicholas, Mt Lewin and Mindy Mindy are expected to host stygofauna. Dewatering of the pits will be required at Christmas Creek, Mt Lewin, Mt Nicholas and Mindy Mindy mines (Sections 5.3.1.4, 5.3.2.3 and 5.3.3.4). Pit dewatering combined with open pit mining methods are likely to directly disturb some stygofauna habitats present within the mining areas. Other potential impacts, if appropriate management measures are not implemented, may include groundwater pollution from surface spills, saline water upconing or incursion of high salinity water into the surrounding aquifer from open pits if the pits are not backfilled to above the water table.

The water supply borefield operation is expected to result in maximum drawdowns of up to 15 m over 16 years of operation (Section 6.2.1). It is expected that stygofauna will inhabit the gravels within the alluviums of the Nammuldi Member in the borefield near Mt Nicholas where these intersect groundwater, and therefore stygofauna populations are likely to be affected by borefield operations.

Impacts on stygofauna from the operation of temporary bores along the rail corridor are likely to be minor due to the lack of suitable habitat for stygofauna and the short-term duration of abstraction. As the study of stygofauna in Western Australia is relatively new, the conservation status of numerous species many of which are yet un-named, is uncertain, and the Project will need to consider the regional distribution of any stygofauna populations encountered.

6.5.1.2 Management Strategies

In order to first understand the abundance, diversity and geographic distribution of subterranean fauna, FMG has commenced a detailed sampling program. The first survey was conducted in September 2004, with subsequent surveys to be undertaken in January 2005, June 2005, December 2005, June 2006 and December 2006. A long term sampling programme will be developed by January 2007 if stygofauna are located within the study area.

The proposed sampling programme aims to satisfy the EPA's requirements outlined in Guidance Statement 54, to ensure that adequate protection is given to important habitats for these species. The following points have been considered during the development of this sampling plan:

- Subterranean fauna sampling will be undertaken in areas affected by dewatering and borefield operations to assist in establishing the conservation significance of any species within the affected areas.
- Characterisation of subterranean fauna habitats will be undertaken in the area to be affected by the dewatering operations and borefield operations, and identification of similar subterranean fauna habitats outside the affected areas.
- Subterranean fauna surveys will be carried out in similar habitats outside the areas to be affected by dewatering and borefield operations to assist in establishing the conservation significance of fauna within the areas to be affected.
- Specific measures to record and preserve biological information on any species collected in the Project area will be undertaken.

The proposed sampling programme has been developed to provide a representation of the range of geological and hydrogeological structures in the area and intersect a range of potential habitats around the proposed mine and borefield environments and also more regionally. Table 14 presents details on the proposed bores identified for the sampling program.

The selection criteria for the bores that are proposed to be sampled included the following:

- Geological Setting – bores were selected which were likely to have intersected a geological sequence, where there is potential for stygofauna to exist.
- Regional Distribution – a broad range of locations were chosen to provide representative distributions across a number of geological and hydrogeological environments, both in the immediate Project area and the surrounding district.

Figure 21 shows the location of bores to be sampled for stygofauna within the immediate proposed mine and borefield areas and regional sampling bores located away from the influence of the mines.

The Subterranean Fauna Management Plan is presented as Appendix M.

Table 14. Proposed Bores for Subterranean Sampling

Bore ID	Easting (MGA94)	Northing (MGA94)	Total Depth (m)	Area Station	SWL	Casing Details	Geology /Aquifer Type	Comments
Kullawarri Well	237604	7496984	24.380	Noreena Downs	N/A	N/A	Calcrete and soil	Located on low calcrete rise
WSE 28	237677	7494412	106	Balfour Downs	48.3	50mm uPVC	Unconfined Alluvial /Marra Mamba Aquifer	
Limestone Bore	246641	7481374	24.3	Balfour Downs	N/A	N/A	Outwash with Calcrete	Adjacent to a drainage line on a low calcrete rise.
Hole 64	240925	7472213	N/A	Balfour Downs	N/A	N/A	Alluvium/Marra Mamba	
Badgeannah Well	227976	7460257	14.6	Ethel Creek	N/A	N/A	Alluvium	
22 Bore	238039	7455081	N/A	Ethel Creek	N/A	N/A	Alluvium	
17 Mile Well	213263	7485911	N/A	Roy Hill	N/A	N/A	Alluvium	
9 Mile Bore	200714	7499738	N/A	Roy Hill	N/A	100mm PVC no collar	Alluvium	
Mt Lewin Drillers Bore	212600	7492050	N/A	Roy Hill	N/A	N/A	Alluvium/Marra Mamba	
Old Well	210615	7490400	N/A	Roy Hill	N/A	N/A	Alluvium	
Knuckleduster Bore	800884	7482757	11.5	Roy Hill	N/A	N/A	Alluvium	

Bore ID	Easting (MGA94)	Northing (MGA94)	Total Depth (m)	Area Station	SWL	Casing Details	Geology /Aquifer Type	Comments
Eaton Bore	799072	7479803	N/A	Roy Hill	N/A	N/A	Alluvium	
Bore near Mt McKay	807181	7514786	N/A	Roy Hill	N/A	150mm PVC with concrete collar	Alluvium	
Parker Bore	779272	7523229	32.9	Roy Hill	N/A	N/A	Alluvium/Marra Mamba	Located on hardpan plain
22 Mile	781855	7517724	N/A	Roy Hill	N/a	N/A	Alluvium	
F7A	782007	7517844	82	Roy Hill	14.05	50mm uPVC	Marra Mamba Aquifer (Nammuldi Member)	Intersects hypersaline water drilled in the calcrete aquifer
New Roy Hill Bore	801787	7503658	N/A	Roy Hill	N/A	N/A	Alluvium	
Emu Well	790476	7543653	N/A	Bonney Downs	N/A	N/A	Maddina Basalt	
Bonney Downs Bore	806238	7523712	N/A	Bonney Downs	N/A	150mm PVC with concrete collar	Jeerinah Formation	

Bore ID	**Easting (MGA94)**	**Northing (MGA94)**	**Total Depth (m)**	**Area Station**	**SWL**	**Casing Details**	**Geology /Aquifer Type**	**Comments**
Prairie Bore	760683.00	7476376	34.75	Marillana	N/A	N/A	Alluvium	Windmill
Fred Bore	754894.00	7478882	39.9	Marillana	N/A	N/A	Alluvium	
Nelson Bore	744725.00	7492965	34.4	Marillana	N/A	N/A	Alluvium	Windmill
Pugs Bore	738164.00	7492720	34.1	Marillana	N/A	N/A	Alluvium	Bore situated on Mulga hardplain

6.6 DUST

The EPA's objectives for management of dust during construction and operation of the Project are to:

- protect the surrounding land users such that dust and particulate emissions will not adversely impact upon their welfare and amenity or cause health problems; and
- ensure that particulate/dust emissions from FMG's activities meet appropriate criteria and do not cause environmental or human health problems.

6.6.1 Dust Sources

The four proposed mines will be constructed in an arid area, which has naturally high background dust levels. Other than vehicles travelling along unsealed roads, there are currently no anthropogenic sources of dust in the vicinity of the Project areas.

Dust may be generated during construction of the Project, and during subsequent mining and transportation activities. Material stockpiles generated during construction and operation of the mines, and topsoil spreading during rehabilitation, may also generate windblown dust.

Dust may be generated during construction of the railways. Due to high moisture content of the ore, as a result of the beneficiation process, it is not anticipated that loaded trains will generate significant dust during their daily operations.

6.6.1.1 Potential Impacts

The impact of dust emissions on residential communities during construction and operation of the mine sites is not expected to be significant due to the remoteness of the mines. The closest settlements to the Project area are Roy Hill Station located approximately 19 km west of Mt Lewin, and Marillana Homestead, approximately 16 km north of the Mindy Mindy mine site.

In localised areas of heavy dust deposition, there is the potential for vegetation to be adversely affected by repeated coatings of dust, which may be generated during construction or operation of the mines.

There is unlikely to be any impact of dust on any significant Aboriginal heritage sites, as these have been avoided in the design of the Project.

6.6.1.2 Management Strategies

FMG intends to keep dust emissions to a minimum during construction of the Project such that dust does not create a hazard or nuisance to the human or natural environment.

The railway will be constructed in an arid area, which has naturally high background dust levels. Other than vehicles travelling along unsealed roads, there are no anthropogenic sources of dust in the vicinity of the rail corridor. In the unlikely event that dust from the trains becomes an issue engineering design solutions (such as applying water sprays following loading) will be investigated and applied.

A Dust Management Plan will be prepared prior to the commencement of construction and operations. The Dust Management Plan will identify specific management measures to minimise dust generation during construction and operation, including:

- the incorporation of dust control measures into project design, (e.g. covers on conveyors and transfer points and installation of sprinklers to stockpile areas where appropriate);
- the use of water carts on high traffic areas (e.g. access roads, temporary camps and laydown areas);
- progressive rehabilitation of disturbed areas to minimise potential for dust generation;
- minimisation of vegetation clearing;
- optimisation of vehicle movements;
- daily visual inspections of construction areas to ensure dust control management measures are implemented and effective;
- regular vegetation surveys to assess ongoing dust impacts; and
- ambient dust monitoring where appropriate.

The commitments contained within the Dust Management Plan will be consistent with the amount of dust expected to be generated at various locations on the mine sites, and the environmental values to be protected in those areas.

In preparing the Dust Management Plan, FMG will also investigate options for the implementation of water efficient dust management practices and the use of recycled water, or other alternatives for dust suppression to minimise water abstraction impacts.

6.7 NOISE AND VIBRATION

The EPA's objective for the Project is to:

- ensure noise impacts emanating from construction and operation activities comply with statutory requirements and acceptable (and appropriate) standards.

6.7.1 Noise Modelling

Transportation and operational noise impacts to noise sensitive premises associated with the Stage B project were investigated by Lloyd Acoustics and compared against the relevant noise level criteria (Appendix P). A summary of the findings is presented below.

The computer modelling programme SoundPlan 6.2 was used to predict the noise propagation from the mines and railway to the surrounding areas. For the operational scenarios the programme was selected to use the CONCAWE algorithms. The CONCAWE methodology deals with the influence of wind and the stability of the atmosphere. Railway noise levels have been predicted using a modified version of the Nordic Rail Prediction Method (Kilde Rep. 130) algorithm. Noise from blasting is calculated using equations developed by Orica Explosives Australia. Meteorological information utilised was in accordance with the default conditions nominated in the draft EPA Guidance for the Assessment of Environmental Factors No. 8. As the Project will operate 24 hours a day, the night-time noise criteria were considered the most critical as these are stricter than daytime criteria and therefore only these conditions were modelled.

For operational noise, four scenarios were considered which included both short and long-term planning.

- Scenario 1: Mine machinery and processing equipment at Christmas Creek mine, on surface (initial to medium phase);
- Scenario 2: Processing equipment at Christmas Creek mine, three-quarters of mine machinery at Christmas Creek mine (40 m below natural surface) and one quarter at Mt Lewin mine (on surface) (medium to long phase alternative 1);
- Scenario 3: Processing equipment at Christmas Creek mine, three-quarters of mine machinery at Christmas Creek mine (40 m below natural surface) and one quarter at Mt Nicholas mine (on surface) (medium to long phase alternative 2); and

- Scenario 4: Processing equipment at Christmas Creek mine, three-quarters of mine machinery at Christmas Creek mine (40 m below natural surface) and one quarter at Mindy Mindy mine (on surface) (medium to long phase alternative 3).

In addition to the above, the likely impacts of blasting on nearby residences and birdlife on the Fortescue Marsh were also investigated.

6.7.1.1 Potential Impacts

Residential Impacts

The results show that for the four scenarios considered, the operational noise is significantly below the *Environmental Protection (Noise) Regulations 1997* most critical assigned night-time noise level of L_{A10} 35 dB with the most affected residence (Roy Hill homestead), likely to receive a noise level of L_{A10} 17 dB resulting from the Christmas Creek operations (Table 15). The predicted noise contours for the worst-case scenario is presented in Figure 40. The predicted noise level at the Christmas Creek mine camp is L_{A10} 49 dB. As it is associated with the proposed mine, it is considered an industrial premises under the Regulations and the assigned noise level is therefore L_{A10} 65 dB. The predicted noise level from mining operations on the camp is therefore compliant with the Regulations, and it is also considered that these noise levels will not have an unacceptable affect on the amenity of the camp.

Table 15. Predicted L_{A10} Night-time Noise Levels – Operational Scenarios

Receiver Location	**Scenario Predicted Noise Level, dB(A)**			
	1: Initial to Medium Phase	**2: Medium to Long Term Phase Alternative 1**	**3: Medium to Long Term Phase Alternative 2**	**4: Medium to Long Term Phase Alternative 3**
Roy Hill	17	16	14	14
Bonney Downs	5	0	0	0
Noreena Downs	13	8	8	8
Marillana	8	8	8	15
Ethel Creek	0	5	0	0
Warrie Outcamp (not residential)	20	19	19	19
Fortescue Marsh	40	-	-	-
Christmas Creek Mine Camp	49	-	-	-

Note: Only night-time scenario modelled, as this is the most critical.

Based on the expected blasting configurations, confined blasts are predicted to comply with the *Environmental Protection (Noise) Regulations 1997* at all times, whereas unconfined blasts comply Monday to Saturday only, where the most critical noise level is 115 dB $L_{Linear\ Peak}$ for 9 out of every 10 consecutive blasts between 0700 and 1800 hours on Sundays and Public Holidays. The most affected residents are Roy Hill and Bonney Downs homesteads (Table 16).

Table 16. Predicted Blasting Noise Levels

Receiver Location	**Mine Site Predicted Linear Peak Noise Level, dB**			
	UNCONFINED BLAST			
	Christmas Creek	**Mt Lewin**	**Mt Nicholas**	**Mindy Mindy**
Roy Hill	116	119	-	-
Bonney Downs	116	-	-	-
Noreena Downs	114	112	116	-
Marillana	-	-	-	120
Ethel Creek	-	115	111	-
Bamboo Springs	112	-	-	-
Warrie Outcamp (not residential)	122	-	-	-
Poonda Outcamp (not residential)	-	-	-	112
Fortescue Marsh	129	-	-	-
Receiver Location	**CONFINED BLAST**			
	Christmas Creek	**Mt Lewin**	**Mt Nicholas**	**Mindy Mindy**
Roy Hill	93	96	-	-
Bonney Downs	93	-	-	-
Noreena Downs	91	89	83	-
Marillana	-	-	-	97
Ethel Creek	-	92	88	-
Bamboo Springs	89	-	-	-
Warrie Outcamp (not residential)	99	-	-	-
Poonda Outcamp (not residential)	-	-	-	89
Fortescue Marsh	106	-	-	-

Noise impacts from the proposed railway are predicted to comply with both the preliminary draft EPA Guidance for Road and Rail Transportation Noise (EPA Guidance for the Assessment of Environmental Factors No. 14) and the noise criterion of $L_{Aeq\ (8\ hour)}$ 55 dB, used for similar projects in the region. The most affected residence resulting from railway noise is Roy Hill homestead, with a predicted $L_{Aeq\ (8\ hour)}$ noise level of 39 dB (Table 17) (Figure 41).

Table 17. Predicted $L_{Aeq\ (8\ hour)}$ Night-time Noise Levels from Trains

Receiver Location	Night-time Noise Level dB
Roy Hill	39
Bonney Downs	16
Noreena Downs	22
Marillana	(Stage A railway)
Ethel Creek	33
Warrie Outcamp (not residential)	43
Fortescue Marsh	42

Impacts on Fauna

The Australian Government Department of Environment and Heritage notes that research into the effects of noise on animals is relatively scarce. Most studies have been undertaken in Europe or America, with particular reference to military operations. Although many of the studies were inconclusive, it is known that a large number of animals have adapted to the presence of humans and the noise generated by humans. The animal's initial reaction to a new noise source may be fright and avoidance but if other sensory systems are not stimulated (for instance optical or smell), the animal learns quite quickly to ignore the noise source. Further detail of the findings of research into noise impacts on different bird species is presented in Appendix P.

Based on this research, it is concluded that there is likely to be some short-term disturbance of birds and other fauna in the vicinity of the Fortescue Marsh in the short term, although birds are quick to adapt to a changing environment and should resume normal activities in a short period of time. It is likely that the majority of fauna will become accustomed to the noise levels and that the only impacts might be localised effects on certain populations.

Despite this FMG will develop a Noise and Vibration Management Plan and monitor the effects of blasting on birds as described below. In terms of transportation and operational noise, the research suggests that an adverse impact to the wildlife from these noise sources is unlikely.

6.7.1.2 Management Strategies

FMG will develop a noise and vibration management plan specific to its mining operations, to minimise noise on the nearest residence. Specific noise management measures that will be investigated will include:

- use of low-noise equipment where practicable;
- monitoring blast noise near sensitive receptors to determine allowable blasting mass, in accordance with Regulation 11;
- monitoring the effects of blast noise on birdlife and other fauna using the Fortescue Marsh;
- avoid blasting under worst-case meteorological conditions (i.e. wind blowing towards residences, or Fortescue Marsh during bird breeding season);
- design of the mine (e.g. placement of ore and overburden stockpiles) to reduce potential noise impacts; and
- selection of explosives and modified blasting practices to minimise impacts on bird life.

6.8 GREENHOUSE GAS EMISSIONS

The EPA's objective for the Project with regards to greenhouse gas emissions is to:

- minimise greenhouse gas emissions for the Project and reduce emissions per unit product to as low as reasonably practicable, and mitigate greenhouse gas emissions in accordance with the *Framework Convention on Climate Change 1992*, and with established Commonwealth and State policies.

The greenhouse effect is a natural phenomenon that warms the earth and enables it to support life. However, since the industrial revolution, the amount of greenhouse gases in the atmosphere has increased dramatically, resulting in increased global warming. The six greenhouse gases specifically covered by the Kyoto Protocol are carbon dioxide (CO_2), methane (CH_4), perfluorocarbons (CF_x), hydrofluorocarbons (HFCs), sulphur hexafluoride (SF_6) and nitrous oxide (N_2O) (Commonwealth of Australia, 1998). To compare warming potential of the different gases, their impact is usually expressed in terms of CO_2 equivalents, where the potential of each to lead to heating in the atmosphere is expressed as a multiple of the heating potential of CO_2 (i.e. t CO_{2e}).

Australia, with 0.3% of the world's population contributed 1.4% of global anthropogenic greenhouse gases in 1995 (Government of Western Australia, 1997; Department of

Foreign Affairs and Trade, 1997; Government of Western Australia, 1998). Western Australia contributed around 11% of national emissions in 1990 and approximately 12% in 1995 (National Greenhouse Gas Inventory Committee, 1998).

The EPA has developed a guidance statement to minimise greenhouse gas emissions (EPA Guidance Statement No. 12, October 2002) which requires proponents of new projects to consider the potential impacts of their project, and compare this impact with that of similar projects.

6.8.1 Greenhouse Gas Sources

In the construction and operation of the Project, greenhouse gases will be released to the atmosphere by:

- decomposition of cleared vegetation and release of carbon from the soil (estimated 17,107 ha cleared over 20 years); and
- combustion of diesel fuel for the mining vehicles (50 MLpa of diesel consumed); and
- combustion of diesel/gas to meet the Project's power requirements (45 MW).

Combustion of diesel fuel for locomotives was not included in greenhouse gas emissions calculations for Stage B, as these were addressed in the Stage A PER (FMG, 2004). However, the impact of the Pilbara Iron Ore and Infrastructure Project as a whole (both Stage A and Stage B) is discussed below.

An estimate of the annual greenhouse gas emissions was based on the methodology outlined in:

- Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks 2002: Energy (Stationary Sources), Australian Government, Australian Greenhouse Office (2002a);
- Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks 2002: Energy (Transport), Australian Government, Australian Greenhouse Office, (2002b); and
- Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks: Land Use Change and Forestry. Workbook for Carbon Dioxide from the Biosphere (No. 4.1, Revision 1,) (Australian Greenhouse Office, 1996).

6.8.1.1 Potential Impacts

An estimate of the average annual greenhouse gas emissions associated with the Project is presented in Table 18. Assumptions used to calculate these emissions are also provided in the table.

Table 18. Estimated annual greenhouse gas emissions for Stage B Project

Activity	**Assumptions**	**Average tCO_{2e} per year**
Mobile equipment	• 50 ML of automotive diesel oil consumed per year	135,000
Power consumption	• Continuous operation of 45 MW power station	180,468
Locomotive fuel consumption	• Assessed during Stage A	0
Vegetation clearing (4 mines + railway)	• A one-off period of clearing of 1,600 ha for rail areas during first year • Clearing of 775 ha for mining each year for a period of 20 years • 27 t of carbon per hectare of aboveground biomass • 70 t of carbon per hectare in soil • For each hectare cleared, a 10 yr period of consistent biomass decay and a 25 yr period of consistent soil carbon release • No revegetation offsets	135,209
Total		***450,677***

This equates to approximately 10.0 $kgCO_{2e}$ per tonne of ore shipped for Stage B, and 14.3 $kgCO_{2e}$ per tonne of ore shipped for the Pilbara Iron Ore and Infrastructure Project as a whole (Stage A and Stage B projects). However, this is likely to be an overestimate of emissions because it does not take into account offsets that will occur as cleared areas are progressively rehabilitated. Revegetation offsets were not included in the calculations based upon advice from the Australian Greenhouse Office.

A comparison of total emissions calculated for similar projects is presented in Table 19.

Table 19. Comparison of Greenhouse Emissions for Recent Iron Ore Proposals

Project	**$kgCO_{2e}$/t of ore shipped**	**Reference**
Robe River West Angelas Project	10-13	Robe River, 1998
BHP Mining Area C Project	12	BHPBIO, 1997
Hamersley Iron Nammuldi Silvergrass Iron Ore Project	9-12	Hamersley Iron, 1999
Hope Downs Iron Ore Project	13.6	Hope Downs, 2002
FMG (Stage A and Stage B)	**14.3**	-

The higher unit emissions for the FMG proposal is due to a number of factors, including:

- the area of land proposed to be cleared, which accentuates any overestimations caused by not including revegetation offsets in the emissions calculations;
- the relatively long haulage distances associated with this proposal; and
- the higher proportion of beneficiated ore to be processed by FMG compared with these other operations.

It is also possible that the methodology used to calculate the emission figures are different as two of the guidance references on methodology were published in 2002 after the assessment of the Robe River, BHPBIO Mining Area C and HI Projects. Also, the calculations were based on the assumption that the vegetation proposed to be cleared was 'forest', as no category is provided in the methodology guidelines for the less-dense shrubland, grassland, and open woodland vegetation forms present in the Pilbara (see Section 4.5.2 and Appendix J). This assumption would result in an overestimation of predicted greenhouse gas emissions. It is also unclear whether the other projects considered revegetation offsets.

FMG propose to make the Stage A and Stage B railways available to third-party users. This means that greenhouse gas emissions due to clearing for future third-party railways (which would otherwise need to be constructed for future projects) will be avoided. In addition, FMG has considered greenhouse gas emissions in its evaluation of alternative rail routes. One of the reasons that the preferred route was selected is it requires less overall ground disturbance and vegetation clearing and during operations will require less fuel consumption (resulting in less greenhouse gas emissions for the Project; Section 5.2.1).

6.8.1.2 Management Strategies

FMG has committed to undertaking management practices to ensure that greenhouse gas emissions are minimised as far as practicable.

During construction and subsequent operation of the Project, FMG has committed to minimising both the land area and total amount of biomass cleared. Cleared vegetation will be stockpiled for use in rehabilitation, to provide mulch and a seed source to assist revegetation and will not be burnt. Clearing of the proposed 17,107 ha will be over the life of the Project (20 or more years) and will be progressively rehabilitated as mining progresses. This will offset greenhouse gas emissions to some extent.

The rail construction schedule and mining construction and operations will also be designed to be undertaken in the most efficient manner, to minimise vehicle movements, and duplication of activities and use of natural resources.

In designing the Project, FMG has, where practicable, selected the most energy efficient technology available. Once operational FMG will monitor greenhouse gas emissions and continue to look for ways to improve energy efficiency and reduce greenhouse gas emissions, as part of continual improvement. Renewable energy sources will be used where appropriate (e.g. solar panels for power in remote areas).

6.9 WASTE MANAGEMENT

The EPA's objective with regards to the Project is:

- to ensure that disposal/management of waste does not adversely affect environmental values or health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.

The inappropriate management of waste can result in an increase in the use of natural resources, increased disposal costs and an increased risk of pollution to surface water, groundwater, soil and air and a reduced danger to human health. Therefore FMG will develop a Waste Management Plan to manage the potential impacts from the waste streams that will be generated by its operations.

The three main waste streams associated with FMG's mining operations will be:

- overburden;
- rejects from the beneficiation process; and

- general waste.

6.9.1 Overburden

6.9.1.1 Potential Impacts

Overburden is considered to be the material that is covering the ore body, excluding vegetation and topsoil. Although this material must be removed prior to mining, it is considered an important component of the rehabilitation process. The overburden is used to construct the post-mining landform. On start-up of a mining area, overburden material will be placed in a permanent surface storage area. This is necessary to establish a safe and stable mine area. Once sufficient mined-out pit is available, the overburden will be placed in the pits and contoured to form a safe, stable and free-draining landform. FMG will aim to minimise the size of the off path storage areas and thereby maximise the amount of material available to reconstruct the final landform within the mine path. Detail of the proposed overburden/rejects surface facility is provided in Section 6.9.3.

The final design and therefore height of the permanent off path storage areas will be based on the surrounding topography in the specific area. Where practicable local features will be incorporated into the design of these areas. The overburden storage areas will be rehabilitated and revegetated as part of FMG's standard procedures (refer to the Rehabilitation and Revegetation Management Plan in Appendix D).

6.9.1.2 Management Strategies

During the start-up phase of an area, overburden will be placed in a surface storage area. This facility will be contoured to blend with the surrounding environment and create a free-draining, erosion resistant structure. The facility will then be capped with topsoil or other growth media. If propagation of native vegetation from the topsoil is insufficient direct seeding will be undertaken.

Following the start-up phase the overburden will be placed within the mine pit to establish the post-mining landform. Where practicable, this will resemble the pre-mining land form and will be covered by topsoil from newly stripped areas (Section 6.12.1).

6.9.2 Acid Mine Drainage Potential

With regards to the potential for Acid Mine Drainage (AMD), the EPA's objective is to:

- minimise the risk to the environment resulting from potentially acid forming materials.

6.9.2.1 Potential Impacts

Geochemical characterisation of rock types at all mines for Acid Forming Potential (AFP), multi-element composition and mineralogy was carried out by Graeme Campbell & Associates (2004). Geochemical tests have indicated that overburden sampled from the four mining deposits is relatively inert and unlikely to create Acid Mine Drainage (AMD) problems. In addition, geochemical analyses indicated that the assayed samples contained low levels of any other environmentally significant elements. Further detail is provided in Appendix O.

Christmas Creek, Mt Nicholas and Mt Lewin

Based on the testwork results undertaken by Campbell and Associates (2004) (Appendix O), it is concluded that, with the exception of the black shales, the regoliths and waste-bedrocks to be produced during open-pit mining of the Christmas Creek, Mt Nicholas and Mt Lewin deposits should be classified as NAF, due to negligible amounts of sulphide-minerals. Enrichments in minor-elements in the NAF-lithotypes should only be slight (or nonexistent), and soluble-salt contents should be low-to-moderate. The High-S varieties of the Black-Shales are classified as potential acid forming. However, based on economic evaluations, open-pit mining will not extend deep enough for the Black-Shales to be intersected.

In brief, assuming that the Black-Shales remain undisturbed in situ, no geochemical concerns are foreseen for the mine-waste materials to be produced during open-pit mining of the Christmas Creek Deposit.

At this stage, groundwater modelling suggests that the cone of depression will not extend into the Jeerinah formation and acid formation within the groundwater is unlikely. The black shales lithotype at Christmas Creek, Mt Lewin and Mt Nicholas chiefly comprises micro-pores due to its clay matrix. In the event that dewatering lowers the water table sufficiently to drain the black shales, the primary pore spaces within the black shales would remain near-saturated and therefore protect the pyrite against oxidation. Any oxidation of exposed pyrite-grain surfaces should be largely restricted to secondary pore spaces such as produced through fragmentation from blasting in the overlying pits.

Based on the available information the likely magnitude of the various weathering processes that may occur within the cone of groundwater depression is uncertain, although it is thought that any remobilisation of acidity following cessation of dewatering activities would be modest. FMG will monitor bores within the cone of depression to determine if dewatering activities are impacting on the black shales (Jeerinah Formation). If monitoring suggests that the cone of depression is extending into the Jeerinah Formation, additional modelling (such as oxygen diffusion modelling) will be undertaken to determine the extent of impact and how best to manage this.

Mindy Mindy

Based on the testwork results undertaken by Campbell and Associates (2004) (Appendix O), it is concluded that, the regoliths and waste-bedrocks to be produced during open-pit mining of the Mindy Mindy Deposit should be classified as NAF, due to negligible amounts of sulphide-minerals. Enrichments in minor-elements in the NAF-lithotypes should only be slight (or nonexistent), and soluble-salt contents should be low-to-moderate.

In brief, no geochemical concerns are foreseen for the mine-waste materials to be produced during open-pit mining of the Mindy Mindy Deposit.

6.9.2.2 Management Strategies

If monitoring indicates that dewatering activities are likely to have an impact on the Black-Shales within the cone of groundwater depression, then additional modelling (such as oxygen diffused modelling) will be undertaken to determine the extent of the impact and how best to manage this.

Should acid-generating materials be encountered (although unlikely), a management plan will be developed. This will include the material being placed to minimise oxidation and subsequent transport of low pH drainage.

6.9.3 Rejects

6.9.3.1 Potential Impacts

The Beneficiation Plant will include beneficiation of the ore, which involves upgrading the crushed ore to increase its iron content and reduce impurities. The secondary crushed and screened ore is beneficiated using various unit processes such as screening, wet gravimetric processes and magnetic separators to reduce contamination and increase the ore grade to a marketable product. This process is completely inert and does not involve the use of chemical additives and therefore will not result in the production of chemical pollutants.

The rejects from the Beneficiation Plant consist of approximately 85% solids which will be placed in the mined-out pits with overburden. The remainder of the rejects is a thickened slurry which will be added as a final component of the fill. Water drained from the slurry after deposition will be collected in sumps and returned to the Beneficiation Plant for further use (Figure 29).

However, during the first two years of processing, rejects will be placed within a surface placement area at Christmas Creek, until sufficient mined-out pit becomes available for co-disposal with overburden. This surface reject placement area will be incorporated into the Christmas Creek overburden storage area. Further detail on rejects management is presented in Section 5.3.6. Seepage from placement of rejects is not expected to create a significant environmental issue as it is upstream of the proposed pit, and will be managed to ensure no surface breakout of seepage. The rejects placement area will be rehabilitated as part of the overburden storage area.

6.9.3.2 Management Strategies

A rejects placement area will be required for the first two years of mining operations at Christmas Creek, until sufficient area is available to commence backfilling through the placement of rejects and overburden. This placement area will be incorporated into the initial permanent overburden storage area. Water drained from the rejects will be reused in the Beneficiation Plant. The rehabilitation and revegetation of this area was discussed in the previous section and additional information can be found in the Rehabilitation and Revegetation Management Plan (Appendix D).

The initial overburden and rejects storage area will be situated to the north of the Christmas Creek mining pits (refer to Figure 25). This area has been selected as it does not impact on any major surface water flow areas and it is unlikely to impact on sheet flow zones due to its elevation. In addition the facility is located north of a natural breakaway (elevated rocky area) as can be seen by the contours on Figure 25. The height of the breakaway varies and in some areas is in excess of 30 m. The breakaway will form a natural barrier for the storage area.

The final landform of the storage area will be designed to resemble the surrounding topography. The storage area will be designed and placed over an area of 160 ha. Within engineering and safety constraints the storage area will be designed to form an artificial breakaway (in effect extending the natural breakaway to the north). A rock perimeter will initially be constructed around the storage area from overburden and then the internal area will be filled. The perimeter wall will be designed to ensure the risk of failure is minimised.

Calculations have been undertaken to determine the amount of material that will be placed in the off path storage areas. Based on the proposed production rate for the first 2 years of operation approximately 7.48 mLCM (million loose cubic metres) of rejects from the Beneficiation Plant and 36.47 mLCM of overburden will be placed in the storage. These figures have been based on the assumption that during the period of 18 months to 2 years after the commencement of operations overburden and rejects will be placed both within the off path storage area and in the mined out pit area. Therefore a total of 43.2 mLCM of material will be placed over an area of 160 ha, resulting in an average height of 27 m.

As stated above, 7.48 mLCM of rejects from the Beneficiation Plant will be placed in the storage area. The maximum total volume of water to be discharged each day in the rejects (based on the above figure) is estimated to be 634m^3. Even if only 75 ha of the storage facility contains rejects at any one time (under half of the area), all water within the reject storage area will evaporate. That is, spread over an area of 75 ha, the average depth of water within the rejects is 0.0008 m/day. The natural evaporation rate in the area is approximately 3 m per annum or 0.008 m/day (DoIR average evaporation rate for Newman). Therefore there is potential for 10 times more water to be evaporated from the rejects than has actually been estimated to be present (over an area of 75 ha). Once the rejects are spread over the full 160 ha evaporation rates will increase, resulting in even less potential for groundwater seepage.

The storage area will have topsoil placed on the final landform and will be rehabilitated as per the Rehabilitation and Revegetation Management Plan (Appendix D). Based on the average height and size of the storage area and the rehabilitation to be undertaken, it is believed that the storage area will resemble the surrounding topography and have minimal visual impact.

6.9.4 General Waste

6.9.4.1 Potential Impacts

General waste expected to be generated at the four mine sites include:

- construction waste;
- maintenance waste (e.g. hydrocarbons, tyres, scrap metals);
- spill clean-up waste;
- sewerage and grey water from site amenities and on-site accommodation facilities; and
- miscellaneous waste (e.g. putrescible wastes, old equipment)

Appropriate management of these waste streams will be required to ensure there is no pollution of the environment, or risk to human health.

6.9.4.2 Management Strategies

FMG will produce a Waste Management Plan prior to construction. As part of this Plan, FMG will implement a procurement policy which minimises waste generation.

In line with best practice environmental management principles, FMG will implement the following waste management hierarchy, during the construction and operational phases of Stage B of the Project:

1. Avoidance – reduce the amount of waste generated at the site. Such measures could include:
    - bulk purchasing of consumables;
    - standardising the size and type of materials purchased;
    - minimising the use of disposable products;
    - consideration of waste generation during process design; and
    - regular maintenance of equipment.

2. Re-use – reuse waste products without substantially changing their form (i.e. using effluent from sewage treatment plants in the Beneficiation Plant, re-filling printer cartridges and mulching of vegetative wastes).

3. Recycling – treat waste that is no longer usable in its present form and using it to produce new products (i.e. segregation and storage of scrap metal, oil, plastics, aluminium cans, glass and paper for periodic collection for transport to an off-site recycling facility).

4. Energy Recovery from Waste – adopt management practices that recover and use energy generated from waste (i.e. off-site burning of waste oil; and high temperature incineration of workshop wastes).

5. Treatment and/or Disposal – adopt management practices that reduce the potential for environmental harm by disposing of waste, or treating and disposing of waste. Such measures could include:
   - composting/vermiculture;
   - biotreatment of contaminated soils;
   - blending or mixing waste; and
   - disposal to inert and putrescible landfills.

An Environmental Awareness training programme will encourage waste reduction and reuse and recycling. Waste that cannot be reused or recycled will be disposed of in approved landfill facilities (either on-site or off-site), in accordance with relevant legislation and standards.

Recyclable materials

Recyclable materials will be separated on site. A local waste management and recycling contractor will be utilised to collect and remove waste from site, reusing and recycling waste wherever practicable. FMG currently recycles material at its exploration sites.

Hydrocarbons and hazardous wastes

During construction and operations, FMG will ensure that hydrocarbons and other potentially polluting substances are correctly stored according to Australian Standards, and will implement procedures for correct transport, storage, handling, spill prevention and emergency response procedures to minimise the risk of contamination from inappropriate waste disposal.

Oil drums, oil filters and batteries will be collected and stored appropriately prior to removal by a licensed contractor. Workshops will be constructed in such a manner to allow the safe and efficient storage of these wastes.

Material to landfills

Field landfills will be used for putrescible waste and inert non-recyclable material only and will not be used for the disposal of waste oil or other hazardous wastes. Waste will be covered daily to minimise wind-blown litter, odour, and animal scavenging. Field landfills will be managed in accordance with the Department of Environmental Protection's Code of Practice for Country Landfills (DEP, 1996a) and Landfill Waste Classifications (DEP, 1996b).

Sewerage and grey water

Sewerage treatment plants will be located at major accommodation areas, where the generation of waste water is sufficient to warrant the operation of such a facility. As a minimum a sewage treatment plant will be constructed at Christmas Creek. Waste water from this plant will be treated to a standard approved by the Health Department of Western Australia and recycled to the Beneficiation Plant for use in processing. Depending on the treatment plant chosen sewage sludge may not be produced in large quantities. If sludge is produced by the sewerage treatment plant it will be buried in mine backfilling operations, or removed to an approved landfill facility once the sludge has been dried.

More remote sites will have stand-alone systems to manage sewage. This may include, but not be limited to, septic tanks, composting and/or waterless toilets. If septic tanks are used they will be pumped out as required by licensed waste disposal contractors. The final treatment option selected will minimise the amount of effluent requiring offsite disposal.

6.9.5 By-products

6.9.5.1 Potential Impacts

Wherever possible, FMG will seek to value add to its product through further processing of waste. This can result in the generation of economic by-products, with little or no adverse incremental environmental impact, as greater amounts of valuable product can be extracted from the equivalent mining and disturbance area. Should the opportunity arise, FMG will pursue the extraction of economic by-products from the Project. At this stage the extraction of by products is not planned. Should this position change in the future, a separate approval will be sought.

6.10 ABORIGINAL HERITAGE

The EPA objectives with regard to Aboriginal heritage are to:

- ensure that the proposal complies with the requirements of the *Aboriginal Heritage Act 1972*; and
- ensure that changes to the biological and physical environment resulting from the Project do not adversely affect cultural associations with the area.

FMG has established a protocol of regular meetings with the affected native title Working Groups established by the three native title claimant groups that are impacted by the proposed mines and east-west railway spur. These meetings are facilitated by PNTS and are held in a co-operative manner enabling FMG to present information on a range of matters associated with the proposed development of the railway alignment and mines. The matters discussed at these meetings include the timing and conduct of Aboriginal heritage surveys, negotiation of the native title agreements as well as employment and contracting opportunities.

6.10.1 Use of Land by the Aboriginal Traditional Owners

The Aboriginal Traditional Owners, represented by their particular native title claimant groups, have continually used and occupied the land covered by the Project prior to the European settlement of the Pilbara region. This continued use and occupation of the land is evidenced by the existence of Aboriginal communities such as Wiliyarmarra and Youngaleena on the Mulga Downs pastoral lease as well as Jigalong and various communities in and around the towns of Port Hedland, Marble Bar, Nullagine, Newman and Tom Price. Evidence of the long term occupation and use of the region by the Aboriginal Traditional Owners is reflected in the richness and variety of the Aboriginal sites that are found in abundance throughout the region today.

The Aboriginal Traditional Owners of the land covering the Project area have registered three native title claims to ensure that their stated native title rights and interests within their traditional country are recognised at law. These rights and interests include the continued use and occupation of the land for traditional purposes such as ceremonies, hunting, fishing and procuring ochre and bush foods.

FMG acknowledges that there are specific areas of land that the Aboriginal Traditional Owners wish to protect to ensure that they are available for their ongoing traditional use and enjoyment. These places will be identified during consultation with the Aboriginal Traditional Owners to ensure that any potential impacts during the construction and development of the Project are kept to a minimum. One example is the desire of the

Nyiyaparli Aboriginal Traditional Owners to be able to continue to access the Mankarlyirrkurra ethnographic site complex east of the proposed Christmas Creek mine. FMG will ensure that the proposed CHMP will take into consideration the need for the Aboriginal Traditional Owners to continue to have access to significant ethnographic sites within imposed health and safety requirements.

Where the presence of the Project is likely to have an adverse impact on access to food, medicinal and other natural resources by the Aboriginal Traditional Owners, FMG will discuss management measures with them, and will ensure that these measures are also included in the proposed CHMP. Management measures may include providing alternative access to resources, using native plant species traditionally used for food in the rehabilitation of disturbed areas, or assistance to the Aboriginal Traditional Owners in other ways.

FMG will implement the proposed management measures outlined in Sections 6.3, 6.4 and 6.2 to minimise the impacts on vegetation, fauna and water supplies. Mitigation of socio-economic impacts in general on both the local Aboriginal and non-indigenous community are discussed in Section 6.14.

6.10.2 Protection of Aboriginal Sites

As detailed in Section 4.7.1, the Chichester Range, the Fortescue Plain and the Hamersley Plateau are known to contain a rich diversity of Aboriginal sites. FMG has been able to avoid impacting any Aboriginal sites to date as a result of the Aboriginal heritage surveys commissioned with PNTS and the participation of the Aboriginal Traditional Owners (refer to Figure 42 for known sites). FMG has also considered the known potential for Aboriginal heritage sites in its selection of the preferred rail route, which was moved away from known sites in crossing the Chichester Ranges, and followed one crossing of the ranges to avoid potential further sites (Section 5.2).

FMG will ensure that Aboriginal sites are located, recorded and protected wherever possible. The Aboriginal heritage surveys commissioned by FMG to date have revealed that there are archaeological sites of significance to the Aboriginal Traditional Owners within the land covered by the proposed railway corridor and the mines. However, FMG has been able to avoid impacts to ethnographic sites to date and will avoid disturbing Aboriginal sites (particularly ethnographic sites) in the final design of the Project however it is acknowledged that it may not be possible to avoid impacting all known archaeological sites.

The results of the Aboriginal heritage surveys that are currently occurring and which will be commissioned for the final mine design and east-west railway spur in the near future will be used to identify the location, nature and significance of any Aboriginal sites. The final alignment of the mines and railway layout will take into account the location of any Aboriginal sites. The alignment of the proposed railway will be refined within its current 2 km wide corridor to avoid where practicable as well as taking into account Aboriginal sites, environmental and engineering constraints. The construction corridor will be generally less than 40 m wide, although additional areas will be required for the access track, yards, and temporary facilities (e.g. contractor laydown areas).

The long term management of Aboriginal sites within the Project area will necessitate the involvement of the Aboriginal Traditional Owners and PNTS in the development and application of an appropriate Cultural Heritage Management Plan (CHMP). The CHMP will be in place prior to construction and will apply during the operation and subsequent decommissioning and rehabilitation of all aspects of the Project by FMG and its contractors. Agreed management measures will be implemented by FMG in consultation with and the participation of the Aboriginal Traditional Owners.

The proposed CHMP will provide for Aboriginal Monitors to be employed by FMG and/or the construction contractors to oversee the construction of the Project infrastructure within the relevant native title claims to ensure that no known Aboriginal sites are inadvertently impacted and to ensure that changes to the physical environment do not affect Aboriginal heritage and culture. Additionally, the CHMP will contain procedures for the protection and mitigation of any Aboriginal sites that are uncovered during construction (human burials, stratified deposits) as well as procedures for the physical management of Aboriginal sites in close proximity to the construction (fencing and signposting engravings) as necessary.

Should FMG need to disturb an Aboriginal site or disturb the physical environment in a way which affects Aboriginal heritage and culture, then consultation with the Aboriginal Traditional Owners of the affected native title claimant group will occur to ensure that disturbance is kept to a minimum and any mitigation of the site is undertaken in consultation with the Aboriginal Traditional Owners with the resultant salvaged material (stone artefacts) being stored in a culturally appropriate Keeping Place.

FMG will apply under Section 16 and Section 18, of the *Aboriginal Heritage Act 1972* only after consultation with the affected native title claimant group has occurred.

6.11 EUROPEAN HERITAGE

The EPA's objective for the Project is to:

- comply with statutory requirements in relation to areas of cultural or historical significance.

6.11.1 Heritage Sites

A search of the State Register of Heritage Places indicated that there are no sites of European Heritage significance within the Stage B Project area. However, there are two sites that are listed on the Shire of East Pilbara's Municipal Inventory. These are the Roy Hill Homestead (site 14228), which was used as a former post office, general store and directional beacon, and the concrete road bridge over the Fortescue River on Roy Hill Station (site 3401, Bridge No. 976).

6.11.1.1 Potential Impacts

The construction and operation of the proposed rail corridor (or conveyor corridor) and mine sites will not interfere with either of these sites. The Roy Hill Homestead which is the closest to the Project area will not be affected by blasting operations (Section 6.7).

The concrete road bridge was designed in 1929 and has a load capacity of less than 42.5 tonnes gross. The bridge is available for normal vehicular traffic, and its condition is currently monitored by Main Roads. FMG is not proposing to alter or upgrade the concrete road bridge and heavy traffic will use the existing alternative low level crossing provided, if required.

6.11.1.2 Management Strategies

FMG will ensure that it complies with statutory requirements in relation to areas of European heritage or historical significance, during the construction and operation of the Project. For example blasting at the mine sites will be undertaken in accordance with regulatory requirements, so as to avoid potential damage to the Roy Hill Homestead.

FMG will have in place procedures to ensure that all heavy traffic using the Roy Hill to Nullagine road have the appropriate permits and do not use the Roy Hill concrete bridge, but rather the adjacent low level crossing.

6.12 LAND REHABILITATION AND PROJECT CLOSURE

The EPA objective for the Project with regards to mine closure and rehabilitation is to:

- ensure as far as practicable, that rehabilitation achieves a stable and functioning landform which is consistent with the surrounding landscape and other environmental values.

It is recognised that mining is a temporary land use which should be integrated with, or followed by, other forms of land use. Rehabilitation of mines will be aimed towards a clearly defined future landuse for the area. If the revegetation and rehabilitation of an area does not achieve the agreed completion criteria, future land uses may be impacted. For example pastoral areas may not be able to carry the same number of stock or there may be a requirement for continued maintenance.

6.12.1 Progressive Rehabilitation

A Rehabilitation and Revegetation Management Plan has been developed for the Project and is presented in Appendix D.

A construction corridor of generally less than 40 m will be disturbed during construction of FMG's railway, which is similar to the area proposed for disturbance by the Hope Downs railway (HDMS, 2002). The FMG railway corridor will be progressively rehabilitated as construction of sections of the rail is completed. Cleared areas not required for operation of the railway will be rehabilitated to re-establish a stable landform and promote regeneration of a self-sustaining ecosystem. Areas prone to erosion will be stabilised, and where practicable, similar substrate and hydrodynamic features to that which was present prior to construction, will be re-established.

Areas of temporary disturbance will be rehabilitated in a manner similar to the railway corridor, once these are no longer required for construction, to re-establish a stable landform and promote the regeneration of a self-sustaining ecosystem. Ballast material for construction rail and operations will be from existing or new quarries. Rehabilitation of these quarries will be required by the owners of the quarries according to legal requirements.

Compacted areas of borrow pits will be ripped on the contour. The slopes of borrow pits will be battered down and contoured to reduce the risk of excessive erosion and left as free-draining structures where practicable. Topsoil and vegetation debris will be spread over the surface of the pits to promote regeneration of a stable community.

The mine sites will be progressively rehabilitated throughout the life of the mine. For example, progressive backfilling of the pits will enable individual pit cells to be contoured and rehabilitated. Similarly the starter overburden stockpiles and initial rejects placement area will be rehabilitated once they are no longer required, (expected to be after the first two years of operations). Pits will be backfilled to above the water table and where practicable will be designed to be free-draining. Whilst the final pits' post mining landform will be below the pre-mining landform, no deep voids will be left by the Project. Further detail of the volume of material available to backfill mined out pits is provided in Section 5.3.7.

Rehabilitation activities will include:

- ripping of compacted areas;
- re-establishment of a stable landform with erosion protection where necessary for long-term stability;
- construction of a post-mining landform that resembles the pre-mining landscape as closely as practicable;
- reinstatement of surface drainage patterns similar to that which were present pre-construction;
- replacement of topsoil;
- spreading of vegetation debris to return organic matter to the area, and provide an additional seed source; and
- additional seeding and planting of seedlings if regeneration from topsoil is insufficient.

Areas of temporary disturbance following construction will be rehabilitated once these are no longer required, to re-establish a stable landform and promote the regeneration of a self-sustaining ecosystem.

Remediation may be required if rehabilitation is unsuccessful in certain areas and may include repair of eroded areas, weed control, and seeding or planting of areas where vegetation has not established from natural seed sources in the topsoil and mulch applied to rehabilitated areas.

The rehabilitation programme will include development of rehabilitation and revegetation completion criteria in consultation with key stakeholders, to determine when a rehabilitated area can be considered self-sustaining, or indicate a continuous positive trend towards a stable community. Examples of criteria that will be considered are included in the Rehabilitation and Revegetation Management Plan (Appendix D).

6.12.2 Rail Decommissioning

The railway is expected to have a design life in excess of 20 years. However, with continuing exploration throughout the Pilbara, industry diversification and through proper maintenance the railway could have an indefinite operating life. With the low level of existing regional infrastructure the railway, provided it is actively maintained, should be considered an asset to the State.

In the event that all or part of this infrastructure is no longer required, by FMG or another party, the facilities no longer required will be decommissioned. Decommissioning will comprise the safe dismantling and removal of infrastructure, the appropriate disposal of waste materials and site rehabilitation to return the environment as close to its original state. Where the removal of non visible infrastructure, or features that have been incorporated into the natural landscape, may cause more environmental damage than if left in situ, then their retention will be discussed with the relevant authorities at that time.

Decommissioning procedures, closure plans, and completion criteria will be established in accordance with the applicable legislation and standards at the time.

6.12.3 Mine Closure

Detail on the future closure and rehabilitation of the proposed mine sites is presented in the Conceptual Mine Closure Plan in Appendix Q, and key points summarised below.

The Stage B Project is expected to have a life in excess of 20 years. The four mines will be constructed and operated in a staged manner, and will be progressively rehabilitated during operations. However, with continuing exploration throughout the Pilbara, it is possible that the Beneficiation Plant may remain insitu or be relocated to process ore from other deposits in the region.

Mine closure will include the safe dismantling and removal of infrastructure, the appropriate disposal of waste materials, backfilling and/or contouring mining areas where appropriate and site rehabilitation to return the environment to a safe stable landform which is not incongruous with the background environment, and capable of supporting a self-sustaining ecosystem comprising local plants and animals. Detailed procedures and completion criteria will be established in accordance with the applicable legislation and standards at the time of closure, and will be documented in the detailed Mine Closure Plan.

FMG will develop a comprehensive Life-of-Mine Closure Plan within two years of commencement of mining activities which will include the following:

- confirmation of closure objectives;
- stakeholder consultation program;
- closure aspects risk register;
- revised closure design criteria;
- closure standards and preliminary completion criteria;
- brief description of progressive closure methodology;
- closure research and monitoring plan;
- basis for financial provisioning; and
- revised closure schedule.

FMG will revise and update the Life-of-Mine Closure Plan at least every two years during the operational life of the Project.

6.12.4 Monitoring

Rehabilitated areas will require on-going monitoring to assess the effectiveness of the rehabilitation and remedial works. Baseline monitoring will commence prior to disturbance for mining activities, and will be continued at control sites throughout the life of the Project. Monitoring during operations will assist FMG in assessing the effectiveness of progressive rehabilitation of the pits, starter overburden stockpiles and rejects placement area. Monitoring will indicate where remedial works may be required including repair of eroded areas, weed control, and seeding or planting of areas where vegetation has not become established. This monitoring will be used to improve rehabilitation methods over the life of the mine, and develop appropriate closure criteria for different parts of the Project.

The Rehabilitation and Revegetation Monitoring Plan will include development of rehabilitation completion criteria to determine when a rehabilitated area can be considered self-sustaining, or indicate a continuous positive trend towards a stable community.

6.13 FUTURE CONSERVATION AREAS

The EPA's objectives for the Project with regards to conservation values are to:

- avoid, minimise, mitigate and offset direct and indirect impacts on the critical values of the Mulga woodlands (Chichester Ranges foot-slopes) and the Fortescue Marsh; and
- avoid adversely affecting the future conservation value of the pastoral stations proposed for inclusion in the Conservation Estate, or managed for conservation purposes.

6.13.1 Regional Context

The Fortescue Marsh has been identified as a 'Nationally Important Wetland' (Section 4.5.1) and is listed as an 'indicative place' on the Register of National Estate due to its importance as a habitat for migratory birds. CALM is proposing that portions of the Mulga Downs, Hillside, Marillana and Roy Hill Stations be excluded from the renewal of pastoral leases in 2015 so that they can be added to the conservation estate (or managed by conservation agreement with the Pastoralists). CALM's negotiations with the Pastoral Lessee's regarding the final boundaries of the exclusion areas, have not concluded, and are not yet approved by the Minister for Planning and Infrastructure. As such final boundaries of the exclusion zones are not available publicly or to FMG. If the exclusion zones are agreed and approved by the Minister, a further approval process will be required to be sought for the areas to be included in the conservation estate (refer to Insert 1).

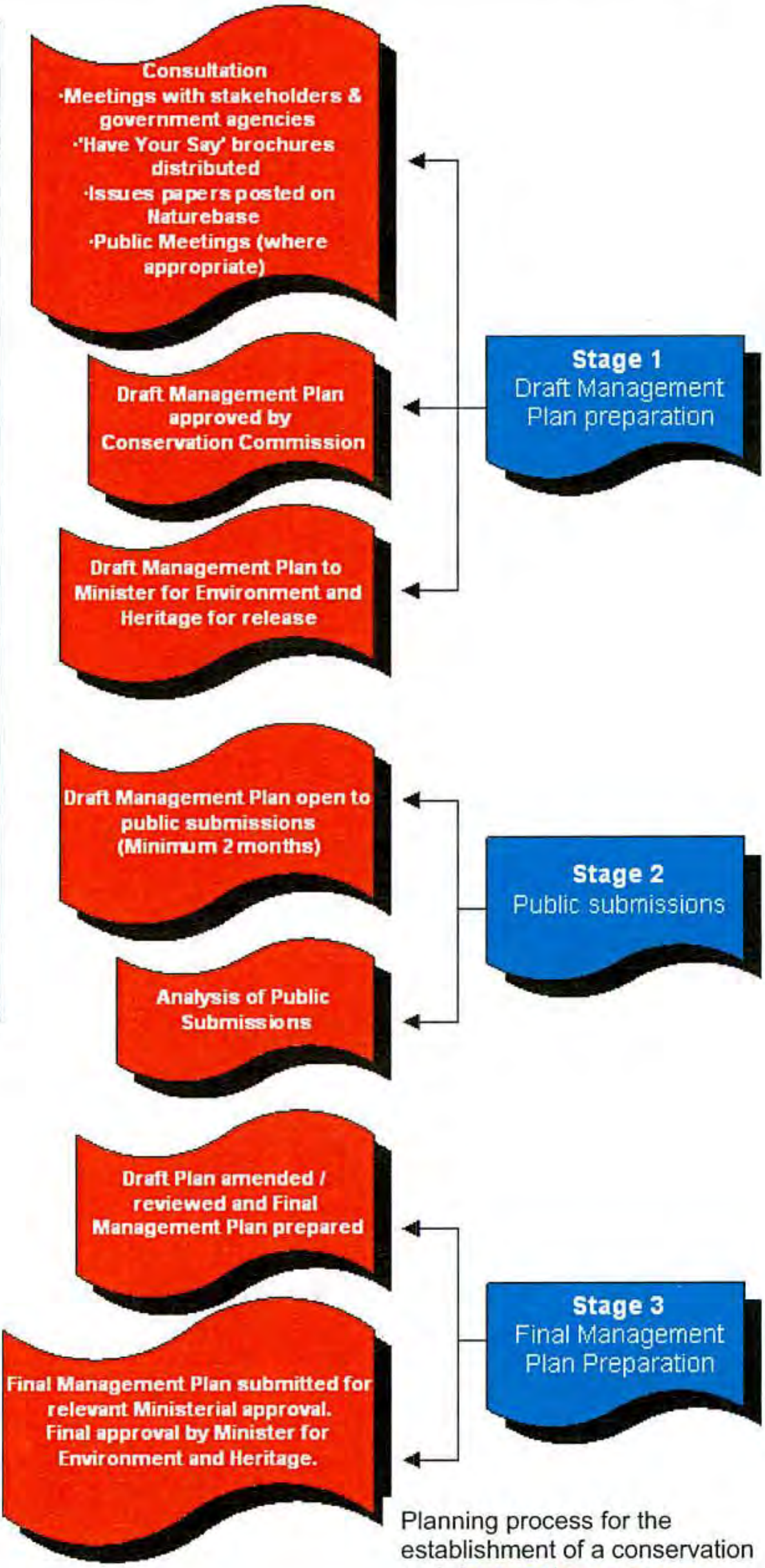
A proposed conservation park, east of Karijini National Park, extends from the vicinity of Mt Meharry some 70 km to the south and east almost to Mt Newman, with the Great Northern Highway forming the eastern boundary. FMG's Project area coincides with a small portion of this proposed park in the vicinity of the Mindy Mindy mine (as do a number of other existing mining and infrastructure projects in the region). The park has been proposed since 1987 and the proposal to add this area to the conservation estate has not yet been approved under the Western Australian Reservation Process (see Insert 1).

As the future status of the proposed conservation park and pastoral lease exclusion areas is uncertain FMG has focussed on a hierarchy of controls to avoid, minimise and mitigate potential impacts on the conservation values of the area, so that its future conservation value is not reduced.

Western Australian Reservation Process (Insert 1)

Identification of areas for reservation represents only the first step towards creation of national parks, nature reserves or conservation parks. Reservation of lands as national park, nature reserve or conservation park occurs by a Ministerial order in accordance with the Land Administration Act 1997, and then land is automatically vested under section 7 of the Conservation and Land management Act 1984 in the Conservation Commission.

Before an order of reservation occurs the Department of Land Administration generally requires advice of clearances or approvals from the Department of Industry and Resources (in terms of its interests with respect to granted tenements, State Agreement Acts and prospectivity for minerals, basic raw materials and petroleum), water agencies and local government authorities, as well as meeting native title requirements, (CALM, 2003).



Planning process for the establishment of a conservation park (www.calm.wa.gov.au

6.13.1.1 Potential Impacts

The key issues relating to the protection of future conservation values of the area include:

- potential impacts on the Mulga Woodlands (Chichester Ranges footslopes) such as:
  - vegetation clearing;
  - disruption to surface hydrology;
  - erosion;
  - weeds;
  - fire;
  - dust; and
- potential impacts to the Fortescue Marsh ecosystem such as:
  - hydrogeological impacts;
  - surface water impacts;
  - weeds and pests;
  - noise;
  - light overspill.

These issues are discussed in Section 6.1 (Surface Water), Section 6.2 (Groundwater), Section 6.7 (noise) and Section 6.3 (Mulga groves) and also outlined below.

6.13.1.2 Management Strategies

The management of these potential impacts have been addressed throughout Sections 6.1, 6.2, 6.7 and 6.3. However, the management strategies that will be adopted which are applicable to conservation areas are detailed in Table 20.

Plate 7. Mulga grove/intergrove association, showing dense grove in background and sparse intergrove in foreground.

Table 20. Management strategies that will be adopted which are applicable to conservation areas

Area of Conservation Value	Potential Impact	Management Strategies
Mulga Woodlands (Chichester Ranges Footslopes)	Vegetation Clearing	Detailed in Section 6.3.1, briefly clearing impacts will be managed as follows: • Some direct clearing of Mulga will occur during construction of the railway and mining operations. The final location and design of the railway and mines has been selected to minimise these direct clearing impacts as far as practicable. • A number of alternative rail alignments were considered, however these were not feasible due to environmental, access and engineering constraints as discussed in Section 5.2.1. The final rail alignment will be selected to reduce direct impact on Mulga through clearing, by ensuring it traverses through areas without Mulga or through less dense Mulga wherever possible, rather than intersecting dense or groved areas (see Section 5.2.1). The construction corridor will generally be less than 40 m wide except where areas are required for the access track, temporary facilities (e.g. contractor laydown areas) and operating yards. • Locations of the mine sites, in particular the pits, are dictated by the locations of the orebodies. However, within these areas, locations of the permanent overburden placement areas, rejects placement area, processing plant and supporting infrastructure have been selected to take into consideration the location of Mulga communities. For example the starter overburden stockpiles were located towards the northern end of the proposed pits away from Mulga communities. • To assess the total impact on the Chichester Ranges Mulga woodlands from direct clearing, FMG undertook a review of the Pilbara Ranges Project Rangeland Survey (Payne *et al.*, 2002). When the total area of the Chichester Mulga Woodland (1,641 km^2) and the total area of Mulga in a 12 km buffer surrounding the Fortescue Marsh (3,204 km^2) is taken into account, direct impacts on Mulga from the rail account for approximately 0.2% of the Chichester Mulga Woodland and 0.1% of the Fortescue Marsh surrounds Mulga. For the mines direct clearing will account for 2.5% of the Chichester Mulga Woodland and 1.3% of the Fortescue Marsh surrounds Mulga. For a discussion on these two Mulga units, refer to Section 4.5.2.3. For the basis of these percentages refer to Section 6.3.1. If only the Chichester Footslopes Mulga woodland is considered, direct clearing from the Project will impact only 2.7% of the total Mulga in the unit, which is unlikely to have an effect on the conservation value of the area. • A Rehabilitation and Revegetation Management Plan has been developed for the Project and is presented in Appendix D. For further information on the rehabilitation and revegetation refer to Section 6.12.1. As part of the PER, investigations have been undertaken into rehabilitation methods used in Mulga communities in the Pilbara.

Area of Conservation Value	Potential Impact	Management Strategies
		This review has highlighted that with appropriate topsoil/overburden handling and seeding (as required) it has been possible to undertake Mulga rehabilitation on similar environments in the Pilbara region (*pers. comm.* Dr. E. Mattiske, 2004). FMG will rehabilitate all disturbed Mulga areas, back to Mulga communities as close as possible to their pre-disturbance state. In addition, FMG will fund research into the rehabilitation of Mulga. This will assist in preserving the conservation value of the area. • A construction corridor of generally less than 40 m will be disturbed during construction of FMG's railway, which is similar to the area proposed for disturbance by the Hope Downs railway (HDMS, 2002). The FMG railway corridor will be progressively rehabilitated as construction of sections of the rail is completed. Cleared areas not required for operation of the railway will be rehabilitated to re-establish a stable landform and promote regeneration of a self-sustaining ecosystem. Areas prone to erosion will be stabilised, and where practicable, similar substrate and hydrodynamic features to that which was present prior to construction will be re-established. • The mine sites will be progressively rehabilitated throughout the life of the mine. For example, progressive backfilling of the pits will enable individual pit cells to be contoured and rehabilitated. Similarly the starter overburden stockpiles and initial rejects storage area will be rehabilitated once they are no longer required (expected to be after the first two years of operations).
	Disruption to Surface Water	Detailed in Section 6.1, briefly: • Indirect impacts on Mulga, through disruption of sheet flow have been minimised as far as possible, by the railway being moved as far north as practicable to cross more defined drainage channels, rather than the diffuse drainage patterns further south. Due to the topography of the Chichester foothills, which consist of headlands and "valley like" low lying areas, some areas of groved Mulga will still be traversed as there are engineering constraints in developing a railway to mirror the tight curves around the base of the headlands (Figure 11). • Whilst there has been extensive research into Mulga, it has not been possible to fully quantify the catchment area required for Mulga survival (*pers. comm.* Dr. P. Grierson). However, in grove-intergrove Mulga patterns, the Mulga grove is mainly dependent on runoff from the intergrove upslope (*pers. comm.* Dr. E. van Etten) suggesting that water shadow (if present) would not extend far beyond one grove-intergrove area downstream of a surface flow barrier. However, FMG believe that the east-west rail will not create a significant barrier to sheetflow, because the culverting and the sheetflow redistribution system planned will be designed to minimise potential water shadows (see Section 6.1.4). As such, disruption to surface hydrology will not have an impact on the conservation value of the area.

Area of Conservation Value	**Potential Impact**	**Management Strategies**
	Erosion	Discussed in Section 6.1 and 6.3, briefly erosion will be managed as follows: • Riprap (rock fill) pads to encourage flows to slow and disperse in sheetflow zones. • Rehabilitation of disturbed areas to stable landforms. • Erosion protection installed upstream and downstream of culverts. • Railway access road constructed downslope of the rail in sheetflow zones to minimise the potential for erosion of the road.
	Weeds	Detailed in Section 6.3.4, briefly weeds will be managed through the following measures: • A Weed Hygiene and Management Plan will be prepared to the satisfaction of CALM and Agricultural Protection Board. • Off-road driving will be prohibited onsite.
	Fire	Detailed in Section 5.5.4, 6.3.5, and 6.4.3, briefly fire will be managed as follows: • A Fire Management Plan will be developed. Measures will be included to address normal construction activities, including the use of heavy plant and equipment in dry vegetated areas, welding, grinding and other activities with the potential to start fires.
	Dust	Detailed in Section 6.6, briefly dust will be managed as follows: • A Dust Management Plan will be developed prior to construction detailing measures to minimise dust generation.
Fortescue Marsh	Groundwater	Detailed in Section 6.2, briefly groundwater will be managed as follows: • A groundwater study has been conducted by Aquaterra and possible impacts on the Marsh from minesite dewatering and borefield abstraction were investigated using a numerical model. The model indicated that groundwater drawdown will not extend as far as the Marsh, which is predominately a surface water feature. • FMG has committed to further work to confirm the model results and will install groundwater monitoring bores and implement a groundwater monitoring programme. Data from the programme will be used to revise the groundwater impact model.
	Surface Water	Detailed in Section 6.1, briefly surface water will be managed as follows: • The potential impact of runoff water volume loss to the Fortescue Marsh, due to the proposed pit developments, is considered to be minor. During the mining phase, assuming that a quarter of the pits are open at any one time (a conservative estimate, as FMG will minimise its open areas), the open pit areas will represent approximately 0.1% of the total Marsh catchment area.

Area of Conservation Value	Potential Impact	Management Strategies
	Weeds and pests	Detailed in Section 6.3.4, briefly weeds and pests will be managed as follows: • A Weed Hygiene and Management Plan will be prepared to the satisfaction of CALM and Agricultural Protection Board. • Off-road driving will be prohibited onsite.
	Noise	Detailed in Section 6.7, briefly noise will be managed as follows: • Potential impacts of noise and vibration from blasting at the mines on migratory birds utilising the Marsh has also been assessed (Section 6.7). The Fortescue Marsh is recognised as providing an important wetland habitat, particularly for inland water birds, when in flood. • As the proposed rail alignment is approximately 4 km from, and the closest mining area approximately 6.5 km from, the boundary of the Fortescue Marsh at the closest point, no direct impacts on the Great Egret or other migratory species using the Marsh are expected to occur. The only possibility is if blasting undertaken during mining or construction of the railway is conducted under meteorological conditions that direct noise towards the Marsh and disturbs migratory birds on the Marsh. However, noise and vibration impacts are expected to be minimal due to the distance from the Marsh and can be readily managed. For the predicted blasting noise levels of $L_{\text{Linear peak}}$ 129 and 106 dB for unconfined and confined blasts respectively, the research suggests that there is likely to be some short-term disturbance, however birds are quick to adapt to a changing environment and should resume normal activities in a short period of time. FMG will, however, be implementing blast management strategies to minimise this impact (see below). In terms of transportation and operational noise, the research suggests that an adverse impact to the wildlife from these noise sources is unlikely (Lloyd Acoustics, 2004; Appendix P) • Despite the low risk of impact, FMG will develop a Noise and Vibration Management Plan prior to construction of the Project, in consultation with the DoE, to ensure any potential impacts are managed adequately. This Noise and Vibration Management Plan will include the following noise management measures: o use of low-noise equipment where practicable; o monitoring blast noise near sensitive receptors to determine allowable blasting mass, in accordance with Regulation 11; o monitoring the effects of blast noise on birdlife using the Fortescue Marsh; o avoid blasting under worst-case meteorological conditions (i.e. wind blowing towards residences, or Fortescue Marsh during bird breeding season);

Area of Conservation Value	Potential Impact	Management Strategies
		○ design of the mine (e.g. placement of ore and overburden stockpiles) to reduce potential noise impacts; and ○ selection of explosives and modified blasting practices to minimise impacts on bird life. • With these control measures in place, FMG do not believe that blasting or any other of the Project's activities will adversely impact listed migratory species using the Fortescue Marsh.
	Light Overspill	FMG will manage the potential impact of light overspill through a Management Plan, which will include measures such as limited lighting at night directed inwardly at operations, light shielding and selection of lighting that minimises overspill and insect attraction.

FMG conducted a risk assessment to further investigate the potential impact on the Fortescue Marsh ecosystem as a result of the proposed Stage B Iron Ore and Infrastructure Project (Appendix M). The risk assessment investigated the potential impact on the Fortescue Marsh ecosystem and primarily focused on water abstraction (water supply and mine dewatering), the potential disruption to surface water flows and any impacts on water quality or habitats due to the introduction of foreign materials or by-products of the mining process into the area (Section 6.2.7).

The work was carried out as a team-based risk assessment in October 2004 by a team of specialists using a model based on AS/NZS 4360: 1999 "Risk Management" and utilising risk criteria specifically developed from the guidelines within HB 203: 2000 "Environmental Risk Management". Initially, the impacts were assessed on the basis of no specific control measures being in place (defined as "inherent risk"), followed by a re-evaluation of the expected risk with the proposed management procedures and safeguards in place (defined as the "residual risk").

The overall residual risk to the Fortescue Marsh ecosystem as a result of the proposed Project was found to be minimal when control measures were considered. The initial, uncontrolled (inherent) risk levels were found to be low in most instances; due to the geographical separation of the mining, railway and borefield facilities from the Fortescue Marsh resulting in an insignificant impact on the surface or groundwater flows. Modelling of the groundwater reserves predicts minimal drawdown on water table levels within the immediate Marsh area and within the current range of variations due to normal rainfall effects.

The surface water catchment area will be reduced to a small degree, but this reduction is considered to be very small with regards to the total catchment area that flows to the Marsh. Disruption to surface water flows has been minimised by the provision of culverts and spillways within the design for the railway embankment formation (see Section 6.1.4).

Introduction of foreign plant or fauna species is considered low risk and will be managed through specific procedures and monitoring programs. Environmental damage resulting from unexpected events (e.g. hydrocarbon spills) was assessed as a low risk, due to the improbability of the event (on the basis of the routine practices demonstrated regularly elsewhere) and the emergency response plans proposed to mitigate any impacts. Seepage or spillage from within the proposed mining and processing areas was determined to be outside the area of influence for the Marsh, and, additionally, was to be minimised through bunding, process controls or localised catchments.

Management of surface hydrology and hydrogeology will be in accordance with the measures outlined in Sections 6.1 and 6.2.

FMG will continue to work with CALM throughout the life of the Project to ensure that that the Project does not adversely affect the conservation values of the Fortescue Marsh, and where opportunity arises, to enhance the conservation values of the proposed conservation area.

6.14 SOCIO-ECONOMIC ISSUES

6.14.1 Socio-Economic Context

The EPA objective for the Project is to:

- ensure a net benefit to the local community potentially affected by the Project.

The regional social setting is described in Section 4.6. FMG's proposed east-west railway is relatively remote from any settlements, being at its closest, 8.4 km to Roy Hill homestead. Similarly, the mine sites are relatively remote with the townsite of Newman approximately 100 km to the south. The nearest residences to the proposed mining areas are:

- Marillana Homestead: 16 km north of Mindy Mindy mine site
- Roy Hill Homestead: 20.6 km south of Christmas Creek mine site and 18.7 km west of Mt Lewin.
- Balfour Downs Homestead: 33.5 km east of Mt Nicholas
- Bonney Downs Homestead: 21 km north of Christmas Creek.

The social and economic context of the Project presents a number of opportunities and risks which FMG will consider in planning for the Project. A summary of the key risks and opportunities are presented in ERM (2004) (Appendix H) and outlined below.

6.14.1.1 Potential Impacts

Potential impacts associated with the development of the Project include:

- additional demands on unfunded local community service provision;
- wage inflation and local price inflation (including housing) due to increased demand for housing and employment attraction schemes;
- supplier organisation and community dependency on FMG operations for their sustainability;
- increase in the relative poverty of the indigenous community due to wage inflation of industry employees and contractors;
- added pressure on social and medical services; and
- increase in anti-social behaviour and illegal activities.

These risks are associated with a range of activities throughout the pre-construction, construction, operation and decommissioning phases of the Project as described below.

Pre-Construction

The Project activities that have the potential to give rise to socio-economic impacts at the planning and pre-construction stage include:

- project approvals and negotiations (including Native Title negotiations);
- public communications about the Project;
- procurement; and
- changes to land tenure.

The potential impacts that may occur in this phase will be generated by community awareness of the Project and the interactions with stakeholders in relation to project approvals and negotiations over land tenure and Native Title Rights. In particular, the Project may generate investment confidence in the region and locally. This has the potential to be both a positive and a negative impact. Positive impacts will result from the development of additional local business through expansion or new start-ups in addition to multiplier effects. Negative impacts may occur where poor investment decisions are made, potentially on the basis of false expectations about project benefits.

Construction

The potential impacts for this phase of the Project will relate to the mobilisation of the workforce and procurement of goods and services. These activities have the potential to have significant positive impacts in terms of employment, economic activity and business development. Project activities that have the potential to give rise to impacts at the construction stage include:

- procurement;
- mobilisation of construction workforce;
- construction of temporary work camps;
- earthworks and blasting activities;
- general construction activities; and
- creation of an area around construction activities that excludes the public.

The majority of the construction workforce for the mines and rail (about 800 personnel) will be accommodated on site. Given the restricted capacity of the local construction industry, it may be that relatively few construction workers will be residents of the shires of Ashburton, Port Hedland or East Pilbara. If this is the case, the positive local impacts arising from wages spending, will be small. The ability of local people to acquire the skills required by FMG during the construction phase, will determine to a large extent, the benefits felt by the existing community during this phase.

Due to the remoteness of the proposed railway and mine sites, construction activities are unlikely to create a nuisance with noise, vibration (from blasting) (Section 6.7) and dust (Section 6.6). In areas where pastoral activities occur or where indigenous people use the lands, construction of the railway may restrict or modify these activities. However, FMG is in close consultation with the pastoral lease holders and traditional owners to ensure potential impacts are managed in an agreed manner.

Operation

Project activities that may result in socio-economic impacts at the operational stage include:

- payment of royalties and taxes;
- procurement;
- mobilisation of the operational workforce;
- accommodation in residential areas (e.g. Port Hedland and Newman)
- training;
- operation of the railway;
- power use; and
- water use.

The impacts of the Project will result from the payment of royalties and taxes which will have impacts at both the State and Commonwealth level. The benefits of these royalties and taxes will be felt broadly through Government expenditure/reduced borrowing.

Procurement and employment related to mining operations will predominantly be felt at the State and the local levels. State level impacts will be largely economic benefits associated with the export of iron ore. The Project is expected to result in about 500 jobs for operation of the railway and mines. FMG's operational workforce will not be FIFO and will be accommodated in new or existing residences in the town of Newman. Discussions with Local and State Government departments have been ongoing regarding permanent accommodation in Newman. Accommodation will be available on site for contractor personnel, although contractors will be encouraged to consider accommodation in Newman for extended stays. FMG has been consulting with a number of local government departments, housing development companies and real estate agents regarding the provision of housing for its workforce[4].

Training activities associated with the Project have the potential to create benefits for local communities.

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[4] FMG is aware through its consultation that the housing vacancy rates reported by ERM are based on 2001 Census Data and that since then vacancy rates have decreased. This is being factored into FMG's Housing Plan.

Decommissioning

FMG expect the Project to have at least a 20 year project life, and have a 50 year vision. On completion of mining operations, demobilisation of the operations workforce may result in socio-economic impacts during this phase of the Project, such as a decline in population, with impacts on goods and services provided in town, particularly those directly supplying the Project. If at the end of the Projects life, the east-west railway is no longer required by FMG, the State or any other third party, then it will be decommissioned.

The mine sites will be decommissioned and rehabilitated so that the land may be returned to pastoral or other (e.g. conservation) use.

6.14.1.2 Management Strategies

The key opportunities relate to economic development and infrastructure provision in the Pilbara including:

- contribution to economic development of the Pilbara Region through local procurement and multiplier effects of income;
- creation of opportunities for sustainable indigenous employment; and
- additional investment in services infrastructure.

FMG has developed a range of policy goals and commitments to address some of the risks and realise opportunities as follows. FMG will:

- facilitate community involvement in company planning processes and decision making;
- use a predominantly non-FIFO operational workforce;
- develop a housing plan to ensure quality and equitable housing for employees whilst minimising negative impacts on existing communities;
- develop a Vocational Training and Education Centre (VTEC) to provide meaningful training opportunities for indigenous people who would like to work for FMG with guaranteed employment on completion;
- maintain a focus on regional capacity building through:
  - offering local employment opportunities;
  - implementing education and training programs for a local workforce;
  - using local suppliers and establishing partnerships with local businesses where commercially practicable; and
  - offering a competitive open access regime for the use of its port and rail infrastructure to contribute to the long term economic development and sustainability of the Pilbara region.

FMG will continue to liaise with stakeholders who have an interest in this region to enable FMG to assess the potential socio-economic risks and opportunities and appropriate management measures (see Section 7).

Closure of the mines will be undertaken in accordance with an approved Mine Closure Plan that will take into account management of socio-economic impacts during closure and post-closure. A Conceptual Mine Closure Plan which is presented in Appendix Q outlines the framework for mine closure. This plan will be adapted to consider the specific closure requirements of each mine, and will be further developed during the life of the Project.

Ongoing stakeholder liaison will enable FMG to further assess potential risks and opportunities and mitigation measures.

6.14.2 Impacts on Pastoral Activities

6.14.2.1 Potential Impacts

The mining developments and railway have the potential to impact pastoral leases by limiting stock movements, minimising access to pasture and compromising vehicle access from one side of the rail line to the other.

6.14.2.2 Management Strategies

FMG will continue liaising with affected pastoralists regarding impacts on land access, land use, and stock access to pasture, to reach an appropriate outcome. Management measures may include additional fencing and gates, cattle crossings and land use agreements. Any road crossings of the railway will be constructed and signalled in accordance with Australian Standards.

Fences disturbed during construction of the railway will be reinstated on completion of construction activities unless another agreement with the pastoralist is reached. Public access will be restored except where the risk to the public would be unacceptable (e.g. within operational and maintenance areas).

6.14.3 Visual Amenity

The EPA objective for the Project is to:

- ensure visual amenity of the area is not unduly affected by the proposal.

6.14.3.1 Potential Impacts

The operating mining developments and railway will be visible from the pastoral stations within the immediate vicinity of the Project area, and may be visible from nearby unsealed roads and pastoral tracks. On completion of rehabilitation, the mining areas are not expected to create an unacceptable visual impact on the landscape when viewed from areas proposed for future conservation (refer to Section 6.13).

As it is proposed to develop the power supply for the Project separately as "Build-Own-Operate" power stations, (see Section 5.3.10) an independent provider will assess the potential visual impact of gas pipelines and/or transmission lines separately and submit separate environmental approvals for these components.

6.14.3.2 Management Strategies

FMG will minimise the impacts on the landscape by ensuring post mining land form replicates the pre-mining landscape as close as practicable. This will be achieved through progressive rehabilitation during both construction and mining activities as outlined in FMG's Rehabilitation and Revegetation Management Plan (Appendix D).

Ongoing consultation with Pastoralists and other interested parties regarding management of the visual impact of the Project, will continue throughout the life of the Project.

6.15 PRINCIPLES OF SUSTAINABILITY

The EPA's objective for FMG's Project is to:

- ensure as far as practicable, that the proposal meets, or is consistent with, the sustainability principles in the National Strategy for Ecologically Sustainable Development (Ecologically Sustainable Development Steering Committee, 1992).

The definition for sustainability that has been widely adopted is outlined in the World Commission on Environment and Development's Brundtland Report (World Commission on Environment and Development, 1987) as:

> *"Development which meets the needs of the present without compromising the ability of future generations to meet their own needs."*

There are at least three aspects to sustainability which are interrelated: social sustainability, economic sustainability and environmental sustainability. It has been said that a sustainable society depends upon a sustainable, stable economy which in turn depends on the global ecosystem, whose health is vital to all (World Commission on Environment and Development, 1987).

Australia's National Strategy for Ecologically Sustainable Development (NSESD) defines ecologically sustainable development (ESD) as

> *"using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased."*

The Core Objectives of the NSESD are:

- to enhance individual and community well-being and welfare by following a path of economic development that safeguards the welfare of future generations;
- to provide for equity within and between generations; and
- to protect biological diversity and maintain essential ecological processes and life-support systems.

The Guiding Principles of the NSESD are:

2. Decision making processes should effectively integrate both long and short-term economic, environmental, social and equity considerations.
3. Where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.
4. The global dimension of environmental impacts of actions and policies should be recognised and considered.
5. The need to develop a strong, growing and diversified economy which can enhance the capacity for environmental protection should be recognised.
6. The need to maintain and enhance international competitiveness in an environmentally sound manner should be recognised.
7. Cost effective and flexible policy instruments should be adopted, such as improved valuation, pricing and incentive mechanisms.
8. Decisions and actions should provide for broad community involvement on issues which affect them.

In 2003, the Western Australian Government also released a State Sustainability Strategy "Hope for the Future" which outlines six broad goals for sustainability that envisage how sustainability can be applied across the whole of government. These goals include:

- Ensure that the way we govern is driving the transition to a sustainable future.
- Play our part in solving the global challenges of sustainability.
- Value and protect our environment and ensure the sustainable management and use of natural resources.
- Plan and provide settlements that reduce the ecological footprint and enhance our quality of life.

- Support communities to fully participate in achieving a sustainable future.
- Assist business to benefit from and contribute to sustainability.

In addition the strategy sets out a vision for the State's mining industry which includes some key future actions:

- Work towards assessment of projects using sustainability criteria.
- Foster local community involvement (particularly Aboriginal communities, pastoralists and local shires).
- Establish a transparent process to enable community awareness of the day-to-day regulatory system for the resources industry.
- Implement strategies that support the use of local employment in mining ventures, particularly using regional centres as employment hubs and encourage mining companies to maximise their purchasing of goods and services within regions.

FMG understands that it needs a balanced approach to the way it operates. FMG's planning takes into account all of the above objectives and principles to pursue the goal of sustainable development, such that no objective or principle should predominate over the others.

Whilst FMG's Pilbara Iron Ore and Infrastructure Project involves the mining of a finite resource, and use of fuel resources that will one day be depleted, the way in which the Project is constructed, operated and decommissioned can be undertaken in a manner which meets the Guiding Principles of the NSESD and State Sustainability Strategy. In order to implement the principles of sustainability, FMG will develop a Sustainability Strategy which addresses its contribution to global impacts such as greenhouse gas emissions and focuses on managing impacts across the triple bottom line of Social Capital, Economic Wealth and Environmental Assets. This Strategy will include such things as:

- establishing sustainability principles in purchasing and contracting;
- ensuring efficient energy and water use;
- minimising waste and encouraging recycling; and
- providing for industry and community partnerships.

The following sections outline how FMG proposes to manage the potential impacts of the Project, in the light of the NSESD Guiding Principles. Community consultation (Principle 7 NSESD) is addressed in Section 7 of this PER.

In recognition of the above sustainability frameworks, FMG has commissioned a Socio-economic review as part of its Environmental Impact Assessment (EIA). This review identifies the key socio-economic issues that require further consideration in the project planning process and is being used to undertake informed consultation with stakeholders, and as a planning tool during project development. FMG has developed a range of policy goals and commitments (as outlined in Section 6.14) which are well aligned with the State

Sustainability Strategy in recognition of the risks and opportunities identified by the socio-economic review.

6.16 ENVIRONMENTAL MANAGEMENT SYSTEMS

FMG is in the process of developing and implementing an Environmental Management System (EMS) that will assist the company in proactively managing environmental issues and promoting environmental excellence. The EMS will be developed to be consistent with the ISO 14001 standard and will be integrated with Quality, Health & Safety, and other business management systems.

FMG will also be interested in the environmental standards of supplies and this will be reflected in the EMS. For example when FMG is considering power suppliers an audit will be undertaken to ensure the suppliers meet FMG's environmental requirements.

An Environmental Management Plan (EMP) is a key element in the successful implementation of the EMS. It includes plans for the management of specific environmental aspects of the Project. An EMP will be developed in two stages to address the environmental management for both the construction and operation of the east-west railway and mining operations. A Draft EMP for construction of the Project has been developed and is presented as Appendix B. Specific procedures for this EMP will be developed prior to construction, for the management of site-specific environmental issues.

The EMP will be the principal management tool to ensure the Project's environmental commitments and objectives are met. The staged EMP will be presented in a table format for ease of use by staff and contractors involved in the Project, and assessment by Decision Making Authorities (DMAs). The EMP will outline management strategies for the following environmental issues associated with both the construction and operations phases of the Project:

- terrestrial flora and vegetation communities and land clearing;
- weed management;
- terrestrial fauna;
- stygofauna;
- surface water;
- water supply;
- dust emissions;
- greenhouse gas emissions;
- surface water quality;
- groundwater quality;
- waste management;
- acid mine drainage;

- noise and vibration;
- Aboriginal heritage;
- European heritage;
- bushfires;
- rehabilitation, revegetation and decommissioning;
- stakeholder liaison; and
- incident reporting.

The EMP will address four key components:

- Key Issues – this identifies the key issues associated with the construction and operation of Stage B that require specific management strategies.

- Objectives – outlines the standard of environmental management that FMG will achieve in undertaking construction and operation of Stage B.

- Management strategies – FMG will achieve its environmental objectives for Stage B construction and operations through the identified management strategies. These strategies will provide clear and concise direction to staff and contractors on how construction and operational activities will be undertaken to avoid environmental disturbance where possible, and to manage and mitigate where avoidance is not possible.

- Monitoring – construction and operation of Stage B will have impacts on the environment and FMG will monitor these impacts to ensure they are minimised and managed in accordance with both the commitments given in the PER (Section 8), and relevant legislation.

- Reporting – FMG will be required to report to the Regulators and other key stakeholders on a regular basis. Reporting will include general environmental management performance, compliance with, and review of, existing environmental management commitments, and compliance with other environmental requirements.

The EMP will also provide mechanisms for review and continual improvement. The EMP will be supplemented with the following specific documentation which will be developed as required for the respective phases of construction and operations:

- detailed issue specific management plans;
- procedures and work instructions where required;
- training and awareness documentation; and
- monitoring, audit and inspection protocols.

As part of the EMP, FMG will develop an internal reporting structure, to monitor compliance with the commitments given in the Stage B PER during the course of construction and operational activities. Reports will be produced on a monthly basis, including information on environmental impacts, issues and management and will highlight any instances of non-compliance. Should the monitoring programs identify any non-compliances (such as exceedance of regulations or standards), FMG will contact the relevant decision making authorities to discuss mitigation measures.

The implementation of the management strategies and the results of all monitoring programs required under this EMP will be detailed in an end of construction environmental report and submitted to the relevant government agencies. Ongoing operational environmental reporting will be undertaken in a coordinated manner to meet requirements of various government agencies (i.e. annual / triennial environmental reports).

This Project will provide the opportunity to demonstrate to the international community the progressive mining techniques and environmental management that have been adopted in Western Australia, and can be demonstrated by the FMG Project.

7. STAKEHOLDER CONSULTATION

7.1 CONSULTATION PROGRAMME

The stakeholder consultation process for the Pilbara Iron Ore and Infrastructure Project was initiated by FMG prior to submission of the Stage A Environmental Referral in April 2004. A consultation strategy was prepared by FMG to facilitate effective communication with the regulators, local and wider community and other stakeholders, and to allow issues raised during the consultation process to be taken into consideration in the design and planning of this Project.

Consultation has included public presentations, government presentations, one on one discussion with pastoral lease holders, environmental groups, community groups, local members of parliament, government departments and members of local Aboriginal communities.

All stakeholders have been contacted in writing where the Project area intersects land in which the stakeholders hold a registered interest. Follow up meetings have been arranged where requested by stakeholders to further discuss the Project and the potential impacts.

A Stakeholder consultation strategy for the Stage B Project has been implemented to ensure that the concerns and interests of stakeholders are taken into consideration in design and development of the Project. The consultation strategy includes but is not limited to:

- community updates;
- mail-outs;
- newsletters;
- website information;
- display material;
- letters;
- personal visits;
- newspaper articles;
- radio advertising;
- site tours;
- public and government presentations and community meetings; and
- one on one discussions with pastoral lease holders, environmental groups, local members of parliament, government departments and members of local Aboriginal communities.

The consultation strategy has been included in the Project scheduling and will continue throughout the life of the Project.

A list of consultation activities held is shown in Table 21 and a summary of issues raised by stakeholders and FMG's response are presented as Appendix R. For all consultation activities undertaken prior to July 2004, please refer to the Stage A PER (FMG, 2004).

Table 21. Summary of Consultation Undertaken to Date

(Note: Consultation undertaken prior to July 2004 is summarised in the Stage A Public Environmental Review)

Consultation	Date
Presentation to Town of Port Hedland council – Stage A	11 August 2004
Meeting with Technical members of Port Hedland Council	12 August 2004
Meeting with PHPA	12 August 2004
Visit to Wedgefield Association Vice President	12 August 2004
CALM, DoE meeting and tour of rail alignment for project	20 & 21 September 2004
Meeting with Indee Station	27 September 2004
Meeting with PHPA	28 September 2004
Meeting with Pilbara Aboriginal Chamber of Commerce	28 September 2004
Displays regarding Stage A of the Project erected at public libraries in Port Hedland	28 September 2004
Presentation on Stage B of project to Care for Hedland Environmental Group	28 September 2004
Visit of Pastoral Stations – Mulga Downs, Roy Hill Station, Bonney Downs Station, Balfour Downs Station, Wallareenya Station	29 September 2004
Project overview for Mumbultjari	30 September 2004
Town of Port Hedland – State Agreement discussions	30 September 2004
Shire of Ashburton – State Agreement discussions	1 October 2004
Shire of East Pilbara – State Agreement discussions	1 October 2004
Presentation at PIEC meeting	1 October 2004
Yamatji Weekly Progress Meeting (PNTS)	5 October 2004
Native Title preparation meeting (PNTS & consultants)	8 October 2004
Yamatji Weekly Progress Meeting (PNTS)	12 October 2004
Working Group Meeting (MIB Traditional Owners & PNTS)	14 October 2004
Meeting with Wedgefield Association	14 October 2004
Working group meeting with Palyku	15 October 2004
Working group meeting with Marty Idja Banyjima	15 October 2004
Land Access Discussions (PNTS)	18 & 19 October 2004
Yamatji Weekly Progress meeting (PNTS)	19 October 2004
Meeting PNTS	25 October 2004
Yamatji Weekly Progress Meeting	26 October 2004
Working group meeting with Kariyarra	27 October 2004
Working group meeting with Martu Idja Nanyjima	28 October 2004
Working group meeting with Nyiyaparli	29 October 2004
Yamatji Weekly Progress Meeting (PNTS)	2 November 2004
Meeting with EPA – Stage B scoping document	2 November 2004
Meeting with DoE	4 November 2004
Working group meeting with Palyku	5 November 2004
Meeting with DoIR	5 November 2004
Meeting with PNTS	8 November 2004
EPA site tour	8 & 9 November 2004
Meeting with CALM	10 November 2004
Meeting with Conservation Council & WWF	24 November 2004
Meeting with Newman Community Consultative Group	22 November 2004

Consultation	Date
DOE – Waters and Rivers	23 November 2004
Yamatji Weekly Progress Meeting	25 November 2004
CALM	3 December 2004

Consultation with indigenous communities has included discussion on heritage, Native Title, environmental issues and other concerns. Similarly consultation with the wider community has included not only environmental issues, but also socio-economic and other concerns. A number of letters and verbal communications have been received that express stakeholder interest and support for the Project.

7.2 ISSUES RAISED

Issues raised during consultation and the section of this document in which these issues are addressed, include the following.

Table 22. Key Issues Raised During Consultation

Issue	Section of PER addressing these issues
Restriction of access and impact on pastoral activities	5.5.6
Presence of fibrous minerals (e.g. asbestos minerals)	4.2.3
Water supply and water efficiency	6.2
Groundwater impacts from mine dewatering and borefield operation	6.2
Protection of significant flora species	6.3
Weed management	6.3
Area of clearing	6.3
Railway and impact on surface water sheetflows	6.1.4
Protection of significant fauna species	6.4
Acid mine drainage	6.9.2
Impact on Mulga groves as a result of interruption to surface water sheetflows	6.1and 6.3
Impacts on Fortescue Marsh	6.2.7 and 6.13
Employment opportunities	6.14
Aboriginal heritage	6.10
Rehabilitation	6.12

Key issues that were raised are briefly discussed below, and more fully in the sections listed above.

7.2.1 Surface Water Impacts

7.2.1.1 Railway

Concern was raised over the potential impacts of construction of a railway and access road without adequate or appropriate drainage structures. This infrastructure corridor could interrupt the natural drainage patterns, in particular the sheetflow process, with consequences for downstream vegetation condition if adequate surface hydrology management measures are not in place.

FMG has aligned the rail corridor as far north of the Fortescue Marsh as practicable, to cross drainage flowpaths higher in the catchment where they are more defined. A number of alternative railway lines were considered before the selection of the proposed rail alignment (Section 5.2.1).

FMG has investigated the impacts of existing railways in the Pilbara region and are currently working with its engineers and hydrologist to design drainage structures for the proposed railway and access road to maintain surface water flow patterns as close as practicable to natural flows. Surface hydrology management measures for the proposed railway are discussed in further detail in Section 6.1.

7.2.1.2 Mine sites

Three of the mine sites are located on the southern flanks of the Chichester Plateau in an area which drains towards the Fortescue Marsh to the south, and the fourth mine site is in an area which drains towards Weeli Wolli Creek. Design, construction and operation of the open pits, ore and overburden stockpiles, rejects placement area, access and haul roads, Beneficiation Plant and other infrastructure will need to take into account natural surface hydrology conditions.

All of the mines will require drainage diversion structures. FMG and its consultants have designed the Project to minimise impacts on natural drainage flow patterns and downstream areas. Surface water management in the mining areas is discussed in further detail in Section 6.1.

7.2.2 Groundwater Impacts

It is proposed to use groundwater from a borefield located at Mt Nicholas to supply water for the Project, mainly in the beneficiation of ore. It is estimated that 11 GLpa of water will be required at the Chichester mines, to be provided principally from the borefield, but supplemented by mine dewatering should this be required. Mindy Mindy will also require approximately 0.4 GLpa to be supplied from pit dewatering. FMG is currently investigating water efficiency measures to reduce this water requirement, such as recovery of water from beneficiation rejects and capturing excess surface water runoff.

It is expected that mine dewatering will be required at all four mines. Groundwater drawdown will occur in the vicinity of the borefield and mines to be dewatered, the risks to phreatophytic (groundwater dependent) vegetation from groundwater drawdown are predicted to be low. The proposed management measures for groundwater are discussed in detail in Section 6.2.

7.2.3 Mulga Groves

One of the important vegetation formations within the Project area are the Mulga communities including areas of grove-intergrove Mulga. Whilst Mulga in the East Pilbara is considered the northern-most extent of Mulga in Western Australia, there is approximately 2,781 km^2 of Mulga north of FMG's proposed Project area (Section 4.5.2.3). They are partially dependent on surface water sheetflow and therefore have the potential to be adversely affected by changes to surface hydrology patterns as a result of construction of the Project if this aspect is not appropriately managed.

Direct clearing impacts from the Project will account for approximately 3% of the total Mulga in the Chichester Range Footslopes (see Section 6.3.1). This is not expected to affect the conservation value of the area.

A potential indirect impact on Mulga is the obstruction of surface water flow patterns through construction of the proposed railway and access road. As discussed above, FMG has aligned the rail corridor to cross the drainage lines higher in the catchment where they are more defined, and design appropriate drainage structures to maintain sufficient sheetflow to support downstream Mulga (and other) communities. Refer to Section 6.1 for proposed surface water management measures.

Other potential indirect impacts include fire and weeds, however, FMG will implement management plans to address these issues (Section 6.3). FMG has developed a Rehabilitation and Revegetation Management Plan for the mining areas that will focus on re-establishment of native vegetation communities after mining, to resemble as close as practicable the original communities (Section 6.12). Successful revegetation of mining and other disturbed areas will rely on sound baseline survey data and ongoing research into revegetation techniques. With appropriate techniques, it is possible to effectively revegetate Mulga (pers. comm. Dr. E. Mattiske) (Section 6.13).

7.2.4 Fortescue Marsh

The Fortescue Marsh, to the south of the proposed east-west rail line, is listed as a 'Nationally Important Wetland'. It is recognised by the Department of Conservation and Land Management (CALM) as supporting a rich diversity of migratory birds when in flood. The Fortescue Marsh is also listed as an 'Indicative Place' on the Register of the National Estate (natural heritage) due to its importance for conservation of waterbirds. Much of the northern Fortescue Marsh is being sought by CALM for inclusion in the conservation estate, during the review of pastoral leases that will occur when all leases expire in 2015.

FMG has committed to avoiding, minimising, mitigating and offsetting direct or indirect impacts on the Fortescue Marsh. As such, FMG has located the Project as far north of the marshes as practicable (including realigning the proposed rail corridor), within resource location, transport, engineering and heritage constraints. The proposed railway will be approximately 4 km at its closest point from the peak flood boundary recognised by the Commonwealth Department of Environment and Heritage. The proposed mining areas will be 6.5 km from the edge of the marshes at the closest point.

As discussed under 'Surface Drainage', FMG intends to design, construct and operate the Project to minimise hydrological impacts on the upper catchment, and ensure that there are no resultant impacts on the marshes (Section 6.1). Similarly proposed pit dewatering and borefield design and operation will take into consideration the regional groundwater system and potential hydraulic linkage to the Fortescue Marsh, and avoid impacts on the marshes (Section 6.2.7). FMG has conducted a risk assessment regarding the Fortescue Marsh ecosystem to ensure all risks are identified and managed (Appendix N).

7.2.5 Vegetation Clearing

FMG's resources are relatively shallow and cover extensive areas. As such, strip mining is considered the most suitable method of mining. This allows one or more strips (or shallow parallel pits) to be mined, whilst progressively placing overburden and beneficiation rejects as backfill in mined-out sections of the pits. This reduces the extent of the working open pit, reduces surface area for storage of overburden and rejects, and allows the pit to be progressively filled and rehabilitated.

The majority of this area will be rehabilitated during the life of the Project, with the exception of the 800 ha working rail corridor. Land clearing and open pit areas will be kept to a minimum for safe working practices, and sensitive vegetation communities and significant flora species will be avoided where practicable. No Declared Rare Flora are known to occur within the Project area. Whilst a large area will be cleared over 20 or more years, the area cleared at any one time will be minimised.

As successful revegetation is key to the minimisation of impacts from land clearing, FMG has developed a Rehabilitation and Revegetation Management Plan which outlines how FMG propose to re-establish as close as practicable the vegetation communities that were present prior to mining. Implementation will include revegetation trials and ongoing research into revegetation methodology and regular review and update of the Management Plan (Section 6.12 and Appendix D).

7.2.6 Threatened Fauna

Two species of Schedule fauna and three Priority listed species were recorded from the FMG Project area during the current survey. A further two Schedule species and one Priority species were not recorded during the current survey, but are considered likely to occur in the area based on other survey data and records from the region. The Project was referred to the Federal Department of Environment and Heritage (DEH) under the *EPBC Act 1999* on the basis of evidence of Mulgara (*Dasycercus cristicauda*) which is listed as Schedule 1, 'vulnerable' occurring within the Project area. The DEH determined that the Project is not a 'controlled action' under Part 9 of the *EPBC Act 1999* (Appendix C).

FMG will minimise habitat disturbance and avoid where practicable, known populations of Mulgara or any other threatened fauna species that may occur within the Project area. FMG has committed to discussing potential 'off-sets' with CALM and academic experts, which may include funding towards taxonomic issues, or other relevant research such as CALM's Mulgara research programme (Section 6.4).

7.2.7 Stygofauna

The University of Western Australia carried out an initial stygofauna sampling programme within the Project area in September 2004. Eleven bores were sampled throughout the Project area; however no stygofauna were seen or recorded. Given the widespread occurrence of stygofauna though the Pilbara it is expected that stygofauna will be located within the Project area. FMG has therefore developed a Subterranean Fauna Management Plan (Appendix M), which includes a biannual sampling plan to be implemented for the first two years prior to Project commissioning. Depending on the outcomes of the sampling plan, further ongoing sampling will be conducted throughout the life of the Project (see Section 6.5).

8. ENVIRONMENTAL MANAGEMENT COMMITMENTS

FMG intend to design, construct and operate the proposed east-west railway and four mine sites for the Pilbara Iron Ore and Infrastructure Project in a manner which encompasses the principles of Sustainability (Section 6.15).

The following environmental management commitments have been developed for the more significant environmental issues for FMG's Project. These will represent key components within FMG's EMS (Section 6.16).

Table 23. Environmental Commitments for the Pilbara Iron Ore and Infrastructure Project (Stage B)

Topic	Objectives	Actions	Timing	Advice from
Sustainability Strategy	To ensure as far as practicable, that the proposal meets, or is consistent with, the sustainability principles in the National Strategy for Ecologically Sustainable Development.	1. Develop and implement a Project Sustainability Strategy which addresses contribution to global impacts such as greenhouse gas emissions and focuses on managing impacts across the triple bottom line of Social Capital, Economic Wealth and Environmental Assets.	Prior to the start of construction.	DoE
Environmental Management System (EMS)	Be proactive in managing environmental issues, and promoting environmental excellence during construction and operation of the Project.	2. Prepare and implement an EMS that is consistent with the ISO 14001 standard.	Prior to the start of construction.	DoE
		3. Integrate the EMS with Quality, Health & Safety and other business, systems.	Prior to the start of construction.	DoE DoIR
Environmental Management Plan (EMP)	To minimise the environmental impacts associated with the Project. To provide a mechanism for monitoring environmental parameters, impacts, compliance with legal requirements, feedback, reporting and continual improvement.	4. Prepare and implement an EMP as part of the EMS, containing specific environmental management strategies for the construction of the Project *(refer to Appendix B for draft)*.	Prior to the start of construction.	DoE DoIR
		5. Prepare and implement an EMP as part of the EMS, containing specific environmental management strategies for the operation of the Project.	Prior to commissioning.	DoE DoIR
		6. The Proponent will ensure that all personnel and contractors comply with the requirements of the EMPs and be made aware of their obligations through an environmental awareness training programme.	During construction and operations.	DoE DoIR

Topic	Objectives	Actions	Timing	Advice from
Project Closure Plan	To ensure, as far as practicable, that decommissioning and rehabilitation achieves a stable and functioning landform which is consistent with the surrounding landscape and meets other environmental objectives including biodiversity.	7. Develop a comprehensive Project Closure Plan which includes Closure Criteria to be agreed with the regulators *(refer to Appendix Q for draft).*	Within two years of commencement of mining.	DoIR DoE
		8. Review the Project Closure Plan regularly during the operational life of the Project.	At least every two years during the operational life of the Project.	
		9. Submit a final Project Closure Plan to the regulators for approval, no later than two years prior to the planned closure of operations.	Two years prior to the planned closure of operations.	DoIR DoE
Terrestrial Flora and Vegetation	Maintain the abundance, species diversity, geographic distribution and productivity of vegetation communities. Protect Declared Rare and Priority Flora, consistent with the provisions of the *Wildlife Conservation Act* 1950.	10. Design infrastructure to avoid declared rare and priority flora and species of conservation significance, and minimise disturbance to flora and vegetation communities.	During the design phase.	CALM
		11. Prepare and implement a Rehabilitation and Revegetation Management Plan, to address the impact of vegetation clearing *(refer to Appendix D).*	As part of the PER. Review prior to commencement of construction.	CALM DoE
		12. Complete revegetation and rehabilitation activities in accordance with agreed closure criteria to be developed as part of the Closure Plan.	During progressive rehabilitation activities throughout the life of the Project and on closure.	DoIR DoE

Topic	Objectives	Actions	Timing	Advice from
Weed Hygiene and Management Plan	Maintain the abundance, species diversity, geographic distribution and productivity of vegetation communities.	13. Prepare a Weed Hygiene and Management Plan that contains procedures to minimise the introduction and spread of weeds, including: • identifying target weeds; • hygiene inspection and washdown procedures for all mobile plant and equipment. • control measures that may be necessary for some species; • monitoring and any follow-up control including reporting to relevant authorities.	Prior to construction.	CALM APB
		14. Implement the approved Weed Hygiene and Management Plan.	During construction, operations, and decommissioning.	CALM APB
		15. Ensure sites (including temporary construction camps) have contained wash down facilities.	During construction and operations.	
Fire Management Plan	Reduce the risk of unplanned fires and provide contingency measures to minimise any impacts in the event that a fire is started.	16. Prepare a Fire Management Plan to include: • installation of necessary fire breaks; • safe work procedures for all welding and grinding work; • personal fire hazard procedures; • vehicle fire hazard procedures; • emergency fire response procedures; and • bushfire contingency plans.	Prior to construction.	CALM FESA
		17. Implement the approved Fire Management Plan.	During construction and operations.	CALM FESA
Terrestrial Fauna	Maintain the abundance, species diversity and geographical distribution of terrestrial fauna. Protect Specially Protected (Threatened) Fauna, consistent with the provisions of the Wildlife Conservation Act 1950,	18. Design infrastructure to avoid specially protected (threatened) fauna habitats, other significant fauna habitats, and minimise disturbance to fauna habitats in general.	During the design phase.	CALM

Topic	Objectives	Actions	Timing	Advice from
Water Supply	Maintain (sufficient) quality of groundwater so that existing potential uses, including ecosystems maintenance are protected.	19. FMG will conduct further hydrogeological work (including pump testing) as outlined in Section 6.2.13, to confirm the numerical hydrogeological modelling assumptions made for this PER, and submit the results of this work to the EPA for review.	Prior to finalisation of the EPA Report and Recommendations.	DoE (WRC)
		20. Prepare a Borefield Management Plan *(refer to Appendix G)*.	As part of PER. Review prior to development of the borefield.	DoE (WRC) DoIR
		21. Implement the Borefield Management Plan, including the groundwater and vegetation monitoring programmes.	During construction, operations and post-closure.	DoE (WRC) DoIR
		22. Develop a contingency plan for timely development of an alternative water supply borefield if the groundwater impacts model and/or vegetation conditions assessment predict an adverse impact on phreatophytic vegetation.	During operations.	DoE (WRC)
Subterranean Fauna Management Plan	Maintain the abundance, diversity and geographical distribution of subterranean fauna.	23. Prepare a Subterranean Fauna Management Plan for the water supply borefield and mine dewatering areas *(refer to Appendix M)*.	Prior to construction.	CALM
		24. Implement the approved Subterranean Fauna Management Plan.	During construction and operations.	CALM
Water courses and wetlands	Maintain the integrity, functions and environmental values of watercourses and sheet flow.	25. Design and construct the Project to minimise disturbance to natural surface water flows.	During the design phase.	CALM DoE
		26. Design and construct bridges, culverts and other drainage structures to maintain surface water flows if there are dependent ecosystems downstream (e.g. such as implementation of approved surface water redistribution systems).	During design and construction.	CALM DoE
		27. Ensure borrow pits are suitably placed, managed and rehabilitated to ensure surface water drainage patterns are not adversely affected.	During construction.	CALM DoE

Topic	Objectives	Actions	Timing	Advice from
Dust Management Plan: Construction	Protect the surrounding land users such that dust and particulate emissions will not adversely impact upon their welfare and amenity or cause health problems and ensure that dust emissions, both individually and cumulatively, meet appropriate criteria and do not cause an environmental or human health problems.	28. Prepare a <u>Construction</u> Dust Management Plan that addresses: • minimising clearing (as practicable) • minimising the generation of dust and impacts and emissions on and off site; • dust control measures; and • outlines a complaints and response process.	Prior to construction.	DoE DoIR
		29. Implement the approved Construction Dust Management Plan.	During construction.	DoE DoIR
Dust Management Plan: Operations	Protect the surrounding land users such that dust and particulate emissions will not adversely impact upon their welfare and amenity or cause health problems and ensure that dust emissions, both individually and cumulatively, meet appropriate criteria and do not cause environmental or human health problems.	30. Prepare an <u>Operations</u> Dust Management Plan that addresses: • minimising the generation of dust and impacts and emissions on and off site; • dust control measures; • ore stockpiles moisture content; • dust monitoring network; and • outlines a complaints and response process.	Prior to commissioning.	DoIR DoE
		31. Implement the approved Operation Dust Management Plan.	During operations.	DoIR DoE
Greenhouse Gases Management	To minimise greenhouse gas emissions for the Project and reduce emissions per unit product to as low as reasonably practicable, and mitigate greenhouse gas emissions in accordance with the *Framework Convention on Climate Change 1992*, and with established Commonwealth and State policies.	32. Develop and Implement a Greenhouse Gas Management Plan that addresses efficient use of resources and equipment and other measures to reduce greenhouse gas emissions.	Prior to construction	DoE

Topic	Objectives	Actions	Timing	Advice from
Water Quality – surface and groundwater	To maintain or improve the quality of surface and groundwater, to ensure that existing and potential uses, including ecosystem maintenance are protected.	33. Treat any waste water or surface water runoff that is potentially contaminated prior to discharging to the environment.	During construction and operations.	DoE
		34. Ensure potentially polluting substances are stored, bunded and handled in accordance with appropriate standards.	During construction and operations.	DoE
Acid Mine Drainage	Minimise the risk to the environment resulting from potentially acid forming materials.	35. Complete sampling and analysis of materials potentially exposed during mining.	Prior to commencement of mining.	DoE DoIR
	Avoid disturbance of potentially acid-generating materials during construction and mining.	36. Design and implement mining schedule to avoid where practicable potentially acid generating material, or manage to minimise potential acid generation.	During construction, operations and mine closure.	DoE DoIR
Waste Management Plan	Ensure that disposal/management of wastes do not adversely affect environmental values or health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.	37. FMG will produce a Waste Management Plan.	Prior to construction.	DoE
		38. As part of the Waste Management Plan, FMG will implement a procurement policy which minimises waste generation.	During construction, operations and mine closure.	DoE

Topic	Objectives	Actions	Timing	Advice from
Noise Management Strategy	Ensure noise levels comply with statutory requirements and acceptable (and appropriate) standards.	39. Prepare and implement a Construction Noise and Vibration Management Plan.	Prior to and during construction.	DoE DoIR
		40. Prepare and implement an operational Noise and Vibration Management Plan for the mines that: • identifies noise reduction strategies; • minimises disturbance to the Fortescue Marsh and residence(s) from blasting noise generated at operations; • outlines monitoring program to measure noise emissions and assess optimal placing of noise barriers.	Prior to commissioning and during operations.	DoE DoIR
Aboriginal Heritage	Ensure the proposal complies with requirements of the *Aboriginal Heritage Act* 1972 and that changes to the biological and physical environment resulting from the Project do not adversely affect cultural associations with the area.	41. Complete ethnographic and archaeological surveys of the proposed port and railway corridor.	Prior to the start of construction.	DIA PNTS
		42. Develop a Cultural Heritage Management Plan for the Project in consultation with the Aboriginal Traditional Owners.	During the design phase.	DIA PNTS
		43. Implement the Cultural Heritage Management Plan in consultation with the Aboriginal Traditional Owners.	During construction, operations and decommissioning.	DIA PNTS

9. CONCLUSIONS

The Pilbara Iron Ore and Infrastructure Project will be undertaken in line with the guiding sustainability principles outlined in the *National Strategy for Ecologically Sustainable Development (Commonwealth, 1992)*. FMG also recognises the Western Australian Government State Sustainability Strategy, which sets out a vision for the State's mining industry.

FMG has made a number of formal commitments with respect to Stage B (the mine sites and east-west railway) to show its commitment to constructing and operating in an environmentally responsible manner. The formal commitments will be implemented to the satisfaction of the Environmental Protection Authority.

The key environmental issues associated with the development of the mines and east-west railway have been identified as surface drainage, Mulga groves, groundwater impacts and vegetation clearing. In particular FMG is aware of the significance of the Fortescue Marsh and has completed a risk-based assessment of potential impacts on the marsh and has identified management measures to ensure that all identified environmental risks to the marsh are low. The conservation significance of selected vegetation communities and threatened fauna species has also been given priority and the design of the Project incorporated management and mitigative measures to reduce impacts as far as practicable.

FMG is committed to avoiding environmental impacts where practicable and otherwise minimising, mitigating and offsetting potential impacts. FMG will ensure all impacts are managed using the Construction and Operations Environmental Management Plans to be developed for the Project. FMG will work closely with the relevant authorities to achieve improved environmental standards wherever practicable.

The development of the Pilbara Iron Ore and Infrastructure Project will provide a number of significant benefits including:

- rail infrastructure to be available for other operations in the area which will stimulate development in the area;
- creation of significant direct and indirect employment opportunities;
- expenditure of approximately A$1.85 billion during the construction of the Project which represents a significant contribution to the State's economy;
- employment of individuals from the towns of Port Hedland and Newman and the Pilbara region as a priority;
- housing of FMG's operational workforce in the regional township of Newman; and
- improved regional community support through local employment opportunities, including meaningful vocational training and employment for local indigenous people.

FMG believes that construction and operation of Stage B of the Pilbara Iron Ore and Infrastructure Project will result in net economic and social benefits to the local and regional community and the State as a whole.

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11. GLOSSARY

Abbreviations

AMD	Acid Mine Drainage
ANZECC	Australia New Zealand Environment and Conservation Council
APB	Agricultural Protection Board
ARI	Average Recurrence Interval: How many times an event could be expected to occur over a period of time, for example a 1 in 100 year storm event).
ARMCANZ	Agricultural and Resource Management Council of Australia and New Zealand
BHPBIO	BHP Billiton Iron Ore
BIF	Banded Iron Formation
CALM	Department of Conservation and Land Management
CF_x	Perfluorocarbons
CH_4	Methane
CO_2	Carbon dioxide
d(B)	Decibels
d(B)A	Decibels (A-weighted)
DoE	Department of Environment
DoIR	Department of Industry and Resources
DRF	Declared Rare Flora
EPBC Act	*Environmental Protection and Biodiversity Conservation Act*
EPA	Environmental Protection Authority
ESD	Ecologically sustainable development
HFCs	Hydrofluorocarbons
N_2O	Nitrous oxide
NEPC	National Environment Protection Council
NSESD	National Strategy for Ecologically Sustainable Development
PER	Public Environmental Review
PNTS	Pilbara Native Title Service
SF_6	Sulphur hexafluoride
TDS	Total Dissolved Solids
TPH	Tonnes per hour
WAM	Western Australian Museum
WRC	Water and Rivers Commission

Definitions

Alluvium: Young sediment, eroded rock particles that are carried downslope by streams.

Anthropogenic: Man-made

Archaeological: Containing traces of past human activity, including artefact scatters, quarries, art sites, stone arrangements, rock shelters etc.

Banded Iron: Ironstone deposited in a banded structure.

Basalt: A hard, dense, dark volcanic rock composed chiefly of plagioclase, pyroxene, and olivine, and often having a glassy appearance.

Biodiversity: The variability among living organisms on the earth, including the variability within and between species and within and between ecosystems.

Bioregion: A region constituting a natural ecological community with characteristic flora, fauna, and environmental conditions and bounded by natural rather than artificial borders.

Chert: A variety of silica that contains microcrystalline quartz.

Diagentic: Near-surface rock forming processes.

Dolomite: A magnesia-rich sedimentary rock resembling limestone.

Ethnographic: Pertaining to the study of human cultures in their natural settings.

Geothitic: A rock which is usually a brown black colour and containing mainly goethite. A Goethite is a later derived oxide often formed by weathering of hematite (FeO[OH]).

Gilgai: Soil type with uneven micro-relief, often as a result of expansion and contraction of soils. Nutrients may accumulate in the depression areas or salts/carbonates may accumulate on mounds.

Herpetofauna: Cold-blooded terrestrial vertebrates (reptiles and amphibians).

Holocene: Of, or belonging to, the geological time, rock series, or sedimentary deposits of the more recent of the two epochs of the Quaternary Period, beginning at the end of the last Ice Age about 11,000 years ago.

Invertebrate: Lacking a backbone or spinal column.

L_{A1}: An A-weighted noise level which is exceeded for one percent of the measurement period. An L_{A1} level is considered to represent the "intrusive" noise level.

L_{A10}: An A-weighted noise level which is exceeded for 10 percent of the measurement period. An L_{A10} level is considered to represent the 'intrusive' noise level.

L_{Amax}: The maximum A-weighted noise level measured during the measurement period.

Limonitic: A rock which is usually a brown yellow colour and containing mainly limonite.

Linear sound pressure level: A sound pressure level that has not been filtered. It is described in the linear scale and noted by the symbol dB(L).

Mesic: A moderately moist habitat

Obligate: Species restricted to a particular condition of life.

Passerines: Perching birds.

Phreatophytes: Plants which are dependent on the water table for survival.

Physiographic Unit: Distinct landscape grouping based on geomorphology, climate and biological features.

Pisolitic: Consisting of rounded grains, often pea-size, like pisolites which are a spherical concretionary body over 2mm in diameter and made of concentric internal layers that developed around a nucleus.

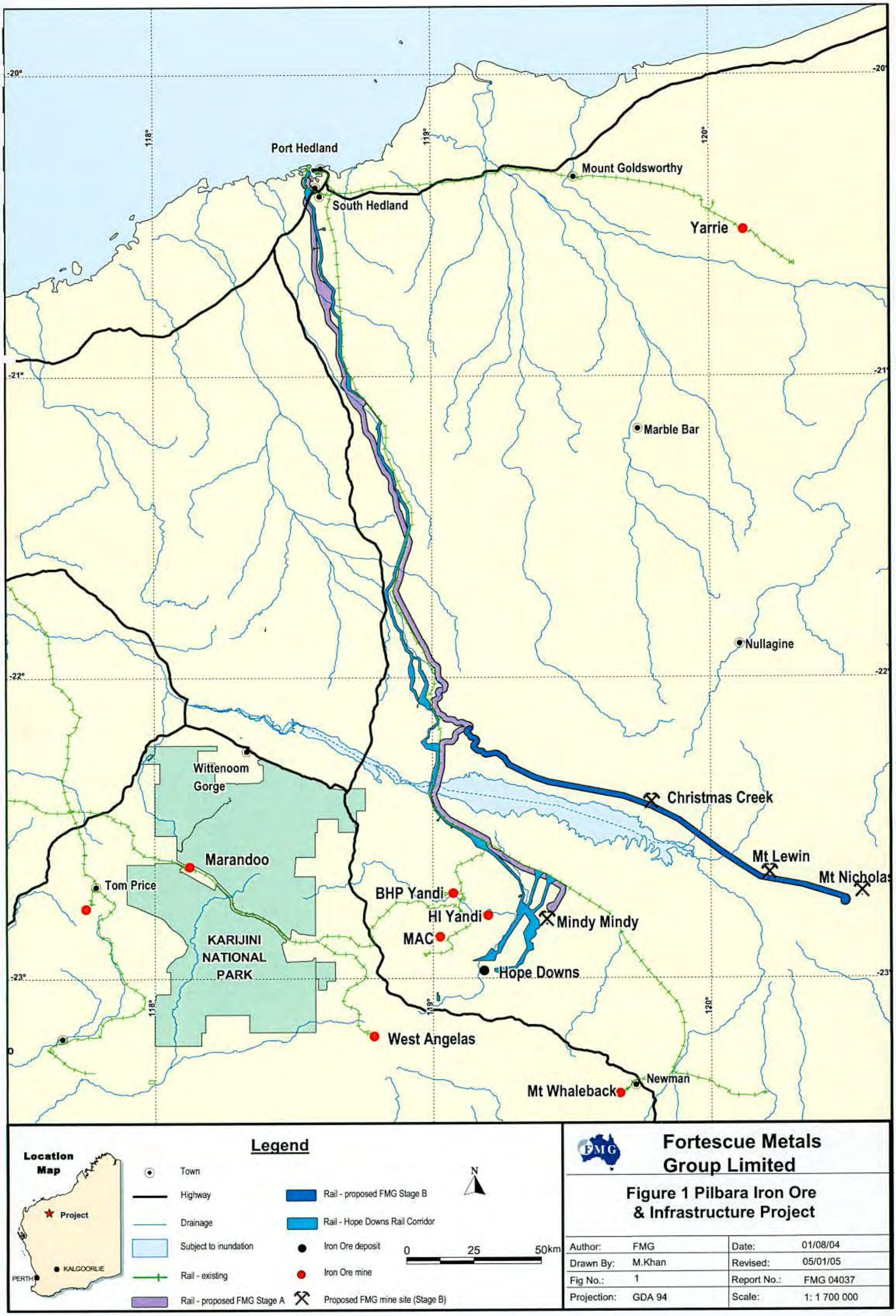
Potentiometric Head: The pressure head. In an unconfined aquifer the potentiometric head is the water table.

Primary porosity aquifer: An aquifer where the porosity occurs in inter-particle void space originating from the time of deposition.

Quaternary: Of, or belonging to, the geological time, system of rocks, or sedimentary deposits of the second period of the Cenozoic Era, from the end of the Tertiary Period through the present.

Shale:	A fissile rock composed of layers of claylike, fine-grained sediments.
Stygofauna:	Subterranean fauna living in aquatic environments
Vertebrate:	Having a backbone or spinal column.
Vuggy:	Porosity resulting from dissolution in small cavities (typically less than 1 cm).
Yandeeying:	From 'yandy' which is a long shallow dish to separate minerals from alluvium by means of a rocking motion.

FIGURES



Fortescue Metals Group Limited

Figure 1 Pilbara Iron Ore & Infrastructure Project

Author:	FMG	Date:	01/08/04
Drawn By:	M.Khan	Revised:	05/01/05
Fig No.:	1	Report No.:	FMG 04037
Projection:	GDA 94	Scale:	1: 1 700 000

Legend

- ▭ Stage A FMG Proposed Rail Corridor
- ▭ Stage B FMG Proposed Rail Corridor
- ▭ FMG Tenements - Granted
- ▭ Joint Venture Tenements
- – – River
- + Rail Existing - BHPB
- — Road
- ● Homesteads / Camp

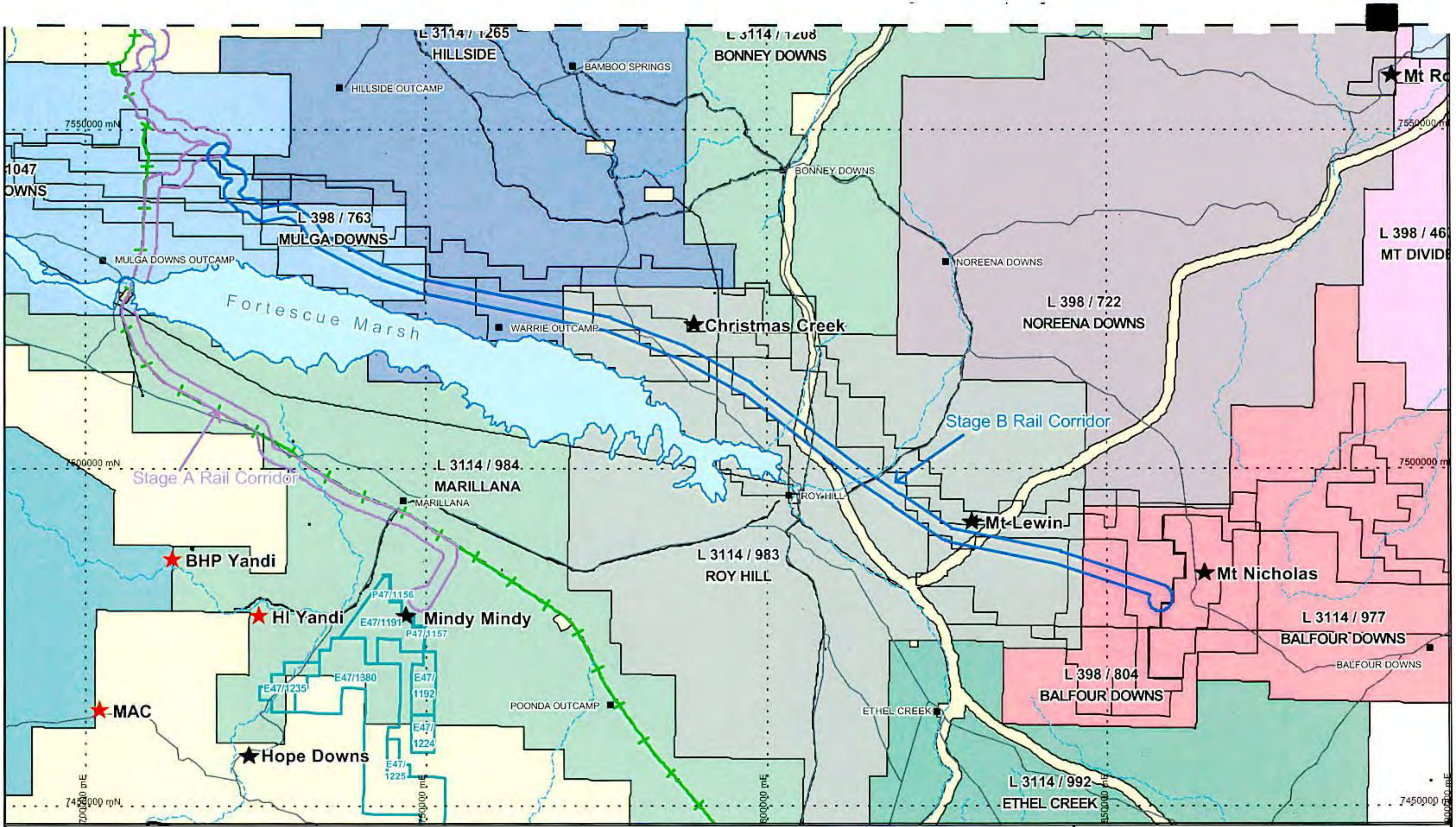
N

0 10 20Km

Fortescue Metals Group Limited

Figure 2 Project Area Map

Author:	FMG	Date:	10/11/04
Drawn By:	M.Khan	Revised:	05/01/05
Fig No.:	2	Report No.:	FMG 04084
Projection:	GDA 94	Scale:	1: 1 000 000



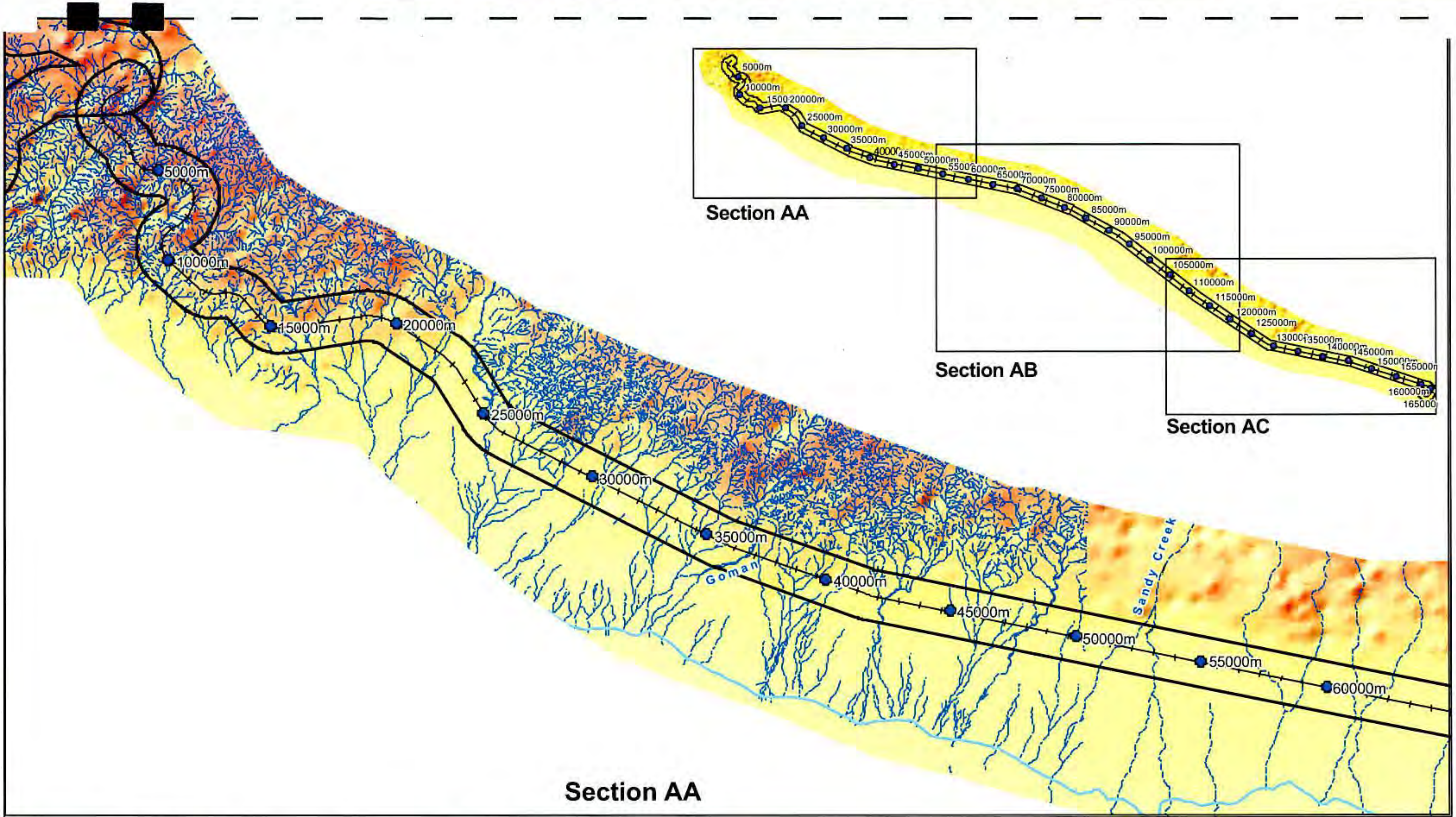
Legend

- ▭ Stage A FMG Proposed Rail Corridor
- ▭ Stage B FMG Proposed Rail Corridor
- +++++ Rail - existing
- — Road
- ★ FMG Mine site
- ★ Exisiting Mine Site
- - - - River

Fortescue Metals Group Limited

Figure 3 Pastoral Lease Map

Author:	FMG	Date:	10/02/04
Drawn By:	M.Khan	Revised:	31/12/04
Fig No.:	3	Report No.:	FMG 04021
Projection:	GDA 94	Scale:	1:750 000



Height

🟦 0-100m
🟦 100-200m
🟩 200-300m
🟨 300-400m
🟧 400-500m
🟪 500-600m
🟥 600-700m

Legend

- - - - Drainage
┼┼┼┼ Proposed FMG Rail Line
—— Fortescue Marsh Boundary

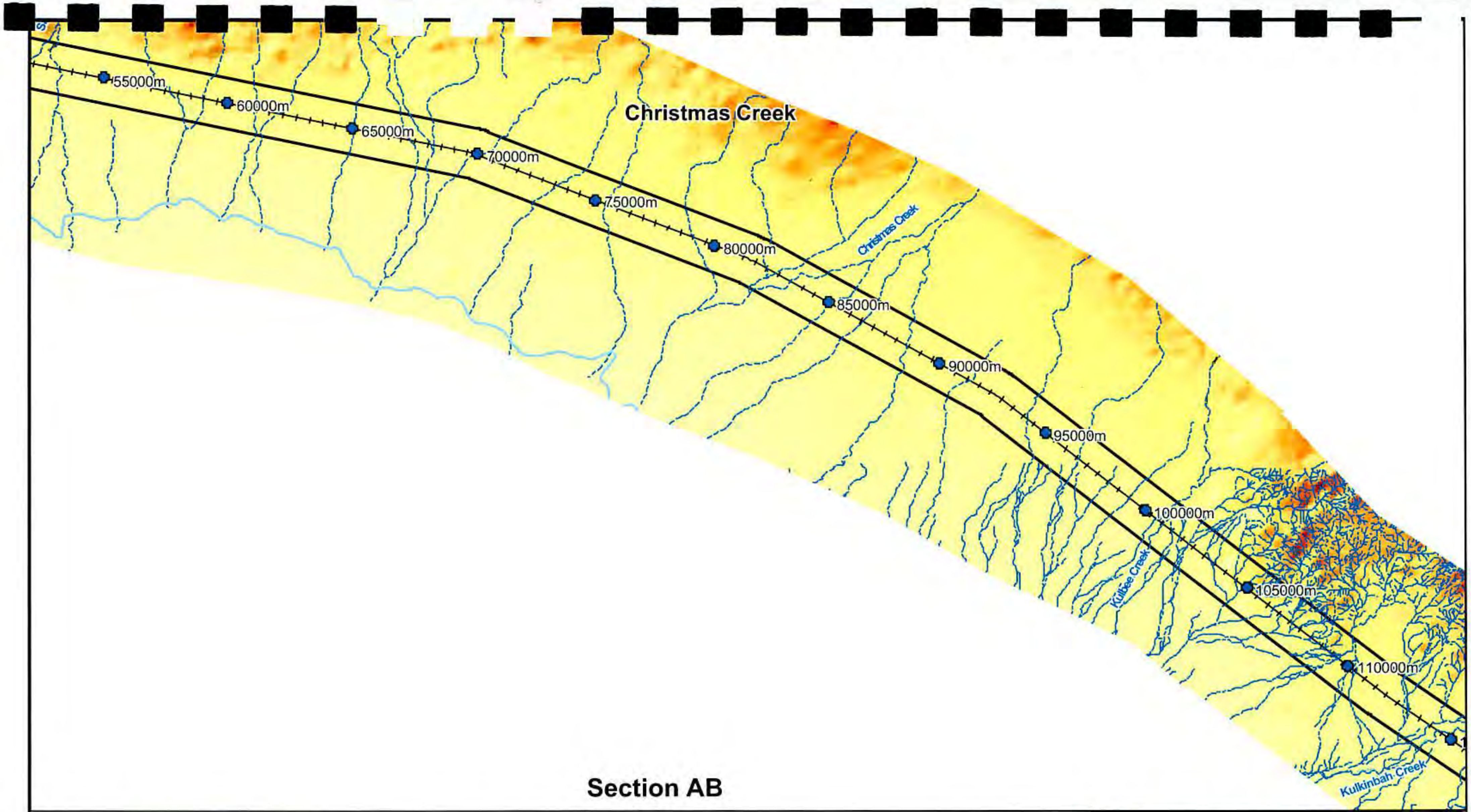
N

0 2.5 5 km

Fortescue Metals Group Limited

Figure 4 Detail of Stage B Rail Corridor

Author:	FMG	Date:	09/11/04
Drawn By:	M.Khan	Revised:	31/12/04
Fig No.:	4	Report No.:	FMG 04081
Projection:	GDA 94	Scale:	1:200 000



Section AB

Height

🟦 0-100m
🟦 100-200m
🟩 200-300m
🟨 300-400m
🟧 400-500m
🟪 500-600m
🟥 600-700m

Legend

- - - - - - Drainage
┼┼┼┼ Proposed FMG Rail Line
—— Fortescue Marsh Boundary

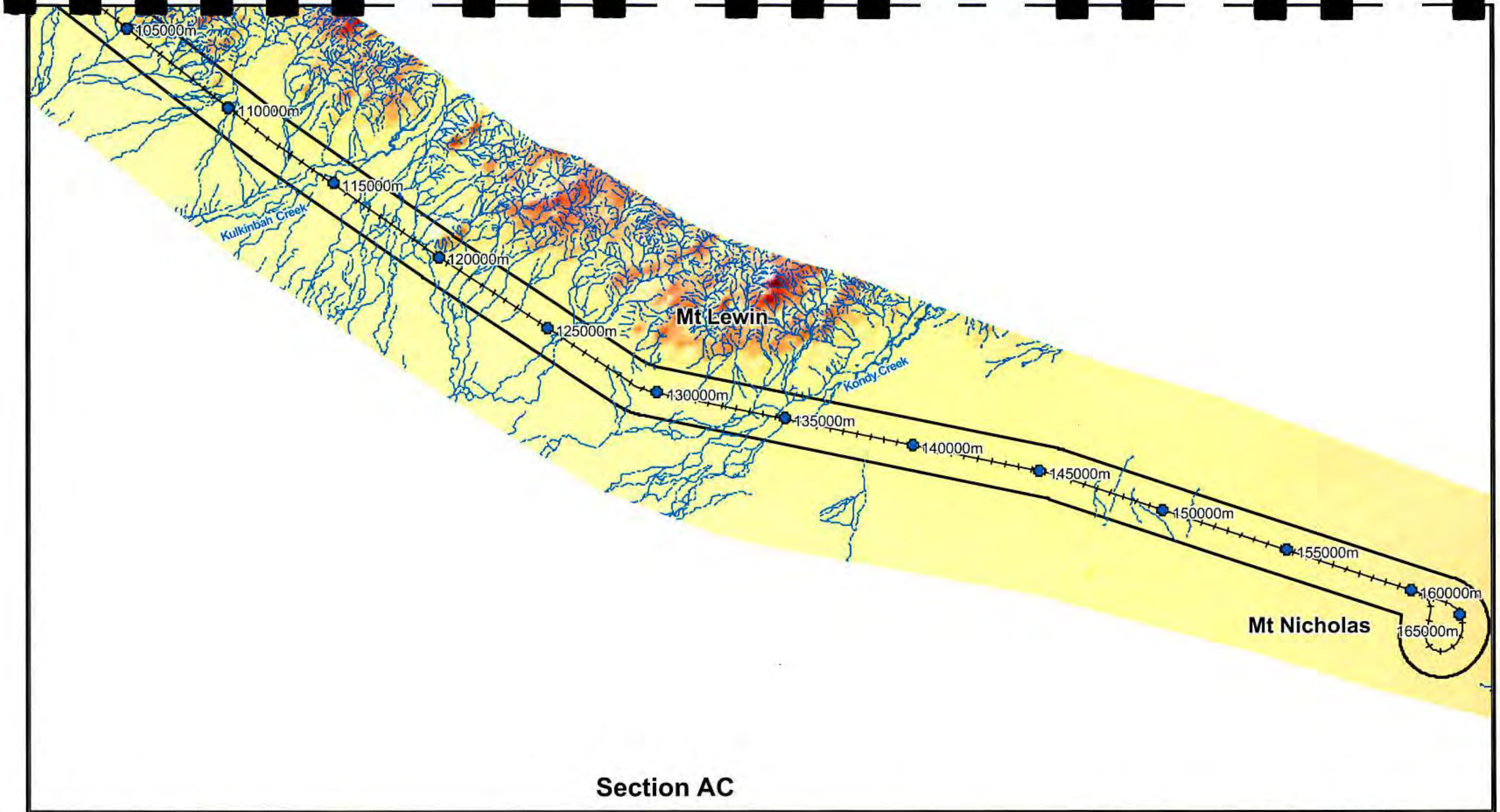
N

0 2.5 5km

Fortescue Metals Group Limited

Figure 5 Detail of Stage B Rail Corridor

Author:	FMG	Date:	09/11/04
Drawn By:	M.Khan	Revised:	31/12/04
Fig No.:	5	Report No.:	FMG 04081
Projection:	GDA 94	Scale:	1:200 000



Height

🟦	0-100m
🟦	100-200m
🟩	200-300m
🟨	300-400m
🟧	400-500m
🟪	500-600m
🟥	600-700m

Legend

------	Drainage
+-+-+	Proposed FMG Rail Line
—	Fortescue Marsh Boundary

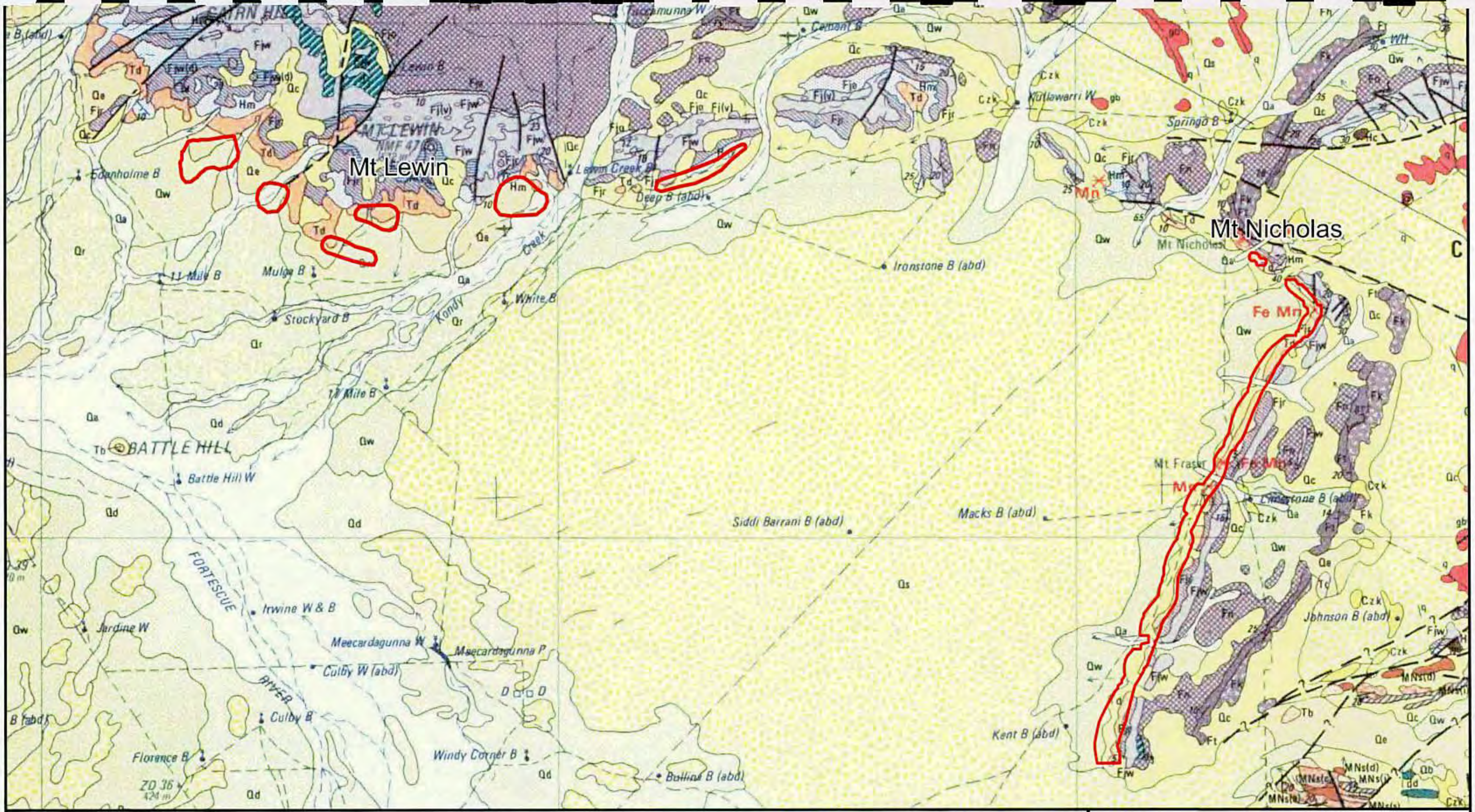
N

0 2.5 5 km

Fortescue Metals Group Limited

Figure 6 Detail of Stage B Rail Corridor

Author:	FMG	Date:	09/11/04
Drawn By:	M.Khan	Revised:	31/12/04
Fig No.:	6	Report No.:	FMG 04081
Projection:	GDA 94	Scale:	1:200 000



Legend

🟥 Pit Outlines

N

0 5 10
kilometres

Fortescue Metals Group Limited

Figure 7 Regional Geology
Mt Lewin and Mt Nicholas

Author:	FMG	Date:	29/12/04
Drawn By:	A. Gregory	Revised:	10/01/05
Fig No.:	7	Report No.:	FMG 04129
Projection:	GDA 94	Scale:	1:200 000

Fortescue Metals Group Limited

Figure 7 Regional Geology Legend (1of 2) Mt Lewin and Mt Nicholas

Author:	FMG	Date:	30/12/04
Drawn By:	A. Gregory	Revised:	10/01/05
Fig No.:	7	Report No.:	FMG 04129
Projection:	Unprojected	Scale:	Not To Scale

REFERENCE

PHANEROZOIC

CAINOZOIC

QUATERNARY

Qa	Ql	Qd	Qs	Qp

Qa Alluvium – clay, silt, sand, gravel; in drainage channels and adjacent flood plains
Ql Lacustrine deposits – clay, silt; saline in part
Qd Mixed lacustrine and eolian deposits – clay, silt, sand
Qs Eolian sand – in sheets and longitudinal (seif) dunes
Qp Eolian sand mixed with ironstone pebbles derived from Tl and Tc

Qr	Qb	Qw	Qc	Qe	Qt

Qr Colluvium – mixed gilgai and gravel flood plains; low slope deposits
Qb Eluvium – gilgai; swelling clay soils characterised by "crabholes"; derived from basalt, dolerite or shale
Qw Colluvium and alluvium – silt, sand, gravel in broad, striped, sheet wash areas
Qc Colluvium and minor alluvium – sand, gravel on slopes adjacent to bedrock
Qe Colluvium and eluvium – clay hardpan, partly ferruginised silt, sand, gravel derived from and overlying Tc and Tb
Qt Colluvium and eluvium – gravel, boulder deposits, clay matrix; derived from **PATERSON FORMATION**

Czk Calcrete, sandy limestone – in sheets and lenses; old valley fill

TERTIARY

Tc	Tl	Td	Tb	Tp

Tc Colluvium – consolidated, ferruginised silt, sand, gravel; dissected by present drainage
Tl Laterite – massive, nodular and pebbly
Td Ferruginous duricrust overlying **MARRA MAMBA FORMATION**
Tb Mixed siliceous caprock and colluvium; secondary siliceous breccia, jasperoidal chalcedony over ultramafic rocks
Tp Pisolitic limonite, goethite, hematite deposits; in old drainage lines

To **OAKOVER FORMATION** : vuggy white opaline silica and calcareous sandstone, sandy limestone

PALAEOZOIC

PERMIAN

Pa **PATERSON FORMATION** : basal polymictic conglomerate and tillite overlain by cross-bedded sandstone, conglomerate and laminated claystone

PRECAMBRIAN

q /	d_4 /

q Quartz veins, various ages
d_4 Dolerite dyke

Savory Group — SAVORY BASIN

SVc **COONDRA FORMATION** : massive and flaggy quartz sandstone characterised by large cross-beds, some pebble bands
SVc(w) Quartz wacke, lithic wacke
SVw **WATCH POINT FORMATION** : laminated siltstone, shale and fine-grained sandstone

Yeneena Group — PATERSON OROGEN

c. 890 Ma

Yi **ISDELL FORMATION** : fine-grained, laminated and coarse-grained clastic carbonate rocks, stromatolitic dolomite, minor sandstone and conglomerate
Yi(q) Quartz sandstone and pebble conglomerate
Yb **CHOORUN FORMATION** : interbedded shale, micaceous siltstone, silicified quartz sandstone
Yy **YANDANUNYAH FORMATION** : interbedded laminated dolomite, calcareous siltstone and shale
Yr **BROWNRIGG SANDSTONE** : cross-bedded, flaggy siliceous quartz sandstone
Yw **WAROONGUNYAH FORMATION** : laminated and stromatolitic dolomite, interbedded shale, siltstone and quartz sandstone
Yg **GOOGHENAMA CONGLOMERATE** : conglomerate with interbedded quartz sandstone

Manganese Group — BANGEMALL BASIN

dd / **DAVIS DOLERITE** : fine to medium-grained dolerite in sills and dykes

MNh **WHITEWOOD FORMATION** : interbedded coarse-grained lithic sandstone and conglomerate
MNb **BALFOUR FORMATION** : pale-grey to grey-green shale, fine-grained micaceous, calcareous and glauconitic sandstone interbedded with chocolate, purple to red-brown shale, micaceous siltstone containing braunite pellets
MNe **ENACHEDOONG DOLOMITE** : laminated and massive dolomite; minor shale

MNs	MNs(a)	MNs(c)	MNs(d)	MNs(i) /	MNs(s)	MNs(f)	MNs(t)

MNs **STAG ARROW FORMATION** : interbedded sandstone, siltstone, shale, conglomerate, dolomite and chert
MNs(a) Medium and coarse-grained sandstone
MNs(c) Interbedded quartz sandstone and conglomerate
MNs(d) Massive and laminated dolomite
MNs(i) Massive and weakly banded chert
MNs(s) Shale and micaceous siltstone
MNs(f) Laminated fine-grained sandstone interbedded with shale and siltstone
MNs(t) Stromatolitic dolomite

MNw	MNw(a)	MNw(c)	MNw(i) /

MNw **WOBLEGUN FORMATION** : light-grey, maroon and green shale, interbedded fine-grained micaceous sandstone
MNw(a) Medium and coarse-grained quartz sandstone
MNw(c) Polymictic conglomerate
MNw(i) Chert

c. 1050 Ma

MNc **COONDOON FORMATION** : poorly sorted conglomerate, coarse-grained lithic sandstone, quartz wacke, glauconitic sandstone, minor dolomite interbedded red-brown manganiferous shale

PREC IAN

Mount Bruce Supergroup

pb **PINJIAN CHERT BRECCIA** : chert breccia, poorly banded chert, commonly capped with secondary, silicified breccia Tb, overlies **CARAWINE DOLOMITE**

t Microcline biotite-trachyte, lamprophyre; in dykes and small irregular bodies

Hamersley Group

Hc **CARAWINE DOLOMITE** : massive and weakly banded recrystallised grey, brown dolomite, minor chert; stromatolitic dolomite

Hm **MARRA MAMBA IRON-FORMATION** : green-grey banded chert, thin banded iron-formation, shale

d_3 Fine to coarse-grained dolerite sills and dykes

Fortescue Group

Fj **JEERINAH FORMATION** : shale, chert, jaspilite, mudstone, sandstone, dolomite; minor pillow lava and felsic volcanic lava and tuff

- Fjr **Roy Hill Shale Member** : leached white shale; silicified; pyrite balls
- Fjw(d) Dolomitic unit in **Warri Member** interbedded blue chert
- Fjw **Warri Member** : interbedded shale, mudstone, chert, thin bedded dolomite
- Fj(v) Discontinuous pillowed basalt flows, some amygdaloidal; carbonate-rich; intermediate tuff and porphyritic flows, pisolitic tuff north east of Canning Bore
- Fjo **Woodiana Sandstone Member** : lithic sandstone, grey-green mudstone, pebble conglomerate

Fn **NYMERINA BASALT** : dark-green to grey amygdaloidal, vesicular and massive basalt; amygdales of agate and carnelian common

- Fn(p) Pyroclastic and sedimentary units in **NYMERINA BASALT**

Ft **TUMBIANA FORMATION** : pisolitic tuff, tuff, mudstone, lithic sandstone, dolomite with stromatolites

- Ftc **Meentheena Carbonate Member** : banded dark-grey dolomite, limestone with bioherms of stromatolite
- Ftt **Mingah Tuff Member** : interbedded tuff, pisolitic tuff, mudstone, lithic sandstone

c. 2760 Ma

Fk **KYLENA BASALT** : dark-green amygdaloidal, vesicular and massive basalt; minor pillowed basalt

- Fk(v) Agglomerate

Fh **HARDEY SANDSTONE** : quartz, lithic and feldspathic sandstone, minor tuffaceous shale, pisolitic tuff

- Fh(c) Very coarse boulder conglomerate in poorly sorted matrix

Fr **MOUNT ROE BASALT** : massive and amygdaloidal basalt

Low grade regional metamorphism (burial metamorphism)

HAMERSLEY BASIN

do d_1 fr d_2

do	Gabbro and coarse-grained dolerite dykes
d_1	Melanocratic dolerite, gabbro, pyroxenite dykes
fr	Felsic dyke; aplite
d_2	Dolerite dyke

fp dl

fp	Foliated fine-grained felsic porphyry with rounded feldspar phenocrysts
dl	Layered mafic intrusion; pyroxenite to gabbro

gc gb ge

gc	Medium to coarse-grained biotite syenogranite and monzogranite
gb	Fine to coarse-grained biotite syenogranite and monzogranite, weak foliation
ge	Medium to coarse-grained leucocratic syenogranite and monzogranite

c. 2800 – 3300 Ma

gg ga gm gmx

gg	Strongly deformed schistose and well foliated syenogranite and monzogranite
ga	Strongly deformed granitic augen gneiss
gm	Fine to medium-grained biotite granitic gneiss; flaser gneiss, some migmatitic phases
gmx	Meta-sedimentary and meta-volcanic xenoliths and granitic rocks in approximately equal proportions

Gorge Creek Group

c. 3000 Ma

GCm **MOSQUITO CREEK FORMATION** : greywacke, pelite, psammite, minor conglomerate

- GCmx Chert

sq si sp sr

sq	Quartzite, fuchsite quartzite
si	Banded quartz magnetite rock, jaspilite
sp	Pelitic schist; muscovite-garnet-andalusite (-staurolite) assemblages
sr	Corundum-muscovite-rutile assemblages; some crystalline diaspore

ba Amphibole-plagioclase schist

uu uc ux

uu	Ultramafic rock (unassigned); tremolite-chlorite-talc assemblages
uc	Serpentinite, some talc; after peridotite
ux	Coarse-grained pyroxenite; pyroxene generally altered to amphibole

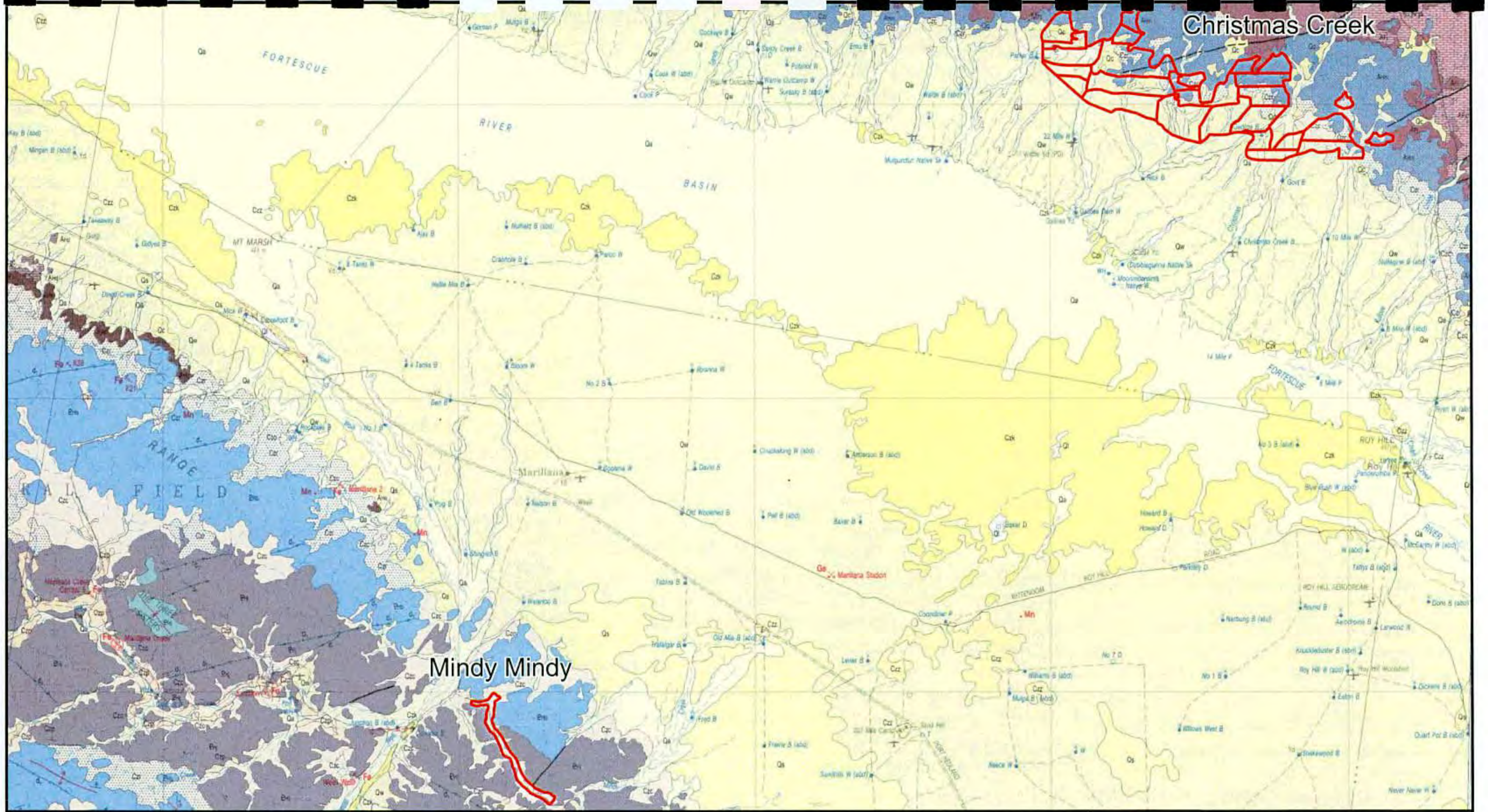
Regional metamorphism attains amphibolite facies

PILBARA CRATON

Fortescue Metals Group Limited

Figure 7 Regional Geology Legend (2 of 2) Mt Lewin and Mt Nicholas

Author:	FMG	Date:	30/12/04
Drawn By:	A. Gregory	Revised:	10/01/05
Fig No.:	7	Report No.:	FMG 04129
Projection:	Unprojected	Scale:	Not To Scale



Legend

☐ Pit Outlines

Fortescue Metals Group Limited

Figure 8 Regional Geology Mindy Mindy and Christmas Creek

Author:	FMG	Date:	29/12/04
Drawn By:	A. Gregory	Revised:	10/01/05
Fig No.:	8	Report No.:	FMG 04129
Projection:	GDA 94	Scale:	1:350 000

PHANEROZOIC

CAINOZOIC

QUATERNARY

Qa	Ql	Qc	Qs	Qw

Qa	Alluvium—unconsolidated silt, sand, and gravel; in drainage channels and on adjacent floodplains
Ql	Lacustrine deposits—clay and silt; claypan (predominantly freshwater) deposits
Qc	Colluvium—unconsolidated quartz and rock fragments in soil; locally derived soil, and scree, and talus deposits
Qs	Eolian deposit—sand; in sheets and longitudinal dunes
Qw	Alluvium and colluvium—red-brown sandy and clayey soil; on low slopes and sheetwash areas

Cza	Czc	Czg	Czz	Czk	Czl	Czr	Czp

Cza	Alluvium—partly consolidated silt, sand, and gravel; old alluvium dissected by present-day drainage
Czc	Colluvium—partly consolidated quartz and rock fragments in silt and sand matrix; old valley-fill deposits
Czg	Sand over granitoid rock—quartzofeldspathic sand; includes areas of low, weathered outcrop
Czz	Brecciated siliceous caprock over dolomitic rock; angular chert fragments in a chert matrix; overlies WITTENOOM FORMATION
Czk	Calcrete—sheet carbonate; found along major drainage lines
Czl	Lateritic deposits—massive and pisolitic ferruginous duricrust
Czr	Hematite-goethite deposits on banded iron-formation and adjacent scree deposits
Czp	ROBE PISOLITE : pisolitic limonite deposits developed along river channels

d_4, d_6, d_7 /	Dolerite dykes, sills, and small intrusions; numbers identify different suites, lowest number earliest

PROTEROZOIC

c. 2490 Ma

0 Ma

Mount Bruce Supergroup

Hamersley Group

PHd	Medium- to coarse-grained metadolerite sills intruded into Hamersley Group
PHo	**BOOLGEEDA IRON FORMATION** : fine-grained, finely laminated iron-formation, pelite and chert
PHw	**WOONGARRA RHYOLITE** : metamorphosed rhyolite, rhyodacite, rhyolitic breccia, and banded iron-formation
PHj	**WEELI WOLLI FORMATION** : banded iron-formation (commonly jaspilitic), pelite, and numerous metadolerite sills
PHb	**BROCKMAN IRON FORMATION** : banded iron-formation, chert, and pelite
AHs	**MOUNT McRAE SHALE** and **MOUNT SYLVIA FORMATION** : pelite, chert, and banded iron-formation
AHd	**WITTENOOM FORMATION** : thin- to medium-bedded metadolomite, dolomitic pelite, chert, and metamorphosed volcanic sandstone
AHm	**MARRA MAMBA IRON FORMATION** : chert, banded iron-formation, and pelite

c. 2690 Ma

AFd	Medium- to coarse-grained metadolerite sills intruded into Fortescue Group
AFj	**JEERINAH FORMATION** : pelite, chert, and thin-bedded metasandstone; intruded by metadolerite sills in the Hamersley Range
	Pillowed and massive metabasaltic flows and metabasaltic breccia
AFjd	Pelite and thin-bedded metadolomite
AFjo	**Woodiana Member** : metamorphosed quartzitic sandstone, pelite, and chert (locally stromatolitic)

Hamersley Basin

Fortescue Metals Group Limited

Figure 8 Regional Geology Legend (1 of 2) Mindy Mindy and Christmas Creek

Author:	FMG	Date:	30/12/04
Drawn By:	A. Gregory	Revised:	10/01/05
Fig No.:	8	Report No.:	FMG 04129
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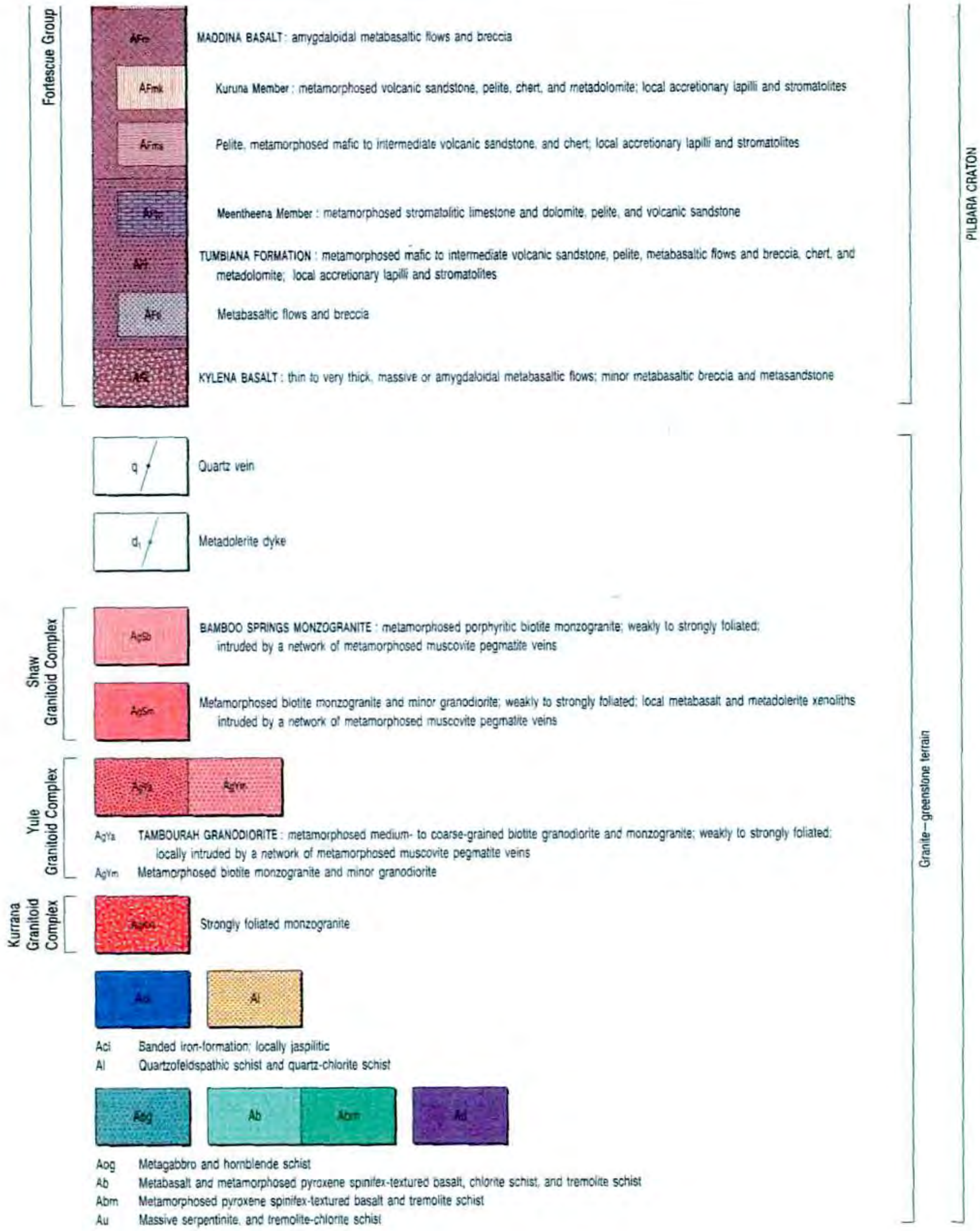

MADDINA BASALT : amygdaloidal metabasaltic flows and breccia

Kuruna Member : metamorphosed volcanic sandstone, pelite, chert, and metadolomite; local accretionary lapilli and stromatolites

Pelite, metamorphosed mafic to intermediate volcanic sandstone, and chert; local accretionary lapilli and stromatolites

Meentheena Member : metamorphosed stromatolitic limestone and dolomite, pelite, and volcanic sandstone

TUMBIANA FORMATION : metamorphosed mafic to intermediate volcanic sandstone, pelite, metabasaltic flows and breccia, chert, and metadolomite; local accretionary lapilli and stromatolites

Metabasaltic flows and breccia

KYLENA BASALT : thin to very thick, massive or amygdaloidal metabasaltic flows; minor metabasaltic breccia and metasandstone

Quartz vein

Metadolerite dyke

BAMBOO SPRINGS MONZOGRANITE : metamorphosed porphyritic biotite monzogranite; weakly to strongly foliated; intruded by a network of metamorphosed muscovite pegmatite veins

Metamorphosed biotite monzogranite and minor granodiorite; weakly to strongly foliated; local metabasalt and metadolerite xenoliths intruded by a network of metamorphosed muscovite pegmatite veins

AgYa **TAMBOURAH GRANODIORITE** : metamorphosed medium- to coarse-grained biotite granodiorite and monzogranite; weakly to strongly foliated; locally intruded by a network of metamorphosed muscovite pegmatite veins

AgYm Metamorphosed biotite monzogranite and minor granodiorite

Strongly foliated monzogranite

Aci	Banded iron-formation; locally jaspilitic
Al	Quartzofeldspathic schist and quartz-chlorite schist

Aog	Metagabbro and hornblende schist
Ab	Metabasalt and metamorphosed pyroxene spinifex-textured basalt, chlorite schist, and tremolite schist
Abm	Metamorphosed pyroxene spinifex-textured basalt and tremolite schist
Au	Massive serpentinite, and tremolite-chlorite schist

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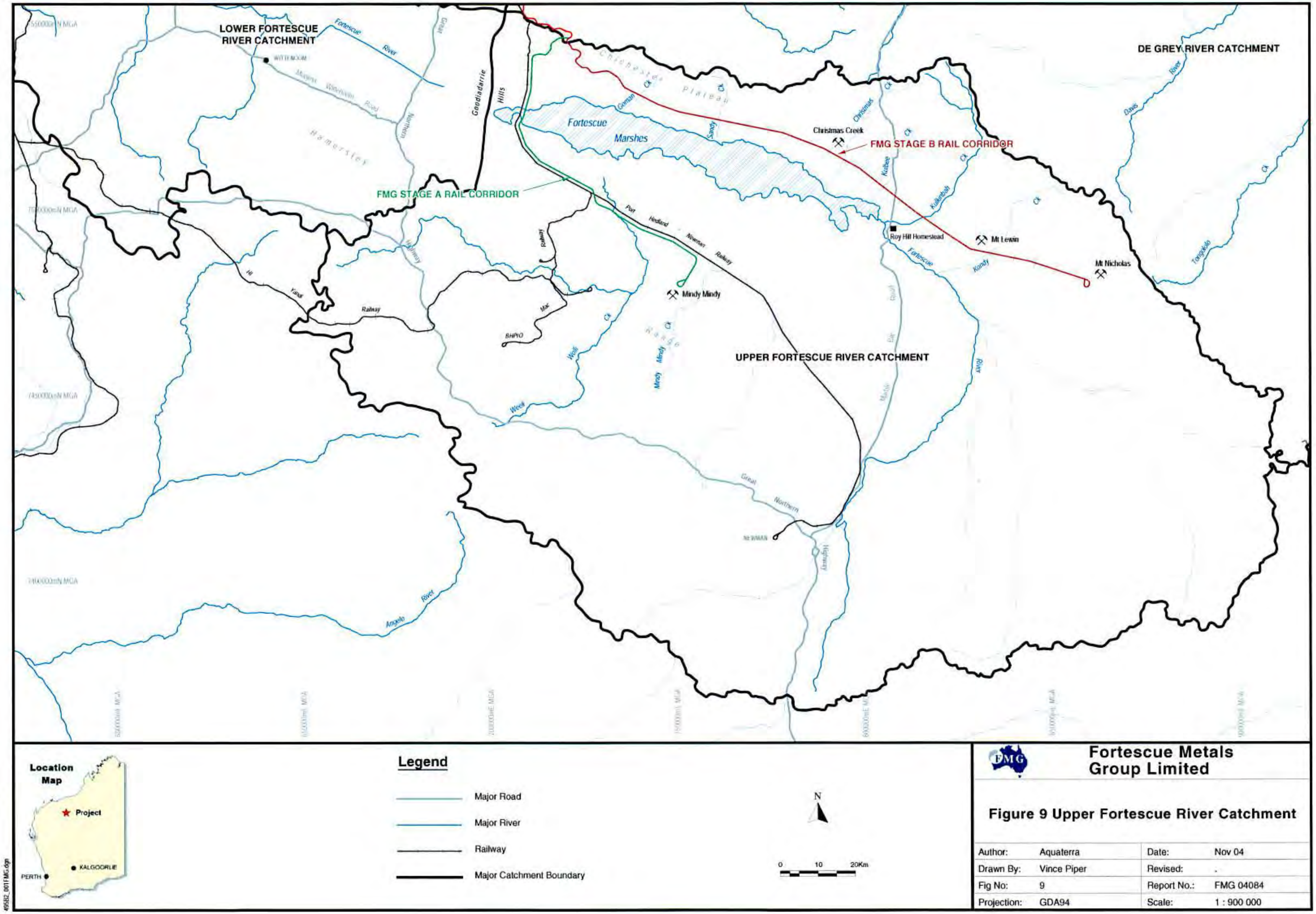
Figure 8 Regional Geology Legend (1 of 2)
Mindy Mindy and Christmas Creek

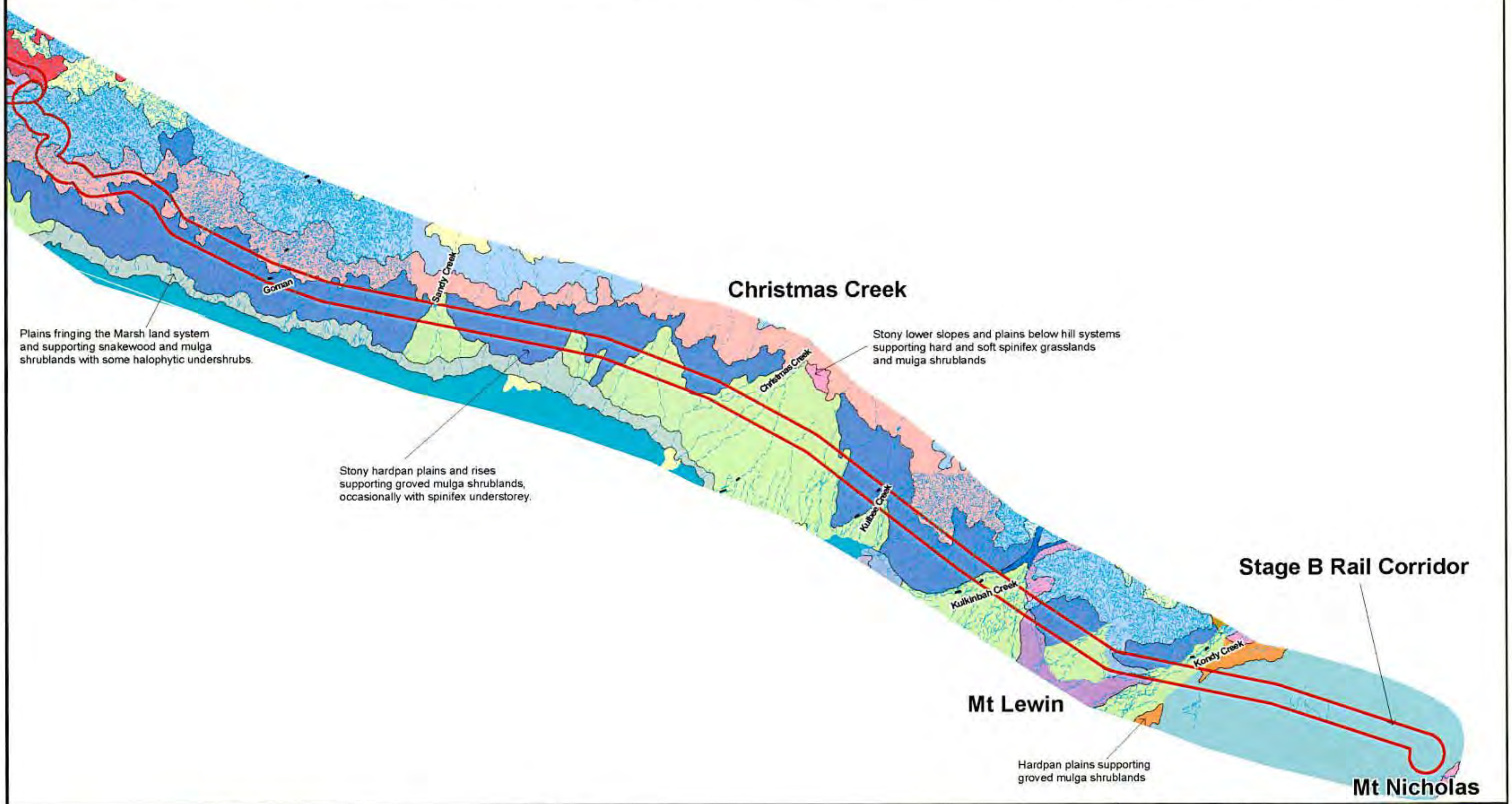
Author:	FMG	Date:	30/12/04
Drawn By:	A. Gregory	Revised:	10/01/05
Fig No.:	8	Report No.:	FMG 04129
Projection:	Unprojected	Scale:	Not To Scale



Fortescue Metals Group Limited

Figure 9 Upper Fortescue River Catchment

Author:	Aquaterra	Date:	Nov 04
Drawn By:	Vince Piper	Revised:	.
Fig No:	9	Report No.:	FMG 04084
Projection:	GDA94	Scale:	1 : 900 000



Legend

🟦	Lake beds and flood plains subject to regular inundation supporting samphire shrublands, salt water couch grasslands and halophytic shrublands.
🟩	Stony alluvial plains with gilgaied and non-gilgaied surfaces supporting tussock grasslands and grassy shrublands
🟥	Rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands
🟦	Hills, ridges, plateaux remnants and breakaways of metasedimentary and sedimentary rocks supporting hard spinifex grasslands
🟨	Basalt hills, plateaux, lower slopes and minor stony plains supporting hard spinifex (and occasionally soft spinifex) grasslands.
🟥	Basalt upland gilgai plains supporting tussock grasslands and minor hard spinifex grasslands
🟩	Dissected plains and slopes supporting hard spinifex grasslands.
🟪	Alluvial plains with cracking clay soils supporting tussock grasslands.
🟦	Sandplains and occasional dunes supporting shrubby hard spinifex grasslands
🟦	Active flood plains and major rivers supporting grassy eucalypt woodlands, tussock grasslands and soft spinifex grasslands
🟦	Flood plains with weakly gilgaied clay soils supporting coolibah woodlands with tussock grass understorey

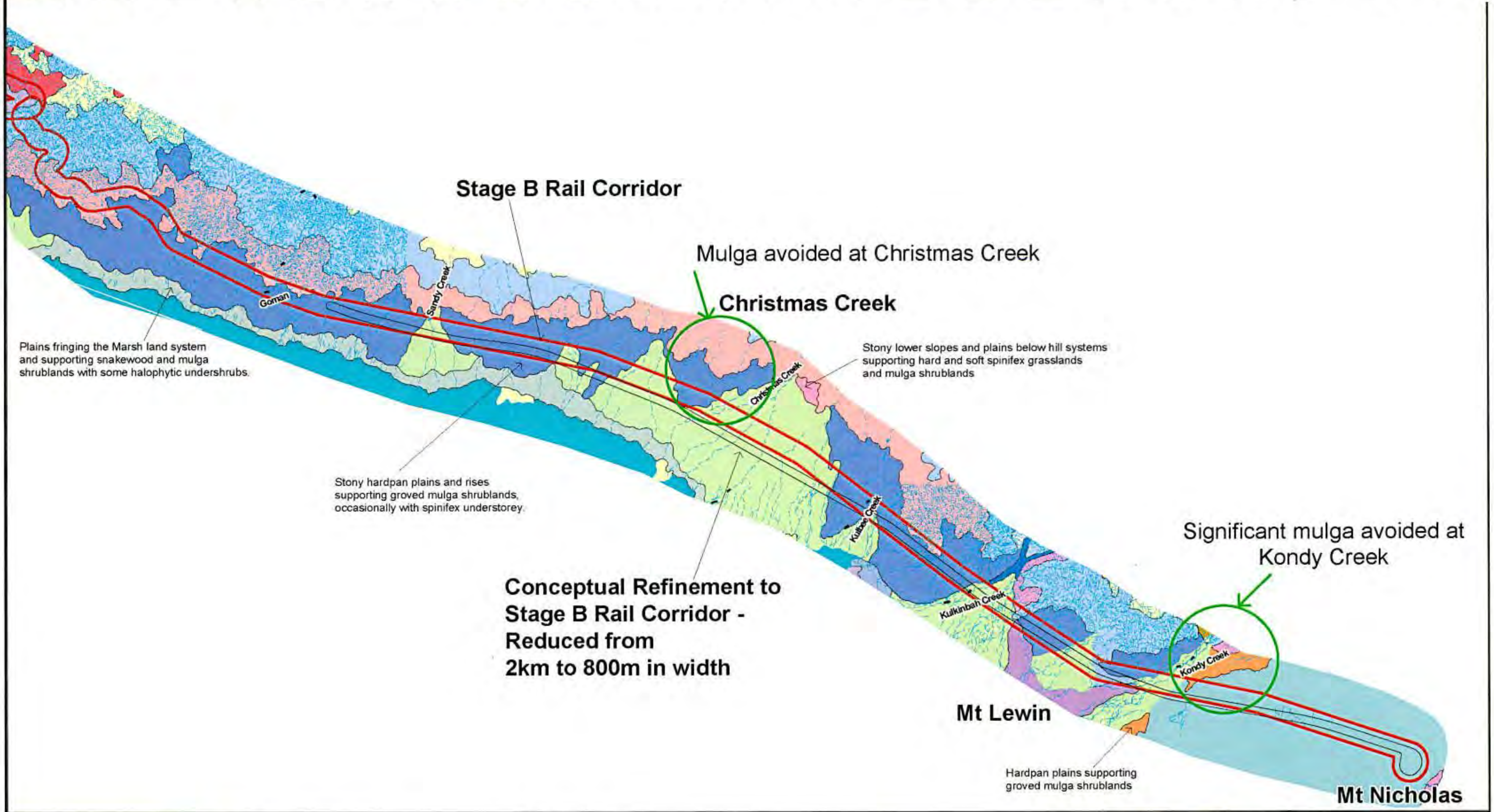
N

0 7.5 15 km

Fortescue Metals Group Limited

Figure 10 Mulga Zones and Major Creeks along Stage B Rail Corridor

Author:	FMG	Date:	23/11/04
Drawn By:	M.Khan	Revised:	10/01/05
Fig No.:	10	Report No.:	FMG 04093
Projection:	GDA 94	Scale:	1:525 000



Location Map

Legend

🟦 Lake beds and flood plains subject to regular inundation supporting samphire shrublands, salt water couch grasslands and halophytic shrublands.

🟩 Stony alluvial plains with gilgaied and non-gilgaied surfaces supporting tussock grasslands and grassy shrublands

🟥 Rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands

🟦 Hills, ridges, plateaux remnants and breakaways of metasedimentary and sedimentary rocks supporting hard spinifex grasslands

🟨 Basalt hills, plateaux, lower slopes and minor stony plains supporting hard spinifex (and occasionally soft spinifex) grasslands.

🟥 Basalt upland gilgai plains supporting tussock grasslands and minor hard spinifex grasslands

🟩 Dissected plains and slopes supporting hard spinifex grasslands.

🟪 Alluvial plains with cracking clay soils supporting tussock grasslands.

🟦 Sandplains and occasional dunes supporting shrubby hard spinifex grasslands

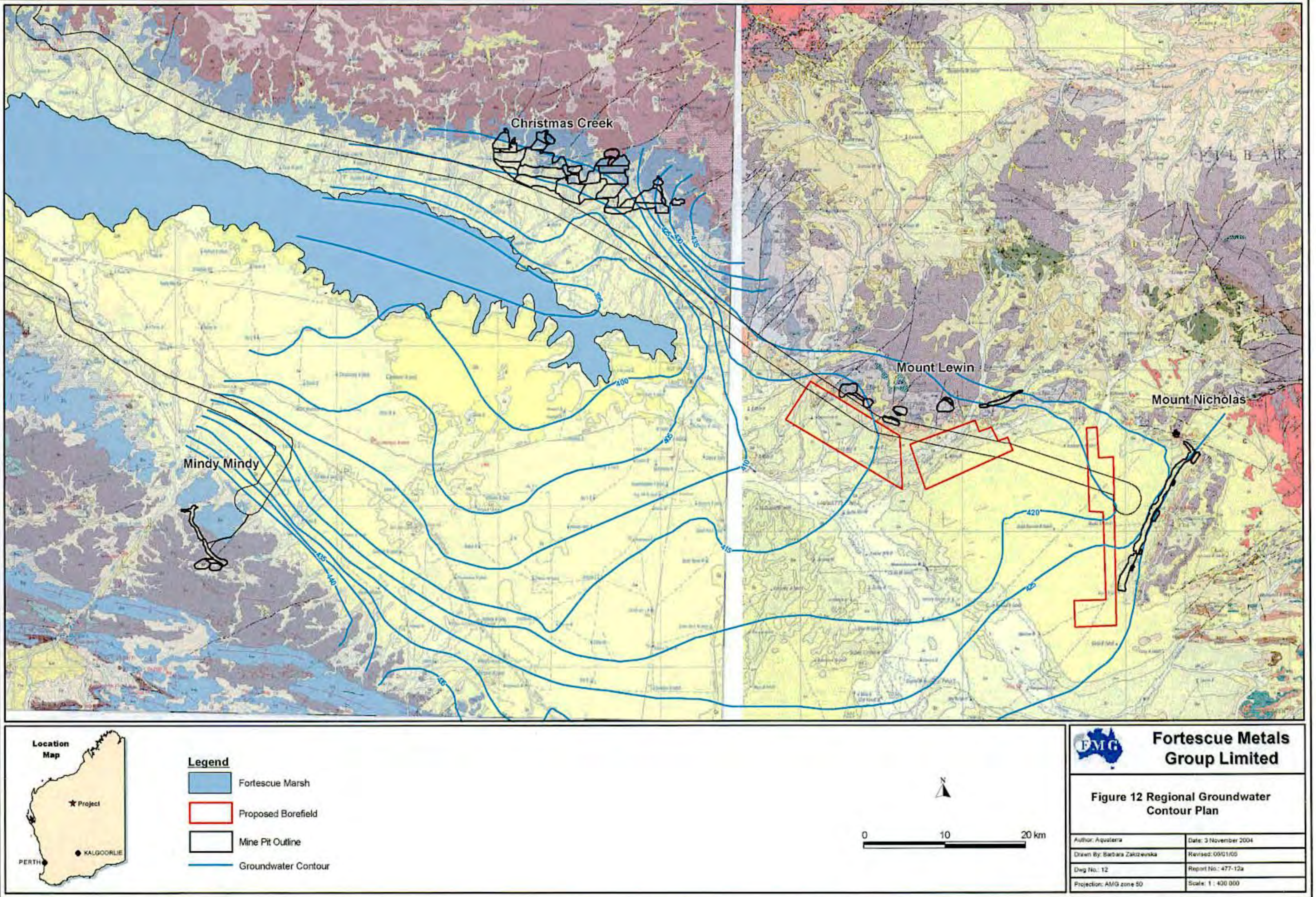
🟦 Active flood plains and major rivers supporting grassy eucalypt woodlands, tussock grasslands and soft spinifex grasslands

🟦 Flood plains with weakly gilgaied clay soils supporting coolibah woodlands with tussock grass understorey

Fortescue Metals Group Limited

Figure 11 Conceptual Refinement of Stage B Corridor to Reduce Impact on Mulga

Author:	FMG	Date:	23/11/04
Drawn By:	M.Khan	Revised:	10/01/05
Fig No.:	11	Report No.:	FMG 04093
Projection:	GDA 94	Scale:	1:525 000



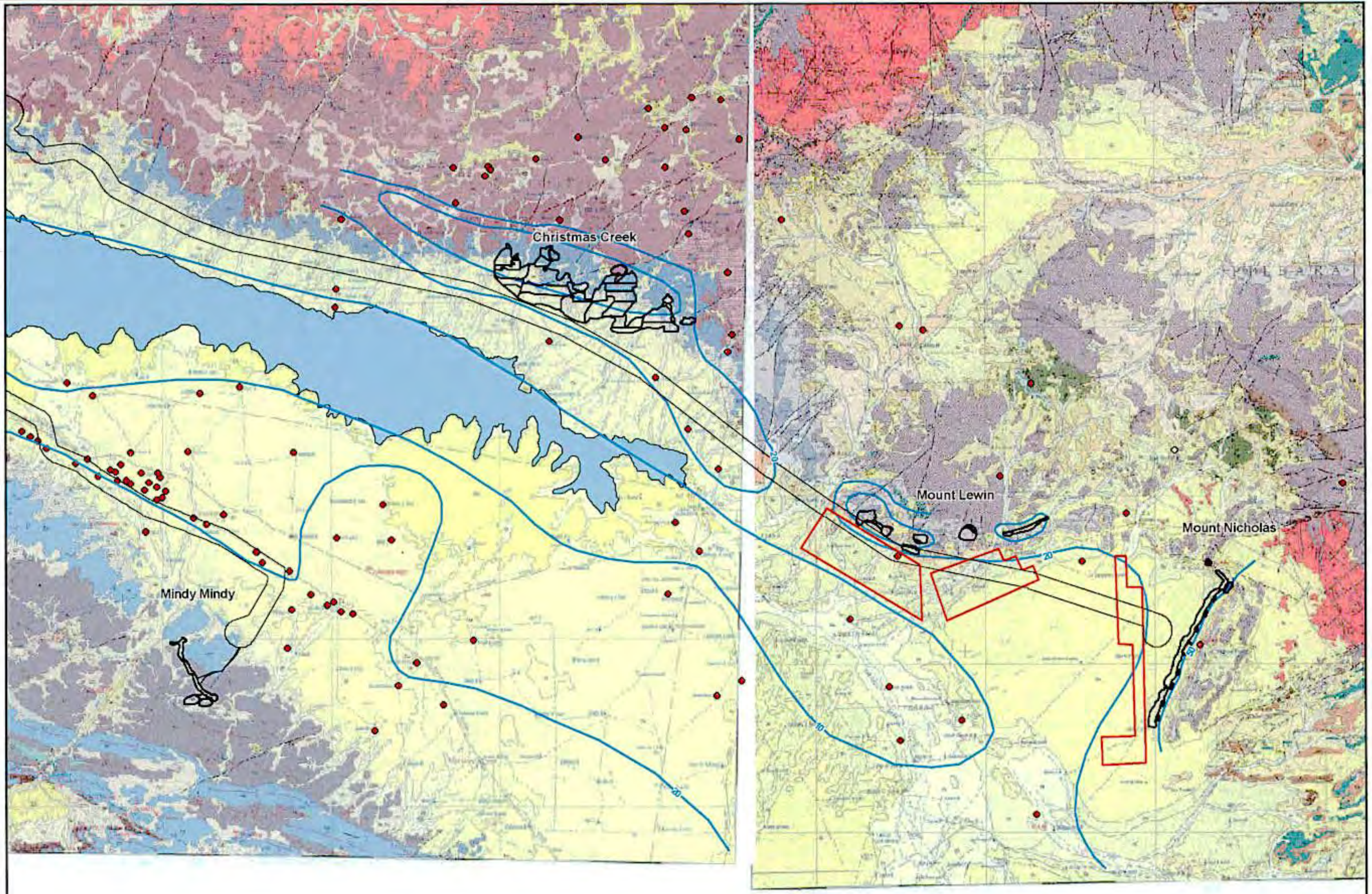
Legend

🟦	Fortescue Marsh
🟥	Proposed Borefield
☐	Mine Pit Outline
—	Groundwater Contour

Fortescue Metals Group Limited

Figure 12 Regional Groundwater Contour Plan

Author: Aquaterra	Date: 3 November 2004
Drawn By: Barbara Zakrzewska	Revised: 06/01/05
Dwg No.: 12	Report No.: 477-12a
Projection: AMG zone 50	Scale: 1 : 400 000



Legend

- 🟦 Fortescue Marsh
- 🟥 Proposed Boreholes
- ☐ Mine Pit Outline
- — Groundwater Contour
- ● Regional Monitoring Bore

N

0 10 20 km

Fortescue Metals Group Limited

Figure 13 Depth to Groundwater Table

Author: Aquaterra	Date: 3 November 2004
Drawn By: Barbara Zakrzewska	Revised: 10/01/05
Dwg No.: 13	Report No.: 477-12b
Projection: AMG zone 50	Scale: 1 : 400 000

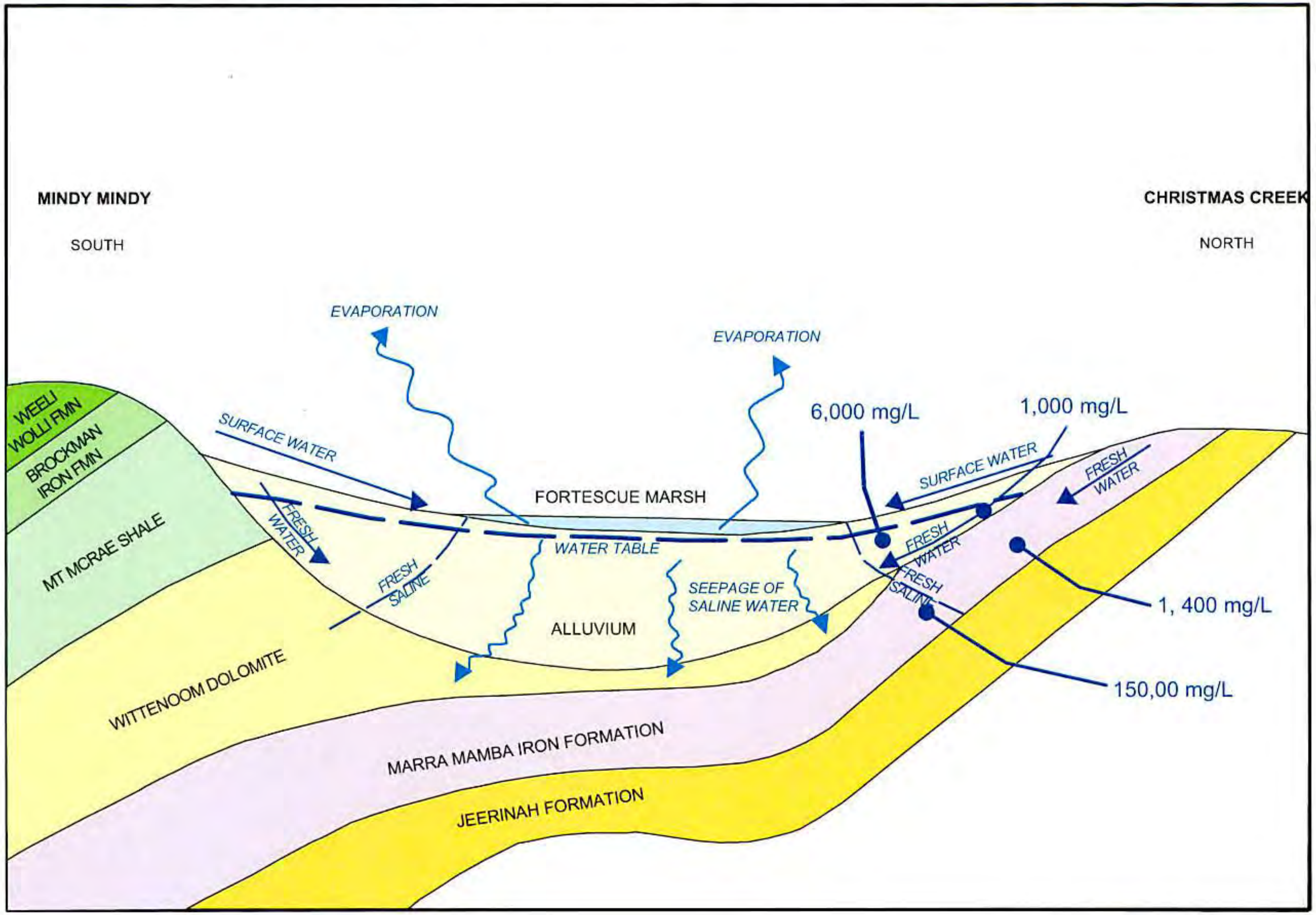


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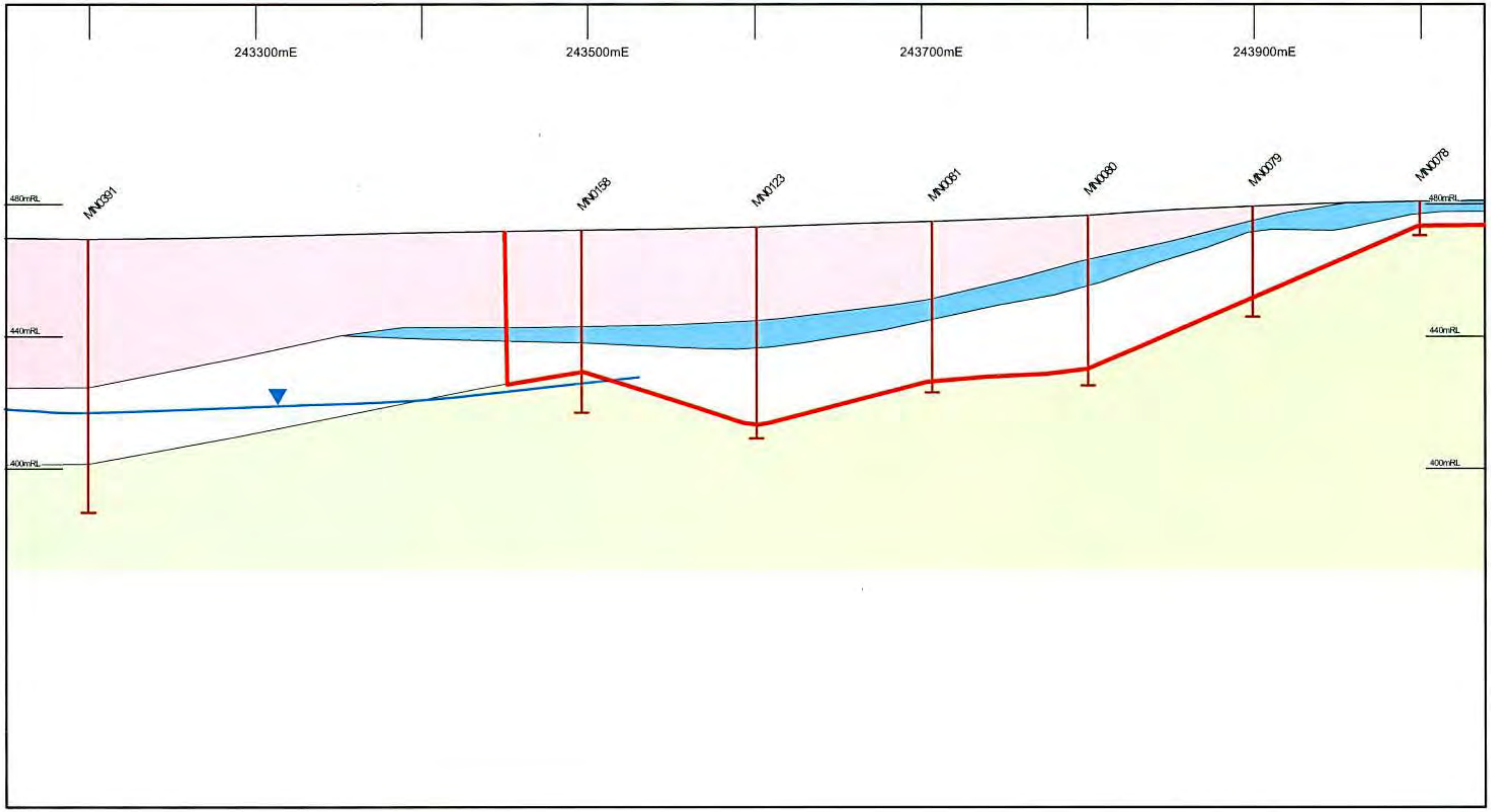
Figure 14 Schematic Section Across the Fortescue Marsh

Author:	FMG	Date:	01/12/04
Drawn By:	A. Gregory	Revised:	10/01/05
Fig No.:	14	Report No.:	FMG 04111
Projection:	Unprojected	Scale:	Not To Scale



Location Map

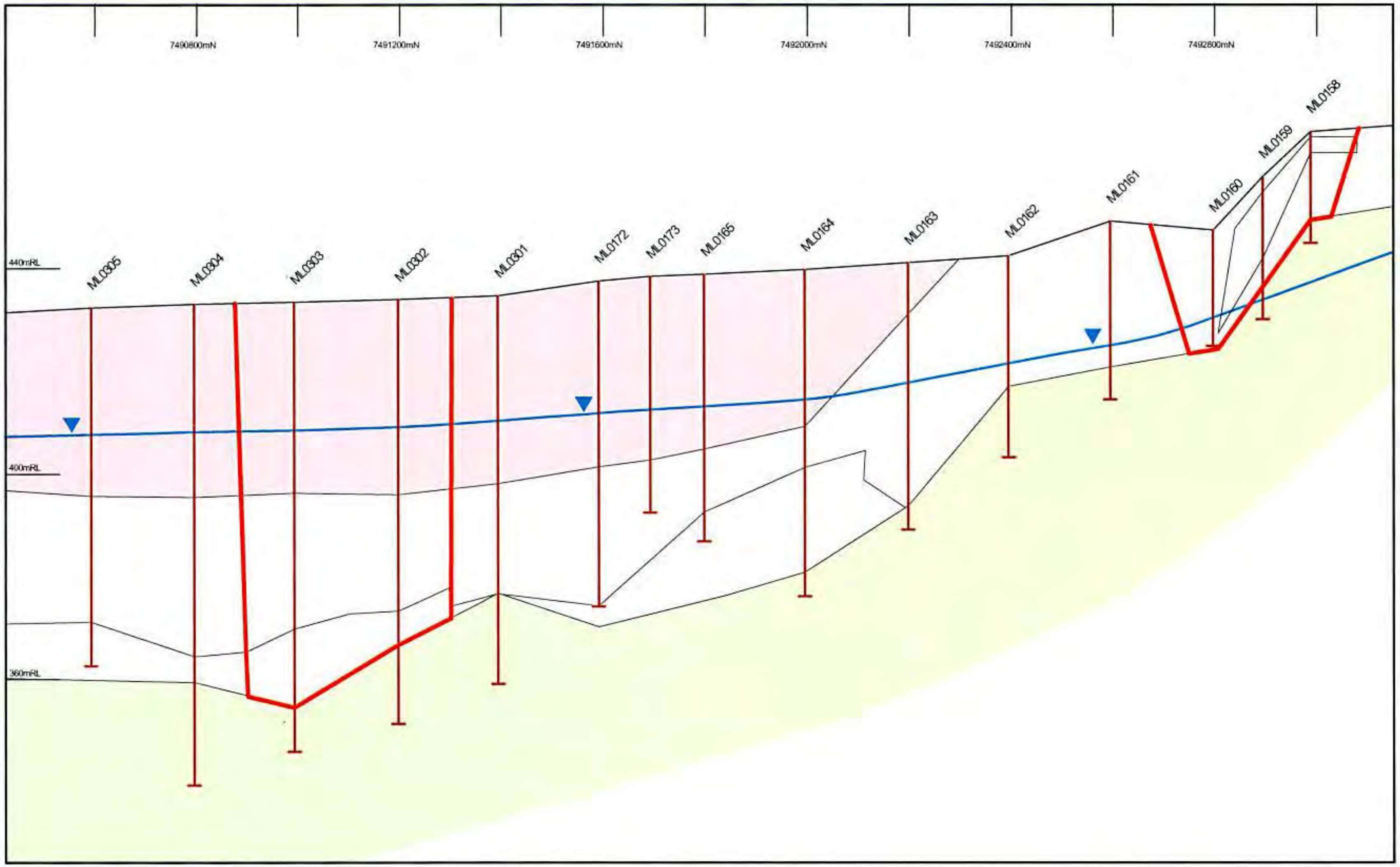
LEGEND

▨	Quaternary Deposits
🟦	Unmineralized Marra Mamba Iron Formation
☐	Ore Body
🟩	Basement
▼	Static Water Level
🟥	Mine Pit Outline

Fortescue Metals Group Limited

Figure 15 Hydrogeological cross section of Mt Nicholas

Author: Aquaterra	Date: 01/12/04
Drawn By:	Revised: 10/01/05
Plan No.: 15	Report No.: 15b
Projection: non-earth metres	Scale:



LEGEND

🟪 QUATERNARY DEPOSITS

☐ ORE BODY

🟩 BASEMENT

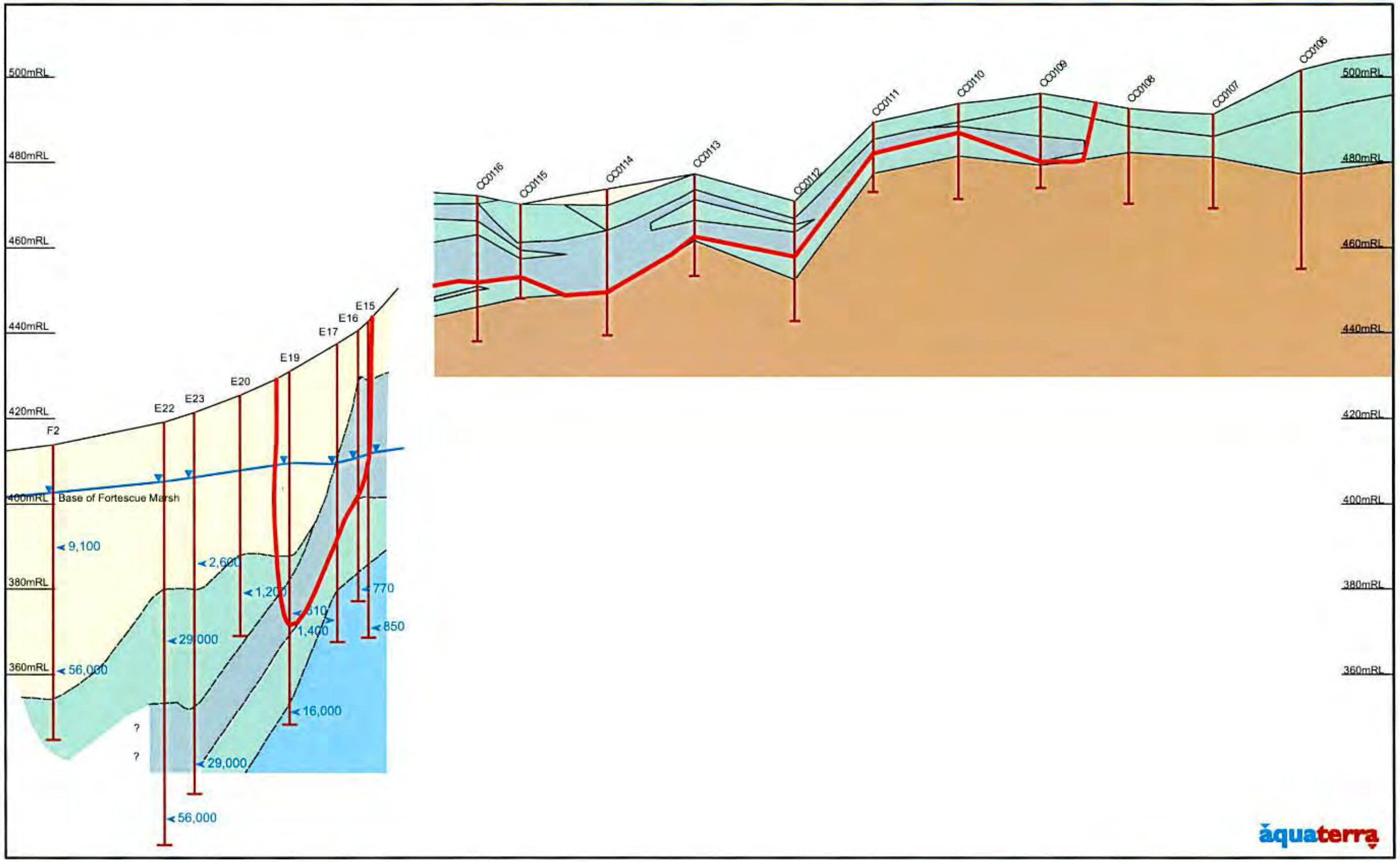
▼ Static Water Level

— Mine Pit Outline

Fortescue Metals Group Limited

Figure 16 Hydrogeological cross section of Mt Lewin

Author: Aquaterra	Date: 01/12/04
Drawn By:	Revised: 10/01/05
Plan No.: Fig 16	Report No.: 15b
Projection: non-earth meters	Scale:



Location Map

LEGEND

Drillhole Lithology

- 🟨 COLLUVIUM
- 🟨 ALLUVIUM
- ⬜ QUATERNARY DEPOSITS
- 🟩 HARDCAP/UNMINERALIZED MARRA MAMBA FORMATION
- 🟫 FOOTWALL(MUb)
- 🟦 JEERINAH FORMATION
- ⬛ ORE BODY
- 🟥 Mine Pit Outline

Interpreted Hydrogeology

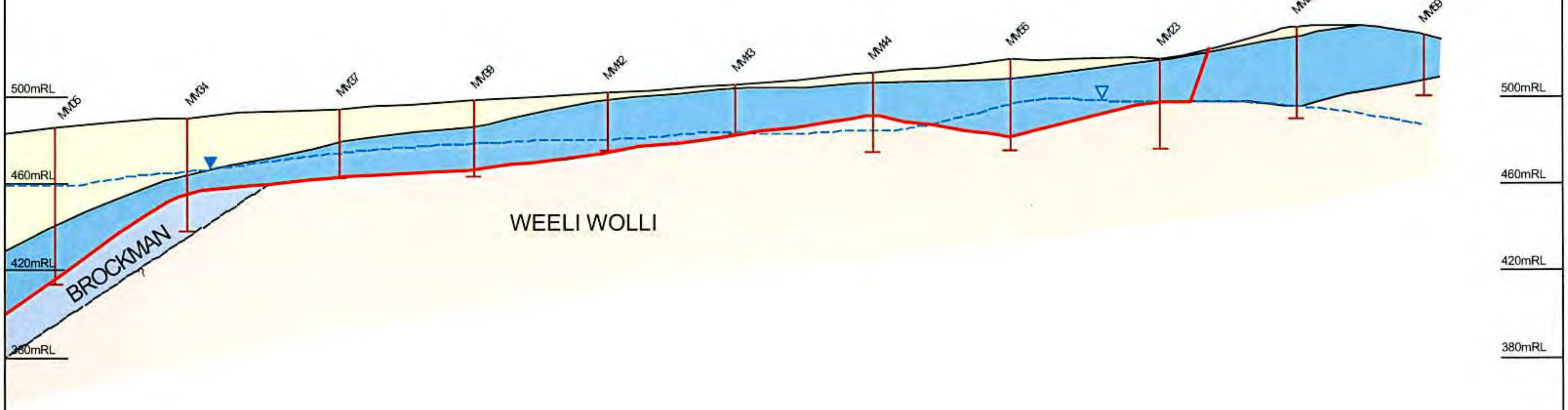
- ▼ Static Water Level
- ◄ 1,600 TDS (mg/L)

Fortescue Metals Group Limited

Figure 17 Hydrogeological cross section of Christmas Creek

Author: Aquaterra	Date: 01/12/04
Drawn By:	Revised: 10/01/05
Plan No.: 17	Report No.: 15c
Projection: non-earth meters	Scale:

Mindy Mindy Section MM4



Location Map

LEGEND

🟨 ALLUVIUM/COLLUVIUM

🟦 CID

🟥 BEDROCK

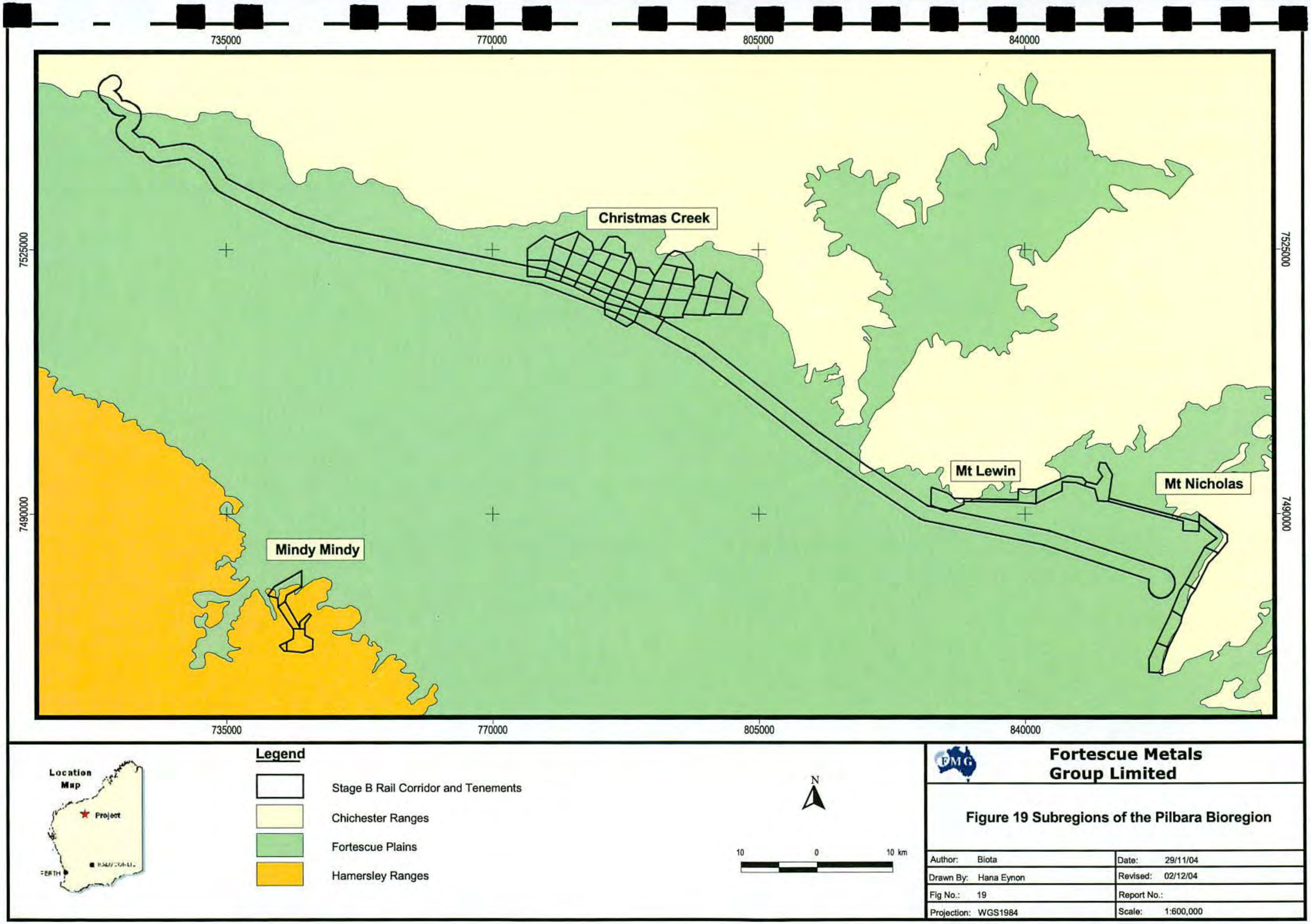
--▼-- Static Water Level

━━ Mine Pit Outline

Fortescue Metals Group Limited

Figure 18 Hydrogeological cross section of Mindy Mindy

Author: Aquaterra	Date: 01/12/04
Drawn By:	Revised: 10/01/05
Plan No.: 18	Report No.: 15d
Projection: non-earth meters	Scale:



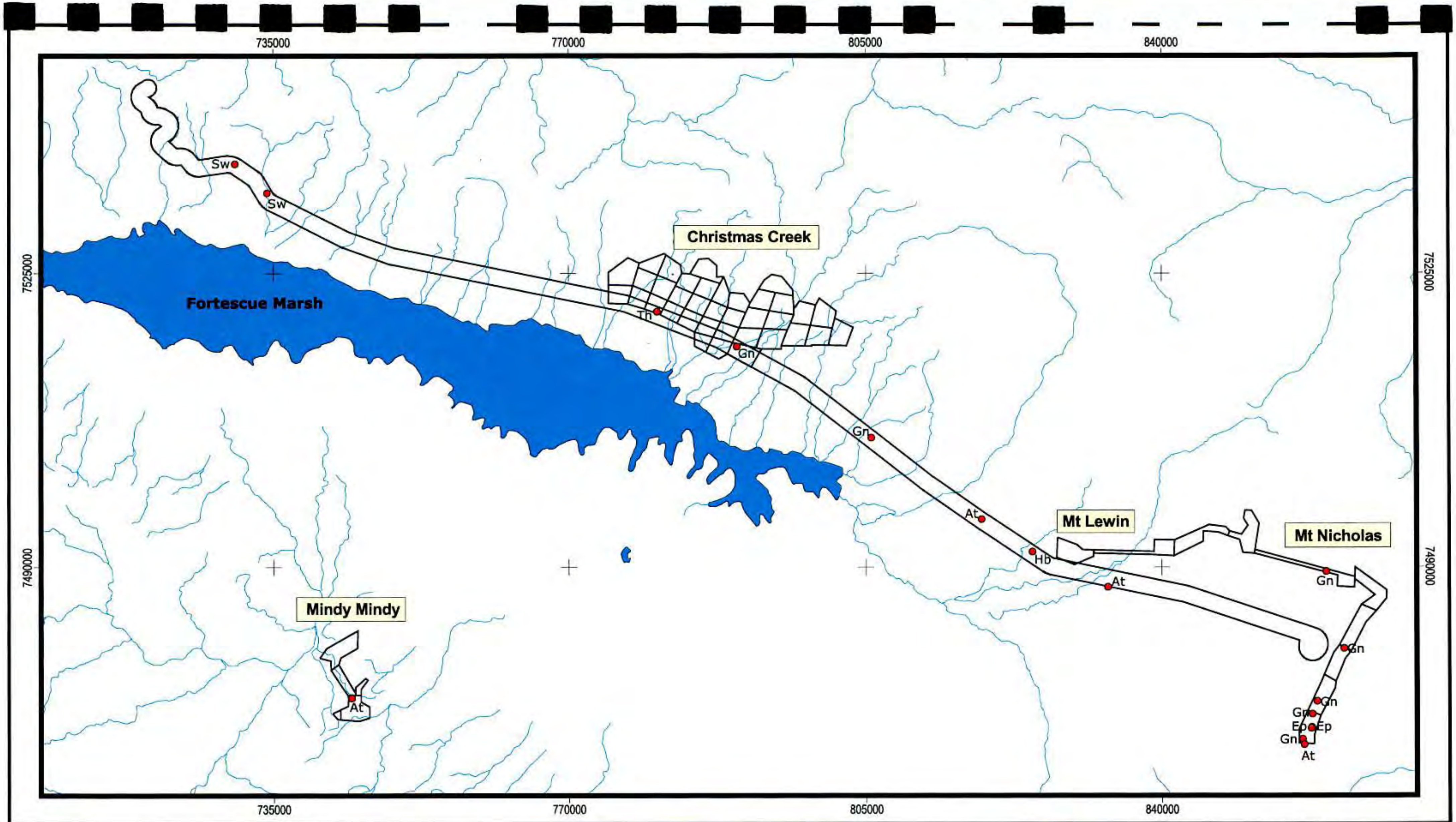
Legend

☐	Stage B Rail Corridor and Tenements
🟨	Chichester Ranges
🟩	Fortescue Plains
🟧	Hamersley Ranges

Fortescue Metals Group Limited

Figure 19 Subregions of the Pilbara Bioregion

Author:	Biota	Date:	29/11/04
Drawn By:	Hana Eynon	Revised:	02/12/04
Fig No.:	19	Report No.:	
Projection:	WGS1984	Scale:	1:600,000



Legend

▭ Stage B Rail Corridor and Tenements

— Drainage

● Priority Flora

Th	*Themeda* sp. Hamersley Station (M.E.Trudgen 11431)
At	*Abutilon trudgenii* ms.
Sw	*Sida* sp. Wittenoom (W.R. Barker 1962)
Hb	*Hibiscus brachysiphonius*
Gn	*Goodenia nuda*
Ep	*Eremophila pilosa*

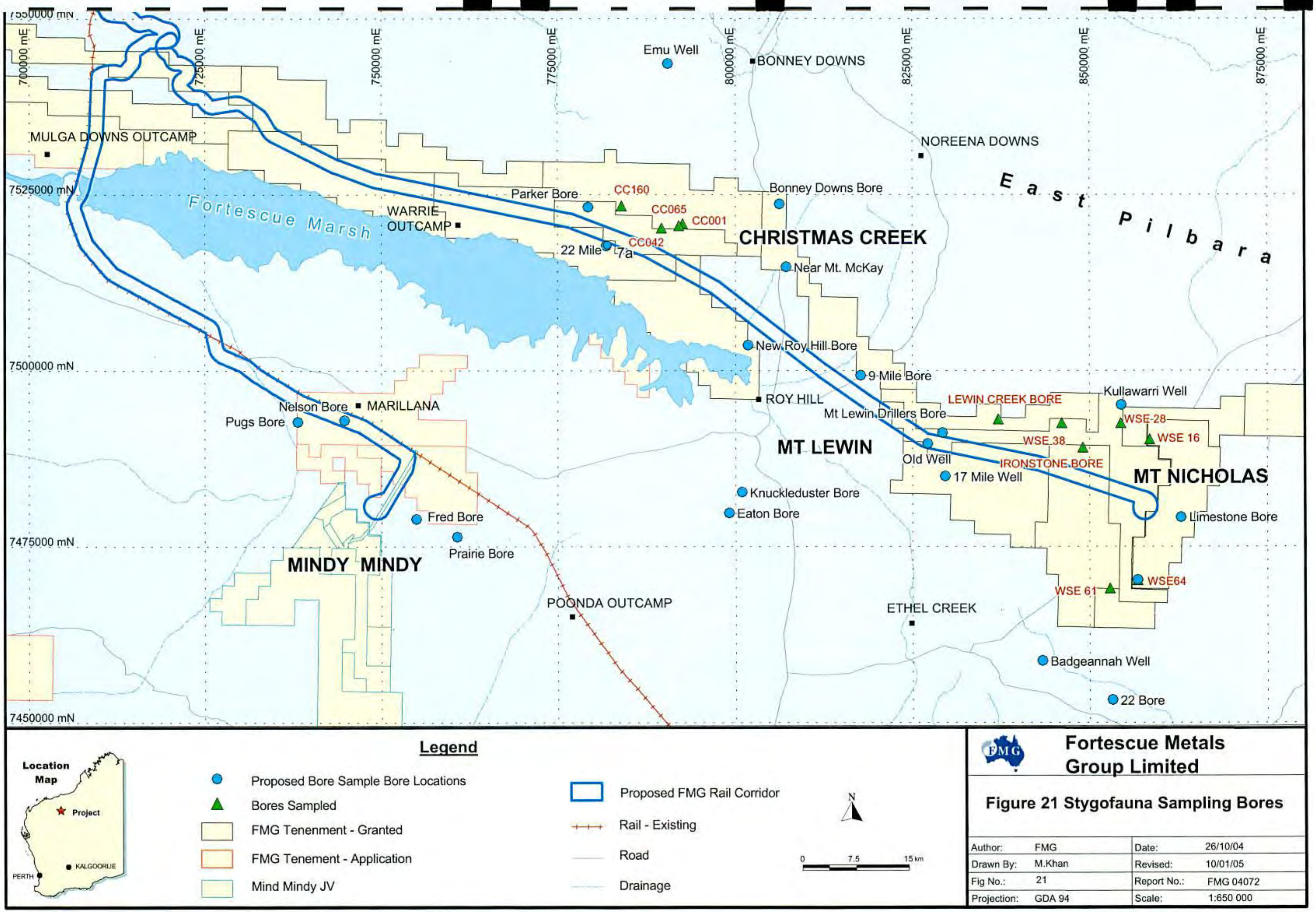
N

10 0 10 km

Fortescue Metals Group Limited

Figure 20 Distribution of Priority flora in the FMG rail corridor and tenements

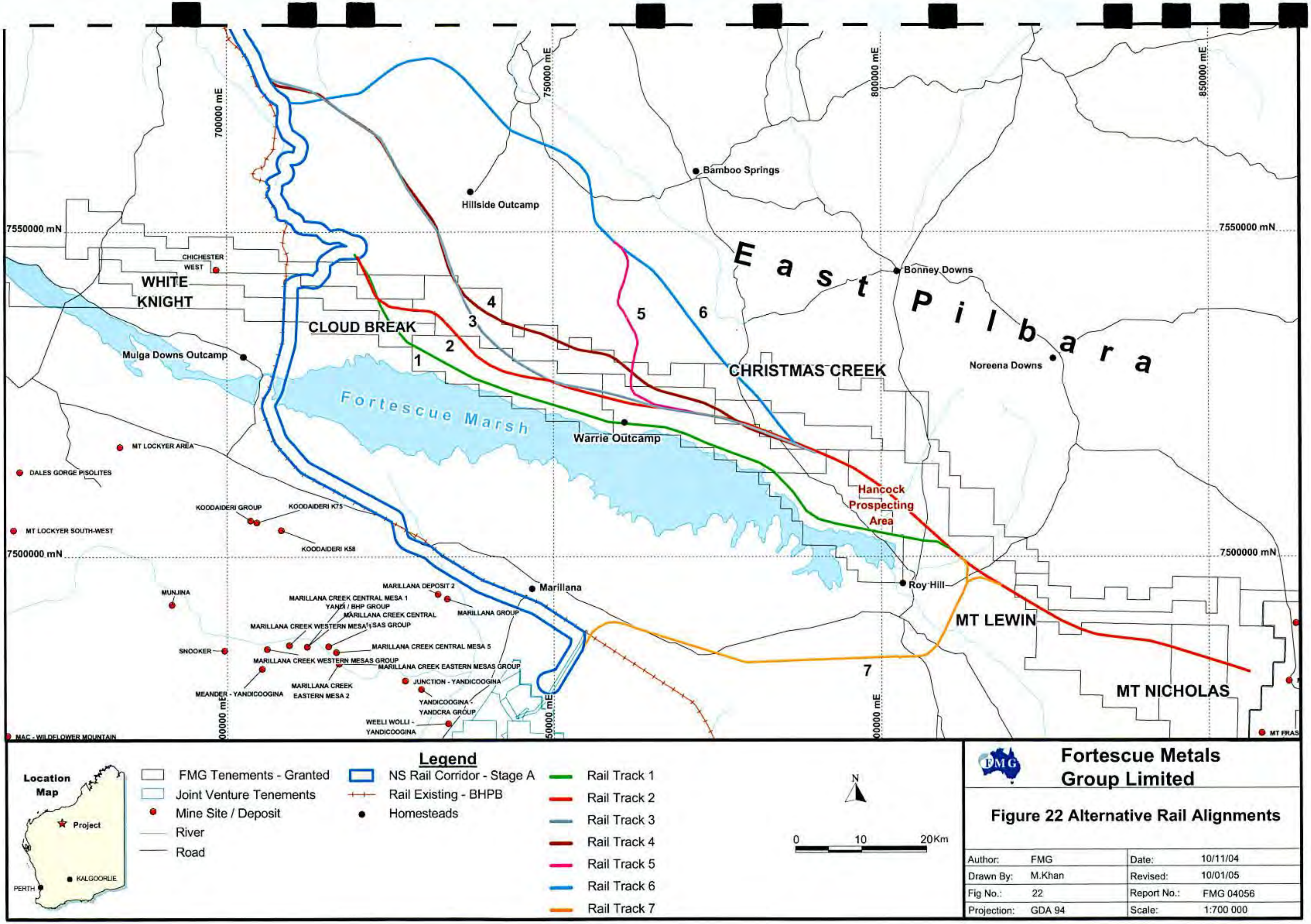
Author:	Biota	Date:	29/11/04
Drawn By:	Hana Eynon	Revised:	02/12/04
Fig No.:	20	Report No.:	
Projection:	WGS1984	Scale:	1:600,000



Fortescue Metals Group Limited

Figure 21 Stygofauna Sampling Bores

Author:	FMG	Date:	26/10/04
Drawn By:	M.Khan	Revised:	10/01/05
Fig No.:	21	Report No.:	FMG 04072
Projection:	GDA 94	Scale:	1:650 000



Fortescue Metals Group Limited

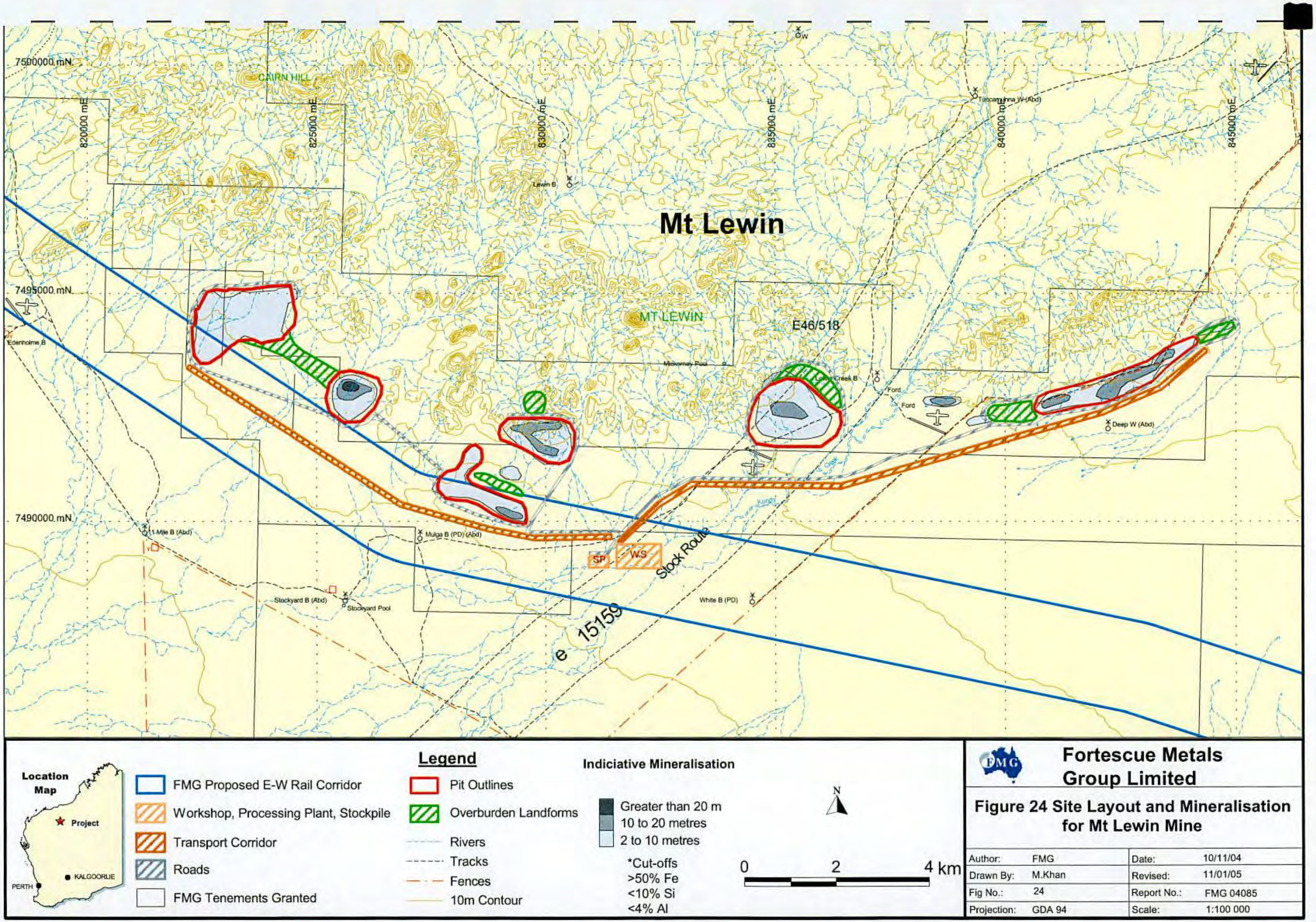
Figure 22 Alternative Rail Alignments

Author:	FMG	Date:	10/11/04
Drawn By:	M.Khan	Revised:	10/01/05
Fig No.:	22	Report No.:	FMG 04056
Projection:	GDA 94	Scale:	1:700 000

Fortescue Metals Group Limited

Figure 23 Site Layout and Mineralisation for Mt Nicholas Mine

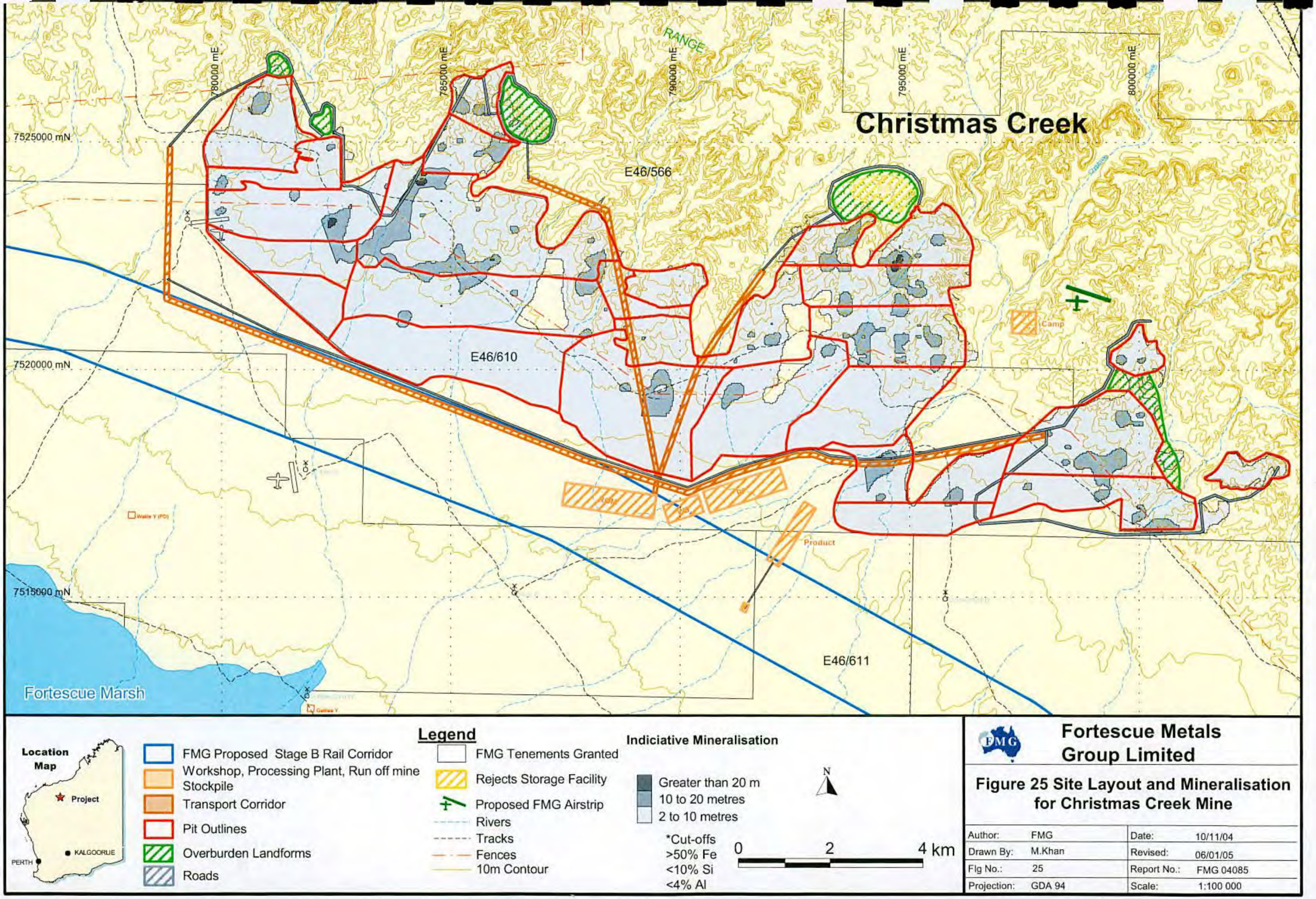
Author:	FMG	Date:	10/11/04
Drawn By:	M.Khan	Revised:	10/01/05
Fig No.:	23	Report No.:	FMG 04085
Projection:	GDA 50	Scale:	1:150 000



Fortescue Metals Group Limited

Figure 24 Site Layout and Mineralisation for Mt Lewin Mine

Author:	FMG	Date:	10/11/04
Drawn By:	M.Khan	Revised:	11/01/05
Fig No.:	24	Report No.:	FMG 04085
Projection:	GDA 94	Scale:	1:100 000



Fortescue Metals Group Limited

Figure 25 Site Layout and Mineralisation for Christmas Creek Mine

Author:	FMG	Date:	10/11/04
Drawn By:	M.Khan	Revised:	06/01/05
Fig No.:	25	Report No.:	FMG 04085
Projection:	GDA 94	Scale:	1:100 000

Legend

▭	FMG Proposed Stage A , N-S Rail Corridor
▭	Mindy Mindy Joint Venture
▭	Pit Outlines
▨	Overburden Landforms
▨	Workshop, Processing Plant, Stockpile
▨	Transport Corridor
▨	Roads
✈	Proposed FMG Airstrip
----	Rivers
------	Tracks
—·—	Fences
——	10m Contour

Indiciative Mineralisation

■	Greater than 20 m
■	10 to 20 metres
□	2 to 10 metres

*Cut-offs
>50% Fe
<10% Si
<4% Al

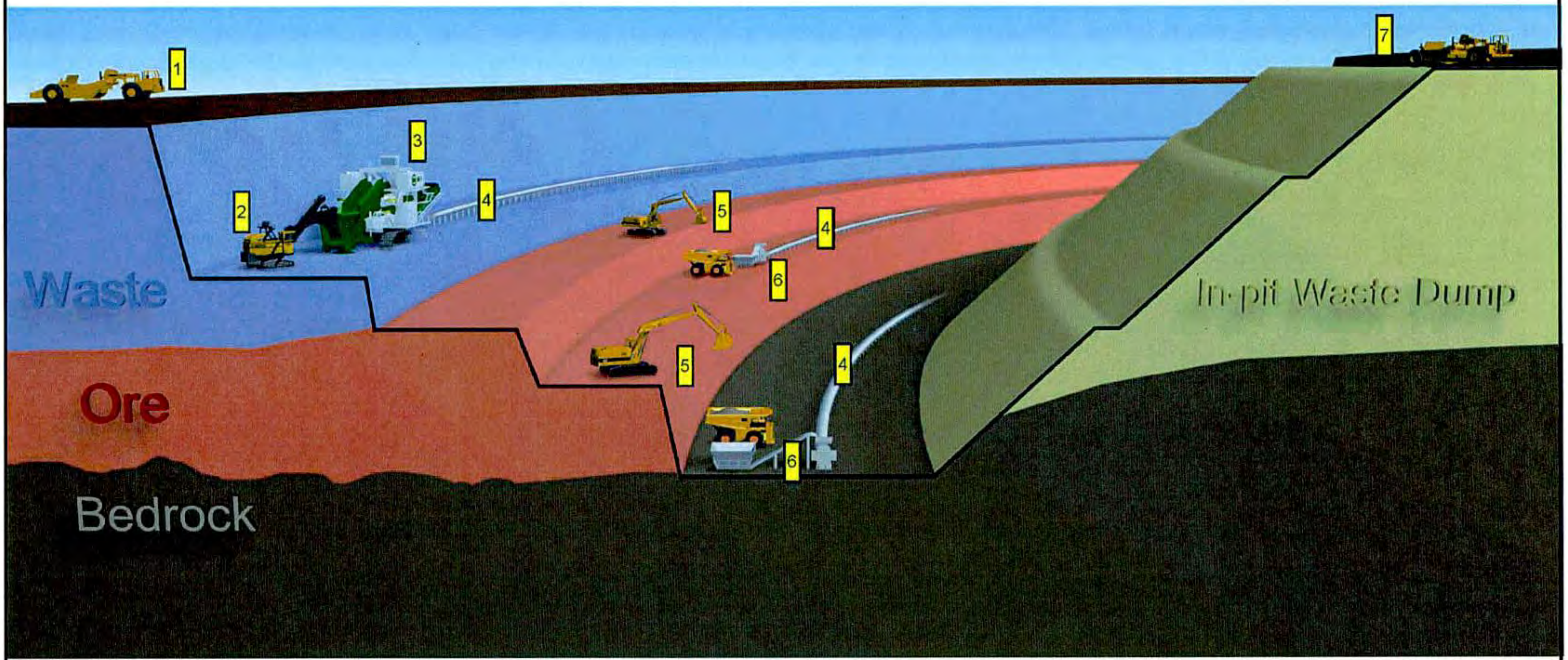
0 2 4 km

N

Fortescue Metals Group Limited

Figure 26 Site Layout and Mineralisation for Mindy Mindy Mine

Author:	FMG	Date:	10/11/04
Drawn By:	M.Khan	Revised:	06/01/05
Fig No.:	26	Report No.:	FMG 04085
Projection:	GDA 94	Scale:	1:100 000



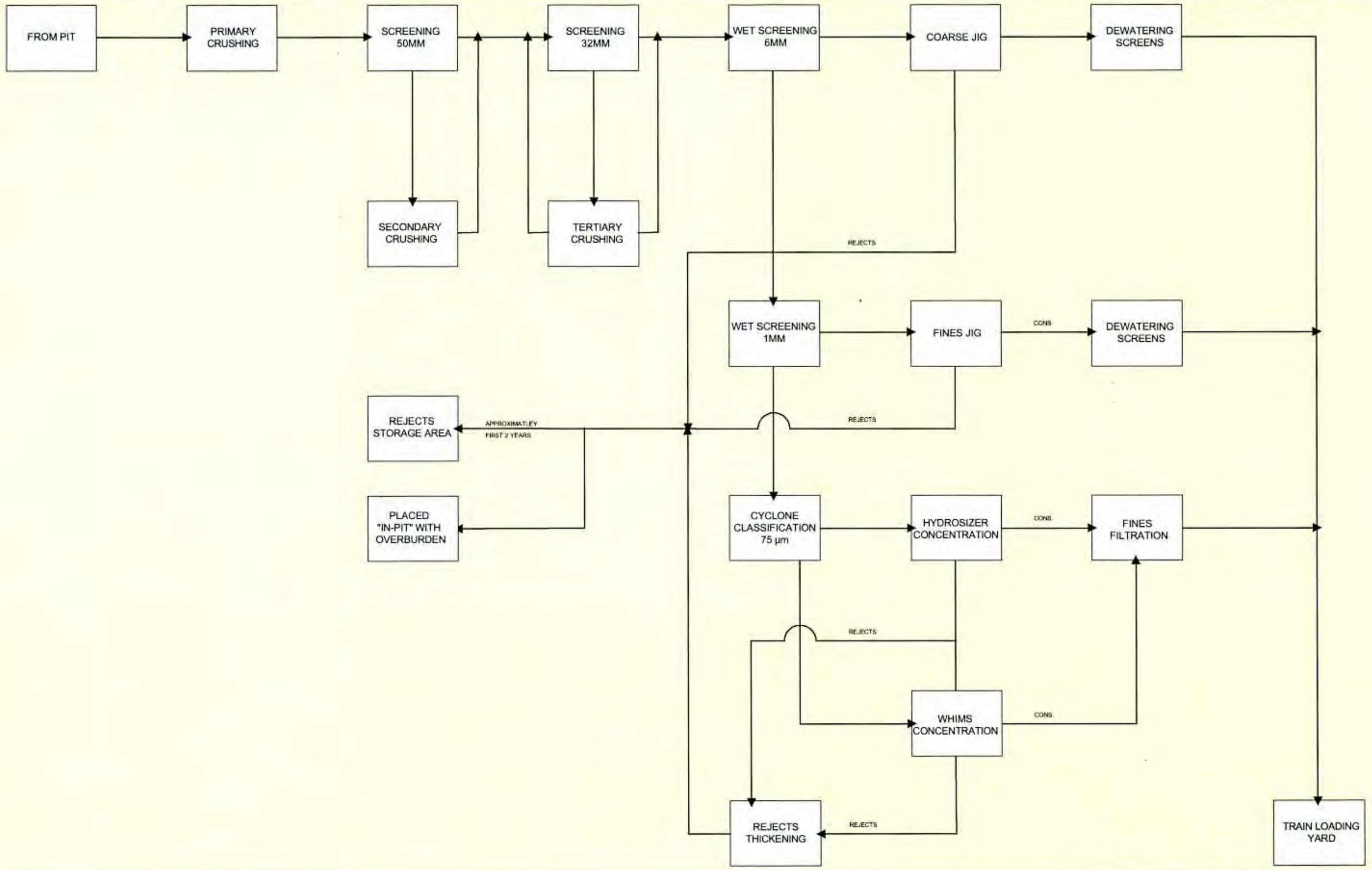
LEGEND

1. Scraper stripping topsoil for placement on rehabilitation areas.
2. Stripping shovel used to remove overburden.
3. In-pit crusher to crush overburden prior to permanent placement.
4. Conveyors to transport material.
5. Excavators placing ore in haul trucks for transport to crusher.
6. Ore crushed and transported to Benefication Plant or to stockpile for direct shipment.
7. Scraper placing topsoil on rehabilitation areas.

Fortescue Metals Group Limited

Figure 27 Conceptual Mining Method

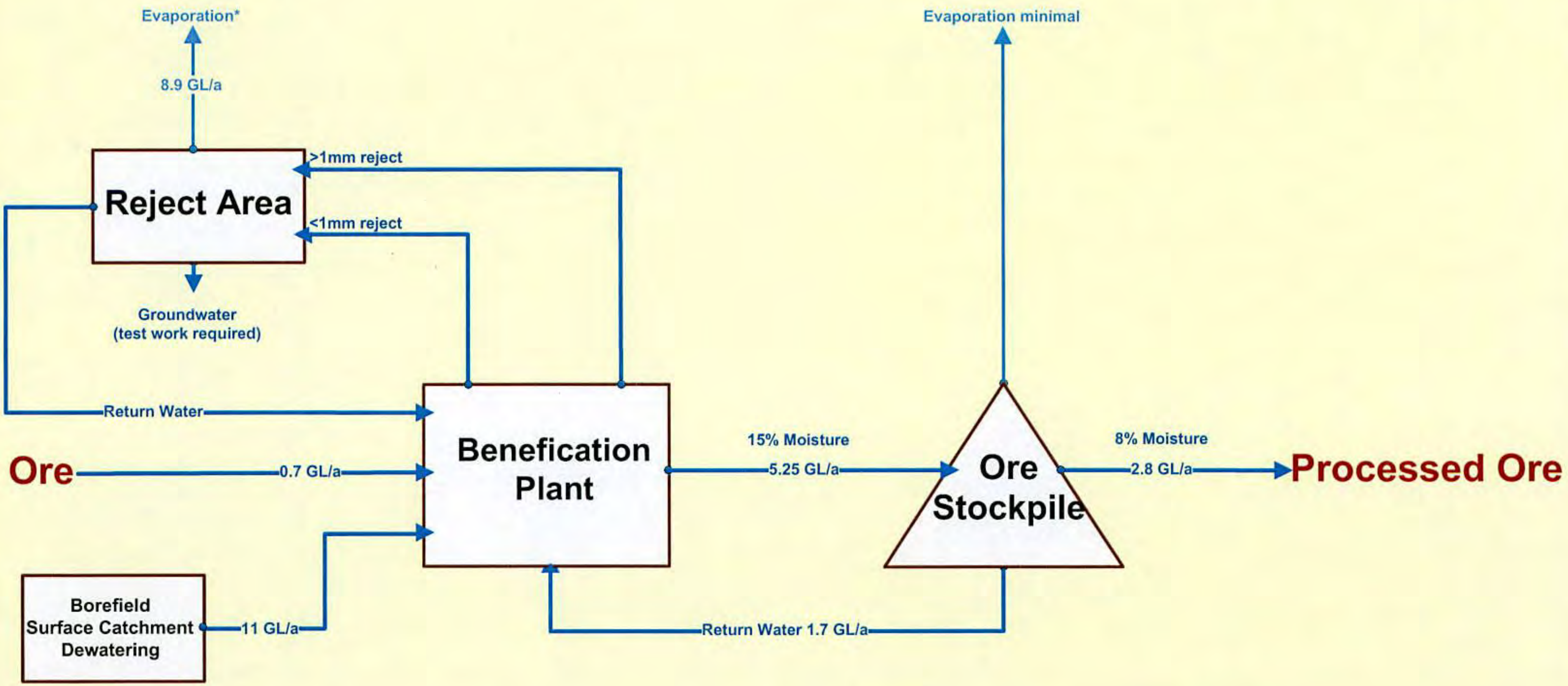
Author:	FMG	Date:	10/11/04
Drawn By:	Mapability	Revised:	
Fig No.:	27	Report No.:	FMG 04106
Projection:	Unprojected	Scale:	Not To Scale



Fortescue Metals Group Limited

Figure 28 Process Plant: Overall Block Flow Diagram

Author:	FMG	Date:	10/11/04
Drawn By:	A. Gregory	Revised:	10/01/05
Fig No.:	28	Report No.:	FMG 04105
Projection:	Unprojected	Scale:	Not To Scale

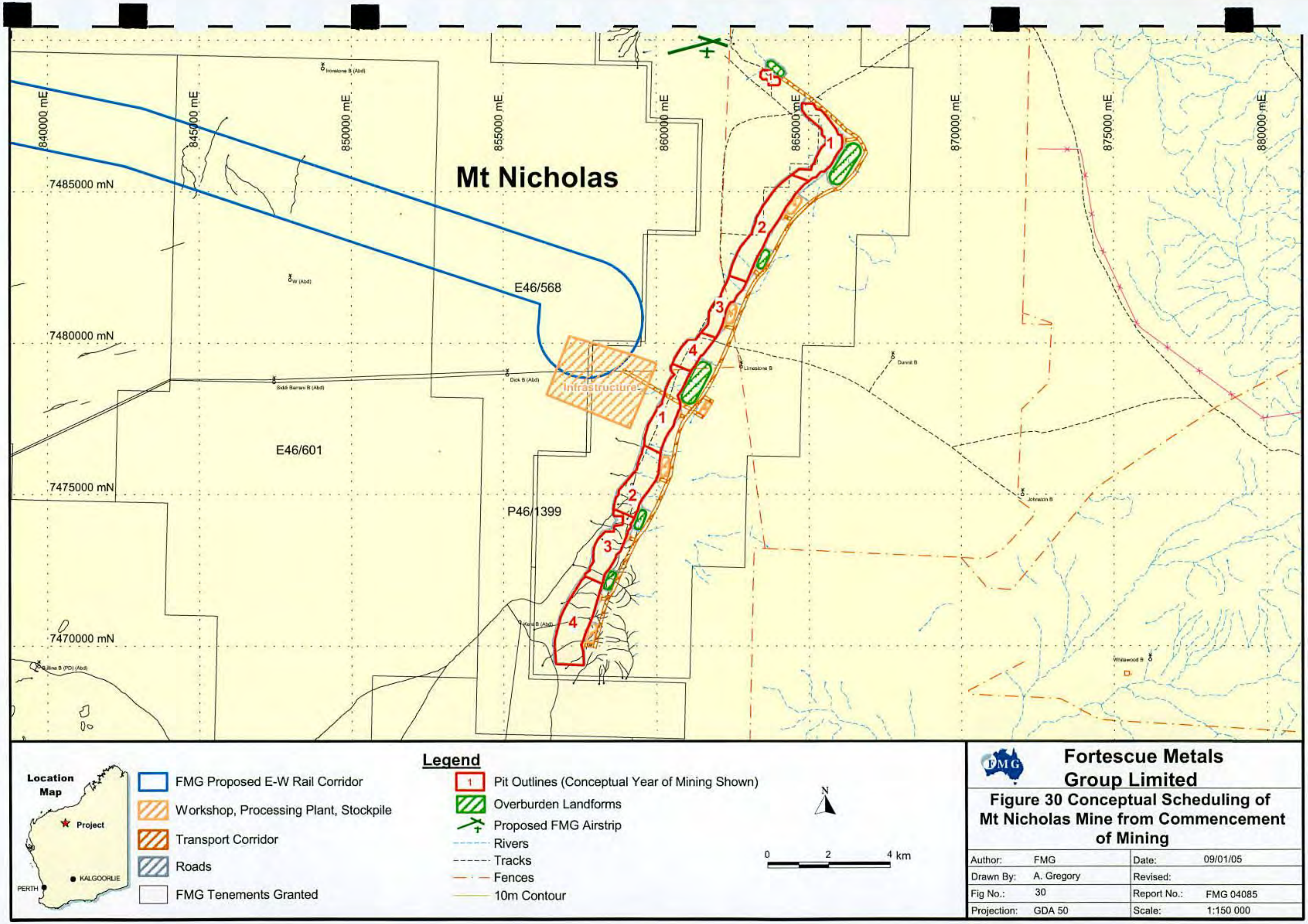


*Based on DoIR evaporation rate for Newman of 0.03 GL/ha/year

Fortescue Metals Group Limited

Figure 29 Water Supply: Process Flow

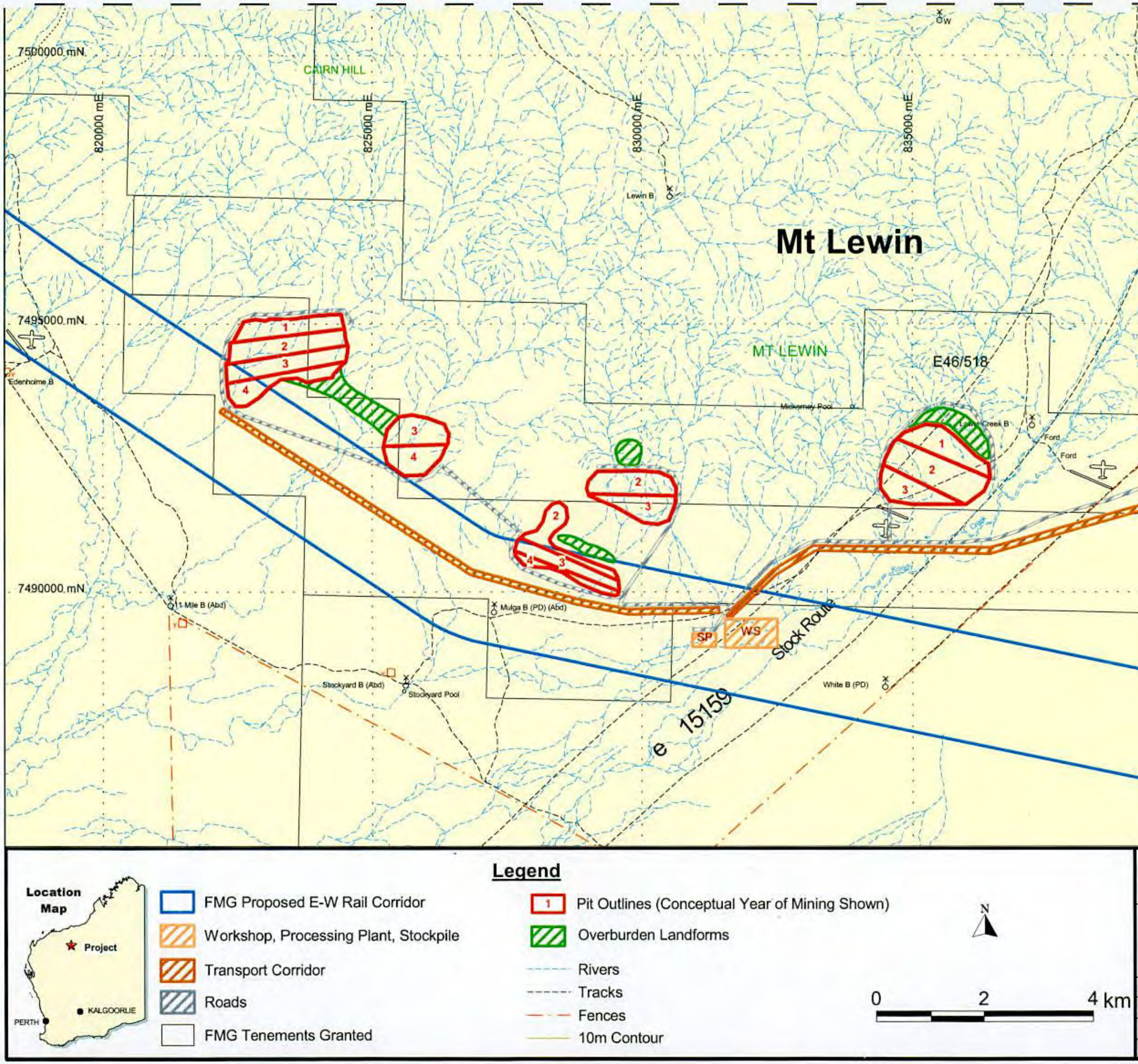
Author:	FMG	Date:	25/11/04
Drawn By:	A. Gregory	Revised:	31/12/04
Fig No.:	29	Report No.:	FMG 04103
Projection:	Unprojected	Scale:	Not To Scale



Fortescue Metals Group Limited

Figure 30 Conceptual Scheduling of Mt Nicholas Mine from Commencement of Mining

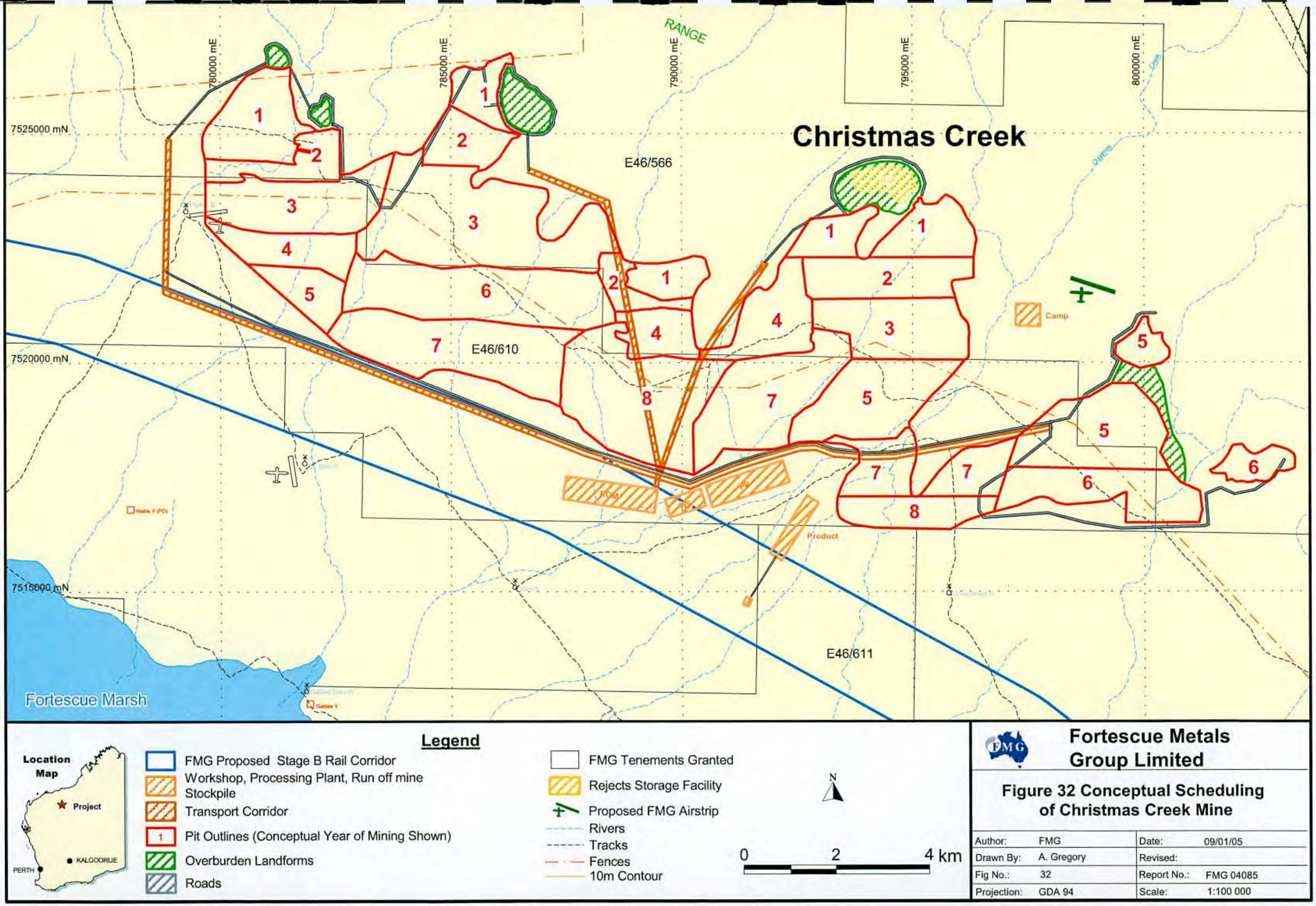
Author:	FMG	Date:	09/01/05
Drawn By:	A. Gregory	Revised:	
Fig No.:	30	Report No.:	FMG 04085
Projection:	GDA 50	Scale:	1:150 000



Fortescue Metals Group Limited

Figure 31 Conceptual Scheduling of Mt Lewin Mine from Commencement of Mining

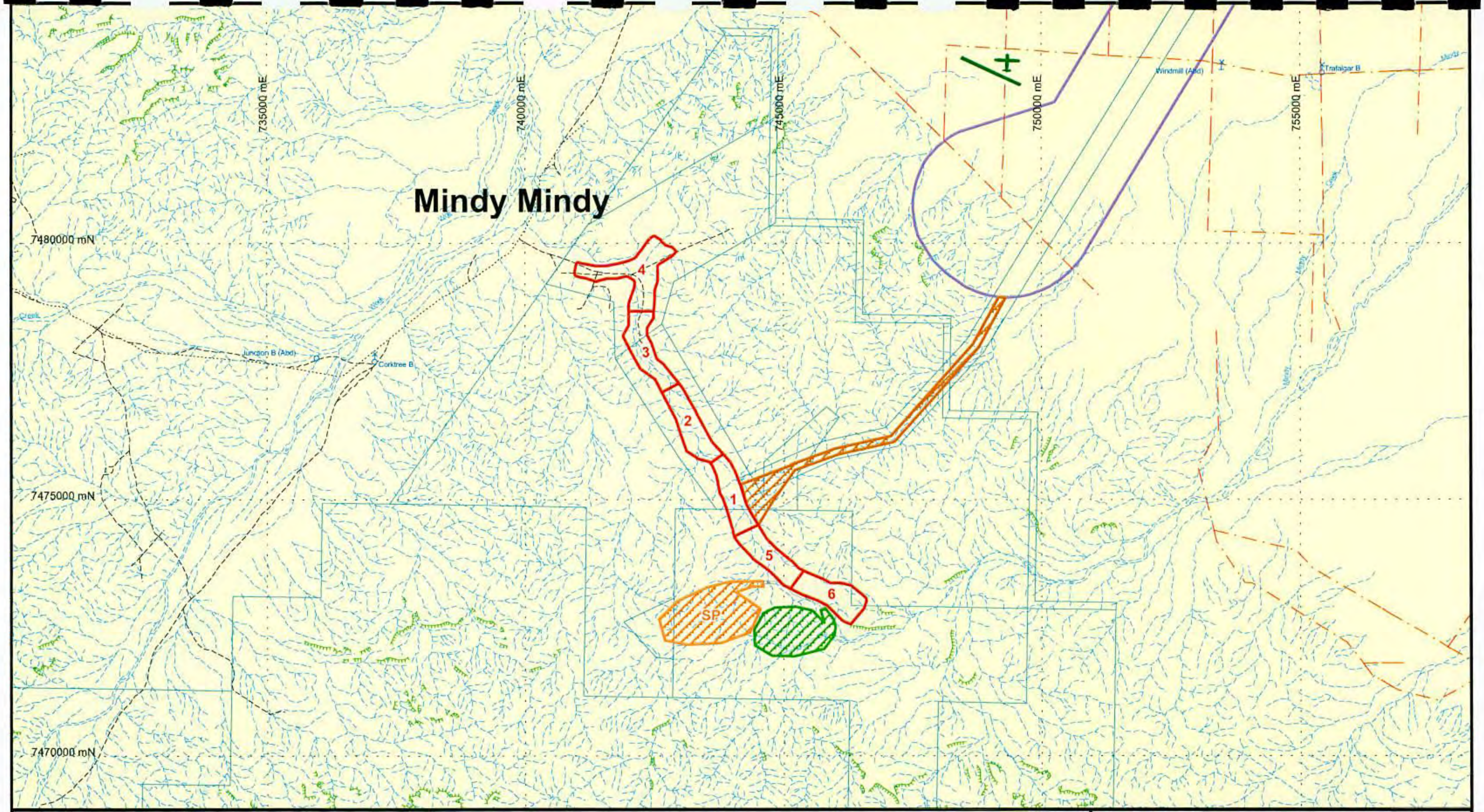
Author:	FMG	Date:	09/01/05
Drawn By:	M.Khan	Revised:	
Fig No.:	31	Report No.:	FMG 04085
Projection:	GDA 94	Scale:	1:100 000



Fortescue Metals Group Limited

Figure 32 Conceptual Scheduling of Christmas Creek Mine

Author:	FMG	Date:	09/01/05
Drawn By:	A. Gregory	Revised:	
Fig No.:	32	Report No.:	FMG 04085
Projection:	GDA 94	Scale:	1:100 000



Location Map

Legend

- ▭ FMG Proposed Stage A , N-S Rail Corridor
- ▭ Mindy Mindy Joint Venture
- 1 Pit Outlines (Conceptual Year of Mining Shown)
- ▨ Overburden Landforms
- ▨ Workshop, Processing Plant, Stockpile
- ▨ Transport Corridor
- ▨ Roads
- Proposed FMG Airstrip
- - - - - - Rivers
- - - - - - Tracks
- — · — Fences
- —— 10m Contour

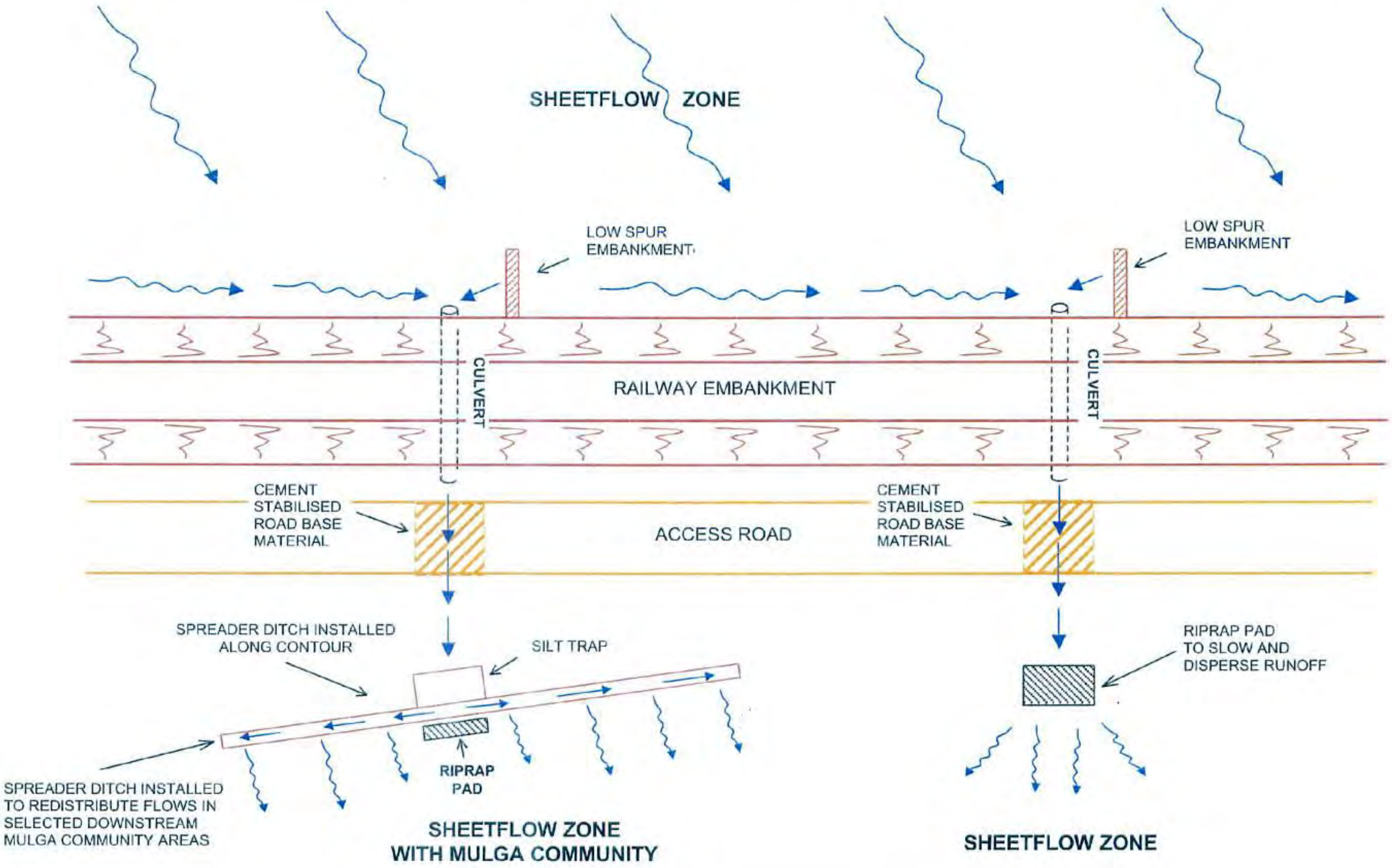
N

0 2 4 km

Fortescue Metals Group Limited

Figure 33 Conceptual Scheduling of Mindy Mindy Mine from Commencement of Mining

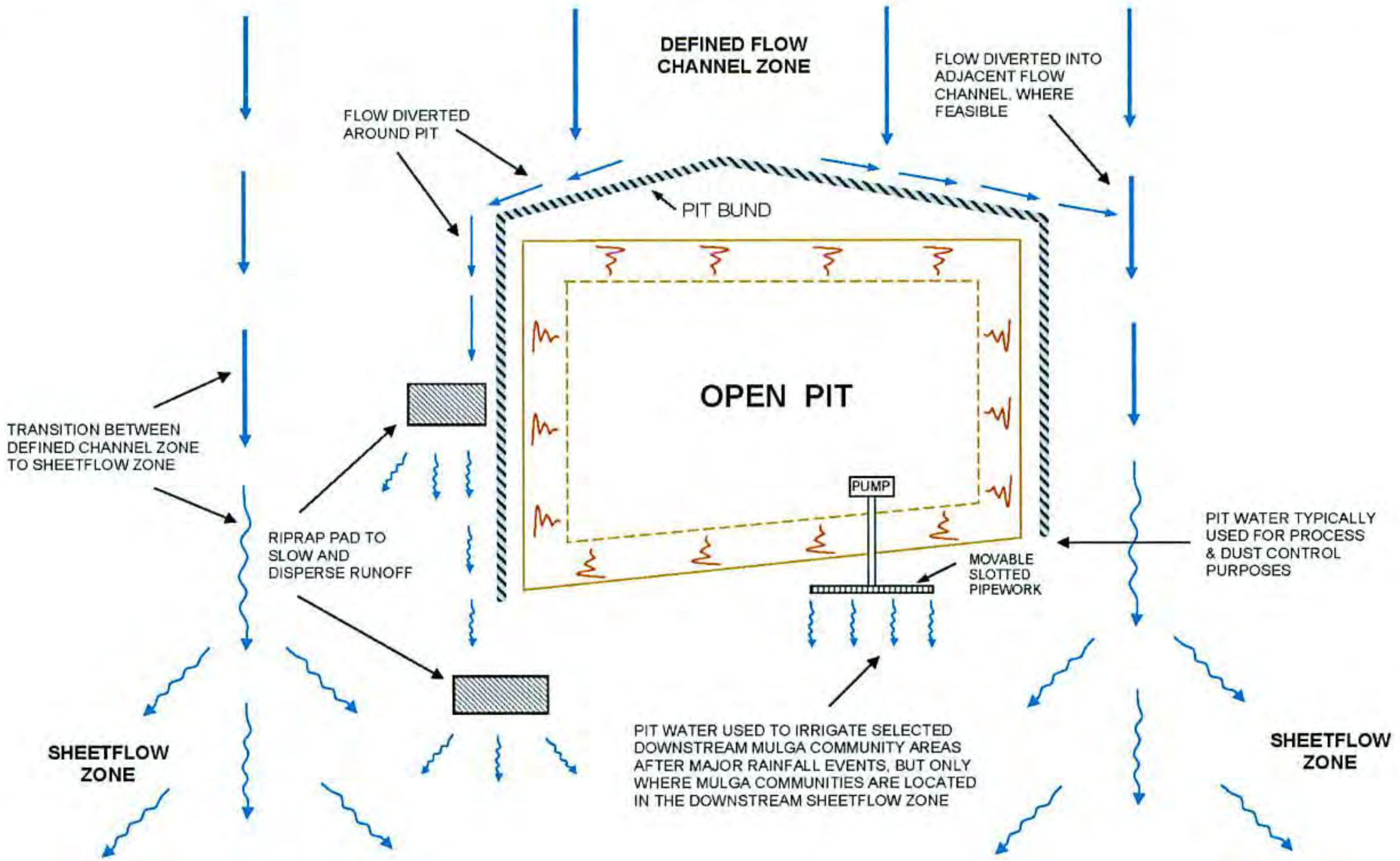
Author:	FMG	Date:	09/01/05
Drawn By:	A. Gregory	Revised:	
Fig No.:	33	Report No.:	FMG 04085
Projection:	GDA 94	Scale:	1:100 000



Fortescue Metals Group Limited

Figure 34 Conceptual Sheetflow Distribution for the Proposed Railway Corridor

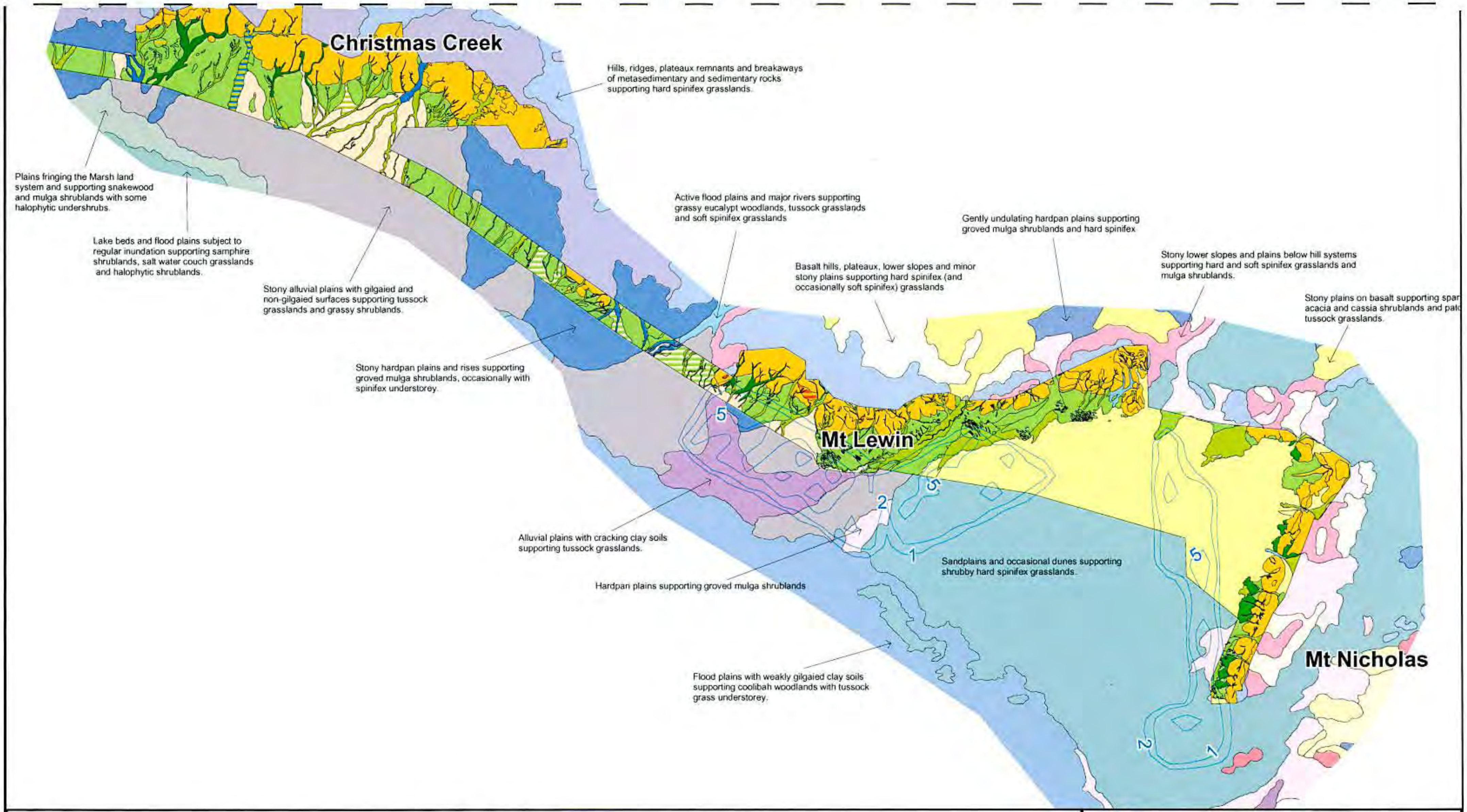
Author:	FMG	Date:	10/11/04
Drawn By:	A.Gregory	Revised:	
Fig No.:	34	Report No.:	FMG 04107
Projection:		Scale:	Not to Scale



Fortescue Metals Group Limited

Figure 35 Conceptual Sheetflow Distribution for an Open Pit

Author:	FMG	Date:	10/11/04
Drawn By:	A. Gregory	Revised:	
Fig No.:	35	Report No.:	FMG 04108
Projection:		Scale:	Not To Scale



Location Map

Legend

1 Drawdown Contours

For Biota Vegetation Mapping See Attached Legend

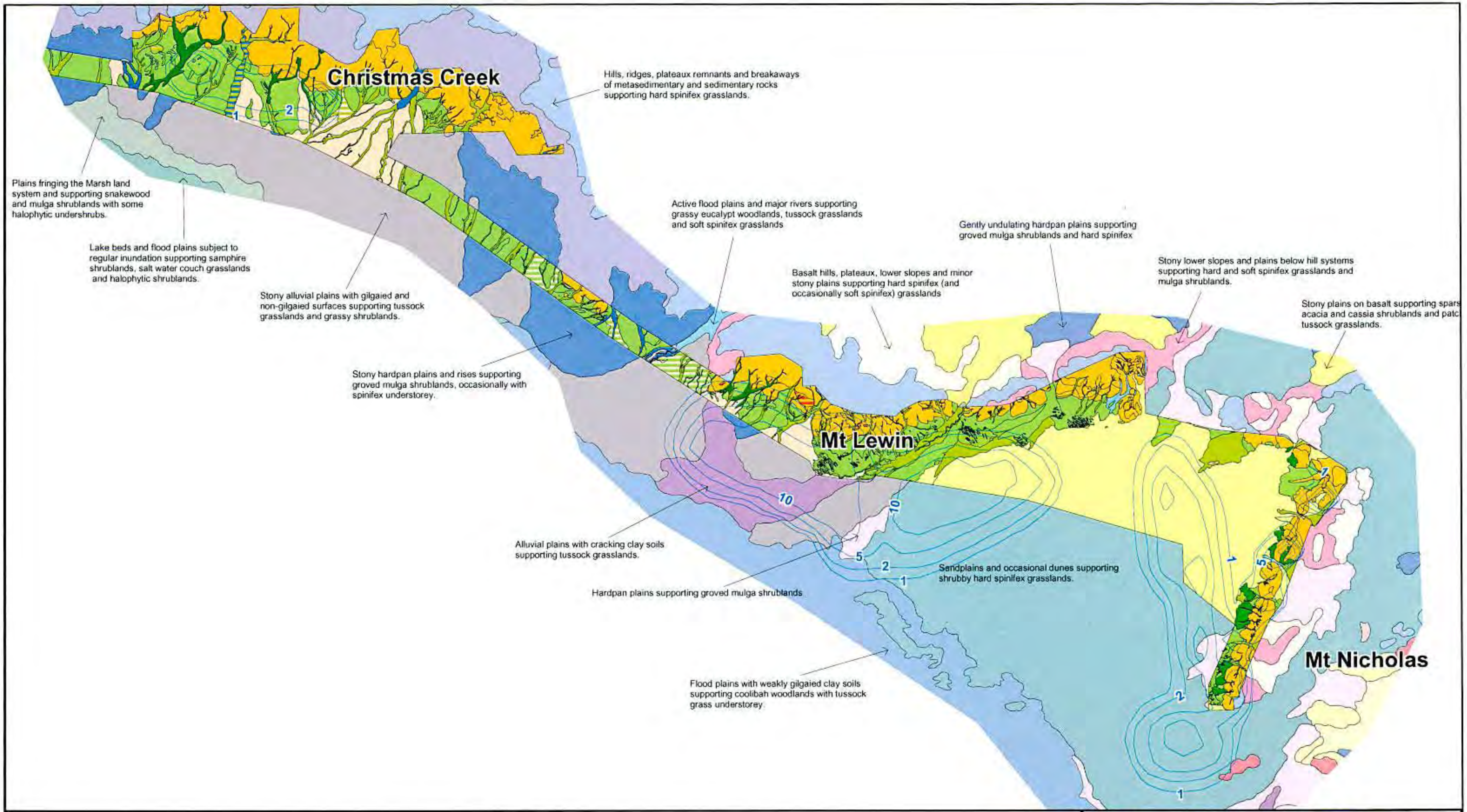
N

*Note: This Figure contains a composite of vegetation data. The Rangelands mapping has been labeled accordingly on the map and the Biota sourced mapping is described in the attached 3 legend pages.

Fortescue Metals Group Limited

Figure 36 Predicted Five Year Drawdown Contours on Vegetation Types

Author:	FMG	Date:	10/01/05
Drawn By:	M.Khan	Revised:	
Fig No.:	36	Report No.:	FMG 04131
Projection:	GDA 94	Scale:	1:100 000



Legend

1 Drawdown Contours

For Biota Vegetation Mapping See Attached Legend

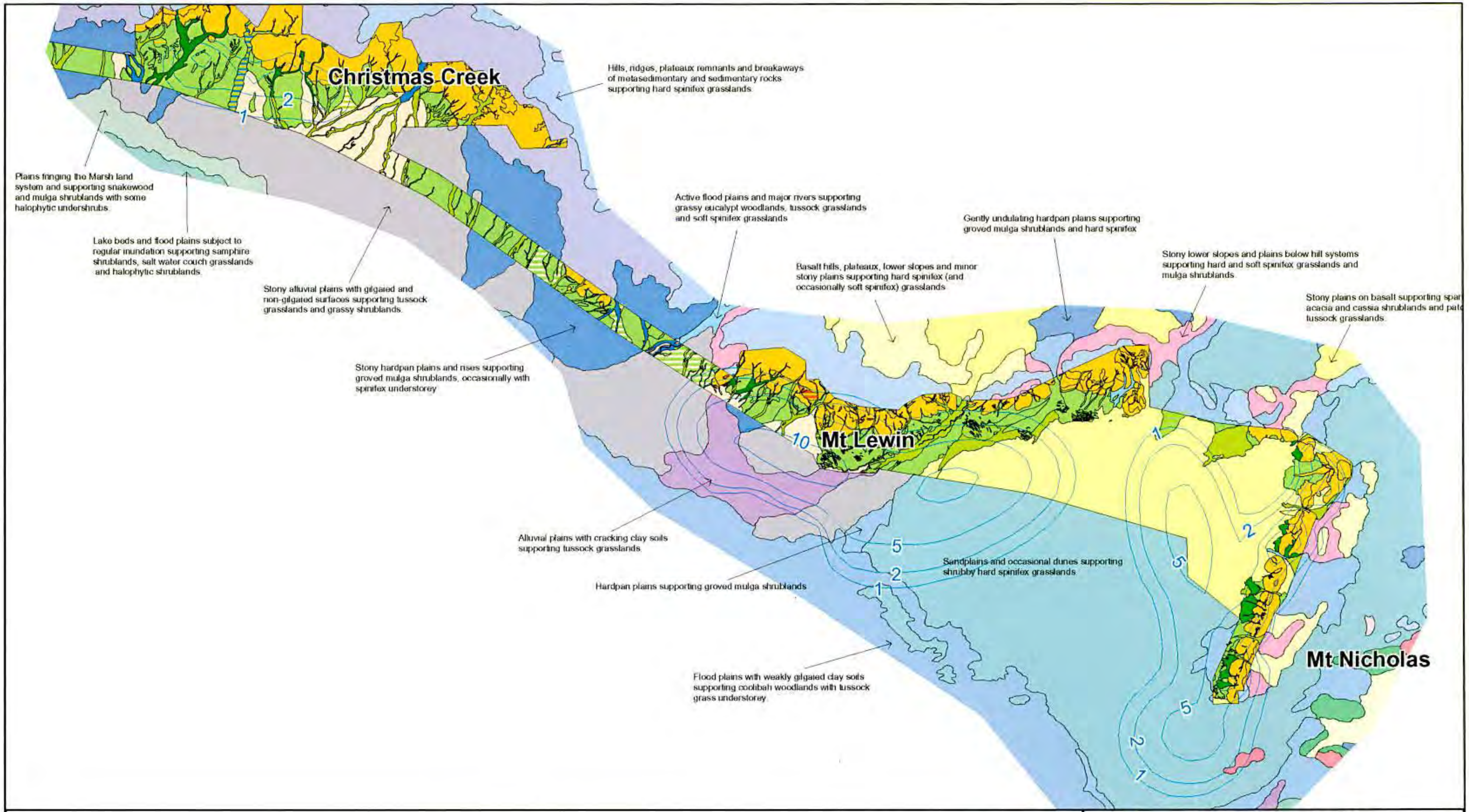
N

*Note: This Figure contains a composite of vegetation data. The Rangelands mapping has been labeled accordingly on the map and the Biota sourced mapping is described in the attached 3 legend pages.

Fortescue Metals Group Limited

Figure 37 Predicted Sixteen Year Drawdown Contours on Vegetation Types

Author:	FMG	Date:	10/01/05
Drawn By:	M.Khan	Revised:	
Fig No.:	37	Report No.:	FMG 04131
Projection:	GDA 94	Scale:	1:100 000



Legend

—1— Drawdown Contours

For Biota Vegetation Mapping See Attached Legend

N

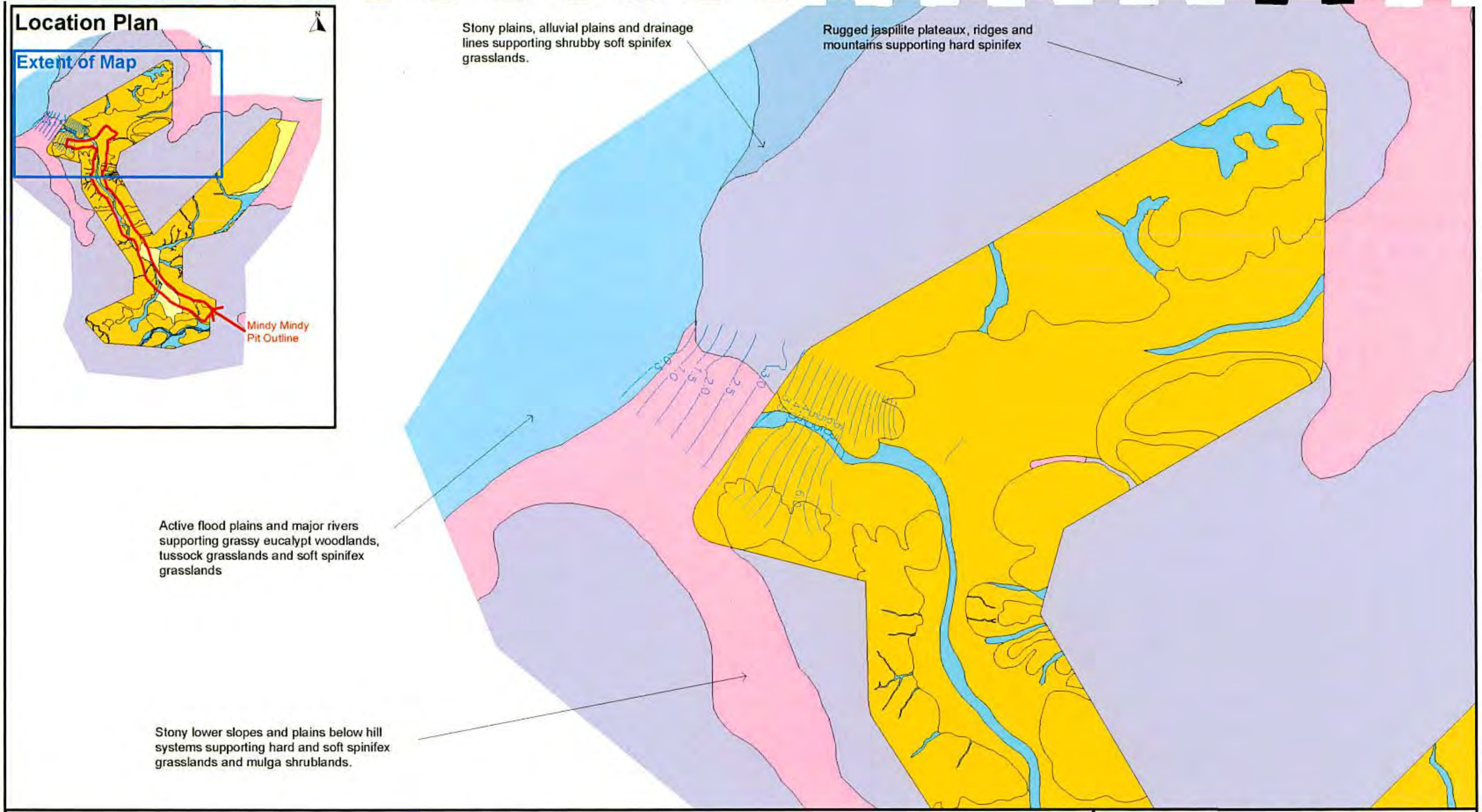
*Note: This Figure contains a composite of vegetation data. The Rangelands mapping has been labeled accordingly on the map and the Biota sourced mapping is described in the attached 3 legend pages.

FMG

Fortescue Metals Group Limited

Figure 38 Predicted Thirty Year Drawdown Contours on Vegetation Types

Author:	FMG	Date:	10/01/05
Drawn By:	M.Khan	Revised:	
Fig No.:	38	Report No.:	FMG 04131
Projection:	GDA 94	Scale:	1:100 000



Legend

—1— Drawdown Contours

For Biota Vegetation Mapping See Attached Legend

*Note: This Figure contains a composite of vegetation data. The Rangelands mapping has been labeled accordingly on the map and the Biota sourced mapping is described in the attached 3 legend pages.

Fortescue Metals Group Limited

Figure 39 Predicted Six Year Drawdown Contours on Vegetation Types at Mindy Mindy Mine

Author:	FMG	Date:	10/01/05
Drawn By:	A. Gregory	Revised:	
Fig No.:	39	Report No.:	FMG 04131
Projection:	GDA 94	Scale:	1:300 000

Creeklines

🟦 Moderate to Large Creeks

Cc18 *Eucalyptus victrix* open woodland over *Melaleuca glomerata, Acacia pyrifolia* tall open scrub over *Typha domingensis, Cyperus vaginatus* open sedgeland and '*Cenchrus* spp. closed tussock grassland

🟦 Small Creeks

Cc19 *Corymbia candida, C. hamersleyana, Acacia aneura* low woodland over *Acacia tumida* var.*pilbarensis* open scrub over *Dodonaea petiolaris* open shrubland over *Eriachne mucronata, Triodia epactia* open tussock / hummock grassland

Cc20 *Corymbia* spp. scattered low trees over *Acacia coriacea* subsp. *pendens, A. ancistrocarpa, A. tenuissima* tall open shrubland over *Triodia epactia* mid-dense hummock grassland and open tussock grasses

Cc21 *Grevillea wickhamii* tall open scrub over *Acacia ancistrocarpa, A. bivenosa, A. adsurgens, A. tenuissima* open shrubland over *Triodia* aff. *basedowii* very open hummock grassland and *Paraneurachne muelleri* open tussock grassland

Cc22 *Grevillea wickhamii* scattered tall shrubs over *Acacia monticola* closed scrub over scattered hummock grasses

🟨 Low Stony Hills

Ch2 *Cassia* spp. scattered tall shrubs over *Triodia wiseana* mid-dense hummock grassland

Ch13 *Triodia brizoides, T. longiceps* mid-dense hummock grassland

Ch14 *Triodia brizoides, T.* aff. *basedowii* mid-dense hummock grassland

Ch15 *Acacia bivenosa* scattered shrubs over *Triodia longiceps* mid-dense hummock grassland

Ch16 *Acacia aneura, A. paraneura*scattered low trees over *Cassia* spp. scattered tall shrubs over *Triodia longiceps* hummock grassland

Ch17 *Acacia aneura, A. adsurgens, G. wickhamii, Cassia glutinosa, C. luerssenii*scattered shrubs over *Triodia* aff. *basedowii* mid-dense hummock grassland

Ch18 *Eucalyptus leucophloia, Hakea*spp. scattered low trees over *Acacia atkinsiana, Grevillea wickhamii*scattered tall shrubs over *Triodia epactia* mid-dense hummock grassland

Ch19 *Cassia luerssenii* scattered shrubs over *Triodia epactia, T.*aff. *basedowii* mid-dense hummock grassland

Ch20 *Grevillea wickhamii* tall shrubland over *Acacia adsurgens, A. ancistrocarpa* shrubland over *Triodia* aff. *basedowii* mid-dense hummock grassland

Ch21 *Grevillea wickhamii* tall open shrubland over *Triodia epactia, T.* aff. *basedowii* mid-dense hummock grassland

Ch22 *Acacia arida* open shrubland over *Triodia* aff. *basedowii* mid-dense hummock grassland

Ch23 *Cassia luerssenii* scattered tall shrubs over *Eremophila cuneifolia* low open shrubland over *Triodia* aff. *basedowii* mid-dense hummock grassland

Ch24 *Acacia bivenosa* open shrubland over *Triodia wiseana* mid-dense hummock grassland

Ch31 *Acacia aneura* low woodland over *Triodia* aff. *basedowii* hummock grassland

Ch32 *Eucalyptus gamophylla* scattered low mallees over *Acacia ancistrocarpa* shrubland over *Triodia* aff. *basedowii* hummock grassland

Ch33 *Grevillea berryana* scattered tall shrubs over *Triodia melvillei* hummock grassland

🟧 More Dense Shrublands

Ch25 *Acacia aneura*low woodland to low open forest over *Acacia rhodophloia* scattered tall shrubs over *Eremophila forrestii, E latrobei, E. cuneifolia*scattered shrubs ove *Triodia epactia, T. brizoides* open hummock grassland

Ch26 *Eucalyptus leucophloia*scattered low trees over *Acacia rhodophloia* tall open scrub over *Triodia* aff.*basedowii* mid-dense hummock grassland

Ch27 *Acacia aneura* low open forest over *Grevillea berryana* scattered tall shrubs over *Dodonaea petiolaris, Eremophila exilifolia* open shrubland over *Triodia* aff. *basedowii* hummock grassland

Ch28 *Acacia aneura* tall open shrubland over *Dodonaea petiolaris* open shrubland over *Ptilotus obovatus* var. *obovatus* low shrubland over *Eriachne mucronata, Paspalidium clementii* grassland

Ch29 *Acacia rhodophloia* tall open shrubland over *Eriachne mucronata* tussock grassland, annual grasses and herbs

Ch30 *Acacia aneura* low woodland over *Eremophila forrestii* subsp. *forrestii* scattered shrubs over *Triodia epactia* hummock grassland and *Enneapogon polyphyllus* very open annual grassland

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Legend (1 of 3) for Figures 36, 37, 38, 39

Author:	FMG	Date:	10/01/05
Drawn By:	A. Gregory	Revised:	
Fig No.:		Report No.:	FMG 04131
Projection:	Unprojected	Scale:	Not to Scale

Mulga - Dominated Vegetation

Groved Vegetation

🟩

Fa1 *Acacia aneura* open scrub to low open forest over *Dodonaea petiolaris, Eremophila forrestii* subsp. *forrestii, Cassia helmsii, Sida* sp. unisexual open heath with very open annual grassland

Fa1a *Acacia aneura* scattered tall shrubs to low open woodland over *Aristida contorta, Enneapogon polyphyllus, Eragrostis pergracilis, Eriachne pulchella* and / or *Fimbristylis dichotoma* closed annual grassland / sedgeland

Fa11 *Acacia aneura* low closed forest over *Eremophila lanceolata* low open shrubland over *Aristida contorta, Enneapogon polyphyllus* open annual grassland and *Goodenia prostrata* very open herbland

Fa12 *Acacia aneura* low forest over *Chrysopogon fallax, Digitaria brownii* open tussock grassland and *'Bidens bipinnata* open herbland

Fa15 *Acacia aneura* low open forest over *Chloris pectinata, Eragrostis tenellula* open annual grassland and *Ptilotus gomphrenoides* var. *gomphrenoides* open herbland

Fa18 *Acacia aneura, A. rhodophloia* low closed forest over *Eremophila forrestii* subsp. *forrestii, Indigofera georgei* low open shrubland over *Themeda triandra, Digitaria brownii* open tussock grassland and annual grasses

Fa20 *Acacia catenulata, A. aneura* low open forest over *Eremophila forrestii* subsp. *forrestii, Sida* sp. unisexual open shrubland with open annual grassland

Drainage Vegatation

🟩

Fa10 *Acacia aneura* low open forest over *Chrysopogon fallax* very open tussock grassland over *Centipeda minima* herbland and open annual grassland

Fa13 *Acacia aneura* low open forest over *Chrysopogon fallax, Digitaria brownii* open tussock grassland

Fa14 *Acacia aneura* low open forest to low woodland over *'Cenchrus ciliaris* tussock grassland

Fa16 *Acacia aneura* low open woodland over *Dodoanaea petiolaris, Psydrax latifolia, Acacia ancistrocarpa* open shrubland over *Chrysopogon fallax, Cymbopogon ambigu*. *Triodia epactia* open tussock / hummock grassland

Fa17 *Acacia aneura* tall shrubland over *Aristida contorta, Enneapogon polyphyllus, Dichanthium sericeum* subsp. *humilius, Iseilema* annual grassland

Fa19 *Acacia aneura* low woodland over *Acacia rhodophloia* high shrubland over *Eremophila forrestii* subsp. *forrestii, Dodonaea petiolaris, Sida* sp. unisexual open shrubland over open grassland

Fa21 *Acacia catenulata, A. aneura* low closed forest over *Sida* sp. unisexual, *Eremophila forrestii* subsp. *forrestii, Dodonaea petiolaris* open heath to open shrubland

Fa22 *Acacia catenulata, (A. aneura)* low open forest over *Eriachne mucronata, Paspalidium clemetii, Triodia epactia* very open tussock / hummock grassland

Fa23 *Acacia aneura, (A. pruinocarpa, A. catenulata)* low open woodland to low open forest over *Acacia wanyu* tall shrubland over *Eremophila forrestii* subsp. *forrestii* shrubland over *Triodia* spp. very open hummock grassland

Fa24 *Acacia aneura, A. ayersiana* low woodland over *Triodia* spp. open hummock grassland

Fa25 *Acacia aneura* low open woodland over *Themeda triandra* open tussock grassland and *Eragrostis leptocarpa, E. tenellula* annual grassland

Other

🟩

Fa26 *Acacia aneura, A. catenulata* tall open shrubland over *Eremophila forrestii* open shrubland over *Triodia* aff. *basedowii* mid-dense hummock grassland

Fa27 *Acacia aneura, A. catenulata* tall open shrubland over *Aristida inaequiglumis, A. contorta* grassland

Creeklines; not dominated by Mulga

Moderate to Large Creeks

🟦

Fc4 *Eucalyptus victrix* open woodland over *Acacia coriacea* subsp. *pendens, A. aneura, Atalaya hemiglauca* low woodland over *'Cenchrus ciliaris* tussock grassland

Fc5 *Acacia coriacea* subsp. *pendens* low woodland over *Hakea lorea* subsp. *lorea, Acacia tetragonophylla, A. pyrifolia, Atalaya hemiglauca* tall open shrubland over *'Cenchrus ciliaris* closed tussock grassland

Fc6 *Eucalyptus victrix* low open woodland over *Grevillea wickhamii, Acacia pyrifolia* tall open scrub over *'Cenchrus ciliaris* tussock grassland and *Triodia longiceps, T. epactia* scattered hummock grasses

Small Creeks

🟩

Fc7 *Eucalyptus leucophloia, Corymbia* spp. scattered low trees over *Acacia tumida* var. *pilbarensis* tall open scrub over *Themeda triandra, Triodia epactia* scattered tussock / hummock grasses

Fc8 *Corymbia hamersleyana* scattered low mallees over *Grevillea wickhamii, Acacia tumida, A. pyrifolia* tall open shrubland over *Cassia luerssenii, C. glutinosa* open shrubland over *Triodia epactia* mid-dense hummock grassland

Fc9 *Acacia aneura* scattered low trees over *Acacia pyrifolia, Grevillea wickhamii* tall open scrub over *Indigofera monophylla* open heath over *Enneapogon polyphyllus* open annual grassland

Fc10 *Acacia pyrifolia* tall open scrub over *Triodia longiceps* mid-dense hummock grassland

Fc11 *Corymbia hamersleyana, Eucalyptus leucophloia, Acacia pruinocarpa* scattered low trees over *Acacia atkinsiana, A. bivenosa, A. maitlandii, A. ancistrocarpa, Petalostylis labicheoides* tall open shrubland to open scrub over *Triodia epactia* open hummock grassland

Fc12 *Acacia pruinocarpa, A. tetragonophylla, A. aneura, Atalaya hemiglauca* tall shrubland over *Triodia longiceps* hummock grassland

Sandy Plains

🟨

Fp1 *Acacia ancistrocarpa, A. coriacea, A. melleodora* scattered tall shrubs over *Triodia schinzii* closed hummock grassland

Fp2 *Acacia ancistrocarpa, A. coriacea, A. melleodora* scattered tall shrubs over *Triodia lanigera* closed hummock grassland

Fp3 *Acacia ancistrocarpa, A. coriacea, A. melleodora* scattered tall shrubs over *Triodia epactia* hummock grassland

Fp4 *Corymbia hamersleyana* scattered low trees over *Acacia ancistrocarpa, A. adsurgens* shrubland over *Triodia epactia* mid-dense hummock grassland

Clayey Plains

🟧

Fx1 *Acacia xiphophylla* open scrub over *Cassia sturtii* shrubland to low open heath over *Eragrostis xerophila* open tussock grassland

Fx10 *Acacia synchronicia* tall open shrubland over *Aristida latifolia* open tussock grassland and *Ptilotus gomphrenoides* var. *gomphrenoides, Chloris pectinata* open annual herbland / grassland

Fx11 Mixed herbland and annual grassland

Fx11 *Eragrostis setifolia* closed tussock grassland

Location Map

Fortescue Metals Group Limited

Legend (2 of 3)
for Figures 36, 37, 38, 39

Author:	FMG	Date:	10/01/05
Drawn By:	A. Gregory	Revised:	
Fig No.:		Report No.:	FMG 04131
Projection:	Unprojected	Scale:	Not to Scale

Creeklines

Moderate to Large Creeks

🟦

Hc22 *Eucalyptus victrix* low woodland over *Acacia tumida* var.*pilbarensis*, *A. pyrifolia*, *Grevillea wickhamii*, *Gossypium robinsonii*tall open shrubland over *Tephrosia rosea* var.*globrior* low open shrubland over '*Cenchrus ciliaris*, *Digitaria brownii*, *Eriachne tenuiculmis*, *Triodia pungens*very open tussock / hummock grassland

Small Creeks

🟦

Hc7a *Corymbia hamersleyana* scattered low trees over *Acacia pyrifolia* tall shrubland over *Triodia pungens* mid-dense hummock grassland

Hc16 *Corymbia hamersleyana* scattered low trees to low open woodland over *Acacia tumida* var. *pilbarensis*, *A. bivenosa*, *Grevillea wickhamii*subsp. *hispidula*, *Petalostylis labicheoides* closed scrub over *Triodia pungens* hummock grassland and *Themeda triandra* open tussock grassland

Hc17 *Corymbia hamersleyana* scattered low trees over *Acacia tumida* var.*pilbarensis*, (*A. pyrifolia*, *Grevillea wickhamii* subsp. *hispidula*, *Gossypium robinsonii*) open scrub over *Themeda triandra*, *Triodia pungens* open tussock / hummock grassland

Hc23 *Corymbia hamersleyana* low open woodland over *Acacia dictyophleba*, *A. tumida*var.*pilbarensis* tall open shrubland over *Eulalia aurea*, *Themeda triandra* tussock grassland

Hc24 *Eucalyptus leucophloia* scattered low trees over *Acacia monticola*, *Grevillea wickhamii*, *Sida arenicola*open shrubland over *Triodia pungens* open hummock grassland

Hc25 *Eucalyptus gamophylla* scattered low mallees over *Petalostylis labicheoides* shrubland over *Aristida holathera* var. *holathera* open grassland

Hc26 *Corymbia hamersleyana* scattered low trees over *Eucalyptus gamophylla* low open mallee woodland over *Acacia bivenosa* tall open shrubland over *Eragrostis eriopoda*, *Paraneurachne muelleri*, *Triodia pungens* open tussock / hummock grassland

Low Stony Hills

🟧

Hh3 *Eucalyptus gamophylla* scattered low mallees over *Gossypium australe*, *Grevillea wickhamii* scattered tall shrubs over *Triodia lanigera* hummock grassland with *Aristida holathera* var. *holathera* annual open grassland

Hh4 *Corymbia hamersleyana*, *Eucalyptus gamophylla* scattered low trees over *Acacia pachyachra*, *Petalostylis cassioides* tall open shrubland over *Triodia lanigera* (*T. pungens*) mid-dense hummock grassland

Hh5 *Eucalyptus leucophloia* scattered trees over *Acacia inaequilatera*, *Hakea chordophylla* scattered tall shrubs over *Acacia hilliana* low open shrubland over *Triodia* aff. *basedowii* mid-dense hummock grassland

Hh5b *Corymbia hamersleyana* scattered low trees over *Hakea chordophylla*, *Acacia bivenosa*, *A. pachyacra*, *Grevillea wickhamii*scattered tall shrubs over *Triodia* aff. *basedowii* mid-dense hummock grassland

Hh6 *Acacia inaequilatera* scattered tall shrubs over *Triodia wiseana* mid-dense hummock grassland

Hh13 *Acacia pruinocarpa* low open woodland over *Cassia glutinosa* scattered shrubs over *Eriachne mucronata*, *Themeda triandra*, *Triodia pungens* open grassland / hummock grassland

Hh14 *Acacia aneura*, *A. pruinocarpa* low woodland over *Cassia luerssenii* scattered shrubs over *Triodia pungens* mid-dense hummock grassland

Sandy Plains

🟨

Hp5 *Corymbia hamersleyana*, *Eucalptus gamophylla* scattered low trees over *Acacia ancistrocarpa*, *A. dictyophleba*, *A. pachyacra*, *Hakea* spp. high open shrubland ove *Triodia pungens* hummock grassland

🟨

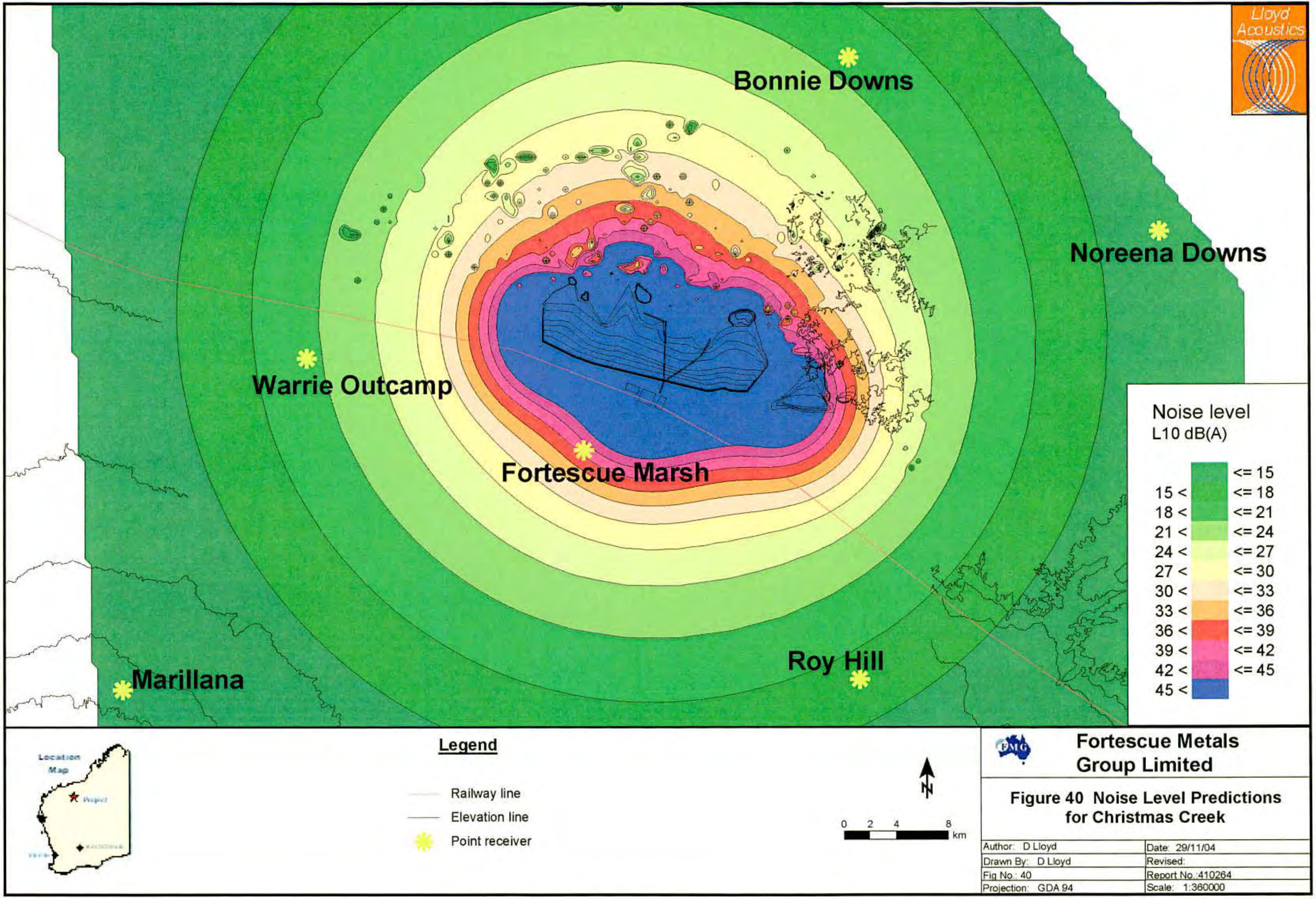
Hp7 *Corymbia hamersleyana*, *Eucalptus gamophylla* scattered low trees over *Acacia dictyophleba*, *A. ancistrocarpa* tall shrubland to tall open shrubland over *Triodia schinzii*, *T. pungenc* mid-dense hummock grassland

Location Map

Fortescue Metals Group Limited

Legend (3 of 3) for Figures 36, 37, 38, 39

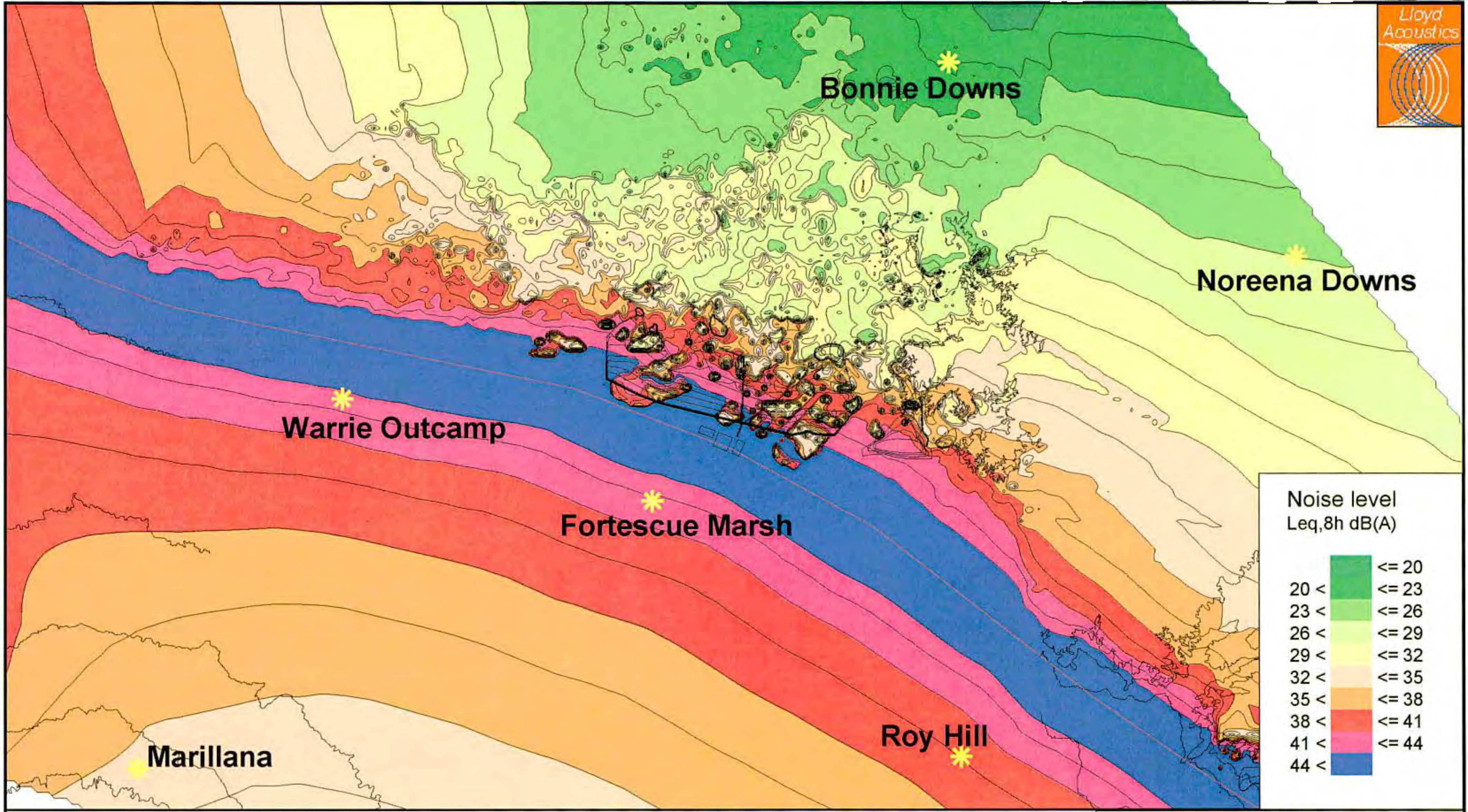
Author:	FMG	Date:	10/01/05
Drawn By:	A. Gregory	Revised:	
Fig No.:		Report No.:	FMG 04131
Projection:	Unprojected	Scale:	Not to Scale



Fortescue Metals Group Limited

Figure 40 Noise Level Predictions for Christmas Creek

Author: D Lloyd	Date: 29/11/04
Drawn By: D Lloyd	Revised:
Fig No.: 40	Report No.:410264
Projection: GDA 94	Scale: 1:360000



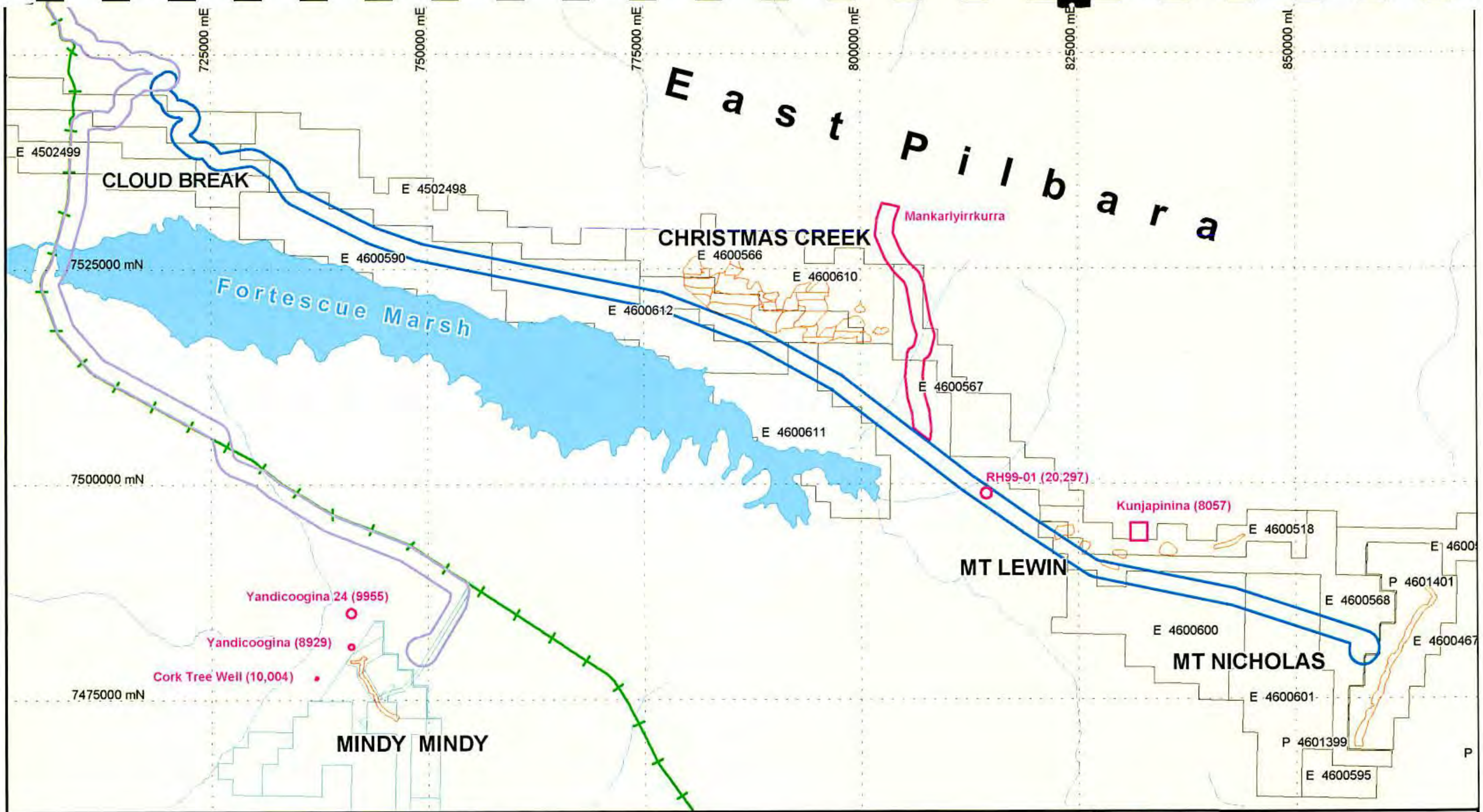
Legend

- Railway line
- Elevation line
- Point receiver

Fortescue Metals Group Limited

Figure 41 Noise Level Predictions for Stage B Railway

Author: D Lloyd	Date: 29/11/04
Drawn By: D Lloyd	Revised:
Fig No.: 41	Report No.:410264
Projection: GDA 94	Scale: 1:360000



Legend

🟥	Aboriginal Registered Sites (DIA) / Heritage Sites
▭	FMG Tenements Granted
▭	Mindy Mindy JV
▭	Proposed Pit Outlines
▭	Stage A - FMG Proposed Rail Corridor
▭	Stage B - FMG Proposed Rail Corridor
┼	Existing Rail - BHBP
—	River

N

0 10 20 km

Fortescue Metals Group Limited

Figure 42 Aboriginal heritage sites within the project area

Author:	FMG	Date:	08/11/04
Drawn By:	M.Khan	Revised:	10/01/05
Fig No.:	42	Report No.:	FMG 04083
Projection:	GDA 94	Scale:	1:600 000

Appendix A

Environmental Scoping Document

(refer to CD of Technical Appendices)

Appendix B

Draft Construction Environmental Management Programme

ENVIRON

CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN

Pilbara Iron Ore and Infrastructure Project:
East West Railway and Mine Sites (Stage B)

Fortescue Metals Group Limited

ENVIRON Australia Pty Ltd
Suite 7, The Russell Centre
159 Adelaide Terrace
East Perth WA 6006
Australia

Telephone: +618 9225 5199
Facsimile: +618 9225 5155

Ref: 30-0086F Stage B PER
January 2005

1.1 Project Background

Fortescue Metals Group Limited (FMG) is planning to construct a port facility at Port Hedland and a connecting railway to its proposed iron ore mining operations approximately 345 km to the southeast.

The majority of the proposed railway will run parallel and in close proximity to the existing BHP Billiton Iron Ore Newman to Port Hedland railway and the proposed Hope Downs corridor. The FMG Port facility will be constructed on the western side of the Port Hedland Harbour at Anderson Point, which will be serviced by a conveyor system that will transfer iron ore from the railway via a stockyard to a new wharf and shiploader. The railway and port will be open to other users who also have undeveloped deposits in the Pilbara.

The Project has been broken down into two stages for separate assessment by the State Environmental Protection Authority (EPA):

- Stage A - the proposed port and north south rail infrastructure; and
- Stage B - the development of the mining operations and east west rail, which is the subject of this Environmental Management Plan (EMP).

The EPA has set the level of assessment as a Public Environmental Review (PER) for both Stage A and B. This EMP has been developed as part of the PER process for the construction and site preparation phases of Stage B.

1.2 Purpose of the EMP

The EMP is a management tool that outlines environmental management strategies to ensure the Project's environmental commitments and objectives are met. The EMP will be used over the proposed 20 month construction period. During this period, site preparation will be also undertaken. This will include removal of topsoil and overburden from proposed mining areas.

The EMP will outline:

- key environmental issues associated with construction;
- management measures to minimise construction impacts;
- monitoring to be undertaken during construction;
- environmental accountabilities; and
- legislative requirements which must be met by the Company.

1.3 Scope of the EMP

This EMP addresses the environmental management for the construction of all infrastructure components of the East - West Railway and Minesites, as well as all components of site preparation, including removal of topsoil and overburden from proposed mining areas. The four minesites are Mt Nicholas, Christmas Creek, Mt Lewin and Mindy Mindy. The main components are as follows:

- Semi-mobile primary crusher;
- Overland conveyors, haul roads and/or slurry pipelines;
- Secondary crushers, screening plant and beneficiation plant(s);
- Product stockpile and train loading yard;
- Mobile plant and machinery workshop;
- Power station (s) and transmission lines;
- Bulk hydrocarbon storage;
- Explosive and detonator, ammonia nitrate storage and magazine;
- Accommodation and camp facilities;
- Administration and ancillary support facilities;
- Haul roads and access tracks;
- Borefield and associated pipelines;
- Airstrip upgrade;
- Concrete batching plant;
- Process water supply reticulation;
- Railway;
- Sidings, passing bays and loading loops;
- Train loader;
- Rail maintenance track;
- Borrow pits and ballast quarry(s); and
- Sewage treatment facilities.

1.4 Regulatory Framework

The Project will be subject to regulatory control under a range of State and Commonwealth Acts. Applicable legislation includes:

- *Environmental Protection Act* 1986;
- *Environmental Protection and Biodiversity Conservation Act* 1999;

- *Conservation and Land Management Act* 1984;
- *Aboriginal Heritage Act* 1972;
- *Australian Heritage Commission Act* 1975;
- *Agriculture and Related Resources Protection Act* 1976;
- *Bush Fires Act* 1954;
- *Wildlife Conservation Act* 1950;
- *Rights in Water and Irrigation Act* 1914;
- *Soil and Land Conservation Act* 1945;
- *Mining Act* 1978;
- *Health Act* 1911;
- *Occupational Safety and Health Act* 1984;
- *Mines Safety and Inspection Act* 1994;
- *Explosives and Dangerous Goods Act* 1961;
- *Dangerous Goods (Transport) Act* 1998;
- *Land Administration (Amendments) Act* 1997;
- *Local Government Act* 1995;
- *Private Railways (Level Crossings) Act* 1966;
- *Rail Safety Act* 1998;
- *Rail Freight System Act* 2000; and
- *Town Planning & Development Act* 1928.

Commonwealth legislation likely to be relevant to the Project includes the following:

- *Environmental Protection and Biodiversity Conservation Act* 1999; and
- *National Native Title Act 1993.*

1.5 Environmental Accountabilities

Environmental accountabilities for this construction EMP within FMG are as follows:

Role	Accountability
General Manager Sustainable Development - FMG	• Ensure implementation of the EMP.
Head of Environment - FMG	• Advise on environmental management issues. • Ensure that all environmental management issues are resolved in a timely manner to the satisfaction of all stakeholders. • Ensure all required notifications to Government are submitted in a timely manner and are to the

Role	Accountability
	satisfaction of the Government. • Ensure environmental performance audits are conducted in accordance with the requirements of the EMP. • Implement the monitoring requirements set out in the EMP.

1.6 Reporting

FMG will develop an internal reporting structure, to monitor compliance with the commitments given in the Stage B PER as construction progresses. Reports will be produced on a monthly basis, will include information on environmental impacts, issues and management and will highlight any instances of non-compliance with the PER.

Should the monitoring programs identify any non-compliances (such as exceedance of regulations or standards), FMG will contact the relevant decision making authorities to discuss mitigation measures.

The implementation of the management strategies and the results of all monitoring programs required under this EMP will be detailed in an end of construction environmental report and submitted to the relevant government agencies.

1.7 Environmental Management Plan

The environmental management plan is presented in a Table format for ease of use by staff and contractors involved in Stage B construction and assessment by decision making authorities. The EMP outlines management strategies to manage the following environmental issues associated with construction of the Project:

- terrestrial flora and vegetation communities;
- terrestrial fauna;
- stygofauna;
- water courses and surface water sheet flows;
- water supply;
- air emissions – dust and greenhouse gases;
- water quality – surface water;
- water quality – groundwater;

- waste management;
- acid sulphate soils;
- land clearing;
- noise and vibration;
- Aboriginal heritage;
- bushfires;
- rehabilitation;
- sewage;
- stakeholder liaison; and
- incident reporting.

The EMP is broken into four key components:

- Key Issues – this identifies the key issues associated with the construction of Stage B that require specific management strategies.

- Objectives – outlines the standard of environmental management that FMG will achieve in undertaking construction of Stage B.

- Management strategies – FMG will achieve its environmental objectives for Stage B construction through the identified management strategies. These strategies provide clear direction to staff and contractors on how construction activities will be undertaken to limit environmental disturbance and to manage and mitigate where avoidance is not practicable.

- Monitoring – Construction of Stage B will have impacts on the environment and FMG will monitor these impacts to ensure they are minimised and managed in accordance with both the Commitments given in the PER, and relevant legislation.

The EMP will be supplemented with the following specific documentation prior to construction:

- More detailed issue specific management plans;
- Procedures and work instructions where required;
- Training and awareness documentation;
- Monitoring, audit and inspection protocols.

Issue	**Objective**	**Management Strategies**	**Monitoring**
Terrestrial Flora and Vegetation Communities	Protect declared rare flora (DRF) and minimise disturbance to other flora and vegetation communities.	▪ Conduct DRF surveys prior to clearing an area. ▪ Avoid the disturbance of DRF and minimise the disturbance of flora and vegetation communities where practicable. ▪ Ensure that the necessary approvals are obtained from the DoIR/DoE/CALM prior to clearing being undertaken. ▪ If disturbance of DRF is unavoidable, ensure 'Application to Take' is completed and approval obtained from CALM prior to disturbing DRF. ▪ Notify the Environmental Manager of the discovery of any DRF (or potential DRF) during actual clearing of vegetation, before continuing with planned clearing operations. ▪ Fence off and clearly demarcate DRF communities/individuals. ▪ Already disturbed and degraded areas and existing roads and tracks will be used where practicable to minimise vegetation clearing. ▪ Develop a Weed Hygiene and Management Plan. ▪ All vehicles and equipment will be clean and free of soil and plant material before commencing work to minimise introduction of weeds and diseases. ▪ Clearly demarcate areas to be cleared to ensure only the defined areas are cleared. ▪ Stockpile vegetation debris and topsoil in windrows during clearing for use in rehabilitation. ▪ Discuss the importance of protecting flora and vegetation communities during site Environmental Inductions. ▪ Report any unauthorised disturbance to vegetation (including DRF) to the Environmental Manager.	▪ Conduct annual vegetation assessments during the construction phase and summarise results in the AER. ▪ Vegetation assessments will be conducted both within and outside the construction area.
Terrestrial Fauna	Maintain the abundance, species diversity and geographical distribution of terrestrial fauna Ensure feral animal populations do not increase as a result of construction activities.	▪ Minimise disturbance to fauna and their habitat where practicable. ▪ Report all fauna deaths and injuries to the Environmental Manager. ▪ Discuss the importance of protecting native fauna during site Environmental Inductions. ▪ No firearms or pets permitted in the construction area. ▪ Keep work and accommodation areas free of food scraps to prevent encouraging native and feral animals into these areas. No feeding of feral or native animals permitted. ▪ Injured fauna should be taken to Newman for rehabilitation. ▪ Develop a Light Overspill Management Plan to minimise light impacts on fauna.	▪ Conduct annual fauna surveys to monitor fauna populations in the vicinity of the Project area. Report findings in the AER.

Issue	Objective	Management Strategies	Monitoring
		▪ All vehicles required to stay on designated roads and tracks and to drive within the defined speed limit. ▪ Remove dead fauna from roads and tracks to prevent further deaths of scavenging animals and to reduce the potential for vehicle accidents. ▪ Cap newly constructed (not yet equipped) boreholes to prevent fauna becoming trapped in these areas. ▪ Store equipment responsibly to minimise the potential for fauna to become trapped within confined spaces.	
Stygofauna	Maintain the abundance, diversity and geographical distribution of subterranean fauna	▪ Prepare a Subterranean Fauna Management Plan. ▪ Ensure no hydrocarbon based drill fluids are used during construction of production bores. ▪ Ensure no chemicals or litter deposited in boreholes.	▪ Conduct annual sampling for stygofauna.
Water courses and sheetflow	Maintain the integrity, functions and environmental values of watercourses and sheet flow.	▪ Locate infrastructure so as to minimise impact on watercourses and surface flows. ▪ Undertake drainage construction works during dry periods, if practicable, to reduce the risk of erosion of unstabilised surfaces. ▪ Install bridges over major river channels and culverts over other drainage channels. ▪ Align East West railway so that bridges cross perpendicular to main drainage channels. ▪ Culverts and small interceptor banks will be installed, where required to prevent formation of local drainage and to protect dependent downstream vegetation. ▪ Install guide banks, rip-rap or similar erosion protection blankets around culvert inlets and outlets to reduce erosion, where required. ▪ Employ sediment controls such as settling ponds and silt fences, where required.	▪ Conduct photographic erosion monitoring at designated points along major water courses. Monitor the effectiveness of installed culverts and drains.
Water supply	Maintain (sufficient) quantity of groundwater so that existing and potential uses, including ecosystem maintenance, are protected.	▪ Develop a Borefield Management Plan for construction and operation of the water supply borefield. ▪ Develop a Water Use Management Plan which is to include a water balance, for the Project. ▪ Discuss water supply during site Environmental Inductions and prepare an environmental awareness training module in water management (supply and quality management). ▪ Alternate source production bores regularly to ensure sustainable water production. ▪ Exclude bores which are not adequately recharging from production for a period of time to ensure water table levels are allowed to recover to pre-construction levels. ▪ Bores that have salinity of greater than 10,000mg/L will not be used.	▪ Monitor groundwater drawdown through measurement of standing water levels and flow meter readings. ▪ Report groundwater monitoring results and status of the Project water balance in the AER.

Issue	**Objective**	**Management Strategies**	**Monitoring**
		- Conduct regular maintenance on production bore flow and hour metres to ensure accurate recording. - Ensure recharge of the Fortescue Salt Marshes is not affected by groundwater drawdown during construction.	
Air Emissions – Dust and Greenhouse Gases	Minimise both dust particulate and greenhouse gas emissions from the Project and mitigate greenhouse gas emissions in accordance with the *Framework Convention on Climate Change 1992* and with established Commonwealth and State policies.	- Set a target for a percentage reduction in greenhouse gas emissions. - Prepare management plans for Dust and Greenhouse gases. - Use water and/or chemical dust suppressants on roads, stockpiles and highly trafficked areas. - Employ good housekeeping practices in operational areas. - Rehabilitate disturbed areas progressively to minimise total open area.	- Monitor dust particulates in dusty areas, including operational areas, around the border of the Project area and in the vicinity of the closest residence, if necessary. - Prepare an annual Greenhouse Gas Inventory. - Report dust and greenhouse gas emission monitoring results in the AER.
Water Quality - Surface water	Maintain or improve the quality of surface water to ensure that existing and potential uses, including ecosystem maintenance are protected, consistent with the *Australian and New Zealand Water Quality Guidelines (ANZECC 2000).*	- Develop a Hazardous Materials Management Plan. - Develop a Surface Water Management Plan. - Manage surface runoff from the Project area effectively to ensure surface water channels and the Fortescue Salt Marshes are not contaminated. - Ensure hydrocarbon and chemical storage vessels are surrounded by low permeability bunding with capacity maintained at all times. - Avoid disturbance to surface water courses where practicable, during construction.	- Conduct surface water quality monitoring in local surface water bodies including the Fortescue Salt Marshes. - Monitor surface water quality quarterly (if flowing) during the dry season and fortnightly during the wet season. Include field measurements of EC, pH and TSS and laboratory analysis for major ions and metals. - Report monitoring results in the AER.
Water Quality - Groundwater	Maintain or improve the quality of groundwater to ensure that existing and potential uses, including ecosystem maintenance are protected, consistent with the *Australian and New Zealand Water Quality Guidelines (ANZECC 2000).*	- (see reference to Hazardous Materials Management Plan above). - Clean-up and manage spills effectively to ensure groundwater does not become contaminated. - Discuss spill management during Environmental Inductions and prepare an environmental awareness training module for Spill Management. - Ensure dewatering does not impact on groundwater quality. - Ensure waste dumps and landfills are constructed in accordance with DoIR and DoE standards.	- Monitor groundwater quality on a quarterly basis. Collect and analyse water samples for EC, pH, major ions and metals and report results in the AER.

Issue	**Objective**	**Management Strategies**	**Monitoring**
Waste Management - Overburden - Rejects Dumps - General Waste	To ensure that disposal/management wastes do not adversely affect environmental values, or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.	▪ Implement priority of Avoid, Reuse, Recycle, Recover Energy, Treat/Dispose for waste management. ▪ Prepare a Waste Management Plan and include a target for reducing waste production. ▪ Recycle waste where practicable and give preference to purchasing products with recyclable packaging and refillable containers. ▪ Construct overburden storage areas according to standards produced by DoIR and DoE. ▪ Only putrescible waste and inert non-recyclable material may be disposed of to on-site landfill. ▪ Chemical and hydrocarbon waste and any other hazardous material must be disposed of to an approved facility. ▪ Manage on-site landfills according to the principles outlined in the DoE Code of Practice for Country Landfills (DEP 1996a) and Landfill Waste Classifications (DEP, 1996b). ▪ Discuss waste management in the site Environmental Induction and prepare an Environmental Awareness training module in waste management.	▪ Monitor volumes of waste disposed of to on-site landfill and removed from site (for recycling or disposal) and report figures in the AER. ▪ Conduct regular inspections of landfills to ensure they are being managed correctly.
Acid Mine Drainage	Minimise the risk to the environment resulting from potentially acid forming materials.	• Sampling has shown that AMD is a low risk in the project area. However, the material removed from the mining area will be monitored for AMD.	▪ Visual monitoring of the mined material for the presence of AMD.
Land Clearing	Minimise land clearing where practicable and ensure approvals obtained prior to clearing commencing.	▪ Project designed and constructed to minimise the area of land to be cleared. ▪ Ensure approvals to clear have been granted from DMA's. ▪ Clearing areas are to be clearly marked, to ensure no accidental clearing. ▪ Clearing controls discussed during the Environmental Induction.	▪ Regular inspection of cleared area by environmental personnel during construction. ▪ Survey cleared areas boundaries and record in the FMG database.
Noise and Vibration	Ensure noise and vibration impacts emanating from construction activities comply with statutory requirements and acceptable (and appropriate) standards.	▪ Develop a Noise and Vibration Management Plan. ▪ Environmental noise issues discussed during site Environmental Inductions. ▪ Prior to the start of construction, noisy activities (e.g. blasting) will be identified and where practicable the quietest available equipment will be sourced. ▪ Equipment Sound Power Levels (SPL) will be reduced in noise sensitive areas, for example in close proximity to Mulgara habitat. Stationary and mobile equipment will have adequate, fully operational noise control equipment fitted. ▪ Ensure that activities comply with the requirements of the *Environmental Protection (Noise) Regulations*	▪ Noise and vibration levels will be monitored for every blast and the results submitted to the DoE in an annual Blast Noise and Vibration Report. ▪ Environmental noise levels at various locations within the Project area and at the closest residence will be monitored on a quarterly basis. The result will be reported in the AER.

Issue	**Objective**	**Management Strategies**	**Monitoring**
		1997. Any breach of the regulations will be reported to the DoE. ▪ Noise complaints will be reported to the Environmental Manager and recorded on the FMG complaint database. ▪ The Environmental Manager will liaise with the complainant on the outcome of the complaint.	
Aboriginal Heritage	Ensure that the proposal complies with the requirements of the *Aboriginal Heritage Act* 1972. Ensure that changes to the biological and physical environment resulting from the Project do not adversely affect cultural associations with the area.	▪ Infrastructure will be designed to avoid disturbance of any Aboriginal Heritage sites, where practicable. ▪ A 100 m buffer zone free of construction/operational activity will be established around existing Aboriginal heritage sites. ▪ Clearances will be obtained to disturb sites under Section 16 and 18 of the *Aboriginal Heritage Act*. ▪ A Cultural Heritage Management Plan will be prepared prior to construction commencing. ▪ If damage to a site is noted, the damage will be reported to the Department of Indigenous Affairs. ▪ Local Aboriginal people involved in development of environmental awareness training package in Aboriginal Heritage for presentation to all personnel. ▪ Aboriginal culture and heritage discussed in site Environmental Induction. ▪ Location of Aboriginal heritage sites identified on Project maps and recorded on FMG database. ▪ Notify the Environmental Manager immediately of the discovery of a potential Aboriginal heritage site.	▪ Aboriginal Heritage surveys will be completed by approved anthropologists in conjunction with local Aboriginal representatives prior to construction commencing in each area.
Bushfires	Prevent bushfires being caused by construction activities and ensure natural bushfires events.	• Prepare a Fire Management Plan. • FMG will use best practice rail grinding technologies and dust suppression systems to reduce fire risk. • No open fires permitted in the Project area. • Fire management discussed during site Environment and Safety Inductions and environmental awareness training package in fire management and prevention presented to all employees. • Fire warden(s) appointed and trained in emergency fire management procedures. • Project site equipped with fire tenders and all vehicles, drill rigs and buildings equipped with fire extinguishers. • Hot work permits required for work that has the potential to create ignition sources, such as grinding and welding. Work to be undertaken in a cleared area. • All vehicles must be diesel run. • FMG will liaise with local pastoralists on fire management and will keep informed on Shire announcements in	• Field monitoring to be conducted by the fire warden daily during the dry season to ensure bushfires identified as soon as practicable. • All personnel to monitor their work environment for fire hazards at all times.

Issue	Objective	Management Strategies	Monitoring
		relation to bushfires and fire bans.	
Rehabilitation	Rehabilitate disturbed areas to re-establish a stable landform and a self-sustaining ecosystem	• Prepare a Revegetation and Rehabilitation Management Plan. • Conduct direct return of topsoil and vegetation debris where practicable. • Conduct progressive rehabilitation to minimise the total area open. • Disturbed areas will be re-contoured, spread with topsoil and vegetation debris and deep ripped to improve drainage. • Apply seed of local provenance species if propagation from the topsoil is not sufficient. • No vehicle access permitted in rehabilitated areas. • Develop completion criteria in consultation with the relevant stakeholders.	• Monitor vegetation establishment at regular intervals during initial 3 years after rehabilitation completed. • Continue long-term monitoring on an annual basis.
Sewage	Minimise the impact sewage effluent has on the environment.	• All sewage will be managed on-site using an approved septic tank system, treatment system, waterless or chemical toilets (or similar).	• Monitor surface and groundwater quality in the vicinity of the Project area on a quarterly basis.
Stakeholder liaison	Ensure that the concerns and interests of stakeholders are taken into consideration during the construction phase.	• Continue to implement the Stakeholder Consultation Strategy during the construction phase. • The Environmental Manager is available to respond to environmental issues raised by stakeholders. • Set up a register to record and respond to environmental complaints or issues raised by stakeholders.	• Time taken to respond to complaints / issues.
Incident reporting	Report and record all environmental incidents and investigate where required.	• Discuss how to define and how to report environmental incidents and hazards in the site Environmental Induction. • Report all environmental hazards and incidents to the Environmental Manager using the Environmental Incident Report form. • All environmental incidents and hazards will be recorded in the FMG database. • Conduct an incident investigation for significant environmental incidents. Significant incidents are those which breach regulations or licence conditions. • Any breaches of environmental regulations or licence conditions will be reported to the DoE/DoIR/CALM.	• Record the total number of environmental incidents and a description of each incident in the FMG database. Report the number of environmental incidents and details for significant incidents in the AER.

Appendix C

Correspondence from the Federal Department of Environment and Heritage

COMMONWEATLH OF AUSTRALIA

ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999

DECISION THAT ACTION IS NOT A CONTROLLED ACTION

I, GERARD PATRICK EARLY, First Assistant Secretary, Approvals and Wildlife Division, Department of the Environment and Heritage, a delegate of the Minister for the Environment and Heritage for the purposes of section 75 of the *Environment Protection and Biodiversity Conservation Act 1999*, decide that the proposed action, set out in the Schedule, is not a controlled action.

SCHEDULE

The proposed action to undertake the development and operation of iron ore mining operations at Mt Nicholas, Mt Lewin, Christmas Creek and Mindy Mindy, and a 160km east-west rail spur connecting mine sites to the north-south railway line, and as described in the referral received under the Act on 2 December 2004 (EPBC 2004/1897).

Dated this 23rd day of December 2004

Gerard Early

FIRST ASSISTANT SECRETARY
APPROVALS AND WILDLIFE DIVISION
DEPARTMENT OF THE ENVIRONMENT AND HERITAGE

Appendix D

Rehabilitation and Revegetation Management Plan

PILBARA IRON ORE PROJECT

REHABILITATION AND REVEGETATION MANAGEMENT PLAN

Document Title:	**Rehabilitation and Revegetation Management Plan**
Document No:	
Document Type:	**Management Plan**

First Issue Date: **9 December 2004**

Rev Code	Issue Date	Description & Location of Revisions Made	Signatures		
			Originator	Checked	Approved
0			Ben Garnett	Dr E Mattiske	

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1. INTRODUCTION

1.1 BACKGROUND

Fortescue Metals Group Limited (FMG) is proposing to develop the Pilbara Iron Ore and Infrastructure Project (the Project), which involves a series of iron ore mines in the Pilbara region of Western Australia, and rail and port infrastructure for export of iron ore through Port Hedland. A 345 km long north-south railway will link the Mindy Mindy deposit (55 km northwest of Newman) with the port facility, and a 160 km east-west rail spur will link the Mt Nicholas, Mt Lewin and Christmas Creek deposits northeast of Newman, to the main north-south rail line just north of the Chichester Ranges.

The Project is currently being assessed under the Western Australian *Environmental Protection Act 1986*. For the purposes of the State environmental assessment process, FMG is assessing the Project in two stages:

- Stage A: Proposed port and north-south railway from Mindy Mindy to Port Hedland; and
- Stage B: The mining operations and east-west rail spur.

1.2 PURPOSE

The purpose of this management plan is to outline the actions that will be undertaken during the rehabilitation and revegetation of the mining operations and east-west rail spur (Stage B of the project). This management plan will highlight the general rehabilitation and revegetation management actions that will be adopted. The plan will be continually updated to incorporate successful procedures identified in site specific trials throughout` the life of the project.

1.3 REHABILITATION AND REVEGETATION

It is recognised that mining is a temporary landuse which should be integrated with, or followed by, other forms of landuse. Rehabilitation of mines will be aimed towards a clearly defined future landuse for the area. This use will be determined in consultation with relevant interest groups including government departments, local government councils, traditional owners and private landowners. Different components of a mine, such as reject rock dumps, plants and office sites, access roads, may have different post-mining landuses.

2. RELEVANT LEGISLATION

There are a number of legislative mechanisms that are applicable to the rehabilitation and revegetation of mine sites in Western Australia. Legislative obligations and potential liabilities are created under the *Mining Act* 1978 (Mining Act) and the *Mines Safety and Inspection Regulations* 1995 which are administered by the Department of Industry and Resources (DoIR). In addition all mining operations in Western Australia are also subject to the State *Environmental Protection Act* 1986 (EP Act). The EP Act overrides all other Acts, including the Mining Act and is administered by the Environmental Protection Authority (EPA) and the Department of Environment (DoE). An approval to mine issued under the Mining Act does not override the requirement to obtain an environmental approval under the EP Act. Consequently the requirements of both Acts and their regulators must be satisfied.

3. EXISTING ENVIRONMENT

The Project is located within the Pilbara Bioregion as described in the Interim Biogeographic Regionalisation for Australia (IBRA) (Thackway and Cresswell, 1995; Environment Australia, 2000).

The proposed mining areas and railway line occur within three major physiographic units within the Fortescue District. These are:

- Chichester Plateau - a plateau of mainly basalts, with included siltstone, mudstone, shale, dolomite and jaspilite; forming a watershed between numerous rivers flowing north through the Abydos Plain to the coast, and the Fortescue drainage on the southern side of the range (Beard, 1975). The plateau supports shrub steppe characterised by *Acacia pyrifolia* over *Triodia pungens* hummock grass. Snappy Gum (*Eucalyptus leucophloia*) tree steppes occur on ranges.' (IBRA Revision 5.1; Environment Australia, 2000). The Mt Nicholas, Mt Lewin and Christmas Creek mine sites are located on the southern edge of this unit.
- Fortescue Valley - occupying a trough between the Chichester and Hamersley Plateaux; the eastern portion drains into the Fortescue Marshes, while the western portion drains through a valley through the Chichester Plateau (Beard, 1975). These alluvial plains and river frontages support salt marsh, *mulga/bunch grass, and short grass communities. River Gum (Eucalyptus* camaldulensis) / Coolibah (*Eucalyptus victrix*) woodlands fringe the drainage lines. This is the northern limit of mulga (*Acacia aneura*). (IBRA Revision 5.1; Environment Australia, 2000). The rail spur from Mt Nicholas follows the northern edge of the Fortescue Valley where it meets the Chichester Plateau.

- Hamersley Plateau - rounded hills and ranges, mainly of jaspilite and dolomite with some shale, siltstone and volcanics (Beard, 1975). This plateau supports mulga low woodland over bunch grasses on fine textured soils and Snappy Gum over hummock grass (*Triodia brizoides)* on skeletal sandy soils of the ranges. (IBRA Revision 5.1; Environment Australia, 2000). This subregion contains the Mindy Mindy mining area.

3.1 VEGETATION

Beard (1975) mapped the vegetation of the Pilbara at a scale of 1:1,000,000. The entire Project Area lies within the Fortescue Botanical District of the Eremaean Botanical Province as defined by Beard. The vegetation of this province is typically open, and frequently dominated by spinifex, wattles and occasional eucalypts.

According to Beard's (1975) mapping, vegetation along the proposed east-west rail line is predominantly sparse low mulga woodland discontinuous in scattered groups, with Coolibah (*Eucalyptus victrix*) trees scattered over various sedges and forbs near Mt Lewin. Where the rail spur terminates near Mt Nicholas, there are hummock grasslands, shrub steppe with *Eucalyptus gamophylla* over hard spinifex.

Vegetation at Christmas Creek is a mosaic of low woodland with mulga in valleys and hummock grasslands, low open tree steppe with snappy gum (*Eucalyptus leucophloia*) over *Triodia wiseana,* and kanji over soft spinifex and *Triodia wiseana* hummock grasslands. Mt Lewin and Mt Nicholas are characterised by low mulga woodland and shrub steppe with kanji over soft spinifex and *Triodia wiseana* hummock grasslands.

Mindy Mindy is characterised by low tree steppe with snappy gum over *Triodia wiseana* hummock grasslands.

3.2 CLIMATE

The inland Pilbara region is classified as arid, with most rain falling during the hot summers. The closest Bureau of Meteorology weather station is Newman. Climatic data from this station indicates that peak rainfall occurs in the summer months between January and March with a smaller peak in May and June.

Climatic conditions in the Pilbara are influenced by tropical cyclone systems predominately between January and March. Rainfall during May and June is generally a result of cold fronts moving across the south of the State, which occasionally extend into the Pilbara.

Annual average rainfall for the Pilbara ranges from 180 mm to over 400 mm (Beard 1975) with the Bureau of Meteorology data indicating an average of 312 mm at Newman. Average maximum temperatures are generally between 35°C and 40°C and winter maximum temperatures generally between 22°C and 30°C. In this climate annual evaporation rates generally exceed the mean annual rainfall.

Winds are predominately east-south-easterly at Newman between May and August with stronger west-north-westerly winds between September and March and an annual average wind speed of 9.4 km/hr.

3.3 STUDIES

Extensive studies were carried out as part of the Public Environmental Review for Stage B of the Project. These studies include:

- Hydrogeology: Aquaterra
- Surface Hydrology: Aquaterra
- Flora and Vegetation: Biota Environmental Sciences
- Terrestrial Fauna: Biota Environmental Sciences
- Stygofauna: University of WA
- Dust: ENVIRON
- Noise: Lloyd Acoustics
- Greenhouse Gas Emissions: ENVIRON
- Aboriginal Heritage: Anthropos Australis
- Socio-economic study: Environmental Resources Management

Reference should be made to these documents for detailed information. Throughout the project additional studies will be undertaken on various areas and if relevant this information will be incorporated into this management plan.

4. MINING

The ore body that FMG is proposing to mine is relatively shallow. Therefore, FMG mines will look different to traditional open cut mines. The FMG mines will be relatively shallow and progress along a face, rather then mining to depths in a stationary pit. Parallels can be drawn between FMG's mining technique and mineral sands mining seen elsewhere in Western Australia.

Due to the mining technique adopted by FMG there is an opportunity to progressively rehabilitate the mine sites. FMG will therefore aim to minimise the amount of area that is open during operations and rehabilitation is likely to commence shortly after mining has begun (potentially within two years). Refer to figure one.

There will be three broad categories of land uses during FMG's operations:

- Cleared land – land that has had the vegetation removed and topsoil stripped in preparation for mining.
- Operational land – land that is being utilised for operations, such as mine pits, access tracks, workshops etc.
- Rehabilitated land – land that has been re-profiled, had topsoil spread and has been seeded with local native species if necessary.

Mining will occur within the pit footprint with overburden removed utilising stripping shovels and backhoes working with crushers and conveyors or via haul-pak dump trucks to its final location. Ore will be transported within the pit via haul-pak dump trucks or a conveying system to the crusher(s) which will be located in the pit or at the pit rim. As soon as practicable after the ore is removed from a strip it will be back-filled with overburden and/or reject material from the process plant(s). The back-filled strip will be contoured and superficial material being stripped from advancing strips be placed over the area as part of the rehabilitation programme, where practicable (figure two).

Primary crushing is planned using semi-mobile crushing units. The modular design of these units will allow reuse and relocation of the equipment as necessary. Overland conveyors, haul roads and/or rail spurs will convey the crushed ore to the central processing plant(s) and return rejects to the mined out areas.

The average waste to ore stripping ratio is expected to be approximately 1.0 – 1.5 waste to 1.0 ore at Christmas Creek, 1.1 – 2.0 waste to 1.0 ore at Mt Nicholas, 1.7 – 2.2 waste to 1.0 ore at Mt Lewin and 0.7 – 1.2 waste to 1.0 ore at Mindy Mindy. Initially, for at least two years, overburden will be disposed of to permanent placement areas, which will be rehabilitated, and then as the mining faces progress the concurrent overburden product will be placed within the pit voids, where practicable. For every tonne of screened ore processed the beneficiation process generates approximately 0.35 tonne of rejects.

The process plant(s) will beneficiate the ore, which involves upgrading the crushed ore to increase its iron content and reduce impurities. The secondary crushed and screened ore is beneficiated using various unit processes such as screening, wet gravimetric processes and magnetic separators to reduce contamination and increase the ore grade to a marketable product. This process is completely inert and does not involve the use of chemical additives and therefore will not result in the production of chemical pollutants.

4.1 MINE SITE DISTURBANCE

The following are the approximate areas of mine site disturbance for the life of each mine site:

- Christmas Creek East – 4,245 ha
- Christmas Creek Central – 4,100 ha
- Christmas Creek West – 1,778 ha
- Mt Lewin – 1,772 ha
- Mt Nicholas – 2,757 ha
- Mindy Mindy – 852 ha
- Railway construction – 1,600 ha
- Railway Operation – 800 ha

The above disturbance figures detail the total disturbance that will occur over the life of the mine. Due to FMG's progressive rehabilitation, the amount of area that will be considered 'open' will be much less. It is also noteworthy that the above areas will not necessarily all be operating at the same time.

Open area is land that has either been cleared or is used in active operations. Land would no longer be considered open when it has been re-profiled and has had topsoil spread. The amount of land that is required to be open will depend on operational issues and the depth and thickness of the ore body. If the ore body is thick, less land would be required to achieve the output of the mine. However, a minimum amount of open area would be required regardless of the depth of the ore body to ensure safety requirements are met.

5. REHABILITATION AND REVEGETATION PROCEDURES

5.1 OBJECTIVE

FMG has developed a closure plan for the mining operations and east west rail (Stage B of the project). The closure plan addresses all the areas associated with closing the operations, of which rehabilitation and revegetation forms a component. As such the post-mining land use and objectives for closure are relevant to rehabilitation and revegetation.

The first step in developing the overall mine closure strategy is to identify potential post-mining land use options and establish key objectives for closure to be incorporated in the project design.

The most likely post-mining land use is pastoral, with management of the land being returned to the pastoral leaseholders on completion of closure, decommissioning and rehabilitation. This may be reviewed at a later date, depending on the outcome of the Pastoral Lands Board's review of pastoral lease holdings, scheduled for 2015. This review may result in some areas of pastoral lease holdings being excluded for 'public purposes' (e.g. conservation areas).

In this context, the primary objectives for the closure of the mining operations and east-west railway are:

- Establish a safe and stable post-mining land surface which supports vegetation growth and is erosion resistant over the long-term.
- Re-establish a self-generating ecosystem comprising local native flora and vegetation which resembles the surrounding environment, as close as practical.
- Leave site in a safe, stable, non-polluting and tidy condition with no remaining plant or infrastructure that is not required for post-operational use.
- Minimise downstream impacts on vegetation due to interruption of drainage.
- Identify any potential long-term soil, surface water or groundwater pollution associated with the operations and formulate an action plan to address this.
- Develop a stakeholder consultation group prior to the onset of closure, to facilitate discussion of closure planning.
- Continue to monitor environmental performance during decommissioning, rehabilitation and post-closure stages of the project and take appropriate action until the approved completion criteria have been met.

5.2 CLEARING

The area to be cleared will be kept to a minimum based on safety and operational constraints. Maps will be produced that detail the areas to be cleared, including the timing of the clearing operations for the life of the mine. These maps will be updated on a regular basis, to match the actual progress of the mining operations. Cleared vegetation will not be burnt. Where practicable the cleared vegetation will be used as mulch, a seed source or as habitat for fauna during the rehabilitation and revegetation programme.

A clearing procedure has been developed to manage clearing operations. The draft Clearing Procedure is presented in Appendix One.

5.3 SOIL HANDLING

A topsoil management procedure has been developed to address the handling of soil from the site. The draft Topsoil Management Procedure is presented in Appendix Two. The general concepts are described below.

5.3.1 Salvage

Topsoil is often the most important factor in the success of a rehabilitation and revegetation programme. Topsoil typically refers to the upper 250 mm of soil however, site specific surveys may identify areas that differ from this figure.

The topsoil will be stripped with scrapers or similar. Where possible the scrapers will directly return the topsoil to the rehabilitation areas behind the mine face. However, scrapers are not operationally viable over extended distances (nominally 1 km). Therefore, it may be necessary to stockpile the topsoil for a short period (limited to a few weeks) prior to placing it into trucks for transportation. Minimising the amount of time that the topsoil is stockpiled will maximise the return of the floral species from the seed resource within the topsoil.

5.3.2 Stockpiling

Where practicable topsoil will not be stockpiled for an extended period. However, during the start-up phase of an area it may be necessary to stockpile topsoil until rehabilitation begins. If topsoil requires stockpiling it will not be stored for a period greater then 2 years and will not be stockpiled at a height greater then 2 metres. Stockpiles will be located as close as possible to the area to be rehabilitated and revegetated to limit transportation requirements. Site traffic will not be permitted on any topsoil stockpiles. All topsoil stockpiles will be clearly marked.

5.3.3 Timing of Topsoil Stripping

Where practicable, topsoil will not be stripped when it is too wet or too dry, as this can lead to compaction, loss of structure and the loss of the viability of the seeds. FMG will investigate the viability of stripping topsoil following the period when the native plants set their seeds, to maximise the seed store in the soil.

5.3.4 Replacement

As far as possible topsoil will be placed along the contour to help reduce erosion. Placing the topsoil in such a manner will reduce the down slope flow of water and increase water storage.

5.4 REHABILITATION WORKS

5.4.1 Landform Design and Reconstruction

The re-shaping and grading of a site is an essential component of the rehabilitation process. During the initial stages of mining material will be placed in an overburden storage area. When the mine has progressed a sufficient distance, material will be placed in the mining void to progressively rehabilitate the mine. Within FMG's Conceptual closure plan some objectives have been included for the landform design.

The Closure Objectives for the mining areas to be backfilled, the mining voids and the overburden storage areas include:

- Establish a safe and stable post-mining land surface which supports vegetation growth and is erosion resistant over the long-term.
- Rehabilitated land surface functioning as uninterrupted water catchment for sheetflow-reliant mulga communities.
- Re-establish self-generating ecosystem comprising local native vegetation which resembles the surrounding environment, as close as practical.
- Continue to monitor environmental performance during decommissioning, rehabilitation and post-closure stages of the project and take appropriate action until the completion criteria have been met.

The final landform will resemble the pre-mining landform where practicable. The overburden storage area will take into consideration the surrounding landform and as far as practicable match the surrounding features. Typically the slopes will be less then 20^0 and the length of slope will also be minimised (figure three). However, in some circumstances the rehabilitated areas may be designed to resemble outcrops. If this is the case detailed geotechnical investigations will be undertaken to determine stability.

5.4.2 Erosion Control

The main mechanism to control water erosion is through the design of the final landform. The angles of the slopes in the rehabilitated areas will be minimised to reduce the velocity of the down slope water flow. The final angles will be based on site specific information and consider the surrounding topography. Typically the slopes will be less then 20^0 and the length of slope will also be minimised. Up slope surface water flow will also be managed to minimise erosion potential.

Wind erosion to the freshly placed topsoil will be monitored. If wind erosion is excessive measures will be investigated to reduce the erosion potential. This may include but not be limited to:

- Using a mulch over the affected area;
- Applying a surface treatment to reduce the erosion potential (may include spraying a clogging agent over the area);
- Reducing the wind velocity over the area by constructing wind breaks; and/or
- Seeding with a single generation (sterile) cover crop.

The final method chosen will depend on the area to be treated and site specific experience.

Refer to section 5.4.6 for information on erosion control when rehabilitating roads and tracks.

5.4.3 Mine Areas

Mining areas will be progressively rehabilitated. During the initial start-up phase of an area, overburden will be placed off path at a permanent storage area and topsoil will be stockpiled.

Following the initial start-up phase, overburden will be returned to the mining void and the final landform will take into consideration pre-mining landform. It is likely that overburden will be placed off path for the first two years of operation at Christmas Creek and Mt Lewin and the first year at Mt Nicholas. Based on the ore body at Mindy Mindy, only a small off path area is required to contain material from the initial pit margins.

The establishment of vegetation on the rehabilitated areas will rely on the seed source within the topsoil; however where required seeding with local native species will also be undertaken. Refer to section 5.5 for additional details on revegetation.

5.4.4 Overburden Storage Area

Mining operations will be scheduled to maximise the backfilling of mined out pits and therefore minimising the required area for the off path placement of overburden. However, there will be a requirement to construct permanent off path storage areas. It is necessary to use an overburden area to establish a safe and stable operational area. The topsoil from these areas will be stripped and stockpiled adjacent to the area. Refer to section 5.3.2 for details on topsoil stockpiling.

The feasibility of progressively rehabilitating overburden areas will be investigated and implemented if practicable. The final design of the overburden areas will take into consideration surrounding topography and as far as practicable match the local features.

5.4.5 Rail Corridor

During the construction phase, the rail corridor will be up to 40 metres wide with additional areas for access roads, lay down areas and borrow pits. However, following construction the corridor will be reduced. Topsoil disturbance will be kept to a minimum within the rail corridor during construction operations. The only area that will have topsoil stripped is the area that will be directly covered by the permanent rail infrastructure. Where practicable topsoil that is stripped from these areas will be used to rehabilitate nearby areas such as borrow pits or cuttings.

The estimated life of the east west railway is 20+ years. When the operation of the railway is no longer viable the track will be removed and the area rehabilitated using FMG's standard procedure.

5.4.6 Roads and Tracks

Prior to the rehabilitation of road and tracks, consultation will be undertaken with the relevant stakeholders to determine whether the tracks will be required for future access. Any roads and tracks that are not required will be rehabilitated.

Typically roads and tracks will be ripped to encourage revegetation. However, in some circumstances it is not appropriate to rip roads and tracks. Roads and tracks that are on steep slopes will not be ripped as this can encourage gully formation and enhance erosion. If vegetation regrowth has occurred on a road or track then ripping may not occur.

When ripping is undertaken a number of measures will be utilised to ensure maximum efficiency with minimal disturbance. Any ripping that occurs along slopes will have regular contour banks built across the tracks to prevent erosion from water runoff. Ripping of road and tracks will be done so as to create an undulating broken surface in which seeds can become trapped and germinate in uncompacted soil. Vegetation that was pushed to the side of the track by the initial clearing of the tracks will be pulled over the ripped tracks to promote seed germination if practicable.

When a track or road has been rehabilitated it will be appropriately signed to prevent traffic using the area. Roads and tracks will be monitored to determine the success of the rehabilitation and revegetation programme.

A procedure for the rehabilitation of roads and tracks has been developed. The draft procedure can be found in Appendix Three.

5.4.7 Borrow Pits

Borrow pit locations will be selected based on the characteristics of the fill required and minimising disturbance to vegetation. Prior to the establishment of a borrow pit, topsoil will be stripped and stockpiled as per FMG's standard procedures. The borrow pits will be designed to encourage natural drainage and prevent the establishment of ponded water. The slope of the re-contoured land will be minimised to reduce the potential for water erosion. The pit floor will be deep ripped to relieve compaction. Where practicable the cleared topsoil will be spread over the borrow pit. Refer to Appendix Four for a draft Borrow Pit Rehabilitation Procedure.

5.5 REVEGETATION

The revegetation technique that is adopted for an area site must be based on site specific trials and experience. The following details the broad concepts that will be adopted. However, these concepts will be modified based on experience and trials throughout the life of the project.

5.5.1 Species Selection

The species selection will be based on the flora surveys that were carried out during the Public Environmental Review for Stage B. These surveys were conducted by consultants who are experts in the area of floral surveys. It is likely that additional surveys will be undertaken throughout the project life to supplement these initial surveys. The latter will maximize the coverage of the areas and knowledge of the species present after varying seasonal rainfall conditions including post – cyclonic surveys.

A range of terrestrial vegetation types were defined for the proposed operational areas, representing a wide range of structural and floristic variants. These types can be grouped in as the following:

- Mulga *Acacia aneura* woodlands and tall shrublands over spinifex or various grasses on the plains of the Fortescue Valley, including extensive areas of groved mulga within the Stage B rail corridor;
- Hummock grasslands of spinifex *Triodia* species with a variable shrub overstorey on stony plains, hillslopes and crests of the mine areas;
- Tall shrublands of *Acacia* species, usually with an overstorey of *Corymbia*, in creeklines;
- Open woodlands of Coolibah *Eucalyptus victrix* over tall shrublands of *Acacia* spp. on river banks and beds;
- Variable vegetation on cracking clays of the Fortescue Valley (ranging from tussock grasslands to herblands).

5.5.2 Establishment

The initial establishment of the native vegetation will be from the seed bank contained within the topsoil. Due to FMG's proactive approach to topsoil management by returning the topsoil as soon as practicable to the rehabilitated areas (typically within a few weeks), it is likely that the seed bank from the topsoil will be maximised.

The propagation of native species from the seed bank in the topsoil has been a technique that has been successful in the Pilbara in the past. Investigations have been undertaken into rehabilitation methods used in Mulga communities in the Pilbara. This review has highlighted that with appropriate topsoil/overburden, handling and seeding (as required) it is feasible to undertake Mulga rehabilitation on similar environments in the Pilbara region (pers.comms Mattiske, 2004)

If establishment is shown to be ineffective, trials of directly seeding the areas with a seed mix of native vegetation will be undertaking. The final seed mix for a particular area will depend on the species that have already established.

One of the first areas that will be revegetated is the railway construction corridor. As the topsoil will remain insitu in this area, it will provide valuable information on the establishment of floral species from the seed bank in the topsoil. This information will be incorporated into this management plan.

5.5.3 Seed Collection, Processing and Storage

Seed collection will be undertaken if the establishment of native vegetation from the topsoil does not achieve the revegetation criteria. Seed used to revegetate an area will be sourced from the general location of the rehabilitation works. The collection, processing and storage methods implemented will be species specific. Generally the following will be applied to collection, processing and storage methods:

- The capsules or pods that are collected may be dried in the sun or in an oven or cones may be burnt to release the seeds;
- Clean seed will be stored in dry, insect and vermin proof containers;
- Containers will be clearly labelled with details of the species, date collected and collection location;
- The seed may be treated with an insecticide and fungicide prior to storage;
- The seed storage area will be regularly fumigated if necessary;
- The seeds will be stored in a low humidity low temperature environment;

- The seeds of some species may require pre-sowing treatment. This may include heat and/or smoke treatment. The species that are targeted for collection will be investigated to determine the most appropriate pre-sowing treatment.

5.5.4 Weed Control

A weed management plan will be developed for the project. Based on the vegetation surveys areas that contain a high density of weeds will be identified and appropriately managed. One such management technique will be the development of a vehicle hygiene procedure. Surveys of the rehabilitated areas will also be undertaken to determine species diversity, including weed levels.

5.6 FAUNA

FMG will aim to encourage native fauna to return to the rehabilitation areas. Some of the invertebrate species will be introduced in the topsoil. This introduction will be maximised through the direct return of topsoil to the rehabilitated areas. Typically faunal groups will quickly colonise any areas which contain the resources they require such as food, shelter and breeding sites. As one of FMG's closure objectives is to *Re-establish a self-generating ecosystem comprising local native vegetation which resembles the surrounding environment, as close as practical,* this will encourage the return of native fauna.

FMG will also investigate the feasibility of using the cleared vegetation to encourage the return of fauna, for example by establishing log piles for shelter.

5.7 MAINTENANCE

Rehabilitated areas need to be monitored and managed after the initial rehabilitation. FMG's primary tool for maintenance of the rehabilitated area will be monitoring of the sites. If areas are identified that are considered unsatisfactory then maintenance may include, but not be limited to:

- Replanting failed or unsatisfactory areas;
- Repairing any erosion problems;
- Fire management; and
- Pest and weed control.

5.8 SUCCESS CRITERIA AND MONITORING

In order to assess when the rehabilitation and revegetation process is complete, FMG will develop a set of completion criteria. These criteria will be reviewed by FMG senior management before being submitted to the regulatory authorities for approval and sign off. The approved set of completion criteria will be used as a basis for assessing the closure of the mining and rail operations, with FMG required to be in compliance with the specified criteria before the land management can be relinquished. The completion criteria will be reviewed every two years with the closure plan and updated to include findings of FMG's mine rehabilitation research and development program as well as additional requirements of the regulatory authorities.

When selecting completion criteria consideration must be given to the climatic conditions in the Pilbara. Using simple %species and %cover may not be appropriate as this is dependant on when the samples are taken. If the baseline was established during a wet year and the assessment undertaken during drought the criteria will not be met. FMG is currently investigating the operations for completion criteria.

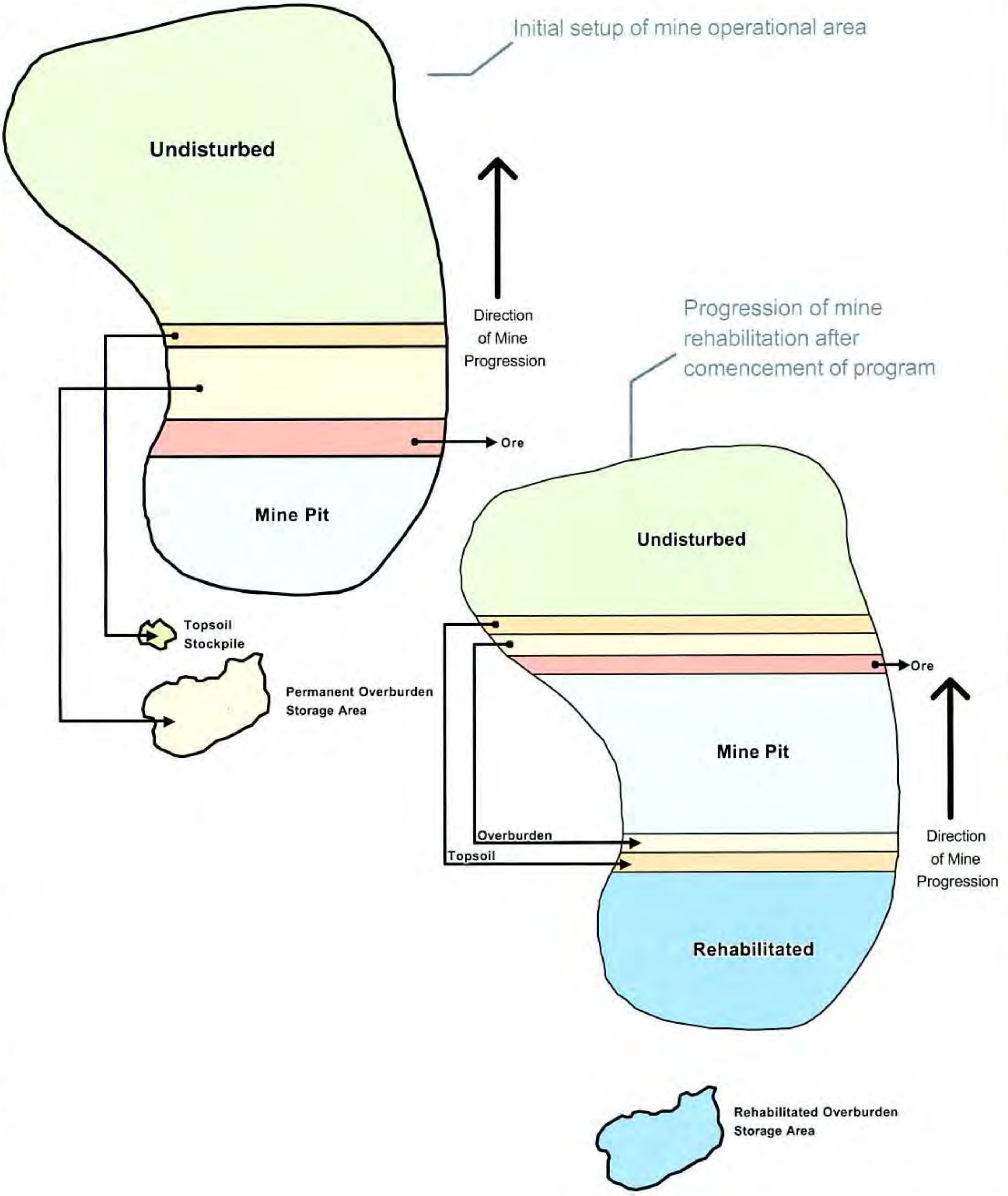
The rehabilitated and revegetated areas will be monitored to determine the progress of the programme. Monitoring is likely to be a combination of methods and may include photographic monitoring, transects and standard plot areas.

6. RESEARCH AND DEVELOPMENT

Throughout the project a number of research and development programmes will be undertaken. The information from these programmes will be incorporated into this management plan. The research and development programmes will aim to offset the disturbance that is caused by FMG's operations. These programmes have not been finalised however, may include the ecology and taxonomy of the mulga, revegetation trials, the success of water distribution techniques through culverts and seed collection and propagation of *Acacia aneura.*

Figures

Plan View



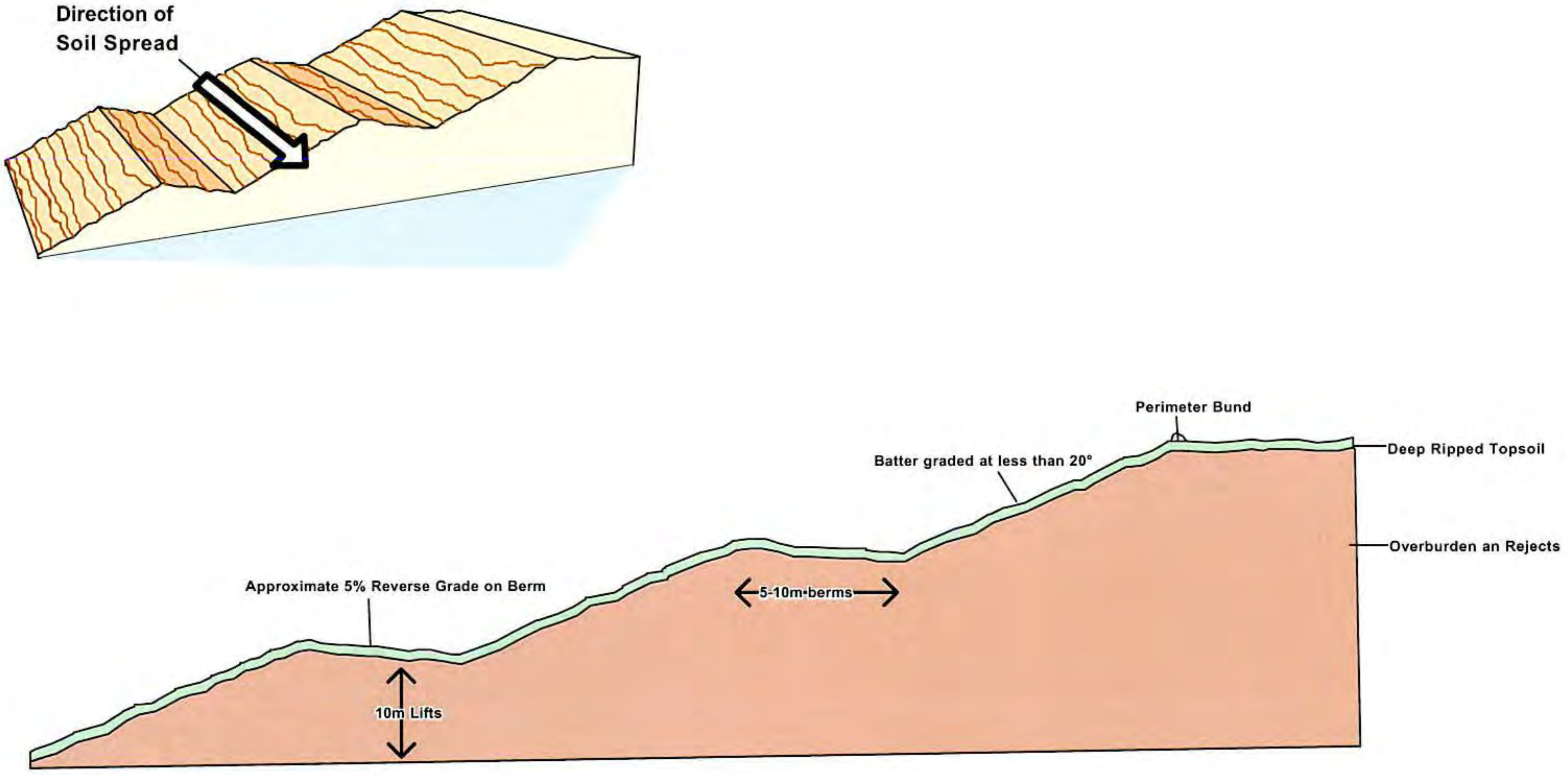
* Information shown is for conceptual purposes only and is not to scale or indicative of the actual pit/storage areas shape or size

Fortescue Metals Group Limited

Figure 1 Progression of Mine Rehabilitation Over Time

Author:	FMG	Date:	29/11/04
Drawn By:	A. Gregory	Revised:	06/01/05
Fig No.:	1	Report No.:	FMG 04095
Projection:	Unprojected	Scale:	Not To Scale

Figure 2 – Conceptual Mining Method (refer to Figure 27 in the Stage B PER)



* Information shown is diagramatic only
and is not to scale or indicative of
the actual pit/storage areas shape or size

Fortescue Metals Group Limited

Figure 3 Design Concept for Overburden Storage Area

Author:	FMG	Date:	29/11/04
Drawn By:	A. Gregory	Revised:	06/01/05
Fig No.:	3	Report No.:	FMG 04097
Projection:	Unprojected	Scale:	Not To Scale

APPENDIX ONE – DRAFT CLEARING PROCEDURE

Purpose

The purpose of this procedure is to manage and coordinate areas that require clearing. FMG aims to minimise the amount of area that is cleared at any one time.

Scope

Clearing permits are required for all clearing of vegetation on site (even previously disturbed areas), that have not been approved under the mine path plan.

Clearing Permits are our way of protecting native fauna and flora, not to mention the aesthetics of environment. It regulates how much clearing is done on site and it gives us a record of the clearing operations that have been undertaken.

Clearing Procedure

1. Contact the Environmental Department who will provide you with a clearing permit.
2. Fill out the form, detailing the reason for the work, a description of what clearing will be involved, the amount of clearing, a general description of the site and environmental management practices to be used whilst the clearing is being undertaken.
3. The Permit needs to be signed by person proposing to clear and the signature of the supervisor of the contractor or person carrying out the work.
4. Pass the plans on to the survey department who will survey the proposed area and attach plans to the permit.
5. Return the clearing permit to the Environmental Department who will carry out a site assessment.
6. Once the site assessment is carried out then the Environmental Department will approve / not approve the clearing proposal. Reasons for non approval may include rare flora and fauna located, aboriginal artefacts located, difficulties with the site in terms of position, erosion risk or the clearing can not be justified.
7. Once the clearing permit has an Environmental signature, it will be returned and the clearing can commence. Clearing will be checked to confirm all procedures have been adhered to.
8. A final survey is to be carried out of the area disturbed and the amount of topsoil stockpiled.

Responsibilities

Environmental Dept: Ensures that disturbance is carried out in an environmentally sound manner.

Area Managers: Ensuring that all employees under their control are aware of this procedure.

All Employees: Ensure that clearing permits are in place prior to any surface disturbance.

Document Control

Document Control will be as per FMG's Environmental Management System, which will be developed to the ISO14001 framework.

APPENDIX TWO – DRAFT TOPSOIL MANAGEMENT PROCEDURE

Purpose

Soil is of critical importance in relation to mined land rehabilitation because of the nutrients, mycorrhiza and native seed store it contains. Topsoil provides an essential resource for the establishment of vegetation on mine rehabilitation areas.

This Procedure has been developed to ensure that available soil resources are adequately managed, that the quantity and quality of the soil resource is maximised and that statutory obligations regarding soil removal and rehabilitation requirements are met.

Scope

This procedure applies to management of topsoil from areas that have been cleared as part of FMG's operations and includes the placement of topsoil at rehabilitated areas.

Topsoil Stripping

The key points of the Topsoil Stripping are:

- A vegetation survey of the area to be cleared is to be carried out prior to disturbance.
- Stripping of soil must proceed prior to the commencement of mining activities on undisturbed ground.
- Stripping involves the removal and stockpiling of all large shrubs and trees together with the pushing back of all unconsolidated soil materials including sand, loam and gravel.
- Topsoil will be stripped and where practicable returned directly to a rehabilitation area. If the topsoil must be stockpiled it will be done so for as short a time as possible. The topsoil is considered to be the top 250 mm of the soil profile. However, site specific surveys may identify areas that have differing levels of topsoil.
- If practicable subsoil will be stripped and managed separately.
- Subsoil is considered to be all sand, loam or gravel occurring deeper than 250mm from the surface within the soil profile. As with topsoil, surveys may indicate areas that have subsoil of greater or lesser depths.

- If topsoil requires stockpiling, they are to be layed out in strips no more than 2 metres in height and as close as possible to where they are to be used in future rehabilitation work. Cleared vegetation should be spread on the stockpiles.
- Subsoil stockpiles are to be placed adjacent to associated topsoil stockpiles. Subsoil stockpiles need not be restricted to 2 metres in height, depending upon the availability of storage space.
- A buffer zone of *at least* two bulldozer widths (10 metres) must be maintained between unstripped and mined areas to allow access to soil and vegetation stockpiles.
- Ideally, soil stripping should not proceed in wet conditions when handling and separation into constituent components may prove difficult and there may be some compaction of the soil profile in wetter conditions.

Clearing and Disturbance Notification

FMG has a clearing procedure. This procedure requires specific input including details relating to the reason for a particular area is to be cleared, its specific location and an estimate of the area to be cleared. Approval must be obtained prior to any clearing operations.

Topsoil Stockpiling

The stockpiling of topsoil will be kept to a minimum. Where practicable topsoil will be directly returned to rehabilitation areas. If topsoil requires stockpiling the time it is stored will be kept to a minimum (a few weeks were practicable). However, topsoil will require stockpiling during the initial start-up phase of a project area.

Scrapers will be used to strip topsoil and transport the topsoil to the rehabilitation areas. However, scrapers are only operational viable over short distances. It may therefore be necessary to store the topsoil in stockpiles for a short period, prior to it being loaded into trucks for transportation.

If it is practicable to strip the subsoil separately, it will be stockpiled *separately* in order to gain maximum benefit from each resource. Where gravels are present, these will be stockpiled together with stripped subsoil. Gravel has proven to be an exceptional growth medium and provides a valuable addition to the soil stockpile inventory.

Topsoil Inventories

If topsoil is to be stockpiled for an extended period, a topsoil inventory will be maintained with information collected including, but not limited to:

- Location by stockpile number, tenement, position in landscape and location description.
- Date reviewed.
- Stockpile dimensions - stockpile volume, surface area occupied by the stockpile, average maximum stockpile height and stockpile layout (piles or windrows).
- Stockpile characteristics - material type/colour, % sand, % gravel, % rock, presence of any boulders/rocks, presence of any rubbish/waste material and type of rubbish present.
- Resource availability - % of stockpile suitable for use as a growth medium and the stockpile volume suitable for rehabilitation use.
- Vegetation (growing on stockpile).
- Date stockpiled.
- Comments (if any).

As soon as an area has been cleared then a survey should pick up the area and volumes and passed on the Environmental Department who can update the topsoil inventory.

Responsibilities

Environmental Dept: Ensures that topsoil inventories are maintained

Area Managers: Ensuring that cost of topsoil stockpiling is added to clearing costs.

All Employees: Ensure that clearing permits are in place before topsoil removal and this procedure is adhered to.

Document Control

Document Control will be as per FMG's Environmental Management System, which will be developed to the ISO14001 framework.

APPENDIX THREE – DRAFT ROADS AND TRACKS REHABILITATION PROCEDURE

Purpose

A number of roads and access tracks are constructed throughout the life of a project. The rehabilitation of these roads and tracks are necessary to achieve FMG's closure objectives. The purpose of this procedure is to provide guidance on the necessary steps for the rehabilitation of a road and track.

Scope

This procedure applies to all roads and tracks constructed within FMG's areas.

Prior to the Rehabilitation of Roads and Tracks

Some of the roads and tracks that have been established on FMG areas may be required following the completion of FMG's operations. Therefore, consultation must be undertaken with relevant stakeholders prior to the rehabilitation of any roads or tracks. When approval has been given the rehabilitation may commence.

Rehabilitation of Roads and Tracks

When rehabilitating roads and tracks, the following will be adhered to:

- An assessment will be made to determine whether ripping of the road or track is appropriate. Roads and tracks that are on steep slopes or have vegetation re-established on them may not be ripped.
- Any ripping that occurs along slopes will have regular contour banks built across the track to minimise water erosion potential.
- Ripping of road and tracks will be done so to create an undulating broken surface in which seeds can become trapped and germinate in uncompacted soil, as well as assist in the infiltration of water into the soil profile.
- Vegetation that was pushed to the side of the track by the initial clearing of the tracks will be pulled over the ripped tracks to promote seed germination if practicable.
- When a track or road has been rehabilitated it will be appropriately signed to prevent traffic using the area.
- Roads and tracks will be monitored to determine the success of the rehabilitation and revegetation programme.
- If the establishment of vegetation does not achieve the stated criteria, the roads and tracks will be seeded with a native seed mix.

Responsibilities

Environmental Dept: Ensures that roads and tracks are not required prior to rehabilitation and determine the appropriate method to be adopted. Monitor the success of the rehabilitation.

All Employees: Ensure this procedure is followed when rehabilitating roads and tracks.

Document Control

Document Control will be as per FMG's Environmental Management System, which will be developed to the ISO14001 framework.

APPENDIX FOUR – DRAFT BORROW PIT REHABILITATION PROCEDURE

Purpose

A number borrow pits will be constructed throughout the life of a project. The rehabilitation of these areas is necessary to achieve FMG's closure objectives. The purpose of this procedure is to provide guidance on the necessary steps for the rehabilitation of borrow pits.

Scope

This procedure applies to all borrow pits constructed within FMG's areas.

Prior to the Construction of Borrow Pits

Prior to establishing a borrow pit, the following should be considered:

- Select borrow pit sites in accordance with minimal vegetation disturbance.
- Survey the area to be disturbed and plot on map.
- Clear vegetation with the dozer blade raised above the soil surface in order to preserve vegetation rootstock.
- Strip the top 250mm of topsoil and conserve in piles not more than 2 metres in height.
- Spread cleared vegetation over the topsoil stockpiles. This helps to keep the topsoil seed bank viable.
- The pit should be designed to be self draining where practicable. In addition the slope of the edges should be less then 20^{O}.

Rehabilitation of Borrow Pits

When rehabilitating borrow pits, the following will be adhered to:

- Use a bulldozer for rehabilitation work. Spacing between tines should be minimal to provide comprehensive ripping.

- Deep ripping is required, not simple scarification, to enable rip lines to hold up after heavy rainfall.

- Ripping to be done along contour, not up and down slope which leads to enhanced erosion.

- Topsoil to be re-spread across borrow pit evenly.

- Minimise bowl effect within pit, i.e. attempt to reduce the depth of the pit as far as is practicable to minimise ponding - surface ponding reduces the efficiency of revegetation, leading to bare patches or poor regrowth and potential erosion.
- Around the perimeter of the borrow pit, drag in undisturbed vegetation from up to 5m to break up edge-effect and promote seed distribution and mulching.
- All rubbish, equipment, etc, to be removed from the borrow pit.
- Clearly identify the borrow pits which have to be left open for future work.

Responsibilities

Environmental Dept: Ensures that rehabilitation of borrow pits are undertaken in an appropriate manner. Monitor the success of the rehabilitation.

All Employees: Ensure this procedure is followed when rehabilitating borrow pits.

Document Control

Document Control will be as per FMG's Environmental Management System, which will be developed to the ISO14001 framework.

Appendix E

Analysis of Alternative Rail Routes
by Townley & Associates Pty Ltd

(refer to CD of Technical Appendices)

Appendix F

Surface Hydrology Study

by Aquaterra Consulting Pty Ltd

(Peer Review by Townley & Associates Pty Ltd)

(Refer to CD of Technical Appendices)

Appendix G

Hydrogeology Study

by Aquaterra Consulting Pty Ltd

(refer to CD of Technical Appendices)

Appendix H

Socio-economic Assessment

by Environmental Resources Management Australia

(refer to CD of Technical Appendices)

Appendix I

Aboriginal Heritage Information

by Anthropos (on behalf of Yamatji Marlpa Barna Baba Maaja Aboriginal Corporation Inc.)

(refer to CD of Technical Appendices)

Appendix J

Flora and Vegetation Surveys

by Biota Environmental Sciences

(refer to CD of Technical Appendices)

Appendix K

Fauna Studies

by Biota Environmental Sciences

(refer to CD of Technical Appendices)

Appendix L

Stygofauna Survey

by University of Western Australia

(refer to CD of Technical Appendices)

Appendix M

Subterranean Fauna Management Plan

PILBARA IRON ORE PROJECT

SUBTERRANEAN FAUNA MANAGEMENT PLAN

Document Title:	**Subterranean Fauna Management Plan**
Document No:	
Document Type:	**Management Plan**

First Issue Date: **3rd December 2004**

Rev Code	**Issue Date**	**Description & Location of Revisions Made**	**Signatures**		
			Originator	**Checked**	**Approved**
0			**Nicky Hogarth**	**ENVIRON**	
1			**Nicky Hogarth**	**Mike Scanlon (CALM)**	**Laura Todd**

TABLE OF CONTENTS

1. INTRODUCTION

1.1 BACKGROUND

Fortescue Metals Group Limited (FMGL) is proposing to develop the Pilbara Iron Ore and Infrastructure Project (the Project), which involves a series of iron ore mines in the Pilbara region of Western Australia, and rail and port infrastructure for export of iron ore through Port Hedland. A 345 km long north-south railway will link the Mindy Mindy deposit (55 km northwest of Newman) with the port facility, and a 160 km east-west rail spur will link the Mt Nicholas, Mt Lewin and Christmas Creek deposits northeast of Newman, to the main north-south rail line just north of the Chichester Ranges (Figure 1).

The Project is currently being assessed under the Western Australian *Environmental Protection Act 1986*. For the purposes of the State environmental assessment process, FMG is assessing the Project in two stages:

- Stage A: Proposed port and north-south railway from Mindy Mindy to Port Hedland; and
- Stage B: The mining operations, and east-west rail spur

This Plan outlines an initial subterranean sampling program and methodologies to be carried out for the Stage B proposal. Initially the sampling program will be carried out biannually for a 2 year period, to provide baseline data on the population and distribution of stygofauna prior to the commencement of mining and commissioning of the borefields in early 2007.

Sampling events will occur in Jan 2005, June 2005, December 2005, June 2006 and December 2006 to account for seasonal variations. A long term sampling program will be developed by January 2007 if stygofauna is located within the Project area.

1.2 PURPOSE

Initial sampling by UWA in the Project area for stygofauna did not find any subterranean fauna, most likely due to lack of suitable sampling bores. As the Project occurs within suitable geological environments it has been assumed that stygofauna will habitat the study area and as such, a monitoring plan has been prepared.

This plan has been prepared in line with the EPA Guidance Statement No. 54 "Consideration of Subterranean Fauna in Groundwater and Caves during Environmental Impact Assessment in Western Australia".

1.3 SUBTERRANEAN FAUNA

Subterranean Fauna refers to both troglofauna (terrestrial subterranean fauna) and stygofauna (aquatic subterranean fauna).

Troglofauna occur in the air chambers in underground caves or other smaller voids. Due to the lack of likely troglofauna habitats occurring within the Project area, this plan is targeting stygofauna only.

Stygofauna (stygo meaning adapted to living underground) are obligate, groundwater dwelling fauna. They are typically strongly adapted for the subterranean environment, with features such as lack of pigment, elongated appendages and reduced or absent eyes. Many of these fauna have primitive features which link them to geological periods when the Pilbara was covered with rainforest. They are therefore regarded as 'relict' fauna which has survived in the aquifer over geological timeframes.

Stygofauna are known to be present in a variety of rock types including Karst (limestones), fissured rock (eg granite) and porous rock (eg alluvium) (Marmonier et al., 1993).

2. RELEVANT LEGISLATION

Two Western Australian State Acts are primarily relevant to the conservation and protection of subterranean biota and the assessment of proposals which may impact on them.

- *Environmental Protection Act 1986*
- *Wildlife Conservation Act 1950-1979*

3. EXISTING ENVIRONMENT

3.1 PREVIOUS STUDIES

Studies by the Department of Conservation and Land Management (CALM) and UWA, investigating the scope of stygofaunal diversity at the regional scale across the Pilbara region of Western Australia are ongoing. The sampling to date has revealed an extensive and diverse fauna from the ground waters of the Pilbara, with >200 species across all taxa being logged. As part of the Pilbara regional biological survey CALM have sampled a number of bores close to the Project area and the location of these are shown in Figure 2. The results of these surveys are still unknown as the samples have yet to be analysed. However FMG have approached CALM and an agreement was made to exchange data.

The University of Western Australia carried out a stygofauna sampling program within the Project area in September 2004. The objective of the survey was to determine if stygofauna were present in the groundwater to be affected by mine dewatering and water supply areas. Eleven bores were sampled; however no stygofauna was seen or recorded. Given the widespread occurrence of stygofauna though the Pilbara the lack of any stygofauna in the samples was unexpected. The likely reason for the absence of stygofauna in the bores, is that most of the bores had been recently installed for mineral exploration. Typically it takes months before stygofauna are recorded from new bores (UWA 2004). Figure 3 shows the location of bores sampled.

3.2 REGIONAL GEOLOGY

Figure 4 present a portion of the 1:200,000 Balfour Range (SF51-9) geological map sheet series. Figure 5 presents a portion of the 1:200,000 Roy Hill (SF50-12) and Newman (SF50-16) geological map sheet series.

The Project lies within the Hamersley Basin where granitoid rocks of the Pilbara Craton (2800 – 3500 Million years old), are overlain throughout most of the Project area by sedimentary rocks. The lowest of sedimentary group is known as the Fortescue Group, which is itself overlain, in parts, by the Hamersley Group. These sedimentary formations were originally formed in horizontal layers, but over time, tectonic movement has resulted in folding of the rocks and several major geological faults have developed. Weathering processes have resulted in erosion of some of these rocks into alluvium and colluvium. These eroded rocks include gravels, sands and clays, which have been deposited in the lower lying areas, including ancient river channels.

3.3 MINE GEOLOGY

3.3.1 Mount Nicholas

The iron ore at Mount Nicholas lies within the Hamersley Group, which has been subdivided into different formations. The lowest formation is the Marra Mamba Iron-Formation, which has been further divided into different members, of which the Nammuldi Member contains the highest ore grades. The Marra Mamba overlies the Jeerinah Formation, which is the top formation in the Fortescue Group.

At Mount Nicholas, the Nammuldi Member dips from southeast to northwest. To the west, it is concealed beneath layers of sands, clays and gravels, which are the weathered remnants of the surrounding rocks, whereas to the east, it has been eroded away and the underlying formations are now exposed at the surface. The iron ore therefore lies in a strip, which runs in a northeast – southwest direction.

3.3.2 Mount Lewin

Geologically, the Mount Lewin mine is similar to that at Mount Nicholas. As with Mount Nicholas the iron ore is located in the Nammuldi Member of the Marra Mamba Formation. However, unlike Mount Nicholas where the Marra Mamba Formation is completely covered by weathered material there are areas in the northern sections of the mine where the Marra Mamba outcrops at the surface.

3.3.3 Christmas Creek

The geology at Christmas Creek is similar to that at Mount Lewin. However there are some subtle differences. As at Mount Lewin, the Marra Mamba Formation at Christmas Creek dips in a southeasterly direction, but the gradient is shallower, so the formation appears at the surface as a broader outcrop than at Mount Lewin. Secondly, the weathered material overlying the southern section of the Christmas Creek mine is generally more coarse-grained than that overlying the southern area of Mount Lewin.

3.3.4 Mindy Mindy

The geological setting of Mindy Mindy is different to the other three sites. The ore is located in an ancient riverbed associated with the current-day Mindy Mindy Creek. Iron ore mineralisation in such Channel Iron Deposits (CID) results from chemical processes. At Mindy Mindy, this ancient channel passes through the Weeli Wolli Formation of the Hamersley Group for most of its length, with the most northerly section passing through Brockman Iron Formation. Unlike many CID deposits in the Pilbara, where the CID's occurrence is indicated by mesas formed by erosion of the surrounding rocks, the Mindy Mindy deposit lies below the surrounding topography.

3.4 HYDROGEOLOGY

In general, the water table throughout the region is a subdued reflection of the topography, so that groundwater levels are generally highest along topographic high points, and lowest in valley locations. However, because groundwater gradients are generally shallower than topography, the depth to the water table is generally least in low-lying areas and greatest along the mountain ridges. As a result, the Nammuldi Member, which dips across the Hamersley Basin, tends to be below the water table where it occurs in low-lying areas, and above the water table at higher elevations.

Within the mining areas the Nammuldi Member of the Marra Mamba Iron Formation and gravel deposits in the alluvium formations found at Christmas Creek, Mt Nicholas, Mt Lewin and Mindy Mindy are expected to host stygofauna.

3.4.1 Mount Nicholas

Investigations undertaken to date indicate the occurrence of two aquifers within the area of the proposed mine; both drain from east to west, towards the Fortescue River.

The most extensive aquifer is associated with an alluvial sequence that extends southeast from the lower slopes of the hills (below 480mRL) across to the Fortescue River channel. The alluvial deposits consist of clays, silts, sands and gravels and extend to depths of 70m. Over most of the area, the alluvial sequence is dominated by low permeability clays with occasional sand and gravel lenses. In these areas, the permeability is typically low (0.1 m/d). At some locations however, higher proportions of sands and gravels occur within alluvial fans and in these areas, permeability values of 0.5m/d have been recorded.

Mineralised sections of the Nammuldi Member form a second aquifer. Geophysical studies indicate the presence of significant faulting across Mount Nicholas. In general, these faults trend in a northeast-southwest orientation. Drilling amongst these faults has indicated that there is little evidence of increased permeability along these features.

Groundwater levels across Mount Nicholas have been measured in mineral bores, and bores drilled for the hydrogeological investigation. The data shows that groundwater levels vary from approximately 410mRL in the lower slopes at the southern end of the deposit, to 485mRL along the eastern ridge, in the northern-most part of the mine. Contouring of the groundwater levels shows that the water table is generally flat in the southern part of the mine, but there is an east-west hydraulic gradient in the northern sections. Groundwater in the Mt Nicolas region is generally fresh, with electrical conductivity typically in the order of 2,000 µS/cm at 25°C.

3.4.2 Mount Lewin

Bore drilling at, and in the vicinity of, the mine has determined that, as with Mount Nicholas, there are two aquifers to consider. The first is the alluvium, which, as at Mount Nicholas has been shown to consist mainly of clay and fine-grained material, and the second is the mineralised Nammuldi Member. At Mount Lewin, these aquifers dip in a southeasterly direction.

The Mount Lewin mine is bounded on the west by the Kulkinbah Creek and is dissected by the Kondy Creek. Both these creeks flow from northeast to southwest and into the Fortescue River. These creeks have been shown to be closely aligned to geological faults and have extensive alluvial fans associated with them. These fans consist of higher permeability material than the surrounding alluvial clays.

Water quality analysis showed that water in the ore body and in the alluvium was fresh, with electrical conductivities typically of 2200 µS/cm at 25°C.

3.4.3 Christmas Creek

There has been an extensive programme of bore drilling, hydraulic testing and water sampling in the Christmas Creek area to determine the existing hydrogeology. In particular, studies have been undertaken to determine the relationship between the Fortescue Marsh and surrounding aquifers.

The investigation has shown that there are two aquifers in the vicinity of the mine, and a third to the south, close to the Fortescue Marsh. The first is within the alluvial deposits that occur below 450mRL, and which dip to the southwest, becoming increasingly thicker towards the Fortescue Marsh where the sequence was proven to be 60m thick. These deposits consist mainly of fine-grained material, with occasional gravel lenses. Hydraulic tests have shown that the alluvium is more permeable that at Mount Nicholas, with values of the order of 1m/d.

The second aquifer is the Nammuldi Member of the Marra Mamba Iron Formation, which dips in a southwesterly direction to a depth of approximately 100m. Tests have indicated that permeability values are generally in the order of 3 m/d.

In one bore, (F2), Wittenoom Dolomite was encountered at depth. This formation, which is part of the Hamersley Group, is an aquifer in other parts of the Pilbara.

Measurements have shown that to the north of the rail corridor the water table is generally below the base of the alluvium, but that on, and south of, the proposed railway, the alluvium is partially saturated. Water samples have shown that groundwater in the alluvium is generally fresh with Electrical Conductivity values typically 2,600 µS/cm. The conductivity of water in the alluvium increases towards the Fortescue Marsh, with a maximum value of 6,000 µS/cm measured.

In the northern tenements, the Nammuldi Member is above the water table. Measurements in bores in the southern parts of the proposed mine show that the ore is partially or fully saturated with fresh groundwater, but that, below the ore zone, hyper-saline water occurs. Drilling to the south of the proposed mine indicates that the Marra Mamba and Jeerinah Formations are saturated with hyper-saline water. Measurements of electrical conductivity in bores intercepting hyper-saline water were typically in the order of 150,000 µS/cm.

Monitoring of groundwater levels in specially constructed bores close to the Fortescue Marsh indicate that the relatively fresh water in the alluvium and the hyper-saline water in the Marra Mamba and Jeerinah Formations have the same potentiometric head.

From the water samples taken, it is evident that the salinity of groundwater in the alluvium, Marra Mamba and Jeerinah formations increases towards the Fortescue Marsh. The highest recorded salinity in the Fortescue Marsh itself was in October, when electrical conductivity was 19,000 µS/cm, an order of magnitude lower than the hyper-saline groundwater in the underlying Marra Mamba and Jeerinah Formations, but similar to values in the alluvium.

3.4.4 Mindy Mindy

The alluvium will form a primary porosity aquifer where saturated. However, the alluvium is generally only saturated in the centre of the valley in the north-west of the site. The alluvium is likely to be in hydraulic continuity with the underlying CID.

A Channel Iron Deposit (CID) has been deposited within the palaeo-valley. The CID is up to 34 m thick. The CID is typically goethitic and limonitic, and is pisolitic in parts. The CID is typically highly porous and vuggy with significant secondary permeability from joints and solution cavities. The upper surface of the CID has been weathered forming a Surface Weathered Profile (SWP). The SWP is likely to have a higher permeability than the unweathered CID due to greater degree of weathering enhancing the secondary porosity.

Basement rocks in the area comprise the Brockman Formation and the Weeli Wolli Formation of the Hamersley Group. The Weeli Wolli Formation forms the basement to most of the site. The Weeli Wolli Formation comprises banded iron-formation (BIF) together with shale and dolerite. The Brockman Formation forms the basement in the north of the site. The Brockman Formation comprises banded iron formation with shale and chert. The Weeli Wolli Formation and Brockman Formation form fractured rock aquifers, with secondary porosity from fractures, ore-mineralisation, weathered horizons, joints and bedding planes. The Weeli Wolli and Brockman Formations are generally considered to form poor aquifers.

The depth to groundwater ranges from approximately 8 m below ground level (bgl) to 50 m bgl. Groundwater generally flows down the valley flowing approximately south-east to north-west.

4. SAMPLING PLAN

The proposed sampling program aims to satisfy the EPA'a requirement's outlined in Guidance Statement 54, to ensure that adequate protection is given to important habitats for these species. The following points have been considered during the development of this sampling plan:

- Subterranean fauna sampling will be undertaken in areas affected by dewatering and borefield operations to assist in establishing the conservation significance of any species within the affected areas.

- Characterisation of subterranean fauna habitats will be undertaken in the area to be affected by the dewatering operations and borefield operations, and identification of similar subterranean fauna habitats out side the affected areas.

- Subterranean fauna surveys will be carried out in similar habitats outside the areas to be affected by dewatering and borefield operations to assist in establishing the conservation significance of fauna within the areas to be affected.

- Specific measures to record and preserve biological information on any species collected in the Project area will be undertaken.

4.1 SAMPLING PROGRAM

The proposed sampling program has been chosen to provide a representation of the range of geological and hydrogeological structures in the area and intersect a range of potential habitats around the proposed mine and borefield environments and also more regionally. Table 1 shows the proposed bores identified for the sampling program.

The selection criteria for the bores that are proposed to be sampled include the following:

- Geological Setting – bores were selected which were likely to have intersected a geological sequence, where there was potential for stygofauna to exist.
- Regional Distribution – a broad range of locations were chosen to provide representative distributions across a number of geological and hydrogeological environments, both in the immediate Project area and the surrounding district.

Figure 6 shows the location of bores to be sampled for stygofauna within the immediate proposed mine and borefield areas and also more regional bores.

Initially the sampling program will be carried out biannually for a 2 year period, to provide baseline data prior to the population and distribution of the stygofauna prior to the commissioning of the mines and borefields in early 2007.

Sampling events will occur in Jan 2005, June 2005, December 2005, June 2006 and December 2006. A long term sampling program will be developed by January 2007 if stygofauna are located within the study area.

As the Project is in its initial stages, there are limited bores which are suitable for stygofauna sampling. As the Project becomes more advanced additional bores may be added to the sampling program and less suitable bores will be subtracted.

Table 4.1

Proposed Bores for Subterranean Sampling

Bore ID	Easting (MGA94)	Northing (MGA94	Total Depth (m)	Area Station	SWL	Casing Details	Geology /Aquifer Type	Comments
Kullawarri Well	237604	7496984	24.380	Norrena Downs	N/A	N/A	Calcrete and soil	Located on low calcrete rise
WSE 28	237677	7494412	106	Balfour Downs	48.3	50mm uPVC	Unconfined Alluvial /Marra Mamba Aquifer	
Limestone Bore	246641	7481374	24.3	Balfour Downs	N/A	N/A	Outwash with Calcrete	Adjacent to a drainage line on a low calcrete rise.
Hole 64	240925	7472213	N/A	Balfour Downs	N/A	N/A	Alluvium/Marra Mamba	
Badgeannah Well	227976	7460257	14.6	Ethel Creek	N/A	N/A	Alluvium	
22 Bore	238039	7455081	N/A	Ethel Creek	N/A	N/A	Alluvium	
17 Mile Well	213263	7485911	N/A	Roy Hill	N/A	N/A	Alluvium	
9 Mile Bore	200714	7499738	N/A	Roy Hill	N/A	100mm PVC no collar	Alluvium	
Mt Lewin Drillers Bore	212600	7492050	N/A	Roy Hill	N/A	N/A	Alluvium/Marra Mamba	

Bore ID	Easting (MGA94)	Northing (MGA94	Total Depth (m)	Area Station	SWL	Casing Details	Geology /Aquifer Type	Comments
Old Well	210615	7490400	N/A	Roy Hill	N/A	N/A	Alluvium	
Knuckleduster Bore	800884	7482757	11.5	Roy Hill	N/A	N/A	Alluvium	
Eaton Bore	799072	7479803	N/A	Roy Hill	N/A	N/A	Alluvium	
Bore near Mt McKay	807181	7514786	N/A	Roy Hill	N/A	150mm PVC with concrete collar	Alluvium	
Parker Bore	779272	7523229	32.9	Roy Hill	N/A	N/A	Alluvium/Marra Mamba	Located on hardpan plain
22 Mile	781855	7517724	N/A	Roy Hill	N/a	N/A	Alluvium	
F7A	782007	7517844	82	Roy Hill	14.05	50mm uPVC	Marra Mamba Aquifer (Nammuldi Member)	Intersects hypersaline water drilled in the calcrete aquifer

Bore ID	Easting (MGA94)	Northing (MGA94	Total Depth (m)	Area Station	SWL	Casing Details	Geology /Aquifer Type	Comments
New Roy Hill Bore	801787	7503658	N/A	Roy Hill	N/A	N/A	Alluvium	
Emu Well	790476	7543653	N/A	Bonney Downs	N/A	N/A	Maddina Basalt	
Bonney Downs Bore?	806238	7523712	N/A	Bonney Downs	N/A	150mm PVC with concrete collar	Jeerinah Formation	
Prairie Bore	760683.00	7476376	34.75	Marillana	N/A	N/A	Alluvium	Windmill
Fred Bore	754894.00	7478882	39.9	Marillana	N/A	N/A	Alluvium	
Nelson Bore	744725.00	7492965	34.4	Marillana	N/A	N/A	Alluvium	Windmill
Pugs Bore	738164.00	7492720	34.1	Marillana	N/A	N/A	Alluvium	Bore situated on mulga hardplain

4.2 SAMPLING METHODOLOGY

All sampling and interpretation of results will be carried out by suitably qualified experts.

Sampling will be carried out using established techniques of bore bailing, by utilising a standard plankton net design. Various sizes of mesh plankton nets will be used with a range of diameters to accommodate the range of bore holes present within the study area. Nets will be dropped to slightly above bottom on the first sample, allowed to settle for a few minutes, and then pulled to the surface. On subsequent sampling the bottom will be agitated using a weighted line raising to hauling to the surface in an attempt to mobilise sediment infauna.

In order to minimise the risks of accidentally transferring collected fauna from one hole to the next (cross contamination) a sampling hygiene procedure will be put in place. This will consist of thoroughly washing all nets and sample vials to remove all sediment and other material prior to reuse at the next location.

Physical water quality data (salinity, pH, dissolved oxygen, turbidity and electrical conductivity) will be collected in conjunction with stygofaunal sampling. All sampling will be collected in accordance with Australian *Standard AS/NZS 5667:1998*

Live and Dead specimens would be stored in vials containing 100% ethanol for morphological identification and provision for potential DNA analysis at a future date. In some cases a sub sample may be preserved in 10% Formalin to carry out morphological work.

Specimens will be identified to the lowest known taxonomic unit possible, using genetic testing methods where appropriate to assist in determining taxonomic relationships. Voucher specimens will be lodged with the Western Australian Museum and, if appropriate, other institutions, in order to facilitate the exchange of information between interested parties.

5. IMPACTS AND MANAGEMENT

Potential impacts from mining operations on stygofauna may include the following:

- Sealing of aquifers as a result of clearing

- Pollution (e.g. chemical pollutants from fuel farms, accidental spills, sewage, unlined landfills, and direct discharge of wastes into streams and aquifers.
- Nutrient enrichment of groundwater, which may lead to invasion by surface dwelling forms.
- Aquifer dewatering for operations mining below the water table.
- Aquifer extraction for water supply.

Results of the initial sampling program will be assessed after a 2 year period and a long term sampling plan will be developed if stygofauna has been identified within the Project area. Impacts and management of stygofauna will be dealt with at this time.

Table 5.1 summaries the types of management approaches which may be employed to minimise the impact on subterranean communities.

Table 5.1

Potential impacts on subterranean fauna and management strategies

Potential Impact	Management Strategies
Sedimentation and	Best practice drainage design
Pollutants	Settlement basins, sediment traps and gross pollutant traps to intercept drainage prior to discharge to the environment in Alluvial / Karstic terrain
	Adequate maintenance of drainage treatment infrastructure.
Abstraction	Maintaining pumping rates at the minimum for operational requirements
Dewatering	Monitoring of pumping rates and cone of depression.

6. REPORTING

Results of the Stygofauna sampling plan will be reported in the Annual Environmental Report which is submitted to the Department of Environment (DoE) and the Department of Industry and Resources (DoIR) on an annual basis. Results will also be submitted to the Environmental Protection Authority, Department of Conservation and Land Management and the West Australian Museum. FMG will also make the results of the sampling program publicly available if required.

7. REFERENCES

Biota Environmental Services (2001). *Resources Development and Subterranean Biota in the Pilbara Region – Management and Approval Process*. Submission to the EPA advisory scope for BHP Iron Ore Pty Ltd. June 2001.

Environmental Protection Authority (2003). *Consideration of subterranean fauna in groundwater caves during environmental impact assessment in Western Australia*. December 2003.

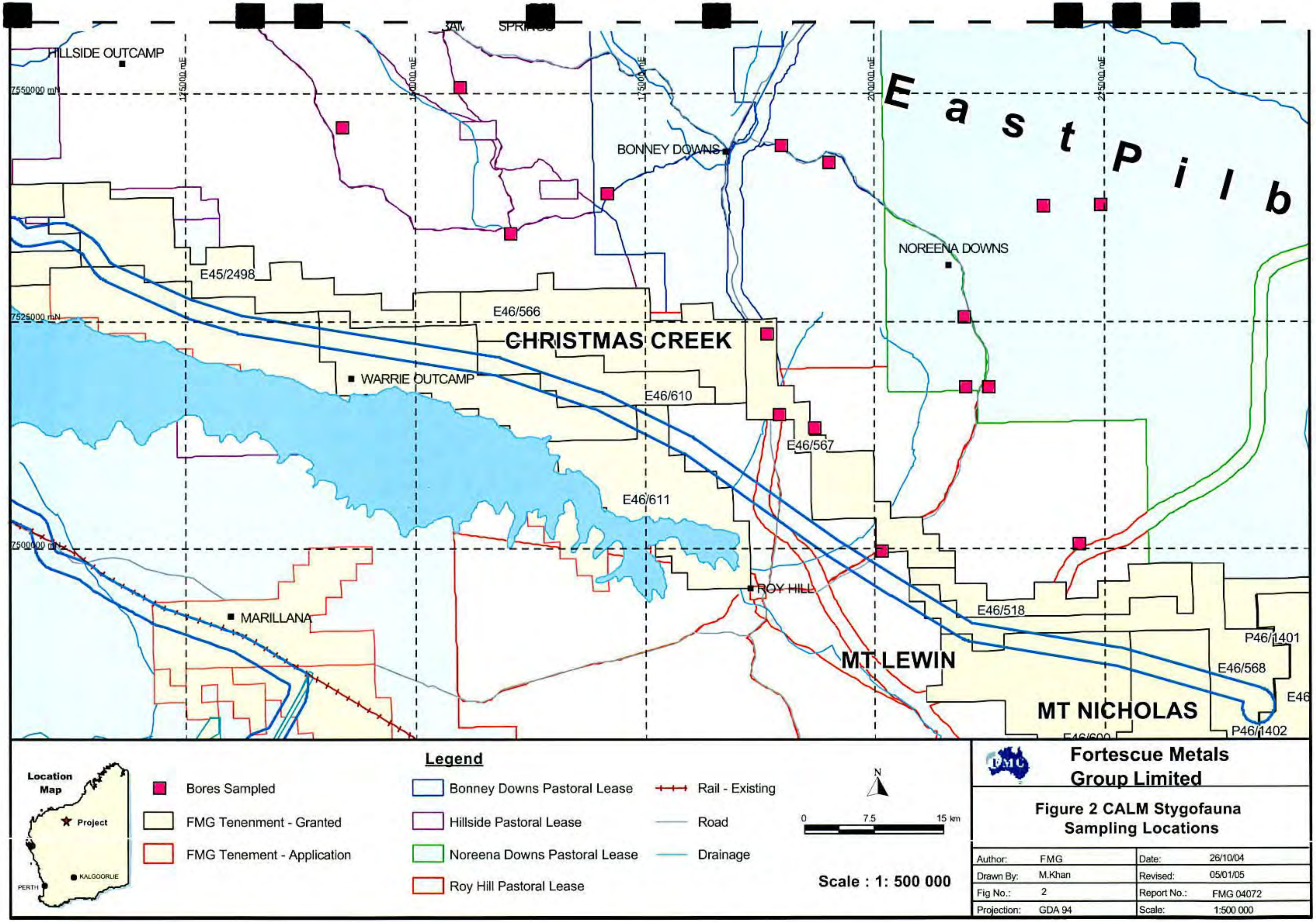
Mamonier, P., Vervier, P., Gilbert, J., and Dole-Oliver, M.J. (1993). Biodiversity in Groundwaters. TREE 8(11): 392-395

UWA (Brenton Knott and Sarah Goater) Pilbara Iron Mine Sites – Subterranean Sampling, September 2004.

FIGURES

Figure 1 – Project Location

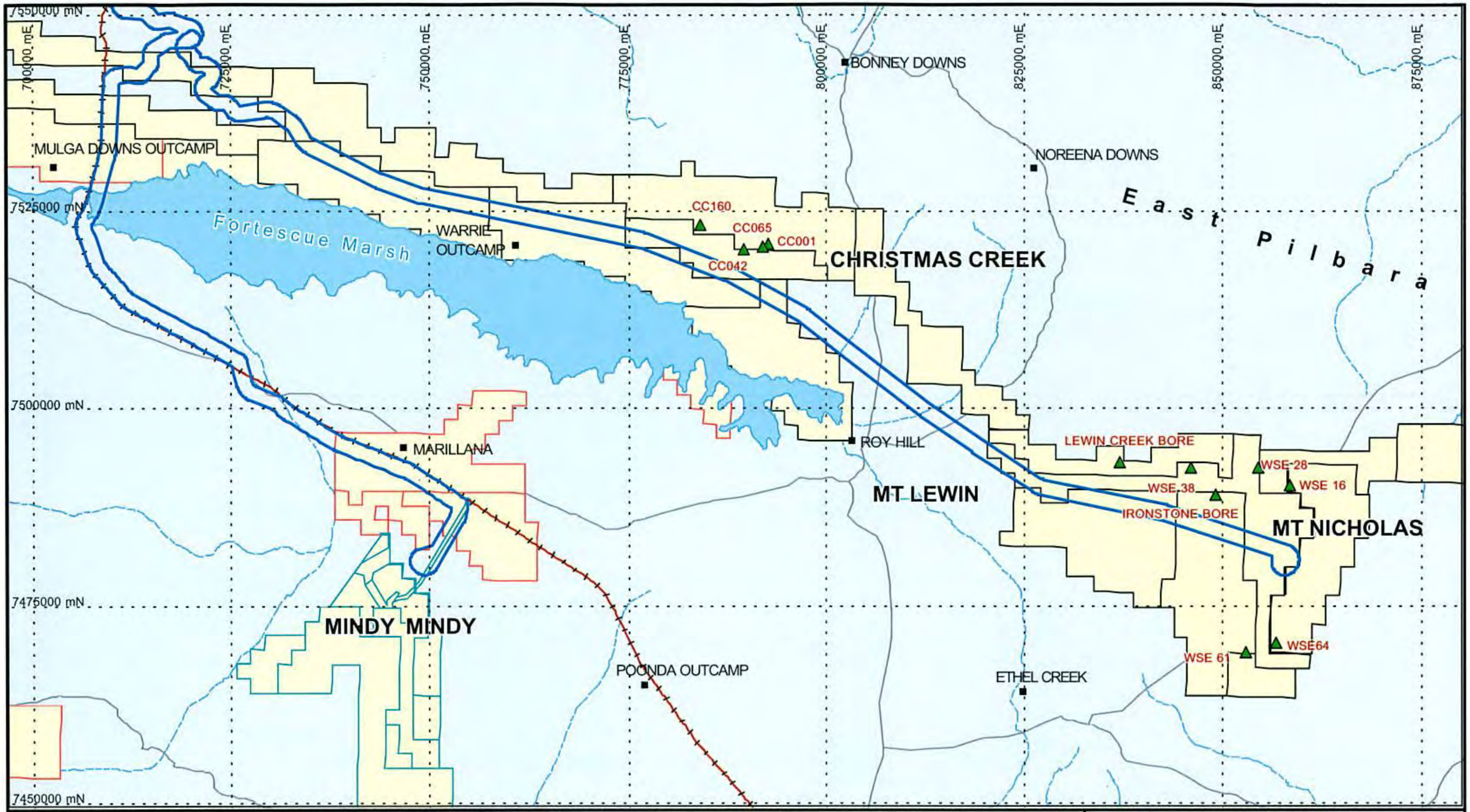
(refer to Figure 1 in Stage B PER)



Fortescue Metals Group Limited

Figure 2 CALM Stygofauna Sampling Locations

Author:	FMG	Date:	26/10/04
Drawn By:	M.Khan	Revised:	05/01/05
Fig No.:	2	Report No.:	FMG 04072
Projection:	GDA 94	Scale:	1:500 000



Legend

▲	Bores Sampled
▭	FMG Tenement - Granted
▭	FMG Tenement - Application
▭	Mind Mindy JV
▭	Proposed FMG Rail Corridor
┼┼┼	Rail - Existing
—	Road
- - -	Drainage

Fortescue Metals Group Limited

Figure 3 UWA Stygofauna Sampling Locations, September 2004

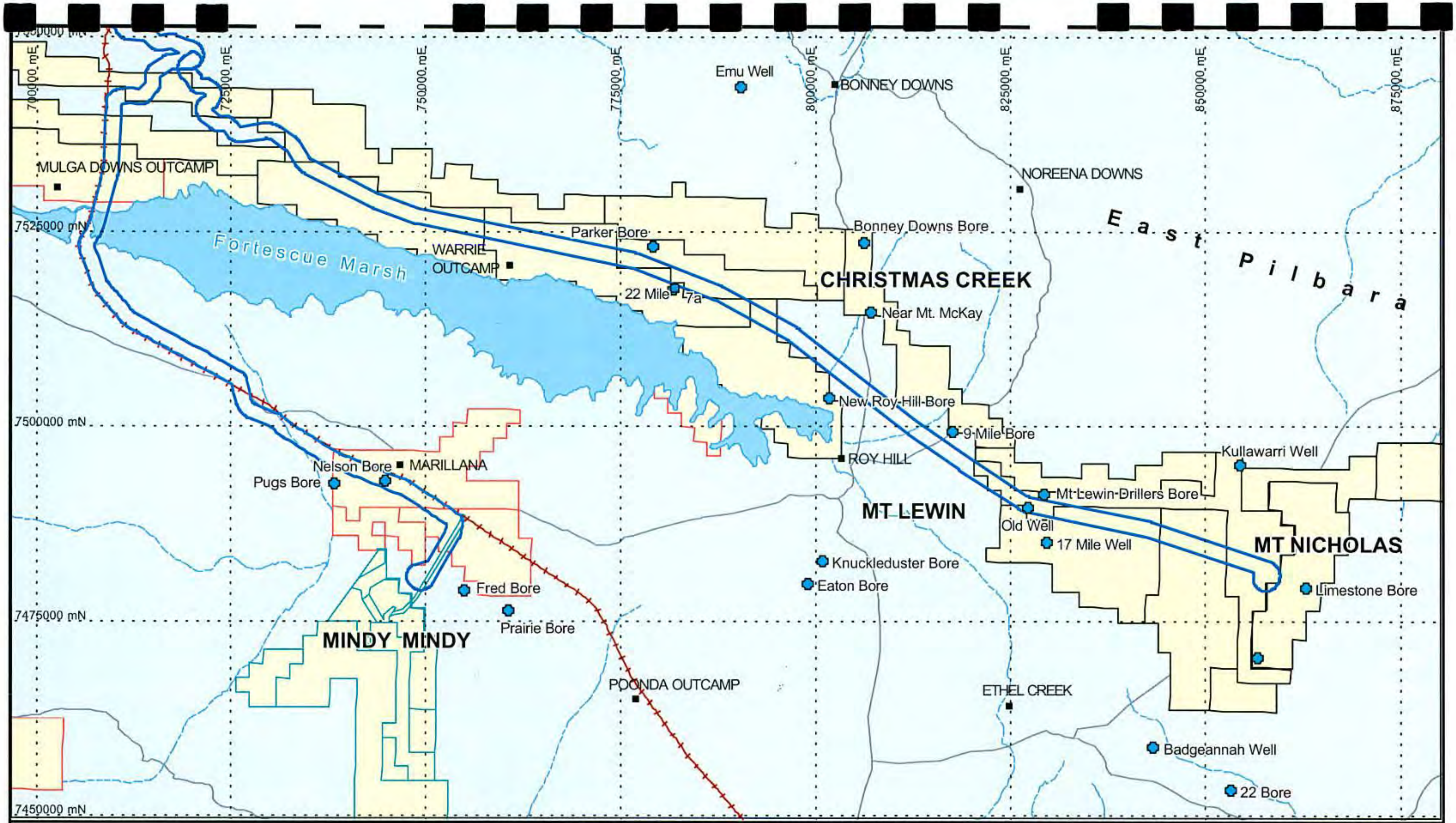
Author:	FMG	Date:	26/10/04
Drawn By:	M.Khan	Revised:	05/01/05
Fig No.:	3	Report No.:	FMG 04072
Proje	GDA	cale:	1:650

Figure 4 – Regional Geology Mt Lewin and Mt Nicholas

(refer to Figure 7 in Stage B PER)

Figure 5 – Regional Geology Christmas Creek and Mindy Mindy

(refer to Figure 8 in Stage B PER)



Legend

▲ Bores Sampled

▭ FMG Tenement - Granted

▭ FMG Tenement - Application

▭ Mind Mindy JV

▭ Proposed FMG Rail Corridor

+++ Rail - Existing

— Road

---- Drainage

0 7.5 15 km

N

Fortescue Metals Group Limited

Figure 6 Proposed Stygofauna Sampling Locations, September 2004

Author:	FMG	Date:	26/10/04
Drawn By:	M.Khan	Revised:	05/01/05
Fig No.:	6	Report No.:	FMG 04072
Projection:	GDA 94	Scale:	1:650 000

Appendix N

Fortescue Marsh Risk Assessment

by minRISK Pty Ltd

(refer to CD of Technical Appendices)

Appendix O

Assessment of Acid Mine Drainage Potential

by Graeme Campbell & Associates

(refer to CD of Technical Appendices)

Appendix P

Noise and Vibration Assessment

by Lloyd Acoustics

(refer to CD of Technical Appendices)

Appendix Q

Conceptual Mine Closure Plan

(refer to CD of Technical Appendices)

Appendix R

Stakeholder Consultation Undertaken

Summary of Stakeholder Issues & Responses for Stage B
Pilbara Iron Ore & Infrastructure Project

Date	Issue	Raise by stakeholder(s)	Method used for responding to Issue	Response provided / result (Was an amendment made to original proposal in response to issue?)	Refer to PER section
7/4/04	Concerned about impact on groundwater supply.	Resident	Verbal discussion	Any affect to water supply to other users, would need to be replaced or otherwise managed by the company. FMG have undertaken studies to determine potential impact on water supplies to pastoral and other users.	6.2.8
22/6/04	How will FMG deal with erosion issues for tracks around mine sites?	Govt Dept	Verbal discussion	Studies will be undertaken to ensure that erosion on roads will be minimised. Ongoing monitoring will be undertaken to determine potential erosion areas and repaired as soon as practicable. Erosion protection works will be installed on the culvert inlet and outlet zones, to manage potential adverse scouring effects.	6.1 6.3.3
21/6/04	Will any dewatering be required at mine sites and if so how will this be managed?	NGO	Meeting	All mine sites will require dewatering. Any excess water will be managed to minimise environmental impacts (such as creation of artificial ecosystems).	6.2
21/6/04	How will you ensure the mine sites use brackish water instead of potable water sources?	Govt Dept	Meeting	In development of the mine water supply borefield, a preference will be to develop non-potable water supplies over potable water supplies, if different qualities of water are shown to be available in Hydrogeological studies.	6.2

Summary of Stakeholder Issues & Responses for Stage B
Pilbara Iron Ore & Infrastructure Project

Date	Issue	Raise by stakeholder(s)	Method used for responding to Issue	Response provided / result (Was an amendment made to original proposal in response to issue?)	Refer to PER section
21/6/04	Concerns raised regarding Mulgas: 1. Rail line will need to be as high as possible in the Chichester foot hills. 2. Any depression will need to have appropriate drainage eg. Culverts. 3. Gravel/ballast pits and sizes will need to be identified and advised to CALM.	Govt Dept	Meeting	All concerns raised will be reviewed a appropriate Government Departments consulted. 1. FMG's studies have shown that placing the rail line high in the landscape is not always the best option. 2. FMG will ensure adequate culverting, with culverts placed frequently along the railway line where there are depressions. 3. Gravel/ballast pits will be located and designed to avoid environmental impacts and finalized in consultation with CALM and DoE.	6.1 5.4.2 Appendix F
3/7/04	Concerned on the impact to the Chichester Range.	NGO	Meeting	Advised that FMG will not be disturbing the whole of the Chichesters and that our mine sites are small in comparison. FMG is proposing 4 mine sites which will be rehabilitated progressively. Offered opportunity for this group to have input into FMG's rehabilitation program.	5 6.12 6.14.3
3/7/04	Concern regarding the possibility of Public access to the project	NGO	Meeting	During construction and operation of the project public access to the project area will be restricted Our mining operations will be on pastoral leases so	5.5.6 6.14.2

Date	Issue	Raise by stakeholder(s)	Method used for responding to Issue	**Response provided / result** (Was an amendment made to original proposal in response to issue?)	Refer to PER section
	area.			these needs to be taken into consideration as well.	
4/11/04	Concern that not enough focus was put on alternative rail routes	Govt Dept		Advised that FMG has conducted a study assessing the alternative routes and that it is presented in the PER	5.2
28/10/04	Rail Alternatives need to be assessed with more rigor	Govt Dept	Meeting	As Above	5.2
22/11/04	Housing Availability is a concern in the town of Newman	Community Group	Verbal	FMG are aware of the limited vacancy rate in the town of Newman and have held discussions with the Shire of East Pilbara and Landcorp and are currently involved in the Pilbara Development Commission, Central Pilbara Coordinating Taskforce which are looking at many issues in the Central Pilbara, including housing. This group is looking at housing requirements for industry as a whole.	6.14
22/11/04	Indigenous employment is a contentious issue as other employers in town do not necessarily employ local indigenous people.	Community Group	Verbal	Advised that FMG will endeavour to employ and train local aboriginal people in the first instance. FMG will also be implementing an Vocational Training and Employment Centre for local indigenous people which will incorporate meaningful training with guaranteed employment.	6.14