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Delivering tomorrow's Iron Ore

MARILLANA IRON ORE PROJECT

PUBLIC ENVIRONMENTAL REVIEW

EPA Assessment No. 1781

May 2010

ecologia ENVIRONMENT

BROCKMAN RESOURCES LIMITED

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March 2010

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11	K. van der Beeke		29/03/10	C. Paterson	OEPA	29/03/10

***ecologia* Environment**

1025 Wellington Street

WEST PERTH WA 6005

Phone: 08 9322 1944

Fax: 08 9322 1599

Email: admin@ecologia.com.au

www.ecologia.com.au

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BROCKMAN MARILLANA IRON ORE PROJECT

Invitation to Make a Submission

The Environmental Protection Authority (EPA) invites people to make a submission on this Proposal. The environmental impact assessment process is designed to be transparent and accountable, and includes specific points for public involvement, including opportunities for public review of environmental review documents. In releasing this document for public comment, the EPA advises that no decisions have been made to allow this proposal to be implemented.

Brockman Iron Pty Ltd proposes to develop a new iron ore mine at Marillana, approximately 100 km from Newman. The proposal location abuts the Hamersley Ranges, is dissected by the Weeli Wolli Creek and is bounded by the Fortescue Marsh, some 15 km to the north. Brockman propose to mine iron ore at a rate of up to 19 Mtpa for approximately 20 years.

This document covers the assessment of the Marillana Iron Ore Project. In accordance with the *Environmental Protection Act 1986* (WA), 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 for 4 weeks from Monday 10 May 2010 and closing on Tuesday 8 June 2010.

Comments from government agencies and from the public will help the EPA to prepare an assessment report in which it will make recommendations to the Minister for the Environment. If you are able to, the EPA would welcome electronic submissions in particular, emailed to the project assessment officer or via the EPAs website (see contact details below).

Where to get copies of this document

Printed copies of this document may be obtained, at a cost of $10, from:

Garry Connell
ecologia Environment
1025 Wellington St
WEST PERTH WA 6005
Phone: (08) 9322 1944

A CD version of the PER can be obtained, at no charge, from the above contact. Copies of the PER may also be downloaded from the proponent website, which is www.brockman.com.au/projects_environmentalreview.html.

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. Electronic submissions will be acknowledged electronically. The proponent will be required to provide adequate responses to points raised in submissions. In preparing its assessment report for the Minister for the Environment, the EPA will consider the information in submissions, the proponents responses and other relevant information. Submissions will be treated as public documents unless provided and received in confidence subject to the requirements of the *Freedom of Information Act 1992*, and may be quoted in full or in part in the EPA's report.

Why not join a group?

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

Developing a submission

You may agree or disagree with, or comment on, the general issues discussed in the PER or the specific proposal. It helps if you give reasons for 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 proposals in 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 and address;
- Date;
- If 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: **8 June 2010**.

The EPA prefers submissions to be sent in electronically using one of the following:

- the submission form on the EPA's website: www.epa.wa.gov.au/submissions.asp; ot
- by email to eia@dec.wa.gov.au

Alternatively submissions can be

- posted to: Chairman, Environmental Protection Authority, Locked Bag 33, CLOISTERS SQUARE WA 6850, Attention: Danielle Griffiths; or
- delivered to the Environmental Protection Authority, Level 4, The Atrium, 168 St Georges Terrace, Perth, Attention: Danielle Griffiths; or
- faxed to (08) 6467 5562.

If you have any questions on how to make a submission, please ring the Office of the EPA assessment officer, Danielle Griffiths on 6467 5440.

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Note - Appendices are provided on a CD inside the rear cover of this document.

GLOSSARY OF TERMS AND ABBREVIATIONS

ABN	Australian Business Number
ACHM	Australian Cultural Heritage Management Pty Ltd
ACN	Australian Corporate Number
AER	Annual Environmental Review
AHD	Australian Height Datum
ANZMECC	Australian and New Zealand Minerals and Energy Council
ARI	Average Recurrence Interval
ASX	Australian Stock Exchange
BHPB	BHP Billiton
BIF	Banded Iron Formation
BOM	Bureau of Meteorology
CALM	Department of Conservation and Land Management
CAMBA	China-Australia Migratory Bird Agreement
CCP	Conceptual Closure Plan
CID	Channel Iron Deposit
CRS	Course Rejects Stockpile
CWR	Critical Weight Range
DCC	Department of Climate Change
DEC	Department of Environment and Conservation
DEWHA	Department of Environment, Water, Heritage and the Arts
DFS	Definitive Feasibility Study
DIA	Department of Indigenous Affairs
DMP	Department of Mining and Petroleum
DoH	Department of Health
DoIR	Department of Industry and Resources
DoW	Department of Water
DSO	Direct Ship Ore
DTIR	Department of Tourism, Industry and Resources
EA	Environment Australia
EIA	Environmental Impact Assessment
EMB	Environmental Management Branch (DEC)
EMP	Environmental Management Plan
EMS	Environmental Management System
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999

ERA	Environmental Risk Assessment
FRS	Fines Rejects Storage Facility
GL	Gigalitres
GWMP	Groundwater Management Plan
ha	Hectare
HME	Heavy Mining Equipment
IBRA	Interim Biogeographic Regionalisation for Australia
ICMM	International Council on Mining and Metals
IFRS	In-pit Fines Rejects Storage
ISO	International Organization for Standardization
ISO 14001	International standard for environmental management systems
JAMBA	Japan-Australia Migratory Bird Agreement
LNG	Liqified Natural Gas
MAR	Managed Aquifer Recharge
Mbcm	Million Bank Cubic Meters
MCA	Minerals Council of Australia
Mbgl	Meters Below Ground Level
MIB	Martu Idja Banyjima
Mlcm	Million Loose Cubic Meters
MLpa	Megalitres per Annum
mRL	Relative Level
Mt	Million Tonnes
Mtpa	Million Tonnes per Annum
MW	Megawatt
NAF	Non-Acid Forming
NG	Natural Gas
PEC	Priority Ecological Community
PER	Public Environmental Review
PFS	Pre-Feasibility Study
ROM	Run of Mine
SoEP	Shire of East Pilbara
SRE	Short Range Endemic
SWMP	Surface Water Management Plan
TEC	Threatened Ecological Community
TDS	Total Dissolved Soilds
THD	Tertiary Hematite Detrital

µS/cm	Microsiemens per centimetre
WAM	Western Australian Museum
WRC	Water and Rivers Commission
WRD	Waste Rock Dump
WWTP	Waste Water Treatment Plant

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EXECUTIVE SUMMARY

PROJECT DESCRIPTION

The proposal nominated by Brockman Iron Pty Ltd (Brockman) for which approval is sought from the Minister for the Environment is the Marillana Iron Ore Project (the Project) which consists of a 700-750 Mt iron ore mine, processing facility and associated infrastructure located within the Pilbara of Western Australia. It is anticipated that traditional open pit mining methods of excavating, load and haul will be utilised for the pit development, and that the mine will produce 17-19 Mt of beneficiated ore per annum.

The Project is located within mining leases M47/1414 and M47/1419 which have been granted. The project area (encompassed by E47/1408) is located approximately 100 km north west of the township of Newman, covers 96 km^2 of the Fortescue Valley, borders the Hamersley Range and lies approximately 15 km south of the Fortescue Marsh. It is intersected by distributaries of the Weeli Wolli Creek delta.

The main access to the project area is via the Great Northern Highway and the unsealed Munjina – Roy Hill Road. Approximately 58 km along the Munjina – Roy Hill road the BHPB rail line into the Yandi Mine intersects the road. The western boundary of the tenement is a further 1 km east of this rail line intersection.

The project area is subject to two non-overlapping Native Title Claims. The western half of the licence is held by native title claimants of the MIB. The eastern half of the licence is held by the Nyiyaparli people. Brockman have negotiated native title agreements with both parties.

PROJECT BENEFITS

Australia is the world's largest exporter and the world's third largest producer of iron ore (17%) after China (21%) and Brazil (20%). Although iron ore resources occur in all the Australian States and Territories, almost 90% of identified resources occur in Western Australia.

Western Australia's economy is heavily dependent on mineral resources, and its future growth and development rely on the continued viability of resource development projects. The nearby town of Newman has developed as a result of mineral exploitation, and requires ongoing resource projects to provide revenue to the community. The development of the Project will provide financial and social benefits for the area through employment and flow-on effects to the non-mining sector.

The Project will have a significant beneficial impact on the Pilbara region, bringing revenue and jobs to the area.

The Project will result in further substantial regional and state benefits, including:

- Investment of up to $1 billion of capital into Western Australia's regional and state economies.
- Positive contribution to training and business opportunities for the indigenous community in the region.
- Increasing demands for goods and services creating business and employment opportunities.

- Additional Commonwealth and State Government revenues through collection of additional royalties, taxation and other charges.
- Provide employment opportunities and general financial support for traditional land owners.
- Provide permanent employment (on a Fly in Fly Out basis) for an estimated 500 employees.

STAKEHOLDER CONSULTATION

Consultation has focused on how best to realise the Project with acceptable outcomes for the local community, local indigenous groups and the environment at large.

Key outcomes from the consultation process to-date are:

- Brockman has incorporated stakeholder feedback into the design of investigations and where required, commissioned additional investigations to provide appropriate information to inform this PER.
- Brockman has formed partnerships with MIB and Nyiyaparli Native Title groups and will continue to collaborate on cultural heritage matters throughout the life of the Project.
- Brockman has addressed all issues and concerns raised by stakeholders within the scoping phase of the Project.
- Brockman has proactively sought advice and input from government departments and knowledgeable individuals.
- Brockman has ensured that the appropriate guidelines and 'best practice' techniques have been incorporated into the design of this Project.

Brockman will continue to engage with and consult relevant stakeholders and key interest groups throughout the public review period and beyond into the construction, operation and decommissioning phases of the Project.

THE EXISTING ENVIRONMENT

The project area lies on the Fortescue valley floor and is bounded to the south by the Hamersley Range. The Weeli Wolli Creek runs through the project area from the south-east to the north-west and forms an extensive delta with numerous flow paths in major flood events. From this delta, the Weeli Wolli Creek channels extend northwards into the Fortescue Marsh, which is an extensive intermittent wetland located on the floor of the Fortescue River valley.

The Fortescue Marsh is located approximately 15 km north of the project area and has been listed as a wetland of national significance in the directory of important wetlands and is currently considered as an ecosystem at risk by the Department of Environment and Conservation (DEC). Groundwater and surface water modelling indicates that the marsh will not be impacted as a result of mining activities over the 20 year mine life.

The Weeli Wolli Creek catchment area is 4,769 km^2, and this upstream catchment includes three major mining areas: Hope Downs, Area C, and Marillana Creek. The Weeli Wolli Creek system has a combination of groundwater and surface water flow, which represents the upstream recharge. During high rainfall events, there is significant surface water flow into the project area, some of which reaches the Fortescue Marsh, while some infiltrates in the groundwater system.

The project area lies on a landscape that is still being utilised for pastoralism and is significantly degraded in some areas. In recent ecologia botanical surveys of the area, (ecologia, 2009a), eight vegetation units were identified within the project area, with some units further classified into twelve subunits. The vegetation units were associated with the following landforms: Creekline, minor drainage channels on footslope, clay pan, minor channel/depression, floodplain, longitudinal sand dunes, swale between dunes, and sandy plain/minor footslope.

No declared rare flora species were recorded at the project area. One Priority 3 Flora species (*Goodenia nuda*) was recorded in low densities at two locations on the project site, however neither of these populations are expected to be impacted by the Project. Ten environmental weeds were also recorded.

There are no nationally or state listed threatened ecological communities (TEC) within the project area. However one State-listed PEC occurs within the survey area, the Priority 3 'Vegetation of sand dunes of the Hamersley Range and Fortescue Valley'. This dune system will not be impacted by the proposal.

ecologia (2009b) identified five main fauna habitat types in the project area during their 2008 surveys. Open plain habitat makes up the majority of the project area south-west of Weeli Wolli Creek, covering much of the Hamersley Range alluvium deposits. The open plains fall on two different land systems, the Divide and Boolgeeda, providing two similar but sufficiently distinct fauna habitat types: sandy spinifex grassland and stony spinifex plains respectively.

Two conservation significant species were recorded at numerous locations within the survey area; the Australian Bustard (*Ardeotis australis*, DEC Priority 4) and the Rainbow Bee-eater (*Merops ornatus*, EPBC Act Migratory). A further six conservation significant species are considered to potentially occur in the project area based on previous nearby records (from state and national databases and other surveys conducted in the vicinity) and the habitat types available within the project area.

Four stygobitic species were collected during the survey. One of the species, the amphipod *Pilbarus millsi*, was found both inside and outside the tenement. Two of the species (an unidentified copepod and oligochaete) were found only within the tenement and were represented by single specimens. The fourth species, the isopod *Pygolabis weeliwolli*, was found only outside the tenement. The amphipod and the isopod were the focus of recent publications (Finston et al., 2007; Finston et al., 2009) within which it was indicated that these species were present in the Weeli Wolli Creek and Marillana Creek palaeo-drainage channel. Although the other two organisms could not be identified to species level they are expected to occur outside the tenement because their body size is significantly smaller than the size of the amphipod and the isopod, and they are therefore expected to be subject to the same or lesser dispersal limitations.

Six troglofauna species were found to occur within the project area. Their range appears to extend north east from the base of the Hamersley Range and both north-west and south-east along the ranges. An estimate of the extent of connected habitat is 20,203 ha. This assessment is based upon an extensive risk analysis incorporating both regional and local geological data.

KEY ENVIRONMENTAL IMPACTS AND MANAGEMENT

The following factors have been assessed as being the key environmental issues relevant to the Project and are described in detail within this PER:

Subterranean invertebrate fauna

The effect of clearing and pit excavation on troglofauna is likely to be a significant environmental aspect associated with the proposed Project, because by their nature troglofauna are incapable of surviving for long periods on the surface. Such dispersal limitations result in extremely small and localized species ranges and thus high levels of endemism (EPA, 2003). Troglofauna will be directly impacted by excavation of the mine pit and may be indirectly impacted by clearing of vegetation (reducing nutrient input and soil moisture) and changes to surface hydrology.

The potential direct impact to predicted troglofauna habitat from the excavation of the proposed mine pit is 8.2 %. Indirect impacts (from clearing) may result in a further impact to 4.5 % of the predicted available habitat within the project area.

Predicted impacts to stygofauna populations are expected to be negligible. One of the species found within the project area occurs throughout the wider Weeli Wolli Marillana-paleo-drainage channel (ecologia, 2009c), as does the species found only outside the tenement. The other two are predicted to be subject to lesser dispersion pressures. The percentage impact resulting from pit excavation and dewatering is expected to be very small when compared to the larger habitat available to these species.

A Project Environmental Management Plan will be implemented as part of the environmental management framework for the Project and details strategies to limit impacts to subterranean fauna associated with soil and groundwater contamination, clearing and alterations to surface and groundwater.

Subterranean hydrology

The main impact on the groundwater system from the Project will be a decline in groundwater levels in the area around the dewatering borefield and a reduction in groundwater outflow to adjacent areas resulting from the abstraction of groundwater for mine dewatering. The extent of this cone of depression as predicted by groundwater modelling is presented within this document as a ‘worst case’ scenario, where depending on the extent and continuity of the calcretes and the amount of groundwater recharge received, the drawdown is likely to be significantly reduced.

The drawdown is at a maximum of 40 m below pre mining levels in the western end of the orebody to facilitate dry mining conditions and reduces with distance from the main pit area. The predicted 10 m drawdown contour in piezometric levels extends northwards across the Fortescue Valley and southwards from the mine area to beneath the Hamersley Ranges.

The downstream impacts resulting from the dewatering are predicted to be minimal, as the area is characterised by low rates of groundwater recharge and throughflow and a reduction in outflow from the project area to adjacent areas affects relatively small volumes of water.

Groundwater quality abstracted during dewatering will generally remain in the range of fresh to brackish and utilised in the beneficiation process, resulting in no affect to the beneficial use of this water resource by other users. Water excess to plant requirements that will be abstracted the first three years of operations will be re-injected into the mine aquifer via a Managed Aquifer Recharge (MAR) system.

A Groundwater Study and Management Plan will be implemented as part of the environmental management framework for the Project and details strategies to minimise, where possible, the requirements for water abstraction, retain water quality between acceptable levels and implement a groundwater monitoring program.

<u>Surface hydrology</u>

The Project has the potential to impact surface water resources by changing local surface water flow patterns and by affecting surface water quality as a result of erosion from disturbed areas or contamination from chemicals / hydrocarbons.

However the planned development is likely to have only a localised and comparatively small effect on surface water runoff through the redirection of flow and the development of bunded areas which may intercept minor drainage lines and collect some surface water. The estimated reduction in runoff is less that 0.2% of the catchment. These changes are not significant to the overall hydrological system, particularly in comparison to the natural seasonal variations in catchment runoff associated with cyclonic storm events.

A Surface Water Management Plan will be implemented as part of the environmental management framework for the Project and details strategies to manage the impacts of surface water diversions, manage surface water quality, control the effects of flooding, implement a surface water monitoring program and rehabilitate the surface water drainage post closure.

<u>Vegetation and flora</u>

Impacts on flora and vegetation from the proposed mine site include the clearing of 2,985 ha of native vegetation, incorporating a small percentage (<0.6%) of vegetation associated with the small Fortescue land system and the loss of some of the vegetation of the locally significant colluvial fan areas (Unit 8a).

No Priority Flora are proposed to be impacted by this proposal, nor is the regionally significant dune vegetation (Units 6 and 7).

The alteration of surface hydrology may temporarily impact upon approximately 450 ha of vegetation (mulga) downstream of where small creeks currently emerge from the Hamersley Ranges and south of the Weeli Wolli Creek and the BHPB rail line however management such as spreader mechanisms will be used to mitigate this impact.

There is the potential for groundwater drawdown to affect a proportion of the vegetation lining the Weeli Wolli Creek (which may be phreatophytic). However this may be mitigated by channel flow events numerous times per year that will recharge the creek channel groundwater level. Natural seasonal fluctuations in groundwater level are not currently well-understood, but are estimated (on the basis of experience in the region) to be up to several metres (potentially significantly larger in the vicinity of the creek channel).

A Project Environmental Management Plan will be implemented as part of the environmental management framework for the Project and details strategies to limit impacts to vegetation and flora.

A summary of all relevant factors is provided in Table ES 1.

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Table ES 1 Summary of Key Environmental Factors and Management

ENVIRONMENTAL FACTOR	ENVIRONMENTAL OBJECTIVES	EXISTING ENVIRONMENT	POTENTIAL IMPACTS	MANAGEMENT STRATEGIES	PREDICTED OUTCOME
Biophysical					
Subterranean Invertebrate Fauna	Minimise the impact on the abundance, diversity, geographic distribution and productivity of troglofauna and stygofauna at species and ecosystem levels. Protect rare or priority fauna (listed under the *Wildlife Conservation Act 1950* or the *Environmental Protection and Biodiversity Conservation Act 1999*) habitat.	Six species of troglofauna and three species of stygofauna are found within the project area (E47/1408). An estimate of habitat available to troglofauna within and adjacent to the project area is 20,203 ha. Stygofauna habitat is likely to be the extent of the Weeli Wolli Marillana paleo-drainage channel which extends southwards into the Hamersley Range.	A direct impact to the predicted troglofauna habitat of 1,648 ha or 8.2 % will result from pit excavation. An indirect impact of 4.6 % will result from clearing for associated mine infrastructure. Impacts to stygofauna habitat are predicted to be negligible relative to the Weeli Wolli Marillana drainage channel.	The Project Environmental Management Plan contains procedures to control clearing, surface waters, waste and hazardous materials. Surface and Groundwater Management Plans will be implemented over the life of the mine. A subterranean fauna monitoring program will be implemented to inform management strategies.	The impact of the proposal on subterranean fauna is likely to be low due to the available habitat and inferred distribution of these communities off the tenement.
Groundwater	To prevent or minimise detrimental impacts on the groundwater system resulting from mining operations. To ensure that the	Groundwater contours across the region are a subdued reflection of topography, ranging from more than 428 m RL along the Hamersley Ranges, to less than 410 mRL along the floor of the valley.	The downstream impacts resulting from the dewatering are predicted to be minimal, as the area is characterised by low rates of groundwater recharge and	A Groundwater Management Plan will be implemented as part of the environmental management framework for the Project and details strategies to minimise,	There is no predicted impact on the Fortescue Marsh as a result of mine dewatering. Following cessation of dewatering, natural

ENVIRONMENTAL FACTOR	ENVIRONMENTAL OBJECTIVES	EXISTING ENVIRONMENT	POTENTIAL IMPACTS	MANAGEMENT STRATEGIES	PREDICTED OUTCOME
	quality of water returned to local and regional groundwater resources will not result in significant deterioration of the beneficial use of those resources. To prevent or minimise mining related impacts on Weeli Wolli Creek and Fortescue Marsh.	Water quality distributions are distinct in the alluvial and basement sequences. The basement has 20,000 mg/L TDS below the mine area, increasing to an estimated 150,000 mg/L TDS beneath the southern margin of the Fortescue Marsh. Within the alluvial sequence, water is fresh <1,000 mg/L TDS near the base of the Hamersley Ranges, increasing to an estimated 7,000 mg/L TDS near the southern margin of the Fortescue Marsh.	throughflow. No changes to water quality are anticipated as a result of MAR. A reduction in outflow from the project area to adjacent areas affects relatively small volumes of water.	where possible, the requirements for water abstraction, retain water quality within acceptable levels and implement a groundwater monitoring program. Several layers of contingencies will be in place to ensure adequate monitoring of any impacts, improved forward predictions of future impacts, and development of appropriate impact management strategies. Excess water production from dewatering is anticipated for the first 2-3 years of operation. A MAR system is proposed to reinject water into the same aquifer to ensure the water is available for reuse.	recharge and inflow processes will result in water levels recovering to 80% of pre-mining levels within 50 years. All areas mined below the water table will be in-filled to at least two metres above original water table level. There will therefore be no long-term pit-lake or void in the water table. Consequently, there will be no significant long-term impacts on water quality or groundwater flow.
Surface Hydrology	Maintain the quality and quantity of	The project area is located on a floodplain within the Fortescue	Altered surface hydrology will result	A Surface Water Management Plan will	There will be some temporary and

ENVIRONMENTAL FACTOR	ENVIRONMENTAL OBJECTIVES	EXISTING ENVIRONMENT	POTENTIAL IMPACTS	MANAGEMENT STRATEGIES	PREDICTED OUTCOME
	surface and groundwater so that existing and potential environmental values, including ecosystem maintenance, are protected. Maintain the integrity, ecological functions and environmental values of nearby wetlands. Ensure that the quality of water returned to local and regional surface waters does not result in the deterioration of these. Prevent or minimise project related impacts to Weeli Wolli Creek.	Marsh catchment, approximately 15-20 km south of the nearest boundary of the marsh itself. Several large creek systems discharge to the Fortescue Marsh with a total catchment area of approximately 31,000 km^2. The Weeli Wolli Creek bisects the project area and flows in a north westerly direction out of the ranges and towards the Fortescue Marsh and contributes approximately 15% of the total natural catchment area of the marsh.	from the diversion of several small creeks running out of the Ranges around the mine infrastructure and pit. However the diversions will impact less than 0.2% of the catchment and the predicted impact on the Fortescue Marsh is negligible.	be implemented over the life of the mine. It details strategies to maintain the quality and quantity of surface water entering the Fortescue Marsh, monitoring surface waters and for rehabilitating existing drainage lines on closure.	permanent modifications made to the surface water drainage the form of diversions around the pit and infrastructure. However these diversions will be redirected into established drainage lines and the potential decrease in runoff volume to the Weeli Wolli Creek catchment will be less than 0.2%.
Geology and Landform	Maintain the integrity, ecological functions and environmental values of landforms and geology.	This proposal will not involve mining in or on the Hamersley Range. The project area incorporates the northern foot slopes of the Hamersley Ranges and the flat plains	Permanent landform modification as a result of the mine pit and infrastructure. Altered surface	The footprints of unnatural landforms have been minimised. Landforms will be contoured and	The mine site will modify existing landforms and result in permanent new landforms. These landforms will be

ENVIRONMENTAL FACTOR	ENVIRONMENTAL OBJECTIVES	EXISTING ENVIRONMENT	POTENTIAL IMPACTS	MANAGEMENT STRATEGIES	PREDICTED OUTCOME
	Minimise permanent landform alterations and establish stable, sustainable landforms that will not compromise post-disturbance land uses. Ensure that rehabilitation achieves an acceptable standard compatible with the intended post – disturbance land use, and is consistent with appropriate completion criteria. Meet the post-construction expectations of the various stakeholders involved.	extending away from the base of the ranges.	hydrology will result from altered landforms. Short to medium term changes to the landscape will occur as a result of construction of infrastructure. No PAF substances have been recorded.	rehabilitated to mimic the surrounding natural landforms as much as possible. Most of the mine waste and fines will be backfilled into the pit above the pre-existing water table. A Project Environmental Management Plan will be implemented as part of the environmental management framework for the Project and details strategies to inform landform restoration.	rehabilitated to establish stable, sustainable landforms that will not compromise post-disturbance land uses.
Vegetation and Flora	Avoid or manage adverse impacts to vegetation and flora during the construction and operation phases of the Project.	The project area incorporates moderately to significantly degraded vegetation resulting from pastoralism. One Priority Flora species (*Goodenia nuda*) is present on	Due to the condition of much of the vegetation across the tenement, impacts of a regional significance are not anticipated. Impacts of a local significance	The Project Environmental Management Plan contains procedures to control clearing, weeds, dust and bushfires. The Surface Water	This aspect can be adequately managed through the implementation of clearing procedures, standard surface water and erosion control

ENVIRONMENTAL FACTOR	ENVIRONMENTAL OBJECTIVES	EXISTING ENVIRONMENT	POTENTIAL IMPACTS	MANAGEMENT STRATEGIES	PREDICTED OUTCOME
	Avoid impacts to the dune community. Minimise the loss of native vegetation and plant communities. Protect Priority flora species within the project area. Minimise the risk of introducing and spreading noxious weeds.	site at two locations. There is regionally significant (PEC) dune vegetation (Units 6 and 7) present within the project area.	include the direct loss through clearing of 2,985 ha of native vegetation in moderate to significantly disturbed condition. Indirect impacts may include reduction in vegetation health and/or distribution resulting from dust emissions, alterations to surface water flows, spread of weeds and soil erosion. No impacts to *Goodenia nuda* are anticipated. No impacts to the significant dune vegetation are anticipated. Approximately 450 ha of Mulga located south of the BHPB rail line may be affected by surface water diversions and clearing. The possibly phreatophytic	Management Plan and Groundwater Management Plan will be implemented throughout the life of the mine and will ensure that alterations to surface and floodwaters have minimal effect on vegetation.	mechanisms and employee and contractor training. These controls are outlined in detail in the PEMP (Appendix F).

ENVIRONMENTAL FACTOR	ENVIRONMENTAL OBJECTIVES	EXISTING ENVIRONMENT	POTENTIAL IMPACTS	MANAGEMENT STRATEGIES	PREDICTED OUTCOME
			vegetation (unit 1) lines the Weeli Wolli Creek and may be impacted by groundwater abstraction.		
Vertebrate Fauna	Minimise the impact on the abundance, diversity, geographic distribution and productivity of vertebrate fauna at species and ecosystem levels. Protect rare or priority fauna (listed under the *Wildlife Conservation Act 1950* or the *Environmental Protection and Biodiversity Conservation Act 1999*) habitat.	Five main fauna habitat types were identified in the project area; 23 species of mammal, 82 species of bird, and 43 species of reptile were recorded within the survey area. Two conservation significant species were recorded at numerous locations within the survey area; the Australian Bustard (*Ardeotis australis*, DEC Priority 4) and the Rainbow Bee-eater (*Merops ornatus*, EPBC Act Migratory).	No nationally or regionally significant fauna will be impacted as a result of this proposal. Important habitats such as the sand dunes and Weeli Wolli Creek will not be directly impacted by this proposal. Impacts to vertebrate fauna as a result of this proposal are predicted to be minimal due to the availability of habitat in bordering tenements.	The Project Environmental Management Plan contains procedures to control clearing, weeds, bushfires, noise and light. A Traffic Management Plan will be developed prior to construction beginning. This will assist to reduce traffic-related fauna deaths.	Native fauna can be managed appropriately through the implementation of standard clearing, dust, traffic, noise and light management procedures and through employee and contractor training programs.
Pollution Management					
Dust and Particulates	Ensure that emissions do not adversely affect environmental values or the health, welfare	The Pilbara is a naturally dusty environment due to often sparse vegetative cover, arid conditions and winds.	Dust emissions generated from mining activities may impact human health, visual amenity of the	The Project Environmental Management Plan contains standard procedures for dust	Due to the lack of sensitive receptors in close proximity to this proposal, dust management measures

ENVIRONMENTAL FACTOR	ENVIRONMENTAL OBJECTIVES	EXISTING ENVIRONMENT	POTENTIAL IMPACTS	MANAGEMENT STRATEGIES	PREDICTED OUTCOME
	and amenity of people and land uses by meeting statutory requirements and acceptable standards. Minimise dust associated with the construction and operation of the mines. Minimise exposed surfaces through clearing minimisation, staged clearing and progressive rehabilitation.	No ambient dust monitoring has been carried out nor is considered necessary.	surrounding area and vegetation health. As the mine site is isolated from settled areas and sensitive receptors, dust is not anticipated to constitute a significant environmental or health issue.	management. Field measurement will be used to measure and monitor actual dust emissions on site once construction and operations commence.	outlined within the PEMP are expected to adequately control fugitive dust resulting from mining, processing, stockpiling and roads.
Greenhouse Gas Emissions	Comply with relevant inventory and reporting regulations. Minimise emissions to levels as low as practicable on an on-going basis and consider offsets to further reduce cumulative emissions.	Not applicable	Greenhouse gas emissions such as carbon dioxide are thought to contribute to global climate change by absorbing infrared radiation (heat) and trapping it close to the earth's surface. While these gases are commonly found in nature, gases such as carbon monoxide,	The Project Environmental Management Plan contains procedures for greenhouse gas emissions management. Brockman will implement a Greenhouse Reduction Program as part of their commitment to continuous	Greenhouse gas emissions will not contribute significantly to the environmental impact of this project and can be adequately managed through the implementation of the PEMP.

ENVIRONMENTAL FACTOR	ENVIRONMENTAL OBJECTIVES	EXISTING ENVIRONMENT	POTENTIAL IMPACTS	MANAGEMENT STRATEGIES	PREDICTED OUTCOME
			carbon dioxide and methane are also produced from anthropogenic sources such as the combustion of fossil fuels. These anthropogenic greenhouse gases are thought to be responsible for a change in global climate. Fuel combustion also contributes to atmospheric pollution through generating emissions such as carbon monoxide, nitrogen oxides, carbon dioxide and benzene.	improvement. The Greenhouse Reduction Program will involve employee training, site audits and internal reporting to identify areas where energy consumption, waste production or greenhouse gas production can be reduced.	
Noise, Light and Vibration	Minimise the noise and vibration associated with the construction and operation of the proposal. Ensure the noise and vibration levels meet statutory requirements and	No ambient noise, light or vibration studies have been undertaken. Noise, light and vibration are not significant factors in the existing environment and land use is pastoral and mining exploration.	Noise, light and vibration as a result of this proposal are not anticipated to contribute significantly to the Project's impacts. Due to the distance of mining activities from the Fortescue Marsh, noise and light are not	The Project Environmental Management Plan contains procedures for noise and light management. Minimal blasting is expected and will be strictly controlled to minimise vibration.	Noise and vibration levels will be typical of or better than most Pilbara iron ore mine sites, due to the mining method being predominantly free digging with little need for blasting. Noise and vibration are

ENVIRONMENTAL FACTOR	ENVIRONMENTAL OBJECTIVES	EXISTING ENVIRONMENT	POTENTIAL IMPACTS	MANAGEMENT STRATEGIES	PREDICTED OUTCOME
	acceptable levels. Minimising the impacts of artificial light on native fauna.		likely to significantly impact migratory birds.	Lighting controls will be put in place to limit light spill.	not anticipated to adversely affect native fauna due to the availability of suitable habitat adjacent to the project area and the distance from the Fortescue Marsh.
General Solid, Liquid and Hazardous Waste	Reduce the volume of waste through product selection, reuse and recycling. To comply with the *Environmental Protection Act 1986* and the *Health Act 1911* and other applicable standards. To minimise the impact of municipal and sewage waste on the local and regional environment and prevent pollution to the air, land and water. All site generated waste is appropriately contained within the	No soil assessments have been undertaken however the site is not registered as a contaminated site.	Wastes resulting from mining have the potential to pollute soil, ground and surface waters if not managed appropriately. This can indirectly affect native flora and fauna through habitat modification or poisoning food or drinking water.	The Project Environmental Management Plan contains procedures for solid, liquid and hazardous waste management.	The generation of general solid, liquid and hazardous wastes can be adequately managed through the PEMP and is expected to result in negligible environmental impact.

ENVIRONMENTAL FACTOR	ENVIRONMENTAL OBJECTIVES	EXISTING ENVIRONMENT	POTENTIAL IMPACTS	MANAGEMENT STRATEGIES	PREDICTED OUTCOME
	on-site landfill. Minimise the environmental impacts of hydrocarbons / chemicals (solvents, cleaning fluids etc.) through appropriate storage, handling and disposal.				
Social Surroundings					
Social and Visual Amenity	Minimise project impacts to community use and access to significant environmental features. Ensure landscape values are considered and measures are adopted to reduce the visual impacts of the project.	The current land use is pastoral and mineral exploration. The project area is remote from areas of habitation, abuts the Hamersley Range and is situated on a floodplain.	Potential impacts of mining activities to surrounding communities and landholders will be minimal. This is in part due to the remote location of the project area some 60 km from any area of habitation and the nature of the surrounding land use, which is primarily utilised for mining and pastoral purposes.	Stockpiles will be shaped to mimic local landforms where possible and will be revegetated with native vegetation typical of the area. Infrastructure removal and rehabilitation of the site to final land use requirements will be carried out upon closure.	As much of the surrounding area is already being utilised for exploration and mining activities, the anticipated impact to social and visual amenity from this proposal is predicted to be minimal.
Indigenous Heritage	Meet or exceed statutory obligations in relation to the	Four archaeological sites (stone artefact scatters), a modified tree, and a total of 98 isolated	Brockman is not proposing to impact any of the areas where	Brockman are developing a Cultural Heritage Management	Due to the lack of cultural heritage sites within the project

ENVIRONMENTAL FACTOR	ENVIRONMENTAL OBJECTIVES	EXISTING ENVIRONMENT	POTENTIAL IMPACTS	MANAGEMENT STRATEGIES	PREDICTED OUTCOME
	management of cultural heritage items, places or issues within the project area Avoid disturbance to cultural and heritage sites. Respect the rights of land owners. Identify all heritage sites and/or culturally-significant plants, sites and artefacts using heritage surveys and local knowledge.	finds are located within the project area. No archaeological or ethnographic sites have been identified within the project footprint.	stone artefacts were discovered. Impacts to indigenous heritage as a result of this proposal are predicted to be low.	Plan in consultation with Traditional Owners. This Plan will be implemented throughout the life of the mine and manage any future sites that may be discovered within the project area.	footprint, it is anticipated that the project will have negligible impact on cultural heritage. However Brockman will ensure that procedures are in place to minimise the risk of disturbing sites that may become apparent in the future.
Mine Decommissioning and Rehabilitation	Ensure that rehabilitation achieves a long term safe, stable and functioning landform which is consistent with the surrounding landscape and other environmental values. Fulfil commitments made to stakeholders	Not Applicable	Aspects of the Project that will require decommissioning and rehabilitation include: • plant and processing infrastructure; • offices, workshops and the accommodation village;	A Conceptual Closure Plan has been developed and will be updated over the life of the mine. A full Closure Plan will be developed within two years of the planned closure of the mine site.	Rehabilitation of portions of the landforms and other impacted areas will commence as early as possible. Mine site infrastructure will be removed at the end of mining and waste dumps, fines rejects storage and pit rehabilitation completed

ENVIRONMENTAL FACTOR	ENVIRONMENTAL OBJECTIVES	EXISTING ENVIRONMENT	POTENTIAL IMPACTS	MANAGEMENT STRATEGIES	PREDICTED OUTCOME
	and regulators regarding closure outcomes.		• water supply and sewage infrastructure; • power supply infrastructure; • fuel and bulk storage facilities; • landfill and contaminated sites; • borrow pits, roads and tracks; • surface water diversions; • waste dumps and other man-made landforms; and • the pits.		to support self-sustaining ecosystems with minimal post-mining maintenance.

ENVIRONMENTAL MANGEMENT COMMITMENTS

Brockman maintain an Environmental Policy which guides their environmental conduct across all aspects of their operations.

Brockman's Environmental Policy outlines the following objectives:

- Abide by and comply with the *Environmental Protection Act 1986* and all other applicable environmental laws, regulations, policies, standards and codes of practice.
- Establish the Company's Environmental Management System to conform with the requirements of the International Standard ISO 14001.
- Provide employees with the necessary training, education and resources to fulfil their environmental responsibilities and ensure that operations are performed with appropriate respect for the environment.
- Specify the need for all contractors to perform work in accordance with this policy and to supervise such compliance.
- Conduct regular review of the Company's environmental performance and act on the results.

In addition to implementing Brockman's Environmental Policy and associated Environmental Management System (EMS), Brockman has committed to undertaking the following with respect to the Marillana Iron Ore Project:

C1. Brockman will develop a subterranean fauna monitoring program in liaison with the DEC.

C2. Brockman will investigate the potential for subterranean habitat restoration in liaison with the DEC.

C3. Brockman will contribute data collected on subterranean fauna to the DEC on a confidential basis for the purposes of research and cumulative impact management.

C4. Brockman will initiate a groundwater monitoring program and implement associated procedures (including contingencies) throughout the life of the Project as outlined within this PER document and the Marillana Project Groundwater Study and Management Plan.

C5. Brockman will make site-specific groundwater data available to regulatory and decision-making agencies on a confidential basis for inclusion into a regional groundwater model and cumulative impact studies.

C6. Brockman will actively pursue an off-take agreement to provide water to the Project in preference to sourcing water from ground resources.

C7. Brockman will implement the Surface Water Management Plan and associated procedures including contingencies throughout the life of the Project.

C8. Brockman will ensure that modified and/or created landforms are left in a stable and safe condition post mine closure and reflect natural landforms in the surrounding area.

C9. Twenty-four months prior to mine closure, a Mine Closure Plan will be finalised in consultation with the DEC and DMP. The plan will define appropriate closure criteria necessary for the establishment of safe landforms and self sustaining ecosystems, and set out procedures for monitoring in order to meet compliance with the closure criteria.

C10. A rehabilitation programme will be developed within the first two years of mining in liaison with the DEC.

C11. Rehabilitation will occur progressively as disturbed areas are no longer required for mining activities.

C12. Soil characterisation assessments will be conducted to determine the suitability of topsoil for supporting rehabilitation.

C13. Brockman will develop a monitoring program to assess impacts to the potentially phreatophytic vegetation within the project area as a result of dewatering.

C14. A management plan will be developed in consultation with the DEC if groundwater abstraction is found to be affecting the health of the potentially phreatophytic vegetation.

C15. The regionally significant PEC (Units 6 and 7) will not be cleared or excavated.

C16. Brockman will continue to liaise with relevant local authorities throughout the life of the project to ensure that potential impacts of social and visual amenity are minimised.

C17. Brockman will develop and implement a Traffic Management Plan prior to construction commencing on-site.

C18. Brockman will facilitate the development of a full Cultural Heritage Management Plan by Native Title claimants and implement, monitor and review this plan in consultation with claimants throughout the life of the Project.

C19. Brockman will implement a Greenhouse Inventory and Reduction Program once operations are underway.

C20. Brockman will report carbon emissions to the Department of Climate Change under the *NGER Act 2007*.

C21. Other atmospheric emissions will be reported to the National Pollutant Inventory as and when they meet the reporting threshold values.

C22. Contaminated material will be removed from site and either bio-remediated (if biodegradable) or disposed of at a licensed facility.

C23. The surface irrigation waste water disposal systems shall be managed in such a manner as to encourage rapid evaporation, prevent spray drift, misting, pooling and run-off from the surface irrigation disposal area.

1.0 INTRODUCTION

The proposal nominated by Brockman Iron Pty Ltd (Brockman) for which approval is sought is the Marillana Iron Ore Project (the Project).

Brockman proposes to develop the Project which consists of a 700-750 Mt iron ore mine, processing facility and associated infrastructure within the Hamersley Iron province in the Pilbara region of Western Australia, approximately 100 km from the town of Newman.

The project area comprises E47/1408 and mining leases M47/1414 and M47/1419.. It is anticipated that traditional open pit mining methods of excavating, load and haul will be utilised for the pit development.

The Marillana Project will comprise:

- An open cut iron ore mine producing 17-19 Mt of beneficiated ore per annum.
- Above ground overburden and fines rejects storage facilities.
- In-pit disposal of mine waste after year two of operation.
- In-pit disposal of fines rejects after year seven of operations.
- Crushing, screening and processing facilities.
- A train loading facility.
- An accommodation camp for 550 personnel.
- A borefield to supply potable water to the accommodation and offices.
- Offices, workshops, a laboratory and supporting infrastructure including an explosives facility, landfill, water treatment plant and bulk fuel storage.

Brockman have undertaken significant environmental and social investigations to establish the potential risks of the Project and to inform appropriate management strategies for key aspects such as native flora and fauna, ground and surface water, heritage values and the local community.

1.1 IDENTIFICATION OF PROPONENT

The contact details for Brockman Iron Pty Ltd are as follows:

Address:	1/117 Stirling Highway,		
	Nedlands WA 6009		
Telephone:	(08) 9398 3000	Fax:	(08) 9389 3033
Point of Contact:	Jason Greive		
ACN:	122 652 886		

Brockman Iron Pty Ltd is a wholly owed subsidiary of ASX listed Brockman Resources Limited.

ecologia Environment (ecologia) has been engaged by Brockman to facilitate the environmental impact assessment process. This role involves:

- Assisting Brockman when liaising with government, public stakeholders and contractors.

- Providing advice to Brockman on the environmental requirements for the project impact assessment process.
- Undertaking the required environmental impact assessment studies.
- Providing specialist technical advice on environmental matters.
- Preparing the environmental documentation required to be submitted to regulatory authorities.

The ecologia key contact for this proposal is Garry Connell:

ecologia Environment

1025 Wellington Street

WEST PERTH WA 6005

Phone: 08 9322 1944

Fax: 08 9322 1599

Email: admin@ecologia.com.au

1.2 PURPOSE OF DOCUMENT

The purpose of this document is to assist the Environmental Protection Authority (EPA) and relevant advisory bodies in assessing this proposal under the *Environmental Protection Act 1986*.

It aims to:

- adequately describe the components of this proposal;
- identify key environmental issues, including cumulative impacts;
- detail environmental management measures to mitigate, minimise or offset these environmental issues;
- communicate with all stakeholders so that informed public comment can be made.

This document has been prepared in accordance with the guidelines outlined in the *Guidelines for Preparing a Public Environmental Review / Environmental Review and Management Program* (EPA, November 2004). Additionally the principles of environmental protection outlined in the *EPA Position Statement No 7: Principles of Environmental Protection* (August 2004), and the *EPA Position Statement No 6: Towards Sustainability* (August 2004) were considered.

1.3 PROJECT SCOPE AND TIMING

The Project scope is described through the key aspects summarised in Table 1-1.

Table 1-1 Key Aspects of the Proposal

KEY ASPECT	DESCRIPTION
Mining Operations	
Proposed commencement	2012
Project life span	20 years
Anticipated year of decommissioning	2032
Size of ore body	700-750 Mt
Ore type	Hematite Detrital and Channel Iron Deposit
Ore mining rate	37.5 Mtpa
Total mining rate	80-90 Mtpa
Total estimated production (beneficiated ore)	17-19 Mtpa
Average Stripping ratio (overburden : ore)	1.4:1
Mine Pit	
Depth of pit	40-80 m below surface
Depth of water table	20-38 m below surface
Total pit area	1,648 ha
Overburden stockpiles	587 ha
Ore Stockpiles	13 ha
Topsoil stockpiles	78 ha
Processing Requirements	
Crushing (and Screening)	Yes
Beneficiation Process	Wet gravity beneficiation
Product Characteristics	Hematite Detrital and Channel Iron Deposit
Processing area footprint (incl. stockyard and rail loop)	234 ha
Fines Rejects Storage	247 ha
Mine Site Infrastructure	
On-site camp	15 ha
Waste Water Treatment and landfill	15 ha
Power source	On site diesel-NG/LNG dual fuel generators
Anticipated Power Requirement	35 MW
Water source	Pit de-watering
Miscellaneous Infrastructure footprint	148 ha
Total estimated area of clearing	2,985 ha
Anticipated annual water requirement	
Processing	7,250 MLpa

KEY ASPECT	DESCRIPTION
Dust suppression	1,400 MLpa
Accommodation	60 MLpa

The implementation of the proposed development is contingent on the Project meeting financial risk and return criteria, statutory requirements and the favourable determination of the Minister for the Environment. The anticipated timeline for the major elements of the environmental impact assessment process is outlined in Table 1-2 below.

Table 1-2 Project Development Stages

STAGE	ACTIVITIES	TIMEFRAME
Project Planning	Feasibility assessment, technical studies, approvals.	Q4 2008 – Q3 2010
Project Funding Approval	Financial commitment to the project, sales agreements, construction agreements	Q4 2010
Construction	Earthworks, erection of infrastructure, mine pre-strip.	Q1 2011 – Q3 2012
Operation	Mining and processing of ore, transport of ore off-site, progressive rehabilitation.	Q4 2012 - 2032
Decommissioning	Contaminated site assessment, removal or burying of infrastructure, landform rehabilitation and revegetation.	2033

2.0 PROJECT JUSTIFICATION AND ALTERNATIVES

2.1 STATE AND NATIONAL BENEFITS

Australia is the world's largest exporter and the world's third largest producer of iron ore (17%) after China (21%) and Brazil (20%). Although iron ore resources occur in all the Australian States and Territories, almost 90% of identified resources occur in Western Australia.

Iron ore, the raw material used to produce iron and steel provides the foundation for one of Australia's major export industries. Iron Ore is Australia's fourth largest mineral export (IOMA, 2009). Western Australia dominates the iron ore industry, accounting for 97% of total production. The Pilbara region of Western Australia is particularly significant with 85% of Australia's total identified resources and 92% of its production (Geoscience Australia, 2008).

Western Australia's economy is heavily dependent on mineral resources, and its future growth and development rely on the continued viability of resource development projects. The nearby town of Newman has developed as a result of mineral exploitation, and requires ongoing resource projects to provide revenue to the community. The development of the Project will provide financial and social benefits for the area through employment and flow-on effects to the non-mining sector.

The Project will have a significant beneficial impact on the Pilbara region, bringing revenue and jobs to the area.

The Project will result in further substantial regional and state benefits, including:

- Investment of up to $1 billion of capital into Western Australia's regional and state economies.
- Positive contribution to indigenous training and business opportunities in the region.
- Increasing demands for goods and services creating business and employment opportunities.
- Additional Commonwealth and State Government revenues through collection of additional royalties, taxation and other charges.
- Provide employment opportunities and general financial support for traditional land owners.
- Provide permanent employment (on a Fly in Fly Out basis) for an estimated 500 employees.

2.2 NO DEVELOPMENT OPTION

The consequences of not proceeding with the proposed Project are that the economic and employment benefits of the proposal as outlined in Section 2.1 would not be achieved.

2.3 EVALUATION OF ALTERNATIVES

2.3.1 Project Scale

Prior to the referral of the Project to the EPA, Brockman evaluated several options for the project in a scoping study. The scoping study identified the potential for mining of only the deeper Channel Iron Deposit (CID) which involved removal of all material above the CID to waste. This option would result in the potential loss of a valuable resource in the detrital hematite above the CID. Hence Brockman commissioned a Pre-feasibility Study (PFS) on the current project which aimed to maximise the potential of the detrital material and the underlying CID.

In early 2008 Brockman considered a shallow detrital mining operation at a nominal 2 Mtpa of above water table material, without wet process beneficiation. This alternative involved road transport using the existing road network and potentially linking to existing rail and port infrastructure. This alternative was rejected due to the short life and the inability to achieve the economies of scale necessary to justify dedicated rail transport and the inability to secure a rail haulage agreement with existing infrastructure owners.

During October 2008, the world economy was buffeted by the effects of the global financial crisis. In light of the uncertainty and deterioration of pricing in the Iron Ore sector, as well as delays being experienced in securing binding rail and port access arrangements, Brockman concluded that the most prudent strategy was to progress the Project as a long-life, world-scale operation supported by sustainable rail and port infrastructure agreements and off-take arrangements.

2.3.2 Mine Plan and Design

A significant study of options for the mine plan was undertaken throughout the early design and development phases of the Project. Considerations factored into the design of the mine pit and placement of infrastructure including waste stockpiles, the processing plant and rail loop include:

- Topography of the land and suitability for supporting infrastructure.
- Surface water flows off the Hamersley Range and flood waters extending out from Weeli Wolli Creek.
- The relative grades of mineralised material.
- The requirement to backfill the pit above the water table.
- Engineering and operational controls for noise and dust reduction.
- Location of plant and associated infrastructure to maximise efficiency of operations.
- Location of the BHP rail line.
- Vegetation of local conservation significance.

Aspects that were considered in significant detail and are represented by independent studies are outlined below.

<u>Mine by-product storage options</u>

At the commencement of the PFS, a number of locations were identified for the potential storage of the different mining byproduct material types. These were investigated, and a short list developed for incorporation into the final PFS site layout and into the cost estimation process.

Assessment of the location of mine waste and fines rejects incorporated both financial and environmental factors. The areas that were considered were: (a) adjacent to the pit, (b) in-pit and (c) to the north of the Weeli Wolli Creek.

The establishment of a waste dump to the north of the creek would need to consider adequate flood protection for 1 in 10 and 1 in 100 Annual Recurrence Interval (ARI) floods and a creek crossing to transport waste to that location. The environmental impacts associated with such a development include significant alterations to surface water flow and associated sediment erosion from the dump. Financial factors included the increased cost of transporting material the additional distance. Based upon assessment of these factors, this alternative was discarded.

Due to the space restrictions south of Weeli Wolli Creek, surface disposal of mine waste was also not favoured. However a certain amount of waste needs to be stored ex-pit early on in the mine’s life, as there is no empty void available in which to store it. This waste will permanently remain adjacent to the pit and the bulk of the waste is proposed to be stored within mined out voids after year five of operation. Appendix A details the methodology selected for waste and fines rejects disposal.

This preferred combined option reduces the disturbance footprint, maximises available space south of the Weeli Wolli Creek and ensures that the water table is not exposed throughout the pit void subsequent to mining.

The constraints on selection of a suitable location for fine rejects storage (FRS) included the following:

- “No go” areas included BHPB rail line, proposed mine pit, processing plant, and train loading area, and one major surface water drainage channel (Weeli Wolli Creek).
- No other “no go” areas were identified (heritage, flora/fauna, infrastructure, active faults, other environmental, groundwater quality sensitivities).
- Munjina-Roy Hill Road was able to be re-aligned if required, but preferred exit points at lease boundary be maintained.
- Adequate space for installation of perimeter seepage interception ditches was allowed for in the FRS design, in case they are required.
- To mitigate risk of potential dust impact, there should be sufficient distance between the FRS and potential receptors including the site administration offices and camp site.
- Locating the FRS close to a surface drainage route would require erosion protection and there is limited competent rock available to the project.
- Sufficient space should be available around the FRS to mitigate the consequences of a potential embankment failure, particularly with respect to major infrastructure and lease boundaries.

The final location chosen can be viewed in Figure 5-4 under the Project Description.

<u>Camp accommodation locations</u>

The process of selecting the accommodation village site has been through three phases. At each step, an alternative village site has been evaluated. The evaluation process is discussed in the following section and includes an assessment of the following areas:

Site A During the 2008 Scoping Study (present location in Figure 5-4)

Site B During the 2009 Pre-feasibility Study (south of the dune system)

Site C After the 2009 Pre-feasibility Study (south west of the present location)

At the start of the PFS, the first surface hydrology assessment became available. This report indicated that the entire area to the north of Weeli Wolli Creek within the exploration lease would be inundated with water during a 1 in 10 Year ARI flood event. This would result in Site A being cut off from the mine site when flooding overtops the banks of the creek and bunding and an elevated pad would need to be constructed to protect the village from these flood events (Appendix B, Figure 2-1).

Consequently an investigation into locations that would not be impacted by flooding was conducted. Surface water hydrology superimposed onto regional topography was utilised to assist in selecting potential sites. With all land north of the Weeli Wolli Creek affected by floodwaters, a site north of the BHPBIO rail line and south of the dune system to the west of the tenement was identified.

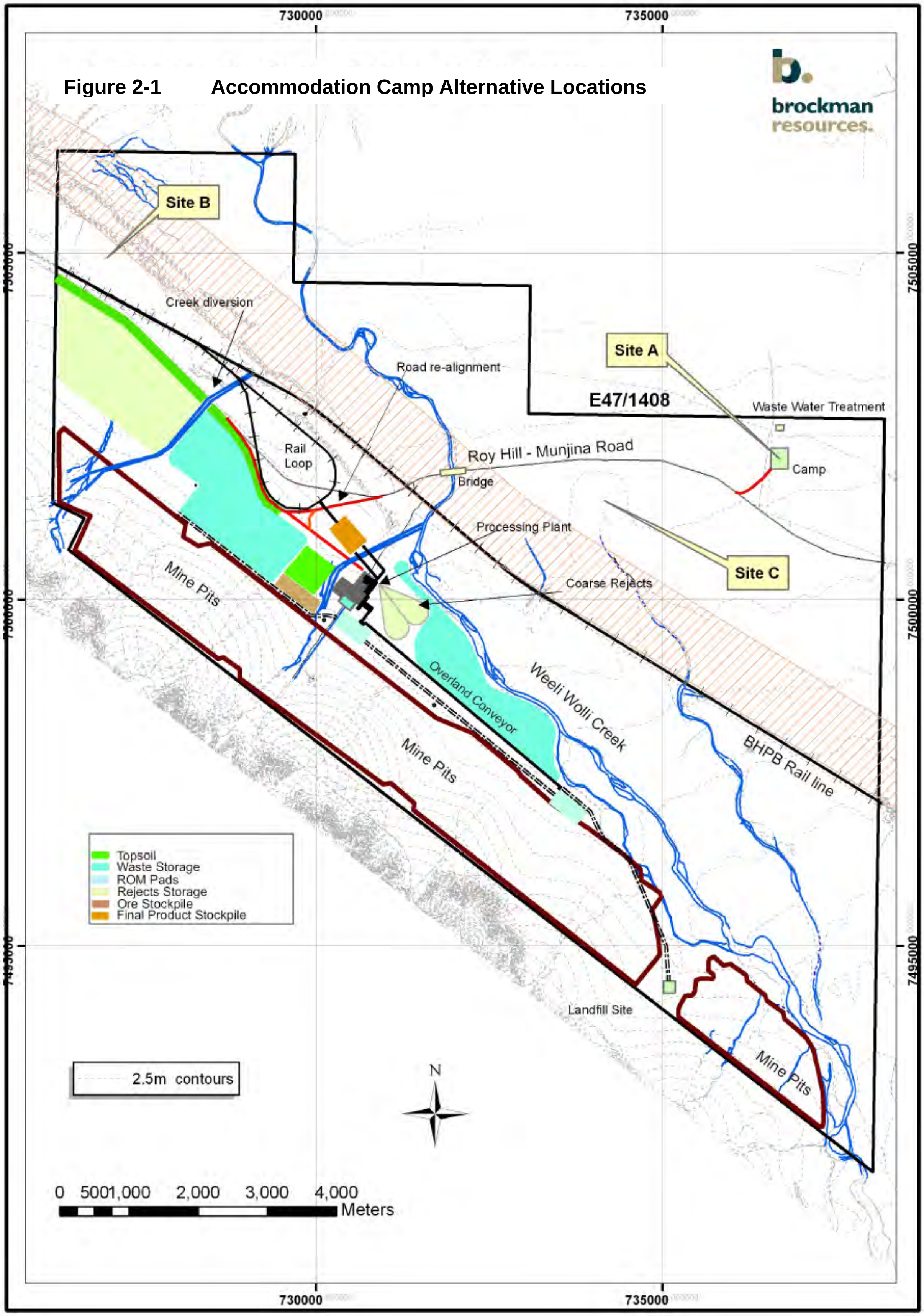
However some of the issues with this site included noise from the rail line and dust transmitted by prevailing winds from the stockpiles which are located close by, both causing potential health and safety issues for site personnel. Cultural and archaeological surveys had indicated that a clay pan immediately off-lease to the west of Site B had the potential to be archaeologically sensitive. Finally, the site is subject to a proposal by BHP to duplicate their rail line and is immediately adjacent to HPPL's File Notification Area and an intended rail over-crossing. This would sandwich the village between two rail lines resulting in further noise impacts.

Towards the end of the PFS the site infrastructure plan was completed and post-development surface water modelling started to indicate that not all of the land north of the creek would be inundated during floods. Site C (south west of Site A) was selected as it appeared to have lower water levels during flooding than Site A. The advantages of this site were that there was no requirement to construct an elevated pad to protect from a 1 in 10 ARI flood and the site is closer to the administration offices which would result in shorter roads and power lines. However the disadvantages include the potential for an HPPL rail line to be constructed nearby, which would create a noise issue outside of the control of Brockman.

Once all three sites were evaluated, a decision was made to adopt Site A (Figure 2-1) as this site provided Brockman with maximum control over the activities and associated impacts likely to result from these. Engineering solutions will be undertaken to adequately protect the site during a 1 in 10 ARI flood event.

Impacts of this decision are discussed in section 7.5 Surface and Floodwater Management.

Figure 2-1 Accommodation Camp Alternative Locations



Waste water treatment plants

The locations of the two waste water treatment plants (WWTP) were largely governed by the need for their proximity to the accommodation village and plant. However due to their environmentally sensitive nature (i.e. the potential for significant flood events to inundate plant and irrigation areas releasing nutrients into surface waters), further siting parameters were considered.

Design guidelines based upon relevant legislation and *AS/NZS 1547:2000 On-site domestic – wastewater treatment* and the *Australian Guidelines for Water Recycling: Managing Health and Environmental Risks* were developed to guide this assessment process (Appendix C).

The design guidelines incorporated locating treatment facilities where odour and spray drifts would not cause nuisance or health concerns. The location also took into account the depth of the underlying water table (> 2 m), slope (< 1:20), proximity of natural waterways and the propensity for seasonal flooding.

Both sites selected conformed to these guidelines, as they were located on appropriate slope, in areas where the water table is > 13 mbgl, downwind from accommodation and offices and between 0.6 km and 2.2 km from the Weeli Wolli Creek. Flood management structures will be required to protect the treatment plants as both facilities are located on a floodplain. Aquaterra (Appendix C) conducted an assessment of the risks associated with inundation of the surface irrigation areas and concluded that the risk of nutrients or coliforms being mobilised is low due to the high evaporation rate and likelihood that nutrients will become quickly fixed by vegetation.

These facilities have been assessed as a negligible risk to the Fortescue Marsh, as there will be no surface water ponding of treated waters, low flow velocities in the event of inundation, and a distance of 12 km from the facilities to the southern edge of the Fortescue Marsh.

2.3.3 Airfield Access

Although only 100 km in a direct line from Newman, Marillana is 250 km from Newman by road (via Auski), and is expected to be a fly-in/fly-out operation, with the accommodation camp on site. There are a number of options to facilitate the fly-in/fly-out component of the operation. These range from accessing existing fly-in/fly-out airstrips via new or existing roads, using the commercial airfield at Newman, and constructing an airstrip on site for the dedicated use of the Project.

The Barimunya Aerodrome is a dual use (BHPB and Rio) airstrip approximately 9 km south west of the Marillana tenement. Being already dual use, there is a reasonable possibility that access can be negotiated. The Hamersley Ranges lie in between, and the development of an access road is required and a number of potential routes have been evaluated, from constructing a road directly over the range, to using existing roads.

In summary, these include:

A. Shortest Direct Route;
B. Optimal Direct Route;
C. Skirting the Range;
D. Via Yandi Rail Spur Access Road;
E. Via Existing Marillana to Weeli Wolli Road via Gray Crossing; and

F. Via Auski, Great Northern Hwy and Yandi Access Road.

Another option was to use the Mt Newman public access airstrip, where competitor negotiations are not required.

The third option was to build an on-site airstrip to the south-west of the accommodation village. This option raises issues of noise and the requirement for flood protection.

The selected option was to use the Barimunya Aerodrome with option E for access as there is the potential to share flights with other operations. Appendix D describes in detail the rationale behind the selection of this option.

2.3.4 Water Supply

Water for the Project will be supplied from dewatering (process plant, dust suppression) and four potable bores (accommodation) (Appendix E). After year 9 of mining, it is projected that further supplementary water supply, above that produced through dewatering, will be required for the operations. Supplementary requirements are estimated at 20 L/s in year 10, increasing to 180 L/s by year 20 (refer Table 5-3 for details). It is the preference of Brockman, in alignment with the philosophy of the DoW hierarchy of water management options, to source this supplementary supply from nearby operations that are discharging significant surplus water. However several other options also exist including on and off-tenement bores.

Direct off-take option

There are a number of mining operations in the vicinity of the Project that are currently discharging significant surplus water via direct discharge to the creeks, or via re-injection into a down gradient palaeochannel aquifer. As part of the DoW Water in Mining Guidelines (DoW 2009), a hierarchy of disposal options has been developed. In terms of the options being discussed, direct off-take (relocation for nearby use) is the preferred option, and has to be justified as being unsuitable for the project prior to implementing a scheme further down the hierarchy.

This option would require a pipeline corridor from the discharge point to the Marillana operations. Any pipeline corridor would require a vegetation survey to be carried out, and it is likely that the preferred option will be that the pipeline be buried.

Brockman have commenced negotiations to progress a direct off-take agreement and acknowledges that additional environmental impact assessment may be required for this component.

Alternative water supply

The extent and thickness of tertiary aquifer below the base of proposed mining is anywhere between 20 and 60 m where the palaeochannel thickens to the north. This means that there will be further groundwater available on tenement to meet water demand after year 9 of the Project, should a water off-take agreement not eventuate. Numerical groundwater modelling of any such abstraction would be undertaken to adequately assess the potential impacts of this option in the event that direct off-take is unable to be adopted.

Other off-tenement water solutions have also undergone preliminary investigations, particularly options that target the identified groundwater throughflow excess within the Weeli Wolli groundwater system. This elevated groundwater throughflow is related to the excess dewatering disposal of up-gradient mining operations. Therefore there is a high level of confidence that the water resource is available should it be required later in the life of mining operations.

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3.0 ENVIRONMENTAL IMPACT ASSESSMENT

3.1 STATE ASSESSMENT PROCESS

The Western Australian *Environmental Protection Act 1986* provides that where a development proposal is likely to have a significant effect on the environment, the proposal may be referred to the EPA for a decision on whether or not it requires formal assessment under the *Environmental Protection Act 1986*, and, if it is to be assessed, the level of assessment.

Based on the information in the Environmental Referral Supporting Document, referred to the EPA in February 2009, it was determined that the likely environmental impacts are sufficient to warrant formal assessment of the proposal under the *Environmental Protection Act 1986*. The level of assessment for the proposal was set at Public Environmental Review (PER) with a 4 week public review period.

A draft Environmental Scoping Document was prepared and submitted in April 2009 and finalised in July 2009.

This PER document and associated appendices will be released for public comment from 10th May 2010 to 8th June 2010.

The Minister for the Environment will determine whether, and in what manner the proposal may be implemented. The Minister will issue a Bulletin that legally binds Brockman to implement the proposal as described within this document, subject to the Minister's conditions and commitments made by Brockman.

3.2 OTHER APPLICABLE LEGISLATION

The proposal will be assessed pursuant to Part IV of the *Environmental Protection Act, 1986* and is subject to other state and federal legislation described below and summarised in Table 3-1.

<u>Mining licences</u>

The project area comprises a single exploration licence (E47/1408) which was applied for on 10 May, 2004 and was granted to Yilgarn Mining (WA) Pty Ltd (a wholly owned subsidiary of Brockman Resources Limited) on 6 October, 2005. In 2007, the licence was transferred to Brockman Iron Pty Ltd, also a wholly owned subsidiary of Brockman Resources Limited. The licence covers an area of 36 graticular blocks, or about 96 square kilometres after excisions. Brockman is authorised to explore for iron ore on the licence.

Brockman also made application for two Mining Leases (M47/1414 and M47/1419) over part of E47/1408. The applications cover 8,249 ha and 3,254 ha respectively, although there is considerable overlap between the applications, with the combined total area approximately 8,700 ha. Mining Lease M47/1414 has been granted by the Department of Mines and Petroleum (DMP). The Mining Leases secure tenure over the project for a period of 21 years, renewable for a further period of 21 years.

<u>Operating licenses</u>

Subsequent to undergoing assessment under Part IV of the Environmental Protection Act 1986, approvals under the *Mining Act 1978* and the *Environmental Protection Act 1986* (Part V) will be sought in Quarter 4, 2010, pending the Minister for Environment's decision on whether the Project may commence.

Various Works Approvals and Licences will be required for construction and operation of prescribed premises under Part V of the *Environmental Protection Act 1986*. These licenses usually take 3 -4 months to process and can only be granted once Ministerial approval is issued under Part IV of the *Environmental Protection Act 1986*.

Approval under the *Mining Act 1978* will also be required in the form of a Mining Proposal which will be required from the DMP prior to the commencement of construction. The development and review of this documentation typically takes around 4 months, and final DMP approval will be granted pending Ministerial approval under Part IV of the *Environmental Protection Act 1986*.

A Bed and Banks permit will be sought under the *Rights in Water and Irrigation Act 1914* to construct a bridge over the Weeli Wolli Creek on the tenement. This process is likely to take between 2 – 3 months and can only be granted once Ministerial approval is issued under Part IV of the Environmental Protection Act 1986.

A Development Application / Planning Consent and building permit applications will need to be made to the Shire of East Pilbara (SoEP) which typically take around one month to process. Section 5C bore licenses will need to be applied for at the Department of Water (DoW). These licenses can take up to 5 - 6 months to process and can only be granted once Ministerial approval is issued under Part IV of the *Environmental Protection Act 1986*.

Native Title

The Project is located on the boundary between two Native Title claim areas, the Nyiyaparli native title claim (NNTT number WC05/6; Federal Court number WAD6280/98), as amended from time to time and the Martu Idja Banyjima (MIB) native title claimant application (NNTT number WC98/62), as amended from time to time.

Brockman has signed a Mining Compensation Agreement with the MIB and Nyiyaparli native title claimants and a State Deed has been executed by the Company, the Native Title Party and the Government Party to ensure the validity to tenements M47/1414 and M47/1419 in satisfaction of section 28(1)(f) and section 31(1)(b) of the *Native Title Act 1993* in a form acceptable to the Government Party.

Table 3-1 Legislation that May be Applicable to the Project

LEGISLATION	RESPONSIBLE GOVERNMENT AUTHORITY	ASPECT
Commonwealth Legislation		
Environmental Protection & Biodiversity Conservation Act 1999	Department of Environment, Water, Heritage and the Arts	Rare flora and fauna, Cetaceans.
Native Title Act 1993	National Native Title Tribunal	Aboriginal rights
Protection of Moveable Cultural Heritage Act 1986	Protection of Moveable Cultural Heritage Act 1986	Protection of moveable cultural artefacts
National Greenhouse and Energy Reporting Act 2007	Department of Climate Change	Climate change
State Government Legislation		
Aboriginal Heritage Act 1972	Department of Indigenous	Archaeological and

LEGISLATION	RESPONSIBLE GOVERNMENT AUTHORITY	ASPECT
	Affairs	ethnographic heritage
Agricultural and Related Resources Protection Act 1976	Department of Agriculture, Western Australia	Weeds and feral pest animals
Bush Fires Act 1954	Bush Fires Board	Wild fire control
Conservation and Land Management Act 1984	Department of Environment and Conservation	Flora and fauna / habitat / weeds / pests / diseases
Contaminated Sites Act 2003	Department of Environment and Conservation	Management of pollution
Country Areas Water Supply Act 1947.	Department of Water	Water resources supply
Dangerous Goods Safety Act 2004	Department of Consumer and Employment Protection	Dangerous goods management
Environmental Protection Act 1986	Department of Environment and Conservation	Environmental impact assessment and management
Explosives and Dangerous Goods Act 1961	Department of Consumer and Employment Protection	Explosives and dangerous goods, transport and management
Health Act 1911	Department of Health	Human health management
Heritage of Western Australia Act 1990	Heritage Council of Western Australia	European heritage management
Land Administration Act 1997	Department of Land Administration	Land administration
Local Government Act 1995	Western Australia Local Government Association, Shire of East Pilbara	Development approvals and management
Local Government (Miscellaneous Provisions) Act 1960	Shire of East Pilbara	Community issues / resources / facilities
Mining Act 1978	Department of Mines and Petroleum	Land access, mining
Mines Safety and Inspection Act 1994	Department of Mines and Petroleum	Mine safety
Occupational Safety and Health Act 1984	Department of Consumer and Employment Protection	Occupational safety and health
Public Works Act 1902	Department of Housing and Works	Development approvals and management
Rights in Water and Irrigation Act 1914	Department of Water	Access to and use of water resources
Soil and Land Conservation Act 1945	Department of Agriculture	Protection of soil resources
Waterways Conservation Act, 1976	Department of Water	Protection of surface and groundwater
Wildlife Conservation Act 1950	Department of Environment and Conservation	Protection of indigenous wildlife

3.3 COMMONWEALTH ASSESSMENT PROCESS

The Project is not anticipated to cause a significant impact to matters of national significance, and therefore is not considered to be a Controlled Action under the *Environmental Protection and Biodiversity Conservation Act 1999.*

3.4 PRINCIPLES OF ENVIRONMENTAL PROTECTION

The EPA takes into account five principles in the assessment of development proposals. Brockman has embraced the EPAs principles of environmental protection as part of project engineering and design. In meeting the EPAs principles, Brockman have developed the following ‘hierarchy of control’ methodology in the design of the Project:

- completely avoid the impact if possible;
- substitute with a lesser impact;
- include rehabilitation and engineering solutions to reduce the degree and risk of impact;
- design operational controls and emergency response around reduction of impact; and
- provide primary environmental offsets for the impact.

Demonstration of this approach is described in detail within this document. The application of principles of environmental protection (Table 3-2) includes consideration of alternative designs for the Project, the extent of environmental investigations undertaken, the level of stakeholder and community consultations and the commitment to environmental awareness training of personnel for construction and operation phases of the Project.

In addition Brockman have developed a Project Environmental Management Plan (PEMP) (see Appendix F), within the framework of an Environmental Management System (EMS) based on ISO14001 criteria. The EMS (Appendix G) provides a systematic process for ensuring compliance with legal requirements, minimisation of environmental impacts, and promoting continual improvement in environmental performance.

Table 3-2 Application of the EPAs Principles to the Marillana Iron Ore Project

PRINCIPLE	RELEVANT YES / NO	CONSIDERATION
The Precautionary Principle Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In application of this precautionary principle, decisions should be guided by: (a) careful evaluation to avoid, where practicable, serious or irreversible damage to the environment; and (b) an assessment of the risk-weighed consequences of various options.	Yes	Brockman's Environmental Policy states that Brockman will apply the principle of assessing the actual and potential impact on the environment of all activities and taking appropriate action to minimize any risk. Brockman has commissioned biological work to ascertain the level of likely impact to key environmental aspects and has undertaken a risk assessment on which appropriate management plans have been based. Brockman has undertaken the requisite surveys and risk assessments to inform the planning and design process.
The Principle of Inter-generational Equity The present generation should ensure that the health, diversity and productivity of the environment is maintained and enhanced for the benefit of future generations.	Yes	Brockman have developed a Conceptual Mine Closure Plan which outlines strategies to ensure that rehabilitation achieves a long-term safe, stable and functioning landform that is consistent with the surrounding landscape and other environmental values. This plan will be updated throughout the life of the mine, including estimated costing to a +/- 15% accuracy and finalised into a full Closure Plan at least two years prior to mine closure. Greenhouse gas emissions will result from the Project and Brockman will continue to assess options for reducing and/or offsetting these emissions, including options for the use of LNG in lieu of distillate for power generation. Energy efficiency will be a key consideration in the design of project infrastructure.

PRINCIPLE	RELEVANT YES / NO	CONSIDERATION
The Principle of the Conservation of Biological Diversity and Ecological Integrity The conservation of biological diversity and ecological integrity should be a fundamental consideration.	Yes	The Project will result in new clearing of 2,985 ha of native vegetation. Appropriate flora and fauna surveys have been undertaken to identify options for avoidance or mitigation of environmental impacts. One Priority Three species; *Goodenia nuda* has been located on the project site and these populations will be actively avoided through appropriate infrastructure planning and placement. Where clearing is necessary rehabilitation commitments have been made.
Principles relating to improved valuation, pricing and incentive mechanisms (a) Environmental factors should be included in the valuation of assets and services; (b) The polluter pays principle – those who generate pollution and waste should bear the cost of containment, avoidance and abatement; (c) The user of goods and services should pay prices based on the life cycle of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste; (d) Environmental goals, having been established, should be pursued in the most effective way, by establishing incentive structures, including market mechanisms, which enable those best placed to maximise benefits and/or minimise	Yes	Project impacts and associated environmental management costs have been considered during the planning stages of the Project and will be developed further during the Definitive Feasibility Study (DFS). Management measures to avoid, mitigate or offset adverse impacts have been developed and will be implemented for the life of the Project in line with Brockman's Environmental Policy.

PRINCIPLE	RELEVANT YES / NO	CONSIDERATION
costs to develop their own solution and responses to environmental problems.		
The Principle of Waste Minimisation All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge to the environment.	Yes	This has been addressed in the project EMS and PEMP. Integrated environmental management will be implemented across all operations.

3.5 SUSTAINABILITY

The Western Australian Government has released a Sustainability Strategy for Western Australia: *Hope for the Future: the Western Australian State Sustainability Strategy* (Government of Western Australia, 2003). The strategy includes a vision for the State's mining industry and some key future actions are:

- 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 encouraging mining companies to maximise their purchasing of goods and services within regions.

The Minerals Council of Australia (MCA) states that:

"The future of the Australian minerals industry is inseparable from the global pursuit of sustainable development. Through the integration of economic progress, responsible social development and effective environmental management, the industry is committed to contributing to the sustained growth and prosperity of current and future generations". (MCA, 2005).

The International Council on Mining and Minerals (ICMM) lists 10 principles of sustainable development, which are:

01: Implement and maintain ethical business practices and sound systems of corporate governance.

02. Integrate sustainable development considerations within the corporate decision-making process.

03. Uphold fundamental human rights and respect cultures, customs and values in dealings with employees and others who are affected by our activities.

04. Implement risk management strategies based on valid data and sound science.

05. Seek continual improvement of our health and safety performance.

06. Seek continual improvement of our environmental performance.

07. Contribute to conservation of biodiversity and integrated approaches to land use planning.

08. Facilitate and encourage responsible product design, use, re-use, recycling and disposal of our products.

09. Contribute to the social, economic and institutional development of the communities in which we operate.

10. Implement effective and transparent engagement, communication and independently verified reporting arrangements with our stakeholders.

Brockman, in addressing these actions and principles and managing impacts across social capital, economic wealth, environmental assets and corporate governance, will address the principles of sustainability in a number of ways including:

- 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.

4.0 STAKEHOLDER ENGAGEMENT

4.1 OVERVIEW OF CONSULTATION

Stakeholder consultation refers to a two-way, mutual process where information is provided to participants and new information and views are absorbed (AS HB 203:2006). Consultation can add significant value to the risk identification process in major projects by highlighting information about the local and historical context and how proposed activities are likely to affect stakeholders (AS HB 203:2006).

This PER document already incorporates significant input from key stakeholders and provides and opportunity for the wider public to gain an understanding of the project and provide informed comment.

Brockman commenced consultation with community and government during the project scoping stage, and have continued to seek input in an ongoing and proactive manner during the development of this PER.

Consultation has focused on how best to realise the Project with acceptable outcomes for the local community, local indigenous groups and the environment at large. Many of the alternatives considered have already been discussed in section 2.3.

The objectives of consultation and engagement were to:

- inform stakeholders of the Project scope, highlight potentially significant issues and possible solutions;
- gather specialist knowledge of the area and potential environmental and other impacts resulting from this proposal; and
- determine the relative significance of environmental and social issues and develop acceptable management strategies.

Methods of consultation have included letters to neighbouring tenement and land holders, meetings and one-on-one discussions with key government agencies, website updates, newsletters, site visits, community meetings and public presentations.

Brockman has actively sought to involve key stakeholders such as the MIB and Nyiyaparli Native Title claimants in the heritage surveys and development of a Cultural Heritage Management Plan, the Interim of which is appended to this PER (Appendix H).

Key government stakeholders have been, and continue to be regularly consulted to ensure that concerns are identified and proactively addressed. This has particularly been the case concerning issues such as subterranean invertebrate fauna and water management.

A summary of the consultation activities and the issues raised can be found in Table 4-1. A full consultation register can be viewed as Appendix I.

Table 4-1 Summary of Stakeholder Consultation

ISSUE	STAKEHOLDER	OUTCOMES	SECTION
Subterranean Fauna			
Sampling regime (troglofauna)	DEC (EMB, Brad Durrant)	Sampling requirements met and exceeded although capture rate is very low. Off tenement sampling could not be undertaken.	6.9
Sampling regime (stygofauna)	DEC (EMB, Brad Durrant)	Sampling requirements met. Off tenement sampling also undertaken.	6.9
Troglofauna habitat boundaries and percentage impact	DEC (EMB, Brad Durrant)	Reasonable approach adopted to quantify level of impact.	6.9, 7.3
Subterranean fauna sampling, access	FMG, BHP Billiton Iron Ore, Rio Tinto, Marillana Station	No useful access arrangements could be negotiated.	6.9
Groundwater			
Modelling	DoW (Head office, Pilbara region)	The proposed approach was accepted by the DoW.	6.6, 7.4
Potential water disposal options	DoW (Head office, Pilbara region)	The proposed approach was accepted by the DoW.	6.6, 7.4
Groundwater abstraction, water use, management	DoW	DoW is comfortable with level of understanding exhibited to date.	5.3.3, 5.7, 6.6, 7.4
Groundwater abstraction, water use, management	DEC (EMB)	The proposed approach was explained to the DEC.	5.3.3, 5.7, 6.6, 7.4
Surface Water			
Surface water diversions	DEC	The proposed approach was explained to the	6.5, 7.5

ISSUE	STAKEHOLDER	OUTCOMES	SECTION
		DEC.	
Waste water disposal	DEC, DoH	Department of Health guidelines incorporated into Wastewater Treatment design. Disposal	5.6.11, 7.15
Mine Planning and Closure			
Positioning of infrastructure	DEC	The justification was explained to the DEC.	2.3
Accommodation village, waste water treatment plant, road re-alignment, traffic considerations	SoEP	The appropriate process will be followed regarding seeking approval of works from the local shire.	5.6
Pit backfilling	DoW, DEC	The proposed approach was explained to the DEC and DoW.	5.5, 7.6, 7.7
Acid Rock Drainage potential	DMP, DEC	Appropriate guidelines have been addressed. Classed as NAF.	5.5, 7.3
Indigenous Heritage			
Botanical (bush tucker) surveys	MIB, Nyiyaparli	No surveys conducted	6.11
Heritage surveys, Cultural Heritage Management Plan.	DIA, MIB, Nyiyaparli	Interim Cultural Heritage Management Plan (CHMP) will be presented in PER, with a full plan under development in liaison with Native Title Claimants.	6.11, 7.11
Native Title agreement. Heritage sites, surveys	MIB, Nyiyaparli	Native Title Claimants undertook heritage surveys. No sites identified. CHMP to be developed.	6.11, 7.11

4.2 KEY OUTCOMES

Key outcomes from the consultation process to-date are:

- Brockman has incorporated stakeholder feedback into the design of investigations and where required, commissioned additional investigations to provide appropriate information to inform the PER.
- Brockman has formed partnerships with MIB and Nyiyaparli Native Title groups and will continue to collaborate on cultural heritage matters throughout the life of the Project.
- Brockman has addressed all issues and concerns raised within the scoping phase of the Project.
- Brockman has proactively sought advice and input from government departments and knowledgeable individuals.
- Brockman has ensured that the appropriate guidelines and 'best practice' techniques have been incorporated into the design of this Project.

Brockman will continue to engage with and consult relevant stakeholders and key interest groups throughout the public review period and beyond into the construction, operation and decommissioning phases of the Project.

5.0 PROJECT DESCRIPTION

5.1 PROJECT LOCATION

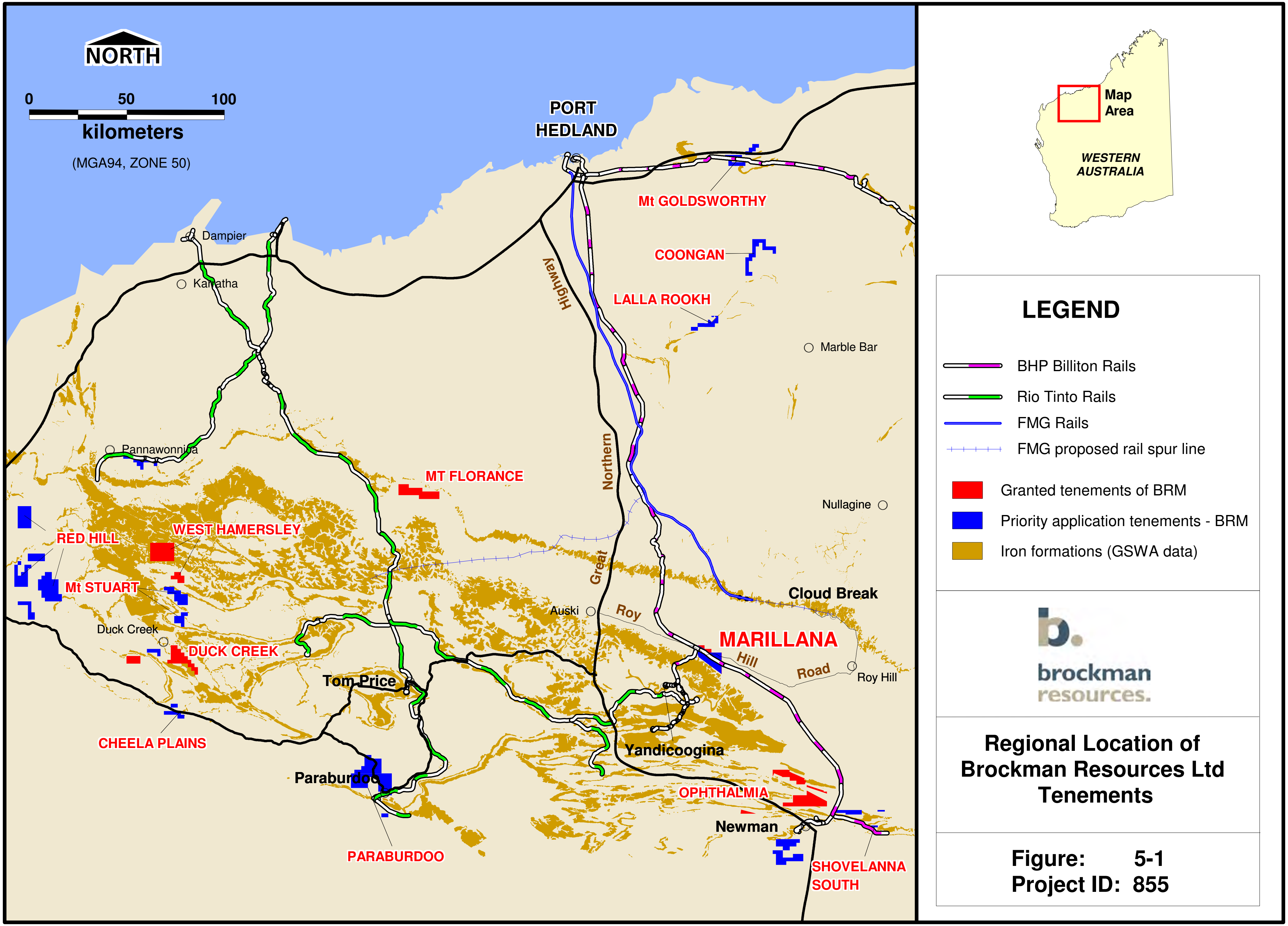
The Marillana mine site is located within the Pilbara region of Western Australia approximately 100 km north west of the township of Newman (Figure 5-1). The Project is located within mining leases M47/1414 and M47/1419.

The project area (the original E47/1408 lease) covers 96 km^2 of the Fortescue Valley and borders the Hamersley Range, where extensive areas of supergene iron ore mineralisation have developed within the dissected Brockman Iron Formation which caps the range.

The main access to the project site is via the Great Northern Highway and the unsealed Munjina – Roy Hill Road. Approximately 58 km along the Munjina – Roy Hill road the BHPB rail line into the Yandi mine intersects the road. The western boundary of the tenement is a further 1 km east of this rail line intersection (Figure 5-2).

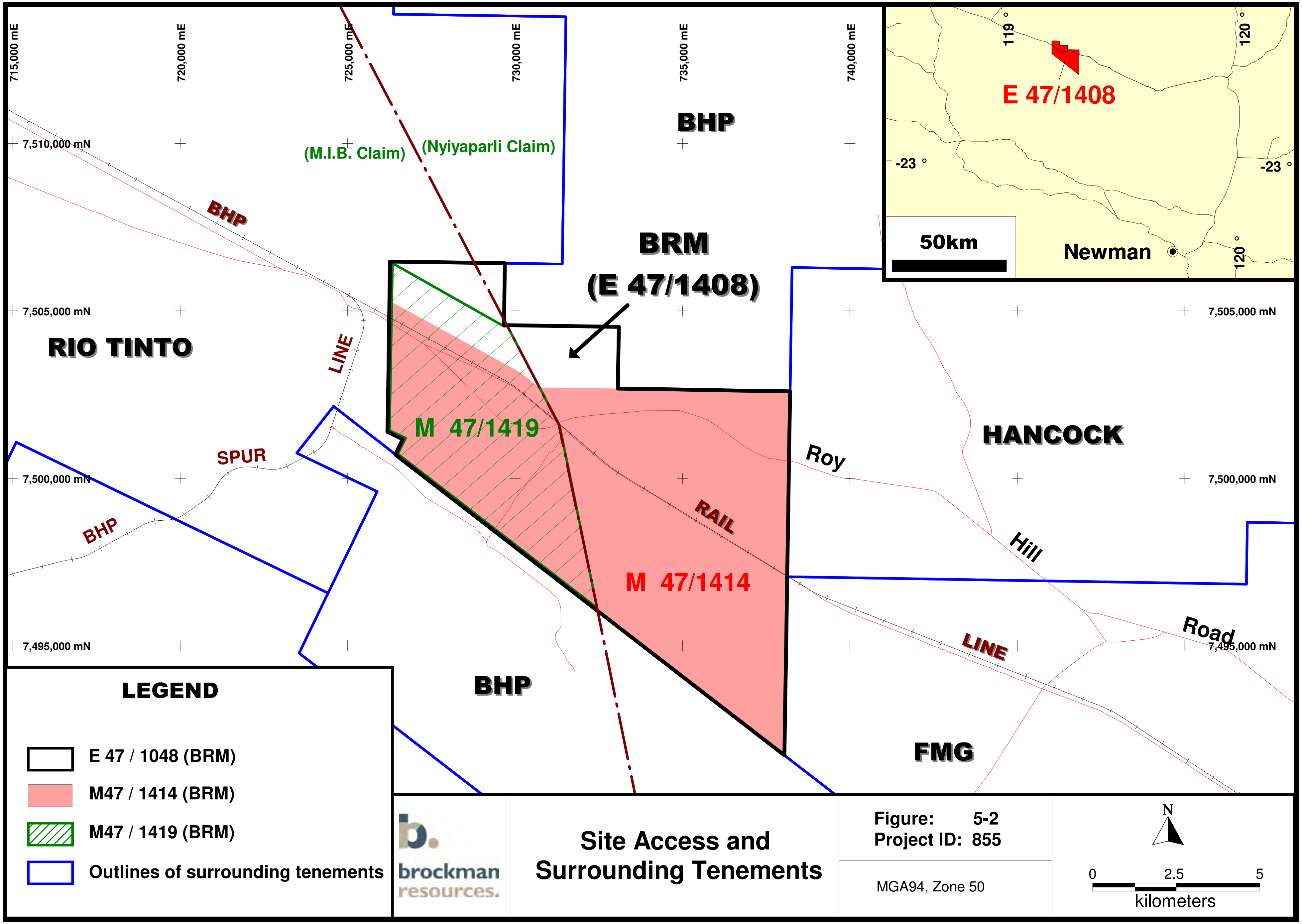
The Project lies approximately 15 km south of the Fortescue Marsh, and is intersected by distributaries of the Weeli Wolli Creek delta (Figure 5-3).

The project area is subject to two non-overlapping Native Title Claims (see Figure 5-2). The western half of the licence is held under native title determination application number WC 98/62 and is claimed by Wobby Parker and Maitland Parker being the registered native title claimants of the MIB. The eastern half of the licence is held under native title determination application number WC 05/06 by the Yamatji Marlpa Barna Baba Maaja Aboriginal Corporation ("YMBBMAC") as agent for the Nyiyaparli people.



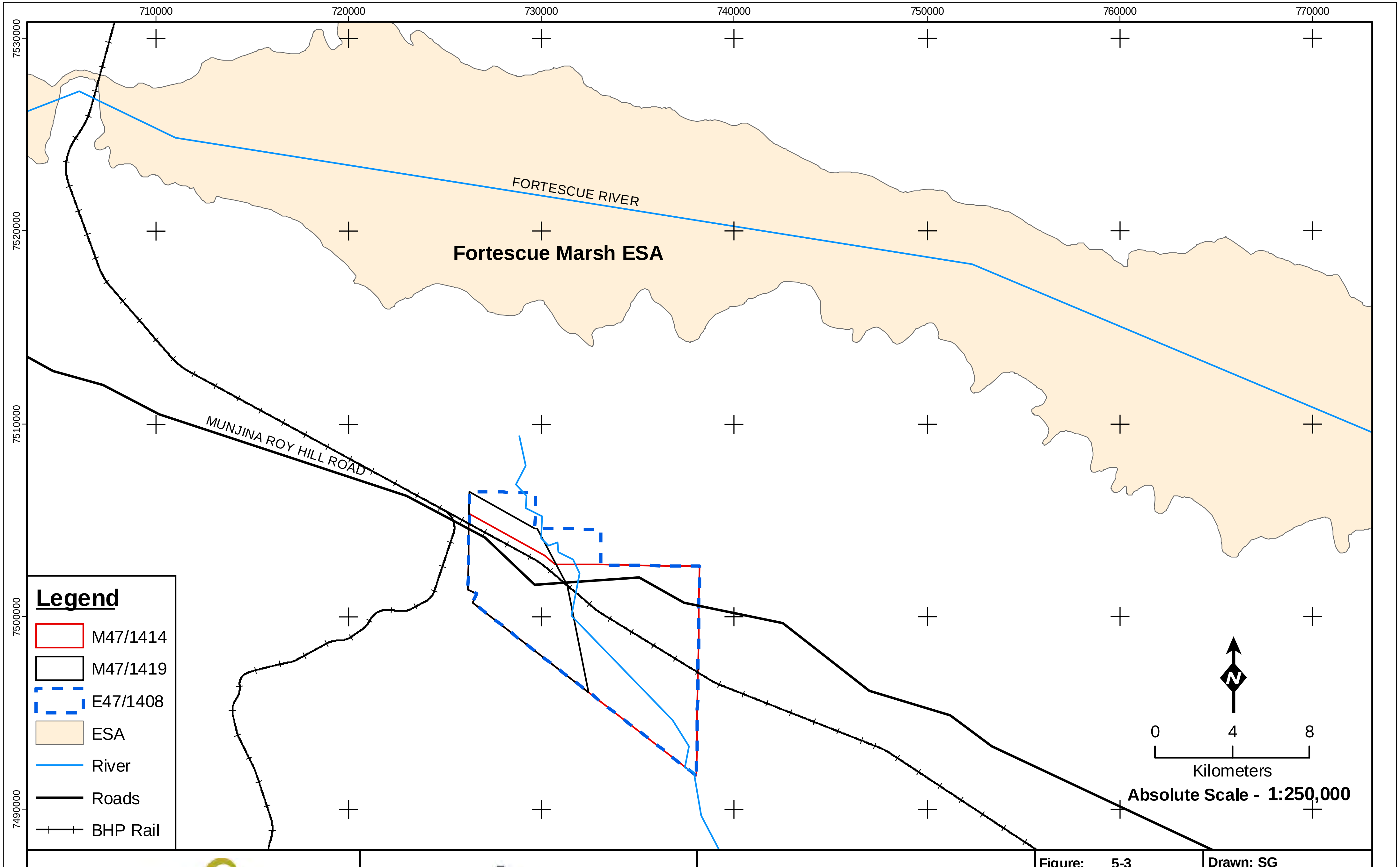
Regional Location of Brockman Resources Ltd Tenements

Figure: 5-1
Project ID: 855



Site Access and Surrounding Tenements

Figure: 5-2
Project ID: 855



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Project Site in Relation to Key Natural Features

Figure: 5-3
Project ID: 855

Drawn: SG
Date: 07/04/09

Coordinate System
Name: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Unique Map ID: M067

A4

5.2 CONSTRUCTION ACTIVITIES

5.2.1 Site Development and Construction

Site development and construction activities are summarised in Table 5-1 below.

Table 5-1 Proposed Construction Activities and Description

ACTIVITY	DESCRIPTION
Temporary Accommodation	Construction of a temporary "fly camp" of up to 25% of the village rooms to allow construction workers to mobilise to site and commence construction.
Preliminary Earthworks	Clearing of starter borrow pits, construction office site, accommodation village site, installation of construction water bores and/or pumps, and mobilisation of earthmoving equipment. Earthworks for accommodation village and offices.
Accommodation facilities	Installation of modular buildings for accommodation village, offices, and their associated services, including power generators, fuel storage, potable water supply and treatment, plumbing, power distribution and communications. Construction of potable water bores, potable water treatment systems, waste water treatment systems, and treated effluent spray fields. Relocation of buildings from the fly camp to the accommodation village. Establishment of the waste landfill.
Temporary Facilities	Erection of a concrete batching plant, construction water infrastructure, construction fuel supply, areas for contractor offices and car parking, areas for unloading of trucks and storage of construction materials (laydown areas)
Contractor mobilisation	Transport of construction workers to site, transport of construction equipment to site, assembly of construction cranes and site offices.
Bulk earthworks	Clearing and establishment of borrow pits and construction water supplies. Stripping and stockpiling of topsoil. Surveying, clearing and earthworks for the process plant site, pads for infrastructure facilities and temporary facilities. Construction of roads, railway cuttings and embankments and associated drains, with culvert crossings. Construction of flood protection levees. Construction of Fines Rejects Storage (FRS)
Concrete works	Excavation, installation of reinforcing steel, formwork and pouring of concrete for plant and infrastructure foundations. Construction of elevated concrete structures to hold the primary crushing station equipment and associated feed hoppers

ACTIVITY	DESCRIPTION
Bridge Works	Construction of a concrete and/or steel bridge over Weeli Wolli Creek. Excavation installation and back-filling of concrete or steel culverts under roads and rail embankments
Erection of process plant	Assembly and installation of steel building structures, installation of conveyor components, crushers, screens, beneficiation equipment, water and air piping, electrical equipment, instruments and cables.
Erection of infrastructure	Construction of stockpile stackers and reclaimers Construction of train load out bin and feed chute. Construction of mine workshops, laboratory, power station, fuel storage, power lines, water pipelines, water storage dams and tanks, fire and process water pumps, explosives storage,
Rail Construction	Laying of sleepers, installation and welding of rail, placement of ballast, lifting of rails and sleepers and tamping of ballast. Installation of rail signalling equipment.
Mine Pre-strip	Clearing of waste dump footprints, stripping and stockpiling of topsoil, construction of sediment drains and sediment traps. Excavation of mine waste (Overburden) from initial mining areas and haulage to waste dump/s Piling of waste to create an elevated pad adjacent to the Run Of Mine (ROM) feed hoppers (the ROM pads)
Mine Dewatering	Construction and commissioning of bores, head works, poly pipelines power supplies and associated infrastructure.
Commissioning	Testing and/or inspection of completed equipment and facilities at the completion of construction. (Pre-energisation testing) Energisation of completed equipment and facilities. Test running of completed equipment and facilities without ore. (Dry commissioning) Test running of completed equipment at its designed function (Wet Commissioning) e.g. processing iron ore.
Handover	Formal acceptance of the facilities and/or its component parts by the owner from the contractor/s responsible for construction.

5.2.2 Roads and Access

The main road access to the Project will be from the Great Northern Highway at the Auski Roadhouse, eastwards along Munjina-Roy Hill Road. The Munjina-Roy Hill Road is a regional access road, an unpaved gravel road, approximately 6 m in width, with 2 m shoulders. The plant site is approximately 1.2 km from Roy Hill-Munjina Road, 61 km east of Auski. This road also passes some 800 m south of the proposed camp site. The following road development activities are proposed:

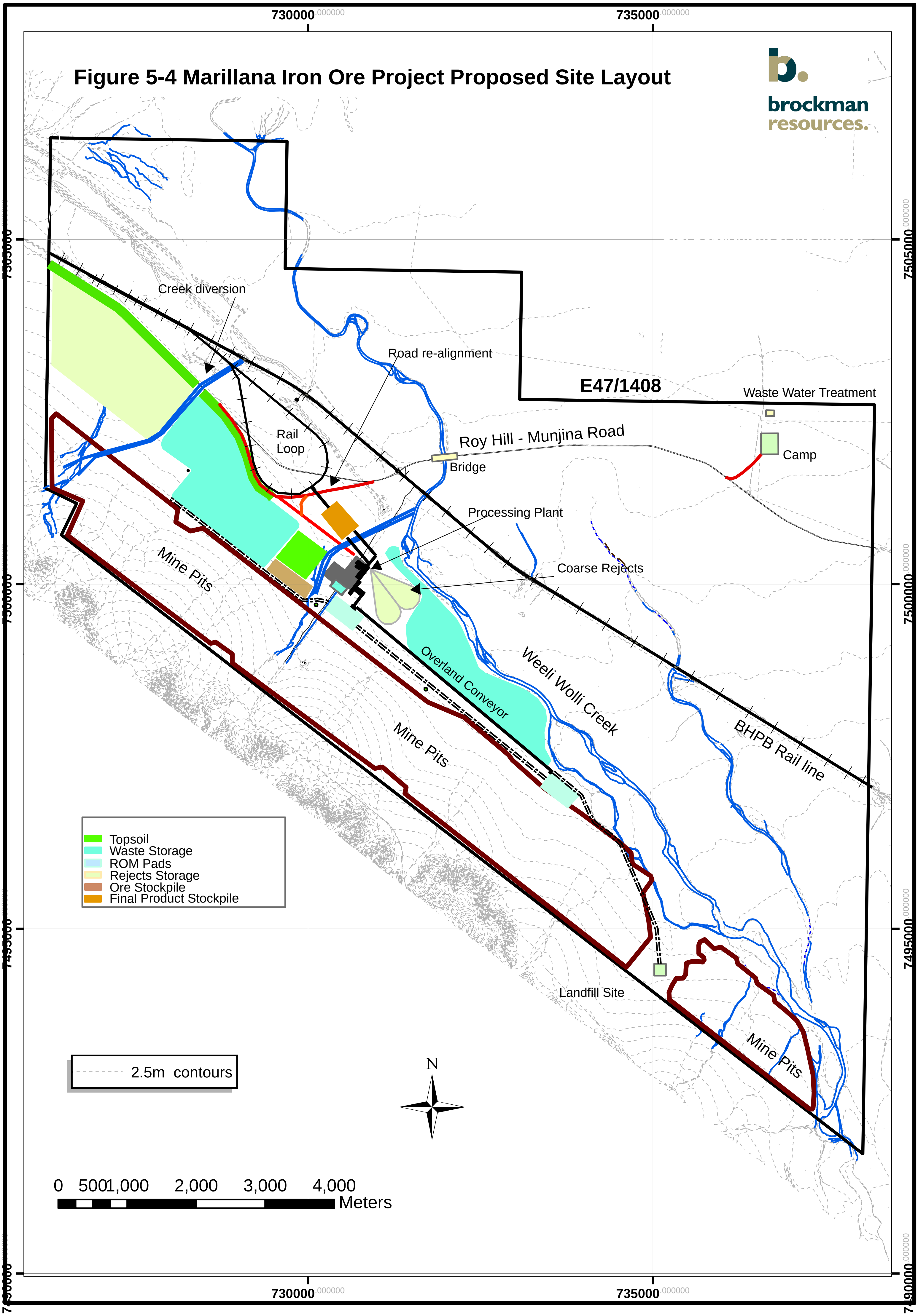
- Construct a 1.2 km access road from Munjina-Roy Hill Road to the plant site to the same standard as Munjina-Roy Hill Road.

- Construct a 0.8 km access road from Munjina-Roy Hill Road to the camp site to the same standard as Munjina-Roy Hill Road.
- Pave the 6.8 km from the plant site to the camp site, to reduce dust and road maintenance requirements.
- Construct a causeway or bridge across Weeli Wolli Creek where it is crossed by Munjina-Roy Hill Road, to provide access between the camp and plant when rainfall events cause Weeli Wolli Creek to flow without overtopping its banks. The creek bed is approximately 2 m deep at this point.
- The proposed rail loop also crosses the existing Munjina-Roy Hill Road and a 2.9 km diversion of the road has been designed (see Figure 5-4).

5.2.3 Borrow Pits

Materials for construction will target overburden from the mine pits. In the event that the overburden is unsuitable for some of the construction requirements, such as road building, separate borrow pits may be established within the footprint of disturbance, such as under the waste dumps or fines reject storage.

Figure 5-4 Marillana Iron Ore Project Proposed Site Layout



5.3 MINING ACTIVITIES

5.3.1 Mining Method

Mining will employ open pit methods of excavating, load and haul for the pit development, similar to the methods employed at the larger well-established open cut mines of the Pilbara.

Where the material to be mined is sufficiently hard to warrant blasting, drill holes will be charged with explosives and blasting will be used to loosen the material in accordance with well established safety procedures of the industry. Much of the material is alluvial gravel or Detrital ore deposited from erosion of the ‘solid rock’ Brockman formations in the Hamersley Ranges nearby. Much of the ore has been found to be sufficiently unconsolidated for modern mining equipment to excavate without blasting. Such material is referred to as “free-dig” material.

Hydraulic excavators will be employed to dig the material from working mine faces. The excavators will load the material into haul trucks for transport to either waste or ore dumping locations as appropriate. Waste will be transported by haul trucks to waste dumps, located adjacent to the mine pit in the early years, and in mined-out areas of the pit in later years. The Run of Mine (ROM) ore will be transported to an elevated pad (ROM pad) for tipping into a ROM feed bin. Two ROM pads and associated ROM feed bins are proposed, both of which feed the process plant. Mining will occur in multiple faces simultaneously and the ROM ore will be blended to ensure consistent mix of ore qualities. In some cases, stockpiles of ROM ore will be employed to further enhance the degrees of blending.

5.3.2 Pit Planning and Design

A mine plan has been developed as part of the PFS. The mine plan utilizes large 500 m wide panels (Figure 5-4) the width of the deposit to demonstrate the viability of working within the main constraints of:

- ore blend quality; and
- establishment of voids for back-filling.

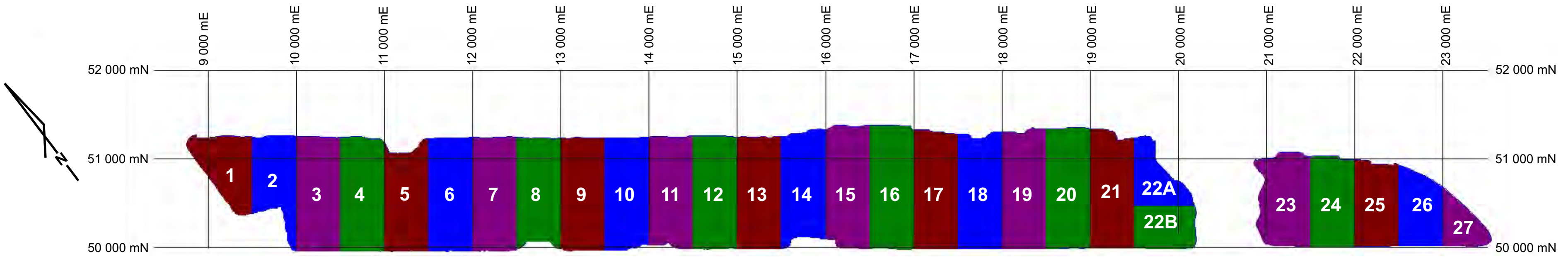
The depth of the pit will be between 40 and 70 metres below natural surface and will intersect the groundwater table which sits 20 to 30 m below natural surface. The mined-out blocks will be back-filled with waste or fines rejects material, or a combination of both. The total area of the pit is 1,648 ha however continuous back-filling of the pit will enable the amount of void open at any one time to be significantly reduced.

The pit has been designed to have an average standoff distance of 50 m from the pit crest to the lease boundary. This allows for a 30 m wide service corridor to be maintained along the power line and an additional 20 m accommodating surface drainage, bunding and access along the pit crest.

Pit design parameters are in keeping with established Pilbara mining practice and are detailed in Table 5-2.

Table 5-2 Pit Design Parameters

PIT DESIGN			PARAMETER
Pit Slope Angles	- North wall:	Batter angle	50^0
		Berm width	8m every 16m of wall height
	- South wall:	Batter angle	50^0
		Berm width	8m for every 8m of wall height
Haul Road Design			
Width			30m
Gradient			10%
Minimum radius of turning circle			25m
Working Widths			
Minimum pit base width			30m
Minimum cutback width			50m



Panel Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22A	22B	23	24	25	26	27
Start Mining (Yr #)	3	6	6	3	7	8	5	2	2	1	2	1	2	3	7	9	10	11	14	14	9	5	3	16	16	17	17	20
Finish Mining (Yr #)	18	19	9	7	9	12	18	8	7	6	2	2	3	4	9	10	11	15	15	17	13	9	5	16	18	19	20	20
Start Back Filling (Yr #)	19	20	10	8	10	13	19	9	8	7	3	3	4	5	11	11	12	16	16	18	14	21	21	17	20	20	21	21
Finish Back Filling (Yr #)	19	20	10	9	10	14	20	10	8	7	3	4	5	6	11	12	13	16	17	19	15	21	21	18	21	21	21	21

PLAN VIEW

kms
0 1 2
Scale 1:50 000

coffey mining
SPECIALISTS FROM BOARDROOM TO MINE FACE

Drawn	FAC	**Figure 5-5**	Original Size	A3
Approved	CL		Project no:	MWP00706AA
Date	25/08/2009	**MINING AND BACK FILL SEQUENCE**	Drawing	MWP00706AA-01
Scale	1:50000			

5.3.3 Dewatering Activities

The mine pit will intersect the water table during the project. Dewatering will utilize bores drilled in pit to reduce the level of the water table to below the level of the working pit floor. In addition to this, drains and sumps will be constructed in the floor of the pit to capture incident rainfall and other surface water from within the pits. Water from pit dewatering will be directed to the process plant for re-use in the processing of ore, and, where it is of suitable quality, for dust suppression.

The proposed borefield characteristics are:

- Comprise up to thirty bores.
- Bores will be up to 80 m in depth (generally 50-60 m).
- Long-term average pumping rates from individual bores will vary up to 2000 kL/d.

5.4 ORE PROCESSING

Ore will be delivered to the ROM feed bins by haul trucks. Ore will then be fed to primary crushing equipment to reduce oversize material to a size suitable for the downstream equipment. Ore will be mixed with water and fed into drum scrubbers to break up agglomerated material which have been cemented together by clays and silt sized materials. The drum scrubber works by agitating a slurry of ore in water in a turbulent manner.

Ore then passes to wet screens for separation into different sizes for processing. Ore larger than the maximum product size (nominally larger than 8 mm) will be crushed further and returned to the screens.

Ore sized between 1 mm and 8 mm will be conveyed to a mineral jig circuit for separation of product from reject (waste). Ore smaller than 1 mm will be directed to a series of cyclones for removal of the clay portion, nominally material smaller than 0.09 mm. Ore sized between 1 mm and 0.09 mm will be directed to a spiral separation circuit for separation of product from reject. A simplified plant flow diagram is shown in Figure 5-6.

Coarse rejects will be de-watered for disposal in the Coarse Rejects Storage (CRS).

Clay fines and rejects from the spirals will be directed to the fines rejects stream. Fines rejects will be directed to thickeners for recovery of process water. Thickened fines rejects will be pumped to FRS where solar drying and consolidation takes place. Additional water is decanted from the FRS and returned to the process plant for re-use.

Coarse concentrate from jigs and fine concentrate from spirals will be dewatered and conveyed to the product stockpiles.

When processing CID ore, which is a Direct Ship Ore (DSO) grade and does not require beneficiation, CID ore will by-pass the Spiral and Jig circuits and be conveyed directly to the product stockpiles on site and reclaimed for loading into trains for transport. A loading facility will be constructed consisting of a train loop and product reclamation systems for the loading of iron ore product from the product stockpile onto trains for transport to Port Hedland.

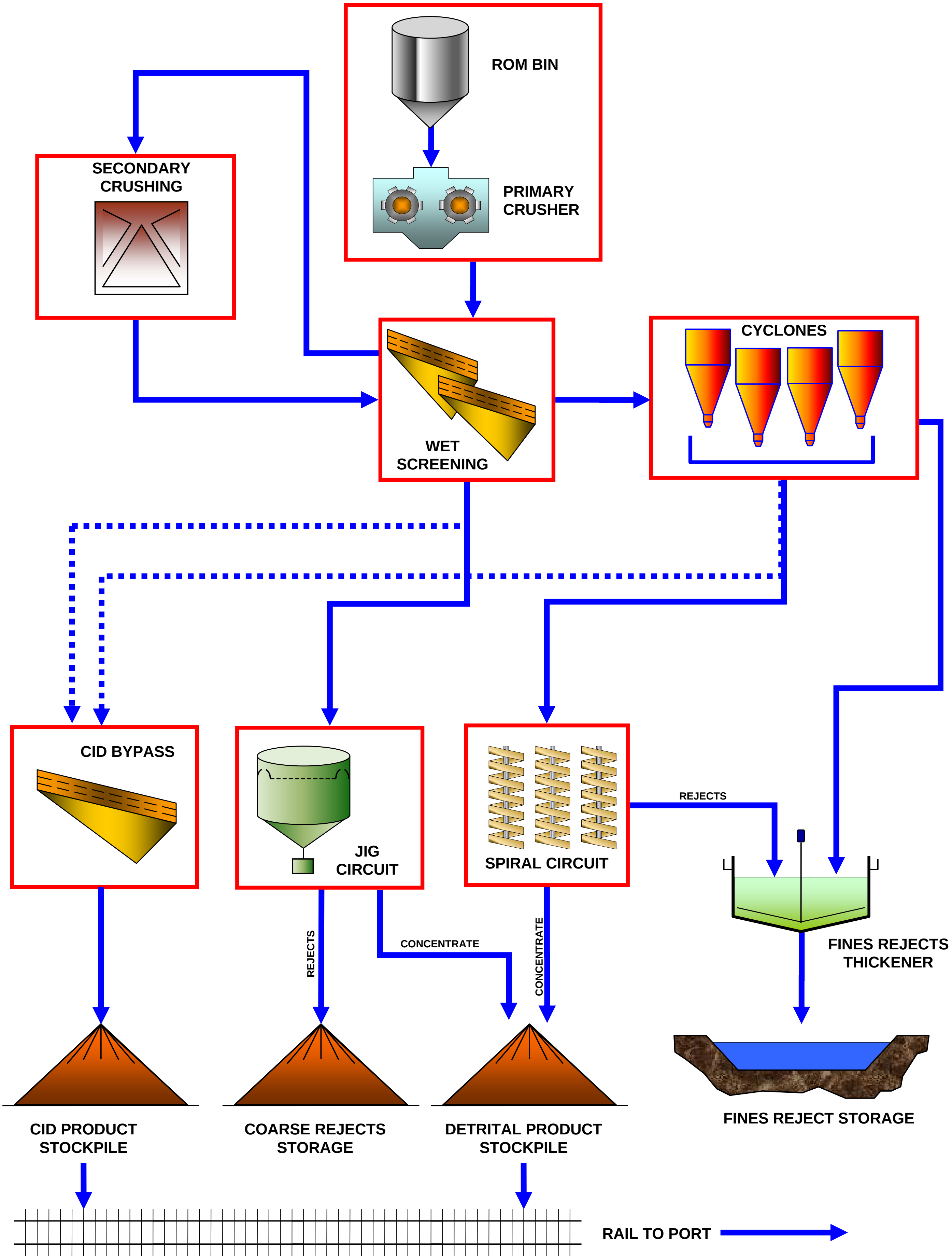


FIGURE 5-6 SIMPLIFIED PLANT FLOW DIAGRAM	ROM FEED	CID PRODUCT	DETRITAL PRODUCT	COARSE REJECTS	FINES REJECTS
ALL DETRITALS	37.5 mt/y	0.0 mt/y	16.8 mt/y	9.0 mt/y	11.7 mt/y
MAXIMUM CID	37.5 mt/y	5.0 mt/y	14.4 mt/y	7.7 mt/y	10.4 mt/y

5.5 MINING BYPRODUCTS

5.5.1 Mine Waste

Mine waste (overburden) is material that originates from within the proposed mine pit that does not contain sufficient iron to be processed economically into a saleable final product, but must be moved from its original location in order to access ore lying underneath it. The process of moving the mine waste will be predominantly performed using large excavators and haul trucks. During the relocation process, the mine waste does not undergo any physical transformation, other than that through the excavation process itself.

Mine waste extracted prior to the commencement of ore processing will be used to construct site infrastructure such as the FRS, the plant pad and flood protection bunds along the southern side of Weeli Wolli Creek.

A total of 110 million bank cubic meters (Mbcm) of waste out of a total of 561 Mbcm (20%) is scheduled to be dumped in external waste dumps (Figure 5-7), with the balance being stored inside mined out areas of the pit (Figure 5-8).

Representative testing for sulphur content show that the 99th percentile sulphur content is 0.05% across all domains in the deposit indicating that the material can be classified as non acid-forming (NAF) and therefore the waste rock and tailings are considered to be environmentally benign (see Appendix J).

There are a number of factors that have been considered in evaluating the best option for the waste rock dumps (WRD). They include:

- storage capacity;
- need to minimise visual impact;
- haul distance and disposal costs;
- site drainage; and
- site access and preparation.

In the interests of minimising trucking haul distances, two waste dumps will be required, one each to the east and west of the processing plant site, to service the two ends of the orebody. WRD locations can be viewed in the proposed site layout (Figure 5-4).

A number of perimeter drains and sediment traps will be constructed around the pit, waste dump areas and the ROM pad to manage local water run-off and to ensure merging of the run-off into the natural water courses. Drains will be constructed, where required, to ensure excess run-off from disturbed areas is controlled and directed to sediment traps before reaching natural watercourses downstream of the development.

5.5.2 Coarse Rejects

As the coarse rejects leave the processing plant on a conveyor and are dry-stacked, they will be stockpiled adjacent to the processing plant on start-up. Approximately 163 Mt of coarse rejects are expected to be generated over the life of the mine, at an average rate of 8.5 Mt/y. A total of 43 Mt of coarse rejects is scheduled to be stored in external waste dumps and a separate coarse reject stockpile, with the balance (120 Mt) being able to be stored inside mined out areas of the pit after year 3 of operation, once sufficient open-void is available.

Course rejects may also be utilised for mine haul road construction purposes.

5.5.3 Fines Rejects

The FRS was designed to contain thickened fine rejects generated from beneficiation of Detrital and CID ore. Approximately 215 Mt of fine rejects are expected to be generated over the life of the mine, at an average rate of 11.1 Mt/y. Seventy eight Mt of fine rejects will need to be stored in the FRS over the first seven years. The remaining 137 Mt (64%) is scheduled to be returned to the mine void.

The fine rejects (process waste) will be pumped from the fine rejects thickener to the final storage location at a target density of 50% w/w. The coagulants and flocculants added at the thickener to assist in the dewatering process are benign, and the fine rejects themselves are geochemically inert (non-acid forming). Consequently, the FRS is not required to be lined, and water seepage back into the aquifer will assist in the final consolidation of the fine rejects.

The operational design (Appendix K) of the FRS has been aimed at:

- ensuring geotechnical stability;
- optimising the removal of surface water for return to the processing plant;
- maximising fines rejects density and storage capacity by undertaking cyclic deposition for the above ground storages; and
- minimising land disturbance and maximising visual amenity.

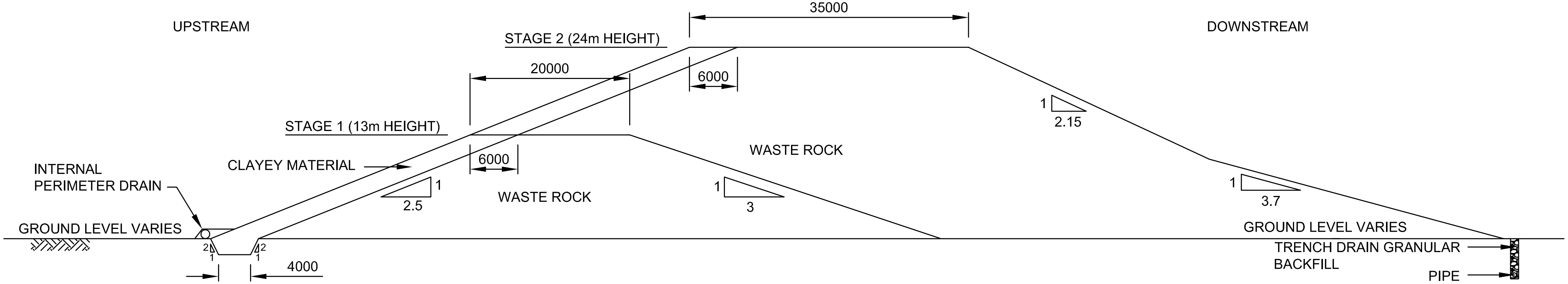
Fines rejects in the form of slurry will be discharged sub-aerially and spirally from the full circumference of the perimeter embankments of the above-ground FRS. Fines rejects will be deposited in discrete layers from numerous spigot point discharges.

Figure 5-7 illustrates the design of the above-ground FRS facility. The FRS was sited to avoid impacts to the Weeli Wolli Creek and to mitigate risk of the potential impacts of dust by maintaining sufficient distance between the FRS and potential sensitive receptors (including the site administration offices and camp site), constructing the FRS on the higher ground (see Figure 5-4) and ensuring appropriate bunding is in place (Appendix A).

The design concept for the in-pit (IFRS) facility involves scheduling placement of mine waste to create a series of nine rectangular cells, shaped like inverted pyramids (Appendix L). Process waste (fines rejects) and mine waste will be combined and located into one pit facility, with separate fines rejects cells crested by specific placement of mine waste to allow for the encapsulation of fines rejects. Fines rejects placement will be from a single point spigot discharge location that may be varied throughout the operation to provide optimum fines deposition and water pond manoeuvring.

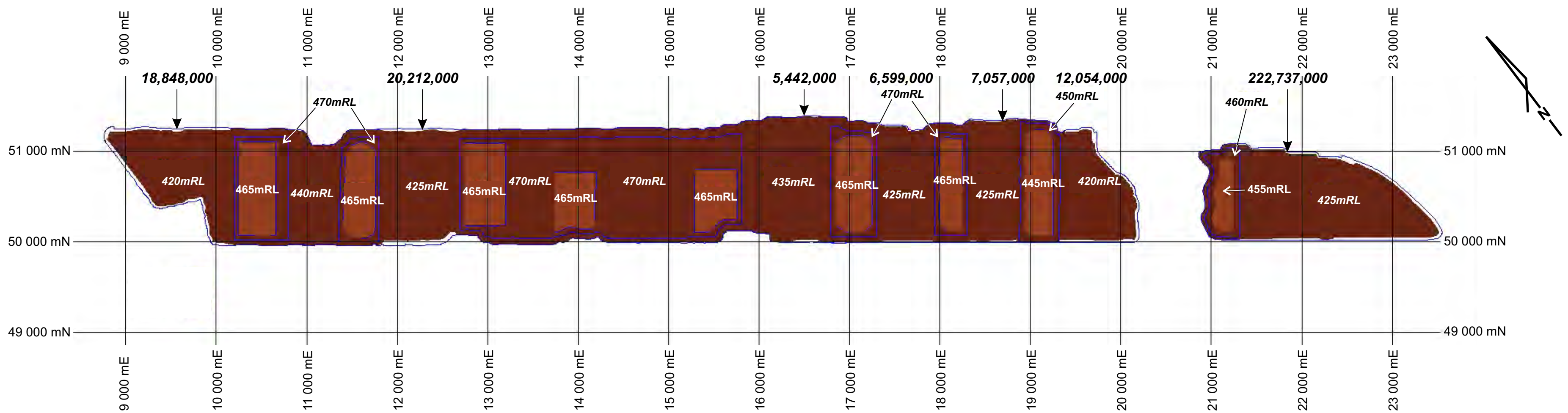
The cells have side slopes of 1:2 (vertical to horizontal) and will be constructed with a filter layer on each side, and across the base where mine waste is present in the floor of each cell, to separate the fines rejects from the mine waste. The filter will allow water to pass from the fines rejects into the mine waste during consolidation of the fines rejects.

Figure 5-8 illustrates the design for in-pit fines rejects and waste disposal.

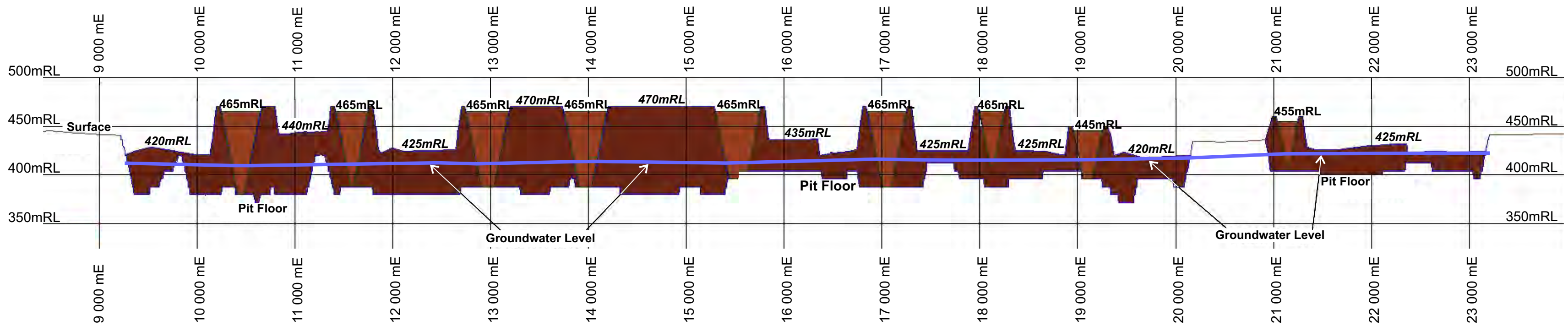


A
01
FRS1 EMBANKMENT
TYPICAL SECTION
SCALE 1:500

coffey mining SPECIALISTS FROM BOARDROOM TO MINE FACE	Drawn	LM/CF	Figure 5-7	Original Size	A3
	Approved	CL		Project no:	MWP00706AA
	Date	02/09/2009	FINES REJECTS STORAGE FACILITY SECTION		
	Scale	AS SHOWN		Drawing	MWP00706AA-02 Rev E



PLAN - MINE BACKFILL



SECTION @ 50650 mN (Vertical scale exaggerated)

LEGEND

- Waste
- Fine Rejects

Areas with fill below pit rim have volumes as shown

Co-ordinates shown are mine grid

kms
0 1 2
Scale 1:50 000

coffey mining
SPECIALISTS FROM BOARDROOM TO MINE FACE

Drawn	FAC	**Figure 5-8** **CONCEPT DESIGN FOR BACKFILL**	Original Size	A3
Approved	CL		Project no:	MWP00706AE
Date	22/07/2009		Drawing	MWP00706AE-01
Scale	1:50000			

F:\MINE\Projects\Brockman Resources\MINEWPER00706AE_Inpit TSF Evaluation\Figures\MWP00706AE dwg MWP00706AE-01 A3 Fig 5-8.pdf

5.6 ANCILLARY FACILITIES

The following mining services and infrastructure will be required for the Project:

- fuel storage and dispensing facilities;
- lubricant storage facilities, including reticulation for bulk oils and waste oil recovery;
- tyre bay;
- wash down bay to accommodate heavy and light vehicles;
- mobile equipment workshop;
- dust suppression water fill points;
- explosives storage facility including magazines;
- mining crew muster room, crib room and ablutions;
- general storage and lay-down areas; and
- lighting plants.

The key ancillary facilities are described below.

5.6.1 Landfill

A minor Class II landfill will be established on the tenement to manage the disposal of both putrescible and inert wastes. The landfill will be located in an area that poses minimal impact on surface and ground water, reducing the potential for pollution.

5.6.2 Power Requirements

Brockman intends to install a duel fuel power plant with a capacity of approximately 40 MW and a maximum demand of 34 MW on site to cater for the power requirements of the project.

The power supply has been designed such that it has adequate capacity for emergency standby, with a number of generators operating in parallel, and capable of being turned on and off in response to power demand.

Power reticulation requirements to remote locations will be by overhead power distribution lines. Thirty three kV power lines will be installed from the main switch room at the process plant to the accommodation village, train loadout, remote primary crushing, FRS and bore field areas.

Power lines will distribute power to the various infrastructure loads as follows:

- Village and construction camp 6.5 km
- Fines rejects storage 3.8 km
- General plant area 5.9 km
- Pit dewatering and explosives magazine 12.8 km

5.6.3 Flood Potential and Prevention Structures

The proposed mine site area will lie within the Weeli Wolli Creek floodplain during large flow events. Consequently, flood management and protection measures will be required around mine site infrastructure to prevent inundation and minimise the risk of uncontrolled flooding (details are presented in 7.5 Surface and Floodwater Management).

Aquaterra modelled the post development flow conditions in Weeli Wolli Creek using the site layout in Figure 5-4 and necessary flood protection measures to assess the potential impact of flooding on infrastructure.

Post development modelling shows that 10 and 100 year ARI water levels do not increase significantly from pre development conditions due to the widespread flooding that would occur in such events. The model predicts that water levels will increase by about 0.1 m in areas where flood protection bunding is required around mine infrastructure. Additionally the access roads between the accommodation village and the mine site will also be flood prone during large storm events.

To help manage the flows around the mine site, the use of bunds, earth pads and diversions is expected. Bunding and earth pads will be constructed above the estimated floodplain water depths and freeboard provisions provided to cover possible water level variations above the modelled water levels. Freeboard heights for the protection of critical infrastructure will be a minimum of 2 m above the 100 year ARI event or the flood level with the flow rate increased by 50%, whichever is the greater.

The plant site and waste dumps are located within the main Weeli Wolli Creek floodplain. The typical flow depth at the locations of the required flood protection bunding is around 1 m during a 10 year ARI flood event and between 2 m and 4 m during a 100 year ARI event. Associated flow velocities are less than 1 m/s, suggesting limited potential for erosion of any flood protection structures around the mine infrastructure.

5.6.4 Bulk Fuel Storage

Two bulk fuel facilities will be established on site for the storage of diesel fuel for the power house, mining heavy equipment and owners vehicles. Two diesel storage areas will be required as the mine and power station are separately contracted and use similar volumes. A 5,300 m^3 storage facility is expected to be required in two tanks at both the power station and the heavy vehicle workshop. The tanks will be located in a concrete bund equipped with a storm water / spillage sump pump.

Refuelling facilities are provided in the heavy equipment workshop area for the vehicles belonging to the operation. The facilities will be constructed with full containment of the diesel storage units as well as fuel transfer points and will comprise single skinned tanks within a containment bund or a series of double skinned tanks on a compacted gravel base.

The primary facility will be located at the mine operations area for re-fuelling of the mine fleet as well as power generation for the mining, processing and stockpiling facilities.

A second facility will be located adjacent to the accommodation village for supplying power generators and light vehicles.

Concrete slabs will be provided to contain fuel spillages during transfer of incoming fuel from road trains or refuelling of vehicles.

5.6.5 Explosives Storage

An explosives storage facility will be constructed on the site for the storage of explosives, and ammonium nitrate prill and/or emulsion.

5.6.6 Accommodation Village

A 550 person permanent village will be constructed approximately 6 km north-east of the plant site, and 800 m north of Munjina-Roy Hill Road, close to the northern corner of the lease. Access from the plant is via the site access road and Munjina-Roy Hill Road (Figure 5-4). This facility will include a first aid room, a dry mess, wet mess, recreation facilities, gym, sewage treatment and potable water supply to current Pilbara standards. All components of the village will be rated appropriately for the cyclone zoning of the area.

The permanent rooms in the village comprise four rooms per block and are constructed on a steel chassis. They will be 3.3 m x 3.6 m and will include ensuite facilities, bar fridge, bed, cupboard and desk.

All rooms include TV and air-conditioning.

In addition, the village will also contain the following facilities:

- dry mess;
- wet mess;
- administration office, store and shop;
- recreation room, including tv and internet;
- meeting and training room;
- gymnasium;
- first aid room;
- outdoor area lighting;
- gazebos and bbq area;
- landscaping; and
- internet access area for general use.

Construction personnel building the accommodation village will be housed at the nearby Auski Roadhouse until the construction camp is habitable and ready to be utilised.

5.6.7 Administration Complex

Administration offices will be located within close proximity to the pit and process plant. This area will accommodate owner and contractor offices.

5.6.8 Transport of Product

The transportation of iron ore production from the Project will be via either existing rail infrastructure available in the Pilbara or new rail infrastructure as is required.

The Project PFS identified two key potential rail transportation options being the use of:

1. BHPBIO rail Infrastructure or,
2. Fortescue Metals Group (TPI) rail infrastructure.

Access rights to the existing rail infrastructure are covered under various Stage Agreements that are currently in place. Negotiations regarding haulage agreements with existing infrastructure owners and operators are progressing as part of the

Project definition and it is anticipated that the commercial details of any potential agreements will be concluded in line with the Project Definitive Feasibility Study.

The Applications for Land Tenure relating to any required extensions of the existing rail infrastructure have commenced. The first step in these applications is to gain access for non-ground disturbing activities such as environmental field surveys. This process is well advanced and environmental surveys are scheduled to commence in the first half of 2010.

Application for regulatory approvals for the required additional rail infrastructure does not form part of this current PER submission for the Project. A separate application for environmental impact assessment and other regulatory approvals will be made once the requisite surveys and technical studies for extensions to existing rail infrastructure have been completed.

5.6.9 Aerodrome Facilities

The Marillana operation will be by a fly-in/fly-out working arrangement. The nearby Barimunya Aerodrome (Figure 5-9) is available for charter flight operations. Access to this facility will be via the existing Marillana to Weeli Wolli road via Gray Crossing.

The airstrip is currently utilised by two other companies (BHPB and Rio). The current operators of the Barimunya Aerodrome have been approached, and an agreement for the use of the Barimunya Aerodrome is being progressed.

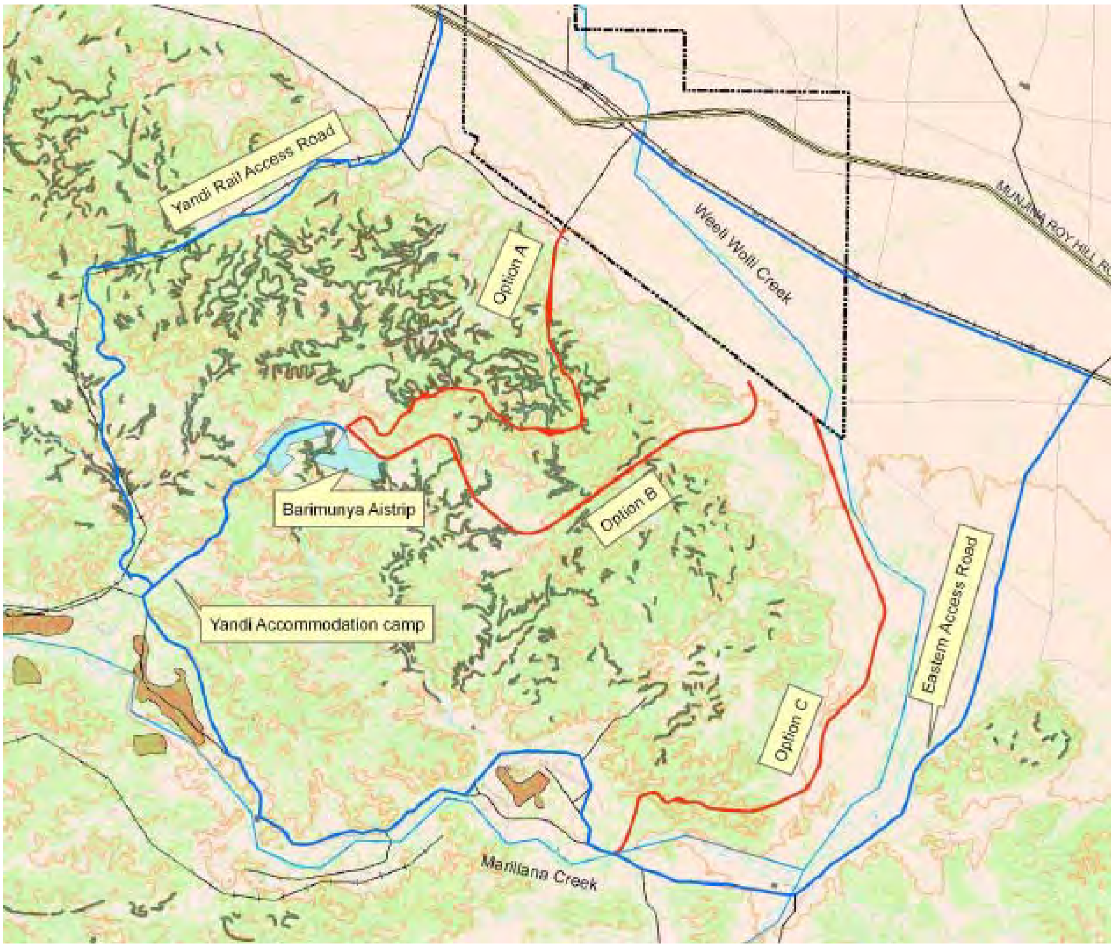


Figure 5-9 Location of Aerodrome Facilities and Existing Roads

5.6.10 Workshop Facilities

Workshop facilities to support maintenance of heavy mining equipment (HME) and process plant maintenance will be located close to the mining operations, and will be supplemented by vehicle washing facilities, tyre changing facilities, and other necessary ancillary infrastructure.

The mine maintenance surface infrastructure includes a heavy-vehicle workshop and an electrical workshop.

The front of the building has permanent openings (no doors) facing due south, with a clearance of 15 m, large enough to accommodate a CAT793 mining truck with the tray fully raised. Two of the vehicle bays have roller doors on the back wall of the building, providing the ability to drive through the workshop.

Space has been allowed for an outdoor tyre changing pad at one end of the workshop building. A vehicle wash-down area is also located in the area, providing separate wash-down pads for both heavy and light vehicles. Wash-down water will be collected and hydrocarbons and sediment removed to allow the water to be recycled.

5.6.11 Laboratory Facility

An ore sample preparation facility will be established on-site complete with sample jaw crusher, splitter, scale, screens, ovens and pulveriser. A laboratory will be established on site for preliminary testing of ore material. The laboratory services the assaying requirements for the mine and processing plant and provides metallurgical test work capability of approximately 90-100 samples per day.

Potable water, fume hood discharge, power and waste water services will be connected to the facility.

5.6.12 Waste Water Treatment

The process plant sewage treatment plant will be a 1000-person equivalent plant. The plant will incorporate pre-treatment and biological treatment processes to produce an effluent quality compliant with local and state government regulations. A similar plant will be installed for the village. The size of this plant will be designed to cater for the peak construction workload, to ensure adequate capacity, and will be installed up-front on construction commencement.

Influent (grey and black water) will be gravity fed from the camp facilities and amenity blocks to a wet well incorporating alternating duty/standby macerator pumps.

Influent from the wet well will then be pumped to balance tanks located adjacent to the waste water treatment plant (WWTP) for primary solids settling and for balancing the inlet flow which will be variable through each day, with peaks in the mornings and evenings.

Stored influent from the balance tanks will be then transferred at a constant flow rate via a duty/standby feed pump to the inlet of the packaged sewage treatment unit. The wastewater will be fed to the different stages of the bioreactors for organic matter removal and nitrogen reduction. The treated wastewater from the bioreactor will flow into a clarifier (settling tank) for biomass removal. In addition, chemicals (e.g. alum) will be added into the wastewater for phosphorus removal.

The overflow from the clarifier will be collected in a supernatant tank where chlorine (e.g. sodium hypochlorite) will be injected using a chemical dosing pump.

The treated effluent will then be filtered through a multimedia filter for removal of fine particulate followed by disinfection and re-chlorination to achieve the desired treated effluent quality. Water will be transferred to a storage tank prior to discharge to disposal as required.

The packaged plant provides a level of treatment sufficient for the discharged effluent to be disposed of via spray fields. The treated effluent will be spray-irrigated in areas approximately 500 m to the north of each wastewater treatment plant (see Figure 5-4).

5.7 WATER REQUIREMENTS

Major water sources are:

- pit dewatering;
- decant water from the FRS; and
- potable water bores.

Major water losses are:

- evaporation from the FRS;
- seepage from the FRS into the local aquifer;
- residual moisture in fines rejects;
- residual moisture in coarse rejects;
- residual moisture in product;
- water used in earthworks construction;
- dust suppression; and
- potable water consumption.

The total water demand for the Project is between 280 and 230 L/s (24,000 – 20,000 kL/d). This demand is broken down below and potential additional water requirements are discussed below.

5.7.1 Construction Water Requirements

During the construction phase of the Project, water will be used for:

- road construction;
- earthworks associated with plant infrastructure;
- dust suppression; and
- potable water consumption.

Construction water will be sourced from bores constructed within the ore body under licenses CAW 168340, CAW 168341 and CAW 165750 on current estimates. Approximately 2.3 GL of water will be required over a construction period of two years.

5.7.2 Potable Water Requirements

It is proposed to obtain water for the Project camp from low capacity bores installed into alluvium and calcrete in the vicinity of the camp and offices. Two production bores are anticipated at each location, and would operate on a duty/standby basis.

Hydrogeologically, relatively low yields (<2 L/s) were obtained from the alluvium/calcrete aquifer in the northeast of the tenement (Aquaterra 2008b), and it is likely that smaller capacity supplies to meet camp water supply requirements can be obtained from a combination of local calcretes and overlying alluvium close to creek channels. The location of bores close to creek channels will enhance the prospects of groundwater recharge after significant rainfall events.

Potable water for the accommodation village is estimated at 60 MLpa or 160 kL/d and the mine facility at 6 MLpa or 16 kL/day.

5.7.3 Process Water Requirements

Process water requirements over the life of the Project are estimated to be 7,250 MLpa. Process water will be sourced from pit dewatering (see section 5.5.3) and supplied to the processing plant and used for dust suppression systems and the vehicle wash-down area.

5.7.4 Water Budget

On the basis of water demand volumes for processing, dust suppression and potable supplies; along with numerical modelling of dewatering volumes, a water budget is outlined in Figure 5-10.

To achieve dewatering in the initial stages (year 1 to 3) water volumes above that required to meet water demand are anticipated. This surplus is planned to be re-injected into the aquifer (at a location distant from mining operations to minimise recirculation effects). See Table 5-3 for detailed breakdown.

Table 5-3 Preliminary Site Water Balance - Life of Mine

YEAR	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Water Demand (L/s)	220	280	280	280	230	230	230	230	230	230
Dewatering (L/s)	320	360	330	280	230	230	230	230	230	210
Surplus / Shortfall (L/s)	100	80	50	0	0	0	0	0	0	-20
Year (continued)	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Water Demand (L/s)	230	230	230	230	230	230	230	230	230	230
Dewatering (L/s)	190	180	160	120	120	100	100	100	60	50
Surplus / Shortfall (L/s)	-40	-50	-70	-110	-110	-130	-130	-130	-170	-180

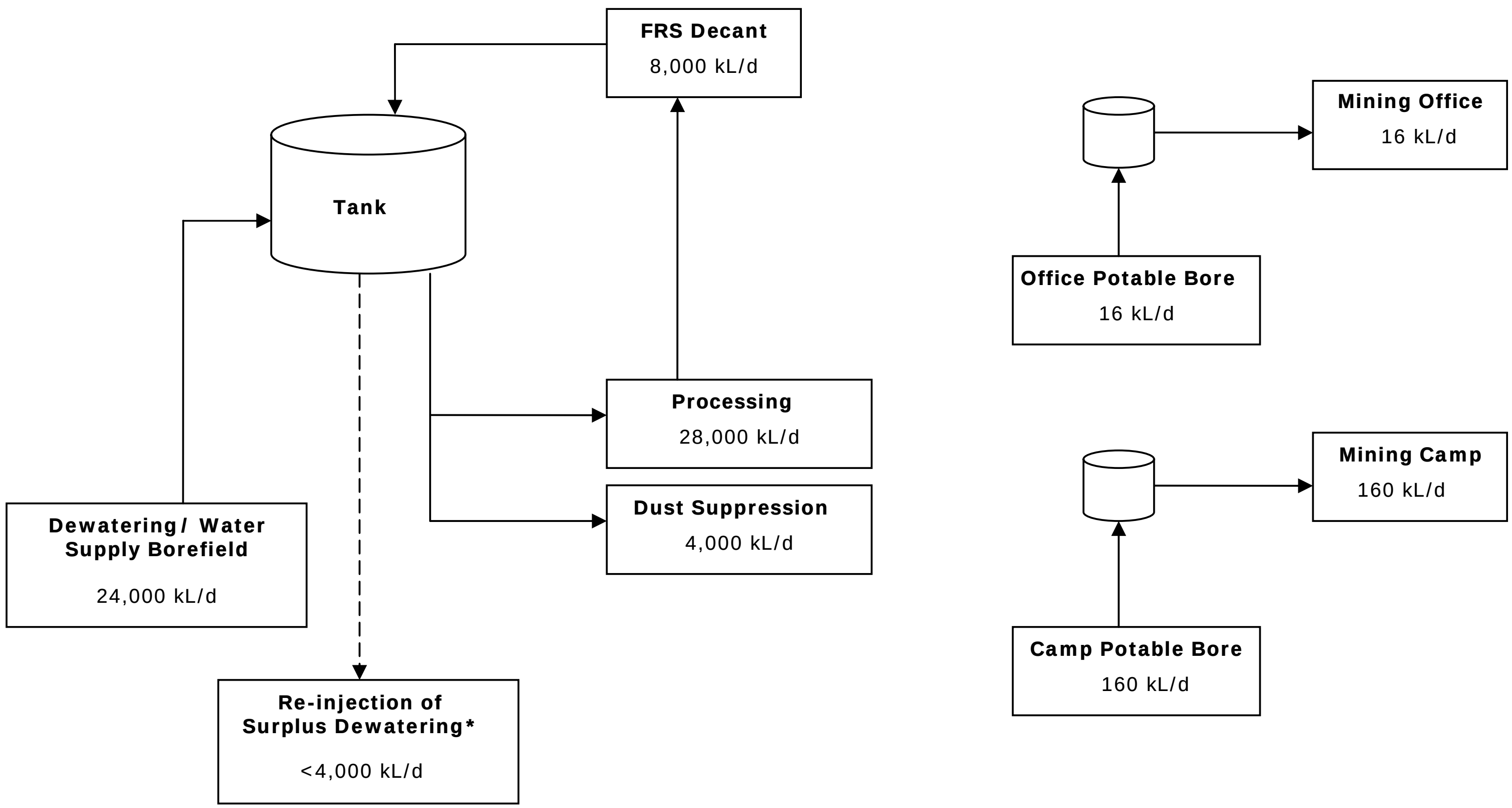
To conserve water during the initial period when production will exceed water demand, a re-injection borefield of four bores would be installed at a location distant from dewatering operations and within the defined orebody. The location is selected on the basis of the mine plan; currently Abalone East, the southeastern end of the orebody, is the identified site for the Managed Aquifer Recharge (MAR) operations. The conceptual design is four bores, spaced 500m apart, with each bore re-injecting ~25L/s. This means that in year 1, four bores will be operational; in year 2, three bores will be operational; and in year 3, two bores will be operational (management is discussed in section 7.4.4)

It should be noted that optimisation of the scheme design and location will occur during ongoing investigations. Optimising the distance from the dewatering operations is particularly important, as this will control the amount of water pipeline infrastructure required for system installation, and therefore impacting on capital and operational expenditure.

The modelling results for this option indicate that peak groundwater mounding (at ~2 years operation) will be 11m above the pre-mining water level (12mbgl at the Abalone East site). Recirculation effects increase dewatering requirements by less than 3%.

A conservative numerical modelling approach has been applied with regards to assessing groundwater mounding associated with the MAR options, for the following reasons:

- The pre-existing groundwater level is shallowest beneath the currently modelled MAR location, ~23mbgl at Abalone East. Alternate MAR locations have an increased depth to water table, and therefore the same mounding would be deeper beneath the ground surface;
- The extreme distance between the dewatering operations and MAR operations minimises the effects of recirculation, and therefore maximises the groundwater mounding predictions;
- The direct application of recharge to the water table in the model is conservative, as it does not account for any system losses such as evaporation (a consideration for the infiltration pond and galleries).



* Note: Re-injection is potentially required in Years 1 to 3 only

aquaterra

FIGURE 5-10

MARILLANA PROJECT – WATER BUDGET SCHEMATIC

5.7.5 Additional Water Requirements

Groundwater modelling was conducted by Aquaterra (Appendix E) to assess the potential for dewatering of the CID and detrital orebody to supply the project water demand. The model indicates that the proposed borefield, with one bore located in each mining panel, operated consistent with the proposed mining sequence (see section 5.3.2) will be sufficient to satisfy water supply requirements until year 9 of the project.

Beyond year 9 of operations, it is projected that further supplementary water supply (above what is produced through dewatering) will be required for the operations. It is the preference of Brockman, in alignment with the philosophy of the DoW hierarchy of water management options, to source this supplementary supply from nearby operations that are discharging significant surplus water (DoW 2007).

To this end, discussions are progressing to develop an off-take agreement with a neighbouring operation that is discharging excess water, to deliver this as a water supply to the Project.

Various other groundwater source options exist in the vicinity of the project. The extent and thickness of tertiary aquifer below the base of proposed mining is anywhere between 20 and 60 m where the palaeochannel thickens to the north. This means that there will be further groundwater available on tenement to meet water demand after year 9 of the Project, should a water off-take agreement not eventuate. Numerical groundwater modelling of any such abstraction would be undertaken to adequately assess the potential impacts of this option in the event that direct off-take is unable to be adopted.

Other off-tenement water solutions have also undergone preliminary investigations, particularly options that target the identified groundwater throughflow excess within the Weeli Wolli groundwater system. This elevated groundwater throughflow is related to the excess dewatering disposal of up-gradient mining operations. Therefore there is a high level of confidence that the water resource is available should it be required later in the life of mining operations.

It is acknowledged by Brockman that assessment of the environmental impacts associated with this additional supply (if any) will need to be addressed as part of a separate impact assessment and approval process.

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6.0 EXISTING ENVIRONMENT

6.1 CLIMATE

The Project is situated in the Pilbara region of Western Australia and experiences an arid-tropical climate with two distinct seasons; a hot summer from October to April and a mild winter from May to September. Annual evaporation exceeds rainfall by as much as 500 mm per year. Seasonally low but unreliable rainfall, together with high temperatures and high diurnal temperature variations are also characteristic climatic features of the region. This region has in the past experienced no rainfall in any month of the year, which is typical of a desert climate (Beard, 1975).

Within the Pilbara, the temperature range is large and maxima are high. Summer temperatures may reach as high as 46°C at Newman, with a mean maximum of 31.3°C. Light frosts occasionally occur during July and August. The climate experienced throughout the year is usually very dry since high temperature and humidity seldom occur simultaneously.

Rainfall in the Pilbara is highly unpredictable and recordings are highest at stations around the Hamersley Ranges, which lie at altitudes of up to 900 m (Beard, 1975). From January to March, rain results from moist tropical storms penetrating from the north, producing sporadic and drenching thunderstorms. Tropical cyclones moving south from northern Australian waters also bring sporadic heavy rains.

From May to June extensive cold fronts move easterly across the state and occasionally reach the Pilbara. These fronts produce only light winter rains that are ineffective for plant growth other than herbs and grasses. Larger perennial species require the intense and prolonged storms of summer.

Surface water can be found in some pools and springs in the Pilbara all year round, although watercourses only flow briefly due to the short wet season. Meteorological data has been recorded at the Bureau of Meteorology (BOM) weather station at Newman (23°22'S, 119°44'E). This BOM weather station is located approximately 100 km to the south-west of the project area, providing an indication of climatic conditions experienced within the study area.

The calculated average annual rainfall is 310.3 mm, occurring over 45 rain days. It loosely follows the typical Pilbara bimodal distribution pattern, with a peak between December and March and a smaller peak in May and June. Most of the rainfall occurs in the summer period, with over 55% of total annual precipitation occurring between December and March.

Mean annual maximum and minimum temperatures for Newman are 31.3°C and 17.3°C respectively. Mean monthly maxima range from 38.8°C during January to 22.2°C in July, while mean monthly minima range from 25.3°C in January to 8.0°C in July (Figure 6-1).

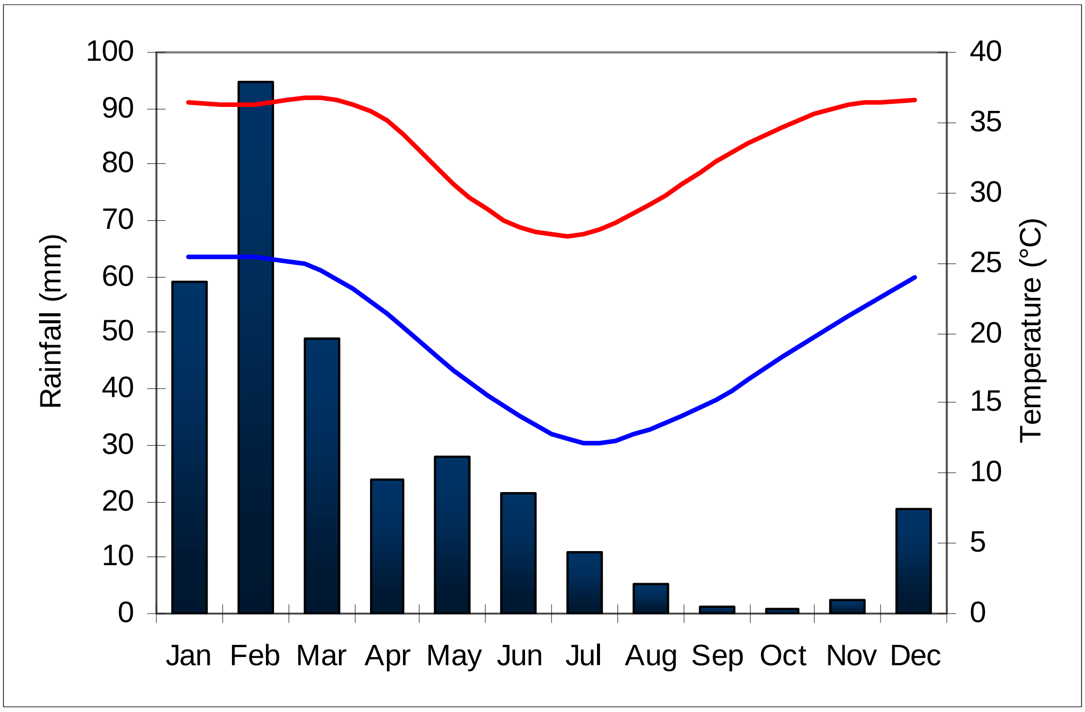


Figure 6-1 Summary of Climatic Data for 2008 (Bureau of Meteorology)

6.2 BIO REGIONS

The Interim Biogeographic Regionalisation for Australia (IBRA) represents a landscape-based approach to classifying the land surface of Australia, in which bioregions (broad scale regionalisation) are formally recognised and mapped. Biogeographic regions are defined on the basis of climate, geology, landforms, vegetation and fauna.

Western Australia encompasses 26 IBRA bioregions and 53 subregions, each affected by a range of different threatening processes and with varying levels of sensitivity to impact (DEC, 2002). The EPA utilises IBRA regions and subregions as the largest unit for EIA decision-making in relation to the conservation of biodiversity (EPA 2002).

The project area lies in the Pilbara biogeographic region of the IBRA. With an area of 179, 287 km^2, the Pilbara bioregion is in the largest area class. Other bioregions vary from 2,372 to 423,751 km^2, most being between 14,000 and 200,000 km^2 in size. The size of the Pilbara bioregion is fairly typical of bioregions situated in remote arid and semi-arid areas.

Dominant limiting factors and constraints for the Pilbara bioregion listed by Thackway and Cresswell (1995) include extinction of critical weight range (CWR) mammals, wildfire, feral animals (in particular the cat and fox), weeds, and grazing or pastoral activities. The reservation status of the bioregion is 1-5%, which is relatively low (some bioregions have a greater than 10% reservation status).

The Pilbara bioregion has been separated into four sub-regions; the Hamersley, Fortescue Plains, Chichester and Roebourne sub-regions. The project area is located within the Fortescue Plains sub-region (PIL2), with a small section crossing the border of the Hamersley sub-region (PIL3) (Figure 6-2).

Figure 6-2 Location of the Project Area within Pilbara IBRA Sub-Regions

The Fortescue Plains subregion is characterised by alluvial plains, hard pan wash plains and sandplains (with stony plains, floodplains and some salt lakes) on alluvial deposits over sedimentary rocks of the Hamersley Basin (Kendrick 2001). The soils associated with these habitat types include; red deep sands, red loamy earths and red-brown non-cracking clays with some red shallow loams and hard cracking clays. These soils support mulga shrublands and spinifex grasslands (with some tussock grasslands and halophytic shrublands (van Vreeswyk *et al.* 2004).

The areas of the project area that extend into the hills and dissected plateaus of the Hamersley Ranges have stony soils with red shallow loams, some red-brown non-cracking clays and red-loamy earths. These soils support spinifex grasslands with Snappy gum (*Eucalyptus leucophloia*) and Kanji (*Acacia inaequilatera*) (Beard 1975).

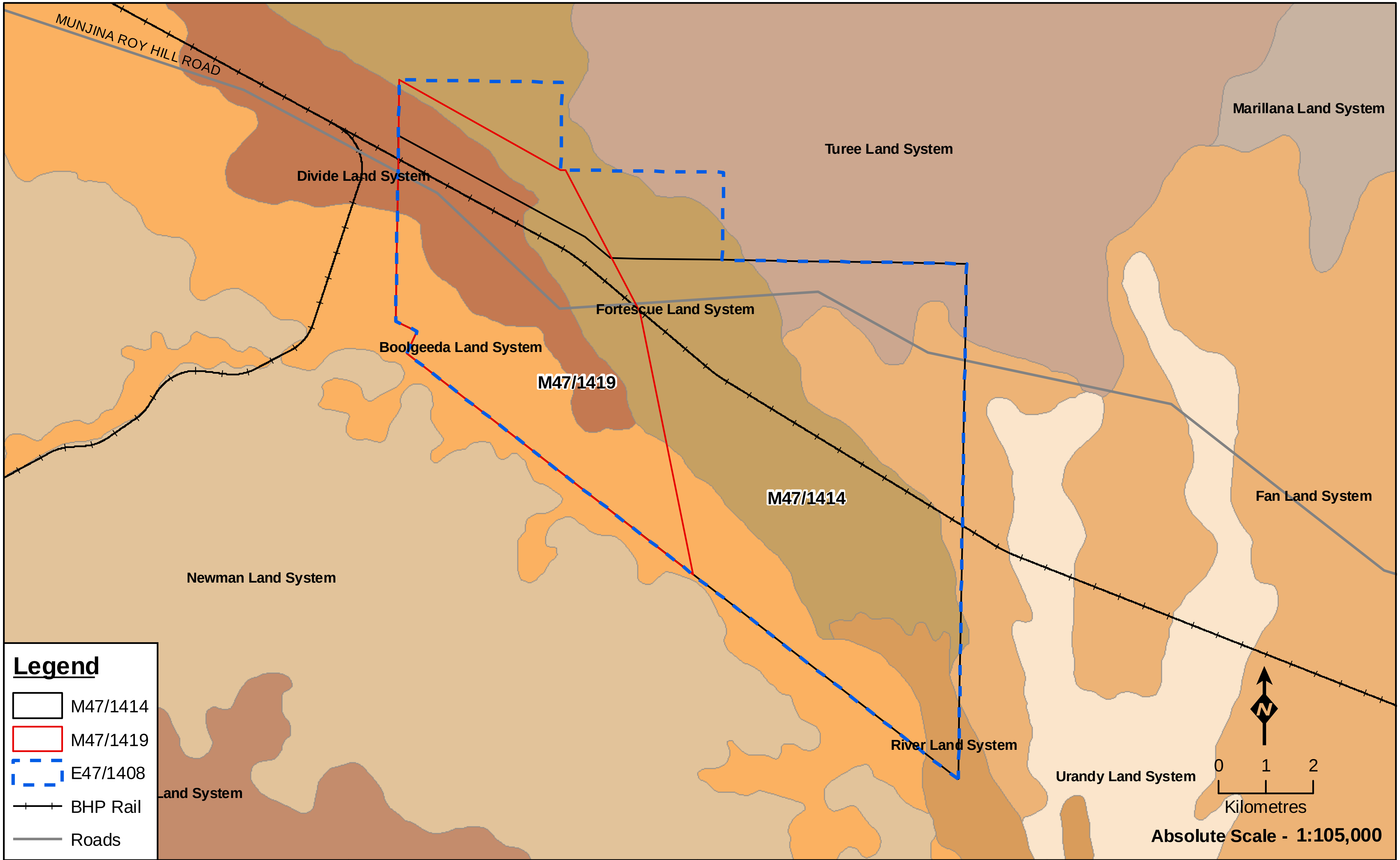
6.3 LAND SYSTEMS

The project area spans six land systems (Figure 6-3) as described by Van Vreeswyk *et al*. (2004).

Table 6-1 shows the total area of each land system in the project area (exploration and mining leases), within the actual project footprint and in the Pilbara region in total.

Table 6-1 Land Systems of the Marillana Project Area (from van Vreeswyk *et al.* 2004).

LAND SYSTEM	HABITAT	PROJECT AREA (km^2)	PROJECT FOOTPRINT (km^2)	TOTAL AREA IN PILBARA (km^2)
Fortescue	Alluvial plains and floodplains supporting patchy grassy woodlands, shrublands and tussock grasslands	41.91	2.88	504
Turee	Stony alluvial plains with gilgaied and non-gilgaied surfaces supporting tussock grasslands and grassy shrublands of mulga and snakewood.	6.76	0.09	581
Fan	Wash plains and gilgai plains supporting groved mulga shrublands and minor tussock grasslands	10.46	0	1,482
Boolgeeda	Stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands and mulga shrublands	20.56	17.12	7,748
Divide	Sandplains and occasional dunes supporting shrubby hard spinifex grasslands	12.18	5.31	5,293
River	Active floodplains and major rivers supporting grassy *Eucalyptus* spp. woodlands, tussock grasslands and soft spinifex grasslands	3.44	0.44	4,088



ecologia ENVIRONMENT

brockman resources.

Marillana Land Systems

Figure: 6-3
Project ID: 936

Drawn: SG
Date: 07/04/09

Coordinate System
Name: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Unique Map ID: M065

A4

6.4 GEOLOGY AND SOILS

Geologically, the Project is located within the Hamersley Province on the southern Pilbara Craton of Western Australia.

The Hamersley Group is an approximately 2,500 m thick sequence of banded iron formation (BIF), shale, dolomite, mafic volcanics and dolerite sills, and is Archaean to Paleoproterozoic in age. A notable feature of this group is the presence of five major BIF units that are laterally continuous throughout the province with no apparent facies change. Two of these BIF units, the Marra Mamba Iron Formation and the Brockman Iron Formation host all of the major iron ore deposits in the Pilbara, and are the source for most detrital iron deposits.

The project area lies on the Fortescue valley floor to the northeast of the Hamersley Range. The area is flat lying and consists of mainly transported colluvium and alluvium deposits, with minor outcrops of Canga and Archaean Wittenoom Dolomite. The combined thickness of the transported cover is up to 80 m, and it hosts the targeted detrital deposits.

Transported cover can be divided into four subdivisions, including: colluvium (and alluvium), hematite detritals, pisoliths and cemented pisoliths. The colluvium and alluvium are interbedded and varies in thickness from 10 m to 57 m in the areas drilled. Below the colluvium/alluvium are hematite detrital accumulations, interbedded with lenses of pisolite rich material. In places, the base of the profile is a cemented goethitic pisolite, interpreted to represent a buried and partially re-cemented CID.

The sequence is typical of the detrital sequences in the region.

The Project lies within a large region of soils that have been classified by Bettenay *et al.* (1967) as dominated by:

- red earth;
- hard-setting loamy soils;
- loamy soils with pedalogic organisation;
- dissected pediments; and
- outwash plains.

The three soil types that are most applicable to the project area are the red earth plains of the Fortescue valley, the surface cover of which consists of stony gravels, the dissected pediments forming low stony hills and the outwash plains; both of which support a surface cover of gravel and the hard setting loamy soils with red clay subsoils forming dissected stony pediments, hills and mesas. As a consequence of the sparse vegetation cover and the erosive force of heavy summer cyclonic rains, much of the soil on the hill slopes tends to be transported down to the valleys and plains.

6.5 SURFACE HYDROLOGY

The Hamersley Ranges are located immediately to the south of the project area. The ranges extend from an elevation of 440 m in the project area to include peaks of up to 775 m within the catchments which drain through the project area.

Outside of the project area catchments, the Hamersley Ranges contain Western Australia's highest peak Mt Meharry reaching 1253 m. The Hamersley Ranges catchments which impact the project site have a moderately dense network of streams which generally have very steep upper catchments and bed slopes ranging from 3% to 19%. Drainage from these areas occurs via incised, topographically controlled channels.

The catchments typically level out to a wide, flatter plain with bed slopes of 1% to 2% before forming a delta upon leaving the ranges and draining through the project area. Slopes through the project area range from 0.2% to 1%. The flow occurs within numerous small and shallow distributary channels which often become indistinct. In major events, runoff through the project area would occur as wide, shallow slow moving sheet flow (Aquaterra, 2009b).

Weeli Wolli Creek is a major Pilbara drainage system and flows diagonally across the tenement from the south-east to the north-west. In addition there are numerous smaller streams that flow down the Hamersley escarpment and form deltas when they reach the flatter country at the base of the escarpment. They then flow in the form of sheet/overland flow until they reach Weeli Wolli Creek (Aquaterra, 2009b).

Weeli Wolli Creek is recharged mainly from Weeli Wolli Springs, located approximately 40 km upstream of the mine site, and Yandicoogina and Marillana Creeks which discharge into Weeli Wolli Creek at approximately 25 km upstream of the mine site. Upon exiting the ranges, Weeli Wolli Creek has formed an extensive delta with numerous flow paths in major events. The split of flow between the channels will vary with the intensity of the event. For example, during low flow events, flow will be confined exclusively to the main Weeli Wolli Creek channel, however during large events, the flow within the main channel would only represent a small proportion of the total flow. From this delta, the Weeli Wolli Creek channels extend northwards into the Fortescue Marsh, which is an extensive intermittent wetland located on the floor of the Fortescue River valley.

The main creek channel flows in a north westerly direction through the project area. The channel is typically trapezoidal in shape with steep banks and a flat wide channel. The typical creek width is 50 m with banks typically 1.5 to 2 m high. In places the width between creek banks extends to as much as 200 m. This width typically includes a main channel of around 50 m and islands which typically support eucalypts. Bed slopes through the project area are typically low at around 0.1%. With the exception of the in-stream islands, and occasional isolated eucalypts, there is little in-stream vegetation. Eucalypts are common on the bank of the creek channel, typically occurring within 20-30 m of the creek bank.

Waterloo gauging station is located approximately 8 km downstream of the confluence of Yandicoogina Creek and Weeli Wolli Creek. A record of streamflow data between 1984 and 2008 shows that on average, Weeli Wolli Creek can be expected to flow a mean of 24 days/year and a median of 7 days/year (DoW, 2009). The duration of a 1 in 2 year flow event is about 7 days, while a 1 in 10 year flow event is approximately 18 days in duration.

The proposed development is located in the Fortescue Marsh catchment. The marsh area is in the physiographic unit known as the Fortescue Valley, and occupies a trough between the Chichester and Hamersley Plateaux (Beard, 1975).

The Goodiadarrie Hills, located on the valley floor just west from the marsh rail crossing, effectively cuts the Fortescue River into two separate river systems. West from the Goodiadarrie Hills, the Lower Fortescue River Catchment drains in a general north-westerly direction to the coast, whereas east of the hills the Fortescue Marsh receives drainage from the Upper Fortescue River Catchment. Several large creek systems discharge to the Fortescue Marsh with a total catchment area of approximately 31,000 km^2. These systems include the Fortescue River, Weeli Wolli

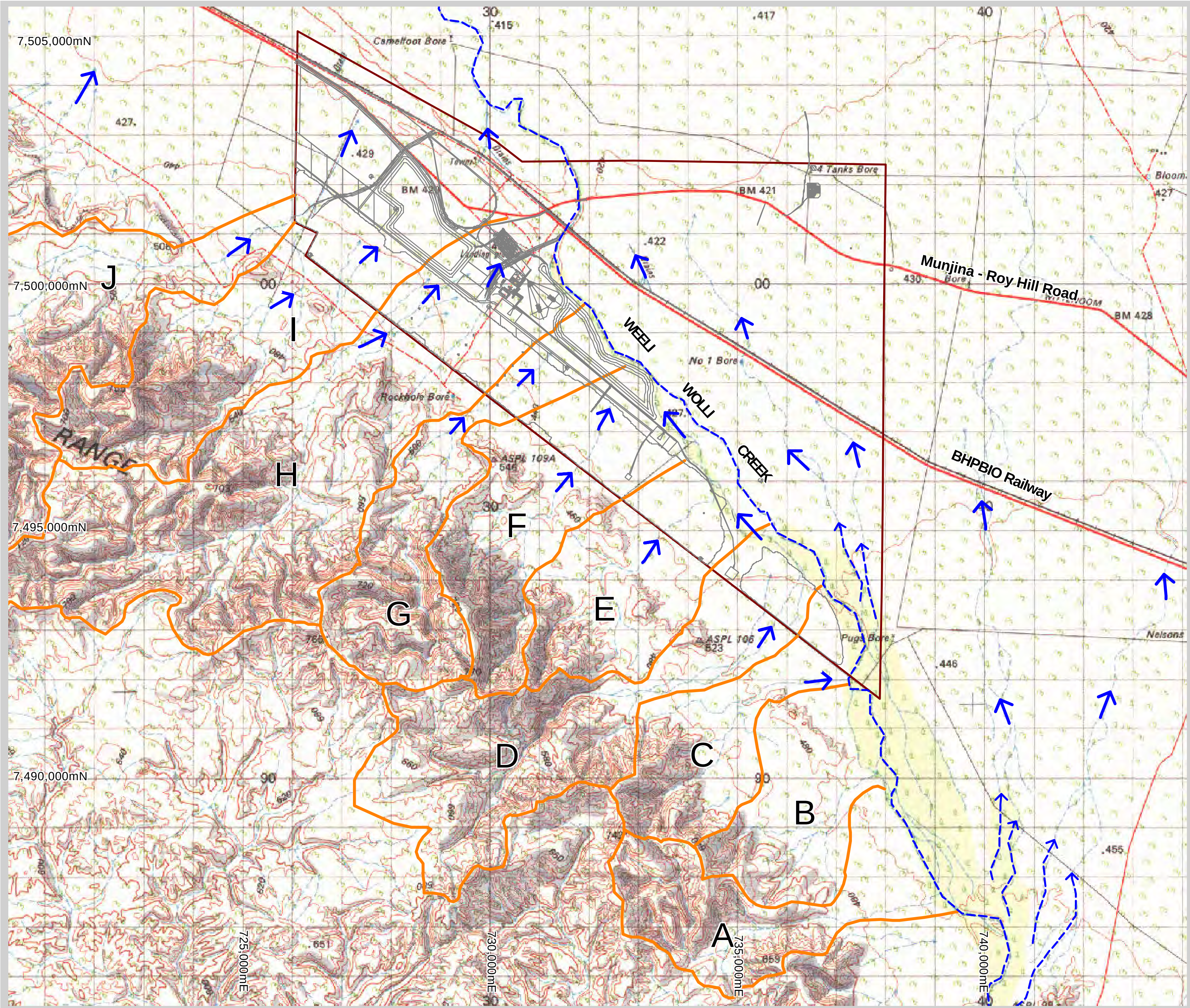
Creek, Marillana Creek, Caramulla Creek, Jigalong Creek, Kondy Creek and Kulkinbah Creek. The alluvial outwash fan from the Weeli Wolli Creek and other smaller creek systems abutting the Goodiadarrie Hills is believed to be partially responsible for this obstruction to the Fortescue River and forming the Fortescue Marsh. The DoW considers the upper portion of the Fortescue River which drains to the Marsh as a closed system.

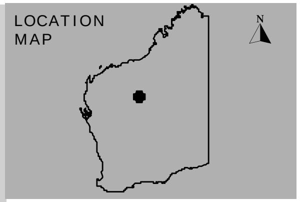
The Fortescue Marsh itself is an extensive intermittent wetland acting as a flood storage and occupying an area around 100 km long by typically 10 km wide, located on the floor of the Fortescue Valley. The marsh has an elevation around 400 m AHD. To the north, the Chichester Plateau rises to over 500 m AHD, whereas to the south the Hamersley Ranges rises to over 1000 m AHD. Following significant rainfall events, runoff from the creeks drains to the marsh. For the smaller runoff events, isolated pools form on the marsh opposite the main drainage inlets, whereas for the larger events the whole marsh area has the potential to flood.

Published topographical mapping indicates that the lower bed levels in the Fortescue Marsh predominantly lie between 400 m and 405 m AHD. Data provided by the DoW states that the flood level in the marsh would need to be marginally higher than 413m AHD to overspill westwards past the Goodiadarrie Hills. No published flood level data are available for the marsh. Anecdotal evidence suggests that over the last 50 years, following major cyclonic events, flood levels of approx 410 m AHD have occurred.

Surface water runoff to the marsh is of low salinity and turbidity, though the runoff turbidity typically increases significantly during peak periods of flooding (WRC, 2000). Following a major flood event (that flooded the whole marsh area), anecdotal data indicates that the water could pond up to 10 m in depth in the lowest elevation marsh areas. Water stored in the marsh slowly dissipates through the processes of seepage and evaporation. During the evaporation process, the water salinity increases and as the flooded areas recede, traces of surface salt can be seen. During the seepage process, the increasingly more saline water is believed to seep into the valley floor alluvial deposits.

Figure 6-4 shows the natural (pre-development) surface water drainage across the project area.





LEGEND

- Weeli Wolli Creek and Distributaries
- Existing Flow Paths
- Hamersley Ranges Catchments
- Brockman Mining Lease Boundary
- Proposed Mine Infrastructure

SCALE

1 0 1 2 3
Kilometers
Scale: 1:75,000

aquaterra

Figure 6-4

Pre Development Surface Water Drainage

AUTHOR:	LC	REPORT NO:	044a
DRAWN:	LC	REVISION:	a
DATE:	13/08/2009	SCALE:	1:75,000 at A3
JOB NO:	832H/H5	PROJECTION:	GDA94 Z50

Location: F:\Jobs\832H\SWMP\044a Figure 5.1

6.6 HYDROGEOLOGY

Regional hydrogeology

The Weeli Wolli Creek catchment area is 4,769 km^2, and this upstream catchment includes three major mining areas: Hope Downs, Area C, and Marillana Creek. The Weeli Wolli Creek system has a combination of groundwater and surface water flow, which represents the upstream recharge. During high rainfall events, there is significant surface water flow into the project area; some of this run-off reaches the Fortescue Marsh, while some infiltrates in the groundwater system.

The most extensive aquifer in the area is associated with an alluvial sequence that extends northeast from the lower slopes of the Hamersley Ranges across to the Fortescue Marsh. The alluvial deposits consist of clays, silts, sands, gravels and calcretes, and extend to depths of 100 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 to 1 m/d).

Closer to the base of the Ranges, a CID and detrital sequence lies within a palaeo-valley. The CID is up to 40 m thick, is typically goethitic, and is pisolitic in parts. The CID is typically highly porous and vuggy with significant secondary porosity from joints and solution cavities. It is assumed that the palaeochannel continues downstream beyond the project area (perhaps aligning to the north towards the Fortescue Marsh west of the project area), while upstream, it is anticipated that the palaeochannel aligns with the modern drainage line of Weeli Wolli Creek where it extends up into the Hamersley Ranges.

Groundwater levels across the project area have been measured from existing regional water bores, along with recently installed stygofauna monitoring holes and piezometers. The data shows that groundwater levels on tenement vary from approximately 424 mRL, where Weeli Wolli Creek exits the Hamersley Ranges to the east of the project area; down to 410 mRL several kilometres into the valley towards the Fortescue Marsh, and also west along strike of the orebody near the base of the Hamersley Ranges. Groundwater levels tend to be a subdued reflection of topography.

Contours of the groundwater levels shows that the water table generally has a low gradient to the north (towards the centre of the valley); while locally within the palaeochannel, the flow is in a north-westerly direction along the base of the Hamersley Ranges, likely an artefact of preferential groundwater flow through the more permeable palaeochannel.

Significant rainfall events can potentially induce a groundwater level increase of several metres, and it is likely that sizeable background seasonal fluctuations occur in the region, and are likely to be accentuated in the vicinity of Weeli Wolli Creek, which sustains numerous channel flow events every year.

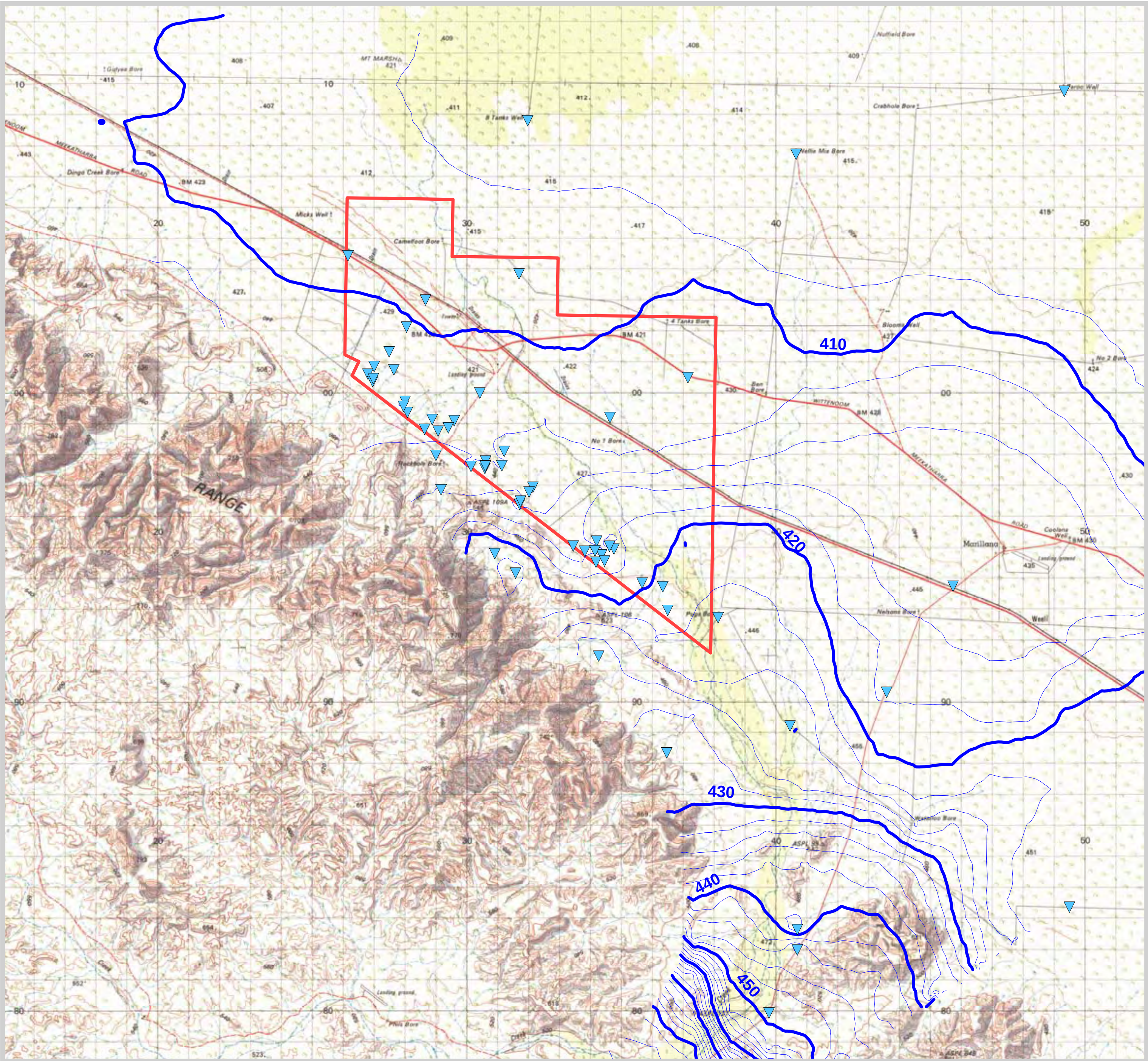
Table 6-2 and Figure 6-5 summarises the hydrogeology of the project area.

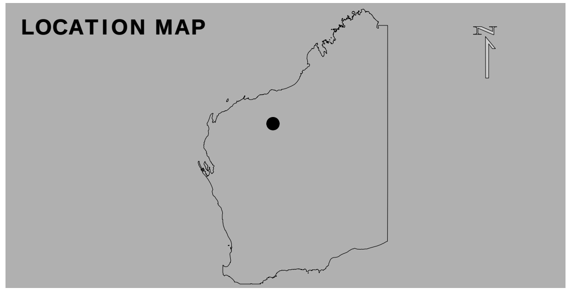
Table 6-2 Summary of Local Hydrogeology

AGE	LITHOLOGY	DESCRIPTION	GROUNDWATER POTENTIAL
Quaternary	Transported overburden	Poorly consolidated silty sandy colluvial gravel, with angular to sub-rounded clasts of BIF, cherts and	Generally of low permeability, but will be a source of storage where located below the water table, due to its hydraulic

AGE	LITHOLOGY	DESCRIPTION	GROUNDWATER POTENTIAL
		shales, and occasional clay bands.	connection with the underlying THD.
TD3	Tertiary Hematite Detritals	Transported mineralised detrital unit, comprising of poorly consolidated hematite-rich BIF clasts, angular to sub-rounded, with varying pisolith and clay content.	This unit is generally of moderate permeability where present below water table. The Potable bore drilled in 2008 is constructed in this aquifer, and testing results suggested a transmissivity of 110m^2/d, and a hydraulic conductivity of 7m/d.
TD3	Tertiary Pisolite Gravel	Similar to the Tertiary Hematite detritals, but with the well-rounded pisolith component increasingly dominant. This formation has variable clay content and is poorly to very poorly consolidated.	During recent drilling, much air was lost to the formation, suggesting that where the clay content is low, that this formation has high permeability and is high-yielding.
TD3	Calcrete	Unit is buff/pink/white in colour, with calcareous and siliceous zones. It is generally 10-20m thick, although reached ~50m thickness is some areas.	It is thought to be of moderate permeability, although this is likely to vary to the degree that the calcrete has been reworked and weathered.
TD2	Channel Iron Deposit	Cemented pisolite gravel which has developed vuggy porosity. There is variable clay content, and the unit is poorly to moderately consolidated. CID forms from palaeo creek beds.	With its high permeability it forms a preferred pathway for groundwater flow. As both the Hematite Detritals and Pisolite Gravel that surround CID are permeable, the discontinuous nature of the CID is not expected to significantly affect the continuity of groundwater flow through the system.
TD1	Basal Conglomerate	Below the CID at several locations an unmineralised transported chert-dominated detrital material was encountered. The extent of this basal conglomerate is unknown, but it is suspected to be limited to the bounds of the palaeochannel.	This unit is of low permeability, while being is hydraulic connection with the overlying ore zone.
Proterozoic	Hamersley Group	The Wittenoom Formation is made up of three members, two of which are likely to be	Permeability of this unit was low where encountered in recent drilling. There is no evidence of

AGE	LITHOLOGY	DESCRIPTION	GROUNDWATER POTENTIAL
		present beneath the Project tenement. These are the Bee Gorge Member (calcareous shale and dolomite) and Paraburdoo Member (dolomite).	this unit being in hydraulic connection with the overlying Tertiary units.





LEGEND

Brockman Mining Lease Boundary

Groundwater Level Contours

Water Level Measuring Point

0 2 4 km

FIGURE 6-5
REGIONAL GROUNDWATER LEVEL CONTOUR MAP

AUTHOR:	DJ	REPORT NO:	145
DRAWN:	MS	REVISION:	...
DATE:	08/09/09	PROJECTION:	MGA94 Z50
JOB NO:	832G	SCALE:	1:185,000

Location: F:\Jobs\832G\MapInfo\145a_Figure2.1.wor

Fortescue Marsh system

Current hydrogeological data indicates that water levels in the alluvium on the plain are below the bed of the Fortescue Marsh, thus suggesting that the marshes are a predominantly surface water feature as opposed to a groundwater discharge area. During flood events salts deposited during previous drying episodes are redissolved, and the freshwater entering the marshes 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 groundwater 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 would reduce the duration of surface water ponding. However as discussed above, the proposal will have an insignificant impact on the groundwater levels beneath the Marsh, so impacts to surface hydrology as a result of drawdown will be negligible.

The alluvium and orebody aquifers on the flanks of the valley are recharged with fresh water during rainfall events. Given there is a hydraulic gradient towards the marshes, this water will drain towards it. As a result of recharge from the ponding on the marshes, groundwater both below and close to the marshes is saline, whilst that further away and up gradient is fresh (Appendix E).

Groundwater quality

Water quality distributions are distinct in the alluvial and basement sequences. The basement has 20,000 mg/L TDS below the mine area, increasing to an estimated 150,000 mg/L TDS beneath the southern margin of the Fortescue Marsh. Within the alluvial sequence, water is fresh <1,000 mg/L TDS near the base of the Hamersley Ranges, increasing to an estimated 7,000 mg/L TDS near the southern margin of the Fortescue Marsh.

Data regarding the salinity of groundwater within the area was gathered from the DoW's AQWABASE system, along with hydrogeological drilling programmes completed by Aquaterra in 2008 and 2009. There are two distinct aquifers which show different salinity profiles. Within the shallow alluvial aquifer, groundwater is freshest (<1,000 mg/L TDS) close to the Hamersley Ranges, as this is the recharge zone for the alluvial aquifer, where groundwater flows in from the Weeli Wolli groundwater system. The salinity of the groundwater in the alluvial aquifer increases to approximately 6,000 mg/L TDS over a distance of 15 km northwards in the valley. Due to a lack of time series water quality data, it is not clear whether there is a fluctuation in water quality related to seasonal variations. The salt distribution is likely related to the Fortescue Marsh surface water body recharging relatively fresh water immediately following an inundation event, and becoming progressively more saline as evapo-concentration takes place.

Within the Wittenoom Formation dominated basement, groundwater is approximately 20,000 mg/L TDS in the basement beneath the orebody. The groundwater salinity increases rapidly within the basement further north into the valley, with a salinity of 75,000 mg/L TDS 10 km into the valley. This is attributed to the longer residence times of groundwater within the basement aquifer; the limited affects of freshwater recharge to the system; and the limited mixing between the shallow and deep aquifers, which means salt content concentrates over longer time periods without dilution.

Water samples taken from within the project area suggest that a large proportion of recharge enters the groundwater system further up-gradient, rather than locally, or that mixing of local recharge with mature waters is taking place. Waters within the basement and the orebody were found to differ in salinity which indicates that there is little to no connectivity between the alluvial and basement aquifer systems within the project area.

6.7 VEGETATION AND FLORA

6.7.1 Previous Work

The Pilbara is a region of considerable environmental significance, lying on the southern limits of the Northern Botanical Province (Burbidge, 1959; Beard, 1979). The region includes species from the north-west, a region of high species endemism, and the arid interior, as well as numerous species which are either endemic to the Pilbara or have restricted geographic distributions (Beard, 1975).

The project area lies in the Pilbara Biogeographic Region as classified by IBRA, with over approximately 95% of the area in the Fortescue plains sub-region and the remainder in the Hamersley sub-region.

The vegetation of the Fortescue Plains sub-region is described by Kendrick (2001a) as salt marshes fringing the salt lakes, *Acacia aneura* (mulga) and tussock grasses on the alluvial plains, short grass communities on the alluvial plains and *Eucalyptus camaldulensis* (River Gum) woodlands fringing the drainage lines.

The vegetation of the Hamersley sub-region is described by Kendrick (2001b) as a mountainous area of sedimentary ranges dissected by gorges with *Acacia aneura* (mulga) low woodlands, over tussock grasses on the valley floors and *Eucalyptus leucophloia* (Snappy Gum) over *Triodia brizoides* on skeletal soils of the ranges.

Beard (1975) classifies the project area as falling within the Fortescue Botanical region of the Pilbara. Beard described these communities as;

1. *Acacia aneura* (mulga) in groved patterns with an understorey of *Triodia pungens* (spinifex);
2. *Eucalyptus gamophylla* shrub steppe, over *Triodia basedowii* (spinifex) hummock grassland; and,
3. *Eucalyptus brevifolia* (Snappy Gum) sparse low trees, over *Triodia wiseana* open hummock grassland.

Beard's classification characterises the project area as *Acacia aneura* (mulga) in the majority of the north eastern half and the south west of the tenement is located within the area classified as *Eucalyptus gamophylla* shrub steppe, over *Triodia basedowii* (spinifex) hummock grassland.

6.7.2 Recent Surveys

ecologia undertook a two phase flora and vegetation assessment during July and September 2008 (Appendix M).

The survey methods used were developed to meet the Environmental Protection Authority's Guidance Statement 51 (Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia; EPA, 2004) and Position

Statement Number 3 (Terrestrial Biological Surveys as an element of Biodiversity Protection; EPA, 2002). The field survey involved systematic flora sampling in quadrats measuring approximately 50 m x 50 m = 2 500 m^2 (or an equivalent area for land forms that are linear i.e. creeklines). This is the accepted size for surveys conducted in the Pilbara. Figure 6-6 shows the locations of the quadrats across the project area.

The vegetation of the project area has been separated by ecologia into eight main units (listed below) with twelve sub-units;

1. *Eucalyptus victrix* and *Acacia citrinoviridis* low woodland (with two sub-units);
2. *Acacia tumida* and *Grevillea wickhamii* tall shrubland;
3. *Acacia aneura* low woodland, over *Acacia synchronicia* tall shrubland, over **Cenchrus spp*. tussock grassland;
4. *Acacia aneura* low open forest (with two sub-units);
5. *Acacia citrinoviridis*, *Corymbia hamersleyana*, *Acacia aneura* and *Acacia pruinocarpa* open woodland, over *Acacia spp*. tall shrubland, over **Cenchrus spp*. closed tussock grassland (with three sub-units);
6. *Acacia dictyophleba* tall shrubland, over *Triodia schinzii* open hummock grassland;
7. *Acacia spp*. medium to high open shrubland, over *Triodia basedowii* and *Triodia schinzii* hummock grassland;
8. *Corymbia hamersleyana* isolated low trees, over *Eucalyptus gamophylla* mallee woodland, over *Acacia spp*. and *Grevillea wickhamii* tall shrubland, over *Triodia basedowii* hummock grassland (with five sub-units).

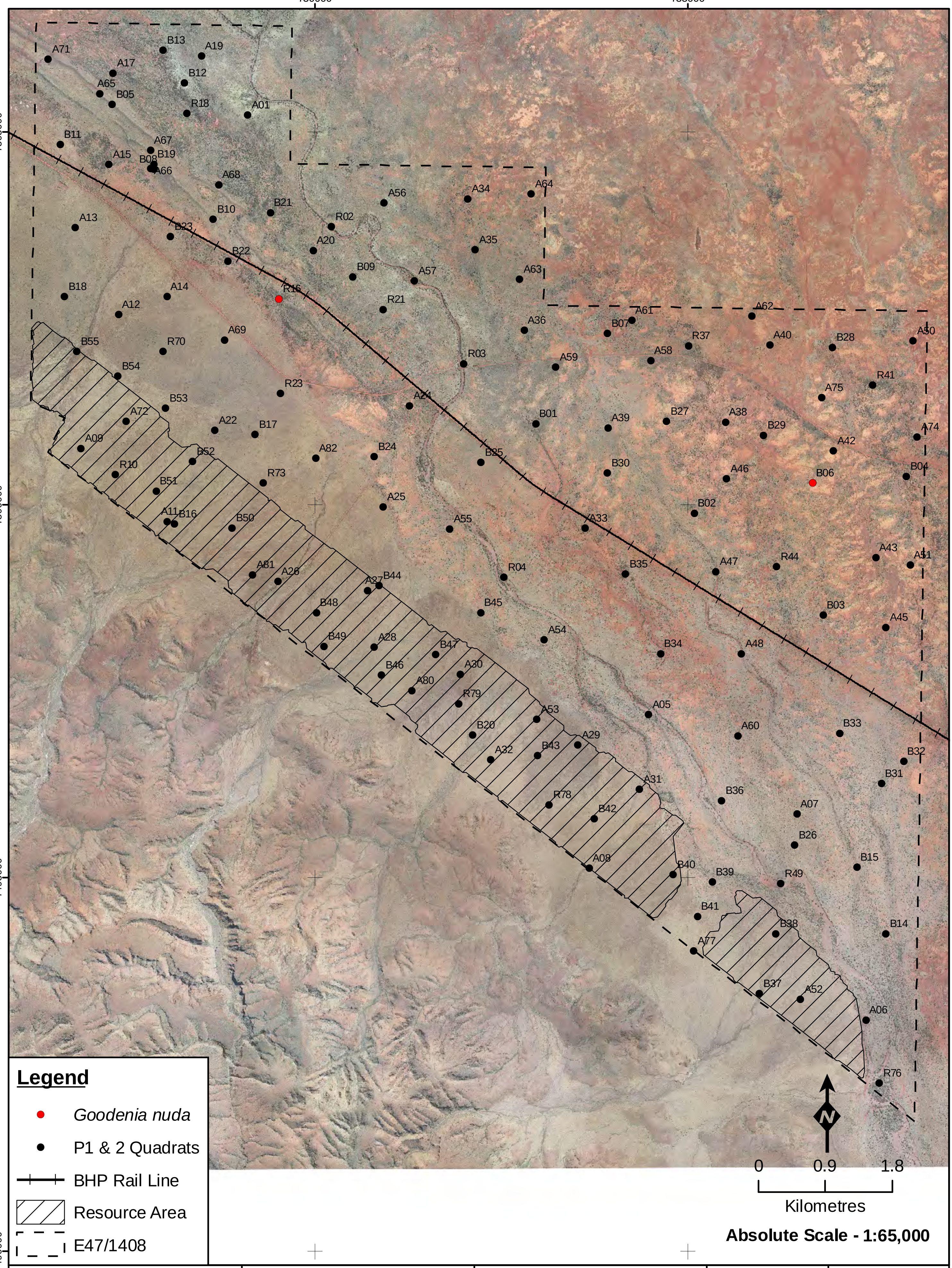
The sub-units are not visible on the aerial photographs and consequently the vegetation has been mapped into the eight main units described above (Figure 6-7).

No flora species or threatened ecological communities of national or state significance were recorded during this vegetation and flora survey.

One State-listed PEC occurs within the project area, the Priority 3 'Vegetation of sand dunes of the Hamersley Range and Fortescue Valley'. The Fortescue Valley Sand Dune PEC occurs in the Divide Land System (Van Vreeswyk et al. 2004). The dunes are considered to be regionally rare, small, fragile and susceptible to threatening processes (Biota 2004b).

The vegetation associated with colluvial fans of the survey area (Unit 8a) are considered to be of local conservation significance. All other vegetation types in the area are not considered to be regionally or locally significant.

Two sub-units of potentially phreatophytic vegetation were recorded within the survey area. These have been mapped as vegetation Unit 1 in Figure 6-7.



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Flora Quadrats Surveyed in the Project Area and Locations of *Goodenia nuda*

Figure: 6-6
Project ID: 1140

Drawn: SG
Date: 16/10/09

Coordinate System
Name: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Unique Map ID: S035

A4

6.7.3 Vegetation Condition Assessment

Vegetation condition of the project area was noted in the field using the levels indicated in Table 6-3. Factors considered when determining these levels are the presence of weeds, tracks, litter, grazing and any other ground disturbances.

Table 6-3 Marillana Vegetation Condition Assessment

VEGETATION CONDITION	LEVEL	% OF SURVEY AREA
Pristine	No disturbance	0
Excellent	Minimal disturbance	11
Good	Moderate disturbance	44
Poor	Significant disturbance	45
Degraded	Very high disturbance	0

The creek banks, floodplains and flat clay-pan areas at Marillana are in a poor condition (ecologia*,* 2008a). These areas are characterised by high levels of cattle grazing and significant weed populations. The introduced taxa; *Cenchrus ciliaris* and *Cenchrus setiger* are the dominant tussock grasses within the project area due to introduction by pastoralists as fodder. The dominance of these introduced grasses is likely to be decreasing the diversity of native grasses and species in the lower shrub and herb stratum (ecologia*,* 2008a).

The rocky foot slope located along the southern perimeter of the project area is dominated by spinifex. Because of this cattle grazing pressure is low and there is minimal weed establishment, with the exception of tracks which have been populated by *Cenchrus ciliaris*. These areas have significantly better vegetation condition (ecologia*,* 2008a).

6.7.4 Significant Flora

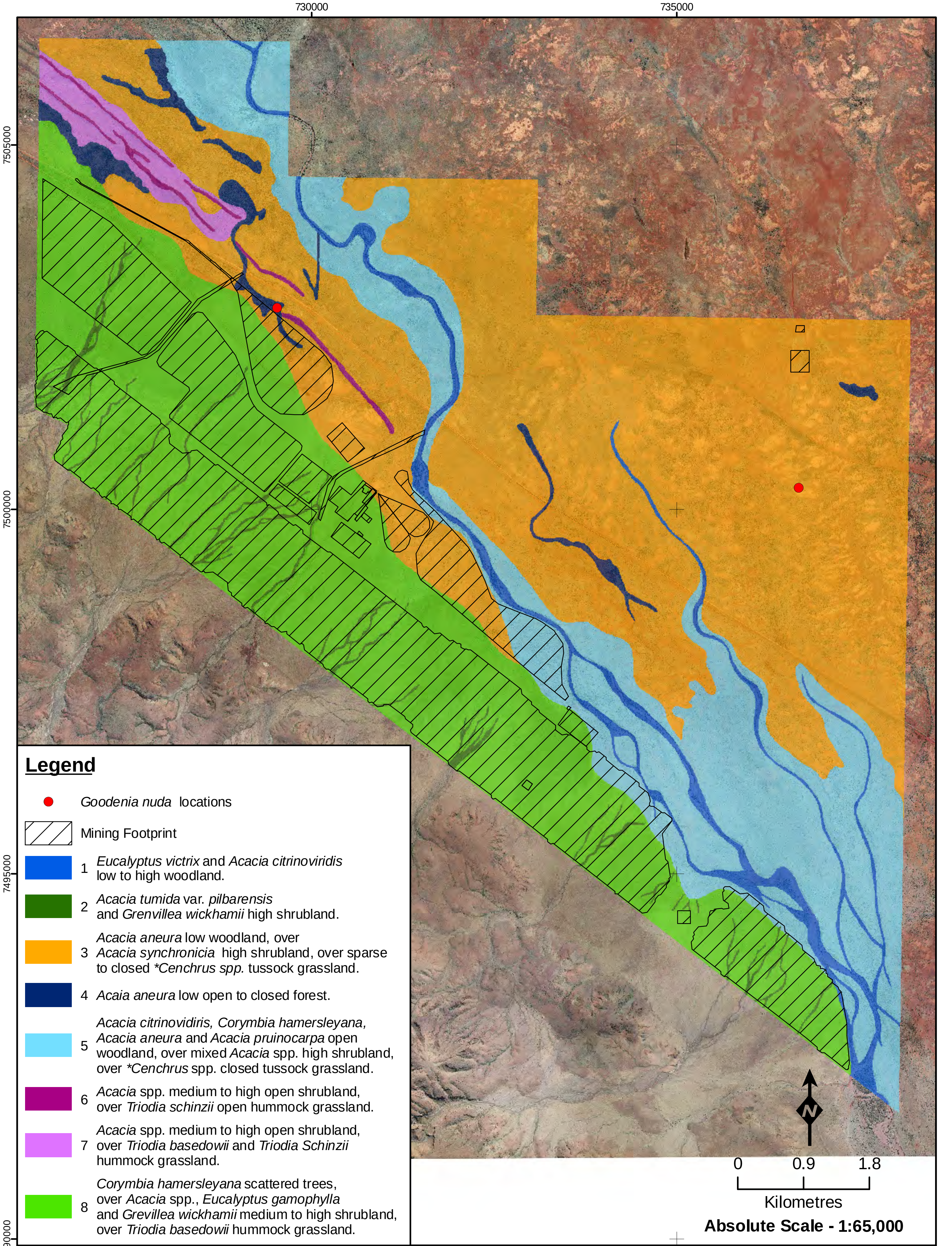
Three hundred and two taxa were recorded during the survey and this total includes subspecies, varieties, forms and affinities. Of this combined total, 224 taxa from 38 families and 100 genera were recorded during the first phase of the survey and 244 from 39 families and 104 genera during the second phase.

Ten of the 302 taxa were introduced species and one was a priority flora species. Sixteen taxa collected during the survey could not be confirmed to species level.

No Declared Rare Flora taxa were recorded during the survey, however one Priority Flora taxon; *Goodenia nuda* (P 3) was recorded once in low numbers (< 2% cover) on the banks of the Weeli Wolli Creek. The location is provided and shown in Figure 6-6.

Goodenia nuda is an erect non woody herb growing to 50 cm high. The leaves and stems are a pale green to grey-green colour, sometimes with a frosted look from a powdery coating and are between 4 - 10 cm in length and 0.5 - 1 cm in width. The flowering section can be up to 25 cm long, with the yellow flowers less than 2 cm long, occurring between April and August.

The preferred habitat of *G. nuda* is in dry river beds and at the edge of floodplains on stony hard pans and cracking clays. There are currently 12 records on FloraBase of *G. nuda* from areas including Newman, Roy Hill and Weeli Wolli Creek (FloraBase, 2008).



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Marillana Vegetation Map

Figure: 6-7
Project ID: 1140

Drawn: SG
Date: 16/10/09

Coordinate System
Name: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Unique Map ID: S036

A4

6.7.5 Introduced Species

No Priority or Declared weed species were recorded during the 2008 surveys.

Ninety species of naturalized alien flora are currently known to occur in the Pilbara region (FloraBase, March 30, 2009). Ten general or environmental weeds were recorded at the Marillana survey area: **Aerva javanica, *Argemone ochroleuca* subsp*. ochroleuca, *Cenchrus ciliaris, *Cenchrus setiger, *Chloris virgata, *Datura leichhardtii, *Malvastrum americanum, *Portulaca oleracea, *Setaria verticillata* and **Vachellia farnesiana.*

**Argemone ochroleuca subsp. ochroleuca* and **Datura leichhardtii* are listed as declared weeds in other districts in Western Australia but not in the Marillana area.

The frequency of occurrence and densities of populations are provided in Table 6-4.

Table 6-4 Weeds Recorded at the Marillana Survey Area

WEED SPECIES	NUMBER OF TIMES RECORDED PHASE 1	NUMBER OF PLANTS OR COVER (%) PHASE 1	NUMBER OF TIMES RECORDED PHASE 2	NUMBER OF PLANTS OR COVER (%) PHASE 2
**Aerva javanica*	**5**	< 10 plants - < 2%	**1**	< 10 plants
**Argemone ochroleuca subsp. ochroleuca*	Not recorded		**1**	< 10 plants
**Cenchrus ciliaris*	**66**	< 10 plants - > 70%	**63**	< 10 plants - > 70%
**Cenchrus setiger*	**35**	< 10 plants - > 70%	**29**	< 10 plants - 70%
**Chloris virgata*	**1**	2 – 10%	**1**	< 2%
**Datura leichhardtii*	**2**	< 10 plants	**1**	< 2%
**Malvastrum americanum*	**10**	< 10 plants - 70%	**19**	< 10 plants - 70%
**Portulaca oleracea*	**15**	< 10 plants - < 2%	**3**	< 10 plants - < 2%
**Setaria verticillata*	**1**	< 2%	**1**	< 10 plants
**Vachellia farnesiana*	**15**	< 10 plants - < 2%	**12**	< 10 plants – 30%

**Cenchrus ciliaris* and **Cenchrus setiger* are the dominant tussock grasses at the Marillana survey area. Extensive populations were recorded covering a large proportion of the tenement.

6.8 VERTEBRATE FAUNA

ecologia undertook a two phase vertebrate fauna survey from 25th April to 7th May 2008 and from 30th August to 10th September 2008 using a variety of sampling techniques, including systematic (trapping) and opportunistic sampling (Figure 6-8, Appendix N). The survey methods adopted by ecologia were aligned with the Environmental Protection Authority's Guidance Statement No. 56 (EPA 2004) and Position Statement No. 3 (EPA 2002).

Five main fauna habitat types were identified in the project area during site selection, and these were chosen for systematic sampling; (1) sandy spinifex grassland (Site 1), (2) stony spinifex plains (Site 2), (3) creekline (Site 3), (4) longitudinal sand dune (Site 4) and (5) mulga woodland (Site 5 and Site 6). Open plain habitat makes up the majority of the project area south-west of the Weeli Wolli Creek, covering much of the Hamersley Range alluvium deposits. The open plains fall on two different land systems, the Divide and the Boolgeeda land system, providing two similar but sufficiently distinct fauna habitat types: sandy spinifex grassland and stony spinifex plains.

Twenty-three species of mammal, 82 species of bird, and 43 species of reptile were recorded within the survey area.

Two conservation significant species were recorded at numerous locations within the survey area; the Australian Bustard (*Ardeotis australis*, DEC Priority 4) and the Rainbow Bee-eater (*Merops ornatus*, EPBC Act Migratory). A further six conservation significant species are considered likely to occur in the Marillana project area based on previous nearby records (from state and national databases and other surveys conducted in the vicinity) and the habitat types available within the project area.

All conservation significant species that occur or are likely to occur in the project area are described below in order of significance.

Night Parrot (Pezoporus occidentalis) – EPBC Act Endangered, WC Act Schedule 1

The Night Parrot is a medium-sized, nocturnal parrot that spends much of its time on the ground. Historical evidence indicates that Night Parrots were distributed over much of semi-arid and arid Australia.

Two fauna habitat types present in the project area, sandy spinifex grassland and longitudinal sand dune, have the potential to support Night Parrots, as they both have a thick, long unburnt cover of spinifex hummocks. Furthermore, there are several active bores present within and immediately adjacent to the project area, providing the drinking water potentially required by the species.

The probability of Night Parrots occurring in the project area is difficult to estimate, as the species is unlikely to be recorded even in areas where it may be common. If the Night Parrot occurs in the project area, the sandy spinifex grassland and longitudinal sand dune habitats, which also occur in surrounding areas, have the greatest potential to support this species.

The EPBC threatened fauna database indicated that the nearest record of the Night Parrot occurs at Mulga Downs (approx. 90 km north-west of the project area) but there is a more recent record from Minga Well, approx. 35 km north-east of the project area (Davis and Metcalf 2008). It is difficult to assess any potential regional impact to this species due to the paucity of data regarding population size and distribution. However correspondence with Stephen Van Leeuwin has indicated that suitable Night Parrot habitat is unlikely to exist within the project area, as this species is thought to inhabit the samphire and lignum community and fringing hummock grassland of the Marsh proper. Therefore impacts to this species is likely to be negligible.

Pilbara Olive Python (Liasis olivaceus barroni) – EPBC Act Vulnerable, WC Act Schedule 1

The Pilbara subspecies of the Olive Python only occurs in the ranges of the Pilbara region of Western Australia. It is a dull olive-brown or pale fawn python that can grow to 2.5 m. In the Pilbara it inhabits watercourses and areas of permanent water in rocky gorges and gullies (Garnett and Crowley 2000). This subspecies is an adept swimmer, regularly hunting in water, with which it is often associated. It feeds on a variety of vertebrates including rock wallabies, fruit bats and birds.

The species prefers to inhabit the gorges and escarpments more typically found in the nearby Hamersley Range, but may be attracted to the Weeli Wolli Creek for hunting, or as a conduit to dispersal, when water is present. For most of the year the species is unlikely to be affected by mining activities in the project area, but individuals may enter the area when the creek is in flood.

Pilbara Olive Pythons are widespread in the Pilbara and the impact to the regional population is expected to be negligible.

Rainbow Bee-eater (Merops ornatus) – EPBC Act, Migratory

The Rainbow Bee-eater is a strikingly colourful bird that lives almost anywhere suitable for hawking insects - principally bees, flies, dragonflies and grasshoppers. They are scarce to common throughout much of Western Australia, except for the arid interior, preferring lightly wooded, preferably sandy, country near water (Johnstone and Storr 1998). Rainbow Bee-eaters can occur as a resident, breeding visitor, postnuptial nomad, passage migrant or winter visitor and are common in the Pilbara.

Rainbow Bee-eaters were recorded at Sites 3, 4, 5, and 6, however, survey records of this species were concentrated around the Weeli Wolli Creek system, and also the longitudinal sand dune in the north-west of the project area. Individuals were also recorded opportunistically throughout the project area. The most likely place for this species to breed within the project area, if it does, would be at Weeli Wolli Creek, where ideal sandy embankments occur.

Fork-tailed Swift (Apus pacificus) – EPBC Act Migratory

The Fork-tailed Swift is a small insectivorous species with an almost entirely aerial lifestyle. This species is distributed from central Siberia and throughout Asia, breeding in north-east and mid-east Asia, and wintering in Australia and south New Guinea. It is a relatively common trans-equatorial migrant from October to April throughout mainland Australia (Simpson and Day 2004). In Western Australia the species begins to arrive in the Pilbara in November (Simpson and Day 2004). In Western Australia, the Fork-tailed Swift is considered uncommon to moderately common near the north-west, west and south-east coasts, common in the Kimberley and rare or scarce elsewhere (Johnstone and Storr 1998).

Fork-tailed Swifts are likely to occasionally overfly the project area, since they are highly nomadic and associated with storm fronts that sweep through the Pilbara. However, they are almost entirely aerial and will not utilise habitat within the project area.

Peregrine Falcon (Falco peregrinus) – WC Act Schedule 4

This nomadic or sedentary falcon is widespread in many parts of Australia and some of its continental islands, but absent from most deserts and the Nullarbor Plain. It most commonly occurs near cliffs along coasts, rivers and ranges and around wooded watercourses and lakes. Peregrines feed almost entirely on birds, especially parrots and pigeons.

Peregrines primarily nest on ledges in cliffs, granite outcrops and in quarries, but may also nest in tree hollows around wetlands. Eggs are predominantly laid in September (Johnstone and Storr 1998). The species is considered to be moderately common in the Stirling Range, uncommon in the Kimberley, Hamersley and Darling Ranges, and rare or scarce elsewhere (Johnstone and Storr 1998).

Although this species may occasionally hunt within the project area, particularly around the Weeli Wolli Creek area, there is no suitable breeding habitat within it due to the absence of any rocky ridges. No impacts to the regional population of Peregrine Falcon are likely.

<u>Northern Short-tailed Mouse (Leggadina lakedownensis) – DEC Priority 4</u>

Northern Short-tailed Mouse is distributed across northern Australia. The species has been recorded from diverse habitats ranging from the monsoon tropical coast to semiarid climates, including spinifex and tussock grasslands, samphire and sedgelands, acacia shrublands, tropical eucalyptus and melaleuca woodlands and stony ranges.

This species was recorded in the Chichester Range to the north during recent ecologia surveys (ecologia 2008), where they were recorded from cracking clay soils. It has a medium potential to occur within the project area but was not recorded during ecologia's survey.

<u>Australian Bustard (Ardeotis australis) – DEC Priority 4</u>

Australian Bustards are nomadic, ranging over very large areas, and their abundance varies locally and seasonally from scarce to common, depending on rainfall and food availability. Breeding occurs when conditions are favourable. In northern Australia, this is generally late in the wet season or early in the dry (January to March).

Although the population size is still substantial, there has been a large historical decline in abundance, particularly south of the tropics, but also across northern Australia (Blakers *et al.* 1984).

Australian Bustards were directly and indirectly recorded at Site 2 and Site 5 and also by four opportunistic sightings within the project area. This species appears to be relatively common in the project area. With the exception of Site 2 all observations were made north of the existing rail line.

Even though the Australian Bustard was recorded within the project area, it is a nomadic species which is relatively common in the Pilbara. Suitable habitat is widespread and common in surrounding areas.

<u>Grey Falcon (Falco hypoleucos) – DEC Priority 4</u>

Grey Falcons are a rare, nomadic raptor species, sparsely distributed across much of arid and semi-arid Australia. In Western Australia, the current distribution is now thought to be restricted to north of 26°S (Johnstone and Storr 2004). Because the species is scarce, and occurs over a large area, sightings are very uncommon.

Grey Falcons prey primarily on birds, although reptiles and mammals are also taken (Johnstone and Storr 1998). Two to three eggs are laid in winter in the nests of other birds of prey and ravens, typically in tall eucalypt trees near water (Johnstone and Storr 1998).

The Grey Falcon is widespread but scarce in the Pilbara. There are a few records of this species in proximity to the project area (ecologia 2008c; ecologia 2009), and suitable hunting and breeding habitat (at Weeli Wolli Creek) does exist. Although the species has potential to inhabit or breed within the project area, this conspicuous species was not recorded during the surveys. It is therefore thought to be absent and the risk to the regional population minimal.

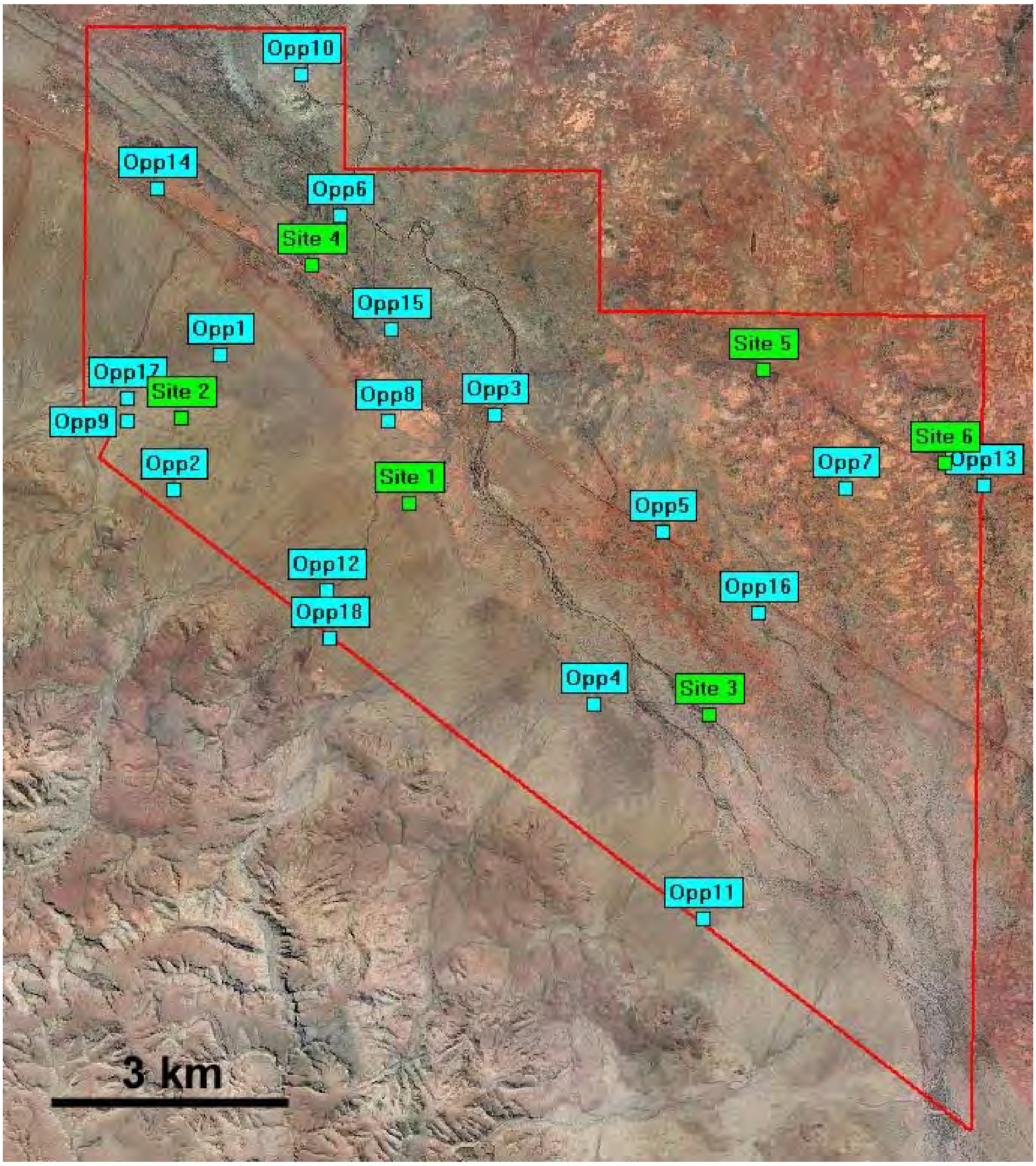


Figure 6-8 Location of Fauna Sites within the Project Area

6.8.1 Ecologically Important Habitats within the Project Area

<u>Longitudinal Sand Dunes</u>

The longitudinal sand dunes running north-west to south-east though the middle of the western half of the project area represents a unique land form within the project area. Sand dunes are an occasional feature present in the divide land system, a common land system in the south-east Pilbara with a total area of 5,293 km^2. The overall fauna assemblage at Site 4 in this habitat had affinities with Site 1 and Site 2.

However, a small number of species were recorded mostly or only at the longitudinal sand dune site such as the skink Burton's legless lizard, the gecko *Strophurus wellingtonae*, and the Spinifex Slender Blue-tongue.

Weeli Wolli Creek

The Weeli Wolli Creek is likely to perform an important ecological role in the project area, with creeks in arid zones forming refuges and habitat corridors. The majority of bats recorded in the fauna survey were recorded from this habitat which is not surprising given the preference of bats for tree lines which provide invertebrate prey as well as shelter (Ekman and De Jong 1996; Verboom and Spoelstra 1999). The Weeli Wolli Spring, represents the most northerly record of the Chocolate Bat (*Chalinolobus morio*) and the Ghost Bat (*Macroderma gigas*; DEC Priority 4) has been recorded foraging above pools downstream of the spring (Van Leeuwen, 2009).

When holding water, this creekline would attract large numbers of bird species, with over 60 species of bird previously recorded along the Weeli Wolli Creek (Van Leeuwen, 2009). As has been noted previously, this creek system was where Rainbow Bee-eaters (EPBC Act Migratory) were most frequently recorded and represents the most likely location this species would breed within the project area.

6.9 SUBTERRANEAN INVERTEBRATE FAUNA

6.9.1 Stygofauna

Stygofauna are groundwater dwelling fauna known to be present in a variety of subterranean strata including porous karst and calcrete limestones, fissured rock and coarse gravels (Mamonier et al., 1993). They are typically adapted for, and restricted to, the subterranean environment, with features such as lack of pigmentation, elongated appendages, filiform body shape (worm like) and reduced or absent eyes.

Numerous stygofauna studies have taken place in the Pilbara (Figure 6-9) with over 150 published records of stygofauna existing within the Fortescue Basin (Eberhard et al., 2005). Stygofauna found in the Pilbara region tend to colonise most groundwater environments, whether karst conduit or the benthic and interstitial zones of springs and spring-brooks (Eberhard et al., 2005).

The main aquifer sequence within the project area is the ore body itself, representing a palaeo-channel of the ancestral Weeli Wolli Creek (Coffey, 2009). More broadly, the aquifer comprises channel iron deposits overlain by an uncemented pisolite gravel, hematite and BIF detritals. In places, calcrete is developed below and adjacent to the detrital zone. Underlying the detrital ore body are low permeability strata including BIF, Shale and Dolomite.

In the vicinity of the project area, the Weeli Wolli palaeo-drainage area is likely to be restricted Weeli Wolli Creek and its alluvial outwash fans associated with the Hamersley Range front. The detrital sequences along the base of the ranges are bounded to the north by distal clayey-alluvial deposits that form the flood plain of the Fortescue Valley. These alluvial deposits are generally of low permeability and thus likely to represent the northern limit of the stygofauna habitat (Coffey, 2009). To the south of the tenement the aquifer is likely to follow the Weeli Wolli Creek and Marillana Creek palaeo-channels into the Hamersley Range.

Two phases of sampling were conducted by ecologia in February and May 2009 within the project area, each comprising 44 samples (88 samples in total), thus satisfying the requirements of EPA Guidance Statement 54a. In addition, a single phase of sampling was undertaken (July 2009) in six nearby bores off-tenement (Appendix O).

Four stygobitic species were collected during the survey. One of the species, the amphipod *Pilbarus millsi*, was found both inside and outside the tenement (Figure 6-10). Two of the species (unidentified copepod and oligochaete) were found only within the tenement and represented by singletons. The fourth species, the isopod *Pygolabis weeliwolli*, was found only outside the tenement. The amphipod and the isopod were the focus of recent publications (Finston et al., 2007; Finston et al., 2009) within which it was indicated that these species were present in the Weeli Wolli Creek and Marillana Creek palaeo-drainage channel. Although the other two organisms could not be identified to species level they are expected to occur outside the tenement because their body size is significantly smaller than the size of the amphipod and the isopod. They are therefore expected to be subject to the same or lesser dispersal limitations.

<u>Order Amphipoda (amphipods)</u>

Pilbarus millsi was found in sample wells MRC0804, MRC0567, MRC050, MRC0577 (Figure 6-9) as well as from the outside tenement survey in Pug Bore, Coolana Bore, MAPB01 Bore and Waitawhile Bore (Figure 6-10).

Until recently, *Pi. millsi* was thought to have a widespread distribution throughout the Pilbara region (Finston et al. 2007). Using molecular evidence (COI gene sequences), Finston et al. (2007) revealed significant divergences between populations within the Pilbara which were consistent with different species. Of these cryptic species populations, Finston et al. (2007) found the Marillana Creek and Weeli Wolli Creek populations to comprise a “Fortescue lineage” associated with the Weeli Wolli and Marillana Creeks.

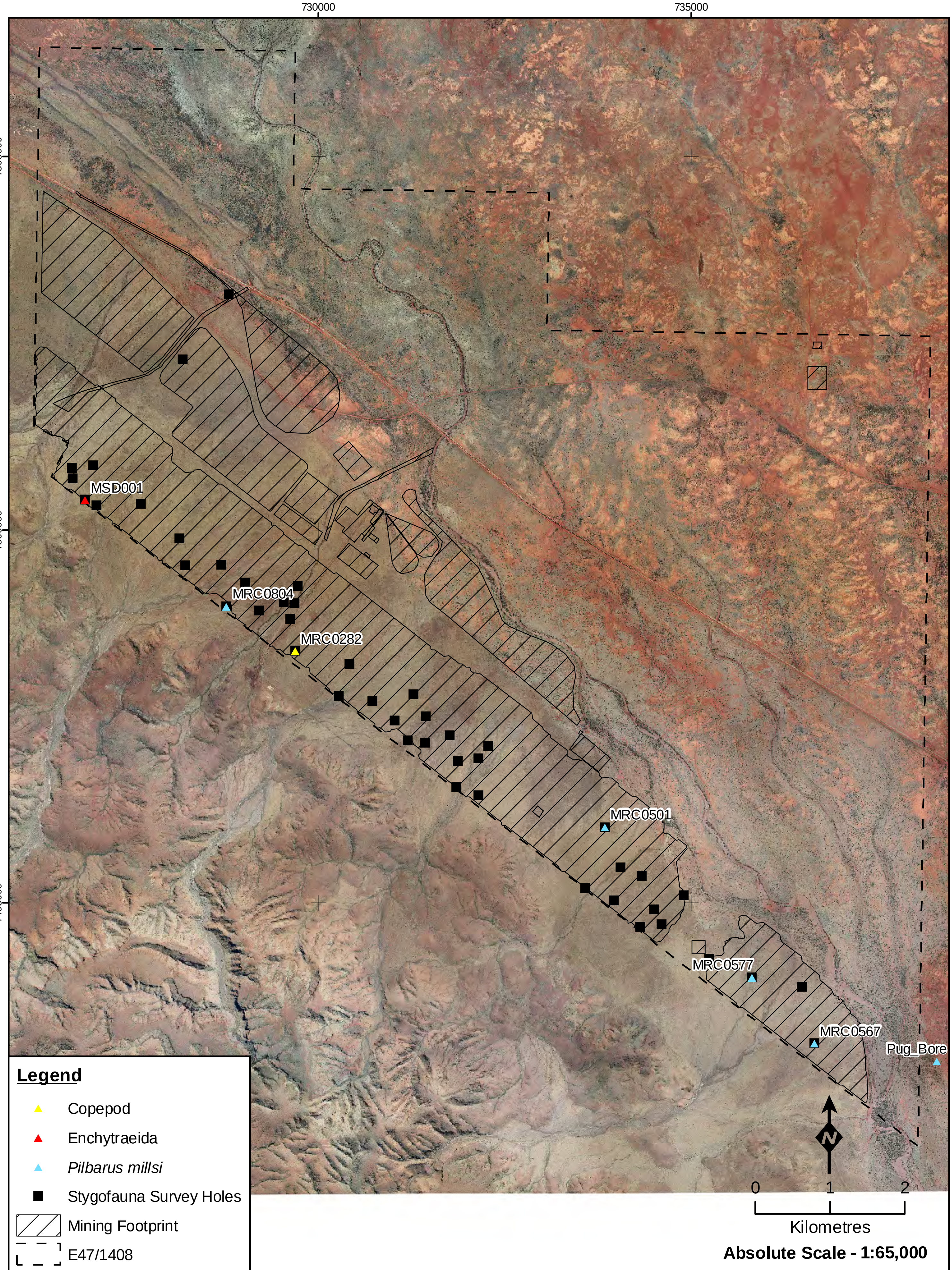
<u>Subclass Copepoda (copepods)</u>

A single copepod specimen was collected from bore MRC0282 on tenement (Figure 6-9). The specimen was badly damaged, making even ordinal level identification impossible. The species could not be sequenced owing to previously having been cleared with lactic acid during slide preparation (D. Tang, UWA, pers. comm.).

<u>Order Oligochaeta (segmented worms)</u>

A single enchytraeid oligochaete specimen was collected from bore MSD001 (Figure 6-9). This specimen was a sub-adult and thus could not be identified to species (M. Scanlon, Bennelongia, pers. comm.).

The two largest species detected during this survey, *Pi. millsi* and *Py. weeliwolli*, have distribution ranges extending well outside of the proposed area of development. Their large size and wide distribution pattern suggests an extensive stygobitic habitat comprising relatively large pore spaces. Therefore, it seems likely that the much smaller enchytraeid oligochaete and copepod species will follow similar distribution patterns as their adults and larvae would be capable of dispersing through the aquifer to the same (or larger) degree as *Pi. millsi* and *Py. weeliwolli*.



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Stygofauna survey sites and records

Figure: 6-9	**Drawn: SG**
Project ID: 1140	**Date: 16/10/09**

Coordinate System Unique Map ID: S037
Name: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994
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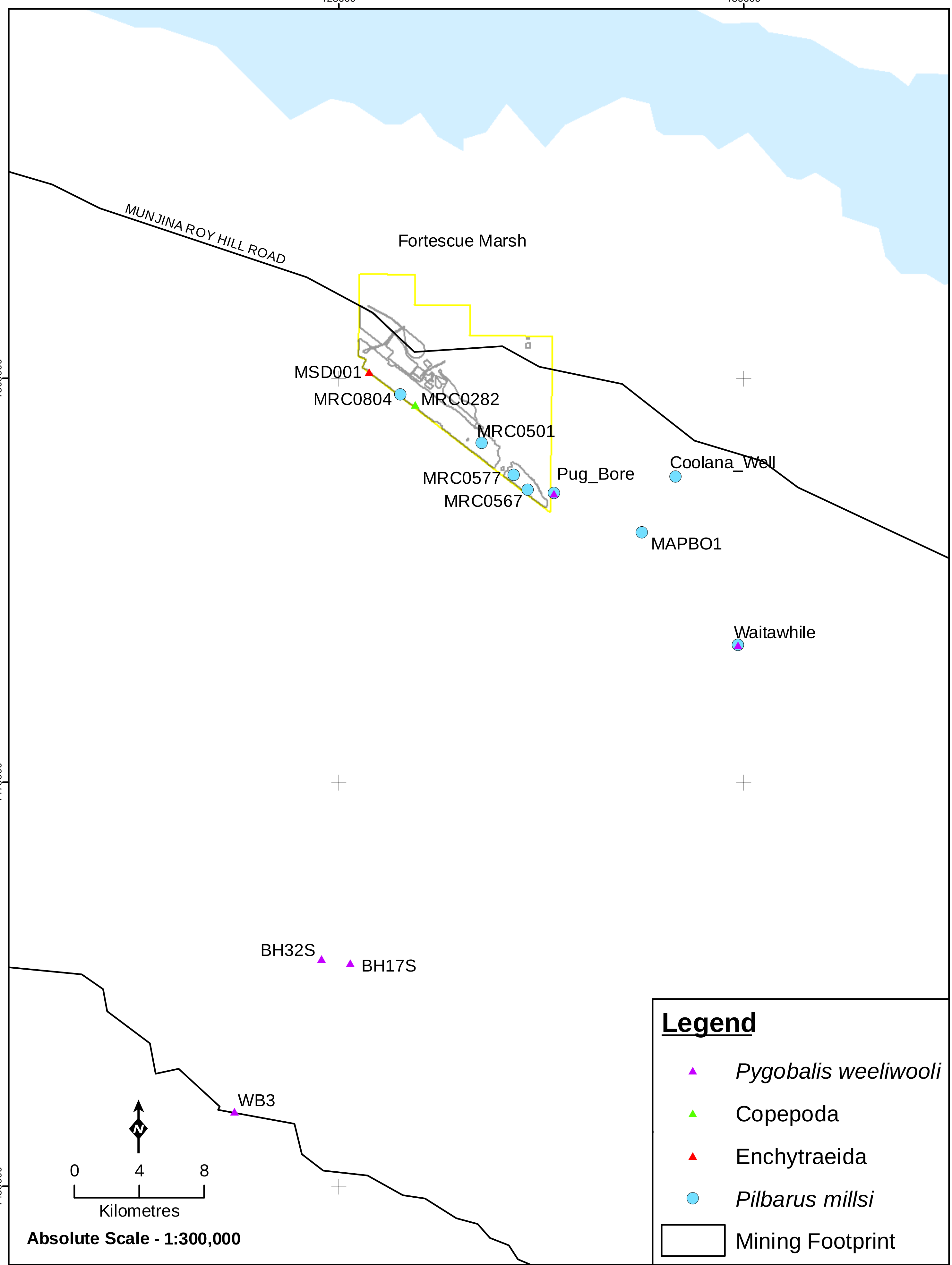

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Stygofauna survey sites and records outside of tenement

Figure: 6-10
Project ID: 1140
Drawn: SG
Date: 23/09/09

Coordinate System
Name: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Unique Map ID: S019

A4

6.9.2 Troglofauna

Troglofauna are communities of terrestrial subterranean animals that inhabit air chambers in underground caves or small, humid voids. A species is considered truly troglobitic if it displays morphological characters resulting from specialized evolution within subterranean habitats (Howarth, 1983): absence of body pigment, attenuation of appendages, loss or reduction of eyes, loss and or reduction of wings and or reduced metabolic rate.

Troglobites are obligate inhabitants of subterranean habitats and are incapable of surviving on the surface for long periods. Such dispersal limitations result in extremely small and localized species ranges and thus high levels of endemism (EPA, 2003), which is characteristic of subterranean fauna worldwide (Strayer, 1994).

The presence of troglofauna in Western Australia is still poorly understood and documented (Eberhard, 2001). To date, troglofauna have been recorded from karstic limestone systems at Cape Range, Barrow Island and in the Kimberley (Biota, 2005; Harvey, 1988), pisolitic mesa formations in the Pilbara (Biota, 2006) and in the cave systems of Yanchep (EPA, 2005), Margaret River (Eberhard, 2006) and across the Nullarbor (Moore, 1995).

A three phase troglofauna survey was undertaken within the proposed pit area on M47/1414. Phase 1 (61 samples) was conducted between 29 May - 14 July 2008, Phase 2 (61 samples) between 14 July - 15 September 2008 and Phase 3 (30 samples) between 13 August – 14 October 2008 (Appendix P). Trapping in 61 bores was undertaken over two back-to-back phases (122 survey samples) and, in conjunction with the additional 30 samples, provided a total of 154 samples; thus satisfying the requirement of the EPA Guidance Statement 54a. Five definitive troglobites were discovered during these surveys.

Subsequent to Phase 3, additional survey phases were undertaken within new survey bores drilled outside of the proposed pit area. Phase 4 (45 bores) was conducted between 16 February - 15 April 2009, Phase 5 (44 bores) between 15 April 2009 -26 May 2009 and Phase 6 (39 bores) between 26 May - 10 July 2009. This survey comprised 128 samples and produced one additional troglobitic species and two troglobitic species that were previously sampled during the first three phases.

The capture rate of troglobites is lower than expected from these surveys. This may be due to the strata supporting the troglobitic community, in which there are no survey precedents in Western Australia. Not-withstanding these low capture rates, species accumulation curves (see Appendix P) do suggest that the majority of the expected species were detected (estimation predicted up to seven species), so it is anticipated that the sample of the community collected is representative and the survey was comprehensive (ecologia, 2009d).

The six phases of sampling produced a total of six definitive troglobites and one tentative troglobite. These are outlined below and listed in Table 6-5. The locations of the Troglofauna across the project area can be found in Figure 6-11.

Table 6-5 Summary of Definitive and Tentative Troglobites Found at Marillana

ORDER	FAMILY	MORPHOSPECIES	PHASE	SPECIMENS	HOLE ID
Definitive Troglobites					
Schizomida	Hubbardiidae	*Draculoides* 'marillana'	1 2	2	MRC219 MRC212
Pseudoscorpiones	Olpiidae	Olpiid 'marillana'	2	1	MRC175
Isopod	Armadillidae	Armadillid 'marillana'	2 5	2	MRC367 Trog24
Hemiptera	Reduvidae (Emesinae)	Emesine 'marillana'	2	1	MRC112
Polyxenida	Polyxenidae	Polyxenid 'marillana'	2 5 6	7	MRC247 MRC084 Trog41a Trog04
Coleoptera	Undetermined	Coleoptera 'marillana2'	5	6	Trog41a
Tentative Troglobite					
Coleoptera	Undetermined	Coleoptera 'marillana1'	2	5	MRC247, MRC213

Order Schizomida (schizomids)

Schizomids are small arachnids that superficially resemble spiders (Harvey, 1992). They are found in moist environments in tropical and subtropical regions of the world. Their reliance on high humidity environments and their absence in the terrestrial short range endemic survey indicate that this is not an accidental species from the surface.

Two specimens of schizomid were detected from survey boreholes MRC219 and MRC212.

Order Pseudoscorpiones (pseudoscorpions)

Pseudoscorpions are predatory arachnids that capture and subdue their invertebrate prey using pincer-like anterior appendages (Brusca and Brusca, 2003). Numerous troglobitic psedoscorpion species are known (Harvey, 1991).

A single undescribed species of olpiid (family Olpiidae) pseudoscorpion was recorded from borehole MRC175. The family Olpiidae is very diverse and contains numerous undescribed species (Mark S. Harvey, WAM, pers. com.). The specimen collected was sub-adult and thus specific identification was impossible, however the species is a definitive troglobite.

Order Hemiptera (Sucking Bugs)

Emesine bugs are characterised by extremely long and thin legs and possess mantis-like raptorial front legs (Gross et al. 2000). They occur worldwide and all known species are predatory, using their raptorial front legs to capture and secure prey items (Gross et al. 2000). Emesines are known from cave habitats; however, taxonomic knowledge of the Western Australian species is poor. Approximately 44 named species are known from Australia (Gross et al. 2000).

One specimen of an undescribed emesine bug species was collected from sample bore MRC112. The specimen was white and possessed eyes that lacked pigment while epigean species possess well developed compound eyes and body pigmentation. This species is clearly a definitive troglobite.

<u>Order Isopoda (Slaters)</u>

An undescribed slater (suborder Oniscoidea) was detected.Terrestrial isopods are a diverse order of the subphylum Crustacea with more than 4000 species known (Brusca and Brusca 2003). Isopods are known from nearly all environment types, including subterranean habitats (Brusca and Brusca 2003). The suborder Oniscoidea contains all terrestrial species, members of which are generally omnivorous or herbivorous (Brusca and Brusca 2003).

Two specimens of a new species of oniscoid isopods (slaters) were detected from holes MRC367 and Trog24. The species is pale and blind and is a definitive troglobite (S. Judd, ECU, pers. com.).

<u>Order Polyxenida (pincushion millipedes)</u>

Polyxenids are very small, caterpillar-like millipedes, usually less than 5mm in length. They possess numerous setae over the dorsal surfaces; giving them a bristly or pincushion-like appearance. Polyxenids are herbivorous or omnivorous and may occur in very large aggregations (Koch 1985).

Seven specimens of ployxenid millipede were found during the survey from sample bores MRC084, MRC247, Trog41a and Trog04. The specific identity of this species is presently unknown as the general taxonomy of Australian polyxenid millipedes is poorly known. Polyxenids typically have well pigmented bodies and well developed eyes and the pale and blind features of the species collected during this survey indicate that it is a definitive troglobite.

<u>Order Coleoptera (beetles)</u>

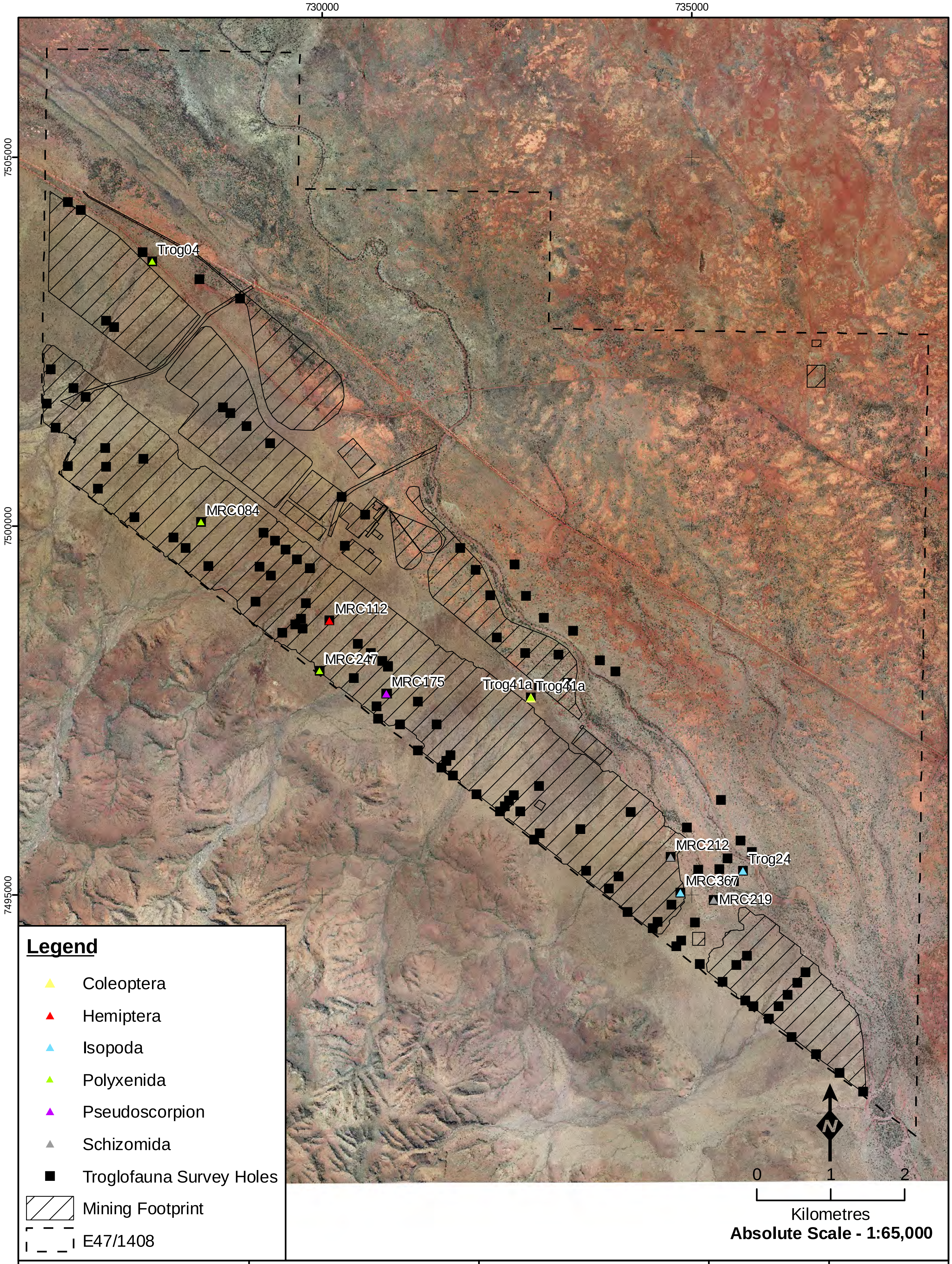
Two different types of beetles were collected during this survey and for the purpose of this report were assigned the morphospecies names Coleoptera 'marillana1' and Coleoptera 'marillana2'.

Coleoptera 'marillana1'

Several specimens of an unknown beetle species were detected from sample bores MRC247 and MRC213. The specimens possess much reduced eyes spots and lacks pigmentation; however they are also extremely tiny leading to the conclusion that they may be an element of the soil fauna. For this reason this species is only tentatively considered to be a troglobite.

Coleoptera 'marillana2'

Six specimens of this species were detected from sample bore Trog41a. The larger size of this species and its complete lack of eyes and pigmentation lead to the conclusion that this is more likely to be a definitive troglobite species.



ecologia ENVIRONMENT

brockman resources.

Troglofauna survey sites and records

Figure: 6-11
Project ID: 1140

Drawn: SG
Date: 16/10/09

Coordinate System
Name: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Unique Map ID: S038

A4

6.10 SHORT-RANGE ENDEMICS

A four phased short-range endemic survey was undertaken by ecologia within the project area over approximately three months, July-October 2008 (Appendix R). The primary objectives of this survey were to fulfil the requirements outlined in the EPA's Guidance Statement 56 (EPA 2004) and Position Statement No. 3 (EPA 2002), thus providing an inventory of short-range endemic (SRE) fauna species occurring in the survey area, incorporating recent published and unpublished records.

Thirty sites were selected in and around the proposed development. Site selection aimed to target as wide a range of habitats as possible, focussing on areas where SRE species were most likely to occur. Each site was represented by five wet pitfall traps and approximately 60 hours of targeted foraging (Figure 6-12, Table 6-6).

Table 6-6 Summary of SRE Survey Effort

METHODOLOGY	NUMBER OF TRAPS PER SITE / FORAGING TIME (HRS) PER SITE	NUMBER OF SITES	TOTAL TRAPPING EVENTS / FORAGING HOURS
Pitfall Traps (*ca* 90 nights)	5	30	*ca* 13,500 events
Foraging	2.5 person hrs	14	70 person hours
Burrow Pitfall Trapping	n/a	20	20 traps

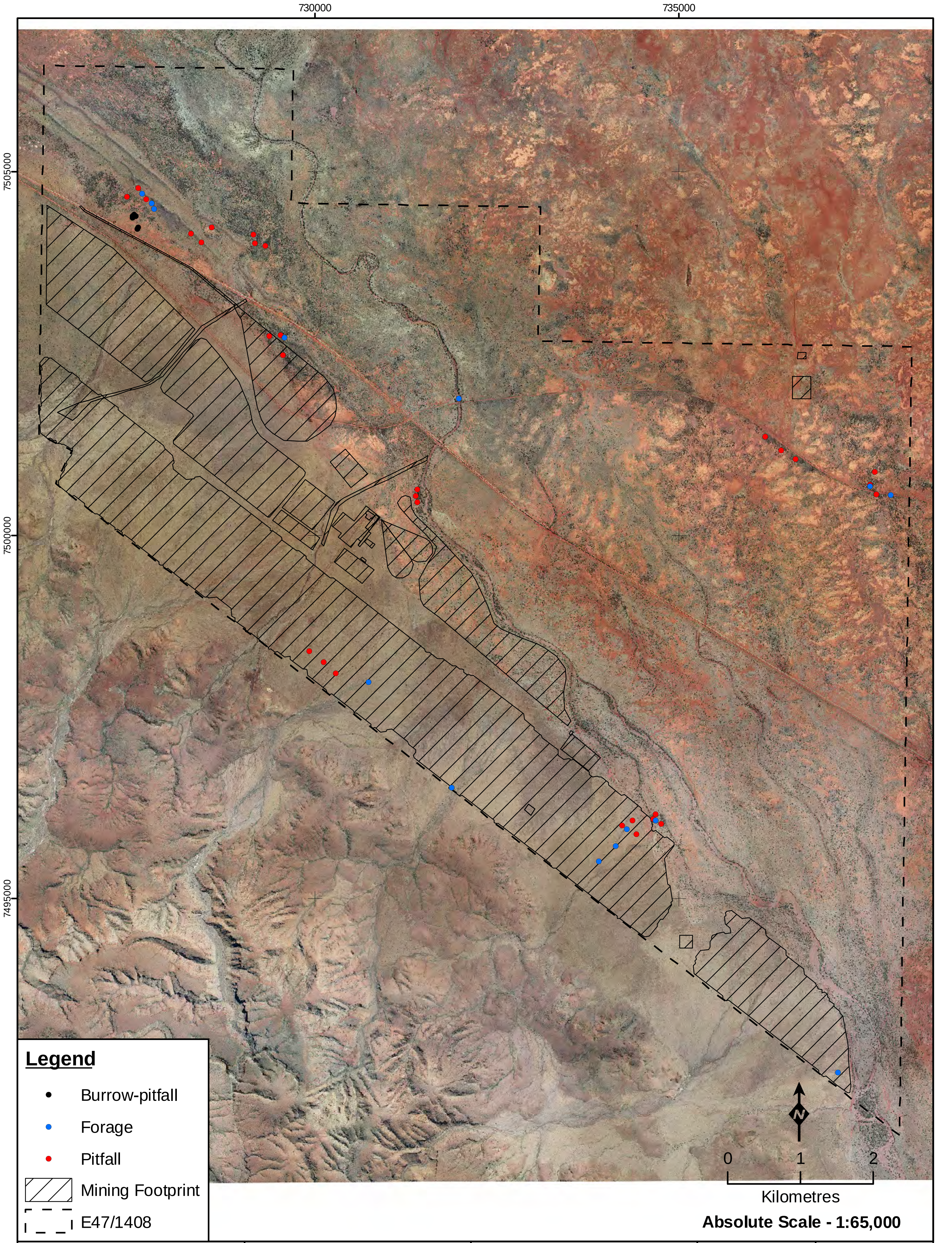
Short-range endemic organisms are characterised by having highly restricted natural distributions of 10,000 km² (100 km x 100 km) or less. Habitats conducive to supporting short-range endemics are typically isolated patches of landscape with abiotic properties (ambient moisture, sun exposure or temperature profiles) differing from the surrounding land forms (Harvey, 2002)

These landforms are frequently remnants of historically wetter periods that became isolated during the last 30 million years as much of the Australian landscape became drier. Speciation within the invertebrate populations is mediated by the amount of genetic cross over that occurred (emigration and immigration of individuals) between populations. Isolation over sufficiently long periods of time produces species that are restricted to the habitat in which they have evolved (Harvey, 2002).

ecologia's survey revealed six invertebrate groups known to contain SRE species. These were: pseudoscorpions, scorpions, trapdoor spiders, isopods, centipedes and snails. Closer inspection of these groups revealed three taxa that may potentially be considered as SRE, being two undescribed species of *Beierolpium* pseudoscorpions (family Olpiidae) and a species of geophilomorph centipede.

In all three cases, the taxonomic knowledge of the respective group is very poor and a clear determination of SRE status will only be known after significant revisions of the groups are undertaken at a regional level (pers. com. V.W. Framenau and M.S. Harvey, WAM).

However the lack of typical SRE island habitats within the project area supports the absence of classically recognised terrestrial SRE invertebrates from these surveys. .



ecologia ENVIRONMENT

brockman resources.

SRE Sampling Sites (Foraging, Wet pitfall and Burrow Pitfall)

Figure: 6-12
Project ID: 1140

Drawn: SG
Date: 16/10/09

Coordinate System
Name: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Unique Map ID: S039

A4

6.11 CULTURAL HERITAGE

6.11.1 Indigenous

There are no established Aboriginal communities in the vicinity however the project area is subject to native title claims from the Martu Idja Banyjima (MIB) people and the Nyiyaparli people. A native title agreement is in place between Brockman and the MIB People, dated October 2008 and another between Brockman and the Nyiyaparli people dated November 2009.

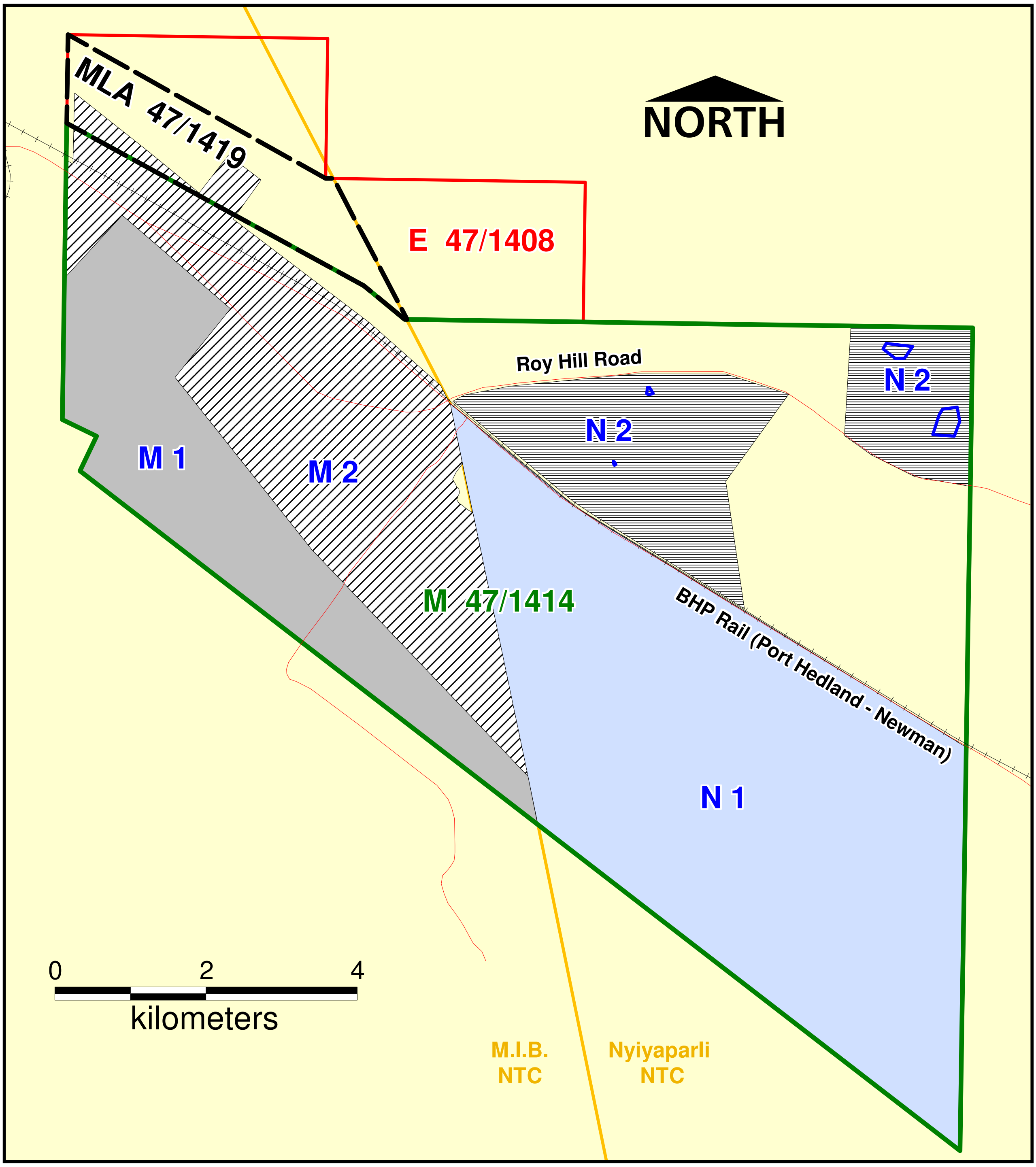
A search of the Department of Indigenous Affairs (DIA) sites register revealed that there were no Aboriginal archaeological or ethnographic sites registered within the project area. An Aboriginal site is a defined place – i.e., a specific area of land and/or water to which special heritage significance applies, and therefore attracts the protection of the *Aboriginal Heritage Act 1972*, and potentially also the protection of the *Commonwealth Aboriginal and Torres Strait Islander Heritage Protection Act 1984*.

Heritage surveys have been completed by Australian Cultural Heritage Management (ACHM) in consultation with and involving the participation of MIB elders over the entire project footprint within the MIB claim area (the majority of the resource area) and further surveys have been conducted covering all remaining proposed resource and infrastructure areas within the Nyiyaparli claim area (see Figure 6-13). The ground clearance surveys were carried out by archaeologists, with hand held GPS units, flanked by Traditional Owner (TO) representatives spaced at increments ranging from 20 to 50 m depending on ground surface visibility. Transects of the survey areas were then walked and any culturally significant sites or materials were recorded. Ethnographic surveys were also carried out in consultation with Traditional Elders.

In the Nyiyaparli claim area the archaeological survey and assessment resulted in the identification of four archaeological sites (stone artefact scatters), a modified tree, and a number of isolated finds (AAA, 2009). A common feature of all these areas was the generally large size of the stone artefacts and nodules, as well as the diversity of raw material types present. This implies that the area is close to raw material sources, and it is presumed that the prominent ridges to the south and north of the project area contain plentiful supplies of high quality raw materials for stone knapping.

No archaeological or ethnographic sites have been identified within the project footprint and none of the sites identified within the broader project area (Figure 6-13) are in areas proposed to be developed by Brockman.

Ongoing consultation between Brockman and the Nyiyaparli and MIB people regarding Native Title will ensure that any impacts to land utilisation are managed in a way that recognises their customs and traditions.



LEGEND

HERITAGE SURVEY AREAS

M1 MIB heritage survey area , completed in April 2007

M2 MIB heritage survey area, completed in Aug 2009

N1 Nyiyaparli heritage survey area, completed in Dec 2007

N2 Nyiyaparli heritage survey area, completed in Aug 2009

Area of artefact scatters identified (4 in total)

Brockman Resources Ltd

PROJECT: **Marillana**

BRM Tenement &
Heritage Survey Areas

Figure: 6-13
Project ID: 855

6.11.2 European

A search of the Australian Heritage Database showed that no non-indigenous heritage sites are listed as occurring in the areas surrounding the project area.

The tenement is located 100 km north north-west from the township of Newman, within the Marillana pastoral station. The neighbouring area is predominated by pastoral and mining activities (predominantly exploration) and its supporting infrastructure.

The nearby town of Newman has developed as a result of mineral exploitation, and requires ongoing resource projects to provide revenue to the community. The development of the Project will provide financial and social benefits for the area through employment and flow-on effects to the non-mining sector.

The impacts of mining activities to surrounding communities and landholders will be minimal due primarily to the remote location of the project area, some 60 km from any area of habitation, and the nature of the existing land use.

The Karijini National Park is located 100 km to the west and is the primary tourism attraction in the area. Access to the Park is encouraged from Tom Price off the Paraburdoo Tom Price Road.

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7.0 KEY ENVIRONMENTAL FACTORS AND MANAGEMENT

7.1 ENVIRONMENTAL MANAGEMENT SYSTEM

Brockman maintains an Environmental Management System (EMS) (Appendix G) that allows the Company to identify and control potential environmental impacts resulting from its operations and activities, and continually improve on its environmental performance.

Central to the EMS, is Brockman's publicly available Environmental Policy, which aims to:

- Comply with the *Environmental Protection Act 1986* and all other applicable environmental laws, regulations, policies, standards and codes of practice.
- Establish the Company's Environmental Management System to conform with the requirements of the International Standard ISO 14001.
- Provide employees with the necessary training, education and resources to fulfil their environmental responsibilities and ensure that operations are performed with appropriate respect for the environment.
- Specify the need for all contractors to perform the work in accordance with this policy and to supervise such compliance.
- Provide a framework for regular review of the Company's environmental performance and act on the results.

7.1.1 Planning and Risk Management

Legal and other requirements relevant to Brockman activities are identified and documented in an obligations register. These requirements form an important component of Brockman risk management process, which involves the systematic identification of environmental aspects of activities over which Brockman has an influence. Risk assessment takes into consideration risk to the environment (i.e. the potential for pollution) and risk to the Company, (i.e. inability to achieve targets and non-compliance with legal or other requirements).

Significant risks are addressed through the setting of objectives and targets, and the implementation of management programs. The risks associated with changes to process, plant, organisation, personnel or procedure are identified and managed in the same way.

7.1.2 Implementation

To ensure that risk management requirements are effectively implemented, personnel holding roles that could have a significant interaction with the environment are experienced, qualified or trained to competency in managing their environmental risks. Internal and external communications are maintained to facilitate discussions on risks and environmental performance.

Aspects associated with significant environmental risks have documented operational controls in place to minimise impacts arising from inconsistent work practices. These procedures together with all other documents and records essential to the environmental management system are controlled and maintained.

System procedures together with separate management plans for aspects such as vegetation and dust, threatened flora and fauna ensure that all key environmental aspects are appropriately managed.

The potential for environmental emergency situations has been recognised. Such scenarios are identified by the Operations / SHE Manager and response and preparedness requirements addressed.

7.1.3 Corrective Actions

Environmental performance is monitored at various levels through inspection, reporting, investigation and analysis of incidents and non-conformances and regular audits. Corrective actions are implemented to address the non-conformances.

7.1.4 Audit and Management Review

Performance results are discussed at management level to ascertain the appropriateness of the Policy, objectives and targets, and the adequacy and effectiveness of elements of the EMS.

An Annual Environmental Review (AER) will be undertaken and a report submitted to the DEC outlining performance against environmental objectives and targets, further biological assessments undertaken, environmental management improvements and results of ongoing stakeholder consultation.

7.1.5 Continual Improvement

The cyclic nature of the EMS structure described above facilitates continual improvement in Brockman environmental performance, and provides the mechanism for managing significant risks, achieving targets and complying with legal and other requirements.

7.2 ENVIRONMENTAL RISK ASSESSMENT

A central component of an EMS is to identify those activities that may have a significant risk to the natural environment and develop management strategies to:

- completely avoid the impact if possible;
- substitute with a lesser impact;
- design rehabilitation and engineering solutions to reduce the degree and risk of impact;
- design operational controls and emergency response around reduction of impact; and
- provide for environmental offsets.

Brockman have undertaken a qualitative environmental risk assessment (ERA) based upon the methodology in AS/NZS 4360 and HB 203:2000. The full results of the risk assessment are presented within the PEMP (Appendix F). Importantly, this process will be undertaken on at least an annual basis as project activities change and new legislation and/or biological information is developed or identified.

The risk assessment process involved:

- identification of the key environmental aspects of the Project;

- identification of the potential sources of risk, risk events and potential impacts for each of the environmental aspect;
- an estimation of the likelihood of each risk event occurring, the potential environmental consequences if it did occur and the subsequent determination of an inherent risk rating for each event; and
- development of appropriate controls and a re-rating of residual risk.

Table 7-1 Consequence Ranking

LEVEL		CONSEQUENCE (*EXAMPLE*)
1	Insignificant	No lasting effect. Low level impacts on biological or physical environment. Limited damage to minimal area of low significance.
		Individual mortality (i.e. roadkill).
2	Minor	Minor effects on biological or physical environment. Minor short-medium term damage to small area of limited significance.
		Removal of a small proportion of habitat for a short period of time.
3	Moderate	Moderate effects on biological or physical environment but not affecting ecosystem function. Moderate short-medium term widespread impacts.
		Removal of a large proportion of habitat that will be rehabilitated as suitable habitat in the future.
4	Major	Serious environmental effects with some impairment on ecosystem function. Relatively widespread medium-long term impacts.
		Removal of habitat to the threshold required to maintain a viable population.
5	Catastrophic	Very serious environmental effects with impairment of ecosystem function. Long term, widespread effects on significant environment
		Excessive removal of habitat beyond the threshold required to maintain a viable population.

Table 7-2 Likelihood Ranking

LEVEL		LIKELIHOOD
5	Almost certain	The incident is expected to occur most of the time (*i.e.* every time).
4	Likely	The incident will probably occur in most circumstances (*i.e.* quarterly).
3	Moderate	The incident should occur at some time (*i.e.* once every few years)
2	Unlikely	The incident could occur at some time during the life of the project.
1	Rare	The incident may occur only in exceptional circumstances and may never happen.

Table 7-3 Risk Matrix

		CONSEQUENCES				
		1	2	3	4	5
LIKELIHOOD		Insignificant	Minor	Moderate	Major	Catastrophic
5	Almost certain	5	10	15	20	25
4	Likely	4	8	12	16	20
3	Moderate	3	6	9	12	15

2	Unlikely	2	4	6	8	10
1	Rare	1	2	3	4	5

Table 7-4 Impact Definitions

	High impact	Senior management involvement, planning and significant DEC / EPA input will be required.
	Moderate impact	Senior management attention required and the DEC / EPA must be consulted with.
	Low impact	Manage by routine procedures.

Significance was determined as a function of the sensitivity of the receiving environment and the magnitude of the impact.

In assessing the significance of environmental impacts potentially resulting from this proposal, Brockman considered the following:

- relevant legislation, standards and guidelines;
- biological assessments of the project area;
- the EPA's Principle's of Environmental Protection (Table 3-2); and
- input from government and community-based stakeholders.

The following activities have been identified as the key components of the Project that are likely to contribute to environmental impacts:

- Clearing of 2,985 ha of native vegetation- will impact the available vertebrate fauna habitat, subterranean invertebrate fauna habitat through limiting nutrient input and may facilitate the introduction or spread of weed species and the frequency of wild fires.
- Ground disturbance - the stripping of topsoil, if stored incorrectly may reduce its viability as a rehabilitation resource. Ground disturbance may generate dust emissions, alter soil structure and facilitate the dispersal and spread of weed species.
- Alteration of surface hydrology- could locally impact upon vegetation downstream of where small creeks currently emerge from the Hamersley Ranges and south of the Weeli Wolli Creek. However changes to surface flows will not significantly impact the Fortescue Marsh.
- Excavation of ore- will directly impact on troglofauna habitat within the project area, generate dust emissions and permanently alter the landforms of the project area.

The full risk register is presented within the PEMP (Appendix F).

Management programmes addressing significant factors are summarised within this PER document and are addressed in more detail within the PEMP (Appendix F), the Surface Water Management Plan (SWMP) (Appendix S), Groundwater Management Plan (Appendix E) and Conceptual Closure Plan (Appendix T). Management controls have been particularly focused on the above activities and potential impacts listed above.

In the following section, environmental aspects are described and discussed in order of their environmental significance from the most potentially significant risks to those most easily managed through standard mine site operating procedures.

7.3 SUBTERRANEAN INVERTEBRATE FAUNA

Three stygobitic species were collected on the exploration tenement and one species was collected during off-tenement sampling of stock bores. Both the amphipod (*Pilbarus millsi*) and the isopod (*Pygolabis weeliwolli*) were the focus of recent publications (Finston et al., 2007; Finston et al., 2009) within which it was indicated that these species were present in the Weeli Wolli Creek and Marillana Creek palaeo-drainage channel. Although the other two species could not be identified to specific level due to their sub-adult stage and significant damage, they are expected to occur outside the tenement because their body size is significantly smaller than the size of the amphipod and the isopod and thus they are expected to be subject to the same or lesser dispersal limitation (ecologia, 2009c).

A total of six definitive (unambiguous) troglobite species were collected during ecologia's survey of the project area: emisine bug (Hemiptera); beetle (Coleoptera); schizomid (Schizomida); slater (Isopoda); pseudoscorpion (Pseudoscorpiones) and polyxenid millipede (Polyxenida). Species richness estimation predicted up to seven species based on the data collected and, coupled with species accumulation curves, indicated that the survey was comprehensive (ecologia, 2009d).

Troglobites were found primarily within alluvial sediments at the base of the Hamersley Range and their distribution appears to extend northwards towards the Weeli Wolli Creek following old alluvial outflows (ecologia 2009d). The Weeli Wolli Creek appears to act as a natural northern geological barrier to their distribution however the lack of positive records may also be an artefact of the sampling regime.

7.3.1 Management Objectives

The objectives for management of subterranean invertebrate fauna are to:

- Minimise the impact on the abundance, diversity, geographic distribution and productivity of troglofauna and stygofauna at species and ecosystem levels.
- Protect rare or priority fauna (listed under the *Wildlife Conservation Act 1950* or the *Environmental Protection and Biodiversity Conservation Act 1999*) habitat.

7.3.2 Applicable Standards and Guidelines

Applicable standards and guidelines for the management of subterranean invertebrate fauna include:

- *Environmental Protection Act 1986.*
- *Wildlife Conservation Act 1950.*
- Guidance Statement No. 56. Terrestrial Fauna Surveys for Environmental Impact Assessment in WA (EPA, 2004).
- Guidance Statement No. 54a: Sampling Methods and Survey Considerations for Subterranean Fauna in Western Australia.
- Guidance Statement 54: Consideration of Subterranean Fauna in Groundwater and Caves during Environmental Impact Assessment in Western Australia.
- Position Statement No. 3. Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA, 2002).

- Biodiversity Management (DMP, 2007).

7.3.3 Potential Impacts

The construction and operation of the Project may have an impact on subterranean invertebrate fauna as a result of:

- clearing and habitat destruction;
- alterations to water availability;
- alterations to soil structure;
- alterations to nutrient input; and
- alterations to groundwater levels and soil humidity.

7.3.3.1 Stygofauna

Threatening processes to stygofauna involve two main types of impact. These can be classified as primary and secondary impacts. Primary impacts are direct and physical in nature and result in the physical removal of their habitat. Secondary impacts on the stygofauna community relate to other aspects of a mining operation that may affect the quality of the stygofauna habitat, such as changes to the water chemistry.

Physical destruction of subterranean habitat

Physical destruction of the habitat is likely to result from the developments of the mining pit. This impact physically removes the stygofauna habitat.

<u>Excavation</u>

The detrital iron resource that the Project aims to target is situated within the palaeo-channel and almost completely below the standing water table. This also represents a major component in which the aquifer resides (Coffey, 2009) and thus the bulk of the sampled stygofauna habitat within the proposed pit shell will be removed. However the detrital aquifer extends up to 60 m below the base of mining at various locations.

In a regional context, however, the proportion of the stygofauna habitat to be impacted is small relative to the known distribution of two of the species discovered during the survey. The habitat extends well outside of the boundary of the project area as demonstrated by the largest stygobites occurring further upstream of the Weeli Wolli palaeo-channel system (Figure 6-10), suggesting that this habitat is continuous along this palaeo-channel.

Alteration of aquifer hydrology and biochemistry

<u>Altered aquifer hydrology</u>

Alteration of the subterranean hydrology is likely to occur from dewatering operations in the proposed mining pit, which will result in a draw-down cone extending off tenement. Negligible impact is expected on the broader hydrology of the Weeli Wolli / Marillana palaeo-channel or the stygofauna community residing within this palaeo-drainage system due to the comparatively small size of the drawdown cone (see section 7.4) relative to the extent of the broader system.

<u>Contamination</u>

Groundwater contamination results from a pollutant (usually liquid) entering the subterranean water system and interfering with the life processes occurring within the system. Chemical spills can have varying degrees of impact, depending on the size of the spill and nature of the chemical/s spilled.

Nutrient starvation

While the Project will require the clearing of some 2,985 ha of vegetation, the energy input to the aquifer incorporates a much larger area, particularly the upper catchment of Weeli Wolli and Marillana Creeks. Water-born nutrients are carried with the flow of subterranean water and thus nutrient levels are not expected to decrease beneath, or downstream of, the proposed infrastructure footprint. No significant alteration to the nutrient content in the palaeo-channel is likely to result from the proposal.

7.3.3.2 Troglofauna

One of the important features of troglobitic habitats is their extremely stable environmental parameters (primarily temperature and humidity) and very low energy and nutrient influx (Howarth, 1982; Howarth, 1983; Howarth, 1993; Humphreys, 2000).

Two types of impact could occur from the Project. These are classified as primary and secondary impacts. Primary impacts involve the physical destruction of the subterranean habitat, while secondary impacts include alteration of the microclimate and nutrient influx into the subterranean environment.

Physical destruction of subterranean habitat

Physical destruction of the habitat is likely to result from two aspects of the proposed development, pit mining and vibration (see below). Both impacts result in a destruction of the air filled cavities and therefore a destruction or removal of troglobitic habitat.

Excavation

Troglobitic habitat within the proposed mining pit will be completely removed (as overburden or waste) in order to access the underlying resource which lies below the water table. The two mine pits occupy an area of approximately 1,648 ha.

Vibration

Sufficient levels of vibration from heavy machinery or heavy vehicles are likely to cause the collapse of subterranean void spaces in unconsolidated gravels. The extent and severity of this impact is unknown because the location of the troglofauna community is not clear, nor is the actual impact of vibration clearly understood; however, it stands to reason that the unconsolidated strata containing the troglobitic habitat will be more sensitive to vibration than would be expected of void spaces formed in rock.

The Project will require minimal blasting, as much of the target material is unconsolidated rock. Blasting that does occur will be carried out during daylight hours and strictly controlled to minimise air blast and ground vibration issues.

Troglofauna habitat risk assessment

To gain a better understanding of the significance of impacts resulting from this proposal on troglofauna, sampling off the tenement was pursued with neighbouring tenement holders. However access to the areas to the north-west and south of the project area was declined. This, along with the low capture rate made gaining an understanding of the habitat constraints of the troglofauna community difficult.

To explore the likely extent of habitat available to troglofauna off-tenement in the absence of the ability to directly sample, a detailed assessment of the subterranean geology of the project area and regional surrounds was undertaken. The assessment utilised drill core samples taken from on-tenement and historical exploration drill data.

Longitudinal models of the geological strata above the standing water table were developed across the pit, extending out to the northwest and northeast along the base of the ranges. Holes where troglofauna had been found were overlaid onto the cross sections to better determine the geological strata that the troglofauna occupied. This assessment showed that troglofauna are likely to inhabit both the siliceous detritals (SD) and the haematite-rich detritals (HD) above the existing water table (~ 20-40 mbgl). These strata are shown to extend uninterrupted off-tenement both along the ranges and to the east towards the marsh (see Figures 7-1 and 7-2). It was noted that the present-day creeklines do not appear to bisect the strata and thus are unlikely to act as a barrier to fauna dispersal.

The results of the risk assessment indicate that the impacts of the pit and associated infrastructure are likely to represent only a moderate (12.8 %) impact on the inferred distribution of this community.

Alteration of subterranean microclimate and biochemistry

Alteration of the subterranean microclimate, particularly humidity, can result from alteration of surface and subterranean hydrology, which can occur naturally, i.e. from large inundation events. Alteration of nutrient influx and contamination of the subterranean environment with pollutants can also cause significant changes to the subterranean microclimate. Details of these changes are listed below.

<u>Altered surface hydrology</u>

Alterations to surface hydrology can result either in flooding of the troglobitic habitats where water is dammed; or dehydration of the troglobitic community where important water is diverted away from the troglobitic habitats. Large scale changes to surface hydrology may also change aquifer recharge and thus alter water table depth.

However surface water modelling of the project area (Appendix S) suggests that predicted changes to surface water flow are not likely to be significant to the overall hydrological system, particularly in comparison to the natural seasonal variations in catchment runoff.

<u>Altered subterranean hydrology</u>

Drawdown of the water table is likely to occur from dewatering operations in the proposed mining pit. The draw down model at 20 years predicts an extensive 10 m drawdown cone (Figure 7-1) extending beyond the modelled distribution of the troglobite communities.

Based on Sands (2001), Bennelongia (2008) argued that the draw-down of the water table could expose additional habitat for troglobite colonization. This hypothesis is plausible if habitat below the water table can be demonstrated to be conducive to supporting troglobites (i.e. comprising interconnected, porous strata). In this case the troglofauna habitat appears to be the alluvial fans extending out from the Hamersley Range (ecologia 2009d). Drawdown will be a gradual process over time as dewatering activities continue over the life of mining operations. If the descending water level exposes more porous material, troglobites may be able to colonize this new habitat.

<u>Altered soil humidity</u>

A review of the literature on troglofauna and other subterranean fauna (Howarth, 1982, 1983, 1993; Humphreys, 1991, 2000, 2001, Weinstein, 1994) identified that soil humidity, in addition to stable pore space of sufficient size and connectivity, is generally regarded as one of the most critical factors influencing the presence/absence and subsequent distribution of troglofauna (Howarth, 1980, 1982).

Recent troglofauna studies in Western Australia (Biota, 2006, 2006a; Subterranean Ecology, 2007; ecologia, 2009d) have linked soil humidity to groundwater or more specifically the capillary fringe overlying the watertable. Implicit in this theoretical association is that the humidity in the soil environment is directly related to groundwater and therefore alteration of the watertable (i.e. in response to dewatering) will impact on humidity levels in the soil, and subsequently on the conditions suitable for troglofauna habitation. However this relationship between high soil humidity and proximity to groundwater is theoretical and dependent upon many site-specific parameters such as soil grain size.

In most situations where a declining watertable occurs, the soil will only drain to field capacity (i.e. 10 kPa), which is equivalent to a relative humidity of approximately 99.99%. The impacts of dewatering levels on soil moisture are expected to be further limited by the very low unsaturated hydraulic conductivity of the soils found within the project area (inferred from sieve analysis data).

Therefore, even though the groundwater table will be lowered as a result of dewatering, it is expected that the limited soil moisture fluctuations will equate to a relative humidity that may vary from 100% to 98.9% at permanent wilting point. It is likely that soil moisture, and subsequently soil humidity levels throughout the soil profile will be significantly more sensitive to infiltrating rainfall than dewatering operations.

On the basis of this, dewatering is not anticipated to significantly impact soil humidity and consequently troglofauna habitat.

<u>Contamination</u>

Ground contamination results from a pollutant (usually liquid) entering the troglobitic habitat and interfering with the life processes occurring within the system. Chemical spills can have varying degrees of impact, depending on the size of the spill and nature of the chemical/s spilled. The most likely type of chemical contamination is a contamination by diesel, owing to its extensive use as a machinery fuel.

<u>Nutrient starvation</u>

Alteration of nutrient influx into the troglobitic habitat can arise from large scale surface clearing, such as in areas proposed for the infrastructure and the waste dump. Most troglobitic communities are solely dependent on allochthonous nutrients (derived from surface environments) (Howarth, 1993). Organic compounds dissolved in rainwater percolate through the subterranean strata and are the sole nutrient source for most troglobitic systems (Howarth, 1993). The level of this type of nutrient influx is therefore extremely low and removal of the nutrient source by clearing large areas of surface vegetation is likely to result in starvation of the troglobitic community directly beneath it.

Total Predicted Impact

As the effects of dewatering on troglofauna are predicted to be negligible, the total predicted impact as a result of the proposal is the sum of the area of the mining pit and major elements of the infrastructure footprint (Figure 7-3).

The direct impact as a result of excavation of the mine pits is 1,648 ha or, approximately 8.2 % of the inferred troglofauna distribution (20,203 ha). Secondary impacts resulting from the clearing of vegetation for mine infrastructure (such as the waste dumps, plant and stockpiles) total 936 ha, or 4.6 % of the inferred troglofauna distribution. It is not anticipated that this degree of impact will significantly affect the connectivity of the troglofauna community nor its viability

Table 7-5 summarises the predicted direct and indirect impacts to troglofauna habitat.

Table 7-5 Projected Project Impacts on Troglofauna

	FOOTPRINT (ha)	% IMPACT
Pit	1,648	8.2%
Mine Infrastructure	936	4.6%
TOTAL	**2,584**	**12.8%**

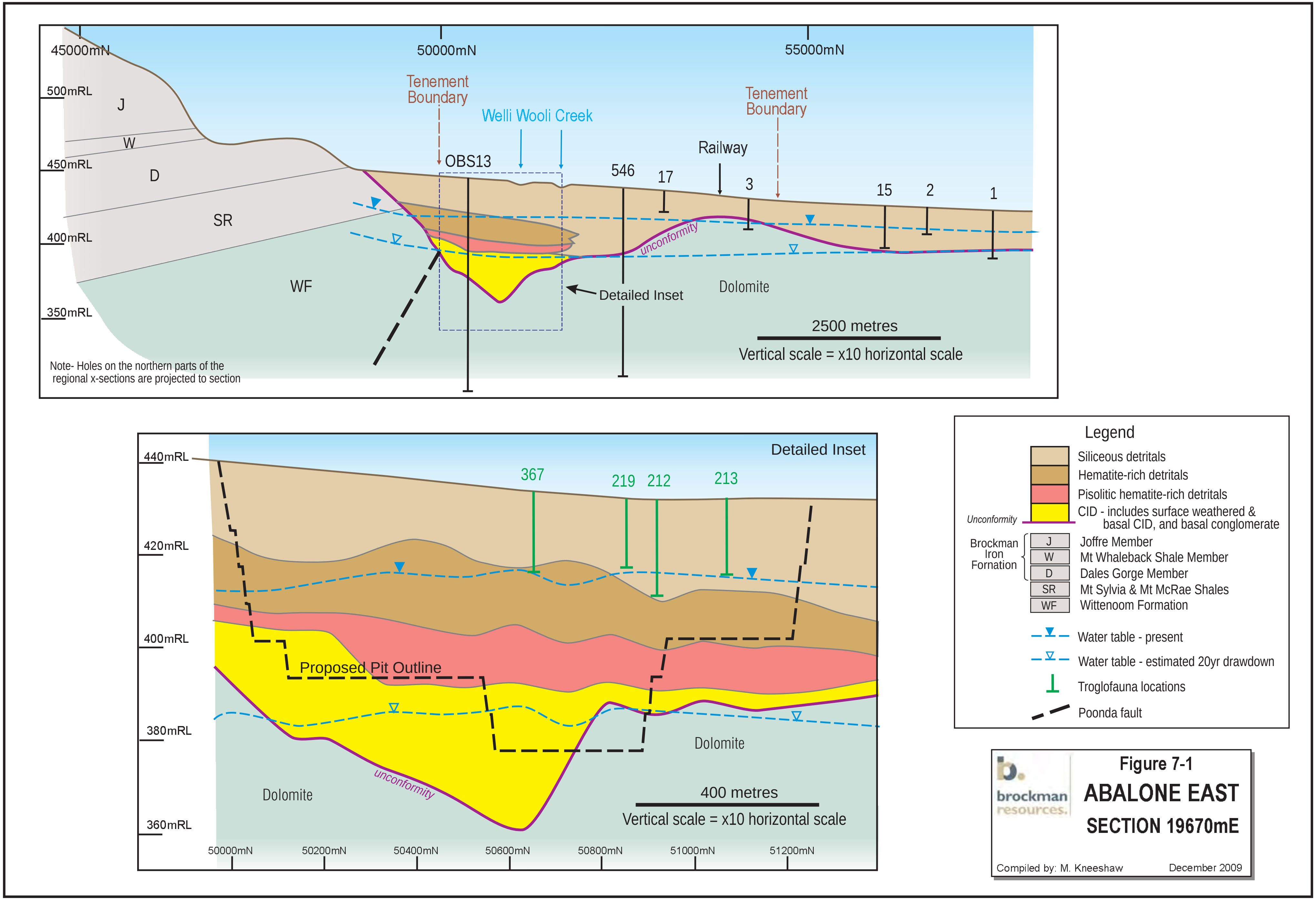
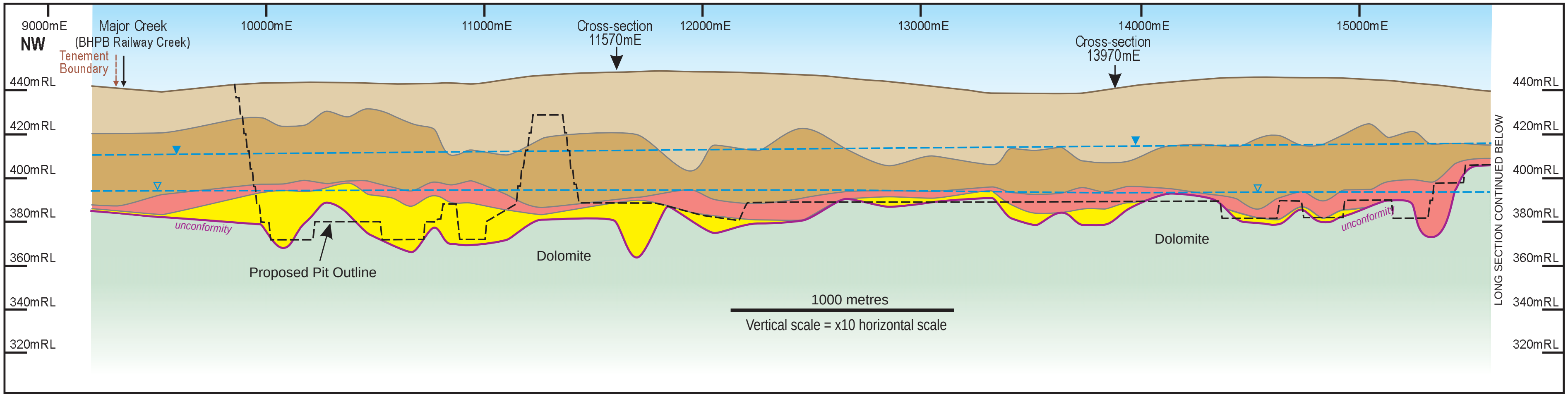
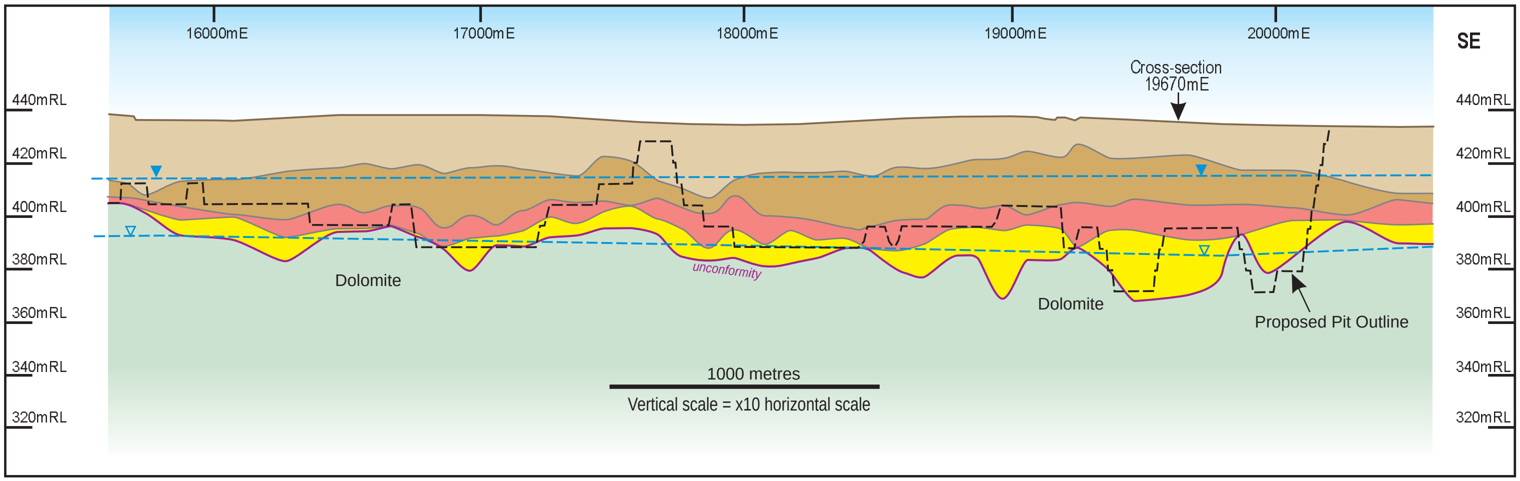
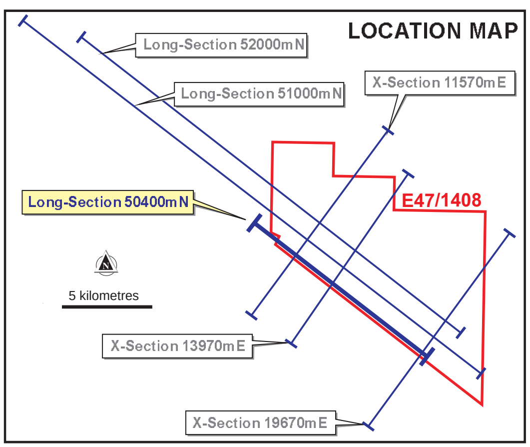


Figure 7-1
ABALONE EAST
SECTION 19670mE







Legend

- Siliceous detritals
- Hematite-rich detritals
- Pisolitic hematite-rich detritals
- CID - includes surface weathered & basal CID, and basal conglomerate
- Unconformity
- Wittenoom Formation - dolomite
- Water table - present
- Water table - estimated 20yr drawdown

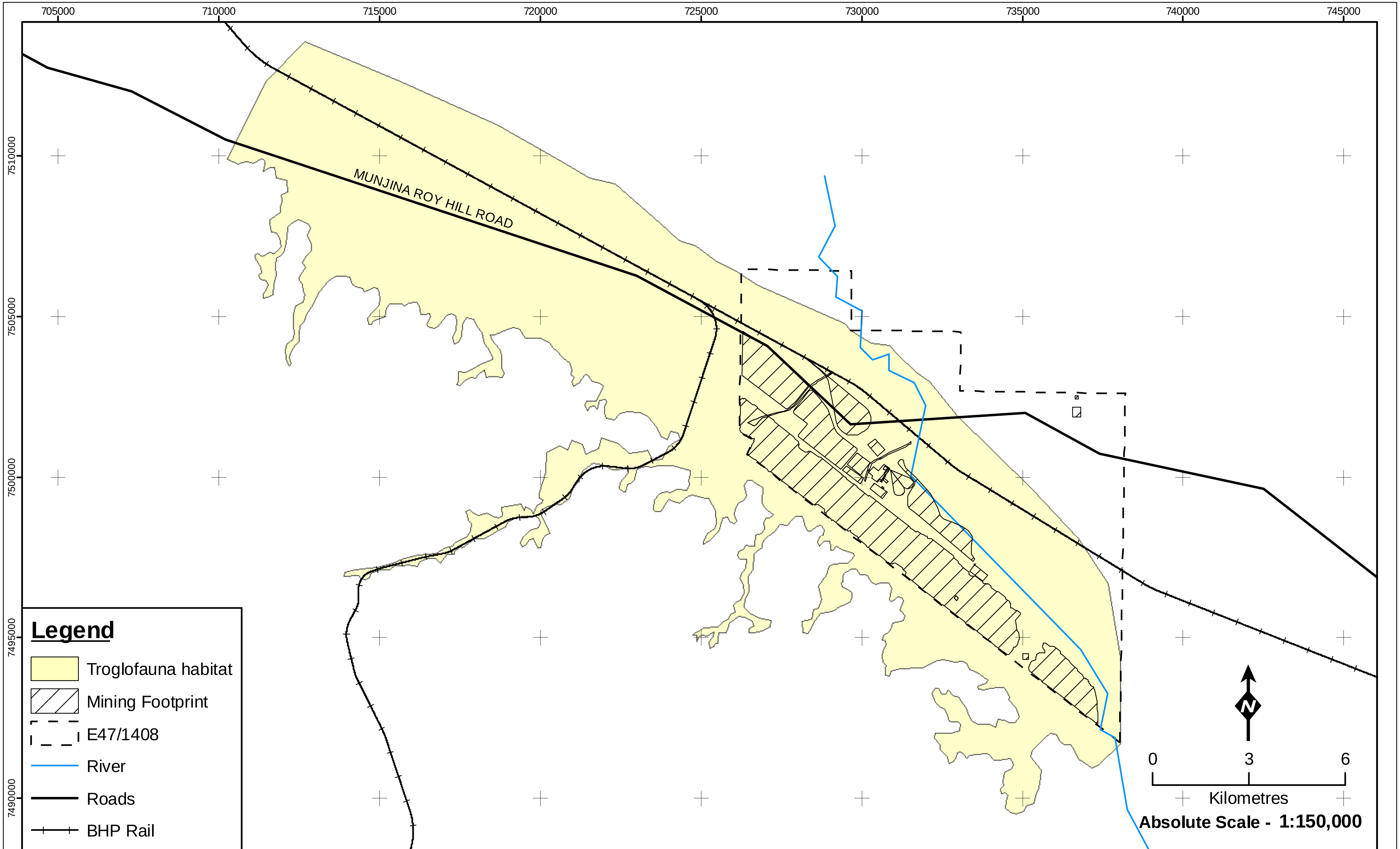
brockman resources.

Figure 7-2

MARILLANA PROJECT

LONG SECTION 50400mN

Compiled by: M. Kneeshaw December 2009



ecologia ENVIRONMENT

brockman resources.

Predicted Troglofauna Habitat Impacts

Figure: 7-3
Project ID: 1140

Drawn: SG
Date: 11/02/10

Coordinate System
Name: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Unique Map ID: S089

A4

7.3.4 Management

Brockman will implement the following management actions to reduce the potential for and severity of impacts to subterranean invertebrate fauna.

Excavation

Site disturbance and excavation will be minimised to only those areas required and applied for with a Site Disturbance Permit (Appendix G). Pit excavation will be staged over the 20 year mine life and areas of the pit backfilled to above the pre-existing water table progressively and rehabilitated.

Clearing (mine infrastructure)

Impacts to troglofauna and stygofauna as a result of clearing that may lead to nutrient starvation will be managed by minimising the footprint of infrastructure such as waste dumps and stockpiles. These landforms have been designed to minimise the area required for their construction while conforming to the appropriate standards (such as Safe Design and Operating Standards for Tailings Storage, 1999 and Environmental Notes on Mining Waste Rock Dumps, 2001). Additionally, waste will be stored in-pit after year five of operations further reducing the overall project footprint.

All areas impacted by mining will be contoured and rehabilitated in accordance with section 7.7 of this document and the PEMP (Appendix F) as soon as they are decommissioned to restore conditions suitable for troglofauna.

Altered surface hydrology

Where water is diverted around mine site infrastructure, troglofauna habitat will have been already heavily impacted through excavation and/or clearing. In areas left untouched by infrastructure, surface water flow will be re-dispersed to mimic pre-development flows to reduce impacts to the downstream ecosystem.

The management of alterations to surface water flow is described in detail in section 7.5 Surface Water and Flood Management.

Altered subterranean hydrology

Dewatering operations will be managed as per section 7.4 and the GWMP (Appendix E).

Modelling of the proposed closure strategy suggests that water levels within the mine path will not be significantly impacted by the closure strategy with little to no impact predicted outside of the mine path. Further detail is presented in Appendix E and Appendix T.

Contamination

Contamination of soil and groundwater through hydrocarbon or chemical spills or through the on-site landfill will be managed through the appropriate implementation of the PEMP (Appendix F) and by carrying out the management actions in section 7.15 of this document.

Rehabilitation and restoration

There is some precedence for the concept that subterranean fauna habitat can be rehabilitated after the completion of mining (i.e. Mesa K). Owing to the unique geology that these subterranean fauna are located within (loose, unconsolidated gravels), it is possible that reinstating key habitat requirements through pit backfilling, rehabilitating waste dumps and revegetation may effectively reinstate subterranean fauna habitat over the medium to long term. As this theory has not yet been tested to any significant extent, and certainly not within this geology, Brockman proposes to investigate the potential for habitat restoration and rehabilitation in liaison with the DEC.

<u>Monitoring and measurement</u>

The design of an appropriate monitoring program will be discussed with the DEC and may incorporate the following:

- Investigation into effects of dewatering on the subterranean environment / habitat humidity surrounding the pit.
- Investigation into effects of revegetation and rehabilitation of waste dumps and backfilling of the pit with respect to replacing subterranean habitat.
- Additional regional sampling for species found within the impact zone.
- Contribution of pertinent data and collaboration with the DEC to ascertain the range of species found within the impact area.

7.3.5 Expected Outcome

The impact of the Project on stygofauna is predicted to be very low, due to the extent of the Weeli Wolli palaeochannel.

The direct impact to troglofauna as a result of the Project is predicted to be 8.2 %. Secondary impacts related to clearing may also affect troglofauna, and these will be managed through the implementation of the PEMP (Appendix F).

7.3.6 Management Commitments

C1. Brockman will develop a subterranean fauna monitoring program in liaison with the DEC.

C2. Brockman will investigate the potential for subterranean habitat restoration in liaison with the DEC.

C3. Brockman will contribute data collected on subterranean fauna to the DEC on a confidential basis for the purposes of research and cumulative impact management.

7.4 GROUNDWATER MANAGEMENT

Regional groundwater flow is in a general northerly direction, flowing from the Hamersley Ranges to the Fortescue Valley with a relatively low hydraulic gradient. Locally, the preferential groundwater flow path of the CID means that groundwater flows in a north-westerly direction in the vicinity of the palaeo-channel.

Significant rainfall events can potentially induce a groundwater level increase of several metres, and it is likely that sizeable background seasonal fluctuations occur in the region, and are likely to be accentuated in the vicinity of Weeli Wolli Creek, which sustains numerous channel flow events every year.

Water quality distributions are distinct in the alluvial and basement sequences. The basement has 20,000 mg/L TDS below the mine area, increasing to an estimated 150,000 mg/L TDS beneath the southern margin of the Fortescue Marsh. Above this, within the alluvial sequence, water is fresh <1,000 mg/L TDS near the base of the Hamersley Ranges, increasing to an estimated 7,000 mg/L TDS near the southern margin of the Fortescue Marsh.

7.4.1 Management Objectives

- To prevent or minimise detrimental impacts on the groundwater system resulting from mining operations.
- To ensure that the quality of water returned to local and regional groundwater resources will not result in significant deterioration of the beneficial use of those resources.
- To prevent or minimise mining related impacts on Weeli Wolli Creek and Fortescue Marsh.

7.4.2 Applicable Standards and Guidelines

Applicable standards and guidelines for the management of groundwater include:

- Mine Void Water Issues in WA (WRC, 2003).
- Environmental Notes on Mining Acid Mine Drainage (DoIR, 2006).
- Guidance No. 33 Environmental Guidance for Planning and Development (EPA, 2005).
- Australian Drinking Water Guidelines (NHMRC, 2004).
- DoH (Draft) Guidelines for the Use of Recycled Water in Western Australia.
- Australian New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC / ARMCANZ, 2000).
- Environmental Water Provisions for Western Australia; Statewide Policy No. 5 (WRC, 2000).

7.4.3 Potential Impacts

The main impact on the groundwater system from the Project will be a decline in groundwater levels in the area around the dewatering borefield, located in the orebody, and a minor reduction in groundwater throughflow to adjacent areas. The drawdown cone is not predicted to extend to the Fortescue Marsh, and changes in groundwater levels relating to the Project are not expected to effect the hydrological system at the Marsh. The extent of this cone of depression as predicted by groundwater modelling is illustrated in Figure 7-4.

It is anticipated that these impacts will be minimal for the following reasons:

- Groundwater modelling (as discussed in section 6.6 and demonstrated in figure 7-4) shows that watertable levels beneath the Fortescue Marsh will not be significantly affected (less than 1m predicted drawdown after 20 years dewatering for the worst-case scenario).
- Groundwater levels beneath the orebody at the base of the Hamersley Ranges are naturally deep, and generally do not support phreatophytic vegetation.
- The exception to this may be the potentially phreatophytic vegetation localised in the vicinity of the Weeli Wolli Creek channel. The drawdown effects in this area are expected to be mitigated by channel flow events numerous times per year that will recharge the creek channel groundwater level.

- Elsewhere over the project area, while there is reduction in overall potentiometric levels, no geological units will be dewatered.
- The only existing groundwater user in the area is the Marillana Station bores utilised for cattle watering points. Any potential shortfall would be supplemented from Brockman water supply.
- The area is characterised by low rates of groundwater recharge and throughflow. As such a reduction in outflow from the Marillana area to adjacent areas affects relatively small volumes of water.

Also, Managed Aquifer Recharge (MAR) will, for a few years, lead to elevated groundwater levels in the vicinity of the MAR operations. Modelling indicates that ongoing dewatering operations will quickly mitigate any impact associated with MAR.

It is considered likely that there will be minimal detrimental impact caused by MAR-related groundwater mounding for the following reasons:

- Groundwater levels are predicted to remain greater than 10m below ground level during re-injection operations;
- The groundwater mounding feature is predicted to be short-lived, being completely gone only two years after MAR operations cease;
- Groundwater mounding will be localised to a few square kilometres directly surrounding the MAR operations.

There is also potential for groundwater quality to deteriorate at the Project over time. However, it is anticipated that these impacts will be minimal for the following reasons:

- Groundwater quality abstracted during dewatering will generally remain in the range of fresh to brackish, and will be utilised in the beneficiation process.
- The beneficial use of this water resource will not be affected. The only groundwater users in the area relate to Marillana Station stock water points. Water quality in the brackish range is currently found in most bores to the north of the project area.

<u>Groundwater drawdown</u>

The predicted impact of water supply and dewatering development on the regional piezometric levels is presented for the end of year 20 mine life in Figure 7-4 and Figure 7-5. The drawdown is at a maximum of 40 m below pre mining levels in the western end of the orebody to facilitate dry mining conditions and reduces with distance from the main pit area. Predicted drawdowns in piezometric levels extends northwards across the Fortescue Valley and southwards from the mine area to beneath the Hamersley Ranges. Drawdown is elongated northwest-southeast in alignment with the general strike of the detrital orebody.

The predicted drawdown is extensive as a result of the following factors:

- The mining time frame of 20 years and the 15 km long strike length of the proposed mining/dewatering area;
- The thickness and assumed lateral continuity of the calcrete (a conservative modelling assumption); and
- The minimal groundwater throughflow in this system means that the majority of dewatering coming from storage in the target orebody aquifer, and the adjacent calcrete aquifers.

On this basis, the lateral extent of the dewatering zone of influence as represented by the model represents the "worst case" scenario, and is considered unlikely to eventuate. For example, if the calcretes are less extensive or less continuous in nature than simulated (NB. calcretes in the Pilbara are typically "patchy" in nature), the lateral extent of drawdown to the north will be significantly reduced.

It should also be noted that:

- Over most of the affected area, the dewatering drawdowns represent a drop in the potentiometric surface (hydrostatic heads in confined aquifers). Other than in the immediate vicinity of the mine, no hydrogeological units are dewatering.
- The rate of expansion of the drawdown zone of influence is very slow, particularly late in the mine life when the extent of drawdown approaches the Fortescue Marsh. The 1m drawdown contour is predicted to approach the southern boundary of the Marsh in the last five years of operation only. The predicted 5m drawdown contour remains some 5km south of the Marsh at the end of mining.
- While research (by joint industry-government) into the hydrogeological nature of the Marsh continues, it is generally accepted that the Marsh is a surface water driven system.

The predicted worst case reduction in potentiometric surface under the Marsh is negligible and even these predicted drawdowns are not expected to have any impact to the Fortescue Marsh over the life of the mine. . As a surface water driven system, drawdowns in the potentiometric surface of the calcretes (if any) are not expected to affect inundation frequency, ponding, or infiltration rates.

Groundwater quality

The potential impacts on groundwater quality from mining and dewatering activities are:

- Pollution from chemical and hydrocarbon materials and waste water streams from the operation.
- Increases in salinity caused by the concentration of salts by evaporation of water in mined-out pit voids.
- Increases in salinity caused by the lateral movement of groundwater from the Fortescue Valley. Salinity modelling indicates that some deterioration of water quality is likely during dewatering operations, although still within the limits of what can be utilised for beneficiation.
- Increases in salinity caused by the up-coning of saline groundwater from within the underlying basement. Due to further Tertiary aquifer below base of mining, and a weathered, clay-rich, basement interface, the effects of up-coning are likely to be mitigated, due to low vertical permeabilities.

A site-specific study (see Appendix J) has indicated that the local geology is non-acid forming (NAF) and therefore exposure of these sediments to air and/or water will not result in a reduction of water quality at the project or at the Fortescue Marsh.

Groundwater recovery at closure

Following cessation of dewatering, natural recharge and inflow processes will result in water levels recovering to pre-mining levels. All areas mined below the water table will be in-filled to at least two metres above original water table level. There will therefore be no long-term pit-lake or void in the water table. Consequently, there will be no significant long-term impacts on water quality or groundwater flow.

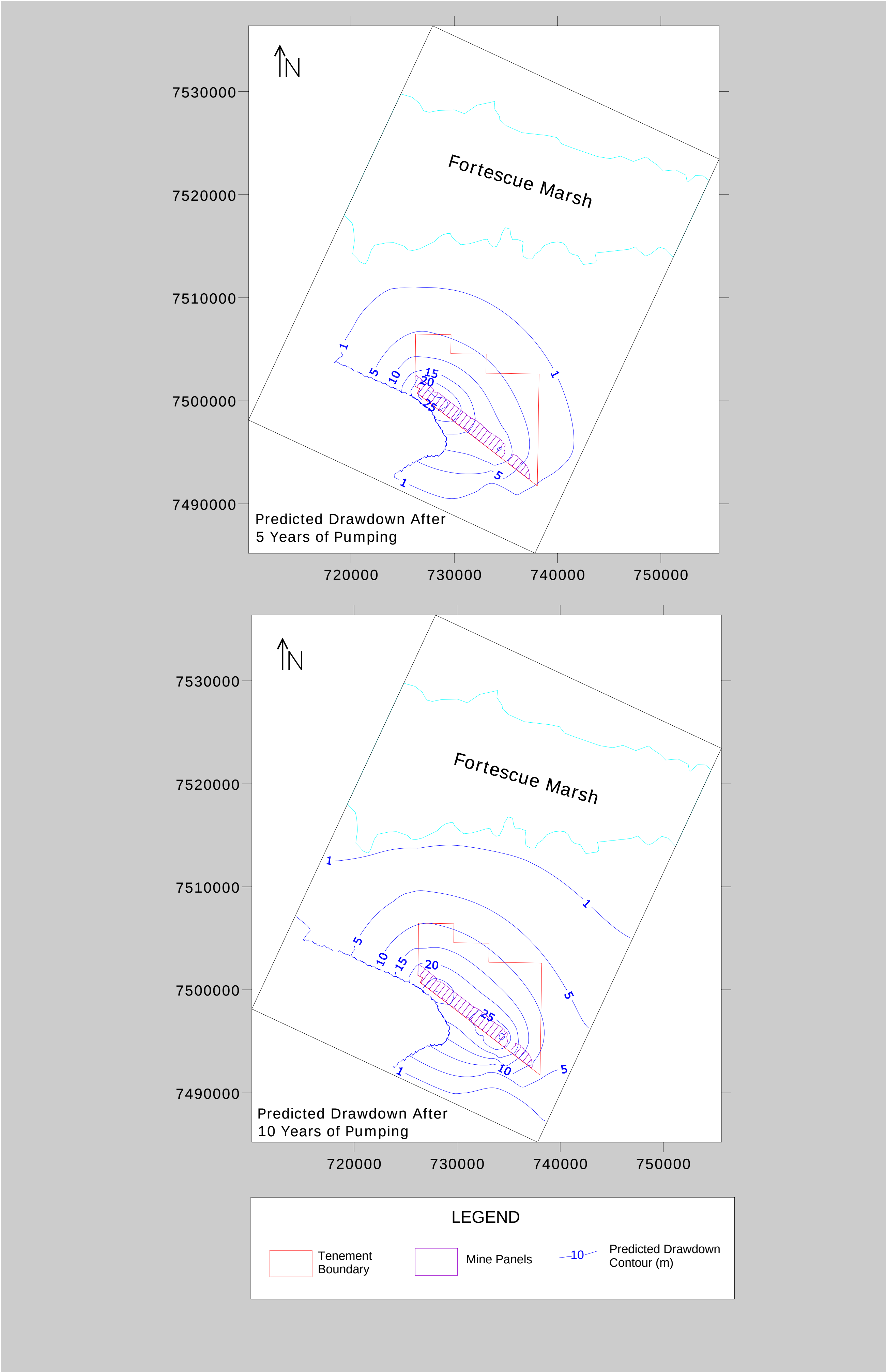
The modelling prediction results suggest that the depressed groundwater levels recover to 80% of their pre-mining levels in the first 50 years, and full recovery is predicted to take 120 years.

However, it is likely that the site will receive enhanced rainfall recharge to the mine path post-closure (due to the nature of the backfill strategy). Also, groundwater throughflow in this area is low, and recovery relies upon recharge events. Significant rainfall events will therefore shorten the groundwater recovery period for the project.

Cumulative impacts

Currently there are no other operations and no proposals undergoing formal assessment within the local vicinity of the proposed Project. For those operations that are being undertaken in neighbouring areas, it is impossible for a proponent to assess cumulative impacts on groundwater due to an inability for proponents to access the necessary data. Brockman have utilised both local and regional groundwater data where it is available to make an assessment of the likely impact of the Project which is presented above.

However, Brockman commits to make pertinent data available to government agencies for inclusion into a regional groundwater model to ensure that cumulative impacts are considered adequately.



PREDICTED DRAWDOWN AFTER 5 & 10 YEARS FIGURE 7.4a

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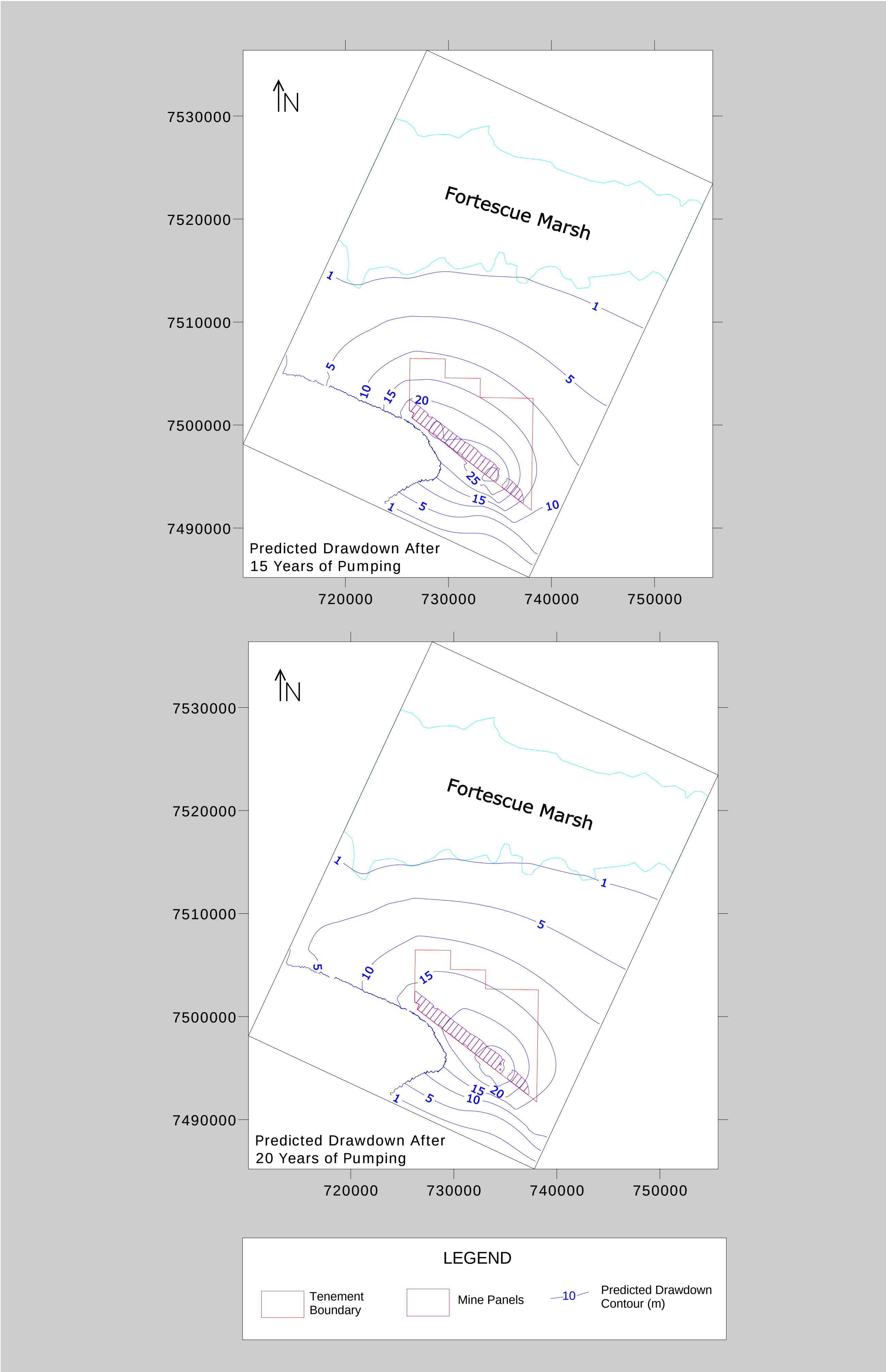

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PREDICTED DRAWDOWN AFTER 15 & 20 YEARS FIGURE 7.4b

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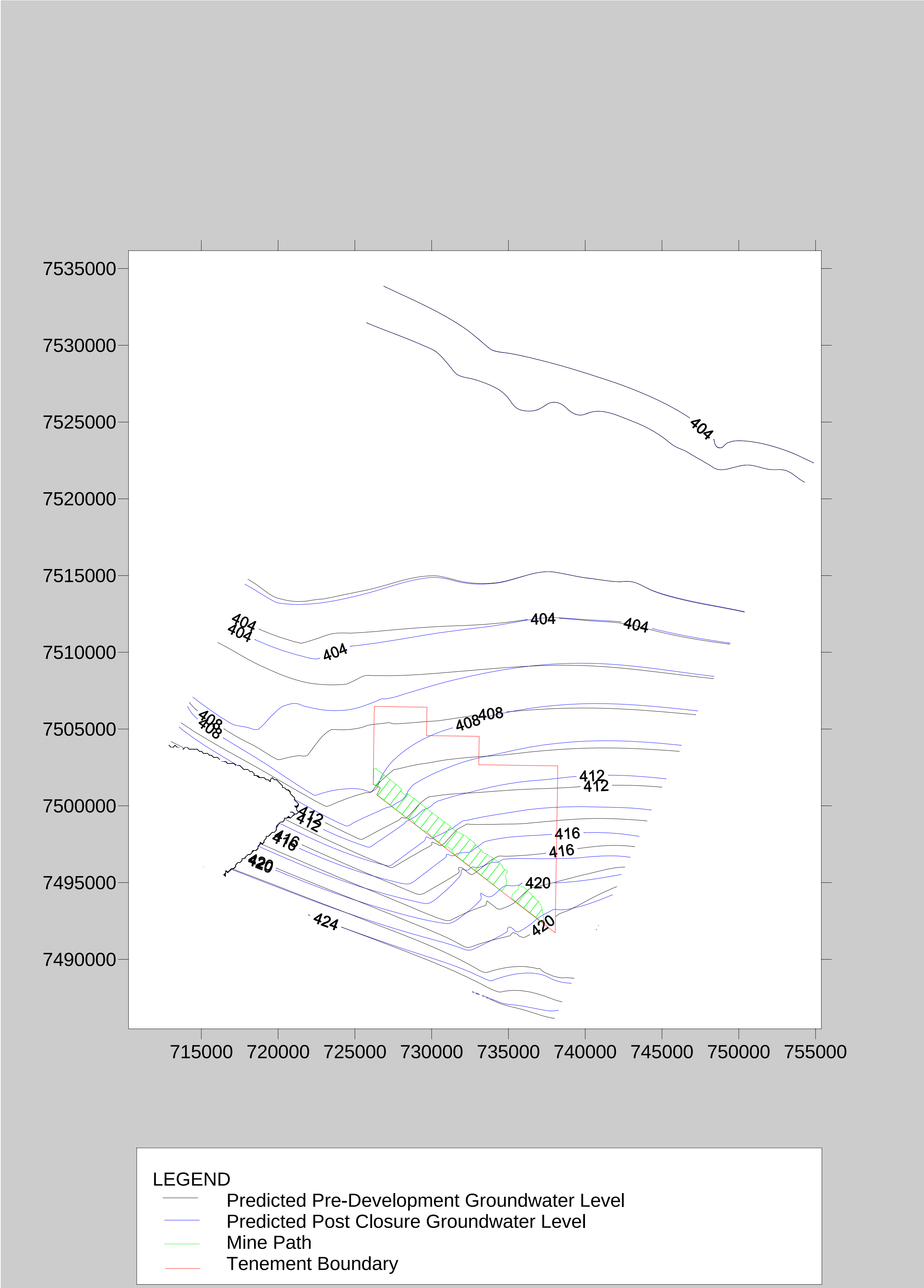

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PREDICTED PRE-DEVELOPMENT & POST-CLOSURE GROUNDWATER LEVELS

FIGURE 7-5

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7.4.4 Management

Brockman will implement the following management actions to reduce the potential for and severity of impacts to groundwater. These management actions include several layers of contingencies to ensure adequate monitoring of any impacts, improved forward predictions of future impacts, and development of appropriate impact management strategies.

Dewatering

As outlined in Section 7.4.3, a conservative approach was adopted in the prediction of the impacts of dewatering (using numerical groundwater modelling). Worst case predictions indicate that drawdown zone of influence will expand very slowly away from the immediate mine area with the 1m drawdown contour approaching the southern Marsh boundary in the last five years of operation only. It should be noted that the 5m drawdown contour is still approximately 5km south of the southern Marsh boundary at the end of mining. It should also be noted that, even if such drawdowns did eventuate, it is unlikely that these drawdowns would have any impact on the Fortescue Marsh.

Contingency planning to minimise the possible impacts of dewatering includes:

1. Minimising total groundwater abstraction.
2. Extensive monitoring of local and regional drawdowns and further investigation of key hydrogeological features.
3. Ongoing validation of prediction models and ongoing revised prediction.
4. Modification to pumping and MAR discharge as/when required.
5. Infilling of all pits to facilitate full and rapid recovery of post-mining groundwater levels.
6. Contribution to ongoing research programmes on the hydrogeological nature of the Fortescue Marsh.

These are outlined in more detail below.

1. Mine dewatering and water supply abstraction will be integrated to reduce, as much as possible and practicable, overall groundwater abstraction. For the majority of mine life (year 4 onwards), some of the dewatering bores will be operated to provide the project water supply requirements, rather than solely to achieving dewatering targets. In the event of short-term surplus water being generated due to storm or recharge events, this water would be utilised for water supply in preference to operating the dewatering bores that are more distant from active mining areas.

2. Comprehensive groundwater monitoring will include the following:

- Regional groundwater levels on a monthly basis.
- Pumping bore water levels and pumping volumes from abstraction bores on a monthly basis.
- Re-injection bore water levels and re-injection volumes on a monthly basis

Also, further work to install monitoring piezometers between the Project and the southern marsh boundary will allow for ongoing assessment of background seasonal fluctuations in groundwater levels and quality, monitoring of longer -term drawdowns and confirming the nature of the calcretes (continuous aquifer or discontinuous patchy aquifer system)..

The above expansion to the monitoring system will require drilling off-lease and will require approval from relevant land-holders and authorities.

3. Annual review and assessment of all monitoring data, including validation of the groundwater model against observed aquifer responses and recalibration and refined prediction as required. In this way, the reliability of predictions will improve with time.

4. In the unlikely event that drawdowns in response to dewatering (and water supply pumping) do reach the Fortescue Marsh and in the further unlikely event that it is found to be negatively impacting upon the marsh system, the operation of the dewatering and MAR systems would be modified to manage the extent of drawdown. This might include refocussing of dewatering pumping from bores to pit sumps and/or re-direction of some MAR discharge to the calcrete aquifer. It should be noted that any requirement for this would be towards the end of the mine life when there will be significantly more information available on aquifer response/performance which will allow for optimum design of any reconfigured dewatering/MAR system.

5. Once mining and groundwater abstraction in the project area ceases, water levels are expected to recover to pre-mining conditions and no significant permanent impact will occur. Mine closure strategies have been developed, including in-pit dumping of waste rock, along with coarse and fine rejects, to backfill pits to above the regional water table, to facilitate sustainable aquifer recovery.

6. In the interim, Brockman is continuing its involvement in government-led research initiatives such as the Fortescue Marsh Working Group, which seeks to improve the level of conceptual understanding of the dynamic processes involved within the Fortescue Marsh system,

Surplus Water Disposal

It is predicted that there will be surplus water generated (in achieving dewatering targets) in the initial stages of mining (yrs 1 to 3), above what is required for project water supply requirements.

It is proposed to dispose of this water back into the orebody aquifer system via a Managed Aquifer Recharge (MAR) scheme. A re-injection borefield of four bores will be installed at a location distant from dewatering operations and within the defined orebody. The location will be selected on the basis of the mine plan. Currently, Abalone East at the southeastern end of the orebody, is the identified site for the MAR operations. Aquifer re-injection has the added benefits that it will mitigate drawdown effects and make maximum use of water, that is, storing the early surplus volumes for later utilisation for water supply when there will be a net water deficit.

Details of the assessment of the MAR scheme are presented in Appendix E. This assessment shows that the aquifer system has more than sufficient capacity to accept the required volumes of discharge for the limited time required (first 3 years of mining), and could, if required, accept discharge for longer. However, it is recognised that, while the aquifer easily has the capacity to accept the required discharge, MAR schemes rely on the efficiency of the aquifer injection/recharge system and that these do require regular maintenance.

Contingency planning to cover both short term maintenance requirements and the possibility (unlikely though it is) that surplus water volumes are larger than predicted include the following elements:

1. Monitoring to validate prediction models and refine predictions of surplus discharge requirements,
2. Extra capacity built into the start-up injection borefield.
3. Use of pre-stripped areas of the mine path as infiltration ponds.
4. Use of open mine voids and/or infilled voids as temporary storage areas.

These are discussed in more detail below.

1. Data from the detailed monitoring, as outlined in the previous section, will be used to validate (and recalibrate if necessary) the groundwater model, which will then be used on an ongoing basis to confirm dewatering requirements and surplus discharge requirements. In this way, any additional dewatering surplus discharge requirements will be identified early which will allow for the timely planning of the implementation of contingency planning items 2, 3 and 4 (see below).

2. The start-up injection borefield will include four injection bores (NB these bores will be located in target locations for future dewatering bores and will eventually be used for dewatering beyond year 3). Only three bores (operating efficiently) are required to accommodate the predicted dewatering surplus and the fourth bore will be used rotationally to allow for regular borefield maintenance. If ongoing operational data (and ongoing groundwater modelling) indicate the need for additional injection bores, these will be installed, again at locations targeted for future dewatering bores.

3. Investigation work completed elsewhere in the region shows that infiltration capacity of disturbed shallow sediments overlying the orebody is such that the infiltration capacity of ongoing pre-stripped mine areas is more than sufficient to accommodate all of the dewatering surplus. Should there be any short-term deficit in the capacity of the injection borefield, surplus water would be discharged onto pre-stripped areas of the mine path.

4. In the event that the injection borefield or the pre-strip infiltration systems are unavailable (eg short term breakdown of overland pumping system from the active mining area to the disposal sites), then surplus dewatering production would be discharged to nearby open or infilled mine voids.

Please note that, for all contingency plans, in all options, no water will be discharged to the environment and that it is the intention of Brockman to conserve the early surplus volumes for later in the mine life, when supplementary water supply is predicted to be required.

Groundwater quality

The prevention of groundwater pollution and contamination will be achieved through appropriate waste management practices, see section 7.15.

Salinity modelling currently predicts that groundwater quality will be maintained in the range of fresh to brackish during dewatering operations, and thereby still suitable for the beneficiation process.

Comprehensive groundwater quality monitoring will include the following:

- Quarterly water quality sampling and analysis from pumping bores and a selection of piezometers (screened in alluvial and basement sequences). Samples to be analysed for major ions, salinity and pH as a minimum.

- Annual review and assessment of all monitoring data, including updating the groundwater model to confirm that predictions remain valid on the basis of operational data

Further work to constrain the thickness and extent of the Tertiary sequence below the base of mining will improve confidence in the conservatism of salinity modelling completed to date.

Contingency planning, to cover the unlikely event that dewatering discharge water quality deteriorates to a level that makes it unsuitable for beneficiation processing use (>7,000 mg/L TDS) or dewatering related drawdowns induce a change in water quality for other groundwater users include the following:

1. Blending with supplementary water source.
2. Aquifer re-injection of saline water to source.
3. Providing “fresh” water to other users if required.

These contingency plans are detailed below.

1. Should dewatering discharge become brackish (>7,000mg/L), the water would be blended or “shandied” with fresh water from supplementary sources to bring it in line with process water requirements.

2. In the extreme case that dewatering water quality is too poor for it to be shandied to less than 7,000 mg/L TDS, this would indicate that the basement aquifer (the source of saline water at depth below the orebody aquifer) is more permeable than currently understood. If this is the case, the aquifers would be suitable for aquifer re-injection and any excess saline water would be re-injected specifically back into these saline aquifers.

3. In the unlikely event that water quality deteriorates significantly in the areas surrounding the proposed mine, and the beneficial use of the water resources tapped by other users is affected, then supplementary water supplies would be made available to these existing users (station watering points) from the mine water supply system.

Mine closure strategies have been developed that allow for all pits to be backfilled to above the pre-mining regional water level to prevent long term salinisation of groundwater.

<u>Water recovery and seepage controls</u>

The design concept for the FRS incorporates water recovery systems comprising underdrainage and a decant system. The underdrainage is designed to recover water from the base of the deposited fine rejects and assist with seepage control and fine rejects consolidation. A trench drain to intercept seepage outside the waste dump toe is included in the design as an extra seepage control measure.

Surface water from the fine rejects slurry will be recovered from the impoundment area and pumped back to the process plant. Water liberated from the fines rejects can be collected in the mine dewatering system and returned to the process plant. For the above-ground FRS, water return will be achieved via pumps deployed within the decant structures. For the in-pit storage, filters prevent the loss of solids and water return will be achieved by pontoon mounted pumps located on each cell.

<u>Potable water</u>

Any potable bores will be appropriately equipped with suitable treatment/filtration equipment, and the minimal abstraction is likely to have negligible effect on the regional groundwater system.

7.4.5 Expected Outcome

Mine dewatering and water supply abstraction will be integrated to reduce, where practicable, groundwater abstraction. The proposed orebody borefield will assist dewatering and no excess groundwater production and disposal is anticipated beyond what has already been identified for initial MAR operations.

Following cessation of dewatering, natural recharge and inflow processes will results in water levels recovering to pre-mining levels. All areas mined below the water table will be in-filled to at least two metres above original water table level. There will therefore be no long-term pit-lake or void in the water table. Consequently, there will be no significant long-term impacts on water quality or groundwater flow.

7.4.6 Management Commitments

C4. Brockman will initiate a groundwater monitoring program and implement associated procedures (including contingencies) throughout the life of the Project as outlined within this PER document and the Marillana Project GWMP (Appendix E).

C5. Brockman will make site-specific groundwater data available to regulatory and decision-making agencies on a confidential basis for inclusion into a regional groundwater model and cumulative impact studies.

C6. Brockman will actively pursue an off-take agreement to provide water to the Project in preference to sourcing water from ground resources.

7.5 SURFACE AND FLOODWATER MANAGEMENT

The project area is located on a floodplain within the Fortescue Marsh catchment, approximately 15 km south of the nearest boundary of the marsh itself. Several large creek systems discharge to the Fortescue Marsh with a total catchment area of approximately 31,000 km^2. These systems include the Fortescue River, Weeli Wolli Creek, Marillana Creek, Caramulla Creek, Jigalong Creek, Kondy Creek and Kulkinbah Creek.

The Weeli Wolli Creek bisects the project area and flows in a north westerly direction out of the ranges and towards the Fortescue Marsh. It contributes approximately 15% of the total natural catchment area of the marsh. Surface water runoff to the marsh is of low salinity and turbidity, though the runoff turbidity typically increases significantly during peak periods of flooding (WRC, 2000).

7.5.1 Management Objectives

The objectives for management of surface waters are to:

- Maintain the quality and quantity of surface and groundwater so that existing and potential environmental values, including ecosystem maintenance, are protected.
- Maintain the integrity, ecological functions and environmental values of nearby wetlands.
- Ensure that the quality of water returned to local and regional surface waters does not result in the deterioration of these.

- Prevent or minimise project related impacts to Weeli Wolli Creek.

7.5.2 Applicable Standards and Guidelines

Applicable standards and guidelines for the management of surface water include:

- AS 3500: 1 - 2003 Plumbing and Drainage.
- Australian Drinking Water Guidelines (NHMRC, 2004).
- DoH (2007) Guidelines for the Use of Recycled Water in Western Australia.
- Australian New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC / ARMCANZ, 2000).
- Environmental Water Provisions for Western Australia; Statewide Policy No. 5 (WRC, 2000).
- Guidance No. 33 Environmental Guidance for Planning and Development (EPA, 2005).
- Mosquito Management (DoH Mosquito Management Manual).

7.5.3 Potential Impacts

The Project has the potential to impact surface water resources by changing surface water flow patterns within the project area and by affecting surface water quality as a result of erosion from disturbed areas or contamination from hydrocarbons.

However the planned development is likely to have only a very localised effect on surface water runoff through the redirection of flow and the development of bunded areas which may intercept minor drainage lines on site and collect some surface water.

Off-site impacts of changes to surface hydrology will be negligible as the reduction in effective contributing catchment to Weeli Wolli creek is predicted to be 0.04%

Altered surface hydrology

The interruption of surface water flow patterns has the potential to reduce and in some cases, increase the surface water runoff volumes (Aquaterra, 2009b).

The catchment boundaries and flowpaths around the project area are shown on Figure 6-4. The planned development area naturally drains to Weeli Wolli Creek upstream (south) from the Fortescue Marsh.

While there will be no diversion of Weeli Wolli Creek or its distributaries (with the exception of potential modification to road crossings at existing locations), resulting from this proposal, drainage paths from the Hamersley Ranges extend through the proposed mine area and will be diverted around the mine pit and infrastructure.

Due to the placement of the pit and infrastructure on the floodplain, there will be a reduction in the available area (and thus surface runoff) into Weeli Wolli Creek. These areas total approximately 22 km^2 or approximately 0.4% of the Weeli Wolli Creek catchment area.

Adopting a maximum 50% runoff loss from the pit and WRDs, the effective runoff volume loss from the Weeli Wolli Creek catchment is 10 km^2 (~50% of 22 km^2), which represents a maximum of 0.2% of the total catchment. Therefore, the effects of planned pit and WRD developments at Marillana are a potential decrease in runoff volume to the Weeli Wolli Creek catchment by up to 0.2%.

The reduction in runoff to the Fortescue Marsh is estimated at 0.04% (based upon the Weeli Wolli Creek catchment contributing 15% of the overall flows to the marsh). These changes are not significant to the overall hydrological system, particularly in comparison to the natural seasonal variations in catchment runoff.

Unnatural ponding (i.e. around bunding and on top of fines rejects facilities) can create conditions suitable for mosquitos to breed. This can become a significant nuisance and a health risk for on-site personnel and surrounding communities if not effectively managed.

Additionally, permanent standing water introduced into a system that under natural conditions had only temporary water may affect native fauna and flora, creating a temporary artificial wetland ecosystem. Further impacts associated with native fauna are discussed in section 7.9.3.

Impacts to vegetation communities as a result of alterations to surface water flow are discussed in section 7.8.3.

Increased erosion and sedimentation

Runoff from the waste rock dumps and other disturbance areas has the potential to significantly increase erosion and sediment loads in the natural drainage systems, if appropriate management measures are not implemented.

The concentration of flows from overland flow into diversion drains has the potential to increase peak flow rates and consequently increase the potential for erosion and sedimentation at locations with increased or decreased velocities.

Surface water contamination and eutrophication

Spillage of chemicals or hydrocarbons from storage and/or transfer areas is possible if the appropriate control measures and operating procedures are not implemented. Even small spillages may lead to a significant deterioration of water quality. In addition, nutrient loading from treated waste water may alter the quality of surface waters interacting with spray fields.

An assessment of the potential impacts of flooding on the waste water treatment facilities and associated nutrient loading has been undertaken (see Appendix C). The risk to Weeli Wolli Creek and the Fortescue Marsh from the waste water treatment plants is deemed to be low. Projected low floodwater velocities and the absence of surface water ponding associated with irrigation design are anticipated to ensure that only minor mobilisation of nutrients into the surface water occurs. The processing plant location area will be protected from flooding by bunding incorporating an appropriate freeboard during a 1 in 10 year event. Also, due to the drainage directions at the selected sites, little to none of this flood water would make its way directly to Weeli Wolli Creek.

In a 1 in 10 year ARI flood event, the village disposal area would be inundated by less than 1 m of water, which would drain away to the northeast as sheet flow; while a 1 in 100 year ARI flood event would be inundated with 1.5 m of water.

Cumulative impacts

Currently there are no other operations and no proposals undergoing formal assessment within the local vicinity of the proposed Project. For those operations that are being undertaken in neighbouring areas, it is impossible for a proponent to assess cumulative impacts on surface water due to an inability for proponents to access the necessary data. Brockman have utilised both local and regional surface water data where it is available to make an assessment of the likely impact of the Project which is presented above.

However, Brockman commits to make pertinent data available to government agencies for inclusion into a regional model to ensure that cumulative impacts are considered adequately.

7.5.4 Management

The general objectives with regards to the management of surface water, erosion and runoff include the maintenance of natural watercourses and sheet flow, and the quality of surface water to ensure that existing and potential uses including ecosystem maintenance are protected.

The SWMP (Appendix S) and PEMP (Appendix F) outlines strategies to minimise the impact on the natural drainage systems of the project area in detail and these are summarised below.

Roads and crossings

Pre-existing haul roads and access tracks will be used where possible to minimise interference to natural drainage.

Drainage of the minor streams and drainage lines that the access route crosses will be maintained with effective culverts and/or flood ways.

Infrastructure placement

The SWMP (Appendix S) and PEMP (Appendix F) outlines strategies to ensure that surface waters draining from site infrastructure is adequately managed in regards to water quality, flow velocities and distribution. For example, disturbance areas will be located where possible to avoid drainage lines and will be designed for minimal impact on surface drainage as far as practicable. Construction on or near natural flowpaths will be planned for the dry season and temporary stabilisation measures will be used in areas where there is a high risk of erosion.

Site infrastructure such as the accommodation village and the process plant have been situated on higher ground or will be constructed on an elevated earth pad to ensure they are above the 1 in 10 year flood level.

Buffer zones are planned between the areas of disturbance and the natural drainage lines to protect the drainage lines from impacts resulting from construction activities. For example the toe of the flood bunding around WRDs will be located a minimum of 50 m from the Weeli Wolli Creek bank to provide a 30 m non disturbance zone to protect existing riparian vegetation and a 20 m access corridor (Figure 7-6).

Bunding will be provided as appropriate around all stockpiles to contain internal surface water runoff for treatment, plus to divert external surface water runoff. Topsoil storage will be located away from drainage lines and upstream of sediment basins. Topsoil will be stored such that it is protected from rainfall and runoff using temporary vegetation or mulching, and protected from external runoff using diversion banks/drains.

Internal stormwater runoff in the development areas may cause localised flow velocities to increase around the mine infrastructure, as water is concentrated in diversion channels, or alongside flood bunds or raised pads. This flow will be handled by the internal stormwater provisions for the developed areas. Formalised drainage networks will be installed in plant site areas.

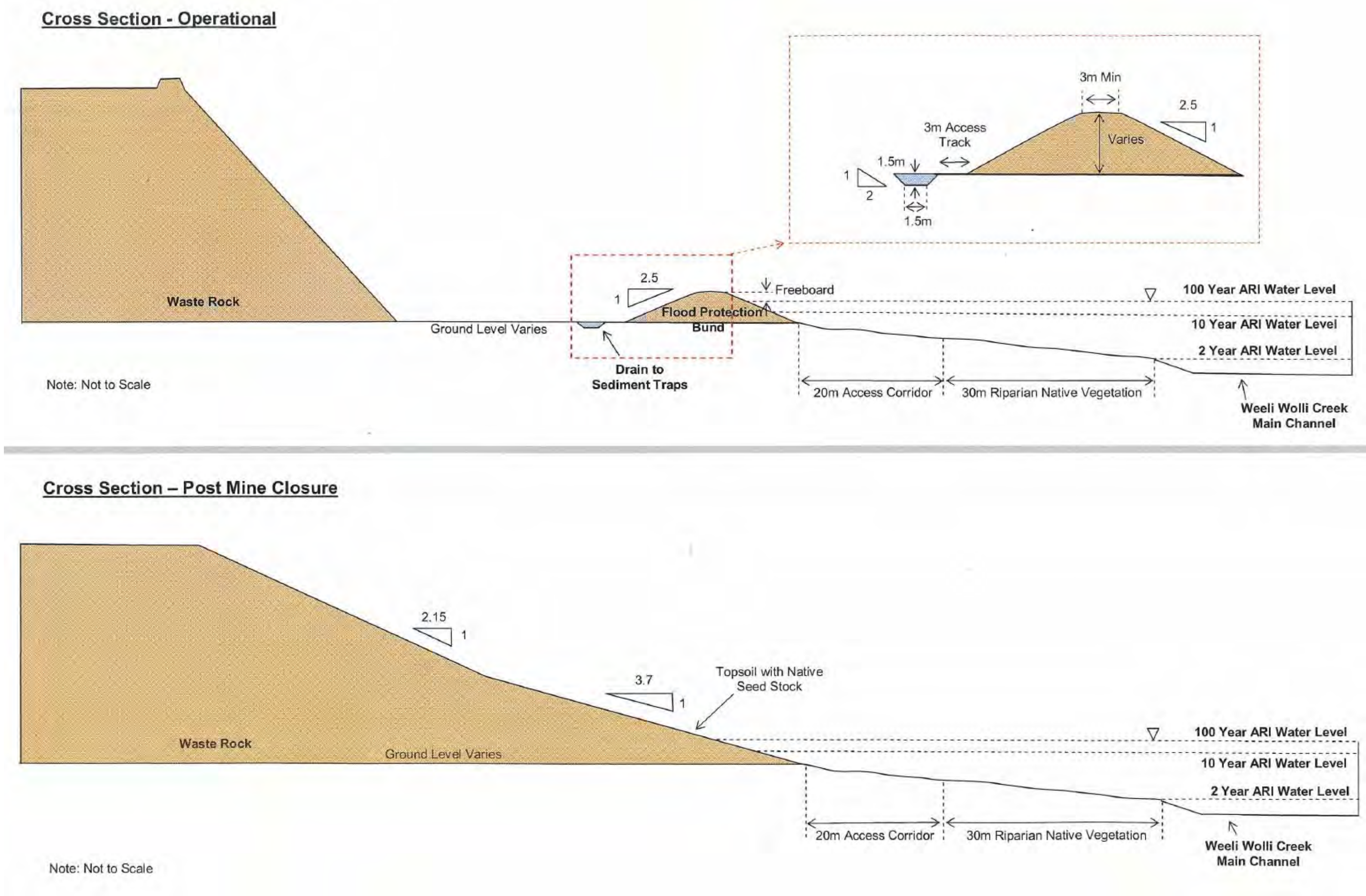


Figure 7-6 Cross Section of Waste Rock Disposal to Weeli Wolli Creek

Alteration to existing surface water drainage

The mine layout has been designed to ensure that any direct impact on the Weeli Wolli Creek is avoided and impacts to all watercourses are minimised. Diversions will be limited to the downstream reaches of the unnamed creeks draining the Hamersley Range. The operational life of diversion drains and bunds will vary from a few years to permanent structures. Overall, there will be no impact upon the net volume of water, or the frequency of flows, as a result of drainage path diversions.

Brockman plans to use a staged mining approach to maintain a continuous drainage outlet for the Hamersley Ranges sub-catchments towards Weeli Wolli Creek. Creek diversions will typically initially occur through areas either not scheduled for mining or with a late start date (see Figure 7-7).

As mining progresses, selected pits will be used for the storage of waste material and fine rejects. The creek(s) will then be permanently re-established over in-filled section(s) of the pit (see Figure 7-8). To permit the conveyance of surface water from the Hamersley Ranges catchments across the backfilled material a 1 m thick layer of fines rejects will be installed beneath the channel base. This material has an estimated permeability of $1x10^{-8}$ m/s which will ensure that the majority of water reaching the upstream boundary of the backfilled pit section will discharge downstream. The diversion drains will either connect with Weeli Wolli Creek, or discharge upstream of the main creek and reach Weeli Wolli via minor channels and overland flow. Four diversion drains will direct surface water flow through the post-closure mine site.

The drains and bunds will be designed based on an ARI event selected with consideration to the expected life and consequences of failure. Flows in excess of this will overtop the drain and flow within a confined “flood plain” zone. As this zone will be highly permeable and located well above the groundwater table, it is expected that the majority of this water will infiltrate, reducing the peak flood rate.

A combination of fines reject lined drain and high permeability flood plain will result in the conveyance of low flow events which may assist in supporting riparian vegetation whilst reducing potential flows and erosion during major flood events. Spreading mechanisms will also be utilised to encourage water to slow and disperse, particularly upstream of areas of mulga.

Where possible permanent standing waters will be avoided. However where this is not possible, the potential for mosquitos to inhabit standing waters (ie. rejects storage facility, sediment basins) will be managed using the Department of Health’s (DoH) *Mosquito Management Manual* and in liaison with the DoH and DEC.

Native fauna will be excluded from accessing standing waters through physical barriers or scare mechanisms.

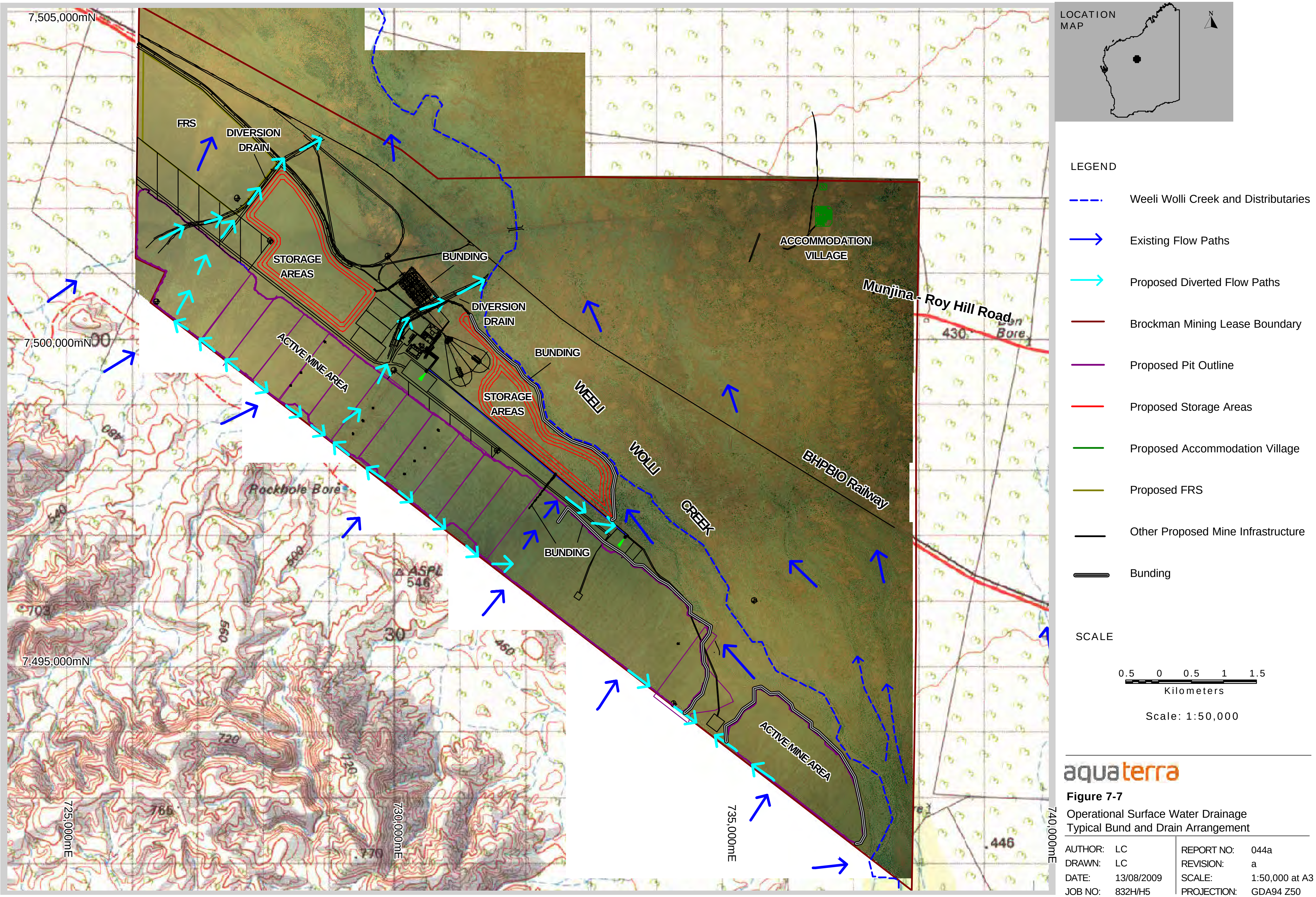
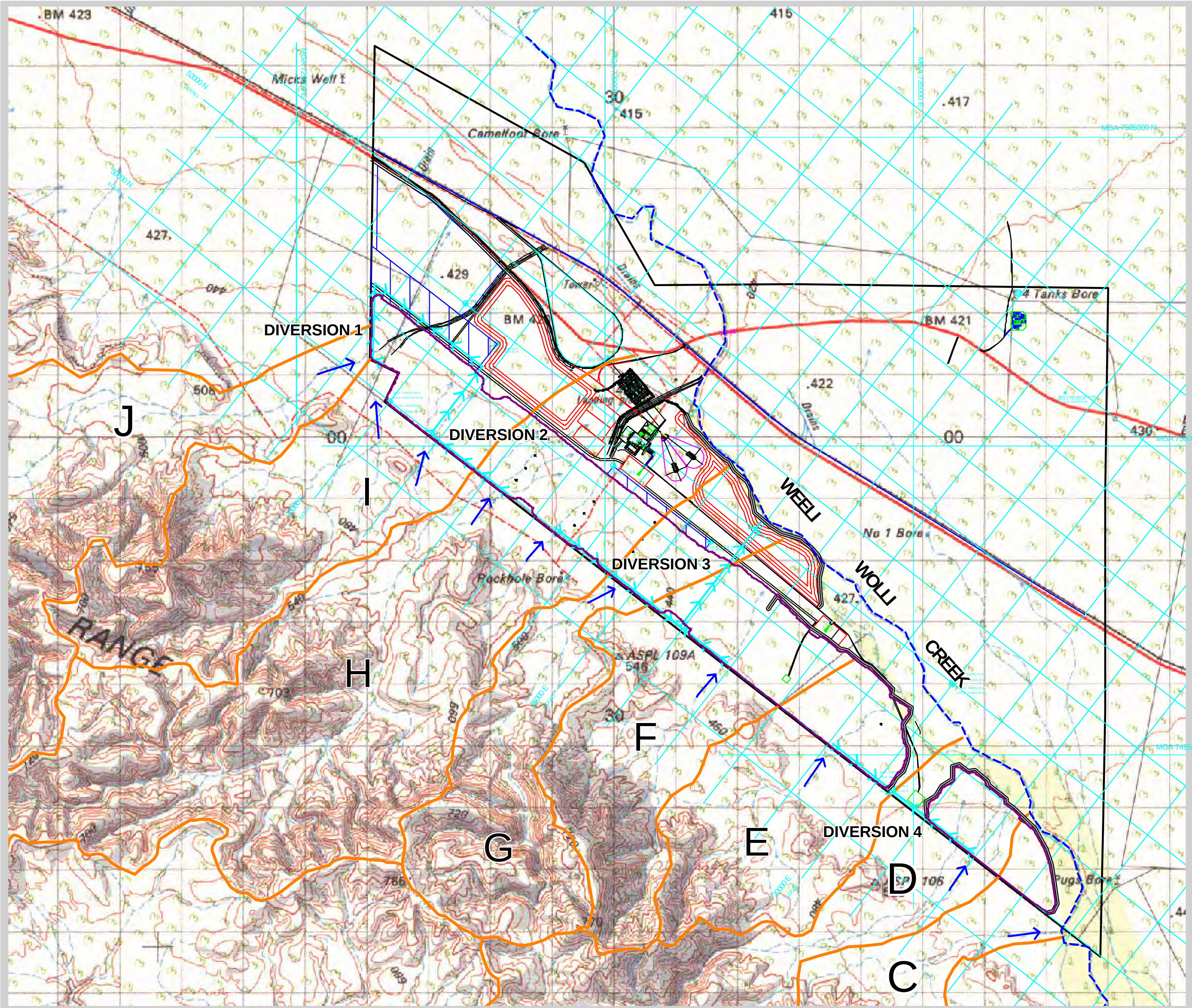


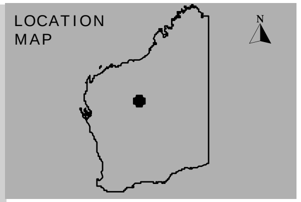
Figure 7-7

Operational Surface Water Drainage
Typical Bund and Drain Arrangement

AUTHOR:	LC	REPORT NO:	044a
DRAWN:	LC	REVISION:	a
DATE:	13/08/2009	SCALE:	1:50,000 at A3
JOB NO:	832H/H5	PROJECTION:	GDA94 Z50

Location: F:\Jobs\832H\SWMP\044a Figure 5.3





LEGEND

- Weeli Wolli Creek and Distributaries
- Mine Closure Diversion Channels
- Existing Flow Paths
- Hamersley Ranges Catchments
- Brockman Mining Lease Boundary
- Bunding

SCALE

1 0 1 2 3

Kilometers

Scale: 1:60,000

aquaterra

Figure 7-8

Proposed Mine Closure Surface Water Diversion Channels

AUTHOR:	LC	REPORT NO:	044a
DRAWN:	LC	REVISION:	a
DATE:	31/07/2009	SCALE:	1:60,000 (at A3)
JOB NO:	832H	PROJECTION:	MGA94 Z50

Location: F:\Jobs\832H\SWMP\044a Figure 7.1

Increased turbidity from soil erosion

Mining activities will potentially mobilise additional sediments to the natural drainage systems, with the main potential sediment sources being the plant, waste dumps and stockpiles. The management of sediment will therefore be a key focus for the Project. The most effective method of sediment management is to control the sediment at its source.

Sediment basins will be constructed down slope of all waste dumps, stockpiles and pits (as appropriate) to manage this issue. Local runoff will be collected and treated to remove sediments to acceptable levels prior to release to the natural environment. In areas where sediment basins are constructed within the Weeli Wolli Creek flood plain, measures will be included to ensure that flood events do not scour collected sediment. This may involve design features such as overflow pipes or discharge slots to limit the potential for flooding and scouring.

Bunds and drainage diversion works will be constructed around the perimeter of infrastructure areas, to divert and prevent natural runoff from outside the development sites from mixing with internal site runoff.

Erosion minimisation strategies such as vegetated batters, coarse sheeting and engineered drainage systems will also be used to control turbidity.

Surface water contamination and eutrophication

Due to the potential for surface water contamination to have a significant environmental impact, Brockman will implement the following management practices:

- Management of hydrocarbon, chemical and waste products on site will be in accordance with the Project EMP (5.12) and relevant regulations for transport, storage and use.
- The support infrastructure will be designed to ensure the safe storage and handling of all hazardous and waste materials to prevent contamination.
- Drainage areas and settling basins will be suitably designed to minimise contamination of surface water.
- Potentially contaminated water from work areas will be kept separate from clean storm water.
- Water interfacing with work areas will be directed to oil-water separators.

Surface waters have the potential to be affected by increased nutrient loads stemming from the waste water treatment plants. Management of this aspect of the Project is discussed in section 7.15 in detail. In general treated effluent irrigation rates will be managed to ensure that evaporation exceeds irrigation rates so that water is not allowed to pond or runoff. It is expected that much of the nutrient will be taken up by vegetation and thus will not be affected by flooding.

Monitoring and measurement

The proposed surface water monitoring programme includes collecting water samples via rising stage samplers at six stations located on Hamersley Range catchments and Weeli Wolli Creek, and monitoring stormwater discharge points from hydrocarbon storage areas.

The proposed locations for the rising stage samplers are:

- Weeli Wolli Creek adjacent to the upstream lease boundary;

- Weeli Wolli Creek downstream of the mine operations and south of the BHPB railway;
- Undisturbed Hamersley Range catchment at southern lease boundary;
- Undisturbed Hamersley Range catchment near Weeli Wolli Creek confluence;
- Diverted Hamersley Range catchment at southern lease boundary; and
- Diverted Hamersley Range catchment near Weeli Wolli Creek confluence.

Stormwater collected from the hydrocarbon storage areas will be assessed using a grab sample prior to release.

A summary of the proposed surface water monitoring programme is provided in Table 7-6.

Table 7-6 Surface Water Monitoring Programme

LOCATION TO BE MONITORED	PARAMETER	LOCATION	AIM	MONITORING PROGRAMME/ REQUIREMENTS	FREQUENCY
Weeli Wolli Creek	Water Quality	Adjacent to the upstream (east) lease boundary; Downstream (northwest) of the mine operations	Monitor changes in water quality across the mine lease	Water Quality Suite: pH, EC, TDS, Turbidity, Total Suspended Solids (TSS), HCO3, CO3, Cl, SO4, Na, K, Ca, Mg, Fe, Mn, Zn, Cu, Al, Cd, Pb, As, Hg, Se, Ba, Cr, Ni, Mo and Alkalinity (CaCO3).	Flow Event Basis
Diverted Hamersley Range catchment	Sediment Load	Adjacent to the upstream (south) lease boundary; Downstream prior to Weeli Wolli Creek confluence	Monitor changes in turbidity and suspended solids across the lease area	Turbidity, Total Suspended Solids	Flow Event Basis
Undisturbed Hamersley Range catchment	Sediment Load	Adjacent to the upstream (south) lease boundary; Downstream prior to Weeli Wolli Creek confluence	Provide baseline data as to changes in turbidity and suspended solids across the lease area	Turbidity, Total Suspended Solids	Flow Event Basis
Hydrocarbon Storage Area	Total Petroleum Hydrocarbon (TPD)	Hydrocarbon Storage Areas	Monitor levels of hydrocarbon discharge	If discharge of stormwater is required, conduct monitoring to	Event Basis (If Required)

LOCATION TO BE MONITORED	PARAMETER	LOCATION	AIM	MONITORING PROGRAMME/ REQUIREMENTS	FREQUENCY
	Concentration			ensure a hydrocarbon concentration of less than 5mg/L.	

Contingency

Adverse impacts identified from event monitoring will trigger the implementation of a management response. Table 7-7 provides a summary of the identified triggers and associated management response.

Table 7-7 Management Response to Monitoring Results

LOCATION	TARGET	TRIGGERS	MANAGEMENT RESPONSE
Weeli Wolli Creek	No change in water quality of the creek beyond +/- 10% of natural seasonal background range	Water quality in creek is above the +/-10% variation from background range	Investigate cause of water quality change and appropriate remedial action
Diverted Hamersley Range Catchment	Minimise increases in turbidity and total suspended solids in mine site drainage water	Turbidity and total suspended solids is greater than 50% above background levels	Improve stormwater drainage to decrease sediment loads and/or turbidity
Hydrocarbon Storage Area	No release of water with hydrocarbon concentration greater than 5mg/L.	Collected stormwater with hydrocarbon concentration greater than 5mg/L needing to be released	Further treat water prior to release. Investigate options to reduce potential for hydrocarbon contamination.

7.5.5 Expected Outcome

There will be some temporary and permanent modifications made to the surface water drainage the form of diversions around the pit and infrastructure. However these diversions will be redirected into established drainage lines. The potential decrease in contributing catchment equates to 0.2% of the Weeli Wolli Creek catchment and 0.04% of the Fortescue Marsh catchment. This reduction is considered to have a negligible impact, particularly when considering the strong variability of rainfall events in this region.

As mining is completed in stages, drainage lines will be re-established across the backfilled pit. In both the short and long term no impacts on the drainage system entering the marsh is anticipated.

7.5.6 Management Commitments

C7. Brockman will implement the Surface Water Management Plan and associated procedures including contingencies throughout the life of the Project.

7.6 GEOLOGY AND LANDFORM

The protection of natural landforms and landscapes is important as they influence human wellbeing and visual amenity, and reflect environmental health and essential ecosystem services (EPA, 2008).

This proposal will not involve mining in or on the Hamersley Range. The project area incorporates the northern foot slopes of the Hamersley Ranges and the flat plains extending away from the base of the ranges.

The current mine schedule estimates that 36% of the fine rejects, 26% of the coarse rejects, and 20% of the mine waste will need to be stored ex-pit. The remainder will be backfilled into the mine void to reduce the potential for long-term impacts to surface and groundwater, reduce the project footprint, the visual amenity of the area and to produce a final landform similar to its surroundings.

Landforms will be planned and constructed in accordance with 7.10 Social and Visual Amenity and contoured and rehabilitated in accordance with 7.7 Mine Decommissioning and Rehabilitation.

7.6.1 Management Objectives

The key objectives for the management of geology and landforms are to:

- Maintain the integrity, ecological functions and environmental values of landforms and geology.
- Minimise permanent landform alterations and establish stable, sustainable landforms that will not compromise post-disturbance land uses.
- Ensure that rehabilitation achieves an acceptable standard compatible with the intended post – disturbance land use, and is consistent with appropriate completion criteria.
- Meet the post-construction expectations of the various stakeholders involved.

7.6.2 Applicable Standards and Guidelines

Applicable standards and guidelines for the management of geology and landforms include:

- Environmental Notes on Mining Waste Rock Dumps (DoIR, 2001).
- Environmental Notes on Mining Acid Mine Drainage (DoIR, 2006).
- Guidelines for Mining in Arid Environments (DoIR, 2006).
- Safe Design and Operating Standards for Tailings Storage (DoIR, 1999).
- Mine Void Water Issues in WA (WRC, 2003).
- Guidance No. 33 Environmental Guidance for Planning and Development (EPA, 2005).
- Landform Design for Rehabilitation (Environment Australia, 1998).

7.6.3 Potential Impacts

The potential impacts of the Project on the geology and landform resources are associated with the following:

- permanent landform modification as a result of the mine pit;

- permanent new landforms as a result of mine infrastructure;
- alterations to surface hydrology as a result of altered landforms; and
- short to medium term changes to the landscape as a result of construction of infrastructure.

Changing the existing landform with the excavation of the pit void and construction of the mine waste dumps will be the most significant visual impact on landforms of the mining operation.

Landform modification

The project area lies on the Fortescue valley floor to the northeast of the Hamersley Range. The area is flat lying and consists of mainly transported colluvium and alluvium deposits, with minor outcrops of canga and Archaean Wittenoom Dolomite. The combined thickness of the transported cover is up to 80 m, and it hosts the targeted detrital deposits (Coffey, 2009).

The primary impacts to landforms and geology will encompass the addition to the landscape of permanent site infrastructure such as the rehabilitated FRS and waste dumps, and the backfilled pit.

Chemical alteration

All samples from drilling are routinely assayed for a ten element suite (Fe, SiO_2, Al_2O_3, P, S, MnO, K_2O, CaO, MgO and TiO_2) plus loss on ignition (LOI). The results of this comprehensive sampling have demonstrated that there is limited variability in whole rock chemistry across the deposit, with the main variation being in the major elements Fe, SiO_2 and Al_2O_3. Routine analysis of all samples (ore and waste) for sulphur has provided a substantial database of over 36,000 samples for sulphur contents, the single main cause of acid generation. Analysis of these results has shown that the 99th percentile sulphur contents are only 0.05% S across all domains in the deposit, clearly demonstrating that the material is non-acid forming (NAF), (see Appendix J).

Visual amenity

One of the most significant impacts of the storage/disposal of waste rock and fines is likely to be the effects to visual amenity and the loss of original land use (discussed in detail in 7.10). Long-term visual amenity will be impacted to some degree as a result of the waste rock and fines stockpiles becoming a permanent feature of the landscape.

7.6.4 Management

Brockman will implement the following management actions to reduce the potential for and severity of impacts to natural landforms.

Waste Rock Dumps

Brockman have endeavoured to reduce the long term impacts on the geoscape by opting to backfill much of the mine waste and fines rejects into the mined out pit void. Eighty percent of mine waste will be stored in-pit, reducing the clearing footprint required for mine waste disposal and minimising effects on surface water and visual amenity. Due to the restricted space available south of the Weeli Wolli Creek and the desire to minimise the footprint of these structures, they have been designed to be up to 24 m in height.

The final design of the waste rock landforms of the Project are based on waste rock landforms previously constructed at other mine sites in Western Australia. Specifically, waste rock dumps will be designed, constructed and operated to:

- retain water, minimise runoff, and enhance the establishment of self-sustaining native vegetation;
- incorporate a rounded footprint to conform to surrounding natural landforms;
- consider the physical nature of material and landform stability, chemical nature of waste materials, associated pollution prevention, integration into surrounding landscape and revegetation issues;
- incorporate windrows along the crest of slopes to prevent erosion of the slopes. Toe windrows will be used to contain eroded material if needed;
- reduce the potential for erosion and are protected from floodwaters by protective bunding and diversion drains (see section 7.5 for further details).

Waste rock stockpiles will be constructed in accordance with the *Environmental Notes on Mining Waste Rock Dumps* (DMP, 2001) and *Landform Design for Rehabilitation* (EA, 1998). These documents specify minimum technical criteria that should be met in mining landform construction and take into account the potential for erosion and progressive revegetation and rehabilitation of waste rock stockpiles.

<u>Fines Rejects Storage</u>

Fines rejects will be managed to prevent soil or water contamination, and the FRS facility constructed for long term stability in compliance with the *Guidelines on the Safe Design and Operating Standards for Tailings Storage* (DMP, 1999) and *The Strategic Framework for Tailings Management* (DMP, 2003).

The perimeter embankment of the FRS will comprise a starter embankment constructed using compacted clayey mine waste which will be formed against the adjacent mine waste rock dump. The clayey mine waste materials will be sourced from the pit. The embankment earthworks were calculated based on a geometry of a 20 m wide crest and 3 (horizontal):1 (vertical) downstream batters and 2.5:1 upstream batters. This geometry was selected to allow for waste dump construction with large mine earthmoving equipment and to minimise the footprint of the facility (see Figure 5-7). The final landform will be 24 m high and occupy and approximate area of 285 ha.

The majority of the fines rejects (64%) will be placed in-pit which will reduce the impact footprint required for ex-pit storage and minimise visual amenity issues (Appendix L).

The design concept for the IFRS facilities involves scheduling placement of mine waste to create a series of nine rectangular cells, shaped like inverted pyramids, for rejects storage within the mined open pit, with the storages protruding above ground level (Figure 5-8).

Process waste, rejects, and mine waste will be combined and located into one facility, with separate rejects cells crested by specific placement of mine waste to allow for the encapsulation of rejects. The objective of the IFRS is to create cells for rejects deposition which can be safely operated whilst mining is being undertaken in other parts of the pit. The conceptual design the cells have internal side slopes of 1:2 (vertical to horizontal). The conceptual design of the above ground section of each facility has a 40 m wide crest, 5 m above the final surface of the rejects.

The installation of standpipe piezometers will be used to measure water levels in the embankments and the area adjacent to the FRS. The results of this monitoring will be utilised for embankment stability assessments. Water levels within the piezometers will be measured periodically and results compared to previous measurements to assess changes in the phreatic surface. Water sampling and laboratory testing of water samples from monitoring bores around the FRS will be undertaken to characterise potential seepage and impacts to groundwater. Collected information shall be reviewed regularly and reported in an annual facility audit.

Mine Pit

The pit itself will be between 40 and 80 m below natural surface and will intersect the groundwater table which sits 30 to 40 m below natural surface. The mined-out blocks will be progressively back-filled with waste or fine rejects material, or a combination of both at least 2 m above the water table, with some areas having fill 20 m above the water table. The total area of the pit is 1,648 ha however continuous back-filling of the pit will enable the amount of void open at any one time to be significantly reduced. The final pit landform will comprise nine cells that have been backfilled to varying heights above and below the pre-existing surface (see Figure 5-8). Benching and grading will produce landforms that mimic surrounding natural landforms (i.e. the foothills of the Ranges). The final landform will be contoured to reinstate natural surface water drainage lines or to re-direct surface water around final depressions.

7.6.5 Expected Outcome

The mine site will modify existing landforms and result in permanent new landforms. These landforms will be rehabilitated to establish stable, sustainable landforms that will not compromise post-disturbance land uses.

It is expected that through careful construction and management of the Project, the objectives for the overall management of landforms and geology can be achieved.

7.6.6 Management Commitments

C8. Brockman will ensure that modified and/or created landforms are left in a stable and safe condition post mine closure and reflect natural landforms in the surrounding area.

7.7 MINE DECOMMISSIONING AND REHABILITATION

The development of a mining operation and its associated infrastructure involves the permanent alteration of existing landforms, disturbance to vegetation and fauna habitats, hydrological impacts and some level of contamination (DTIR, 2006).

While appropriate management of these issues during operation will minimise many of these impacts, residual impacts are inevitable and it is important that the closure and decommissioning of the mine site considers these with regard to the following priorities: public safety, sources of ongoing contamination, future land use, ecological compatibility, community expectations and aesthetics (DTIR, 2006).

7.7.1 Management Objectives

The objectives for decommissioning and rehabilitation are to:

- Ensure that rehabilitation achieves a long term safe, stable and functioning landform which is consistent with the surrounding landscape and other environmental values.

- Fulfil commitments made to stakeholders and regulators regarding closure outcomes.

7.7.2 Applicable Standards and Guidelines

Applicable standards and guidelines for decommissioning and rehabilitation include:

- AMEC - AMEC Mine closure Guidelines (AMEC, 2000).
- Strategic Framework for Mine Closure (ANZMECC, 2000).
- Mine Closure Guideline for Minerals Operations in WA. (DoIR, 2000).
- Mine Void Water Issues in WA (WRC, 2003).
- Guidance Statement No 6: Rehabilitation of Terrestrial Ecosystems (EPA, 2006).
- Mine Closure and Completion (DITR, 2006).
- Mine Rehabilitation (DITR, 2006)
- Planning for Integrated Mine Closure: Toolkit (ICMM).

7.7.3 Potential Impacts

Poorly closed and derelict mine sites provide a legacy for the local community (DITR, 2006). If appropriate mine closure and completion are not undertaken, a site may continue to be hazardous and a source of environmental pollution for many years (DITR, 2006) and cannot be utilised for other purposes. By failing to return a mine site to something resembling its pre-mining condition by rehabilitating native vegetation, surface waters and removing hazardous wastes, a site may also harbour weeds and feral animals and promote their spread to neighbouring properties.

Aspects of the Project that will require decommissioning and rehabilitation include:

- plant and processing infrastructure;
- offices, workshops and the accommodation village;
- water supply and sewage infrastructure;
- power supply infrastructure;
- fuel and bulk storage facilities;
- landfill and contaminated sites;
- borrow pits, roads and tracks;
- surface water diversions;
- waste dumps and other man-made landforms; and
- the mine pits.

<u>Impacts to surface and groundwater as a result of mine closure are discussed in sections 7.5.3 and 7.4.3 respectively.</u>

7.7.4 Management

A mine backfill plan (Appendix L) has been developed to guide the progressive backfilling and rehabilitation of the mine pit to reduce the depth of the void and minimise surface interactions with groundwater.

Planning for mine closure commenced as part of exploration activity and PFS. Baseline data is being collected in accordance with ANZMEC /MCA (2000) standards to identify potential risks to successful mine closure.

Brockman has prepared a Conceptual Closure Plan (Appendix T) based on ANZMEC/MCA (2000) and DITR (2006) for submission to regulatory bodies as an appendix to the PER. Closure considerations include assessment and remediation of contaminated sites, ongoing placement of waste materials to improve the form of existing waste dump areas, and the rehabilitation of all project disturbed areas.

The land will be returned to pastoral use after mining activities have ceased. Every effort will be made by Brockman to ensure that the impact areas are rehabilitated and returned, as near as possible to pre mining conditions.

<u>Decommissioning</u>

During the decommissioning phase of the project all infrastructure that cannot be used by another party will be removed or buried and the disturbed areas rehabilitated. Decommissioning will comprise the safe dismantling and removal of infrastructure, the appropriate disposal of waste materials and the return of impacted areas to a variety of vegetation types and fauna habitats that simulate the pre-disturbance state as closely as possible or other agreed post-mining land use.

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. For further information on particular aspects of decommissioning refer to the Conceptual Closure Plan (Appendix T).

<u>Rehabilitation</u>

Rehabilitation will occur progressively as disturbed areas are no longer required for mining activities. Rehabilitation activities will include:

- Developing designs for appropriate landforms for the mine site.
- Creating landforms that will behave and evolve in a predictable manner, according to the design principles established.
- Establishing appropriate sustainable ecosystems.

A detailed rehabilitation programme will be developed within the first two years of mining activities which will include development of completion criteria to determine when rehabilitation can be considered self-sustaining. Soil characterisation assessments will also be conducted to ascertain the suitability of the topsoil for rehabilitation purposes.

Topsoil will be stripped and placed directly onto areas requiring rehabilitation to a depth of 100 mm where possible. Where this is not possible it will be stockpiled separately and away from water courses. Erosion control techniques will be employed to guard against loss of topsoil.

Prior to revegetation, ripping on contours will take place to relieve compaction, reduce erosion and improve water infiltration. In areas where the soil or waste material is of very high permeability scarifying on contours will be undertaken. On steep slopes this may require terracing or benching. All ripping, terracing or benching will be surveyed to ensure that they occur on contours.

Local provenance seed stock will be gathered pre-clearance, to provide an effective provenance seed-set for use during rehabilitation practices.

Following rehabilitation, the area will be monitored for weed invasion and native seedling success.

Activities with respect to the closure and rehabilitation of waste and fines storage will in general include:

- providing erosion protection to prevent sedimentation of the Weeli Wolli Creek;
- providing a safe and stabilised surface; and
- designing for minimal post-closure maintenance.

Landforms (two waste rock dumps and the FRS) will be constructed to reduce the requirement for double handling and will be reshaped prior to rehabilitation in order to produce appropriate slopes and a shape that is compatible with the surrounding landscape.

Topsoil removed from the FRS area during the construction of the facilities will be redeployed on the final surfaces of the FRS to assist with rehabilitation. The downstream slopes of the final embankments will be covered with topsoil, contour ripped, seeded with native species and fertilised as appropriate.

Once fine rejects deposition has been completed and little further settlement is expected, the top surface of the storages will be capped with a layer of mine waste rock (0.5 m nominal thickness) in order to minimise dust generation from the dried fine rejects surface and provide support for topsoil / growth medium for re-vegetation of the top surface.

The upper surface of the FRS will assume the form of a truncated prism with a depressed cone. On decommissioning, the FRS will remain a permanent feature of the landscape but be completely enclosed in a mine waste rock dump forming the integrated waste landform.

The main objectives of the IFRS cover will be to:

- provide a robust long-term cover that will stabilise the surface of the IFRS;
- retain/store all rainfall from most precipitation events within the cover system for subsequent release by a combination of evaporation and evapotranspiration; and
- control the flow of any excess surface water across the IFRS such that significant erosion does not occur.

At final closure, the decant structures will be sealed by:

- backfilling of the slotted concrete pipe annulus with dried fine rejects;
- removal of the slotted concrete pipes and filter rock to the level of the surrounding fine rejects, and
- capping of the central area of the FRS using clayey mine waste.

A spillway will be required for decommissioning the above ground storages to control the release of excess water resulting from large rainfall events on the facility surface. The design of the spillway will be prepared during the rehabilitation planning stage.

The IFRS will be rehabilitated to store rainfall from most precipitation events within the cover systems for subsequent release by a combination of evaporation and evapotranspiration. Surface water controls will remain in place post closure to ensure significant erosion of fines materials does not occur. The finished surface will be covered with mine waste and will take the form of the natural landscape.

Fines reject storage and waste dump rehabilitation requirements are further outlined in the Conceptual Closure Plan (Appendix T).

Surface water re-instatement

Post-closure, a series of diversion drains will be constructed to redirect water around or through the mine site. Once downstream of the minesite, flow will be diverted back to the original drainage course wherever possible. These post-closure diversion drains will include sections re-established over the backfilled pits. As the backfilled pits may have high permeabilities, to enable the drains to convey water across the pit, the drains will be lined with fines reject materials under the base of the channels. The channels will be combined with a flood plain zone. Consequently, minor events will be conveyed to Weeli Wolli Creek ensuring environmental flows are maintained while major flow events will be attenuated.

Groundwater re-instatement

Results from the groundwater modelling undertaken by Aquaterra suggest that long term changes in groundwater level are less than 3 m on a local scale and unaffected regionally. At the most upstream end of the mine path, predicted water levels are higher than the natural case, as groundwater flow is reduced consistent with the placement of tailings and waste rock of lower hydraulic conductivity than the existing orebody aquifer. At the downstream end of the mine path, due to the restriction in groundwater flow, predicted water levels are up to 3 m lower. Further downstream, between the mine path and Fortescue Marsh, predicted water levels are not significantly impacted by the proposed in pit waste rock and tailings scheme. Groundwater modelling indicates that groundwater will recover to 80% of pre-mining levels within 50 years, although it will take up to 120 years for the groundwater system to return to pre-mining levels. However, actual recovery times will also be influenced by the periodicity of inundation events, with higher than average rainfall accelerating the recovery.

Submission of mine closure documents

Mine closure plan documents will be continually updated thought the life of the mine as new technology and methodologies become available. The status of Project closure will be discussed with relevant agencies at least three years prior to the scheduled closure, and a finalised closure plan will be submitted to the DMP at least two years prior to final mine closure.

7.7.5 Expected Outcome

Rehabilitation of portions of the FRS, waste dumps and other impacted areas will commence as early as possible. Mine site infrastructure will be removed at the end of mining and waste dumps, FRS and pit rehabilitation completed to support self-sustaining ecosystems with minimal post-mining maintenance.

7.7.6 Management Commitments

C9. Twenty-four months prior to mine closure, a Mine Closure Plan will be finalised in consultation with the DEC and DMP. The plan will define appropriate closure criteria necessary for the establishment of safe landforms and self sustaining ecosystems, and set out procedures for monitoring in order to meet compliance with the closure criteria.

C10. A rehabilitation programme will be developed within the first two years of mining in liaison with the DEC.

C11. Rehabilitation will occur progressively as disturbed areas are no longer required for mining activities.

C12. Soil characterisation assessments will be conducted to determine the suitability of topsoil for supporting rehabilitation.

7.8 VEGETATION AND FLORA

The vegetation of the project area has been separated by ecologia into eight main units and 12 sub-units. The vegetation associated with the dunes (Units 6 and 7) is considered to be of regional significance, comprising only 1% of the Divide Land System. These dunes are classified by the DEC as a Priority Ecological Community (PEC). The colluvial fans of the survey area (Unit 8a) are considered to be of local conservation significance as these associations are probably uncommon locally within the area.

All other vegetation types in the area are not considered to be regionally or locally significant implying that at a regional scale, impact to the vegetation associations, habitat types and landforms found in the survey area will not constitute a significant loss to biodiversity.

The site has previously been subjected to pastoralism and almost 90% of the project area is either moderately or significantly disturbed. Ten of the 302 taxa recorded by ecologia were introduced species. No Declared Rare Flora taxa were recorded during the Marillana survey and one Priority Flora taxon; *Goodenia nuda* (P 3) was recorded in low numbers (< 2% cover) on the banks of the Weeli Wolli Creek; once on a minor channel and once on a clay pan. These habitats are not locally restricted, and *G. nuda*'s distribution range is quite wide in the Pilbara. Because of this, if the *G. nuda* located during the survey were to be impacted at Marillana it is considered unlikely to lead to the local extinction of the species.

7.8.1 Management Objectives

The Project objectives for the protection of vegetation and flora are:

- Avoid or manage adverse impacts to vegetation and flora during the construction and operation phases of the Project.
- Avoid excavation and clearing of the dune community (Units 6 and 7).
- Minimise the loss of native vegetation and plant communities.
- Protect Priority flora species within the project area.
- Minimise the risk of introducing and spreading noxious weeds.

7.8.2 Applicable Standards and Guidelines

Applicable standards and guidelines for the management of vegetation flora include:

- *Environmental Protection and Biodiversity Conservation Act 1999*.
- *Soil and Land Conservation Act 1945.*
- *Environmental Protection Act 1986.*
- Environmental Protection (Clearing of Native Vegetation) Regulations 2004.

- Position Statement No. 2 Environmental Protection of Native Vegetation in WA (EPA, 2000).
- Position Statement No. 3. Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA, 2002).
- Position Statement No. 9 Environmental Offsets (EPA, 2006).
- Guidance Statement No. 3. Separation Distances between Industrial and Sensitive Land Uses (EPA, 2005).
- Guidance Statement No. 51. Terrestrial Flora and Vegetation Surveys Environmental Impact Assessment in WA (EPA, 2004).
- CALM Policy Statement No 9, Conserving Threatened Species and Ecological Communities (CALM, 1999).

7.8.3 Potential Impacts

Vegetation clearing can have direct and indirect effects on the vegetation and flora and the scale of impact is underpinned by the national, state, regional or local significance of a vegetation unit or flora species.

Potential impacts from mining activities on the vegetation and flora of the survey area include:

- impacts to potentially phreatophytic vegetation lining the Weeli Wolli Creek as a result of mine dewatering;
- impacts to the vegetation of the Fortescue and River land systems;
- impacts to the vegetation of the regionally significant dunes (Unit 6 and 7) in the north-west of the project area;
- impacts to the colluvial fans (Unit 8a) running along the base of the escarpment;
- impacts to individuals of the Priority 3 species *Goodenia nuda*;
- impacts to general vegetation and flora through clearing; and,
- indirect impacts to vegetation and flora from infrastructure and ongoing practices e.g: degradation of areas due to alteration of surface water flow, dust from tracks, further weed infestation and human activities.

Assessment of Conservation Significance

ecologia undertook an assessment of the national, state, regional and local significance of the vegetation and flora found in the project area (Appendix M).

No TEC or DRF of state significance were recorded at the project area; however, dunes within the project area form part of the State-listed Priority 3 PEC - vegetation of sand dunes of the Hamersley Range and Fortescue Valley.

Regional significance addresses the representation of species and habitats at a biogeographic regional level. It considers species or habitat types that are endemic to the Pilbara bioregion and whose distributions are limited or unknown are considered regionally significant (ecologia, 2009a). The conservation significance of the vegetation of the region was assessed based upon land systems of the survey area Beard's vegetation mapping of the survey area and the mapping of vegetation along proposed rail corridors in the vicinity of Brockman's Marillana tenement.

Land system analysis

The project area spans six land systems, however the based on the proposed project footprint, only five of these land systems will be impacted by the proposed development. An estimated percentage impact to each has been calculated using the proposed infrastructure area footprint and is presented in Table 7-8.

Table 7-8 Land System Impacts of the Project Footprint

LAND SYSTEM	IMPACT FOOTPRINT (ha)	TOTAL AREA IN PILBARA (ha)	% IMPACT IN THE PILBARA
Boolgeeda Land System	1,712	961,637	0.18
Divide Land System	531	437,577	0.12
Fan Land System	0	148,205	0.00
Fortescue Land System	288	49,024	0.59
River Land System	44	482,179	0.01
Turee Land System	9	62,032	0.01

The land systems analysis assessed the Boolgeeda, Turee and River land systems as being of low to medium regional significance due to the common vegetation units and their relatively poor condition (ecologia, 2009a).

The project footprint comprises 531 ha of the Divide land system and 0.12% of its area in the Pilbara. The sand dunes associated with vegetation units 6 and 7 (described above) are considered to have high regional conservation significance because are regionally rare and only make up 1% of the area of this land system in the Pilbara as a whole. The other vegetation units (3 and 4) of the Divide land system are common, are in a poor condition and are considered to have low regional conservation significance.

The Fortescue land system is a small land system (49,024 ha) that is mapped over only 0.3% of the Pilbara. The Fortescue land system is mapped as four discrete units in the Pilbara and the survey area is located at the western end of the western-most unit. Because of its small size this land system is considered to have high regional significance. However, locally the vegetation of this land systems is degraded, as it has been grazed and **Cenchrus spp*. are the dominant tussock grasses in these grazed areas.

Beard mapping analysis

The majority of the survey area occurs on Beard's "mulga in groved patterns" vegetation unit, and this area was mapped by ecologia as four vegetation units. Beard mapped this vegetation over a large area of the Pilbara and it can be rated as having low regional conservation significance because of this.

The small area running along the Hamersley Range falls within Beard's "tree steppe on ranges" unit and was mapped as two vegetation units during the survey (2 and 8). Beard mapped this vegetation over a large area of the Pilbara and based on this it can be rated as having low regional conservation significance.

The remainder of the project area occurs on Beard's "shrub steppe on sandplain" and was mapped as six vegetation units during this survey (1, 3, 4, 5, 6 and 7). Beard maps this unit as occurring over a much smaller area of the Pilbara and can be viewed as being of moderate conservation significance because of this – especially as the project area occurs close to the western edge of Beard's mapped unit. Table 7-9 outlines the predicted impacts to the Beard vegetation units resulting from the Project.

Table 7-9 Beard Mapping Analysis Impacts of the Project Footprint

BEARD VEGETATION UNITS	IMPACT FOOTPRINT (ha)	TOTAL AREA IN PILBARA (ha)	% IMPACT IN THE PILBARA
a1Lp	403	1132437	0.0356
e16Lr t3Hi	21	2564777	0.0008
e25Sr t2Hi	2159	551179	0.3918

Other relevant surveys

One of the vegetation units identified as having high conservation significance by Biota (Hd1 (shrublands on dunes); Biota, 2004) occurs on the dunes in the north-west of the project area and was mapped by ecologia as Unit 6. Biota rated the conservation significance of this vegetation unit as extremely high for a number of reasons i.e. it is regionally rare and small, fragile and highly susceptible to overt threatening processes (Biota, 2004).

Buffel grass cover ranged from < 2% to between 30% and 70% cover at the sites that fell within vegetation unit 6 on the sand dunes. While Buffel grass cover was relatively low on the dune crests (< 2%), its presence lessens the unit's regional significance.

Two of the vegetation units mapped by Biota on the colluvial fans along the escarpment were rated as having low to moderate conservation significance (Hh3 and Hh4). Biota notes that while these vegetation units are locally common they are probably regionally uncommon. Of these two vegetation types Biota's Hh3 is equivalent to ecologia's vegetation Unit 8a. This sub-unit could not be discriminated from the other vegetation sub-units on the aerial photographs and was therefore mapped as one vegetation unit – Unit 8.

Direct loss of vegetation and flora

The most substantial environmental impacts likely to arise from the Project are the clearing of 2,985 ha of native vegetation, the potential loss to areas of the Fortescue land system and associated vegetation, potential loss to the vegetation of the dunes and colluvial fan areas, and loss of individuals of the Priority Three species *Goodenia nuda*.

Due to the locations of the known populations of *Goodenia nuda* on the project area (Figure 6-7), direct impacts to this taxa are unlikely given the proposed infrastructure locations, and if occur would not be considered significant due to the regional distribution of this species.

Clearing of vegetation in the Fortescue land system will impact this small land system. However, direct impacts are calculated to be less than 0.6% of currently mapped areas.

As discussed above, the *Acacia dictyophleba* tall shrubland over *Triodia schinzii* open hummock grassland (Unit 6 and 7), on the dunes in the north-west of the project area are regionally rare and is listed as a PEC. These dunes will not be excavated or cleared as a result of this proposal.

The vegetation of the colluvial fans (Unit 8a) at the base of the escarpment will be affected, as mining activities will occur predominantly in these areas. Seventy six percent of vegetation unit 8 will be directly affected by the Project (Table 7-10). Unit 8 is broken down into five sub-units which cannot be separately mapped and so the impact to unit 8a will be significantly smaller. Biota also notes that this sub-unit (Hh3) occurs off tenement to the south-east of the project area.

All other vegetation types in the area are not considered to be regionally or locally significant implying that at a regional scale impact to most of the vegetation associations, habitat types and landforms found in the survey area will not constitute a significant loss to biodiversity.

Table 7-10 Impacts to Vegetation Units within the Project Area

VEG CODE	TOTAL VEG IN THE PROJECT AREA (HA)	AREA IMPACTED (HA)	% DIRECT IMPACT
1	308.03	18.82	6.11
2	129.31	113.25	87.58
3	4193.23	220.13	5.25
4	155.82	7.42	4.76
5	1784.49	120.88	6.77
6	51.32	0.00	0.00
7	142.32	0.00	0.00
8	2767.50	2102.91	75.99
Total	**9532.03**	**2583.41**	**27.10**

Within the project area *Goodenia nuda* was recorded at two locations – once on a minor channel and once on a clay pan. Current FloraBase records indicate that *Goodenia nuda*'s habitat requirements are not this specific and that plants have also been found in other habitats including spinifex grasslands, hill midslopes and mulga scrub. Because of this, the individuals recorded in the survey area are regarded as having low regional conservation value. Due to the location of the *Goodenia nuda* found on the project area, it is not expected that these populations will be impacted by the proposal.

Indirect loss of vegetation and flora

Flora habitats can be impacted indirectly by increased activity in an area leading to increased dust, fire and the introduction and/or spread of weeds. Erosion and soil compaction can result from off road driving, and the use of saline water in construction and operations can affect vegetation, as can alterations to surface water flow and ground water levels.

<u>Damage to vegetation from dust</u>

Excessive dust can impact plants by clogging their stomata and inhibiting photosynthesis. This can affect respiration and transpiration and lead to localised deaths. This occurs particularly at track edges.

Introduction and spread of weed species

Implementation of the project has the potential to introduce new weed species or spread weed species already in the area. This could result from increased vehicle movements, increased ground disturbance, disposal of water from drilling and dust suppression operations. Ten general environmental weeds, with potential to spread were recorded during survey, these were: **Aerva javanica, *Argemone ochroleuca* subsp*. ochroleuca, *Cenchrus ciliaris, *Cenchrus setiger, *Chloris virgata, *Datura leichhardtii, *Malvastrum americanum, *Portulaca oleracea, *Setaria verticillata* and **Vachellia farnesiana.*

Weeds can increase the risk and frequency of wildfires, by increasing the fuel load. Fires are a frequent occurrence in the arid zones of Australia. Spot fires are known to occur during the summer months, predominantly through lightning strikes.

While native flora is adapted to, and in many instances dependant on fire for seed germination, too frequent or too hot bushfires can result in detrimental changes to the composition and diversity of the vegetation, causing local extinctions of vulnerable species.

The risk of fire as a result of mining activities can be minimised by implementing appropriate fire control measures.

Erosion and compaction from off-road driving

Water can flow preferentially in areas where vehicles have driven and this could cause erosion. Soil compaction results from off-road driving and plants cannot re-establish easily in these areas.

Additionally increased sediment load could be transported into the Weeli Wolli Creek and potentially affect the vegetation growing along the creek.

Altered surface hydrology

Where the defined drainage channels from the steeper Hamersley Ranges 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 even 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. This overland flow can be important for soil moisture replenishment in mulga grove areas. Mulga has a root system that is adapted for taking up water from thin surface soils and has adaptations that concentrate soil water near the plant and conserve water within the plant. Consequently, the distribution and abundance of mulga is particularly influenced by soil moisture and the pattern of surface drainage (Paczkowska and Chapman, 2000).

The diversion of this overland flow into diversion drains will potentially impact vegetation downstream of these drains and south of the Weeli Wolli Creek. Vegetation investigations undertaken by ecologia indicate that the area south of the creek (around the rail loop and to the north of the dunes) is dominated by low mulga woodland over tussock grass with some mulga low open to closed forest (ecologia, 2009a).

It is anticipated that this vegetation (approximately 450 ha or 10.7% of Unit 3 in the project area) would utilise surface waters originating from the Hamersley Ranges as well as flood events overtopping the Weeli Wolli Creek and direct rainfall and thus may be adversely affected by the diversions of these small creeks around the mine pit.

Areas north of the creek are not expected to be affected by the Project as no infrastructure is planned for these areas and diversion drains as surface water will be diverted into the creek where possible to mimic natural conditions. Areas north of the BHPB rail line are impacted by the rail as this structure acts as a considerable barrier to surface flow north of the creek.

<u>Altered subterranean hydrology</u>

Although groundwater variations occur naturally, human alterations may exacerbate these fluctuations and affect vegetation that may rely on groundwater for all or part of its survival (Naumberg et al, 2005). As the Project will involve dewatering, there is the potential for an alteration to existing groundwater levels in areas where phreatophytic vegetation exists, in particular lining the Weeli Wolli Creek (ecologia, 2009a). A reduction in groundwater levels decreases the accessibility of a permanent water source (Naumberg et al, 2005). However this may be mitigated by channel flow events numerous times per year that will recharge the creek channel groundwater level.

As shown in Appendix E, the cone of depression resulting from abstraction will move along the length of the deposit over the 20 year mine life. Model predictions indicate that the likely drawdown beneath the Weeli Wolli Creek ranges from 10 -20 m, depending upon the proximity of active mining to the Weeli Wolli Creek channel.

Whether the extent of the drawdown proposed is likely to significantly affect the potentially phreatophytic vegetation lining the Weeli Wolli Creek is yet unknown, given the predicted natural variability in groundwater underneath the creek. A study of the potential impacts of groundwater drawdown resulting from the Project on phreatophytic vegetation will be undertaken by Brockman prior to dewatering commencing, the results of which will be presented to the DEC for their review.

While there may be an affect locally on phreatophytic vegetation, only 0.08% of the River land system occurs within the project area. Therefore the regional impact to the vegetation of the rivers of the Pilbara would be very low even if all of this vegetation was affected by changes in groundwater levels.

7.8.4 Management

Brockman will implement the following management actions to reduce the potential for and severity of impacts to native vegetation and flora.

<u>Clearing of native vegetation and loss of Priority Flora</u>

Mine infrastructure has been located to avoid known populations of the Priority flora, *Goodenia nuda*, and to minimise impacts to riparian vegetation lining the Weeli Wolli Creek (Unit 1). The extent of vegetation to be cleared for construction and operational activities will be minimised as much as possible, and staged clearing will minimise the time between clearing and rehabilitation. Standard clearing procedures will be implemented (see Appendix F) and employee and contractor training programs will be implemented to ensure clearing procedures are adhered to (Appendix G).

The sand dunes (Vegetation Units 6 and 7) form part of a regionally significant Priority Ecological Community (PEC) and these units will not be cleared or excavated. This vegetation will be demarcated as a ‘no go’ area on site maps and access restrictions communicated to site staff and contractors through inductions throughout the life of the Project. Signage will be erected between the rail and the dunes to notify employees and contractors that the sand dunes are a ‘no go’ area. No tracks will be created to allow access to the dunes and vehicles are prohibited off tracks. Fencing is not considered appropriate as it may impede fauna movement and visual amenity.

Dust deposition

Dust management is extensively described in section 7.12. Standard Pilbara iron ore mining procedures will be implemented with respect to dust management.

Additionally progressive rehabilitation with appropriate, locally sourced species will take place progressively over the life of the mine to minimise the area of land exposed to erosive forces (see section 7.7).

Weed management

The project area already has a significant weed problem as a result of cattle grazing. However Brockman recognises that preventing the spread and / or introduction of new weeds is important in managing the overall health of the vegetation on site.

Weed management will include:

- A weeds identification guide will be provided to all relevant on-site personnel and induction/training will incorporate weed control measures.
- All vehicles, earthmoving/mobile plant and construction equipment will be washed down and cleaned of all vegetative, soil and rock material, prior to arrival on site.
- Quarantine areas will be established and demarcated surrounding known infestations/outbreaks of declared weed species and the outbreak reported to the DEC.
- During construction and drilling activities, the location of suspected new weed outbreaks will be reported to the Operations / HSE Manager.
- Stockpiles will be inspected for weeds and treated if required.
- Approval will be required before entering or leaving known weed infested quarantine areas.
- Revegetation will occur as soon as possible after clearing to limit weed mobility.
- Vehicle movement will be restricted to existing tracks and roads.
- Weed monitoring will be undertaken to ensure that weeds are not being spread into native vegetation surrounding the mine site.

Erosion and sedimentation

Erosion and sedimentation will be controlled within disturbed regions by employing soil stabilisation techniques (i.e. vegetated batters, water spraying) and sediment control structures.

Sediment basins will be constructed down slope of all waste rock dumps and stockpiles to help manage surface water sediment. Bunds and diversion drainage works will be constructed to divert and separate natural runoff from outside the development areas from internal site runoff.

Altered surface hydrology

While mine site infrastructure has been positioned to minimise disturbance to drainage lines, the pit will intersect with several small drainage lines flowing off the Hamersley Ranges. Drainage lines that must be re-directed to accommodate mine infrastructure will be directed to flow into Weeli Wolli Creek via sedimentation ponds or similar to ensure high water quality is maintained.

The maintenance of mulga within the project area will be managed where feasible by discharging diverted water from the ranges over spreader mechanisms to encourage the flows to slow and disperse, mimicking pre-development drainage. Mulga within the project area will continue to be flooded during events when the Weeli Wolli Creek overtops its banks, once every two years.

Further information regarding the management of altered surface water is presented in detail within section 7.5.

<u>Altered subterranean hydrology</u>

Groundwater drawdown as a result of dewatering will be managed as per PEMP (Appendix F) and the GWMP (Appendix E) and are discussed in further detail in section 7.4 of this PER.

A monitoring program will be established to assess potential impacts of dewatering to the health of potentially phreatophytic vegetation lining Weeli Wolli Creek. Appropriate management responses (such as artificial watering) will be implemented if this vegetation is found to be negatively impacted by groundwater drawdown.

7.8.5 Expected Outcome

Due to the condition of much of the vegetation across the tenement, impacts of a regional significance are not anticipated. Impacts of a local significance include the direct loss through clearing of 2,985 ha of native vegetation in moderate to significantly disturbed condition.

This aspect can be adequately managed through the implementation of clearing procedures, standard surface water and erosion control mechanisms and employee and contractor training. These controls are outlined in detail in the PEMP (Appendix F).

The potentially phreatophytic vegetation lining the Weeli Wolli Creek may be affected as a result of dewatering. The degree to which these eucalypts rely on groundwater and the extent of the impact of the drawdown above natural fluctuation is not yet known and a monitoring program will be established to assess this.

7.8.6 Management Commitments

C13. Brockman will develop a monitoring program to assess impacts to the potentially phreatophytic vegetation within the project area as a result of dewatering.

C14. A management plan will be developed in consultation with the DEC if groundwater abstraction is found to be affecting the health of the potentially phreatophytic vegetation.

C15. The regionally significant PEC (Units 6 and 7) will not be cleared or excavated.

7.9 VERTEBRATE FAUNA

ecologia surveyed five fauna habitats across the project area and identified 23 species of mammal, 82 species of bird, and 43 species of reptile.

Two conservation significant species were recorded at numerous locations within the survey area; the Australian Bustard (*Ardeotis australis*, DEC Priority 4) and the Rainbow Bee-eater (*Merops ornatus*, EPBC Act Migratory). A further six conservation significant species are considered likely to occur in the Marillana project area based on previous nearby records (from state and national databases and other surveys conducted in the vicinity) and the habitat types available within the project area.

ecologia's assessment of the potential impacts on these conservation species is that they are expected to be negligible to minimal, due to the availability of suitable habitat outside the project area, the avoidance of sensitive habitats within the project area, the small level of impact on preferred habitat predicted by the project and the transient nature of the species.

7.9.1 Management Objectives

The objectives for management of terrestrial vertebrate fauna are to:

- Minimise the impact on the abundance, diversity, geographic distribution and productivity of vertebrate fauna at species and ecosystem levels.
- Undertake project activities in a manner which minimises the adverse impacts to fauna.

7.9.2 Applicable Standards and Guidelines

Applicable standards and guidelines for the management of vertebrate fauna include:

- *Environmental Protection and Biodiversity Conservation Act 1999.*
- *Wildlife Conservation Act 1950.*
- *Conservation and Land Management Act 1984.*
- *Environmental Protection Act 1986.*
- Guidance Statement No. 56. Terrestrial Fauna Surveys for Environmental Impact Assessment in WA (EPA, 2004).
- Position Statement No. 3. Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA, 2002).
- Biodiversity Management (DoIR, 2007).
- CALM Policy Statement No 9, Conserving Threatened Species and Ecological Communities (CALM, 1999).

7.9.3 Potential Impacts

<u>Clearing of native vegetation/fauna habitat</u>

The principle impact on vertebrate fauna arising from this proposal will be the loss and degradation of fauna habitat through the clearing of native vegetation. Vegetation clearing at the mine site will impact fauna populations within the mine site footprint, but is not anticipated to have significant impacts at a regional level.

The initial impact from habitat loss will be immediate on non-mobile poorly dispersing fauna unable to move from the area. The localised loss of all fauna due to the direct mortality arising from clearing and construction activities will occur across the project footprint.

The fauna habitat that will be most affected by the proposed development are the sandy and stony spinifex plains. Species likely to use this habitat type include the Kaluta (*Dasykaluta rosamondae*), a carnivorous marsupial endemic to the Pilbara bioregion (McKenzie *et al.* 2003), is confined to subtropical arid hummock grassland

(Menkhorst and Knight 2004). In the fauna survey, it was recorded primarily where hummock grass was thick and well established.

Thick, long-unburnt cover of spinifex had the potential to provide habitat for Night Parrot (*Pezoporus occidentalis*), which is listed as Endangered under the *Environmental Protection and Biodiversity Conservation Act 1999* and Schedule 1 under the *Wildlife Conservation Act 1950*. A lack of records for the Night Parrot, due to its extremely secretive behaviour, means that its habitat preferences and distribution are not well known; however, the sandy spinifex grassland and the longitudinal sand dune habitats are considered possible, if improbable, areas of occurrence. This consideration was based on the limited available knowledge of its habitat, which suggests that Night Parrots inhabit spinifex (*Triodia* spp.) grasslands on stony or sandy terrain; samphire (*Sarcocornia* spp.) and chenopod shrublands on claypans, floodplains or the margins of saltlakes, and creeks or other water bodies (Higgins 1999). It is also notable that the most recent record of this species from the Pilbara was made at Minga Well, approx. 35 km north-east of the project area (Davis and Metcalf 2008).

The relative openness of the sandy spinifex grassland also made this habitat suitable for the Australian Bustard, listed DEC Priority 4. This species was common throughout the project area. The Black Kite (*Milvus migrans*), which prefers to hunt in open plains, was also recorded here.

Indirect impacts associated with habitat degradation also have the potential to occur through factors associated with the mining process and increased human activity in the area. These include introduction of weed and feral fauna species, dust generation, changes to groundwater and surface water availability and habitat fragmentation.

<u>Altered surface hydrology</u>

Altered surface water flow is expected to have only very localised impacts on native fauna on the project area. Where surface water is diverted, it will continue to empty into the Weeli Wolli Creek and is not anticipated to greatly affect water levels in the creek, which is seasonal and not a permanent water source.

Surface water management (Appendix S) will ensure that no additional water is available to native fauna seasonally and consequently no significant risk to native fauna resulting from additional surface waters is anticipated.

Noise, dust and light

Noise can adversely affect fauna by interrupting communication, causing stress and avoidance reactions and even temporary hearing damage (EA, 1998). However impacts to fauna are predicted to be low, due to the availability of similar habitat surrounding the project area (see section 7.14 for more detail on noise and light impacts and management).

Damage to vegetation may arise from airborne particulate matter, resulting in altered species composition, reduced growth and biomass and increased ecosystem stress. This may result in insect infestations and plant disease epidemics (Grantz et al. 2003). A decline in vegetation quality is likely to impact faunal assemblages, affecting food and habitat resources.

Light can affect fauna by either attracting species to an area or by triggering avoidance mechanisms. Further detail on impact of light to native fauna is presented in section 7.14.

<u>Vehicle strikes</u>

Ongoing impacts in adjacent areas may arise from more frequent vehicle movements and machinery operation. Increased traffic movements along the access and haul roads will invariably increase the potential for collision and therefore inadvertent injury or mortality. Vehicle strikes constitute a relatively small impact on regional vertebrate fauna. Incidents are relatively rare and typically affect only single individuals.

Fire

Three of the five main fauna habitats types available within the project area are vegetated primarily by spinifex (Sandy Spinifex Grassland, Stony Spinifex Plains, and Longitudinal Sand Dune). Spinifex is particularly susceptible to fire and blanket fire of large areas of spinifex would be damaging to biodiversity as very little cover would remain for small mammals and reptiles.

As well as the direct loss of habitat, fires can also result in habitat fragmentation in the area. Fire tends to travel along the sand dunes (where spinifex grows), isolating the dune swales from surrounding areas. This may limit fauna movement between the swales or increase the predation risk due to an absence of ground cover.

7.9.4 Management

Brockman will implement the following management actions to reduce the potential for and severity of impacts to native vertebrate fauna.

Clearing of native vegetation

Impacts to fauna from vegetation clearing will be minimised by minimising the clearing footprint to only that which is necessary and conducting staged clearing. Clearance programs will occur over a period of time to allow the movement of fauna away from clearing activities and into adjoining habitats. Disturbed areas will be rehabilitated as soon as possible, with ongoing rehabilitation throughout the mine life to facilitate habitat restoration.

Dead trees will be regarded as valuable habitat and will be protected where possible and the collection of firewood from the area will be prohibited.

To prevent habitat fragmentation caused by vegetation clearing it is important that habitat corridors are maintained. For example, the Weeli Wolli creekline habitat is likely to function as a habitat corridor assisting fauna to disperse away from the areas of impact during development. Brockman operations at Marillana will not directly impact the Weeli Wolli Creek habitat to ensure that this is maintained as a functional corridor for native fauna.

Other important habitats, such as the sand dunes (Unit 6) will be avoided to ensure that this habitat is maintained intact.

Altered surface hydrology

The management of alterations to surface water flow is described in detail in section 7.5.

Noise, dust and light

The adverse affects of noise, dust and light will be managed through the implementation of standard noise, dust and light controls. These are set out in detail in sections 7.12 and 7.14.

Vehicle strikes

Vehicles will only use designated tracks and vehicle speeds will be limited to 40 km/hr on tracks and to 90 km/hr on haul roads to minimise fauna deaths.

Operational control procedures, site inductions and employee training programs will be implemented to protect native fauna from intentional harm, and to appropriately manage injured fauna if found.

Any incidents that involve conservation significant species will be reported to local authorities such as DEC staff and bodies frozen and sent to either DEC or Western Australian Museum (WAM) representatives.

<u>Fire</u>

To prevent further degradation of habitat from wildfire, Brockman are implementing strict fire controls, ensuring that appropriate fire fighting equipment is readily available onsite, all vehicles are fitted with fire extinguishers, and staff are trained in their use.

Brockman is will also discourage personnel from creating new tracks through dune fields or areas with mature spinifex and educate personnel on the impacts of fire on native fauna and vegetation.

A fire control procedure is outlined in Appendix F.

7.9.5 Expected Outcome

No nationally or regionally significant fauna will be impacted as a result of this proposal. Important habitats such as the sand dunes and Weeli Wolli Creek will not be directly impacted by this proposal. Interactions with native fauna can be managed appropriately through the implementation of standard clearing, dust, traffic, noise and light management procedures and through employee and contractor training programs.

7.10 SOCIAL AND VISUAL AMENITY

The human experience of a physical environment is based on what is perceived (landscape) and the enjoyment derived from what is perceived (aesthetics). Enjoyment or amenity is a function of personal values. Landscape is not just a visual, phenomenon it relies on a number of other features/influences that will have shaped its character. For example topography, geology, ecology, land management and architecture all play a part in the formation of a landscape.

A visual impact assessment was undertaken from two locations along the Munjina-Roy Hill Rd which involved superimposing mine site infrastructure over photographs of the natural landscape to give an indication of how the new landscape will look post-closure. View locations were chosen to represent areas where amenity may be impacted by the Project.

An assessment of current use of the project area was also conducted to ascertain whether restricted access to part of the area would impact on the local community.

7.10.1 Management Objectives

The objectives for management of social and visual amenity are to:

- Minimise project impacts to community use and access to significant environmental features.
- Ensure landscape values are considered and measures are adopted to reduce the visual impacts of the Project.

7.10.2 Applicable Standards and Guidelines

Applicable standards and guidelines to manage impacts to social and visual amenity include:

- Guidance No. 33 Environmental Guidance for Planning and Development (EPA, 2005).
- Guidance Statement No 3 Separation Distances between Industrial and Sensitive Uses (EPA, 2005).

7.10.3 Potential Impacts

Potential impacts of mining activities to surrounding communities and landholders will be minimal. This is in part due to the remote location of the project area some 60 km from any area of habitation and the nature of the surrounding land use, which is primarily utilised for mining and pastoral purposes.

<u>Land use and access</u>

Access to the site will be restricted, from the Weeli Wolli Creek to the south of the BHPB rail line. Access north of this line will continue to be available to Traditional Owners, who utilise the site for recreation and as a meeting place.

The Munjina-Roy Hill Rd will be diverted further north on the tenement to accommodate the waste stockpiles south of the Welli Wolli Creek. Brockman is liaising with the SoEP regarding the diversion, additional crossings and culverts and ongoing road maintenance. The road will continue to be utilised by the general public and no restrictions to public access (other than on tenement and off the road) are planned.

Tourists to the area are encouraged to utilise the Great Northern Hwy, turning off at Munjina and Karijini Drive from Tom Price to access the Karijini National Park, west of the project area. It is not anticipated that this proposal will have any impact on tourist access to this park, as the mining fleet will predominantly utilise the Great Northern Hwy from Newman and the Munjina-Roy Hill Rd heading east towards the tenement.

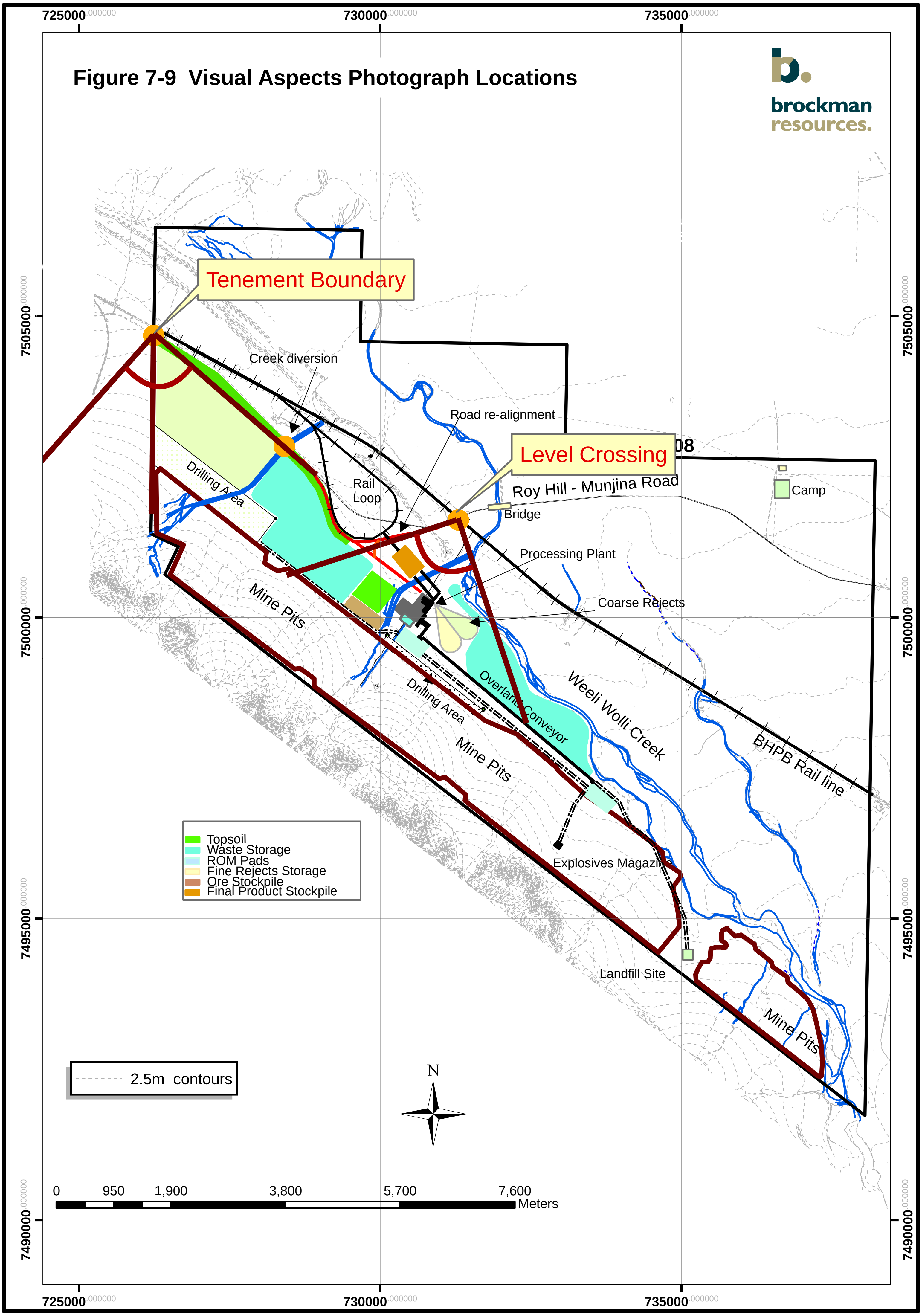
<u>Visual amenity</u>

The project area is centred on the north-eastern foot slopes of the Hamersley Ranges. This range protrudes from the plains of the Pilbara. While there will be no alteration to the peaks of ranges (the project is located on the floodplain), there will be additional features (e.g. overburden stockpiles) added to the plains which may alter the visual aesthetics of the natural landforms.

Therefore impacts to visual amenity of area will result from this proposal. The mine site will be very visible from the Munjina-Roy Hill Road. Brockman have undertaken a visual impact assessment of three locations along the Munjina-Roy Hill Road to assess the likely impacts to landform during operation and after mine closure.

Photographic control points have been fixed by GPS and were utilised to assess the pre and post mining landscape (Figure 7-9). Results of this assessment are displayed in Figure 7-10 and show both pre and post-closure aspects.

Figure 7-9 Visual Aspects Photograph Locations



Tenement Boundary Pre Development

Tenement Boundary Post Development

Level Crossing Pre Development

Level Crossing Post Development

Figure 7-10 Pre and Post Development Visual Aspects from the Munjina - Roy Hill Road

<u>Local community</u>

Brockman recognises that operating in a remote community can have implications for local services such as fire, police, emergency and communications.

The outsourcing of labour through a fly-in-fly-out operation, spikes in population during construction and the potential for local price inflation due to increased demand for goods and services are examples of other impacts that can typically influence rural communities as a result of mining projects.

Brockman recognises that the use of the Munjina-Roy Hill Road as an access route to the mine may impact on other road users.

7.10.4 Management

Brockman will implement the following management actions to reduce the potential for and severity of impacts to social and visual amenity.

<u>Land use and access</u>

Access to the mine site must be restricted to promote human safety. However areas of the project area north of the Weeli Wolli Creek will remain open to Traditional Owners. Brockman will continue to liaise with both the MIB and Nyiyaparli peoples to retain equitable access arrangements throughout the life of the project.

On closure the land will be rehabilitated to support the desired end land use, which will be developed in consultation with relevant stakeholders as part of mine closure planning.

Access to the Munjina-Roy Hill Rd will need to be managed to facilitate driver safety. Brockman will develop a Traffic Management Plan prior to construction commencing on-site to manage potential interactions between the community and the mine fleet.

<u>Visual amenity</u>

Brockman have attempted to minimise the visual impact of the project through the placement of infrastructure, however the presence of Weeli Wolli Creek has constrained infrastructure between the Hamersley Range and the creek. There is consequently only a confined area in which to build infrastructure and final landforms.

The waste dumps will be visible from some points along the Munjina-Roy Hill Road and vegetative screens may be utilised to minimise visual impact at these points.

Stockpiles and waste dumps will be shaped to mimic local landforms where possible and will be revegetated with native vegetation typical of the area.

Infrastructure removal and rehabilitation of the site to final land use requirements will be carried out upon closure.

<u>Local community</u>

Possible management strategies to ensure that the local community is not unduly impacted as a result of this proposal may include:

- use of local contractors where possible;
- training and employment for local residents;
- financial contributions to the Shire of East Pilbara;
- participation in or sponsorship of community events and initiatives; and

- ongoing liaison with Traditional Owners and implementation of the project Cultural Heritage Management Plan (CHMP).

Brockman will develop a Traffic Management Plan prior to construction beginning on site to effectively manage traffic related issues with respect to the use of Munjina-Roy Hill Road by the mine fleet and the broader community.

7.10.5 Expected Outcome

As much of the surrounding area is already being utilised for exploration and mining activities, the anticipated impact to social and visual amenity from this proposal is minimal.

7.10.6 Management Commitments

C16. Brockman will continue to liaise with relevant local authorities throughout the life of the project to ensure that potential impacts of social and visual amenity and minimised.

C17. Brockman will develop and implement a Traffic Management Plan prior to construction commencing on-site.

7.11 INDIGENOUS HERITAGE

There are no established Aboriginal communities in the vicinity however the project area is subject to native title claims from the Martu Idja Banyjima (MIB) people and the Nyiyaparli people. Native title agreements are in place between Brockman and both groups.

No archaeological or ethnographic sites have been identified within the project footprint and none of the sites identified within the Nyiyaparli claim area are in areas proposed to be developed by Brockman.

7.11.1 Management Objectives

The objectives for management of indigenous heritage are to:

- Meet or exceed statutory obligations in relation to the management of cultural heritage items, places or issues within the project area
- Avoid disturbance to cultural and heritage sites.
- Respect the rights of land owners.
- Identify all heritage sites and/or culturally-significant plants, sites and artefacts using heritage surveys and local knowledge.

7.11.2 Applicable Standards and Guidelines

Applicable standards and guidelines to manage impacts to indigenous heritage include:

- *Native Title Act 1993.*
- *Aboriginal Heritage Act 1972.*
- Guidance Statement No. 41. Assessment of Aboriginal Heritage (EPA, 2004).
- Brockman's Native Title Agreements with Traditional Owners.
- Brockman's Cultural Heritage Management Plan (CHMP).

- Guidelines for Consultation with Indigenous People by Mineral Explorers (DoIR, 2004).

7.11.3 Potential Impacts

A preliminary archaeological assessment of the Nyiyaparli claim area resulting in four archaeological sites (stone artefact scatters) within this area, however Brockman are not proposing to impact these sites.

The north-western portion of the tenement is not included as part of the development proposal as it encompasses a clay-pan system that has a high potential for containing archaeological sites. Brockman will not be impacting this area.

During the PFS some of the TOs noted that they utilised some of the native species found on the tenement for bush tucker, and that the Project could negatively impact on their ability to access these resources. Brockman offered to facilitate an investigation of these plants through a joint enthnobotany survey performed by ecologia and the TOs.

As there are no known registered heritage sites nor any identified ethnographic or archaeological sites within the project footprint, the impacts of the project are likely to be negligible.

However, Brockman recognises that future sites may be uncovered through the process of site preparation or construction, and even later on into the mine's operational life and is committed to ensuring that potential future impacts are identified and managed.

In regards to indigenous use of the project area, the Weeli Wolli Creek is considered to be a culturally significant waterway and parts of the creekline are sometimes utilised by TOs for recreational purposes. These areas will not be directly impacted by mining operations and would be available to these groups during and post mining although would be subject to HSE requirements and access protocols during operations.

As there are no permanent pools along the Weeli Wolli Creek, there will be no impacts to indigenous heritage values related to groundwater abstraction and resulting changes to water availability.

7.11.4 Management

Brockman have developed Native Title Agreements with both land owners, and ongoing consultation between Brockman and the Nyiyaparli and MIB people ensures that any impacts are managed in a way that recognises their customs and traditions.

Although extensive archaeological and ethnographic surveys have been completed over the proposed development area, there is always the possibility that previously unrecorded or unidentified Aboriginal sites may be located through ground disturbing works or monitoring of works. In the event that a new site or sites are located, the following procedures shall apply to all Brockman employees and contractors.

<u>Procedure if skeletal remains are located</u>

In the event of the discovery of human skeletal remains within the proposed development area, the following steps will be followed:

- Immediately cease all works within 25m of the find.
- Inform the construction manager.

- Inform archaeological representative of the relevant indigenous group.
- Inform Western Australian Police Service. When informing the Police indicate that the remains are likely to be of Aboriginal origin and that an archaeologist and Indigenous representatives should be present during any handling of the remains.
- Nothing will be disturbed at all without archaeologists present.
- Inform the local (Karratha) branch of the Department of Indigenous Affairs (DIA) and the Registrar of Sites.
- Where the remains are determined to be Aboriginal, they must remain in situ until the DIA Registrar determines how to proceed.
- Brockman will manage the remains in accordance with the DIA's instructions, and report the whereabouts of the remains to the WA Museum and the DIA.

<u>Procedure if a new archaeological site is located</u>

In the event of the discovery of a new archaeological site within the proposed development area, the following steps will be followed:

- Cease all works in the vicinity immediately.
- Inform the construction manager who will cordon off an appropriate area.
- Archaeologist to record the site in conjunction with the authorized project delegate, native title claimant representatives, and other relevant contractors.
- Newly located heritage items will not be disturbed.
- Where any new heritage materials or items are located, the DIA will be notified of the existence of the material or item and the actions taken to record and manage the material.

As part of the Native Title agreements, the Traditional Owners are preparing a full Cultural Heritage Management Plan (CHMP) in consultation with Brockman to ensure that:

- Prior to entering the project construction area, personnel must have attended a heritage management induction which includes cross cultural awareness training.
- Prior to any ground disturbing work commencing on previously undisturbed land, a heritage clearance permit is issued by the authorized project delegate and signed by the Works Supervisor.
- Incidents are reported and recorded using Brockman's incident management process.

An interim Cultural Heritage Management Plan has been prepared and is included in Appendix H.

7.11.5 Expected Outcome

Due to the lack of cultural heritage sites within the project area, it is anticipated that the project will have negligible impact on cultural heritage. However Brockman will ensure that procedures are in place to minimise the risk of disturbing sites that may become apparent in the future.

7.11.6 Management Commitments

C18. Brockman will facilitate the development of a full Cultural Heritage Management Plan by Native Title claimants and implement, monitor and review this plan in consultation with claimants throughout the life of the Project.

7.12 DUST & PARTICULATES

Limited vegetation cover and an arid climate within the region result in natural dust generation, particularly in conditions of high wind. However a number of project related activities at the mine site may contribute to elevated dust concentrations in the immediate area. This includes mining, crushing, screening, stockpiling of ore, haulage and clearing.

Localised dust will be generated from the movement of vehicles at the mine site and from the handling of ore. The lay down and loading areas will be unsealed and subject to dusting when dry. Dust will also be generated during the construction period from the earthworks, stripping of the mine site, movement of vehicles and from exposed bare ground.

Dust generation from wind will depend upon the wind speed and the surface properties of the surface material. This includes whether the material is crusted, the amount of non-erodible particles and the size distribution of the material (SKM, 2009).

As the mine site is isolated from settled areas and sensitive receptors, dust is not anticipated to constitute a significant environmental or health issue. The mine accommodation is located several kilometres away from operations and upwind of the prevailing wind direction, (north easterly) and is therefore unlikely to be adversely affected by mine site dust. The Fortescue Marsh is located approximately 15 km from the northern boundary of the tenement and dust resulting from the project is not anticipated to impact on this important wetland system due to this adequate buffer distance and prevailing winds.

7.12.1 Management Objectives

The objectives for the management of dust emissions are to:

- Ensure that emissions do not adversely affect environmental values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.
- Minimise dust associated with the construction and operation of the mines.
- Minimise exposed surfaces through clearing minimisation, staged clearing and progressive rehabilitation.

7.12.2 Applicable Standards and Guidelines

Applicable standards and guidelines to manage dust and particulates include:

- Guidance Statement No. 18 Prevention of Air Quality Impacts from Land Development Sites (EPA, 2000).
- Guidance No. 33 Environmental Guidance for Planning and Development (EPA, 2008).
- National Environmental Protection Measure (NEPM) Ambient Air Quality 1998.

- Draft guideline for development and implementation of dust management program (DEC, 2008).
- All Ambient Air – Guide for the Siting of Sampler Units AS 2922.
- All Workplace Atmospheres – Methods for Sampling Respirable Dust AS 2985.
- All Workplace Atmospheres – Methods for Sampling Inspirable Dust AS 3640.
- Total Suspended Particles (TSP) Determination of Total AS 2724.3.

7.12.3 Potential Impacts

Airborne dust can arise from a wide variety of sources on a minesite, including the following:

- wind-blown dust from exposed surfaces such as bare land and construction sites;
- wind-blown dust from stockpiles of dusty materials;
- construction activities;
- mining activities (crushing, screening); and
- dust caused by vehicle movements on unsealed roads.

The amount of dust generated as a result of an activity depends upon the moisture content of the soil, the temperature and wind conditions, aspect, whether vegetation cover is intact and the particle size of the soil.

The potential impacts arising from dust emissions may include:

Health of mine employees

The potential health effects of dust are closely related to particle size. Human health effects of airborne dust are mainly associated with particles less than 10 microns in size (PM_{10}), which are small enough to be inhaled (MFE, 2001). The mine accommodation is located several kilometres north east of the mine and supporting infrastructure. The prevailing wind direction is north-easterly, placing the camp upwind from the mine in the prevailing wind direction.

Reduced visual amenity

Loss of visibility is also a safety concern under extreme conditions, especially for road traffic. Dust generation also has the potential to reduce visual amenity within the SoEP, however as the project area is located approximately 20 km from the nearest residence (Marillana Station), dust resulting from the project is considered unlikely to significantly impact on local resident's amenity.

Smothering of vegetation

Dust has the potential to impact plants by clogging their stomata and inhibiting photosynthesis, affecting respiration and transpiration and may lead to localised deaths.

Dust can also act as a medium for the growth of fungal diseases and can increase the incidence of plant pests and diseases.

This is more likely to occur locally to vegetation lining roads and tracks.

7.12.4 Management

Due to the remoteness of the project, dust emissions are unlikely to affect persons not directly associated with the operations. However Brockman will apply the NEPM air quality standard to the project for fugitive emissions, where PM_{10} will not exceed $50µg/m^3$ averaged over 24 hours. Dust monitoring will involve monitoring fugitive dust emissions at the mine accommodation to ensure that NEPM levels for PM_{10} are not exceeded and will be in compliance with relevant Australian Standards.

Brockman have developed a Dust Management Procedure within the PEMP (Appendix F) to accompany the PER. This includes the following actions to minimise and mitigate dust:

<u>Measurement</u>

Laboratory testing is used to determine the emission characteristics of ore before material handling commences, therefore allowing appropriate dust reduction strategies to be incorporated during the initial design phase, and reducing the need to retrofit dust reduction equipment (SKM, 2009).

Brockman will undertake the appropriate testing to ascertain potential emission levels to further inform the management actions described below.

Field measurement will be used to measure and monitor actual dust emissions on site once construction and operations commence.

<u>Drilling</u>

Drills will be fitted with effective water mist and dust-suppression systems, installed and maintained to the manufacturer's specifications. In particular, care will be taken to ensure that the dust extraction systems operate effectively whenever drilling occurs.

<u>Roads and construction</u>

Clearing required for construction will occur at a time of the year when dust can be minimised (i.e. winds are not high and soil is reasonably moist) and will be staged to minimise the area exposed at any one time. Vegetation will be left as wind breaks where practicable and areas where construction has been completed will be progressively rehabilitated.

Dust suppression will be carried out in such a manner to ensure that saline or polluted water is not sprayed onto areas of vegetation, areas undergoing rehabilitation or areas and/or material designated for future rehabilitation.

Road construction techniques will consider dust minimisation with respect to wheel generated dust. Roads will be graded regularly and water trucks or environmentally friendly chemical dust suppressant such as lignin will be utilised to wet cleared surfaces as necessary (i.e. during particularly windy and/or dry conditions) and regular inspections to visually assess dust generation. Wet suppression of unpaved areas can achieve dust emission reductions of about 70% or more, and this can sometimes be increased by up to 95% through the use of chemical stabilisation.

Dust emissions due to vehicles will be minimised with the follow controls:

- Limiting vehicle speeds. Speed controls on vehicles have an approximately linear effect on dust emissions. In other words, a speed reduction from 30 km/hr to 15 km/hr will achieve about a 50% reduction in dust emissions.
- Limiting load size to avoid spillage.

- Covering loads with tarpaulins or the use of enclosed bins to prevent dust re-entrainment from trucks.
- Minimising travel distances through appropriate site layout and design.
- The use of wheel and truck wash facilities at site exits.

Operation

The crushing and screening plant will be fitted with dust suppression and extraction equipment features that may include but are not limited to:

- The conveyor belt and conveyor transfer points and stockpiles will be fitted with scrapers, suppression sprinklers and collection/containment apparatus as appropriate.
- Deluge sprays will be located at the ROM area and the hopper.
- A dust control system will be installed on the primary crusher.
- Ore handling and transfer will be minimised as much as practicable and water will be applied where required.
- Drop heights into hoppers and loading chutes will be minimised.
- The use of sprinklers or water sprays around hoppers and other transfer points.
- Hooding or enclosure of significant fugitive sources, with the emissions being ducted to bag filters or other dust control equipment.

If any infrastructure is required to be moved from its original position once the project is operational, then dust control equipment will be reinstalled and operated according to the original plant specifications.

Stockpiles and storage

Fine material stored in stockpiles (such as soil or fines rejects) can be subject to dust pick-up at winds in excess of about 10 knots (MFE, 2001). Dust emissions can also occur as material is dropped onto the stockpile from a conveyor. Brockman will manage dust emissions from stockpiles by implementing the following controls:

- Sufficient distance between the FRS and potential receptors including the site administration offices and camp site will be maintained.
- Stockpiles will be dampened and stabilisation in the form of seeding or chemical stabilisation will be applied where required.
- Stockpile heights and slopes will be minimised to reduce wind entrainment
- Vegetation surrounding stockpiles will be left intact where possible to offer wind breaks, or another form of windbreak will be implemented.
- Drop heights from conveyors will be limited.

Drains, sediment traps and settling ponds will be constructed around the perimeter of the FRS to control runoff and ensure no sediment loss impacts the Weeli Wolli Creek.

Both in and ex-pit FRS facilities have been designed to ensure stability over the life of the mine and on past mine closure. The in-pit fines rejects will be encapsulated in waste rock, with the cells side slope of 2:1 (horizontal to vertical). The above-ground FRS will be encased in waste rock with slopes at a maximum ratio of 3:1 (horizontal to vertical) on the downstream side of the facility. Stabilisation techniques such as capping with waste rock and revegetation will be utilised to ensure that significant erosion does not occur. Further stabilisation analysis will be completed at the next stage of the design work.

<u>Rehabilitation</u>

Techniques such as hydro-seeding or the use of geotextiles will be used on sloping ground and other difficult surfaces. Rehabilitation will be carried out in accordance with the PEMP (Appendix F) and as detailed further in section 7.7.

7.12.5 Expected Outcome

Due to the lack of sensitive receptors in close proximity to this proposal, dust management measures outlined within the PEMP (Appendix F) will adequately control fugitive dust resulting from mining, processing, stockpiling and roads.

7.13 GREENHOUSE GAS EMISSIONS

Greenhouse gas emissions such as carbon dioxide are thought to contribute to global climate change by absorbing infrared radiation (heat) and trapping it close to the earth's surface. While these gases are commonly found in nature, gases such as carbon monoxide, carbon dioxide and methane are also produced from anthropogenic sources such as the combustion of fossil fuels. These anthropogenic greenhouse gases are thought to be responsible for a change in global climate.

Fuel combustion also contributes to atmospheric pollution through generating emissions such as carbon monoxide, nitrogen oxides, carbon dioxide and benzene.

7.13.1 Management Objectives

The objectives for management of gaseous emissions are to:

- Comply with relevant inventory and reporting regulations.
- Minimise emissions to levels as low as practicable on an on-going basis and consider offsets to further reduce cumulative emissions.

7.13.2 Applicable Standards and Guidelines

Applicable standards and guidelines to manage greenhouse gas emissions include:

- *National Greenhouse and Energy Reporting Act 2007*
- Guidance Statement No. 12. Guidance Statement for Minimising Greenhouse Gas Emissions (EPA, 2002);
- Guidance Statement No. 18 Prevention of Air Quality Impacts from Land Development Sites (EPA, 2000);
- Guidance No. 33 Environmental Guidance for Planning and Development (EPA, 2005);
- Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks 2006 Series (Australian Greenhouse Office 2002);
- Draft National Carbon Offset Standard (AGO, 2008);
- Environmental Protection (NEPM -NPI) Regulations 1998;
- Western Australian Greenhouse Strategy (WA Government, 2004).

7.13.3 Potential Impacts

During the construction and operation of the project greenhouse gases and other gases will be released to the atmosphere as a result of:

- decomposition of cleared vegetation and release of carbon from the soil;
- generation of solid and liquid wastes;
- combustion of diesel fuel for equipment at the mine site; and
- combustion of diesel fuel for the power supply to the project.

The *National Greenhouse and Energy Reporting Act 2007* listed direct (scope 1) and indirect (scope 2) emissions as being reportable under the Act. Scope 1 emissions are those that are generated within the boundaries of a facility (or on site) and as a result of the activities of that facility (NGA, 2009). Because this project will generate its own energy (which falls under scope 1), scope 2 emissions are likely to be less significant than scope 1. The primary scope 2 emissions likely to be generated will be linked with transport of the ore off-site. A full scope 2 assessment will be undertaken once transportation is finalised.

An estimation of scope 1 emissions has been undertaken (below).

Total annual consumption of diesel is estimated to be 54.5 million litres for power generation and the operation of mine machinery, and a further 40 million litres for the operation of the mine fleet.

Using *National Greenhouse Accounts (NGA) Factors* (June 2009) as a guide, an estimate for the Project greenhouse gas emissions has been prepared.

Assuming a fleet diesel usage of 40 million litres per annum, the diesel energy content factor of 38.6 GJ/kL and a CO_2 emission factor of 69.2 kg CO_2-e/GJ. It is estimated that the project will emit 107.93 kt CO_2-e per annum during operation.

Based upon a process plant capacity of 35 MW and an average running capacity of 225 GW/h, the estimated CO_2 emissions resulting from the power station are 146.94 kt CO_2-e per annum.

7.13.4 Management

As the total emissions exceed the *NGER 2007* threshold of 25,000 T of CO_2 per annum, Brockman will report to the Department of Climate Change annually as required by the Act.

Brockman aims to minimise and reduce emissions by incorporating minimisation targets into mine planning in accordance with the Guidance Statement for Minimising Greenhouse Gas Emissions (EPA, 2002) and establishing reduction targets once operations are underway.

Mine planning has considered:

- the use of energy efficient technology;
- improvements in process energy efficiency;
- energy consumption as a criterion in equipment selection; and
- the utilisation of alternative energy sources.

Brockman will implement a Greenhouse Reduction Program as part of their commitment to continuous improvement. The Greenhouse Reduction Program will involve employee training, site audits and internal reporting to identify areas where energy consumption, waste production or greenhouse gas production can be reduced.

Other atmospheric emissions will be reported to the National Pollutant Inventory as and when they meet the reporting threshold values.

7.13.5 Expected Outcome

Greenhouse gas emissions will not contribute significantly to the environmental impact of this project and can be adequately managed through the implementation of the PEMP.

7.13.6 Management Commitments

C19. Brockman will implement a Greenhouse Inventory and Reduction Program once operations are underway.

C20. Brockman will report carbon emissions to the Department of Climate Change under the *NGER Act 2007*.

C21. Other atmospheric emissions will be reported to the National Pollutant Inventory as and when they meet the reporting threshold values.

7.14 NOISE, VIBRATION AND LIGHT POLLUTION

Noise and light pollution may disrupt fauna species, or even alter community structure due to the phobic response of wildlife to new stimuli. Noise and light sources may also attract fauna species to areas of the mine infrastructure that provide suitable microhabitats and resources (food wastes, grass and water), providing new habitat to these species.

Vibration is known to disrupt some sub-surface dwelling invertebrates (such as spiders) and can also affect human health.

7.14.1 Management Objectives

The objectives for the management of noise, light and vibration are to:

- Minimise the noise and vibration associated with the construction and operation of the proposal.
- Ensure the noise and vibration levels meet statutory requirements and acceptable levels.
- Minimise the impacts of artificial light on native fauna.

7.14.2 Applicable Standards and Guidelines

Applicable standards and guidelines to manage noise, vibration and light emissions include:

- *Environmental Protection Act 1986.*
- *Wildlife Conservation Act 1950.*
- Draft Guidance No 8 Environmental Noise (EPA, 2007).
- Noise, Vibration and Airblast Control, (Environment Australia, 1998).
- Environmental Protection (Noise) Regulations 1997, Western Australian Government.
- Guidance No. 33 Environmental Guidance for Planning and Development (EPA, 2005).

- Statement of Planning Policy Road and Rail Transport Noise (WAPC, 2005).
- AS2670:2001 Evaluation for human exposure to whole body vibration.
- *Mines Safety and Inspection Act 1994.*

7.14.3 Potential Impacts

Noise is defined as pollution under the Environmental Act 1986 when the noise emissions exceed the acceptable or assigned noise levels defined under the Environmental Protection (Noise) Regulations 1997.

Noise and people

Noise and vibration will be generated by operating plant and machinery at the mine site during both the construction and operational phases of the project. The nearest sensitive receptor is the accommodation camp and is located approximately six kilometres from the main mine infrastructure. The next closest human occupied sensitive receptor is Marillana Station, some 20 km away. Because of the distance of the mine accommodation and its position relative to the mine site (being upwind of the prevailing wind direction), noise is not considered to be a significant aspect of this project in relation to human health and safety. Any impacts of noise and vibration on mine site employees and contractors can be managed through the implementation of Brockman's integrated Safety, Health and Environment system and compliance with relevant legislation and standards.

Noise and native fauna

Noise pollution may disrupt fauna species, or even alter community structure due to the phobic response of wildlife to new stimuli. For example noise pollution may benefit bat species with low frequency echolocation calls (generally larger species) which could alter the natural species composition in an area (Zagorodniuk 2003).

Studies suggest that over time most fauna species habituate to noise associated with mining operations, or move a suitable distance away from the noise source so that the noise event is no longer disturbing (Larkin 1996; Radle 1998). It is anticipated that noise will not significantly impact fauna species utilising the project area due to the availability of large areas of relatively undisturbed adjacent habitat to which they can move to avoid noise sources.

A desktop assessment of noise and fauna utilising the Fortescue Marsh, some 15 km from the operational area, has been undertaken (Appendix U). Bird utilisation of the marsh is highest following cyclonic events every 3-5 years between December and April (R. Johnston pers. Comm.). During this time birds feed and breed until the water begins to dry up and dissipate (R. Johnston pers. Comm.).

Noise is predicted to be below background levels within the area due to the distance of the operations from the marsh (approximately 15 km) and the attenuation rates over this distance (Appendix U). Therefore machinery noise will not significantly impact birds utilising the marsh.

Noise from blasting is predicted to reach the southern extent of the marsh (at 89 – 109 db) without the implementation of blasting controls (which are outlined below). Whether this area is utilised by waterbirds is unknown, although it seems likely that birds would predominantly congregate in the central reaches of the marsh where water occurs most often.

Noise can affect wildlife in a variety of ways; by interrupting communication, causing physiological stress and altering behaviour which may in turn affect reproductive success or feeding (Larkin, 1996). While there has been considerable work undertaken on the effects of noise on birds, little has been undertaken in Australian and much of the work is inconclusive or contradictory (Lloyd Acoustics, 2010). Some studies do suggest that birds will habituate to human-induced noise, although the intensity of response to noise and the degree of habituation appears to be species-specific (Larkin, 1996). However it is anticipated that the likely more northern utilisation by feeding and breeding birds, the ability for most species to habituate and the blasting controls that will be put in place will adequately manage any potential impacts that might have occurred from blasting.

Light and native fauna

Many bat species are sensitive to light pollution, particularly approaching and during the maternity season (Mann et al. 2002; Stone et al. 2009). The presence of lighting in preferred bat flight paths has been shown to cause bats to seek alternative, potentially less favourable paths (Stone et al. 2009). In contrast, some bat species are attracted to insects that congregate around light sources (Frank 1988) which could result in altered ecological community structures (Longcore and Rich 2004).

With respect to the ten bat species recorded during ecologia's 2008 surveys, light is unlikely to have a significant effect due to the availability of similar habitat adjacent to the project area, the implementation of any blasting during daylight and the precedence for habituation.

Light sources may also attract fauna species to areas of the mine infrastructure that provide suitable microhabitats and resources (food wastes, grass and water). Insects attracted to light sources may attract insectivorous species (as discussed above) and thus increase the frequency of fauna-human interactions in these locations. Feral predators may associate human activity with food resources and become attracted to these areas.

Light pollution may disrupt migrating birds, particularly nocturnally migrating species, when environmental conditions force them to fly lower to the ground (Longcore and Rich 2004). Birds can become trapped in artificially lit areas as they will not move out into dark areas where they have difficulty navigating. Trapped individuals may become exhausted, collide with other individuals or suffer from increased predation (Longcore and Rich 2004).

7.14.4 Management

Methods for minimising noise and vibration emissions will comply with the principles of best practice and continuous improvement and will include:

- management of employee noise exposure will be in compliance with the *Mines Safety and Inspection Act 1994;*
- design and layout of mine site (e.g. stockpile locations) to minimise the impacts of noise emissions on the camp accommodation;
- selecting the quietest practicable plant and machinery consistent with construction and operational requirements. All dedicated mining equipment will be purchased new and specified to comply with DMP requirements for noise and emission levels;
- regular maintenance of plant and machinery;
- noise emissions from the mining operations will comply with the assigned noise levels as determined in the *Environmental Protection (Noise) Regulations 1997*;

- the implementation of noise monitoring programs;
- blasting will be carried out during daylight hours and strictly controlled to minimise air blast and ground vibration issues; and
- leaving material in front of the blast face to eliminate the risk of a face burst.

The potential effects of light spill will be managed by:

- eliminating all bare bulbs and any lighting pointing upward;
- using the latest management technologies so that continued growth and expansion leads to no increase in the impact of light pollution;
- using only the minimum amount of light needed for human safety;
- using narrow spectrum bulbs as often as possible to lower the range of species affected by lighting;
- shield, canter or cut lighting to ensure that light reaches only areas needing illumination. This will significantly reduce sky glow; and
- light only high-risk stretches of roads, such as crossings and merges.

7.14.5 Expected Outcome

Noise and vibration levels will be typical of or better than most Pilbara iron ore mine sites, due to the mining method being predominantly free digging with little need for blasting.

Noise and vibration are not anticipated to adversely affect native fauna due to the availability of suitable habitat adjacent to the project area and the lack of migratory waders utilising the area at night. There is no anticipated effect of noise on birds utilising the Fortescue Marsh.

The impacts of noise and vibration on mine site employees and contractors will be managed through the implementation of Brockman's integrated Safety, Health and Environment system.

7.15 SOLID, LIQUID AND HAZARDOUS WASTES

The project is expected to generate the typical iron ore mine site wastes; including construction and maintenance wastes, general refuse, liquid effluent, some chemical (from the laboratories) and hydrocarbon wastes.

The mine site will contain a Class II landfill which will be licensed under Part V of the *Environmental Protection Act 1986* and comply with appropriate conditions and local health regulations. It is not anticipated that the site will need to dispose of significant chemical wastes other than those used in the laboratories and processing plant.

7.15.1 Management Objectives

The objectives for waste management are to:

- Reduce the volume of waste through product selection, reuse and recycling.
- To comply with the *Environmental Protection Act 1986* and the *Health Act 1911* and other applicable standards.
- To minimise the impact of municipal and sewage waste on the local and regional environment and prevent pollution to the air, land and water.

- All site generated waste is appropriately contained within the on-site landfill.
- Minimise the environmental impacts of hydrocarbons / chemicals (solvents, cleaning fluids etc.) through appropriate storage, handling and disposal.

7.15.2 Applicable Standards and Guidelines

Applicable standards and guidelines to manage solid, hazardous and liquid wastes include:

- Water Quality Protection Guidelines No. 10 Mining and Mineral Processing Above-ground fuel and chemical storage (Department of Water, 2000).
- Australian Standard 1940-2004: The storage and handling of flammable and combustible liquids.
- AS/NZS 1547:2000. On-site domestic wastewater management.
- Guidance No. 33 Environmental Guidance for Planning and Development (EPA, 2005).
- Guidance Note S301, Storage of Dangerous Goods Licensing and Exemptions (DoIR, 2004).
- *Dangerous Goods Safety Act 2004* and associated regulations.
- Australian Dangerous Goods Code (Road and Rail) 7th Ed, (Australian Government, 2008).
- Environmental Protection (Controlled Waste) Regulations 2004.
- Environmental Protection (Rural Landfill) Regulations 2002.
- Used Tyre Strategy for Western Australia, Waste Management Board, 2005.
- Health Treatment of Sewage and Disposal of Effluent and Liquid Waste Regulations (DoH, 1974).
- Water Quality Protection Note- Irrigation with nutrient-rich wastewater (DoW, 2008).
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2000).
- *Metropolitan Water Supply, Sewerage and Drainage By-Laws 1981.*
- *Water Services Licensing Act 1995.*
- *Contaminated Sites Act 2003.*
- *Health Act 1911.*

7.15.3 Potential Impacts

The construction and operation of the project will generate the following types of wastes:

- domestic waste;
- recyclable products;
- waste oils, greases and lubricants;
- organic debris including vegetation;

- general refuse including waste metal, cardboard and packaging;
- sewage; and
- inert waste including excess fill.

These wastes have the potential to pollute soil, ground and surface waters if not managed appropriately. This can indirectly affect native flora and fauna through habitat modification or poisoning food or drinking water.

Treated waste water

The project will require two packaged sewage treatment plants, one located 500 m north of the camp accommodation and 12.4 km from the Fortescue Marsh, the other 500 m from the main office buildings and > 100 m from the Weeli Wolli Creek.

Waste water from domestic sources can contain phosphates, nitrates, bacteria, viruses and organic compounds. Typical treated sewage effluent has an inorganic nitrogen concentration of 10 mg/L and phosphorus of 2 mg/L (DoW, 2008).

The soils at the irrigation sites are fine grained and are believed to be classified as a eutrophication risk category D (DoW, 2008), although this will be verified through soil testing. The parameters required for treated waste water on soils of this category include a nitrogen loading of < 480 kg/ha/yr and a phosphorus loading of < 120 kg/ha/yr.

Due to the high average evaporation rates (estimated to be 3,600 mm/yr) and a relatively low annual rainfall (300 mm), it is expected that irrigation spray will not result in ponding of waste water or waterlogging of the soil. The lowest estimated monthly evaporation rate (105 mm) has been used to estimate the minimum area required for spray irrigation. Aquaterra anticipate that based upon the figures described above and expected discharge rates of 60 KL/day at the accommodation village and 33 KL/d at the mine site, nutrient loading to the irrigation areas will be less than 30% of the maximum recommended application rates (DoW, 2008), allowing increased opportunities for microbial action and vegetation to reduce the nutrient load in the soil.

The spray fields may be inundated by severe flood events from Weeli Wolli Creek including events of 1 in 10 year ARI or greater (see Appendix C). When flooding occurs, it occurs as a low velocity (< 1 m/s) combination of overland and channel flow. In the event of flooding, floodwaters are likely to wash over the spray fields. However an assessment on the impacts of inundation on the irrigation areas carried out be Aquaterra determined that the risk of mobilising nutrients and coliforms from the soil is low (due to the soil structure and likely take-up of available nutrients by plants), there would be rapid dilution of any mobilised nutrients and the potential impact to the Weeli Wolli Creek or the Fortescue Marsh would be negligible.

Groundwater levels have been measured at 11–12 mbgl at the irrigation areas. In a 1 in 10 ARI flood event, there is a potential that nutrients and coliforms present in the soil profile may be mobilised downwards and reach the local groundwater system. Due to there being few sensitive receptors down gradient from these fields (some sparsely located stock bores exist) and the increasing salinity of the groundwater extending northwards, it is unlikely that this would impact on the beneficial use of groundwater. The Fortescue Marsh is located down gradient from these fields however it is not an expression of the groundwater and therefore will not be impacted to any degree as a result of limited nutrients entering the groundwater system.

7.15.4 Management

Brockman will implement the following management actions to reduce the potential for and severity of impacts of waste on the surrounding environment.

General waste

Waste reduction will be a priority at the project site. Domestic and construction waste will be minimised through reuse and recycling where appropriate. General waste (putrescibles) will be disposed of at the landfill on-site which will be appropriately licensed under Part V of the *Environmental Protection Act 1986*.

While in operation the following will be undertaken to ensure the landfill site impacts are managed:

- Only inert, general and putrescible waste will be disposed of in the landfill. All hazardous material will be disposed of according to government guidelines.
- The landfill has been sited and designed to prevent surface water from draining into the landfill. Diversion drainage structures will be used to divert stormwater flows away from the landfill area.
- Surface water and groundwater monitoring will be undertaken if deemed to be necessary to determine any impacts to water quality. If changes in water quality are identified the DEC will be notified and an action plan developed.
- Adequate separation distance will be maintained between the base of the landfill and the water table.
- To facilitate consolidation of the landfill to minimise subsidence, waste material will be compacted in layers not exceeding 500 mm thickness. Each deposit of waste will be covered by a depth of soil no less than 230 mm and compacted. Not only will this facilitate consolidation of the waste material but ensure other impacts such as fire, pests and odour are minimised.

Treated waste water

Liquid wastes will primarily comprise treated sewage waste water generated from the mine site and accommodation village.

Waste water from the mine administration complex and the accommodation village will be treated in a purpose designed waste water treatment system (Table 7-11). Treated waste water will be disposed of via two spray fields.

Table 7-11 Waste Water Treatment Plant Specifications

PARAMETER	ABV	UNITS	RAW SEWAGE QUALITY	TREATED WATER SPECIFICATION
Biochemical Oxygen Demand	BOD_5	mg/L	300 - 400	< 20 (ave)
Total Suspended Solids	TSS	mg/L	200 - 250	< 30 (Ave)
Total Nitrogen	TN	mg/L	30 - 40	<20
Total Phosphorous	TP	mg/L	5 – 15	<8
pH			6.5 – 7.2	6.5 – 8.5

PARAMETER	ABV	UNITS	RAW SEWAGE QUALITY	TREATED WATER SPECIFICATION
Faecal Coliforms		cfu/100mL		< 1,000
Residual Free Chlorine		mg/L		> 0.5

The treatment plants will be designed considering AS/NZS 1547:2000 and will produce liquid waste compliant with Department of Health standards. They will utilise bioreactors to remove organic matter and reduce nitrogen loads in the waste water. The treated wastewater from the bioreactor will then be passed into a settling tank for biomass removal. In addition, chemicals (e.g. alum) will be added into the wastewater to remove phosphorus.

The treatment plants will be operated and maintained in accordance with the appropriate regulations and standards (Appendix C). Additional treatment plant and spray field capacity will be installed to accommodate increased waste water effluent associated with increased manning levels during construction in order to ensure the system complies with the applicable regulations, design standards and guidelines and can cope with the maximum peak load. Waste water from a building that produces not more than 540 litres per day of sewage and which is remote from the waste water treatment plant, such as a security gate house, may use septic and leach drain systems in accordance with Shire of East Pilbara (SoEP) regulations.

Facilities for the storage and treatment of waste water will be located away from the effects of a 1 in 10 year ARI flood event. The spray fields for disposal of treated waste water will be located more than 100 m from the defined banks of Weeli Wolli Creek and the two-year ARI flood footprint. The spray areas will be located at least 500 m downwind of the prevailing wind direction (E/SE) from offices and the accommodation village and will be fenced and signposted to Department of Health (DoH) requirements. The locations of the two plants and spray fields are shown in Appendix C.

The size of the two fields have been planned to address the maximum likely throughput and are estimated to be 5 ha for the accommodation village and 1 ha for the mine site (processing plant).

The surface irrigation disposal systems shall be planned and operated in such a manner as to encourage rapid evaporation, prevent spray drift, misting, pooling and run-off from the surface irrigation disposal area.

Flood protection bunding, (extending from the sand dune located north of the proposed area southwards, connecting onto higher ground), will be utilised at the mine site irrigation area to prevent ponding after a flood.

To ensure that the surface irrigation disposal areas operates at its maximum efficiency, media such as pinebark, wood chips, scoria etc may be applied to the soil and suitable plants capable of effecting a high evapo-transpiration rate, will be maintained. Vegetative buffers may be utilised to separate the mine site spray area from the Weeli Wolli Creek.

Further work on effluent quality, soil structure and potable water supply needs to be completed, and details will be discussed with the SoEP and the DEC as part of Part V approvals under the *Environmental Protection Act 1986*.

Hazardous substances

During construction hazardous substances will be stored in accordance with Australian Standard 1940. Bulk fuel will be stored in above ground fuel tanks within bunded, impermeable enclosures, or in double skinned tanks.

Hazardous substance management (hydrocarbons) are addressed in the PEMP (Appendix F), including procedures for correct handling, storage, spill management and clean up. Contaminated material will be removed and bio-remediated (if biodegradable) or disposed at a licensed facility. Spill response equipment will be located in the vicinity of work areas, with site personnel trained in spill response management.

Storage of explosives will be in a remote magazine in accordance with the *Explosives and Dangerous Goods Act 1961*.

Hazardous waste will be removed from site by a licensed contractor for disposal in an approved facility in accordance with the requirements of the controlled waste regulations.

7.15.5 Expected Outcome

The generation of general solid, liquid and hazardous wastes can be adequately managed and is expected to result in negligible environmental impact.

7.15.6 Management Commitments

C22. Contaminated material will be removed from site and either bio-remediated (if biodegradable) or disposed of at a licensed facility.

C23. The surface irrigation waste water disposal systems shall be managed in such a manner as to encourage rapid evaporation, prevent spray drift, misting, pooling and run-off from the surface irrigation disposal area.

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8.0 OFFSETS

Brockman are in the process of negotiating a package of suitable offsets which may incorporate one or more of the following:

- a contribution of funding to support appropriate research;
- a contribution of data on subterranean fauna collected on site;
- a contribution of data on groundwater collected on site;
- negotiating the de-stocking of parts of the tenement to allow for rehabilitation;

Offsets will be finalised once the EPA has determined the total residual impact resulting from the proposal.

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9.0 ENVIRONMENTAL MANAGEMENT COMMITMENTS

A summary of the environmental management commitments with respect to the Project, the objectives they seek to satisfy, their timing and the stakeholders from whom advice will be sought are presented in Table 9-1.

Table 9-1 Summary of Environmental Management Commitments

COMMITMENT NO	TOPIC	ACTIONS	OBJECTIVES	TIMING	ADVICE FROM
C1	Subterranean Invertebrate Fauna	Brockman will develop a subterranean fauna monitoring program in liaison with the DEC.	Understand the effects that secondary impacts may have on troglofauna.	Ongoing	DEC
C2	Subterranean Invertebrate Fauna	Brockman will investigate the potential for subterranean habitat restoration in liaison with the DEC.	Restore the project area to a condition that supports subterranean fauna as soon as possible after infrastructure is no longer required.	Ongoing	DEC
C3	Subterranean Invertebrate Fauna	Brockman will contribute data collected on subterranean fauna to the DEC on a confidential basis for the purposes of research and cumulative impact management.	Facilitate data sharing with respect to subterranean fauna in the Pilbara.	Ongoing	DEC
C4	Groundwater	Brockman will initiate a groundwater monitoring program and implement associated procedures (including contingencies) throughout the life of the Project as outlined within this PER document and	To prevent or minimise detrimental impacts on the groundwater system resulting from mining operations.	Construction	DEC, DoW

COMMITMENT NO	TOPIC	ACTIONS	OBJECTIVES	TIMING	ADVICE FROM
		the Marillana Project Groundwater Study and Management Plan.			
C5	Groundwater	Brockman will make site-specific groundwater data available to regulatory and decision-making agencies on a confidential basis for inclusion into a regional groundwater model and cumulative impact studies.	Facilitate data sharing with respect to hydrogeology in the region.	Ongoing	DoW
C6	Groundwater	Brockman will actively pursue an off-take agreement to provide water to the Project in preference to sourcing water from ground resources.	To reduce the environmental impacts associated with groundwater abstraction.	Ongoing	DoW
C7	Surface and Floodwaters	Brockman will implement the Surface Water Management Plan and associated procedures including contingencies throughout the life of the Project.	Maintain the quality and quantity of surface and groundwater so that existing and potential environmental values, including ecosystem maintenance, are protected.	Ongoing	DEC, DoW

COMMITMENT NO	TOPIC	ACTIONS	OBJECTIVES	TIMING	ADVICE FROM
C8	Geology and Landform	Brockman will ensure that modified and/or created landforms are left in a stable and safe condition post mine closure.	Minimise the long-term impact on the landscape.	Post-closure	DEC, DMP
C9	Mine Decommissioning and Rehabilitation	Twenty-four months prior to mine closure, a Mine Closure Plan will be finalised in consultation with the DEC and DMP. The plan will define appropriate closure criteria necessary for the establishment of safe landforms and self sustaining ecosystems, and set out procedures for monitoring in order to meet compliance with the closure criteria.	Manage the risk of unforseen closure; Ensure that rehabilitation achieves a long term safe, stable and functioning landform which is consistent with the surrounding landscape and other environmental values.	24 months prior to mine closure	DEC, DMP
C10	Mine Decommissioning and Rehabilitation	A rehabilitation programme will be developed within the first two years of mining in liaison with the DEC.	Ensure that rehabilitation achieves a long term safe, stable and functioning landform which is consistent with the surrounding landscape and other environmental values.	First 2 years of mining.	DEC

COMMITMENT NO	TOPIC	ACTIONS	OBJECTIVES	TIMING	ADVICE FROM
C11	Mine Decommissioning and Rehabilitation	Rehabilitation will occur progressively as disturbed areas are no longer required for mining activities	Reduce the likelihood of soil erosion and dust. Restore the area to natural system as soon as possible.	Ongoing.	DEC
C12	Mine Decommissioning and Rehabilitation	Soil characterisation assessments will be conducted to determine the suitability of topsoil for supporting rehabilitation.	Ensure that rehabilitation is appropriately planned for.	Prior to mining commencing.	DEC, DMP
C13	Vegetation and Flora	Brockman will develop a monitoring program to assess impacts to the potentially phreatophytic vegetation within the project area as a result of dewatering.	Understand the effects that dewatering may have on phreatophytic vegetation.	Ongoing	DEC
C14	Vegetation and Flora	A management plan will be developed in consultation with the DEC if groundwater abstraction is found to be affecting the health of the potentially phreatophytic vegetation.	Management the impacts of groundwater abstraction on vegetation.	Within first five years of operation.	DEC
C15	Vegetation and Flora	The regionally significant	Conservation of	Ongoing	DEC

COMMITMENT NO	TOPIC	ACTIONS	OBJECTIVES	TIMING	ADVICE FROM
		PEC (Units 6 and 7) will not be cleared or excavated.	biodiversity.		
C16	Social and Visual Amenity	Brockman will continue to liaise with relevant local authorities throughout the life of the project to ensure that potential impacts of social and visual amenity and minimised.	Minimise the impacts of the Project on the social and visual amenity of the area.	Ongoing	SoEP
C17	Social and Visual Amenity	Brockman will develop and implement a Traffic Management Plan prior to construction commencing on-site.	Reduce the likelihood of traffic-related incidents involving the community.	Prior to construction	SoEP
C18	Indigenous Heritage	Brockman will facilitate the development of a full Cultural Heritage Management Plan by Native Title claimants and implement, monitor and review this plan in consultation with claimants throughout the life of the Project.	Avoid disturbance to sites of cultural significance; Engage indigenous stakeholders in management.	Prior to construction	DIA, MIB, Nyiyaparli
C19	Greenhouse Gas Emissions	Brockman will implement a Greenhouse Inventory	Minimise emissions and continually identify area	Ongoing	DCC, DEHWA

COMMITMENT NO	TOPIC	ACTIONS	OBJECTIVES	TIMING	ADVICE FROM
		and Reduction Program once operations are underway.	for improvement.		
C20	Greenhouse Gas Emissions	Brockman will report carbon emissions to the Department of Climate Change under the *NGER Act 2007*.	Comply with relevant legislation.	Ongoing	DCC, DEHWA
C21	Greenhouse Gas Emissions	Other atmospheric emissions will be reported to the National Pollutant Inventory as and when they meet the reporting threshold values.	Comply with relevant legislation.	Ongoing	DCC, DEHWA
C22	Waste	Contaminated material will be removed from site and either bio-remediated (if biodegradable) or disposed at a licensed facility.	Ensure no contaminated wastes are left on-site; Reduce the likelihood of environmental pollution.	Ongoing	DEC, SoEP
C23	Waste	The surface irrigation waste water disposal systems shall be managed in such a manner as to encourage rapid evaporation,	Reduce nutrient input into ground and surface waters.	Ongoing	DEC, SoEP, DoH

COMMITMENT NO	TOPIC	ACTIONS	OBJECTIVES	TIMING	ADVICE FROM
		prevent spray drift, misting, pooling and run-off from the surface irrigation disposal area.			

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11.0 LIST OF APPENDICES

The following technical appendices are contained on a CD attached to the rear cover of this PER:

A	Marillana Project Mining Byproducts Management
B	Marillana Project Accommodation Village Site Selection
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D	Marillana Project Airfield Option Analysis
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